

Feeding Villages: Foraging and farming across Neolithic landscapes

by

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Dedication

This dissertation is dedicated to Robin G. Nelson.

Acknowledgments

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Table of Contents

Dedication	ii
Acknowledgments	iii
List of Tables	xvii
List of Figures.....	xviii
List of Appendices.....	xxi
Abstract.....	xxii
Chapter 1: Introduction	1
Theoretical Perspectives	1
Research Topic: Economic Change and Village Development.....	10
Research Area: The Pre-Pottery Neolithic B of the Southern Levant	24
Research Questions	29
The Anthropological Significance of Village Life	30
The Anthropological Significance of Subsistence Change in Small-Scale Societies.....	37
The Historical Significance of the Neolithic of Southwest Asia	49
Impact of this Research on the Study of the PPNB of the Southern Levant	50
Broader Anthropological Impact of Dissertation.....	51
Organization of Dissertation.....	55
Chapter 2: Village Settlement and Subsistence Production System	57
Defining the Village.....	57
The Structures of Village Subsistence Systems.....	63
Defining Processes of Village Development and Subsistence Change	74
The Limits of Settlement Growth	75
Social Pressures	75
Biological Pressures.....	76
Subsistence Pressures.....	77
The Alleviation of Village Life Pressures	79
Chapter 3: Isolated Structures and Other Small-Scale Sites within Village Settlement Systems.....	85
Satellite Settlements.....	85
Field Houses.....	92
The Uses of Field Houses	96
Assumptions.....	96
A General Explanation of Field House Development	97

Specific Uses of Field Houses: Subsistence	99
Specific Uses of Field Houses: Social and Biological.....	101
Chapter 4: The Archaeology of Village Subsistence Systems and Satellite Settlements	104
Archaeological Investigation of Village Subsistence Systems	104
Village-Based Investigations and their Challenges	104
Investigating Village Hinterlands in the Archaeological Record	107
Determining the Function of Archaeological Isolated Structure Sites	110
Temporary Field Structures	112
Description:.....	112
Criteria:	112
Permanent Field Structures	112
Description:.....	112
Criteria:	113
Field Houses.....	113
Description:.....	113
Criteria:	114
Agricultural Compounds.....	115
Description:.....	115
Criteria:	115
Agricultural Communities	116
Description:.....	116
Criteria:	117
Other Small Sites	117
Farmhouses	117
Description:.....	118
Criteria:	119
Homesteads.....	119
Description:.....	119
Criteria:	120
Farming Hamlets.....	120
Description:.....	120
Criteria:	121
Discussion.....	122
Chapter 5: Setting the Stage	123

Chronology and Terminology.....	123
Chronological Construction Using Knapped Stone Remains.....	125
Constructing Chronologies from Radiocarbon Dates.....	129
Constructing Chronologies: Multiple lines of evidence and the importance of site autonomy	133
Study Area	139
West-Central Jordan.....	139
The Topography Surrounding Al-Khayran.....	144
Al-Khayran’s Geological Catchment.....	147
Al-Khayran’s Ecological Catchment	154
M-LPPNB Social Geography of West-Central Jordan	156
Sites Identified Through Survey	159
Chapter 6: Village Development in the Pre-Pottery Neolithic B.....	161
Village Settlements and Associated Sites in the PPNB	161
Non-Village Settlements and their Relationships to PPNB Villages.....	167
Village Development in the PPNB of the Southern Levant	169
Evidence of Changing Settlement Forms through Time in the PPNB.....	170
Settlement Patterns.....	170
Site Size	174
Architectural Density	180
Architectural Compartmentalization.....	181
Number of Stories within Structures.....	184
Renovations and Remodeling of Structures.....	186
Storage Capacity and Access	187
Non-Domestic Architecture	188
Specialized Production Areas	198
Waste Disposal Systems	212
Chapter 7: Demographic and Social Changes in the PPNB	214
Settlement Size in the PPNB.....	214
Health Changes	222
Changing Social Practices in the PPNB of the Southern Levant.....	225
Social Segmentation and Households in the MPPNB	225
Ritual and Social Cohesion during the MPPNB.....	237
Social Leveling Mechanisms in the MPPNB.....	240
Social Differentiation in the MPPNB	244

LPPNB Residential Patterns	247
LPPNB Ritual Community Integration and Differentiation	249
Chapter 8: Economic Change in the PPNB	252
Changing Subsistence Practices in the PPNB of the Southern Levant: Plant Economies	252
MPPNB Plant Economies	252
LPPNB Plant Economies	258
Changing Subsistence Practices in the PPNB of the Southern Levant: Animal Economies ..	264
MPPNB Animal Economies	264
LPPNB Animal Economies	271
Pastoral Nomadism in the Early Neolithic.....	282
Subsistence and Technological Changes in the PPNB of the Southern Levant	287
Chapter 9: Economic Organization in the PPNB	291
Previous Models of PPNB Subsistence Systems	291
Undocumented Aspects of PPNB Subsistence Systems.....	303
Evidence of PPNB Economic Relations.....	309
MPPNB Economic Relations.....	309
LPPNB Economic Relations.....	316
Southern Levantine PPNB Economics	319
Chapter 10: Detailed Presentation of Hypotheses	326
Hypothesis 1.....	326
Expectations Outside of Villages:.....	326
A: A Shift in Settlement Patterns	327
Hypothesis 2.....	329
Expectations within and Outside of Villages:.....	329
Intensified Subsistence Production: Plants.....	330
A: Reduced Number of Plant Species Consumed by Households.....	330
B: Shift in Ratio of Plants Consumed from Highly Nutritious Species to High Calorie Ones.....	334
C: Increasing Processing of Plants.....	335
D: Increased Storage Capacity per Inhabitant	336
E: Domestication of Plants	338
F: Cultivation of Plant Foods	339
G: New Extractive Technologies.....	340
H: New Settlement and Production Organization	341
Intensified Subsistence Production: Animals.....	342

A: Narrowing of Diet Spectrum	342
B: Herd Management.....	345
C: Domestication of Animals.....	346
D: Keep of Herds On-Site	347
Intensified Subsistence Production: Agro-Pastoralism.....	349
A: The Husbandry of Both Plants and Animals at a Single Site	349
Expectations Outside of Villages.....	350
Satellite Subsistence Settlements.....	350
A: Small Site Construction.....	350
B: Temporary and Repeat Occupation.....	351
C: Specialized Subsistence Productive Activities On-Site.....	353
Subsistence Landscape Modifications	353
A: Water Management Systems	353
B: Terracing	355
C: Field Walls.....	355
D: Fertilizing of Agricultural Fields	356
E: The Development of Farm Field Pathways	357
Hypothesis 3.....	358
Expectations within and Outside of Villages:.....	358
A: Multi-Person Households	358
B: Kin- or Fictive Kin-Based Households	360
Expectations Outside of Villages:.....	361
A: Subsistence Focused Satellite Settlements Occupied by Kin-Based Household	361
Hypothesis 4.....	362
Expectations within and Outside of Villages:.....	362
A: Private Production Space.....	362
B: Private Storage.....	363
C: Intergenerational Inheritance of Material Items.....	364
Expectations Outside of Villages:.....	366
A: Locating Structures near Production Resources.....	366
B: Assertion of Land Tenure with Material Markers.....	367
C: Increased Investment in Subsistence Infrastructure	367
Hypothesis 5.....	368

Expectations within and Outside of Villages.....	369
A: Commodification of Goods.....	369
Hypothesis 6.....	370
Expectations within and Outside of Villages.....	370
A: Limited Number of Activity Areas for the Production of New Extractive Technologies	371
B: Extensive Dispersion of New Extractive Technologies throughout Residential Units at Sites with Limited Numbers of Specialized Production Areas.....	371
C: New Extractive Technologies Created Through Complex Production Processes	372
D: Labor Intensive Raw Material Procurement Strategies.....	374
Expectations Outside of Villages.....	375
A: Small Sites with Evidence of the Intensive Production of a Narrow Set of Goods.....	375
Hypothesis 7.....	375
Expectations within and Outside of Villages.....	376
A: Inter-Community Exchange	376
B: Surplus Production for Exchange.....	377
C: Craft Production for Exchange.....	379
Chapter 11: Research Methods	380
Identification of al-Khayran.....	380
Fieldwork Procedures	382
2007 Season	382
Surface Collection at al-Khayran.....	386
Test Excavation Units.....	387
2010 Season	388
Site Mapping.....	388
Site Catchment Survey and Mapping.....	390
Excavation	392
Lab Work Procedures	397
Scientific Samples.....	397
Material Culture	398
Spatial Information	401
Chapter 12: Chronology and Spatial Data.....	402
Architecture.....	402
Earlier Phase – Structure 001: Phase 01	403
Later Phase – Structure 001: Phase 02.....	405

Stratigraphy.....	407
Chronology	409
Relative Dating	409
Absolute Dating	412
Site Catchment.....	414
Surface Water Resources	414
Pedology	416
Geology.....	417
Plants and Animals in the Area.....	423
Access	424
Chapter 13: Ecofactual Remains.....	425
Pollen	425
Phytoliths	427
Macro-Botanical Remains	429
Spherulites.....	431
Faunal Remains.....	431
Taphonomy	432
Sample Size.....	432
Species	432
Element Representation	434
Age.....	434
Sex.....	435
Size.....	435
Meat-Bearing versus Non-Meat-Bearing.....	436
Butchering.....	437
Cooking.....	437
Discard	437
Isotopic Analysis.....	437
Implications of These Remains for the MPPNB Environment.....	438
Chapter 14: Material Culture Finds	440
Knapped Stone	440
Raw Material Selection.....	440
Core Types	442
Core Production Debitage.....	446

Core Reduction Debitage	448
Informal Tool Utilization	449
Formal Tool Production Debitage	450
Formal Tools	451
Formal Tool Use-Wear	453
Knapped Stone Cache	453
Ground Stone	454
Ochre	456
Chapter 15: Evaluation of Hypotheses	457
Hypothesis 1	457
Expectations Outside of Villages:	457
A: A Shift in Settlement Patterns	458
Hypothesis 2	462
Expectations within and Outside of Villages:	462
Intensified Subsistence Production: Plants	462
A: Reduced Number of Plant Species Consumed by Households	462
B: Shift in Ratio of Plants Consumed from Highly Nutritious Species to High Calorie Ones	462
C: Increasing Processing of Plants	463
D: Increased Storage Capacity per Inhabitant	464
E: Domestication of Plants	464
F: Cultivation of Plant Foods	464
G: New Extractive Technologies	465
H: New Settlement and Production Organization	465
Overall Implications for Increased Plant Subsistence Production	465
Intensified Subsistence Production: Animals	466
A: Narrowing of Diet Spectrum	466
B: Herd Management	466
C: Domestication of Animals	467
D: Keeping of Herds On-Site	467
Overall Implications for Increased Animal Subsistence Production	467
Intensified Subsistence Production: Agro-Pastoralism	469
A: The Husbandry of Both Plants and Animals at a Single Site	469
Expectations Outside of Villages:	469
Satellite Subsistence Settlements	469

A: Small Site Construction.....	469
B: Temporary and Repeat Occupation.....	469
C: Specialized Subsistence Productive Activities On-Site.....	470
Overall Implications for the Construction and Utilization of a Field House at al-Khayran	471
Subsistence Landscape Modifications	471
A: Water Management Systems	471
B: Terracing	471
C: Field Walls.....	471
D: Fertilizing of Agricultural Fields	471
E: The Development of Farm Field Pathways	471
Implications for the Modification of the Landscape Around al-Khayran in Order to Increase Subsistence Production	472
Evaluation of Hypothesis 2.....	472
Hypothesis 3.....	472
Expectations within and Outside of Villages:.....	473
A: Multi-Person Households	473
B: Kin- of Fictive Kin-Based Households.....	474
Expectations Outside of Villages:.....	475
A: Subsistence Focused Satellite Settlements Occupied by Kin-Based Household	475
Evaluation of Hypothesis 3.....	476
Hypothesis 4.....	476
Expectations within and Outside of Villages:.....	476
A: Private Production Space.....	476
B: Private Storage.....	477
C: Intergenerational Inheritance of Material Items.....	477
Expectations Outside of Villages:.....	477
A: Locating Structures near Production Resources.....	477
B: Assertion of Land Tenure with Material Markers.....	480
C: Increased Investment in Subsistence Infrastructure	480
Evaluation of Hypothesis 4.....	481
Hypothesis 5.....	481
Expectations within and Outside of Villages.....	482
A: Commodification of Goods.....	482
Evaluation of Hypothesis 5.....	482

Hypothesis 6.....	483
Expectations within and Outside of Villages.....	483
A: Limited Number of Activity Areas for the Production of New Extractive Technologies	483
B: Extensive Dispersion of New Extractive Technologies throughout Residential Units at Sites with Limited Numbers of Specialized Production Areas.....	484
C: New Extractive Technologies Created Through Complex Production Processes	484
D: Standardization of Form and Production Sequence of Potential Craft Goods.....	485
E: Labor Intensive Raw Material Procurement Strategies	486
Expectations Outside of Villages.....	487
A: Small Sites with Evidence of the Intensive Production of a Narrow Set of Goods.....	487
Evaluation of Hypothesis 6.....	488
Hypothesis 7.....	488
Expectations within and Outside of Villages.....	488
A: Inter-Community Exchange	488
B: Surplus Production for Exchange.....	489
C: Craft Production for Exchange.....	489
Evaluation of Hypothesis 7.....	490
Chapter 16: Conclusions	491
Question 1: What past economic practices are manifested within the archaeological remains at the site of al-Khayran?	491
Question 2: How were these past practices structured spatially, temporally, and socially?... 491	
Spatial Structure of Economic Behavior at al-Khayran.....	491
Temporal Structure of Economic Behavior at al-Khayran	498
Social Structure of Economic Behavior at al-Khayran.....	501
Question 3: What are the implications of these practices and the social, spatial, and temporal structures within which they were enacted for the structures and processes of regional economic systems?.....	505
Question 4: What are the implications of the development of PPNB economic systems for the general relationship between the processes of village development and economic change? . 509	
Conclusions.....	511
Appendix 1: Archaeological Surveys in West-Central Jordan.....	515
Appendix 2: List of Early Neolithic Sites.....	516
Appendix 3: Late PPNA-Early LPPNB Village Sites with Radiocarbon Dates.....	522
Appendix 4: Campbell (2009) Data	525
Appendix 5: Knapped Stone Finds from al-Khayran	544

Appendix 6: Resource Locations for al-Khayran	546
Appendix 7: Phytolith Report, Prepared by Sarah Elliott.....	548
Appendix 8: Macro-Botanical Report, Prepared by Chantel White	563
Appendix 9: Faunal Finds from al-Khayran.....	571
Works Cited.....	574

List of Tables

Table 1: Epipaleolithic and Neolithic Chronology (Maher et al., 2011)	2
Table 2: Radiocarbon Results for al-Khayran	413

List of Figures

Figure 1: West-Central Jordan (Eliza Wallace)	3
Figure 2: The Southern Levant (Eliza Wallace)	4
Figure 3: Al-Khayran (Eliza Wallace)	22
Figure 4: Wadi 'Assal Natural Resources (Eliza Wallace)	23
Figure 5: (A) el-Khiam Point; (B) Helwan Point; (C) A45 Point; (D) Jericho Point; (E) Byblos Point; (F) Amuq Point; (A, B, D-F: Kuijt and Goring-Morris, 2002; C: Simmons and Najjar, 2006)	126
Figure 6: Regions of the Levant.....	127
Figure 7: Beidha Phase A2 (Byrd 1994).....	135
Figure 8: Shkarat Msaied; Prepared by Mikkel Bille Peterson (Jensen, 2004)	136
Figure 9: Beidha Phase C (Byrd, 1994).....	137
Figure 10: MPPNB House from 'Ain Ghazal; Reconstructed over 400 years of occupation (Rollefson, 1997)	138
Figure 11: Wadi 'Assal; Including Roman Road Course and Arab Potash Company Power Line Course (Jacobs, 1983).....	146
Figure 12: Tobacco Farmed at al-Khayran	147
Figure 13: The Spring of 'Ain er-Rsais	148
Figure 14: Lower Spring below 'Ain er-Rsais	149
Figure 15: Flint Source at al-Khayran	150
Figure 16: Acheulean Hand Axe from al-Khayran.....	151
Figure 17: Ha-Parsa Point from al-Khayran	152
Figure 18: A Series of Springs at the Head of Wadi 'Assal	153
Figure 19: Finds from the Flint Source at the Mouth of Wadi 'Assal.....	154
Figure 20: Boy Wearing a Mask Made from the Pelt of a Wolf He Hunted (Chantel White) ...	156
Figure 21: Excavated PPNB Sites in the Southern Levant (Eliza Wallace/Matthew V. Kroot)	162
Figure 22: Excavated MPPNB Sites (Eliza Wallace/Matthew V. Kroot)	171
Figure 23: Excavated LPPNB Sites (Eliza Wallace/Matthew V. Kroot).....	173
Figure 24: Tell Abu Suwwan (al-Nahar, 2010)	179
Figure 25: LPPNB Architecture at 'Ain Ghazal, Drawn by M Bataineh (Rollefson, 1997).....	184
Figure 26: Tower at Jericho (Kenyon, 1981).....	188
Figure 27: Large Structure (O75) at WF16 (Finlayson et al., 2011)	189
Figure 28: Large Central Structure at Shkarat Msaied (Abu-Laban et al., 2012).....	190
Figure 29: Large-Scale Staircase at Ghuwayr 1, Photograph by A.H. Simmons (Simmons and Najjar, 2013)	191
Figure 30: Large Structure at Wadi Hamarash I, Picture by A. Sampson (Sampson, 2012).....	193
Figure 31: Kfar HaHoresh (Goren and Goring-Morris, 2008)	194
Figure 32: Large Structure at Tell Abu Suwwan (al-Nahar, 2010)	195
Figure 33: MPPNB Pier Houses (Goring-Morris and Belfer-Cohen, 2012)	227
Figure 34: Courtyard House at LPPNB Basta (Gebel, 2004)	228
Figure 35: LPPNB Ba'ja Agglutinated Architecture (Purstwitz and Kinzel, 2007)	229
Figure 36: Cache of Cattle Figurines from 'Ain Ghazal (Rollefson, 2008).....	237
Figure 37: Partially Refitted Replica Naviform Core (Barzilai and Goring-Morris, 2013)	288

Figure 38: Slide of Knapped Stone Surface Collection Finds at al-Khayran from the 1981 Survey of the South Ridge of Wadi 'Assal (Linda Jacobs)	381
Figure 39: Map of Survey Designations and Surveyed Blocks (Eliza Wallace)	383
Figure 40: Dog-Leash Collection Unit	384
Figure 41: View of Dead Sea, Looking Northeast from al-Khayran. Note the Limestone Terrace in Front and Sandstone at Lower Elevations within the Wadi.....	385
Figure 42: Plant Collection Units (Eliza Wallace)	386
Figure 43: Profile of Test Excavation Unit.....	387
Figure 44: Surface Mapping at al-Khayran (Eliza Wallace)	389
Figure 45: Orchards and Barley Fields on the Western Outskirts of Kathrabba	391
Figure 46: Neolithic Trenches, Final Planview (Eliza Wallace)	394
Figure 47: Northeast Corner of Structure 001: Phase 01,02	403
Figure 48: Structure 001: Phase 02 in the Foreground Looking South and Structure 001: Phase 01 in the Background Showing the Difference in Surface Elevations from the Earlier to the Later Phase of Construction	404
Figure 49: Interior of Southeast Corner of Structure 001. Note Inset Quern in Center of Picture and Inset Cutting Stone Embedded in the Trench Profile. Also Note the Clear Stratigraphic Layers of the Profile.....	405
Figure 50: Structure 001. Note Cobble and Flagstone Surfaces in the Foreground. Facing Southwest.....	406
Figure 51: Harris Matrix along Center Line of Structure 001, Facing West, Running North-South	409
Figure 52: Utilized Naviform Core (Gabriela Perez-Dietz/Matthew V. Kroot).....	410
Figure 53: (A) A45; (B, C) A45, Retouched Tip; (D) Broken A45; (E-J) A45, Tip Impact Fracture; (K-N) Broken Helwan; (O) Un-Notched Helwan; (P) Broken Helwan or Gilgal Truncation; (Q) Byblos, Tip Impact Fracture; (R) Jericho; (S) Bipolar el-Khiam, Tip Retouch; (T) el-Khiam; (U) Lunate (Gabriela Perez-Dietz/Matthew V. Kroot).....	410
Figure 54: Terra Rosa Soils at the Base of al-Khayran	415
Figure 55: (A) Shaft Straightener (Basalt); (B) Incised Pillow-Shaped Piece (Sandstone); (C) Pestle (Basalt); (D) Double Hand Stone (Sandstone); (E) Stone Ring Blank (Sandstone); (F) Single Hand Stone (Sandstone)	418
Figure 56: Walking Routes to Three Major Flint Sources (Eliza Wallace/Matthew V. Kroot) .	419
Figure 57: Bitumen Sources with Walking Distances and Times (Eliza Wallace/Matthew V. Kroot).....	420
Figure 58: Flint Sickle Blade with Bitumen Residue	421
Figure 59: Basalt Sources with Walking Distances and Times (Eliza Wallace/Matthew V. Kroot)	422
Figure 60: Calcite Encrusted and Iron Oxide Stained Bones	434
Figure 61: Unused Naviform Core (Gabriela Perez-Dietz)	442
Figure 62: Examples from a Cache of Bipolar Blades, Crested Blade, Tip Retouched A45 Point, Cortical Blades, Hinge Removal, Profile Correction Blades, and Facade Maintenance Blades from a Single Core (Gabriela Perez-Dietz/Matthew V. Kroot)	444
Figure 63: Hammer Stones (Gabriela Perez-Dietz)	445
Figure 64: Crested Blades (Gabriela Perez-Dietz).....	447
Figure 65: (A-S) Perforators; (T) Burin (Gabriela Perez-Dietz/Matthew V. Kroot).....	452

Figure 66: Bipolar, Notched Blade; Possible Broken Nahal Hemar Knife (Gabriela Perez-Dietz) 453
Figure 67: Ground Ochre Mass..... 456

List of Appendices

Appendix 1: Archaeological Surveys in West-Central Jordan	515
Appendix 2: List of Early Neolithic Sites.....	516
Appendix 3: Late PPNA-Early LPPNB Village Sites with Radiocarbon Dates.....	522
Appendix 4: Campbell (2009) Data.....	525
Appendix 5: Knapped Stone Finds from al-Khayran	544
Appendix 6: Resource Locations for al-Khayran	546
Appendix 7: Phytolith Report, Prepared by Sarah Elliott.....	548
Appendix 8: Macro-Botanical Report, Prepared by Chantel White	563
Appendix 9: Faunal Finds from al-Khayran	571

Abstract

Feeding Villages: Foraging and farming across Neolithic landscapes

by

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This dissertation investigates the relationship between village development trajectories and changing economic practices. It is focused on the Pre-Pottery Neolithic B (PPNB) of west-central Jordan, examining three specific dimensions of economic change: (1) subsistence practices, (2) production systems, and (3) economic relations. This research employed survey and excavation at the PPNB site of al-Khayran, as well as scientific, knapped stone, ground stone, and faunal analyses of materials from the site.

This dissertation argues for a broader view of the relationship between increasing subsistence production and productivity and village growth and development than is traditionally taken. A narrow set of variables, the primary one being domestication, have been viewed as the key to understanding subsistence intensification in the early villages of southwest Asia by most researchers. However, novel choices about settlement patterns, time management, and economic relations are all attested to within the remains of al-Khayran. This shows that the development of agriculture was embedded in wider systems of economic change. Specifically, it is argued that al-Khayran is a type of site which has yet to be identified in the PPNB: the agricultural field house. Such a settlement type is a secondary residential site for a household production unit. It

allows for dual residence mobility, whereby members move between a village household for most of the annual cycle and an in-field structure during period of high in-field labor demands.

The study highlights the ways that feedback between social structures and spatial and temporal practices created novel behavioral patterns in the early Neolithic. New forms of economic relations, such as strengthened property rights and household land tenure, and new production units, such as the nuclear family household, opened up space for new production behaviors, such as the use of field houses. These new behaviors opened spaces for new economic relations, such as access rights or even control of natural resources like flint and water sources. Thus, we see that not only did the development of agricultural technologies and practices contribute significantly to later historical developments, but so did the ideological underpinnings of these methods.

Chapter 1: Introduction

Theoretical Perspectives

This dissertation is concerned with a classic anthropological problem: What is the relationship between village development trajectories and changing economic practices? In order to explore this question it analyzes data from the Pre-Pottery Neolithic B (PPNB: ca. 8500/8350-7000/6700 cal. BCE; Banning, 2012: 397) (Table 1: Epipaleolithic and Neolithic Chronology (Maher et al., 2011) of west-central Jordan (Figure 1) and the broader southern Levant (Figure 2). More specifically, this dissertation will examine three dimensions of economic change in the development of politically and/or economically autonomous village communities or clusters: those of (1) subsistence practices, (2) production systems, and (3) economic relations. While it is widely understood that there is a general relationship between increasing production and the development of early villages (e.g., Johnson and Earle, 2000: 22-32; Bandy and Fox, 2010a: 4-5), how this relationship operates in specific cases varies significantly (Feinman and Neitzel, 1984; Netting, 1990). One of the great challenges of understanding village development trajectories is the fact that there are a host of different dimensions of social variation between any two village communities. These can include differences in political leadership roles, subsistence practices, and community size to name a few. Yet, despite this variation in the social

Table 1: Epipaleolithic and Neolithic Chronology (Maher et al., 2011)

Culture/Period	Date of onset (68% confidence, ka cal. BP)	Date of onset (95% confidence, ka cal. BP)
Wadi Rabah	7.8–7.7	7.9–7.6
Yarmoukian	8.45–8.36	8.52–8.3
PPNC	9.0–8.7?	9.0–8.7?
Late PPNB	9.53–9.45	9.56–9.4
Middle PPNB	10.45–10.3	10.54–10.26
PPNA	11.9–11.7	12.1–11.6
Late Natufian	13.58–13.04*	13.74–12.95*
Early Natufian	15.08–14.74	15.37–14.57
Geometric Kebaran	17.89–17.66	18.0–17.5

organization of villages, their inhabitants enact similar settlement practices (Flannery, 1972: 23). In other words, the settlement pattern of the village provides something common for a variety

of different social formations.

This fact has challenged archaeologists through the years who have attempted to explain the development of villages and the different trajectories they follow through time. Over the last forty years or so, there has been a significant increase in the critical theorizing about small-scale sedentary communities from the social, political, economic, and kin relations found in villages (Flannery, 1972) to the dimensions of social variation between village-based communities (Feinman and Neitzel, 1984) to the internal social dynamics of villages (Netting, 1990; Upham, 1990) to the place of villages in social evolutionary processes (Townsend, 1985) to shared social traits across village-based societies (Carneiro, 2002) to the effects of villages on the sensory world of inhabitants (Wilson, 1988) to the temporal scales of social processes of change in villages (Fowles, 2002) to the socio-ecological dynamics within villages (Kohler, 1989) to the biological effects of village life on humans (Cohen and Armelagos, 1984) to the general comparative study of early villages (Bandy and Fox, 2010b). As a consequence of these new

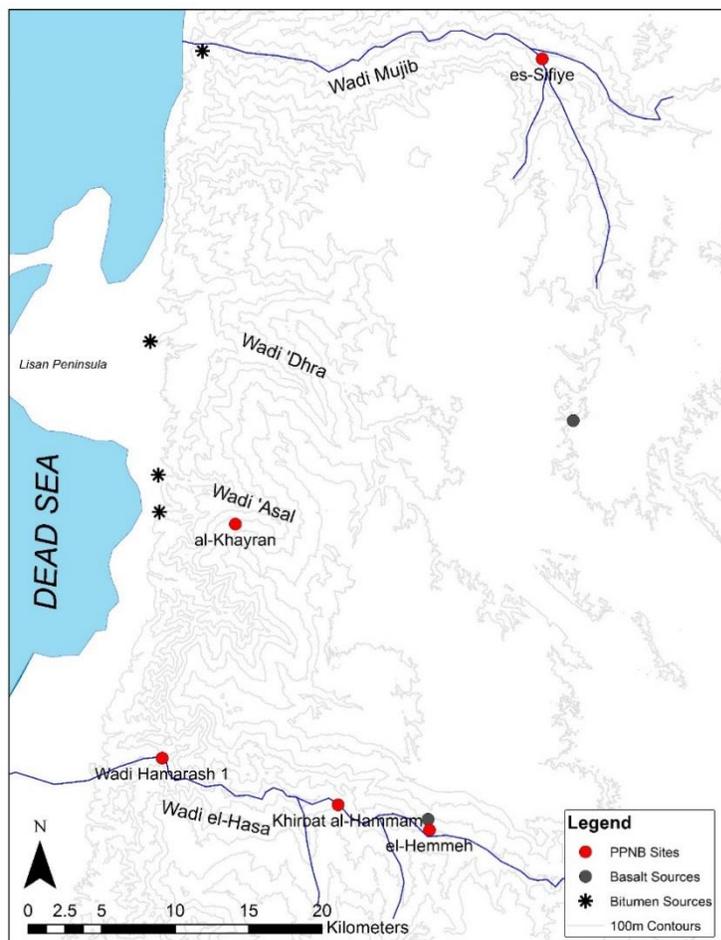


Figure 1: West-Central Jordan (Eliza Wallace)

perspectives, researchers interested in villages must now control a dizzying array of theory on the social, temporal, material, and biological dynamics at play in such settlements.

For the past three decades or so a second trend in theorizing the village has been to attempt to bring a greater degree of order to our understanding of villages by suggesting ways that research questions can be directed at certain key aspects of archaeological

villages. The following brief review of this literary trend will look specifically at recent theory on the social dynamics of village-based communities, as this is the focus of this dissertation.

That is not to say that other topics such as subsistence production, material relations, and spatial and temporal aspects of village life will not be considered. In fact they play as prominent a role in this research as do social dynamics. However, the real puzzle to understand is not the spatial

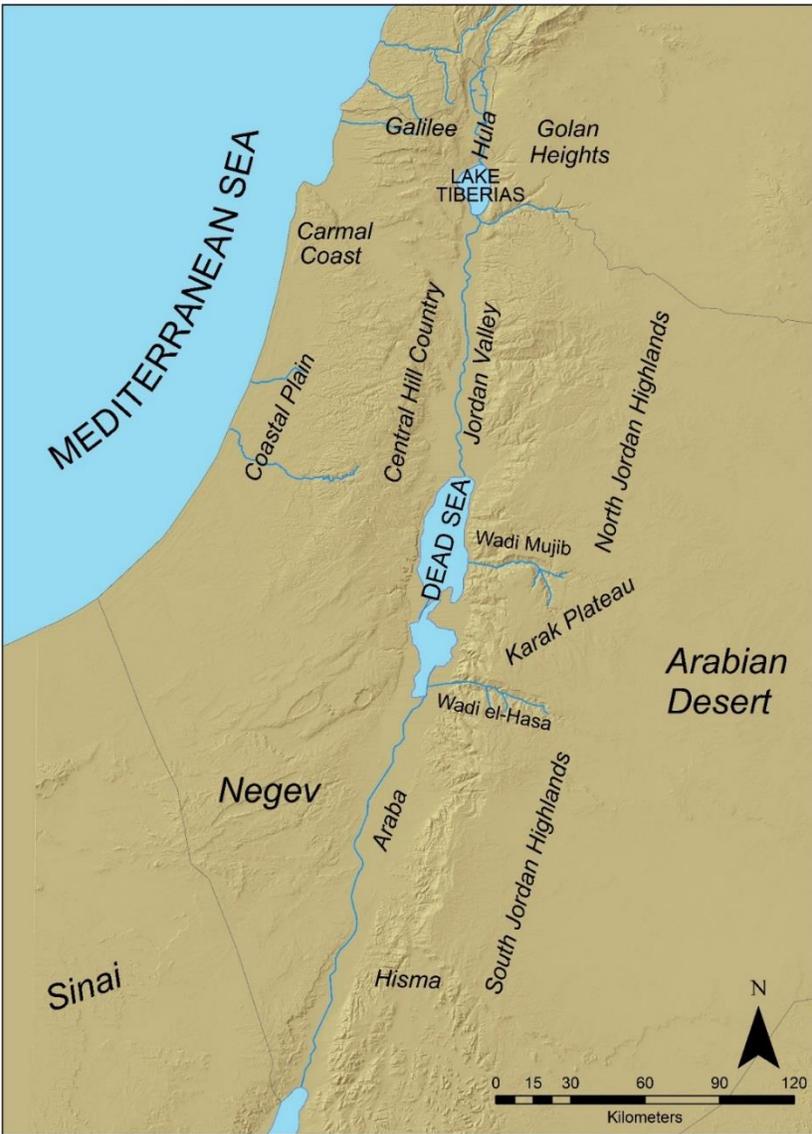


Figure 2: *The Southern Levant (Eliza Wallace)*

and material facts that archaeologists dig up, but rather the social processes that produced these remains and how they can be inferred from the archaeological record. This is why the long-term social dynamics within villages are still debated and researched, even following all the rich work on the topic over the past few decades.

As our knowledge about and case-studies of early villages have grown, some researchers have

focused on social variation between village communities in order to rework our understandings of the production, reproduction, and change of village-based communities. They argue that different forces can be present and interact in variable ways with each other to produce different social outcomes (Feinman and Neitzel, 1984; Netting, 1990; Upham, 1990). In other words, settlement types and social systems do not directly and consistently map onto one another in autonomous village communities. These theorists have generally advocated looking to the

variation along a set of dimensions internal to small-scale societies to understand different developmental trajectories.

Such theoretical viewpoints were developed in reaction to neo-evolutionary perspectives on social development. Specifically, they were reacting against the view that different social formations were steps along evolutionary trajectories. That is to say, they argued against variation in social formations as being a product of lineal developmental differences. Such a theoretical perspective, when confronted with the infinite variation of the social world could only produce more steps along different trajectories. Both unilineal and multi-lineal evolutionary perspectives can only accommodate social variation through a proliferation of social types (Feinman and Neitzel, 1984).

Theorists from this camp also noted that certain specific forms of archaeological systematics and systems theory popularized by New Archaeology advocates (e.g., Binford, 1965) also constrained our understandings of variation. Such theories were initially introduced to understand variation in the archaeological record, reacting against what they characterized as the normative school of archaeological thought. According to this critique, normative archaeology viewed societies as sets of individuals following shared cultural belief. This led to a homogenization of past behaviors and tended to characterize past communities in a narrow set of social types or through a comparison of difference and similarity, rather than differences and similarities (Binford, 1965).

However, the position that some New Archaeologists took was to advocate a society's overall structure as a function of internal sub-systems, which articulated with one another to produce the specific overall system as a singular functional whole. Thus, variation in social structure was due to variation in sub-systems (Binford, 1965). A slightly later trend within the

New Archaeology was that of systems theory, which attempted to characterize cultural sub-systems, as defined by the New Archaeology's systematics theory, using the vocabulary of cybernetics and general systems theory (Clarke, 1968). This provided archaeologists with a manageable set of terms and processes that could be mapped onto past social change.

Researchers could search for social equilibrium and disequilibrium, cycling or oscillations in social formations, and positive feedback loops and amplification of social relations or negative feedback loops and their dampening, to name some of the more prominent concepts (Salmon, 1978).

However, critics noted that in the application of this new vocabulary, a number of archaeologists began to uncritically invoke sets of variables in feedback loop relationships (Upham, 1990) borrowed from certain early and insightful uses of systems theory concepts (e.g., Flannery, 1968). Repeated usage of these sets of social, political, and economic variables joined together in positive feedback loops without linking them through middle range theory to archaeological data essentially created another proliferation of types. This time types of social formations were types of consistently co-varying feedback loops which led to cross-culturally observed processes of social change (Upham, 1990: 2).

Those who argued against this form of systems theory noted that it could artificially link all social systems in operation within any given community while at the same time artificially bracketing other systems as bounded by a primary political-residential community or regional network. Instead, what such theorists argued was that the creation of variation in social form was through differences in the internal dynamics of different communities along certain dimensions, which could in large part develop through time independent of regional political formations such as states or tribes. In other words, political boundaries did not create a bounded social system.

Additionally, certain social forces could only affect specific realms of practice while others may pervade a variety of realms on a variety of scales. Social processes were not all functionally interlinked in such a way as to produce a singular coherent system.

Rather, it is specific dynamics at work within societies which lead to specific practices. One must, “decouple” (Upham, 1990) or “unpack” (Netting, 1990) the various dynamics and the dimensions of social variation they lead to within a community in order to understand what has led to its specific form. This critique was somewhat of an exaggeration of early New Archaeology’s systematics or the later systems theory approach, with Binford (1965) advocating a similar position as early as 1965. Rather, it was the application of this theory and the later description of positive feedback loops and social equilibrium that reactionary authors were writing against.

While such arguments provided an important corrective to the tendency within certain circles to easily shoehorn any society under study into a set of neat types, thus obscuring variability and its causes, there has again been a reaction against this reactionary approach. In recent writings some scholars have turned an eye back to generalizations about societal development, noting that while there is certainly variation in the internal dynamics of communities based on more than just typological differences, social disequilibrium, or amplification through positive feedback and dampening through negative feedback, there are also important parallels between early village societies and their social processes across space and time (Bandy and Fox, 2010a; Fowles, 2002).

What this new crop of authors has advocated is a change from decoupled processes to types of societies that exhibit parallels in social processes, which may or may not co-vary either consistently or within a subset of small-scale societies. While they do allow for and in fact

frequently advocate for variability in developmental processes (see Fowles' 2002: 14 reference to Upham, 1990), they place a new emphasis on scales of processes. By looking not only at internal dynamics on similar temporal scales, these authors have advocated other dimensions of variability that include regional and multi-regional systems and long-term processes. It is on this scale that they see parallel processes across small-scale societies, leading to similar settlement structures and social formations out of differential internal social dynamics (Fowles, 2002).

This is not to say that such nuanced and complex understandings of social processes did not exist amongst archaeologists of earlier generations. Certainly it is not difficult to find New Archaeologists who were able to analyze social change on different scales and via different dynamics producing different dimensions of variation (e.g., Flannery, 1976, 1972, 1968). Rather, each generation of critiques was of the past generation's normative thought, as well as cases where theory had not been articulated formally, even if it has been applied by earlier writers.

The theoretical background on social change in small-scale societies used in this study is drawn largely from these currents in archaeological thought. This dissertation starts with the argument that processes of village development and economic change come in a wide variety of forms which often coexist alongside each other. Sometimes a single process, such as subsistence intensification can be driven by multiple forms of practice, some overlapping, others running in parallel. Other times a single form of practice such as the assertion of property rights by individual households can be mobilized to claim different forms of objects from labor products to natural resources. However, in such dynamic social environments certain hard realities channel social practices into similar forms across communities. The temporal and spatial aspects of human behavior structure practices, as do the material properties of the world in which people

live, the biological functions of people's bodies, and the cognitive abilities, structures, and limits of the human mind.

This dissertation is not only focused on social change through time, but also the specific processes that drive such change. It attempts to utilize our complex theoretical understanding of all the social, biological, and material processes at work in villages to characterize the dynamics of early village societies, while keep in mind the fact that these dynamics do in fact lead to major societal changes through times. It looks at how sets of practices are drawn together culturally and socially towards singular effects (e.g., Stone, 1996: 30-32), how singular material challenges can lead to a variety of practices all directed at overcoming such challenges (e.g., Stone, 1996: 33-34), how singular social relations can be repurposed to a variety of social uses (Bourdieu, 1977: 72), and how new forms of individual practices can emerge from the discursive fusion of multiple already existent cultural behaviors (Marcus and Flannery, 1996: 93-94).

A review of southern Levantine PPNB data relevant to economic systems and their change through time, which is done in subsequent chapters, shows population growth and the limits of settlement growth had ramifications across a wide range of social realms from lithic technology to food systems to settlement organization to economic relations. However, it shows equally well that the spatial and temporal aspects of natural resources in the region heavily structured the specific changes observed in these realms. This dual process of the interaction of social and spatio-material forces leads to variation between fields of practice across the village communities of the southern Levantine PPNB. For example, the same technologies can be enacted through different production systems in different communities or different productive processes can be enacted by the same economic units in a single community. What we see is that variation in southern Levantine economic systems can be driven by both variation in social

processes and natural resource availability, but also, seemingly contradictorily, by similarities in productive practices, as these practices may be enacted by variable social units within and across communities.

Changes in the realms of economic production and their ramifications in social relations seem, as will be discussed in succeeding chapters, particularly potent in driving significant societal change in small-scale societies. The consequences of these changes in early villages for the history of humanity and even our present-day economic, political, and social relations are enormous. This dissertation will show that so many of the social relations and processes that vex us today, from unequal access to resources to the competition between environmental stewardship and economic growth, have their roots in early village life and that there is a very direct historical thread from these earliest developments to the present, largely maintained through time by the self-reproducing economic forces first developed in the subsistence economies of early villages.

Research Topic: Economic Change and Village Development

This dissertation looks specifically at three different fields of economic practice, (1) increasing subsistence production, (2) economic segmentation and the structuring of productive systems, and (3) the expansion and strengthening of property rights, in order to address the question of the relationship of subsistence change and village development. In a recent chapter introducing their edited volume on early village societies, Bandy and Fox (2010a) provide a trait list for what they see as the essential factors which shape what they term “the early village social process.” (p. 3) They included in their list: “(1) the availability of an intensifiable system of food production, (2) relatively permanent residence in nucleated settlement clusters, (3) political autonomy of the village or settlement cluster and (4) nearness in time to the origins of sedentary

village life.” (Bandy and Fox, 2010a: 3-4) While this list serves the purposes of the authors in introducing the chapters that follow and to frame the process of village reproduction and change (as opposed to emergence), it is interesting to note that only one of these traits, an intensifiable food system, is a trait that inherently implies process. That being said, as will be explored further in later sections, these other three traits do exert force on practices which lead to processes of social change.

The process of increasing subsistence production, one of the main focuses of this dissertation, is complex and multivariate. Not only does it play out in a variety of practices, but it also produces a number of social effects, which are also a focus of this research. While the classic example of subsistence change is intensification (i.e., the substitution of labor and capital for land), whereby farmers increase the amount of time spent laboring in the fields and the amount of material inputs (including tools, fertilizer, and infrastructure such as irrigation or terracing to name a few) they use on fields to increase outputs rather than bring greater quantities of land under production (Boserup, 1965), there are a number of other mechanisms that can be used to increase production. These include technological innovation (Boserup, 1981) and changes in production scheduling, such as shortening fallow periods (Boserup, 1965), and labor organization (Pasternak et al., 1976).

Another set of processes through which subsistence production increases can occur is changes in economic relations (Bowles and Choi, 2003, 2013). In fact, two such processes, the segmentation of village economies (Flannery, 1972) and the intensification of property rights (Bowles and Choi, 2013; Smith et al., 2010), are major drivers of increasing production. The rewards of increasing production might seem obvious on the surface, as increased products for labor associations can be put to use by those associations for nourishment, gifting, or exchange.

However, such rewards are not always available to producers. Specifically, in the vast majority of small-scale societies without intensive food production systems and/or agriculture, subsistence items are shared communally (Gowdy, 1999; Ingold, 1999; Kelly, 2007; Lee and Devore, 1968; Lee, 1990, 1968; Pryor, 1977; Sahlins, 1972; Stiner et al., 2011). This is not to say that subsistence items are shared evenly, but rather that there are typically mechanisms in place to assure the distribution of subsistence items across communities and to prevent comparatively excessive consumption or accumulation by any individual or association of individuals.

It only makes sense for any given individual or labor association to increase inputs in order to increase outputs, if the rewards of such behavioral changes are reaped by those who sowed them (Boserup, 1965; Kohler, 1992). In fact, people have developed a whole host of mechanisms through which they will never have to do so, choosing instead to leave behind the settlements in which they would have to increase production inputs through fissioning (e.g. Bandy, 2004; 2010; Carneiro, 1987; Chagnon, 1975), abandonment (e.g. Cameron and Tomka, 1993), or dispersal / reorganization (e.g. Hegmon et al., 1998; Nelson, 1993; Nelson and Hegmon, 2001; Nelson et al., 2006; Nelson and Schachner, 2002).

The flip side of the development of stronger property rights, whereby the subsistence products of labor can be claimed more fully by producers, is the inevitable segmentation of the economy. Economic units within communities must develop for them to be able to claim exclusionary rights over goods. This process is reinforced by another common change in economic practices during subsistence intensification: the restructuring of labor organization (Arnold, 1993; Banning and Byrd, 1989a, 1987; Blumberg and Winch, 1977; Blumberg, 1978; Cordell, 1994; Cordell et al., 1994; Crown and Kohler, 1994; Dohm, 1990; Erasmus, 1956;

Flannery, 2002; Goody, 1972; Hill and Trierweiler, 1986; Hunter-Anderson, 1979; Pasternak et al., 1976; Speth, 2000; West, 2010, 2009).

Frequently, intensifying subsistence practices can require increasingly complex labor organization whereby individuals become linked through production chains (Stone, 1996). Non-intensive subsistence production can frequently be done either on an individual or communal level (Boserup, 1965; Kelly, 2007). However, with intensification, complex production processes may require multiple individuals to work sequentially or simultaneously (Erasmus, 1956). Thus, this labor organization creates economic links between individuals. With intensifying property rights and the justification of these rights through labor investment (Becker, 1977), the property rights of these individuals become linked. Thus, it makes sense for those economic units which are developing in communities to become labor units as well.

Typically, these economic links are mapped onto those links already present in communities; namely onto kin relationships (Blumberg and Winch, 1977; Blumberg, 1978; Goody, 1972; Henderson, 2010; Pasternak et al., 1976; Sahlins, 1972; West, 2010, 2009). Thus, we see the emergence of the nuclear family household as economic unit in many small-scale societies under conditions of subsistence intensification (Banning and Byrd, 1989a, 1987; Blumberg and Winch, 1977; Blumberg, 1978; Flannery, 1972; Henderson, 2010; Pasternak et al., 1976; Rollefson, 1997). However, this process does not stop with the emergence of nuclear households. As labor complexity and demands continue to increase, driven by subsistence intensification and population growth, new economic unit forms can emerge. A common response is for the emergence of extended households to expand labor pools (Blumberg and Winch, 1977; Blumberg, 1978; Flannery, 2002, 1972; Pasternak et al., 1976). Another potential response is the development of temporary synthetic compound households during periods of high

labor demands (Eskelinen, 1977a; Sidibe, 1978). Households can also develop a greater economic character, shedding all but a façade of kin relations, and creating dynamic residential patterns with individuals joining and leaving households based on economic relations while still maintaining their associations through the discursive language of kinship. This social form has been labeled a house society (Beck, 2007; Carsten and Hugh-Jones, 1995; Joyce and Gillespie, 2000; Levi-Strauss, 1988, 1987). Thus, we see that the processes of economic segmentation / production reorganization and the intensification economic relations enable increases in subsistence production. This is why all three of these processes are the subject of this dissertation.

In their discussion of early villages Bandy and Fox (2010a) also note two important processes other than subsistence intensification at work in early villages: (1) population growth and (2) the countervailing forces which place limits on the growth of settlement populations. These three forces of population growth, subsistence production increases, and the limits of settlement growth – all interlinked in autonomous villages – are central to change in village communities. Population growth creates challenges for village inhabitants such as increased nutritional demands (Cohen, 1977). In turn this requires increased subsistence production, which creates further challenges for village inhabitants such as increased labor loads (Stone et al., 1990). The concomitant challenges of the two processes of population growth and increased subsistence production, in turn produce limits on settlement growth (Flannery, 1972). Such pressures must be overcome with social mechanism, such as the reorganization of economic relations or the intensification of religious practices for villages to be reproduced and grow (Bandy and Fox, 2010a).

The improvisation and reproduction of these mechanisms creates new cultural concepts, such as the nuclear household, and restructures practical systems, such as the production of subsistence items, in order to alleviate these challenges for populations. Additionally, these new cultural concepts can provide the means through which agents can enact novel practices, such as the intergenerational reproduction of the household as a coherent association. These new systems of practice themselves can create new associations of actors, such as the labor group, which can agentively act in the social world with novel drives and properties, such as the enactment of exclusive property rights claims over the fruits of the association's labors.

It is through such processes that major social change can develop through time in village-based communities. Novel agents and agents with novel cultural concepts, as well as the novel processes produced by the interaction of these forces with agents who resist change, continually restructure the village as they reproduce it through time. Beyond the social, the ever changing material world in which villagers are embedded and the biological processes of change at work in village societies and their place in the broader ecology require constant adjustment by communities, again driving social change.

It is the goal of this dissertation to describe the specifics of just such a process in the early villages of the west-central Jordanian PPNB. Much of the theoretical information presented above comes from contemporary studies of small-scale societies. However, as the relationship between economic change and village development is a long-term process, we have very little information about the unfolding of these processes through time. Rather we typically have micro-scale observations of individual phenomena that we have stitched together into a developmental narrative. In order to see how such processes actually played out in the human past, we must turn to archaeology to study change over time.

Such a research agenda is still in its infancy relative to many other social studies, which have preoccupied theorists as long as we have had their writings. It is only really with the development of social evolutionary theory in the nineteenth century and more recently with the development of the New Archaeology and allied neo-evolutionary ethnologists in the mid- to late twentieth century that we have had sustained efforts put actual research into such long-term processes in small-scale societies. While this is several decades of work, the basic methodological challenges of ethnology of long-term social change based on works of the ethnographic present and of archaeology based on the highly fragmentary and spatially transformed remains of past societies have made such research quite difficult.

It is the goal of this dissertation to utilize this corpus of knowledge which has been developed, to analyze a single case-study in detail. While the analysis of a single case-study may seem to be antithetical to the anthropological goals of understand social process rather than historical contingency, it is only through the repeated testing of theoretical constructs largely derived from the ethnographic present against actual long-term change that such theory can be rejected and reconstructed to give us a closer and more predictive and productive approximation of social process through time in small-scale political and social associations.

Beyond simply ground-truthing the theories of change in small-scale society laid out above, the study of social development in the long-term has the potential to bring out aspects of this change not identified through ethnographic analogy. As the theories of social variation describe above highlighted, this narrative of change may not be as neat as articulated, with potential dimensions of variation existing in differential relation to one another through time (Upham, 1990). Thus, some of these processes of economic intensification may be at work in the

PPNB while others may not. Additionally, some of these processes of economic intensification may have consequences not hypothesized from ethnographic analogy (Bourdieu, 1977).

What is intended with this dissertation is to not only test this simple reconstruction of economic intensification and village development through the interlinking of increases in subsistence production, property rights intensification, and economic segmentation, but to also test further hypotheses drawn from the literature about the processes of economic intensification in early village communities. What the testing will do is to whittle down these over-determining processes of economic intensification to the realities of how such phenomena could and did happen in the past. By casting a wider net than simply these three interlinked processes, it may be possible to develop new links between them and other phenomena which researchers have identified as being associated with village development trajectories.

The topic of subsistence change in the early villages of the Middle East has been studied quite extensively. Thus, in order to not cover ground already treaded upon by other theorist, fresh perspectives must be brought to the arena to justify the research described and argumentation that follows. A trend in recent years has been the development of extensive economic literature about subsistence change in early village communities (Ashraf and Michalopoulos, 2010; Baker, 2008, 2005; Bowles and Choi, 2012, 2003, 2013; Dow et al., 2009; Guzmán and Weisdorf, 2011; North and Thomas, 1977; North, 1981; Robson, 2010; Rowthorn and Seabright, 2010; Weisdorf, 2005). This literature has focused primarily on the shift from foraging to farming, typically using the Middle East as its main archaeological referent, although cross-cultural surveys of non-hierarchical small-scale foraging and farming communities are also engaged.

While archaeological and anthropological knowledge is marshaled in the construction of the models proposed by these economic theorists, it is primarily broad generalizations, a narrow

set of prominent cases, and rigid economic concepts which are used. What these writings lack is both an extensive use of primary data to construct the models and rigorous tests of these models. They instead use mainly economic concepts and mathematical or simulation testing to develop their proposed means by which Neolithic communities in the Middle East transitioned from foraging to farming. While there is much value to this vein of theory, especially in the utilization of mathematical expressions, they can only be theory until tested against the remains of reality.

Many within this set of recent economic theorists have argued for is the coevolution of farming and property rights (Baker, 2008, 2005; Bowles and Choi, 2012, 2003, 2013; North and Thomas, 1977; North, 1981). More specifically, they have argued that not only must subsistence methods change, but so must economic relations in order for husbanded resources to be the dominant economical choice for producers. These changes include the segmentation of the economy, the development of individual land tenure, and the expansion of individual, familial (nuclear, extended, or some other association), and/or household property rights to include subsistence products. Beyond this basic agreement, there is little consensus as to the specifics of the process through which this coevolution occurs and the causes of it in the first place. These theories serve as inspiration for this study.

Archaeologists have on occasion invoked the likely importance of the development of land tenure (Kohler, 1992) or the lack thereof (Bogaard and Isaakidou, 2010; Bogaard, 2005), property rights (Flannery, 1972), and economic segmentation (Byrd, 2005a, 2000, 1994; Flannery, 1972) in subsistence change in small-scale societies. However, these discussions have remained highly theoretical with very little data available to writers to analyze and illustrate the process of change. Rather, we typically see a before and after sort of perspective in which we know that certain earlier communities were largely communal in the economic relations and that

later communities more segmented. Therefore, it is possible to infer that some sorts of processes occurred within these societies whereby economic relations changed. However, we do not have significant evidence of the process of change itself. More importantly, we have very little evidence of the forces which would bring about such changes. This produces a situation where little more than culture history can be verified and culture process can only be hypothesized.

While some archaeologists have been able to use especially nuanced analyses to illustrate likely transitions in economic relations through time from village-derived data, these same archaeologists have acknowledged that there is a notable lack of evidence for such things in subsistence production loci, where these key transitions matter most (Banning, 2012). This is not a simple critique as village-based foraging and farming communities in the ethnographic present exhibit a range of land tenure and property rights regimes (Ames, 1994; Forde, 1931; Sidibe, 1978), making us unable to invoke simple ethnographic analogy (i.e., analogy of social types whereby one says that x society and y society each inhabit villages and we know that x society did z, therefore y society must have done z) as evidence. Additionally, such differences in economic relations have been shown to have significant differences in long-term economic outcomes, with, for example, communally-held land tenure for subsistence loci, even with individual, familial, or household usufruct rights, acting as a control on the development of inter-generational wealth differences and the rise of inequality and hierarchy (Smith et al., 2010). Thus, if subsistence change was a major spur to social evolution as so many contend, then understanding the specifics of how such a process did or did not unfold is key.

This dissertation analyzes the evidence within subsistence landscapes as well as villages for various economic relations including land tenure, property rights, economic segmentation, specialized production, and subsistence during the Middle and Late Pre-Pottery Neolithic B

(MPPNB: ca.8300/8000-7580/7450 cal. BCE; LPPNB: ca. 7580/7450-7000/67000 cal. BCE; Banning 2012: 397) of west-central Jordan and situates these analyses within the long-term development of subsistence methods and systems in the region. It performs two tasks which have been especially difficult to do previously with archaeological evidence. It uses broader subsistence landscape data to analyze economic relations more thoroughly and situates these analyses in time to moves beyond even those rare cases where such landscape analyses have been possible (e.g., Woodbury, 1961; Henderson, 2010) to understanding processes of change.

This dissertation takes an economic perspective on subsistence change in the village societies of the southwest Asian Neolithic, where recent analyses have tended to prioritize cultural, cognitive, or ecological perspectives (Bar-Yosef and Meadow, 1995; Hodder, 1990; Renfrew, 2007; Watkins, 2010; Zeder, 2011). Every theory that deals with subsistence change in the Neolithic – typically studied as the origins of agriculture – must in some way be economic, as subsistence production is the quintessential economic practice in small-scale societies. As Cauvin (2000: 220) noted in the conclusion to his decided cultural cognitive argument for the transition to agriculture, these are two sides of the same process. Even if there is a symbolic revolution (Cauvin, 2000; Hodder, 1990) that drives subsistence change, subsistence change is still inherently part of the story. Where some authors disagreed is whether it is economic or ecological pressures or semiotic understandings which drive subsistence change in the Neolithic.

In the past, a handful of theorists have turned to economic pressures as a driver of subsistence change during the Neolithic (Bender, 1978; Binford, 1968; Cohen, 2009, 1977; Flannery, 1973; Hayden, 2009, 1990; Rosenberg, 1998, 1990). What almost all of these theorists share is the premise that the interaction of ecological and demographic change drove economic necessity for subsistence change. However, Bender (1978) and Hayden (1990) have presented

slightly different models where social relations and power are the drivers behind subsistence change. Specifically, both authors see aggrandizers' demands for subsistence goods to undergird (Bender 1978) or produce (Hayden 1990) higher status for themselves as the primary driver of subsistence change during the Neolithic.

This dissertation argues that subsistence change in the PPNB of the southern Levant was driven by basic economic processes rather than cultural and cognitive shifts or environmental change. The economic processes have to do with demographic increase, especially in individual settlement populations (Feinman and Neitzel, 1984; Keeley, 1988). However, while such demographic forces may have been what jump started subsistence change in the Neolithic, the economic trajectories followed by the early villagers of the PPNB had more to do with the specific novel social developments and how these developments spatially, temporally, and biologically structured subsistence producers' practices.

Flannery (1972) was the first to note the potential economic processes at work in segmented economies that permit increased population growth and subsistence production in the PPNB. However, virtually no data relevant to economic relations was available at the time of this writing, making his model highly theoretical; including and explaining the meager evidence available to him. Since this publication a number of lines of evidence from archaeological villages of the PPNB have emerged for economic segmentation, further supporting his model. These include the extensive renovation and remodeling of habitation structures through time, individual structures with habitation durations well beyond a few generations, and a significant number of habitation structures with human skeletons interred beneath floors (Banning, 2012).

These new data along with the data derived from excavations at the site of al-Khayran (Figure 2; Figure 3; Figure 4) in west-central Jordan and survey in the surrounding areas along

Wadi ‘Assal, the Dead Sea Basin, and the west-central Transjordan Plateau, conducted for this dissertation, have provided an opportunity to revisit socio-economic explanations of subsistence change in the PPNB. These data will be interpreted using reasoning borrowed from both economics and economic anthropological literature to make the case that economic dynamics in the villages of the PPNB opened up social spaces for changes in economic relations. These relations, in turn, were necessary for much of the subsistence change seen in the PPNB.

However, unlike the economic literature on subsistence change in the Neolithic, this dissertation will contextualize the process in a more long-term understanding derived from archaeological data. While domestication and agriculture certainly turned out to be important in

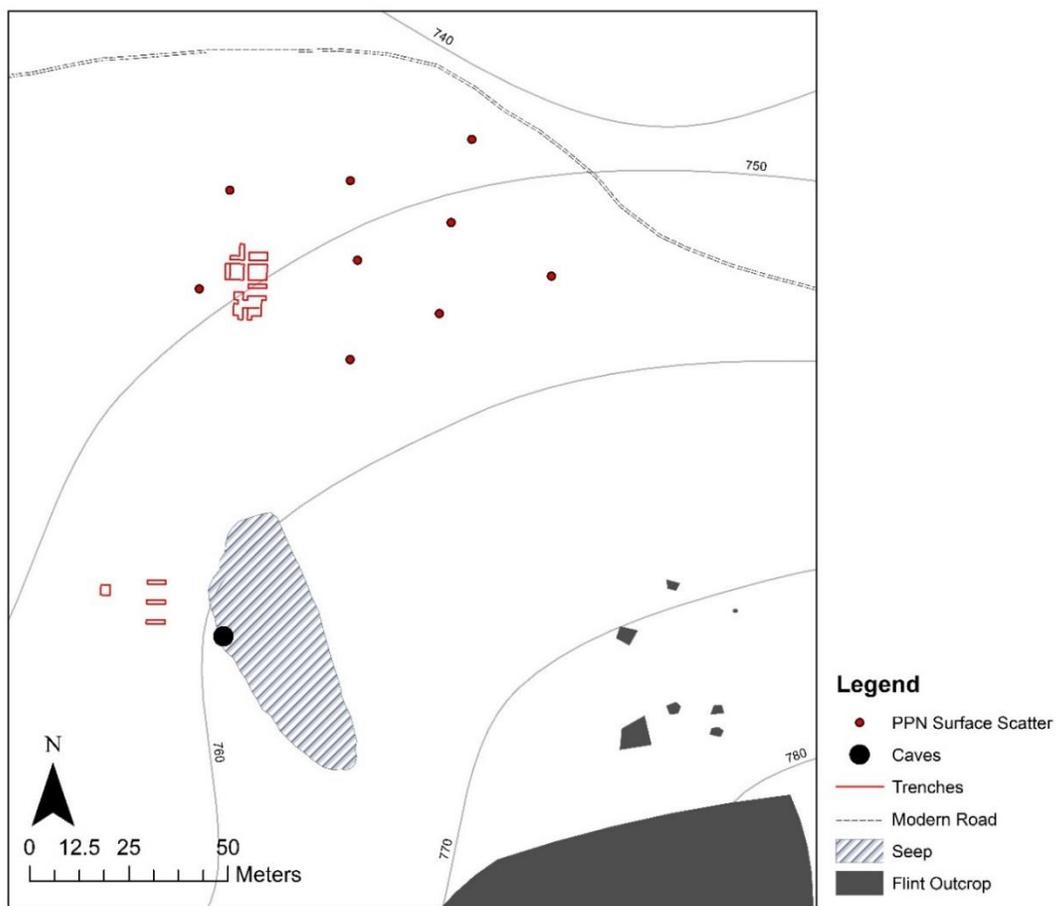


Figure 3: Al-Khayran (Eliza Wallace)

the long-run of human history, they must be viewed as part of a wide spectrum of human subsistence practices. We have evidence of significant human manipulation of subsistence ecologies well before the Neolithic (Zeder, 2011). Therefore, economic choices made by producers in the past were not as easily categorized as foraging or farming. Rather, as some have recently begun to advocate (Kuijt and Prentiss, 2009; Rowley-Conwy and Layton, 2011; Smith, 2011a, 2011b, 2007a, 2007b; Zeder and Smith, 2009; Zeder, 2012, 2011), subsistence change in the Neolithic can best be seen as changing patterns of human structuring of their subsistence context; frequently referred to as niche construction.

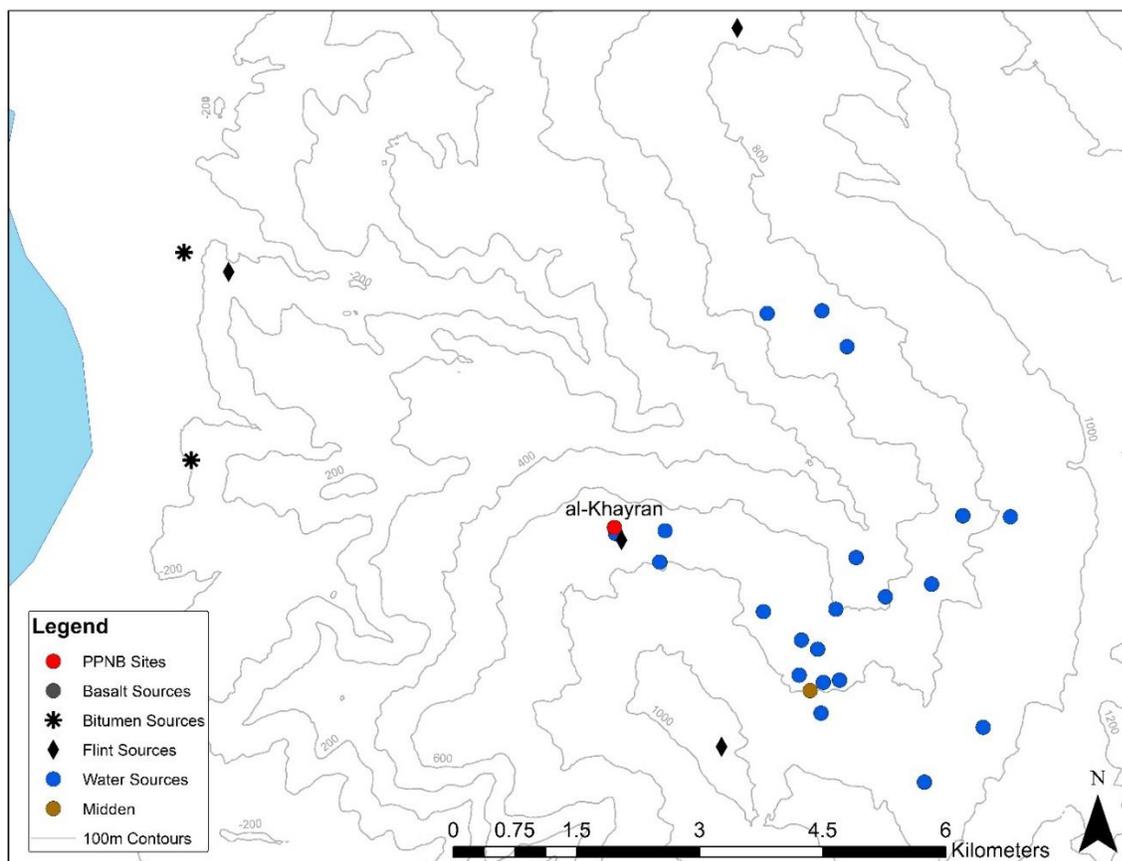


Figure 4: Wadi 'Assal Natural Resources (Eliza Wallace)

Such a perspective emphasizes the environmental, spatial, and temporal aspects of subsistence production in a way that models of economic relations typically do not. This is important as the choices being made by producers are always situated in specific environmental contexts. Thus, economic processes certainly can drive and structure change, but only in context. It is through the combination of a thorough analysis of economic relations, prioritized by economists, subsistence ecology, prioritized by archaeo-biologists, and demographics, prioritized by neo-evolutionists, all grounded in the material, spatial, temporal, and social realities and processes attested to in the archaeological record that this dissertation is able to provide a new perspective on village development and subsistence change.

Research Area: The Pre-Pottery Neolithic B of the Southern Levant

This study is based on fieldwork conduct in Wadi ‘Assal (Canyon of Honey) in west-central Jordan (Figure 4). This work included survey and excavation at the PPNB site of al-Khayran. It will be argued in this dissertation that al-Khayran is a unique site for this time period, being the first subsistence production field house yet identified for the entirety of the early Neolithic of southwest Asia. As such, the site and contextual analysis of its place in the local catchment and broader regional social systems provide new insights into a number of aspects of the PPNB of the southern Levant and the broader processes of subsistence change and early village development.

The PPNB of the southern Levant is generally agreed upon as the period when a number of novel processes of village life and important subsistence practices first appear in the region, including the emergence of orthogonal architecture (Bafna and Shah, 2007; Byrd, 2005a, 2000, 1994; Flannery, 2002, 1972), household storage of subsistence items (Flannery, 2002, 1972; Kuijt, 2008a), domesticated cereals (Asouti and Fuller, 2013, 2012; Nesbitt, 2002), herd

management (Horwitz, 2003a; Horwitz et al., 1999; Makarewicz, 2007), segmented household-based production and economic risk (Flannery, 2002, 1993, 1972), and potentially craft production (Barzilai, 2010; Quintero and Wilke, 1995; Quintero, 2011, 1998, 1997). A detailed description and analyses of these aspects of the periods will be presented in subsequent chapters. However, in order to justify the relevance of these time periods to the research questions being asked in this dissertation, it is necessary to provide a brief presentation of some of the broader processes at work in the PPNB.

The two most studied aspects of the PPNB of the southern Levant are the husbandry of domestic plants and animals and the reorganization of settlement structures. Taking the first of these topics, it is during the MPPNB that a number of sites in the southern Levant first provide evidence of the morphological changes associated with plant domestication (Nesbitt, 2002), here defined as a change in the structure of the gene pool of plant populations and associated morphological changes caused by human action. The MPPNB is also the first period where we have strong evidence of new human-animal interactions suggestive of either herd management or actual husbandry (Horwitz, 2003a; Horwitz et al., 1999; Makarewicz, 2007). By the LPPNB there is even stronger evidence of domestic animals in the southern Levant, with species such as sheep not naturally found in the region appear at a number of sites. This suggests that they were imported into the area through human husbandry practices (Becker, 1991; Kohler-Rollefson et al., 1988).

However, beyond this evidence of domestic plants and animals, there are a number of other aspects of plant (Colledge, 2004, 2001; Meadows, 2004; White and Makarewicz, 2012) and animal husbandry (Horwitz, 2003a; Horwitz et al., 1999; Makarewicz, 2007) from the even earlier. What can be said in general is that humans began to interfere not only in the ecological

aspects of plant and animal populations, but also their genetics in the PPNB. It is also important to note that these events were part of a much longer process, starting perhaps as early as the Middle Pleistocene, of humans in the southern Levant intensifying their subsistence production (Flannery, 1969; Stiner, 2001; Stiner et al., 2000, 1999; Weiss et al., 2004; Zeder, 2012).

As for the second process associated with the PPNB which has garnered so much attention, the reorganization of settlement structure, researchers have identified a number of different aspects having to do with this shift. First articulated by Flannery (1972), settlements in the PPNB are rather distinct in their structure as compared to those of preceding periods. While there is reasonable evidence that people began to settle down is what might be termed villages either semi-permanently or permanently during both the Early Natufian (ca. 14850-13300 cal. BCE; Simmons, 2012: 131) of the later Epipaleolithic and Pre-Pottery Neolithic A (PPNA: ca. 9950/9750-8500/8350 cal. BCE; Banning, 2012: 397) (Bar-Yosef and Belfer-Cohen, 1989; Belfer-Cohen and Bar-Yosef, 2000; Goring-Morris and Belfer-Cohen, 2008), it is not until the PPNB and more specifically, especially in the southern Levant, the MPPNB, that we see the form of villages restructured dramatically to accommodate a great number of new practices and processes occurring in these early villages (Byrd, 1994; Finlayson et al., 2011a; Flannery, 1972; Kuijt, 2000a).

This is not to say that such processes were not at work in earlier time periods. In fact, a recent review (Finlayson et al., 2011a) of newly published materials from the PPNA, focusing specifically on west-central and southern Jordan, shows that in this time period there is a diversification of architecture not previously appreciated. Such things as large-scale storage (Kuijt and Finlayson, 2009), public architecture (Finlayson et al., 2011b), codified disposal patterns (Hardy-Smith and Edwards, 2004), and highly differentiated small-scale architecture

(Finlayson et al., 2011b) all are present. Additionally, in other areas of the Levant there is evidence of transitional architectural styles from directly before the MPPNB (Khalaily et al., 2007; Stordeur, 2000a, 2000b). However, what we find in the PPNB is village architecture changing to accommodate both architectural expansion and remodeling (Bafna and Shah, 2007), as well as the introduction of two-story architecture, terraced construction, further increases in public architecture, more highly structured waste disposal systems, increased interior elaboration of structures, and much more (Banning, 2003; Byrd, 1994; Flannery, 1972; Goring-Morris and Belfer-Cohen, 2008; Kuijt, 2000a; Rollefson, 2000, 1983).

While settlement structure and subsistence practices have been a major focus of research on the PPNB, a number of other processes quite relevant to economic intensification have also been studied. It is during the PPNB that the earliest evidence of economic specialization appears in the southern Levant (Barzilai, 2010; Quintero and Wilke, 1995; Quintero, 2011, 1998; Rollefson and Parker, 2002; Wright, 2008), as do new extractive practices and technologies (Barkai et al., 2007; Quintero, 1996; Schyle, 2007). Population expands significantly in certain regions (Bocquet-Appel and Bar-Yosef, 2008; Goodale, 2009), as does the population of specific settlements (Kuijt, 2000a), which is typically a more important force of change in village-based societies than regional population (Feinman and Neitzel, 1984; Keeley, 1988). Beyond these material and demographic aspects of early Neolithic economic intensification, it has been recognized that much of this evidence reflects and plays a part in the reorganization of economic relations starting in the MPPNB. It is during this period that a number of theorists have presented evidence of household economic segmentation (Byrd, 1994; Flannery, 1972; Kuijt, 2000a; Wright, 2000). Additionally, there is evidence of the transfer of materials and social positions, likely between kin, across generations (Banning, 1998; Kuijt, 2008b).

Almost all of the evidence for these processes derives from village sites, with only a handful of specialized ritual (Bar-Yosef and Alon, 1988; Goring-Morris et al., 2009; however, see Garfinkel, 2006) or resource extraction (Barkai et al., 2007; Schyle, 2007) sites having been identified within the settlement systems of the early villages of the PPNB. While many of the changes that are of such great importance to this period have to do with subsistence production, a process which predominantly occurs outside the borders of villages, we have had no remains of village subsistence hinterlands until the excavation and regional analysis of al-Khayran (Kuijt, 2009a: 321; Banning, 2012: 405).

Another major hole in our understanding of these economic processes at work in the early Neolithic has been our inability to give contours to the economic practices and relations of individual households (Banning, 1998: 222, 2003: 11-13; Kuijt, 2000b: 318; Gebel, 2010: 59; Peterson, 2010: 260; Price and Bar-Yosef, 2010: 323-325). While we have clear evidence of individual structures of similar size at a great many PPNB sites (Banning, 2003; Byrd, 2000, 1994; Kuijt, 2000a) and we have a decent amount of evidence for the structuring of space within PPNB villages (Flannery, 1972; Kafafi, 2006; Kuijt, 2000a; Wright, 2000), we have had difficulty associating artifacts with architecture, in large part due to the intensification of waste disposal systems in the PPNB (Hardy-Smith and Edwards, 2004). So, while we know that space was divided up in certain regular patterns (Banning and Byrd, 1989b, 1987), we do not typically know what activities were performed in these spaces and who performed them.

If one were to characterize our knowledge of the relationship between economic intensification and village development in the PPNB of the southern Levant, again, we know that as villages grow their economies intensify. We know what some of the specifics of this growth, such as increased settlement size and increased architectural density, and economic

intensification, such as the animal husbandry. However, because of certain gaps in our data, we do not know how exactly this process unfolded through time. There are three areas of interest for which we lack significant data: village hinterland subsistence production, the organization of production systems, and intra-community economic relations.

It is in all three of these areas that the site of al-Khayran is ideally suited to test our hypothesized understandings of economic intensification. This is because (1) as will be demonstrated, it is part of the subsistence hinterland infrastructure of the west-central Jordanian PPNB, (2) it is potentially associated with the production of craft goods, and (3) by virtue of being an isolated residential structure all remains recorded on-site can be associated with a single household and/or economic unit. Additionally, a site catchment analysis allows for not only artifacts, but also natural resources to be associated with individual household economic units. Thus, we have the opportunity to test what methods of subsistence intensification and what economic practices were being enacted by sub-village economic units during the PPNB.

Another advantage of al-Khayran for developing an understanding of the relationships between economic intensification and village development trajectories is that it is within one of the most widely studied regions for early village development. Specifically, the southern Levant is the most thoroughly investigate area of southwest Asia and southwest Asia is the most thoroughly investigated primary center of both agricultural development and village emergence. Thus, by providing new areas of study within a huge archaeological database, al-Khayran provides the best of both worlds; novel research material and adequate background information.

Research Questions

This dissertation asks four interlinked research questions:

- (1) What past economic practices are manifested within the archaeological remains at the site of al-Khayran?
- (2) How were these past practices structured spatially, temporally, and socially?
- (3) What are the implications of these practices and the social, spatial, and temporal structures within which they were enacted for the structures and processes of regional economic systems?
- (4) What are the implications of the development of PPNB economic systems for the general relationship between the processes of village development and economic change?

In order to answer these questions a set of seven hypotheses has been developed to be tested via the results for survey and excavation at al-Khayran, as well as published data from the southern Levant. These hypotheses, as well as the tests used to reject or uphold them are described and discussed in Chapter 8 of this dissertation.

The Anthropological Significance of Village Life

While this research is about the PPNB of the southern Levant, it is relevant to a number of areas of broader anthropological interest and the understanding of specific historical events. Village development trajectories have been a significant topic of anthropological research for many years as the transition to village-based life, with its concomitant sedentarization and nucleation of populations, is the earliest and one of the most wide-spread major shifts in settlement spatial, social, and ecological organization for humanity (Flannery, 1972). Anything found repeatedly across space and time in human social existence is ripe for anthropological

explanation as one of the major goals of a variety of anthropological archaeologies is the explanation of variability in social practices (e.g., Binford, 1965; Pauketat, 2007) from the individual to the large-scale imagined community and from the momentary to the long-term process.

The flip side of this is that variability can only be understood in relationship to similarity. That is, if there is grounds to posit similarity between two case-studies as they are two examples of the same social process, then variability is about contrasting different types or trajectories of this process (Fowles, 2002). Thus, to investigate an individual case-study of a specific social phenomenon – in this case village developmental trajectories – is to both investigate parallelism due to shared biological structures in humans (Renfrew and Zubrow, 1994), uniformitarian environmental processes in which humans are embedded (Binford, 1981: 198), and shared characteristics of material objects with which humans interact (Binford, 1978: 452-458), as well as variability due to the specifics of the socio-environmental contexts in which the case-study is embedded and enacted (Binford, 1978: 452; Hodder and Hutson, 2003: 14).

The comparative study of village development trajectories is therefore of great anthropological interest as certain basic structures of and social relations within village settlements have appeared repeatedly through space and time. Yet, the trajectories of such developmental processes vary quite widely. Understanding how the basic structures and relations of villages emerge repeatedly, yet there is also so much variation within such settlements, is, as was discussed above, both the goal of this research and one of the great challenges of anthropological studies of village development and change. The southern Levant specifically provides a wonderful opportunity to study village development as it is such a richly documented process within the region.

In addition to village development trajectories as whole being one of the major changes of population sedentarization and nucleation, there are a number of consequences of such a new settlement form that have been studied cross-culturally by anthropologists. Villages did not come into being for several million years of human existence. With their emergence a whole host of other significant social and behavioral changes emerge as well (including a number of changes in subsistence practices). While earlier researchers may have been overly mystical (and overly ethnocentric and modernist as well; cf. Flannery, 2006: 5) in their understandings of the causes of these changes (e.g., Braidwood, 1967: 113-114), with the emergence of structural and relational social forces as a focus of research (e.g., Flannery, 1972), it has been possible to understand what social processes led to the development of village settlement patterns and how these settlement patterns catalyzed other subsequent social processes.

Some of the most prominent of these consequences of the development of village life have to do with changing economic relations. Early understandings of villages tended to view them in much the same way that urban planners and economists view cities today, as cauldrons of innovation (Schmieder, 1930: 76; Braidwood, 1967: 113-114; Renfrew, 1975: 27; Evans, 1978: 124, 126). In such a description there is a certain mystical quality, as noted above. Authors tended not to move much beyond this idea that population increase within villages could lead to economic differentiation and specialization. However, substance has been added to this idea by careful analysis of how economic relations create opportunities within villages for differentiation and specialization (Flannery, 1972: 48). Most importantly, it is the segmentation of the economy through the assumption of subsistence risk by individual households (Flannery, 1993: 110, 2002: 421) that restructures economic relations, producing incentives for production and innovation and opening up spaces for craft production and economic differentiation.

A second aspect of economic relations, very closely related to the segmentation of village economies, is the intensification of property rights. As discussed above, it is clear that with the growth of villages and the intensification of production, individual property rights intensify as well (Boserup, 1965; Brown and Podolefsky, 1976; Morgan, 1877; Netting, 1982; Shenk et al., 2010; Smith et al., 2010). There are some who have argued that this process was perhaps the defining process of economic growth and social change in early village societies (Baker, 2005; Bowles and Choi, 2012, 2003, 2013; Crothers, 2008; North and Thomas, 1977; North, 1981). In fact, Bowles and Choi (2003, 2012, 2013) have termed this intensification of property rights as the Holocene Revolution, essentially equating the impact of the transition to what Childe (1952) claimed as the impact of the emergence of agriculture. In other words, for Bowles and Choi (2003, 2012, 2013), the intensification of property rights to include land tenure and private control of subsistence goods was the major transition that kick started social evolution towards larger-scale societies and greater inequality.

Flannery (1972) presented some of the productive advantages of segmented economies with private property over communally distributed subsistence products. Noting that certain subsistence production practices required either coordinated (1) simultaneous and differential or (2) sequential and differential behaviors to increase yields, segmentation of labor would intensify production (Erasmus, 1956). However, in order for there to be an incentive to increase inputs to increase outputs, a social space for the rewards of intensification must be created. Thus, property rights are key to opening up increased economic growth in villages. The social relations that underpin this intensification continue to this day to be incredibly important drivers of economic growth (Hardin, 1968).

Beyond these social models of economic change, a number of researchers have proposed even more grand changes both as a cause of and an effect of village life. Wilson (1988) argued that the transition to village life and, more specifically, the partitioning of living spaces within communities by permanent architecture created new social forces based on the altering of the role that sight played in society. Wilson contrasted mobile foraging groups who do not typically build significant structures nor conduct many activities behind walls, shielded from the eyes of others, with sedentary villagers who do just that. Wilson looked to ethnographic data and cognitive research to argue that social regulation within mobile foraging groups is largely dependent on the ability of individuals to witness the behaviors of other. Thus, the social systems commonly found within mobile foraging communities are in many ways products of this form of social regulation.

This all changes, however, with an intensification of the built environment. Wilson (1988) argues that mobile foraging societies are, “marked by an emphasis on ‘focus’ in contrast to [village-based] societies, which are distinguished by an emphasis on the boundary.” (p. 5) The author goes on to elaborate a number of consequences of such a shift in emphasis in social regulation, as well as how architecture as built environment provides new opportunities for thought and regulates both thought and bodily practice. Architecture can routinize movement and stand as a social assertion. Architecture can also create space for power struggles by both concealing behavior and providing means of both witnessing and regulating the behavior of others.

In many ways, Wilson’s (1988) argument pairs quite well with and can even be viewed as an extension in some ways of the arguments set forth by Flannery (1972) about the restructuring of social and economic relations in villages. The emphasis on public versus private is shared as is

the recognition that the restructuring of the built environment reflects and creates physical and social spaces for economic change. Private space allows for greater accumulation. The segmentation of the built environment reflects the segmentation of the economy. All of these processes that are such important aspects of the economic changes found in villages are essentially the linking of the economics described by Flannery (1972) with the cognition described by Wilson (1988).

A second, similar approach to understanding the significance of the development of village life has been presented by Renfrew (2007: 114-134). In a number of ways in fact, Renfrew has used some of Wilson's (1988) ideas as a springboard for his own (e.g., Renfrew, 2007: 121-122). However, Renfrew places greater emphasis on cognition and meaning, in line with his long-time interests in cognitive archaeology (Renfrew and Scarre, 1998; Renfrew and Zubrow, 1994; Renfrew, 1998, 1993, 1982). Instead of emphasizing the shifting ways that the senses interact with the world, he looks to how the mind makes meanings out of the information from the senses and how the body then acts in the world, inspired by these meanings. Renfrew calls this second process material engagement (Renfrew, 2004).

What Renfrew (2007) finds to be novel during the development of village life is the ways that the intensification of the built environment provides more materials to structure thoughts and how human action inspired by new meanings can intensify the interaction of people with their material worlds. In Renfrew's (2007) model, we see sudden rapid change in human cultural practices when people settle down and begin to accumulate things. An intensified built environment increases the amount of portable objects which can be kept in storage as compared to mobile communities, where populations must carry all things with them to create long-term usage and rights to an object. With this new accumulation of material things, there is a dramatic

increase in the potential for things to have meaning and for this meaning to inspire action in the world.

Such meaning is described as external symbolic storage by Renfrew (1998), borrowing a term from Donald (1991). What is meant by this is that objects within semiotic cultural systems (Keane, 2005, 2003) can store or hold meaning external to any individual meaningful actor. This concept shares many elements of the concepts of the extended artifact (Robb, 2005), artifact agency (Gell, 1998), thing theory (Brown, 2001), entanglement theory (Hodder, 2012), and whole host of other theories (Hodder, 2012: 1, 15) which emphasize how material objects can act in the world even outside of the direct human manipulation or directed conscious human agency. Thus, when sedentism enables the intensification of the built environment and the rapid accumulation of things, there is a veritable explosion of socio-cultural change. This is what Renfrew (2007) labels the sedentary revolution.

While both Wilson (1988) and Renfrew (2007) emphasize the individual in the changing material worlds of village development, Bandy and Fox (2010a: 13-16) have reviewed a host of different authors who have noted the effects of the changing social worlds of village development on the individual. Taken together the authors label these processes the limits of settlement growth. They note that new social experience in the larger and more intense social world of the village require individuals to cooperate, but also place significant pressures on those individuals, encouraging conflict and the breakdown of social cohesion. Following Rappaport (1968: 116), who labeled these pressures the “irritation coefficient of group size,” Bandy and Fox (2010a) argue that for village life to survive, some sort of resolution must be found to these conflicts. They identify a series of possible responses of people to these pressures that alleviate

them either through the dis-intensification of social life, the introduction of stronger forces of social cohesion, or the restructuring of social life.

The problems that Bandy and Fox (2010a) identify are significant. They include the breakdown of reciprocal relationships that typically hold small-scale societies together (Kohler et al., 2000), the inability to move information through social networks to make group decisions (Johnson, 1982, 1978), and various forms of cognitive overwhelming (Fletcher, 1995; Kosse, 1990). Even more significant are the ways in which these pressures are alleviated. Johnson (1978, 1982), similar to Kohler et al (2000), has argued that scalar stress from increasing group size leads to the development of decision making hierarchies if groups are to hold together. Such hierarchies include nascent authority and social differentiation. A number of archaeologists too great to reference individually have observed the intensification of ritual during village emergencies, which is assumed to produce group cohesion in order to hold ever growing community populations together (Johnson and Earle, 2000: 133-136; Bandy and Fox, 2010b: see especially Part II). Chagnon (1975), Carneiro (1987), and Bandy (2004, 2008, 2010), amongst other, have all argued that nucleating communities frequently fission under the pressure.

The Anthropological Significance of Subsistence Change in Small-Scale Societies

While a number of authors have looked to the development of village life as a major cause of social change, others have emphasized the ways that subsistence change in autonomous village communities and other small-scale societies has a ripple effect well beyond the subsistence economy into the very heart of social relations. One such social consequence specific to subsistence intensification, as reviewed above, is that it is typically paired with an intensification of property rights (Baker, 2005; Boserup, 1965; Bowles and Choi, 2012, 2003; Brown and Podolefsky, 1976; Crothers, 2008; Herskovitz, 1952; Hesse, 1992; Kohler, 1992;

Netting, 1982; North and Thomas, 1977; Shenk et al., 2010; Smith et al., 2010; Stone, 1996). It has been observed repeatedly that an increase in the types of objects which may fall under the category of private property with the increase in inputs associated with subsistence intensification. This can include subsistence goods, land, and other natural resources to name some of the more prominent new types of property (Netting, 1993, 1982).

Another similarly related realm of theory has to do with the utilization of subsistence goods to develop wealth and power inequalities (Hayden, 1990, 2009; but see Netting, 1990). Most prominently Hayden (1990, 2009) has argued that domestication of plants and animals was the by-product of competitive individuals, what he terms aggrandizers, attempting to gain power, prestige, and unequal access to wealth through the redistribution of subsistence items. Using analogy with ethnographically reported cases, Hayden (1990, 2009) has argued that in order to procure sufficient food to be redistributed through such mechanisms as sponsored feasts or individual prestations, those economic units participating in such behavior must increase production above subsistence levels. As this process unfolds multiple competitive units will increase production for redistribution, continually increasing subsistence production.

With these redistribution practices, the goal of aggrandizers is to gift others with food items so valuable in their bounty, their rarity, or their potency that the receiver cannot possibly repay in material wealth. This creates an unequal relationship with the receiver incurring a form of social obligation or obedience to the aggrandizer. Thus, we see that a process which in material terms is about increasing subsistence production has very real social consequences. When such a process becomes enmeshed with new forms of property rights and these rights include not only individual control of subsistence goods, but also the means of production, then

inequality can and is produced through time. If new property rights include intergenerational wealth inheritance, then these inequalities can be preserved and exacerbated through time.

Childe (1954: 75-77), using the language of Marxism, proposed a chain of events directly running from subsistence production changes in Neolithic village societies, which lead to any number of anthropologically important consequences. Essentially, his model is dependent on two factors: (1) early village economic autonomy and (2) subsistence risk. Childe (1954) argued that early village societies are typically economically autonomous. He saw this as a holdover from earlier foraging economies where autonomy was key to economic units being able to adjust to changing environmental conditions. By not developing economic interdependences with other groups, foraging communities could always maintain control over their nutritional fate. Childe (1954) saw early villagers preserving this pattern.

However, this economic autonomy increased subsistence risk as populations began to sedentarize. Without the ability to move as easily, environmental catastrophe could be visited upon communities and they had no response. In Childe's (1954: 77) words, this was the fundamental contradiction in the early village economy. Subsistence intensification which allowed for village life, also tied populations to one location. Thus, when disaster hit, their risk levels were much higher. In other words, subsistence change allowed for social change, but also allowed for economic collapse.

In order to transcend this contradiction, early village populations had to start producing above subsistence level to guard against risk. This process then opened up social and economic space for the manipulation of surpluses, which would not need to be consumed during non-disaster years. These surpluses could be used in the sorts of processes described by Hayden (1990, 2009) to create various forms of inequality. Additionally, during disaster years, if

individual economic units did have surpluses, they could use them to manipulate their relationships with those units which have short-falls. Surpluses could also open up space for the transition to city life where non-subsistence specialists, such as scribes, priests, and royalty, could be sustained through the movement of subsistence surpluses produced by farmers and foragers into their hands (Childe, 1954). Thus, we see that subsistence change in autonomous villages can spur social change and evolution.

Another area in which subsistence change in small-scale societies has been shown to have a significant impact cross-culturally, has been on economic segmentation and labor organization. As discussed above, cross-cultural regularities have been found in societies where subsistence production is being intensified, whereby increased investment by individuals and subsets of the entire community population lead to greater currency for private property rights claims over both subsistence products and the means of subsistence production (Bowles and Choi, 2013; Brown and Podolefsky, 1976; Crothers, 2008; Netting, 1982). Additionally, such investments are incentivized by intensified property rights. Thus, within sedentary communities which have increasing subsistence demands, there are several forces which both push and pull communities towards allowing for both subsistence products and the means of subsistence production to be held privately. An obvious consequence of this, as has been noted previously is that as such products and means become privatized, subsistence economies become segmented along the lines of the social units with can claim property rights (Flannery, 1972).

Changing labor demands are another aspect of increasing subsistence production, which can restructure intra-community economic relations. Many forms of subsistence intensification, such as field preparation or deep planting of seeds or the coordinated harvest of crops which ripen simultaneously (Stone, 1996: 55), require greatly increased repeat labor inputs. One

common response to this demand is to restructure labor organization so that work parties are larger (Cordell and Plog, 1979; Hill and Trierweiler, 1986; Longacre, 1966) and more segmented in the performance of tasks (Stone, 1996).

In foraging communities, the hunting of herds and larger animals is typically a coordinated communal activity which requires multiple individuals for any single successful procurement while gathering plant foods is typically done in groups, but by independent individuals requiring minimal coordination (Keeley, 1995; Waguespack, 2005). With the transition to intensive subsistence production, labor and the means of production typically become segmented (Flannery, 1972; Netting, 1990). However, as subsistence production continues to intensify, it is typical for labor demands and, thus, labor party size to increase again (Flannery, 2002, 1972; Pasternak et al., 1976). Because labor groups tend to be family households or compounds (Blanton, 1994; Netting, 1993, 1990; Netting et al., 1984; Wilk and Rathje, 1982; Wilk, 1991; Yanagisako, 1979), this trend has been called the curvilinear relationship between familial or household and social or economic complexity (Blumberg and Winch, 1977; Blumberg, 1978). Thus, we see that subsistence change can drive both labor organization, but also, more importantly, economic relations, household composition, and even familial structures.

Subsistence change has also been closely linked to rapid population growth in small-scale societies. This is an especially important process associated with subsistence change as demographic expansion is widely viewed as a major driver of social change in general (Bandy, 2010; Boserup, 1981, 1965; Cohen, 1977; Johnson and Earle, 2000; Keeley, 1988; Netting, 1990). A number of specific consequences of this population growth will be discussed further below. The most prominent process linking subsistence change and population growth is through

subsistence intensification (Bandy, 2010; Bocquet-Appel and Bar-Yosef, 2008; Bocquet-Appel, 2011a, 2009, 2002; Clark et al., 2010; Hassan and Sengel, 1973; Stiner et al., 2000, 1999; Winterhalder and Leslie, 2002).

In recent years, there have been a number of studies that have identified a demographic pattern whereby with the introduction of agriculture into village communities, population growth increases significantly. The rate of population growth eventually reaches a new high level and then quickly declines (Bandy, 2005; Bocquet-Appel and Bar-Yosef, 2008; Bocquet-Appel and Naji, 2006; Bocquet-Appel, 2011a, 2011b, 2009, 2002). While it has long been argued that there was an increase in population growth rates upon the introduction of agriculture in many places (Bentley et al., 1993a, 1993b; Buikstra et al., 1986; Eshed et al., 2004a; Hassan and Sengel, 1973; Henry, 2002; Larsen, 1995; Winterhalder and Leslie, 2002), the two-stage nature of the demographic transition and the consistency with which it has been identified through multiple methods in multiple places, from skeletal data in Eurasia (Bocquet-Appel, 2002) to settlement data in the Americas (Bandy, 2005), has been a surprise.

However, this process is not quite as simple as it appears on the face of it. Chamberlain (2006) was the first to point out that this pattern, if it was repeated in every village community upon the introduction of domesticates, would be surprising indeed. This is because low-level food producers have not been shown to have significantly higher reproductive rates than foragers (Bentley et al., 1993a, 1993b). It is only with the introduction of what Chamberlain (2006) describes as intensive agriculture that fertility rates increase dramatically (see also Kramer and Boone, 2002). It might be slightly more accurate to say that when economies become predominantly based on intensive carbohydrate-focused agriculture that we see dramatic rises in

fertility (Bocquet-Appel, 2008; Buikstra et al., 1986; Valeggia and Ellison, 2009; Winterhalder and Leslie, 2002).

Chamberlain (2006) pointed to demographic data from eastern North America – one of the areas of primary plant domestication – presented by Bocquet-Appel and Naji (2006) to show that the introduction of domesticates under conditions of low-level food production (Smith, 2001) did not lead to population growth. Instead, there was a 1,000 year delay until the introduction of corn-beans-squash agriculture in the area before the demographic transition was seen. Additionally, in other areas of primary domestication, even in places such as Mesoamerica where the corn-beans-squash package introduced into eastern North America developed locally and became the focus of high intensity farming capable of sustaining massive cities (Palerm, 1955), it could take time for such an economy to develop (Flannery, 1973, 1972; Pearsall, 1995).

Turning to southwest Asia – another area of primary plant domestication – a different, but equally unique pattern emerges. Some have argued, on the basis of settlement data in the western portions of the southern Levant, that there was no detectable demographic transition with the introduction of domesticates (Goring-Morris and Belfer-Cohen, 2010, 2008). Others have argued that in the eastern portions of the southern Levant, where we have evidence of significant developments in storage technology before domesticates appear in the archaeological record (Finlayson et al., 2011a, 2011b; Kuijt and Finlayson, 2009), that fertility rose significantly based on subsistence intensification via storage before agriculture (Goodale, 2009; Kuijt, 2009b, 2008a).

Additionally, in the southern Levant, a number of researchers have shown that the tempo of increasing population growth with the slow onset of agriculture was equally slow (Goodale, 2009; Guerrero et al., 2008; Kuijt, 2008a), similar to the situation identified by Chamberlain

(2006) in the eastern US. Kuijt (2008a) and Goodale (2009) argued that domestication was not what kick started population growth, but rather the slow convergence of a number of subsistence technologies that allowed for increased production through time. They looked to the areal coverage of sites, depth of deposits, radiocarbon date frequencies, and storage technology. Guerrero et al. (2008) looked at osteological demographic data from cemeteries and noted the same pattern.

Interestingly, another study of cemetery data came to a more complex conclusion. Hershkovitz and Gopher (2008) found evidence that population growth was significant during the Early/Late Natufian – the period of initial sedentism (Bar-Yosef and Belfer-Cohen, 1989), the PPNA – the period of initial significant storage (Kuijt and Finlayson, 2009), and the PPNC – a more puzzling period to have experienced significant population growth as it is often viewed as a time of social reorganization where large villages begin to shrink. However it is also the period where large-scale pastoralism is believed to have grown to significant proportions in subsistence economies (Kohler-Rollefson, 1992; Martin, 1999; Nissen, 1993; Quintero et al., 2004). They also found much lower rates of growth during the Final Natufian – a period of dispersal and increased residential mobility (Bar-Yosef, 1998) and the LPPNB – again, a puzzling period for such a low rate of growth, as it is often viewed as a period of population growth given the dramatic expansion of individual village areas (Kuijt, 2000a).

However, when considering the sample used, the LPPNB/PPNC puzzle is easily explained. During the LPPNB the Jordan Valley and Judean Hills may have experienced depopulation of sites, while the Transjordan Plateau shows explosive growth within villages (Gebel, 2004; however, see Goring-Morris and Belfer-Cohen, 2013, 2010, 2008 for an argument and chart of settlement frequencies for Cisjordan - without the presentation of supporting data -

that such a depopulations is not seen). The authors only use the MPPNB Jordan Valley site of Jericho and the PPNB Judean Hill sites of Kfar HaHoresh and Abu Ghosh in their analysis. As for the PPNC, again the sample site is small, with only 'Ain Ghazal and Atlit Yam, both of which are thought to have become highly specialized in their subsistence strategies in order to maintain or expand their populations during a period of general population dispersal, with Atlit Yam extensively consuming marine, as well as terrestrial subsistence resources (Galili and Nir, 1993) and 'Ain Ghazal developing an intensive pastoral component to its subsistence economy (Wasse, 2002, 2000). Thus, the surprising trends in population growth during the LPPNB/PPNC observed by the authors can be explained as a product of the sample selected for analysis.

Others have pointed out that while one would see an immediate signal of plant husbandry's introduction into secondary areas based on the appearance domesticates, this does not hold true for primary areas of domestication where significant husbandry can be occurring before morphological changes in crops (Zeder and Smith, 2009). This point is of primary importance, as much of Bocquet-Appel and his colleagues' data are derived from secondary centers of agriculture where whole packages of nutritionally and ecologically complimentary crops were introduced at once. The classic example of this being the introduction of the Neolithic Package, consisting of cereals, pulses, and medium and large mammals, into Europe from southwest Asia (Bogaard, 2005; Colledge, 2005; Halstead, 2006; Richards, 2003). Thus, Bocquet-Appel's (2002) original data from the Neolithic of Europe derive from a set of circumstances where an immediate spike in population growth would be expected.

So, while there is some variation in demographic patterning around agriculture, increasing subsistence production does, in general, seem to lead to more rapid population growth. This process, in turn, drives further increases in production as population growth is the

classic cause of subsistence intensification (Boserup, 1965). In the southern Levant for example, likely rapid population growth in the LPPNB coincides with the introduction of agro-pastoral economies (Bogaard and Isaakidou, 2010) and potentially pastoral nomadism (Quintero et al., 2004). It is quickly followed by the introduction of water wells (Galili and Nir, 1993) and check dams (Kuijt et al., 2007). In fact, it is useful to remember that domesticates also appear after population growth, not before (Kuijt, 2009b). While Zeder and Smith (2009) note that husbandry precedes the emergence of domestic morphologies (Hillman and Davies, 1990a, 1990b), those domestic morphologies selected for either consciously or unconsciously by cultivators allow for greater crop productivity and are, therefore, a form of intensification (Cohen, 1977; Makarewicz, 2012: 219)

A number of authors have argued that another important historical effect of this rapid population growth has been the expansion of farming populations into either uninhabited territory or into lands controlled by foragers (Ammerman and Cavalli-Sforza, 1971, 1984; Bellwood, 2001, 2005, 2009; Bellwood and Renfrew, 2002; Diamond and Bellwood, 2003; Bellwood and Oxenham, 2008; But see Richards, 2003 for critique). While these authors do vary in the details of how this process occurs, there are some general elements that most of these models share. The three key factors in these models are (1) the military advantages of larger population size, (2) the push to expand into new territories in order to increase production that demographic expansion encourages, and (3) long-term population effects of higher reproduction rates in agricultural populations as compared to forager ones. With these three factors, farmer populations would expand due to demand for land and would do so either through population swamping or by force. No matter what the method, the outcome was the same.

Another area in which subsistence change in small-scale societies has been of great interest to anthropologists is the seeming cross-cultural reformulation of relations of humans to their environments. This process is essentially rearranging the place of humans within their ecosystems and the ways that they participate in the transfer of energy through such systems (Stiner and Feeley-Harnik, 2011). A number of recent authors have argued that human agency within an ecological context allows for people to actively participate in constructing ecological niches and reformulating their niches through time (Bleed, 2006; Kuijt and Prentiss, 2009; Laland and O'Brien, 2010; Rowley-Conwy and Layton, 2011; Smith, 2011a, 2011b, 2007a).

One of the most profound changes in the subsistence production systems of small-scale societies has been the process of subsistence intensification through the husbandry of resources. During this process, people began to relate to and interact with both animals and plants dramatically differently than they had previously. Bird-David (1990) argued that foraging groups related to their environment as parent and that parents give unconditionally to their children. Foragers essentially place themselves in the world of the environment where it gives them what they need to survive and guides them in life. This is contrasted with cultivators who view the environment as ancestor whereby they must make ritual offerings in exchange for the giving of subsistence products. Thus, as people begin to husband their environment they transition from the giving environment to exchanges with the environment. The latter, being the active husbandry of environmental resources, acknowledges the human intervention in the relationship of production or, in other words, the restructuring of the transfer of energy through the ecosystem.

Ingold (2000) looked specifically to the ways that foragers versus people practicing husbandry related to animals. He argued against the idea that foragers were part of nature, but

with the domestication of animals, pastoralists rose above animals. Rather, he saw both foragers and pastoralists as participating in human-animal relations. These relations are simply on different terms. Foragers interact with animals in a trusting relationship. With the advent of pastoralism humans no longer attempt to interact in a trusting manner. Rather they attempt to dominate animals in order to make them behave in ways they desire.

Russell (2012), in an impressively large volume on social zooarchaeology, makes an expansive review of animal domestication and the seemingly endless theories of how animal husbandry altered human-animal relations. While there are many ideas out there in the literature, Russell (2012) does hold to a single aspect of animal husbandry as core to the idea, no matter what the cultural complexities built up around any specific relationship may be: ownership. While such a definition can be complex when it comes to the relationship of wild herds and territoriality in foraging communities, the emergence of individual, familial, household, or corporate group ownership of animals is central to husbandry and is likely a result of the same sorts of processes through which all intensively produced goods tend to come under more narrow ownership.

Many of the same processes that occur with the husbandry of animal resources also occur with the husbandry of plant resources. Rindos (1984) argued that people did not domesticate plants in a unidirectional process of human agency. Rather, plants and people entered into symbiotic relationships where they coevolved together into dependent relationships. He notes that agriculture had created a population explosion for a great many species of both plants and animals, suggesting that their genes had been highly adaptive. Thus, subsistence change altered the relationship between humans and plants into one of extreme co-evolutionary interdependence. Recently, Smith (2011a, 2011b) has taken a more agent-based perspective on

subsistence change in small-scale societies advocating the conscious construction of ecological niches by knowledgeable individuals and communities attempting to improve subsistence production outcomes. Thus, subsistence change is ever present and human-plant and human-animal relations are constantly being reworked

The Historical Significance of the Neolithic of Southwest Asia

A second perspective taken on the Neolithic of southwest Asia is that of the historically specific event. So, while there has been subsistence change throughout the world, the specific changes that occurred in the Middle East during the Neolithic were especially important for local, regional, continental, and even world history. Recently, Gamble (2007) has argued against the idea that the Neolithic “changed everything.” By this he means that the Neolithic did not create a new human identity. Rather it was merely a total shift in the organization of human social worlds, which does seem to still be a significant event in Old World prehistory. He argued that the Neolithic witnessed a transition in human extension through technological means from instruments (items intended to change objects) to containers (items intended to hold objects), using the exact same language as Mumford (1961) and strikingly similar to Hodder (1990).

However, perhaps the most classic of the historical perspectives on subsistence change in the Neolithic was first brought out fully within archaeology by Childe (1952). Childe (1952) and later researchers argued that the Neolithic Revolution as he termed it was essentially the origins moment of social evolution in Eurasia. With the advent of agriculture during this period, a space was opened up for increasing subsistence production and, thus, for social evolution.

Such a perspective is hardly passé, with any number of authors still looking to the Neolithic of southwest Asia specifically for the foundational moment of Old World history (Diamond, 1997; Gamble, 2007; Gowlett et al., 2012). However, now the specifics of how and

why this transition took place have become quite variable with advocates arguing a whole host of causes from the most psychological (Cauvin, 2000; Hodder, 1990) to the most environmental (Bar-Yosef and Meadow, 1995) and everything in between. What many of these theorists share is the background assumption that the event of the Neolithic Revolution, however it is now understood, was of some historical import. Perhaps the most prominent recent example of this has been argued by Diamond (1997), who moved one step beyond the idea that the Neolithic is the origins of Eurasian social evolution. In many ways he advocates the position that contemporary inequalities around the world have their roots in the Neolithic. Thus, we see that to understand subsistence change in the Neolithic is of utmost importance to any number of prominent historical theories and understandings.

Impact of this Research on the Study of the PPNB of the Southern Levant

This study will have an impact on both our understandings of the specifics of the PPNB of the southern Levant and broader anthropological understandings of village development and subsistence change in small-scale societies. Within the early Neolithic of the southern Levant this dissertation will show that some early villagers practiced dual residence mobility with a secondary residence for nuclear family households located directly within subsistence production loci. It will also show that individual nuclear family households held land tenure claims to specific plots, extensive property rights to both subsistence products and intensively produced artifacts, and even access rights to or potential control of limited natural resources.

Beyond these new understandings, this study will speak to a number of previous conceptions of the PPNB of the southern Levant. It will provide an opportunity to analyze the composition of households, following up on the suggestions of Flannery (1972). It will also add information and provide several possible alternative potential understandings of the hypothesized

specialized craft production of naviform blades suggested by Quintero and Wilke (Quintero and Wilke, 1995; Quintero, 2011, 1998). It will furnish data on labor group size which can be used to assess Kuijt (2009a)'s idea that village size increased during the PPNB because there was a need for greater labor forces. It will also add significantly to our understandings of certain social phenomena previously only inferred from ethnographic analogy. This research will begin to redress the situation noted by Kuijt (2009a) and Banning (2012) of a lack of data to help reconstruct subsistence methods and not just subsistence products. It will also help address Banning (1998) and Simmons (2007)'s critiques by add nuance to our understandings of Neolithic economic relations in the realms of composition of economic units, the nature of property rights and land tenure, and the sorts of resources procured outside of villages.

Broader Anthropological Impact of Dissertation

This dissertation is primarily concerned with three topics of significant anthropological interest in a wide variety of regions around the world: (1) the emergence of villages, (2) subsistence change in small-scale societies, and (3) changing economic relations in small-scale societies. It is hoped that by analyzing the process of village emergence and its relationship to subsistence change during the PPNB of the southern Levant that much of the general theory about these processes can be studied diachronically. The southern Levant is especially suited for such analysis being one of the most intensively studied areas of village emergence under conditions of subsistence intensification and change. The diachronic perspective available through the archaeological record of the region is key to testing models developed largely from the ethnographic record. Additionally, through the comparison of the processes of village emergence and subsistence change in the southern Levant with other small-scale societies, it will be possible to understand not just parallels between case-studies, but also differences. This has

the potential to complicate models of social change through time in small-scale societies, but also to help rework our understandings of the important social processes internal to communities, which bring about villages and subsistence change.

As will be discussed in detail later, the dating of al-Khayran to the MPPNB puts it right at this time when the earliest agricultural villages in western Transjordan begin to rapidly grow into large-scale, economically and socially elaborated settlements. The contents of al-Khayran, including the material remains and the economic systems in which they were embedded indicate that a number of phenomena previously hypothesized to exist in the PPNB, including increasing subsistence production (Cohen, 1977; Flannery, 1972; Makarewicz, 2012), the expansion of property rights (Banning, 2012, 1998; Bowles and Choi, 2013; Flannery, 1972; Kuijt, 2000a), the emergence of segmented economies (Byrd, 2005a, 2000, 1994; Flannery, 1972), and the development of complex possibly craft production system (Barzilai, 2010; Quintero and Wilke, 1995; Quintero, 2011, 1998; Rollefson and Parker, 2002) all did in fact develop early on in the village development process.

However, an analysis of the remains at al-Khayran shows that these processes of social change were enacted through several behaviors not previously recognized within village sites of the early Neolithic of southwest Asia. By giving contours to the general processes that have been hypothesized for early village development during the PPNB and throughout the world, this dissertation will identify the social mechanisms through which such changes occurred and the ways that these social mechanisms had multiple effects beyond those previously hypothesized.

This research will show that a dual residence settlement pattern, whereby residents move between two structures during the annual labor cycle – typically a primary house within a village and a satellite field house located within a subsistence production locus – developed amongst

some households during the PPNB. Such a settlement pattern has a number of social uses, including increasing subsistence production (Chisholm, 1979; Stone, 1996; Sutton, 1977), decreasing social tensions in settlements which are growing in density and population (Moore, 1979; Bandy and Fox, 2010a: 8-16), and reducing exposure to biological pressures such as disease risks (Moore, 1979) and cognitive overwhelming (Fletcher, 1995; Kosse, 1990). However, in order for dual-residence mobility to be practiced by subsistence producers, certain economic relations, which are not universal in small-scale societies, must be in place. Such things as individual, familial, or household land tenure must exist (Henderson, 2010), as must exclusive property rights over subsistence products (Flannery, 1972; Hayden, 1990; Kuijt, 2000a). Thus, we see that village development can drive subsistence change, which in turn can drive changes in economic relations.

However, as will be seen in later chapters, materials from al-Khayran illustrate that not only do these demographic, ecological, sociological, and economic forces drive change in early villages, but so does human agency operating through cultural meanings. Novel cultural concepts developing through the processes of social change were malleable and open to manipulation by households looking to control valuable resources. Many of the changes to economic relations that are witnessed during the PPNB had a rational basis in the intensification of subsistence production. However, the social logics that opened up the space for intensifying practices could be repurposed to create not just community-wide economic growth, but intra-community economic differentiation. Specifically, the emergent concepts of property rights which became applicable to subsistence production loci and subsistence products based on the labor theory of property could be used to justify access rights to scarce natural resources, such as flint sources, based on the first occupancy theory of property (see Becker, 1977 on property rights theory).

Such social maneuverings also had down the line consequences beyond the simple control of natural resources. They also potentially affected the control of valuable craft items. This is because emergent craft specialization in the PPNB was dependent on access to limited natural resources, like high-quality flint for the production of complexly knapped blades (Barzilai and Goring-Morris, 2012; Quintero and Wilke, 1995; Quintero, 2011, 1998) or colorful stone for beads (Bar-Yosef Mayer and Porat, 2008; Fabiano et al., 2004; Rollefson, 2002). If craft producers could claim exclusive access rights to these resources, they could more thoroughly protect the economic and social benefits they accrued from such activities (Arnold, 1993, 1987; Costin, 2001, 1991). Thus, we see that subsistence change in early villages did not only accommodate demographic patterns seen in such settlements, but also opened up social spaces for novel social and economic relations. These new forms of relations, in turn, were some of the most potent forces of social change in small-scale societies.

However, interestingly, this dissertation also provides a nuanced critique of simplistic economic models of the rise of wealth inequality as an inevitable product of economic relations. Rather, it shows that the ritual intensification previously identified in the region (Cauvin, 2000) and in other early village societies (Bandy and Fox, 2010b, Part 2) could not only serve to tamp down conflict (Bandy and Fox, 2010c: VIII) and create a sense of community cohesion (Adler and Wilshusen, 1990; Adler, 1989; Kuijt, 2008b), but also regulate against the development of inequalities (Kuijt, 1996).

What we see in the PPNB of the southern Levant is the emergence of economic relations which could potentially provide the material means for the creation of durable intergenerational wealth differentiation (Shenk et al., 2010; Smith et al., 2010) through stronger land tenure claims and the broadening of the sorts of landscape resources which can come under tenure claims. The

means of nutritional production in the form of subsistence production loci, as well as the means of specialized craft production in the form of limited and valuable natural resources in the landscape are both being claimed by households.

Finally, this dissertation will analyze the potential for the assertion of access rights by the residents of al-Khayran to the high-quality flint source directly adjacent to the site. The craft for which this flint was likely destined was the production of naviform cores and the high number of long straight blades which can be produced from them. Quintero and Wilk (1995) who first demonstrated the high likelihood that such blades were craft products argued that naviform core-blade technology developed within the intensifying cereal-based subsistence economies of the PPNB and vanished from the archaeological record with the dis-intensification of agricultural production in the subsequent Pottery Neolithic.

Organization of Dissertation

Chapter 2 of this dissertation reviews the theoretical background of village development, and subsistence systems in villages, as well as methodological issues around studying the relationship between villages and subsistence. Chapter 3 reviews the geographical and chronological background of the specific case analyzed in this dissertation. Chapter 4 presents the evidence for the growth of villages in the early Neolithic of the southern Levant. Chapter 5 presents the evidence of demographic growth and changing social organization in the early Neolithic villages of the southern Levant. Chapter 6 describes changing economic practices in the early Neolithic. Chapter 7 presents previous research on the functioning of subsistence production systems, changing economic relations which structure these systems, and an overall reconstruction of economic practices and relations as a coherent system. Chapter 8 describes in greater detail the seven interrelated hypotheses about village development and subsistence

change which are tested in this dissertation. Chapter 9 briefly outlines the research procedures followed in order to generate the necessary data to test these hypotheses. Chapter 10 is the first of three chapters presenting the results of fieldwork at the site of al-Khayran. It covers site-specific and regional spatial data as well as the chronological place of al-Khayran. Chapter 11 present the ecofactual results of the analyses of several types of scientific samples taken from al-Khayran. Chapter 12 presents the artifactual results from al-Khayran. Chapter 13 then mobilizes these results to test the seven hypotheses presented in Chapter 8 and discusses the implications of the test results. The final chapter of this dissertation, Chapter 14, presents a comprehensive analysis of the results from ADAP and their implications for the relationship between village development trajectories and subsistence change, as well as the implications of these results for future research both in anthropology in general and the ADAP study area specifically.

Chapter 2: Village Settlement and Subsistence Production System

Defining the Village

The word “village” has a number of popular meanings in English. British law, for example, sees a village as a category that contrasts with the smaller settlement unit known as a hamlet and a large unit known as a town. All three are clusters of residences in a single settlement. A village has a parish church and a town has a church (or several) and a public agricultural marketplace (Rowley, 2006; Wild, 2004). Anthropologists have used more inclusive, broader definitions that fit other cultural contexts outside of Britain and the Church of England. Bandy and Fox (2010: 6), in their introduction to an edited volume on the comparative study of early villages, choose to leave the meaning up to individual authors while noting and specifying the differences in the definitions used. As quoted in the previous chapter, they choose to define early villages using four criteria: (1) intensifiable food production, (2) sedentism, (3) settlement autonomy, and (4) recent formation of the settlement type within the region. They say that “the early village process” is shaped by these four factors. Thus, they do not specify size or content, either architectural or institutional, as a criterion. Rather, they isolate social and economic processes at work within settlements, as well as temporal aspects of development. However, this definition still does not help differentiate villages from other sedentary, autonomous settlement types.

Struever's (1971) definition of the “maximum local aggregate,” the maximum number of individuals who occupy a single settlement at some time during a settlement cycle, is important

for defining the social boundaries of the village (K. V Flannery, 1976), but still does not bracket a set of settlements under a single definition of village. Braidwood (1973) chose to emphasize (1) residence clustering, (2) permanent habitation, and (3) agriculture in his definition of the “primary village-farming community.” In southwestern US and Latin American archaeology, size criteria tend to be used to contrast villages from smaller hamlets and larger towns (harkening back to the vocabulary of the English usage). Thus, we get the minimum count of 15 houses or 75 inhabitants (Wilshusen, 1991: 204; cf. Sanders et al., 1979). While there is some basis for these counts, it is hard to imagine that archaeologists can distinguish between a village of 15 households and 74 individuals or 15 households and 75 individuals. Thus, we are stuck with a definition that ignores just the kinds of processes put forth by Bandy and Fox (2010a).

Additionally, these definitions were developed from very different settlement patterns than those seen in village-based societies. Namely, the difference between a hamlet and village is not necessarily particularly important until you are looking at a two- or three-tiered settlement hierarchy like the one found in 19th-century England. In non-hierarchical settlement patterns, size differences are differences in total number of residences and little more (although this is not true for other site types such as logistical resource extraction or ritual sites). Certainly size differences can matter, but not in the functional differentiation of village sites. In fact, if size differences in residential settlements do begin to matter in certain areas such as political or economic relations, then this is the definition of change away from a non-hierarchical settlement patterns to a hierarchical one or at the very least economic and/or social segmentation through such processes as the development of economic specialization or the formation of neighborhoods.

Thus, there is no perfect or ready-made definition of the village that fits all cultures. Instead, the village remains a category in need of specification. In this study I develop a

definition of the village for the specific purposes of my analyses. According to the definition I use, sedentism is not a necessary aspect of the village. Would it seem reasonable to say that New York City is not a city if some of its inhabitants travel overnight for work, go on vacations, visit relatives, or own summer homes (Bell and Ward, 2000)? In the case of New York City it is easy to dismiss these concerns, but such concerns become more relevant in sites that were less continuously occupied. Do villages where young men and women move back and forth between them qualify as villages, even if the occupation in any one place is short-term but the settlement itself is permanent (Chapman and Prothero, 1983; Farmer, 1999; Silitshena, 1983)? What do we do with sites that were inhabited only in summer and winter where there is a seasonal pattern of aggregation into large settlements and dispersal into smaller ones (Ames, 1994; Prentiss and Kuijt, 2004)? In other words, when do we consider a settlement a *base-camp*, rather than a village (Boyd, 2006; Edwards, 1989; Henry, 1995, 1989)? I sidestep this question by simply using “village” as shorthand for the type of settlements found in the PPNB. Such settlements seem to fit rather easily into our popular definition and have been identified all over the world and in different time periods, making their comparative study with similar such villages a fruitful exercise.

Two common settlement patterns have been identified by anthropologists for village-based populations in settlement types similar to PPNB villages. The first is populations living permanently in a single settlement except for the occasional logistical procurement trip (Quintero, 1996; Schyle, 2007; Titiev, 1937), social visit (Amiry and Tamari, 1989), hunting trip (Beaglehole, 1936), or religious ritual or pilgrimage (Bar-Yosef and Alon, 1988; Goring-Morris and Horwitz, 2007). The second is populations living semi-permanently within a multi-residence settlement, with an annual seasonal departure to and from a subsistence production loci by a

significant portion of the population (Preucel, 1990). The former is what invoked for the PPNB by essentially all authors, with the latter most commonly studied in the archaeology of the late prehistoric US Southwest (e.g., Crown, 1983; Henderson, 2010; Kohler, 1992; Moore, 1979; Pilles, 1969; Preucel, 1990; Ward, 1978), but are also known from quite a few other places and times (Amiry and Tamari, 1989; Antoun, 1972; Eskelinen, 1977a; Moore, 1979; Sidibe, 1978).

The latter of these settlement types does raise the issue of full sedentism and its place in the definition of the village. If a base-camp is different from a village because people move to and from the base-camp annually, then why would a settlement where a significant portion of the population disperse and aggregate seasonally not be a base-camp? In order to understand why such a pattern is different in some socially significant way, I turn to humans as agents embedded within a material world. This material not only constrains human behavior, but provides the material through which humans give meaning to their world and, thus, are capable of acting in it.

Perhaps one of the more intriguing aspects of what I define as a village is the investment of labor into houses and residential architecture. Typically, architecture in villages is built to last beyond the short-term or season occupation of an individual house (Lane, 1986). A house is intended to last, even if its inhabitants leave for some duration. Whereas, in camps, habitations are renovated or newly assembled upon each return (Maher et al., 2012; Nadel and Werker, 1999). Certainly, the remains of past structures can be re-used and architectural portions may be permanent, such as wall foundations (Bar-Yosef and Goren, 1973; Boyd, 1992). But each time occupants move into a camp, structures are renewed in some way. Thus, we see that villages can be viewed as places where the architecture itself (i.e., the built environment) is a key component of the definition (Wilson, 1988). Such is the character of villages embedded within settlement systems like those of the late prehistoric US Southwest.

There are also characteristics specific to the settlement type of the village which are important for understanding the arguments put forth in this study. Villages have a concentration of population beyond the individual house or single functional economic unit within a society. It is a settlement that contains multiple economic units (Stone, 1996). When such a settlement is embedded within a landscape of autonomous villages or village clusters – as is typical in early village societies like those of the PPNB – ethnological studies have shown that there is likely to be a small degree of specialized production of goods or knowledge, but not a functional segmentation of a significant number of economic realms within the whole (Costin, 2001; Sahlins, 1972). Households are largely self-sustaining through production of their own subsistence, even if certain individuals or associations do practice various specialized production behaviors (Flannery, 2002, 1972).

This contrasts sharply with villages embedded in hierarchical settlement systems where certain households may not be self-sufficient. However, it does accommodate many types of villages found within hierarchical settlement patterns such as peasant or subsistence agricultural communities (Kroot, 2011). This exception is made in the definition as compared to others used by archaeologists interested in early village social processes because it can open up a great deal of ethnographic, sociological, economic, and historic data for comparative analysis. In other words, the material, spatial, and temporal realities faced by smallholder subsistence economic units can frequently lead to similar choices in economic behavior regardless of broader economic relations within society. What is not, however, accommodated in this definition of the village settlement type is the economically specialized village. In many hierarchical settlement patterns individual villages can be highly specialized production centers. In such settlements households or individual economic units are not self-sustaining. Additionally, the village itself is not the

primary economic universe of the inhabitants. Many goods required for the sustenance and reproduction of the economic unit must flow into the village from other areas (Schwartz and Falconer, 1994).

One aspect that is seemingly definitional according to ethnological and comparative archaeological studies of early village societies, such as those of the PPNB, which is not viewed as absolutely definitional of the village settlement type for the comparative study within this dissertation, is the political autonomy of the village. A number of authors have argued that the autonomous village is a common form of political organization seen developing all over the world during the process of social evolution (Bandy and Fox, 2010a; Braidwood, 1973; Carneiro, 2002, 1987b; Childe, 1954; Marcus, 2008; Steel, 2010; Townsend, 1985). While this seems to be true empirically for both worldwide observations on social change and specifically in southwest Asia (Baird, 2002; Kuijt and Goring-Morris, 2002: 388), there are a number of more complex political formations whereby settlements and more specifically their economic units can be largely but not absolutely autonomous politically, socially, and economically.

Many states and empires which practice indirect rule can contain villages which are nominally part of the political unit, but which are largely autonomous save perhaps a single government official and the taxes this individual collects (Kroot, 2011). Thus, many of the processes of subsistence change found in such villages are predominantly driven by the same forces that drive change in autonomous village. Even in peasant villages where certain legal institutions such as land tenure and property taxes have led to highly differentiated household wealth, the scale of the household and the household as production unit can still create many of the same processes of subsistence change that are found in more egalitarian societies (Lutfiyya,

1966). This make the comparative study of subsistence change in any village-based household production unit community a useful exercise.

It also must be noted that autonomous villages may not be isolated, but spatially located in village clusters (Adams and Duff, 2004). This is a common phenomenon which can be found throughout the world. Villages may be embedded in multiple politico-spatial arrangements whereby non-hierarchical clusters of villages may exist within a wider regional context of autonomous village clusters. The classic example of this is in the US Southwest where non-hierarchical village clusters of largely (although not entirely) shared ethnic identity existed and these clusters, rather than the individual villages, were typically the actors in regional politics.

The Structures of Village Subsistence Systems

In order to understand subsistence change in village development, it is first necessary to understand how village subsistence systems are structured. Two overarching categories of forces structure village subsistence systems: material/spatiotemporal forces and socio-economic forces. Such things as the geography of settlement catchment areas, the subsistence ecology of a community, and human anatomy and physiology all are material aspects of a subsistence system. The properties of these materials serve as both mediums through which people creatively work (Gell, 1998; Heidegger, 1962; Ingold, 2000b; Keane, 2005, 2003; Latour, 2005; Mead, 1934; Munn, 1986; Peirce, 1958), but also barriers to the potentially infinite creative solutions available to agents (Binford, 1978; Foucault, 1975; Giddens, 1984; Hodder, 2012; Latour, 2005; Renfrew, 2004). The same could be said of the social world of agents (Bourdieu, 1977; Giddens, 1984; Latour, 2005). In the following section both these sets of forces will be described before an analysis of how they interact with the temporal development or change of village-based communities.

Agrarian geography (e.g., Losch, 1954; Christaller, 1966; von Thunen, 1966; Hudson, 1969; Chisholm, 1979), subsistence ecology (e.g., Netting, 1974; Stone, 1996), and anthropological archaeology (e.g., Vita-Finzi and Higgs, 1970; Flannery, 1976b; Steponaitis, 1981; Wilkinson, 1989, 2003; Wilkinson et al., 2007) have all developed a significant body of theory on the relationships between settlement patterns, resource locations, human movement, socio-economic structures, and energy expenditures. It has been shown that settlement location and settlement structure are both malleable through time based on the choices available to individual agentive producers concerned with increasing their efficiency of energy usage and resource extraction in subsistence systems. On a very basic level, people tend to locate their settlements in such a way as to have efficient access to resources with energy (in all its forms including both kinetic energy, such as travel, and potential energy, such gasoline for transportation vehicles or fodder) as the primary currency for understanding this efficiency (Chisholm, 1979; Grigg, 1982; Pimentel and Pimentel, 2008; Stiner and Feeley-Harnik, 2011).

This is because, while human behavioral ecology is about the situatedness of humans within the totality of movements of matter and energy that are ecosystems, energy expenditures are the most malleable aspect of subsistence ecological practices by knowing and critical human agents. Tools can be reused, but energy is gone once it is expended. Humans and animals have minimum nutritional requirements below which they cannot survive and reproduce, not matter what technological change has occurred. However, both behavioral change and technological change can frequently improve energy balances either through access to new sources of energy or the more efficient use of energy (Boserup, 1981). Thus, we see that the material aspects of the means, agents, and products of subsistence production are much more constant in their demands than the energetic requirements of these constituent parts of subsistence systems.

Additionally, the positions of behavioral loci are produced through a relationship between the location of resource extraction-sites and the movement of producers. While much of subsistence behavior is about capturing matter and energy from resource locations, because many resource extraction-sites, such as agricultural soils, flint for tool making, and stands of wild plant foods, tend to be virtually stationary, it is movement and its energy expenditure aspects which are the primary method in determining the dynamic actions of agents in subsistence systems. Thus, while matter is a major part of the location of practices (Chisholm, 1979: 95-96; Stone, 1996: 15-17), energy expenditures are the most malleable part of subsistence systems. Therefore, movement minimization behavior, essentially minimizing energy expenditures, is the primary dynamic aspect of food production (Boserup, 1965; Chisholm, 1979; Grigg, 1982; Pimentel and Pimentel, 2008; Stiner and Feeley-Harnik, 2011; Stone, 1996).

Additionally, subsistence practices unfold through time and are embedded within temporal patterns of required inputs, such as seasonal rainfall patterns, and available outputs, such as the seasonal fruiting of trees (McCorriston and Hole, 1991; Sherratt, 1980; Spencer, 1959; Stone et al., 1990). As Blaikie (1971: 4) noted (and as noted above), a major aspect of agriculture is as a system of movements. Thus, these temporal structures of the material inputs and outputs of subsistence production can also effect the spatial and temporal structures of settlement and habitation patterns (Moore, 1975; Preucel, 1990).

The second set of forces which effect the structures of subsistence production systems are socio-economic in nature. One of the most basic ways in which such forces in economically autonomous villages can structure subsistence practices is the organization of production, distribution, and consumption as a whole for a community. In many small-scale societies the fruits of one's labors are redistributed beyond the producer and/or his or her own primary

residential unit or nuclear family. This is done through a variety of means from socially enforced sharing (Lee, 1990; Sahlins, 1972; Wolf, 1982) to rules which govern the processing and consumption of subsistence items to the community as a whole (Gowdy, 1999; Ingold, 1999; Lee, 1990).

In such communities an egalitarian ethos of sharing often pervades economic activity. Most subsistence practices occur during communal activities either through cooperative labor or individual behavior in groups. Within individual-based subsistence activities there is still an attitude that the activity is being conducted for, if not by, the group as a whole. Because subsistence activities are communal and even for those activities which are not, products are shared, there is very little incentive to intensify production (Flannery, 1972; Sahlins, 1972). However, if certain subsistence activities are done by individuals or small groups, then the segmentation of not only production behaviors, but also of risks and rewards from these activities, then there is an incentive to intensify to guard against failure and possibly to aggrandize (Flannery, 1972; Hayden, 1995; Sahlins, 1972).

How this process unfolds is primarily structured by the composition of economic units in villages. It must be noted that segmented economies are not structured in a singular manner with individual economic units remaining fully autonomous and independent at all times. Rather, different economic tasks can be performed by different types of economic units within the same community, from the domestic group to the volunteer labor force to the synthetic household to the communal labor party to the individual market seller (Stone, 1996). Additionally, individual economic units on the same scale of organization, such as the household, can perform different tasks (Costin, 2001, 1991), as can different individuals operating on behalf of the economic unit (Erasmus, 1956; Hendon, 2004, 1996; Roth, 2010). However, this is not to say that economic

units are not durable in segmented small-scale societies or that certain types of units do not predominate in such communities.

In fact, differences in the basic structure of economic units have been shown to be one of the most important aspects of understanding subsistence production (Blumberg and Winch, 1977; Blumberg, 1978; Flannery, 2002, 1972; Netting, 1993, 1982; Pasternak et al., 1976; Wilk, 1984). The domestic unit is typically the most emphasized economic unit in the literature, and with good reason as it is perhaps the most common form of such a unit found in sedentary societies. The domestic unit, or household to use the more common terminology, is a highly variable institution across different communities (Blanton, 1994; Hendon, 2004, 1996; Netting, 1993; Netting et al., 1984; Wilk and Rathje, 1982; Wilk, 1991, 1984; Yanagisako, 1979).

As was briefly noted in the previous chapter, much of this variability derives from various economic pressures which develop during periods of demographic, social, and economic change (Blumberg and Winch, 1977; Blumberg, 1978; Flannery, 2002, 1972; Pasternak et al., 1976). The most basic example of this is the “curvilinear hypothesis” of household and socio-political complexity (Blumberg and Winch, 1977; Blumberg, 1978). It argues that in small-scale mobile societies such as foragers, communities tend to live together as a single large group of related individuals who share in economic products. As communities become more sedentary and increase in size they tend to segment into nuclear family residential production units to increase productivity to meet the needs of growing populations with reduced access to productive lands. Again, as group size increases and the complexity of production does as well in order to continue increases in productivity, households tend to grow into extended family units, similar in size and form to kin-communal foraging communities. This is done in order to increase household labor forces to accommodate more complex production processes. Finally, as society

continues to grow and production of economic staples become the realm of corporate groups, household size again decreases to the nuclear family as the basic reproductive unit becomes prioritized. This is because economic production has now moved outside of the household, making labor organization a matter for non-familial-based producers. Therefore, habitation, consumption, and biological reproduction, rather than economic production are prioritized in the formation of households. Since the nuclear family is the basic unit of biological reproduction, it again becomes the basic co-residential unit.

It may be obvious to any anthropologist that there is going to be considerably more variation to the causes of change and forms which households take when observed cross-culturally. An alternative form of household not analyzed in the hypothesis that has received considerable attention recently, as discussed in the previous chapter, is the house society form of composite household. Members may or may not be co-residents and may or may not be biological kin, but they are regarded as such in discursive practices and economic relations (Levi-Strauss, 1988). Countless additional forms of households, including temporary synthetic households (Eskelinen, 1977a) and aggregate households of adults in distant and fictive kin relations (Nelson, 2008) to name just two examples, have been identified in the anthropological literature. However, the curvilinear hypothesis does draw out both differential potential roles of the household in the economy, culture, and biology of a society, and economic forces which can act upon households. In fact, many of the economic forces attested to in the hypothesis have proven fruitful in the analysis of alternative forms of households (Eskelinen, 1977a; Nelson, 2008).

Perhaps most prominently, the curvilinear hypothesis highlights the relationship between households and labor organization in small-scale societies. In most such communities households

serve not only as the social location of economic rights and relations, but also the organizing institution for economic practices (Blanton, 1994; Netting, 1993; Netting et al., 1984; Wilk and Rathje, 1982; Wilk, 1991, 1984; Yanagisako, 1979). However, as Hendon (1996, 2004) and others (Roth, 2010) have illustrated, this does not simply mean that the household is the agent in economic activities. Rather, individuals within households, while sharing certain economic rights and practicing certain economic relationships, are the ones who must invariably carry out economic activities. Thus, even within households there is a division of labor.

For example, in many small holder farming communities, where farming is done by individual households on plots small enough in size to be conducted by the residential unit, a whole host of different economic units can be found in operation within any given community. Some subsistence tasks are conducted from beginning to end by groups of individuals from multiple households, such as hunting of large herds of animals (Beaglehole, 1936). Other subsistence production methods can require different associations during different tasks.

A wonderful example of this comes from the Dogon of Mali where an extended family serves as the labor force for the patriarch of the harvest season synthetic household. This household, composed of the nuclear families of the oldest generation of labor-age brothers and their children, moves into a large in-field compound of multiple structures during harvest season for the staple crop of millet. The eldest brother is the owner of all subsistence products but pays a set amount of the products derived from the labor association's work to the male head of every participating household, as well as any men in his family too old to labor (Eskelinen, 1977a).

Other cases can be just as complex in vastly different ways, such as amongst Fellahin (village peasant farmers) in Jordan where nuclear household farming units divide up the composition of labor associations based on task. The preparing of fields is done by the male head

of household (i.e., the father), planting is done by a father and daughter, tending is done by mothers and daughters, harvesting is done by the family as a whole and sometimes even outside labor, and processing is done by a father and son (Antoun, 1972). Thus, we can see that the complexities of economic segmentation in village communities heavily effects labor organization as well as household composition.

We can also see from the above examples that the specifics of economic tasks can heavily structure the division of labor within village communities. Thus, certain activities can require labor pools well beyond the extended family in size. In such cases, there are a number of options for the aggregating of labor. All adult men or women, volunteer groups of men and women, individual kinship lineages, and other forms of corporate groups can all be ways of successfully recruiting large labor pools. Another mechanism in market economies is the hiring of labor. As Stone (1996: 53-56) has argued, almost all small-scale communities have certain economic activities that are performed by these various forms of communal labor composed of individuals from multiple households.

When assessing the overall patterns of labor organizations found in village-based communities, we can see that there is a great amount of flexibility. While households do tend to serve as the basic economic unit, the composition of households is flexible and responsive to economic demands. Some small-scale communities have communal economic relations (Lee, 1990), other have nuclear households (Amiry and Tamari, 1989; Antoun, 1972; Bradfield, 1995; Eskelinen, 1977a; Lutfiyya, 1966; Tannous, 1944), and still others have extended households (Pasternak et al., 1976) or even socially constructed house society style economic units (Levi-Strauss, 1988). Some communities have shifting household composition which follows cyclical

patterns (Eskelinen, 1977a). Others have been shown to have the composition and scale of households change through time (Banning and Byrd, 1989a, 1987; Rollefson, 1997).

This complexity does not stop with labor organization. In many small-scale economically segmented communities the distribution of goods can frequently be well beyond the residential or familial unit of the producer through such means as gifting (delayed reciprocity) (Mauss, 1950), immediate reciprocity (Sahlins, 1972), feasting (Hayden, 1995), secondary ritual trading (Malinowski, 1922), the rewarding of “volunteer” labor with food and drink (Beaglehole, 1937; Stone, 1996), rules governing the processing and consumption of subsistence items for those within a labor party (Beaglehole, 1936; Eskelinen, 1977a), ritual redistribution (E. C. Adams, 1991), share-cropping (Lutfiyya, 1966), simple social niceties (Bradfield, 1995), market-based exchange (Bohannon and Dalton, 1962), and, within political economic hierarchies, taxation (Antoun, 1972). Thus, what we see with the segmentation of the economy is not only the creation of an incentive to intensify, but also the creation of a whole host social facts which can be recruited into the process.

Perhaps none of these potential social facts can be more important for economic change than the creation and utilization of various forms of property rights. While all societies have private property (Stiner et al., 2011), mobile groups tend to have property be only things which can be carried with an individual. These items also tend to be goods that have required significant investment of labor, such as arrowheads, ceremonial costumes, and the like (Ingold, 1999). The greater the investments by individuals, the more likely items are to be held privately. Therefore, subsistence production loci in foraging communities are not typically held individually, because no one individual is the sole investor in the production of subsistence items. Only when an individual harvests goods do certain forms of property rights kick in. These

tend to be fairly elaborate and designed to prevent the holding or hoarding of subsistence goods in mobile groups (Lee, 1990).

Many small-scale agricultural societies utilize usufruct land rights where communities or corporate groups own land, but turn over utilization rights to individuals or production units. This is essentially a recognition in a husbandry economy that land itself is the means of production through which subsistence goods are derived. Therefore, in order to maintain egalitarian economic relations over the long-run, land is the object that cannot be held privately (Netting, 1993). Thus, the expansion of absolute private property rights into realms such as subsistence products is a first step towards the privatization of any number of other types of objects and the potential for the development of durable wealth inequalities (Stiner et al., 2011: 255).

The development of corporate group land tenure, as opposed to communal rights, is an all the more potent change in economic relations that allows for durable inequalities. There are several possible ways of doing this. One such possibility is the lineage (Bradfield, 1971) or other large-scale, sub-village economic unit composed of multiple households being a means of maintaining greater equality. The access to land for any individual large-scale corporate group will tend to be balanced by other such economic units and individual households will tend to have similar economic relations to each other as households within wider communal-based economic organizations. It is with the development of segmentary residentially-based economic units who can claim household-based land tenure rights, that durable wealth inequalities have the greatest potential for developing (Netting, 1982). An interesting question would be the relationship between the creation of households as economic units due to economic pressures, as

reviewed above, the creation of land tenure rights for architectural households due to village development, and the creation of land tenure rights for subsistence production loci.

When individual economic units intensify production through increased investment in the means of production then they tend to not only claim the products of their labor, but also the means in which they have invested so heavily. Another way of looking at this is that not only are subsistence goods the products of their labor, but also the modified means of production. Thus, things like land can become private property (Stone, 1994). When individual economic units have land tenure rights to production loci, this opens up several possibilities for the creation of durable inequalities, such as property rights to all the subsistence products of land. With this, the accumulation of greater wealth to be utilized for social purposes, such as creating relationships of obligation, debt, and unequal power relations (Hayden, 1995, 1990; Price and Feinman, 2010). Segmentary land tenure rights also open up the possibility of differential access to higher quality resources, such as the most valuable subsistence production loci. This differential access to quality production loci, in turn, create differential production, accumulation, and creation of obligation opportunities for economic units (Kohler, 1992). Additionally, once land itself is recruited into the realm of property rights, land tenure can become a social tool to claim not only subsistence production loci, but also access rights to other natural resources (Netting, 1982). In this way the segmentation of economic production and the development of property rights can open up a social space for individuals and economic units to control supply chains for scarce items (Arnold, 1993; Hayden, 1995).

Another important contributing factor to the development of economic inequalities in small-scale communities is land inheritance (Shenk et al., 2010; Smith et al., 2010). In many small-scale societies, while individuals may have usufruct rights to land held by corporate

groups, upon social changes or death, those rights can be rearranged (Netting, 1993, 1990, 1982). When individuals and their offspring get to maintain control of land – the resource that enables production – then inequalities easily develops. Just like other forms of property rights, intergenerational wealth transfers largely are tied to utilization. As families tend to work land or practice any number of productive activities together, the means of production tend to be utilized by multiple generations, even if only one individual may hold rights to the means. Thus, upon the passing of individuals, rights will tend to be passed on to those by whom the means have already been a utilized (Goody, 1972). Thus, again, great expenditures during production that both requires multiple generations of labor along with heavy investment in the means of production will encourage the assertion of inheritance rights of these means.

Defining Processes of Village Development and Subsistence Change

While the structures and processes of economic practices in villages have been reviewed above, in order to understand how they relate to village development processes, it is necessary to review the structures and processes of community development in small-scale societies. As has been noted in the previous chapter, there are three basic processes which create, reproduce, and change village social formations: (1) Population growth, (2) subsistence intensification, and (3) limits on settlement growth. The first of these topics has already been discussed in some detail in the preceding chapter and therefore need not be described again. Suffice it to say that the reader must keep population growth in mind as a common and almost essential process at work during village development.

Subsistence change has also been discussed in a certain amount of detail above. However, because the focus of this dissertation is the relationship of village development and substance change, further discussion is warranted. The third process, the limits of settlement

growth, has only been cursorily discussed and, thus, deserves further attention as these limits are typically what directly drive subsistence intensification in village-based communities. Population growth is correlated with subsistence intensification (Boserup, 1965), but it is the pressures (Cohen, 1977) on communities created by population growth that directly drive subsistence change. Therefore, the latter two processes commonly at work in village communities, subsistence change and the limits of settlement growth, will be taken on in the rest of this chapter.

Because the limits of settlement growth typically drive the processes of subsistence change, they will be presented first. This will be followed by a discussion of the processes which alleviate these pressures; specifically how subsistence change is one of the most effective methods for holding together communities as they grow. Not only can subsistence change increase production to meet increasing subsistence needs, but it can also create new social roles and associations through the segmentation of the economy and the development of economic relations, which can be utilized to alleviate both the subsistence and social pressures of village life.

The Limits of Settlement Growth

Social Pressures

The many social pressures that individuals and communities experience in villages have been extensively discussed by a wide variety of researchers. Some of the earliest contributions to this topic of study showed that as population grows, interactions grow. This will increase the number of social conflicts within a community (Carneiro, 1987a; Chagnon, 1975; Rappaport, 1968). This same growth in population also can begin to confound the ability of populations to effectively provide the necessary flow of information to all stakeholders within a community.

This creates greater difficulties in decision-making and increases adverse effects on members of the community from these less-well-informed decisions (Johnson, 1982, 1978). Others have shown that the flow of material goods can also breakdown as populations expand in village communities. One of the cornerstones of small-scale community economics is reciprocity. Many goods flow between agents within small, autonomous communities. As population increases, the balance of reciprocity becomes more difficult to track and enact, thus creating both material and social pressures within communities (Kohler et al., 2000).

Other researchers have look, not to social systems and their strain within villages, but rather to human biology and especially human cognitive adaptations for understanding the social frictions that occur. Fletcher (1995) has argued that the very nature of villages with their increases in sensory experiences push human cognition beyond the limits of comfort. Dunbar (1993) has argued that villages increase social complexity beyond the scope of the social cognitive capacity of the human brain, pointing to the relationship between group size and neo-cortex ratio in primate societies. He notes that village sizes rarely exceed 150 individuals in the Neolithic of Mesopotamia or the ethnographic present in New Guinea. Thus, it is possible that some aspects of the social pressures experiences in villages may have some basis in human physiology (see Kosse, 1990 for a similar argument about human memory capacity).

Biological Pressures

The most basic of pressures, which has received a great deal of attention anthropologically, is that of disease in agricultural villages. Many studies have now shown that with the rise of sedentary village communities, a number of community wide risk factors take shape. These include the buildup of waste and refuse in living and working spaces (Hardy-Smith and Edwards, 2004), an increase in the sharing of space with both domestic (Hershkovitz and

Gopher, 2008) and commensal (Tchernov, 1984) animals, an increase in daily person-to-person contact (Eshed et al., 2010), an increase in community populations, which in turn increases the potential pool of hosts for diseases to maintain themselves in a population and mutate (Pearce-Duvet, 2006), and a reduction in the quality of nutritional intake, itself causing certain illnesses as well as depressing the immune system, thus making populations more susceptible to diseases (Cohen and Armelagos, 1984). All of these pressures lead to increases in morbidity and mortality in populations as well as decreases in health indicators such as height and bone development (Cohen, 2008).

Subsistence Pressures

Large population sizes and nucleated settlements narrow the range of potential subsistence procurement strategies available to producers. Many of the practices available to smaller communities that increase food security and minimize land degradation are not practical in larger and denser villages, which require much higher subsistence outputs, while simultaneously having inhibited access to adequate land due to travel and transport costs (Campbell, 2009). Smaller populations can vary the temporal and spatial structure of their practices to increase the diversity of resources and patches from which they procure food while minimizing the long-term over-exploitation of the environment. This is because land requirements and competition over resources are significantly lower in less-densely populated areas (Kelly, 2007). As villages grow, they require intensified agricultural practices in order to meet the needs of the community. The intensity of these practices constrains the spatial and temporal diversity available to subsistence producers (Stone, 1996). However, social systems and cultural practices still significantly affect who and how this production is structured. Subsistence practices are enacted through the cultural concepts that organize these communities and thus,

these concepts structure the organization of labor within these communities' food systems (Netting, 1982).

Subsistence pressures in agricultural villages are an area of study that has received quite a bit of attention from anthropologists, largely because of its relationship to domestication (e.g. Cohen, 1977). The most obvious and primary of these pressures is the increased demand on subsistence production due to population growth; the more people, the more mouths to feed (e.g. Cohen, 2008). This, in turn, requires increased agricultural outputs, which can be achieved through a variety of methods. These include agricultural intensification (e.g. Boserup, 1965; Brookfield, 1972) and extensification (e.g. Stone, 1996). However, both of these solutions themselves produce pressures on subsistence, with intensification increasing agricultural inputs (Boserup, 1965) and environmental degradation (Blaikie and Brookfield, 1987) and extensification increasing labor costs (Chisholm, 1979; von Thunen, 1966), energy expenditures (Johnson, 1977), inter-community conflicts (Kohler, 1992), environmental degradation (Rollefson and Kohler-Rollefson, 1992), land demands (Stone, 1996), and intra-subsistence system competition between certain varieties of agricultural practices and complementary foraging practices, such as the destruction of crops and wild vegetation by goat herds (Kohler-Rollefson and Rollefson, 1990).

While the reduction in the quality of the nutritional intake of subsistence agriculturalists as compared to some foragers and high-income individuals in post-industrial economies has negative health effects on villagers (Cohen and Armelagos, 1984; Cohen, 1989), as noted above, it also puts pressure on their subsistence systems to overcome these health effects. The largest contributing factor to this decrease in nutritional quality is a narrowing of the variety of foods that contribute to the diets of communities, especially in communities with an emphasis on

highly calorically productive cereal farming (Larsen, 1995). The specifics of the effects of this narrowing of food sources vary from community to community, but some common themes are a reduction in animal proteins (and thus in the consumption of all essential amino acids), fiber, and vitamins and minerals (Hassan and Sengel, 1973). There is also an increase in easily absorbable processed carbohydrates, typically within cereal-based agricultural communities. This occurs because of the ease of calorie consumption from such foods, allowing for short-term energy benefits, but at the cost of long-term nutritional balance (Buikstra et al., 1986).

Additionally, due to the narrowing of diet breadth, subsistence risk increases. Blights or other environmental factors that affect specific species or specific areas, such as floods or droughts, can wipe out a much larger portion of the nutritional resources on which a community relies (Abbo et al., 2010). There is greater potential variation in seasonal subsistence stress when the main crops a community relies upon are not immediately available (Kuijt, 2008a). Finally, certain social processes common in farming communities, such as private property and inequality, can put nutritional stress on large portions of communities (Kohler, 1992).

The Alleviation of Village Life Pressures

While these pressures are not wholly unique to villages, they are especially amplified by increasing regional and settlement populations (Kohler, 1989; Stone, 1996). In order to maintain increasing settlement sizes, the pressures must be alleviated. Many processes that alleviate pressures do not allow for continued growth such as fissioning (e.g. Bandy, 2004; 2010; Carneiro, 1987; Chagnon, 1975), abandonment (e.g. Cameron and Tomka, 1993), dispersal/settlement reorganization (e.g. Hegmon et al., 1998; Nelson, 1993; Nelson and Hegmon, 2001; Nelson et al., 2006; Nelson and Schachner, 2002), or frontier settlement (e.g., Stone, 1996). One of the most studied processes that alleviate many of these pressures is the

development of hierarchical social organization, whereby community decision-making processes are placed in the hands of the few, simplifying organization and mobilization, while simultaneously legitimizing the decisions (Bandy, 2010, 2004; Flannery, 1972; Kosse, 1990; Wright, 1977). However, a number of other processes have been observed that do not lead to class-based institutionalized inequalities (which typically are associated with hierarchical settlement patterns).

There are a number of options open to growing villages in non-hierarchical settlement systems to meet their subsistence needs including (1) increase the territory used for subsistence (i.e. agricultural extensification) (Stone, 1996), (2) increase the extraction of subsistence resources from the same amount of territory (i.e. agricultural intensification) (Boserup, 1965), (3) develop exchange relationships with other communities that produce complementary subsistence goods (Bayman, 1999), and (4) decreasing demand and/or increasing consumption efficiency (“tightening one’s belt”) (Sahlins, 1972). Causal mechanisms and methods for the intensification of agricultural inputs and extensification of agricultural systems in order to gain greater outputs within both small and large-scale farms have been recognized, with an enormous literature developing around agrarian ecology (Stone, 1996). The literature on small-scale agriculturalists is largely devoted to understanding recent and contemporary developing-world farming systems and the challenges they face both entering into and due to the capitalist Modern World-System (e.g. Netting, 1993). However, much of the theory derived from these studies of agricultural change are applicable to villages embedded in a variety of different forms of economic systems, as they are produced within subsistence farming and/or peasant farming communities where subsistence systems are predominantly local in their orientation. Additionally, the goal of increasing productivity can produce similar practices whether this goal is driven by value

concepts or by subsistence needs. Thus, this theory can also be applicable to small-scale village agricultural economies in the deep past.

In order for agricultural practices to extract greater outputs from a given area of land, there must be increases in inputs. This can be done in the form of increased labor intensity and greater efficiency in labor organization (Pasternak et al., 1976), increased material inputs (Stone, 1996), such as increasing use of fertilizers, changes in production scheduling (Boserup, 1965), such as fallow shortening, the introduction of new technologies (Feder et al., 1985), such as more efficient harvesting mechanisms or irrigation systems, infrastructure construction (Netting, 1968), such as terracing, and increasing capital inputs (Boserup, 1981), such as purchases of harvesting equipment. One major form of intensification which has received a considerable amount of attention within prehistoric village communities is storage, which allows for the saving of seasonal agricultural outputs for use throughout the year and beyond (Halstead, 1981; Kuijt, 2008a; O'Shea, 1981).

Extensification comes in a variety of forms as well, including the development of specialized, mobile, logistical task-groups to secure resources outside of the daily site-catchment area (Titiev, 1937) and the development of specialized pastoral-nomadic groups who exchange their animal products with villagers for farm products (Bar-Yosef and Khazanov, 1992; Khazanov, 1984). Extensification can also be viewed as a form of intensification through increases in labor inputs in order to bring more land into the subsistence system. In addition to increase agricultural outputs, extensification can also guard against another of the causes of subsistence pressure in villages, blight or environmental disaster. Spreading out the areas where subsistence production occurs can prevent blight from affecting the entire agricultural system

and can place productive land in a variety of areas, differentially exposed to the various potential environmental disasters that can destroy subsistence resources (Abbo et al., 2010).

Another process that can be used to secure greater quantities and varieties of subsistence goods for both risk-buffering and improved diet is inter-community exchange (Spielmann, 1986), such as agriculturalists exchanging their farmed good with pastoral nomads as mentioned above (Khazanov, 1984), inter-agriculturalist exchange (Halstead, 1981; O'Shea, 1981; Plog, 1989; Upham, 1982; Wallerstein, 1974), or farmer-hunter exchange (Gregg, 1988; Peterson, 1978; Spielmann and Eders, 1994; Spielmann et al., 1990). In these cases, there need not be any increase in subsistence outputs. However, a surplus of some sorts of good desired by outside communities must be produced in order to be available for exchange (i.e. nutritional outputs may not increase, but the value of goods for exchange must in order to be used to secure greater food resources from exchange) (Wallerstein, 1974).

Agricultural intensification and extensification can create their own subsistence pressures. The most obvious of these is environmental degradation, with intensification removing nutrients from soil faster than they can be replaced (Kohler-Rollefson, 1988), using up potentially scarce water resources (Kijne et al., 2003), producing waste and runoff that can destroy surrounding environments (Tilman et al., 2002), and creating monocultures that can be vulnerable to blight and environmental hazards (Kimbrell, 2002) and, thus, can lead to abrupt destruction of all species in a given area (Blaikie and Brookfield, 1987). Extensification can increase the amount of land degraded by agriculture with such practices as shifting cultivation (e.g. slash and burn agriculture: Carneiro, 1960), the expansion of browsers and grazers across larger swaths of land and in greater numbers than the vegetation can sustain (Kohler-Rollefson, 1988), increasing competition to unsustainable levels for wild species (Daehler, 2003), the

reduction in biodiversity in an area (Altieri, 1999), the killing of certain predator species in order to protect flocks from loss (Noss and Cooperrider, 1994), and the cutting off of ecologically complementary habitats for migratory species through cultivation, hunting, and infrastructure construction (Noss, 1983). All of these can have consequences for other sectors of subsistence systems, such as hunting or gathering or the functioning of ecological processes which maintain potential fertility levels outside of human intervention.

Several other developments have been shown to alleviate some of the subsistence problems facing villagers other than through intensification, extensification, exchange, and belt-tightening. The development of social segmentation, when tied to material flows, can create situations where subsistence products, which are embedded in the production and reproduction of social relationships, can be redistributed through gifting, reciprocity, exchange, and/or aggrandizement (Hayden, 1990; Johnson, 1982). These processes, in turn, can enable subsistence intensification through the demand for products and the production of socially embedded, efficient specialist production and, thus, can indirectly produce greater nutritional resources for communities (Hayden, 1990).

How these alleviations of subsistence pressure are enacted varies cross-culturally based on social relations, economic organization, settlement patterns, and the material character of the means of production. However, one common denominator when looking at the development of village communities is an increase in production. It is also clear that the specific characteristics of village communities narrow the choices available to subsistence producers in order to increase production. Many of the solutions to subsistence pressure discussed above, such as settlement dispersal, increasing mobility, and extensification, are antithetical to village-based settlement organization. Thus, subsistence agriculturalists living in villages embedded within non-

hierarchical settlement systems utilize a complex system of intensification processes across their cultural landscapes in order to obtain sufficient resources.

Chapter 3: Isolated Structures and Other Small-Scale Sites within Village Settlement Systems

In this next chapter I will describe the role of isolate subsistence structures and other small-scale subsistence sites found in village settlements systems. Such sites will be referred to as satellite settlements (Chisholm, 1979; Stone, 1996). These structures can serve a variety of functions within a production system from wind breaks and shades to annually constructed structures occasionally utilized for overnight stays (Moore, 1979) to seasonally inhabited field houses and compounds (Sidibe, 1978) to farming communities inhabited by a subset of a larger village population during the agricultural season (Preucel, 1990).

Satellite Settlements

Demangeon (1962: 516) has argued that permanent occupation within fields, rather than the utilization of field houses, farmer's shelters, or any other form of satellite agricultural settlement is frequently the most efficient subsistence production strategy, especially amongst small-scale producers (see also Stone, 1996: 42-50 and references therein). It reduced travel and transportation costs and can free people from social restraints on practices and the stresses of communal life. Thus, this frequently leads to a dispersed settlement pattern amongst agriculturalists with permanent habitations in or near production loci. Chisholm (1979: 114-121) gave a number of examples of this principle from such places as Italy, Upper Volta, Egypt, Thailand, Mexico, and Fiji. In each of these cases the efficiencies of in-field permanent habitations outweighed whatever pull that nucleated settlements may have had.

This is because subsistence production loci “pull” producers’ habitation locations towards them through field-labor demands, as the performance of such tasks requires travel and transportation expenditures for accessing production areas. In order to reduce overall costs, it is more efficient to locate habitations on or near fields as this reduces travel and transportation expenditures. The greater the field-labor demands, the greater the frequency of travel and transportation expenditures which, in turn, increases the pull of production loci on habitation location. Therefore, the more intensive subsistence practices become the more likely habitations are to be located near production loci. This leads to a typical pattern of settlement dispersal as producers increase subsistence expenditures, with the habitations of individual production units separated by the field they utilize (Stone, 1996: 40-48). Thus, the utilization of satellite settlements requires explanation. They are not *a priori* an obvious solution to land pressures considering the travel and transport pressures they create on inhabitants as they move back and forth between primary and satellite settlements.

While the labor demands of increasing production create an incentive to locate habitations near production loci, there are other forces which pull producers towards aggregating settlements – a process which is termed settlement gravitation. Central Place Theory (CPT) (Christaller, 1966) suggests that population aggregations can include other functions important to subsistence producers outside of subsistence production loci, such as specialized tool production or consumers for craft goods. Because multiple autonomous producers can require access to the single location of a function, it is typically most efficient to centralize the location of this function amongst those who utilize it. Additionally, because there are frequently many functions which subsistence producers must access, it is usually most efficient to cluster the loci of these multiple functions in a central place (Stone 1996: 48-52).

This aggregate pulls producers' habitations towards a central place, as easiest access to this myriad of functions reduces travel and transportation costs by reducing the length of trips to the various functions' loci. Therefore, the distance between habitations and central places containing function loci adjust relative to the frequency and duration with which producers access central functions versus production loci and the costs involved in travel and transportation to and from these same central functions and production loci. Greatest efficiency in the form of energy cost minimization can be reached by adjusting the location of production, habitation, and/or function. Thus, producers can be pulled towards aggregating if settlement nucleation proves more efficient due to higher needs to access a variety of centralized functions versus the travel, transportation, and field-labor requirements of in-field production.

Stone (1996: 48) noted that one common scenario argued to bring about population aggregation in village-based communities is access to large labor pools in order to increase subsistence production (e.g. Cordell and Plog, 1979; Hill and Trierweiler, 1986; Vivian, 1989). If continued population growth leads to the need for greater subsistence production, then changes in the organization of field-labor can be a form of increasing subsistence outputs. Often, greater labor investment in production can lead to periods of bottlenecks (Erasmus, 1956), which require large labor forces to perform time-sensitive tasks. In order to accomplish these tasks producers must recruit sufficient labor; something that can be made easier in more nucleated settlements. Thus, a central place function (labor recruitment) creates settlement gravitation (Stone, 1996: 55).

However, the process of aggregation in order to increase ease of access to central functions brings about further subsistence pressures. Larger villages require greater subsistence production to meet the needs of growing populations. At the same time the spatial organization

of nucleated settlements brings about a reduction in the overall availability of production loci relative to population. This is because individual producers can access lands only to a certain distance from habitation location due to increasing travel and transportation costs the further one travels to a locus (Sutton, 1977). Under dispersed settlement patterns, the territories around individuals' habitation locations which producers can effectively reach typically either only partially overlap or do not overlap at all (Stone, 1996). However, in heavily nucleated settlements, producers' effective production territories significantly overlap as their starting point for travel to production loci are so densely clustered. Thus, in order to produce sufficient subsistence goods for the settlement population, greater quantities of outputs must be achieved from the same amount of territory or more efficient means of transportation must develop. Therefore, even though population nucleation may have originally been a strategy to increase outputs, the changes it brings about to the spatial organization of subsistence production create a situation where further increases in outputs per unit of area often must occur (Sutton, 1977).

One common response to a need for high levels of outputs while experiencing settlement gravitation is the development of satellite settlements (Chisholm, 1979; Stone, 1996). There is a whole spectrum of forms that satellite settlements take. In fact, most subsistence production loci repeatedly visited by the same social unit have some form of architectural structure or feature associated with them if any portion of the area is located at a greater distance than a garden plot directly in front of a residence (Moore, 1979). Within this spectrum the form and intensity of in-field settlements varies significantly based on a number of factors, including distance from primary residence (Sutton, 1977), fragmentation of production loci (Stone, 1996), intensity of labor time and energy expenditures in production loci (Moore, 1979), duration of tenure

(Wendorf, 1956), ownership claims (Kohler, 1992), and the extent of economic dependencies between economic units (Preucel, 1990).

At their most basic satellite settlements can consist of low intensity constructions such as temporary wind breaks or shade structures (Moore, 1979). At their most extensive they can include seasonally occupied field houses (Sutton, 1977), compounds for extended families (Eskelinen, 1977a), and even what Preucel (1990) terms “farming communities,” seasonally occupied settlements of multiple household outside of the primary settlement. In addition to these forms of satellite settlements within village-based, there are a number of other forms of small settlements and isolated structures which are used for other purposes than subsistence production. These can include logistical procurement sites for resources other than food, such as knapping stone (Schyle, 2007) or salt (Titiev, 1937), hunting lodges and other forms of recreational activities (Moore, 1979), and even homesteads which are occupied year-round (Banning, 1995).

In many ways, the forces that structure settlement patterns in nucleated versus dispersed agricultural settlements are the same forces which structure the choices made by producers about satellite settlement location and the intensity of their occupation at and investment in the sites. The essential ingredients for understanding the uses of satellite settlements are energy expenditures, use-rights, and economic relations. On the low end of the intensity and investment spectrum, the basic typically temporary structures placed within or near subsistence production loci are used for a variety purposes having to do primarily with human metabolism. These can include wind-breaks and shade structures which provide a respite from harsh weather conditions. They can allow for labor breaks and for the body to conserve energy. Such structures are found within most production loci when a primary residence is at a far enough distance to require too

great an energy expenditure to reach when such breaks are needed or when travel to the primary residence takes too much time for efficient labor utilization (Moore, 1979).

The primary challenge for economic units that more substantial satellite settlements help alleviate is that of travel and transportation costs associated with subsistence production (Sutton, 1977). Such settlements typically develop when overnight stays are necessary within subsistence production loci. This new activity requires accommodation of a number of other living activities, such as meals. What satellite settlements allow for is a more intensive utilization of distant production loci, while still preserving the primary residence within a village settlement (Sutton, 1977). This allows for greater expenditures in subsistence production loci to increase outputs, while still maintaining a primary residence that reduce energy expenditures when procuring those functions responsible for settlement gravitation (Stone, 1996).

However, subsistence producers do not exist in vacuums. They are participants in broader social systems, which include such things as land tenure and other forms of land ownership or access rights and inter-economic unit dependencies. These systems can serve to encourage or discourage the use of satellite settlements and can serve to structure how they are used. One of the primary forces which encourages intensive use of satellite settlements is strong tenure rights to land, both within an individual producer's lifetime and across generations of producers. When producers do not get to maintain control of land for subsistence production through time, they are less likely to invest in durable improvements which can increase productivity (Stone, 1994). This holds true across generations as well where the reallocation of lands upon the death of an individual with usufruct rights can discourage investment that may require the labor of off-spring or others who will lose their investments in these improvements eventually (Adler, 1996).

One of the more astounding examples of this is from 20th century M'saken in eastern Tunisia where farmers inhabiting agro-towns rent land from wealthy owners up to 100 km away from their primary settlements. These producers must live on these plots to effectively farm them starting with plowing and planting and continuing through harvesting, with only minor interruptions of return to central places in order to procure the necessary supplies from weeding and harvesting. They can even rent the same plot repeatedly across annual cycles. However, because they do not own these plots they pack in all of their supplies on the backs of mules, including tents and food (Chisholm, 1979: 110-111). Chisholm (1979: 111) gives the even more dramatic example of San Pedro Carch in Guatemala where peasant farmers transport their products 80 km from agricultural fields back to primary villages without beasts of burden. These producers still do not construct durable architectures in their fields as they do not have land tenure rights to them. Rather, they construct temporary shelters for the season out of vegetation.

On the other end of the spectrum, when economic units are assured of some long-term benefit to significant investment in a production locus, they will construct more substantial architecture and perform more significant landscape modifications (Stone, 1994; Woodbury, 1961). However, there are a number of other factors that also affect the uses of substantial satellite settlements. In such settlements, field houses (individual structures occupied by a single economic/residential unit), are the simplest form of organization. Such settlements can have permanent architecture reoccupied on a seasonal basis during periods of greatest labor intensity within the annually subsistence production cycle by economic units and more sporadically throughout the year by members of the unit for specific tasks.

However, just like less substantial satellite settlements, social systems and economic practices can also structure the uses of seasonally occupied satellite settlements. For example,

amongst the Dogon, seasonal satellite compounds are inhabited by multiple village-based residential compound units in order to meet the labor needs of millet harvesting (Eskelinen, 1977a). In the later prehistoric period of the Puebloan Southwestern US, a number of satellite settlements took the form of agricultural villages because of the inter-dependencies between production units, even during seasonal harvest periods (Preucel, 1990). Another interesting example is the use of field houses during the grape and olive harvest amongst Palestinian smallholders in the 20th century, not so much because of the labor demands as the social demands of village life. Social niceties would require the sharing of grapes with neighbors and informants frequently pointed to the privacy of the field houses as a benefit encouraging their use (Amiry and Tamari, 1989).

Field Houses

In the following section there will be a more thorough review of these sorts of more substantial satellite settlements, focusing on field houses specifically. However, examples of and the processes at work within a variety of different forms of residential satellite settlements will be used. The existence of field houses has been reported the world over from individuals practicing modern industrial agriculture in the Midwestern US (Moore, 1979: 170) to a variety of aboriginal Mesoamerican groups (Fish and Fish, 1978) to the Dogon of West Africa (Eskelinen, 1977a; Sidibe, 1978) to the Fellahin of the Arab world (Amiry and Tamari, 1989: 34-40). Sutton (1977) catalogued numerous examples of field house usage in the Southwestern US (pp. 11-14), as well as New Guinea, Malaya, Guadalcanal, Central America, and East Africa (pp.14-16). Moore (1979: 144) identified 22 ethnographic examples of non-Puebloan field house usage in such varied locations as China, Greece, Nigeria, and the Southeastern US. Preucel (1990: 3) noted that field house utilization has been identified in all four of the major cultural groups of the

later prehistoric southwest: the Eastern and Western Puebloan groups, the Mogollon, and the Hohokam. Chisholm (1979: 110-114) furnished a number of examples of seasonally-occupied satellite agricultural settlements from such diverse places as Hungary, Tunisia, Central Africa, the South Pacific, England, India, Guatemala, and Yorubaland. Stone (1996: 50-52) cited examples of satellite settlements from Peru, the Yucatan, and Guyana. Thus, it could be said that field houses are a wide-spread social phenomenon.

The term field house was first codified in the archaeological literature by Woodbury (1961). It is now a commonly used term, especially within the anthropological and archaeological literature of the Southwestern US. A field house is one of many different types of small sites identified by anthropologists. Moore (1979: 179-180) cited at least 24 different isolate small structure site types from the ethnographic literature of the Puebloan Southwest, one of which was the farmer's shelter. It is within this site type that Moore (1979: 135) placed field houses. The following section will work through the distinguishing features of a field house versus other site types. This will be followed by a discussion of the significance of field houses within broader social processes which justify distinguishing them as a unique class of objects important for anthropological study.

Woodbury (1961: xiii) defined field houses as, "one-room structures associated with... fields, serving for summer shelter of farmers and temporary storage of the harvest." This definition is perhaps too narrow in several ways; a problem that Woodbury himself confronted later in his report when he noted several two-room field houses (Woodbury, 1961: 14). Additionally, as others have pointed out (e.g., Moore 1979: 133-134), not all field houses have evidence of storage as a major function, nor are they necessarily solely occupied during summer or harvest seasons (e.g., Moore, 1979: 88-92; Preucel, 1990: 50-52).

The main issue since Woodbury's (1961) proposed definition has been the significant variability in the function of in-field shelters. Some of the major aspects of variation in such structures' use include: (1) architecture can change purpose through time as social dynamics within communities change (Ellis, 1978: 59; Fish and Fish, 1978: 52; Preucel, 1990: 35); (2) who occupies in-field farming structures can vary across communities from single individuals to nuclear households to extended families and even multiple households (Kroot, 2011); (3) when people occupy in-field structures and for how long can also vary across communities, within communities across time, and even between production units in the same community (Kroot, 2011); (4) different groups of people can cluster in different forms of in-field residences from individual structures to multiple households (Preucel, 1990: 35; Stone, 1996: 55); and (5) not all in-field residences are temporarily occupied (Stone, 1996: 42-44).

Each of these processes can produce different field-based farmer's shelters. Permanent field-based shelters for a single production unit are typically called farmhouses if they are long-term fixed settlements or homesteads or farmsteads if they are embedded within the process of expansionary settlement (Banning, 1995; Bogaard and Isaakidou, 2010; Crown, 1983; Groover, 2008; Stone, 1996). Clusters of structures temporarily occupied by multiple production units are often labeled farming communities (e.g., Preucel, 1990: 54-56) or summer pueblos. Structures which do not serve as overnight shelters are typically excluded from any sort of terminology which includes the word "house," with authors preferring such terms as windbreaks, lean-tos, ramadas, and the like. While each of these site types would fall under the rubric of seasonally utilized farm shells (SUFS) (Moore 1979: 16) or satellite settlements (Chisholm, 1979: 110-114; Stone, 1996: 50-52) – two terms developed for in-field subsistence infrastructure – they are not field houses.

Moore (1979: 12-18), in his definition of field houses, first differentiated all isolated small structure sites into two categories: (1) limited activity sites and (2) SUFS. The former is any small site with limited architecture at which no farming activities occurs and which is at a distance from larger sites with multiple structures. The latter is any isolate small site with limited architecture where farming activities do occur. SUFS were further subdivided into farmer's shelters and field-site granaries; the former being a structure meant to shelter people and the latter being meant to store farm products. Field houses were one of three sub-categories of farmer's shelters; the other two being field shades and summer pueblos. This classification is largely followed here. Field houses are, thus, defined as (1) temporarily, but (2) repeatedly occupied (3) overnight habitation structures, (4) inhabited by an individual production unit or a portion of its members, (5) located on or near a subsistence locus or loci, (6) utilized during subsistence production activities.

As is clear from the functional variation of in-field structures described above, this definition of a field house is not merely the parsing of sites based on variation in material structure, but on the social processes in which they are bound up. As will be apparent in the following sections, these definitional aspects of field houses are due to their specific roles in social systems and processes. Certain aspects of this definition of field houses require specific social formations to be in place. Different site types emerge because of specific circumstances and play unique roles within the production, reproduction, and change of social systems. Field houses, as defined above, are a reflection of particular social phenomena and their inhabitants are social agents enacting important roles in social processes. In other words, field houses materialize specific aspects of communities' social organization, but also play specific roles in the development of these same communities' social and economic relations through time.

The Uses of Field Houses

Assumptions

The essential ingredient for each of the subsistence-based uses of field houses described below is land pressure. How this land pressure is brought about varies, but the basic circumstance within communities of producers practicing subsistence self-sufficiency (van Bath, 1963: 24) is demand for food being higher than availability. Such a situation can be brought about by increasing population (Boserup, 1965), decreasingly productive land (West, 2009), or high levels of risk in subsistence production. For such situations to exist populations must essentially be sedentary, as mobile or shifting populations adjust their settlement systems to subsistence resource availability as opposed to sedentary populations which adjust subsistence systems to resource demands (Boserup, 1965).

Alternatively, social processes can bring about increased land demands, no matter what the demographic, environmental, or settlement system processes at work within communities. The potential to accrue social and/or, especially within market economies, material capital can create incentives for intensification. The monetization of markets can amplify these incentives even further, as monetary placeholders of value tend to be highly durable (Bohannon and Dalton, 1962). These social processes which bring about land pressure are predicated on differential access to the pool of subsistence goods within communities of producers. Such economic relations can also increase in intensity as the spatial and social organization of economic systems becomes hierarchical within such social formations as multi-community subsistence economies and extractive polities (Wallerstein, 1974).

Where subsistence production is primarily focused on the local community, whether or not there are trade or extractive economic relations with outside individuals, institutions, and/or

communities and whether or not there is unequal access to subsistence goods within communities, increasing demand created by whatever forces, be they demographic, environmental, or social, can produce increased land pressure for producers. In such situations, subsistence intensification is the typical response. What follows are several ways in which field houses are a mechanism through which intensification can occur.

A General Explanation of Field House Development

One solution, which allows for population aggregation in order to have easy access to central place functions and can still bring sufficient amounts of territory under production is to change habitation and labor scheduling. Typically in intensive subsistence production there is patterned variability in labor demands through time during annual subsistence cycles. Thus, at certain known periods of the annual cycle field-labor demands are minimal, while at other times they can require long periods of full-day's work. Still other times labor demands may require the recruitment of additional workers beyond the members of the basic unit of production. Similarly, central place functions also tend to have either temporally patterned during the annual cycle or of limited durations (i.e. do not require continuous access and do not require access during specific periods of the annual subsistence cycle). The pull of a central settlement occurs only at the times when producers must access central functions and the pull of production loci occur only when fields require labor. Thus, producers can move between a primary habitation location and a satellite settlement based on when and where labor and function demands exist.

Therefore if (1) there are central place functions that pull habitations towards a central settlement, (2) there are field-labor demands which pull habitation towards production loci, (3) neither gravitational force requires permanent habitation in either a central or production location due to variable demands across time, and (4) field-labor and central function access can be

scheduled during different periods of the annual cycle, then construction of an in-field satellite settlement inhabited during periods of high subsistence labor demands can be an efficient solution to allow for both nucleated and dispersed settlement patterns that adjust to the dynamic labor and function demands of the annual subsistence cycle. Therefore, field houses, along with other forms of satellite settlements, can develop in order to accommodate new forms of labor organization due to population aggregation and nucleation and subsistence intensification.

A second, more complex scenario of the ways in which the organization of subsistence production can lead to the development of satellite settlements described by Stone (1996: 49, 50) is field fragmentation under intensive production regimes. The most common subsistence forces encouraging land fragmentation within non-market village-based economies are seasonality and risk reduction (Bentley, 1987; Blarel et al., 1992). Frequently, producers will exploit loci in multiple environments, be they edaphically, hydraulically, topographically, or ecologically different. Seasonality can play a major role in the location of multiple production loci as the productivity of variable environmental zones can be temporally differential throughout the annual subsistence cycle. Therefore, exploiting multiple environments can help create a consistent flow of subsistence goods throughout the year and/or stagger labor demands, thus reducing labor bottleneck. Exploitation of loci in multiple environments can also buffer producers from risk if, during a subsistence season, anyone of the above-listed environmental factors is problematic in one of the exploited zones, it is possible for it not to be in a different zone.

As Stone (1996: 49) described, if production loci are fragmented, then the pull of any individual locus is felt relative to the pull of all the other loci as well as central place functions. Therefore, the pull of central place functions may be stronger than that of any individual field as

central places tend to contain multiple functions which pull producers. Thus, land fragmentation may encourage settlement nucleation. However, if some or all fields still require intensive production, one or more may require some form of in-field construction. Frequently, these constructions are more ephemeral, supporting daily or occasional overnight utilization of the production locus (Colton and Colton, 1918; Hack, 1942). However, if a single or, infrequently, multiple subsistence production plots are intensively utilized requiring extended periods of labor by either individuals or multiple members of a productive unit, then it is possible to construct a field house or other habitation structure in or near fields. The greater the labor demands in any given production locus, the more likely producers are to invest heavily in the satellite settlement.

Specific Uses of Field Houses: Subsistence

Haury (1956: 7) argued that field houses provided a number of benefits for Puebloan farmers. They were used for guarding of crops and storage of harvests. They also allowed for farmers to reduce travel expenditures during agricultural production by providing temporary shelter when traveling back to one's primary village was time consuming. Woodbury (1961: 14) added more detail to these ideas by argued that field houses dating to the development of large Puebloan villages of the eleventh century CE Reserve Phase and later periods in the Point of Pines region of northeastern Arizona served to provide overnight shelter for farmers during the growing season so that they could protect their fields from predators (both human and animal) and to allow for temporary storage of harvests so that labor could be sequentially utilized. Thus, producers could harvest crops continuously, placing them in storage within field houses to dry and then, subsequently once harvesting and drying was finished, producers could transport the crops to primary habitations in villages. This created a more labor-efficient production system

where the time required to harvest crops did not cut into the time required to transport subsistence goods back to the village and vice versa.

Sutton (1977: 35, 37, 43) largely reiterated these same uses of field houses when discussing their usage amongst the Sinagua populations of central Arizona following the eruption of Sunset Crater in the eleventh century CE. However, slightly more generally, he argued that field houses provided overnight shelter to producers within or near farm fields located at a significant distance from primary village habitations in order to decrease travel and transportation expenditure during periods of high labor inputs, whatever they maybe. He argued that this increased the efficient exploitation of field (Sutton, 1977: 35, 37, 43) by reducing commute times and allowed for more continuous presence in fields, thus increasing producers' abilities to guard crops (Sutton, 1977: 43).

Moore (1979: 162-168) developed six possible arena in which field houses may have provided benefits to their inhabitants from an analysis of the ethnographic literature. Three of them have to do with subsistence production efficiency, similar to early ideas of Haury (1956), Woodbury (1961), and Sutton (1977). They perhaps added slightly more detail to these earlier writing by further parsing how field houses provided multiple different efficiencies and other benefits to producers. Moore (1979: 164-165) showed that field houses helped to conserve the energy of producers by providing in-field shelter from the elements and reducing travel and transportation expenditure through the provision of sleeping quarters. He also showed that field houses helped to reduced time inefficiencies in labor expenditures through the reduction of travel times by providing in-field habitations (Moore, 1979: 166). Thirdly, Moore (1979: 166-167) demonstrated how field houses and in-field storage structures allowed for increased subsistence production through the guarding of crops (see also Preucel, 1990: 35) and their storage for later

consumption; allowing for present surplus production to be preserved for consumption later during periods when there was a lull in subsistence production.

Preucel (1990: 35) suggested another potential subsistence-based use of field houses arguing that in-field habitation allowed farmers to more thoroughly monitor growing conditions, especially during periods of high crop vulnerability such as sprouting or fruiting when predators might destroy plants or their edible elements. Producers could also adjust micro-environmental conditions within fields due to variability in weather patterns and the surrounding ecology through time with such practices as watering, weeding, fertilizing, or the construction of agricultural infrastructure.

Specific Uses of Field Houses: Social and Biological

Moore (1979: 165-168) also gave three social uses of field houses which he gleaned from the ethnographic record of the Southwestern US. Perhaps the most prominent of these was relief from the many stresses of daily life in villages (Moore, 1979: 168). He detailed several ethnographic sources which note that life in field houses was considered by many to be an escape from the heat, crowding, social tensions, hustle and bustle, and the biological pressures of unhygienic conditions of villages (Lange, 1960: 43; Ellis, 1978; see also Titiev, 1944: 69-95 for a more detailed description of the pressures of pueblo life). These same pressures have been noted by Preucel (1990: 35, 55, 177) who suggested this use for field houses in the Pajarito Plateau of north central New Mexico during the Early Coalition Phase (ca. 1150-250 CE).

A second social use of field houses identified by Moore (1979: 165-166) was to aid in defense. He saw two ways in which this could occur. First, as notes by other field researchers (see Moore, 1979: 52 for references), individuals could retreat to field houses if their villages were attacked. Second, if villages are heavily nucleated for defensive reasons (see Haas, 1989:

502-508), which can put significant subsistence pressures on communities, field houses can allow for such a defensive stance to be maintained while production is sufficient to meet the densely-packed population's subsistence needs.

Moore's (1979: 167) third potential social use of field houses is the ability to utilize sufficient quantities of arable land in resource poor environments by heavily intensifying production at distant fields while maintaining extensive participation in community activities in nucleated villages. There may be social, cultural, religious, economic, and other reasons why a producer might want to maintain a residence within a nucleated village. However, because nucleation reduces the availability of subsistence production loci, making distant fields attractive to producers, a field house allows for them to take advantage of village-based activities while still being able to utilize distant fields.

Wilcox (1978: 28) noted that there was evidence of increased in-field labor expenditures and increased material investment in agricultural infrastructure, including field houses, in Woodbury's (1961) study of the Point of Pines region and associated this with likely increases in the assertion of land tenure rights (see also Preucel, 1990: 33; Henderson, 2010: 101, 105, 114-115). An earlier author who recognized this potential, even if he did not state it outright, was Wendorf (1956: 24) when he suggested one possible explanation for the construction of above-ground masonry isolated structures by Mogollon inhabitants of the Tularosa Basin of south-central New Mexico during a period of significant settlement aggregation (ca. 1150 and 1200 C.E.) was that families could have utilized and, therefore, maintained ownership over subsistence production loci even if they lived outside of the Basin. Thus, another potential social use of field houses, made explicit, if only briefly, by Preucel (1990: 178) is their potential to assert and/or mark land tenure rights.

Subsequently Kohler (1992) expanded this interpretation, arguing that durable, above-ground, stone masonry field houses built in the Dolores Archaeology Project (DAP) area of southwestern Colorado during the period of early village formation (ca. 600-925 CE) came to assert and mark corporate claims of land tenure within formerly communally-utilized subsistence loci as environmental degradation increased due overexploitation. Such claims were asserted on lands which provided the best opportunities for sustainable agricultural use.

Stone (1994: 321) added ethnographic detail to this premise of the field house as land tenure assertion by showing that the physical presence of a producer, allowed for by field houses located in production loci, is a major social enforcement of property rights. Where boundaries are unmarked or assertions of property rights are novel and/or not universally held or obeyed, other social cues about use rights, general sociality, and the like can be used by field house occupants to produce and enforce land tenure.

Preucel (1990: 35) also noted that a potential social use of field houses was to serve as “experimental stations” whereby producers could test out the productivity of new lands. This could help determine the viability of these lands for permanent settlement, thus facilitating the expansion of communities into new territories. This is an especially important use under conditions of demographic growth due to potential subsistence and social pressures brought about by population expansion within settlements and regions. Such a process has been observed in England where Chisholm (1979) described the budding off of new primary settlements via three step process of field house utilization, permanent residency in fields, and finally the growth of a multi-household settlement around the first permanent residence.

Chapter 4: The Archaeology of Village Subsistence Systems and Satellite Settlements

Previous chapters have been devoted to describing the structures and processes of settlement development and subsistence change in village-based communities, with special attention paid to the satellite settlements and the concept of the field house. The goal has been to understand how the two structures and processes operate and interact. Most of the analyses were derived from geographical, agronomic, economic, and ethnographic studies. However, this dissertation is devoted to analyzing villages and their subsistence economies in the archaeological record. There are some unique challenges to this, some of them already mentioned in passing. This chapter is devoted to the methods and challenges of understanding village-based subsistence systems through time from the archaeological record and how to determine the role of satellite settlements within these systems.

Archaeological Investigation of Village Subsistence Systems

Village-Based Investigations and their Challenges

There are two basic techniques used by archaeologists to reconstruct past subsistence practices: various analyses of (1) architecture and spatial data and (2) refuse and otherwise abandoned materials derived from archaeological deposits (Feinman, 2008). Through a combination of the identification of materials, their spatial contexts, and their temporal relationships as identifiable through relative and absolute dating methods, it is possible to reconstruct many of the past economic activities in which the material remains of the

archaeological record were embedded. Such things as macro-botanical (Pearsall, 2000) and phytolith (Piperno, 2006) analyses allow for the identification of remains from plants utilized by past societies. Faunal and spherulite analyses can do the same for animal remains (Canti, 1999; Reitz and Wing, 2008).

Beyond these basic methods of identifying subsistence items, other techniques such as artifact, feature, and architectural analyses allow for the identification of subsistence production and consumption practices (Andrefsky, 2005; Steadman, 1996; Wright, 1993). In addition to identifying plant and animal species within past subsistence economies, more nuanced analyses of macro-botanical and faunal assemblages (Colledge and Conolly, 2010; Marom and Bar-Oz, 2013; Munro, 2004; Redding, 2005; White and Makarewicz, 2012; Zeder and Hesse, 2000), as well as other scientific techniques such as bone isotope analysis (Makarewicz and Tuross, 2012) allow for the identification of such things as hunting strategies and husbandry methods.

Another common methods used in the reconstruction of past subsistence economies is catchment analysis (K. V. Flannery, 1976; Jarman et al., 1972; Roper, 1979; Vita-Finzi and Higgs, 1970). In such analyses the natural resources utilized by past societies are identified in region surrounding sites. This allows for archaeologists to begin modeling the movements of people to and from resources. It must always be kept in mind however, that resource availability can change through time. Such things as plants, animals, and water are all affected by human activity and climate change (Mithen and Black, 2011). One common technique used to help reconstruct such changes in ecology is pollen analysis, where fossil pollen trapped in stratigraphic layers of archaeological sites can help identify the regional presences of plants in the past (Bryant and Hall, 1993; Bryant and Holloway, 1983).

While the above review shows that archaeologists have a number of techniques for understanding past subsistence economies, the nature of these technique and the archaeological record do present some challenges for their reconstruction as well. Perhaps the most prominent such challenge in village-based communities is that residential aggregates are the most common type of site excavated. As has already been noted, most subsistence practices occur outside of such residential spaces. Thus, refuse deposits, the bread and butter of economic analyses, are only the final destination of those aspects of production and consumption which are regarded as trash. This process removes many of the spatial aspects of the economy (Hayden and Cannon, 1983).

A second challenge for understanding the structuring of subsistence systems from village refuse data is that within residential aggregates, refuse disposal is typically highly structured for reasons of cleanliness and hygiene (Hardy-Smith and Edwards, 2004; Hayden and Cannon, 1983; Smith, 1987). Therefore, refuse disposal areas are removed from residential area and are shared by multiple consumers. Thus, associating refuse with specific consumers is often impossible (Smith, 1987: 323-325; Banning, 1998: 222, 2003: 11-13; Kuijt, 2000a: 318; Gebel, 2010: 59; Peterson, 2010: 260; Price and Bar-Yosef, 2010: 160).

There are several further consequences of this issue. Not only is the refuse from consumption practices disassociated from its locus of production, but so are the tools used in production and consumption. This leads to two further difficulties. Firstly, such tools are often strong indicators of the composition of communities of practice such as households or craft producers (Binford, 1981; Flannery, 1972; Hendon, 2004, 1996; Wilk and Rathje, 1982). This makes it difficult to associate portable artifacts with the economic units which utilized them (Banning and Byrd, 1989a; Byrd, 2005a), making the identification of economic units' practices

and properties difficult (Byrd, 1994). It also makes the identification of the composition of associations utilizing spaces difficult to reconstruction (Byrd, 1994; Hayden and Cannon, 1982; Kuijt, 2000b).

Interestingly, in more dispersed settlements the opposite can be a problem. In such settlements, because space is so available, refuse systems are highly informal. This prevents trash from being concentrated in middens as most discard is done on an *ad hoc* basis and highly dispersed. Thus, identifying and recovering a significant quantity of this refuse from which to understand subsistence practices is more difficult for archaeologists (Hayden and Cannon, 1983).

Investigating Village Hinterlands in the Archaeological Record

As noted above, village excavations create challenges for understanding subsistence systems as much of the relevant behavior for such practices occurs outside of residential aggregates. The next section reviews some of the aspects of subsistence economies manifested across landscapes outside of settlements. There is an emphasis on landscape production and modification as these processes are identifiable in the archaeological record. They are simply harder to spot than more intensively utilized parts of the built environment such as villages. There is also an emphasis on agricultural subsistence as the intensity of farming versus foraging tends to leave a greater footprint in the landscape.

Archaeologists have developed a number of techniques for identifying agricultural landscapes. It is possible to identify intensely utilized farm fields on occasion from the remains of material inputs such as pottery sherd scatters resulting from manuring or irrigation systems for the delivery of water (Wilkinson, 1989; Wilkinson et al., 2007). However, in the PPNB of Transjordan neither pottery (except in very rare cases) (Kuijt and Goring-Morris, 2002) nor irrigation systems (Kuijt et al., 2007) were in use, so such techniques are not available for the

time period. Fields and certain aspects of intensive agricultural practice can also be identified through the material remains of agricultural infrastructure such as the aforementioned irrigation systems, as well as terracing and field boundaries to name two more examples (Stone, 1994; Woodbury, 1961). Again, none of these materials have yet to be identified for the early Neolithic of the southern Levant (Banning, 2012).

Another type of agricultural infrastructure not known from the PPNB was the agricultural satellite settlement. Such a settlement is perhaps the most informative of all village hinterland site types when it comes to understanding subsistence practices (Moore, 1979; Preucel, 1990; Ward, 1978). Such settlements tend to be located on or near agricultural fields (Chisholm, 1979; Moore, 1979; Preucel, 1990; Stone, 1996; Sutton, 1977), thus providing significant information about movement and the location of practices. More substantial satellite settlements, such as field houses or agricultural villages also tend to contain the remains of tool kits specialized for subsistence production. Such tools kits can provide a more direct and/or second option for understanding subsistence techniques than the analysis of food remains (Moore, 1979).

Because satellite settlements are typically occupied by in-field labor groups, they can also provide insight into labor organization that is not available in village sites (Chisholm, 1979; Crown, 1983; Henderson, 2010; Kohler, 1992, 1989; Moore, 1979; Preucel, 1990; Stone, 1996; Sutton, 1977; Ward, 1978). As has already been noted, labor group composition can be dynamic in communities with associations forming in far greater variety than the household; the most visible economic association in villages (Erasmus, 1956; Stone, 1996). A perfect example of this given above is the synthetic in-field household composed of multiple related residential units utilized by Dogon producers during the harvest season (Eskelinen, 1977a).

Similarly, not only do subsistence-based satellite settlements inform archaeologists about the composition of labor units, but also what subsistence practices and products are associated with what units. By combining analysis of labor unit composition and subsistence production practices it is possible to see what products derive from agricultural fields and which do not. An excellent example of this is amongst Palestinian Fellahin where wives produced vegetables in village-house gardens, grain was produced by a set of shifting associations through the production process as reviewed above in near-fields, and olives and grapes were tended by husbands and harvested by whole families in far-fields with field houses. The families would retreat to their in-field abodes where they could enjoy sweet fruit away from the demands of neighbors and peace and quiet during the late summer grape harvest season as an escape from overheated villages (Amiry and Tamari, 1989). Another aspect of this is of course the temporal patterning of production processes. Thus, with detailed analysis of the temporal pattern of agricultural ecology and human interventions within the life-cycles of plants and animals, it is possible to reconstruct the temporal organization of agricultural practices and their social units which conducted them (Preucel, 1990).

Satellite settlement location, as understood through catchment analysis, can also inform archaeologists about resource acquisition and utilization. Because such sites are typically located on or near production loci, the placement of these settlements in regional resource context can inform researchers not only about where and how resources were acquired (K. V. Flannery, 1976), but also about who acquired them (Woodbury, 1961). Satellite settlements can be used to identify both the spatial organization of production (Struever, 1968), the location of productive resources (K. V. Flannery, 1976; Jarman et al., 1972), and the economic relations in which production is embedded (Henderson, 2010; Kohler, 1992).

We can see that satellite settlements, when rigorously analyzed and contextualized within regional data sets can be highly informative about subsistence production in ways that village-derived data cannot. This chapter has reviewed the complex set of factors which effect subsistence production in village-based communities and the ways in which archaeologists can access this information about past societies through a combination of village, hinterland, and regional resources data analyses. In the following chapter the social and environmental context of this specific case-study will be reviewed.

Determining the Function of Archaeological Isolated Structure Sites

As reviewed above, there is significant variability in the form and function of small sites within village-based settlement systems, including isolated structures sites. In order to identify this variation in the archaeological record it is necessary to construct criteria for differentiating between sites types. It is also important to look to regional settlement patterns in order to determine if sites are indeed embedded within village settlement systems. This is especially true for the Neolithic where there is ample evidence of mobile foraging and farming communities existing within the more arid environments of the Levantine fringes (Kuijt and Goring-Morris, 2002; Simmons, 2007). The following section is devoted to developing just such a set of criteria for determining site function from archaeological remains. The criteria will be based both on the contents of sites, but also the broader spatial context of sites within the socio-natural landscape. This section utilizes a hierarchical method of site differentiation similar to that developed by Moore (1979), focusing on the most common forms of small sites embedded within village-based settlement systems as identified from the ethnographic record.

The primary category within which all sites reviewed within this section fall is that of the satellite settlement. Such sites, as defined within this dissertation, are embedded within village

settlement systems, as opposed to other small sites such as farmsteads embedded within expansionary frontier settlement systems or farmhouses embedded within dispersed settlement systems (Stone, 1996). Satellite settlements are contrasted with village settlements along three lines: (1) long-term habitation in villages versus short-term habitation or daily use for satellite settlements, (2) a maximal local aggregate for villages versus a sub-village population for satellite settlements, and (3) a high intensity of utilization of village settlements, complete with all the activities of the annual life-cycle of community populations for villages and a low intensity of utilization with only a portion of the full complement of activities within village communities for satellite settlements.

Satellite settlements can be further sub-divided along the lines of subsistence production sites versus non-subsistence production sites with subsistence production obviously as the key difference between these site types. It is within subsistence production sites that the variability in satellite settlements discussed in the preceding chapter is found. These include field houses, agricultural compounds, and agricultural communities. Within each of these categories there will also be significant variation around the subsistence items produced, be they plants or animals or some combination of the two from foraging or farming.

From this hierarchy we see that there are several types of satellite settlements which may be difficult to differentiate from one another without thorough investigation and rigorous models of expected material differences in the archaeological remains of each. Additionally, certain forms of permanent settlements such as heavily eroded agricultural hamlets (i.e., small clusters of permanent habitations for multiple households), farmhouses, and homesteads. What follows is a list of potential small site types and other similarly size settlements, along with a trait list and justification of these traits through a review of the anthropological literature.

Temporary Field Structures

Description:

Temporary field structures are insubstantial low-durability structures utilized by subsistence producers in-field for daily breaks, such as wind-breaks or shade structures, or to accommodate individuals performing low-intensity activities, such as platforms for crop guarding. They are typically built out of perishable materials and are expected to last only a single agricultural season (Chisholm, 1979; Moore, 1979). They can be constructed both by those with inter-annual tenure rights to specific subsistence production loci and those who do not have such rights (Chisholm, 1979). Most significant periods of utilization are annually temporary and inter-annually repeated, typically on a seasonal basis. Utilization occurs primarily during the agricultural season (Chisholm, 1979; Moore, 1979).

Criteria:

- (1) Isolated structure located within a region with evidence of only sedentary villages settlements systems
- (2) Located in productive farmland
- (3) Minimal investment in temporary architecture
- (4) Small scale of architecture capable of accomodating an individual or small group
- (5) Minimal architectural accomodations for overnight stays
- (6) No architectural features associated with daily-life activities
- (7) Few production tools associated with structure
- (8) Limited refuse from production activities apart from low-intensity food preparation
- (9) Limited refuse from consumption activities apart from low-intensity food consumption
- (10) Refuse is deposited in a stratigraphic pattern whereby there is a period of higher levels of deposition during temporary occupation followed by a period of little to no deposition during temporary abandonment and/or sporadic use, followed by a period of higher deposition as the site is reoccupied and so on.

Permanent Field Structures

Description:

Permanent field structures are typically utilized by producers with shorter travel distances to fields from villages. This allows for efficient enough daily travel to and from fields to not require overnight stays. Instead it is the transportation of subsistence production tools that creates an unacceptable energy expenditure (Moore, 1979). If tenure within specific production loci can be assured, producers can construct a permanent structure in which to store production tools in-field (Chisholm, 1979). Such structures typically also serve multiple purposes such as those of temporary structures, as well as a location for social or personal activities outside of the pressures of the village (pers. obs.; Moore, 1979). Utilization occurs primarily during the agricultural season (Chisholm, 1979; Moore, 1979), but can also occur sporadically throughout the year, especially for non-subsistence production activities (pers. obs.).

Criteria:

- (1) Isolated structure located within a region with evidence of only sedentary villages settlements systems
- (2) Located in productive farmland
- (3) Significant investment in permanent architecture
- (4) Small scale of architecture capable of accomodating an individual or small group
- (5) Minimal architectural accomodations for overnight stays
- (6) No architectural features associated with daily-life activities
- (7) Primarily subsistence production tools associated with structure
- (8) Limited refuse from production activities apart from low-intensity food preparation
- (9) Limited refuse from consumption activities apart from low-intensity food consumption
- (10) Refuse is deposited in a stratigraphic pattern whereby there is a period of higher levels of deposition during temporary occupation followed by a period of little to no deposition during temporary abandonment and/or sporadic use, followed by a period of higher deposition as the site is reoccupied and so on.

Field Houses

Description:

As described above, a field house is a temporarily and repeatedly occupied substantial in-field satellite settlement which can accommodate the basic unit of production in a society during periods of high labor input in the annual production cycles. They are constructed by producers who are assured of tenure rights over the long-term. They reduce travel and transport costs by providing a space to store tools and conduct all the activities of daily life in-field. Most significant periods of overnight stays are annually temporary and inter-annually repeated, typically on a seasonal basis. Occasional overnight stays by members of the occupying unit may occur more sporadically, mainly during the entire extent of the agricultural season, but also during other seasons (Moore, 1979; Preucel, 1990; Sutton, 1977).

Criteria:

- (1) Isolated structure located within a region with evidence of only sedentary villages settlements systems
- (2) Located in productive farmland
- (3) Substantial investment in durable architecture
- (4) Small scale of architecture capable of accomodating the basic productive unit
- (5) Significant architectural accomodations for overnight stays
- (6) Limited set of architectural features associated with household daily-life activities
- (7) Certain activities performed indoors within villages for privacy purposes may more outdoors as privacy concerns reduce in isolated settlements and outdoor spaces can be better work spaces for some dirty activities such as fire building or knapped stone production. Certain activities performed outdoors in villages for social purposes may move indoors for protection from predators and predatory individuals and groups to which isolated habitations are more vulnerable, especially associated with food production.
- (8) The diversity of architectural features within structures may reduce as compared to village-based structures as subsistence production is the primary focus of the temporary occupation. Thus, areas for craft production, elaborate ritual, or long-term storage are typically not necessary. Additionally, many activities which require special architectural accomodations to be performed indoors can be performed outdoors without any architectural accomodation.
- (9) Some refuse from production activities
- (10) Some refuse from consumption activities
- (11) Limited tool assemblage focused only on household daily-life and subsistence production activities (i.e., minimal evidence of non-subsistence or household daily-life activities, such as industrial production or highly-elaborate ritual)

- (12) Refuse is deposited in a stratigraphic pattern whereby there is a period of higher levels of deposition during temporary occupation followed by a period of little to no deposition during temporary abandonment and/or sporadic use, followed by a period of higher deposition as the site is reoccupied and so on.

Agricultural Compounds

Description:

Agricultural compounds are temporarily and repeatedly occupied substantial in-field satellite settlements composed of a single habitation compound inhabited by multiple residential units for agricultural activities which require larger labor forces than individual households during periods of high labor input in the annual production cycles. They are constructed by producers who are assured of tenure rights over the long-term. They reduce travel and transport costs by providing a space to store tools and conduct all the activities of daily life in-field. Most significant periods of overnight stays are annually temporary and inter-annually repeated, typically on a seasonal basis. Occasional overnight stays by members of the occupying unit may occur more sporadically, mainly during the entire extent of the agricultural season, but also during other seasons (Eskelinen, 1977a; Sidibe, 1978).

Criteria:

- (1) Isolated compound located within a region with evidence of only sedentary villages settlements systems
- (2) Located in productive farmland
- (3) Substantial investment in durable architecture
- (4) Multiple structures of differentiated function with a surrounding wall or other form of barrier or a single large structure with rooms of differentiated function sizable enough to accomodate multiple village households or compounds
- (5) Structures are typically smaller than those found in villages
- (6) Significant architectural accomodations for overnight stays
- (7) Limited set of architectural features associated with household daily-life activities
- (8) Certain activities performed indoors within villages for privacy purposes may more outdoors as privacy concerns reduce in isolated settlements and outdoor spaces can be

better work spaces for some dirty activities such as fire building or knapped stone production. Certain activities performed outdoors in villages for social purposes may move indoors for protection from predators and predatory individuals and groups to which isolated habitations are more vulnerable, especially associated with food production.

- (9) The diversity of architectural features within structures may be reduced as compared to village-based structures as subsistence production is the primary focus of the temporary occupation. Thus, areas for craft production, elaborate ritual, or long-term storage are typically not necessary. Additionally, many activities which require special architectural accommodations to be performed indoors can be performed outdoors without any architectural accommodation.
- (10) Some refuse from production activities
- (11) Some refuse from consumption activities
- (12) Limited tool assemblage focused only on household daily-life and subsistence production activities (i.e., minimal evidence of non-subsistence or household daily-life activities, such as industrial production or highly-elaborate ritual)
- (13) Refuse is deposited in a stratigraphic pattern whereby there is a period of higher levels of deposition during temporary occupation followed by a period of little to no deposition during temporary abandonment and/or sporadic use, followed by a period of higher deposition as the site is reoccupied and so on.

Agricultural Communities

Description:

As briefly described above, agricultural communities, as defined by Preucel (1990), are temporarily and repeatedly occupied substantial in-field satellite settlements composed of multiple independent, but inter-dependent residential production units utilized during periods of high labor input in the annual production cycles. These separate units may coordinate some productive activities, are dependent on one another for certain functions within the community, and are frequently members of a super-household corporate group which provides access rights to the subsistence production loci associated with the settlements. Agricultural communities are constructed by multiple producers who are assured of tenure rights over the long-term. They reduce travel and transport costs by providing a space to store tools and conduct all the activities of daily life in-field. Most significant periods of overnight stays are annually temporary and

inter-annually repeated, typically on a seasonal basis. Occasional overnight stays by members of the occupying unit may occur more sporadically, mainly during the entire extent of the agricultural season, but also during other seasons.

Criteria:

- (1) Small cluster of structures located within a region with evidence of only sedentary villages settlements systems
- (2) Located in productive farmland
- (3) Substantial investment in durable architecture
- (4) Multiple structures of similar form
- (5) Significant architectural accommodations for overnight stays
- (6) Limited set of architectural features associated with household daily-life activities
- (7) Similar patterns of enclosed versus open architectural features for those that are present on-site as to the patterns seen within village contexts.
- (8) The diversity of architectural features within structures may be reduced as compared to village-based structures as subsistence production is the primary focus of the temporary occupation. Thus, areas for craft production, elaborate ritual, or long-term storage are typically not necessary. Additionally, many activities which require special architectural accommodations to be performed indoors can be performed outdoors without any architectural accommodation.
- (9) Some refuse from production activities
- (10) Some refuse from consumption activities
- (11) Limited tool assemblage focused only on household daily-life and subsistence production activities (i.e., minimal evidence of non-subsistence or household daily-life activities, such as industrial production or highly-elaborate ritual)
- (12) Refuse is deposited in a stratigraphic pattern whereby there is a period of higher levels of deposition during temporary occupation followed by a period of little to no deposition during temporary abandonment and/or sporadic use, followed by a period of higher deposition as the site is reoccupied and so on.

Other Small Sites

There are a number of other small sites which also must be differentiable from satellite settlements in order to determine the presence of specific types of sites. Many of these site types have already been noted, but it is necessary to present archaeological criteria for differentiating them from the various forms of satellite settlements described above.

Farmhouses

Description:

Farmhouses are permanently inhabited structures accommodating the basic productive and residential unit of a dispersed farming settlement pattern. Inhabitants can assert with some assurance tenure rights to the subsistence production loci surrounding the settlement.

Farmhouses are the product of the pull of subsistence production loci, whereby it is most efficient for producers to locate their residences directly on their fields; reducing travel and transportation costs to a minimum (Demangeon, 1962). If farmhouses are located within areas of long-term settlement they will typically be passed on across generations.

Such a settlement pattern is found in a variety of different forms of settlement patterns, the most prominent being a settlement hierarchy whereby most economic units are subsistence producers. A certain sector of the regional population may work in or inhabit a nucleated settlement which provides those functions necessary for farmhouse occupants to produce. Farmhouse inhabitants do not need to access these central places frequently, thus making permanent habitation in-field with brief temporary visits to central places for specific functions energetically efficient (Stone, 1996).

There are also cases of dispersed settlement patterns without central settlements where by settlement densities are sufficient enough to accommodate the meeting of individuals from multiple households in an unoccupied central place for community political, economic, and ritual activities. In such a settlement pattern this unoccupied central meeting point provides some of the functions that would typically be found in a central residential settlement. It must be noted that such a pattern requires a high degree of economic independence amongst farmhouses. In order to be able to meet most labor and material needs of independent farming households, such households are typically occupied by larger extended families (Goody, 1962).

Criteria:

- (1) Isolated structure or structures located within a region with evidence a settlement hierarchy or a dispersed settlement patterns of farmhouses
- (2) Located in productive farmland
- (3) Substantial investment in durable architecture
- (4) Evidence of significant renovation and reorganization of architecture
- (5) A large-scale structure with highly differentiated interior space to accommodate multiple functions and an extended family
- (6) Significant architectural accommodations for overnight stays
- (7) All architectural features associated with household daily-life activities
- (8) Certain activities performed indoors within villages for privacy purposes may move outdoors as privacy concerns reduce in isolated settlements and outdoor spaces can be better work spaces for some dirty activities such as fire building or knapped stone production. Certain activities performed outdoors in villages for social purposes may move indoors for protection from predators and predatory individuals and groups to which isolated habitations are more vulnerable, especially associated with food production.
- (9) Minimal evidence of craft production or elaborate ritual. Additionally, many activities which require special architectural accommodations to be performed indoors within villages can be performed outdoors without any architectural accommodation.
- (10) Significant refuse from production activities
- (11) Significant refuse from consumption activities
- (12) An extensive tool assemblage focused on all aspects of household daily-life and subsistence production activities.
- (13) Continuous deposition of refuse

Homesteads

Description:

Homesteads are permanently inhabited structures accommodating the basic productive and residential unit of an expansionary (frontiering) dispersed farming settlement pattern. Many can be inhabited for multiple years, but inhabitants tend to practice long-term shifting settlement patterns (Netting, 1982; Stone, 1996). Typically, such settlements are largely self-sufficient and do not exist within regional settlement hierarchies. In recent such settlements, resources which are necessarily acquired from other economic institutions are typically gotten via shipments, boomtown market places, or on special long-distance logistical trips (Netting, 1982). Inhabitants

can assert with some assurance tenure rights to the subsistence production loci surrounding the settlement. Homesteads are the product of the dual forces of (1) the pull of subsistence production loci, whereby it is most efficient for producers to locate their residences directly on their fields; reducing travel and transportations costs to a minimum (Demangeon, 1962) and (2) the economic dynamics that typically underpin frontier settlement (i.e., households looking for greater economic opportunities due to poverty or diminishing returns in their current locations) (Netting, 1982).

Criteria:

- (1) Isolated structure or structures located within a region with evidence of frontier settlement and typically without a settlement hierarchies
- (2) Located in productive farmland
- (3) Substantial investment in durable architecture
- (4) Structures with highly differentiated interior space to accomodate multiple functions
- (5) Significant architectural accomodations for overnight stays
- (6) All architectural features associated with household daily-life activities
- (7) Certain activities performed indoors within villages for privacy purposes may move outdoors as privacy concerns reduce in isolated settlements and outdoor spaces can be better work spaces for some dirty activities such as fire building or knapped stone production. Certain activities performed outdoors in villages for social purposes may move indoors for protection from predators and predatory individuals and groups to which isolated habitations are more vulnerable, especially associated with food production.
- (8) Minimal evidence of craft production or elaborate ritual. Additionally, many activities which require special architectural accomodations to be performed indoors within villages can be performed outdoors without any architectural accomodation.
- (9) Significant refuse from production activities
- (10) Significant refuse from consumption activities
- (11) An extensive tool assemblage focused on all aspects of household daily-life and subsistence production activities.
- (12) Continuous deposition of refuse

Farming Hamlets

Description:

Farming hamlets are small permanently inhabited agricultural settlements composed of multiple household productive units with significant inter-household economic dependencies. They exist in a variety of settlement patterns from fully urbanized hierarchical structures to dispersed non-hierarchical patterns (Bandy and Fox, 2010a). Hamlets are settlements small enough to significantly reduce land pressure. Hamlets can be seen as a balancing act between the pull of subsistence production loci and settlement gravitation. While individual household may be the basic productive unit, they exist in these small settlements because of their significant interdependencies with other households (Stone, 1996).

Within a dispersed hamlet settlement pattern, typically settlements are fairly socially and economically independent, although populations are too small to fully be so and certainly are too small to be biologically autonomous (Hegmon et al., 1998; Nelson et al., 2006). Within a dispersed non-hierarchical settlement pattern of hamlets, large-scale social interactions, such as inter-settlement rituals and craft production typically occur outside of individual settlements (Stone, 1996) as they require multiple settlement populations. Within hierarchical settlement patterns, hamlets do not typically accommodate craft production, large-scale production, or large-scale ritual as well (Schwartz and Falconer, 1994) as these activities typically occur within larger settlements associated with elite classes who control such activities.

Criteria:

- (1) Small cluster of structures
- (2) Located in productive farmland
- (3) Substantial investment in durable architecture
- (4) Multiple similarly formed structures with redundant features across structures
- (5) Significant architectural accommodations for overnight stays
- (6) All architectural features associated with household daily-life activities
- (7) Significant number of production and consumption activities conducted indoors
- (8) Minimal evidence of craft production or elaborate ritual
- (9) Significant refuse from production activities

- (10) Significant refuse from consumption activities
- (11) An extensive tool assemblage focused on all aspects of household daily-life and subsistence production activities
- (12) Continuous deposition of refuse

Discussion

As can be seen from the above trait lists of different small site types, they are possible to differentiate from one another with careful investigation. This task is made all the more challenging by taphonomic processes which may destroy portions of the archaeological record. Thus, investigators must thoroughly analyze small sites in order to understand their extents and functions. The above-trait lists will be used in this research to assess the role that al-Khayran played within the settlement systems of west-central Jordan during the PPNB.

Chapter 5: Setting the Stage

This chapter is the first of four devoted to describing the background for my case study. I present a discussion of previous approaches to understanding the early Neolithic, and describe my approach. I then present the study area and summarize the early Neolithic remains in the area.

Chronology and Terminology

The term Neolithic was first used to describe the appearance of ground stone axes in Europe; hence they used the term *Neo*-lithic to refer to new production methods in stone industries. Later Neolithic came to be defined by the appearance of pottery. By the early 20th century Neolithic came to mean the appearance of agriculture (Childe, 1935; Trigger, 1989). This definition is still with us today.

In the southern Levant, the periodization of the Neolithic has its own history. While early 20th century excavators recognized different archaeological cultures, traditions, technologies, and so forth, they focused on differences in lithic typologies across space and time (Simmons, 2007). The sequence and terms most often used for the southern Levant were those started by Kenyon (1957). She observed several Neolithic phases at the site of Jericho in the southern Jordan Valley. The first two lacked pottery, but both contained evidence of Neolithic type material culture (presumably evidence of agriculture) and dramatically different architectural styles. She labeled these phases Pre-Pottery Neolithic A (PPNA) and B (PPNB).

These terms were used by a number of researchers, but not universally accepted for several decades. Some still preferred to label phases at sites by local names such as Sultanian, Khiamian, Mureybetian, and Aswadian. Even Kenyon (1957) used alternative terms such as proto-Neolithic – later shown to be indistinguishable from the PPNA (Crowfoot-Payne, 1983) – and hog-back brick phase on occasion. Then, in the 1970s and 1980s, in an effort to standardize terminology and draw attention to commonalities across the Middle East, a number of authors expanded Kenyon's periods to allow them to accommodate stratigraphic sequences identified in recent decades (Bar-Yosef, 1981; Cauvin, 1975). From these discussions the sequence of PPNA followed by Early, Middle, and Late PPNB developed. Following excavations at 'Ain Ghazal, the term PPNC was added as a period between the PPNB and Pottery Neolithic (Rollefson, 1989; Simmons et al., 1988), once thought to be absent and known as the *Hiatus Palestinien* (Nissen, 1993; Perrot, 1968). Others have termed this period the Final PPNB (Banning, 1998; Kuijt and Goring-Morris, 2002; Kuijt, 2000c).

There are other chronological schemes, the most prominent being the Lyon system (Aurenche et al., 2001) and a four-stage sequence developed by Moore (1982). However, these systems are not as widely used as Kenyon's sequence and terms. Thus, I will use PPNA, EPPNB, MPPNB, LPPNB, and PPNC. Recent discussions have also added some important details. Some have advocated that PPNA of the southern Levant can be split into two periods: a brief early transitional period between the Epipaleolithic and the Neolithic known as the Khiamian and the later Sultanian (Bar-Yosef, 1995; Crowfoot-Payne, 1983; Ronen and Lechevallier, 1999). More recently, such a sequence has been criticized and new finds seem to invalidate this division (Garfinkel, 1996; Kuijt, 2001a, 1997; Mithen et al., 2000; Nadel, 1990; Sayej, 2004). Thus, I only use the term PPNA.

A second issue with this sequence in the southern Levant is the missing EPPNB. While initial formulations of the PPNB subdivisions were developed using northern and central, as well as southern Levantine sequences, a number of authors have advocated splitting the south from the north. Scholars note that very few sites are of EPPNB date in the southern Levant; some scholars (Edwards et al. 2004; Cauvin and Cauvin 1993) see the MPPNB as a northern entity which came south, replacing the PPNA. Kuijt (1997b; 2003) argues that such an event – northerners moving south – has not as-of-yet been identified. However, he also argues that there is little evidence for an EPPNB.

By contrast, there are those who strongly support the idea of an EPPNB in the southern Levant (Gopher, 1996a). The site of Motza in the Judean Hills has been excavated, showing evidence of a PPNA-PPNB sequence with what could be characterized as an EPPNB stratum between the PPNA and MPPNB. This stratum has been dated by a large number of radiocarbon samples. Additionally, the samples were analyzed using advanced methods, calibrated, and interpreted using advanced Bayesian statistics to define the absolute chronology of the site. The dates derived from this intermediate layer fall right where some expect the EPPNB should (ca. 8600/8550-8,200/8150 cal. BCE) (Khalaily et al., 2007; Yizhaq et al., 2005).

Chronological Construction Using Knapped Stone Remains

To understand the chronology we must examine individual sites because early Neolithic settlements were likely autonomous villages. Because village communities were likely autonomous and, thus, had social barriers to the flow of materials, information (Finlayson, pers. comm.), and people (Alt et al., 2013) between sites, the material practices enacted at specific settlements may not have fit into broader regional style sequences. Earlier researchers saw changes in tool types through time as reliable chronological markers of different periods across

all sites in the Levant (Bar-Yosef, 1981; Gopher, 1994, 1989). Early Neolithic relative chronologies based on point type frequencies were perhaps most thoroughly presented by Gopher (1994). At the time of his analysis, such a chronological scheme was incredibly important, as many of the other markers of early Neolithic periods articulated by Kenyon (1958) and Bar-Yosef (1981), such as architectural styles and building technologies, were shown to vary not only chronologically, but also geographically (and, it would seem, based on differences in social relations within communities). Thus, in order to compare sites where absolute dates were not available or numerous, lithic types provided the basis for such comparisons. In his analysis, Gopher (1994) reviewed 67 point assemblages (assumed to be a chronologically coherent group

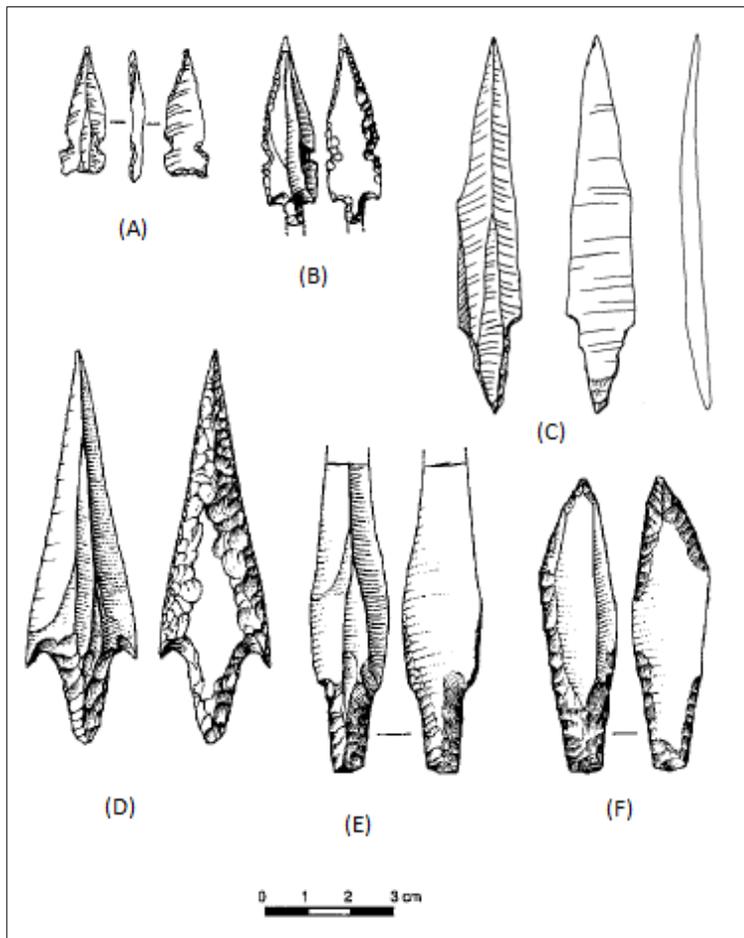


Figure 5: (A) el-Khiam Point; (B) Helwan Point; (C) A45 Point; (D) Jericho Point; (E) Byblos Point; (F) Amuq Point; (A, B, D-F: Kuijt and Goring-Morris, 2002; C: Simmons and Najjar, 2006)

of artifacts) from 48 sites throughout the northern, central, and southern Levant for which he deemed the chronological and sampling reliability to be comparable. He constructed a point typology and did both a frequency and stylistic analysis for each assemblage. He then compared these analyses across sites and assemblages taking into account geographical location and absolute chronology.

From this analysis he proposed that different point types appeared in different regions of the Levant at different times, with those types associated with the beginnings of the early Neolithic (i.e., the PPNA and EPPNB) appearing first in the northern Levant and subsequently in the central and then southern Levant. This was the case for el-Khiam (PPNA in the southern

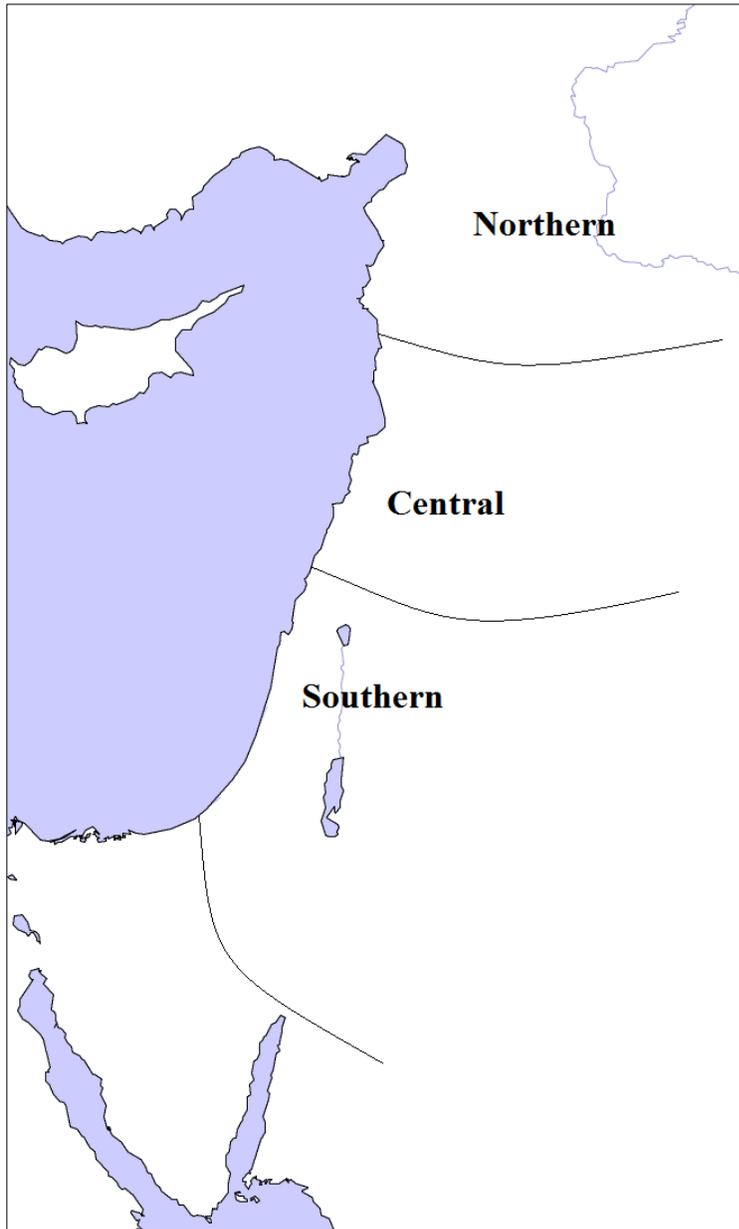


Figure 6: Regions of the Levant

Levant) and Helwan (EPPNB in the southern Levant) points in his assemblage. Byblos point, often seen as a marker for the M-LPPNB throughout the Levant, appeared significantly earlier in the northern Levant than either of the southern two regions, where they are roughly contemporaneous in their onset. Byblos points rapidly come to dominate northern assemblages in Gopher's analysis, completely replacing Khiam and Helwan points, both of which were present in the PPNA for the region. The same happens in the central Levant, but lagging behind in absolute chronological terms. However, in

the southern Levant, even before the introduction of Byblos points, Jericho points appear and

continue throughout the entirety of the PPNB. This point type was not present in any of the central or northern Levant assemblages analyzed by Gopher. Finally, near the end of the PPNB, the Amuq points appear first in the northern and central Levant, and much later in the southern Levant (Figure 5).

This chronology by types has been utilized by researchers ever since its development. However, it was developed at a time when there was a dearth of excavations in Transjordan and most of the sites with absolute chronological indicators were only partially dated. Most of the sites used in the analysis were undated. Thus, Gopher (1994) assumed that those sites for which there were radiocarbon dates would have chronologies representative of the three regions: the northern, central, and southern Levant (Figure 6). As I previously noted, it has become clear through time that there is significant variability within these regions, based on geography and social processes, than formerly appreciated. At the time of Gopher's analysis, radiocarbon calibration was not common. As more and more dates are calibrated from the Neolithic Levant, it has become clear that certain real date ranges can show significant variation in their radiocarbon dates (Maher et al., 2011).

As a consequence, many of the dates used by Gopher to tie together this analysis have been shown to be less precise than previously thought. It has become apparent from more recent excavations, including those at al-Khayran, and from reexamination of older reports that certain point types used to define different periods can be found at sites dated both earlier and later than they should be (Edwards et al., 2004; Kuijt, 2003; Mortensen, 1970; Simmons and Najjar, 2006). This is a result of increases in excavations across the Levant, absolute dating of sites, calibration of radiocarbon dates, and sophistication of methods used to compare radiocarbon dates within and between sites.

Constructing Chronologies from Radiocarbon Dates

Since Gopher's (1994) publication, radiocarbon dating has moved to the fore in the construction of PPNB chronologies in the southern Levant (see Appendix 3). A great number of authors have favored aggregating radiocarbon dates from different sites to run more sophisticated Bayesian analyses to define regional chronologies (Aurenche et al., 2001; Blockley and Pinhasi, 2011; Maher et al., 2011). However, questions should be raised about aggregating dates when sites are politically autonomous and potentially endogamous (Alt et al., 2013). For example, the division of the PPNB into Early and Middle in the southern Levant based on the dates attributed to Motza alone, ignores other sites in the region with similar dates. With the advanced methods and statistics used, Motza's EPPNB was dated to ca. 8600/8550-8200/8150 cal. BCE (Khalaily et al., 2007; Yizhaq et al., 2005). Using similarly advanced statistics, the PPNA site of Zahrat adh-Dhra 2 (ZAD 2) was dated to ca. 8800-8450 cal. BCE (Edwards and House, 2007; Edwards et al., 2004). Again, through a thorough review of calibrated dates and stratigraphy, the south-west Jordanian PPNA site of WF16's most recent phase was dated to 8400-8280 cal. BCE, while its second most recent phase was dated to ca. 8760-8630 cal. BCE (Finlayson and Mithen, 2007). It has been suggested that the final phase at the site be labeled EPPNB (Benz, n.d.), but this appears to be based simply on dates and not on any change in material culture. While there certainly are changes through time at WF16 attributed to the later phases of the site, including the abandonment of certain structures and the construction of new architecture (Finlayson et al., 2011b), there are no novel social processes, such as the appearance of new economic or political relations, or material culture changes, such as the appearance of knapped stone types. In fact, it is the earlier phases of the site, in the heart of the PPNA chronology, which show dramatic changes

in architecture and social organization (Finlayson et al., 2011b). Thus, we can see that the end of the PPNA and the beginning of the EPPNB is not as clean as we might imagine.

The situation does not improve on the other side of the EPPNB, with the earliest MPPNB site of 'Ain Ghazal's initial phase starting at ca. 8460±130 cal. BCE, with subsequent dates spread fairly evenly over a range of 8300-7600 cal. BCE (Benz, n.d.; Kuijt, 2003). Other sites dating to the earlier portions of the MPPNB in the southern Levant prove just as instructive for yet another pitfall of the methods used for periodization in the PPN. Shkarat Msaied, located in the southern Transjordanian highlands, yielded an unidentified wood charcoal date of ca. 8350±70 cal. BCE. A series of later dates range from ca. 8150±125 cal. BCE from unidentified wood charcoal to ca. 8000±150 cal. BCE from ephedra charcoal (a shorter lived woody species) (Benz, n.d.; Hermansen et al., 2006). Beidha's earliest date is ca. 8300±300 cal. BCE, however the bulk of the dates which can be arranged in stratigraphic order fall within a range of ca. 8050-7650 cal. BCE (Benz, n.d.; Rambeau et al., 2011). Thus, we see that, like PPNA sites, several MPPNB sites have dates that overlap with the EPPNB dates from Motza.

In addition to these issues of multiple overlapping chronologies, there is the basic issue of the meaning of radiocarbon dates. Individual specimens yield a single radiocarbon date with an error range, which is then calibrated to give another absolute date, again with an error range. There is no convention within the Levantine PPNB literature as to how to report these dates apart from calibrated dates now predominating. This can be an issue as error ranges can be reported to a single standard deviation or to two standard deviations. Some authors choose to take the range of potential dates given by such techniques as the duration of occupation (e.g., Benz, 2011). However, individual samples date a singular event, the death of the carbonized remain, not a span of time.

The uncertainty given in the error range of dates does not even account for the utilization of dated samples by people in the past such that some items might be curated for significant durations making any date derived from them not particularly relevant to the context from which the material was derived (Finlayson, Mithen, and Smith, 2011). Beyond this issue, dates that accurately represent the contexts from which they are derived always have significant error ranges during the early Neolithic of the southwest Asia. Thus, context must be used to construct chronologies using multiple dates in stratigraphic sequence and, hopefully, multiple samples for any event or process which the researcher is attempting to date. This is the goal of many of the Bayesian analyses performed on PPNB assemblages (Edwards et al., 2004). However, as mentioned above, such analyses can be problematic when performed on regional assemblages (e.g., Maher et al., 2011), as relative context across multiple sites is nearly impossible to determine for this period and place.

Additionally, even at certain sites where we do have a significant number of dates, we do not always have sufficient stratigraphic context to know if they are representative of the entire occupation. For example, the MPPNB site of Ghuwayr 1 does have a significant number of dates. However, the artifacts and ecofactual remains seem to indicate the potential for a habitation sequence that stretches later than the radiocarbon samples show. These include the presence of two forms of wheat at the site (Simmons and Najjar, 2007) and, at least in the latest phase of the site, large-scale residential structures subdivided by cell-like partitions on the ground floor, both of which are more typical of the LPPNB (Kuijt, 2000b; Asouti and Fuller, 2012). That being said, there are 22 radiocarbon dates from every phase of the site, the knapped stone assemblage is more in line with the MPPNB (Simmons and Najjar, 2006), and most sites from the region where we have significant paleo-botanical reports contain wheats during the

MPPNB, even if they are not prominent in the assemblages, including ‘Ain Ghazal, Beidha, and Jericho (Asouti and Fuller, 2012). Additionally, the final phase of MPPNB Beidha also contains architecture similar to Ghuwayr 1 (Byrd, 2005), suggesting the possibility that such changes in structural form were beginning during the MPPNB. And, again, like Beidha, the final phase of Ghuwayr 1 does appear to date to the latter portion of the period (Simmons and Najjar, 2006).

Ghuwayr 1 can be used to highlight another issue with radiocarbon dating and aggregation. In order for Bayesian analyses to work, radiocarbon dates must cluster tightly, have narrow error ranges (which can be extended both by the materials and methods being used for the dating of samples and the curve being used for calibration which can vary in its precision), and be in chronological order (Edwards et al., 2004). However, if dates cluster too tightly, it is possible for them to not appear in chronological sequence stratigraphically. This is an issue at Ghuwayr 1 where the 22 dates cluster tightly and derive from all three phases of the site, but do not follow the stratigraphy. Such an issue is not exclusive to Ghuwayr 1, with most PPNB sites with significant radiocarbon assemblages having a great number of them out of stratigraphic order (Benz, 2011). The difference is that other sites with many dates also typically have much longer habitation sequences stretching across periods, such as Natufian, PPNA, MPPNB, Pottery Neolithic A, and Pottery Neolithic B Jericho, Natufian and MPPNB Beidha (although this site also contains a number of challenges in understanding the dating of the MPPNB phase stratigraphically; Rambeau et al., 2001) and MPPNB, LPPNB, PPNC, and Yarmoukian ‘Ain Ghazal, which allows for greater flexibility in the conceptualization of stratigraphic sequences. One possible structure to radiocarbon assemblages which sidesteps this issue of stratigraphy is a site with large numbers of dates and little stratigraphic phasing, such as EPPNB Motza (Khalayli

et al., 2007) where 19 radiocarbon dates essentially represent a single phase, allowing for all of them to be pooled in a single Bayesian analysis to give one occupation.

A final issue that many sites in the southern Levantine PPNB face is a lack of representative dates for the duration of the occupation. While some sites such as ‘Ain Ghazal, Jericho, Beidha, and Ghuwayr 1 have a significant number of dates (Benz, 2011), a great number of other sites either lack dates or have inadequate numbers to be representative of the total occupational sequence. Thus, some attempts to date sites based on a dearth of samples (e.g., Aurenche et al., 2001; Benz, 2011) have produced site chronologies which later must be wholly revised as new dates are published (see Finlayson, Mithen, and Smith, 2011 on Dhra’). It should be with all of this in mind that the absolute dates presented in this dissertation should be considered. Wherever possible the number of samples and the specific dates, along with error ranges where standard deviations are specified, will be given.

Constructing Chronologies: Multiple lines of evidence and the importance of site autonomy

The basis for attributing both the bulk of the occupation at Shkarat Msaied and the earliest Neolithic phase of settlement at Beidha to the MPPNB, which has been done by most researchers since the inception of the three-phase PPNB periodization, is questionable based purely on regional chronologies. Their periods are all the more questionable because of a lack of fit between material culture markers at the sites and chronologies. As Kuijt (2003) has argued, many of the material criteria used to define PPN periods can be ambiguous or outright ignored by investigators in order to create a teleological narrative.

The classic definition of PPNA includes round structures, el-Khiam points, a number of flaking techniques, single, bidirectional, or multiple platform cores, and, if present, Hagdud truncations and Beit Tamir knives. The classic definition of the MPPNB includes Jericho and

Byblos points, square structures, heavy use of plaster, and naviform cores. However, the EPPNB has often been defined as something in between with only Helwan points being used as a distinctive marker. Structures can be round, rectangular, or sub-rectangular. Plaster can be used. El-Khiam and related types, Byblos, Helwan, and Jericho points can all be present. Thus, we see that periodization is based largely on vocabulary from other regions and absolute chronologies, rather than processes of cultural change.

The same can be said about criteria for the MPPNB. However, instead of vocabulary borrowed from other regions, the open criteria that allows for the earliest phases of Beidha and the entire occupation of Shkarat Msaied to be defined as MPPNB despite having rounded architecture (Figure 7; Figure 8) and including el-Khiam or Helwan points within their knapped stone assemblages (Byrd, 2005a; Jensen et al., 2005; Mortensen, 1970) has to do with the history of excavation in the region and absolute chronologies rather than cultural change. Thus, while the later phases of Beidha are the prototypical example of a MPPNB village (Figure 9), the earliest phase shares many similarities with PPNA sites (Byrd, 1994). However, because there is a continuous occupation of the site with the architecture slowly transitioning to rectangular and the knapped stone assemblage slowly phasing out el-Khiam point (Byrd, 2005a; Mortensen, 1970), the entire site has been labeled MPPNB because of the bulk of the occupational history. In other words, there is no evidence for any sort of social break, such as the emergence of new

knapped stone technologies tied to new economic behaviors or new architectural forms tied to

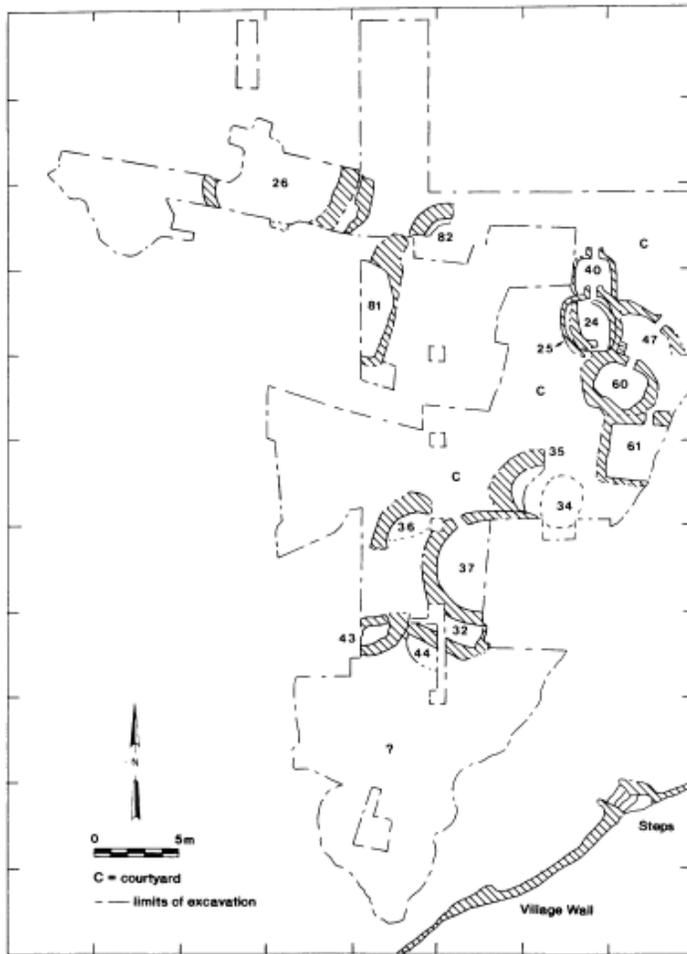


Figure 7: Beidha Phase A2 (Byrd 1994)

new economic relations, which would constitute a new period.

Shkarat Msaied has been the focus of excavation since 1999 (Jensen et al., 2005). It has been dated to the MPPNB, first based on the basis of point types (Jensen et al., 2005) and later on radiocarbon dates (Hermansen et al., 2006). In the second instance, the excavators suggested that the earliest portion of the occupation was during the EPPNB. The only support for this claim, apart from dates that placed the site in the accepted chronology of the

EPPNB, was a handful of Helwan

points (Hermansen et al., 2006), rather than any evidence of social change. Both Beidha and Shkarat Msaied and their periodization highlight the potential pitfalls of using material culture change and absolute dating methods compared against established chronologies to arbitrarily assign labels to sites.

Sites such as MPPNB 'Ain Ghazal, with its earliest date for the period in the region, exhibit all the attributes of the MPPNB. 'Ain Ghazal has yielded domestic cereals (Asouti and

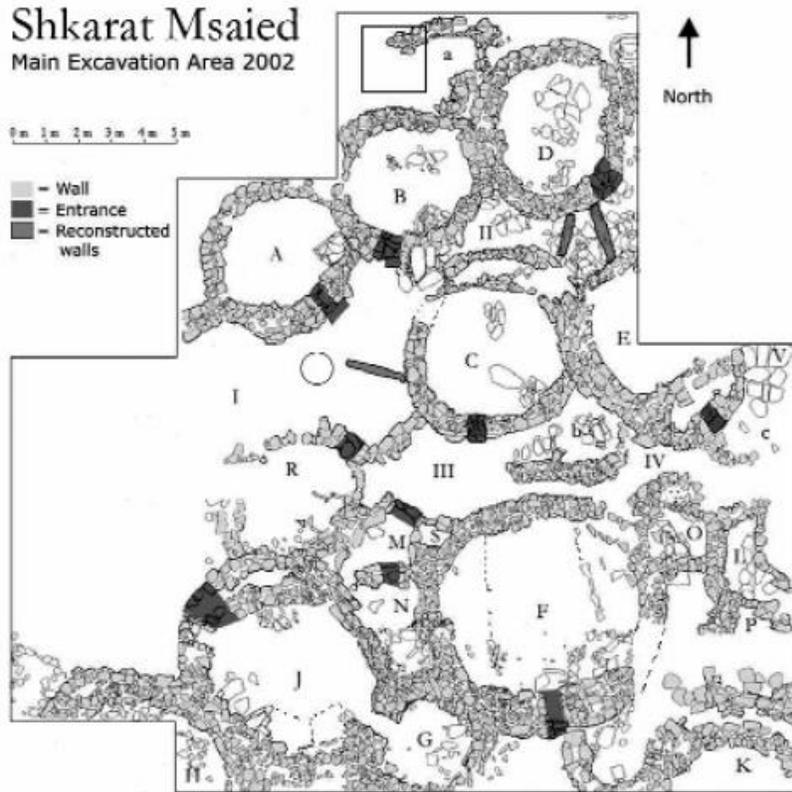


Figure 8: Shkarat Msaied; Prepared by Mikkel Bille Peterson (Jensen, 2004)

Fuller, 2012), evidence of managed herds (Wasse, 2002), orthogonal architecture and nuclear family households (Byrd, 1994; 2000) (Figure 10), the extensive use of lime plaster, and the presence of naviform cores and Jericho and Byblos points (Rollefson and Kafafi, n.d.). Therefore, we see that certain sites such as the later phases of Beidha and the

entire MPPNB occupation of 'Ain Ghazal do fit with established chronological criteria.

However, when absolute dates are presented as if they match up with stone typologies and other material culture across the entire southern Levant, we run into trouble.

When attempting to define the end of the MPPNB and the beginning of the LPPNB, material evidence and dates can be ambiguous. A comparison of those sites assigned to the LPPNB in earlier and later publications is instructive. In his book chapter which laid out the current terminology on the PPNB, Bar-Yosef (1981) attributes certain portions of the stratigraphy at Jericho and Beidha to the LPPNB. Later, Kuijt and Goring-Morris (2002), in line



Figure 9: Beidha Phase C (Byrd, 1994)

with contemporary understandings of these sites, do not include either of these settlements in their list of LPPNB sites.

Bar-Yosef's (1981) chapter laid out the definitional material attributes of LPPNB assemblages which are still with us today. He attributes certain point types to the various periods within the PPNB which we still use to define the period. He also discusses other trends in material culture, such as mortuary treatments and architecture styles, which are still in use. However, as his attribution of the sites of Beidha and Jericho to the LPPNB show, these

material definitions cannot be used to differentiate M- from L-PPNB assemblages, as these sites can fit any definition of M- or L-PPNB, except the absolute chronologies which have been developed more recently. However, because these chronologies are anchored in time by the attribution of the sites from which dates are derived, we are stuck with a tautological argument for how to differentiate the M- from the L- PPNB.

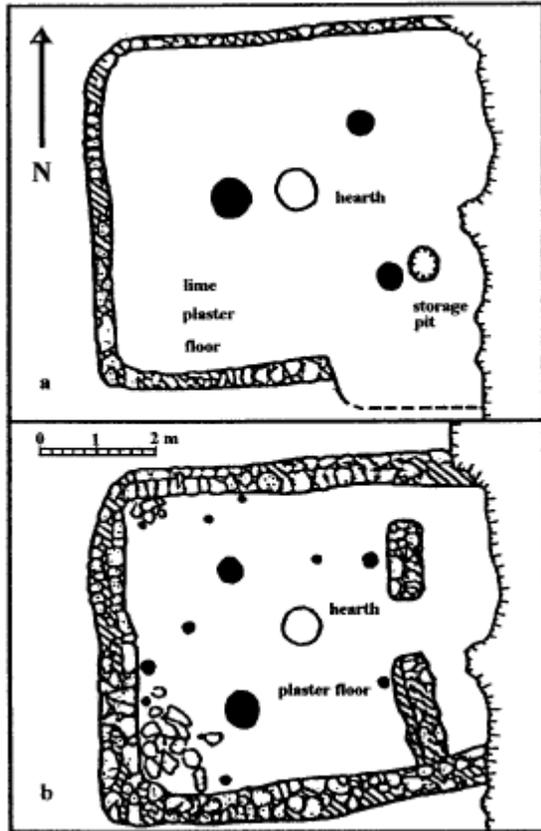


Figure 10: MPPNB House from 'Ain Ghazal; Reconstructed over 400 years of occupation (Rollefson, 1997)

When Kuijt and Goring-Morris (2002) reviewed changes in material assemblages between M- and L-PPNB sites, there was significant ambiguity. The authors noted that some sites grow in area (p. 406). Architecture can be denser, but certainly not always (p. 407). Certain lithic forms and techniques become more and less prevalent, although there is a significant degree of continuity with the MPPNB (p. 412). Certain mortuary treatments become less common, although, again, there is significant continuity with the MPPNB (p. 410-411). Certain architectural technologies become less common (p. 412-413).

Some new forms of architecture can appear, including an increase in the frequency of non-domestic architecture at some sites (p. 408-410). Settlement patterns trend away from the Jordan Rift Valley (p. 404-406). Domesticated animal species become more prominent in faunal assemblages (p. 412). Thus, we see that differences between the M- and L-PPNB are gradual, rather than abrupt changes, with changes in the frequency of certain material markers across the region, but not necessarily individual sites, being the main identifiable trend. Again, this makes defining the beginning or the end of the period difficult and somewhat arbitrary. Rather, a discussion of specific social processes observed within and between sites, grounded in an absolute chronology would be more informative than cultural-historical sequences.

What all of these contradictions suggest is that the EPPNB through the LPPNB still needs a different method to construct better chronologies. The people using the methods to date the southern Levantine PPNB make problematic assumptions that absolute dating has exposed. That is, the assumption that diagnostic tools co-vary chronologically across the entire region is clearly wrong. We tend to look to major sites at their peak to define ideal material markers, while smaller sites, different types of sites, and these very same sites from which material markers are developed at different points within the same period may all vary significantly in their assemblage compositions from the ideal type. This fact is perhaps most exacerbated in this period because it would seem that primary residential settlements were largely autonomous social, political, and economic entities, based on material culture patterning across the region and through time (Kuijt and Goring-Morris, 2002; Kuijt, 2000a) and ethnological and ethno-archaeological studies of early villages and village societies of the ethnographic present (Bandy and Fox, 2010a; Carneiro, 2002; Marcus, 2008; Townsend, 1985).

Thus, in this study I look at processes of social change within communities, rather than make assumptions about sites based on chronological labels. I will use the terms PPNA, EPPNB, MPPNB, LPPNB, and PPNC. I also will provide the widely accepted dating of the various PPN periods as proposed by Banning (2012), who recently participated in a thorough reexamination of PPN radiocarbon dates (Maher et al., 2011). Nevertheless, I will attempt to specify relevant cultural processes at work within sites during specific times. Discussions of Neolithic periods must note diachronic changes at sites within the periods, not just between periods.

Study Area

West-Central Jordan

The locality called “west-central Jordan” within this study is a region approximately 3,000 square km in area within the state of Jordan. It is bounded on the north by the Wadi Mujib, on the east by the Syro-Arabian Desert, on the south by the Wadi al-Hesa, and on the west by the Dead Sea (Figure 1). The terrain is highly variable, with a significant east-west slope or gradient. There are three principal north-south running geographical bands. On the western edge is the Dead Sea Basin, the lowest point of dry land on earth at more than 400 meters below sea level (mbsl). Directly to the east of the Dead Sea Basin is the Dead Sea Escarpment, a dramatic and steep wall of rock that rises to over 1200 m above sea level (masl) over a horizontal distance of only 17 km at its widest. To the east of the escarpment is the Kerak Plateau, by far the largest portion of the region, making up nearly two-thirds of the total area. This semi-arid plateau slopes gently eastward, ending in the arid Syro-Arabian Desert on the eastern border of the region. The other significant topographical features of west-central Jordan are the major east-west running *wadis* (water cut channels), the sources of which can be found on the Kerak Plateau and the debouchments found along the base of the Dead Sea escarpment. The two largest *wadis*, the Mujib and Hesa, form the northern and southern boundaries, respectively; both stretching from the edge of the Syro-Arabian Desert all the way to the Dead Sea Plain. Other major *wadis* which have sources within the Kerak Plateau include Wadi Ibn Hammad, Wadi Kerak, Wadi Dhra’, Wadi ‘Assal, and Wadi Numeira in descending order from north to south.

West-central Jordan has several geological formations, the greatest variety of which are found within the Dead Sea Basin and Escarpment and differentiated primarily by elevation. The primary geological resource from the Dead Sea Basin utilized in the PPNB is bitumen, used for pigment and as an adhesive. Other resources likely used in the PPNB are marls for plaster and salt, but their use for this time period has yet to be definitively documented. The Dead Sea

escarpment is composed of sedimentary rock layers, predominantly sandstone in the lower sections and limestone on top. Interspersed throughout the limestone are bands of flint (Bender, 1974). Additionally, fissures in the limestone have allowed for rainfall on the Kerak Plateau to seep below the top soil of the area, slowly eroding sub-surface channels which flow downwards to either hard limestone layers or the sandstone layer below. They then are forced westward towards the Dead Sea Escarpment, emerging along the rim of the Plateau and its *wadis* in the form of springs (Harlan, 1988). Along the western portions of the Kerak Plateau are found red Mediterranean soils, which are significantly more fertile than the hyper-saline sediments of the Dead Sea Basin, the steep, heavily eroded, rocky cliffs and small patches of yellow Mediterranean soils of the escarpment, and the sandy sediments of the eastern Plateau. Also on the Plateau are a number of basalt deposits created by now-extinct formerly underwater volcanoes (Bender, 1974).

The major factor effecting climatic variability in west-central Jordan is elevation. Humidity, rainfall, sun intensity, cloud cover, wind, and temperature are fairly consistent across the entirety of the Kerak Plateau. As one moves south or east, rainfall, humidity, and cloud cover decrease slightly and sun intensity and temperature increase slightly. Wind strength, direction, and frequency are fairly constant no matter the location. However, within the Dead Sea Basin humidity, cloud cover, and temperature are significantly higher, while rainfall and sun and wind intensity are significantly lower. Variability in rainfall not only occurs across the terrain but also over time. Currently, west-central Jordan contains the following climatic regions: (1) the arid Dead Sea Basin, (2) the semiarid Dead Sea escarpment, and (3) the Mediterranean Kerak Plateau (Cordova, 2007).

Perhaps the most relevant climate variable to subsistence ecology and, therefore, this study is precipitation. On the plateau, median annual rainfall is greater than 200 millimeters (mm) in the south and 300 mm in the north. However, it is actually highest in the center of the western highlands where elevation is highest. The heavy incising of the plateau by the Wadi Mujib and Hesa have gently lowered elevations in the north and south, increasing temperature and aridity. In the center of the plateau, the Kerak-Wadi al Fayha fault system raises the portion of the region below the town of Kerak (Donahue and Beynon, 1988), where median rainfall is over 350mm.

In the Dead Sea Basin median annual rainfall along the entire north-south extent is just above 50 mm. In each of these regions rainfall occurs predominantly from November to April with the Mediterranean section of the region having the longer rainy season and receiving more total rain. There is also significant inter-annual variation. In the Basin, rainfall can be lower than 10 mm annually and higher than 150 mm. On the Plateau, rainfall can be as low as 100 mm annually and as high as 650 mm in the north. However, in the south, where summer monsoonal moisture from the Arabian Peninsula can occasionally reach, rainfall has been lower than 85mm annually and above 750 mm (Harlan, 1981). On the northern edge of the Plateau the standard deviation for annual rainfall is 130.3 mm, showing the highly variable nature of precipitation in west-central Jordan, as it is as the boundary between the warm Mediterranean climate of the Levant and the warm arid climate of the Arabian Desert (Dahamsheh and Aksoy, 2007).

While most climate dynamics found today in the region also occurred during the PPNB, there is strong evidence that the overall climate was wetter in the past (Robinson et al., 2011). Recent estimates of rainfall in the southern Levant during the early Holocene suggest that levels may have been twice or more what they are today (Black et al., 2011). Thus, mean annual

rainfall on the plateau may have ranged from 400 to 600 mm in the southern and northern reaches of west-central Jordan, respectively. There has also been some suggestion from paleo-climatic simulations that the summer monsoonal rains of the Arabian Peninsula may have consistently reached the southern Levant, increasing water availability in late summer (Robinson et al., 2011). However, there is, as of yet, very little direct evidence of this (Cordova, 2007). Most other climatic phenomena, such as sun and wind intensity, are thought to have been roughly equivalent to the present.

Several different types of wild ecological zones exist in west-central Jordan. They map fairly directly onto the climatic and geological zones described above. These include relict pistachio woodlands and grasslands of the red Mediterranean soils of the warm Mediterranean zone, saline desertic zones around the Dead Sea, relic tropical Sudanian vegetation within *wadis*, and what has been described as “wormwood steppe” located on the yellow Mediterranean soils of the rockier terrain within the various *wadis* on the western extreme of the Kerak Plateau (White et al., 2010). Within these zones, a variety of animals can be found, including both the Palestinian wolf (*Canis lupus*) and striped hyena (*Hyena hyena*). The most common medium or large herbivorous mammal in the area is the Nubian ibex (*Capra ibex nubiana*), which can be found year-round in the region; as can a number of game birds. Mountain gazelles (*Gazella gazella*) have also been historically known in the area (Hatough-Bouran and Disi, 1991).

According to local inhabitants of the plateau, one in every three or four years has sufficient rainfall to allow for dry farming most cereals and pulses alongside goat foraging. Yearly rainfall typically is sufficient to allow for dry farming of barley alongside very carefully regulated goat herding. Complete crop failure occurred during only three years in the entirety of the twentieth century (Lancaster and Lancaster, 1995). Today, most farmers in the area grow

barley through dry farming techniques and other predominantly orchard crops (e.g., grapes by individuals and olives by both individuals and villages) through irrigation. In the Dead Sea Basin a wide variety of garden and orchard crops (e.g., tomatoes, eggplants, and bananas) are grown using intensive irrigation techniques, channeling surface water resources from the bases of *wadis*. Goats are the dominant herd animal. Wormwood is gathered wild for medicinal purposes or for daily fuel for heating tea when working outside and game birds are hunted for food. Carnivores are hunted to protect goat herds (pers. obs.).

Most species found today existed during the PPNB. They would have been far more abundant, as anthropogenic pressures such as over-hunting, environmental degradation, and large-scale agriculture and animal husbandry have drastically reduced wild life in the area (Cordova, 2007). Additionally, the increased rainfall of the PPNB would likely have increased vegetation overall and, therefore, increased animal life as well. Some of the main evidence from the southern Levant of increased rainfall is from such indicators as Mediterranean woodland expansion, southward migration of the Negev Desert boundary, and increased surface water in southern Jordan in the form of slow-flowing perennial streams in now dry *wadi* beds (Robinson et al., 2011). Such indicators suggest that the relict pistachio woodlands of the Kerak Plateau and the grasslands of the red Mediterranean soils both would have been significantly expanded in the PPNB. Within these habitats, wild wheat and barley, wild pistachio and other nuts, wild figs and other fruits, and various wild pulses would all have been abundant. In fact, wild cereals require significantly higher rainfall than their domestic forms, which would have been consistently available in this region during the early Holocene climatic optimum (Kennedy, 2007).

The Topography Surrounding Al-Khayran

Al-Khayran is located on a hill slope on the south ridge of Wadi ‘Assal, less than .5 km from the edge of the steep cliffs of the *wadi*. The site lies at an elevation of 750-760 m above sea level in the southern portion of west-central Jordan. It is about 50 m north of a small plateau upon which a large (30 x 25 m) Chalcolithic/Bronze Age structure was built (Figure 3). While the primary area accessible from the site is the south ridge of Wadi ‘Assal, it is also possible to reach the Dead Sea Basin or the Kerak Plateau in less than a day’s walk. The mechanically-cultivated, dry-farming barley fields of the Plateau can be found less than 8 km to the east on a gently up-sloping walk, while the flat Dead Sea Plain, is a significantly more rugged trek (pers. obs.) (Figure 1).

The steep edges of the Dead Sea/Wadi ‘Assal Escarpment make it difficult to know the exact route which would have been used in the early Neolithic. However, during a number of different periods in human history along the *wadi*, governments and economic entities have had to choose the best route between the Basin and Plateau for the construction of roads or other infrastructure. In each successive project the path chosen was located almost directly next to al-Khayran along the south ridge of Wadi ‘Assal. Iron Age (Mittmann, 1982) and Roman roads (Jacobs, 1983) terminating at Ghor ‘Assal were each located less than 200 m north of the site, the construction route for power lines to carry electricity to the Arab Potash Company plant west of Wadi Dhra’ in the north (Jacobs, 1983) was located less than 100 m north of the site, and the recent construction of a major highway by the Jordanian government terminating at Ghor Numeira adjacent to the southern basin of the Dead Sea is routed less than a kilometer of gently sloping hills to the south (pers. obs.) (Figure 11). The nearest similar routes from the Basin to the Plateau beyond the south ridge of Wadi ‘Assal can be found 18 km to the south in the Wadi al-Hesa (Politis et al., 2007) or 10 km to the north in Wadi Kerak (Miller, 1991).

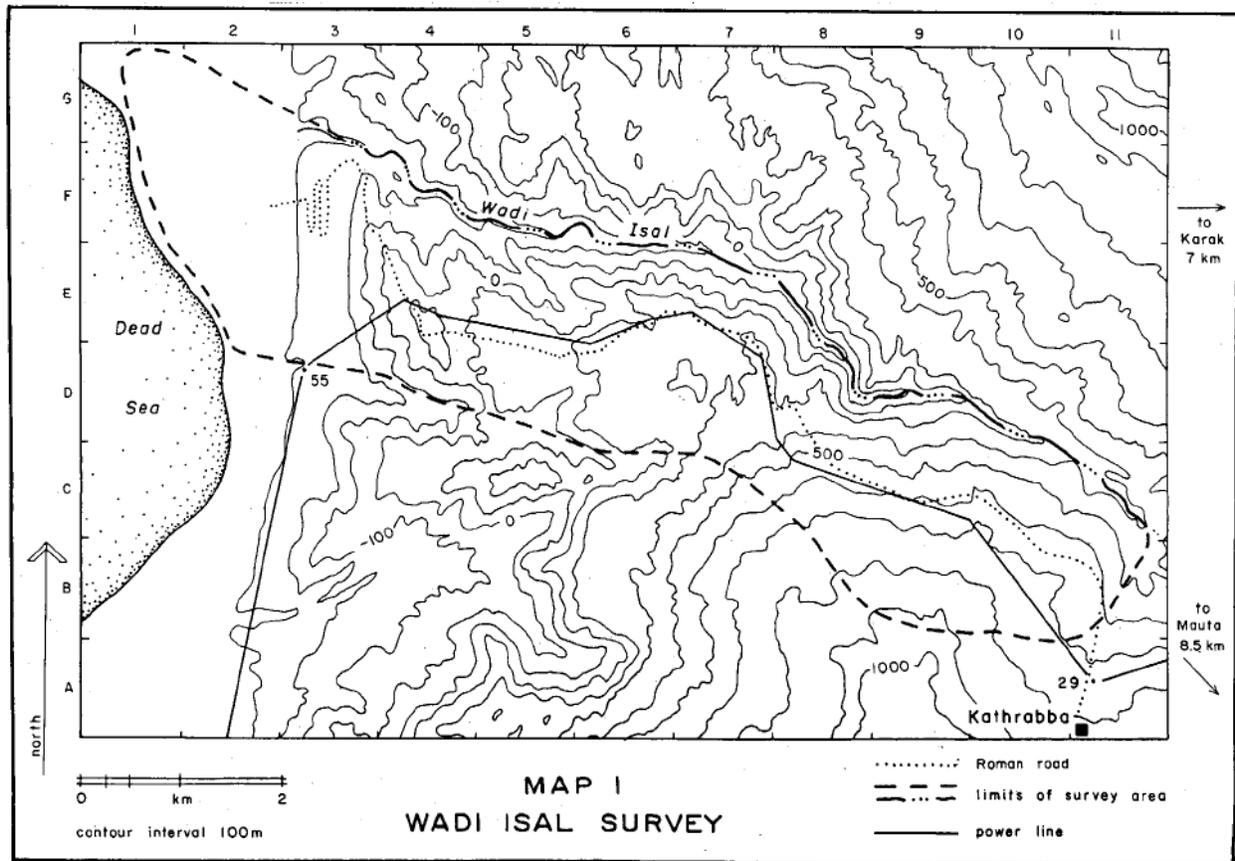


Figure 11: Wadi 'Assal; Including Roman Road Course and Arab Potash Company Power Line Course (Jacobs, 1983)

All of these choices by builders and surveyors through the years suggest that the site is located on terrain more hospitable for travel to the Dead Sea Basin than in most areas of west-central Jordan. However, the ease of travel along these routes should not be exaggerated. By foot it still takes an entire day to cover the 9 km section of stone-paved route from the site of al-Khayran to the Dead Sea Plain along the previously-noted Roman Road (Mittmann, 1982), with the uphill climb significantly more challenging (pers. obs.). Additionally, there has been no evidence identified yet for such an engineered travel route in the early Neolithic, suggesting greater travel times in the period. In fact, the location of al-Khayran at the western edge of the walkable section of the south ridge of Wadi 'Assal, does create a certain amount of isolation for the site with access from the west, north, or south extremely difficult (pers. obs.). While it would certainly be possible for individuals to travel to the Plain to conduct economic or social activities, such a choice would

not have been made casually and such a practice would likely not have been frequent or part of the daily routine.

Al-Khayran's Geological Catchment

In relation to natural resources al-Khayran is located a short walk from most of the more common geological material utilized by the PPNB inhabitants of the southern Levant. The site itself is on what is the current far western extent of *terra rossa* soils along the south ridge, still fertile enough that the owners of the land recently dry-farmed barley and are still cultivating



Figure 12: Tobacco Farmed at al-Khayran

tobacco at al-Khayran (Figure 12). This continued farming of the water-intensive crop of tobacco is aided by groundwater seep, which may have been a spring in the past, as indicated by two small limestone caves directly above it (pers. obs.).

Additionally, because of the increased rainfall in PPNB, it is likely that there was more water being discharged at the site. The combination of the most fertile soils of the region and access to groundwater in a semi-arid region would have made al-Khayran an attractive locale for plant production. A spring known as 'Ain ar-Rsais is less than .5 km to the east, allowing direct access to flowing water a short walk away, even if the current seep was also underground during the PPNB (Figure 13). Another spring, .5 km from al-Khayran, is lower down the escarpment of Wadi 'Assal (pers. obs.), making it less than ideal for use; but never-the-less accessible (Figure 14).



Figure 13: The Spring of 'Ain er-Rsais

Al-Khayran is approximately 200 m north of a major flint outcrop with a variety of colors of thin and thick tabular flints including medium-grain brown, white, and grey flints, as well as fine-grain lustrous black, red, and yellow flints (Figure 15). The large size of the outcrop and the extensive evidence of stone knapping on-site indicating that the outcrop was utilized in the past. Diagnostic knapped stone tools recovered include an Acheulean hand axe (Figure 16), several Chalcolithic tools (e.g. Ha-Parsa points) (Figure 17), and large quantities of debitage produced by nodule testing and

preliminary core shaping with no diagnostic features to allow for its placement in the regional chronology. Al-Khayran itself is on top of a limestone outcropping laid down in layers of ideal thickness for dry-slab construction of architecture, as is found in many PPNB sites. The limestone is also of high enough quality (i.e., purity) to be used in lime plaster production. Additionally, the site is directly above the juncture between the sandstone of the Dead Sea Basin

and the limestone of the Kerak Plateau with sandstone blocks used for ground stone querns and hand stones less than 200 m to the north (pers. obs.).

Within easy walk of the site, but still at a significant distance, a number of other



Figure 14: Lower Spring below 'Ain er-Rsais

resources can be found. Starting 2 km southeast of al-Khayran are the closest of a series of 15 springs concentrated within the boundaries of the contemporary small village of Kathrabba and its suburbs (Figure 3; Figure 18). While there is strong evidence that this village has been around since the Iron Age (Mittmann, 1982), it is possible that the area was also utilized in earlier periods. This profusion of springs is what has given the *wadi* its name (Canyon of Honey) and today Kathrabba and its surroundings are filled with olive and grape orchards fed by these

many springs. Additionally, at a distance of 3 km to the east of al-Khayran is a midden deposit on the outskirts of town over 3 m deep and filled with carbonized materials, pottery, and knapping waste. While it has not been possible to sample the deposit (it is located below private property), this midden does indicate significant past habitation intensity in the area (pers. obs.).



Figure 15: Flint Source at al-Khayran

Within this same range of distances lies at least one more flint outcropping, 3 km southeast of al-Khayran and just one and a quarter miles from the midden deposit within

Kathrabba (Figure 4). This outcropping produces medium-grain grey flint and also has evidence of knapping on-site, including large quantities of debitage produced by nodule testing and preliminary core shaping with no diagnostic features to allow for its placement in the regional chronology. Analysis has yet to be able to visually differentiate the flints recovered at this source from the grey flints identified at al-Khayran (pers. obs.). Thus, we do not know if any of the knapping materials at the site derive from this outcrop.

Another significantly sized flint outcropping has been identified on the north ridge of Wadi ‘Assal. This outcropping is found on a small plateau overlooking a major Roman/Byzantine fortress and cemetery directly to the north. It is located 6.3 km from al-Khayran as the crow flies. However, because it is separated from the site by Wadi ‘Assal, the distance on foot between the two locations is likely closer to 15 km (Figure 56). The outcropping produces high quality fine-grain lustrous blue flints and has extensive evidence of utilization in the past with large quantities of debitage produced by nodule testing and preliminary core



Figure 16: Acheulean Hand Axe from al-Khayran

shaping with no diagnostic features to allow for its placement in the regional chronology. However, unlike the grey flints located near Kathrabba it is easy to differentiate this flint from those found at al-Khayran (pers. obs.). Thus, a

small quantity of flints from this source have been identified at the site, suggesting that the flint catchment of the community in which the inhabitants of al-Khayran participated extended to at least this location. That being said, it is also possible that the blue flints found at al-Khayran are a product of intentional or unintentional heating (Rollefson et al., 2007).

Further afield near the mouth of Wadi ‘Assal on the Dead Sea Plain are several resource locations as well. On a hill overlooking the debouchment of the *wadi* is an outcropping of flints in a variety forms including high-quality, fine-grain, lustrous black flint, as well as greens, browns, and white banded flints of fine to medium-grain flint. There is significant evidence of utilization through time including the recovery of an Acheulean hand axe, coarse-grain, thick, burnish black and red ware typical of the Pottery Neolithic, and large quantities of debitage produced by nodule testing and preliminary core shaping with no diagnostic features to allow for its placement in the regional chronology (Figure 19). This source is located 6.1 km directly from



Figure 17: Ha-Parsa Point from al-Khayran

al-Khayran. However, because of its location near the Dead Sea Plain, the actual walk to the outcropping would have been over 10 km and quite arduous given the steep slopes between it and al-Khayran. Again, because of the similarities between this flint and some of those identified at al-Khayran, analysis has yet to be able to visually differentiate them (pers. obs.), making it impossible to determine if this source was within the flint catchment of al-Khayran's community.

In addition to this high-quality flint outcropping, one of only four surface seeps of bitumen for all of west-

central Jordan is located at the southern edge of the debouchment at the intersection of the Plain and Escarpment (Abed et al., 2004), 6.4 km from al-Khayran. Again, because of its location at the debouchment of the *wadi* the actual walking distance would have been closer to the 9 km of the Roman road described above (pers. obs.). A second such seep is also found 2.5 km to the south of the first source and 5.3 km west of al-Khayran at the base of the Escarpment (Abed et al., 2004) (Figure 1). Accessing this second source, while closer to the site than the first, would have potentially been more difficult given the steep edge of the Dead Sea Escarpment directly above it. Thus, the most likely route would have been down Wadi 'Assal and then south along the Dead Sea Plain, giving an approximate walking distance of 11.5 km (pers. obs.). Two other sources of bitumen in west-central Jordan are at the mouth of Wadi Kerak, 9.2 km north of the first source described, and Wadi Mujib, 29.4 km north of the first source (Abed et al., 2004); that it, approximately 18 km and 38 km respectively on foot from al-Khayran.



Figure 18: A Series of Springs at the Head of Wadi 'Assal

The sources of two other material resources recovered from al-Khayran have been identified at a significant distance from the site. The first of these is basalt used for a handful of small ground stone objects, including pestles and a shaft-

straightener. As has already been noted, basalt occurs only sporadically across the Kerak Plateau. The two closest surface outcroppings of basalt along the Plateau are both located approximately 25 km from al-Khayran; one to the northeast and one to the southeast (Mehyar et al., 2006) (Figure 1). The source of the basalt artifacts at al-Khayran has not been determined. However, it should be noted that an LPPNB village site, the settlement of el-Hemmeh, is located directly below one of these sources (Makarewicz et al., 2006). The second non-local item found at al-Khayran is marine shell. There are only two sources of these for the region: the Mediterranean and Red Seas (Bar-Yosef Mayer, 2005). It is unknown from which source the shells found at al-Khayran derived. However, whatever the source, the distance between the site and the location and the treacherousness of the terrain suggests that they would have moved across social networks rather than procured by the inhabitants of the site.

A final resource for which the likely source has yet to be identified is the ground ochre used at al-Khayran to decorate plaster surfaces. This mineral derives from ochre clays excavated, separated, dried, and ground or nodules formed in the fissures of iron oxide containing sandstones (Weinstein-Evron, 1994). The red color of the ochre found on-site derived from a form of iron oxide known as hematite. No study of the presence of such ochre clays in Jordan is



Figure 19: Finds from the Flint Source at the Mouth of Wadi 'Assal

known to the author and no sources have been identified during field survey. However, the usage of the mineral is quite common throughout the

PPNB of the southern Levant in both ritual (Cauvin, 2000) and domestic contexts (Banning, 2003), suggesting that it was probably widely available.

Al-Khayran's Ecological Catchment

Al-Khayran is located at the far southern extreme of the Mediterranean environmental zone of western Jordan, bordering on the more arid Irano-Turanian zone in the southern Transjordanian highlands (Al-Eisawi, 1996). As al-Khayran is located near the plateau in the southern portion of the region, rainfall temperatures, and sun and wind intensity are similar to those described above for the southern reaches of the plateau zone. Rainfall is right on the border for dry farming of wheat and only slightly above the minimum requirements for barley, with a median annual total of around 250mm (Miller, 1991). In the MPPNB it is likely that rainfall was significantly above this, at the levels required even for wild stands of cereals during most years.

The Wadi ‘Assal’s escarpment created a vertical landscape where the inhabitants of al-Khayran would have had access to a variety of different zones. Directly around the site the gentle slope of the Plateau and the *terra rossa* soils likely would have allowed for grassland crops, including cereals and pulses, to be grown or harvested wild. The plethora of springs near the source of the *wadi* would have preserved small relict stands of forest which could include oak, pistachio, fig, and other nuts and fruits or allowed for such orchard crops to be grown. Given the higher rain during the period and lack of any evidence of irrigation systems dating the PPNB (Mithen, 2010) springs and associated pools, unlike today where flows are low and all water is immediately collected and channeled through small-scale irrigation systems, could have supported more water-demanding plants for roofing and basketry such as reeds. *Wadi* bottoms, would likely have included relic tree stands, reeds, and the typical tropical Sudanian vegetation found today in such locals.

Within such varied plant zones a number of medium and large mammals and a variety of birds important to PPNB subsistence economies could survive. Hyenas and wolf are the primary predators in the area and carcasses of both have been shown to me by local hunters (Figure 20). While ibex are reported to be the most common prey species (Harrison and Bates, 1991; Hatough-Bouran and Disi, 1991), they have largely been replaced by domestic goat herds in the area (pers. obs.). However, in nature reserves across Jordan there are reports of significant numbers of ibex still in their natural habitat when not competing with domestic herds for forage (Al-Eisawi, 1996). Additionally, the higher levels of rainfall in the PPNB would have supported greater forage and, thus, more prey animals.



Figure 20: Boy Wearing a Mask Made from the Pelt of a Wolf He Hunted (Chantel White)

Another effect of the high density of springs near al-Khayran, apart from the support of potential water intensive plant communities is the support of associated game birds. To this day the orchards of Kathrabba are a chosen local for birds to visit given the plentiful water in such a dry area and the large quantities of

food in the form of fruits and insects which are attracted to the areas for the same reasons as the birds. Local inhabitants frequently hunt in these orchards, most of which are held communally. Thus, anyone has the right to utilize the areas. Such a phenomenon is known as garden hunting (Linares, 1976) and would likely have been available to the inhabitants of Wadi ‘Assal in the PPNB even if garden agriculture (Bogaard, 2005) was not occurring in the area, given the concentration of natural springs.

M-LPPNB Social Geography of West-Central Jordan

Two primary methods – pedestrian survey and excavation – help us learn the social geography of the PPNB in west-central Jordan. Each yields different information. Survey reveals site densities through time. Excavations help us establish fine-grained chronology and intra-settlement spatial patterns. My review of the regional social geography starts by looking at excavation data and then I will turn to survey results.

Excavated Sites

An important fact is that no early Neolithic sites (apart from al-Khayran) have been identified along Wadi ‘Assal and the adjacent Basin and Plateau lands. There are, however, four PPNB sites: MPPNB Wadi Hamarash 1 (Politis, 2010; Politis et al., 2009, 2007; Sampson, 2012, 2011, 2010a, 2010b) and LPPNB el-Hemmeh (Makarewicz and Austin, 2006; Makarewicz and Rose, 2011; Makarewicz et al., 2006; Rollefson, 1999), Khirbet Hammam (Peterson, 2009, 2007, 2004), and es-Sifiye (Gorsdorf, 2000; Mahasneh and Bienert, 2000; Mahasneh, 2004, 1997). All three of these LPPNB sites have produced potential evidence of potential MPPNB habitation, be it remains typical of the period at Khirbet Hammam and es-Sifiye or an early radiocarbon date (attributed to old-wood effect by the authors) at Hemmeh.

In addition to these sites, the site of Tor at-Tariq has been described in passing as containing a PPNB (Olszewski et al., 2004: 12) or LPPNB (Hill, 2006: 72) component. However, we do not yet have published materials from this site. That being said, the Epipaleolithic component of Tor at-Tariq has been more extensively published and is interpreted as a temporary camp on the edge of a paleo-lake (Coinman, 2000; Hill, 2006; MacDonald, 1988). There were excavations in both 1984 and 1992 that did not identify the PPNB component (Coinman, 2000; Peterson, 1996) until radiocarbon dates were produced (Olszewski et al., 2004), suggesting that the site was not particularly different during the PPNB as compared to the temporary camp of the Epipaleolithic.

It is notable that all of the sites but es-Sifiye yet identified to the PPNB in the region are found within the Wadi al-Hesa. Es-Sifiye is located near the source of the Wadi Mujib all the way in the north of the Kerak Plateau. That being said, this may partially be a product of survey bias as the Wadi al-Hesa has been the location of two of the most extensive prehistoric survey projects in the Jordan: the Wadi Hasa Survey (WHS) (MacDonald, 1988) and the Wadi Hasa

North Bank Survey (WHNBS) (Clark et al., 1994), the latter as part of the Wadi al-Hasa Paleolithic Project (WHPP). The WHPP also served to review assemblages from sites found on the WHS and attempt to identify those from both surveys for which there was evidence of intact subsurface deposits for targeted excavation. This led to the excavations at Khirbet Hammam and Tor at-Tariq.

All of the relevant results from previous excavations of PPNB sites in west-central Jordan will be described as needed to understand PPNB social processes. Beyond the limits of each village, it is difficult to identify the connections between sites. One of the challenges is determining exact contemporaneity. This is a problem in the Wadi al-Hesa where at least two LPPNB sites – the small village of el-Hemmeh and the large village of Khirbet Hammam – were 6 km apart. Radiocarbon dating of these sites has been minimal and, therefore, it has been impossible to determine if they are contemporaneous. This problem is all the more compounded by the fact that the single radiocarbon determination from the portion of el-Hemmeh which has yielded a knapped stone assemblage and architectural styles typical of the LPPNB falls towards the latter portion of the standard MPPNB chronology at ca. 7670 ± 70 cal. BCE. This date has been attributed to the old-wood-effect by the researcher (Makarewicz et al., 2006). However, the species of plant for the sample was not identified. Additionally, two radiocarbon determinations from Khirbet Hammam, which derive from a lower layers, yielded slightly later dates than the Hemmeh sample, right around the transition from M-LPPNB in the standard chronology at ca. 7500-7400 cal. BCE (Peterson, 2009).

Yet, there are two radiocarbon dates that fall within the early to middle portion of the standard LPPNB chronology at Khirbet Hammam at ca. 7400-7100 cal. BCE (Peterson, 2004). Additionally, the excavators have not presented evidence of significant changes in either social

processes or material culture assemblages through time at the site. Thus, it would seem as if the bulk of the occupation at Khirbet Hammam was during the earlier portions of the LPPNB. Because there is only a single published radiocarbon date for el-Hemmeh from the PPNB portion of the site, it is perhaps prudent to turn to the knapped stone assemblage for guidance on its placement chronologically. Similarly to Khirbet Hammam, eleven of thirteen points were Byblos in form, while two were Amuq. The former is found in both the M- and L- PPNB, while the latter is typically slightly later in the PPNB (Gopher, 1994).

When the radiocarbon and knapped stone assemblage evidence is taken together from both el-Hemmeh and Khirbet Hammam, it is difficult to differentiate them chronologically. When other lines of evidence, such as the substantialness of the architecture and the depth of deposits at the site are considered, it is likely that both settlements were occupied for significant durations. Thus, it does seem likely that they were inhabited at the same time.

Sites Identified Through Survey

At least 24 surveys have been conducted in west-central Jordan (see Appendix 1). However, the quality of results from these surveys for understand Neolithic settlement patterns has been variable. A number of surveys were not systematic or intensive (e.g., Albright, 1924; Glueck, 1933; Raikes, 1980). Others did not identify prehistoric sites (e.g., Mittmann, 1982; Miller, 1991). Still others were conducted in areas where settlement would likely have been ephemeral as these survey were interested in historic era phenomena (e.g., Parker, 2006) – although the Limes Arabicus survey did return a surprising number of early Neolithic sites. Some were so small in scale as to only identify a handful of sites (e.g., Jacobs, 1983; Rollefson, 1999).

In areas where large, intensive surveys have been conducted, many more early Neolithic sites are found. Of these 24 survey projects 11 have identified early Neolithic sites. Approximately 175 total early Neolithic sites have been identified by survey. Of these, only those six noted above from excavation, as well as four others for the WHS have been dated to the PPNB (MacDonald, 1988). The other 165 sites have only been described as Pre-Pottery Neolithic (PPN). The WHS identified 116 PPN sites (MacDonald, 1988), the WHNBS identified 28 (Clark et al., 1994), the Limes Arabicus Survey identified 14 (Parker, 2006), the Southern Ghors and Northeast 'Araba Archaeological Survey identified two (MacDonald, 1992), and another five sites were identified individually by different surveys ("MEGA Jordan," n.d.). Without absolute chronologies for these sites it is very difficult to understand any relations between sites.

Chapter 6: Village Development in the Pre-Pottery Neolithic B

Here I present the archaeological evidence for village development during the PPNB of the southern Levant. First, I introduce the types of sites found within village settlement systems during the PPNB. I then look at the specific development trajectories in this period and region by describing various lines of evidence. While my discussions are focused on the artifacts and architecture from the period, I will interpret those data to link them to the social phenomenon of village development. Thus, I will discuss a number of social issues in this and subsequent chapters.

Village Settlements and Associated Sites in the PPNB

As I briefly discussed earlier, perhaps the most dramatic social phenomenon in the MPPNB is the formation of large-scale, densely packed, internally heterogeneous villages (Byrd, 2005a, 2000, 1994; Flannery, 2002, 1972; Kuijt, 2000a; Rollefson, 1997) of orthogonal architecture (Bafna and Shah, 2007). As of 2002, more than 30 sites were identified as possibly having a MPPNB component in the southern Levant (Asouti, 2006; Kuijt and Goring-Morris, 2002) and in a recent presentation of regional settlement systems during the PPNB of the Lower Galilee, Birkenfeld (2013) noted that more than 40 sites had been identified to that time period. Additionally, a recent review by myself of published survey data in west-central Jordan shows that 175 sites are either PPN or PPNB (“MEGA Jordan,” n.d.) (See Appendix 2). However, far fewer of these loci contain the remains of permanent villages and associated sites (Figure 21). And fewer still have been excavated sufficiently to expose large areas with MPPNB materials

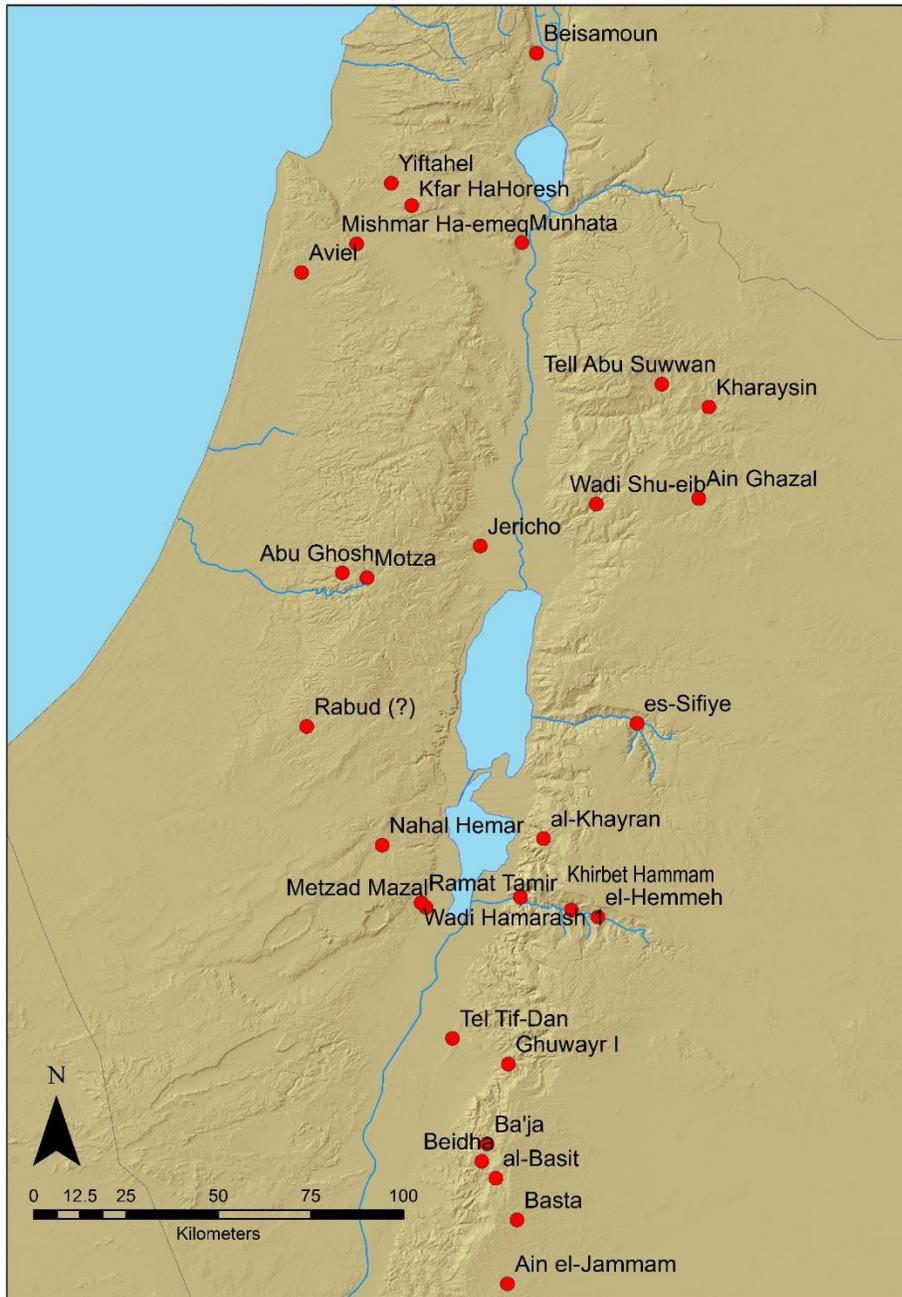


Figure 21: Excavated PPNB Sites in the Southern Levant (Eliza Wallace/Matthew V. Kroot)

(Simmons, 2007).
 These sites include Jericho (Kenyon, 1981, 1957), Beidha (Byrd, 2005a; Kirkbride, 1966), ‘Ain Ghazal (Banning and Byrd, 1984; Kafafi, 2006; Kohler-Rollefson et al., 1988; Quintero, 2011; Rollefson, 2000, 1997; Wasse, 2002), and Ghuwayr 1 (Simmons and Najjar, 2006). Of these, only Beidha and Jericho have final site reports, with ‘Ain Ghazal and Ghuwayr 1 known only through

articles, book chapters, and web presentations. A more thorough review of these sites and others dated to this period will be included in this chapter. Broad exposures of settlements help us the most in reconstructing village development in the MPPNB.

The same holds true for the LPPNB where, in 2002, at least 40 sites had been identified with likely components from the period (Asouti, 2006; Kuijt and Goring-Morris, 2002). Again, only a handful of these sites contain the remains of villages and have broad exposures of LPPNB materials, including Ba'ja (Bienert and Gebel, 1998; Gebel and Kinzel, 2007; Gebel, 2003; Gebel et al., 1997; Purschwitz and Kinzel, 2007), Basta (Gebel et al., 2006b; Nissen et al., 2004), and 'Ain Ghazal (Banning and Byrd, 1984; Kafafi, 2006; Kohler-Rollefson et al., 1988; Quintero, 2011; Rollefson, 2000, 1997; Wasse, 2002). Of these sites, only Basta has begun final publications, with the other two only known through articles, webpage, and book chapters.

It must be noted that nearly every one of the broad exposures listed above, with the exception of MPPNB Jericho, is located in Transjordan. This is not to say that sites in Cisjordan have not been excavated from these time periods. In fact, it is possible to argue that a far greater number of sites on the western side of the Jordan Rift Valley have produced significant knapped stone, fauna, and other material remains for the PPNB. However, due to several factors including theoretical interests, research methods, permit procedures, and funding opportunities, as well as site structures and past settlement systems, results from each side of the Jordan Rift Valley have been significantly different. Thus, such MPPNB village settlements as Yiftahel (Garfinkel et al., 2012), Munhatta (Perrot, 1964), Beisamoun (Bocquentin et al., 2011), and Abu Ghosh (Khalaily and Marder, 2003a) have also produced significant data for understanding Neolithic practices, with research presently continuing at Beisamoun. The MPPNB village site of Motza (Khalaily et al., 2007) in the Central Hill Country of Cisjordan is less extensively published, but does have a continuing research program.

There are also a number of on-going projects at site which the researchers label village settlements, but for which the extent and intensity of the occupation is not yet clear. These

include MPPNB Mishmar Ha'emeq in the Jezreel Valley of the Lower Galilee (Barzilai and Getzov, 2008) and LPPNB Aviel (Barkai and Biran, 2011) in the foothills of Mount Carmel, both dated purely on knapped stone assemblages. Mishmar Ha'emeq has produced a single structure with a paved flagstone surface inside and an adjacent burial ground with the remains of at least eight individuals. Thus, it could potentially be a village settlement or, similar to the nearby Kfar HaHoresh (Goring-Morris, 2000, 1991), a potential mortuary/ritual site (Barzilai et al., 2011), although such an interpretation for the latter has been challenged (Garfinkel, 2006).

The site of Aviel has only been reported from surface collections. However, the extent of surface finds reaches 50 hectares, suggesting a large settlement. Such a settlement would be unprecedented in scale for the Neolithic and caution must be taken with this areal scatter as the site is buried below a contemporary farm, likely spreading artifacts far beyond the original extent of the settlement.

Additionally, there has been a recent publication of materials from earlier test excavations for the LPPNB(?) site of Rabud in the southern portion of the Central Hill Country of Cisjordan, which the analysts claim to be a village site despite the absence of architecture (Gubenko et al., 2009). Like, Mishmar Ha'emeq and Aviel, Rabud is dated based on knapped stone assemblage characteristics. The site of Sheikh 'Ali near the southern edge of Lake Tiberius is another potential village site for which there is ambiguous evidence of a PPNB occupation. The site is rather extensive in size, with some estimates putting it at over 10 ha (Simmons, 2007), and recent analysis has identified at least seven different strata from five different cultural periods, including the PPNB, PPNC, Wadi Rabah (late Neolithic), and Pre-Ghassulian and Ghassulian Chalcolithic. However, the dating of the early Neolithic phases is difficult to confirm, because those phases have not been encountered by the most recent work at the site. While it

appears as if there is a PPNB component to the site (based on knapped stone assemblage characteristics) from the original excavations, information about context is sorely lacking and collections appear to be mixed (Garfinkel, 1999, 1993; Lev-Tov, 2000; Prausnitz, 1960, 1959, 1957, 1955). Thus, while it is likely that there is a PPNB component of some sort at the site, the nature of these strata is not clear nor the social practices during the early Neolithic occupation. Because of its apparent size, it is possible that Sheikh 'Ali was a major village settlement during the period.

Transjordan also has a fair share of less extensively published sites, many of which have on-going research, such as MPPNB Wadi Hamarash I (Politis et al., 2009; Sampson, 2012), as well as LPPNB el-Hemmeh (Makarewicz and Austin, 2006; Makarewicz and Rose, 2011; Makarewicz et al., 2006; Rollefson, 1999), Khirbet Hammam (Peterson, 2009, 2007, 2004), and Tell Abu Suwwan (Al-Nahar, 2010a). Several major LPPNB sites from Transjordan have only had test excavations published in article and chapter form including Wadi Shu'eib (Simmons et al., 2001), 'Ain Jammam (Fino, 2004; Makarewicz, 2009; Waheeb and Fino, 1997), es-Sifiye (Mahasneh and Bienert, 2000; Mahasneh, 2004, 1997), and al-Basit ('Amr, 2004; Fino, 1998, 1997). The village settlement of Tel Tif'dan (R. B. Adams, 1991; Moreno, 2009; Twiss, 2007a) has been the site of fairly extensive excavations which have primarily been published in dissertation form and are thus awaiting final publication. Additionally, the large sites of Kharaysin in northern Transjordan (Edwards and Thorpe, 1986) likely had significant PPNB components and, given its extensive areal coverage (approximately 36 ha, although this number is likely greatly inflated by slope erosion and farming), was likely a village settlement.

Another category of site that is important to understanding PPNB village-based settlement systems is a series of sites occupied temporarily and repeated by village dwellers.

These sites can be found on both sides of the Jordan, but are primarily studied in Cisjordan. They present evidence of several activities/functions, including the MPPNB ritual cave of Nahal Hemar (Bar-Yosef and Alon, 1988), the seemingly PPNB ritual and interment site of Kfar HaHoresh, the LPPNB flint workshop site of Metzad Mazal in the southwestern Dead Sea Basin (Schyle, 2007; Taute, 1994), and the Neolithic flint mining sites of Ramat Tamir in the southwestern Dead Sea Basin (Barkai et al., 2007; Schyle, 2007; Taute, 1994), Har Gevim in the Negev (Gopher and Barkai, 2011), Wadi Huweijer in the North Jordan Highlands (Quintero and Wilke, 1995; Quintero, 2011, 1996, 1994; Rollefson et al., 2007), and Nahal Dishon in the Galilee (Barkai and Gopher, 2001; Gopher and Barkai, 2006).

While it is difficult to date mining locales because of their usually long-term utilization and a typical lack of diagnostic architecture, prepared cores, or formal tools, it is likely that most of these special-function-sites were utilized in the PPNB. One of the mining areas, Har Gevim, did return a number of opposed platform cores termed “naviform”, typical of the PPNB (Gopher and Barkai, 2011). However, it is not clear who is utilizing the mine, whether it is village inhabitants or mobile groups. The same can be said for Ramat Tamir. It is also likely that Ramat Tamir was utilized as early as the LPPNB, given that it is thought to be associated with the LPPNB workshop site of Metzad Mazal (Schyle, 2007). It is not clear who is extracting flint from the site. For Wadi Huweijer, there is strong evidence for exploitation of the flints by the villagers of ‘Ain Ghazal as early as the MPPNB, as flints typical of these mines appear extensively in ‘Ain Ghazal PPNB knapped stone remains (Quintero and Wilke, 1995; Quintero, 2011, 1996, 1994; Rollefson et al., 2007). Similar arguments have been put forward, if less specifically, for the Nahal Dishon mines, which were likely utilized in the MPPNB by village inhabitants in the Galilee (Barkai and Gopher, 2001; Gopher and Barkai, 2006).

Another type of logistical site perhaps associated with village settlements has been proposed for the eastern desert region of Transjordan. A handful of sites, tentatively dated to the LPPNB based on knapped stone, appears to contain remains of herded ovicaprids, a species not present in earlier faunal assemblages in the region, suggesting their introduction through human management. Thus, the excavators of the sites have argued that such remains represent the refuse of LPPNB semi-mobile pastoralists who practiced herding; these people were attached to large highland settlements termed mega-sites in the literature (Quintero et al., 2004). While some argue that such sites represent independent mobile herder-hunters (e.g., Martin, 1999), it is possible these are herding camps that were part of the same economic system operated by village dwellers.

Non-Village Settlements and their Relationships to PPNB Villages

The southern Levant was not just a land of villages. Much of the region was populated by more mobile populations. While these communities were not occupants of village-based settlement systems, they were part of wider regional economic systems. Thus, while such sites will be described below, they will not be included in much of the cultural-historical review of village development in the PPNB. Many of these short-term and temporarily occupied sites are found on the desert fringes of the Mediterranean zone, including in the eastern deserts (Betts, 1998; Fujii and Abe, 2008; Garrard et al., 1994; Jobling and Tangri, 1991), the Judean Desert (Echegaray and Freeman, 1989; Echegaray, 1966), the Negev and Sinai (Goring-Morris, 1993; Tchernov and Bar-Yosef, 1982), and the Wadi Araba (Henry, 1995). Interestingly, there is also evidence that sites in the Cisjordan Coastal Plain and adjacent regions remained small and likely temporarily occupied throughout much of this period (e.g., Steklis and Yizraeli, 1963; Noy et al., 1973).

Such sites typically include small-scale round structures with minimal differentiation in form. There is no evidence of communal structures. These sites have temporary occupations and were inhabited during portions of an annual cycle of mobility. One of the more intriguing of these sites is that of MPPNB 'Ayn Abu Nukhayla (ca. 7550±40 cal. BCE) in southern Transjordan (Henry and Albert, 2004; Henry et al., 2003; Portillo et al., 2009). The excavators argue that the site was a seasonally occupied village where both farming and herding activities occurred, closely paralleling the economies of fully sedentary village communities while maintaining a greater degree of mobility.

In addition to habitation-sites utilized by mobile communities, a number of logistical production loci, typically located either in the eastern or southern desert fringes of the Levant and devoted to stone bead production (Betts, 1998; Fabiano et al., 2004), sometimes labeled burin sites (Betts, 1993, 1982). There are also habitation-sites found near the Red and Mediterranean Seas which are typical of most PPNB southern Levantine temporary settlements in most ways except for a high concentration of shell bead and bead making remains, suggesting intensive production of these objects on-site (Bar-Yosef Mayer, 1997). At such sites there is evidence of exchange with village-based communities, according to Bar-Yosef Mayer (1997), who has argued that large stores of cereals found at shell bead production-sites in the Sinai must have been traded in because of the arid environment of the desert. She suggests that village-based farmers may have been engaged in exchange with mobile groups. Additionally, stone beads from eastern and southern desert sources are found in a great number of PPNB village settlements of the Mediterranean and adjacent regions of the southern Levant (Bar-Yosef Mayer and Porat, 2008), suggesting that they were traded in from areas inhabited by mobile communities. While the bead trade is perhaps the most obvious form of inter-community

interactions between villagers and mobile communities in the southern Levantine PPNB, there remains the possibility that interactions were much more extensive in perishable goods, as is common in ethnographic contexts where rare or high-valued goods are exchanged between communities (Malinowski, 1922; Peterson, 1978; Spielmann and Eders, 1994).

Village Development in the PPNB of the Southern Levant

A number of material markers from PPNB sites have been used to identify the increase internal variability, longer habitation durations, and greater complexity of village life, including increases in (1) site size, (2) architectural density, (3) architectural compartmentalization (Kuijt, 2000a), (4) storage capacity (Kuijt, 2008a), (5) the privatization of space (Byrd, 1994; Flannery, 1972; Kuijt, 2000a; Peterson, 2003; Wright, 2000), (6) duration of occupation (Banning, 2012, 1998; Rollefson, 1997) and (7) renovation and remodeling (Bafna and Shah, 2007; Banning and Byrd, 1989a, 1989b, 1987; Flannery, 2002, 1972; Rollefson, 2010, 1997) of structures, (8) height of architecture (Gebel, 2006; Kuijt, 2000a), (9) amount of ritual paraphernalia and contexts (Rollefson, 2008), (10) discrete industrial or craft production loci both within (Barzilai, 2010; Gebel, 2010, 1996; Kafafi, 2006; Quintero, 2011; Rollefson and Parker, 2002; Rollefson, 2002; Starck, 1988) and outside (Barkai and Gopher, 2001; Barkai et al., 2007; Gopher and Barkai, 2011, 2006; Quintero, 1996, 1994; Rollefson et al., 2007; Schyle, 2007; Taute, 1994) of villages, and (11) systematic waste disposal systems, such as the development of off-site dumps (Hardy-Smith and Edwards, 2004). Additionally, a number of social processes indicative of settlement, social, and economic intensification have been identified through diachronic and contextual analyses at PPNB sites including increases in ritual practices (Cauvin, 2000; Hodder, 1990; Kuijt, 2008b, 2000d, 1996), economic segmentation (Byrd, 2005a, 2000, 1994; Flannery, 2002, 1972), craft specialization (Barzilai, 2010; Garfinkel, 1987a; Quintero, 2011; Rollefson and

Parker, 2002; Wright, 2008), and increased subsistence production (Asouti and Fuller, 2012; Bogaard and Isaakidou, 2010; Bogaard, 2005; Campbell, 2009; Goodale, 2009; Kohler-Rollefson and Rollefson, 1990; Kuijt, 2008a, 2000a; Makarewicz, 2007; Nesbitt, 2002; White, 2013).

I will review these material indicators and social processes in more depth. I will discuss sites within a detailed chronology of the PPNB, and contextualize the results from ADAP within broader processes of social change.

Evidence of Changing Settlement Forms through Time in the PPNB

Settlement Patterns

Village location shifts through time in the early Neolithic of the southern Levant. Major early village sites from the PPNA of the southern Levant, such as Jericho (Kenyon, 1957), Netiv Hagdud (Bar-Yosef and Gopher, 1997), Gilgal (Bar-Yosef et al., 2010), Dhra' (Finlayson et al., 2003), and WF16 (Finlayson and Mithen, 2007), tend to be found on alluvial terraces next to flowing water within the Jordan Rift Valley and its tributaries (Kuijt, 1994; Sherratt, 2007, 1980). In the MPPNB some village sites are still found in the lowlands of the Rift Valley, such as Jericho (Kenyon, 1957), Ghuwayr 1 (Simmons and Najjar, 2006), Beisamoun (Bocquentin et al., 2011; Samuelian et al., 2010), and Munhatta (Perrot, 1964), but many are also found at higher elevations or outside of the valley and its tributaries, such as Beidha (Byrd, 2005a; Kirkbride, 1966), Wadi Hamarash I (Sampson, 2012), and 'Ain Ghazal in the southern, central, and northern Jordanian Highlands respectively, Abu Ghosh (Khalaily and Marder, 2003a) and Motza (Khalaily et al., 2007) in the Central Hill Country of Cisjordan, the potential village site of Mishmar Ha'emeq (Barzilai and Getzov, 2011, 2008) in the Jezreel Valley, and Yiftahel (Garfinkel, 1987b; Garfinkel et al., 2012) of the Upper Galilee (Figure 22).

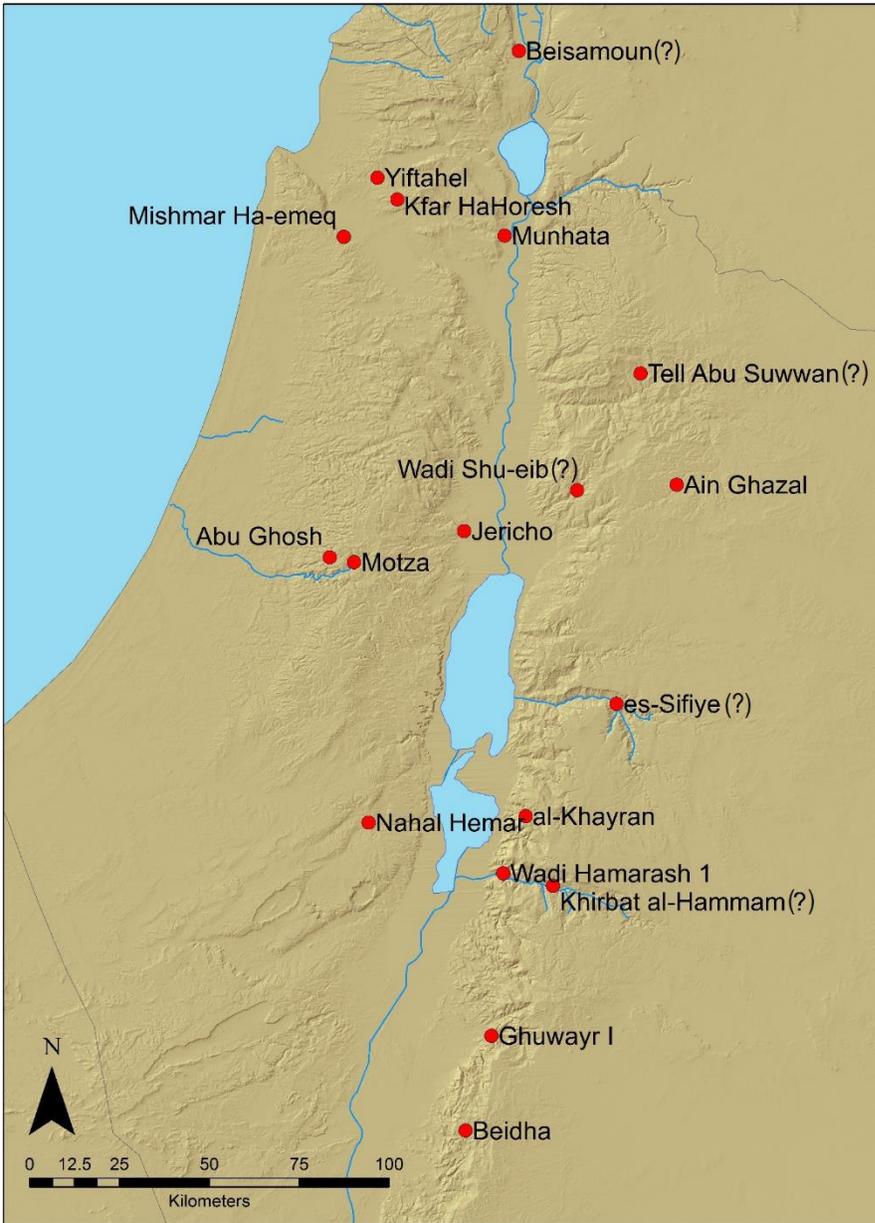


Figure 22: Excavated MPPNB Sites (Eliza Wallace/Matthew V. Kroot)

In the succeeding LPPNB both Jericho and Ghuwayr 1 in the Jordan Rift Valley are abandoned, as are Munhata, Abu Ghosh, Motza, Mishmar Ha'emeq, and Yiftahel. Beisamoun may have grown to impressive proportions, according to excavators; the site, however, has yet to be excavated extensively (Bocquentin et al., 2011), making such a claim largely speculative. We know

that the site has been found to extend over 20 ha, with Neolithic finds over between 12 and 15 ha on the surface. However, test excavations have only identified MPPNB remains in one unit, suggesting that perhaps much of this total area was not in use during the period. There have also been finds of PPNC/FPPNB age. The most recent excavators suggest that while no LPPNB finds

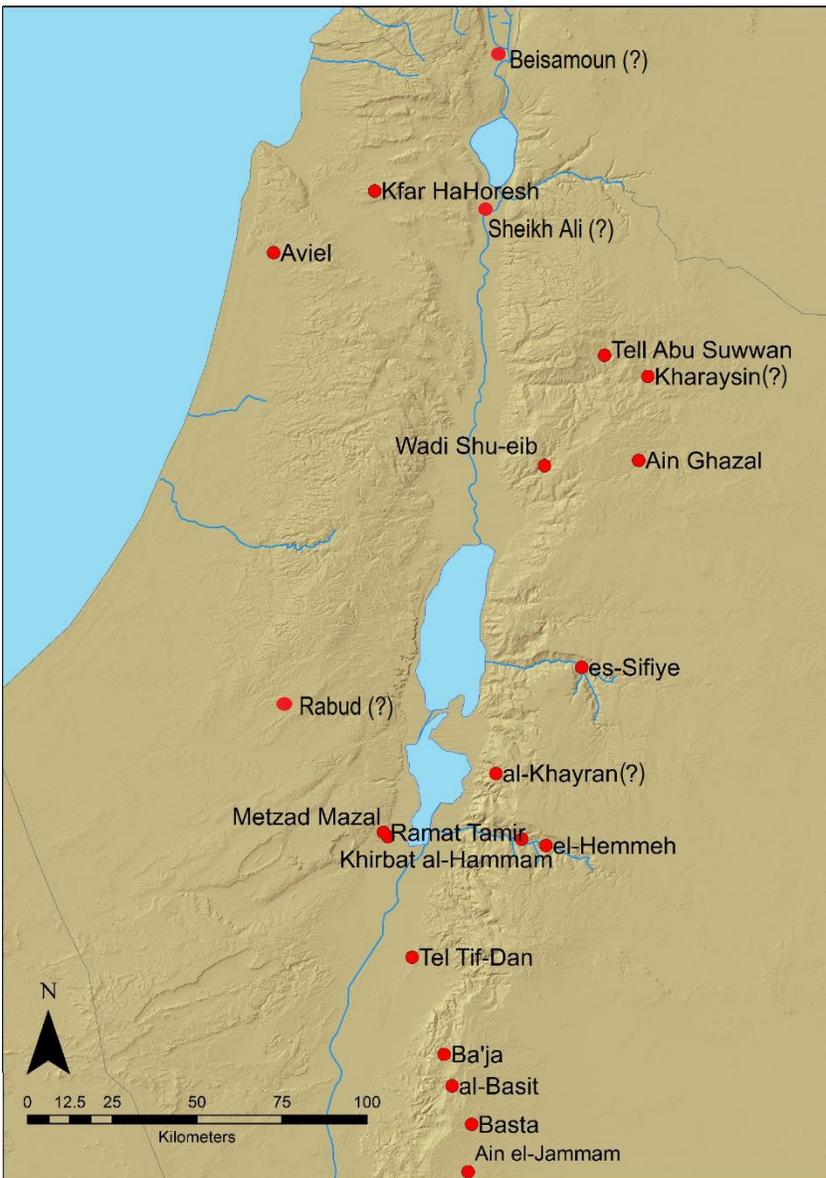
have been identified, the site may have been continuously inhabited. They point to the fact that much of the remains from all PPN periods are highly dispersed. The Jordanian sites of Beidha (Byrd, 2005a) and Wadi Hamarash I (Sampson, 2012) were abandoned.

Meanwhile, sites like the northern Transjordan village of 'Ain Ghazal experience explosive growth (Gebel, 2004a; Rollefson, 2010, 1987). Several Transjordanian large sites, such as Wadi Shu'eib (Simmons et al., 2001), es-Sifiye (Mahasneh and Bienert, 2000), Abu Suwwan (Al-Nahar, 2010a), and Khirbet Hammam (Peterson, 2009, 2007, 2004), similar to Beisamoun in the Hula Valley of the Jordan Rift Valley (Samuelian et al., 2010), lack strong radiometric evidence of an MPPNB occupation, but have produced material suggesting occupation into the LPPNB. Therefore, they may be included in the list of settlements experiencing dramatic growth with the onset of the LPPNB. Additionally, a number of sites are founded in Transjordan Highland LPPNB, which are equally impressive in scale to those mentioned above, including Basta (Gebel et al., 2006b; Nissen et al., 2004), al-Basit (Fino, 1998), 'Ain Jammam (Waheeb and Fino, 1997), and, potentially, Kharaysin (Edwards and Thorpe, 1986), as are a number of smaller village sites such as Ba'ja (Bienert and Gebel, 1998; Gebel, 2003; Gebel et al., 1997), el-Hemmeh (Makarewicz and Austin, 2006; Makarewicz et al., 2006), and Tel Tif'dan (Bennallack, 2012; Moreno, 2009).

There are also potential LPPNB villages founded in the LPPNB of Cisjordan for which we have no or minimal excavation data: Aviel (Barkai and Biran, 2011) in the Coastal Plain and Rabud (Gubenko et al., 2009) in the Central Hill Country. Another site, Sheikh' Ali in the northern Jordan Valley near Lake Tiberius has a PPNB component which may be LPPNB in date (Garfinkel, 1993) (Figure 23). However, there are a significant number of sites which have not been tested which potentially date to the LPPNB in Cisjordan. Goring-Morris and Belfer-Cohen

(2008; 2010) have twice presented a chart showing a steady increase in site densities over much of Cisjordan throughout the early Neolithic. However, site size and function are not noted on the chart and the source material for its construction remains uncited. Additionally, nearly all of these sites lack radiocarbon dates or have so few dates as to not allow to complete chronologies to be determined, making any such chart potentially problematic.

LPPNB excavations seem to show a shift in the density of sedentary village populations,



with the Jordan Rift Valley and Cisjordan having fewer sites recognized from the period while the Transjordanian highlands clearly show major growth in individual settlement sizes and likely overall settlement numbers (Rollefson, 1992: 124, 1998: 114, 2000: 185, 2010: 184; Simmons, 2000: 216-217; 2007: 175-197; Kuijt, 2000a; Kuijt and Goring-Morris, 2002: 404-413; Bienert et al., 2004; Gebel, 2004: 4-5). This is

Figure 23: Excavated LPPNB Sites (Eliza Wallace/Matthew V. Kroot)

not to say that sites do not continue to exist in the Rift Valley and adjacent regions (Goring-Morris and Belfer-Cohen, 2010, 2008). However, the vast majority of evidence for settled village life in the LPPNB comes from the Transjordan Highlands.

Site Size

Perhaps the most easily identifiable evidence for village development from the PPNB is the notable increase in overall areal coverage of each village site through time. Kuijt (2000a) has most thoroughly presented the evidence showing that the mean and largest site sizes from the PPNA to the MPPNB and through the LPPNB and PPNC grow significantly. In the PPNA, the largest site yet identified in the southern Levant is Jericho (ca. 9300-8400 cal. BCE; Aurenche et al. 2001), with an estimated maximum area of 2.5 ha. It should be noted that this areal estimate is highly speculative as only a very small proportion of the PPNA component of the site was ever excavated and the density of architecture identified is significantly lower than at contemporary sites (Kenyon, 1981).

Four other PPNA village sites in the southern Levant have been excavated extensively. The major early village sites of Netiv Hagdud (ca. 9300-8850 cal. BCE; Benz 2011) and Gilgal I (ca. 9450-9250 cal. BCE; Kislev et al., 2006) in the southern Jordan Valley are estimated to have a maximal areal coverage of 1.5 and 1 ha, respectively (Bar-Yosef and Gopher, 1997; Bar-Yosef et al., 2010; Kuijt, 2000a). Dhra' (ca. 9600-9100 cal. BCE; Aurenche et al., 2001; but see Finlayson, Mithen, and Smith [2011] who mention unpublished dates as far back as ca. 10,000 cal. BCE) in the southeastern Dead Sea Basin, is estimated at .65 ha (Kuijt and Finlayson, 2009) and WF16 (ca. 9650-8300 cal. BCE with a possible abandonment early in the occupational history; Finlayson and Mithen, 2007; but see Finlayson, Mithen, and Smith, [2011] for the earliest dates potentially being ca. 10650 cal. BCE and likely around ca. 10150 cal. BCE) in the

Wadi Faynan of west-central Jordan is estimated at .6 ha (Mithen et al., 2011). All of these villages are larger than most contemporaneous sites and are more densely built, with buildings closer together and more compartmentalized than Jericho. This suggests that the intensity of occupation may have been lower at Jericho and that the size estimates might be exaggerated.

In addition to these major village sites, a set of small sites have been identified for the period. One site which has been studied extensively is the small settlement of Geshar (ca. 9650-9300 cal. BCE; Aurenche et al., 2001; Benz, 2011) in the northern Jordan Valley (Garfinkel and Dag, 2006). It is not clear what the total areal coverage of the site is. Only a handful of structures have been uncovered, all occupied for a short time. 'Ain Darat (no absolute dates available) a badly damaged site in the Judean Desert covers .07-.09 ha and contains evidence of 15 structures (Gopher, 1996b) and has been suggested as a long-term occupation. The site of Nahal Oren on the escarpment of Mount Carmel covers .05 ha, although some of the site may have been destroyed by highway construction. Evidence of 20 structures (Steklis and Yizraeli, 1963) suggests a significant occupation.

Two later PPNA habitation-sites identified in west-central Jordan are ZAD 2 (ca. 8800-8450 cal. BCE; Edwards et al., 2004; Sayej, 2004; Edwards and House, 2007) and el-Hemmeh (there is only a single date from the PPNA component of the site at ca. 8850±300 cal. BCE; Makarewicz et al., 2006b; Makarewicz and Rose, 2011). ZAD 2 measures .2 ha and a total of 17 structures have been identified on-site. At el-Hemmeh .03 ha of PPNA deposits have been uncovered. However, the excavators do not claim to have exposed the entirety of the PPNA component. As of now we have no areal estimate for the site. What we do know is that 12 structures have been identified (Makarewicz and Rose, 2011). This does suggest a significant, if perhaps not particularly extensive, habitation sequence at the site. Other sites from the PPNA,

such as el-Khiam (Echegaray and Freeman, 1989), Hatoula (Lechevallier et al., 1989), 'Iraq ed-Dubb (Kuijt, 2002), and Salibiya IX (Enoch-Shiloh and Bar-Yosef, 1997) do not have such robust evidence of habitation, with only a handful of structures uncovered, each suggesting temporary occupations (Kuijt, 1994).

By the MPPNB, after a likely brief period of abandonment (Benz, n.d.; Kenyon, 1981; Kuijt, 2003), there is better evidence that Jericho is 2.5 ha, with a broader horizontal exposure having been excavated at the site and a solid stratigraphic association of a wall seen as the boundary of the site with Neolithic remains (Kenyon, 1981). During this time period the site of 'Ain Ghazal is founded. At foundation, during the earliest portions of the MPPNB (Benz, n.d.; Kuijt, 2003), the site was 2 ha in size. By the end of the period it had grown to 5 ha, double the highest (and likely overly generous) estimate for the areal coverage of any PPNA site.

Additionally, the village site of Horvat Galil (Gopher, 1997), located in the western highlands of the Upper Galilee and dating to the very earliest portions of the PPNB, has been estimated to have been 2-3 ha. During this time a number of other sites have areal estimates of a hectare or more including Abu Gosh (.8-1.5 ha; Marder et al., 1996; Khalaily and Marder, 2003), Ghuwayr 1 (1.2 ha; Simmons and Najjar, 2006), and Yiftahel (maximal estimate of 1.5 ha; Garfinkel, 1987a).

Thus, we see that not only are the largest sites of the period larger than the PPNA, but a number of more typically sized sites also are larger than comparable villages from preceding periods. There are exceptions of course, like the MPPNB village site of Beidha (Byrd, 2005a; Kirkbride, 1966) in southern Jordan, which was only .15-.35 ha in size, as well as Wadi Hamarash I (Sampson, 2012) in the southeastern Dead Sea escarpment of central Jordan, which reaches a size of .5 ha. However, both were also densely constructed with essentially no space

between structures (similar to Pueblo-style architecture), making areal comparisons with PPNA sites misleading in regard to population or habitation intensity.

The trend towards larger settlements continues and accelerates in the LPPNB, with 'Ain Ghazal growing to 10 ha early in the period and reaching 15 ha by the end (Rollefson and Kafafi, n.d.). However, in this period 'Ain Ghazal is not uniquely large. A series of contemporary large settlements have been identified in the southern Levant, predominantly in the western Jordan Highlands. These include Wadi Shu'eib (5.6-12 ha; Simmons et al., 2001), Basta (8-10 ha; Nissen et al., 2004; Gebel et al., 2006), es-Sifiye (12 ha; Mahasneh and Bienert, 2000), Abu Suwwan (10.5 ha; Al-Nahar, 2010), al-Basit (8-10 ha; Fino, 1998), 'Ain Jammam (6-8 ha; Waheeb and Fino, 1997), and Khirbet Hammam (6-7 ha; Peterson, 2004, 2007, 2009). It has also been proposed that the surface-collected site of Kharaysin (up to 36 ha, although likely less; Edwards and Thorpe, 1986), as well as the sites of Beisamoun (12-15 or 20 ha; Bocquentin et al., 2011) and Sheikh Ali (10 ha; Simmons, 2007), both of which are of ambiguous extent in the PPNB could also be included in this list. Additionally, while not all sites from this period are of such grand scale, even smaller village sites such as Ba'ja (1.2 ha; Gebel et al., 1997; Bienert and Gebel, 1998; Gebel, 2003), el-Hemmeh (2 ha; Makarewicz and Austin, 2006; Makarewicz et al., 2006b), and Tel Tif'dan (1-5 ha; Moreno, 2009; Bennallack, 2012) all are larger than their earlier equivalents. Thus, we see that through time, from the PPNA to the end of the LPPNB, villages grew significantly in areal extent.

However, there are those who argue that site sizes are smaller than those given above. Campbell (2009) thoroughly reviewed publications on 'Ain Ghazal, Basta, and Jericho in order to develop estimates of the areal extent of these sites. Her goal in these reconstructions was to determine minimal population estimates for these sites to determine their subsistence

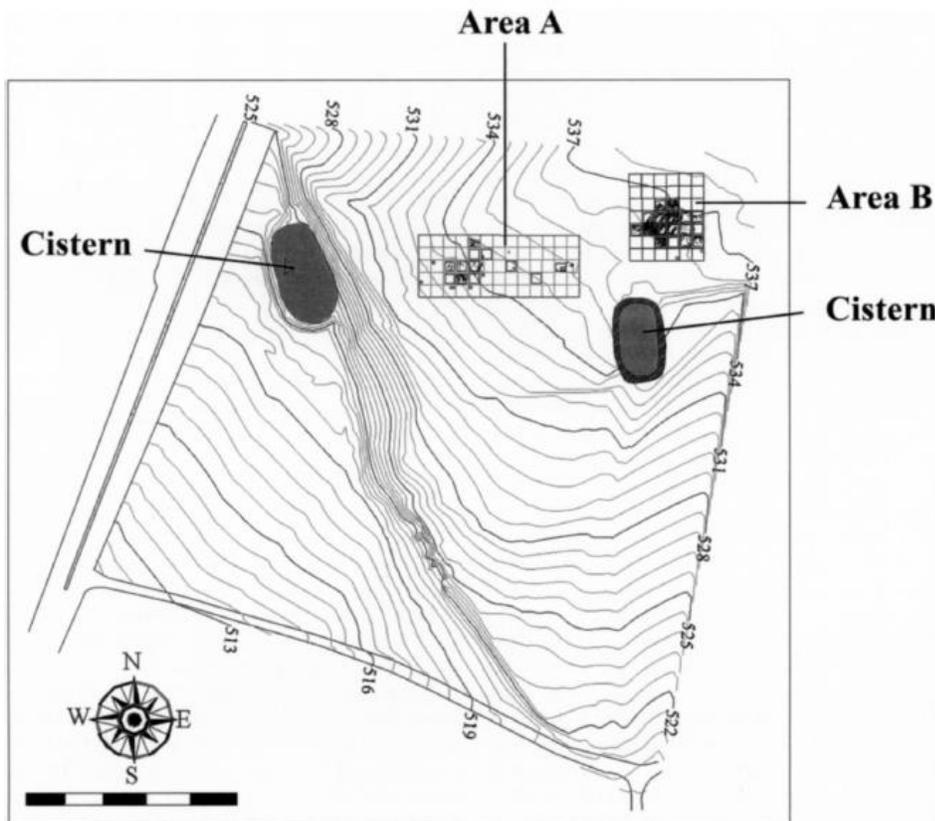
requirements. She convincingly argued that MPPNB 'Ain Ghazal never exceeded 3 ha in size, growing to no more than 7.8 ha in the LPPNB. Basta is estimated to have covered 6.9 ha in the LPPNB. MPPNB Jericho actually increased slightly in size from her reconstructions to cover 2.7 ha. In her formulation Campbell (2009) focused on the extent of the built environment at sites and assumed that all unexcavated space between units to be fully occupied.

Another site, worthy of review is that of Tell Abu Suwwan. While the excavators estimate areal extent (of unspecified periodization) of 10.5 ha, it is not clear that the built environment of the site was nearly this extensive. While certain materials, including a small number of el-Khiam and Helwan points, have been used to suggest a MPPNB or even PPNA occupation at the site, no other evidence of such an occupation has been published. As has been reviewed above, such attributions of specific types to periods has become increasingly problematic in the southern Levant.

The earliest date from the site attributed to an M/LPPNB stratigraphic layer in an unspecified part of the site was calibrated by the excavator to ca. 7185±285 cal. BCE (2 sigma). This date would place this stratigraphic layer likely after the commencement of the LPPNB in the southern Levant, which is typically dated to ca. 7300 cal. BCE (Kuijt and Goring-Morris, 2002). It should also be noted that quite a few sites described as LPPNB have produced dates well before ca. 7300 cal. BCE, including el-Hemmeh (ca. 7670±70 cal. BCE) (Makarewicz et al., 2006), Khirbet Hammam (ca. 7520±50 cal. BCE) (Peterson, 2007), and Basta (a cluster of four dates ranging from ca. 7410±50 to ca. 7310±100 cal. BCE) (Benz, n.d.). While some of these authors (Makarewicz et al., 2006b) attribute these early dates to the old wood effect, it may be that a pattern is emerging in the Transjordanian LPPNB of an earlier onset than previously

appreciated. Either way, the earliest dates from Abu Suwwan do not yet provide evidence for an MPPNB occupation.

While there is strong evidence that all those PPNB settlements termed “mega-sites” were either founded in the LPPNB or grew significantly from their MPPNB size, it is impossible to determine the extent of Abu Suwwan during either period or even whether the site was inhabited during the MPPNB. But, it must be assumed that the 10.5 ha figure given by the excavators represents the LPPNB occupation of the site, as it is typically during this period that large villages reach their maximal size. This areal extent appears to derive from the extent of PPNB artifacts collected on the surface of the site. While this technique for determining the extent of sites is known to slightly exaggerate figures (Banning, 2002), this problem is compounded all the more by the topography of the site. It is situated primarily on the side of a hill, with only a small



portion being located on a plateau at the top of the hill. Additionally, the plateau at the top of the site is now under an agricultural field tilled annually, possibly moving artifacts beyond the

Figure 24: Tell Abu Suwwan (al-Nahar, 2010)

borders of the built environment.

When the researchers opened Abu Suwwan, they excavated a total of 560 square meters, locating evidence of only 3 buildings (Figure 24). One building was located on the top of the plateau and was large in size (11 x 13.5 m). The construction of the building was also notable, with a grid form of architecture much more elaborate than any residential architecture in the PPNB. Additionally, the structure was filled with possible ritual paraphernalia, including large quantities of ovicaprid horn cores and associated with a symbolically rich courtyard which included a large hearth, two in-ground mortars, and a large bone placed upright and sticking out of the clay courtyard surface (it appears to be a cattle tibia, judging from the photos; cattle do not appear in Transjordan in any sizeable quantities in the PPNB before the Late period [Horwitz et al., 1999]). The other two buildings were found in “Area A”. This area covered 240 square meters along the hill slope, with one of the structures represented by three walls and a plaster floor and the other by a solitary wall. All this being said, excavations did return significant quantities of knapped and ground stone, as well as animal bones, including ovicaprid, cattle, gazelle, and dog. This could imply that the site was intensively, but sparsely, occupied. However, intensive use of the large structure on the plateau could also have produced significant quantities of material which eroded down the slope. A third option is that much of the site has been destroyed by agricultural activity and heavy erosion. Thus, it seems impossible to determine the actual extent of the site, based on the biases in the archaeological records, including topography and site preservation issues.

Architectural Density

No single class of artifact helps us understand the development of villages in the MPPNB and their subsequent growth in the LPPNB more than architecture. There are aspects of

architectural change during the early Neolithic of the southern Levant that have informed archaeologists about changing social relations. Like settlement areal coverage, much of this development has best been documented by Kuijt (2000a) who has demonstrated an increase in the density of architectural constructions and compartmentalization through time within early Neolithic settlements in the Mediterranean Levant. He later (Kuijt, 2008a) demonstrated a similar trend with increases in site-wide storage capacity through time, as well as the privatization of storage. Thus, not only were sites growing in areal extent, but more was being packed into them in the form of food, people, social relationships, and structures.

Kuijt (2000a; 2008b) compared the areal ratio of built space to open space across the early Neolithic of the southern Levant. He arrived at estimates of 1:2-1:1 for the PPNA, 1:1-4:1 for the MPPNB, and 4:1-8:1 for the LPPNB. In his 2008(b) paper his sample of sites was expanded to include PPNA Jericho, Netiv Hagdud, Gilgal, Dhra', Nahal Oren, WF16, and ZAD 2, MPPNB Beidha, Munhatta, Jericho, Kfar HaHoresh, 'Ain Ghazal, and Yiftahel, and LPPNB Basta, 'Ain Ghazal, Wadi Shu'eib, Es-Sifiye, 'Ain Jammam, and el-Hemmeh. Thus, with a sizeable sample, which includes most of the extensively excavated and published early Neolithic sites of the southern Levant, Kuijt (2000a, 2008b) was able to demonstrate an increase in areal coverage of the built environment within settlements through time.

Architectural Compartmentalization

Using evidence from PPNA Netiv Hagdud, Jericho, and Nahal Oren, MPPNB 'Ain Ghazal and Jericho, and LPPNB Basta, Kuijt (2000a) showed that the average number of architectural compartments per 100 square meters increased through time from a range of 2.2-2.6 during the PPNA to a range of 5.3-7.5 in the MPPNB, through a range of 13.3-15.7 in the LPPNB. Similar ratios can be found at other sites, such as MPPNB Beidha Phase C (7.3

compartments per 100 square meters) (Byrd, 2005a; Kirkbride, 1966). Even more dramatic ratios can be found at LPPNB sites such as Ba'ja Area B-North (28.4 compartments per 100 meters square) (Gebel and Kinzel, 2007), el-Hemmeh LPPNB area (26 compartments per 100 meters square) (Makarewicz and Austin, 2006), and es-Sifiye Area C (19.7 compartments per 100 meters square) (Mahasneh, 1997). However, earlier sites, such as the honeycombed structures of PPNA el-Hemmeh's PPNA component (8.5 compartments per 100 meters square) (Makarewicz and Rose, 2011) can exhibit denser architectural compartmentalization than Kuijt's sample. It should be noted though that the actual interiors of structures at such early sites are still not heavily differentiated through partitioning walls. They are simply small structures built in a dense pattern, whereas PPNB sites tend to have larger structures with significant interior compartmentalization. Thus, even though some PPNA sites show a significant number of compartments per unit of area, the structures themselves tend not to be compartmentalized.

Two sites from the MPPNB that illustrate this transition quite well are Ghuwayr I (Simmons and Najjar, 2006) and Beidha (Byrd, 2005a); two sites with the broadest exposures from this period. At Ghuwayr I the earliest architectural phase (not to be confused with separate habitation phases as the site was continuously occupied during its MPPNB component) consists of a number of notably large structures, especially for the MPPNB. One such structure completely exposed measures 10 x 10 m. In the second architectural phase, these structures tend to be subdivided with interior walls into four evenly sized sections of 4 x 4 m. In the third and final architectural phase new structures are built using old structures as foundations. While it appears as if many of the structures may have been two stories, typically only a ground-level or slightly below-ground-level footprint is preserved *in situ*. Such bases of the third phase of construction consist of a series of cell-like structures often no more than 1 x 1 m in area. They

can have windows between them, but no doorways, suggesting that they were accessed from above, likely for storage.

At Beidha (Byrd, 2005a) an even more dramatic shift in architectural form occurs at the site during its approximately 400 years of well-documented occupations (ca. 8050-7650 cal. BCE). The earliest architectural phase (again, the site was likely continuously inhabited throughout its MPPNB component) identified at the site consists of a small number of round structures. In the second phase of construction a central curvilinear structure was built and a number of sub-rectangular and rectangular buildings appear. This is followed by the third and final phase of corridor buildings with semi-subterranean stories extensively sub-divided by partitions and above-ground stories with minimal architectural partitioning (Figure 7; Figure 9). Thus, we see at both Ghuwayr I and Beidha that even during the development of the MPPNB some village settlements were experiencing an increase in architectural compartmentalization similar to that shown by Kuijt (2000a) to have developed between the M- and L-PPNB based on inter-site comparisons.

Perhaps the best example of such a transition in architectural compartmentalization from the M- to the L-PPNB at an individual site is that of 'Ain Ghazal (Rollefson and Kafafi, n.d.; Rollefson, 2010). In fact, the two earliest architectural phases at 'Ain Ghazal, dated to the first and second halves of the MPPNB (ca. 8400-8000 and 8000-7600 cal. BCE; Benz, 2011; Rollefson and Kafafi, 2013), show a similar development in form to those of Beidha and Ghuwayr I, with the earliest building on the site being rectangular structures from 35-50 square meters in area and containing minimal interior partitions. Through time, however, while the overall extent of structures remains roughly the same, new structures show increased partitioning and older structures were renovated to include such partitions (Banning and Byrd, 1989a, 1987,

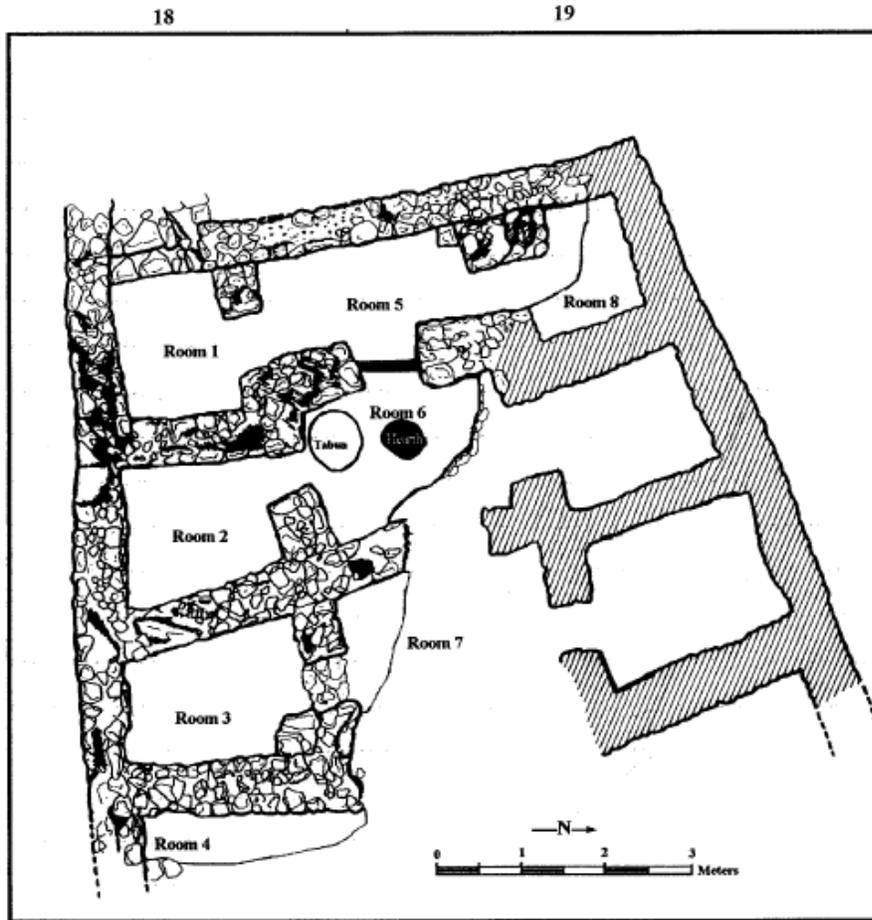


Figure 25: LPPNB Architecture at 'Ain Ghazal, Drawn by M Bataineh (Rollefson, 1997)

overall size (Rollefson, 2010). Thus, we see that while architectural compartmentalization was not as dramatic during the MPPNB of 'Ain Ghazal as it was at Beidha or Ghuwayr I, similar processes were still occurring. Additionally, these processes continued into the LPPNB at 'Ain Ghazal (Figure 10; Figure 25).

Number of Stories within Structures

Kuijt (2000a) also noted that structures become multi-storied with below-ground storage or work spaces below primary ground-level living spaces in the MPPNB and that by the LPPNB certain buildings include a second above-ground floor. He interpreted this as yet another indication that not only were settlements growing in area, but also density of construction and

1984). Then, in the subsequent LPPNB phase, new construction is dramatically different with multi-story corridor structures with cell-like ground floors, similar in construction and layout to those seen at Beidha, although occasionally significantly larger in

habitation. As described above, the well documented MPPNB sites with below-ground-floor storage and/or work areas are the sites of Beidha (Byrd, 2005a) and Ghuwayr 1 (Simmons and Najjar, 2006). Both these sites were founded in the first half of the MPPNB with relatively simple architecture. Structures were open and contained few features. By their abandonment, again, both during the latter half of the MPPNB, the architecture had transitioned significantly to be two-story and include dense, lower-story cell-like structures and features.

At Beidha, during the final architectural phase of the site rectangular rows of structures are built with a two-story design, both stories having their own entrances. The bottom story is partially dug into the ground and is built in a dense cell-like pattern. This lower story with compacted earthen floors contains a variety of internal features, except hearths. The upper stories of the structures are slight above-ground-level with heavily plastered floors and are built in an open plan with virtually no architectural features. Thus, this arrangement has been interpreted as living quarters on the upper story and storage/work areas on the lower story (Byrd, 2005a).

At Ghuwayr I, the final of three architectural phases also contains evidence of two-story structures with the lower stories both dug into the ground surface and free standing. These lower stories were also built in complex, small, cell-like patterns, occasionally with connecting windows between cells or opening to the outside. Preservation at Ghuwayr I, while impressive in many ways, was not as extensive during this phase as at Beidha. There are no good descriptions of what upper stories are like. However, there is evidence of extensive use of plaster in them and occasional staircases connecting lower and upper stories. Additionally, some walls are preserved up to three meters and still show evidence of collapse near their tops. This suggests that these walls were for two-story structures (Simmons and Najjar, 2006).

By the LPPNB sites such as Basta (Gebel et al., 2006b), Ba'ja (Gebel et al., 2006a), and 'Ain Ghazal (Rollefson, 1997) all have evidence of multi-story architecture. What is unique about these sites as compared to earlier MPPNB settlements with two-story architecture consisting of a dug-in lower story and an above-ground upper floor is that most LPPNB sites with evidence of multi-story structures are located in steep terrain. Thus, sites tend to be built upwards, following the contours of the ground surface (Gebel, 2006). The architecture at Ba'ja is perhaps the most well understood of these sites (Gebel and Kinzel, 2007; Gebel, 2006; Gebel et al., 2006a; Purschwitz and Kinzel, 2007). Interestingly, while certain structures at Ba'ja do appear to have a cell-like basement, similar to Beidha, Ghuwayr I, and 'Ain Ghazal, with top access rather than side access, like Ghuwayr I, this basement is actually constructed above-ground rather than dug-in. Otherwise, the architectural trends towards greater compartmentalization and multi-story structures continues during the LPPNB in a similar manner to that seen in the later portions of MPPNB occupations.

Renovations and Remodeling of Structures

As I have alluded above, there is significant evidence for increasing renovations and remodeling of and additions to structures through time in the PPNB (Bafna and Shah, 2007; Banning and Byrd, 1989a, 1987; Byrd, 2000, 1994; Flannery, 2002, 1972). This fact has been seen as an indication of long-term habitation. This can be a sign of either increased habitation (Kuijt, 2000a) or durable property rights (i.e., intergenerational, kin-based inheritance) in the hands of individuals or households (Banning, 2012). It has also been interpreted as illustrating long-term changes in household composition, specifically the development of extended family households (Banning and Byrd, 1989a, 1987; Banning, 2012, 2003, 1998; Rollefson, 2010, 1997).

Storage Capacity and Access

Flannery (1972) was the first to argue that by MPPNB storage had been moved inside residential structures, signaling the privatization of those items; in contrast, PPNA had exterior storage. This MPPNB storage inside residences signaled the privatization of goods, probably subsistence goods. More recently Kuijt (2008a) documented this phenomenon in greater detail, showing that storage capacity increased greatly at sites from PPNA to the LPPNB in both absolute terms and relative to overall populations. He also examined a number of case studies which showed that storage was initially primarily public in the PPNA and moved inside individual houses by the MPPNB.

This sequence of events is illustrated quite well by a number of sites discussed above. During the PPNA the most prominent of these are Dhra' and WF16. At these two sites there is evidence of large-scale stand-alone structures used for grain storage in the center of settlements. They imply that no individual household controlled access to them. There are only a small number of such structures at these sites and it seems likely that only one was in use at any given time (Finlayson et al., 2011a; Kuijt and Finlayson, 2009). Thus, while the capacity of these structures is high, storage capacity (both absolute and relative to population) is relatively low (Kuijt, 2008a).

By the latter portions of the MPPNB, as discussed above, Ghuwayr I has evidence of a partially dug-in lower floor in houses seemingly devoted to storage (Simmons and Kafafi, 2006). Similarly, Beidha has evidence of such stories in residential structures, but there is evidence that at least some of this space was devoted not only to storage, but also productive activities (Byrd, 2005). By the LPPNB a number of sites including 'Ain Ghazal (Rollefson, 1997, 2001), Basta (Gebel et al., 2006), and Ba'ja (Gebel and Kinzel, 2007) all have evidence of similar lower

stories devoted to economic activities of some sort, with storage a likely major component of this. Thus, we see that through time in the early Neolithic, as sites grow storage becomes privatized and grows in overall capacity.

Non-Domestic Architecture

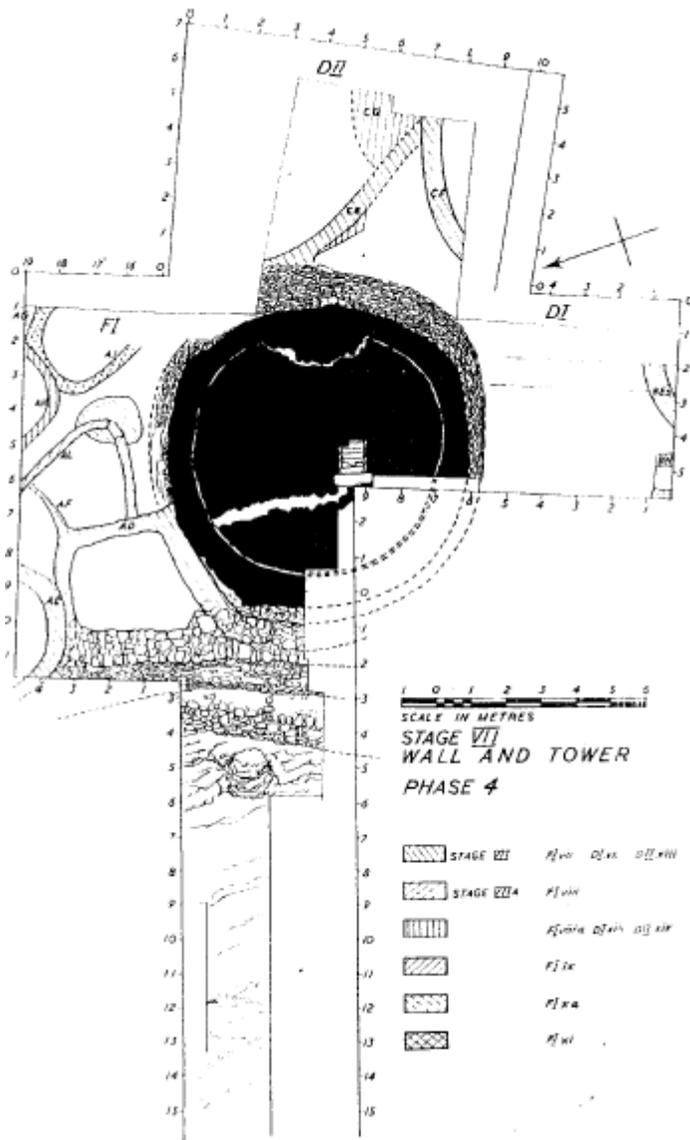


Figure 26: Tower at Jericho (Kenyon, 1981)

(Politis et al., 2009; Sampson, 2012) (Figure 30), as well as the possible mortuary site (Goring-Morris and Horwitz, 2007; Goring-Morris, 2000; Goring-Morris et al., 2001, n.d.) or small

Evidence for the growth and diversification of villages includes the appearance of communal and/or non-domestic architecture in a number of smaller-scale villages, unlike the preceding PPNA where only two of the largest villages in the region, Jericho (Kenyon, 1957) (Figure 26) and WF16 (Finlayson et al., 2011b) (Figure 27), have reported such structures. The early MPPNB roundhouse village of Shkarat Msaied (Abu-Laban et al., 2012; Hermansen and Kinzel, 2013) (Figure 28), the small MPPNB villages of Beidha (Byrd, 2005a, 1994) (Figure 9), Ghuwayr I (Simmons and Najjar, 2006) (Figure 29), and Wadi Hamarash I

village (Garfinkel, 2006) of Kfar HaHoresh have evidence of significant communal architecture (Figure 31). It has also been suggested that there must have been undiscovered communal architecture for the display of a set of statues from MPPNB 'Ain Ghazal (Rollefson, 2000:185). Another intriguing possibility is that the site of Tell Abu Suwwan contains a structure of possible public function, which the excavators partially attribute to the MPPNB (Al-Nahar, 2010a) (Figure 32). Thus, we can see that many of the villages with sufficient exposures have either direct or indirect evidence of communal architecture.

Of course, there are challenges in determining whether structures are indeed public or

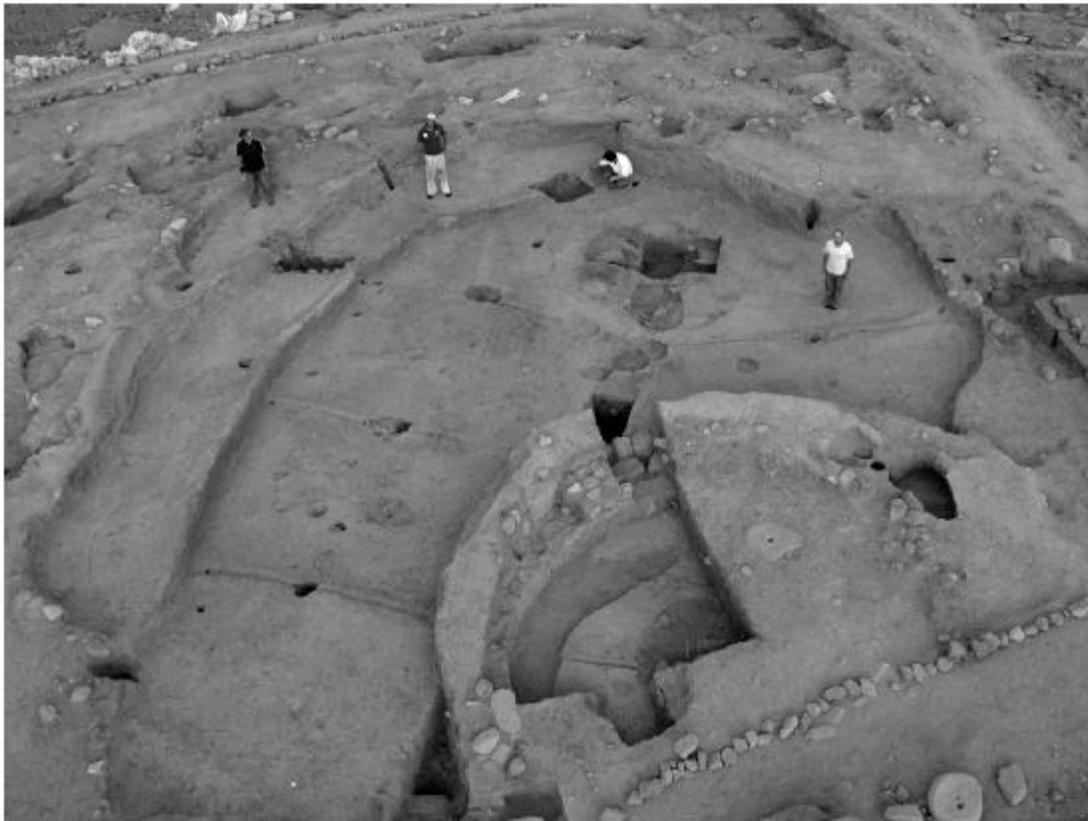


Figure 27: Large Structure (O75) at WF16 (Finlayson et al., 2011)

communal in their usage without the ability to observe the associated utilizing populations. Additionally, defining what public means in the first place can be difficult (Verhoeven, 2002: 245-248). Verhoeven (2002: 245) noted that most of the “public” architecture so far identified

for the PPNB is far too small to hold the population an entire community. He, thus, argued that what has been termed public architecture must be thought of as architecture utilized by a section of the population that perhaps represented multiple households. One could also add the potential use of such facilities by a sodality or other form of corporate group.

However, the sites and/or architecture used in Verhoeven's (2002) analysis



Figure 28: Large Central Structure at Shkarat Msaied (Abu-Laban et al., 2012)

predominantly date to the LPPNB, mostly derived from the northern Levant and central and southeastern Anatolia. At the time of publication Wadi Hamarash I had yet to be identified and Ghuwayr I had yet to be fully published, nor had the excavations at the site of Tell Abu Suwwan. While there was no final publication for the architecture at Beidha, many of the data had already been published (e.g., Kirkbride, 1966; Byrd, 1994). In these publications and subsequent ones (e.g., Byrd, 2005), the presence of a large structure dating to the final phase of the occupation,

presumably communal in nature due to its large floor area, lack of domestic features, central location within the site, having been built on top of a series of earlier non-domestic, large structures, and large central hearth, is presented.

Using Verhoeven's (2002) formula of one occupant per 2 square meters of floor space,



Figure 29: Large-Scale Staircase at Ghuwayr I, Photograph by A.H. Simmons (Simmons and Najjar, 2013)

this structure could have accommodated more than 50 individuals (Byrd, 1994). Beidha may have covered between .15 and .35 ha at this time (Byrd, 2005a) and to have contained up to 24 contemporaneously occupied structures, one of which was the large structure. Using a variety of methods based on floor area and overall settlement size (Kuijt, 2000a), this would lead to an estimated population size of no more than 100. Keeping in mind that 100 is a high estimate and that Verhoeven (2002: 255) acknowledges that his use-population estimate might be low, it seems likely that this latest large structure at Beidha could accommodate close to the entire population of the village (also considering such factors as age, gender, and religious status constraints which are common in determining who participates in rituals) (Adler and Wilshusen, 1990).

If one performs similar calculations for the MPPNB site of Wadi Hamarash I, a .5 ha site with a large central structure measuring close to 150 square meters in size (Sampson, 2012), it seems likely that this structure could also accommodate most of the estimated 50-150 occupations of the settlement. The 1.2 hectare MPPNB site of Ghuwayr I contains a large exterior staircase likely built during the second of the three phases of occupation at the site and continuing in use through the final phase. While the size of the staircase has yet to be determined or published and such an areal estimate would likely not be comparable to ones determined for structures, the excavators note that it is significant in size and likely of a communal nature. Because the staircase is large and exterior, it is probable that it could accommodate a large number of individuals, likely close to the total population of the site (Simmons and Najjar, 2006), given the constraints of age, gender, and religious status noted above. Thus, again, we see that, even at small settlements, if there is sufficient horizontal exposure, super-household or communal architecture is frequently identified at MPPNB village sites.

As noted before, the site of Tell Abu Suwwan has been dated to the LPPNB through radiocarbon dates. However, the excavators have argued for an MPPNB component as well based on knapped stone. This is important for the discussion of non-domestic architecture as the structure located at the top of the site on a plateau is potentially public in nature given its large size (ca. 150 square meters), prominent location overlooking the rest of the site, large amounts of symbolically charged items found within, and associated large-scale features, such as hearths found in an adjacent courtyard (Al-Nahar, 2010a). In fact, the materials which suggest a potential MPPNB component to the site's occupation derive, apparently, from this structure.



Figure 30: Large Structure at Wadi Hamarash I, Picture by A. Sampson (Sampson, 2012)

The excavators have suggested that the structure was initially built in the MPPNB and was continually rebuilt and expanded through the Pottery Neolithic. In this way they account for the variety of knapped stone types typical of this entire span of time found in association with the structure. In a preliminary analysis of the construction and remodeling sequence of the structure, al-Nahar (2010) argues that the building was constructed initially without the complex interior partitions. She also argues that the structure was initially built as a single residential unit for a basic household. It was only later, with subsequent remodelings that the structure may have not only had to accommodate an expanded household, but perhaps was also converted in function to a more ritually significant purpose.

What is not clear from the publications on Abu Suwwan is at what time the large structure on the plateau above the rest of the site was used as public architecture. If al-Nahar's

(2010) reconstruction is to be believed, although there is not much evidence presented for its conclusions in the publications on the site, it seems likely that the structure did not attain such a large-scale and prominent place within the social life of the site until later in the occupation. This would make the structure of LPPNB, PPNC, or PN date. However, if the finds suggesting an MPPNB occupation on the site are confirmed and the structure is shown to have been put to communal use starting in this period, then it would fit well with the trend towards large centrally located structures capable of accommodating over 100 individuals as suggested for the latter portions of the MPPNB.

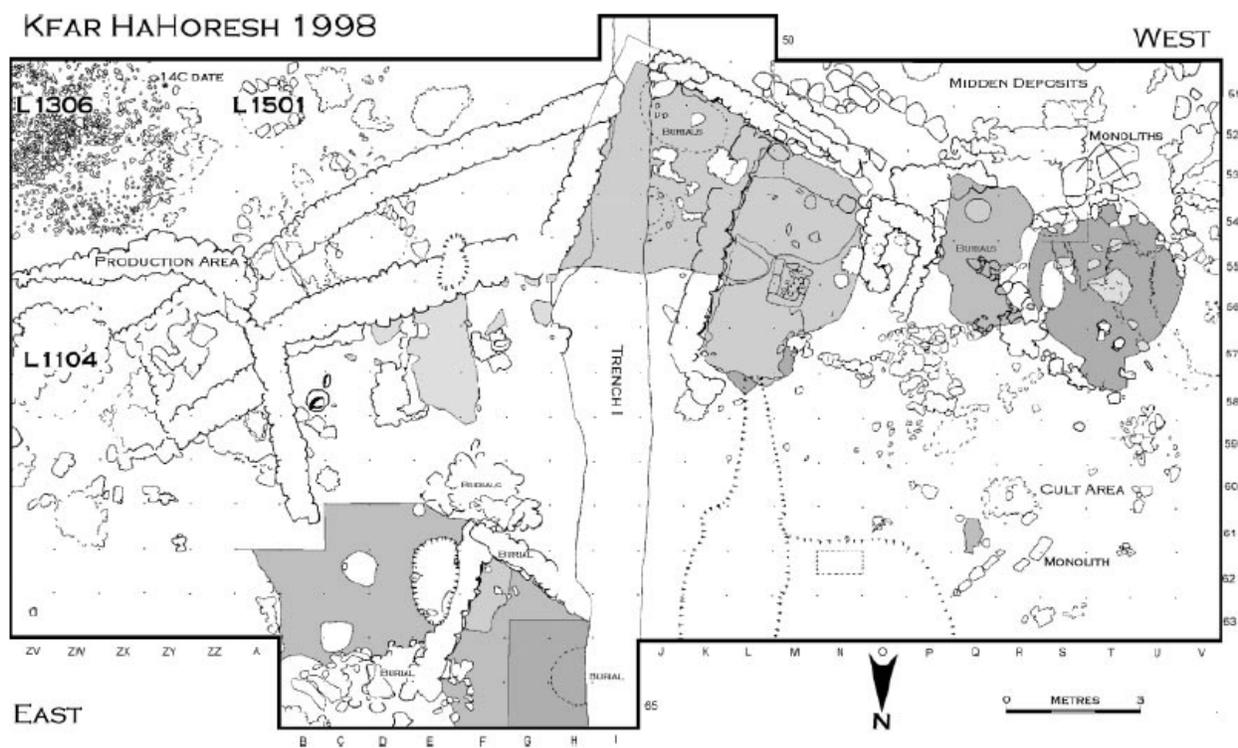


Figure 31: Kfar HaHoresh (Goren and Goring-Morris, 2008)

While it is possible to note such a trend in construction, what is so interesting about the MPPNB is that almost all ritual paraphernalia so far recovered from village sites is associated with houses (Kuijt, 2008b, 2000d, 1996; Rollefson, 2010, 2008, 2000, 1983). This has typically led to the interpretation that MPPNB religion and ritual was primarily practiced on the level of

the household. However, this is also the period of at least two specialized ritual sites, Kfar HaHoresh (Goring-Morris and Horwitz, 2007) and Nahal Hemar (Bar-Yosef and Alon, 1988) which clearly could accommodate supra-household populations. It is also the period to which a series of statues, mostly from 'Ain Ghazal (Rollefson, 1986a; Schmandt-Besserat, 1998), but also from Jericho (Garstang and Garstang, 1948) and Nahal Hemar (Bar-Yosef and Alon, 1988), are attributed. While each of the statues was cached out of sight of daily activities, it is likely that they were displayed at certain times, perhaps in a public setting (Rollefson, 2000: 185).

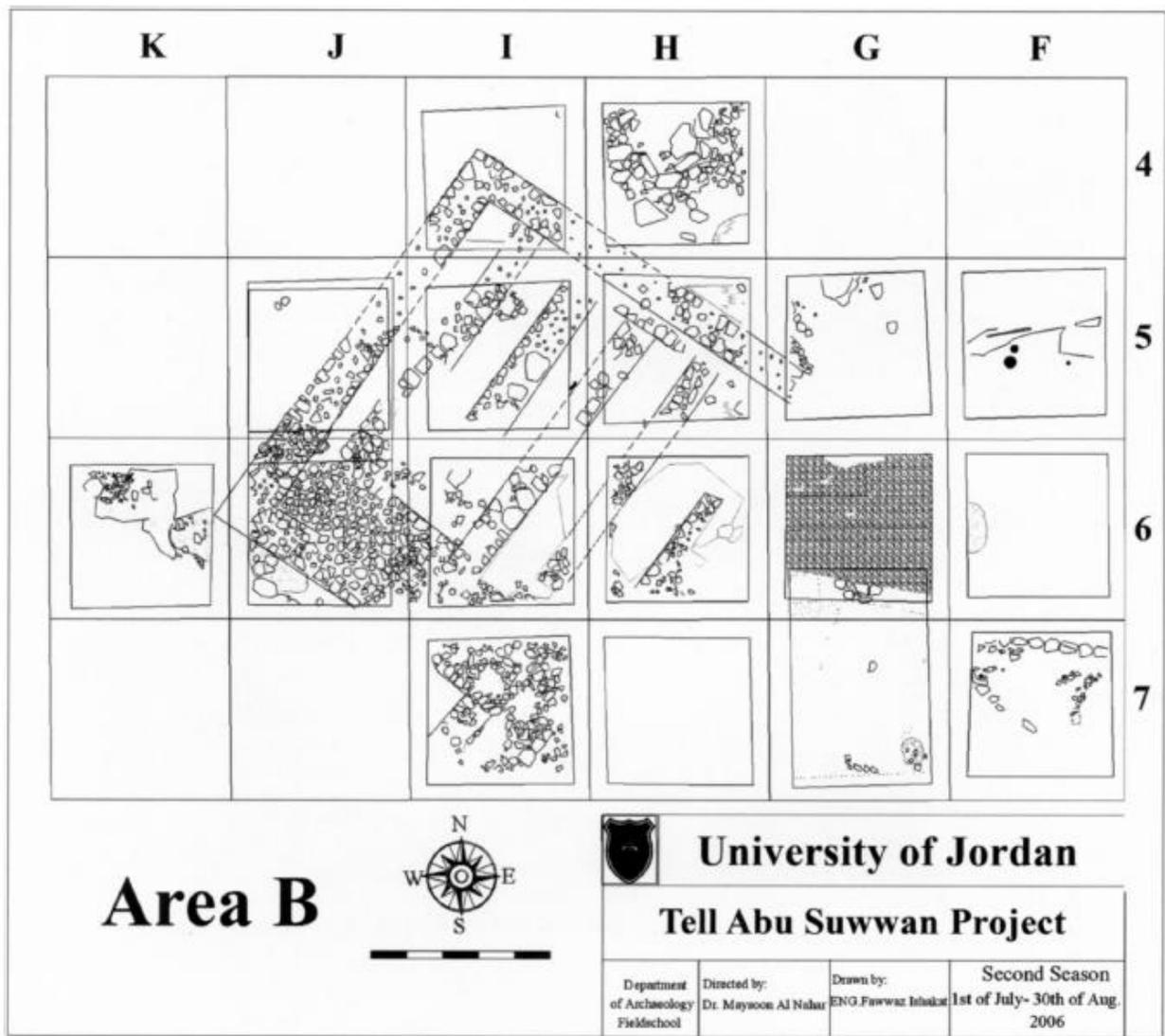


Figure 32: Large Structure at Tell Abu Suwwan (al-Nahar, 2010)

One cannot escape a second important observation about these various manifestations of MPPNB ritual. Village sites in Transjordan contain large communal structures during the MPPNB, while it is Cisjordan which contains specialized ritual sites and no villages with evidence of large-scale, super-household architecture. Another important observation about public architecture is that the scale of the investment in labor for these structures clearly increases through time, suggesting that communal ritual intensified through time. In all three or four of the recently published examples of large-scale communal buildings in Transjordan, the structures date to the end of the MPPNB. Additionally, the site of Kfar HaHoresh in Cisjordan continues to be occupied into the LPPNB where the scale and intensity of ritual continues to increase. This transition in the size of communal architecture and intensity of public religious practice during the MPPNB presages and, in fact, follows an identified thread through time whereby ritual practices seems to transition into the public sphere during the LPPNB, with household ritual decreasing in intensity and evidence of both community-wide and smaller supra-household rituals increasing in frequency (Kuijt, 2008b, 2000d, 1996; Rollefson, 2010, 2000, 1983).

While there is variability both across space and through time for the MPPNB of the southern Levant, it does seem possible that a second layer of religious practices which is on the scale of the community throughout the southern Levant during the MPPNB. And, this variability does seem to follow a trajectory, rather than simply being random. Evidence of the public aspects of religious practice increase through time. This holds true in both Cis- and Trans-Jordan where a potential divide exists between forms of public ritual during the MPPNB.

As for the LPPNB, there are actually fewer sites with evidence of non-domestic architecture. However, the most extensively excavated large LPPNB site, 'Ain Ghazal, does

have significant evidence of special-use buildings including structures which have been interpreted as temples and shrines (Banning, 2012; Rollefson, 2010, 2000, 1998b, 1997, 1983; however see Kuijt, 2011 for an alternative interpretation of these buildings as food storage structures). These interpretations are not typically based on the large areal extent of the buildings, but rather unique architectural plans and features. Thus, if they are indeed part of a cult or public religious practice, they are clearly not intended to accommodate community-wide rituals. Rather, a select group of individuals would utilize them, perhaps in a manner similar to that described by Verhoeven (2002).

This raises another possible use for this architecture that could even date back to the MPPNB: Segmentary identities such as sodalities, clans, lineages, and the like. Such a possibility has been raised for the early Neolithic of Anatolia recently (Flannery and Marcus, 2012). Such structures are utilized by members of a specific segment of society. However, in such a form of social organization, small settlements may only contain members of a single segment. Thus, one would get a single non-household structure which would most likely accommodate those individuals who were members of the segment within the community or representative of the various social units which comprise the segment. This is often the male head of household. The structure itself can be utilized for a variety of purposes from rituals to social interaction to mundane things like sleeping and eating. It is only in larger settlements, such as the large-scale villages of the LPPNB, where we would expect to find multiple non-residential structures utilized by the multiple lineages that inhabit a single settlement.

This pattern can be seen in the archaeology of the southern Levantine PPNB with the small MPPNB sites of Beidha, Ghuwayr 1, Shkarat Msaied, and Wadi Hamarash I each having a single non-residential structure identified at the center of the site. The large LPPNB village of

‘Ain Ghazal is the only PPNB settlement where multiple non-residential structures have been identified. The one enigmatic non-residential structure is that of Abu Suwwan where the dating is unclear, as is the extent of the site. The potential non-village ritual site of Kfar HaHoresh may simply be a separate phenomenon all together more associated with mortuary practices.

Specialized Production Areas

There is significantly less evidence of areas of PPNB village settlements set aside for production craft (specialized) or industrial (multi-household) activities than for many of the other processes associated with the intensification of village life. This is probably due to sampling bias, especially for LPPNB large sites as structures are typically the object of investigation in such settlements. By far the best evidence we have for extra-residential specialized production areas comes from LPPNB ‘Ain Ghazal where the remains of a likely lime kiln of unknown date have been references in the literature (Kafafi, 2006; Rollefson, 1984). Additionally, a courtyard dated to the LPPNB has presented evidence of numerous large fire pits, as well as extensive amounts of burnt limestone, fire cracked rock, and shattered low quality flint. This courtyard is located near to a uniquely designed building with extensive use of plaster, interpreted as a religious structure of some sort. Researchers have presented two possible interpretations of the courtyard, both thought to be associated with activities in the associated structure: (1) lime plaster production on a large scale or (2) cooking of food on a large scale, using stone boiling (Kafafi, 2006).

Plaster has been a much discussed production system in the early Neolithic because of a dramatic increase in its use during the PPNB (Clarke, 2012; Garfinkel, 1987a; Goren and Goldberg, 1991; Goren and Goring-Morris, 2008; Gourdin and Kingery, 1975; Gourdin, 1974; Kafafi, 2006; Kingery et al., 1988; Rollefson and Kohler-Rollefson, 1989, 1992; Rollefson,

1990). The scale of these systems are still debated, with some favoring a more industrial scale (Garfinkel, 1987a) and others advocating a simpler domestic scale of production (Goren and Goring-Morris, 2008). The possible lime kiln at 'Ain Ghazal has been the only such claim from anywhere in the Levantine PPNB (Goren and Goring-Morris, 2008). This is surprising given the seeming extent of lime plaster use at sites throughout the Levant. However, there are references in the literature to areas at Yiftahel (Garfinkel, 1987b; Garfinkel et al., 2012) and Abu Ghosh (Lechevallier, 1978), with Yiftahel being by far the most well described such space. Site finds included a pit filled with chunks of limestone (likely prepared for firing) and a feature with large amounts of kiln slag surrounding it and edges caked with plaster, as well as a large quantity of hearths in the area.

The site of Kfar HaHoresh also contains evidence of lime production (Goren and Goring-Morris, 2008). Recently, excavators at the site, inspired by a series of irregularly-shaped round to oval pit features containing cracked stone in and around them dug up at the site and hypothesized to be pit-kilns, conducted an experimental archaeology project which has shown that significant quantities of lime can be produced using a pit-kiln, rather than a solidly constructed structure. This same experiment showed that evidence of the kiln was essentially completely obliterated by various natural processes within nine years of usage except for whatever stone remains were not removed from the pit at the end of firing. The authors suggest that this is a likely technique for production in the PPNB given the lack of evidence for kilns and that the organization of labor necessary to utilize such a technique allows for lime production on a small scale to produce sufficient quantities of plaster for a PPNB village. Finds from al-Khayran, specifically significant quantities of plaster and plaster-waste at a site containing a single small structure support the contention that plaster production could have been done a small, likely household scale. The

authors also suggested that the wood materials required for the pit-kiln were minimal enough to not likely contribute to the denudation of the local environment (Goren and Goring-Morris, 2008). It should also be noted that such a system could be scaled up to an industrial level like that suggested by the large courtyard of fire pits at 'Ain Ghazal.

Other varieties of production areas have also been identified both within and outside of village settlements. Again, 'Ain Ghazal provides some of the best evidence for one such production system during the PPNB: that of naviform cores and blades (Quintero and Wilke, 1995; Quintero, 2011, 1998, 1997). Naviform cores are a specific type of opposed platform cores which appear in the MPPNB, where they are the dominant formalized core type. They derive their name from their unique boat-like shape when viewed from the side. They are thin flat cores where the opposed striking platforms are angled inwards towards a central point, allowing for straight blades to be struck repeatedly from a core throughout the reduction sequence. Naviform cores continue to be used through the LPPNB, however they do reduce in overall frequency within assemblages from the period, both through time and as compared to MPPNB assemblages.

Through detailed analysis of stone procurement methods and systems, core preparation and reduction techniques, blade characteristics, knapping activity areas, and debitage disposal areas, as well as replicative experiments, Quintero (1998, 2011) has argued that naviform cores were produced and utilized by a select number of part-time household-based craftspeople for the production of blade blanks which would be distributed across the community in both the M- and L-PPNB at 'Ain Ghazal. She pointed to the complex nature of the production process, the standardization of the production techniques and products, the significant amount of effort expended to procure high-quality flints through seam mining, rather than gathering more easily

available lower-quality flints from ground surfaces, the existence of a small handful of activity areas with evidence of naviform core shaping and reduction with numbers far below that of overall households uncovered during excavation, and individual trash dumping episodes, as identified through stratigraphic analysis of midden materials, with high levels of debitage waste significantly greater in quantity than would occur if individual household production was all that was required. She also argued that the number of blades needed by an individual household was not sufficient to keep the skills of a resident knapper sufficiently honed for repeat production only as needed. Rather, highly skilled individuals would have to produce for the site population as a whole to increase knapping time sufficiently to maintain necessary skill levels.

Earlier, Quintero (1997) published an intensive analysis of 169 lithic production waste loci from MPPNB levels at 'Ain Ghazal, which she used to argue for the likelihood of craftspersons producing naviform cores and blades. In this analysis she showed that of the 169 loci, only nine loci contained naviform core reduction waste, with the other 160 containing tool production waste. Of the nine that contained naviform core reduction waste only one was composed solely of naviform core production waste, with the other eight derived from a combination of core reduction and tool production. She, therefore, argued that naviform core production was likely a very restricted activity on-site conducted by a select few members of the overall community who utilized specialized work space. She went on to note that of the debitage derived from this singular naviform reduction locus, 98.9% was derived from pink-purple flints from Wadi Huweijir flint seam mines. This very limited source of flints suggested a highly structured, controlled, and narrow supply chain as would be found in craft production.

Since the publication of Quintero's findings at 'Ain Ghazal (Quintero and Wilke, 1995; Quintero, 2011, 1998, 1997), a number of other investigators have begun to produce similar

evidence for other sites. Gebel (1996) described evidence from knapped stone waste deposits at LPPNB Basta which lined up with Quintero's general description of disposal patterns at 'Ain Ghazal. He thus argued that there was specialized use of space for the production of naviform cores and blades even though no such structures or activity areas had yet been uncovered.

Davidson (2012) has conducted a refitting analysis of several core reduction sequences at Yiftahel, suggesting that the skill level of knappers varied, but there is significant evidence of mastery on a level that suggests craftspeople were producing naviform cores and blades. Earlier, she and Goring-Morris (Davidson and Goring-Morris, 2007) analyzed a single naviform core reduction sequence from Kfar HaHoresh showing significant deficiencies in skill from one knapper's sequence. This was in striking contrast to a number of finds from the same site which showed considerable skill. Such a comparison led the authors to suggest that the analyzed sequence was probably not primarily utilitarian in nature. Rather, it could potentially have been ritualistic or performative.

Barzilai and Goring-Morris (2009) presented evidence of a somewhat less intensive production of naviform cores and blades at the PPNB site of Kfar HaHoresh. They showed that a series of at least 117 reduction episodes occurred at the site and the waste from these was deposited in a single trash dump. This was interpreted as intensive enough to have been the discarded materials of at least part-time craft specialists. However, when comparing the composition of the waste assemblages from Kfar HaHoresh, 'Ain Ghazal, and Basta, Barzilai and Goring-Morris (2009) argued that there was potential evidence for production of great quantities of waste at the latter two sites as compared to the former, suggesting greater quantities of stone being knapped during a given episode.

More recently Barzilai and Goring-Morris (2012) have tentatively supported Quintero's claims by developing a method for estimating blade productivity from naviform cores based on the volume of a core before reduction minus the volume of the spent core, divided by the average volume of individual blades from the core. Using this method they showed that knappers did indeed produce mostly usable blades during reduction, showcasing their skill as craftspeople. They also showed that blades were highly standardized both within individual reduction sequences and between disparate reduction sequences within the PPNB site of Kfar HaHoresh. Both these facts do not nullify Quintero's contention that naviform blades were produced by part-time craftspeople. Additionally, earlier Barzilai (2010) essentially argued that village sites in the PPNB of Transjordan did in fact include craftspeople that produced bi-directional blades. Neither of these works identifies specific craft areas at sites, but does support the possibility through lithic analysis.

In fact, Barzilai (2010), in his analysis of 29 PPNB knapped stone assemblages, provided a model of the potential contours of naviform core and blade production systems through time and across space. He essentially found that while basic knapping techniques across the PPNB were the same, the scale and skill of production varied. He also made an argument for greater productivity per core reduction sequence in the MPPNB at sites in the Mediterranean zone and Jordan Valley of the northern portions of the southern Levant, at sites such as Motza, Yiftahel, and Kfar HaHoresh. In the subsequent LPPNB he found greater blade productivity per sequence at large sites such as 'Ain Ghazal and Basta as compared to smaller villages and other forms of settlements. In his sample he was able to show that larger sites not only had larger scales of production as visible through disposal patterns, but also more highly skilled flint knappers who could produce great quantities of blades from individual cores.

Barzilai (2010) specifies three different patterns of what he described as craft production of bidirectional core and blade production. Borrowing terms from Costin (1991), these consisted of (1) individual specialization, whereby knappers in individual mobile foraging groups, each composed of an extended family, would produce blades for their own kin relations; (2) dispersed workshops, where seemingly all households in smaller villages would produce blades for their own kin relations and for various forms of immediate and delayed reciprocity; and (3) community specialization, whereby a small number of skilled craftspeople would produce blades in specialized activity areas, labeled workshops, on a large enough scale to distribute throughout large-scale villages using various mechanisms of exchange and reciprocity. It should be noted that the use of these terms does not quite fit with Costin's original definitions (cf., Costin, 1991: 8). Nevertheless, because Barzilai does specify his use of the concepts, we have no problem understanding his three patterns.

Barzilai (2010) derived these different forms of production largely from two sources of data: blade caches and knapped stone production waste dumps. Thus, unlike Quintero's analysis of the sole site of 'Ain Ghazal (1998, 2011) for which she was able to look at fine-grained spatial and knapped stone contextual data in order to identify some potential activity areas on-site, Barzilai (2010) was only able to infer their existence from waste disposal and abandonment patterns at most sites. Still, his analysis is worth reviewing in order to understand why it is possible to argue that space within villages was becoming more specialized, segmented, and segregated. Additionally, he was able to identify a number of knapping areas at certain sites, mainly small village settlements. However, such spaces were not identified in either temporary camps or large-scale villages.

Essentially, Barzilai (2010) saw three knapped stone waste disposal patterns. At small, temporarily occupied sites, either in the desert fringes of the southern Levant or the Coastal Plain of Cisjordan, Barzilai concludes that individual specialization was practiced. At such sites there is no particular pattern to the disposal; there are materials spread over the full extent of the sites, suggesting minimal spatial segregation and such a low intensity of manufacture that bidirectional core and blade production did not require any more of a structured disposal pattern than any other knapping activity. At these sites the skill of knappers was low, producing the fewest number of blades from a single core. This suggests that blade demands were low, blade knapping was done infrequently, and that knappers were primarily concerned with manufacture for the communal production unit.

At small villages, in the Mediterranean zone of northern Cisjordan, the Jordan Rift Valley, and the Transjordanian Highlands there were definite pattern of bidirectional blade core production, largely in the basement or ground floors of habitation structures. Most such structures had evidence of naviform core production and utilization at these small village settlements, suggesting to Barzilai (2010) that production was on the level of the household. Additionally, looking at waste disposal patterns in these village sites, Barzilai (2010) was able to show that knapping episodes were small in scale with the entirety of the core production and reduction sequence disposed in a single dump. This would occur if production waste was not as substantial in volume as to require mid-manufacture disposal.

In large villages Barzilai (2010) found evidence of high intensity and volume core production and reduction based, again, on waste disposal patterns. At these sites only a very small proportion of waste dumps included evidence of bidirectional core production or reduction. Additionally, in those dumps where there was evidence, the volume of individual dumping

episodes was high and the composition of the dumps was variable, with only a few of the many stages of production and reduction represented. This led Barzilai (2010) to argue that these dumping episodes represented mid-manufacture cleanup from a very limited number of knapping activity areas where the volume of production was so high as to require multiple cleaning episodes during any sequence of core and blade production. Barzilai (2010) argued that such sites likely contained a limited number of workshops which produced blades for the entire village.

Another line of evidence used to argue for craft production of bidirectional blades has been that of knapped stone blade caches. Barzilai and Goring-Morris (2007) performed a comprehensive review of blade caches and stocks dated to the PPNB of the southern and central Levant and found two distinct patterns of large groups of blades. They were either attributed to the “parochial functional level” or “symbolic or ritual caching.” The former is seen as possible evidence of craft production at sites where stores too large to be used by a single household are found. It is assumed that these groups of tools and blanks were created by craftspeople, and later distributed beyond the individual household level. The authors identify caches at ‘Ain Ghazal and Motza as belonging to this category, suggesting that not only did potential craft production of bidirectional blades at PPNB sites entail new spaces for knapping, but also for storage of blades for future distribution.

A number of PPNB sites have presented evidence of specialized production areas for materials other than knapped stone, typically in semi-subterranean structures. For the MPPNB, the site of Shkarat Msaied has presented evidence of bead manufacture both through production tools and waste (Jensen, 2008, 2004). Excavators have interpreted this as likely specialized production for two reasons. One reason is the similarity in knapped stone tool types and bead

production waste to that found at both logistical production-sites in the Eastern Desert known as burin sites (Betts, 1998, 1984, 1983, 1982; Betts et al., 1990; Finlayson and Betts, 1990) and in a discrete activity area at the LPPNB village site of al-Basit in south-western Jordan (Rollefson and Parker, 2002; Rollefson, 2002), as well as temporary hunting camps in the Eastern Desert (Wright, 2008) and the Sinai (Bar-Yosef Mayer, 1997). In both these types of production areas the argument for some form of craft or specialist production is strong. The second line of reasoning is the high ratio of production tools and waste to actual beads found at the site. This interpretation was later tempered by Jensen (2008) who noted that a single necklace requires a large number of beads and thus, the production of such jewelry could result in large amounts of tools and waste.

Another PPNB site, briefly mentioned above, with evidence of craft production areas is the mega-site of al-Basit, dated to the LPPNB through knapped stone typologies ('Amr, 2004; Fino, 1998, 1997). While the site has been heavily damaged by modern construction activities, salvage excavations and construction back dirt sifting have produced evidence of high numbers of drills and borers. Initial finds from excavations revealed a high number of such tools, but not any spatial concentrations. A subsequent surface assessment of the site included the screening of a discrete back dirt pile which appeared to be derived from a relatively limited and coherent stratigraphic location at the site. The recovered knapped stone assemblage produced an even greater concentration of drills and borers, suggesting that they were derived from a workshop (Rollefson and Parker, 2002; Rollefson, 2002).

Use-wear analysis showed that most of the drills and borers were unused, suggesting that they were produced en masse for quick replacement following breaks. The few tools that did show wear had evidence of twisting, but likely in soft materials such as wood, a material known

to be used for bead production in the PPNB (Bar-Yosef and Alon, 1988), or human skin for tattooing or piercing (Rollefson and Parker, 2002; Rollefson, 2002). However, it must be stated that if the tools were kept in reserve in cases of breaks, it is possible they were used for the drilling of hard materials, but this was not evident from use-wear as they had yet to be utilized. The analysts disagree with this assessment based on the fragility of the points, but we do not have significant evidence of what was being produced with the tools.

The drills and borers at al-Basit are interpreted as a possible example of craft production because of the concentration of the tools in a single location, many of them unused. This would suggest that a large amount of time was spent by a person or persons within the village utilizing these tools for production. Because some of the tools did show signs of use-wear it would seem as if they were being cached for utilization rather than distribution. Therefore, this pattern has been interpreted as suggesting a high intensity of production greater than an individual household level.

Another example of seemingly spatially bounded production areas within a LPPNB site is the sandstone ring workshops of Ba'ja. This small village settlement is dated to the LPPNB based on knapped stone typologies. It also has three radiocarbon dates derived from stratigraphic layers late in its occupation from a single trench that place the abandonment of the site somewhere around ca. 6800 cal. BCE and attest to an occupation stretching back at least to ca. 7100 cal. BCE (Benz, n.d.). The excavators advocate an occupation that last the entire length of the LPPNB starting at ca. 7500 BCE. However, it is not at all clear that such a small site (ca. 1.5 ha) would have been occupied for such duration. However, the density of the occupation does suggest a significant length of occupation (Gebel et al., 1997).

While the spatial structure of sandstone ring production at Ba'ja has yet to be presented in detail, the excavators have reported large quantities of sandstone rings, production blanks, production waste, and partially processed materials which have been analyzed using a *chaîne opératoire* style of analysis (Gebel, 2010; Gebel et al., 1997). The analysts do make reference to workshops and dump zones, suggesting that such activity areas were identified. They also suggest that much of the work was done in the small cellular basement rooms on the ground floor of buildings. Production was only done in a small fraction of the habitations identified at the site, suggesting a similar pattern of production to that of naviform blades. That is, it seems likely that certain households had at least one part-time craftsman who would produce the rings, which would then be distributed across the site and possibly beyond.

Similar rings were found in significant numbers at the near-by large site of Basta, made of oil schist and stained red, like the red sandstone of the Ba'ja rings (Starck, 1988). Other sites throughout the southern Levant including LPPNB el-Hemmeh (Makarewicz et al., 2006), LPPNB 'Ain Jammam (Rollefson, 2005), and LPPNB(?) Rabud (Gubenko et al., 2009), PPNB 'Ain Ghazal (Rollefson, 1984) and even into Europe have also produced such objects from a variety of materials (Gebel, 2010). However, to date, only Ba'ja has yielded evidence of workshops. It should be noted, however, that al-Khayran did yield a single rough-out of a stone ring blank, suggesting on-site manufacture (Kroot et al., 2012). This manufacture, of course, would not have been on the scale of workshop production, but rather the household level.

Another form of production space potentially associated with village settlements is the specialized logistical site (i.e., site whose primary function is the extraction of natural resources). While it is not always clear that such sites are utilized by village populations, a number of authors have advocated for such interpretations at a small number of them. Again, 'Ain Ghazal

presents the best evidence of extra-settlement logistical procurement of materials clearly tied to villages. It has been observed starting in the MPPNB and continuing into the LPPNB that there is a significant bias towards pink-purple flint in the production of naviform blades and cores at 'Ain Ghazal and a number of other sites in the area, as well as west into Cisjordan (Rollefson et al., 2007). In order to determine the source of these materials a non-systematic survey of flint outcroppings in northern Transjordan was undertaken, resulting in the identification of at least one set of flint mines 2 km from the site of 'Ain Ghazal. There, in Wadi Huweijir, a number of flint seams visible along the *wadi* walls had been mined by the inhabitants of 'Ain Ghazal (Quintero, 1996). Quintero (2011) later interpreted these mining activities as part of a production sequence conducted by craftsmen at the site of 'Ain Ghazal. She suggested that these potential part-time specialists in some way controlled access to such raw materials.

There is evidence elsewhere in the southern Levant for flint mining during the PPNB, most notably at the open cast mines of LPPNB Ramat Tamar (Barkai et al., 2007; Schyle, 2007; Taute, 1994). Ramat Tamar is attributed to the LPPNB based on knapped stone typologies and its association with Metzad Mazal, a workshop site located nearby with evidence of habitation and extensive flint knapping. There are six radiocarbon dates from Metzad Mazal which place it solidly within the LPPNB (ca. 7500-7000 cal. BCE) (Bohner and Schyle, n.d.). However, it is not at all clear that these mines were associated with villages. This is due to the minimal excavations at associated flint workshops near mines where nodules were shaped into bifaces, naviform cores, and other tools and at sites such as Metzad Mazal, where there is evidence of further shaping of flint. Also the mines of Ramat Tamar are located in an area without significant evidence of settled village life during the LPPNB.

The situation is slightly different at the flint seam mines found along the Nahal Dishon in far northern Israel within the Galilee (Gopher and Barkai, 2006), which are thought to be associated with the LPPNB site of 'Ain Miri (Gopher and Barkai, 2011). They are attributed to the PPNB based on core technology and a preponderance of flint types found at the local PPNB sites, as compared to other sources of flint in the region. Thus, we do not have evidence of significant working of the flints. Rather, the seam mines seem to have been utilized for local needs. What is not clear is the character of 'Ain Miri itself due to limited excavations.

Similarly, flint quarrying sites south of the Dead Sea within the Wadi Araba on the Cisjordan side are not clearly associated with either settlements or workshop areas (Gopher and Barkai, 2011). They are identified as PPNB in age through the presence of utilized naviform cores and blades. However, there is a paucity of high-quality blades suggesting that individuals would extract flint, knap the nodules into naviform, and produce blades which were then transported from the site. Thus, it is unclear who was doing this or exactly how these practices fit with wider settlement systems. Work in the region is only preliminary and future research will surely supplement our understandings of potential connections between communities.

Recently, Barzilai and Goring-Morris (2009) presented a series of sites dating to the PPNB in Cisjordan using a tripartite classification, which had previously been published in the gray literature of Israeli archaeology. Their classification included (1) dedicated flint workshop sites near flint sources such as Q-1 and Givat Rabi in the Galilee and Daliyat el-Carmel on Mt. Carmel, (2) workshop dumps they place within the site of Yiftahel also in the Galilee similar to the ones they describe for 'Ain Ghazal and Basta, and (3) short-term dumps of entire reduction sequences all at once like the assemblage found at Kfar HaHoresh.

Overall, when looking at flint extraction-sites across the southern Levant during the PPNB one gets a picture of two possible types of production and distribution systems. The first is mines associated with individual village settlements where flint is quarried and reduced both at the mines and back at the villages. The second type are mines utilized, likely by more mobile populations, for the extraction of flint and the production of tool blanks which are then moved long distances, presumably for trading purposes. It is the former of these that is particularly relevant to this section as the procurement sites associated with villages are essentially one more example of the intensification of village life through the structuring of space.

Waste Disposal Systems

Another line of evidence showing the intensification of village life and, specifically, the adjustments made by inhabitants of villages through time to the pressures of such settlement patterns is the development of waste disposal systems through time. While studies of waste disposal behavior in the Neolithic are rare and the publication of archaeological evidence for disposal systems is all the more rare in site reports, a number of authors have tackled the issues. Most prominent amongst these are Hardy-Smith and Edwards (2004), who documented a general trend towards more intensive removal of waste from habitation areas from the Epipaleolithic through the PPNB.

While their primary focus was on the Natufian site of Wadi Hammeh 27, they do show several trends through time. These include, large numbers of waste items found on the floors and around structures during the Epipaleolithic, with these sorts of counts dropping through time into the PPNA and virtually disappearing in the PPNB. Rather, by the PPNB interior spaces will either be completely clear of waste or filled with thick dense refuse. The former situation is interpreted as a structure being abandoned immediately upon the inhabitants moving out while

the latter is interpreted as a structure which is subsequently reused as a trash dump. Hardy-Smith and Edwards (2004) argue that this shows the development of a consciousness around waste removal from living spaces that develop as communities become more sedentary and as inhabitants learn to both adjust their behaviors in the present and plan for future waste production through the structuring of waste disposal areas.

The authors point to reports from the MPPNB site of Beidha describing the floors as thoroughly clean, as well as similar ones for PPNB 'Ain Ghazal and Kfar HaHoresh. They also note that there are areas of incredibly high densities of artifacts at Kfar HaHoresh, but these are only refuse pits, rather than the interiors of structures or courtyards. Since this publication, Byrd (2005) more fully published architectural and spatial findings from Beidha highlighting the cleaning of habitation structures and the strict use of abandoned structures for refuse disposal.

These arguments echoed similar ones by Nadel (1998, 2003) who made his with a different goal. Nadel (1998, 2003) presented the argument that when comparing knapped stone assemblages from different loci within any single Natufian or PPNA site, one gets very different assemblage characteristics. Within Natufian sites any locus will produce virtually the same knapped stone assemblage as any other. However, by the PPNA there are noticeable differences in knapped stone assemblages from different loci. While some authors used this to argue for changing stone typologies through time in the PPNA, Nadel (1998, 2003) argued that this was a function of greater spatial differentiation of activities in PPNA sites. Recently, Kuijt and Goodale (2009) supported this contention through an analysis of the Natufian-PPNA site of 'Iraq ed-Dubb.

Chapter 7: Demographic and Social Changes in the PPNB

Settlement Size in the PPNB

As I discussed in the previous chapter on the early villages of the PPNB, there is growth starting in the Epipaleolithic, culminating in the LPPNB with the development of extraordinarily large villages. While each of the transformations in the artifact and architecture forms, as well as the arrangement of architecture in settlements of the PPNB, they also highlight changes in regional and community demography. The number of anthropologists who have invoked some form of population increase at the onset of the Neolithic is too great to present fully (e.g., Binford, 1968; Flannery, 1973; Cohen, 1977; Bocquet-Appel and Bar-Yosef, 2008), but the above data are some of the strongest supporting both a scenario of intra-village population increase (for the importance of settlement population in understanding social change see Feinman & Neitzel, 1984; Keeley, 1988) through time, as well as the potential consequences of such increases on the social organization of communities (Gebel, 2004a; Goring-Morris and Belfer-Cohen, 2008; Kuijt, 2009a, 2004, 2000a).

Specifically, there is strong evidence from the beginning of the MPPNB through the end of the LPPNB of near continuous growth in settlements populations in the Transjordan Plateau, where al-Khayran is located (Bienert and Gebel, 2004; Henry, 2002; Kuijt, 2008a, 2000a; Rollefson, 2010, 1997). At the end of the MPPNB and the start of the LPPNB there was no comparable evidence for population growth in the Jordan Rift Valley. These are the two key regional demographic trends in the M-LPPNB in the southern Levant.

While we can see these trends at work, but exactly what they mean in terms of actual numbers of inhabitants at individual sites and in regions as a whole is not clear. A handful of authors have estimated population ranges for various sites in the PPNB (Campbell, 2009; Kuijt, 2008a, 2000a; Rollefson and Kafafi, n.d.). There is significant debate about the best ways to estimate actual population, given the problems of sampling and contemporaneity. Thus, most authors choose to err on the side of caution and provide either multiple estimates or ranges. Other have begged off the question entirely, choosing to look at trends in regional population growth rates rather than absolute numbers (Goodale, 2009; Guerrero et al., 2008). However, in order to understand social processes at work in the early villages of the southern Levant such as fissioning (Bandy, 2010, 2004; Chagnon, 1975), scalar stress (Dunbar, 1993; Johnson, 1982), and religious intensification (Adler and Wilshusen, 1990; Adler, 1989), absolute numbers can actually be valuable.

Kuijt (2000a) was the first to offer estimates for village populations in the PPNB. He used three sources for estimating population based on overall built area (Kramer, 1982; Van Beek, 1982; Watson, 1979). Watson (1979) and Kramer (1982) provide estimates of 83 to 97 people per hectare of village area, which Kuijt averaged to 90 people per hectare. Van Beek (1982) suggested a population density of between 286 and 302 inhabitants per hectare at a recently abandoned Yemeni village with similar architectural densities and household sizes as Neolithic settlements. Kuijt (2000a) averaged these numbers to get 294 people per hectare. These size ranges were used as the minimal and maximal estimates of population densities at PPNB sites. Kuijt (2000a) then took estimated areal extent of sites and plugged in numbers. For MPPNB Jericho he arrived at a minimal population of 225 and a maximal of 735, based on an area of 2.5 ha. For MPPNB Yiftahel his population range was 135 to 441 for an area of 1.5 ha.

His LPPNB estimates ranged from 630 to 2058 for 'Ain Jammam with an area of 7 ha (for which he averaged the estimated site extent of 6-8 ha) to 900-2940 for 'Ain Ghazal, Wadi Shu'eib, Beisamoun, and es-Sifiye with an area of 10 ha to 1260-4116 with an area of 14 ha at Basta.

In a subsequent publication Kuijt (2008a: 294) presented a figure similar to one from his 2000a publication where he suggested estimates of site area and population for typical settlements from the M- and L-PPNB along with example sites from each period. In this figure he opted to use the lower population estimates derived from Watson (1979) and Kramer (1982). Thus, the typical MPPNB settlement is estimated to have a population of 225 (the lower figure derived for MPPNB Jericho in his previous article) with an area of 2.5 ha and a typical LPPNB village population is estimated at 900 (the lower figure derived from 'Ain Ghazal, Wadi Shu'eib, Beisamoun, and es-Sifiye) with an area of 10 ha.

Campbell (2009) has similarly provided population estimates for MPPNB Jericho and 'Ain Ghazal and LPPNB 'Ain Ghazal and Basta. She used a slightly different technique with a cross-tabulation of estimated settlement populations based on low, medium, and high ethno-archaeologically derived population density estimates from Jacobs (1979), Kramer (1979), and Van Beek (1982), respectively; and low, medium, and high settlement area with the first derived from her own analysis of publications and geography, the third derived from the largest extent found in the literature, and the second derived from averaging the two.

Campbell (2009) estimated MPPNB site populations of 259-1349 with an area of 3.01-4.7 ha for 'Ain Ghazal and 235-1178 with an area of 2.7-4 ha for Jericho. For LPPNB sites she arrived at a population range of 590-4000 with an area ranging from 6.9 ha to 14 ha for Basta and a population range of 671-3031 with an area range of 7.8-10.6 ha for 'Ain Ghazal. With

Basta, Campbell (2009) actually provides estimates for five different areal extents based on her own analysis and multiple size ranges in the literature.

Finally, Rollefson and Kafafi (2013) presented two figures for the population of 'Ain Ghazal at the end of the MPPNB and LPPNB. They did not cite sources for their estimated population densities; however, they are generally in line with the moderate to high estimates presented above. They argued that at its founding at the commencement of the MPPNB 'Ain Ghazal was likely 2 ha in size and grew to 5 ha by the end of the MPPNB. At this point in time their estimated population was 600-750 people or 125-150 people per hectare. During the LPPNB they see the village grow from 10 ha to 15 ha at the end of the period, with an estimated population level of 2,500 people or 167 people per hectare. They provide one thing in their estimates that others have not: changing population estimates based on evidence of changing architectural densities within an individual site through time.

This is an interesting premise as it is true that architectural density in the form of reduced space between buildings and a greater number of building per unit of area, as well as compartmentalization and number of stories increased at 'Ain Ghazal from the MPPNB to the LPPNB (Kuijt, 2000a). However, structures also change in expanse and use. A number of buildings of non-residential use have been identified for the LPPNB, as have a number of production spaces (Banning and Byrd, 1989a, 1987, 1984; Kafafi, 2006; Rollefson and Kafafi, n.d.; Rollefson, 2004, 2000, 1997). This suggests that more of the site area may have been devoted to activities which do not represent increased populations, but rather increase productive intensity and/or ritual. Additionally, households seem to transform through time, suggesting new living arrangements with unclear numbers of inhabitants per residence. Certainly, residences increase significantly in size by the LPPNB, suggestive of an increased household population

(Rollefson, 2004, 1997), but the exact ratio of individuals per unit of area is unknown. That being said, extended family households typically produce higher population densities in villages (Blumberg and Winch, 1977; Blumberg, 1978; Pasternak et al., 1976) and there is evidence of decreased room size within residences through time at 'Ain Ghazal (Banning and Byrd, 1989a, 1984; Kohler-Rollefson and Rollefson, 1990; Kohler-Rollefson, 1988; Rollefson and Kafafi, n.d.; Rollefson and Kohler-Rollefson, 1989; Rollefson, 2010, 2004, 1997), suggesting high levels of population packing (Kuijt 2000a).

While each of these authors (Campbell, 2009; Kuijt, 2000a; Rollefson and Kafafi, n.d.) has provided important methodological insights into estimating PPNB settlement populations in the southern Levant, there are a number of issues that still exist. Interestingly, at later sites in southwest Asia a number of authors have estimated population densities up to 500 people per hectare, based on contemporary population densities in Middle Eastern cities (Braidwood and Reed, 1957; Shiloh, 1980). While caution must certainly be taken with such estimate of population densities, given the growth of population densities during urbanization as compared to early village sites, some PPNB settlements were extremely densely occupied. Sites such as Ba'ja (Purschwitz and Kinzel, 2007), Basta (Gebel et al., 2006b), and Beidha (Byrd, 2005a) not only were densely built and occupied, but also filled with multi-story structures, suggesting the potential for densities higher than those found in most small-scale agricultural villages as the centrifugal pull of fields tends to lead to dispersal (Stone, 1996). It seems unlikely, given what we know of PPNB social organization and economic structure that such densities existed at larger sites with highly variable spatial organizations, but at small compact sites such as Beidha and Ba'ja they may be possible.

In addition to density estimates, settlement area estimates are debated, with Campbell (2009) providing the most thorough discussion for understanding the extent of villages in the PPNB. Her lower areal estimates are probably the most accurate. However, Campbell (2009) also does not take into account certain aspects of settlement density, the most notable of which is the exact contemporaneity of habitation episodes. As has been shown at Beidha (Byrd, 2005a), some structures were used as trash dumps while others were still inhabited. Van Beek (1982) has provided another example with his discussion of the changing population of Marib for which he had described population variation over a thirty-year period of 75 to 765 people, while overall settlement area and architectural density did not change. The utilized space was reduced, but not the built environment. The village was simply depopulating, but buildings survived after abandonment. Additionally, there have been recent discussions of shifting settlement patterns within sites visible at LPPNB Basta, where at least one analyst has suggested that only 5 ha of the site were ever inhabited at any given time (Hermansen and Kinzel, 2013). Thus, a settlement population as low as 400 or so people (based on Kuijt's 2000a lowest estimates) might be more accurate for LPPNB sites. Additionally, in his notes, Van Beek (1982) provides a useful discussion of variation in population density within settlements based on a number of factors beyond overall area, including number of inhabitants per residence (see also Naroll, 1962 and Byrd, 2005 for a discussion of this work and subsequent critiques as applied to the PPNB of the southern Levant).

If we are to take the low density estimate of 87 people per hectare and the slightly reduced areal extent of sites of 0.72 of the total built environment based on the ratio of estimated habitation area at Basta of 5 ha as suggested by the site's architectural analyst Kinzel (Hermansen and Kinzel, 2013) to the built environment at the Basta of 6.9 ha as carefully

derived by Campbell (2009), then we see that the largest MPPNB sites such as Jericho (2.7 ha of built environment) and 'Ain Ghazal (3.01 ha of built environment) would have populations around 169 and 189, respectively.

Another method applicable to Beidha would be to multiply the number of residential structures by the number of hypothesized inhabitants. Van Beek (1982) has provided a low estimate of 5 people per household in nuclear family residences, the unit thought to inhabit Beidha' habitation structures. The excavated area of 1050 square meters revealed 23 residences in the latest phase of the MPPNB site. The overall areal estimate of the site is 3600 square meters (Byrd, 2005a). When contemporaneity is controlled for, this would lead to a figure of 17 houses per 1050 square meters. The estimated number of residences would be 58. Given a household population of 5, we would get a settlement population of 290. This is a substantially higher number, given the differences in area between Beidha, Jericho, and 'Ain Ghazal.

Beidha is more densely occupied and habitation structures are consistently smaller in size (Byrd, 2000), suggesting great population packing. In fact, if broader exposures were available for other PPNB sites, household densities might be a more accurate method of estimation as it is clear that sites like Jericho (Kenyon, 1981) and 'Ain Ghazal (Banning and Byrd, 1984) were less densely built than sites like Beidha (Byrd, 2005).

Household population estimates would be useful for such an analysis, as Byrd's (2005) discussion of Naroll (1962) shows. There is considerable variation in both number of inhabitants per household and amount of roofed space per inhabitant. I would like to know if sites like MPPNB Ghuwayr 1 with residential structures up to 100 square meters (Simmons and Najjar, 2006) in area had more residents than smaller structures at sites like Beidha.

Byrd (2005) has cogently argued that at Neolithic sites in the southern Levant floor space per individual is actually less than suggested by Naroll's (1962) cross-cultural study. This argument, however, was based on the floor space at Beidha and architecturally similar sites, rather than the full spectrum of variation in MPPNB habitation structures.

While we still have significant variation in population estimates at PPNB villages and significant holes in our understandings, all of these numbers point to populations well over 100 at MPPNB villages and in the several hundred for the LPPNB. These numbers are significant when taking into account the effects of settlement population on social life. Population density (Boserup, 1965; Johnson and Earle, 2000; Johnson, 1982; Stiner et al., 2011) and more specifically, settlement population density (Feinman and Neitzel, 1984; Keeley, 1988) have been shown to strongly correlate with a number of social processes, perhaps none more basic than village fissioning (Bandy, 2010, 2004; Carneiro, 1987c; Chagnon, 1975; K. V Flannery, 1976). It has been shown in a wide variety of case studies that as populations grow conflict increases (Rappaport, 1968).

However, beyond this basic fact, some researchers have been able to assign specific populations threshold above which social change must occur to alleviate the pressures of these increased conflicts. Bandy (2004, 2008, 2010) has suggested a threshold of 277 people for fissioning based on estimated site sizes for Formative Andean data. Adler and Wilshusen (1990; see also Adler, 1989) have shown a threshold of about 250 individuals at a settlement for the appearance of large-scale integrative ritual facilities through cross-cultural examinations of small-scale societies. Dunbar (1993) has suggested an adult population of about 150 as the threshold above which the human brain cannot maintain intimate relationships and, therefore, inter-personal social regulation. What all of these numbers have in common is that clearly village

populations in the MPPNB, even at the low end of estimates, are approaching or reaching such thresholds. This suggests that one possible causal factor for the social changes that emerge at the end of the MPPNB and into the LPPNB is population size. They needed to organize and integrate people in new ways when village population got too large.

Health Changes

Reliance on agriculture has been invoked as a major factor in population growth (Bocquet-Appel, 2011b, 2008; Buikstra et al., 1986; Hassan and Sengel, 1973; Winterhalder and Leslie, 2002), population movement (Ammerman and Cavalli-Sforza, 1984, 1971; Bellwood and Oxenham, 2008; Bellwood and Renfrew, 2002; Bellwood, 2009, 2001; Diamond and Bellwood, 2003), and health changes (Cohen and Armelagos, 1984; Cohen, 2008, 1989; Larsen, 1995; Pearce-Duvel, 2006). The first two have been reviewed above, but the third has not.

Goring-Morris and Belfer-Cohen (2010) have provided an excellent summary of long-term trends in health during the early Neolithic of the southern Levant that echoes many of the broader synthetic works on the subject from throughout the world. As populations settle down and begin to farm health, health can deteriorate significantly (Cohen and Armelagos, 1984; Cohen, 2008, 1989; Larsen, 1995; Pearce-Duvel, 2006) and mortality increases (Bocquet-Appel and Bar-Yosef, 2008; Bocquet-Appel and Naji, 2006; Bocquet-Appel, 2011a, 2011b, 2009, 2002; Caldwell and Caldwell, 2003). However, if we are to look at the PPNB in greater detail a more complex picture begins to emerge.

Many authors have observed patterns in health change for the entirety of the PPNB as compared to the earlier PPNA and late Neolithic (e.g., Eshed, Gopher, Gage, et al., 2004; Eshed, Gopher, Galili, et al., 2004; Eshed et al., 2006, 2010; Mahoney, 2006; Hershkovitz and Gopher, 2008; Eshed and Galili, 2011). However, Smith and Horwitz (2007) published a synthetic

analysis of health by sub-period in the Neolithic. They used four main variables for understanding health changes: (1) skeletal stature and robusticity as indicators of nutrition, (2) dental robusticity as an indicator of diet, (3) skeletal markers as indicators of disease, and (4) dental markers as indicators of diet, nutrition, and disease. Interestingly, when the early Neolithic is divided into the PPNA, EPPNB, MPPNB, LPPNB, and PPNC, the predicted health changes expected with sedentism and domestication do not appear until the LPPNB.

In fact, MPPNB skeletal samples from Jericho show an increase in stature from the preceding PPNA and samples of MPPNB Abu Ghosh show similar stature to MPPNB Jericho. Conveniently, the skeletal sample at Jericho allows for the potential of population replacement to be controlled for with dental morphology indicative of genetically highly similar individuals at the site across the PPNA and MPPNB. There is also an increase in skeletal robusticity at these sites when compared to PPNA samples. Both of these changes suggest improvements in nutrition during the period. Teeth, however, are smaller in size, suggesting a decrease in the hardness of diets. There is also a decrease in tooth hypoplasia, compared to the PPNA and earlier periods, again suggesting improved nutrition consistently throughout life. One of the more interesting dental markers identified from MPPNB samples is hypoplastic defects, typically a product of nutritional stress, found in the cervical region of the canines. This area typically calcifies between 4 and 6 years of age, suggesting the onset of nutritional stress at this point (Smith and Horwitz, 2007). Frequently such stress is associated with weaning in small-scale societies and these data may be an indicator of a significantly later weaning age than is typical in agricultural societies (Buikstra et al., 1986).

Disease indicators in the MPPNB are more mixed with skeletal data showing a decrease in pathologies as compared to the PPNA. However, dental data from MPPNB Kfar HaHoresh,

'Ain Ghazal, and Abu Ghosh show an increase in caries, attrition, and ante-mortem tooth loss (Smith and Horwitz, 2007). Several interpretations are possible. The most obvious is a change in diet which is detrimental overall to tooth health. However, another possibility is that individuals were living longer and therefore increasing their risk of dental pathology. This second possibility cannot be controlled for as most of the data for the MPPNB derives from isolated cranial and mandibular elements, preventing independent aging of individuals. However, it is known that during the MPPNB there is an increase in wheat and barley consumption overall (Asouti and Fuller, 2013, 2012; Nesbitt, 2002). Both these hulled cereals are known to cause dental problems when consumed in large amounts in the form of rough ground flour (Molleson, 1994). That being said, cereals have been part of the diet of southern Levantine populations since long before the MPPNB (Asouti and Fuller, 2013, 2012; Weiss et al., 2004).

By the LPPNB a number of the detrimental health consequences associated with sedentism and agriculture are quite apparent. While there are few LPPNB skeletal samples published, those that are published show dramatically higher rates of defects such as lesions and hypoplasia on both bones and teeth, indicating higher rates of disease. We do not have significant stature or robusticity data from the period. Dental data, however, do provide some evidence of diet quality. The most dramatic difference between the MPPNB and LPPNB in dental nutritional indicators is the appearance of enamel hypoplasia on the vast majority of central incisors, indicative of nutritional stress or infection in the first year of life. This suggests that by the LPPNB weaning was likely occurring much earlier, i.e. by around one year of age. Additionally, dental samples continue to show nutritional stress through the fifth year of age when adult teeth finish forming (before eruption) within the mandibles of children, indicating

continuous dietary challenges throughout childhood once weaning has occurred (Smith and Horwitz, 2007).

There are several potential explanations of these health changes in the LPPNB. Most notably, population growth and increasing aggregation provide environments much more conducive to the maintenance of disease in populations (Cohen, 1989). Secondly, while there are indications of increasing consumption of cereals in the MPPNB, by the LPPNB such crops come to dominate most village botanical assemblages in contrast to an emphasis on pulses in the MPPNB (Asouti and Fuller, 2013). Cereals are known to provide calories more easily than most other foods, but also lack many nutrients. Thus, a heavy reliance on cereals for calories is associated with nutritional stress in the form of reductions in stature and increases in pathologies. Additionally, the carbohydrate-heavy nature of cereals has been known to cause significant dental problems (Cohen, 1989). In many small-scale agricultural societies, cereals are processed into easily digestible gruels for infants, facilitating early weaning, but introducing nutritional stress earlier in their lives (Buikstra et al., 1986). Finally, with the introduction of domestic animals into settlements, disease loads would have increased significantly (Cohen, 1989).

Changing Social Practices in the PPNB of the Southern Levant

Social Segmentation and Households in the MPPNB

All of the above-described changes in the material aspects of villages both reflect and structured social relations during the PPNB of the southern Levant (Flannery, 1972). It is not only possible to describe changes in architectural form and the spatial and temporal structure of settlements, but also the social relations of those individuals who inhabited these settlements. While changes in overall village structure have been argued to illustrate demographic changes within village populations as a whole, the details of these spatial structures will be analyzed

below to better understand shifting social structures. Below the level of the socio-politically autonomous village, no social institution is more important to understanding PPNB society than the co-residential unit – in other words, the household.

Goring-Morris and Belfer-Cohen (2008, 2013) have described three different styles of residential architecture within village sites of the PPNB. While they do not note a temporal dimension to them, there certainly seems to be one. However, local topography clearly plays a role in architectural choice. There is also clear evidence of regional spatial patterning of architectural style. The first form of structure, typically seen in the MPPNB at sites in the Hula Basin such as Beisamoun (Lechevallier, 1978), the Galilee such as Yiftahel (Garfinkel et al., 2012), Lower Jordan Valley such as Jericho (Kenyon, 1981), the southern Jordanian Highlands such as Beidha (Byrd, 2005), and the North Jordan Highlands such as ‘Ain Ghazal (Banning and Byrd, 1984) is described as “the two-storey, long-axis ‘corridor’ house, pier-house or ‘megaron’” (Goring-Morris and Belfer-Cohen, 2008: 261) (Figure 33). These houses are longer than they are wide and typically contain two stories: the first being comprised of small cell-like storage and/or workshop rooms accessible from above or through small raised windows on the side and the second floor being one or two larger rooms for most dwelling activities.

A second form of structure found at LPPNB mega-sites in the central and southern Transjordan highlands such as es-Sifiye (Mahasneh, 2004) and Basta (Gebel et al., 2006b) is the courtyard house (Figure 34). Such structures are composed, again, of two stories with the lower level containing small cell-like storage and/or workshop rooms and the upper story being composed of larger dwelling spaces. However, unlike long-axis structures described above, these structures are clustered around a central courtyard. The third type of structure identified at southern Jordanian LPPNB village settlements such as the small late LPPNB site of Ba’ja (Gebel

et al., 1997) and the large site of ‘Ain Jammam (Fino, 2004) is dense two- and three-story agglutinated architecture (Figure 35). These structures vary more in their layout, most likely due to the topography.

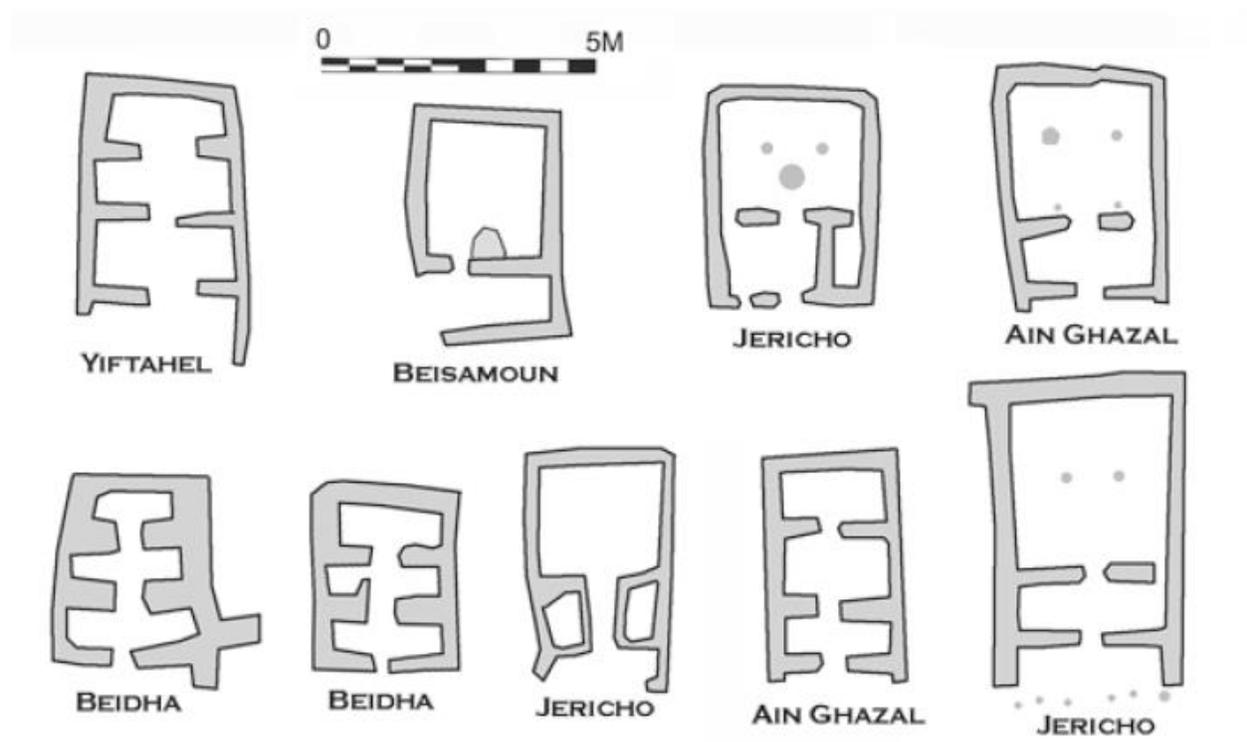


Figure 33: MPPNB Pier Houses (Goring-Morris and Belfer-Cohen, 2012)

In addition to these residential structure types, two other sites are worth noting. The MPPNB site of Ghuwayr 1 has produced three phases of structures which slowly develop into the familiar or corridor structures of MPPNB Beidha and ‘Ain Ghazal. However, the earliest phase of the site actually consisted of large square structures (~10 x 10 m) with minimal internal differentiation of space. It was only later that interior cell-like structures were placed into basement levels below living floors (Simmons and Najjar, 2006). ‘Ain Ghazal has also produced a large residential structure in its LPPNB component which shares characteristics with both the two-story, long-axis structures of the MPPNB and the courtyard houses of the LPPNB. It is a two-story, long-axis structure significantly larger in size than MPPNB residential structures and

with significantly more rooms. It does appear to have a central corridor, but no courtyard (Rollefson, 1997).



Figure 34: Courtyard House at LPPNB Basta (Gebel, 2004)

While Goring-Morris and Belfer-Cohen (2008, 2013) provide essentially descriptive summaries of these forms of habitation structures, it is the social changes, such as the development of the household unit through time and its economic role that are of most interest here. In order to understand these changes we must turn to other authors who have

presented arguments about who inhabited these kinds of architecture. Flannery (1972) presented a model of intra-village social relations in the PPNB whereby the independent nuclear households were the primary units of social action. He saw analogies with communities in the ethnographic present. His basis for such analogies was the spatial form of settlement types; he focused on open versus restricted access to storage and the size of structures. Thus, if similar architecture was observed in the archaeological record, the social units that occupied them might also be similar. Flannery (1972) ventured to propose that PPNB villages (what we now know to

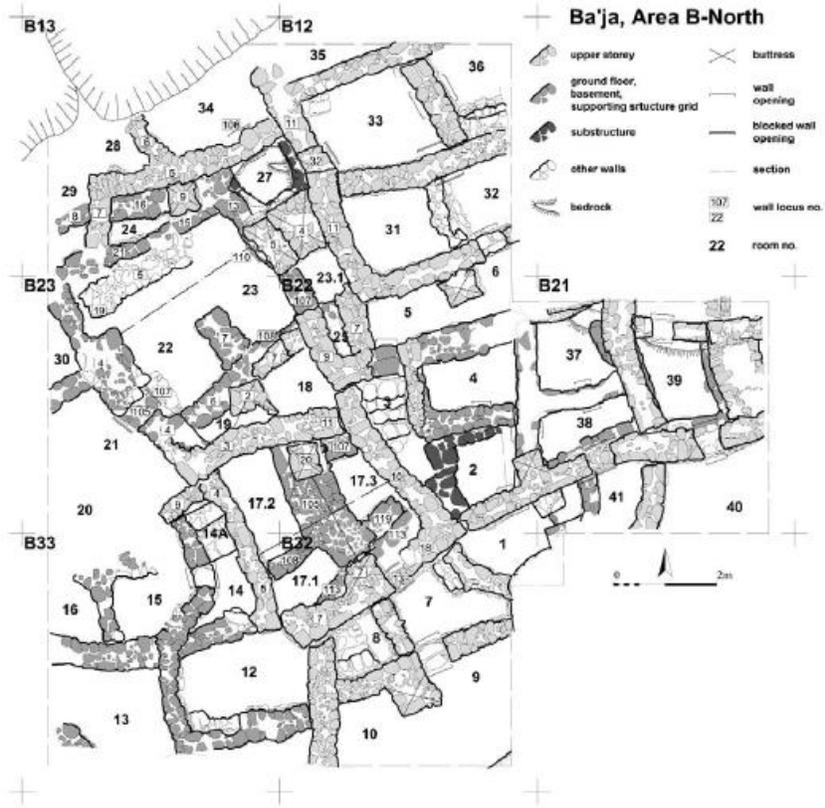


Figure 35: LPPNB Ba'ja Agglutinated Architecture (Purstwitz and Kinzel, 2007)

be MPPNB villages) were composed of a series of nuclear families with the community as a whole tied together by kin relations, but also crosscut by various forms of social relations such as sodalities. These family units were the occupants of individual households, with men, women, and children all occupying a single residential structure. There

may be a head-man's or village storage structure, but the majority of storage was on the level of the household, suggesting both that the household/nuclear family was the basic unit of production and that storage was not shared openly, but rather controlled by and largely distributed to individual residences. As it is easy for rectangular residential structures to be added to and as such additions are frequently seen in the ethnographic and archaeological records, one cultural process which can occur in such villages is the growth of a household from a nuclear to an extended family (Flannery, 1972: 38-40).

Flannery (1972) argued that such a social organization emerged during the MPPNB because of a number of what he termed adaptive advantages over earlier forms of intra-community primarily economic relations. His first observation supporting this idea was the

convergence of settlement forms in Mesoamerica and southwest Asia. Thus, he reasoned, there must be something about such a settlement form that provides a robust solution to issues face by early sedentary communities. A similar pattern of settlement development has been identified in a great number of other regions and time periods (Flannery, 2002).

Flannery's (1972) characterization of the overall social relations in MPPNB villages as "large, nucleated settlements composed of related households (with their own landholdings and storage facilities), cross-cut by sodalities composed of family heads (co-operating in specific acts of ceremony and labour)" (Flannery, 1972: 47) has withstood the test of time well (Byrd, 2005a, 2000, 1994; Finlayson et al., 2011a; Flannery, 2002; Kafafi, 2006; Kuijt, 2000a; Peterson, 2003; Wright, 2000). Following this initial publication based on the comparative study of several of the first Neolithic sites excavated in southwest Asia, Byrd (1994; 2000; 2005) showed that the development of Flannery's hypothesized social relations was visible diachronically at the MPPNB site of Beidha. He demonstrated that, "A more restricted social network for sharing production and consumption endeavors was discerned at Beidha based on changes over time in the spatial organization of the community, the organization of dwelling interiors, and the relation between domestic and exterior areas." (Byrd, 1994: 640) That is, through time, changes in the structuring of social space indicated that individual households gained greater social autonomy and currency from the earliest MPPNB onwards. Similar studies have been shown such changes occurred at MPPNB Shkarat Msaied (Peterson, 2003) and M-LPPNB 'Ain Ghazal (Kafafi, 2006) and across the entire Levant during the PPNB based on food processing and meal production (Wright, 2000).

Byrd (2000, 2005) also subsequently documented that an analysis of interior features within MPPNB architecture did indeed suggest that residential structures were occupied by

nuclear family households as hypothesized by Flannery (1972). This is significant as the occupation of individual structures by multiple individuals and generations is suggestive of social segmentation along household lines. This is because a variety of settlement forms with a variety of intra-community relations systems can contain residential structures which house only a small portion of the overall community. Thus, in many forager camps individual adults or spouses can occupy their own structures while still practicing some form of communal production and consumption pattern (Flannery, 1972; Kelly, 2007; Wilson, 1988). Therefore, key social relations of obligation including rearing and sharing may stretch beyond the walls of residential structures.

An interesting alternative to Flannery's (1972) nuclear family household model, which has been proposed by Kuijt (2000a; 2000b; 2000d), is that of the multi-structure house society social unit. As has been briefly outlined, house societies are a type of social and economic organization whereby socio-economic units within settlements are organized into associations known as houses (Levi-Strauss, 1988). These houses are large groups of individuals sometimes related but not always. They were living in an arrangement like an extended family or small lineage. These houses share significant amounts of subsistence risk and productive responsibilities, as well as political identities. In the communities where such a social organization has been invoked, these associations tend to reside in an actual large residential structure, although some individuals or families may also reside outside the structure in a number of different arrangements. This form of organization and residence pattern has become a popular concept in archaeology with a great number of researchers invoking it, typically for habitation practices Where structures show a great deal of investment and overt symbolically-charged elaboration (Beck, 2007).

Kuijt (2000a; 2000b; 2000d) differed in his model of PPNB social organization from these normative constructs of house societies in that he did not see houses as being an association of individuals residing primarily in a single structure, but rather an association of individuals living in multiple structures, but sharing the same sorts of social relationships as houses in other house societies. Thus, his model does not exclude nuclear family households. Rather, it simply suggests that there is a potential additional layer of social relatedness between the family residential unit and the village, something akin to a lineage or other form of kin-corporate group. However, he did see certain structures as being associated with the house group as a whole, as will be explained further. This is why he viewed these associations as houses – he saw the key role of an individual residential structure as an integral part of the existence of such groups. While they may have occupied multiple, even noncontiguous residences, the individuals of the association shared a certain amount of subsistence risk, productive tasks, group ritual practices, and political identities. Thus, they might be characterized as a sort of kin- and fictive-kin-corporate group, as well as a social and ritual unit. Such a model has subsequently been taken up by a number of authors discussing the Central Anatolia Neolithic site of Catalhoyuk (Hodder, 2010). Since these early publications, Kuijt (e.g., Kuijt and Goring-Morris, 2002; Kuijt, 2004, 2008a, 2008b, 2009; Kuijt et al., 2011) has not invoked the house society model, focusing instead on the general role of intra-village social units, be they households, houses, sodalities, kin-corporate groups, ritual societies, or any other form of cross-cutting social organization.

A second line of evidence which both Kuijt (2000a; 2000b; 2000d) and others who view nuclear family households as the basic social unit of MPPNB society, is mortuary data, their context, and representational structures (e.g., Kuijt 1996). Kuijt (2000a; 2000b; 2000d) has discerned a pattern of burial and secondary mortuary practices whereby certain individuals are

interred beneath the floors of certain residential structures and then, frequently, the skulls of these individuals are removed and decorated, usually with plaster and pigments, but also with bitumen, shells, and other materials. These decorated crania are then utilized in ritual practices for a certain duration after which the skulls are cached together with other similarly manipulated crania. It is during the MPPNB that such treatments are most common although they are known from the LPPNB. Kuijt (2008b) has suggested that this cycle reflects an initial focus of ritual on the individual as a member of the house. Subsequently, through time as the memory of this individual becomes only that of the ritual practices associated with the skull, the individual is transformed into a sort of generic ancestor who is taken to represent the broader community beyond the house. Thus, when skulls are finally deposited, this is done in a group, seemingly derived from multiple households or lineages.

We see that the household seems to play quite a significant role in the MPPNB (2008b). However, while most of those who work on the PPNB of the southern Levant see these households as likely nuclear families in the MPPNB, Kuijt (2000a; 2000b; 2000d) has argued for a variation on a house society form of social organization. His evidence for this is contextual and frequency data from mortuary rituals. He notes that only a small number of individuals receive such treatment as compared to the likely overall population of settlements. He also notes that only some habitation structures have burials below their floors. He finally notes that there is minimal variation in household size or organization and virtually no grave goods associated with interments, which could mark differences in status. He thus argues that these individuals and structures must be representative of broader associations of individuals, invoking an idea similar to that invoked by Byrd and Monahan (1995) for more richly adorned interments from the Natufian. He sees these associations as represented by interments, decorated skulls, and the

structures in which these items are found as the houses in his house society model. While this idea has yet to be taken up by most researchers in the area, it does convey the importance of the household in MPPNB communities, be they nuclear family co-residences or house kin- and fictive-kin-corporate groups. In this case manipulated crania could be interpreted as representative of Houses or other discursively marked kin organization such as the lineage or kin-corporate group. Those households with subfloor burials and modified crania could simply have been structures occupied by these individuals.

Another line of evidence that has been used to demonstrate the emergence of strong household identities in the MPPNB is changes in other forms of ritual practice as compared to earlier periods. One essential line of evidence which has been used in such arguments is imagery such as figurines, statues, and visual representations and the context of such objects (e.g., Rollefson, 2008). While there has been a lot of research published on images and representations from the PPNB of southwest Asia from a symbolic perspective (Hodder and Meskell, 2011; Lesure, 2011; Verhoeven, 2002; Voigt, 2000), I will not concern myself with images as symbolic entities but assess their social implications. Additionally, a number of authors have addressed the symbolic meaning of images/depictions in the context of arguments that the ideas portrayed in the imagery were social forces of change (Cauvin, 2000; Hodder, 1990). While this is possible, they are often decontextualized from social processes which surely structured how such images acquired meaning.

My emphasis will be on context, rather than the meaning of potential ritual objects. A number of authors have presented what might be called 'social functional' interpretations of ritual items (e.g., Kuijt and Chesson, 2005; Kuijt and Chesson, 2007). I will discuss some of these materials further because a number of authors have argued that scale and spatial patterning

of ritual objects show the emergent importance of the household in Neolithic society. This makes the household the primary location within which the marked importance of and long-term coherence to the social unit both within communities and across generations are created (Rollefson, 1983, 2000, 2008: 167-172, 183-185; Kuijt, 1996, 2000b, 2008b).

Interestingly, the use of images and figurines, like secondary burials and the manipulation of dead bodies, peaks in frequency during the MPPNB (Rollefson, 2008). There are also interesting symbolic and meaningful dimensions to image- and figurine-based practices in terms of the relationships between what they represent and what social processes are occurring during the period. While it is well established that religion and ritual can often serve to bind together communities and, thus, there can be an intensification of ritual during periods of greater social stress (Adler and Wilshusen, 1990; Adler, 1989; Bandy and Fox, 2010a; Kuijt, 1996), such rituals typically produce their social cohesion effects based on specific characteristics of their practice. For example, in communities where populations are growing to levels where individuals may not be linked to regulate social tensions through habitual interaction, community-wide rituals and ritual structures appear to serve the role of creating socially-created ties between individuals important enough to mediate interpersonal conflicts (Adler, 1989; Adler and Wilshusen, 1990). Such a process has already been touched on for the early Neolithic of the southern Levant during the discussion of the appearance of communal architecture at a number of sites in the latter portions of the MPPNB.

Rollefson (2008) has analyzed small figurines believed to be involved in some form of ritual or spiritual belief system during the MPPNB. While he cataloged finds from a variety of sites throughout the eastern Mediterranean, his major focus was on the site of 'Ain Ghazal. The 195 figurines (40 human and 155 animal) he recovered were from MPPNB contexts. This is

compared to 18 for the LPPNB, 28 for the PPNC, and 20 for the Yarmoukian despite the MPPNB being the least extensively excavated portion of the site. Additionally, the population during the MPPNB is believed to have been significantly lower than in succeeding periods.

The composition of the animal figurine assemblage is of note as well. The vast majority of figurines are of cattle (Figure 36), a species that makes up only 8% of the overall NISP count. Goats account for about half of the faunal assemblage. Cattle are not believed to be domesticated during this period and were, therefore, likely acquired through hunting. Secondly, while most figurines derive from middens near residential structures, as is typical at most sites for the period, two cattle figurines with evidence of intentional breaks, suggested to Rollefson (2008) that they were “killed.” The cattle figurines were recovered from a sub-floor ritual deposit associated with a residence. Thus we see a pattern emerging of the use of figurines in domestic contexts for ritual purposes.

These observations also suggest that cattle seemingly played a significant role in the ritual life of the settlement. This likely even extended to real cattle as well. There is ample evidence from a number of sites throughout the early Neolithic of the southern Levant that cattle bones are found in probable feasting contexts (Goring-Morris and Horwitz, 2007; Twiss, 2008); this is a tradition that stretches at least from Anatolia (Voigt, 2000) in the north to Arabia (McCorriston et al., 2012) in the south during the Neolithic. The importance of hunted cattle to the domestic ritual sphere of ‘Ain Ghazal is telling. What we can see is that it was seemingly of importance for individual households to have members who participated both the hunting of cattle – likely a group activity – and the subsequent feasting on the remains. This is likely a

community-wide activity. Once again, while community-wide rituals are clearly operating in MPPNB villages, it is important for households to be marked in such activities, suggesting the increasing importance of residential units as social unit.

Ritual and Social Cohesion during the MPPNB

In growing settlements, ritual intensification, defined as an increase in the frequency of ritual, can often serve to hold communities together as a mechanism for mediating tensions and



Figure 36: Cache of Cattle Figurines from 'Ain Ghazal (Rollefson, 2008)

creating a sense of *communitas*. The evidence for the appearance of communal architecture during the later portions of the MPPNB and the removal of curated skulls from residential contexts into caches suggest significant roles for community-wide ritual during the period

(Byrd, 1994, 2000, 2005; Kuijt, 1996, 2000b, 2008b; Verhoeven, 2002: 245-248). Additionally, there is an increase in feasting practices during the MPPNB, suggesting another realm, likely ritual in nature, of community building (Goring-Morris and Horwitz, 2007; Twiss, 2008).

While the site of Kfar HaHoresh has presented a number of apparently ritual-based relationships between human interments and animal deposits, the most detailed of these is an apparent feast described by Goring-Morris and Horwitz (2007). In a pit they found layers of

stones, a broken ground stone tool, a core rough-out, a limestone slab, wild cattle joints from eight individual specimens, including seven adult animals and one immature individual, with some level of soft tissue still apparently attached, as the bones remained articulated, as well as bones from at least five additional animals, more stones, an adult male human burial, a plaster/chalk mixture, and a capping layer of plaster. Of the seven adult wild cattle, the authors suggested that at least one of them was an adult male based on size measurements and three were adult females. The other three skeletons were of medium size and not assigned to either sex. Interestingly, while there is evidence of butchering based on the inclusion of a series of articulated joints, rather than whole skeletons, the bones in the pit do not have any cut or burn marks. Later, a small hole was dug into the plaster to remove the skull for secondary mortuary treatment. This suggests that in the original rite, the location of the skull was somehow marked or remembered.

The analysts of this deposit (Goring-Morris and Horwitz, 2007) have proposed that, unlike other human-animal deposits at the site where small amounts of animal bones are found, this deposit is likely the result of a feast associated with the interment of the human remains near the top of the pit. This is based on the fact that so many individual animals were interred and that the articulation of the remains shows that they were at least partially butchered. They also have calculated the amount of meat produced from fully dressed carcasses of one adult bull, six cows, and one juvenile, conservatively estimating over 200kg. Such a quantity of meat would feed an enormous number of individuals. This volume of meat may mean that the feast was well attended, but also likely highly wasteful given the size of communities at this time, again supporting the contention that the remains derived from a feasting episode. Of course, caution must be taken with such a claim given that the bones had no cut or burn markers. A significant

amount of these cattle were not included in the pit which would have had a substantial amount of meat attached to them. Additionally, the bones of additional animals suggest that these could be the remains of consumed individuals, while the deposited meat-bearing joints would have been conspicuous waste; a strategy typical of feasting episodes. A third possibility, suggested by Twiss (2007) is that of pit roasting, whereby bones would remain articulated but flesh could be torn off after cooking. Such a preparation method is also frequently associated with feasting as much fat is lost in the preparation, something typically more excusable in a non-domestic context.

In a broader analysis of food storage, preparation, and consumption practices, as well as ritual practices frequently associated with feasting, Twiss (2008) has shown a distinct increase in such behaviors at MPPNB sites. She pointed to the evidence of feasting at Kfar HaHoresh, as well as a number of other sites without large individual deposits as potential locales of feasting. She noted that at Yiftahel, in an area of the site with significant evidence of plaster production, as well as green stone beads, there are significant quantities of gazelle and other animal bones associated with a concentration of 27 hearths in an open space. She described similar evidence from Kfar HaHoresh, although no additional large deposits of animal bones from a single episode were identified beyond the one case already presented.

Twiss (2008) also pointed to large concentrations of stored foods, images of animals, rare and labor intensive vessels, the use of the bones of food animals in ritual, and public food preparation as potential evidence of food consumption serving some sort of public purpose in the MPPNB. She cataloged all of the phenomena at MPPNB sites and showed that they have frequently been documented at most village or ritual sites and that this documentation is much more frequent than in earlier periods. She relied significantly on the work of Wright (2000), who

cataloged the location of food preparation facilities at MPPNB sites and showed that certain activities were done in public in front of residential structures, or were totally missing from habitations at all, suggesting a communal location for some forms of food preparation. Again, such social practices, would have served to create communal bonds across households. However, it is important to note that most facilities, even if in public view, were associated with individual residential structures, suggesting a variety of potential relationships between household and community in regards to personal identities and associated food practices from family-sponsored to community-wide feasts.

Another line of evidence for the significance of community ritual is the existence of large statues at a number of MPPNB sites including 'Ain Ghazal (Schmandt-Besserat, 1998), Jericho (Garstang and Garstang, 1948), and, potentially, Nahal Hemar (Bar-Yosef and Alon, 1988). Rollefson (2000) has suggested that these statues would likely have played a broader role in the community than household ritual, based on the fact that they were ritually deposited outside residential structures and are of such a size as to suggest a larger audience or space than a household would provide.

A final line of evidence which has been viewed as the result of community-wide rituals which create a sense of shared identity are sets of cached crania (Kuijt, 2008b, 2000d). As has already been noted, Kuijt (2000b, 2008b) has argued that caches of multiple modified crania deposited in MPPNB village contexts are groups of generic ancestors of multiple intra-community social units whose specific identities have been forgotten, except as ancestors. Thus, their deposition together is an assertion of community-wide identity, regardless of the previous unit identity.

Social Leveling Mechanisms in the MPPNB

While social segmentation and the intensification of the role of households as marked social actors among sedentary agriculturalists, as well as the intensification of ritual practice and a likely increased importance of ritual specialists both create a situation ripe for inter-household competition and the creation of durable inequalities, the MPPNB exhibits little evidence of such phenomena (Kuijt and Goring-Morris, 2002; Kuijt, 2008b, 2000d, 1996). Therefore, a number of researchers have devoted attention to the mechanisms by which inequality was suppressed. They have focused attention on two data sets which typically show signs of inequality: (1) residential architecture and (2) mortuary data.

Kuijt (1996: 319, 331-332; 2000d: 315) and Byrd (2000: 86, 92) have been the most forceful in arguing that MPPNB residential structures show few signs of significant differences in wealth with sites being comprised of similarly sized and equipped structures. However, even beyond this fact, they note that structures within MPPNB sites are remarkable similar in form. In fact, the site that Byrd (2000) most closely analyzes, Beidha, is a good example. Because of the broad exposure at the site and the well understood stratigraphy (which has been divided into three phases), we can see the unfolding of construction choices in greater detail at Beidha than perhaps any other PPNB site.

When the site's stratigraphy is divided into three phases, Byrd (2005) can show that the village was continuously occupied and the three phases simply represent three stylistic shifts in construction and reconstruction on the site. What is perhaps most interesting about this pattern of construction is the fact that once a new residential form appears at the site, all subsequent structures are built as virtual copies of the original. This shocking level of standardization of architecture has regarded as evidence of a strong pervading egalitarian ethos whereby all households assert their sameness (at least on the exterior) and this assertion is manifested in the

construction of residential quarters (Byrd, 2000). A similar pattern, although not as well defined archaeologically due to differences in sampling, is seen at other MPPNB sites including 'Ain Ghazal (Banning and Byrd, 1989a, 1987, 1984; Rollefson, 1997) and Ghuwayr 1 (Simmons and Najjar, 2006).

Kuijt (2000a; 2001b; 2008b) more than any other researcher has cataloged mortuary practices from the MPPNB of the southern Levant and analyzed these data to discover patterns in practice and meaning. While his contention that the similarity in residential structures at MPPNB sites is one form of social leveling, whereby ideologies prevented households (be they nuclear family households, specific households from higher status lineages, or house society houses) from expressing differences in wealth and/or power through architecture, he has also argued that the lack of grave goods and the standardization of a number of dimension of MPPNB burial practices effectively controlled the use of the dead to assert wealth or power by related individuals (Kuijt, 1996; 2000a; 2000b; 2001b; 2008b).

He examined the burial data from a number of MPPNB sites including Jericho, 'Ain Ghazal, Kfar HaHoresh, Nahal Hemar, Yiftahel, Beisamoun, and Beidha. Several important trends come out of this examination. Firstly, there are patterns in mortuary practices across sites of the MPPNB of the southern Levant. This basic pattern of the selective burial of individuals under floors followed by the reopening of graves to remove crania which are then decorated in some form and circulated around the communities of the living, and finally the placement of these crania in caches is found across the entire southern Levant. There are, however, patterns within this widespread region of similar practices, which point to individual community customs as well as intra-community variation in the exact techniques used in interment and cranial decoration (Bonogofsky, 2003; Kuijt, 2008b).

While neither of these contentions is particularly surprising – that there were regional patterns and sub-regional patterns – what Kuijt (2000b; 2008b) did show that is novel is the tension between the roles that decorated crania played for intra-community associations such as families, sodalities, neighbors, or even neighborhoods potentially, and the community as a whole. Kuijt (1996, 2000b, 2001) pointed to many ethnographic accounts that showed that while most small-scale, mobile, foraging societies are essentially egalitarian in their economic relations, this egalitarianism is created through structured practices which emerge from tensions brought about by intra-group competition. That is, egalitarianism is not natural. Rather, it is a process through which the social tensions of potential inequalities are mediated through the structuring of practices. Essentially, he was arguing that the segmentation of society during the MPPNB led to independent social units that could compete with one another for power, prestige, and wealth in new ways. In order to maintain egalitarian social relations, certain practices focused around residential architecture and mortuary ritual developed.

Early societies of the Late Epipaleolithic and PPNA also had leveling mechanisms embedded in their mortuary practices as well as their distribution practices, essentially making valuable subsistence goods (i.e., storable, highly caloric, or large package goods) the shared property of the group. However, with the segmentation of society, the distribution of goods became more restricted (Flannery 1972, Byrd 1994). Thus, leveling mechanisms that could accommodate differential production and therefore differential consumption between social units were amplified in mortuary ritual or newly developed in the case of residential architecture. This led to the standardization of house forms, the standardization of mortuary practices, and the assertively community-forming secondary mortuary rituals which reached their peak in the MPPNB (Kuijt, 1996; 2000b; 2001; 2008b).

Social Differentiation in the MPPNB

A consequence of Kuijt's (1996; 2000b; 2001; 2008b) line of reasoning that the segmentation of society led to cracks in the egalitarian ethos of preceding periods; this segmentation led to social tensions and inequality, as distinct social units differentially produced and consumed. He saw this fact using different lines of evidence. Firstly, there are noticeable differences in mortuary practices, including selective in-life cranial modifications, selective use of certain corpses for residential burials, and for secondary modification, as well as the structured spatial patterning of the interment of individuals who have experienced in-life cranial modification (2000b).

In a more recent article focused on the northern Levantine M-LPPNB of Tell Halula in the Middle Euphrates Valley of western Syria, Kuijt and colleagues (Kuijt et al., 2011) examined six MPPNB and five LPPNB residential structures with subfloor burials. These burials showed small shifts in interment practices through time with an increase in grave goods, changes in the inclusion of grave goods with children and adults, and the location of graves within residential structures. Essentially, household mortuary practices, while remaining highly similar through time, diverge in notable ways. Individual households utilize increasingly distinctive practices that still seem to fit within previous practices. Thus, Kuijt et al. (2011) argued that household autonomy was increasing and that these households were enacting different practices with the effect of asserting independence and/or competition. Interestingly, a similar phenomenon, observable through changes in household architecture has been identified with the growth of early villages in Mesoamerica as well (Lesure and Blake, 2002).

Kuijt has been criticized by some (Belfer-Cohen and Goring-Morris, 2008) for understating the variability in MPPNB mortuary practices with many individuals at 'Ain Ghazal

for example, being interred in midden deposits with minimal ritual attention. However, such an argument in regard to sites where some individuals receive special treatment actually supports Kuijt's contention that there is variability in the treatment of individuals in death based on differential status in life and/or in relation to the living.

There are a number of MPPNB sites, especially in Cisjordan, which do show significant variation from this model in the MPPNB. The most extensively published of these is Kfar HaHoresh where the excavators contend that it is a specialized mortuary site utilized by surrounding village communities. While there are significant parallels in interment style and secondary mortuary treatments, including burials in the flexed position and secondary crania removal and modification, the excavators contend that there are no residential structures and therefore no houses under which selected house members could be buried (Eshed et al., 2008; Goring-Morris, 2000, 1991; Goring-Morris et al., n.d.). Garfinkel (2006) argued that Kfar HaHoresh may be a village site for which taphonomic processes and excavation strategies have produced largely mortuary results from excavation. If this is the case, these mortuary practices line up quite well with Kuijt's (1999; 2000b; 2001; 2008b) model of selective burial under residences and secondary cranial treatments.

Two other sites, however, stand out as contrasts to the general pattern of mortuary practices. One is the newly excavated MPPNB Mishmar Ha'emeq near Kfar HaHoresh in the Galilee (Barzilai and Getzov, 2011, 2008) and the other is MPPNB Ghuwayr 1 in southwestern Jordan (Simmons and Najjar, 2007, 2006). At Mishmar Ha'emeq a major mortuary installation, a walled cemetery, has been identified. Recent excavations have identified sparse architectural remains beyond a uniquely built structure of possible ritual importance associated with the cemetery. This new architecture does seem to indicate that habitation did occur on-site,

suggesting that Mishmar Ha'emeq may have been a village with a cemetery (Barzilai and Getzov, 2011). There is very little information on the mortuary practices at the site, so further analysis is not possible. Interments are in a separate area of the site, rather than under residences; no secondary cranial treatments have been reported so far.

Ghuwayr 1 is unique in its low number of burials, given the extensive excavation. Nine MPPNB burials have been identified at the site with most being highly fragmentary and in the fill of rooms. There is no evidence of secondary mortuary rituals nor skull removal. Only one burial was found under a residential structure, that of a nine-month-old baby. The burial itself contained a single mother of pearl ornament. Directly above the burial were a number of objects thought to be offerings. The infant burial was associated with grave goods, something quite uncommon in the MPPNB. At Ghuwayr 1 there is evidence of significant ritual, but not of the kind seen at other MPPNB sites (Simmons and Najjar, 2006, 2007). While none of these sites invalidate Kuijt's (2008b) model of MPPNB mortuary practice, they do show that at certain, seemingly smaller sites and in the cases of Kfar HaHoresh and Mishmar Ha'Emeq fairly distant from large densely inhabited villages, mortuary practices may include some elements of Kuijt's (2008b) system, but not all of them.

Moving away from mortuary practices, another line of evidence which has been used to observe the increasing importance of intra-group identity has been the use of personal adornments. Wright and Garrard (2003) noted a significant increase in stone bead utilization during the Neolithic, specifically looking at sites in the Eastern Desert region of Transjordan. While the greatest increase in bead quantities and the diversity of forms was found in the Early Late (Pottery) Neolithic, there was also a significant increase during the early Neolithic over the preceding Epipaleolithic. Similar patterns of increased utilization of stone beads has also been

observed in Cisjordan during the early Neolithic (Bar-Yosef Mayer and Porat, 2008). Wright and Garrard (2003) argue that this increase in the frequency of bead utilization and the specific increase in the utilization of stone beads during the period is a result of the intensification of social life. Ornaments and other adornments were expressions of identity and the wearing of them was an assertion by the wearer and a signal to others of those identities. Stone was ideally suited for such a role as it comes in a wide spectrum of colors and can vary greatly in size, as compared to other bead-making materials such as shells. Thus, stone beads increased in utilization during the MPPNB because they could express significantly more information than previously used materials at a time when social life in general was intensifying.

LPPNB Residential Patterns

Typically, the transition from the MPPNB to the LPPNB is documented by several lines of evidence, from differences in behaviors to differences in social organization (Banning, 2012, 1998; Bienert and Gebel, 2004; Gebel, 2004a; Kuijt and Goring-Morris, 2002; Kuijt, 2000a; Rollefson, 2006, 1998a, 1997, 1989). One of the most prominent of these is the changes in residential organization. Much of this has already been outlined in previous sections on architectural differences between the M- and L-PPNB. Here, however, it is necessary to specify the exact social structures and the effects of these structures on social organization to understand not just architectural changes, but also social processes of development through time.

Residential structures in the LPPNB grow in size, become more agglutinated, and have greater compartmentalization (Kuijt, 2000a). Many authors have suggested that this represents the emergence of extended family households (Banning and Byrd, 1989a, 1987; Banning, 2012, 2003, 1998; Gebel, 2010, 2004a; Rollefson, 1997, 2010, 2004, 2000; Wright, 2000) or at least their continued existence (Goring-Morris and Belfer-Cohen, 2013, 2008). There are three

potential reasons for the emergence of larger-scale multi-generational and/or multiple sibling households: (1) the natural outgrowth of intensified land tenure and property rights starting in the MPPNB (Bar-Yosef, 2001; Goring-Morris and Belfer-Cohen, 2008), (2) increased economic security (through unspecified means) (Gebel, 2010, 2004a; Rollefson, 1997), and (3) increased labor demands in new agro-pastoral subsistence economies (Flannery, 1972, 2002); the third of these being a likely reason for Rollefson's (2004) idea that extended family households pooled their labor during subsistence production as has been seen repeatedly throughout the world (Blumberg and Winch, 1977; Blumberg, 1978; Pasternak et al., 1976; West, 2010, 2009). A fourth potential cause of household extension based on Kuijt's (1996, 2000a, 2000b, 2001, 2004, 2008b) and Simmons' (2000) proposition of increased inter-household competition would be the competitive advantages households would accrue by expanding in size due to economies of scale.

While the size and shape of households does change in the LPPNB, many of the functions/activities taking place within residential structures in larger, denser villages, such as basement level storage and workshops, persist. Wright (2000) in a close examination of food preparation and consumption areas throughout the PPNB has shown that while individual MPPNB residential structures did have their own individual food preparation and consumption facilities, many of these features were placed in front of structures in public view. When villages grew in the LPPNB and residential structures increased greatly in size, much of this increase in interior space entailed the movement of food facilities out of public view into interior spaces. She thus argued that food preparation and consumption, both group activities which tend to create strong bonds changed from a segmented but public activity into a closed, household-based activity.

LPPNB Ritual Community Integration and Differentiation

While Kuijt (1996, 2000a, 2001b, 2004, 2008a, 2009) has not directly looked at household extension in the LPPNB, he has advocated the position that community population expansion in the period was partially driven by increasing labor demands with the development of agro-pastoral economies. He has also been one of the strongest advocates for the increase in social tensions that such expanding populations would have faced. He has argued that either in contrast to or in concert with external forces such as climate change or environmental degradation, it was internal social dynamics that led to the eventual decrease in populations at most large sites at the end of the LPPNB. It is, thus, the internal social pressures and their alleviation that he has focused much of his work on PPNB ritual and religion.

What he and others have noted is a decrease in household-based ritual, including the utilization of figurines, sub-floor burials, and secondary crania manipulation (see also, Rollefson, 2000, 2004, 2008). For example, at 'Ain Ghazal no LPPNB burials have shown evidence of cranial removal or secondary manipulation. They are found only in very small numbers under floors or anywhere on-site (Rollefson, 2004), suggesting off-site mortuary treatments. The number of figurines found in domestic contexts decreases significantly (Rollefson, 2008). The same holds true for LPPNB Basta where all burial have their crania still in place and are very few in overall number relative to the likely population size of the settlement (Nissen et al., 2004).

This decrease in household ritual occurs just as there is a notable increase in communal rituals including the appearance of several large-scale structures at 'Ain Ghazal, which seem to have served some sort of super-household aggregation function (Rollefson, 2004, 2000, 1997). Rollefson (2004) has proposed for the LPPNB component of 'Ain Ghazal that a handful of structures within the area of densest construction, built with unique techniques and in unique

forms, were likely utilized in lineage ritual practices while larger structures found beyond the borders of most construction on-site could have accommodated significant swaths of the overall village population, suggesting a more communal use.

Garfinkel (2003) has also identified a trend in ritual practices during the PPNB, whereby depictions of dancing appear in representational objects such as paintings and carvings. He argued that this appearance coincided with the emergence of likely communal dancing rituals which served to bind communities together. Twiss (2008) has documented evidence of feasting at LPPNB sites in addition to her study of MPPNB sites. She noted that the best evidence for ritual feasting comes from Basta where a pregnant cow was extensively butchered while the fetus was left intact. After cooking and consumption, the bones were re-deposited in roughly anatomical order. Additionally, the skeletons of eight ovicapids and a gazelle were included in the pit where the *Bos* skeleton was found and an adult human male burial was found less than a meter away (Becker, 2002). Twiss (2008) also catalogs a number of other more ambiguous data which may suggest large-scale storage and production of food, as well as a variety of ritual performance practices sometimes associated with feasting. Such rituals would appear to be on the level of the community as a whole.

While there is an increase in communal ritual in the LPPNB, Kuijt (2000b, 2008b) has also noted evidence of super-household, sub-community identities in mortuary treatments. Grave goods, which had been so rare in MPPNB contexts appear more frequently in LPPNB inhumations. Additionally, households with sub-floor burials begin to alter their previously highly standardized interment practices. They experiment with locations, orientations, and body positions, in addition to differential types and styles of grave goods. Kuijt (2000b, 2008b) has argued that this variability in mortuary practices was used to mark individual household identity

and served as a medium for houses to reinforce their identities as the primary and competing building blocks of villages.

What we see from the evidence of ritual practices throughout the LPPNB of the southern Levant is at least three scales of social associations. Firstly, while greatly reduced, there is still evidence of household identity in the form of rare sub-floor burials and figurine deposits. Secondly, there is evidence of possible supra-household, sub-community ritual buildings. This would suggest the existence of lineages, sodalities, kin-corporate groups, house society houses, or some other form of supra-village identity. Thirdly, there is significant evidence of community-wide ritual from architecture to feasting to dancing. As population expanded, social identities multiplied. In addition to increasing group identities, there is also evidence of individual identity assertion through mortuary practices and adornments. Thus, ideological and institutional mechanisms for the negotiation of social life were emerging, which served to hold together communities as deep interpersonal relationships could no longer do so.

Chapter 8: Economic Change in the PPNB

In order to increase our understanding of the relationship between village development and economic change in the PPNB of the southern Levant, I have reviewed the evidence for changes in village spatial organization in previous chapters. In this chapter I will look at economic practices in the PPNB.

Changing Subsistence Practices in the PPNB of the Southern Levant: Plant Economies

MPPNB Plant Economies

Perhaps the most prominent topic in the southwest Asian Neolithic is subsistence intensification through plant and animal domestication. Much of the attention on the MPPNB has been focused on the earliest appearance of domesticated plants anywhere in the world. This was first documented by Nesbitt (2002) in a comprehensive review of Neolithic botanical assemblages from the western half of the Fertile Crescent. Two subsequent reviews of various sites' archaeo-botanical assemblages by Asouti and Fuller (2012, 2013) showed that the MPPNB sites of 'Ain Ghazal (Rollefson et al., 1985) and Jericho (Hopf, 1983), two of the earliest occupations from the period, present extensive evidence for domesticated plants that played a major role in the subsistence of these villages. Domestic wheats, barley, lentils, chickpeas, and peas are all present at 'Ain Ghazal, as well as wild flax and "proto- domesticated" (i.e., larger seed size without other evidence of domestic morphologies) broad beans. MPPNB Jericho has produced domestic wheats, barley, lentils, peas, and flax, as well as wild chickpeas and proto-

domestic broad beans. Additionally, preliminary descriptions of the paleo-botanical assemblage at Ghuwayr 1 indicate the presence of a number of common domesticates, include wheats (Simmons and Najjar, 2006), which are only infrequently found in their wild form in the region at Epipaleolithic and PPNA sites (Asouti and Fuller, 2012, 2013). This suggests that the inhabitants of Ghuwayr 1 may have cultivated domestic cereals. One early site from the MPPNB, Beidha (Colledge, 2001; Feldman and Kislev, 2007; Helbaek, 1966), does not, however, present evidence of fully domesticated cereals. Rather, proto-domestic wheats and barley (i.e., a low percentage of non-shattering rachises), as well as domestic lentils and chickpeas and wild bitter vetch have been recovered from the site.

Nesbitt's (2002) and Asouti and Fuller's (2012, 2013) results are in contrast to several reports of earlier reports of possible evidence of domestic species from PPNA sites such as Jericho (Hopf, 1983) and 'Iraq ed-Dubb (Colledge, 2001). All three authors argue that such evidence from the PPNA is often too ambiguous or insufficient to qualify as definitive given such variables as site taphonomy, determining full domestication from wild using chaff versus grains, and the presence of small numbers of specimens with domestic morphologies, such as non-shattering rachises and larger seeds, in wild populations.

It must be noted that paleo-botanical results from most MPPNB sites are often derived from aggregated samples formed over long time spans rather than precisely dated features or structures. Thus, we only have general temporal resolution at most villages with entire paleo-botanical assemblages from sites, like at 'Ain Ghazal and Beidha, or entire paleo-botanical assemblages from a single cultural-historical period from a site, like at Jericho, being aggregated into one data set for analysis. As has previously been reviewed, sites such as 'Ain Ghazal and Beidha go through significant changes in population and/or social organization during their

occupation. Thus, it seems likely that subsistence systems would change through time in response to changing nutritional demands and social relations. Without archaeo-botanical assemblages being tied to precisely dated features, such changes would be masked. Thus, while there are definite trends, caution must be used in assuming that changes in subsistence followed the cultural-historical sequence of the PPNB exactly while other archaeological remains, such as architecture and village extent, do not.

Unfortunately, depositional processes such as prehistoric disposal and the ways in which macro-botanical remains are preserved and enter the archaeological record often prevent precise diachronic analyses. Such analyses are more easily done with stratigraphic lenses where the law of super-position provides temporal contexts and architectural remains where construction sequences indicate relative chronological relationship. For trash deposits, where the vast majority of botanical remains are found, relative sequences can only be constructed through arbitrary rather than natural stratigraphy. It is not always possible to differentiate individual dumping episodes given the frequently small quantities of materials dumped. Additionally, because dumping episodes occur very frequently, unlike construction, it is unlikely that stratigraphy can illustrate long-term change in economic practices, except when individual layers are combined and observed to significant depths and over extensive periods of time. However, while trash deposits can be of great depth and duration, they frequently are not, especially in smaller sites with less systematic disposal patterns (Hardy-Smith and Edwards, 2004). This makes the observation of economic change through time from any given deposit difficult. Beyond the individual trash deposit, such remains do not typically abut one another. Thus, analysts must utilize radiocarbon dates with wide error ranges and whatever architectural associations are

available to place macro-botanical deposits in time. This leads to the problematic strategy in which assemblages covering long time spans up to entire site duration are analyzed as a whole.

‘Ain Ghazal and Beidha illustrate this issue better than any other sites. The reporting of ‘Ain Ghazal’s paleo-botanical assemblage for the site as a whole (Rollefson et al., 1985), when it was occupied for several thousands of years, is problematic. It is all the more so because site occupation spans the entire period when the domestication process is occurring. However, it is noteworthy that essentially all major plant foods at the site are domestic in status, suggesting that they were present from the beginning of the occupation. What is most masked by this process is shifting compositions of the assemblages across space, through time, and between social units. ‘Ain Ghazal, for example, probably experienced shifts in plant production and utilization over time and produced strong evidence for the development of animal herding in the southern Levant (Wasse, 2002). The presence of animal dung and its potential use as a fuel complicates the picture, adding a whole new dimension to understanding plant remains.

Conversely, at Beidha, a clear MPPNB site with early dates, it is noteworthy in that the assemblage only included proto-domestic forms of both wheat and barley (Colledge, 2001; Feldman and Kislev, 2007; Helbaek, 1966). This creates the possibility that if domestic cereals were appearing at Beidha through time then the combining of early wild remains with later domestic ones could have masked the very process that people are so interested in researching. If the site were analyzed by depositional sequence then it might be possible to see changes in the wild versus domestic status of botanical remains through time. This is especially important at Beidha where the assemblage includes both barley, common throughout the southern Levant, and wheats, quite uncommon in the region until it seems to be introduced fully domesticated in the LPPNB from the north. Thus, finding both cereals at a long-lived MPPNB site, even if neither

presents evidence of full domestication, is quite significant, but also potentially hints at changes in crop utilization through time which is being masked by analytic procedures.

Such a possibility is highlighted by the more recently excavated PPNA and LPPNB site of el-Hemmeh, where PPNA levels have evidence of pre-domestication cultivation of barley. There is a higher percentage of non-shattering rachis than is typically found in the wild, a higher percentage of larger grains than is typically found in the wild, and a weed assemblage typical of cereal farming, but also evidence of early harvesting which is typically done with the wild brittle rachis morphology in order to recover the grains before the shatter from the stalk. Additionally, while domestic morphologies are more common in the barley assemblage than is typical in the wild, they are not nearly as common as is found in later fully domestic assemblages, with only roughly an even split between the two morphologies. By the LPPNB fully domestic wheats are present at the site, while there is continued use of proto-domestic barley, although a higher percentage of domestic morphologies are present in the later period, suggesting quite a long duration for the local domestication of cereals (White, 2013) that seems to be following the unconscious model of domestication (Hillman and Davies, 1990a, 1990b). If such a phenomenon is true for not only el-Hemmeh, but for the rest of west-central and southern Jordan, then the interpretation of Beidha's botanical assemblage could be improved by a more contextual and diachronic approach (which may be difficult given the recovery methods used at the site during the 1960's excavations when paleo-botany was in its infancy).

That being said, there are some important trends within Asouti and Fuller's (2012, 2013) results. By the MPPNB almost all cereals and pulses that could have been domesticated were. These MPPNB data seemingly show an abrupt change as compared to the preceding PPNA where sites occupied as late as ZAD 2, the latest PPNA occupation in the southern Levant, utilize

only wild species. While such an observation may be problematic due to the biases in the methods used, because every MPPNB site analyzed thus far has returned domestic cereal and pulse species and every PPNA site wild, the most parsimonious explanation is a relatively abrupt (in terms of early prehistoric time) onset of domestic forms in the MPPNB. Unfortunately we simply do not know exactly when domestication of various species and the appearance of the domestic complex of the southern Levant occurred in this period.

Of course, as recently reviewed by White and Makarewicz (2011), Zeder (2011), and Willcox (2012a, 2012b, 2013) there is significant evidence for the cultivation of a number of wild species across the southern Levant during the PPNA, including at ZAD 2 (Meadows, 2004), Gilgal (Kislev et al., 2010, 2006; Weiss et al., 2006), Netiv Hagdud (Kislev, 1997), Dhra' (Kuijt and Finlayson, 2009), and el-Hemmeh (White and Makarewicz, 2012), for such species as barley (White and Makarewicz, 2012), lentils (Weiss et al., 2006), and figs (Kislev et al., 2006). However, there is no morphological evidence of domestication. Thus, as Zeder (2011) highlighted, morphology cannot be viewed as a leading-edge or only indicator of crop management.

Additionally in the MPPNB, as the architectural evidence reviewed above shows, plant food storage intensified greatly (Kuijt, 2008a). Flannery (1972) was the first to extensively discuss the clear change in the location of storage from communal open space to the interior of individual households. This was his primary evidence for the emergence of the domestic mode of production in the MPPNB. Kuijt (2008) has shown that despite the large-scale storage facilities found at PPNA Dhra' and WF16, the total storage capacity at those sites the total storage capacity at MPPNB village sites such as Beidha and Ghuwayr 1 far outstrips that available at the earlier Transjordan villages. Kuijt (2008) has argued that increases in storage capacity seen in the

MPPNB had the effect of accelerating population growth during the period of the Agricultural Demographic Transition (Bocquet-Appel, 2011a, 2011b). Through a combination of these observations we can see that MPPNB plant economies are increasing in productivity per capita and increasing in prominence in the diets of villagers. Plant products are also privatizing in this period, making the possibility of a link between the two, through the sorts of social processes reviewed in previous chapters such as inter-household competition and risk reduction, likely.

All of this being said, wild species do contribute significantly to the plant food economies of the MPPNB. At the early MPPNB site of Beidha, where proto-domestic forms of cereals and domestic pulses are found, there are also significant numbers of fruits and nuts such as figs, pistachios (the most common species identified), and acorns, as well as a surprising amount of small-grained grasses and small legumes (Colledge, 2001; Feldman and Kislev, 2007; Helbaek, 1966). Thus, we see that the overall plant assemblage of Beidha was not reliant on fully domestic cereals yet but was a clear mix of pre-domestication cultivation and other forms of wild plant management, as well as domestic production and wild gathered plants. In sharp contrast to Beidha, 'Ain Ghazal, which was occupied from the earliest dates of the MPPNB through the Pottery Neolithic, yielded a low percentage of the overall assemblage of pistachios as the only evidence of wild gathered plants (Rollefson et al., 1985). However, it must be kept in mind that these results are for the entire occupational span of the site from the MPPNB through the Pottery Neolithic during which time domestic crops increase in prominence, thus potentially masking the potential importance of pistachios in the earliest phases of occupation. That being said, there is strong evidence of a heavy reliance on domesticated species from the initial settlement at the site.

LPPNB Plant Economies

Another trend in the plant assemblages from the PPNB of the southern Levant illustrated by the results in Asouti and Fuller (2012, 2013) was a greater focus on cereal crops through time. While every village site from the MPPNB of the southern Levant with evidence of domestic plants, such as Jericho, 'Ain Ghazal, and Beidha, do have some percentage of their plant assemblages comprised of cereal species, legumes predominate. In the subsequent LPPNB, the reverse is true with a series of different wheats becoming prominent at Basta (Neef, 2004) and Tell Tif'dan (Colledge, 2001). The same is true for the recently analyzed site of el-Hemmeh (White, 2013), where its PPNA assemblage already shows evidence of pre-domestication cultivation of barley. As already noted, the assemblage from the LPPNB at the site includes both domestic wheat and mixed wild and domestic barley, suggesting a slow progression for the local domestication of barley.

This also suggests that wheat was introduced, after having been domesticated in the north. The indications of this are two-fold. Firstly, because wheat was not harvested during the PPNA, it is likely that it was not available locally. Its larger grains and higher protein content than barley would likely have made it a more desirable food. Both wheat and barley have identical harvesting and processing methods, making them equally easy to exploit. In areas with sufficient resources for both cereals to grow wild, they are found wild in the same fields, making the selective use of one over the other more work than it was worth, as would have been the case if only barley is found in PPNA assemblages because of producer choice rather than availability. Today throughout much of west-central Jordan there is insufficient rainfall to dry-farm wheat and this is likely the reason why it was not available in the PPNA either (Zohary and Hopf, 2000). The second line of evidence is that wheat in the Hemmeh assemblage appears to be fully domesticated, while barley remains a mix of wild and domestic, suggesting that while cultivation

and the process of domestication were underway, it had not had sufficient time to occur for barley (Allaby et al., 2008; Fuller, 2007; Hillman and Davies, 1990a, 1990b; Purugganan and Fuller, 2010).

Domestic crops continue to dominate in the LPPNB and the suite of crops utilized remains roughly similar, except for the introduction of wheat from the north. Rather, it is the intensity of production for specific crops that changes. There is an emphasis on energy-rich, high-productivity cereal crops rather than the protein-rich and nutrient-rich, low-productivity pulses. We see a switch from quality to quantity, in terms of calories and yield per unit of area. This is a classic example of the trade-offs made during the intensification of agriculture. Such a change through time in the macro-botanical assemblages of the southern Levant draws attention to the issues with 'Ain Ghazal; it is one of the few sites in the region with strong evidence for significant utilization of both cereals and pulses (Asouti and Fuller, 2012, 2013). These results suggest that the assemblage is a product of mixing and lumping together what may have been changing and different plant food assemblages/percentages through time.

Trends in wild gathered plants during the LPPNB match up fairly well with expectations for increasing domestication through time. At LPPNB Basta (Neef, 2004), there are small numbers of a wide variety of wild fruits and nuts, including pistachios, almonds, acorns, and figs. There is also a small amount of wild small legumes which have been identified. This pattern is interesting on at least two fronts. Firstly, the presence of such a variety of fruit and nut species indicates a dramatic difference in plant communities around the site than those found today. It seems likely that there were significant woodlands in the region which are no longer found. Additionally, some of these tree species have significantly higher water requirements than available today, suggesting a different weather regime as well. Secondly, this focus on high

calorie, large size, and large package (i.e., each tree yields large numbers of edible fruits and nuts) wild plant foods indicates an even greater emphasis on plant production over foraging for the acquisition of calories as only truly high-quality wild plant resources are being exploited. The LPPNB site of Tell Tif'dan has also produced a wild plant assemblage significantly different from Basta (Colledge, 2001). It contains a number of small legume species, as well as small-grained grasses and wild oats. There is no evidence of fruit or nut exploitation, which could be a by-product of taphonomy or biased sampling, but also potentially local phytogeography. Interestingly, the large site of Basta has strong evidence of a predominantly domesticated plant economy with the addition of high-return wild plants that are gathered, while Tel Tif'dan, a small- to-medium-size site has produced evidence of a more mixed economy largely focused on grass and shrub annuals. Basta is located in the highlands of southern Jordan while Tel Tif'dan is located in a *wadi* in southern Jordan. Thus, it seems likely that the water regimes of the two regions may have been major determinants in the plant utilization/economies of the two sites, as well as the scale of the settlement.

Another trend in the LPPNB, similar to the MPPNB, is that of increased storage capacity, as illustrated by Kuijt (2008). Such provide contextual information that helps us understand the scale and intensity of economic rights, as well as systems of distribution and consumption. While both MPPNB Beidha and Ghuwayr 1 show evidence of ground floor or basement storage within structures that were probably houses, nearly all LPPNB village sites show such architecture. Additionally, the capacity of these structures, the elaborateness of their design, and the compartmentalization of space all illustrate an increase in storage capacity and increased specialization of storage methods. As in the preceding MPPNB, storage is located within

structures suggesting it was private. Changes in storage capacity, intensity, and specialization all suggest a major role for delayed returns (Woodburn, 1982) in LPPNB subsistence economies.

For the LPPNB we have far fewer paleo-botanical reports than for the MPPNB, with reports from on-going excavations at Tell Tif'dan (Colledge, 2001) and el-Hemmeh (White, 2013), a final report from Basta (Neef, 2004), and a preliminary report from the first season of excavation at 'Ain Ghazal. The 'Ain Ghazal data came before the stratigraphy of the site was worked out, leading to the mixing of materials from all levels of the site (Rollefson et al., 1985). Additionally, because of annual growth patterns of most plant foods utilized in the PPNB, it is difficult to determine long-term strategies based on macro-botanical remains. Fruit and nut remains are of minimal help because those remains are typically the annual yield or harvest of fruit from perennial trees, rather than the trees themselves. Most plant remains are recovered far from the location of their husbandry, restricting the visibility of production strategies. Thus, the most prominent aspect that can be described in regards to plant husbandry practices is the composition of the assemblages. With only three such high-quality assemblages published thus far, our understanding of the development of plant use and planting through time has a long way to go.

There are other methods for analyzing cultivation practices, but none of these have been fully implemented in the southern Levant for the early Neolithic. Thus, we do have data from other periods and regions in southwest Asia where geoarchaeological methods have been used to reconstruct available farmland in the past (Roberts and Rosen, 2009) or phytolith analysis to understand water availability (Rosen and Weiner, 1994). Stable isotopes have also been used to analyze water availability (Ferrio et al., 2005), crop yields (Araus et al., 2001), and use of manure (Fraser et al., 2011), while weed assemblages have been used to investigate different

aspects of agriculture, including cropping intensities, companion planting methods, crop processing, planting times, rainfall levels, and potential water management strategies (Jones et al., 2010). The first preliminary results from anywhere in the southern Levantine PPNB for stable isotope analysis at 'Ain Ghazal have been presented, but the sample size is so small, the result too ambiguous, and the presence of adequate context too lacking to have yielded significant results so far. However, the author does plan to do further research on the site's macro-botanical assemblage to fill in these gaps (Bogaard, 2013).

A number of the above-listed methods have been used in the southern Levant on PPNB assemblages, but results have not been precise enough to do further explorations beyond basic assemblage composition interpretations, such as the analysis of weedy taxa at el-Hemmeh by White (2013) to show that cultivation was occurring in the PPNA, as well as the LPPNB or the analysis of phytoliths from MPPNB Ghuwayr 1 by Jenkins et al. (2011) which identified species composition for the assemblage rather than cultivation techniques. Recently Contreras and Makarewicz (2013) presented evidence of what the early Holocene (i.e., the geological period in which the PPNB existed) alluvial landscape of the Wadi al-Hesa would have been like for the inhabitants of LPPNB el-Hemmeh using geoarchaeological techniques. Again, it was not possible to identify the actual location of farming practices. However it was possible to show that there were significant opportunities for such practices adjacent to the site. Such an analysis not only sheds light on ecological opportunities for early farmers, but begins to provide tangible evidence for what have been highly hypothetical, but thoroughly researched, ideas about farming techniques at the site, based on macro-botanical analyses and extensive ethnoarchaeological and ethnographic analogy by White and Wolff (2012).

However, one method (beyond macro-botanical analyses) which has been used to understand agriculture in the M-LPPNB in the southern Levant is that of geological landscape analysis. Campbell (2009, 2010) analyzed detailed geological survey maps for the catchments of MPPNB Jericho, M- and L-PPNB 'Ain Ghazal, and LPPNB Basta to determine the availability of soils appropriate for sustainable farming using manual labor with smallholder techniques. She was able to show that all the sites had sufficient farmland to produce adequate nutrition for the highest population estimates for each village if they used sustainable intensive production methods. While this analysis was not able to determine the actual location of farming in the past, nor was it able to identify the geological catchment of these sites in the PPNB, it was able to begin to understand where farming could have occurred and the ways in which these locations would have constrained and structured agricultural production in the early Neolithic.

Changing Subsistence Practices in the PPNB of the Southern Levant: Animal Economies

MPPNB Animal Economies

A similar pattern of greater human control over their food supply during the M-LPPNB is also visible in the faunal assemblages of village sites. A number of authors have noted that in the MPPNB village faunal assemblages show goats as the primary prey species throughout much of the southern Levant (Horwitz, 2003a; Horwitz et al., 1999; Makarewicz, 2007; Tchernov, 1993). This includes the sites of Beidha (Hecker, 1982), 'Ain Ghazal (Wasse, 2002), and Jericho (Clutton-Brock, 1979), as well as Abu Ghosh (Bar-Gal et al., 2003; Ducos and Horwitz, 2003; Horwitz, 2003b), and Ghuwayr 1 (Simmons and Najjar, 2006). This is a distinct change from the PPNA where gazelles predominate in most faunal assemblages of the southern Levant. Even during the PPNA, caprids are the primary prey species in drier and more rugged terrain such as at

the PPNA village settlement of WF16 in southern Jordan (Carruthers and Dennis, 2007), presumably because they are far more common than gazelles in the area.

Turning back to the MPPNB sites where goats predominate, no such pattern is evident at villages in arid regions such as Ghuwayr 1 and in rugged terrain such as Beidha, as well as those in cooler, wetter Mediterranean climates such as Jericho all exploiting goats as their primary mammal.

However, gazelles remain prominent at small sites, a number of which are seen as seasonal or other forms of temporary settlements such as Nahal Oren (Noy et al., 1973) and Kfar HaHoresh (Goring-Morris et al., 1995, 1994), as well as at the small village sites in the southern Levant Coastal Plain such as Yiftahel (Alhaique and Horwitz, 2012; Horwitz, 2003a). At some of these sites, such as Nahal Oren, gazelles are the vast majority; at other sites, such as Munhatta (Ducos, 1968), gazelles are found in roughly even proportions to goats. However, interestingly, even at Nahal Oren, which has Epipaleolithic and PPNA components, goats appear in far greater numbers in the MPPNB than they do in earlier periods.

An explanation for this pattern has been emerging with more and more sites from the MPPNB showing signs of herd management (Horwitz, 2003a; Makarewicz 2007). This would suggest that goats come to dominate faunal assemblages as animal husbandry emerges, especially in larger, more permanent village settlements. This is not surprising given the fact that gazelles are not predisposed to domestication based on their behavior (Martin, 2000), while goats are ideally suited for human control (Jensen, 2002; Redding, 1981). For example, at Jericho, while most of the caprine bones recovered were large in size, suggesting wild hunting, two twisted horn-cores – a domestic morphology – were recovered from PPNB layers. It is possible that these two horn-cores (out of a total of 26 from the PPNB layers of Jericho) are intrusive

from later levels. However, when their presence is combined with the fact that there is a dramatic increase in goat bones at Jericho from the PPNA to the PPNB (Clutton-Brock, 1979), it could suggest that new animal exploitation strategies involving caprine herd management were appearing by the MPPNB at the site.

The site of Yiftahel has two primary components from which the fauna has been analyzed: the MPPNB and PPNC. While goats do not dominate, they, along with gazelles (the most numerous type of specimen) and cattle, do contribute significantly to the overall assemblage. The MPPNB assemblage showed an interesting difference between slaughtered goats versus gazelles. There was a slight bias towards females in the goat assemblage and a slightly earlier one for goats as compared to gazelles, both patterns commonly associated with herd management. Over-representation of females is typically an indicator of slaughter of younger males and later slaughter of females as juvenile specimens are typically not ascertainable by gender. A young slaughter pattern is typically seen as an indicator of the same practices because a single male can reproduce with multiple females during the same breeding season. Thus, in order to produce meat from a herd while maintaining herd stability through reproduction, most young males are slaughtered to be eaten, with only a handful kept for extended reproduction, while most females are kept until they reach an older age for extended reproduction (Redding, 1981; Zeder and Hesse, 2000).

The differences in goat versus gazelle slaughter curves are important indicators of herd management because goats and gazelles reach full size around the same time (3.5 years). Gazelle slaughter practices serve as a sort of control group against which to compare goat age profiles, as gazelles cannot be domesticated. Thus, culling patterns for gazelles would reflect a hunting strategy. Of course, there are a number of differences in the behavioral ecology of mountain

gazelles (*Gazella gazelle*), dorcas gazelle (*Gazella dorcus*), goytered gazelle (*Gazella subgutturosa*) (Martin, 2000), Nubian ibex (*Capra nubiana*), and wild bezoar goat (*Capra aegagrus*) (Harrison and Bates, 1991; Jensen, 2002; Redding, 1981), as well as the hunting techniques most effective for their capture that can complicate the comparison. Based on this pattern, while she was unable to specify how exactly humans and goats interacted, Horwitz (2003a) argued that the population of Yiftahel was entering into a new relationship with goat herds, which could be thought of as incipient husbandry.

Similar patterns of age distribution and size distribution within morphologically wild gazelle and goat assemblages have been observed from the MPPNB components of 'Ain Ghazal (Kohler-Rollefson et al., 1988; Wasse, 2002) and Abu Ghosh (Bar-Gal et al., 2003; Ducos and Horwitz, 2003; Horwitz, 2003b), suggesting similar human-animal interactions at these sites (Horwitz, 2003a). However, each of these sites does exhibit significant differences both from Yiftahel and each other. At 'Ain Ghazal there is very little question about the culling strategies; they were for meat production and herd stability. Throughout the occupation of the site from the MPPNB through the Yarmoukian (PN), there is a notable pattern of early culling of individuals in the ovicaprid populations, whereby only 15.1% or less of this species live past the age of 3. Additionally, there is a strong bias in the sex ratio based on horn cores of the slaughtered animals with young males and adult females comprising the entirety of the 50 specimen assemblage. This suggests that at 'Ain Ghazal from the MPPNB onwards ovicaprid herds were being managed to produce maximum meat returns while maintaining herd stability (Wasse, 2002).

Perhaps no site from the PPNB of the southern Levant has received more thorough analyses than Abu Ghosh in the Judean Hills. The site has seen three major research teams starting in the 1950's (Khalaily and Marder, 2003a; Lechevallier, 1978; Perrot, 1952). In the

most recent publication, the entire faunal collection from both the Lechevallier and Khalaily and Marder excavations were analyzed and reanalyzed both by Horwitz (2003b) and Ducos and Horwitz (2003). A single radiocarbon date places the site in the earlier half of the MPPNB (ca. 8070±190 cal. BCE), a period which would match well with all three layers of PPNB knapped stone remains.

Wild goats are the most common species in the assemblage, comprising more than 40% of the total number of identified specimens (NISP). Ovicaprid bones not identified to species, cattle, and gazelle also contribute significantly to the overall assemblage ranging in percentage from 11-16. All but eight ovicaprid bones are large and robust. There was no apparent bias towards one sex in the ovicaprid remains, with a preponderance of large bones in the ibex to adult domestic male goat range. Caprids showed a slightly earlier kill-off pattern as compared to gazelles. However, both *Bos* and *Sus* show significantly earlier kill-off patterns. Of course, this is potentially a by-product of different paces of ontogeny between species or of the difficulties of killing an adult animal from these more aggressive species. All major mammals show a bias towards meat-bearing elements, the one exception being a higher number of *Bos* crania than expected.

Thus, the assemblage from Abu Ghosh is somewhat ambiguous. It seems as if goats were being interacted with differently than the closest parallel in the faunal assemblage: gazelles. Thus, it is possible that some form of incipient management was occurring. However, the evidence for the structure of such a system remains obscure. Of course, it is also possible that no such management exists and the differences between goat and gazelle procurement patterns at the site and between the overall MPPNB assemblage of Abu Ghosh and earlier PPNA sites may simply be a product of differences in hunting strategies. The ratio of meat-bearing to non-meat-

bearing bones suggests that all species were being slaughtered off-site and transported back to the village; this is a typical hunting practice (Binford, 1978; Redding, 2005). The one exception, cattle crania, is not surprising given that such bones are known to be of great significance throughout southwest Asia during the Neolithic (Cauvin, 2000; Hodder, 1990; McCorrison et al., 2012). They were likely transported back to the site for symbolic, ritual, and ideological reasons.

To shed light on the domestic status of ovicaprids at the site, a question for which there is ambiguous evidence, several ovicaprid bones from Abu Ghosh had their DNA analyzed to determine their species (Bar-Gal et al., 2003, 2002). Of the six MPPNB samples, three were determined to be either wild bezoar goat or domestic goat, two were (necessarily wild) ibex, and one was tentatively identified as domestic. However, the domestic identification was based on a single region of DNA, which is not typically viewed as species specific. Thus, such an identification could be in error.

The ibex samples were unexpected because today Abu Ghosh is located well outside the territory in which ibex are found (Harrison and Bates, 1991). While there has been climate change since the PPNB (Maher et al., 2011; Robinson et al., 2011; Weninger et al., 2009), most current models would suggest that the environmental conditions in the PPNB were wetter. All other things being equal, this should produce a situation where the local ecology should be more hospitable to bezoar goats than ibex (Al-Eisawi, 1996). A lush biome would provide sufficient resources for ibex as well. It would be expected that bezoar goats would out compete the larger ibex in greener environments. However, if environmental pressures (including human hunting or population pressure/environmental competition and degradation) were low enough it would not be impossible for both species to inhabit the same area.

The second surprise from the DNA testing at Abu Ghosh is the single potential domestic goat sample. As has been stated, it is possible that this identification is in error. The researcher suggested that an alternative hypothesis would be that the sample derives from an early managed gene pool. If such an identification could be confirmed at a number of MPPNB sites, it would be a solid indication that some form of herd management, for which faunal assemblages have provided some hints already, was in place.

The southern Transjordanian Highland site of Beidha had a slightly different pattern, with morphologically wild goats comprising approximately 90% of the overall assemblage based on both horn-core morphology and the large size of the goats. Hecker (1982) suggested that while the goat herds of Beidha may have been morphologically wild, a shift in slaughter patterns is observable through time. Just as the site grew to its maximal size and density there was a notable dip in the average age of slaughter for goats, suggesting selective culling to preserve the reproductive ability of the flock. Unfortunately, there are no data presented on sex ratios of goats, not allowing for a more robust analysis of herd management practices and goals such as meat procurement, reproductive stability, or dairy production.

A recent innovation in studying potential herd management in the PPNB of the southern Levant has been the use of stable isotopes from faunal samples to determine variation in the food consumed by prey animals. To date, every PPNB sample for which we have stable isotope results has been analyzed by Makarewicz (2007) and Makarewicz and Tuross (2009, 2012). These authors have found significant evidence of at least two forms of herd management during the PPNB: (1) foddering and (2) seasonal mobility. At MPPNB Abu Ghosh, Makarewicz and Tuross (2012) found evidence for the foddering of goats with C₄ graze (stubble left from cereal cultivation?) based on carbon isotopic variation between goat and gazelle samples. However,

when Makarewicz (2007) analyzed samples from MPPNB Kfar HaHoresh, she found no evidence of change in goat diet attributable to human management. These results are largely in line with expectations based on species composition from both sites' assemblages, with Abu Ghosh having strong evidence of caprine utilization while Kfar HaHoresh was still focused on gazelle as well as caprine consumption.

LPPNB Animal Economies

By the LPPNB in the southern Levant, there is even more evidence of significant human management of herd mammals at a number of sites. No site from this period has been more thoroughly analyzed and debated than that of LPPNB Basta in the southern Transjordan Highlands (Becker, 2004, 2002, 1998, 1991; Makarewicz and Tuross, 2012, 2009; Makarewicz, 2007). The assemblage is dominated by ovicaprids (82.3% NISP, 64.0% of total bone weight; Becker, 2004). Other common remains include gazelle, cattle, and equids (Becker, 1991; 2004). It is assumed that gazelle and equid remains derive from wild individuals while the majority of ovicaprids come from domestic flocks. Along with 'Ain Ghazal, Basta is one of the earliest sites in the southern Levant to have produced significant evidence of domestic sheep (Becker 1991). While most believe that sheep were introduced into the region from the north during the LPPNB, Becker (1991; 1998; 2004) has proposed local domestication of wild sheep based on minute morphological indicators and size variation in wild identified ovicaprids, with larger wild specimens sometimes being identified as wild sheep. However, others have argued that it is more likely that these larger specimens are ibex, a similar sized species that shares many of the morphological characteristics used to differentiate sheep from goats. The assertion that such faunal elements are more likely ibex than sheep is based on a lack of wild sheep horn cores and a single ibex horn core within Basta's assemblage (Makarewicz and Tuross, 2012, 2009), as well

as a complete lack of evidence for wild sheep at other southern Levantine sites and the location of the site far outside the historically documented extent of such animals, but well within the contemporary range of ibex.

Becker (2002) has argued that there are potentially both wild and domestic cattle on-site with larger bones deriving from hunted male individuals and smaller bones deriving from hunted female and domestic individuals. This is based on contrasting butchery patterns for these two size categories with large animals showing an emphasis on meat-bearing bones and ideologically important elements such as crania and horn cores, whereas smaller individuals show a ratio of meat-bearing to non-meat-bearing typical of on-site slaughter. She suggested that smaller cattle were carried back whole for consumption while larger cattle were butchered in the field with meat and ideologically important sections of the carcass brought back to the village. Another explanation would be the slaughter of smaller domestic cattle on-site and the hunting of larger wild cattle for meat and culturally important elements off-site. If domestic cattle existed at Basta, most analysts agree that the species was domesticated in the north and diffused south (Marom and Bar-Oz, 2013).

Ovicaprids show interesting procurement patterns as well, with a bias towards early slaughter and an overrepresentation of females. Additionally, those specimens identified as male were even more dramatically indicative of a young slaughter age. All this has been seen as indicating a fairly standard herd-stability/meat production strategy of procurement (Becker, 1998; 2004). So much so in fact that this pattern has been taken as an indication of fully domestic herds (Becker, 2004, 1991). A second indicator taken as evidence of essentially fully domesticated herd management is the presence of domestic sheep (Makarewicz and Tuross,

2009a); most view this as an import into the region after having been domesticated elsewhere (Horwitz et al., 1999; Zeder, 2008).

Makarewicz and Tuross (2009a; 2012) have also analyzed ovicaprid bones for stable isotope signatures of various herd management strategies at Basta. They found variation between goat and gazelle in carbon, oxygen, and nitrogen isotopic composition, which they suggest derives from a combination of winter foddering and horizontal transhumance. The authors argue that during the winter, when grazing grasses are not as available anywhere in the region, herds were likely foddered to some degree, perhaps on the hay left from cereal cultivation. In the summer, when grasses for grazing are more available throughout the region but near-in lands were likely used for cultivation, the herds were moved outside of the immediate surroundings of the village in order to protect crops and into areas with different hydrological regimes, thus producing the different isotopic signature from locally hunted gazelles. Thus, we see that not only is there a stronger signature of meat production at Basta than found at MPPNB sites throughout the southern Levant, there is also a stronger signature of increasingly intensive and complex husbandry strategies. This intensification and technical change is likely related to the growth of village settlements, as well as the location of Basta in a more arid environment than most MPPNB villages.

At the smaller and later LPPNB settlement of Ba'ja, ovicaprids comprised an even greater proportion of the faunal assemblage, ranging in NISP and weight percentages in two excavation areas between 72.2% and 79.7% (von den Driesch et al., 2004). All other species appear to have been hunted on an encounter basis with a wide variety of remains found on-site. Interestingly, survivorship curves attest to a later average age of slaughter, although almost all sheep and goats were killed by four years of age. While few bones diagnostic of sex (11 sheep,

28 goats, and 35 sheep/goats; 74 total) were recovered, there is a slightly skewed ratio of more females than males (46 female: 28 male). However, this ratio is not nearly as pronounced as at most sites with strong evidence of a meat procurement strategy. This has opened up the possibility that secondary products such as dairy or wool may have also been derived from the herds (Makarewicz, 2007; von den Driesch et al., 2004).

Additionally, Makarewicz (2007) analyzed stable isotopes from gazelle at Basta and goat bones at Ba'ja (two sites separated by less than 20km) and found little variation in isotope ratios between the two assemblages. Such a procedure was necessary given that the sample of gazelle from Ba'ja was not large enough to compare to the site's goat remains. The similarity in isotopic ratios between gazelles from Basta and goats from Ba'ja suggests that the diet of the Ba'ja goats was derived from local wild plants. This is perhaps not surprising for at least two reasons. Firstly, as is apparent from the morphological analyses of the faunal assemblage at Ba'ja, there is less evidence of significant human manipulation of herd composition and, therefore, herd behavior. This is not to say that the goats of Ba'ja were not husbanded. Rather, if they were, which seems likely given the composition of the faunal assemblage at the site, they were only husbanded in such a manner as to provide ease of access to the animals for whatever productive activities the inhabitants of Ba'ja were enacting.

This leads to the second reason why a lack of evidence for significant manipulation of goat diets is not necessarily surprising. Ba'ja is a small settlement which would not require the same size of herds for subsistence. Because of the compact nature of LPPNB settlements, Ba'ja and larger LPPNB mega-sites would have had access to similar size territories, making the grazing and browsing pressures of a goat herd from a smaller population significantly lower than a larger one. Thus, management would not necessarily have had to have been as intensive.

Makarewicz (2007) also argued that the geographical setting of Ba'ja may have been a contributing factor with the site located in an area with insufficient food for goats. Thus, herds were likely kept at some distance from the site, making foddering a much more costly practice based on travel and transport costs.

Makarewicz (2009) has also conducted a more traditional morphological and morphometrical analysis of a faunal assemblage derived from excavations at the LPPNB mega-site of 'Ain Jammam, located similarly to Basta and Ba'ja in the southern Transjordan Highlands. Using morphological, demographic, and species composition data she compared the composition of the sheep, goat, gazelle, and cattle assemblages from the site. Like the Basta case, bovid remains are found in two different sizes with meat-bearing bones and crania predominating in the larger-sized animals and a more well distributed assemblage of elements found for the smaller-sized individuals. This suggests that wild cattle may have been hunted and domestic cattle may have been herded/controlled and, thus, slaughtered on-site. Gazelles do occur in significant numbers at the site and Makarewicz (2009) suggests that they may have been slaughtered seasonally based on the killing of animals under ten months of age. This would indicate hunting during the summer and fall seasons; that would help herders conserve caprine resources during the driest months for the herds. Hunting would provide wild meat to serve as a substitute for domesticated meat.

However, the most interesting analysis presented by Makarewicz (2009) is her comparison of sheep and goat demographic profiles. She suggested that these two species would be kept in mixed flocks, as they often are today in the southern Levant. However, each of the species was treated differently, based on their uses for the community. Such flocks expand the availability of food per human inhabitant as the two species follow different consumption

strategies, allowing for complementary rather than competitive consumption in mixed floral resource zones. Goats are both potential grazers and preferential browsers while sheep are obligate grazers.

Goats produce more milk than sheep and do better in arid climates. Sheep produce more wool and more tender meat. Additionally, different ages of sheep and goats can be exploited for different purposes, with younger sheep producing more tender meat. Younger goats also provide more tender meat than older goats. However, goats rapidly gain size/weight and can frequently be exploited for their high meat availability at a relatively young age. Sheep were evidently introduced into the southern Levant during the LPPNB.

When considering all these factors Makarewicz (2009) devised a number of hypotheses for the exploitation strategies being followed at 'Ain Jammam. Firstly, goats occur in higher numbers than sheep. Something similar is seen at most LPPNB sites, including Basta (Becker, 2004) and 'Ain Ghazal (Wasse, 2002). Such a pattern may suggest greater herd stability and resilience in the arid fringes of the southern Levant.

Makarewicz (2009) also noted that there is a higher survivorship rate for goats at 'Ain Jammam into their third year than at most other LPPNB sites. She suggested that this may be an indication of low-level dairy exploitation of caprines. There is also an especially low rate of earlier culling, which may be a product of recovery methods during excavation. Female goats tend to live longer, but around four years of age slaughter rates increase significantly for them. This is seen as a balance between milk and meat production as such an age is typically when female goats begin to see declines in milk production. Both male and female sheep survive to three years of age in significant numbers. Thus, male sheep survive to this age in significantly higher numbers than goats. Makarewicz (2009) suggests that this may be a product either of the

high value of sheep as a newly introduced species to the area or a lack of familiarity amongst herders at 'Ain Jammam with sheep, thus spurring them to follow as conservative a strategy as possible with their flocks.

In sum, Makarewicz (2009) sees the animal economy of 'Ain Jammam as a flexible and specialized one with multiple strategies for different species and even, frequently, for any single species. Ovicaprid herds were the primary source of animal products with meat production being the main goal. Gazelles were used to supplement meat supplies from ovicaprid herds during periods of higher stress on flocks. Caprids may also have been used for dairy products. Both wild and domestic cattle were probably exploited both for meat and social/cultural reasons. It must be kept in mind, however, that these patterns were not always strongly indicated by the data and will require more data and modeling to be confirmed. Thus, we do have a working model for animal management at LPPNB mega-sites.

The biggest difficulty in assessing the validity/accuracy of these hypotheses is the lack of contextual data from 'Ain Jammam. All materials were derived from a poorly documented and largely unpublished rescue excavation in the 1990's (Waheed and Fino, 1997). Thus, apart from the faunal analysis (Makarewicz, 2009), we have some plan views of the architecture from a small section of the site (Fino, 2004), a preliminary description of the knapped and ground stone assemblages used to place the site in the chronology of the PPNB (Rollefson, 2005), an areal estimate of the site based on surface collections (Waheed and Fino, 1997), and two radiocarbon dates with minimal stratigraphic control other than coming from the base and center of a sequence exposed by an illegal bulldozer cut (Rollefson, 2005). The former (and earlier) of these dates places the start of the occupation at ca. 7601±253 cal. BCE (1σ), while the latter places the middle of the occupation at ca. 6949±169 cal. BCE (1σ).

Based on these dates the occupation at 'Ain Jammam could have started earlier than or at the same time as Basta, but the former site seems to have lasted longer. It also likely started earlier than Ba'ja, but cannot be shown to have lasted beyond this site's occupation. However, the latest date from Ba'ja is from the highest deposits, while the latest date from 'Ain Jammam is from the middle of the deposits. Thus, it seems likely that the 'Ain Jammam occupation did continue later than Ba'ja. However, caution must be taken with this interpretation as Rollefson (2005) has argued that there are both significant Pottery Neolithic and Roman-Byzantine deposits at the site, making it possible that higher deposits date to these periods.

All of this stratigraphic information is of great importance when trying to understand the fauna of 'Ain Jammam, as Makarewicz (2009) has presented tantalizing evidence of possibly complex herd management strategies in the LPPNB; more complex than previously appreciated. Thus, in order to assess the likelihood of such claims and their place in PPNB economic developmental trajectories, they must be understood within the broader regional chronology. This is all the more true for a site such as 'Ain Jammam where we have so few contextual data to understand social practices. It is virtually impossible to marshal multiple lines of evidence for such claims.

Thus, regional and chronological context, along with the coarse-grained understandings of the site itself must guide our assessment of Makarewicz's (2009) faunal analysis. Based on the dating of 'Ain Jammam from the earliest to the latest portions of the LPPNB, as well as the fact that village settlements of the LPPNB were probably autonomous (both socio-politically and economically), it is possible that the site exhibited changing animal husbandry practices during the LPPNB as compared to earlier sites or exhibited variability between sites during the same period. A third possibility is that the structure of the faunal assemblage from 'Ain Jammam

identified by Makarewicz (2009) could be a by-product of poor preservation and limited recovery methods.

Additionally, because stratigraphic and horizontal control are so poor from the site and the entire faunal assemblage was lumped together from hundreds or thousands of years of occupation but analyzed synchronically, it is possible that different herd management and hunting strategies were enacted at different times or by different economic units within the site. These problems are not restricted to 'Ain Jammam, as a number of LPPNB sites, including Ba'ja and Basta did not consistently sieve deposits with 2mm screen as is standard for the region (Makarewicz, 2009) and every PPNB assemblage thus far described has been analyzed as a single synchronic event.

However, one site for which it has been possible to sequentially analyze the faunal assemblage is that of 'Ain Ghazal. A number of authors have analyzed the faunal assemblage of 'Ain Ghazal from a variety of perspectives and with a variety of methods (Kohler-Rollefson and Rollefson, 1990; Kohler-Rollefson, 1992; Köhler-Rollefson, 1989; Kohler-Rollefson et al., 1988; Köhler-Rollefson et al., 1993; von den Driesch and Wodtke, 1997; Wasse, 2002, 2000). Through these analyses a picture of the herd management strategies followed by the LPPNB inhabitants of 'Ain Ghazal has emerged. Caprine or ovicaprine bones dominate the MPPNB assemblage of the site. By the LPPNB goats still are important in the faunal assemblage, but sheep appear for the first time in significant quantities. Wasse (2002) identified a very small percentage of bones from the MPPNB as sheep and a significant number as sheep/goat. However, the clear identification of a significant number of bones as sheep in the LPPNB likely means that the very few from the MPPNB were intrusive (i.e. all the sheep/goats likely were probably goats) (Makarewicz, 2007). While Wasse (2002) has shown that the overall percentage of the faunal assemblage for

ovicaprids does not change significantly from the MPPNB to the LPPNB (ranging from 64.7-71.6% of the overall NISP), the ratio of sheep to goats does, with 0.4% of the MPPNB NISP being *Ovis* while 41.0% of the LPPNB/PPNC NISP were *Ovis*.

Von den Driesch and Wodtke (1997) argued that goats were domesticated at 'Ain Ghazal based on a consistent reduction in average, minimal, and maximal size of the specimens through the PPNB. Because minimal and maximal sizes also decreased through time, it suggests that this change in morphology was not a product of shifting slaughter patterns of more young males and adult females as compared to adult males. While Zeder and Hesse (2000) have shown that a shift in average size of managed herds through time is a product of sex ratios and of choices made by analysts, maximal and minimal sizes are used to control for this effect. Kohler-Rollefson (1997) also argued for *in situ* domestication based on several lines of evidence. She saw a similar culling profile of goats as at Ali Kosh, a settlement for which local domestication is widely accepted (Zeder and Hesse, 2000). Ali Kosh contrasts with the MPPNB profile at 'Ain Ghazal. Kohler-Rollefson (1997) also noted a higher incidence of bone pathologies, more typical of domestic than wild herds during the MPPNB. Finally, she noted that all horn cores recovered from the site were scimitar in shape, typical of wild individuals. This hints that the MPPNB goat populations exhibited a number of features typical of domestic goats and were derived from wild stock, all of which suggests local domestication.

Wasse (2002), conversely, argued that domestic goats were imported from the north. He saw caprine production strategies at 'Ain Ghazal by the MPPNB as a combination of wild hunting and domestic herding. He noted that the demographic profile of ovicaprids in the MPPNB was no different from that in the LPPNB. In the LPPNB, however, sheep were introduced into 'Ain Ghazal. Thus, we know that in the LPPNB herds of sheep were husbanded.

Therefore, if culling strategies were the same in the M- and L-PPNB, then it would seem likely that herds were already husbanded in the MPPNB. This then becomes an argument for the abrupt introduction of domestic goats to the site upon founding, suggesting the import of the technology from the north.

Of course, without an earlier PPNA occupation at the site, it is impossible to have a control group. The appearance of sheep at the site does not mean that herds would automatically have been managed in a fully domestic manner, especially if sheep had diffused into an already extant management system. If sheep and goats were managed differently, due to the different behaviors of these animals and the different products derived from them, as well as the potential different values placed on them by producers, such a comparison of ovicaprids as a single group across time periods may mask important demographic differences between ovicaprid species in any single period (Makarewicz, 2007). That being said, there does appear to be a rather abrupt change toward caprine exploitation during the MPPNB of the southern Levant so Wasse's (2002) hypothesis cannot be ruled out.

Returning to the LPPNB assemblage at 'Ain Ghazal, the ovicaprid culling pattern observed during the entire PPNB was fairly consistent, matching a typical meat-production and stable herd reproductive pattern (Wasse, 2002). Other species are also found in varying quantities, including gazelles, cattle, and pigs. Gazelles were likely hunted, with Makarewicz (2007) proposing that they could have served as a seasonal food source during lean times for ovicaprid herds, similar to her proposal for such a pattern at 'Ain Jammam as most juveniles were harvested before they reached six months. This would place their slaughter in summer and fall when grazing grasses and forage were the hardest to find for ovicaprids, making herds more vulnerable when culled. However, throughout both the MPPNB and LPPNB large adult gazelles,

with a bias towards males predominate, suggesting hunting with a maximal meat return strategy. It is not until the PPNC, when sheep, and therefore, presumably extensive herding, come to dominate the faunal assemblage at 'Ain Ghazal that gazelles become much less prominent.

For pigs it is unclear to what extent if at all that these animals were husbanded. While there is a pattern of young culling, such a pattern is typical for wild pig harvesting as they produce large litters, making their young vulnerable to hunting (Makarewicz, 2007). Size data for the pigs are also ambiguous (Von den Driesch and Wodtke, 1997). Cattle were also harvested in small numbers, with skeletal elements being smaller in size than certain other early Neolithic sites. Thus, Von den Driesch and Wodtke (1997) have suggested that the inhabitants of 'Ain Ghazal were experimenting with cattle domestication during the PPNB. Since cattle largely disappear from the assemblage in later periods, the authors suggest that it was a failed experiment. A second possible interpretation is that wild cattle were hunted at 'Ain Ghazal and that observed size differences could be the product of targeting smaller, less fierce animals or the product of environmental differences between sites, as has been shown to account for the variation in wild goat sizes (Zeder and Hesse, 2000).

Pastoral Nomadism in the Early Neolithic

One final variant of animal economies in the early Neolithic is mobile pastoralism (Quintero et al., 2004). Makarewicz and Tuross (2012) have made an argument for horizontal transhumance, whereby at least a portion of the Basta population would have travelled a significant enough distance away from the settlement to have grazed their flock in a complementary phyto-geographic zone to the site. However, Quintero et al. (2004) suggested that incipient processes of pastoral nomadism were occurring by the LPPNB. These authors did not propose true pastoral nomadism, with herders moving with flocks throughout the year during

the LPPNB. However, they did suggest that by this time a segment of people in mega-sites located on the semi-arid fringes of the Mediterranean zone were practicing a form of tethered pastoral semi-mobility. This argument accords well with Makarewicz and Tuross' (2012) stable isotope evidence, but these authors have presented complementary evidence, as well as a hypothesized scenario by which such a development would have occurred.

Quintero et al. (2004) focused on the site of 'Ain Ghazal as their primary case study. They argued for the commencement of seasonal mobility by a portion of the population at 'Ain Ghazal at some point in the LPPNB. Quintero et al. (2004), in making an argument similar to Kohler-Rollefson (1992b) who proposed the emergence of incipient mobile pastoralism in the PPNC, contended that incipient mobile pastoralism developed in response to increasing environmental pressures brought about by mixed sheep and goat herding. Such herds were likely introduced to the site during the LPPNB as evidenced by the abrupt appearance of significant numbers of sheep in the faunal assemblage at this time (Wasse, 2002). They suggested that combined sheep and goat herds would have likely had an adverse effect on the vegetation surrounding 'Ain Ghazal and other LPPNB mega-sites as these two species would have consumed all forms of forage in the area given their different feeding habits. Thus, in order to minimize this impact and provide adequate forage for their herds, producers would begin to practice seasonal transhumance.

Quintero et al., (2004) proposed that the mixed sheep and goat herds would be moved away from the site during the late winter, spring, and early summer months to prevent competition for land between farmers who needed to plant their fields and herders who wanted their animals to forage. Winter sowing, spring tending and growing, and early summer ripening and harvesting could occur free of grazing pressures. After crops had been harvested, flocks

could be brought back to the villages to graze on local wild resources and the stubble of the plants in the fields, all the while fertilizing and aerating the soil. At this time the eastern deserts are largely devoid of vegetation or water sources, making the stubble and springs found throughout the western edge of the Transjordan Highlands all the more necessary for flocks (Quintero et al., 2004). Additionally, during the early winter month throughout the Levant there is little vegetation left for grazing flocks the size of those likely found at very large mega-sites, making the potential use of fodder collected from farm fields by agriculturalists in these sites a valuable resource for herders to access (Makarewicz and Tuross, 2012).

The evidence used by the authors (Quintero et al., 2004) to argue for such a chronology is two-fold. Firstly, as has already been noted, they interpret the appearance of sheep at LPPNB mega-sites as the moment when the processes that lead to mobile pastoralism by the end of the period. Secondly, they point to site densities in semi-arid and arid steppe areas to the east of these village sites and the faunal remains identified at them. At most sites from preceding time periods hunted gazelles predominate in clearly foraged subsistence assemblages. Essentially with the appearance of ovicaprid remains in eastern sites, which are not common in the local ecology, the authors argued that site occupants were herding such animals. They note that there is an increase in overall site densities at the time, as well as specialized production-sites (Quintero et al., 2004).

The latter observation paired with ethnographic analogy to contemporary pastoral economies led to an interesting aside from this article. Mobile pastoralists essentially make their living off of the products of their herds. They typically do not practice a meat production strategy as it can create undue pressure on herd stability in arid environments. Rather, they tend to utilize secondary products and exist in symbiotic economic relationships with farming communities.

Thus, dairy foods for subsistence and exchange, as well as other specialized products such as wool and in rare cases, beads, for exchange are the primary products of the flocks utilized by the herders. However, this does not preclude the slaughter of a small portion of flocks for meat production upon return to sedentary village sites during the summer and fall months (Quintero et al., 2004).

Such a model was developed without several lines of evidence which have subsequently published. These include the isotopic analyses of Basta's ovicaprids mentioned above (Makarewicz and Tuross, 2012), as well as the faunal analyses of Martin (1999), who looked at the species composition for ten different sites in the eastern desert region of the Transjordan Plateau. Martin (1999) documented a complete lack of ovicaprid remains before the LPPNB with small but significant amounts of such species appearing at Ibn el-Ghazi (10% of the Minimum Number of Element [MNE]) in the Basalt Desert of far eastern Jordan and Azraq 31 (4% MNE) in the Azraq Oasis of the western portion of the desert fringe. In the succeeding PPNC these percentages increase significantly at the five sites analyzed, ranging in frequency for 18% MNE at Wadi Jilat 13, layer 3 to 54% MNE at Wadi Jilat 25, both located in the arid western fringes of the Azraq Basin along a seasonal water course.

Martin (1999) has interpreted this transition, as well as the continued importance of non-husbanded animals, notably hare and gazelle, in the faunal assemblages of these sites as indicative of a local development of ovicaprid herding with mobile foragers supplementing their animal economies through husbandry. Quintero et al. (2004) also confronted this issue of continued presence of hunted animals in faunal assemblages in desert sites and suggested that hunting would have continued as domesticated meat procurement would have been a potentially destabilizing pressure on herds in arid zones. It is certainly true today that much of the meat

consumed by pastoral nomads in Jordan is hunted (Lancaster and Lancaster, 1991). What we see is that either scenario is difficult to disprove with current evidence. While Martin (1999) considers several sites not considered by Quintero et al. (2004), the reverse is true as well. The site with the strongest evidence for a significant ovicaprid component to its animal economy, Bawwab al-Ghazal (Rollefson et al., 1999), is not included in Martin's (1999) analysis. There has been no quantitative presentation of the faunal assemblage at this site, but publications indicate that a number of ovicaprid horn cores were recovered during test excavations in association with Byblos points, suggesting a LPPNB date. While gazelle remains dominate the assemblage, the excavators (and the same authors of Quintero et al., 2004) suggested that hunting was the primary method for meat procurement while herded animals were kept alive as much as possible to preserve capital (Rollefson et al., 1999).

The stable isotopic evidence at Basta does hint at the potential relationship between non-village grazing areas and villages (Makarewicz and Tuross, 2012). However, the isotopes do not definitively show that herding was done as part of the mega-site economies in the eastern desert sites, just that some form of horizontal transhumance seems likely. However, another line of evidence which does call into question the interpretations of Quintero et al. (2004) that herds were utilized for their secondary products is a recent study of residue analyses from pottery across southwest Asia and Europe. This study found low quantities of animal fat residues on any pottery tested from three later sites in the Levant, suggesting that dairy products were not of particular importance in the late Neolithic and Chalcolithic economies of the area (Evershed et al., 2008). While it is possible that herd economics changed through time, this study found that cattle herding was of central importance to understanding early sites with significant evidence of dairy playing a major role in subsistence economies. Today sheep and goat herding is nearly

ubiquitous in many regions of the southern Levant, with secondary products such as dairy and wool being the primary goods utilized (Lancaster and Lancaster, 1991).

Subsistence and Technological Changes in the PPNB of the Southern Levant

Such developments in subsistence practices have been viewed as enabling and being enabled by technological changes in other economic realms, including knapped and ground stone production. Certain aspects of these changes have been already been reviewed previously in discussions of changing village spatial organization and differentiation. Thus, only those aspects of these changes in economic practices relevant to subsistence production will be presented in this section.

Naviform core technology emerged in the MPPNB of the southern Levant (Figure 37). It allowed for knappers to produce large quantities of long straight blades from a small quantity of flint. Quintero and Wilke (Quintero and Wilke, 1995; Quintero, 2011, 1998) have linked this appearance to the role that naviform blades would have played in the subsistence economy of the MPPNB. As has been noted, during the MPPNB cereal harvesting and general plant production took on a new prominence in subsistence economies. Additionally, in general, subsistence intensification was occurring with a special emphasis on plant-based intensification. By the MPPNB plant production methods were strongly developed as opposed to animal husbandry which was still likely in experimental stages. Thus, the toolkit of plant production would have been both of great importance to MPPNB subsistence economies and likely codified in its composition.



Figure 37: Partially Refitted Replica Naviform Core (Barzilai and Goring-Morris, 2013)

Quintero and Wilke (Quintero and Wilke, 1995; Quintero, 2011, 1998) argued that this is what naviform cores served to do for early Neolithic farmers. The large quantities of high-quality blades produced from naviform cores were necessary for the intensification of plant production during the period. Thus, the technology, essentially an intensification of blade production, emerged in sync with the intensification of plant subsistence production. As subsistence economies changed through the LPPNB with a

growing emphasis on animal husbandry, but a continued overall intensification of production, naviform core and blade production continued with a slight reduction in intensity. It is only with the more dramatic transformations at many larger-sized sites in the PPNC and late Neolithic, whereby settlement populations decrease significantly and settlements become more dispersed that naviform core and blade technology largely disappears; being replaced by low-productivity, high debitage, minimally specialized flake core technologies. Such settlements served to both reduce the intensity of subsistence production through dispersal and population reduction and the need for specialized tool knapped stone tool kits through the extensification (defined in earlier

chapters as the expansion land under production – in this case through the dispersal of populations across landscapes) of subsistence production. Thus, the high skill level necessary for naviform production became too great an expenditure to be economical.

Barzilai (2010), who seems to endorse Quintero's (1998, 2011) argument for craft production of naviform blades, presented evidence which might seem to contradict some of the basic tenants of Quintero's model. He argued that the quality of craftsmanship for naviform blades was actually higher in small-scale household-based production systems of the Galilee and Jordan Valley MPPNB. This would suggest that individual households could potentially have individuals who felt compelled to acquire the significant skill level required to produce high-quality naviform blades even before subsistence intensification drove economic change. Another possibility is that the social rewards for learning naviform knapping skills were great enough to not require subsistence pressures to induce individual to increase their knapping skills during the emergence of significant levels of cereal husbandry.

Rather, it would seem that the blade requirements of communities and, thus, the scale of production would drive increases in output, while sometimes not requiring the highest quality products. Barzilai (2010) observed certain high-skilled individuals at MPPNB and LPPNB highland Jordan sites, but mostly moderately-skilled producers. Rather, it was the dumping patterns of larger quantities of debitage at the largest sites than at smaller sites that showed changes in production. Thus, craft production as opposed to household production may have been driven more by time constraints than skill constraints.

Interestingly, ground stone technology followed a slightly different trajectory. Wright (1993), reviewing ground stone assemblages from 41 sites dating to the PPNB of the southern Levant, also linked their change and diversification to the intensification of cereal economies

specifically, as well as general subsistence production intensification due to settlement population nucleation and growth. She also noted that there was a distinct shift towards greater quantities of grinding tools over pounding tools in PPNB village settlements as compared to earlier and later periods. This trend commences in the MPPNB and continues into the LPPNB with no notable slowdown on intensification or decrease in intensity as seen in naviform core production with the emergence of animal herding. This is likely a product of the increased emphasis on cereals over pulses in the LPPNB.

Chapter 9: Economic Organization in the PPNB

This chapter is the final background chapter of this study. It looks at previous work on economic systems including models of overall subsistence systems, not just components, and the economic relations at work in the villages of the PPNB. This is followed by a final synthesis of which attempts to show how all of the disparate elements of village economies reviewed over the past four chapters articulate with one another in the production and change of socio-economic systems through time in southern Levantine PPNB villages.

Previous Models of PPNB Subsistence Systems

Very few scholars have explicitly modeled PPNB village subsistence systems either on the scale of the site or the region. Much more attention has been devoted to those things which are more immediately obvious from material remains. Thus, the domestic status of plants (and the assumed practices which go along with such status) as attested by macro-botanical remains (e.g., Nesbitt, 2002; Asouti and Fuller, 2012, 2013) and the domestic status and culling patterns of animals as attested by faunal remains (e.g., Horwitz et al., 1999) have been the primary focus of subsistence reconstructions. There have also been those who have focused on production sequences for knapped stone as attested to by the spatial structure and composition of knapped stone assemblages (e.g., Barzilai, 2010; Quintero, 2011) and the composition of residential units and their property rights as attested by architectural remains (e.g., Flannery, 1972; Byrd, 1994; 2000; Kuijt, 2000a).

Bogaard and Isaakidou (2010), Kohler-Rollefson and Rollefson (1990), and, to a certain degree, Campbell (2009, 2010) have presented behavioral models of functional interactions between plant and animal economies in the PPNB. Kohler-Rollefson and Rollefson (1990) and to a lesser extent Campbell (2009, 2010), proposed processes of change through time. All three of these models are presented below. This is followed by a discussion of the evidence needed to better understand the subsistence economies of the early Neolithic in the southern Levant.

Kohler-Rollefson and Rollefson (1990) presented their model of PPNB agro-pastoral subsistence systems arguing that villages which had grown in size from the MPPNB to the LPPNB shrank and dispersed during the PPNC as a result of increasing environmental pressures due to ecological degradation (Kohler-Rollefson and Rollefson, 1990; Kohler-Rollefson, 1988; Rollefson and Kohler-Rollefson, 1989). In their most fully realized presentation of the relationship between plant and animal production practices in the PPNB (Kohler-Rollefson and Rollefson, 1990), they argued that goat husbandry, which was likely introduced during the MPPNB at 'Ain Ghazal, led to the denudation of the local environment around the site. They reconstructed goat husbandry practices and their relationships to agricultural and non-agricultural plant ecologies. Thus, while not specifically focusing on the structure of agro-pastoral systems at 'Ain Ghazal, Kohler-Rollefson and Rollefson (1990) do present what such a system would have looked like in order to mathematically model the impact of goat husbandry on the site catchment.

Intrigued by the seeming correlation between increasing proportion of goat bones and decreasing size of rooms at 'Ain Ghazal, Kohler-Rollefson and Rollefson (1990) constructed a model with three different components: (1) goat herding (2) plant cultivation, and (3) wood use for construction and for burning limestone to make plaster. They estimated goat herd size and pasturage requirements, areal requirements for cultivated land, and extent of the wood catchment

for construction based on population estimated for the site through time. They also analyzed how goat feeding would have affected local environments, focusing on the ways in which browsing prevents the regrowth of trees allowing faster-growing shrubs to take over land which had previously been a mix of species. When they linked each of these components in a diachronic model, they developed the following scenario.

At its foundation and throughout the MPPNB, 'Ain Ghazal would have had sufficient access to cultivable land, goat pasturage, and timber resources for architecture. Crops could be cultivated near the site and goats could browse in more distant fields for which the only real labor was travel and herding, rather than the manual working of the land required for cultivation. Thus, travel costs to reach near farmland or distant pastures with goat herds would not have been a problem. In fact, initially, goat herds could have aided in the clearing of fields to prepare them for cultivation. Nearly half of the faunal assemblage from MPPNB levels at 'Ain Ghazal is made up of non-ovicaprid remains, including significant numbers of small mammals, birds, and crustaceans, suggesting that hunting and gathering still played a significant role in the diet of villagers (Kohler-Rollefson and Rollefson, 1990).

Through time, however, two effects on the local environment would have increased. First, population continued to expand, requiring ever more goats, more pasture, and more agricultural fields. Second, goat herds would have damaged the vegetation requiring ever-greater extension of herding. This destruction of the vegetation would have reduced the habitat available to many of the species hunted by the 'Ain Ghazal villagers. This would have led to a greater reliance on goat herding, accelerating land degradation, and the extension of herding practices. Thus, we see that there are two engines driving the expansion of goat herding: (1) population growth and (2) ecological pressures on hunting. As populations continued to grow through the

LPPNB, such pressures would only have gotten worse until at the end of the period when they spurred portions of the village's population to spend significant periods of time off-site as pastoral nomads, starting in the PPNC (Kohler-Rollefson and Rollefson, 1990). This model would account for the reduction in population density at 'Ain Ghazal' and, by extension, population reductions observed at many other large sites during the transition from the LPPNB to the PPNC. Such a scenario fits with Kohler-Rollefson's (1992) model for the development of pastoral nomadism, a precursor to the Quintero et al. (2004) model.

Most important for Kohler-Rollefson and Rollefson's (1990) model is that goats are kept separate from cultivated land to prevent them from consuming crops. Thus, while the possibility of herding goats into fields to aid with clearing is proposed, once a field is planted, it is used exclusively for cultivation. The products of cultivation are also used exclusively for human consumption. This premise has been challenged by Quintero et al. (2004) in their model of the development of mobile herding. In this later model the authors argue that herds would have grazed on fields following the harvest.

Returning to Kohler-Rollefson and Rollefson's (1990) earlier model, such a subsistence system in which cultivation, herding, and wood cutting were segregated would produce competition for land between these activities. As populations grow and demands for each of these products increase, ecological pressures on the environment would increase. Thus, in order to increase outputs producers increased herd size rather than change the relationship of herds to local agricultural and non-agricultural activities. As argued by Boserup (1965), such a response to increased production requirements – that is, extensification – is a common way to increase production amongst small-scale producers. However, as the environmental pressures on the land that sustained cultivation and timber harvesting, as well as the travel costs of herding became too

great through time, they required a significant reorganization of the subsistence economy with the appearance of semi-mobile pastoralism in the PPNC; again, a common response for small-scale producers (Boserup, 1965).

Kohler-Rollefson and Rollefson's (1990) model has been roundly criticized using three main lines of attack. Some have argued that local subsistence strategies were more resilient than proposed by Kohler-Rollefson and Rollefson (1990) (Campbell, 2010, 2009; Kabukcu, 2013) or that there were alternative methods for increasing agricultural productivity whereby plant and animal economies could be integrated more closely (Bogaard and Isaakidou, 2010; Bogaard, 2005) or cultivation could be intensified to both increase productivity and decrease land degradation (Campbell, 2009). The final of these critiques essentially implies that the critical tipping point from agricultural extensification to intensification was earlier than Kohler-Rollefson and Rollefson (1990) suggested and did not entail the development of semi-mobile pastoralism, but rather the intensification of cultivation practices.

Most of the criticisms against their model are primarily focused on calculating subsistence productivity on a theoretical level. The one exception is Bogaard and Isaakidou's (2010; see also, Bogaard, 2005) argument based on Bogaard's (2004) proposal that once agropastoral economies develop in the Middle East during the Neolithic, they seem to spread as agropastoralism, suggesting a functional interdependence between cultivation and herding, as hunting can provide cultivators with necessary protein and fat. Thus, the question becomes how and why were cultivation and herding interlinked rather than segregated as proposed by Kohler-Rollefson and Rollefson (1990).

Bogaard and Isaakidou (2010) also suggested a number of other critiques of Kohler-Rollefson and Rollefson's (1990) model, largely based on subsequently published data. Firstly,

Bogaard and Isaakidou (2010) claimed that the Kohler-Rollefson and Rollefson (1990) assumed goats to be obligate browsers (i.e., consumers of woody species) and this “undermined” the idea that herds and fields would have to be separated. In order to understand why, it is necessary to expand upon what the investigators have written. The argument would seem to be that if goats are browsers rather than grazers, then they are not considered to be of use in farm fields beyond clearing them. Once fields are planted, all foliage that grows is suitable for grazing. However, as Bogaard and Issakidou (2010) pointed out, goats can both graze (i.e., consume grasses and forbs) and browse. If goats can also graze then they can feed on the stubble of harvested cereals and can even be allowed to consume the tops of young cereal shoots in order to promote tillering (the growth of multiple short sturdy stems from a single plant, which help guard against damage from weather and increase the number of seeds per plant upon ripening) (Bogaard, 2004). Thus, the absolute segregation of herds and farm fields is not necessary, reducing the land competition between these two components of the overall subsistence economy.

Goats certainly are preferential browsers, making feeding on wild shrubs of the Transjordan Plateau an ideal environment for them (Jensen, 2002). Also, the assumption that goats are used for browsing in the PPN of the southern Levant derives from contemporary analogy, whereby contemporary herders tend to have mixed sheep and goat herds (as would be likely in the PPN based on the fact that both species have been identified by the LPPNB at a number of sites). The point of this is to allow for more complete and efficient exploitation of total plant matter in feeding areas which contain both browse and graze. These two species naturally fall into browsing for goats and grazing for sheep when herded together into a mixed ecological zone. Thus, a maximum of meat, dairy, and wool production per unit of area can be gotten through mixed herding (Jensen, 2002; Redding, 1981). That being said, in more arid

environments like west-central Jordan, where sheep are not typically herded, goats both browse on wild plants and graze on harvested cereal fields (pers. obs.). Thus, while Kohler-Rollefson and Rollefson (1990) may have placed too much emphasis on the number of goats in the faunal assemblage of 'Ain Ghazal and made a number of assumptions that, strictly speaking, were incorrect, they did utilize the best understandings of PPN fauna at the time and the most typical understandings of herding practices in the region.

A second critique presented by Bogaard and Isaakidou (2010) is that in subsequent analyses, it has been shown that goats do not in fact continue to dominate and even grow in prominence within the faunal assemblage of 'Ain Ghazal starting in the LPPNB. However, the situation is slightly more complex with goats being found in slightly higher percentages than goats in the earlier LPPNB layers. Sheep finds only begin to outnumber goats by the later LPPNB/PPNC transition (Wasse, 2002).

This fact alone does not negate the potential environmental impact of herds on the landscape as grasslands do exist in many of the Mediterranean environments of the southern Levant (Al-Eisawi, 1996) and sheep can graze not only on grasses and forbs, but also on the young shoots of shrubs and trees, allowing for them to retard the spread or regrowth of forest and shrublands (Jensen, 2002). This is because trees and shrubs grow at slower rates than grasses recovering from grazing. However, because sheep are obligate grazers (Jensen, 2002) the ease of using them on farm fields in the manner suggested above for goats is quite high. An interesting aside that can be derived from this critique is that sheep come to dominate when 'Ain Ghazal was losing population and settlement was less dense. This could suggest that sheep herding either was associated with this demographic change or a response to the pressures of the larger and denser populations at the site just before this transition. Because sheep are easier to integrate

with cultivation, perhaps they increased in importance in the PPNC as villagers began to follow the mixed agro-pastoral strategy suggested by Bogaard and Issakidou (2010).

A third critique of Kohler-Rollefson and Rollefson (1990) by Bogaard and Issakidou (2010) is that the proposed appearance of pastoral nomadism in the PPNC as an explanation for the decrease in population size and density at 'Ain Ghazal and other large sites does not agree well with the faunal evidence known from the Transjordan Plateau arid fringes. The main sites with full analyses published show an appearance of sheep herding at the beginning of the Late Neolithic (Pottery Neolithic) (Martin, 1999). However, a number of preliminary examinations of faunal remains at earlier sites contain evidence of herding as early as the LPPNB (Quintero et al., 2004) and isotopic evidence for the large LPPNB site of Basta suggests significant horizontal transhumance. In any case the only way that such a critique actually challenges the reconstruction of a segregated plant and animal subsistence economy is that such an economy would in fact have damaged the local environment significantly enough to drive the development of nomadic pastoralism as proposed by Kohler-Rollefson and Rollefson (1990). Thus, if such herding did not exist as early as they claimed then this impact would not have been felt nor would it have driven the development of pastoral nomadism.

Given these critiques, Bogaard and Isaakidou (2010) proposed that at large LPPNB villages in the southern Levant, rather than a segregated plant and animal economy, a full agro-pastoral economies in which cultivated cereals, pulses (Asouti and Fuller, 2013, 2012), and potential orchard crops (Kislev et al., 2006), as well as husbanded ovicaprids (Horwitz, 2003a; Horwitz et al., 1999; Makarewicz, 2007) and possibly cattle (Becker, 2002), were functionally integrated in order to minimize environmental impacts and maximize production. Household herding and garden agriculture could be combined to allow for intensive farming. Fields could be

grazed early in plant growth and after harvest. The former would produce tillering and therefore increased productivity and crop resilience, while the latter would help clear fields. Both processes would help convert plant growth that could not be directly utilized by people into calories available through meat culling and fertilizer, increasing subsequent production through manuring, and increased plant production through soil aeration. Additionally, as Makarewicz and Tuross have shown (Makarewicz and Tuross, 2012, 2009; Makarewicz, 2007), additional stubble could be harvested for fodder during the winter. Thus, there would be minimal competition between farming and herding for land, with herds kept in local wild areas during sensitive growth periods for crops, but during most other periods of the year the herds could derive a significant amount of their nutrition from farmlands themselves or, in the case of foddering, their products.

While such a proposal does successfully highlight the assumptions of Kohler-Rollefson and Rollefson's (1990) model of mega-site subsistence economies and Bogaard and Isaakidou (2010) did successfully point out several significant critiques, largely based on more recently published data, there is minimal archaeological evidence to support this model. This is not to say that there is also any evidence to disprove it. Rather, we are sorely lacking evidence of subsistence techniques in the early Neolithic of the southern Levant. Such studies which can explore practices in more detail through isotopic, weedy taxa, phytoliths, or biomarkers analyses (Ferrio et al., 2005; Fraser et al., 2011; Jones et al., 2010; Rosen and Weiner, 1994) have yet to be done on a large scale in the southern Levant (Bogaard, 2013). We also lack material evidence from subsistence production zones for the early Neolithic, with almost all evidence derived from secondary and tertiary contexts within villages (Banning, 2012; Kuijt, 2009a).

One final fully environmental/theoretical rather than archaeological critique of Kohler-Rollefson and Rollefson's (1990) model of mega-site subsistence economies is that of Campbell (2009, 2010). Campbell starts her argument by making several critiques of Kohler-Rollefson and Rollefson's (1990) model. While there is evidence of an overall reduction in species diversity within the faunal assemblage between the MPPNB and the LPPNB, the vast majority of species found in the MPPNB assemblage, but not found in the LPPNB are small carnivores all concentrated within a single structure. She suggested that such a context may suggest hunting for pelts rather than meat and would therefore not be an indication of subsistence pressures (Campbell, 2010) (although, presumably such hunting could also put pressure on species diversity through time). It would seem that this concentration was related to some sort of ritual or other social practice. Campbell (2010) also noted that a number of these small carnivore species live in low densities and would be expected to quickly vanish from the landscape due to pressures from domestic carnivores (it would seem she is suggesting dogs as the culprit) and thus, again, such a change would not be indicative of subsistence pressures, but rather of village commensals. Campbell (2010) also challenged the evidence for deforestation suggesting that increasing compartmentalization of structures (Kuijt, 2000a) driven by social/ideological (or it would seem non-subsistence production changes as well) forces was the primary cause of the increased use of internal walls to buttress roofs rather than reduced availability of timber. She also suggested that it is likely that most of the timber used for making quicklime and other fires was deadwood, which would not produce significant deforestation. Of course, none of these phenomena are easy to identify in the archaeological record.

However, the bulk of Campbell's argument is based on likely sustainable agricultural practices performed by the inhabitants of large LPPNB village sites. It is here that we begin to

see a picture emerging of her proposed total agro-pastoral-foraging subsistence system. She actually suggested several possible practices from worst-case to best-case scenarios, arguing that even in the worst-case scenarios these practices probably would not have degraded the environment to any significant extent. In such a scenario, Campbell (2009, 2010) assumes the largest areal estimates for three exemplary large-scale villages and the highest population densities. She then calculates the amount of territory necessary to produce enough food for these populations based on an 80/20 ratio of plant to animal calories. She assumes that herd lands are kept separate from cultivated lands and that cultivation was done extensively. She then determined the amount of land available for these tasks, ranking land as low, moderate, and high productivity for various plant crops based on geological surveys surrounding the MPPNB village site of Jericho, M/LPPNB site of 'Ain Ghazal, and LPPNB site of Basta.

Campbell was able to show that there was always sufficient high productivity land for crop cultivation and that if this land was exclusively use for farming that there would be sufficient land for grazing within two hours travel from these sites (see Appendix 4). These results were derived from a combination of more current agronomic understandings based on herding experiments in Tunisia, the Negev, and the Sinai and understandings of the impact of non-mechanized, low-till farming – the type of farming practices in the Neolithic – on soil organic material. That being said, the herding experiments for the semi-arid and arid environments of the Middle East and North Africa did show that significant land degradation did occur when herd densities were high enough. Because the size of the herding territories and the size of herds in the early Neolithic are not known, it is difficult to say whether ovicaprids would not have degraded the environment. We do know, however, that many contemporary or historical

herders have made choices that negatively affected environments around the world, including the southern Levant (Bar-Yosef and Khazanov, 1992; Khazanov, 1984).

Embedded within this model are a number of other assumptions worth noting. Firstly, she argued that her estimate of 80% of the diet of villages coming from plant foods was likely exaggerated and therefore the estimates she used for understanding how much territory was necessary for cultivation was also likely high. However, lowering vegetable contributions would require larger herds. Because herds require greater land per calorie returned (Gliessman, 2007), this would actually not reduce the overall territory necessary for subsistence, but increase it. Secondly, she estimated a herd culling rate of one-third per year to produce sufficient meat calories for her model, which is on the high end for sustaining herd size (Jensen, 2002). This would suggest that large sites may have required significantly larger herds for meat production if they were to practice the more typical lower culling rates known from contemporary herder. This would again increase land demands; an issue all the more compounded by the likely higher percentage of calories derived from animal sources.

Third, Campbell (2010) gives estimates of highly localized land regeneration within semi-arid environments of between ten and sixty years after herding has essentially denuded all grazing resources in an area. However, she uses the ten-year duration – the lowest end of the spectrum – for her model and the duration derived from the least arid of her case studies, something that would be problematic for the semi-arid fringes of the southern Levant (although increased precipitation during the Early Holocene must be kept in mind with this critique). Additionally, her reasoning for this is that ‘Ain Ghazal and other sites were inhabited for hundreds or even thousands of years and therefore a sixty-year regeneration periods was certainly possible for the settlement’s economy. However, she does not take into account that

changes in subsistence systems and social organization are created through individual decision-making, coordinated through communities, institutions, and ideologies. Because individual life expectancy in the Neolithic was lower than 60 years (Eshed et al., 2004a) and certainly herding decision-making was done by individuals for far less time than that, time scales would not accord with her model. Such a long regeneration period for herbaceous and arboreal vegetation could affect decision making.

Additionally, much of Campbell's (2009, 2010) critique of Kohler-Rollefson and Rollefson's (1990) model was based upon cultivation techniques, which certainly could have been as efficient as she suggest. However, the latter's model of ecological degradation is more focused on the effects of extensive herding; the component of the subsistence economy for which Campbell (2009, 2010) is less conservative in her calculations. Campbell's (2009, 2010) reasoning does support the value of looking to a more integrated model of agro-pastoral production in the early Neolithic sites, such as those proposed by Bogaard (2005, 2010). Additionally, it must be kept in mind that Campbell (2009, 2010) did provide a thorough review of published archaeological data showing that site populations were likely lower than previously proposed.

Undocumented Aspects of PPNB Subsistence Systems

A number of authors (Kuijt, 2009: 321; Campbell, 2010: 178; Banning, 2012: 405; White and Wolff, 2012: 279; Bogaard, 2013) have pointed out that we know very little about the workings of total subsistence systems in the PPNB of the southern Levant. The previous models are largely based on analogy of contemporary practices with very little archaeological data brought to bear on questions of system organization of function through time. This is not to say that such data cannot be generated, as reviewed above (Araus et al., 2001; Canti, 1998; Evershed

et al., 2008; Ferrio et al., 2005; Fraser et al., 2011; Jones et al., 2010; Makarewicz and Tuross, 2012; Rosen and Weiner, 1994). Rather, there is none for the villages of the southern Levantine PPNB, except in rare cases (Bogaard, 2013; Makarewicz and Tuross, 2012).

However, beyond direct evidence from plant and animal remains and their chemical composition, we lack evidence of the material infrastructure associated with non-village-based subsistence production activities (Banning, 2012; Kuijt, 2009a); the site of al-Khayran being the first exception to this situation. There are three common forms of such infrastructure found outside of villages: (1) fields for herding (Hardin, 1968) or cultivation (Wilkinson, 2003, 1989), (2) landscape modifications such as irrigation canals (Kirch, 1994), terraces (Netting, 1968), dams (Kuijt et al., 2007), and field walls (Stone, 1994), and (3) satellite settlements (Chisholm, 1979; Stone, 1996) and their associated architecture (Crown, 1983; Ellis, 1978; Henderson, 2010; Kohler, 1992; Moore, 1979, 1978, 1975; Preucel, 1990; Sutton, 1977; Wilcox, 1978). While a number of archaeological methods have been developed to identify such infrastructural components of a subsistence system, very few of these can be used for early Neolithic remains.

Farm fields can be especially difficult to locate without specific forms of evidence produced through anthropogenic processes. We know that one of the main forms of agricultural intensification is the use of manure and other organic refuse on fields as fertilizer. As has been suggested by Bogaard (2005, 2010), this is one method for increasing production. However, there are several methods for manuring. Some producers practice household herding whereby animals are kept primarily for secondary products such a dairy, wool, and animal traction. Because animals are not slaughtered for meat, herds can be quite small and are frequently kept within houses and villages for much of the 24 hour cycle and herded into nearby fields for

feeding. Thus, such a practice produces significant quantities of manure within villages which must be transported to farm fields (Eskelinen, 1977a; Sidibe, 1978).

Another possibility is to herd larger flocks on previously harvested fields to feed on stubble, as suggested by Bogaard (2005, 2010). There are several ways that this can be done from exchange relationships between herders and farmers (Khazanov, 1984) to village-based, multi-household synthetic herds (Halstead, 1996) to large corporate groups with both farm fields and flocks which coordinate production activities (Bogaard 2005, 2010). Whatever the exact arrangement, such a method has the advantage of not requiring transportation for the manure. This also tends to be a better practice for either meat producing or mixed meat and secondary product herds, typical of pastoral nomadic communities as these flocks tend to be larger (due to culling pressures and/or production intensification for exchange) and therefore more typically kept outside of villages (Khazanov, 1984). However, it does have the disadvantage of lower rates of nitrogen preservation due to light exposure as compared to more intensive manuring techniques involving composting and either ploughing or injecting manure into soils (Burton and Turner, 2003)

In either of these cases, be it household herding with the transportation of manure to fields or post-harvest grazing of flocks, a number of archaeological methods have been developed for identifying manured fields. There are two basic methods: (1) macroscopic approaches using material culture remains and (2) microscopic approaches using molecular traces of the manure itself. Within macroscopic approaches the main methods used is the identification of sherd scatters outside of habitation-sites (Wilkinson, 2003, 1989, 1982). The basic reasoning for associating sherd scatters with manuring and other forms of fertilizing is that these fertilizers are collected for waste disposal areas within villages. While individuals are

removing fertilizer they also happen to collect other forms of waste, including broken ceramics. Then this waste is dumped in farm fields, producing sherd scatters through time. On the microscopic level a number of biomarkers within deposits believed to be ancient fields have been identified which can indicate manuring (Bull et al., 1999). Additionally stable isotope levels within charred plant remains found within habitation or processing sites, as opposed to field, can be an indication of manuring (Fraser et al., 2011).

Unfortunately, none of the microscopic approaches have been applied to the southern Levantine early Neolithic yet. Interestingly, no fields have been identified through macroscopic approaches either. While it is typical to use pottery sherd scatters to identify fields, there is no reason why other artifacts could not be used as well. Because there is minimal use of pottery in the early Neolithic, perhaps knapped stone scatters could be an alternative. However, no one so far has argued for such a method or identified any fields using it. There are a great number of lithic scatters dated to the PPN throughout the southern Levant, presumed to be deflated remains of habitation-sites or other activity areas. Additionally, artifact scatters from village settlements typically, extend well beyond identified architecture and activity areas in the PPNB. Perhaps some of these could be scatters of artifacts produced by the manuring of fields.

Another common method for identifying farm fields in the archaeological record is the use of perimetrics (Stone, 1994), usually defined as the material used in field modification and preservation, such as stone field walls (Stone, 1994), boundary markers (Woodbury, 1961), terracing (Netting, 1968), and more intensive field preparations such as waffling (Bradfield, 1971; Cutright-Smith, 2007; Forde, 1931) or the production of artificial or raised fields in lakes or swampy environments (Armillas, 1971; Coe, 1964) can all be found in the archaeological record. Yet, none of these date to the PPNB of the southern Levant either. There are several

possible explanations for this, including the difficulty of dating such constructions and the extensive erosion experienced by the landscapes of the southern Levant over the last 10,000 years or so (Cordova, 2007; Hill, 2006; Mithen and Black, 2011). However, it is also distinctly possible that such techniques were simply not used during the period. This latter explanation seems to fit well with the fact that other constructions are preserved from the time period and slightly later Pottery Neolithic landscape modifications, such as check dams (Kuijt et al., 2007), have been identified.

However, it is important to note that construction which is not associated with carbonized materials such as check dams (Kuijt et al., 2007), terracing (Kirch and Lepofsky, 1993; Puleston, 1978), and desert kites (large animal pens designed so game could be driven into them and slaughtered) (Betts, 1998) can be quite difficult to date. In certain cases, artifacts (Betts, 1998) or optically stimulated luminescence dating (Rittenour, 2008) can help. But, both of these methods are highly susceptible to the sorts of erosional processes commonly found within the *wadi* systems of the southern Levant. Thus, even if such remains are identified, placing them in the PPNB or any other period of prehistory can be difficult.

A final material indicator of field systems in the archaeological record is that of water management systems (Henderson, 2010). Less intensive systems, like the check dams of the PN, help to identify to field locations and some of the cultivation methods used (Kuijt et al., 2007). More intensive systems can be used to define field boundaries, intensity of water usage, and even the organization of production and economic relations (Craig, 2004). Again, no such systems have yet to be identified in the early Neolithic of the southern Levant (Mithen and Black, 2011; Mithen, 2010), save one possible series of barrage systems (dams and channels built into natural water systems to increase water depth and/or divert flow) identified in southeastern Jordan in the

Jafr Basin, which have been dated to the PPNB by its excavators (Fujii and Abe, 2008). While this dating is questionable due to a lack of absolute dates and the highly deflated nature of the deposits, it would also seem that such systems, if they were in fact utilized during the Neolithic, were associated not with village communities, but rather mobile ones. Thus, they provide minimal insight into village-based subsistence economies of the southern Levantine PPNB.

The final component of smallholder agricultural systems – satellite settlements – is the component on which this research is focused. An extensive review of satellite settlements and their uses has already been made in previous chapters and, thus, no additional review will be given here. However, it is important to note that no such settlements have been identified for the early Neolithic of the southern Levant before or since the excavation of al-Khayran. Such sites are common throughout the contemporary world in communities of smallholder agricultural producers (e.g., Forde, 1931; Antoun, 1972; Eskelinen, 1977; Sutton, 1977; Chisholm, 1979; Moore, 1979; Stone, 1996) and have been analyzed extensively in the archaeological record of the southwestern US (e.g., Colton and Colton, 1918; Haury, 1956; Wendorf, 1956; Woodbury, 1961; Pilles, 1969; Sutton, 1977; Ward, 1978; Moore, 1979; Crown, 1983; Kohler, 1992; Henderson, 2010). They have proved informative about social organization, mobility, subsistence and social pressures, resource access, and inter-community aggression. They are most fruitfully analyzed within their broader landscape context (Crown, 1983; Ellis, 1978; Henderson, 2010; Kohler, 1992; Moore, 1979, 1978, 1975; Preucel, 1990; Sutton, 1977; Wilcox, 1978).

While no such structures or sites apart from al-Khayran have yet to be identified, this may be due to methodological biases. Hundreds of sites in west-central Jordan have been identified as containing a PPN component (e.g., MacDonald, 1988, 1992; Coinman, 2000;

Parker, 2006). However, few of these have attracted follow-up research without evidence of significant depth of deposits and intensity of occupation (e.g., Clark et al., 1994; Peterson, 2004). Thus, many shallow sites with highly disturbed contexts and with limited or light surface scatters have been passed over in favor of larger village sites for excavation. As Banning and colleagues have shown, even surface survey likely biases the return rates for prehistoric sites with many smaller behavioral loci not detectable except through excavation (Banning, 1986).

Additionally, the interpretation of surface survey finds and data may also play a role in our lack of identified satellite settlements. Because such site types have not been included within the discourse about site variability in the early Neolithic, potential remains of satellite settlements may be interpreted as artifact scatters, deflated short-term occupational sites, or logistical/strategic locales not used for permanent occupation but rather special-purpose sites for either foragers or farmers. This is because the remains of such sites are quite similar when no architectural remains are visible on the surface, as was the case for al-Khayran. Rather, satellite settlements, non-subsistence logistical sites within farming systems, and all logistical sites within mobile foraging systems produce material remains indicative of a low intensity of occupation that is difficult to assign to special activities or functions.

Evidence of PPNB Economic Relations

MPPNB Economic Relations

As has been previously reviewed, individual households, likely comprised of nuclear families in the MPPNB, were increasing in social significance during the period (Flannery, 1972, 1993, 2002; Byrd, 1994: 640-641, 643, 657-660, 2005a; Rollefson, 1997: 287, 302, 2000: 184; Banning, 1998: 222, 2003: 14, 2012: 405; Gebel, 2006: 4, 2010: 58, 2004: 7; Twiss, 2007: 29). Economically speaking, individual households appear to have been the primary locus of storage

(Byrd, 2005a, 2000, 1994; Flannery, 2002, 1972; Kuijt, 2008a), food consumption (Twiss, 2007b; Wright, 2000), and object production (Byrd, 2005a, 2000, 1994) including naviform blades (Barzilai, 2010) and, at least at the site of Shkarat Msaied, beads (Jensen, 2008, 2004). It has also been suggested that the ground stone tool kits found within habitation structure from the MPPNB indicate a wide variety production activities enacted by the household from field clearing and preparation to construction to food processing and craft production (Wright, 2008). Byrd (1994, 2000, 2005a) has also presented evidence of basements at both Beidha and 'Ain Ghazal as having been the locus of production for a number of items from food to knapped stone blanks and tools to adornments to ground stone tools, although others suspect that such areas were more likely used for the storage of both items yet to be completed and fully finished ones (Rollefson, 1997). The latter possibility still implies that members of households would have been the producers of such items and that habitation structures were still integral to this process.

One interesting variation on the household as primary economic locus has been presented by Wright (2000), who analyzed the location of food processing features in MPPNB villages. She showed that many of these tools were located outdoors in publically visible locations. However, they were clearly associated with individual households, being found typically on front porches with tools frequently found in the same relative locations and in similar formations. This suggests that there was some form of public character to the performance of food preparation in the period, while individual households were the ones performing the acts. There are several possible interpretations of such practices, but it is suggestive in general of a prominence of the individual household in economic relations, with the community as a whole likely still playing some sort of role, most likely in consumption. This point is all the more reinforced by the transition observed at LPPNB sites where most food preparation areas are found indoors, away

from public view, located in individual households with food processing tools frequently found indoors and in similarly composed groupings across structures. The contrast suggested to the Wright (2000) that the performance of production reduced in importance and consumption was increasingly a private household affair by the LPPNB.

That being said, Byrd (2000) has also presented evidence of a handful of food preparation areas at MPPNB Beidha located in-between structures, suggesting the potential for shared work spaces between households. While such arrangements are rare, Byrd (2000) has suggested that this may indicate economic and likely other social relationships between households. Thus, there may be two or more layers of actual economic relations in the MPPNB; at least one between households manifested in the external food preparation areas and the other within households manifested by the architectural differentiation of residential units.

Another possible case of variation on the individual nuclear family household as independent productive unit is the growing evidence of household-based craft specialization, whereby certain households contain individuals who manufacture items used by all households but for which not all households have member capable of making them. This has been proposed as the production method for naviform cores and blades within MPPNB village sites (Barzilai, 2010; Quintero, 2011). This would suggest another layer of economic relationships whereby the individual household would still be the locus of production, but there would also be certain economic ties between households in order for all to acquire blades for naviform cores necessary for subsistence production.

As Byrd (2000: 86) has pointed out, one must consider the full range of distinct activities to provide the overall picture of economic relations. Certainly, individual household played different, but significant, parts in production. Such an arrangement is quite common in village-

based communities (Netting, 1993, 1982; Netting et al., 1984; Sahlins, 1972). However, there are a great many examples of villages composed of individual households, which nevertheless also have more inclusive economic institutions which effect economic organization. In fact, Stone (1996) goes so far as to say that there are no examples of communities where at least some essential economic tasks are performed by individuals from multiple households. However, such arrangements typically require reciprocal relationships where all households can receive labor from outside individuals for similar or equally valued tasks over the long-term.

The concept of usufruct rights, common in small-scale societies, whereby land is held communally or in super-household corporate groups, but farmed by individual households (Netting, 1982) is another example of balance between household economic production and communal economic rights. Such a system serves to dampen inequalities while harnessing many of the benefits of a segmented economy. Recently Bogaard (2013) has presented preliminary evidence of her and Isaakidou's earlier hypothesis (Bogaard and Isaakidou, 2010; Bogaard, 2005) that agricultural production may have been done under some sort of communal or usufruct regime in large-scale settlements of the Middle Eastern Neolithic. Her analysis of stable isotopes within macro-botanical samples from the early Neolithic Central Anatolian site of Catalhoyuk showed that multiple households utilized cereals produced under similar watering regimes; something atypical for large-scale villages in which surface water is used to feed crops given the extensive and variable nature of most farming catchments. Of course, if dry farming is done then rainfall would be the only water delivered to cereals and one might expect watering regimes would be expected to be similar across larger regions.

That being said, remains from LPPNB 'Ain Ghazal, located in the southern Levantine cultural region, show significant variation in watering between samples (Bogaard, 2103).

Additionally, the nature of the deposits analyzed at Catalhoyuk are unique in that they are from offerings left on the floors of houses before they were intentionally burned. Thus, it is possible all the houses were closed at once and the cereals were simply taken from a single source. While this may imply some sort of economic connection between houses, a wide variety of other interpretations are also possible. As has been reviewed previously, there is some variation on the idea that nuclear household were the sole economic and social unit of the MPPNB below the level of the community (Byrd, 2005a, 2000, 1994; Kuijt, 2000a, 2000b, 1996), but it is widely thought that the individual household played a significant role in the economics of daily-life. While broader social units may have subsumed households in certain realms, the best evidence for this thus far being from burial data (Kuijt, 2000a, 2000b, 1996), suggesting that economic legitimacy and rights may have been derived from broader social categories, but that the basic practices of economic life were still often enacted by individual households.

In addition, some evidence supports a proposal of super-household corporate groups. Byrd (1994: 641, 643, 650-652, 657-660) has argued most strongly for the existence of corporate sodalities, pointing to several larger-scale structures built through time at the center of the village of Beidha with unique architectural design as a likely communal building of some sort. As reviewed in previous chapters, similar buildings have since been identified at early MPPNB Shkarat Msaied (Jensen et al., 2005) and MPPNB Wadi Hamarash I (Sampson, 2012). Interestingly though, none of these sites contain multiple large-scale buildings occupied contemporaneously, suggesting that they may have been more community-wide in their orientation rather than sub-village super-household in membership as would be expected in a sodality-based form of organization. However, in autonomous village societies, small settlements like Beidha, Shkarat Msaied, and Wadi Hamarash I could have only one sodality of which select

individuals could be members. We would only expect to find multiple sodalities in larger settlements, such as 'Ain Ghazal at the end of the MPPNB or, potentially Jericho (Flannery and Marcus, 2012). However, because we do not have extensive excavations of larger MPPNB settlements in the southern Levant, it is impossible to know if such social structures existed.

Rollefson (1997: 302) has argued that the architectural evidence for social differentiation at Beidha is weak considering that (before the final phase at Beidha at least) the larger structures at the center of the site are still relatively small. However, he suggested that statuary and the notably small number of sub-floor burials relative to expected numbers of deceased at MPPNB villages suggests some form of complexity that would presumably be found in economic organization as well. What that is exactly, however, he was not able to specify. The statuary, likely used in some sort of ritual, could suggest that some individuals may have played an important role in religious practices in that there were likely ritual leaders. The low number of burials also suggests that a select few individuals were given special mortuary treatments.

Another level of economic organization that has commonly been referred to in the literature is that of the community (by which researchers mean the settlement as a whole) with communal building construction and the organization of intensive subsistence production as likely arenas in which some form of communal labor was required (e.g., Byrd, 1994, 2005b; Rollefson, 1997; Kuijt, 2000a, 2000b, 2000c; Kuijt and Goring-Morris, 2002). Interestingly, these are also the arenas most commonly viewed as spaces where increasing power and authority for individuals and sub-village social units may have developed as well (e.g., Rollefson, 1997; Kuijt, 2000a, 2000b, 2000c; Byrd, 2005b). What we see here, though, is that a certain level of society-wide solidarity was maintained through the performance of productive tasks, even if households were taking on a more prominent role in economic life. The best evidence of this is

the large structures and other architecture at MPPNB sites, which likely would have required more individuals than a single household could provide for construction and maintenance. Other hypothesized communal forms of subsistence production labor remain conjectural with no clear material evidence yet shown to illustrate such communal action.

Another dimension of economic activity beyond production is consumption. There are several ways of accessing consumption behaviors in the archaeological record. The most common is the association of trash deposits with adjacent structures and activity areas (Hardy-Smith and Edwards, 2004; Hayden and Cannon, 1983). While such a technique has been used commonly in the early Neolithic, the significant uptick in structured disposal of waste far from areas of consumption that occur with village development have made it difficult to access individual household consumption practices. This is because many PPNB villages have waste disposal areas shared by multiple household from off-site dumps to abandoned structures dispersed throughout settlements (Hardy-Smith and Edwards, 2004). Thus, we can access the broad strokes of household consumption, but not individual practices associated with specific households.

Another method for understanding consumption is to look at property rights. Much of our understanding of property rights is actually derived from ethnographic analogy whereby certain social forms observable in the archaeological record of the MPPNB, such as the nuclear family household, are viewed as likely imbued with strong claims over certain forms of property. Such ideas can also derive directly from the observation that many storage and production activities are found within household structures and the fact that subfloor burials are common. These burials suggest that the household as a trans-generational social unit was important. This importance was clearly reproduced through material practices such as habitation construction

and utilization and likely reproduced through both the production and consumption of subsistence goods (see Banning, 1998: 222 for a discussion of the difficulties in identifying property rights; see Byrd, 2005b: 265-266 for a hypothetical reconstruction of such rights).

Beyond production and consumption rights, it is thought that individual household property rights likely expanded into the realm of land tenure as well, both in the form of habitation structures and subsistence production loci. For the former, subfloor burials are viewed as a fairly strong indicator of household tenure, while for the latter the evidence is weak. In fact, the difficulties in finding subsistence production loci, makes it nearly impossible to determine if individual plots were owned, utilized in a usufruct manner, or any other form of economic system. In ethnographic contexts typically the relationship between land tenure and the fruits of labor are quite complex in subsistence farming communities (Netting, 1993, 1982). It is really only within market-based systems with alienated wage-labor that land tenure and property rights overlap so thoroughly (Becker, 1977; Netting, 1982; Ostrom, 1990; Wallerstein, 1974).

LPPNB Economic Relations

While it could be said that something approaching a consensus exists for nuclear family households as the basic residential unit of the MPPNB, there are a variety of opinions about social organization in the LPPNB. However, a significant number of researchers have marshaled evidence, primarily in the form of large and complex residential structures, that suggest that individuals lived in multiple residential units arranged around courtyards at such sites as ‘Ain Ghazal (Rollefson, 1997), Munhatta (Perrot, 1964), and Basta (Gebel et al., 2006b). These structures tended to have multiple food processing features, again suggesting that multiple productive units could inhabit one such complex. Thus, it has been proposed that the extended family as a locus of habitation, storage, processing, consumption, and, by extension, trans-

generational property rights appears in the LPPNB (Gebel, 2010, 2004a; Kuijt, 2000a; Rollefson, 1997; Wright, 2000). But, as is apparent from the clustering of multiple residential rooms and food processing features, extended families did not simply become the only economic unit. Rather, a more complex relationship between reproductive units, productive units, and kin units developed, partially involving economic practices. We see that individual nuclear families may have been the primary locus of food preparation, storage, and object production (Flannery, 2002, 1972; Goring-Morris and Belfer-Cohen, 2013, 2008; Kuijt and Goring-Morris, 2002; Kuijt, 2000a). As has briefly been mentioned earlier, food processing activities moved inside household or courtyard walls in the LPPNB, suggesting increasing emphasis on privacy and perhaps private property (Wright, 2000), at least in relationship to non-extended family.

Additionally, there was likely extensive sharing of resources within residential compounds, making the extended family a secondary consumption unit. Land tenure rights within smallholder communities can vary greatly (Netting, 1993, 1982). While individuals frequently hold tenure rights, it is the economic units in which the individuals are embedded that perform the labor and consume the products of the labor. It is only during periods of transition in family composition that the intricacies of land tenure rights become more apparent (Goody, 1972). Such episodes are significantly more difficult to identify in the archaeological record than repeated daily practices. Thus, the most that can be said is what groups performed what practices based on the structures of property rights in the PPNB.

Direct evidence of property rights beyond the structure and contents of the residence is difficult to come by, but similar patterns of subfloor inhumations (Kuijt and Goring-Morris, 2002) suggest some form of property rights. The complexities of extra-village land tenure systems as known in the ethnographic present make any simple model problematic. Without any

direct evidence of extra-village land usage, the assessment of competing complex land tenure models is nearly impossible.

Like the preceding MPPNB, there is evidence of larger-scale structures which likely involved individuals from multiple households for construction at sites such as ‘Ain Ghazal (Rollefson, 1997). However, unlike the MPPNB, we do not have LPPNB sites with a single central communal building. Rather, a number of structures dispersed throughout villages seem to predominate. Thus, it is possible that sub-village super-family units such as lineages or sodalities may have been a locus of production. Another possibility is that the sorts of intensive subsistence production necessary to feed large-scale villages, those termed “mega-sites,” would have required some level of super-household labor organization and possibly community-wide planning (Bogaard and Isaakidou, 2010; Bogaard, 2013, 2005; Makarewicz, 2013a). That being said, the evidence for such practices is still totally lacking in the southern Levant.

There is also preliminary evidence of some form of specialized production. As has been reviewed previously, this can be seen in stone ring (Gebel, 2010, 2004a; Starck, 1988), bead (Rollefson and Parker, 2002; Rollefson, 2002), and naviform blade (Barzilai and Goring-Morris, 2012, 2007; Barzilai, 2010; Quintero and Wilke, 1995; Quintero, 2011, 1997) production. At a number of large sites such production was primarily done in workshops, (Barzilai, 2010). This opens up the possibility (although by no means strongly supports the idea) that some with specialized skills may have produced rare items, perhaps even as individuals outside of household identities. This is different from the MPPNB where craft production of naviform blades was done within certain individual households with craftsperson members. This would suggest an additional layer of property rights at the level of the individual (or household

member), although it is likely that either the nuclear or extended household within which the specialist resided would have seen many of the material benefits of this craft work.

As reviewed in the MPPNB, ritual buildings do potentially also provide insight into the additional social, and therefore, economic units above the level of the household. Many ritual buildings are associated with specific groups, such as sodalities, which contain members from a variety of households and sometimes settlements. These group also frequently can hold corporate rights (Flannery and Marcus, 2012). While every MPPNB settlement with evidence of a large structure, frequently with unique features when compared to other architecture within sites, only contained one such structure, three structures have been excavated from the LPPNB layers at 'Ain Ghazal (Rollefson, 2000). Unlike the earlier MPPNB structures at Beidha, these buildings were not built one on top of the other as replacements. Rather, they are found at different locations within the site, with evidence of potential contemporaneous occupation. This would suggest that there were potentially multiple supra-household social units with a potential corporate character.

Southern Levantine PPNB Economics

One of the rare works to devote significant space to the overall structure of PPNB economies in the southern Levant is Kuijt (2000). This book chapter provided some of the most important observations about PPNB economics in the literature. Using several concepts borrowed from the broader field of anthropology, Kuijt (2000) suggested that elements of inequality and hierarchy, as well as egalitarianism and heterarchy were all present in PPNB communities. While many of these relationships were reinforced by differentiation through ritual and domestic practices, many were also produced through economic practices. The PPNB was a period of great changes in economic practices, economic units, and economic relations.

However, interestingly, there is very little evidence of economic differentiation in the period. Kuijt's (2000) emphasis on hierarchy, egalitarianism, and heterarchy looks predominantly at power dynamics created through economic and other relationships. This section attempts to build on this discussion by looking at materials and practices and how they create a functional economic system as much as a political one.

What is fairly obvious from a review of PPNB economics is that many of the same processes and practices are occurring throughout the PPNB. Looking at a host of different economic factors and their changes through time from craft production to the composition of basic economic units to plant and animal husbandry techniques to subsistence-settlement patterns, what is clear is that many of the changes seen are connected with increasing production in a period of settlement growth. While such a claim may now seem passé (cf., Cohen, 1977), having moved beyond the stage where critique even seems necessary, it is the case that a host of phenomena from the emergence of nuclear households in the MPPNB to the emergence of extended households in the LPPNB (Blumberg and Winch, 1977; Blumberg, 1978; Pasternak et al., 1976) to the increase in the scale of production (Morrison, 1994) of naviform cores and blades at larger LPPNB villages to the shift from a focus on pulses to a focus on cereals and cereal processing in agricultural production have all been correlated with increasing subsistence production and population increase in other cases (Boserup, 1965; Brookfield, 1972).

Not only are such changes in practices typically associated with subsistence intensification and population growth, but so is the emergence of new technologies (Boserup, 1981), such as the appearance of naviform cores and blades, and new production systems (Stone et al., 1990), such as the appearance of satellite settlements and potentially craft specialization,

pastoralism, agro-pastoralism, and even secondary herding products. Additionally, extant technologies such as lime plaster also increased in the intensity of production.

We have evidence both of these changes appearing diachronically with settlement populations increasing and synchronically between communities of different sizes. Thus, not only is naviform core and blade production done on a larger scale at sites with larger populations, but this increase in scale appears to require a reorganization of production systems. The complexity of herding practices is correlated with large populations at LPPNB mega-sites and a reduced level of such complexities is found at smaller LPPNB sites. This is suggestive of not only the opportunities for craft specialization at large sites, but also perhaps the necessity. Because site size seems to determine the presence or absence of such economic practices, it suggests that individual specialists worked part-time maintaining an economic identity and livelihood associated with a smallerholder household. The synchronic differences between settlements in their utilization of complex production systems also speaks to novel economic practices not simply being a product of invention, but also of necessity. In other words, technology did not drive social organization. Rather, it was the other way around with technological utilization driven by social organization (cf., Stanish, 2007).

Households appear to have been quite important as the locus of storage, processing, and consumption of foods, as well as many of the basic productive activities of daily-life such as stone tool knapping across the PPNB, even as the composition of households changed. Additionally, there are some hints of potential supra-household social units at large LPPNB site of 'Ain Ghazal associated with ritual structures. While such social units known from the ethnographic present can frequently have an economic character (Flannery and Marcus, 2012),

there has been little evidence of just what this economic character, if any, might have been in the LPPNB.

The production systems for certain more specialized items such as beads, sandstone rings, and naviform cores and blades varied between communities. Interestingly, when changes in production systems are observed across sites and through time for naviform cores and blades, the only factor which appears to correlate with craft production is community size. Skill level does not, nor does distance from the time of invention or chronological period. It is only in large-scale sites such as LPPNB 'Ain Ghazal and Basta that we see production move outside the house into workshops (Barzilai, 2010).

That being said, for beads and sandstone rings, we have yet to find similar evidence of such craft systems. Rather, we know that certain sites appear to have specialized in their production, but do not have direct evidence of non-residential workshops or individual household craft producers. It seems possible that some specialized items may have been produced by individuals at specific sites, and that these were used for exchange. As Gebel (2010) has argued, apparently drawing a parallel between Kula exchange items (Malinowski, 1922; Munn, 1986) and sandstone rings at LPPNB Ba'ja and Basta, these items may have been of value for both the producer and the consumer more for their exchange value (Marx, 1977) than for their exchange value for the producer and their use value for the consumer like naviform blades or for their direct consumption by producers like food.

In sum, there are ground to argue for the development of a social basis for economic complexity such as the potential production of goods based on the concept of exchange value rather than kin or reciprocity-based circulation of goods in the LPPNB (Gebel, 2010) and the intensification of property rights (Byrd, 2005a, 2000, 1994; Flannery, 2002, 1972; Wright,

2000). Additionally, there is significant evidence of increasing economic complexity in the organization of production with economic segmentation into household units during the MPPNB (Byrd, 2000, 1994; Flannery, 1972), expansion of the productive unit into extended families in the LPPNB (Gebel, 2004a; Rollefson, 1997), household craft production systems in the MPPNB and workshop craft production systems in the LPPNB (Barzilai, 2010), the potential development of agro-pastoralism in the LPPNB (Bogaard and Isaakidou, 2010; Bogaard, 2005), and the development of complex herding practices in the PPNB (Makarewicz and Tuross, 2012). Finally, there is also significant evidence of increasing economic complexity in the form of the intensification of subsistence production (White, 2013), storage (Kuijt, 2008a), processing (Wright, 1993, 1991), and consumption (Twiss, 2008; Wright, 2000).

Yet, for all of this increasing complexity in economic practices, there is minimal evidence of economic differentiation in the form of large material disparities or trans-generation accumulation of material wealth. Certainly in the MPPNB there is a notable lack of such differences, even when compared to communities often labeled egalitarian (Byrd, 2000; Kuijt, 2000a). The LPPNB is a little more difficult to assess with a lack of broad enough exposures to have a sufficient sample size of households at any one site to compare. In addition, mortuary data, while suggestive of socially marked differences, do not seem to demonstrate an association of differences in social identity with differences in material wealth (Kuijt, 2000d). Of course a lack of evidence is not evidence of lack.

It is unclear why economic segmentation (Blumberg and Winch, 1977; Blumberg, 1978; Pasternak et al., 1976), intensive storage (Cashdan, 1985), craft production (Arnold, 1987), individual and household property rights, and land tenure (Netting, 1982) did not lead to inequalities during the PPNB. However, as Kuijt (2000a, 2000b) has argued, leveling

mechanisms surely must have existed. He (Kuijt, 2008b, 2000d, 1996) has suggested that mortuary rituals in the MPPNB illustrate some of the ideological underpinnings of such a system. He and others (Byrd, 2000; Kuijt, 2000a) have argued that the notable similarity in household size and form at individual sites also illustrates this egalitarian ideology. However, it is not clear if such practices are merely reflections of an egalitarian ethos or an enforcement of one. Beyond this, some evidence of feasting, which can both serve as an arena for the production of inequality and a mechanism to it down (Dietler, 2001; Hayden and Villeneuve, 2011), may represent another avenue for prevention significant or inter-generational wealth differences (Twiss, 2008).

Of course, this is not a complete catalog of leveling mechanisms at work in the PPNB. However, we do know that these multiple economic forces attested to in the archaeological record of the southern Levantine PPNB which tend to drive economic inequalities were in some ways alleviated. Thus, we have a complicated picture of multiple economic identities in operation within any given village. Most villagers were probably primarily involved in subsistence production. Households appear to have been the basic economic locus with individuals, often as members of households in practice, and/or households having significant property rights. Much intensive labor was needed for farming, storing, and processing of subsistence items. Some households may have contained specialists working either within residential structures in smaller sites or non-residential workshops in large villages producing both subsistence goods, such as naviform blades, and exchange commodities, such as sandstone rings. However, with all of this complexity in economic practices, wealth differentiation seems to have been minimal. Instead we get a picture of a highly elaborate system of interdependent actors participating in a village-wide economic system that does not appear to have created

significant material inequalities through complex economic relations and enacted and enforced leveling mechanisms.

Chapter 10: Detailed Presentation of Hypotheses

In this chapter I will present in detailed form the seven testable hypotheses which are developed to analyze the research questions stated in Chapter 1. In addition to the statement of the hypotheses, the justifications for them, the expectations of how such hypothesized phenomena would operate in PPNB village settlement systems, and the archaeological signatures of such phenomena will also be specified. As has previously been noted, no evidence of non-village archaeological remains from PPNB village-based settlement systems have been identified except al-Khayran. Therefore, there have been no previous studies of such remains.

Hypothesis 1

In order to meet the nutritional needs of increasing populations, communities living in nucleated settlements will alter the spatio-temporal organization of their subsistence behaviors. As reviewed in Chapter 4, the spatial and temporal organization of subsistence practices are some of the more common and effective means of increasing productive efficiency in subsistence practices (Blaikie, 1971). This hypothesis holds steady the social structure of economic units and simply is designed to test the spatio-temporal pattern of subsistence production behaviors for these units. Hypothesis 3 is designed to test the potential for the restructuring of the relations of production, which should have a significant effect on the spatio-temporal structure of subsistence behavior.

Expectations Outside of Villages:

A: A Shift in Settlement Patterns

Justification: The major way that changes in the spatial behavior of production is structured, is through a reorganization of the location of productive activities and their associated material infrastructures (Blaikie, 1971; Chisholm, 1979; Christaller, 1966; K. V. Flannery, 1976; Hudson, 1969; Jarman et al., 1972; Roper, 1979; Steponaitis, 1981; Stone, 1996; Struever, 1968; Trigger, 1968; Vita-Finzi and Higgs, 1970; von Thunen, 1966).

Literature Review: The major shifts in settlement patterns seen during the PPNB, as reviewed in Chapter 6, are the development of significantly size villages outside of the Jordan Rift Valley and its tributaries (where all PPNA village settlements have thus far been identified) predominantly in the Transjordan Highlands during the MPPNB, and the abandonment of most Rift Valley sites during the LPPNB and the appearance of new villages and dramatic growth of old ones in the Transjordan Highlands. These shifts are seen on a regional scale. However, the structure of settlement systems is not entirely clear.

What does seem apparent is that no settlement hierarchies have been identified for PPNB settlements. There are clusters of similarly sized settlements in the northern and southern Transjordan Highlands during the LPPNB. In the northern cluster the sites of 'Ain Ghazal, Wadi Shu'eib, as well as the potential large-scale LPPNB villages of Tell Abu Suwwan and Kharaysin are all separated by between 12 and 35 km. In the south the large LPPNB villages of Basta, 'Ain Jammam, and al-Basit are separated by between 12 and 15 km. Unfortunately, we do not have sufficient radiocarbon dating of sites to identify contemporaneity. We do know that the later LPPNB site of Ba'ja and the earlier large village of Basta, separated by 21 km, are not contemporaneous.

The two villages of Khirbet Hammam and el-Hemmeh only 6 km apart in the Wadi Hesa may have been contemporaneous in the LPPNB. Khirbet Hammam is estimated to have reach 6-7 ha (Peterson, 2009) in area while Hemmeh is thought to have been 2 ha (Makarewicz et al., 2006). While there is a size difference between these sites, it is not on the scale typically indicative of settlement hierarchy. Additionally, there is no evidence from architectural or artifactual remains that either of these sites were notably different in their composition or function. That being said, only a very small portion of Khirbet Hammam has been excavated and reported. There are a handful of medium sized village sites known from the LPPNB outside of the regions in which large-scale sites have been identified, such as the 1-5 ha Tel Tif'dan in Wadi Faynan (Moreno, 2009; Twiss, 2007a). This suggests that such sites could exist as autonomous villages rather than satellite settlements to large-scale villages. There are many examples from the ethnographic (Beierle and Skoggard, 2000; Bradfield, 1995; Lane, 1986; van Beek, 2001) and archaeological (Adams and Duff, 2004) records of village settlement clusters with varying sized settlements operating as essentially co-equal communities, often even more closely spaced than known PPNB village sites.

Previous work within the PPNB core village areas of the southern Levant has not identified any other form of settlement than that of the permanent village or non-habitation logistical extraction sites for raw materials such as stone for knapping or adornment production. Several regions, such as the narrow coastal plain and the arid southern and eastern desert fringes of the Levant do contain sites which were occupied by semi-sedentary or mobile populations (Kuijt and Goring-Morris, 2002). However, as reviewed in Chapter 6, significant numbers of small-scale PPN sites have been identified throughout the southern Levant. These sites have yet to be investigated through excavation to determine if they do indeed contain evidence of other

forms of settlements within village-based settlement systems. Thus, it is possible that small-scale satellite settlements, like those reviewed in Chapter 4, could have existed in the PPNB and have yet to be identified through excavation.

Expectations: There are several possible forms of settlement organization that facilitate more efficient spatio-temporal utilization of subsistence production loci than the aggregated villages of the PPNA. However, the possible range of hypotheses for such potential structures is constrained by our previous knowledge. All evidence thus far points to sedentary communities inhabiting permanent, densely populated villages within a core area of the southern Levant and mobile populations inhabiting a series of sites throughout the annual cycle in the coastal and arid fringes. Thus, within the core village area we would expect to see satellite settlements as the primary means of increasing productive efficiency through spatio-temporal organization, as there is strong evidence against a shift to settlement dispersal. However, to control for the potential that a dispersed sedentary population did exist in the region, the criteria for identifying all forms of small sites describe in Chapter 4 will be tested.

Hypothesis 2

In order to meet the nutritional needs of increasing populations, communities living in nucleated settlement patterns will increase subsistence production per unit of area (i.e., subsistence production must intensify) due to land pressures from both population growth and travel and transportation costs. As discussed in Chapter 2, such a phenomenon was first fully argued and documented by Boserup (1965) and has since been shown to be a common phenomenon throughout the world when travel and transportation costs place limits on land access for growing populations (Chisholm, 1979; Stone, 1996)

Expectations within and Outside of Villages:

Intensified Subsistence Production: Plants

A: Reduced Number of Plant Species Consumed by Households

Justification: Harris (1996) has noted that as plant economies intensified in the northern Levant during the MPPNB that the range of food species found in village paleo-botanical assemblages was greatly reduced. Thus, there would be far fewer food species expected to be found in M-LPPNB village settlement systems than in the preceding PPNA or in M-LPPNB mobile forager settlement systems. Such an observation fits with the broader literature on subsistence intensification. In classic intensification theory (Boserup, 1965) the process is seen as a tradeoff of labor efficiency for increased production. However, there are other sorts of efficiencies which intensification improves such as travel and transportation costs, settlement reorganization costs, and inter-personal, inter-household, inter-social unit, and inter-community costs (Stone, 1996). One such efficiency that has been identified is a focus of labor on the most productive species per unit of area. Thus, economic practices become directed at a more narrow set of high-yield products (Gray, 2005).

Literature Review: A review of paleo-botanical assemblages from PPNA sites and M-LPPNB village and mobile forager settlement systems produces uneven results with certain PPNA village sites, most notably Netiv Hagdud (Kislev, 1997), showing a wide range of recovered plant species. However, other villages sites such as Jericho (Hopf, 1983) and Gilgal I (Kislev et al., 2010) do not. However, this is likely due to methodological biases as the excavators of Netiv Hagdud utilized fully modern recovery methods including sieving and flotation while those of Jericho and Gilgal did not. Additionally, this bias may be due to reporting as earlier reports frequently focused on domesticable species as the only remains of interests. This was because the identification of the earliest domestic plants was a major goal of

the work. Since this time most PPNA sites using contemporary standards of recovery and reporting have identified large assemblages of potential economic taxa at PPNA sites (Kislev, 1997; White, 2013). The one exception to this is the major PPNA site of WF16. However, the reason for this is that macro-botanical preservation at the site was so poor that few remains of any sort have been identified (Kennedy, 2007).

For PPNB mobile forager sites, a similar pattern exists with Wadi Jilat 7 and 13 yielding a high diversity of recovered potential economic plant species (Colledge, 2001), but other small sites being more variable in their results. There are several potential reasons for such a pattern, the most likely being that the economic strategies employed at the sites varied as such settlements were likely only occupied during specific periods during the year when specific economic opportunities were available due to the seasonal nature of plant and animal food availability.

When comparing the results of archaeobotanical assemblages from PPNB village settlements to those of PPNA villages and PPNB mobile forager settlements, there are still strong indications of a reduction in the number of plant species used with the sites of Basta (Neef, 2004) and 'Ain Ghazal (Rollefson et al., 1985) strongly supporting such a contention and the site of Tel Tif'dan likely supporting it as well. All three of these sites utilized contemporary standards of recovery and reporting. At 'Ain Ghazal and Basta there is a notable focus on orchard species such as pistachio, almond, acorn, and fig with virtually no recovery of other likely wild taxa of any other sort. At Tel Tif'dan there is simply a notable reduction in all likely wild species as compared to domesticable ones. The sites of Beidha (Colledge, 2001) and Jericho (Hopf, 1983) may also support the possibility of a reduction in the overall variety of plant species utilized in PPNB villages as compared to PPNA ones, as reports from these sites are almost entirely

comprised of domesticable non-woody and orchard species. That being said, the potential bases of the Jericho assemblage have already been noted and the early date of excavation for Beidha did preclude the usage of fully modern recovery methods. However, results from Beidha do include a number of small wild legumes and grasses, suggesting comparably successful recovery methods to those of more recent excavations.

There is, however, one site which does contradict such a trend. The site of el-Hemmeh was analyzed using new recovery methods (Shelton and White, 2010) which have since been adopted at a number of sites around the world (White, 2013). These methods yielded an assemblage of 42 species recovered from PPNA levels and 57 from LPPNB levels. Accounting for these surprising results can be done when taking other results into account. There are other forms of evidence for an intensification of plant economies, specifically the intensification of cultivation, at the site including a notable uptick in cereal remains, the introduction of domestic wheat (White, 2013), and an increase in storage capacity at the site (Makarewicz and Rose, 2011; Makarewicz et al., 2006); let alone indirect evidence such as a significant increase in site area and architectural density (Makarewicz and Rose, 2011; Makarewicz et al., 2006).

When the changes in the presence of plant taxa are examined more closely two patterns emerge. Firstly, there is an increase in the number of cereal taxa present due to the introduction of domestic wheats. Secondly, a high number of seeds commonly associated with ovicaprid forage increases, such as small legumes and woody shrubs (White, 2013). It is also well established that ovicaprid herding was occurring at el-Hemmeh during the LPPNB (Makarewicz et al., 2006). Thus, it seems likely that the increase in species present at the site in the LPPNB is due to the intensification of production through the introduction of wheat and the transportation of forage seeds back to the site in the form of animal dung. Therefore, while there is not an

overall reduction in the number of plant taxa identified at Hemmeh, the pattern seen is one consistent with an intensification of plant economies.

Expectations: At the site of al-Khayran we would expect to see a reduced botanical assemblage as compared to earlier village sites and contemporaneous mobile foraging sites. In fact there is also the possibility that al-Khayran would have a reduction in the breadth of taxa represented as compared to PPNB village sites as well, as the site is potentially a form of satellite settlement. Thus, if the analysis of Hypothesis 1 does suggest that al-Khayran was a satellite settlement occupied on a temporary and repeat basis with specific economic activities being enacted that were targeting a subset of all the plant-based economic practices of the settlement system in which it was embedded then expectations for which taxa would be present would likely have to do with what activities were hypothesized for the site. In the present dissertation it is hypothesized that plant taxa associated with architectural construction, fire building, food processing, cooking, and the summer harvest would be emphasized. While it is likely that visits to the site were made throughout the year, the bulk of the occupation at the site was during the harvest season, making those items consumed on-site to be significantly more likely to be recovered. If a broad spectrum of plant species was recovered from al-Khayran not fitting the patterns seen at LPPNB el-Hemmeh, then this would disprove the hypothesis that al-Khayran was a specialized subsistence production-site associated with a village settlement system. If a broad spectrum of plant species was recovered from al-Khayran fitting the patterns seen at LPPNB el-Hemmeh then it would disprove the hypothesis that al-Khayran was a satellite settlement focused solely on plant production within the subsistence realm, but also likely had a herding component to its activity repertoire.

When turning to the PPNB village settlement within the study area, the site of el-Hemmeh is the only one with substantial published results of botanical assemblages. As reviewed above, these results do not fit the expectation that a reduced number of plant taxa will be present at village sites. However, these results – when taken within the wider subsistence economic context of the site – do not disprove the hypothesis that plant economies were intensifying during the PPNB.

B: Shift in Ratio of Plants Consumed from Highly Nutritious Species to High Calorie Ones

Justification: Bocquet-Appel (2008) presented the most thorough statement of the nutritional processes at work in intensifying plant economies during population growth. On the most basic level, such economies will tend to emphasize subsistence production where the highest number of calories per unit of area can be achieved when demographic pressure creates land pressure.

Literature Review: As has already been noted in Chapter 6, there is ample evidence of such a process occurring during the PPNB with LPPNB sites showing significantly greater emphasis on cereal crops (greater calories per unit of area) over pulses (greater protein and variety of micro-nutrients).

Expectations: The expectations at al-Khayran would be an emphasis on cereals over other plant foods in the paleo-botanical record. If such an emphasis was not found then it would disprove al-Khayran being a satellite subsistence production locus for cereal crops.

As reviewed in the previous section, the village of el-Hemmeh – the only PPNB village settlement in the study area for which we have significant paleo-botanical results published – does have an assemblage indicative of an increased emphasis on cereals by the LPPNB. Other

village sites in west-central Jordan have yet to have their macro-botanical assemblages published.

C: Increasing Processing of Plants

Justification: Wright (1991, 1993, 2000) has most vigorously argued for the expansion and specialization of plant processing artifacts during the intensification of plant economies in the southern Levantine PPNB. Her essential argument is that as plant economies became more focused on cultivation and cereal production, the extractive methods used for gaining nutrients from plant intensified. This included increasing effort and specialization in the processing of plant foods.

Literature Review: Wright (2000) has already documented such a phenomenon from the MPPNB to the LPPNB.

Expectations: If al-Khayran is a permanently inhabited small site such as a farmhouse, homestead, or agricultural hamlet, then the expectation would be that greater numbers of plant processing tools per household such as querns, hand stones, pestles, cutting stones, and sickle blades would be expected as compared to earlier sites. However, such an expectation may not be prudent at al-Khayran as it is potentially a satellite settlement. Thus, what might be more expected would be an increase in the quantity of plant processing artifacts associated with the practices enacted at al-Khayran. This would include large quantities of cereal harvesting implements such as sickle blades and small quantities of grain processing implements such as querns and hand stones, sufficient in number for seasonal occupation by a single family. It might be expected that major processing such as threshing would occur in villages as is done in many contemporary communities in the area (Amiry and Tamari, 1989).

However, there are other possibilities such as the drying and storage of cereals on-site for later transport back to villages (Moore, 1979) or the threshing of cereals in the field in order to reduce the weight of packages for transportation back to villages as is commonly done by Bedouin seasonal farmers in the area today (pers. obs.). The former of these two potential uses of al-Khayran would likely not change the expected plant food processing assemblage at the site of al-Khayran. However, the latter whereby cereals are threshed in the field and naked grain is transported back to the village would likely produce a larger quantity of querns and hand stones as they would be used not simply to produce daily food for a family but also be used for specialized processing of enough grain for the entire year (Tzarfati et al., 2013).

As for other village settlements in the study area, such an expectation would definitely be a sustainable prediction. Unfortunately, there has been minimal publication of lithic or ground stone assemblages from the villages of es-Sifiye, el-Hemmeh, and Khirbet Hammam, with the latter two being on-going projects. However, the ground stone assemblage for es-Sifiye is currently being analyzed for final publication (Finlayson, pers. comm.) which will provide one more line of evidence through which to test the hypothesis

D: Increased Storage Capacity per Inhabitant

Justification: Kuijt (2008a) has argued for the essential role of storage in subsistence intensification during the early Neolithic of the southern Levant. Storage can serve to allow for the intensive production of resources which are only available seasonally, as they can be harvested and saved for future use. Thus, greater production can be achieved without waste (Ingold, 1983; Testart, 1982; Woodburn, 1982).

Literature Review: As reviewed in Chapter 4, Kuijt (2000a, 2008a) has documented that not only did storage become associated with individual households and move inside residential

structures as predicted by Flannery (1972, 2002), but also increased in volume per capita through time based on any method of population estimation used for early Neolithic villages.

Expectations: If al-Khayran was a small permanently inhabited site then we would expect to see an increase in storage capacity per residential structure as compared to earlier time periods. If al-Khayran was a satellite settlement there would be three possible storage practices associated with the site. (1) Cereals at al-Khayran could have been harvested, bundled, and dried in the fields on the stalk for later transport into villages as is commonly done by local village farmers in the area today (pers. obs.). This would require minimal storage capacity on-site. (2) Cereals could be harvested and dried on the roof of the structure at al-Khayran for immediate transport back to the village as is commonly found in the ethnographic literature of the US Southwest (Beaglehole, 1937; Bradfield, 1971; Forde, 1931; Kennard, 1978). This would also leave minimal traces of storage structures at al-Khayran. (3) Cereals could be harvested, threshed, and stored at al-Khayran for delayed transport back to villages when labor demands were lower than at the end of the harvest season. Such a pattern has been observable predominantly in the archaeological record of the US Southwest (Moore, 1979). Such practices would create an even more outsized volume of storage space at al-Khayran than is observed in PPNB villages as the entire year's crop (including provisioning for spoilage, gifting, and exchange) would have to be storable on-site.

As for the villages of the study area, Kuijt (2008a) has already analyzed es-Sifiye and demonstrated a greater volume of storage per capita than at earlier sites. A similar patterns can be determined at LPPNB Hemmeh using similar methods as those used in Kuijt (2008a), with a large volume of storage space having been identified through excavations (Makarewicz and

Austin, 2006; Makarewicz and Rose, 2011; Makarewicz et al., 2006; White, 2013). There has yet to be significant architectural recovery or publication from the site of Khirbet Hammam.

E: Domestication of Plants

Justification: The domestication of plants during the southwest Asian Neolithic has long been seen as a form of increasing subsistence production amongst theorists looking towards ecology as a cause of domestication (Bar-Yosef and Meadow, 1995; Childe, 1954, 1952, 1936; Cohen, 2009, 2008, 1977; Smith, 1998; Zeder, 2011; Zeder et al., 2006). That being said, a number of theorists more social in their orientation also have viewed domestication as intensification, even if the impetus for such intensification may have been social (Bender, 1978; Cauvin, 2000; Hayden, 2009, 1990). Rare is the theorist who disconnects domestication from intensification as Hodder (1990, 2007); preferring to view domestication as a form of metaphorical control over the wild regardless of differences in labor expenditure or productivity. However, it is well established that domestication can increase subsistence yields (Zohary and Hopf, 2000) and the ease of nutritional extraction from foods (Feldman and Kislev, 2007; Tzarfati et al., 2013). Thus, it is expected that producers will domesticate plants when these benefits are seen (Hillman and Davies, 1990a, 1990b).

Literature Review: As has been reviewed in Chapter 6, domestication has in fact been observed for plants in the MPPNB and the introduction of new domesticates from the north in the LPPNB (Asouti and Fuller, 2013, 2012).

Expectations: The expectations for the botanical assemblage at al-Khayran would be the presence of morphologically domesticated plant species.

The only PPNB village site within the study area for which we have paleo-botanical remains published is el-Hemmeh. The LPPNB assemblage from this site yielded both domestic

wheats and semi-domesticated barley, with both wild and domestic morphologies present in similar ratios.

F: Cultivation of Plant Foods

Justification: A number of authors have recently presented evidence of pre-domestication cultivation in the southern Levantine PPNB (Colledge, 2004, 2001; Edwards et al., 2004; Meadows, 2004; White and Makarewicz, 2012; Willcox, 2013, 2012a, 2012b). They have shown that as village populations grew during the PPNA, there is increasing evidence of the intentional cultivation of morphologically wild species. It has long been known that cultivation is significantly more labor intensive than wild harvesting of cereals (Bowles, 2011; Harlan, 1967; Ladzinsky, 1975). However, as with other aspects of agricultural intensification, there are built-in efficiencies as well. These include the potential reduction of travel and transport costs, the potential for increasing overall yields through extensification (i.e., the placement of crops on land that does not naturally have them growing there) and intensification (the addition of extra inputs to encourage plant production), and the potential reduction of subsistence risk through both the control of material inputs such as water (which can sometimes not come in southwest Asia without human intervention on the ground) and the intentional placement of subsistence production loci in variable environmental settings to guard against any singular catastrophic event (Stone, 1996).

Literature Review: Pre-domestication cultivation has been identified at a great number of sites throughout the southern Levant from the PPNA through the LPPNB (White and Makarewicz, 2012; Willcox, 2013, 2012b). By the MPPNB there is significant evidence of plant domestication throughout the region as well (Asouti and Fuller, 2013, 2012; Nesbitt, 2002).

Because a number of the morphological changes associated with domestication prevent cereals

from reproducing successfully without human intervention (Feldman and Kislev, 2007; Tzarfati et al., 2013), it has been assumed that domesticates are cultivated. Thus, there is ample evidence of cultivation from villages of the PPNB both in the study area and throughout the southern Levant.

Expectations: If cultivation was occurring at al-Khayran then we would expect that any of a number of the potential signatures of cultivation including an increase in the founder crops of southwest Asian agriculture as compared to earlier periods, the presence of plant foods outside of their natural range, the presence of weed assemblages associated with cultivation, an increase in grain size, the appearance of cereals outside of the general habitat of cereals, and evidence of large-scale exploitation of cereals (Willcox, 2012a).

At village sites within the area, again, we only have significant botanical publications from el-Hemmeh where cultivation has been documented since the PPNA and domestic cereals in the LPPNB (White and Makarewicz, 2012; White, 2013)

G: New Extractive Technologies

Justification: It has been argued that as a result of increasing subsistence production new technologies can emerge, both for the early Neolithic of the southern Levant (Quintero and Wilke, 1995; Quintero, 2011, 1998) and in other cases from the ethnographic present (Boserup, 1981). The logic is simple: new extractive technologies can either be more efficient or allow for greater labor inputs in order to increase overall production.

Literature Review: The most widely cited example of such a process in the PPNB is the emerge of naviform core technology (Quintero and Wilke, 1995; Quintero, 2011, 1998). It has been argued that as subsistence economies turned further toward sickle-harvested cereals, the need for long straight blades increased. Naviform core technology was developed in response to

this need as it allows for a large number of long straight blades to be produced from the same quantity of flint as compared to other knapping techniques. Naviform cores and blades are often viewed as a hallmark of the MPPNB and are found at almost all such village sites of the southern Levant (Barzilai, 2010).

Within the study area, the number of naviform cores is relatively low. This is likely because the majority of the occupations at el-Hemmeh (Makarewicz et al., 2006) and es-Sifiye date to the LPPNB. As for Wadi Hamarash I, there is minimal reporting of knapped stone artifacts as of yet.

Expectations: If naviform core technology was being utilized at al-Khayran we would expect a number of signatures within the knapped stone assemblage. First and foremost, we would expect to find naviform cores themselves. Additionally, the products of naviform core production and reduction, such as crested blades and other forms of ridge removals, as well as bipolar blades.

H: New Settlement and Production Organization

Justification: A common response amongst food producers to increased subsistence demands is to alter the organization of production (Boserup, 1965). In practice, this also frequently means an alteration in settlement practices (Chisholm, 1979; Stone, 1996). By changing where and when production activities occur, it is possible to increase outputs without changing other aspects of subsistence activities, such as extractive technologies or labor group size (Moore, 1979; Preucel, 1990). However, such changes can force individuals to change residential practices in order to be present in specific locations for adequate durations to enact these new production systems (Preucel, 1990; Sutton, 1977).

Literature Review: No evidence has been published that has shown a reorganization of subsistence production activities between the PPNA and the PPNB, as no remains from subsistence production loci have yet been identified. However, there have been multiple publications arguing for the reorganization of economic relations during the PPNB, which is likely inherently tied to shifts in subsistence production organization (Byrd, 2000, 1994; Flannery, 2002, 1972). However, this is only indirect evidence, which is more informative of the likelihood that such processes are happening, rather than how they are happening.

Expectations: If the organization of subsistence production is changing from earlier periods within the study area and this change is tied to shifts in settlement systems, we would expect to find evidence of new forms of subsistence production loci, such as agricultural satellite settlements (Chisholm, 1979; Stone, 1996).

Intensified Subsistence Production: Animals

A: Narrowing of Diet Spectrum

Justification: Kohler-Rollefson and Rollefson (1990) suggested that there was a reduction in the breadth of animal taxa exploited during the PPNB as grazing pressures on wild species hunted alongside intensifying herding of ovicaprids reduced habitat. This led to reduced hunting opportunities for PPNB villagers, forcing them to focus their animal economies further on herded species. Thus, a reduction in the breadth of taxa exploited would be driven by competition from herds and an increasing focus on herding by village communities. While Kohler-Rollefson and Rollefson's (1990) scenario was supported by a reduction in the breadth of animal taxa exploited at PPNB 'Ain Ghazal through time, it must be noted that Campbell (2009) disputed the cause of this reduction in species diversity within the faunal record of the southern

Levantine early Neolithic attributing it instead to predation by village-based carnivores (i.e., domestic dogs and cats).

Another analyst, Horwitz (1996), performed a preliminary analysis of 23 early Neolithic sites for species richness and found that there was a significant reduction in the number of taxa exploited from the PPNA to the MPPNB as animal economies became more focused on medium and large mammals which responded in productive ways to human interventions. Beyond these preliminary studies there has been little interest in faunal studies of diet breadth as an indicator of subsistence change once domestication commences in the Neolithic. However, the same logic that applies to diet breadth studies of plant economies under conditions of intensification would apply to animal husbandry economies; as opposed to hunting ones. Thus, in economies utilizing animal husbandry as subsistence pressures increase, a more narrow focus on the most productive species would be expected.

In foraging economies there are at least two possible responses to hunting pressure. In the periods directly before early Neolithic domestication there has been a great deal of focus on increasing diet breadth attributed to hunting pressures (Flannery, 1969; Marom and Bar-Oz, 2013; Munro and Atici, 2009; Munro, 2009, 2004, 2003; Stiner, 2004, 2001; Stiner et al., 2000, 1999; Zeder, 2012). However, another potential response to hunting pressures is a focus on a narrow range of highly productive and resilient species, especially if hunting pressure continues to increase even as the breadth of exploited species increases (Horwitz, 2003a, 1996; Horwitz et al., 1999; Marom and Bar-Oz, 2013). A recent analysis of the PPNC and PNA site of Sha'ar Hagolan in the northern Jordan Valley has suggested just such a long-term process with increasing hunting pressure (noted not through increased diet breadth, but changes within species

of prey size through time) eventually leading to a focus on cattle and pig exploitation through domestication (Marom and Bar-Oz, 2013).

Literature Review: As stated in the above paragraph, preliminary results from a pilot study do support this phenomenon within the villages of the southern Levant (Horwitz, 1996), as does an analysis of the faunal remains during the M-LPPNB transition at ‘Ain Ghazal (Kohler-Rollefson and Rollefson, 1990). None of the excavated faunal assemblages from early Neolithic villages within the study area have been adequately published to be able to compare either PPNA to PPNB diet breadth or for inter-sub-period comparisons during the PPNB. As reviewed in Chapter 6, however, number of published PPNB village sites do have significantly reduced breadths of animal taxa as major contributions to diet as compared to PPNA villages.

Expectations: While we would expect to see a reduction in diet breadth as compared to earlier periods within village settlements, the situation at al-Khayran is more complex. There are three possible options for a pattern which would not disprove the hypothesis that animal economies within al-Khayran’s subsistence-settlement system were undergoing intensification. Al-Khayran could potentially have been used for both farming and herding, in which case we would expect to find a very narrow diet breadth.

Al-Khayran could also have been used solely for farming. In such a situation there would be two possible hunting strategies which the inhabitants of the site may have followed. They could have opportunistically hunted a wide range of animals during other daily tasks. This would produce a very high level of species richness. This strategy has the advantage of reducing travel and transport expenditures by substituting these costs as born in other aspects of life for those of hunting specifically (Linares, 1976; Makarewicz, 2009), essentially reducing these costs to zero during hunting.

The other option available in areas of extremely low hunting pressure (which may have been the case in the catchment of al-Khayran as it was only a single household) is to focus hunting labor on the largest package possible to allow for a maximal ratio of caloric return per caloric expenditure on hunting (i.e., hunting only the largest huntable package available in the area: the medium mammals of the ovicaprid taxa) (Kelly, 2007; Marom and Bar-Oz, 2013; Munro and Atici, 2009; Munro, 2004; Redding, 1988; Stiner, 2004, 2001; Stiner et al., 2000, 1999; Zeder, 2011). This strategy is more productive if the sorts of hunting activities available in an area require the devotion of exclusive labor for successful production.

B: Herd Management

Justification: In cases of subsistence pressure, brought on by population increase or over-exploitation or some other cause, there are certain herd management strategies, including animal husbandry, that can be enacted by hunters to intensify production (Horwitz, 2003a; Makarewicz and Tuross, 2012; Makarewicz, 2009, 2007; Redding, 2005). These strategies leave signatures in the faunal remains of village settlements. They can vary from the specific targeting of animals within catchments which will naturally be replaced by animals from outside the catchment based purely on behavioral patterns (Redding, 2005) all the way through complex herding strategies including transhumance, foddering, and secondary product exploitation (Makarewicz and Tuross, 2012; Makarewicz, 2009). While the numbers of different variations in management strategy are too diverse to describe in detail here, a number of researchers have developed analytic methods to identify them through faunal remains (Payne, 1973; Redding, 2005; Reitz and Wing, 2008; Zeder and Hesse, 2000; Zeder, 2006, 2001). These methods will be used to test different strategies against the faunal record of al-Khayran and the study area.

Additionally, the knapped stone assemblage at al-Khayran can be used to investigate alternative modes of animal resource acquisition. Specifically, one would not expect to find significant evidence of hunting at al-Khayran if herding was occurring on-site. Thus, there should be low quantities of projectile points and formal tools with impact fractures (Edwards et al., 2004; Sayej, 2004).

Literature Review: As reviewed in Chapter 6, there is significant evidence of a wide variety of herd management strategies throughout the southern Levant during the PPNB. It is clear that by the LPPNB large sites were practicing full animal husbandry and there are suggestions that these husbandry methods may have developed to a complex level to include transhumance, foddering, and even potentially secondary products exploitation (Horwitz, 2003a; Horwitz et al., 1999; Makarewicz and Tuross, 2012; Makarewicz, 2009, 2007). As for the study area, there are no extensively published faunal assemblages. However, Makarewicz has reported finding evidence for potential dairying at el-Hemmeh, which will be published in a forthcoming paper (pers. comm.).

Expectations: Again, because the function of al-Khayran is unclear without testing different expectations with the recorded materials from the site, there are two possible expectations. If al-Khayran was used for herding then one would expect to find a demographic profile matching one of the several potential management strategies identifiable through faunal remains. If al-Khayran was used only for plant husbandry and animal remains derive from hunting, then one of the several potential hunting strategies identifiable through faunal remain would be expected to match with the site's assemblage.

C: Domestication of Animals

Justification: As has already been noted for plant, animal domestication is seen as a strategy which allows for the intensification of subsistence production. While the previous expectation was concerned with specific management practices, this one is concerned with the morphological changes associated with domestication itself. It is known that these changes both in and of themselves are advantageous and are indicative of behavioral changes which are advantageous for increasing subsistence production. Examples of such changes in domestic ovicaprids are a reduction in body size and aggressiveness (Jensen, 2002; Reitz and Wing, 2008; Zeder et al., 2006).

Literature Review: In the southern Levantine PPNB there has yet to be any sites for which domestication versus complex herd management strategies has been definitively identified. However, part of the issue is that while some early reports did indicate a general reduction in mean body size through time, Zeder and Hesse (2000; Zeder, 2001) have demonstrated that much of this change was due to changes in the harvesting patterns of male versus female animals. No sites within the study area have had such morphological changes identified by the early Neolithic.

Expectations: There are several morphological changes which have been argued to be indicators of caprine domestication including a reduction in smallest and largest body size by age grade and changes in horn morphology (Zeder, 2006). Other indicators which have been proposed have not stood up to scrutiny in the long-term. Other types of indicators of domestication tend to be demographic and are not differentiable from management of morphologically wild species. Thus, these assemblage patterns are only used to test the previous expectation of herd management rather than domestication itself.

D: Keep of Herds On-Site

Justification: There is a wide variety of possible practices enacted by herders. Some of these have been reviewed previously and include tethered herding of flocks to and from villages daily, seasonal transhumance, and fully mobile pastoralism. The former two of these possibilities and the infinite variation seen within them would require herds to be kept on-site within village-based settlement systems. Such an arrangement would leave a number of different archaeological signatures including structures for holding animals and spherulites from their dropping (Canti, 1999, 1998; Henry and Albert, 2004; Portillo et al., 2009). Thus, if herding was practiced by village inhabitants it should be detectable on-site.

Literature Review: Penning is notoriously difficult to identify in sites as it can frequently be integrated into habitation architecture or similar in style to other structures within villages. As of yet, no one has definitively identified penning structures based on architectural remains alone. Spherulite analysis is also a recent methodological innovation within archaeology with virtually no early Neolithic sites in the southern Levant being tested. The seasonal settlement of 'Ain Abu Nukhayla located on the south-eastern arid fringes of the southern Levant was embedded within a mobile agro-pastoral subsistence-settlement system during the MPPNB. It is the only site which has had spherulite results published in peer-reviewed journals. The results show that certain structures were likely pens (Henry and Albert, 2004; Portillo et al., 2009). The only site within the study area which has had analysis performed on it is el-Hemmeh. In a preliminary presentation of results ovicaprid spherulites were identified at the site, suggesting on-site penning in the LPPNB (White, 2007).

Expectations: If al-Khayran was used for herding as well as farming then we would expect to recover spherulites from deposits with a high degree of integrity. If it was only used for farming then we would not expect to recover spherulites from deposits.

Intensified Subsistence Production: Agro-Pastoralism

A: The Husbandry of Both Plants and Animals at a Single Site

Justification: As has been discussed in Chapter 6, Bogaard and Isaakidou (2010) have described how functional interconnections between plant and animal economies within smallerholder village-based communities can increase production (see also: Flannery, 1969, 1973; Halstead, 1996, 2006; Bogaard, 2004, 2005; Quintero et al., 2004; Campbell, 2009). Because there is evidence of both plant and animal management throughout the PPNB and especially strong evidence for plant and animal husbandry in the LPPNB of the southern Levant, it is possible that villagers did enact some form of mutualism between these two sectors of the economies in order to increase production.

Literature Review: Within the southern Levant all PPNB site with strong evidence of animal management also have evidence of plant management (Bogaard and Isaakidou, 2010; Bogaard, 2005). That being said a number of PPNA village settlements show no evidence of herd management while showing signs of pre-domestication cultivation including Netiv Hagdud (Kislev, 1997), ZAD 2 (Edwards et al., 2004; Meadows, 2004), el-Hemmeh (White and Makarewicz, 2012; White, 2013), Gilgal (Weiss et al., 2006), and Dhra' (Kuijt and Finlayson, 2009). Additionally, by the PPNC there are pastoral nomad sites in the Eastern Desert of Jordan with evidence of herding but not cultivation (Martin, 1999). Thus, it would seem that at least in the southern Levant, intensive plant management for which the archaeological signatures have been identified developed in the PPNA before identifiable herd management developed in the PPNB. However, once they both developed in the region they are always found together in village settlements, with specialized pastoral nomadism developing in the PPNC in more arid zones.

Expectations: At the site of al-Khayran, as with a number of previous expectations there are two possibilities. If the site was used for both farming and herding by the residential unit then there would be an expectation of finding both macro-botanical and faunal remains at the site as well as complementary evidence of farming such as sickle blades, field scatters, biomarkers, and phytoliths and of herding such as penning structures and spherulites. However, even if households enacted both farming and herding, it is possible that the site was only used for farming as other members of the household could have cared for herds while some were living at al-Khayran, as is common in a number of contemporary transhumant populations (Redding, 1981) including amongst contemporary village populations in west-central Jordan (pers. obs.). There are also a great number of other variations which allow for household herding with satellite settlements devoted exclusively to agriculture (Dahl and Hjort, 1976), let alone a separation of such tasks within economies (Khazanov, 1984). In such a situation, we would expect to only find evidence of plant husbandry such as sickle blades and cultivated crops.

Expectations Outside of Villages

Satellite Subsistence Settlements

A: Small Site Construction

Justification: As reviewed in Chapter 2, one common solution for increasing subsistence production in densely inhabited villages is the use of satellite settlements. These settlements are secondary locations where economically, spatially, and temporally limited production can occur. They offer some of the advantages of extensification such as reducing the need to increase labor per unit of area and of intensification such as reducing travel and transportation costs (Chisholm, 1979; Moore, 1979; Stone, 1996; Sutton, 1977). Archaeologists working in the US southwest

have developed a number of criteria for identifying such sites in heavily nucleated village-based smallholder communities (Crown, 1983; Cutright-Smith, 2007; Haury, 1956; Henderson, 2010; Kohler, 1992; Moore, 1979; Pilles, 1969; Preucel, 1990; Sutton, 1977; Ward, 1978; Wendorf, 1956; Woodbury, 1961). The first and most obvious aspect of such settlements is that they habitation-sties small in scale as compared to villages (Moore, 1979; Preucel, 1990; Ward, 1978).

Literature Review: As has previously been noted, no site, apart from al-Khayran has been proposed as being a satellite settlement, thus there is no previous literature on such settlements. However, there have been a great number of small sites identified through survey (Banning, 1996; Clark et al., 1994; Coinman, 2000; Henry et al., 2001; Jacobs, 1983; MacDonald, 1992, 1988; Miller, 1991; Parker, 2006; Rollefson, 1986b, 1999). Researchers have tended to ignore these sites typically as too destroyed to extract much information or as too limited to be analyzed in any depth. They have instead chosen to investigate sites identified through survey where there are indication of deep deposits and broad horizontal sub-surface remains, such as village settlements (e.g., Clark et al., 1994; Coinman, 2000). Because of this lack of investigation, it is impossible to determine what the role of small sites is in the PPNB of the southern Levant. It is solely this first test of the existence of satellite settlements that has been achieved.

Expectations: If al-Khayran was a satellite settlement then we would expect it to be limited in both horizontal and vertical extent. It would contain a single structure or two of limited size with a limited number of rooms (Moore, 1979).

B: Temporary and Repeat Occupation

Justification: As reviewed in Chapter 2, the point of a satellite settlement is to be occupied on a temporary basis only when it is necessary to perform a specific economic task for which the site is specialized. However, it is also intended to be substantial enough for repeat occupations as the economic task or tasks performed on-site are of long-term use to the occupant (Chisholm, 1979; Stone, 1996).

Literature Review: There are no sites hypothesized to be satellite settlements from the PPNB of the southern Levant apart from al-Khayran. There are sites which have been hypothesized to be temporarily and repeatedly occupied by mobile foraging and herding communities not based in villages (Betts, 1992; Garrard et al., 1994; Maher et al., 2012; Martin, 1999; Quintero et al., 2004; Rollefson et al., 1999). However, these sites are not considered satellite settlements as they are rather stops in the annual round. This difference in relationship between settlements is key for understandings any number of important social phenomena from group size to property rights.

Expectations: If the settlement of al-Khayran is a satellite settlement, it should have limited intensity of occupation (Moore, 1979). It should contain a limited number of structures with clear functional distinctions between them as to suggest a single occupational unit (Woodbury, 1961). There should be depositional evidence of occupation succeeded by non-occupational deposits such as water-washer or wind-blown sediments succeeded by occupational ones. These accumulation layers of cultural and non-cultural deposits should also be limited in extent (Sutton, 1977). It is possible that certain migratory faunal only available in specific seasons (Tchernov, 1994) or specific portions of plants which grow only in certain seasons (Weiss et al., 2004) will be found in the faunal and macro-botanical remains from the site. Even if artifact densities may be low, structures should be substantial in order to survive repeat usages

through time (Moore, 1979). Other evidence of a limited number of seasonal activities should be present such as sickle blades (Preucel, 1990).

C: Specialized Subsistence Productive Activities On-Site

Justification: As reviewed in Chapters 2-4, satellite settlements are used for specialized subsistence products and, thus, do not account for the entirety of subsistence production for a household (Moore, 1979).

Literature Review: Again, since no sites have been identified as satellite settlements, there is no relevant literature. Of course, there are temporary sites used for specialized subsistence production by mobile foraging communities (Fujii and Abe, 2008; Henry and Albert, 2004; Martin, 1999; Portillo et al., 2009; Rollefson et al., 1999). None of these sites are satellite settlements, but rather stops on an annual round.

Expectations: A more limited range of subsistence production activities would be expected to be testified to by the material remains at al-Khayran. Thus, perhaps certain types of foods found in village would not be present or certain types of production and processing equipment (Barkai and Gopher, 2001; Barkai et al., 2007; Gopher and Barkai, 2011, 2006; Quintero, 1996, 1994; Schyle, 2007; Taute, 1994). Additionally, it is expected that evidence of certain activities on-site would be outsized as compared to the overall extent of the site when contrasted with village sites (Barzilai, 2010; Gebel, 1996; Quintero, 1997; Schwartz and Falconer, 1994).

Subsistence Landscape Modifications

A: Water Management Systems

Justification: Water management systems are one of the most common forms of agricultural practice intended to increase subsistence production. This is especially true in the Middle East where the arid environment often demands some form of water management to meet the nutritional demands of all but the least densely populated areas (Mithen and Black, 2011; Wilkinson, 2003). Today within the region many of the crops utilized in the early Neolithic are now grown with irrigation (Amiry and Tamari, 1989; Antoun, 1972; Lancaster and Lancaster, 1995; Lutfiyya, 1966; Mazur, 1979; Palmer, 2001, 1998, 1994; Rogan and Tell, 1994; Tannous, 1944). Thus, it would be one likely response amongst early Neolithic communities in west-central Jordan to growing populations and land pressure to increase production through water management.

Literature Review: As reviewed in Chapter 6, there is currently no evidence of water management practices amongst PPNB village communities. The earliest direct evidence of irrigation in the form of check dam from southern Levantine village occur in the Pottery Neolithic (Kuijt et al., 2007; Mithen and Black, 2011; Mithen, 2010). There has also been a contested claim for a PPNB barrage system in the eastern deserts utilized by pastoral nomads (Fujii and Abe, 2008). Finally, there is potential indirect evidence of water management through stable isotope analysis of charred plant remains from the early Central Anatolian Neolithic site of Catalhoyuk (Bogaard, 2013), although an alternative explanation of the pattern seen would be the selective use of similar environments for cultivation.

Expectations: The best chance of demonstrating water management is the identification and dating of architectural features intended for hydraulic control practices (Kuijt et al., 2007; Wilkinson, 2003). Such dating can be done through either radiocarbon remains found within features and below them or optically stimulated luminescence dating of sediments directly below

features (Rittenour, 2008), as well as technological observations of both features and associated artifacts (Betts, 1998).

B: Terracing

Justification: Another form of agricultural intensification briefly touched upon in Chapter 2 is terracing. Terracing allows for sloped land, which is both difficult to farm and susceptible to nutritional erosion, to be leveled for easier access and to have soil nutrients to be preserved (Netting, 1968). It is a common form of intensification found throughout the world (Gray, 2005), including the southern Levant (Amiry and Tamari, 1989).

Literature Review: To date no terrace features have been attributed to the early Neolithic of the southern Levant.

Expectations: The only way to identify terracing in the archaeological record is direct architectural evidence. The key to such identifications is the dating of terrace features. This can be done through either radiocarbon remains found within features and below them or optically stimulated luminescence dating of sediments directly below features (Rittenour, 2008), as well as technological observations of both features and associated artifacts (Betts, 1998).

C: Field Walls

Justification: Another common form of landscape modification in order to increase subsistence production is the construction of field walls. These features can serve to increase output in two primary ways. Firstly, they help preserve nutrients in fields and reduce erosion. Secondly, they are typically indicators of the segmentation of the subsistence economy whereby sub-community productive units control agricultural lands bounded by field walls (Stone, 1994).

This provides all of the benefits for production that a segmented economy furnishes, as discussed in Chapter 2.

Literature Review: Similarly to agricultural terracing, there have been no archaeological indicators of field walls attributed to the early Neolithic of the southern Levant.

Expectations: Like terracing, the only way to identify field walls in the archaeological record is direct architectural evidence. The key to such identifications is the dating of wall features. This can be done through either radiocarbon remains found within features and below them or optically stimulated luminescence dating of sediments directly below features (Rittenour, 2008), as well as technological observations of both features and associated artifacts (Betts, 1998).

D: Fertilizing of Agricultural Fields

Justification: As discussed in Chapter 7, a common form of subsistence intensification within agro-pastoral economies is the fertilizing of agricultural fields to increase soil nutrients and water levels (Bull et al., 1999; Fraser et al., 2011; Wilkinson, 1982).

Literature Review: There has been no evidence presented as of yet for fertilizing in the southern Levantine early Neolithic with the only stable isotope study of potential manuring to date yielding inconclusive results (Bogaard, 2013). There has yet to be research exploring the possible use of artifact scatters in this time period for the identification of farm fields fertilized with village waste, including manure.

Expectations: It would be expected that artifact scatters located on arable lands would exist with artifacts datable to the early Neolithic and a high preponderance of waste artifacts relative to overall settlement assemblages if the fertilizing of fields with village waste was occurring (Wilkinson, 2003, 1989, 1982).

E: The Development of Farm Field Pathways

Justification: As reviewed in Chapter 2, perhaps the most common form of increasing subsistence production in smallholder farming is extensification (Boserup, 1965). In such situations there are certain practices which allow for the reduction of travel and transportation expenditures under conditions of extensification. These include the overt construction of roads or the passive formation of such pathways through time (Wilkinson et al., 2007). While active road construction is a form of intensification in that it requires an investment of labor to increase production (Stone, 1994), once the investment is complete it does allow for greater land to be brought under production through a reduction in daily costs. This is true for passive and active pathway formation (Wilkinson et al., 2007). Methods for identifying such pathways have been developed through the analysis of satellite imagery, aerial photography, and topographical maps (Ur, 2003; Wilkinson, 1993). It must be noted however, that these hollow-ways form best on open plains and are typically associated with high intensities of usage if they are to be identifiable thousands of years later (Wilkinson, 1993). Neither of these criteria is easily met when considering the archaeology of the southern Levantine early Neolithic.

Literature Review: No such remains have yet been identified for the PPNB.

Expectations: It is possible that the largest-scale villages of the PPNB of the southern Levant could have required sufficient travel intensity between settlements and fields to produce hollow-ways. If so they we would expect them to be visible on detailed topographical maps and/or satellite imagery of the territory surrounding villages.

Hypothesis 3

In order to facilitate/incentivize increased subsistence production to meet the higher nutritional demands of larger settlement populations, economic organization will become segmented along kin-based household lines. As discussed in Chapter 2, as populations expand and subsistence demands grow, the segmentation of subsistence economies is a common way for production to increase. This typically is done along residential and familial lines, leading to nuclear or extended family households as the autonomous economic units of larger village-based agricultural communities (Blumberg and Winch, 1977; Blumberg, 1978; Flannery, 2002, 1972; Kohler, 1992; Netting, 1993, 1982; Nimkoff and Middleton, 1960; Pasternak et al., 1976; Shenk et al., 2010; Smith et al., 2010; Wilk, 1984)

Expectations within and Outside of Villages:

A: Multi-Person Households

Justification: Many communally oriented subsistence economies entail individuals and/or married couples occupying their own habitation structures (Flannery, 1972). Such structures typically have very small floor areas (Naroll, 1962) and can often be arranged in a broader compound formation whereby multiple structures are inhabited by a kin-group (Eskelinen, 1977a; Flannery, 2002, 1972). When subsistence economies become segmented along kin-based household lines, habitation structures typically increase in size to accommodate entire nuclear or extended families (Byrd, 2000; Flannery, 1972; Naroll, 1962). Additionally, these larger residential structures should appear rather redundantly on-sties as to suggest multiple multi-person households, likely occupied by families (Byrd, 2005a, 2000, 1994; Kuijt, 2009a, 2000a, 2000b, 1996).

Literature Review: As reviewed in Chapter 4, there is good evidence from all PPNB village settlements that habitation structures are extensive enough in size to house multiple people. While all MPPNB sites have residential structures that would typically be expected to house between three and size individuals, most houses identified at LPPNB large village settlements are sizable enough to accommodate significantly higher numbers of individuals. Also, as described in Chapters 4 and 6, there is ample evidence of multiple similarly sized residential structures at all PPNB village sites with significant exposures (Byrd, 2005a, 2000, 1994; Kuijt, 2009a, 2000a, 2000b, 1996).

The villages of el-Hemmeh (Makarewicz and Rose, 2011) and es-Sifiye (Mahasneh, 2004) are the only settlements with significant architecture recorded in the study area. Neither has produced nearly the extent of some other LPPNB sites, making the identification and presentation of habitation structures difficult. At el-Hemmeh an area devoid of walls but contained several features has been interpreted as a courtyard, suggesting the existence of a significantly size habitation structure surrounding it, similar in form to those found at Basta and ‘Ain Ghazal. Additionally, a large number of cell-like ground-floor storage units have been identified at el-Hemmeh. Unfortunately, the second-story of these structures where habitation activities would have occurred are not preserved, making it difficult to know the size of residential floor space (White, 2013). At es-Sifiye, while only a small portion of the site has been excavated, the architecture uncovered has been suggested to represent a large courtyard house like those of ‘Ain Ghazal and Basta. This would suggest a significant amount of floor space, large enough to accommodate multiple nuclear families or one extended family (Mahasneh and Bienert, 2000; Mahasneh, 2004, 1997).

Expectations: If al-Khayran was inhabited by a residential unit, then it would be expected to have sufficient floor space to accommodate either a nuclear or extended family, rather than an individual or pair of producers.

B: Kin- or Fictive Kin-Based Households

Justification: As reviewed in Chapter 2, in smallholder communities with household-based segmented economies it is by far most common for these households to be organized along familial lines (Netting, 1993, 1982). Even in house societies, houses are comprised largely of kin, along with a handful of fictive kin and all the members are discursively marked as a unit through the language of family (Beck, 2007; Carsten and Hugh-Jones, 1995; Joyce and Gillespie, 2000; Levi-Strauss, 1988).

Literature Review: At all PPNB village sites where significant numbers of residential structures have been excavated, there have been sub-floor burials identified. This is typically taken as an indicator of trans-generational familial transmission of economic relations. This is because the deceased individuals might bear a relationship to the household structure itself, but it is more likely that it is to the individuals who continue to inhabit the structure (Banning, 1998). This includes the sites of el-Hemmeh (White, 2013), es-Sifiye (Mahasneh and Bienert, 2000; Mahasneh, 2004, 1997), and Khirbet Hammam (Peterson, 2009). Additionally, as Flannery (1972, 2002) and Byrd (1994, 2000) have shown, residential structures within MPPNB villages are of appropriate size for nuclear families of between three and six individuals based on both floor area and roofed floor area measures. The consistency of this suggests some form of reproduction which controls the size of the social unit, such as the nuclear family.

Expectations: As Flannery suggested in 1972 and reiterated in 2002, one would expect to find artifacts utilized by men, women, and children within contexts associated with individual

structures. The identification of such artifacts could be done through a number of different methods from musculo-skeletal markers (MSM) indicative of different practices enacted by men and women, to mortuary analysis of associated artifact types by gender and age, to ethnographic analogy. If al-Khayran was occupied by a nuclear family, such a pattern would be expected. If it were occupied by another social unit such as the logistical party, then different patterns would be expected. While many village households from the PPNB have subfloor burials, it would be unlikely that al-Khayran would contain such mortuary practices as it is hypothesized to be a secondary habitation-site. However, if it did, it would be another potential indicator of a kin-based occupation unit.

Expectations Outside of Villages:

A: Subsistence Focused Satellite Settlements Occupied by Kin-Based Household

Justification: As reviewed in Chapter 2, if seasonally occupied satellite settlements are utilized in order to increase subsistence production, then it is likely that already existing social units will be the actors in their development. Thus, such settlements are typically occupied by individuals acting as a member of a household or entire households (Moore, 1979; Sutton, 1977). As Flannery (1993, 2002) has pointed out, with the segmentation of economies in village-based agricultural communities, the nuclear family typically becomes the locus of subsistence risk.

Literature Review: As noted previous, no sites have been suggested as satellite settlements for the PPNB of the southern Levant.

Expectations: There are two basic expectations for identifying satellite settlements as occupied by village-based households. The first is that an isolated structure with indications of subsistence production should share certain features with village-based households, such as

similar roofed area (Byrd, 2000) and food processing features (Wright, 2000), if it is intended to accommodate village-based households (Moore, 1979; Preucel, 1990; Sutton, 1977). However, it would also be expected to not contain the full diversity of architectural features as village-based residential structures, such as basements for non-subsistence production and storage, as production activities would be focused on a narrower set of subsistence behaviors (Moore, 1979; Sutton, 1977). The second is that the scale of production within the structure should be sufficient but not significantly greater than would be necessary for an individual households for the year (Harlan, 1967; Kennard, 1978; Kuijt, 2008a).

Hypothesis 4

In order to facilitate/incentivize increased subsistence production to meet the nutritional needs of economically segmented larger village populations, property rights will intensify. As reviewed in Chapter 2, the development of stronger property rights as applied to subsistence products provides an incentive for increasing production. Additionally, it enables a more efficient development of segmentary economic relations (Bowles and Choi, 2012, 2003, 2013; Brown and Podolefsky, 1976; Flannery, 2002, 1972; Kohler, 1992; Netting, 1982; Shenk et al., 2010; Smith et al., 2010).

Expectations within and Outside of Villages:

A: Private Production Space

Justification: One of the best indicators of strengthen property rights is the appearance of privatize productive space located within residential structures or compounds (Byrd, 2005a, 2000, 1994; Flannery, 2002, 1972; Kuijt, 2000a; Wilson, 1988; Wright, 2000). This allows for

products and their usage to be privatized more easily and creates a cultural space for private production and consumption.

Literature Review: Within the southern Levant, such a spatial arrangement within PPNB villages has been one of the earliest and most analyzed aspects of changing economic relations in the PPNB. Privatized space has been identified throughout the villages of both the MPPNB and LPPNB (Byrd, 2005a, 2000, 1994; Flannery, 2002, 1972; Kuijt, 2000a; Wright, 2000). Within the study area specifically, while none of the three PPNB villages have had such an analysis presented, it is clear from their architectural drawings and spatial descriptions that ground floor production, consumption, and storage space is the most widely preserved component of the residential architecture at el-Hemmeh (Makarewicz and Austin, 2006; White, 2013) and es-Sifiye (Mahasneh and Bienert, 2000; Mahasneh, 2004).

Expectations: It would be expected that a series of structures similar in form and redundant in content (Byrd, 2005a, 2000, 1994) (thus suggesting habitation functions for the architecture) would have interior rooms with production features (Byrd, 1994; Flannery, 1972; Kuijt, 2000a; Wright, 2000) within the PPNB villages of the study area. While it would not be expected that there would be a series of redundant structures at al-Khayran, it would be expected that a single structure similar in form to the residential structures of villages would be present, again with interior spaces which include production features. Additionally, simply having evidence of occupation by an individual household unit isolated from other units and evidence of significant subsistence production activities on-site would suggest that individual economic units would have some sort of rights claim to subsistence goods.

B: Private Storage

Justification: Similar to private production space, storage spaces redundantly found within the interiors of individual residential structures has been viewed as an important marker of strong property rights (Flannery, 2002, 1972; Kuijt, 2008a). Such spatial arrangements within villages would suggest the private control of subsistence goods by the inhabitants of households.

Literature Review: First identified by Flannery (1972), Kuijt (2008a) has recently demonstrated that the intervening 36 years of new data have held up this early analysis and provided far great quantities of evidence for the existence of private storage space within residential structures in the PPNB of the southern Levant. Within the study area, the site of es-Sifiye has been included within Kuijt's analysis and the site of el-Hemmeh has recently published architectural results suggestive of similar architectural phenomena at the sites (Makarewicz and Austin, 2006; White, 2013).

Expectations: It would be expected that storage features would be found within the interiors of village residential structures, as demonstrated previously by Kuijt (2008a) and presented by Makarewicz and Austin (2006) for es-Sifiye and el-Hemmeh respectively. It would also be expected that such features could be found at the site of al-Khayran.

C: Intergenerational Inheritance of Material Items

Justification: It would be expected that as strong property rights develop, such rights would create the economic structures necessary for the intergenerational inheritance of material items (Banning, 1998; Rollefson, 1997; Shenk et al., 2010; Smith et al., 2010). As reviewed in Chapter 2, such inheritance is dependent on the conceptual underpinnings of strong and segmentary property rights (Becker, 1977; Shenk et al., 2010; Smith et al., 2010).

Literature Review: Evidence for intergenerational inheritance has been indirectly inferred from a number of phenomena identified within villages. The first and most commonly

cited evidence is the sub-floor burial of individuals within residential structures (Banning, 2012, 1998; Kuijt, 2008b, 2000d, 1996; Rollefson, 1997). It is hypothesized that such an action served to assert some sort of lineal legitimacy for tenure rights to the structures. Additionally, Banning (2012, 1998) and Rollefson (1997) have pointed to the occupational duration of some structures at M-LPPNB 'Ain Ghazal showing that some residencies were utilized and renovated for up to 400 years (Banning and Byrd, 1989a, 1987, 1984), well beyond the life expectancy of the individual. The maintenance of the house for this long suggests both that the household unit was reproduced through time and that this unit conferred inheritance rights for the residence, including its storage (and its possible perishable contents) and food processing equipment. To date there has been insufficient dating of residential architecture at any of the PPNB sites within the study area to determine the duration of occupation within individual structures. However, it is clear from construction and renovation sequences at el-Hemmeh (White, 2013) that residential units appear to have changes through time as would be expected with long-term intergenerational occupations (Goody, 1972). Additionally, a number of residential structures at es-Sifiye (Kuijt, 2000d) and el-Hemmeh (White, 2013) have revealed evidence of sub-floor burials.

Expectations: As has been demonstrated at el-Hemmeh and es-Sifiye, we would expect there to be sub-floor burials at the village settlements in the study area. It would also be expected that occupational durations of individual residential structures would extend beyond the duration of individual life-expectancy. However, at the site of al-Khayran, neither of these phenomena would necessarily be expected. As reviewed in Chapters 2-4, satellite settlements are secondary residences where the assertion of intergenerational property rights would be expected to be significantly less strong. However, if either of these phenomena were demonstrated at the site, it

would certainly be supportive of strong property rights in the period and also suggestive of a permanent occupation at the site.

Expectations Outside of Villages:

A: Locating Structures near Production Resources

Justification: As reviewed in Chapter 2, the location of architecture or activity areas controlled by individual economic units near production resources is frequently an assertion of property rights over the resource (Kohler, 1992). This provides a space to maintain a watchful eye on the resource and a space which can house individuals during extraction and processing activities which may have to occur outside of villages (Stone, 1994).

Literature Review: To date, no work has been done to demonstrate such activities. However, there have been those who argue that the production chain of naviform blades within large-scale villages of the LPPNB do suggest the assertion of property rights over certain mining sites for high quality flints (Quintero and Wilke, 1995; Quintero, 2011, 1998, 1996, 1994; Rollefson et al., 2007). This has not been demonstrated through the association of architecture with flint mines, but rather the rarity of mined flint within households and work areas in villages, suggesting limited access to the flints. No such work have been done at any of the villages within the study area. While it is clear that a number of flint mines beyond those analyzed by the above-cited authors existed in the PPNB (Barkai and Gopher, 2001; Barkai et al., 2007; Gopher and Barkai, 2011, 2006; Schyle, 2007; Taute, 1994), it has been less clear who utilized them or under what conditions of economic relations.

Expectations: It would be expected that al-Khayran would be located directly on or next to whatever natural resources were being utilized for production activities at the site. This would

include arable land and water for agriculture. If other activities such as the procurement of high-quality flints or the herding of animals were being enacted by the inhabitants of al-Khayran, then it would be expected that high-quality flint and/or forage would be found near the site. If some of the activities at the site produced craft items, such as flint knapping of high-quality materials, then it would be expected that the location of these rare resources would be near the site as well.

B: Assertion of Land Tenure with Material Markers

Justification: As reviewed in Chapter 2, another common form of asserting land tenure outside of villages is the use of material markers, such as field boundary stones, to claim exclusive control over lands even in the absence of the presence of the owner (Woodbury, 1961). When such markers are cultural codified, they can serve to protect land rights beyond face-to-face interactions.

Literature Review: To date, no such remains have been identified anywhere in the southern Levant as belonging to the PPNB.

Expectations: It would be expected that prominently visible, clearly humanly modified material objects would be placed in some form of coherent pattern within lands suitable for cultivation and that such objects could be dated through a number of means including radiocarbon samples carefully excavated to identify their micro-stratigraphic location, the association of surrounding lands with chronologically diagnostic artifacts, and/or the dating of deposits directly below the markers through OSL.

C: Increased Investment in Subsistence Infrastructure

Justification: As reviewed in Chapter 2, with strengthened property rights, increased investment in subsistence infrastructure is incentivized as producers are no longer alienated from the fruits of their labors (Stone, 1994).

Literature Review: As al-Khayran is the first site potentially identified as associated with subsistence production for village-based communities outside of the spatial bounds of residential clusters, no such phenomenon has been identified for the PPNB of the southern Levant.

Expectations: Similar to both the construction of satellite settlements and the placement of material markers in fields, it would be expected that subsistence production infrastructure such as water management systems, terracing, field walls, and other features would be found associated with cultivable lands. Such infrastructure could be dated through radiocarbon samples, OSL, and associated diagnostic artifacts.

Hypothesis 5

In order to meet the nutritional needs of larger village populations, new concepts of value will develop to facilitate the flow of goods between economic units through both intra- and inter-community exchange (Gebel, 2010). Such a process allows for the growth of populations and the movement of goods within these populations with greater ease as craft produced items can be made without concern over the need for extra-economic relationships in order to obtain value for them, un-related individuals can still furnish goods and services to each other under a shared social system of value, craft items can be produced and disseminated beyond the local community while still providing the producer with assured value, thus creating an incentive for increased production, and the movement of goods between individuals, economic units, and

communities can continue when previous logics of obligatory provisioning become contradictory as populations segment economically (Kohler et al., 2000).

Expectations within and Outside of Villages

A: Commodification of Goods

Justification: As just noted, the development of generalized exchange value for goods (Marx, 1977), as opposed to the movement of goods between individuals based on social relationships of obligation and specific inter-subjective relationships (Kohler et al., 2000; Mauss, 1950) can incentivize increased production and ease the flow of goods within and across communities.

Literature Review: Only one researcher has been extensively publishing on this topic for the PPNB of the southern Levant as many have been skeptical of the development of what might be termed a proto-market economy, at least as part of the overall economy of villages (Gebel, 2010). He has claimed evidence for such a process within two LPPNB sites in the southern Transjordanian highlands: Ba'ja and Basta. He has pointed to the fact that both these sites have evidence of some form of large-scale production of red stone rings, which have no clear functional use. However, each site also shows different technologies of production, suggesting that the same goal of production was had by producers at each site, yet the method of production was unimportant for their use. Because they are of unclear function and two very different production methods were used, Gebel (2010) hypothesized that the use of these rings was the production and retention of value. While no similar pattern has been found within the study area for the large-scale production of sandstone rings, the site of el-Hemmeh has yielded at least one example of such an artifact (Makarewicz et al., 2006).

Expectations: Because these sandstone rings are viewed as value holds, they could be present in any form at any site. What would be expected is possible differences in production methods while remaining true to the same general form. Thus, at al-Khayran it would be possible to find sandstone rings at the site, although it would be more likely to find evidence of their production at the site. This is because, if their function was value holding and exchange, then such completed items would most likely be found in contexts where they could be used. However, it would seem likely that they would be produced in privatized spaces such as the satellite settlement. Other evidence of the development of exchange value without full-blown evidence of market exchange (such as markets) is quite difficult.

Hypothesis 6

In order to increase subsistence production to meet the nutritional requirements of larger populations the new extraction technologies that developed require specialized production. As discussed in Chapters 2 and 6 and presented as one of the tests for Hypothesis 1, the emergence new technologies are commonly associated with the impetus to increase production (Boserup, 1981; Dobres and Hoffman, 1994). In the case of subsistence production in the Neolithic of the Near East, it has been claimed that as populations continued to grow throughout the early Neolithic, not only was an intensification of production seen in practices, but also extractive technologies (Quintero and Wilke, 1995; Quintero, 2011, 1998). It has been argued by a number of authors that naviform blade production was done by craft specialists (Barzilai and Goring-Morris, 2012; Barzilai, 2010; Gebel, 1996; Quintero and Wilke, 1995; Quintero, 2011, 1998, 1997)

Expectations within and Outside of Villages

A: Limited Number of Activity Areas for the Production of New Extractive Technologies

Justification: The very definition of craft production is the limited production of goods by individuals above their own personal need in order to distribute these goods throughout the community in exchange for other items and services of value. An inherent aspect of such a system is the limited number of production areas relative to the number of individuals using the products in question (Arnold, 1987; Costin, 2001, 1991; Evans, 1978). It has been proposed that the new extractive technology of the naviform blade specifically was associated with the intensification of plant production economies in PPNB village settlements (Barzilai and Goring-Morris, 2012; Barzilai, 2010; Gebel, 1996; Quintero and Wilke, 1995; Quintero, 2011, 1998, 1997) and it is this item that would be expected to follow such a spatial distribution pattern of production.

Literature Review: As reviewed in Chapter 4 and 6, there is evidence of craft production of naviform blades at a number of large LPPNB sites (Barzilai and Goring-Morris, 2012; Barzilai, 2010; Gebel, 1996; Quintero and Wilke, 1995; Quintero, 2011, 1998, 1997). All of these identifications have first and foremost pointed to the limited extent of production areas relative to the area of the sites. Within the study area there have been no tests of the limited production areas expectation for naviform blades.

Expectations: At the site of al-Khayran it would be possible for there to be evidence of the production of naviform blades if the household which occupied the site was involved in their production. It is also possible that there would be no evidence of such activities if the household was not involved in their production.

B: Extensive Dispersion of New Extractive Technologies throughout Residential Units at Sites with Limited Numbers of Specialized Production Areas

Justification: The flipside of the spatial distribution of craft production locations is the spatial distribution of craft goods. Inherent to the definition of craft production in a limited number of areas for distribution across communities, would be the dispersal of craft goods to residential structure across settlements, beyond the loci of the economic units that produced them (Arnold, 1987; Costin, 2001, 1991; Evans, 1978).

Literature Review: The same studies that have demonstrated the limited location of craft production areas for naviform blades within large-scale LPPNB sites have also demonstrated the much more widely distributed nature of the goods themselves (Barzilai and Goring-Morris, 2012; Barzilai, 2010; Gebel, 1996; Quintero and Wilke, 1995; Quintero, 2011, 1998, 1997).

Expectations: At al-Khayran it would be expected that naviform blades would be present either with evidence of production or without.

C: New Extractive Technologies Created Through Complex Production Processes

Justification: One of the basic concepts used to explain the development of craft production is the complexity of certain production processes, making their enactment as just one of many tasks performed by individual economic units in their broader processes of production to be significantly less efficient than if a limited number of individuals or units produce above need and redistribute their goods across communities through a number of exchange or reciprocal relationships (Costin, 2001, 1991).

Literature Review: A handful of authors have analyzed the production process of naviform blades and found it to be rather complex and requiring significant skill to master. Thus, they have proposed that this production process was a strong candidate for the development of craft production and distribution systems (Barzilai and Goring-Morris, 2012; Barzilai, 2010; Quintero and Wilke, 1995; Quintero, 2011, 1998). Because such an analysis is based more on

technological sequences and replicative studies, it is not tied to specific sites, but rather to specific types of blades found at nearly all PPNB village settlements across the southern Levant. This is true of all three villages within the study area (Mahasneh and Bienert, 2000; Makarewicz et al., 2006; Peterson, 2004).

However, Barzilai (2010) has also shown that naviform blade production was performed by non-craft producers at smaller sites. Interestingly, he also showed that the skill of producers as measure by the number of useable blades per volume of core varied more by geography and chronology than by scale of production. While he does not interpret these results as such, it could be argued that there is evidence of time, not flint volume as the cost calculus being used by craft producers at large LPPNB villages. In such villages Barzilai (2010) has shown only moderate “skill” by his measure, but his and Quintero’s (1997, 1998, 2011) debitage analyses have shown that at such sites knappers are producing huge quantities of debitage during individual episodes of core reduction. This suggests that the cores themselves are plentiful enough that they are simply attempting to produce as many blades as possible in as little time, rather than carefully striking each blow to be as volume efficient as possible. Thus, the emergence of a new extractive technology may in fact be the large-scale production of naviform blades rather than the blades themselves.

Expectations: If the site of al-Khayran was in fact embedded within a settlement system in which craft production of naviform blades was practiced, then it would be expected that such blades would be found at the site. However, if the site were the location of production for such blades then there would be two options. Either the site could return a “moderate” skill blade production assemblage by Barzilai’s (2010) standard and a large overall quantity of debitage per

episode of knapping or a “high” skill blade production assemblage and a moderate overall quantity of debitage per episode of knapping.

D: Labor Intensive Raw Material Procurement Strategies

Justification: Quintero (1998, 2011) has suggested that the labor intensive and limited nature of the extraction of high quality flints for naviform core reduction is possible evidence of craft specialization as such an extraction system allows for the monopolization of raw materials based on the limited access to them. This is commonly seen as one way in which craft producers maintain their specialized role within communities, especially if their goods are highly valued and provide producers with significant benefits relative to consumers (Arnold, 1987; Costin, 2001, 1991).

Literature Review: As noted above, Quintero (1998, 2011) has presented evidence of the limited nature of purple-pink flint extraction-sites near ‘Ain Ghazal – the nearly ubiquitous type of flint used for naviform cores at the settlement. She has, thus, argued that such a spatial arrangement likely allowed for craft producers, as evidenced by within-village workshop spaces and large quantities of naviform core production waste, to monopolize access to this valuable resource. No such similar studies of flint sources and flint types used for naviform core production have been done within the study area.

Expectations: It would be expected that either al-Khayran would be located next to a high quality flint source for naviform core production if the site functioned as a workshop space for such materials or that all of the flint present on the site was derived from a single source. It would also be expected that if al-Khayran was a workshop space that there would be extensive evidence of core reduction as well as blade production. If it was not then it would simply be expected to have evidence of tool production on blades derived from a single flint source.

Expectations Outside of Villages

A: Small Sites with Evidence of the Intensive Production of a Narrow Set of Goods

Justification: Often craft production is done in workshops away from villages in order to assert access rights to raw materials and to reduce transport costs for heavy materials (Binford, 1980; Gopher and Barkai, 2006; Schyle, 2007; Taute, 1994; Titiev, 1937). In such cases, there is frequently a very limited assemblage found at these sites, primarily focused on the production of craft goods.

Literature Review: As was reviewed in Chapter 3, there is growing evidence of extensive flint extraction and workshop sites away from villages through the PPNB of the southern Levant (Barkai and Gopher, 2001; Barkai et al., 2007; Gopher and Barkai, 2011, 2006; Quintero, 1996, 1994; Rollefson et al., 2007; Schyle, 2007; Taute, 1994). However, it has been very difficult to associate the workers at these sites with villages. It is possible that the occupants of these workshop sites were from mobile communities and traded the flints extracted from these mines and quarries into the village communities of the PPNB.

Expectations: It would be expected at al-Khayran that only a very limited assemblage of knapped stone, as well as ground stone, macro-botanicals, and fauna would be recovered. It would also be expected that the knapped stone assemblage would be biased towards core production and reduction waste, including cortical flakes and crested blades.

Hypothesis 7

In order to meet the nutritional needs of larger populations, inter-community and intra-community exchange will intensify. The goal of this exchange for segmentary economic units is

to increase the acquisition of subsistence items and other goods of value which may be used within new systems of valuation to procure subsistence items. As reviewed in Chapter 2, residential nucleation under conditions of population growth creates significant challenges for meeting subsistence needs, through increased travel and transport costs due to spatial arrangements during a period of increasing demand due to demographic factors. New systems of distribution, as well as production as tested by previous hypotheses, would be expected to develop (Gebel, 2010; Pryor, 1977).

Expectations within and Outside of Villages

A: Inter-Community Exchange

Justification: Inter-community exchange is highly encouraged by the development of the concept of commodities whereby goods can be valued in an abstract scale where value itself is the measure rather than comparative value between goods (Algaze, 2005; Gebel, 2010; Malinowski, 1922; Mauss, 1950; Munn, 1986; Renfrew, 1975; Wallerstein, 1974). The development of such a system is encouraged on a regional or inter-community scale when there is a demand for subsistence goods outside of the local economic system of circulation. Such a demand can develop under conditions of population growth or subsistence pressure or both (Wallerstein, 1974). Thus, it is quite possible that PPNB settlement patterns and demography encouraged the development of new systems of exchange and valuation.

Literature Review: While there is evidence of the movement of significant quantities of rare raw materials and products made of materials not widely available across communities well before the early Neolithic (Richter et al., 2011), the earliest evidence of potential symbiotic exchange of subsistence goods between mobile foraging and sedentary farming communities

comes from the a series of forager sites in the Sinai Desert with diagnostic knapped stone material dating the sites to the PPNB. At these sites there is evidence of extensive shell bead production, as well as cereals. Because the cereals could not have been grown locally and shell beads like those produced at the sites are found within village farming settlements of the PPNB, the author hypothesized that the beads were traded for grain (Bar-Yosef Mayer, 1997). No other such analyses involving subsistence items have been presented for the southern Levant either within the study area or outside.

Expectations: Like Bar-Yosef Mayer's (1997) analysis, we would expect to find extensive distribution of goods not found within local catchments (Renfrew, 1975). We would also expect, again like Bar-Yosef Mayer (1997), to find evidence of subsistence goods located well beyond their loci of procurement. Unfortunately, the location of the study area in general and the site of al-Khayran specifically are within the natural range of nearly all plant and animal food species, thus making it impossible to determine if food stuffs were traded in or procured locally. However, the presence of other types of items from distant locals such as shell beads, certain colored stones, and obsidian to name a few examples, would be evidence of the long-distance movement of goods. Because it would be expected that the types of settlement systems in which al-Khayran was likely embedded would be the producers of surplus subsistence goods for trade with mobile foraging communities (i.e., subsistence goods would leave the community and rare raw materials and goods would flow in), it will be difficult to differentiate results at al-Khayran from earlier evidence of long-distance trade of rare materials.

B: Surplus Production for Exchange

Justification: In order to have subsistence goods for exchange, economic units must produce surpluses beyond the need of the unit (Kuijt, 2009b; O’Shea, 1981; Peterson, 1978; Spielmann and Eders, 1994; Spielmann, 1986; Spielmann et al., 1990).

Literature Review: There has only been a single study published quantifying the amount of surplus production per economic unit in PPNB villages. According to Kuijt (2008a), surplus grain storage space was not available to villagers until the LPPNB. This would suggest that it is within this period that the first significant amount of redistribution and exchange of subsistence goods was occurring. This study included the site of es-Sifiye within the study area. While el-Hemmeh was not included, it is likely that similar calculations could be made for the site considering the architectural similarities it shares with a number of other LPPNB settlements included in Kuijt’s (2008a) study, such as ‘Ain Ghazal, Basta, and es-Sifiye.

Expectations: If al-Khayran was a permanently occupied small site then it would be expected to have storage capacity above the level necessary for household maintenance. However, in small site settlement patterns such as dispersed settlements, homesteading, and small agricultural hamlets, surplus production on any significant scale is rare, with only a “normal surplus” being typical (Halstead, 1989). If al-Khayran was a satellite settlement it is difficult to know if storage above the seeming needs of the occupants would either be present or indicative of surplus production. As reviewed in Chapter 2, some satellite settlements are used for longer-term storage as a mechanism to more evenly distribute travel and transportation labor demands over the annual cycle. In such a case, the quantity of storage at the site could be significant as it would be required to hold the entire year’s worth of subsistence goods all at once. However, it is also possible that no subsistence items would be stored at the site long-term. Additionally, if the site was used for the storage of food, it would likely only be for the year’s

crops. A number of studies of long-term storage behavior have shown that sometimes economic units can attempt to store enough food to last three years in order to guard against inter-annual variation (Halstead, 1989; Ingold, 1983; Kuijt, 2008a; O'Shea, 1981; Testart, 1982; Woodburn, 1982). Thus, while there may be surplus production, it might not be evident at al-Khayran.

C: Craft Production for Exchange

Justification: While the previous expectations have focused on subsistence production for exchange, it is also possible to analyze the production of non-subsistence goods by craftspeople for exchange within the same systems of valuation, such as the beads in Bar-Yosef Mayer's (1997) case-study. It is hypothesized that broader systems of valuation might develop and these systems may include craft goods such as beads (Bar-Yosef Mayer, 1997) or red sandstone rings (Gebel, 2010, 2004a; Starck, 1988).

Literature Review: As reviewed above and in Chapter 6, there has been a significant amount of research on craft production in PPNB villages. Within the study area no such studies exist. However, a number of items, which have been proposed as craft goods such as sandstone rings and naviform cores have been identified at the village settlements of the study area (Makarewicz et al., 2006).

Expectations: It is virtually impossible to differentiate craft production in order to acquire subsistence goods and other goods. Thus, the criteria for testing the hypothesis of craft production in general would test the hypothesis of craft production for subsistence acquisition, but not as compared to craft production for intra-community exchange.

Chapter 11: Research Methods

In this chapter the methods used for generating the necessary data in order to test the seven hypotheses presented above will be reviewed. These methods include fieldwork procedure for two seasons of pedestrian environmental and archaeological survey, surface collection, testing, and excavations. They also include post-fieldwork laboratory analysis of scientific samples and recovered material culture.

Identification of al-Khayran

Al-Khayran was first identified within the international archaeological community through a 1981 survey, directed by Jacobs (1983). In the report from the survey Jacobs published several illustrations of formal knapped-stone tools from the site's surface. Included were two point types unique to the Pre-Pottery Neolithic: an el-Khiam point, typical of the PPNA and a Helwan point, typical of the EPPNB (Figure 38). However, because of the large quantities of Chalcolithic pottery and flints found on the site's surface, as well as two structures, one on the terrace edge and one at the bottom of the northern hill-slope, typical in construction techniques to the Chalcolithic and later periods, Jacobs identified the site as Chalcolithic. She estimated the site size as 0.09 hectares, noting that Chalcolithic pottery was concentrated on a terrace at the top of the site's hill-slopes and that flints were distributed below the terrace.

2007 was the first season of the 'Assal-Dhra' Archaeological Project. The aims of the season were to conduct (1) a preliminary survey of the surrounding area looking for prehistoric remains of settlement and subsistence systems, (2) intensive surface collections to determine the

extent and dating of al-Khayran, and (3) test excavations to investigate the existence of sub-surface deposits. The goal of the season was to identify a PPNA village where the economic activities at the site could be compared to two other excavated PPNA sites, Dhra' (Finlayson et al., 2003) and Zahrat adh-Dhra' 2 (ZAD2) (Edwards et al., 2004), located 10 and 12 km north of al-Khayran respectively. The hypothesis being tested was that PPNA communities in central and southern Jordan practiced vertical transhumance (cf. Henry, 1995). Al-Khayran is located on the edge of the Jordan Plateau, above the Dead Sea Basin escarpment and Dhra' and ZAD2 are located on two alluvial terraces at the base of the escarpment over 800 meters lower in elevation, despite being separated by such a short horizontal distance. This provides the inhabitants of each site with access to vastly different environments and, therefore, natural resources. It was thought that perhaps resources specific to the Dead Sea Basin could be found at al-Khayran demonstrating some sort of relationship between the sites.



Figure 38: Slide of Knapped Stone Surface Collection Finds at al-Khayran from the 1981 Survey of the South Ridge of Wadi 'Assal (Linda Jacobs)

The second season of ADAP was in 2010. The aims of the season were (1) to excavate a broad horizontal exposure of al-Khayran in order to determine if any architecture or bounded activity areas could be defined within the sub-surface deposits, (2) detailed mapping of the site and its catchment, and (3) to identify all significant loci of limited or rare natural resources utilized by early Neolithic villagers within Wadi 'Assal including water, flint, bitumen, and basalt. The overall goal of the field season was to locate a PPNA-EPPNB village and determine if those social forces identified in the PPNA as producing the fully-elaborate, large-scale, densely inhabited villages of the MPPNB were amplified in the EPPNB, as an

indigenous model of village formation posits (Edwards et al., 2004), or if the social structures of EPPNB villages were largely conserved from the PPNA as a replacement model of village formation posits (Cauvin, 2000). Following the results of the 2010 season, a new set of hypotheses which this dissertation tests were developed based on the chronology of and the recovered materials from al-Khayran.

Fieldwork Procedures

2007 Season

Survey: A survey area of approximately 54.5 square kilometers stretching from the Dead Sea in the west to the source of Wadi ‘Assal in the east and the northernmost edge of the Wadi Dhra’ debouchment in the north and the southernmost edge of the Wadi ‘Assal was defined. This area was divided into six terrain types: (1) *Ghor* (the shore of the Dead Sea); (2) the Foreslope; (3) the Lower Slope; (4) the Upper Slope; (5) the Plateau; (6) *Wadi* bottoms (Figure 39). Following this, the survey area was divided into 0.5 km x 0.5 km squares. Each square was assigned to one of the six terrain types based on the predominant terrain type found within the square. Then each square within each terrain category was numbered. This was done under the assumption that different terrain types would be differentially utilized during the early Neolithic. There was a total of 218 blocks across the six terrain types.

It was estimated that most of these squares would take approximate one day to survey given the ruggedness of the terrain and the frequently long travel times to reach each square. It was decided that a preliminary survey of 5% of the total area, making sure to sample at least one square from each terrain type, would provide better information for a revised survey strategy in succeeding seasons. Therefore, a random number generator that could be given an upper limit (based on the number of squares in each terrain type), was used to select which square would be

surveyed for the day within the terrain type of the team's choosing. Eleven blocks were surveyed.

The team would drive out to the square guided by a handheld GPS unit. The terrain

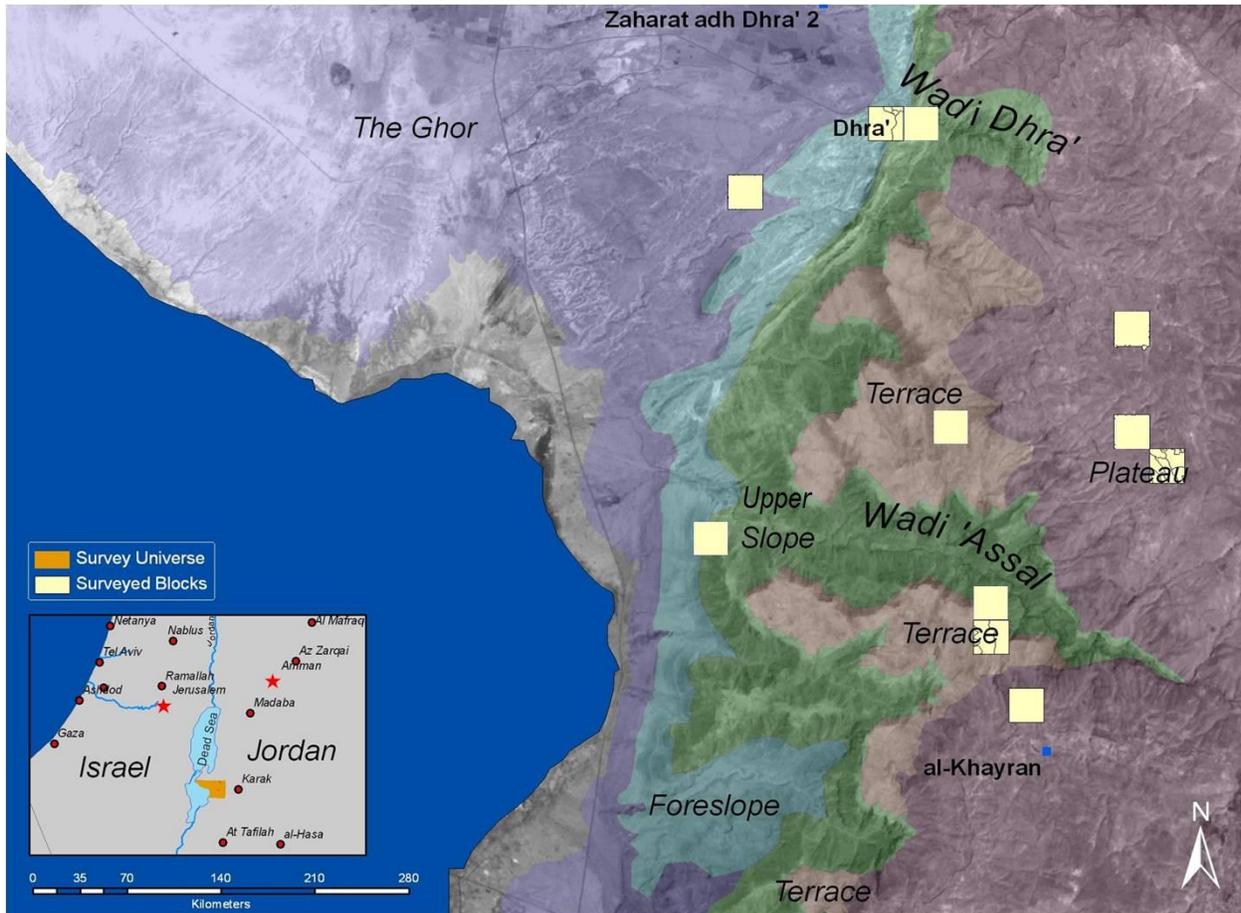


Figure 39: Map of Survey Designations and Surveyed Blocks (Eliza Wallace)

would be assessed and an appropriate strategy for covering all of the area which was not impassable rocky terrain would be devised. Our goal was a series of pedestrian transects spaced 10 meters apart, however because of the variable nature of the terrain, single team members were often assigned areas to cover individually. After each team member was assigned a task, the project leader would take the GPS unit and trace the edges of the square as well as the edges of the various areas being survey and record relevant geographical information about each area such as farming activity, surface cover, and geological and ecological information.

When a cluster of three prehistoric artifacts was identified by a team member he or she would make a 10 square meter dog-leash collection unit (Figure 40) in which all prehistoric artifacts were collected, sorted by type, and photographed before they were re-deposited as per the Department of Antiquities' request. Then this team member would triangulate a second dog leash collection unit within 15 meters of the first and follow the same collection procedures. This would continue until the northern, southern, eastern, and western edges of the artifact scatter was identified based on two successive collection units producing no returns on each side of the



Figure 40: Dog-Leash Collection Unit

collection area. A preliminary assessment of chronology and any potential prehistoric practices at the sites based on artifact types was made in the field. Upon return from the field each day a secondary assessment of the artifact collection was made based on artifact categories and diagnostic artifacts such as cores, tools, and

decorated pottery seen in the photographs. Following the field season, this was subsequently followed up on with a more thorough re-examination of the photographs to determine what time periods were represented in the collection units and in what proportions.

In addition to artifacts, landscape modification and architecture were also recorded including check dams, hunting blinds, burial cairns, chamber tombs, buildings, field walls, terracing, retaining walls, wells, and cisterns. Whenever artifacts could be associated with these architectural and landscape modification features they were collected in the same manner as

described above. Other resources known to be utilized by early Neolithic populations including water sources such as springs, seeps, and perennial streams, as well as flint, basalt, bitumen, and marls were also recorded (Figure 1). Two resources used in the early Neolithic not recorded were limestone and sandstone as they are nearly ubiquitous at different elevations (Figure 41), as outlined in Chapter 3. A series of plant collection units were also made within survey squares by the team's paleo-environmental specialist, Chantel White (White, 2013) (Figure 42). Finally, any



Figure 41: View of Dead Sea, Looking Northeast from al-Khayran. Note the Limestone Terrace in Front and Sandstone at Lower Elevations within the Wadi.

medium or large mammals, both herbivores and carnivores, which were encountered on survey were recorded.

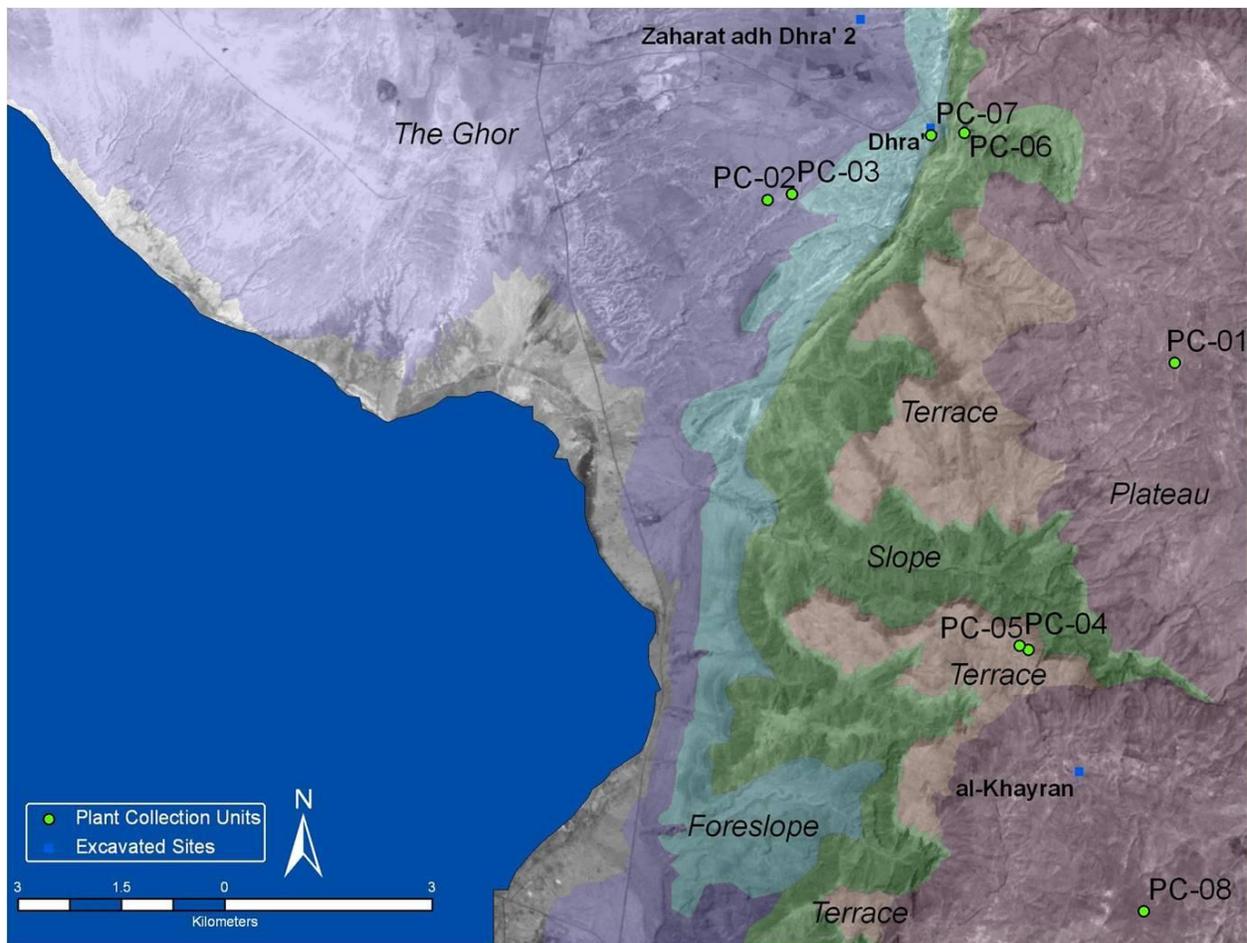


Figure 42: Plant Collection Units (Eliza Wallace)

Surface Collection at al-Khayran

Based on the locational information provided by Jacob's (1983) publication, the site of al-Khayran was located. Using the same dog leash collection unit method as used in survey, a surface collection was made over the extent of the entire site. First a series of collection units were laid onto the site running north-south and east-west, spaced every 15 meters. The end of the collection rows were determined to be when two units in a row produced no artifacts. From these preliminary cross-section of collection units it was possible to identify the north-east portion of the site as the location of heaviest early Neolithic returns based on a high frequency of bi-directional blades, the presence of bi-directional blade cores, formal tools made on bi-directional

blades, and a lack of ceramics. It was also possible to determine that the terrace at the center of the site was the focus of the Chalcolithic occupation, wholly separate from the Neolithic one based on the presence of Chalcolithic pottery, flake cores, and flake-based tools.

Following this determination that the north-east portion of the site was the locus of Neolithic occupation a series of 77 ten-square-meter dog leash collections units were placed on top of this portion of the site using the same method as survey surface collections. This included triangulated locations 15 meters apart continued in all directions until two consecutive units in any given direction yielded no artifacts. From these collection units an area of ~0.36 ha was identified as the extent of the early Neolithic surface scatter (Figure 3). Finds from these collection units were consistent with previous results. Large numbers of bi-directional blades and formal tools from bi-directional blades were recovered, as were two Helwan points.

Test Excavation Units



Figure 43: Profile of Test Excavation Unit

Following the determination of the surface scatter extent at al-Khayran, three 2 x 1 m test excavation units were dug (Figure 43). The first of these units was placed on the eastern edge of the early Neolithic scatter where a number of diagnostic tools were recovered. The second test unit was located in the center of the early Neolithic scatter. The third was located across a retaining wall along the edge of the terrace that was the focus of the

Chalcolithic remains. The units were divided into 1 x 1 m excavation squares and dug in stratigraphic layers subdivided into 10 cm arbitrary levels for better control of vertical changes in recovery rates within strata.

In the eastern unit there was essentially no depth to the deposits except where recent ploughing had buried some artifacts, suggesting that this portion of the scatter was denuded by slope erosion. In the unit located in the center of the Neolithic artifact scatter, the depth of deposits varied from 20 cm downhill to 30 cm uphill. However, no stratigraphic layers were visible in the deposits. The third test unit near the Chalcolithic scatter returned knapped stone and ceramics typical of the Chalcolithic. This reinforced the notion that what had been identified in the Jacobs (1983) survey was in fact two distinct sites from two time periods located on the same hill-slope. Erosion mingled some of the artifacts from the two occupations on the surface.

2010 Season

Site Mapping

The first task of the season was the map al-Khayran topographically and to record all architecture and resource locations visible on the surface of the site. This was done with the help of Jamal Safi of the Department of Antiquities. Using a differential GPS, a single spatial datum was placed at the highest point on the site using rebar and concrete. Then a total station was located directly above the datum from which individual points used for the topographical and resources map were shot. For the topographical map starting on the northern edge of the site, an individual with a prism walked west-east/east-west transects stopping every five meters for another data point. Once each transect was finished the individual would move five meters south and walk another transects until the entire area was mapped.

Following this, individual archaeological features visible on the surface included retaining walls, a series of buildings, hunting blinds, burial cairns, a chamber tomb, a major flint source, a water seep, farming plots, and a Bedouin camp site. This included a series of buildings and a chamber tomb located on a terrace approximate 170 meters east of al-Khayran, constructed in a similar manner to those a large building found on the terrace above al-Khayran, which was the source of the Chalcolithic artifacts. However, no pottery or other datable artifacts were found associated with the architecture to the east, making dating purely speculative. Additionally, it was not possible to date any of the other features visible on the surface of the site to the Neolithic

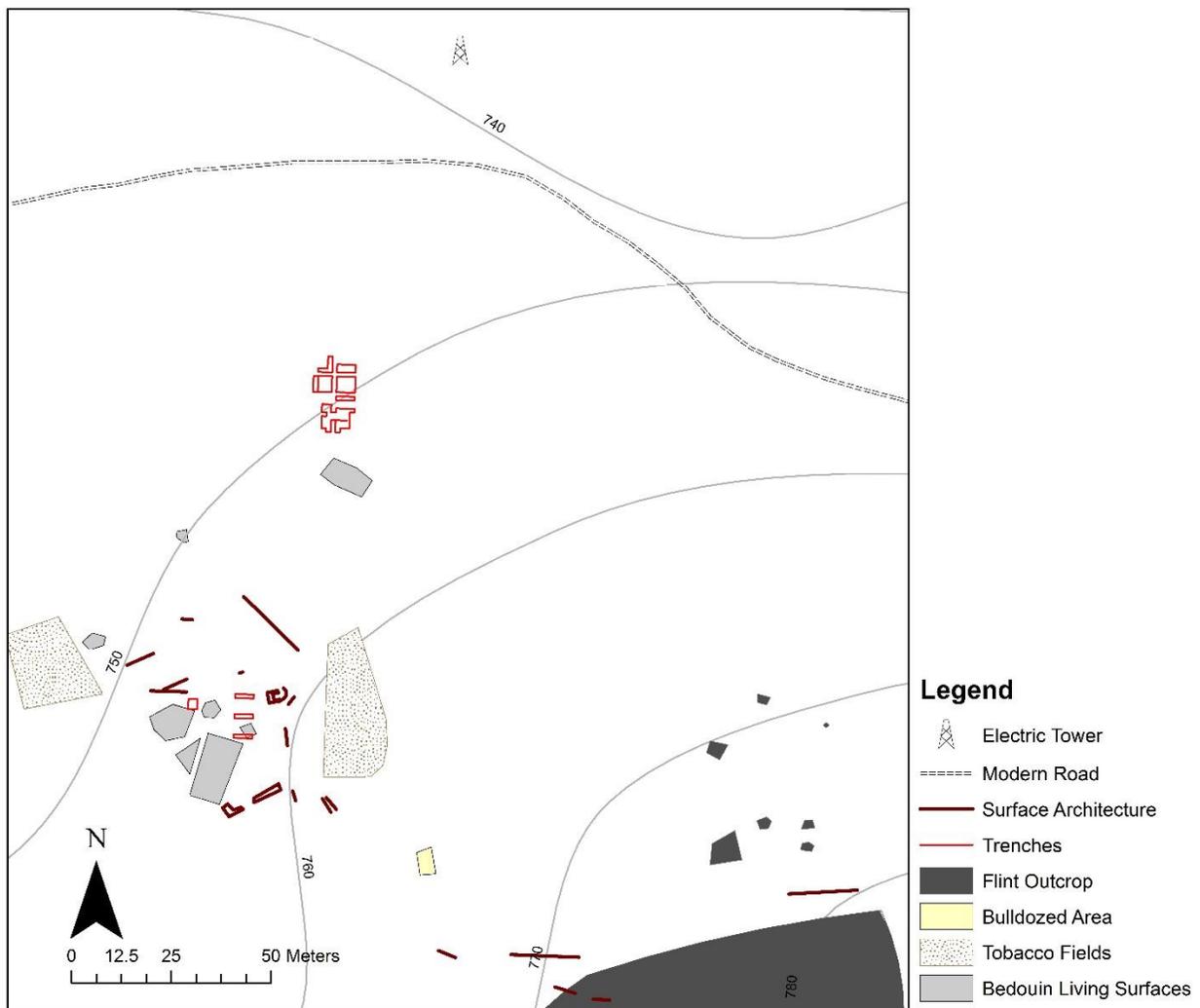


Figure 44: Surface Mapping at al-Khayran (Eliza Wallace)

as they all lacked associated artifacts, apart from the Bedouin camp site and hunting blinds, both of which were datable to the modern era (Figure 44).

Site Catchment Survey and Mapping

Following the mapping of the site, a directed and opportunistic survey of the natural resources of Wadi ‘Assal was done. Ten team members were also contemporary inhabitants of Wadi ‘Assal who worked as farmers, herders, handypersons, and University of Mauta archaeology students. They had extensive knowledge of the *wadi* and the location of natural resources, including surface water in the form of springs and seeps and geological resources such as flint. They all were inhabitants of the towns of Kathrabba and ‘Ai, the two settlements found within Wadi ‘Assal near the head of the canyon. These towns have a series of springs that are held communally, many being used to irrigate the communal olive groves and to supply drinking water. People also can hunt birds which are attracted by the water in the olive groves. Once outside of the old town centers of ‘Ai and Kathrabba access to springs can be controlled by individuals, households, or larger kin-based units. These springs are typically used for farming plots of grapes and/or olives, with surrounding fields frequently utilized for barley growing as the irrigation of orchard crops can raise the moisture content of surrounding soils. This helps to

reduce risk in this area where annual rainfall can be inadequate even for dry farming of barley (Figure 45).

In the case of flint sources, many local inhabitants know of the location of flint sources because they have intimate knowledge of the *wadi* and/or they will frequently scour prehistorically utilized flint sources for formal tools. They can collect this tools for a variety of reasons from personal interest to trading to utilization in charm bags, especially amongst Bedouin populations (reckoned broadly as both mobile pastoralists and their village-dwelling relatives) in the area. Thus, not only were team members aware of the location of flint, which is rather common along the limestone shelf of the upper reaches of Wadi ‘Assal, but also the quality of flints based on their utilization by prehistoric populations.



Figure 45: Orchards and Barley Fields on the Western Outskirts of Kathrabba

Using the team's knowledge of the *wadi* and confirming it with directed driving to resource locations and mapping them using a handheld GPS unit, it was possible to locate most springs and seeps along the southern ridge of Wadi 'Assal, as well as those found near Kathrabba and 'Ai on the north ridge. It was also possible to identify high-quality flint sources and to confirm their utilization by prehistoric populations with dog leash collection units. While it was possible to identify high-quality flint sources, it was difficult to date their utilization by era as almost all formal tools and cores had already been removed from the surface.

Before the 2010 season, archival research was done to determine the location of as many springs, bitumen, and basalt sources as possible in west-central Jordan, which had previously been identified during geological surveys. The location of springs was confined to Wadi 'Assal, while basalt and bitumen sources, two materials which were commonly moved significant distances by Neolithic populations, were recorded for the entirety of the region. Google Earth was also used to identify potential springs before the season. It was then possible to confirm the location of the springs (all of which were known to local team members) and basalt sources as these were accessible by car. The bitumen sources, however, were significantly more difficult to reach and archival and published locations of sources were not confirmed through directed survey. However, these records are likely quite reliable as all other sources of raw materials located through archival work were confirmed and bitumen, above and beyond these other materials, is of significant economic value in the present, with the Jordanian government working hard to attract international companies to extract both the tar sands and oil shale of Wadi 'Assal (Khraisha, 1999).

Excavation

The major work of the season was excavation of a broad horizontal exposure of the site of al-Khayran. A grid divided into 5 x 5 m units was overlaid on the Neolithic artifact scatter with the help of Jamal Safi. Each of these grid units was then divided into 1 x 1 m squares. Additionally, four 5 x 5 m grid units were located on the top of the terrace overlooking the Neolithic site where the focus on the Chalcolithic surface scatter was found and these units were divided into 1 x 1 m squares as well. It was decided that the first two units to be excavated would be those two found directly to the west of the test unit dug in 2007 at the center of the Neolithic surface scatter. This was decided as the test unit on the eastern edge of the scatter suggested that artifacts were eroding from the west to the east.

Before excavation each full 5 x 5 m unit was surface collected and then scraped with shovels. Scrapings were screened in 2 mm mesh to collect surface materials. Once the surface scraping was finished, excavation commenced in the 1 x 1 m squares. Like the test units from the previous season, excavations were done in stratigraphic levels with levels deeper than 10 cm divided into arbitrary 10 cm levels for greater vertical control of the variability of artifact returns within layers. One meter wide balks were left in between units to allow for a vertical reference point during excavation and to be able to record profile views of the units at the end of excavation. All excavated deposits were screened in 2 mm mesh and all knapped stone, ground stone, ceramic, and faunal remains were collected by stratigraphic and arbitrary level within 1 x 1 m squares.

When architecture, such as plaster surfaces, cobble surfaces, slab-constructed surfaces, and stone walls were encountered, they were left in place. When surfaces were encountered, either interior or exterior, an attempt was made to leave five centimeters of deposits above the

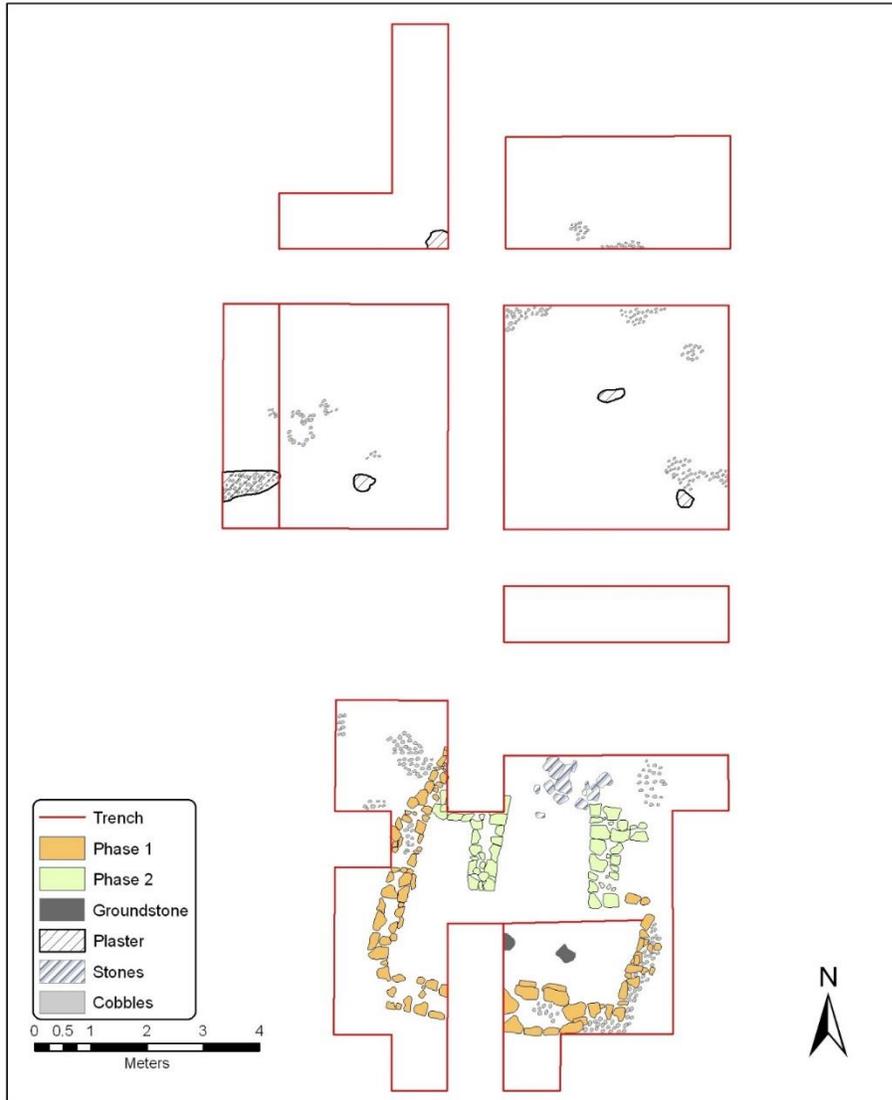


Figure 46: Neolithic Trenches, Final Planview (Eliza Wallace)

cobbles could be sampled, pollen samples were also taken. In any other deposits with extensive evidence of carbonized materials flotation, phytolith, and spherulite samples were taken.

surface to be excavated as a separate level. Within such deposits at least one flotation, one phytolith, and one spherulite sample was taken. The volume of each sample varied by the nature of the ecofacts being sampled. Only for interior surfaces or exterior cobble surfaces where deposits in-between

As excavations continued, we noted a slope to the deposits with stratigraphic layers being thicker and higher on the uphill (south) side of the units. In the southern most portion of these units, architecture was identified which seemed to have walls continuing to the south. Additionally, the erosional pattern seen in the northern units continued. Thus, two more excavation units were placed to the south to fully expose the architecture and determine if any further remains would be found upslope. Within these two units the rest of the structure was uncovered. Subsurface deposits were dug beyond the southern edge of the architecture with virtually no artifacts being recovered. It was decided that because the surface scatter did not continue any further uphill and subsurface returns were minimal that no further units would be placed to the south. Instead two more units were placed to the north of the original two units to find the edge of the subsurface deposits.

Only the first two units dug had their entire 4 x 4 m horizontal extent excavated. All other units were excavated with specific goals in mind to determine the extent of subsurface artifacts (Figure 46). The western column of 1 x 1 m squares in the western of the first two units dug was taken down until no further returns were found as were the northern most rows of 1 x 1 m squares in the northern most units. Thus, the northern and southern extent of the subsurface deposits was identified and the depth of the center of the deposits was determined.

The structure uncovered in the southern most units was excavated with a number of specific goals in mind. The tops of the stone walls were uncovered to determine the interior and exterior of the structure. The northwest corner of the structure presented an unusual shape with the western wall continuing slightly beyond the northern wall. Additionally, while the western, eastern, and southern walls formed 90 degree angles with each other, the northern walls were offset slightly and significantly more robust in their construction. The northern walls also turned

at 90 degree angles at the center point of the northern edge of the structure, creating two interior walls framing what appeared to be a door. It seemed logical to excavate not only the interior of the structure, but also the northern exterior to determine if any other architectural features existed.

The interior and exterior were excavated as two separate sets of loci. At essentially the same level as the tops of the walls of the structure the highly degraded remains of a plaster floor were encountered at the northwest and northeast corners of the structures where the more robust northern walls of the structure had protected these surfaces from plough damage. Over the rest of the structure no remains of a plaster floor were found. Once the entire interior of the structure had been taken down to the same level as the plaster floors remains found in the north, it was decided that the structure should be divided into quarters to be excavated separately and at different rates, still using the 1 x 1 m squares, to dig down to the base of the walls. The southeastern corner of the structure was excavated first, in order to provide stratigraphic information that could be used when excavating the rest of the interior.

As excavations commenced below the level of the structure's floor no artifacts were being encountered and the deposits being dug were largely thin layers of light color water-washed and wind-blown silts. However, a layer of flat sandstone rocks similar in form to those used in the construction of the wall were encountered. After they were removed a thin layer of artifacts was found on top of a puddled plaster floor with most of the artifacts seeming to have been left *in situ* based both on their location and the specific artifacts recovered.

Because of the highly intact nature of the deposits found on the floor of the earlier phase of the structure in the southeast corner, excavation took longer than expected. Thus, it was not

possible to excavate down to the floor of the earlier phase of the structure in any of the three other quadrants of the structure. However, each of the four was taken down below the level of the floor of the later phase of the structure and through these excavations a fragment of a wall running east-west was identified for the earlier phase of the structure. The exterior of the structure was excavated separately and immediately below the level of the wall remains a series of flat paving stones were uncovered to the north and northeast of the doorway. Beyond this paved surface to the northeast a cobblestone surface was identified.

Lab Work Procedures

Scientific Samples

Funding for the analysis of all scientific samples taken at al-Khayran was generously provided by Medland Project (NSF grant BCS-410269) thanks to the support of Maysoon al-Nahar and Michael Barton. This includes radiocarbon, pollen, phytolith, spherulite, and macrobotanical samples. Preservation in general was very poor at the site. Few potential carbonized remains useful for dating were identified with every potential sample noted during excavation bagged in aluminum foil and spatially located both in three dimensions. Ten such samples were taken. Nine of these samples, all of them potential carbonized plant materials, were then screened using a light microscope by Amanda Logan of Northwestern University, to determine if it was possible to identify any of the samples to species and which of them were the three best candidates for dating. All the samples were too small to identify the species of carbonized plant material. Three samples were selected for testing with the caveat that only one of them was verifiable as carbonized plant material. A fourth sample was also dated, which was a charred piece of medium mammal long-bone shaft fragment, also not identifiable to species. The samples were sent to the University of Arizona AMS laboratory for dating.

9.5 liter flotation samples were taken from a random series of loci in the five centimeters of deposits over each individual floor context and a series of random loci in dense midden contexts. 5.5-7.5 liter samples were taken a series of random loci in the deposits found between each individual cobble and paving stone contexts. The samples were bagged and transported back to the American Center for Oriental Research (ACOR) in Amman where they were processed by the author using the Center's flotation system. The heavy fraction was then sorted by the author and the carbonized remains were shipped to Chantel White of Notre Dame University, for analysis.

Samples of between 50 and 100 grams of deposits from interior plaster surfaces were taken for pollen analysis. Excavations were taken down to the surface level and then, using a sterile plastic bag and sterile spoon stored in a sealed plastic bag and wiped clean after every use, the top layer of the surface was scraped clean and the plaster directly below was scraped into the plastic bag. These samples were then shipped to the Palynology Laboratory at Texas A & M University for analysis by Vaughn Bryant.

50 milliliter phytolith samples were taken using a different clean spoon than the pollen samples and placed in clean plastic bags. Samples were taken in the same location as flot samples including interior and exterior surfaces and midden deposits with extensive carbonized remains. For surface samples, multiple locations were taken in order to give the opportunity for spatial analysis of activity areas. These samples were also shipped to Chantel White for analysis. Dr. White also pulled deposits from the phytolith samples for spherulite analysis

Material Culture

As stated in excavation procedures, all scraped and excavated deposits were screened using 2 mm mesh. All knapped and ground stone artifacts, small finds, and animal bones were

bagged separately. Following the field season each of these classes of artifacts was analyzed by the author. They were preliminarily sorted and cataloged at ACOR and then photographed. The Department of Antiquities of Jordan then gave the author permission to ship the artifacts back to the University of Michigan Museum of Anthropology (UMMA) for detailed analysis.

The ground stone, small find, and faunal collections were small enough to allow for essentially a complete cataloging of finds and their attributes. All small finds and ground stone were measured for height, width, and length. They were labeled using typical typologies for the region and time period. The fauna were analyzed using the comparative collection at UMMA. Every attempt was made to record the element, the general size category of the animal from which a specimen was derived, the species, the extent of bone fusion or wear patterns where possible in order to explore age distributions, any elements for which sex was determinable, and any measurements typically taken for individual elements where preservation allowed.

The knapped stone assemblage was significantly larger and was analyzed using a typology specifically developed to test the hypotheses described in Chapter 8 (see Appendix 5). There were three key classes of activities for which the typology was developed to identify: (1) knapped stone core, blank, and tool (both formal and expedient) production (i.e., reduction and rejuvenation sequences), (2) knapped stone tool (both formal and expedient) use based on macro-wear patterns, and (3) knapped stone tool use based on formal tool form. Debitage categories included three categories of cortical (1-3) flakes and flake fragments and (4-6) blades and blade fragments (some-1/3, 1/3-2/3, and 2/3-the entirety of the opposite side [dorsal surface] of a removal surface [ventral surface] of an artifact covered in cortex), (7) chips for pressure-flaked debitage removal less than a centimeter in diameter at its widest, (8) chunks for spall produced by the knapping process with no visible removal surface directly produced by an individual

blow, (9) flakes and flake fragments for any non-formal knapped stone artifact of any size with evidence of a ventral surface removal using basic percussion flaking processes as opposed to pressure flaking or blade knapping, (10) blades and blade fragments for any non-formal knapped stone artifact of any size, although typically of twice as great a length as width with the center lines of length and width being approximately perpendicular in orientation, with evidence of a ventral surface removal blade knapping methods, (11) informal tools with retouch, (12) informal tools with use-wear, (13) formal tools, and (14) opposed platform (naviform) cores. Additionally, debitage types associated with naviform core production and reduction were also classified including (1) ridge removals, (2) crested blades, (3) back-trimming elements, (4) platform production, (5) platform rejuvenation, (6) façade production, and (7) façade rejuvenation.

Blades, blade fragments, and blades and blade fragments with retouch or use-wear were further classified as uni-directional and bi-directional reduction based on the comparison of the direction of force applied to the ventral surface and the blade scars on the dorsal surface.

Informal tools with retouch and use-wear had their debitage type recorded, as well as the location of retouch or use-wear. Formal tools were categorized further using typologies standard for the region and time period and any evidence of retouch or use-wear, including the location and type of the modification, was recorded. For the latter two categories the same procedures as for informal tools of recording the location of retouch or use-wear on the tool were used.

Additionally, any knapped stone artifacts derived from blue or red flint were recorded in order to understand the frequency and pathways of flint movement from beyond the site catchment, as the flint source directly next to al-Khayran produced gray, brown, black, beige, white, and yellow flints. Blue flints were likely derived from a nearby source on the north ridge of Wadi ‘Assal. It is unclear from where red flints were extracted.

Spatial Information

All spatial information including artifact recovery locations, architecture, site catchment resources, and regional resources was recorded by the author in the field. Architecture at the site of al-Khayran was then digitized by Jamal Safi and visualized by Eliza Wallace of Boston University. The same is true for site catchment resources. Regional resources, both natural and cultural, were recorded by the author both in the field and from archival materials and publications and digitized and visualized by Eliza Wallace.

Chapter 12: Chronology and Spatial Data

This chapter is the first of three that presents results from the ‘Assal-Dhra’ Archaeological Project that are relevant to this dissertation. This chapter presents the chronological and spatial data from the site of al-Khayran and the broader study area including architectural finds, relative and absolute chronological results, and stratigraphic information for al-Khayran. It will also present site catchment information including hydrology, pedology, geology, and ecology. These results will be followed by a chapter presenting the faunal, macro-botanical, spherulite, pollen, and phytolith analyses. The third chapter presents the analysis of chipped and ground stone, as well as small finds.

Architecture

The defining characteristic of al-Khayran is the structure (Structure 001) at the southern edge of the site. The structure is comprised of a single room constructed and used in a first phase (Phase 01) and reconstructed and re-used in a second phase (Phase 02). While much of the later phase of the structure obscured the use of the earlier phase, it is possible to detail a number of aspects details of the architecture for both phases. The general outlines of the walls of the earlier phase have been recorded and approximately one quarter of the floor of the earlier phase structure has been excavated. For the second phase of the structure I have excavated all walls, floors, and exterior surfaces. Unfortunately, because the site is so shallow, much of this second phase had been destroyed in the intervening millennia of human use and natural erosion of the site before excavation.

Earlier Phase – Structure 001: Phase 01

The earlier phase of the structure (Structure 001: Phase 01) appears to have been partially dug into the hillside of ar-Rsais, the area in which the site of al-Khayran is located. Excavations revealed the southern (uphill) wall had been dug at least 30 cm into the hillside (Figure 47). It is unclear whether or not the entirety of the structure was slightly dug into the hill as was done at a number of PPNB sites located in steep terrain, such as ‘Ain Ghazal (Banning and Byrd, 1984) and Ba’ja (Purschwitz and Kinzel, 2007). It does seem likely because the level of the earlier phase floor is 15 cm below the elevation of the later phase exterior surfaces (Figure 48). It is also clear that a significant portion of the structure was built above-ground with approximately 10 cm of the eastern and western walls of the structure rising above the base of the midden found on both sides of the structure. It is likely that this base level was the ground surface during the PPNB with refuse being dumped on either side of the structure by the inhabitants. Additionally, a



Figure 47: Northeast Corner of Structure 001: Phase 01,02

significant amount of wall fall was uncovered within the interior of the earlier phase of the

structure, suggesting a significantly higher initial height, well above the level recovered during excavation.

In the southeastern quarter of the structure it was possible to dig down to and into the puddled plaster floor of the earlier phase of the structure. What the inhabitants of al-Khayran appear to have done was dig a square pit approximately 5 x 5 m in area into the side of ar-Rsais. They then built stone walls along the edges of the pit using locally available limestone commonly found in flat slabs ideal for building blocks. They then continued to build the walls up above ground level. It is unclear how high the walls were built as much of the stone appears to have been reused for a later cairn (*rujum* al-Khayran) located approximately 5 m south of the site. Additionally, the site has subsequently been reused for plough farming in the modern era and as the plough hit buried stones, the farmer would remove the stones and place them in refuse piles nearby. Thus, many of the wall stones were ploughed up and mixed with other stones from



the

Figure 48: Structure 001: Phase 02 in the Foreground Looking South and Structure 001: Phase 01 in the Background Showing the Difference in Surface Elevations from the Earlier to the Later Phase of Construction

surrounding fields, making it impossible to calculate original wall height.

After the walls (and presumably the roof of the structure) were built, a large quern and a flat slab for cutting were laid directly on the earth at the bottom of the pit; a slurry of lime and mud was puddled around the grinding stones and up to the edges of the walls to create a hard flat floor with inset ground stones for grinding and cutting (Figure 49).

It is unclear how the roof of the structure was built. It is likely that a combination of perishable tree branches, twigs, and/or reeds (all of which were present on or near the site as attested to in the macro- and micro-botanical record of al-Khayran; see the next chapter), as well as clay or mud. However, since no roof was preserved, I cannot say more. It is unclear whether any exterior surfaces were constructed as was done during the later phase of the structure. These later materials covered over much of the exterior space of the earlier phase.

Later Phase – Structure 001: Phase 02



Figure 49: Interior of Southeast Corner of Structure 001. Note Inset Quern in Center of Picture and Inset Cutting Stone Embedded in the Trench Profile. Also Note the Clear Stratigraphic Layers of the Profile.

The later phase of the structure was built following the partial collapse of some of the walls of the earlier phase. A portion of the earlier phase walls collapsed into the subterranean portion of the interior space of the structure. The subterranean portions of the southern walls also

appear to have split in two with the interior course tipping onto the rubble of the earlier collapse of the above-ground portions of the wall. The general direction of the collapse was to the north (downhill). It appears that much of the northern wall of the earlier phase of the structure collapsed, so that virtually no stones were left standing. Following this collapse a significant amount of sediments accumulated over the collapse on the interior of the structure (Figure 49).

Upon the return of inhabitants to al-Khayran, additional sediments were dumped into the interior of the structure to level off the ground. Portions of the southern, western, and eastern walls were salvaged and rebuilt. Two new wall sections were added to the north, built more robustly and abutting the eastern and western walls at slightly more acute and obtuse angles respectively. A true lime plaster floor was also constructed up to the edges of the now fully above ground structure. Again, it is unclear how high the walls of this structure were nor the



method of
roof

Figure 50: Structure 001. Note Cobble and Flagstone Surfaces in the Foreground. Facing Southwest

construction. Additionally, due to the shallow nature of the site, much of the plaster floor was destroyed with only small plaster fragments recovered from the northeastern and northwestern corners of the structure protected by the more robust northern walls of the later phase of the

structure. No in-set ground stone tools were identified, but it is possible that they were removed by subsequent taphonomic processes.

One aspect of the architecture better preserved in the later phase is the nature of the space used outside the structure. A portion of a flat-slab constructed surface directly in front of the opening in the northern wall and potentially even into the space between the perpendicular walls at the center of this section was uncovered. Preservation on the eastern side of the likely doorway was better. Beyond this slab surface, a cobble stone surface was also uncovered to the east. No such surface was found to the west although a large number of cobbles were identified in the area, suggesting that perhaps a surface was present and later destroyed by taphonomic processes (Figure 50). No other architecture was found on al-Khayran that could be associated with the early Neolithic occupation of the site.

Stratigraphy

As has previously been noted, there are two defining variables which determined the stratigraphy identified at al-Khayran: (1) the structure at the southern edge of the site and (2) the poor preservation at the site due to taphonomic processes. This led to a rather simple stratigraphy for the site. Because of the shallowness of the site and later ploughing, as well as the surface erosion which the entire region has experienced (Cordova, 2007), all areas outside the structure remains have been mixed, creating essentially one large non-differentiable stratigraphic layer. It is only within the interior of the earlier phase of the structure that any form of stratigraphy has been preserved. Within the structure walls, deposits directly below the level of the top of the building walls appear to have been mixed with the exterior deposits.

However, below the top of the walls at about the level of the later phase floor clearly stratified deposits were found. As reviewed above, sediments were transported by the inhabitants

of al-Khayran into the voids left after the collapse of the earlier phase walls and the subsequent deposition of erosional deposits. They appear to have used deposits devoid of artifacts.

Additionally, the erosional sediments found below this layer of human-transported deposits were also devoid of artifacts, presumably eroding in from the uphill slope of the site. Unlike the areas to the east, west, and north of the structure, the hill slope to the south (the uphill portion of the hillside) was not used for refuse dumping by the inhabitants of al-Khayran. A series of small wind-blown and water-washed strata are visible in the profile of the interior of the early phase of the structure. Most of the sediments are light color silts. It is not possible to know the duration of this depositional process and rainfall is annually variable. However, it is possible to note that the water-washed sediments were likely deposited during the winter as al-Khayran is and was located in a Mediterranean climate zone with winter rainfall. This opens up the possibility that the site was not inhabited during this season. However, it is also possible that the site was uninhabited for an entire annual cycle or more with such a pattern.

Below this layer of erosional deposits a layer of wall collapse was found with minimal artifact inclusions. This wall collapse was lying directly on the puddled plaster floor of the earlier phase of the structure. Below the wall collapse the only sediments found were those that had fallen through the wall stones. Finally, excavations were taken down into the puddled plaster floor. Again, these deposits were devoid of artifacts. Overall, a total of five depositional layers can be identified for the site: (1) the mixed layer on the exterior of the structure and above the later floor of the structure, (2) the finds on the plaster floor of the later phase of the structure, (3) the erosional and human transported layers on top of the wall collapse of the earlier phase of the structure which were devoid of artifacts, (4) the finds on the puddled plaster floor of the earlier

phase of the structure, and (5) the thick puddled plaster floor of the earlier phase of the structure, also devoid of artifacts (Figure 51).

Mixed Layer	001		
Phase 02 Floor	002		
Devoid of Artifacts	Unexcavated	003	Unexcavated
Phase 01 Floor		004	
Devoid of Artifacts		005	

Figure 51: Harris Matrix along Center Line of Structure 001, Facing West, Running North-South

Chronology

Relative Dating

The lithic technology, point typologies, and architectural form and materials found at the site provided relative periodization on the site within the broader chronology of the early Neolithic of the southern Levant. All cores found on the site are naviform (Figure 52). Naviform core utilization is dated to the M-LPPNB within the southern Levant. The point types found on the site are slightly more variable. Of the points derived from subsurface deposits which can definitively be placed in the codified typology of the early Neolithic of the southern Levant (1) two present attributes of el-Khiam points, typical of the PPNB, (2) six are Helwan points, typical of the EPPNB (although one of these might be classified as a Gilgal truncation), (3) one is of Byblos type, typical of the M-LPPNB, (4) one is a Jericho point, typical of the M-LPPNB, and (5) ten are A45 points associated with the M-LPPNB (Gopher, 1994). Of these, only one point

was found within a secure context with a singular A45 point found directly on the earlier floor surface of the structure.

However, the Helwan points found in subsurface deposits – in addition to the one identified in the Jacobs (1983) survey – possibly suggest an earlier occupation. In addition to the Helwan points, Jacobs (1983) found an el-Khiam point typical of the PPNA. The potential Gilgal truncation is also noteworthy as this type is typically associated with the PPNA. A final

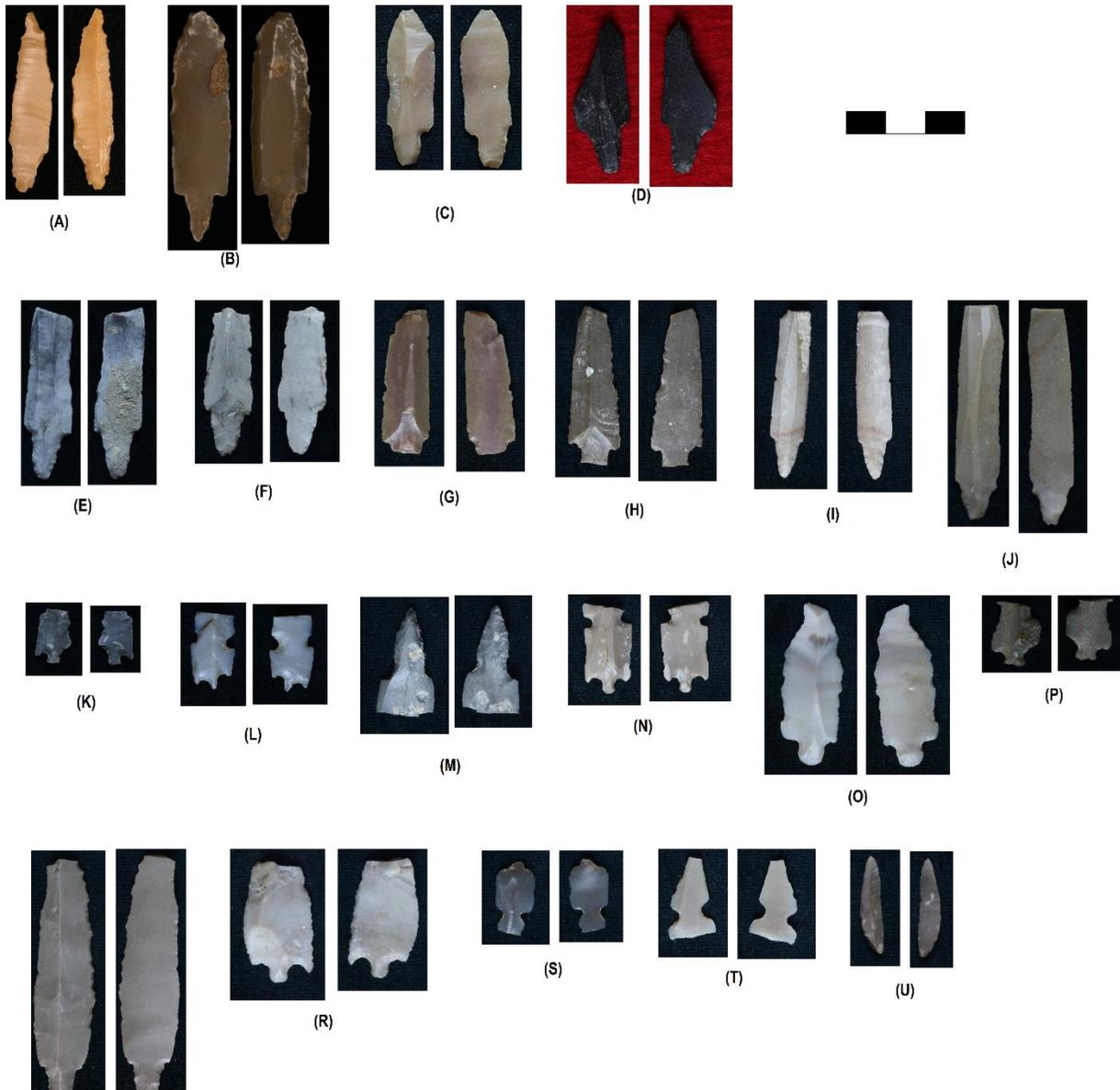


Figure 53: (A) A45; (B, C) A45, Retouched Tip; (D) Broken A45; (E-J) A45, Tip Impact Fracture; (K-N) Broken Helwan; (O) Un-Notched Helwan; (P) Broken Helwan or Gilgal Truncation; (Q) Byblos, Tip Impact Fracture; (R) Jericho; (S) Bipolar el-Khiam, Tip Retouch; (T) el-Khiam; (U) Lunate (Gabriela Perez-Dietz/Matthew V. Kroot)

surprising find that potentially predates the PPNB is a single lunate, typical of the Late Epipaleolithic and PPNA (Figure 53).

That being said, a number of el-Khiam points have been identified at early MPPNB sites (Mortensen, 1970), as have Helwan points (Jensen et al., 2005). One potential check on the dating of these points is to determine if they were knapped using bipolar reduction, typical of the M-LPPNB. With a number of the points it was not possible to determine the direction of flaking for each scar. However, the Byblos point and all ten A45 points were determined to be produced through bipolar reduction. Interestingly, three of the six Helwan points were as well (it was not possible to determine the direction of knapping for all the flake scars on three of them, including the one potential Gilgal truncation). The direction of flaking was not visible on one of the possible el-Khiam points. It was bidirectional on the other, suggesting that the highly utilized and rejuvenated point may have been of later date than the base and notching morphology reminiscent of el-Khiam points suggested. The lunate did have the ventral and two dorsal scars determined to be flaked in the same direction, as would be expected for PPNA or earlier formal tools. However, even with bipolar reduction it is typical for multiple blades to be removed in the same direction before flipping the core for blade removal in the opposite direction.

Another check on the relative dating of the site is to observe the directionality of flake scars on all blades and blade-based tools. All formal blade-based tools (of which all the formal tools found in subsurface deposits were), including points, burins, and perforators, with at least five flake scars for which direction could be determined, were found to be bidirectionally knapped. All blades for which the directionality of at least five flake scars could be determined, were found to be the product of bipolar reduction. Thus, it is likely that the vast majority of the knapped stone found at al-Khayran date to the M-LPPNB.

In addition to the knapped stone material at the site, the architecture provides insight into the periodization of the site. The form of the structure, a square approximately 5 x 5 m, is typical for the MPPNB of the southern Levant (Banning and Byrd, 1989b; Banning, 2003). During earlier periods, round structures predominate (Finlayson et al., 2011a; Flannery, 1972). Additionally, the use of plaster for the later phase floor is typical of the MPPNB as well, with plaster being less popular although still used in earlier and later periods (Clarke, 2012). A final find that also supports dating the site to PPNB (with the MPPNB being the most likely date of occupation) is a mass of ground red ochre on the floor of the earlier phase of the structure. While red ochre has been used since Middle Paleolithic times for pigment in the southern Levant (Maher et al., 2012; Weinstein-Evron, 1994), its extensive use to decorate plaster walls and floors dates to the PPNB, with MPPNB structures showing the highest rates of usage as an architectural pigment (Banning and Byrd, 1989b; Banning, 2003). When all the technical observations about lithic reduction and architectural form and materials are combined, what emerges is a MPPNB occupation with possible evidence for earlier use of the area as well.

Absolute Dating

Two radiocarbon dates, both derived from carbonized remains found trampled into the floor of the earlier phase of the structure where preservation was best, also help place the activities on this surface within an absolute chronology (see Table 2). One of these radiocarbon dates was derived from a wood sample of unknown species. The other sample was a carbonized long bone shaft fragment from a medium-sized mammal. The bone was burnt in a reducing environment and, thus, it was possible for carbonized soft tissue to be analyzed (Bowman, 1990). While both yielded dates from within the accepted time range of the MPPNB, they were quite far apart in absolute terms, despite deriving from the same context. Two other small black nodules

were also analyzed, yielding dates indicative of being derived from materials significantly older than would be datable using radiocarbon dating such as bitumen.

Table 2: Radiocarbon Results for al-Khayran

SUITE	RUN DATE	d13C value	F (d13C)	+/- dF (d13C)	14C age BP	+/- 14C age	OxCal		Material	Context
							1 Std cal BCE	2 Std cal BCE		
1 of 4	N04-29-11	-29	<0.0030		>46,700					
2 of 4	N04-29-11	-28.8	0.0027	0.0010	47,500	3,000				
3 of 4	N04-29-11	-22	0.3347	0.0021	8,793	50	7958-7747	8197-7656	Charcoal	Phase 01 End
4 of 4	N04-29-11	-19	0.3443	0.0027	8,566	63	7633-7532	7715-7515	Bone	Phase 01 End

The charcoal yielded a radiocarbon date of 8793±50 BP and the carbonized animal bone yielded a radiocarbon date of 8566±63 BP. When calibrated using OxCal 3.10 these yield date ranges of 8197-7656 cal. BCE (2 Std) for the charcoal and 7715-7515 cal. BCE (2 Std) for the animal bone; creating an overlap at 7715-7656 cal. BCE. This assumes that both samples date an equivalent chronological point. However, because of differential curation patterns between bone and wood, such an assumption cannot be made. The date derived from the animal bone is from when the animal was slaughtered. This is likely very near to the date of the burning of the bone and the utilization of the floor. The wood fragment is not as clear, as wood can be curated for many years or can be harvested dead or can be derived from the interior portions of the trunk which stopped exchanging carbon with the atmosphere long before the tree died. The factors create what is known as old wood effect (Dean, 1978; Schiffer, 1986).

However, as has been pointed out recently, there seems to be a consistent difference between wood charcoal and other dateable materials from the early Neolithic of the southern Levant, which is often attributed to old wood effect. The consistency with which this happens has led some authors to question whether some other phenomenon is at work (Finlayson et al.,

2011c). Additionally, animal bone seems to consistently yield younger dates than all plant remains, including annuals, likely due to the susceptibility of bone to various forms of contamination from later microbes living in surrounding deposits (Hedges and Van Klinkel, 1992). Thus, it is not possible to determine with certainty the precise use-age of the puddled plaster floor of the earlier phase of the structure. However, it must be noted that both date ranges fall within the consensus for the duration of the MPPNB in the southern Levant (Maher et al., 2011). It would seem likely that the site would fall generally towards the middle of the period.

That being said, if the site was utilized in early time periods within the Pre-Pottery Neolithic, this does not necessarily mean that the construction of architecture on the site existed in these periods as well. There are a number of resources adjacent to the site which have drawn human populations as far back as the Lower Paleolithic, as attested to by an Acheulean hand axe found on the surface of the site (Figure 16) knapped from flint found on a terrace directly above al-Khayran, and continue to draw farming to this day, such as the individual who grows tobacco on-site annually because of a water seep under another terrace just to the south of Structure 001 (Figure 12). When the relative and absolute dating results are taken together it is possible to propose that al-Khayran is only the second site, following the recent demonstration of an MPPNB occupation at Hamarash 1 (Sampson, 2012, 2011, 2010a, 2010b), securely dateable to the MPPNB through both relative and absolute means in all of west-central Jordan.

Site Catchment

Much of the information about natural resources found in the catchment of al-Khayran was presented in Chapter 3. This section provides more details for some of these resources, specifically their distance from al-Khayran.

Surface Water Resources

The only perennial source of running water in Wadi ‘Assal is the small stream that flows through the bottom of the canyon. It is fed by the many springs near the head of the canyon. Through directed survey, archival and publication reviews, and the analysis of google earth images, 20 springs have been identified, with a significant majority of these found along the east reaches of the south ridge of the *wadi* (Figure 4 and Appendix 6). Of these springs, two are located less than a kilometer to the east of al-Khayran, the more substantial and more easily accessible of these two being the spring of ‘Ain ar-Rsais from which the hillside on which al-Khayran sites derives its name. Another spring is found at a distance of 2.5 km to the east, followed by a series of nine other springs at between 3 and 3.5 km to the east. Three of these springs are among the most substantial in the region; two feeding communal olive orchards for the town of Kathrabba and the third serving as the focal point of the eastern residential section of the town as both a public fountain and the source of water for a number of smaller orchards.



In addition to these surface water sources, a

Figure 54: Terra Rosa Soils at the Base of al-Khayran

subsurface seep is found 70 m south of the structure at al-Khayran. It is still used today to feed the only patch of farmed land on the contemporary hillside, where a Bedouin family grows the water-intensive crop of tobacco (Figure 12). It is known that ground-water levels in western Jordan have dropped significantly from the PPNB (Cordova, 2007; Mithen and Black, 2011). Additionally, there are two small limestone caves dissolved by solution underneath the terrace directly above the seep, suggesting that the seep may have been an above ground spring at some earlier point. Therefore, it is possible that not only was the seep present in the early Neolithic, but that the seep may have been a spring at the time. This is especially true considering that MPPNB is thought to fall in a cooler wetter period.

Pedology

In west-central Jordan there is a thin band of fertile *terra rossa* soils which stretch from the Wadi Mujib to the Wadi Hesa. It is a product of the interaction of geology and climate patterns in the area (Bender, 1974; Cordova, 2007). This is the southernmost inland extent of such soils in the Levant. The narrowness of this band of soils in west-central Jordan, bounded by the hyper-arid saline soils of the Dead Sea Basin to the west and the hyper-arid soils of the Syro-Arabian Desert to the east, creates a mosaic environment with multiple ecological zones easily accessible to the inhabitants of the region. Most farming occurs along this narrow band of *terra rossa* soils, the current focus of which is cereal production (Al-Eisawi, 1996; Fischbach, 2000; Harlan, 1988, 1981; Mazur, 1979; Palmer, 2001; Phillips, 1954). There is also personal or communal orchard farming of grapes and olives near water sources (pers. obs.).

Al-Khayran is located on the edge of the *terra rossa* soils today, which end less than 300 m to the west of the site (Figure 54). This places it at the farthest extent of the most fertile soils

in the region. That being said, there has been significant degradation of the local ecology, erosion of top soils, and a reduction in rainfall since the PPNB (Cordova, 2007; Mithen and Black, 2011). Thus, *terra rossa* soils may have extended farther east, west, and south than today and may have been more available in Wadi ‘Assal. However, a major factor limiting the extent of *terra rossa* soils in Wadi ‘Assal is the topography of the terrain. Such soils develop *in situ* as clays trapped in limestone are released during the weathering of the rock. However, the soil can easily erode on steep slopes as it is typically a product of water weathering. Thus, the process that exposes the clays also can wash them away (Schaetzl and Anderson, 2005). Therefore, *terra rossa* soils never develop along the steep edges of Wadi ‘Assal due to erosional processes. Al-Khayran is located 1.5 km east of the steep slopes of the Dead Sea Escarpment and 500 m south of the steep slopes of the south ridge of Wadi ‘Assal (Figure 1). Thus, al-Khayran is located close to the farthest possible extent of *terra rossa* soils due simply to topographical constraints, let alone variations in water availability and plant coverage through time.

Geology

There is evidence of the utilization of a number of geological resources at al-Khayran including flint, limestone, sandstone, bitumen, basalt, and red ochre. A review of published and archival research within west-central Jordan and the above-described directed survey of flint sources has allowed for the identification of the nearest sources for all of these materials except red ochre.

In the case of red ochre, it is a fairly common mineral to be found associated with iron rich mineral deposits in Transjordan. Previous provenance studies for the southern Levant have shown such minerals to exist in association with a variety of sedimentary rocks where volcanic or tectonic activity is documented. The formation of red ochre appears to occur when hematite

can precipitate out of iron rich deposits into voids in rock formations (e.g., Weinstein-Evron, 1994). Thus, while no sources of red ochre have been identified due to a lack of contemporary geological studies on the subject within the region, it is likely that they exist within the site catchment of al-Khayran where the active faulting of the Jordan Rift Valley interacts with the iron rich limestones and sandstones of the Transjordan Plateau.

Both limestone and sandstone are readily available near the site of al-Khayran. The site itself is located on a limestone terrace; one of many in the area. This provides easy access to exposed limestone along terrace walls, which can be used for building materials, carvings, and

the production of lime plaster.

Sandstone is the predominant substrata of the Transjordan Plateau (Bender, 1974) and is available in exposed layers along the south ridge of Wadi ‘Assal less than 250 m north of al-Khayran. Such stone can be used for architecture, carving, and the production of ground stone objects, typically used for grinding as opposed to pounding, such as hand stones and querns. While both

limestone and sandstone can be

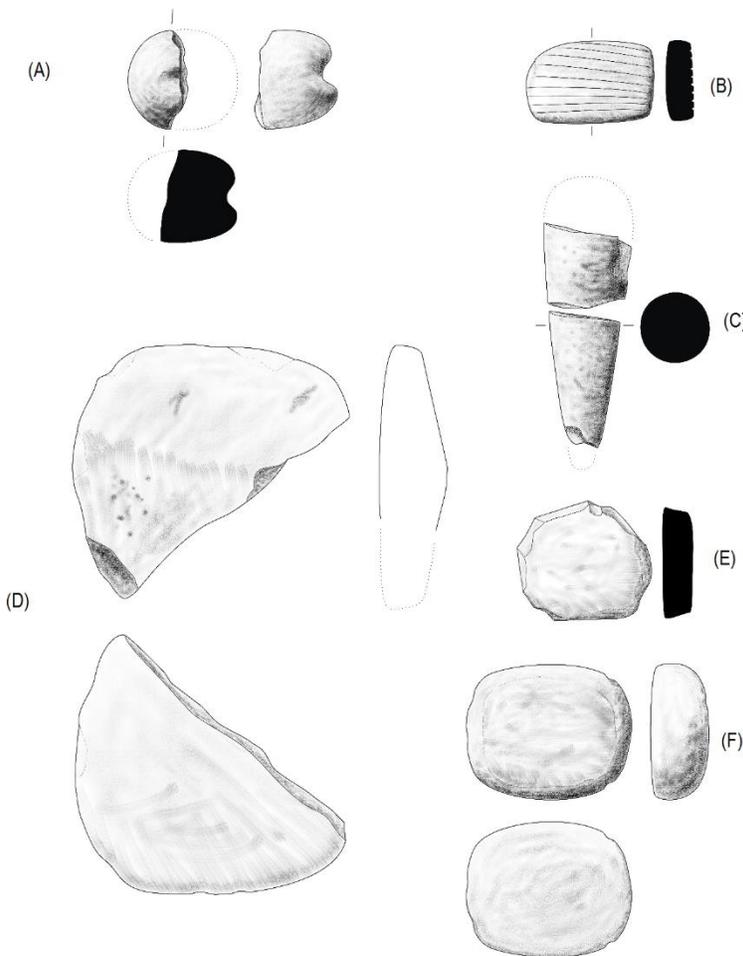


Figure 55: (A) Shaft Straightener (Basalt); (B) Incised Pillow-Shaped Piece (Sandstone); (C) Pestle (Basalt); (D) Double Hand Stone (Sandstone); (E) Stone Ring Blank (Sandstone); (F) Single Hand Stone (Sandstone)

used for building materials, the inhabitants of al-Khayran used limestone, as it was more easily accessible and, in contrast to sandstone, could be transported downhill rather than up. However, they did utilize local sandstones for ground stone items including single and double hand stones, querns, and a number of other items whose function is less obvious (Figure 55).

Flint resources were reviewed in Chapter 3. The, results of the directed survey, however, bear repeating. Three significant sources of flint have been identified within Wadi ‘Assal. The largest is located 200 m south of al-Khayran and produces a variety of colors of thin and thick tabular flints including medium-grain brown, white, and grey flints, as well as fine-grain lustrous black, red, and yellow flints. Another source of medium-grain grey flints indistinguishable from

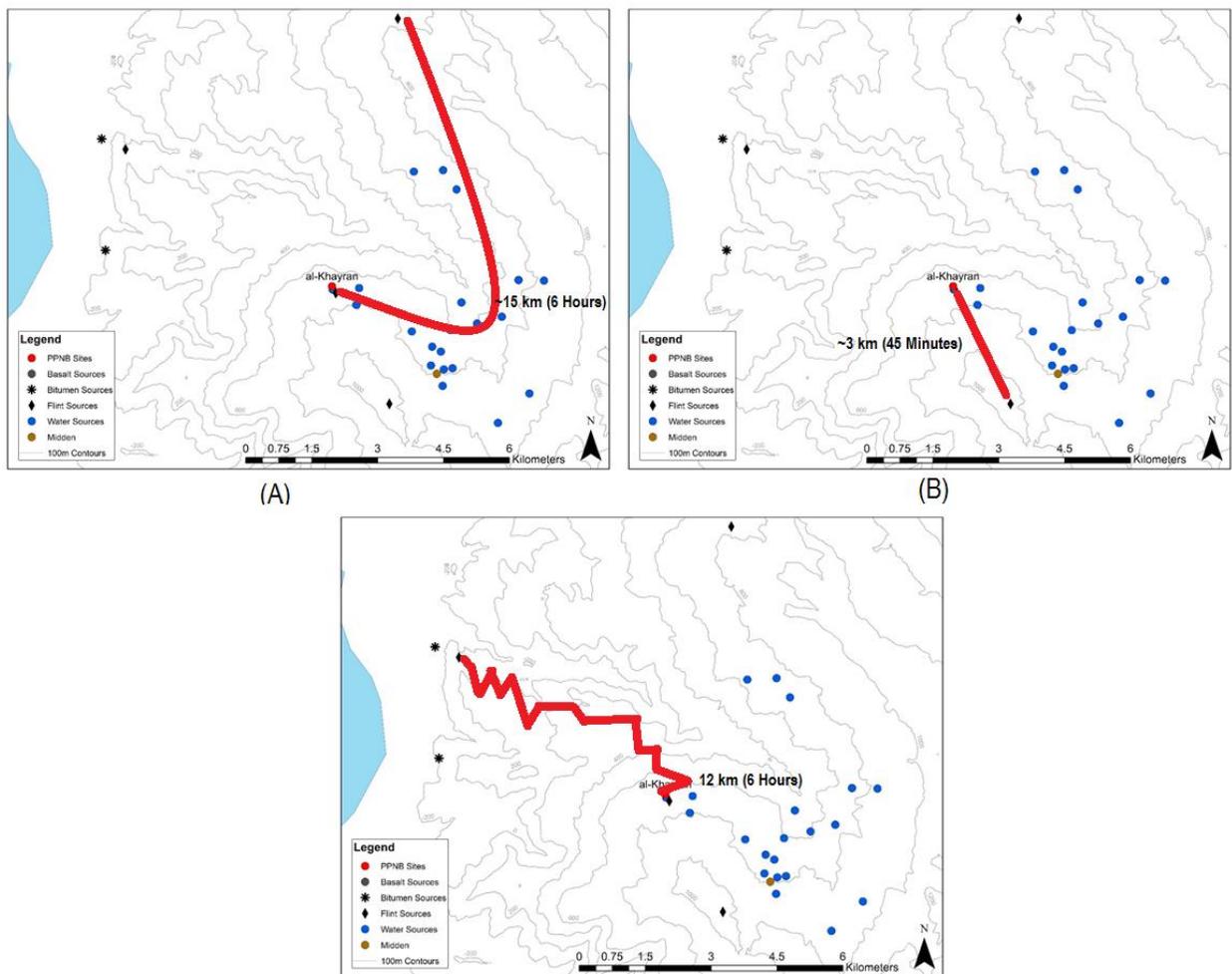


Figure 56: Walking Routes to Three Major Flint Sources (Eliza Wallace/Matthew V. Kroot)

the

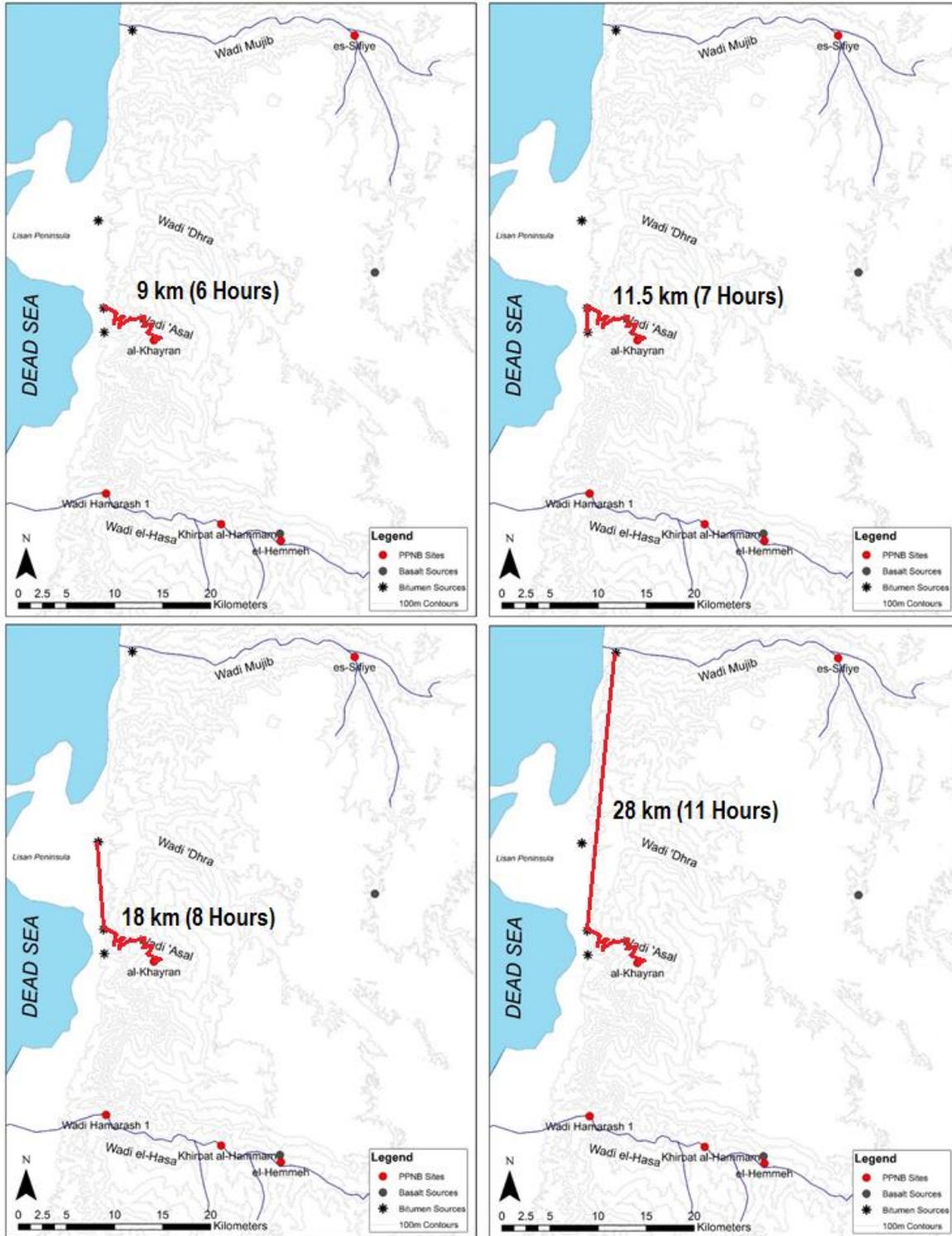


Figure 57: Bitumen Sources with Walking Distances and Times (Eliza Wallace/Matthew V. Kroot)

medium-grain grey flints of the outcropping directly adjacent to al-Khayran is located 3 km southeast of the site. A third major outcropping of fine-grain lustrous blue flints is found 6.3 km

north of al-Khayran, on the north ridge of Wadi ‘Assal, but approximately 15 km of walking distance from the site due to the intervening barrier of the *wadi* itself (pers. obs.). Another source of high-quality fine-grain lustrous black flints is found near the mouth of Wadi ‘Assal. It has not been possible to visually differentiate flints found at these sources from some recovered at the outcrop next to al-Khayran. It is located 6.2 km northwest of the site, but due to its location near the bottom of the *wadi* following the path of the Roman road down the south ridge of Wadi ‘Assal, the walk is closer to 12 km (pers. obs.). Additionally, this walk is across very steep terrain making it all the more costly for travel. While there are other sources of flint, none produce high quality nodules useful for knapping (Figure 56).



Figure 58:
Flint Sickle
Blade with
Bitumen
Residue

As discussed in Chapter 3, two geological resources found at al-Khayran are not easily found in the local catchment. There is evidence of bitumen being used as an adhesive for attaching sickle blades at al-Khayran (Figure 58) and as a pigment at other PPNB sites (Schmandt-Besserat, 1998). While Wadi ‘Assal is one of the largest sources for bitumen in all of Jordan (Abed et al., 2004; Khraisha, 1999), the location of surface seeps is close to the mouth of the *wadi*. The most easily accessible seep is deep in the *wadi*, 6.4 km northwest of al-Khayran. However, in order to reach this seep one must take an indirect route due to the steep terrain along the *wadi* ridge. If one walks along the Roman road down the south ridge of Wadi ‘Assal, the path of least resistance from al-Khayran, the distance traveled is closer to 9 km (Jacobs, 1983; Mittmann, 1982). A second bitumen source is also located 2.5 km south of this one (5.3 km west of al-Khayran), also near the mouth of Wadi ‘Assal. The most direct passable route, however, is approximately 11.5 km long given the greater difficulties of descent from above (pers. obs.) (Figure 57). Thus, while the inhabitants of al-Khayran had easier access to bitumen than most

within the region, it would still have been a significant trip requiring planning and a full day's travel. Another, perhaps more likely possibility is that bitumen could have been collected opportunistically during other activities, such as hunting or herding, as the demand would have been low given the small amounts necessary for adhesives and pigments.

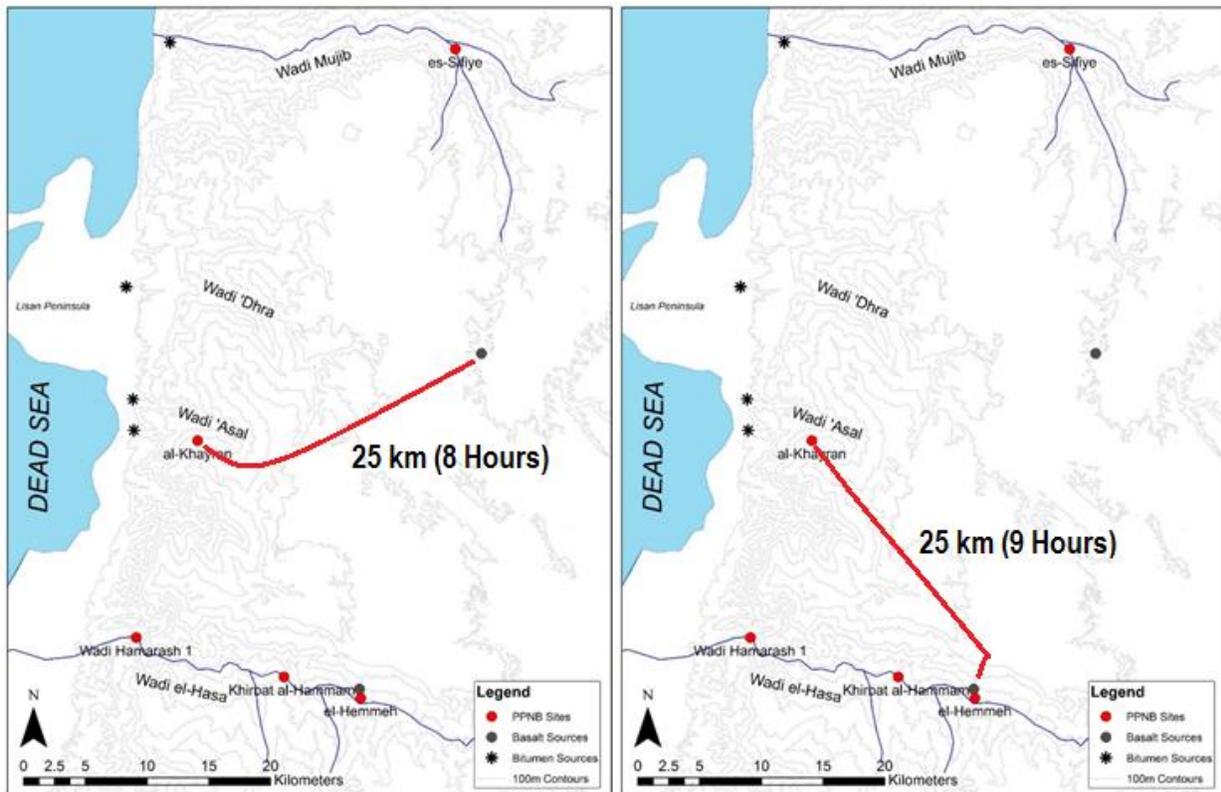


Figure 59: Basalt Sources with Walking Distances and Times (Eliza Wallace/Matthew V. Kroot)

Basalt is found even further afield, well outside any conceivable definition of site catchment. Thus, the few basalt artifacts found on the site, all small and easily transportable ground stone items used for pounding or other high-impact activities, such as pestles and shaft-straighteners, were not extracted from the site's catchment by the inhabitants of al-Khayran, but rather carried long distances. The two closest sources of basalt to the site of al-Khayran are both approximately 25 km, one to the northeast and one to the southeast (Mehyar et al., 2006). The southeastern source is located directly adjacent to the PPNA/LPPNB village of el-Hemmeh

(which has, as discussed in Chapter 3, yielded a radiocarbon date of MPPNB age – attributed to old wood effect to the site’s excavator – but a knapped stone assemblage more reminiscent of the LPPNB) (Makarewicz et al., 2006), 700 m from the edge of the erosional zone for basalt boulders. It is unknown from which source or sources the basalt artifacts derived at al-Khayran (Figure 59).

Plants and Animals in the Area

The flora and fauna of Wadi ‘Assal have been reviewed in Chapter 3. Thus, a brief comment here is sufficient. The south ridge of Wadi ‘Assal is within the natural range of wild barley, but not wheat (Willcox, 2005). As discussed in Chapter 6, this appears to have been true in the early Neolithic as well with wheat appearing in LPPNB archaeological assemblages fully domesticated within the study area (Asouti and Fuller, 2013, 2012; Nesbitt, 2002; White and Makarewicz, 2012; White, 2013). It is also possible that other wild plant food sources and domesticables including pistachios, figs, grapes, almonds, walnuts, acorns, chickpeas, peas, and lentils could have grown naturally or through human intervention in the *wadi* during the early Neolithic.

Because of higher rainfall rates and groundwater levels, other plants of economic use such as trees for wood and fuel and reeds for construction materials would have been available (Mithen and Black, 2011). In fact, while trees are not found without human intervention along the *wadi* ridges, carbonized wood remains were recovered from al-Khayran, suggesting the existence of woody plants during the PPNB. Additionally, phytoliths recovered from the site indicate that reeds were also present within the site catchment. While they exist in the bottom of Wadi ‘Assal today and at the convergence of the runoff from a number of springs near the head of the *wadi*, none can be found less than 5 km from al-Khayran. Their presence on-site suggests

that the springs of ‘Ain ar-Rsais or even the seep directly above al-Khayran would likely have supported such growth during the PPNB.

Likely animal species of economic use in Wadi ‘Assal during the early Neolithic include ibex, bezoar goat, and game birds. The former two are not found commonly in the area today, although Nubian ibex are found within nature reserves of Jordan in similarly arid environments (Al-Eisawi, 1996; Harrison and Bates, 1991). Game birds are still readily available in the *wadi*, drawn to the plentiful water in the many irrigated orchards of Kathrabba and its surroundings.

Access

As reviewed in Chapter 2, one role satellite settlements may play is as a safe place to stay away from main settlements (Preucel, 1990). Thus, if al-Khayran was a satellite settlement ease of access and visibility may have been important aspects of the location of the settlement. The location of al-Khayran along the south ridge of Wadi ‘Assal does provide it with a significant amount of protection, given that it is inaccessible on three sides (it is easily accessible only from the east). As has already been discussed, within 250 m to the north, 1.5 km to the west, and 3.1km to the south, the steep slopes of the Dead Sea Basin and associated *wadis* make pedestrian passage extraordinarily difficult. That being said, the location of the structure appears to have more to do with the location of resources than defense. The structure is downslope for the top of the south ridge of Wadi ‘Assal and in plain view of anyone in the area. However, its relative isolation could have allowed it to secondarily provide safe haven for the inhabitants.

Chapter 13: Ecofactual Remains

As described in Chapter 9 several samples were collected at al-Khayran, including those to retrieve pollen, phytoliths, macro-botanical remains, and spherulites. The pollen was analyzed by Vaughn Bryant of the Texas A&M Palynology Laboratory, the phytoliths were analyzed by Sarah Elliott of Quaternary Scientific and the University of Reading, and the macro-botanical remains and spherulites were analyzed by Chantel White of the University of Notre Dame.

The pollen, phytolith, macro-botanical, and spherulite analyses, like the radiocarbon analyses described in the preceding chapter, were all generously funded by Dr. Maysoun al-Nahar of the University of Jordan through NSF Grant #BCS-410269 for the Mediterranean Landscape Dynamics Project led by Dr. Michael Barton of Arizona State University.

Additionally, faunal remains were collected through the dry sieving of all excavated deposits in 2 mm mesh at al-Khayran and analyzed by the author.

Pollen

Pollen from many different plants can become airborne and then resettle to the surface of the earth in pollen rain. When this pollen is covered by sediment deposition it becomes fossil pollen. Different plants produce different forms of pollen. By analyzing the pollen, it is possible to identify which plants produced the pollen found on-site. When taken in the aggregate, pollen has the potential to inform us about which plants and ecosystems were present in the region (Bryant and Hall, 1993; Bryant and Holloway, 1983).

Two main goals for the palynological analysis at al-Khayran were as follows. The first was to provide an understanding of the flora during the occupation of the site. This was important because it is known that the PPNB was a period of significant climate change in the southern Levant (Byrd, 2005b; Maher et al., 2011; Makarewicz, 2012; Robinson et al., 2011). It is clear that a major determinant of site location in small-scale societies is access to local resource (Trigger, 1968). To understand al-Khayran's function in the settlement system we must also know its environmental setting.

The second goal was to determine if there were any differences in the pollen assemblage of al-Khayran, as compared to earlier sites. Because the MPPNB is the period when domestic forms of plants appear in the archaeological record (Nesbitt, 2002) and there is strong evidence from west-central Jordan of pre-domestication cultivation from the PPNA (White and Makarewicz, 2012), it is possible that people were beginning to alter the floral assemblages through husbandry and other subsistence activities (Cordova, 2007; Kohler-Rollefson and Rollefson, 1990).

Three samples (each of 100 grams) were taken for pollen analysis. Two came from deposits between stones in the cobble surface northwest of the entrance to Phase 02 of Structure 001; one sample was taken from the floor of the earlier phase of the structure. A clean spoon was used to scrape sediments into two small plastic bags from a freshly cleaned surface.

The exterior cobble surface was chosen because it was hoped that the sediments between the stones would be somewhat protected from disturbance and that the pollen would be less degraded. Additionally, because it was not always clear how disturbed the deposits were, the intact nature of the cobble surface indicated that this portion of the site had been subjected to less mixing than others.

The floor of the early phase of the structure was chosen because, even though it had been covered by a roof (blocking much of the potential pollen rain during its use), it likely would not have been buried quickly after exposure because of the continuous cleaning of the interior living space. Thus, it would have had a chance to collect pollen for an extended duration. Because the early phase of the structure collapsed onto the floor, it was sealed and protected (in contrast to the exterior deposits at the site).

A preliminary analysis of the pollen taken from al-Khayran showed the samples to be highly degraded. The pollen was so badly damaged that it was decided to not proceed with a full analysis as none of the potential questions about environmental background at al-Khayran could be analyzed with the results.

Phytoliths

Phytoliths are particles of hydrated silica produced in the bodies of plants, which are quite durable. They are found at archaeological sites liberated from plants after their decay. Most vascular plants produce significant numbers of phytoliths. Different shapes of phytoliths are produced in different portions of plants. Most phytolith shapes are produced by more than one species. However, closely related species tend to produce similar phytoliths. Therefore, in order to identify plant remains at archaeological sites, it is necessary to look at the overall assemblage and the ecological context of its production (Piperno, 2006).

The goal of analyzing phytoliths from al-Khayran was to understand the roles plants played in the PPNB economies of west-central Jordan. There are several advantages as compared to fossil pollen or macro-botanical remains to phytoliths for identifying plant remains at archaeological sites. The most obvious is that almost all plants utilized on-site and for which at least a portion has been left to decay will leave phytoliths. Unlike macro-botanicals, phytoliths

do not typically require carbonization for preservation. Secondly, unlike pollen, they are not deposited from the air, but rather from plant bodies on-site and thus attest to their specific presence on-site rather than in the region as a whole. The obvious disadvantage is that most phytoliths are not easily identifiable to species. Thus, they have the potential to inform us about plant uses and remains not otherwise preserved at the site, but they generally cannot provide the highest level of resolution (Piperno, 2006).

Three samples were taken from the same areas as the pollen samples: two from the cobble surface to the northeast of the entrance to the later phase of Structure 001 and one from the floor of the earlier phase of Structure 001. Each sample was approximately one deciliter in volume. The same reasoning for the location of the samples that was used when selecting pollen sample locations was used when selecting phytolith samples.

The phytolith samples, like the pollen samples, were heavily degraded. However, because it is assumed that phytoliths are deposited by plant materials directly on the site, the analysis of the samples did have the potential to provide a partial understanding of plants present on-site. The dominant types of phytoliths at the site were from woody parts of trees and shrubs. However, there were also remains of C₃ grasses and reeds in lower concentrations (see Appendix 7).

There are two possible explanations for the presence of reeds on-site. The first is that the reeds were brought to the site as raw materials. Given the location of al-Khayran in rocky, sloping terrain bordered on two sides by cliff-faces, it seems likely that the reeds would come from nearby. This would indicate that there was a sufficient water source for such water-intensive species to grow. While there is currently a seep on-site, it is not presently productive enough for either C₃ grass or reed growth today. Additionally, without water control systems,

none of the springs in the area are sufficiently productive to support significant quantities of such plants. This would suggest that there was greater water availability in the past.

The second possibility is that the reeds were brought to the site in the form of finished goods, such as mats, woven baskets, or nets. Reeds are still naturally occurring within Wadi ‘Assal and many other canyons with perennial streams. Additionally, these reeds are still used for basketry (Al-Eisawi, 1996). It is also noteworthy that during the PPNB pottery containers were extremely rare, making containers produced from other raw materials such as reeds highly likely to have existed.

One notable absence from the site is the low amount of monocot remains. There are several reasons why this is surprising. First, monocots typically produce up to 20 times as many phytoliths per unit of mass as do dicots (Albert et al., 2003). Second, monocots tend to dominate PPNB village phytolith assemblages because cereals that were the dominant food source for the period are monocots (Jenkins et al., 2011). Third, this is surprising considering that there is clear evidence of grass cutting through a high concentration of sickle blades (see Chapter 12) at the site and several grinding stones on-site, typically associated with the grinding of cereals in this period (Belfer-Cohen and Hovers, 2005). Thus, it seems likely that preservation problems may account for these results.

Macro-Botanical Remains

Macro-botanical remains at archaeological sites are typically the carbonized remains of plants. When plant materials become carbonized, their shape, even down to the cellular structure, can be preserved. Additionally, when plant remains are carbonized they float in water. Soils are placed in a flotation device to retrieve charred remains that float to the top. These remains are then skimmed from the surface, dried, and analyzed. Because most charred remains have their

shape preserved, they can be identified through the use of a comparative collection. When remains are too heavily degraded to identify without magnification, they can be examined under a microscope to determine species through cellular structure (Pearsall, 2000).

Like the phytolith samples, the goal of the macro-botanical analyses was to identify the plants and determine their roles in the economies of the PPNB of west-central Jordan through contextual analyses. There are a number of advantages and disadvantages to the study of macro-botanical remains. The clear advantage is that it is the best method for identifying specific species. The major disadvantage of the method is that it relies on just carbonized remains, and not all materials happen to be burned (Pearsall, 2000).

Fourteen 2-3 liter samples were taken for flotation from five contexts (with each contexts having 5.5-9.5 liters sampled). They were taken from exterior and interior deposits. The goal was to provide complete coverage of deposit types, from the dirt between stones of the cobble surface and slab-constructed patio of the later phase of Structure 001 to trash deposits, to the interior of the structure during both phases. The samples were floated by me at the American Center for Oriental Research in Amman where they were separated into light and heavy fraction. I sorted the heavy fraction that had macro-botanical remains and bagged the light fraction. Additionally, all artifacts were bagged with the artifacts for the units from which the samples had been taken. The light fraction was shipped to Chantel White at Boston University for analysis.

Like the pollen and phytolith samples, the macro-botanical samples from al-Khayran were heavily degraded. Less than 1 gram of carbonized plant remains was recovered in eight fragments including five unidentifiable seed, two *Lithospermum tenuiflorum* (gromwell) nutlets, and a single cereal grain (unidentifiable to species). Additionally, 48 wood charcoal fragments were identified, none to species. These results are similar to those of the phytolith remains with

woody materials dominating (see Appendix 8). The single cereal grain, identified through its cellular structure, does open the possibility of cereals as a component of the economy at al-Khayran; a possibility reinforced by the high proportion of flint blades with sickle sheen found on-site and the presence of grinding stones.

Spherulites

Spherulites are microscopic crystalline structures found in nature. One way in which they are produced is within the gut of animals and deposited through their droppings at archaeological sites. Different species of animals produce different spherulite shapes; different types of animals produce different quantities of spherulites, with ruminants producing the highest numbers. High concentrations of spherulites have been taken as indicators of on-site husbanding of animals (Canti, 1999, 1998).

Three samples were taken for analysis from the same locations as the pollen and phytolith samples. Each sample was approximately one deciliter in volume. Spherulite analyses did not return a single crystalline particle, suggesting that these particles were not present at the site during the Neolithic. This is likely not due to preservation issues as spherulites preserve well in alkaline soils (Canti, 1999) like those at al-Khayran. In fact, the poor state of preservation for phytolith and macro-botanical samples suggests that spherulite preservation levels should be high as both these types of ecofacts are heavily degraded by the same alkali soils that preserve spherulites (Braadbaart et al., 2009; Cabanes et al., 2011).

Faunal Remains

Faunal remains from archaeological sites are typically the bones of animals which either died on-site or were transported there by the inhabitants. By analyzing the composition of faunal assemblages it is possible to derive significant data about economic activities and the

environmental context of sites. The goal of the faunal analysis at al-Khayran was to determine which animals were being used by site inhabitants and how they were procuring, utilizing, and discarding the material. During excavation, all deposits were dry-sieved through 2mm mesh. All animal bones in the screens were collected. Once back in the project house, all faunal remains were washed and re-bagged. These remains were shipped to the University of Michigan Museum of Anthropology where they were analyzed by the author under the supervision of the Curator of Human Ecology and Archaeobiology, Kent Flannery. Elements were identified using a comparative collection consisting of both wild and domestic sheep and goats, wild gazelle, and various other medium-sized mammals native to southwest Asia.

Taphonomy

Faunal preservation was poor. Most bones were coated by a layer of calcite. Underneath this layer of calcite, the bones were red in color due to iron oxide in the deposits on-site (Figure 60). One of the specimens, a carbonized medium-sized mammal long-bone fragment collected during the clearing of the floor of the early phase of Structure 001, was used for radiocarbon dating.

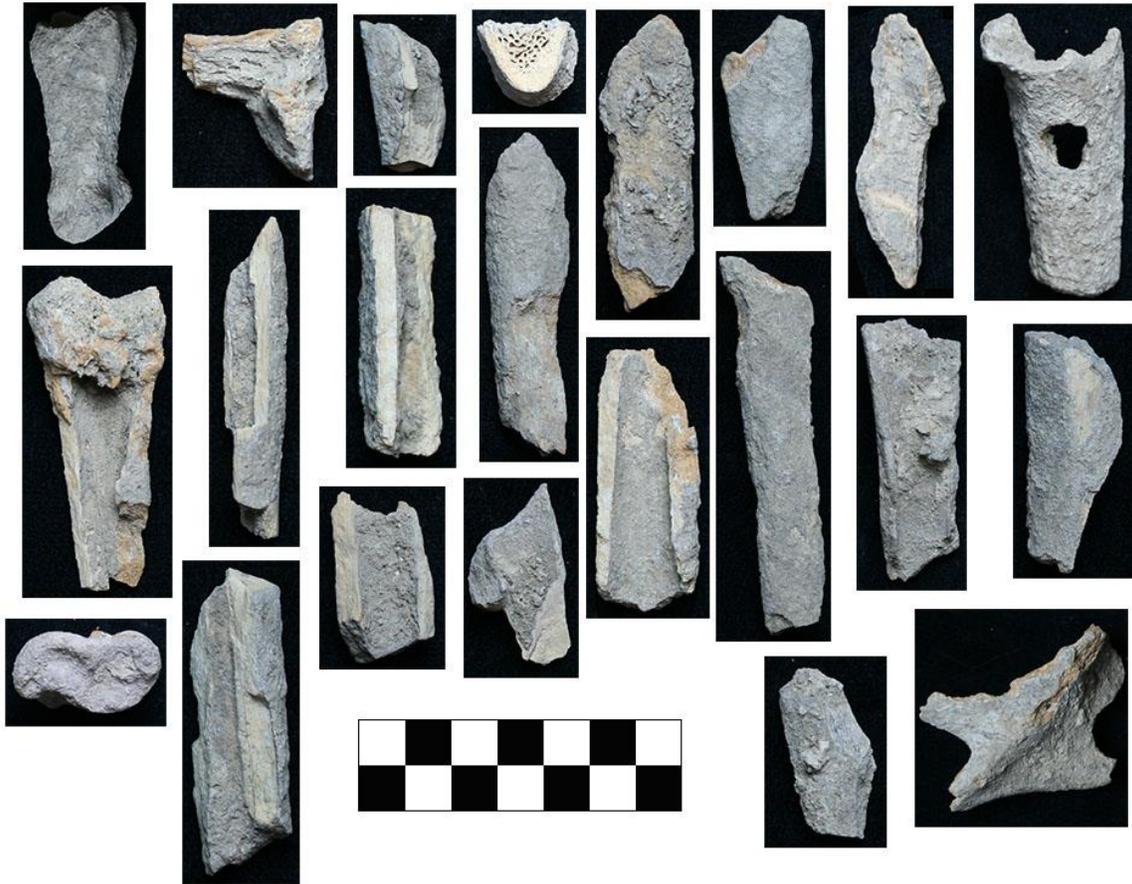
Sample Size

Seventy-eight fragments from 57 elements were recovered during excavation (see Appendix 9). Thus, the sample size is quite small from the site. However, by combining results from the fauna with other analyses and contextual data, it is possible to draw some conclusions about economic behavior involving animals at al-Khayran.

Species

All elements were identifiable as medium-sized mammals with 12 of these identified as ovicaprid (sheep or goat) and two specimens identified as likely ovicaprid. There are two species of caprids, the bezoar goat (*Capra aegagrus*) and the Nubian ibex (*Capra nubiana*), which are native to the area. Ibex was, until recently, common in the steppe of the Jordan Plateau (Al-

Eisawi, 1996).



Element Representation

Figure 60: Calcite Encrusted and Iron Oxide Stained Bones

The most common type of element was “long-bone shaft fragment” (26 of 57 specimens). The second most common was “rib fragment” (13 or 14 of 57). Other elements include long-bone fragments (femur, humerus, radius, tibia), a single cranial fragment (lower orbit), several foot and ankle bones (metacarpal, astragalus, phalanx), thoracic bones (vertebra, sternum), and shoulder bones (scapulae).

Age

Seven (7) of the bones were fully fused (1 astragalus, 2 metacarpals, 2 phalanges, 1 radius, 1 humerus), suggesting a mature age. Of these, six (6) were ovicaprid and one (1) was likely ovicaprid (1 metacarpal). Six elements (6) were unfused (1 lower orbit, 1 radius, 1 scapula, 1 rib, 1 sternum, 1 tibia), indicating they were from younger individuals. Of these, five (5) were identified as ovicaprid, with the sixth identified as medium-size mammal (1 scapula). This gives a roughly even number of younger and older individuals, suggesting that there was not significant selection for one or the other age of prey animal.

Sex

Only a single bone from the cranium existed, a lower orbit bone. And not portion of the pelvic girdle were identified. These two skeletal regions are the best for identifying sex (Zeder, 2001). However, it is also possible to use the length to width ratio of long-bones identifiable to species, controlling for age, in order to determine the male-female proportions of a collection. However, such a technique requires significantly sized assemblage and the ability to identify bones to species (Arbuckle and Atici, 2013). Because the collection from al-Khayran was so small, it was not possible to construct bone-size curved for different elements. Additionally, because both bezoar goat and ibex were present in the area during the PPNB, it was not possible to identify elements to species. It is necessary to have a large assemblage of comparative elements to determine if the distribution is bimodal (as would be expected for a single species). Because adult male bezoar goats and adult female ibex overlap in size to a great extent, as do all adults from both these species to some extent, there was no way to determine the sex of any of the specimens.

Size

Only five (5) elements, all identified as fully fused ovicaprid bones, were intact enough to permit measurement. Of these five measureable elements, three (3), all identified as ovicaprid, were complete specimens (2 proximal phalanges, 1 astragalus). Of the five bones measured, one (1) right proximal (1st) phalanx was exceptionally large for a domestic goat, male or female, and on the large end of wild male ibex. Three (3) elements, a proximal (1st) left phalanx, a proximal end radius fragment, and a metacarpal fragment all were on the small side for wild female ibex or average later domestic female goats or wild female bezoar goats. One (1) measured element, the astragalus, fell on the larger side of domestic male goats or wild bezoar goats and the smaller side of wild male ibex (Zeder, 2001). Thus, we see a variety of sizes, suggesting that size was not a significant factor in the choice of prey animals. All elements, except one, fall within expected size ranges for all three possible caprine species in the area during the PPNB: the wild bezoar goat, the wild ibex, and the domestic goat.

Meat-Bearing versus Non-Meat-Bearing

Fifteen bones were identifiable as meat-bearing or non-meat-bearing (Redding, 2005). Of these nine (9) were meat-bearing (3 radii, 1 tibia, 3 humeri, 2 scapulae) and six (6) were non-meat-bearing (1 astragalus, 1 lower orbit, 2 proximal phalanges, and 2 metacarpals), giving a ratio of 1.5:1 meat-bearing to non-meat-bearing. The expected ratio, if butchering occurred on-site, would be 0.6:1 (Redding, 2005). It is notable that non-meat-bearing bones are virtually absent from the assemblage, save the single lower facial orbit and single vertebra. The high proportion of ribs and long-bone shaft fragments can be seen as over-representation of meat-bearing elements. It is likely that a high proportion of the long-bone fragments derive from meat-bearing bones. Additionally, while not always defined as meat-bearing bones, ribs are frequently treated as such by both hunters and herders (e.g., Atalay and Hastorf, 2006).

Butchering

No butchery marks were identified, likely because of poor preservation.

Cooking

Only a single long-bone shaft fragment (the one used for radiocarbon dating) showed signs of burning.

Discard

Only one (1) element was recovered during the cleaning of the floor of the earlier phase of Structure 001, the carbonized fragment used for radiocarbon dating. Four (4) of the bones identified were recovered directly above the surface of the floor of the early phase of Structure 001. However, because the early phase of Structure 001 collapsed and deposits washed or otherwise eroded into the interior, it is likely that these elements washed into the structure from the exterior trash deposits. The earlier floor of Structure 001 was meticulously cleaned before the inhabitants left. Only a handful of items, clearly placed in storage in anticipation of return, were recovered during floor cleaning. Fifty-two specimens were recovered from trash deposits outside of or above Structure 001. Thus, all but one bone was likely discarded as trash. It also seems likely that the one (1) fragment that was not simply slipped past the inhabitants during cleaning; possibly because it was trampled into the puddled plaster floor of the structure.

Isotopic Analysis

I hoped to submit a sample of fauna for nitrogen and oxygen isotopic analysis to determine if some of the animals were foddered during the winter (Makarewicz and Tuross, 2012, 2009; Makarewicz, 2007). However, such analysis requires a comparative collection of known wild species from the same site derived from animals which exhibit similar feeding

patterns as those bones for which there is a question of husbandry. Because all identified bones were ovicaprid, it was impossible to have a comparative collection against which to test these bones. Thus, no isotopic analysis was possible for the collection.

Implications of These Remains for the MPPNB Environment

This section analyzes the ecofactual analyses presented above for our understanding of the environment in which al-Khayran was embedded. The economic implications of these analyses will be discussed in Chapter 13 through the analysis of the hypotheses presented in Chapter 4. The floral remains in the form of phytoliths and macro-botanicals indicate that the local environment of al-Khayran provided significantly more water than currently found today near the site. This supposition is based on both woody species and reeds in the phytolith assemblage. Today, neither of these plants is found near the site, except for olive groves irrigated using combustion engine-driven pumps.

The macro-botanical remains indicate that a number of the species found today in the area, such as gromwell, were also present during the PPNB. Thus, there were very few surprises from these samples except for the fact that more evidence of cereal cultivation was not present. Only a single cereal grain, identified through its microcellular structures was recovered. This may be an indication of the preservation conditions at the site rather than prehistoric plant use practices.

The fauna from the site, like the macro-botanicals, likely derived from species still present in the area. However, if the bones from al-Khayran are wild caprid, then they would appear to have been far more common in the area during the PPNB. Today few caprids live in the west Jordan steppe outside of nature reserves (Al-Eisawi, 1996). Thus, overall, I see a wetter environment, richer in floral and faunal species than today. This is not surprising given our

understanding of climatic change during the Holocene in Jordan (Cordova, 2007) and the impact of people on the environment of Jordan since the introduction of goat herds during the PPNB (Hill, 2006; Kohler-Rollefson and Rollefson, 1990).

Chapter 14: Material Culture Finds

I present in this chapter the results for three assemblages from al-Khayran: (1) knapped stone, (2) ground stone, and (3) ochre. This chapter furnishes much of the evidence for my assessment of the hypotheses I presented in Chapter 8.

Knapped Stone

There were several goals that I hoped to meet by cataloging the knapped stone at al-Khayran. The three basic processes I investigated were (1) the production of tool blanks through core production, core reduction, and blank production; (2) tool production; and (3) tool use. The description of each of these processes had several relevant purposes for testing the hypotheses described in Chapter 8, from the dating of al-Khayran to the potential for craft production of naviform blades to the subsistence practices of the inhabitants of the site. I used a reduction sequence perspective – looking at raw material, core preparation, core reduction/blank production, tool production, and finally tool utilization. The categories I applied in the knapped stone typology are intended to shed light on each of these processes.

Raw Material Selection

While a number of villages throughout the southern Levant have evidence of raw material acquisition from sources a considerable distance from settlements (Barkai and Gopher, 2001; Barkai et al., 2007; Gopher and Barkai, 2011, 2006; Quintero, 1996, 1994; Rollefson et al.,

2007; Schyle, 2007; Taute, 1994), al-Khayran is located adjacent to one of only two significantly sized, high-quality flint sources along the ridges of Wadi ‘Assal. This source produces a wide variety of flint types, mostly black, brown, gray, and green in hue, but occasionally white, yellow, red, and translucent variations on all of these colors. The flint in fine-grain to medium-grain and can be both highly homogeneous or not. Some of the flint is lustrous; some is not. This variability in flint quality and character within the source has led to both a variety of flint types being used on-site and a significant quantity of testing of the quality of flints on or near the outcropping (pers. obs.).

The other source of flint along the ridges of Wadi ‘Assal is located on the south ridge as well, approximate 3 km southeast of al-Khayran. It is predominantly composed of medium-grain, dull gray, opaque flints. It does not have nearly the variety of grain-size, color, or luster as the outcropping adjacent to al-Khayran. However, the typical type of flint found at this second source of Wadi ‘Assal flint is also commonly found at the source closer to al-Khayran (pers. obs.).

Two other large-scale, high-quality flint sources located nearby are found at the mouth of the *wadi* over 700 m below the ridges of the canyon and north on the Transjordan Plateau near the source of Wadi Dhra’. Each of these sources requires a full day of walking to travel back and forth between the site and the outcrop. Another high-quality flint source is found at the mouth of Wadi Dhra’ as well, but it is a full day’s walk simply to reach the outcropping, let alone return (pers. obs.) (Figure 56). With only one other significant flint source less than a day’s walk from al-Khayran, the inhabitants utilized flints from the adjacent field, with only three flakes out of 6845 knapped stone artifacts identified as potentially coming from a different source (see Appendix 5).

These three flakes are composed of fine-grained, blue, lustrous, waxy flint which is the primary type of knapping stone found at the flint source north of Wadi ‘Assal near the source of Wadi Dhra’. That being said, the local flint source for al-Khayran does produce a number of



Figure 61: Unused Naviform Core (Gabriela Perez-Dietz)

fine-grained, lustrous flints which, when exposed to heat (either intentionally or not) could turn blue in color (Rollefson et al., 2007). Thus, it is not impossible that these few flakes are in fact from the flint source adjacent to al-Khayran. However, they are also potentially sourced from a distance of 3.6 km as the crow flies or 10 km by foot (pers. obs.).

Core Types

While core production precedes the prepared core in the overall knapped stone reduction sequence, a presentation of basic core types informs us about what core production techniques might be present on-site. Thus, presentation of core types allows for the development of debitage analysis methods (Quintero, 2011, 1998) that test both whether the core types directly identified are the only ones being made at the site and whether cores produced on-site may be transported elsewhere (perhaps back to villages), as would seem likely for a satellite settlement which is only occupied for a short period during the annual cycle. Nineteen exhausted naviform cores were recovered during excavation, along with one *in situ* unused naviform core from the floor of the earlier phase of the structure (Figure 61).

The unused naviform core, beyond simply identifying core type utilization for al-Khayran, is also useful for understanding at what point the inhabitants of the site viewed core production to end and core reduction to commence. The core has been extensively flaked on one side and both platform ridges have been flaked bifacially. However, the knapper did not remove the two bifacial ridges located along the opposed platforms, nor did s/he remove the natural ridge along the front face of the core. This suggests that these ridge removal blades, such as crested blades, façade production blades, and initial blades, were viewed as potential tool blanks. This is something borne out through at least two other lines of evidence. Firstly, there are a number of ridge removal blades with evidence of retouch and use-wear. Secondly, a blade cache found alongside the unused naviform core on the floor of the earlier phase of the structure contained a number of utilized blades, including sickles, projectile points, and burins, as well as crested blades and other core maintenance blades such as hinge removal and profile correction blades (Figure 62).



Figure 62: Examples from a Cache of Bipolar Blades, Crested Blade, Tip Retouched A45 Point, Cortical Blades, Hinge Removal, Profile Correction Blades, and Facade Maintenance Blades from a Single Core (Gabriela Perez-Dietz/Matthew V. Kroot)

In addition to the cores themselves, ten hammer stones were recovered during excavation

(Figure 63). All of them were rounded flint cobbles with evidence not only of battery from knapping, but also of intentional shaping of the hammer stones themselves into a rounded form. Such a shape allows for these hammer stones to not only be used for knapping, but also ground stone production (Kadawaki, 2006). Two of these hammer stones were recovered from the floor of the later phase of the structure and two from the earlier phase, suggesting the storage of these

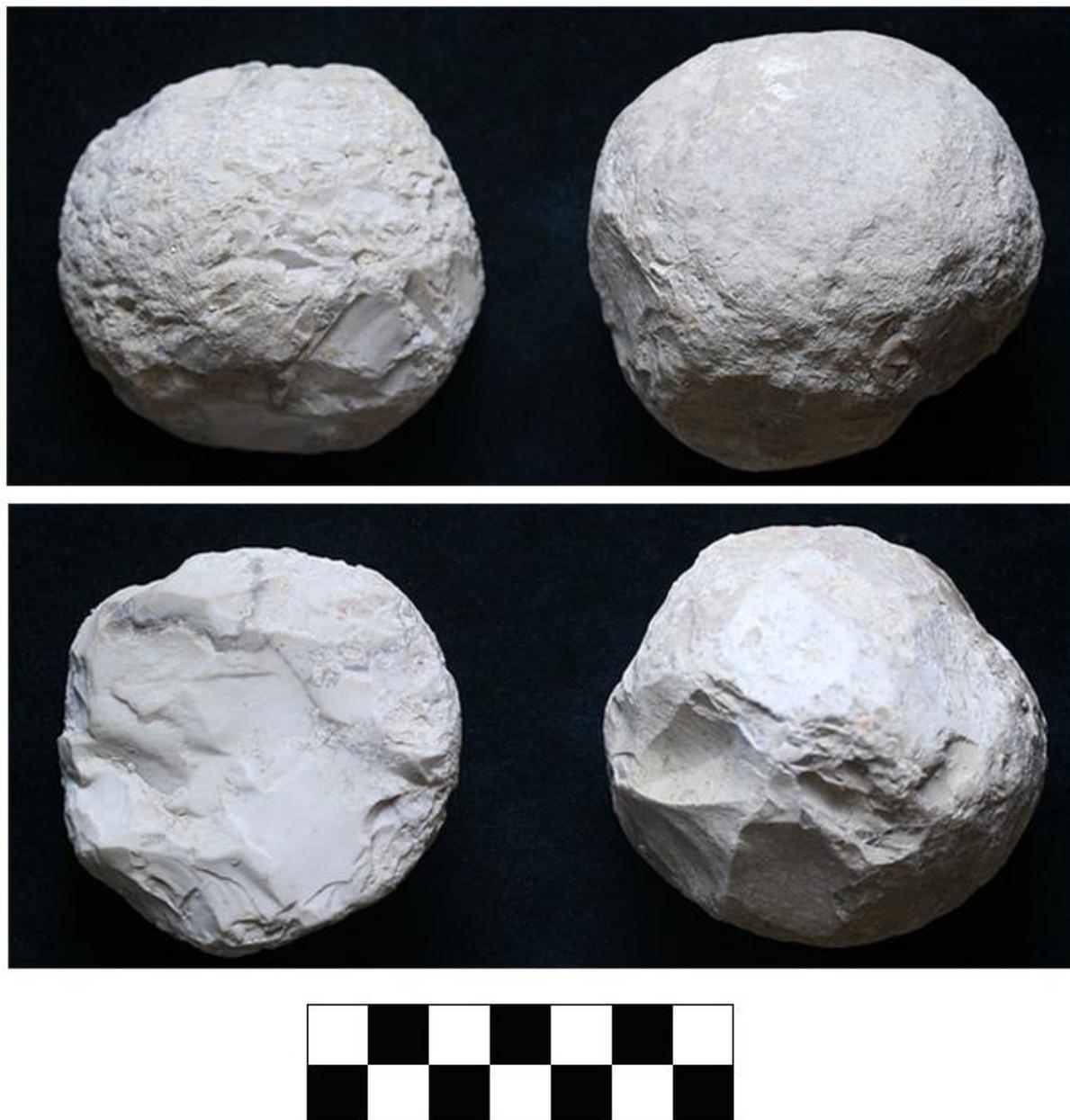


Figure 63: Hammer Stones (Gabriela Perez-Dietz)

items by the inhabitants of al-Khayran and, thus, their value as a product of significant labor and a means for producing items of use.

Core Production Debitage

While cores themselves provide the best direct evidence of core utilization choices, production and reduction debitage analysis can also identify core utilization behavior that may be different from that visible from cores alone. However, in order for such analysis to identify reduction sequences not known through core identification alone, significant quantities of debitage produced by other forms of core production must be present (Quintero, 2011, 1998). Naviform core production yields several forms of rather unique debitage that can be used to identify the technology even beyond the cores and blades that define it. These include significant numbers of (1) crested blades to produce both striking platforms and blade removal faces and (2) back trimming flakes intended to both create a core back that fits the hand well and potential striking platforms for the creation of the bipolar striking platforms utilized during core reduction. When found in significant quantities, both of these debitage types are fairly strong direct evidence of naviform core production as well. Additionally, a number of classes of core preparation debitage are common products of naviform core production, including non-symmetrical cortical flakes and symmetrical and non-symmetrical non-cortical flakes (Quintero and Wilke, 1995; Quintero, 2011, 1998).

What allows for the presence of such debitage types to be understood within the core utilization behavior at a site is their relative frequency to both cores themselves and core reduction debitage (Quintero, 2011, 1998). For example, at 'Ain Ghazal, where raw rounded flint nodules mined in Wadi Huweijier were brought back to the settlement and cores were prepared and reduced within workshop areas, the dumps from MPPNB workshops produced 35 naviform



Figure 64: Crested Blades (Gabriela Perez-Dietz)

naviform cores, 3614 cortical flakes, non-cortical flakes, and chips (referred to as small flakes in the ‘Ain Ghazal report), and 72 crested blades (Figure 52; Figure 64). This is a ratio of 181 flakes/core at al-Khayran as compared to 374 flakes/core at ‘Ain Ghazal. The ratio of cores to crested blades at al-Khayran is nearly identical to that of ‘Ain Ghazal: with 3.8 crested blades/core at al-Khayran and a ratio of 3.5:1 at ‘Ain Ghazal.

It is, however, possible at a site like al-Khayran, where so much of the deposits has been disturbed by later on-site activities, that core to debitage ratios may be problematic due to artifact

cores, 5 non-naviform cores, 14,968 cortical flakes, non-cortical flakes, and small flakes and 140 crested blades out of a total of 41,059 total knapped stone artifacts.

Because of the large sample size of the ‘Ain Ghazal flints and the known behavior of flint procurement and core production at the site, these results can be used as a model for on-site core production (Quintero, 2011, 1998).

Al-Khayran yielded 20 naviform cores, 0 non-

sorting, with heavy cores sifting to the bottom of deposits and, thus, being recovered in lower numbers than debitage. However, because exterior midden deposits were essentially totally excavated, with sediments devoid of artifacts being reached in five of six excavation squares, it is likely that a close to complete recovery of the actual archaeological assemblage of knapped stone materials was made within the constraints of recovery procedures. In other words, it is likely that the ratios seen at al-Khayran are not a product of non-representative recovery.

Core Reduction Debitage

Naviform cores also produce a number of distinctive debitage types during reduction. The most obvious of these is the bipolar blade. The whole point of a naviform core is to produce such blanks for further reduction or utilization. Beyond this, frequently bipolar façade correction or rejuvenation blades, such as hinge removal, ridge-straightening, profile-correction, and overshot blades, are produced and occasionally platform rejuvenation spall. The presence of these debitage types are direct indicators of bipolar reduction, of which naviform blade production is the only common form found in the PPNB of the southern Levant. Al-Khayran yielded 70 hinge removal blades of various kinds, such as bipolarly flakes and cortical ones. This compared to 98 identified in the MPPNB deposits at 'Ain Ghazal. Al-Khayran also yielded 105 façade rejuvenation blades or various kinds such as ridge-straightening and profile-correction blades. This is compared to 1,066 for 'Ain Ghazal. Again, the discordance between hinge removal and façade correction blade ratios at al-Khayran and 'Ain Ghazal are notable. It seems likely that these dramatic differences are due to differences in analyst identification of these artifact types as each of these debitage types is more difficult to ascertain.

Perhaps a better gauge of reduction activities at al-Khayran is the analysis of blades themselves. However, caution must be used when determining the directionality of blade

production from blades themselves, as it is not always possible to identify opposed direction flaking on all bipolarly produced artifacts; especially fragmentary ones. Thus, only a certain select class of debitage can be utilized for reduction behavior determination. For the purposes of this study only complete or near-complete blades (>3/4 complete) blades 5 cm or longer, with four or more flake scars visible on the dorsal surface were used for the identification of bipolar reduction. Of 1,365 total blades, 445 met this description. Of these, all 445 were determined to be reduced using bipolar methods.

Informal Tool Utilization

The knapped stone tools of al-Khayran were divided into two categories: formal and informal. Formal tools are defined as tools knapped into specific forms before utilization while informal tools are ones with evidence of retouch or utilization wear without a specific pre-planned form. Another common term for informal tools is expedient tools. However, this name is eschewed because of the implication that minimal time is spent manufacturing the tool. Retouched informal tools do have additional knapping processes performed on them following the striking of them from cores.

Informal tools were further broken down into retouched and utilized tools. For both of these categories the blank type (blade/bipolar blade, flake, core, etc.) was noted and the location of retouch or use-wear was recorded. Eleven retouched flakes were identified and 134 retouched blades. Ninety-five flakes and 497 blades with use-wear were recorded. Of those blades with retouch, all but 13 had retouch on their sides. For blades with use-wear, 432 had side use-wear, 52 had side and end or back use-wear, and 13 had end or back use-wear. Two additional categories of informal tools were also created: (1) artifacts with sickle sheen and (2) denticulates. Fifty-three items with sickle sheen were found, all on blades. When taken as a percentage of the

overall tool assemblage from al-Khayran, both formal and informal, sickles comprise 6.4% of the collection. While this may seem low, given the likely focus on cereal harvesting at the site, it is actually a higher percentage than is typical at early Neolithic sites in the southern Levant (Goodale et al., 2010). Additionally, three denticulates were identified. A total of 793 informal tools were recorded.

Within the informal tool assemblage of al-Khayran, blades are utilized more frequently than flakes and such blades typically were utilized along their sides. While 53 sickle blades were identified, it seems likely that a significantly higher number of the informal, blade-based tools with side use-wear or retouch and the denticulates were used as sickles as well. In a recent paper Goodale et al. (2010) demonstrated that in order for sickle blades to exhibit sheen they must be used extensively. Thus, it is likely, given the patterns of use-wear and blank choice and the knowledge that at many other sites denticulates do exhibit evidence of use as sickle blades (Goodale et al., 2010), that many more of the informal tools were used for cutting grasses than simply those that exhibit sickle sheen.

Formal Tool Production Debitage

Very few debitage types are diagnostic of tool production as opposed to core production or reduction. Typically, flakes are smaller and can be produced through different flaking methods, which are more controlled and directed, such as pressure flaking. There are two categories of debitage recorded at al-Khayran which are viewed as the product of tool production: chips and burinations. While the latter is more certain in its association with tool production, the former can also be a product of platform maintenance. Additionally, because chips, by definition are so small, they frequently have lower recovery rates than other debitage types, making the identification of tool production on-site all the more difficult. While other

large-scale village sites of the PPNB have had the convenience of having core and tool production waste dumps segregated due to the presence of naviform blade workshop, such a spatial segregation of knapping behavior did not exist at al-Khayran. Thus, due to all of these factors, all that can be noted is that a total of 427 chips were recorded and five burinations.

Formal Tools

The number of formal tools was relatively small at al-Khayran, with only 45 recovered. All formal tools (save one burin) were made on blades and for all those blades for which the direction of at least four dorsal flaking scars could be determined, bipolar reduction was observed. Two classes of formal tools dominate the assemblage: points with 21 total (Figure 53) and perforators with 19 total (Figure 65). Additionally, three burins, a single lunate, and a single potentially broken irregular Nahal Hemar knife were recovered (Figure 53; Figure 65; Figure 66). Within the points were seven Helwan, one Byblos, two Khiam, one Jericho, and ten A45 points. For every point where the direction of flaking of multiple flake scars was determinable, bipolar reduction was used to produce the blank. This is notable for both the Helwan points and one of the two el-Khiam points (the direction of flaking was not identifiable on the other) which are typically made on single platform blades (Gopher, 1994) or even flakes (Khalaily et al., 2007). The thinness of the blades and the extensive retouch on the tips of the two potential Khiam points may suggest that they were in fact not Khiam points at all, but recycled tools with side notching (typical of Helwan points as well) that were eventually transformed through use and retouch into a similar form as the base of a Khiam point.



Figure 65: (A-S) Perforators; (T) Burin (Gabriela Perez-Dietz/Matthew V. Kroot)

The perforators also exhibit significant variation within this class of artifacts. Certain tool types sometimes used in southern Levant Neolithic research are not used here as their names imply functional aspects of the tools that are not warranted. Rather, they are simply morphological classifications, which do little to advance our understanding of either the use of the tools or the goals of the knapper. Thus, such terms as drills, borers, and awls are collapsed into the category of perforator. Within this category the main dimension of variation is the form of the retouched tip, with a number of artifacts having long, thin tips of even diameter flaked

onto the ends of blades, while other artifacts are on blades tapered from the back to the tip at a steady decrease in diameter (Figure 65).

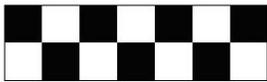


Figure 66: Bipolar, Notched Blade; Possible Broken Nahal Hemar Knife (Gabriela Perez-Dietz)

Formal Tool Use-Wear

In addition to recording the location of use-wear on formal tools, a great number of points also had evidence of impact fractures which were recorded. Of the 21 non-point formal tools, only two burins had evidence of side use-wear and one of these also had evidence of a single notch flaked into the area of use-wear. As for the points, six of the ten A45 points have the tips broken off with clear impact fractures, as does the Byblos point (Figure 53). Three of the other four A45 points are also missing their tips, but are either fractured further down the stem as is the case for one of them or are retouched at the tip as is the case with two. A single, more coarsely knapped A45 point is fully intact. For the seven Helwan points, two are complete, one is broken at the base, three are broken at roughly halfway down the body, and one is broken closer to the tip. None of these points exhibit evidence of impact fractures. While the one Jericho point is broken near the tip, it also shows no evidence of an impact fracture. As discussed above, one of the Khiam points have extensive use-wear on their tips obscuring any potential evidence of impact (Figure 53).

Knapped Stone Cache

Directly on the floor of the earlier phase of the structure a cache of knapped stone object was uncovered. It was primarily composed of a large quantity of blades and other naviform core reduction products from a single reduction sequence (Figure 62). However, a number of other artifacts were also within the cache including one of the two A45 point with a retouched and rounded tip, the potential irregular Nahar Hemar knife, the unused naviform core, and two rounded cobble hammer stones, all of which have been described previously. In addition to these formal tools, core, and hammer stones, a significant number of blades and other naviform reduction products were found such as a crested blade, six sickle blades, one with bitumen on one side, a blade with side retouch, thirteen blades with side use-wear, two façade maintenance blades, a hinge removal blade, and 38 blades. The total number of blades and blade-based tools in the cache is 63 artifacts, not including the naviform core or hammer stones. Of these 63 blade artifacts, 50 are from a single naviform core reduction sequence. This is an extraordinarily high number of blades from a single sequence (Barzilai, 2010). However, it must be kept in mind that when previous authors have counted the typical number of blades yielded by a single naviform core, they have not included platform and façade production spall or façade maintenance artifacts in their counts. But, as the inclusion of these sorts of chipped stone within the knapped stone cache shows, the inhabitants of al-Khayran considered these items to be useable products from core reduction as well as blades. A total of 30 non-cortical blades were from the single naviform core and place the productivity of this core on the high side of normal for such a knapping sequence (Barzilai, 2010).

Ground Stone

The ground stone assemblage from al-Khayran is small with a total of 12 objects (Figure 49; Figure 55). Ten of these artifacts are portable, while two are inset features within the floor of

the earlier phase of the structure. These objects are made from three different types of stone: the brown/red or gray sandstone of the Dead Sea Basin, dark gray basalt of unknown origin, likely at a distance of at least 25 km northeast or southeast of al-Khayran, as reviewed in Chapter 9, and likely pink Dabba marble (Wright et al., 2008) from the eastern Syro-Arabian Desert. The function of the tools, as well as their discard patterns seem to be tied to the material from which they are made, with only broken basalt object found in refuse deposits, while sandstone objects were found directly on the floor of both the earlier and later phases of the structure, suggesting less value associated with them. It is unclear what the single pink marble object is, but it is clear that it is broken, again suggesting that the inhabitants of al-Khayran only parted from the object after its utility was lost or damaged.

As reviewed in Chapter 9, a large gray sandstone quern was inset into the puddled plaster floor of the earlier phase of the structure, along with a sandstone flagstone with shallow striation suggesting a cutting surface. Found sitting in the quern was a red/brown single hand stone. In addition to these *in situ* objects associated with the earlier phase of the structure, a gray sandstone chipped disk, which is likely the blank for a stone ring (Gebel, 2010, 2004a; Starck, 1988), was also found. On the floor of the later phase of the structure a single gray sandstone pillow-shaped piece with deep parallel grooves was found (Hermansen and Gebel, 1996) (Figure 55). Additionally, a brown/red double hand stone broken in half was recycled into the wall of the later phase of the structure.

All other ground stone objects were found in refuse deposits. All ground stone artifacts found in trash deposits were either basalt or Dabba marble. These included two broken pestle fragments, a broken nearly complete pestle, a broken shaft straightener, and a broken quern

fragment, all made with basalt. The sole item made from Dabba marble is a fragment of a cylinder broken on both sides.

Ochre

One of the more unique finds associated with the earlier phase of the structure at al-Khayran is what appears to be the remains of a bag of ground red ochre (Figure 67). The ochre was found in a ball directly on the floor of the earlier phase of the structure. There are three main



Figure 67: Ground Ochre Mass

uses for ochre: (1) as a pigment, as is common in the PPNB for object, architectural, or possibly bodily decoration (Clarke, 2012; Fletcher et al., 2008; Rollefson, 1998b), (2) as a hafting material (Shaham et al., 2010), and (3) for the processing of hides (Dubreuil and Grosman, 2009). It is unknown for which of these uses the inhabitants of al-Khayran intended the ochre as no objects with red staining were identified. That being said, the level of preservation for the plaster, upon which the ochre would have been applied,

was so poor that such a use cannot be discounted.

Chapter 15: Evaluation of Hypotheses

This chapter of the dissertation returns to the hypotheses presented previously and evaluates them through the results of the ‘Assal-Dhra’ Archaeological Project, using the criteria laid out in Chapter 8.

Hypothesis 1

In order to meet the nutritional needs of increasing populations, communities living in nucleated settlements will alter the spatio-temporal organization of their subsistence behaviors. As reviewed in Chapter 4, the spatial and temporal organization of subsistence practices are some of the more common and effective means of increasing productive efficiency in subsistence practices (Blaikie, 1971). This hypothesis holds steady the social structure of economic units and simply is designed to test the spatio-temporal pattern of subsistence production behaviors for these units. Hypothesis 3 is designed to test the potential for the restructuring of the relations of production, which should have a significant effect on the spatio-temporal structure of subsistence behavior.

Expectations Outside of Villages:

A: A Shift in Settlement Patterns

Evaluation: As reviewed in Chapter 10, within the core village area of the Jordan Rift Valley and the Transjordan Plateau it is expected that satellite settlements would develop in order to allow for greater flexibility in labor scheduling through decreasing travel and transportation costs. Such settlements are expected to be small sites. However, another mechanism that can frequently be used to increase subsistence production efficiency is the dispersal of settlements, which would also produce small sites. Thus, the structure of small sites is key to identifying their functions. Chapter 4 laid out eight common forms of satellite settlements and other permanently occupied small site types. The evaluation of Hypothesis 1 will be done using the data from the only small site yet excavated for the MPPNB: al-Khayran.

The architectural remains from al-Khayran can be used to eliminate a number of the eight potential small site types describe in Chapter 4. The isolated single-room structure made of stone and including a number of internal features associated with long-term habitation, such as the inset quern and cutting stone within the puddled plaster floor of the earlier phase of the structure suggest that the site was not a temporary or permanent field structure (Moore, 1979). The lack of multiple structures, as shown through the extensive surface collection and subsurface testing and excavation, eliminates agricultural compounds (Eskelinen, 1977a; Sidibe, 1978) and communities (Preucel, 1990), as well as farming hamlets (Banning, 2003) as potential site types for al-Khayran. In fact, the very basic single structure at al-Khayran also suggests that the settlement was not occupied as a farmhouse (Banning, 2003) or homestead (Banning, 1995; Stone, 1996), as both these forms of settlement typically have complex structures with architecture and features designed to provide specialized space for greater numbers of activities than villages residential structures or field houses. This is because greater economic autonomy,

as compared to village-based residential units, is key to these forms of settlement. Thus, a greater number of economic functions must be accommodated within the individual residence than in village residences.

However, beyond this simple architectural analysis, it is also possible to demonstrate that all criteria for field houses describes in Chapter 4, for which we have sufficient relevant data, are met by al-Khayran and key criteria for all the other seven small sites types described are not met. Al-Khayran (1) was an isolated structure located within a region with evidence of only sedentary village settlement systems, as opposed to dispersed settlements, frontier (homesteading) settlement, or mobile settlement systems, as noted in Chapter 6. It is (2) located in productive farmland, as noted in Chapter 5. There is (3) substantial investment in durable architecture at the site, as described in Chapter 12. (4) The architecture, described in Chapter 12, is appropriated sized to accommodate a nuclear family, which was likely the basic productive unit of the MPPNB within village communities. This is based on residence population estimates described in Chapter 7 for the time period.

There is (5) significant architectural accommodations for overnight stays including durable floors and walls, a roof, food preparation areas, and systematic waste disposal patterns to name a few, as described in Chapter 12. While the architecture at the site does have significant numbers of features intended to accommodate long-term habitation, (6) the range of architectural features at the site is less than is found within village settlements during the MPPNB, as described in Chapters 6 and 7. There are no basements or internal craft production areas. There are not specialized ritual structures. There are no exterior food processing areas apart from likely cooking features. All of these suggest that a reduced range of activities was happening within the residential area.

Interestingly, (7) some activities described in Chapter 7 as found typically within residential structures during the MPPNB, such as cooking and craft production appear to have occurred outside of the structure at al-Khayran, as shown by the presence of charcoal and other carbonized materials within the midden deposits on-site and the stone ring blank. There is a lack of evidence for an interior hearth or basement floor for storage and/or production of craft items, as described in Chapter 12. Both these activities produce significant amounts of unwanted waste (smoke and debitage) and are, thus, preferentially performed outdoors whenever possible. However, if social pressures from the prying eyes of neighbors are great, then these activities might move indoors (Byrd, 2005a, 2000, 1994; Wilson, 1988; Wright, 2014, 2000). Food preparation activities, which were typically performed outdoors in the MPPNB for social purposes (Wright, 2000), were moved indoors. This likely is because as an isolated site inhabited by only a single household, al-Khayran would have been much more vulnerable to non-human and human predators (Moore, 1979).

(8) There is a reduced diversity of architectural features at al-Khayran, as described in Chapter 12, as compared to MPPNB village settlements analyzed in Chapters 6 and 7. (9) In Chapter 12 it was shown that a moderate amount of refuse from productive activities was recovered including knapped stone debitage, broken ground stone tools, and excess plaster waste. The quantities of all of these were not as high as in village settlements, but their diversity was certainly greater than expected at daily-use sites, as described in Chapters 2-4 and 6. (10) There was refuse from consumption activities such as carbonized plant and faunal remains, as described in Chapter 13. (11) The tool assemblage at al-Khayran, described in Chapter 14, was limited as compared to village settlements of the time period (Crowfoot-Payne, 1983; Garfinkel et al., 2012; Kadawaki, 2006; Khalaily and Marder, 2003b; Lechevallier, 1978; Makarewicz et

al., 2006; Mortensen, 1970; Wright, 2000, 1993), with little evidence of industrial-scale production or elaborate ritual.

The most difficult of the dozen criteria for a field house to identify at al-Khayran was (12) the refuse disposal pattern with stratigraphic evidence of repeated inter-annual habitation and abandonment. The only portion of the site where the sub-surface integrity of the stratigraphy was high, described in Chapter 12, was within the interior of the structure. Within this interior there was evidence of occupation followed by abandonment followed by occupation followed by abandonment. However, it was impossible to determine the duration of abandonment. Thus, it is possible that the site was occupied permanently and then abandoned. This was followed by a subsequent opportunistic reoccupation of the site and remodeling of the largely collapsed walls of the earlier phase of occupation. There was one suggestion that this was not the case however. Because of the extensive quantities of materials left in storage within the earlier phase of the structure, it does suggest that there was an intentional abandonment with an intent to return to the site at a later time.

Beyond these twelve criteria, it is also possible to eliminate those small site types occupied by a single residential unit permanently; namely farmhouses and homesteads. There is not significant evidence of remodeling except due to architectural collapse at the site as would be expected for a permanent occupation (Banning, 1995; Stone, 1996). Additionally, the architecture is not as specialized as would be expected for permanent occupation (Banning, 1995). The location of al-Khayran within the core village area of the Transjordan Highlands is also not typical of either farmhouses or homesteads as such a settlement pattern is difficult to maintain within regions where competing economic groups live in larger communities (Flannery, 1972; Stone, 1996). Finally, the patterns of refuse disposal are not intensive or systematic

enough for permanent occupation and the stratigraphic pattern of deposition identified within the structure is not typical of these settlement forms (Hardy-Smith and Edwards, 2004). Thus, the most likely functional explanation of al-Khayran is that of the field house.

Hypothesis 2

In order to meet the nutritional needs of increasing populations, communities living in nucleated settlement patterns will increase subsistence production per unit of area (i.e., subsistence production must intensify) due to land pressures from both population growth and travel and transportation costs. As discussed in Chapter 2, such a phenomenon was first fully argued and documented by Boserup (1965) and has since been shown to be a common phenomenon throughout the world when travel and transportation costs place limits on land access for growing populations (Chisholm, 1979; Stone, 1996)

Expectations within and Outside of Villages:

Intensified Subsistence Production: Plants

A: Reduced Number of Plant Species Consumed by Households

Evaluation: The analysis of both macro-botanical and phytolith assemblages was greatly hindered by levels of preservation. It was not possible to determine the breadth of species utilized by the inhabitants of al-Khayran as compared to earlier sites.

B: Shift in Ratio of Plants Consumed from Highly Nutritious Species to High Calorie Ones

Evaluation: Again, there was insufficient preservation of macro-botanicals and phytoliths to fully analyze this expectation. However, there is a notably high quantity of sickles

and likely sickles within the knapped stone assemblage, suggesting a focus on the production of highly caloric cereals.

C: Increasing Processing of Plants

Evaluation: Two tool assemblages were utilized to evaluate this expectation: ground stone grinding utensils and sickle blades. The presence of an inset quern within the floor of the earlier phase of the structure and several broken or fragmentary ground stone tool types commonly associated with cereal processing, such as hand stones and pestles, does suggest a significant degree of plant processing on-site. A total of 12 ground stone artifacts were identified. Of these, seven are commonly associated with plant processing, including three pestle or pestle fragments, two hand stones or hand stone fragments, and two querns or quern fragments. Additionally, the probable short overall duration of occupation for the site, given that it was likely inhabited by a single family, and the low intensity of occupation, given that the site was only temporarily, but repeatedly occupied, makes the presence of such high numbers of plant processing tools all the more dramatic.

While the number of overall ground stone items per structure at early Neolithic sites is highly variable (Kadawaki, 2006; Wright, 2008, 2000, 1993, 1991), with some sites having over 20 individual artifacts per identified structure (e.g., Makarewicz et al., 2006), when looking at the number of plant processing tools specifically, such as pestle and querns, the numbers per structure are dramatically higher than at other sites, with a 1:1 quern to structure ratio and a 3:1 pestle to quern ratio. Both these ratios are far higher than at other early Neolithic sites (Kadawaki, 2006; Wright, 2008, 2000, 1993, 1991). That being said, the small sample size could skew these results. However, they do tend to support the idea that plant processing was a significant part of al-Khayran's economy. Additionally, as briefly noted above as well, the sickle

blade and likely sickle blade assemblage from the site of al-Khayran also supports the idea that cereal harvesting was likely a large part of the al-Khayran economy. When taken together these results, although not definitive, do tend to support the idea of an increase in plant processing at al-Khayran as compared to earlier Neolithic sites.

D: Increased Storage Capacity per Inhabitant

Evaluation: No evidence of storage of food items, nor specialized storage structures or features were identified at al-Khayran. However, as reviewed in Chapter 8, this does not necessarily indicate a lack of storage intensification during the MPPNB. Rather, it is more likely an indication of a lack of a significant subsistence storage function for al-Khayran and other potential field houses in the era.

E: Domestication of Plants

Evaluation: There was insufficient macro-botanical preservation to determine the domestication status of plant remains at al-Khayran

F: Cultivation of Plant Foods

Evaluation: The macro-botanical remains were too poorly preserved to provide direct evidence of cultivation. However, the higher numbers of sickle blades as a percentage of the overall tool assemblage than other Neolithic sites and a large number of ground stone items potentially used for plant processing (however slight the sample size) is suggestive of a focus on cereal harvesting and processing. While this evidence is too weak to strongly support the idea of cultivation at al-Khayran, it certainly cannot be used to disprove the hypothesis. Rather, it

provides weak support for the least verifiable of Willcox's (2013) criteria for cultivation: extensive cereal processing facilities.

G: New Extractive Technologies

Evaluation: Quintero and Wilke (1995; Quintero, 2011, 1998) have argued that naviform core and blade production was a technological innovation which allowed for the production of large quantities of long straight blades. The demand for these blades was generated by the intensification of agricultural practices, such as sickle usage. Thus, the presence of naviform core and blade technology at al-Khayran can be viewed as evidence of new extractive technologies as compared to earlier periods.

H: New Settlement and Production Organization

Evaluation: The simple existence of a field house is a novel innovation in both settlement and subsistence organization. The presence of al-Khayran and its evidence of plant subsistence production suggests an intensification of plant subsistence economies.

Overall Implications for Increased Plant Subsistence Production

The paleo-botanical and phytolith remains were insufficiently preserved to understand the intensity of plant subsistence production, but the artifactual remains having to do with subsistence production and processing suggest that both were increasing as compared to earlier periods. The only new extractive technology identified were naviform cores, which furnish greater numbers of long straight blades as compared to earlier core types. These results suggest innovations in labor intensity and the organization of production as the primary means of intensification in plant economies.

Intensified Subsistence Production: Animals

A: Narrowing of Diet Spectrum

Evaluation: All faunal remains derive from medium mammals and remains identifiable to subfamily are ovicaprid. This could be the result of two possible animal procurement strategies. Either the inhabitants of al-Khayran acquired their animal products from the herded ovicaprids or they acquired them through the hunting of the largest package available in Wadi ‘Assal: wild bezoar goats or ibex. While there is a narrowing of the diet spectrum, therefore, it is not clear if this is due to a greatly decreased intensity of hunting or greatly increased intensity of herd management.

B: Herd Management

Evaluation: The recovered fauna derives from a range of ages and sizes of medium mammals. No elements which indicated sex were recovered. While there was a skewed ratio of meat-bearing elements to non-meat-bearing elements as compared to butchery sites, there was still a certain quantity of non-meat-bearing bones.

The fact that all fauna derives from older juveniles and adults suggests some focus on package size for slaughter. However the selectiveness of slaughtering was not as intensive as in the case with herding where humans target specific age ranges and sexes to maintain herd stability. The size range of the specimens would hint at a possible hunting scenario where the low population density in Wadi ‘Assal created a low level of hunting pressure. Thus, inhabitants could preferentially hunt the largest species in the region: wild bezoar goats and/or ibex while not being concerned about the effects of the hunting on wild herd populations. The

preponderance of meat-bearing elements suggests preliminary butchering away from the site, again hinting that the population was hunted rather than husbanded.

Another line of evidence suggestive of hunting as opposed to herding is the impact fractures identified on six of the ten A45 points and the one Jericho point, as well as the lack of tips on three of the other four A45 points. This suggests that these points were utilized for hunting and the large quantity of utilized points relative to the size of the site also suggests that hunting was a significant part of the subsistence economy at al-Khayran.

C: Domestication of Animals

Evaluation: No elements which can be used to definitively identify domestication were recovered from al-Khayran. Additionally, the sample size is too small and size range of the elements too variable to identify any patterns indicative of domestication.

D: Keeping of Herds On-Site

Evaluation: No spherulites were identified in the deposits at al-Khayran. No potential penning structures were identified on-site either. This is strong evidence that flocks were not kept at al-Khayran.

Overall Implications for Increased Animal Subsistence Production

The most parsimonious description which would account for the structures of the faunal assemblage would be low intensity hunting focusing on satisfying caloric needs from the largest locally available natural fauna, with in-field butchery. The low intensity of hunting pressure in the area is likely because of the small population at al-Khayran and the lack of evidence for other PPNB settlements along the south ridge of Wadi ‘Assal. With low intensity hunting, there are

two potential strategies: (1) the selective procurement of the largest available animals (i.e., adult males of the largest game in the area) or (2) the opportunistic killing of available prey (Zeder, 2011). The former is frequently associated with the provisioning of significant numbers of individuals, such as villages or courtyard groups, while the latter is typically associated with provisions small numbers of individuals, such as the household. This is because the former is the most efficient way to provide significant quantities of food (and the best way to accrue prestige), while the latter is the best way to minimize energy expenditures while providing sufficient quantities of food. Opportunistic hunting would produce a kill profile similar to that found at al-Khayran with young and old, large and small individuals found in similar amounts. Hunting is also supported by the high ratio of meat-bearing to non-meat-bearing bones.

Herding seems unlikely for two reasons. First, such a mixed kill profile would be poor long-term herd management, as reviewed above. Second, typically, butchering occurs on-site with herding as this reduced transportation costs to the location of preparation and consumption. Because there is a bias toward meat-bearing bones, it seems likely that transportation costs were a significant consideration in the butchering behavior at al-Khayran.

However, all faunal remains are derived from medium mammals and all identified elements are ovicaprid. This does leave open the possibility that the fauna could have derived from herded animals, but that preservation levels were so poor on-site that morphological, demographic, and spherulite evidence of this is missing. A third possibility is that herded animal elements were brought to the site from a village or separate pastoral campsite. However, such a system of animal procurement does seem unlikely given the intensity of occupation at al-Khayran. It would require additional unnecessary travel and transportation costs to retrieve the meat as compared to local hunting. The fourth possibility that the animal bones were transported

to al-Khayran along with meat from villages is inefficient, as bone adds additional costs with no caloric return. Additionally, the transport of non-meat bearing elements, making it unlikely that the bones were derived from village-based butchering of animals or the importing of preserved meat from villages.

Intensified Subsistence Production: Agro-Pastoralism

A: The Husbandry of Both Plants and Animals at a Single Site

Evaluation: As reviewed above, there is some evidence for the husbandry of plants at al-Khayran, but no evidence for the husbandry of animals. This would not support the hypothesis that the inhabitants of al-Khayran practiced a mixed agro-pastoral economy.

Expectations Outside of Villages:

Satellite Subsistence Settlements

A: Small Site Construction

Evaluation: Al-Khayran definitely meets the criterion of being a small site. It is limited in area and depth, with a single structure as the only architecture identified.

B: Temporary and Repeat Occupation

Evaluation: While the faunal and botanical evidence was too poorly preserved to be used for assessments of seasonality, a clear depositional pattern of occupation succeeded by non-occupation succeeded by occupation was visible in the site's stratigraphy. This would suggest a temporary, but repeat pattern of occupation. However, caution must be taken with this overall pattern, as it is not clear how long the duration was between occupations. Additionally, the finds

of a number of items, some of which were perishable, placed into storage in anticipation of return is suggestive of repeat usage. Another line of evidence is simply the isolation of the site in a landscape of villages. As discussed above, isolated structures or small settlements in nucleated village settlement patterns are very rarely inhabited continuously. Instead, they are typically utilized as satellite settlements. Finally, the seeming emphasis on cereal harvesting and processing, as seen through the high numbers of sickles and grinding stones, is indicative of an overemphasis on a set of seasonal behaviors associated with spring and summer. With no evidence of storage on-site, the processing of cereals was likely done on a temporary basis before additional stocks were transported back to villages for long-term usage and safe-keeping.

C: Specialized Subsistence Productive Activities On-Site

Evaluation: As reviewed previously, there is evidence of many similar activities associated with daily life in PPNB villages, including the use of expedient tools, grinding tools, beads, and a potential sandstone ring blank. However, there are several activities for which there is outsized material evidence, suggesting a stronger emphasis on them than at village sites. This includes the high incidence of sickle blades, large quantities of grinding tools, and a high percentage of points and points with impact fractures. The first of these suggests a prominent place for cereal harvesting at the site, while the second suggests a prominent place for cereal consumption in the diet of the inhabitants. The prominence of cereal production is a definite expectation within field houses and intensifying economies. The high levels of cereal consumption on the other hand may simply be a result of what food was most easily available at the site, as it was likely occupied during harvest. The emphasis on hunting at al-Khayran, identifiable through the point assemblage, suggests that the site was used primarily to increase plant subsistence production.

Overall Implications for the Construction and Utilization of a Field House at al-Khayran

There is significant evidence for the temporary and repeat occupation of al-Khayran, as well as the focus of subsistence behavior at the site on plant production. This would support the contention that al-Khayran was a subsistence production field house.

Subsistence Landscape Modifications

A: Water Management Systems

Evaluation: No evidence of definitively PPNB water management systems was identified during survey.

B: Terracing

Evaluation: No evidence of definitively PPNB terracing was identified during survey.

C: Field Walls

Evaluation: No evidence of definitively PPNB field walls was identified during survey.

D: Fertilizing of Agricultural Fields

Evaluation: No artifact scatters on arable land composed of PPNB artifacts were identified on survey

E: The Development of Farm Field Pathways

Evaluation: No evidence of definitively PPNB farm field pathway systems was identified during survey or through Google Earth examination.

Implications for the Modification of the Landscape Around al-Khayran in Order to Increase Subsistence Production

There is no evidence of the modification of landscapes around al-Khayran

Evaluation of Hypothesis 2

There is strong evidence that al-Khayran was utilized to increase plant subsistence production, but no evidence that it was used to increase animal subsistence production. However, it is also clear that many of paleo-technic (i.e., non-mechanized: Stone, 1996) methods of increasing agricultural production known from the prehistory of southwest Asia and other small-scale societies were not used. There is no evidence that villagers within the study area, nor anywhere else in the region utilized irrigation, terracing of agricultural fields (although it does exist for residential architecture: Banning and Byrd, 1989, 1984; Gebel, 2006; Rollefson, 1997), field walls, integrated agro-pastoral systems, and secondary products derived from animal husbandry. This is not to say that such things did not exist as there is some preliminary evidence of irrigation by mobile foragers during this periods (Fujii and Abe, 2008). Additionally, a number of scholars have proposed integrated agro-pastoral economies based on broader patterns of the coterminous spread of both animal and plant husbandry in early Neolithic societies (Bogaard and Isaakidou, 2010; Bogaard, 2005).

Hypothesis 3

In order to facilitate/incentivize increased subsistence production to meet the higher nutritional demands of larger settlement populations, economic organization will become segmented along kin-based household lines. As discussed in Chapter 2, as populations expand

and subsistence demands grow, the segmentation of subsistence economies is a common way to increase production. This typically is done along residential and familial lines, leading to nuclear or extended family households as the autonomous economic units of larger village-based agricultural communities (Blumberg and Winch, 1977; Blumberg, 1978; Flannery, 2002, 1972; Kohler, 1992; Netting, 1993, 1982; Nimkoff and Middleton, 1960; Pasternak et al., 1976; Shenk et al., 2010; Smith et al., 2010; Wilk, 1984)

Expectations within and Outside of Villages:

A: Multi-Person Households

Evaluation: The single structure at al-Khayran measures approximately 4 x 4 m of interior floor space in the earlier phase, which is well within the typical range for the MPPNB (Byrd, 2000). Byrd (2000) has reviewed a variety of means for estimating number of residents from floor area for such structures and their relevance to the PPNB. The variable nature of architecture in cross-cultural samples used to estimate population based on roofed floor space has created several problems when attempting to understand one specific style of architecture. While Naroll's (1962) estimate of 10 m² of floor space per resident is widely cited, the sample used by Naroll included many societies with significantly lower ratios of floor area to population. Additionally, several of the estimates used to arrive at floor area included architectural features not always present in the PPNB, but whose function is assumed to be present in public spaces. This is especially true of the heavily agglutinated architecture of PPNB villages. In the end, Byrd (2000) suggests that nuclear families did in fact occupy the residential structures of the PPNB, with basements and roof work areas, as well as public work areas

providing much of the needed space for activities (similar to Wright's [2000] argument for the prominent role of public space in household activities).

When turning back to al-Khayran, this argument is all the more reinforced by the presence of both a flagstone paved surface directly in front of the northern doorway of the later phase of the structure and the cobble stone surface extending even further to the north, east, and west. While it is not possible to know the full extent of these surfaces, which are clearly associated with the structure, they were preserved in an area of 1.5 x 5 m. When this is included in the floor space calculation for the structure, it would make it on the high side of typical for the MPPNB. This would support the contention that multiple individuals resided in the structure.

A second line of evidence for this is the diversity of activities attested to by the artifactual assemblage of al-Khayran. There is evidence of harvesting, hunting, grinding, cutting, plaster making, construction, knapping, ground stone manufacture, ornament manufacture, composite tool manufacture, fire building, cooking, and a host of other likely activities commonly associated with these processes, such as eating and sleeping, which are not directly attested to in the archaeological record. This sheer variety of behaviors speaks to a high level of residential intensity as compared to highly specialized activity sites (Binford, 1978; Moore, 1979). Additionally, many of these activities are both ethnographically associated with a variety of marked social categories (Flannery, 1972; Kelly, 2007; Waguespack, 2005) and osteologically identified as having been performed by a variety of people from different social categories in the PPNB of the Levant (Molleson, 1994; Peterson, 2010, 2002). This suggests multiple residences from different social categories, specifically adult males and females, occupied the site.

B: Kin- of Fictive Kin-Based Households

Evaluation: As discussed in the previous section, the artifact assemblage at al-Khayran attests to behaviors associated with both men and women, as identified through osteological analyses and ethnographic analogy. Additionally, the fact that the structure at al-Khayran mimics residential architectural forms within MPPNB village sites suggests that al-Khayran was occupied by the same social unit as residences within villages. Thus, there is strong support for the idea that a nuclear family, with its people of multiple gender and age identities, occupied al-Khayran.

Expectations Outside of Villages:

A: Subsistence Focused Satellite Settlements Occupied by Kin-Based Household

Evaluation: As reviewed in the previous section, there is strong evidence of a nuclear family occupying al-Khayran. However, there is additional evidence based on the intensity of subsistence production that, indeed a single residential unit utilized the site. It would be expected that artifacts and architecture at a field house would be sufficient for the annual production of grain by a single household, but no more. If al-Khayran was a logistical extraction-site for individuals from multiple households, then it would be expected to have a more specialized tool kit, increased storage relative to the individual household, and a significantly greater quantity of those tools associated with agricultural production than found within village settlements. While there are more sickle blades than the average village site, this difference is not so dramatic as to suggest the sort of intensity of grain production found at specialized agricultural sites utilized by multiple families (Curvers and Schwartz, 1990; Schwartz and Falconer, 1994). Additionally, there is no evidence of storage structures or features, as might be expected at such sites. Nor is the overall tool assemblage narrower than those found within villages. Rather, there are simply

certain tool classes which are overrepresented on-site. This would suggest that al-Khayran, while a specialized subsistence production-site, was likely occupied by a single nuclear family for subsistence level production.

Evaluation of Hypothesis 3

There is strong evidence for the segmentation of village-based economies in west-central Jordan, both from excavation results at al-Khayran and other villages in the region. It is likely that al-Khayran itself was occupied by a nuclear household for autonomous subsistence production pursuits.

Hypothesis 4

In order to facilitate/incentivize increased subsistence production to meet the nutritional needs of economically segmented larger village populations, property rights will intensify. As reviewed in Chapter 2, the development of stronger property rights as applied to subsistence products provides an incentive for increasing production. Additionally, it enables a more efficient development of segmentary economic relations (Bowles and Choi, 2012, 2003, 2013; Brown and Podolefsky, 1976; Flannery, 2002, 1972; Kohler, 1992; Netting, 1982; Shenk et al., 2010; Smith et al., 2010).

Expectations within and Outside of Villages:

A: Private Production Space

Evaluation: While most production activities clearly occurred outside of the structure at al-Khayran, a handful of activities also occurred inside. The inset quern and cutting stone attest to the private processing of food on-site. Additionally, the evidence of a variety of artifact types

being placed in storage within the structure, including a hand stone, a naviform core, a pillow-shaped piece, multiple hammer stones, points, burins, a blade cache, other formal tools, and ochre suggest a certain amount of privacy within the structure. Additionally, the very fact that al-Khayran is isolated suggests private control of either land or the products of labor. It does not definitively show land tenure as opposed to usufruct rights. But, it is strongly suggestive of the potential for land tenure.

B: Private Storage

Evaluation: No such private storage has been identified at al-Khayran.

C: Intergenerational Inheritance of Material Items

Evaluation: No subfloor burials were identified at al-Khayran, nor was it demonstrated that occupation lasted beyond a generation. Thus, the two main indicators of likely intergenerational inheritance were not present. However, Kohler (1992) has argued that field houses themselves may be indicative of differential access to the means of production between residential units and that they may have even been used to maintain control of prime agricultural land by households across generations. Thus, there is some weak support for intergenerational inheritance, although this support is hardly definitive.

Expectations Outside of Villages:

A: Locating Structures near Production Resources

Evaluation: Al-Khayran is ideally located at the intersection of multiple resources. It is adjacent to a seep in an area where dry farming is inherently risky. It is located on the western edge of the *terra rossa* soils of Wadi ‘Assal; the most fertile soils in the region. It is adjacent to

the larger and higher-quality of the two usable flint sources along the ridges of Wadi ‘Assal. It is half a kilometer from a spring that still flows enough to feed two olive orchards in the present, even with lower groundwater levels and lower replenishment rates due to low rainfall totals as compared to the PPNB. It is located adjacent to the intersection of the sandstone of the Dead Sea Escarpment, which is ideal for architecture and grinding tools, and the limestone of the Transjordan Plateau, which is ideal for architecture and the production of plaster. It is also located along the ridge of the *wadi* which is the best source of bitumen in all of west-central Jordan.

While not all of these resources were either rare enough to require the assertion of access rights nor close enough for habitation on-site to allow for such an assertion, a number of these resources could have been claimed through the occupation of al-Khayran. Specifically, it is likely that the structure at al-Khayran allowed for the inhabitants to claim (sole?) access to the high-quality soils around the site and the seep directly to the south of the structure. Additionally, the location of the major flint outcropping so close to al-Khayran, along with the strong evidence of naviform core manufacture and reduction on-site – something that is not attested to within most households of the MPPNB – is potentially suggestive of access right claims for this resource that may have been exclusionary of individuals from outside the economic unit that occupied the site. This is also supported by the fact that two full-coverage surveys of the area around al-Khayran did not locate any other Neolithic sites within the vicinity of the flint source.

It is possible that a similar flint procurement pattern as that seen at ‘Ain Ghazal was occurring at al-Khayran. At ‘Ain Ghazal, it has been argued that a handful of craftspeople control the supply chain of pink-purple Wadi Huweijir flints which were utilized in over 97% of the naviform core reduction sequences at the site. However, other, lower-quality flints, were

more widely used for non-naviform knapping practices (Quintero and Wilke, 1995; Quintero, 2011, 1998, 1997, 1996, 1994; Rollefson et al., 2007). Because it is likely that most reduction at al-Khayran was naviform in character, it seems possible that the structure was located near the flint source to provide access for the economic unit which occupied al-Khayran to the high-quality stone material found there. If only a subset of the overall population of villages produced naviform cores and blades, as asserted by a number of authors (Barzilai, 2010; Gebel, 1996; Quintero and Wilke, 1995; Quintero, 2011), it seems possible that al-Khayran could have served multiple purposes for the inhabitants and claimed multiple forms of property rights. These would potentially include exclusive control of the *terra rossa* soils of al-Khayran and the production of their utilization, the exclusive control of the seep next to the structure, and either control of access to or assertion of access rights to the flint source adjacent to the site.

Additionally, the location of the field house of al-Khayran next to a high-quality flint source used for naviform cores and blades is fairly unique as compared to other such extraction-sites identified for the PPNB. Two other flint outcroppings have been identified as the source of high enough quality flints to be used for naviform core reduction; one in the Galilee (Gopher and Barkai, 2011, 2006) and one in the northern Transjordan Highlands (Quintero, 2011, 1996, 1994; Rollefson et al., 2007). Each of these extraction-sites are located at some distance from any Neolithic settlements in which their raw materials were utilized. They both also have minimal evidence of permanent architecture or sustained occupation. Thus, the flint outcropping adjacent to al-Khayran is the first such source where there is evidence of its utilization for naviform reduction and where there is evidence for intensive habitation near the source. This would suggest a different sort of relationship to this source for those utilizing it than is found at either of the other two PPNB flint extraction-sites utilized in naviform reduction.

Quintero (2011, 1996, 1994) and Rollefson et al. (2007) have suggested that the complexity of the extraction and transport system for such flints suggests control of resource procurement systems by craft specialists. Such a claim could be even stronger at al-Khayran where there is evidence of the location of material markers of access, such as the field house, and the actual presence of individuals who are inhabiting the field house, both of which are potential active assertions of access and/or control (Stone, 1994). Thus, if naviform cores and blades were manufactured by craftsperson in both small and large villages during the PPNB, as argued by those authors who have studied naviform core and blade production systems in detail (Barzilai, 2010; Gebel, 1996; Quintero, 2011), then the results from al-Khayran are a potential indicator of property rights and maybe even land tenure extending beyond portable goods, farmland, and water sources to other forms of natural resources of great importance in the Neolithic.

B: Assertion of Land Tenure with Material Markers

Evaluation: The only potential material marker of land tenure identified at al-Khayran was the structure itself. No other objects such as field boundary markers, field walls, or terracing were identified near the site. However, as has been noted previously, field houses themselves are frequently assertions of either usufruct or tenure rights (Crown, 1983; Henderson, 2010; Kohler, 1992; Moore, 1979; Stone, 1994; Wendorf, 1956; Woodbury, 1961).

C: Increased Investment in Subsistence Infrastructure

Evaluation: There is strong evidence of increased investment in subsistence infrastructure over earlier periods at al-Khayran with the mere presence of a field house. No such structures have been identified for earlier periods. The construction of substantial residential architecture within subsistence production loci is certainly an increase in labor and material

investment in infrastructure. Additionally, the rebuilding of the structure at al-Khayran after its collapse with thicker sturdier walls again is a sign that the specific location of the site was important both in relation to the resources in the catchment and, potentially, socially.

Evaluation of Hypothesis 4

There is strong evidence for the intensification of property rights from the remains of al-Khayran and their context within Wadi ‘Assal. What is not clear is the specific character of these rights. It seems possible that the site may have been an assertion of land tenure rights over the agricultural fields and seep adjacent to the structure and control of access to the flint source next to the site. However, it is impossible to determine if the nature of property rights was usufruct for the land and seep and simply an assertion of access rights to the flint, rather than control of access. However, the structure of naviform blade supply chains does hint at the potential for the stronger version of these systems with the inhabitants of al-Khayran claiming some sort of exclusionary rights to both the fruits of their labor and the means of production.

Hypothesis 5

In order to meet the nutritional needs of larger village populations, new concepts of value will develop to facilitate the flow of goods between economic units through both intra- and inter-community exchange (Gebel, 2010). Such a process allows for the growth of populations and the movement of goods within these populations with greater ease as craft produced items can be made without concern over the need for extra-economic relationships in order to obtain value for them. Additionally, un-related individuals can furnish goods and services to each other under a shared social system of value rather than social relations, craft items can be produced and disseminated beyond the local community while still providing the producer with assured value,

thus creating an incentive for increased production, and the movement of goods between individuals, economic units, and communities can continue when previous logics of obligatory provisioning become contradictory as populations segment economically (Kohler et al., 2000).

Expectations within and Outside of Villages

A: Commodification of Goods

Evaluation: A single sandstone ring blank was found on the floor of the earlier phase of the structure at al-Khayran. These results are too ambiguous to evaluate Gebel's (2010) claims as it does not negate the potential use of such rings as ornaments of some sort. However, it does remove their production from potential workshop spaces as proposed by Gebel (2010), at least at al-Khayran. Of course, as has been demonstrated with naviform cores, this may simply be due to differences in scale, rather than disproving the craft manufacture of such rings in larger settlements. That being said, the manufacture of potential ornaments or other small items not involved in subsistence activities within residential quarters during one's spare time, as would be suggested for al-Khayran, does fit better with the ethnographic record of adornment manufacture in small-scale societies (Bar-Yosef Mayer and Porat, 2008; Bar-Yosef Mayer, 2005, 1997; Fabiano et al., 2004; Wright and Garrard, 2003; Wright et al., 2008).

Evaluation of Hypothesis 5

To reiterate, there is no definitive evidence of the development of commodities concepts or exchange value ideologies at al-Khayran or any of the PPNB sites within the study region.

Hypothesis 6

In order to increase subsistence production to meet the nutritional requirements of larger populations new extraction technologies developed require specialized production. As discussed in Chapters 2 and 6 and presented as one of the tests for Hypothesis 1, the emergence new technologies are commonly associated with the impetus to increase production (Boserup, 1981; Dobres and Hoffman, 1994). In the case of subsistence production in the Neolithic of the Near East, it has been claimed that as populations continued to grow throughout the early Neolithic, not only was an intensification of production seen in practices, but also extractive technologies (Quintero and Wilke, 1995; Quintero, 2011, 1998). It has been argued by a number of authors that naviform blade production was done by craft specialists (Barzilai and Goring-Morris, 2012; Barzilai, 2010; Gebel, 1996; Quintero and Wilke, 1995; Quintero, 2011, 1998, 1997)

Expectations within and Outside of Villages

A: Limited Number of Activity Areas for the Production of New Extractive Technologies

Evaluation: Because exterior activity areas were not identifiable at al-Khayran, due to taphonomic processes, no such evidence could be found. Additionally, because al-Khayran was likely occupied by a single economic unit, if this economic unit performed any practice it would therefore not be limited in scope at the site. That being said, the manufacture of naviform cores and blades at al-Khayran could be indicative of the limited presence of such manufacturing within the broader settlement system in which al-Khayran was embedded. Of course, this is impossible to assess without other excavated sites within the settlement system. However, if the pattern identified by several authors for PPNB sites throughout the southern Levant holds true within the study region, whereby only certain economic units manufactured naviform blades

within village communities (Barzilai, 2010; Gebel, 1996; Quintero, 2011), then al-Khayran would likely be an example of one such limited activity area.

There is some limited evidence of this potential from the knapped stone assemblage at al-Khayran. The ratio of naviform cores to the two predominant debitage types associated with their production is low enough to suggest the potential that a certain number of naviform cores were produced on-site and removed before reduction. There are two possible behavior systems that could explain this pattern. Either the inhabitants of al-Khayran used the site for both subsistence and craft naviform core production or they used the site both for subsistence and household naviform core production. It is impossible to know which of these is correct at this time without archaeological investigation of the primary settlement from which the inhabitants of al-Khayran came. Barzilai (2010), while labeling all forms of naviform core reduction as craft production, found evidence of naviform core production and reduction in most residences in mobile forager camps and small sedentary agricultural villages. It is only in the large-scale villages of the LPPNB that there is evidence of naviform core reduction outside of residences within workshop areas.

B: Extensive Dispersion of New Extractive Technologies throughout Residential Units at Sites with Limited Numbers of Specialized Production Areas

Evaluation: Naviform core production and reduction, as well as the utilization of naviform blades are evidence from the knapped stone assemblage of al-Khayran. Thus, it is impossible to ascertain the relative dispersal of blades versus cores and core reduction debitage in the study area.

C: New Extractive Technologies Created Through Complex Production Processes

Evaluation: Quintero and Wilke (1995) have tied the development of naviform core technology to the intensification of cereal production in the PPNB. It is the best potential example of the sort of technology that should be present at al-Khayran. However, as Wright (2000, 1993, 1991) has argued, there may also be an increase in the diversity of ground stone items associated with cereal processing. At al-Khayran there is considerable evidence of naviform core use. However, no forms of ground stone not identified from earlier periods was recovered from al-Khayran. Thus, the core technology at the site supports this test of the premise that subsistence intensification required new technologies, while the very small ground stone sample did not. It also did not disprove the premise as absence of evidence is not evidence of absence.

D: Standardization of Form and Production Sequence of Potential Craft Goods

Evaluation: Barzilai and Goring-Morris (2012; Barzilai, 2010) have argued, based on Costin's (2001, 1991) criteria for the assessment of craft specialization, that standardization of form and production for naviform blades is a necessary indicator of craft production in the PPNB. However, such a test for specialization seems problematic because stone knapping is a reductive technology which proceeds from non-standardized core sizes, based on the nature of the flint being utilized. The naviform cores from al-Khayran show the variability in the production choices made by knappers to achieve naviform core blanks based on the form of the raw flint being shaped into a core. They also show variability in the reduction sequence based on the form of the core blank, the quality of the flint, and the somewhat unpredictable outcomes of knapping blows. Finally, they show variability in the form of blade blanks based on variability in flint quality and the form of core blanks. Thus, a standardization of reduction sequences or blade form is not present.

That being said, there is a certain degree of standardization of knapping technique across core production and reduction sequences. However, such standardization is significantly more difficult to quantify that standardization of form, especially considering that all but one of the reduction sequences identified at the site are fragmentary to the point of not being able to determine if any two artifacts derived from the same sequence. Because there is only one such sequence from which at least 50 artifacts have been identified, it is impossible to speak of standardization in reduction technique as there are no other sequences for comparison.

E: Labor Intensive Raw Material Procurement Strategies

Evaluation: Other flint extraction locales dating to the Neolithic do support the premise that labor expenditures for the procurement of flint used in naviform core and blade production increase through greater travel, transportation, and extraction costs (Barkai and Gopher, 2001; Barkai et al., 2007; Gopher and Barkai, 2011, 2006; Quintero, 1996, 1994; Schyle, 2007; Taute, 1994). The location of al-Khayran directly adjacent to a large high-quality flint outcropping with easily accessible raw materials requiring minimal extraction expenditure suggests that al-Khayran was utilized in order to avoid such costs. Thus, the support for the premise that craft production of naviform blades was occurring within al-Khayran's settlement system is neither supported nor refuted. The choice of location for the site does suggest some form of potentially costly resource procurement as being necessary in the knapped stone production systems of the region. However, the choice of location also is indicative of a creative solution to the problem of the potential costs of flint procurement for naviform cores and blades. As stated earlier, there is evidence of the transportation of naviform cores off-site before reduction. Thus, the inhabitants of al-Khayran strategically chose the location of the site to reduce the travel and transportation costs of flint procurement.

Expectations Outside of Villages

A: Small Sites with Evidence of the Intensive Production of a Narrow Set of Goods

Evaluation: There are two potential forms of specialization which could occur at al-Khayran: craft specialization and specialized subsistence activities in the sense that a limited set of such activities would be occurring on-site outside of any sort of craft production system. As has been reviewed previously, there is some evidence of both of these processes at al-Khayran. This is especially true of subsistence production activities for which there is knapped stone evidence of intensive production on the scale of the individual household. However, there is no evidence of food production above the level of household subsistence. Thus, such economic activities might be best characterized as household subsistence production at a specialized activity site.

As for naviform technology, there is some potential evidence of on-site craft production. As reviewed above, there is evidence of the removal of naviform cores from the site before knapping. If al-Khayran was embedded within a settlement system where naviform cores were reduced by craft specialists within villages, as has been argued for a number of sites (Barzilai, 2010; Gebel, 1996; Quintero, 2011), then this pattern of core removal would be evidence that at least one of the inhabitants of al-Khayran participated in the craft production economy. What is clear, either way, is that the inhabitants of al-Khayran did use it to specially procure flint for naviform core production and did use it to produce more naviform cores than were necessary for usage on-site. An interesting additional wrinkle is that naviform blades are typically viewed as most likely used in agricultural production. Because al-Khayran was likely occupied during the period of greatest agricultural intensity, there is a low likelihood that the inhabitants of the site needed significant quantities of naviform cores for the household throughout the rest of the year.

This does potentially hint at the use of the core transported away from the site within a craft production and distribution system.

Evaluation of Hypothesis 6

Overall, there is strong evidence of the new technology of naviform core reduction being present at al-Khayran. There is also some support for the idea that this production was done within a craft economy. However, it has been difficult to differentiate household from craft production of naviform cores at al-Khayran without data relevant to village knapping behaviors. In other words, craft production of naviform cores remains a possibility that has yet to be demonstrated for al-Khayran, but for which there are some tentative hints of its existence.

Hypothesis 7

In order to meet the nutritional needs of larger populations, inter-community and intra-community exchange will intensify. The goal of this exchange for segmented economic units is to increase the acquisition of subsistence items and other goods of value which may be used within new systems of valuation to procure subsistence items. As reviewed in Chapter 2, residential nucleation under conditions of population growth creates significant challenges for meeting subsistence needs, through increased travel and transport costs due to spatial arrangements during a period of increasing demand due to demographic factors. New systems of distribution, as well as production as tested by previous hypotheses, would be expected to develop (Gebel, 2010; Pryor, 1977).

Expectations within and Outside of Villages

A: Inter-Community Exchange

Evaluation: As stated in Chapter 8, while there is evidence at al-Khayran of the long-distance movement of goods at al-Khayran, it is impossible to determine what was exchanged for those goods that appear at the site and exist well outside its catchment. Five basalt ground stone items from at least 25 km from the site were recovered. A single pink Dabba marble item was excavated, which likely came from at least 50 km northeast of the site (Wright et al., 2008). Three shell bead items which derived from either the Red Sea over 175 km south or the Mediterranean Sea over 100 km west of the site. Thus, we do know that the long distance movement of goods was occurring at the site, but how this movement occurred is difficult to determine.

B: Surplus Production for Exchange

Evaluation: While there are some hints of high levels of subsistence production at al-Khayran, the nature of the results makes it extraordinarily difficult to quantify to a point where above-household needs could be determined. As reviewed above, we can say that al-Khayran likely had a greater intensity of cereal harvesting than most early Neolithic village settlements as a proportion of its overall economic system. Beyond this we cannot determine if this high level of production was enough to produce grain for exchange.

C: Craft Production for Exchange

Evaluation: As stated in Chapter 8, it is difficult to differentiate craft products intended to exchange for subsistence items as opposed to any other items. Thus, the tentative hints at craft production found at al-Khayran do not disprove this hypothesis, but neither do they provide much support for it.

Evaluation of Hypothesis 7

There was no support for this hypothesis. However, it was also not specifically disproven. Rather, it was essentially untestable within the study area.

Chapter 16: Conclusions

This final chapter brings together in narrative form the conclusions of this study. It is structured by the four preliminary research questions stated in Chapter 1. Each of the research questions is answered in succession based on the findings from the dissertation. This is followed by a brief concluding discussion about the place of this study within the broader body of theory on subsistence change and village development.

Question 1: What past economic practices are manifested within the archaeological remains at the site of al-Khayran?

There is evidence of three economic activities at al-Khayran: (1) intensive plant subsistence production, (2) ovicaprid hunting, (3) naviform core production and reduction, and (4) the economic functions associated with daily life for a PPNB household. The last of these categories included architectural construction, plaster making, hunting, cooking, cereal processing, fire building, sandstone ring production, ground stone tool production, and knapped stone tool production to name those behaviors for which we have the most direct evidence.

Question 2: How were these past practices structured spatially, temporally, and socially?

Spatial Structure of Economic Behavior at al-Khayran

Perhaps the most important unresolved question from this study is the spatial organization of the broader settlement system in which al-Khayran was embedded. A catchment model for economic practices at al-Khayran has been developed. Thus, we know that farming

was likely done in the surrounding field, perhaps focused around the water seep or spring directly south of the on-site structure. We know that most if not all flint utilized on-site was procured from the large high-quality source just southeast of the structure. The most parsimonious understanding of the fauna suggests that hunting was likely done in the surrounding slopes and steppe of Wadi ‘Assal, specifically targeting wild goats. We also know that some resources used on-site, such as sandstone, limestone, wood, and reeds, were likely easily available within a short walk of the site and that other resources, such as bitumen, basalt, and marine shells we located at greater distances than would allow for expedient logistical trips on an as-needed basis. While marine shell and potentially basalt were likely not available to the inhabitants of al-Khayran through any source other than social networks, bitumen could have been procured through a planned logistical excursion from the site or on an encounter basis while conducting other foraging behaviors such as hunting.

Yet, while we know all of this, the one thing we do not know is the location of the primary settlement for the inhabitants of al-Khayran. This requires significantly more speculation, based on incomplete survey results from ADAP due to issues of access to private lands and universal variables in settlement location choices (Chisholm, 1979; Christaller, 1966; K. V Flannery, 1976; Jarman et al., 1972; Renfrew, 1975; Roper, 1979; Stone, 1996; Vita-Finzi and Higgs, 1970; von Thunen, 1966). There are three possible answers to the question, where is the village from which the inhabitants of al-Khayran came? The first is that it is one of the PPNB villages known within the study area. The second is that it is an as of yet unknown site situated within the landscape of the study area, likely at a location with access to the necessary resources for the maintenance of a permanent village. The third answer is that it is located somewhere else entirely and that our knowledge of the location of natural resources is no guide to identifying it.

If we leave alone the third of these possibilities as untestable, it is possible to weigh the evidence and suggest some hypotheses in need of further testing. If we look first to the PPNB villages of west-central Jordan, there are a number of important factors for evaluating them as the likely source of al-Khayran's population. The first and most obvious of these is contemporaneity. Three of the four PPNB village settlements in the region have been dated to the same period as al-Khayran: Wadi Hamarash I (Sampson, 2012), dated to between ca. 7800-7500 cal. BCE, Khirbet Hammam (Peterson, 2009), with dates starting at ca. 7500 cal. BCE, and el-Hemmeh with a single date at ca. 7580±70 cal. BCE (Makarewicz et al., 2006). All radiocarbon dates from es-Sifiye fall between ca. 7000-6800 cal. BCE.

A second line of evidence for contemporaneity is knapped stone assemblages. While Khirbet Hammam does have one potential Helwan point and one potential Khiam point, both fragmentary, the bulk of the points are Byblos type. Additionally, there is evidence of a certain degree of naviform knapping (Peterson, 2009, 2004). This suggests that the bulk of the site's occupation was during the MPPNB and later. El-Hemmeh also has produced a majority of Byblos points, with two Amuq points suggesting a possible later portion of the occupation (Makarewicz et al., 2006). As was reviewed in Chapter 3, it is likely that both el-Hemmeh and Khirbet Hammam were occupied contemporaneously at some point at the transition to the LPPNB or later. While there has yet to be a full presentation of knapped stone finds for Wadi Hamarash I, preliminary publications have presented what appears to be a handful of A45 specimens flaked on bidirectional blades, similar to al-Khayran (Sampson, 2010a). At es-Sifiye Amuq and Byblos points dominate, suggesting an LPPNB occupation, with the potential for an MPPNB portion of the sequence. (Mahasneh and Bienert, 2000) A smaller proportion of the

point assemblage consists of Jericho points, also suggestive of the potential for an MPPNB occupation (Mahasneh, 1997).

When these two lines of evidence, radiocarbon dates and knapped stone typologies, are considered together, there is the strongest potential for Wadi Hamarash I to be contemporaneous with al-Khayran given the similarity of both the small portion of the knapped stone assemblage published and the radiocarbon dates to those of al-Khayran. However, none of the other sites can be discounted due to incomplete dating and the potential for changes in knapped stone production through time, which has yet to be analyzed for any of the sites. El-Hemmeh and Khirbet Hammam certainly have stronger evidence of earlier occupational periods than es-Sifiye, with radiocarbon dates falling hundreds of years prior to those of the latter site. However, all three share a similar knapped stone assemblage.

A second line of evidence to assess any potential association between al-Khayran and the known village settlements of PPNB west-central Jordan would be the energy costs of travel between the sites. Es-Sifiye is located 60 km from al-Khayran, while Khirbet Hammam and el-Hemmeh are approximate 25 km away. Wadi Hamarash I is the closest site at 17 km. However, none of these distances take into account topography. Al-Khayran is located on the ridge of Wadi 'Assal, essentially at the far western extent of the Transjordan Plateau at 750-760 masl. All four PPNB sites in the study area are located within *wadis*. El-Hemmeh (~400 masl), Khirbet Hammam (~300 masl), and Wadi Hamarash I (~100 mbsl) are all located in the Wadi el-Hesa, while es-Sifiye (~200 masl) is located in the Wadi Mujib. Thus, all four would be significantly more difficult to reach than their distances suggest, as travelers would have to scale the steep cliff of *wadi* escarpments.

There are several ways to consider distance when deciding if a field house could be accessible from one of these villages. The first thing that must be noted is that none of these villages would be located in what is typically considered the catchment range for daily travel without animal or mechanical transportation (Stone et al., 1990). However, field houses can be used specifically to expand beyond such a point (Moore, 1979). It may be that a field house is located well over 10 km from a primary village, but such a situation is not typical, even of a field house. Amongst the Dogon of Mali (Eskelinen, 1977a; Sidibe, 1978; van Beek, 1993) or Fellaheen farmers of the Levant (Amiry and Tamari, 1989; Antoun, 1972; Lutfiyya, 1966), distances do not typically exceed 5 km between village and field house. However, there are ethnographic reports from the southwestern US of field houses being located up to 50 km away following the massive depopulation of the region caused by hundreds of years of violence following the Spanish *entrada* (Moore, 1979).

That being said, these reports must be put in context. No researcher witnessed such settlement behavior. Nor was this considered normal. Most examinations of subsistence behavior amongst Puebloan peoples have found field houses located within an 8 km range of village settlements (Bradfield, 1995, 1971; Forde, 1931; Fox, 1967; Kennard, 1978; Sutton, 1977). Additionally, a recent archaeological investigation found that ancestral Hopi farming rarely was done with field houses and in those cases where they were used, they were typically found within the 8km radius of villages and associated with natural resources other than farmland, such as river fords (Cutright-Smith, 2007). What we see when we consider al-Khayran in relation to any of the known PPNB villages of west-central Jordan is that it is located outside of the typical range for field houses. However, it is within the far extreme range of reports of ethnographic

field houses in relation to Wadi Hamarash I and even, to a lesser extent, el-Hemmeh and Khirbet Hammam.

Beyond distance, the direction of transport and the ruggedness of the terrain is also an important consideration for the location of field houses (Moore, 1979). Again, it is not typical for field houses to be located across rugged terrain from villages (Cutright-Smith, 2007; Moore, 1979; Preucel, 1990). However, there is one exception for this that is found in a variety of places. When villages themselves are located in rugged terrain, typically for defensive purposes, then farmers will frequently locate field houses across difficult terrain because of necessity. That being said, in all such cases, field houses are located downslope from villages (Amiry and Tamari, 1989; Antoun, 1972; Bradfield, 1995, 1971; Cutright-Smith, 2007; Eskelinen, 1977a; Kennard, 1978; Lutfiyya, 1966; Sidibe, 1978), allowing for easier access to them for the myriad behaviors associated with farming before harvest. It is only at the end of harvest, when the entire economic unit is present at the field house, that transportation costs are increased by being located downslope from villages. This is also precisely the time when labor availability is greatest, making it the most efficient spatio-temporal patterning for agricultural production in field houses.

When this factor is considered, no known PPNB village in west-central Jordan is a good candidate for being the primary residential location of the occupants of al-Khayran. Additionally, when considering chronology, distance, and topography es-Sifiye, el-Hemmeh, Khirbet Hammam, and Wadi Hamarash I are all poor candidates for primary village. Thus, we must turn to the landscape for potential locations of the parent village of al-Khayran.

A few of the points noted in the previous discussion are relevant to narrowing the nearly infinite number of potential locations for the parent village of al-Khayran in the landscape.

Firstly, distance is a significant constraint on how far afield to look and, secondly, topography should narrow our view. As noted in Chapter 10, the location of al-Khayran on the far western and north edge of the southern ridge of Wadi ‘Assal narrows access to it significantly. It is unlikely that the primary settlement of al-Khayran’s inhabitants was located to north or west of the site given the precipitous change in elevation of Wadi ‘Assal and the Dead Sea Basin. Thus, we must look to the south and east.

A second factor that should constrain our search is previous archaeological surveys. The Jacobs (1983) survey covered the entirety of the south ridge of Wadi ‘Assal from the base of the *wadi* to the base of Wadi Numeira to the south and from the western edge of Kathrabba to the Dead Sea. No other early Neolithic sites were identified on this survey. Additionally, the two survey strategies employed by ADAP did not identify any potential PPNB village settlement remains. However, both of these surveys did not extend into the village of Kathrabba itself, 3 km to the east, or beyond. Thus, this is the most likely location of the parent village of al-Khayran given the extent of survey coverage closer to the site.

A third factor that should constrain our search is the location of natural resources. Most early Neolithic villages are located near good sources of water, be they perennial streams or major springs (Kuijt, 1994; Rollefson, 2006). They are also typically located within terrain that would allow for farming (Kuijt, 1994; Rollefson, 2006), with the possible exception of later LPPNB Ba’ja (Gebel, 2004b; Gebel et al., 1997). The proximity of flint sources is more flexible, with multiple methods of procurement known from the PPNB, some of which can draw flints from several kilometers away (Rollefson et al., 2007). Thus, it seems likely that the parent village of al-Khayran was located to the east of the site near farmland and surface water sources. Within the typical 10 km radius previously noted for field houses, the only location that meets

this criterion is the source of Wadi ‘Assal upon which Kathrabba and its suburbs are built (Figure 4). Within Kathrabba this study has identified 15 springs which feed the perennial stream of Wadi ‘Assal. Additionally, *terra rossa* soils abound. In fact, today, the town and its surrounding are predominantly agricultural in economic orientation (Figure 45).

Of course, the density of contemporary occupation and the complexities of private property rights have prevented archaeological survey of the town. However, a major midden deposit located underneath a contemporary house on private property has been recorded opportunistically by ADAP. While the deposit was behind a stone wall, extensive carbonized materials, as well as flint debitage were visible from a distance. However, without intensive archaeological survey over the entirety of the source of Wadi ‘Assal, it is impossible to determine if any potential remains of the parent village of al-Khayran can be found.

Temporal Structure of Economic Behavior at al-Khayran

The temporal structure of activities at al-Khayran remains speculative as well, with little direct evidence which can be brought to bear on the question. However, it is possible to construct some preliminary hypotheses. The best evidence for understanding the temporal pattern of usage of al-Khayran is the archaeological indicators of subsistence activities; specifically the extensive evidence of cereal harvesting at the site in the form of sickles and other blades with use-wear. There is a distinct seasonal nature to cereal harvesting (Amiry and Tamari, 1989; Antoun, 1972; Zohary and Hopf, 2000). Cereals, such as wheat and barley, are typically harvested in the early to mid-summer (Amiry and Tamari, 1989; Antoun, 1972; Palmer, 2001, 1998, 1994; Zohary and Hopf, 2000). Such harvesting has typically been performed by the entire household of smallholder farmers within the ethnographic record of southwest Asia (Amiry and Tamari, 1989;

Antoun, 1972; Lutfiyya, 1966; Palmer, 2001) because of the high labor demands. Thus, it seems likely that al-Khayran was occupied at least during the early to mid-summer.

While harvest season is typically when field houses are occupied by full households, they are also frequently occupied sporadically throughout the year by members of the household (Eskelinen, 1977a; Moore, 1979; Sidibe, 1978; Sutton, 1977). These occupational spans coincide with less labor intensive tasks that occur in agricultural fields during the planting and growing seasons, such as planting, weeding, guarding, and tending. There is no clear evidence of this sort of habitation, but such behavior would be difficult to detect in the archaeological record for two reasons. Firstly, it is much lower in intensity both temporally and demographically. Second, the sorts of activities which occur on-site during these stays are essentially indistinguishable from those that occur during harvest season. However, within the context of what we know about MPPNB plant economies, it does seem likely that such occupations were occurring at al-Khayran. This is because there is strong evidence of farming at every PPNB village settlement for which plant economies have been studied extensively (Asouti and Fuller, 2013, 2012; White, 2013) and such pre-harvest activities are necessary for successful plant production (Antoun, 1972).

A second temporal issue for al-Khayran is the frequency of occupation on an inter-annual basis. Again, there is only the slightest of evidence of this, forcing a degree of speculation. However, two lines of evidence can be marshalled which are typically associated with an annual occupation. First, the substantial nature of the structure at al-Khayran is suggestive of fairly continuous usage. Most in-field occupation structures which are occupied less frequently than on an annual basis are insubstantial and rebuilt upon each return (Moore, 1979). Such a strategy has been reported through the southwestern US by farmers who may have multiple subsistence

production loci available. In such a case they select the location which shows the greatest potential production for the year based on observed weather patterns. Such behavior makes extensive investment in architecture, which may not be occupied for several years, inefficient given the potential renovation labor necessary upon return (Moore, 1979).

In addition to the labor expenditures on the architecture at al-Khayran, the artifacts found *in situ* on the floor of both the earlier and later phases of the structure do speak to an expectation by the occupants of return, likely within the near future. The longer the tools and other valuable objects were left in the structure the higher the risk for their loss through such factors as erosion, theft, or the destruction of the structure. Thus, overall, based on the form of architecture and storage behavior at al-Khayran, it is likely that the site was occupied on an annual basis. As argued above, this annual habitation behavior was probably done by a household during early to mid-summer and by various members of this family when other plant production activities were required.

An interesting question brought out by this discussion of the annual pattern of occupation at al-Khayran is the role of naviform core production at the site. Naviform cores seem to have been produced on-site and either reduced on-site or transported back to primary village settlements, no doubt for village-based reduction or exchange. The exact annual temporal pattern of naviform core production is not clear and such labor does not have an inherent seasonal component to it, as flint is available year-round. That being said, the general low number of cores necessary to produce prodigious amounts of blades (Barzilai and Goring-Morris, 2012; Quintero, 2011) does make it seem likely that special logistical trips to procure flint, wholly separately from subsistence production activities, were unnecessary. Thus, knapping activities on-site may have followed identical annual cycles as subsistence production labor at al-Khayran.

Social Structure of Economic Behavior at al-Khayran

The structure of the social unit occupying al-Khayran appears to have been a nuclear family, with evidence of adult male and female activities on-site. Additionally, the structure on-site is reminiscent of residential structures within PPNB villages. It is likely that a (possible craft) producer of naviform cores was a member of the household at al-Khayran. This producer utilized the field house to both aid the household in grain production and to gain access to a high-quality flint source. It is possible that the field house was used to control access to the outcropping itself. While control of access to the subsistence production locus around the structure at al-Khayran, given the evidence of land tenure within village settlements, it is also a possibility for the other natural resources adjacent to the structure, such as the flint source.

One of the more interesting aspects of al-Khayran and its implications for the organization of production in the PPNB is the lack of evidence for ovicaprid management, despite there being significant evidence of it at nearly every MPPNB village settlement. Because al-Khayran was likely occupied by a nuclear family, household herding would necessarily have to be the form of animal husbandry practiced at al-Khayran. However, such a husbandry system presents several problems for households during harvest season. Firstly, herding requires continuous daytime labor and, thus, takes away labor from harvesting. Because the primary purpose of a field house is to create more efficient labor utilization during periods of potential labor shortages, other labor demands from herding would be a significant problem for the harvest season.

That being said, in the region today and in many other regions of the world (Halstead, 2006, 1996; Lancaster and Lancaster, 1995, 1991; Makarewicz, 2013b; Palmer, 2001; Redding, 1981), most of the herding labor is expended by older children; typically boys. As described

previously, these boys do not herd household flocks. Rather, they herd multiple household flocks together. I have also observed this method of aggregating household flocks by older male herders in Melnik, Bulgaria. Both older boys and older men tend to be less important for harvesting labor than adult men and women. Amongst the communities of Wadi ‘Assal today female children are typically used for gathering and bundling hay while older male children assist their fathers in their harvesting tasks. Adult women cut the hay and leave it in piles on the fields. Both adult men and women cut the heads off the stalks of wheat and place them in baskets. Adult men also typically load both grain and hay bales on donkeys and guide the animals back to village homes, as do older boys on occasion. Older boys can also frequently be used for running errands to town (pers. obs.).

There are also areas of the world where individuals households do have sufficiently sized flocks to be herded individually (Halstead, 1996). What seems to be the key difference is the scale of household herding. In such households flock populations reach into the hundreds. This allows for herd stability and independence, as well as the economical production of secondary products such as wool and/or dairy. However, the scale of these flocks also in very much dependent on the organization of residential and settlement space. Such large flocks need enough room to be kept, making these settlements highly dispersed, unlike the villages of the PPNB.

While wool is a secondary product that does require a certain scale of production in order to be economical, dairy is more variable. While most dairying is associated with larger-scale herding and/or, in the modern world-system at least, market exchange of dairy products on some level (Bar-Yosef and Khazanov, 1992; Makarewicz, 2013b), there are examples of households within dense villages keeping small flocks of under a dozen animals for a variety of purposes, including dairy, waste disposal, vegetation clearing, and manure production. In such

communities, herding decision-making is very dynamic with animals being fed a variety of foods in a variety of locations, from table scraps in the yard to wild vegetation in new agricultural fields (Eskelinen, 1977a, 1977b; Sidibe, 1978). This allows for household to independently keep small herds as long as meat is not the primary goal of production.

A second major problem for keep flocks at al-Khayran us that they would be a threat to crops by potentially eating into human food supplies. While Bogaard & Isaakidou (2010; Bogaard, 2005) have convincingly argued against this as inherently a problem with agro-pastoral systems in general, they acknowledge certain times in the annual labor cycle when the presence of herds would have been problematic. Namely, harvest season would have been a period of highest risk for animal consumption. This is also when the entire household would have likely occupied al-Khayran and, therefore, would have had to keep flocks on-site. In fact, in Bogaard & Isaakidou's (2010) model of an integrated agro-pastoral system, ovicaprids would have been herded away from field during late crop growth and harvest season.

A final challenge for household herding at a field house in the PPNB is that most faunal analyses point to meat production as the primary goal of husbandry during this period. Because household herds would have to be so small at al-Khayran, herd stability would be threatened by a meat production strategy. Rather, it is likely that some other form of herding was practiced within the villages of the PPNB. In the contemporary village of Kathrabba, as well as in many other village, town, or city-based communities with household flocks which I have observed throughout southwest Asia and southeastern Europe, the typical practice is to have one or more individuals within a village or neighborhood whose job it is to gather the animals of multiple households to be herded out of town while avoiding agricultural fields for their daily grazing in a single compound flock. Such a strategy is typically associated with a primary interest in

secondary products with meat in these communities being traded or sold from mobile pastoralists with larger flocks.

However, recently Makarewicz (2013c) has argued for a more complex view of herding as a broader economic practice which included meat, dairy, and wool as possible goals and which was an essential part of economic change in the period. In her analysis, meat was still a major goal of production and thus, independent, small-scale household herding would seem to have not been efficient. That being said, it is not entirely possible to discount the keeping of flocks by households for dairy production, as well as other secondary products given the resolution quality of most faunal assemblages from the period. What can be said, however, at al-Khayran is that beyond a lack of faunal evidence for herding, there is a lack of architectural or spherulite evidence as well. This does suggest that herding was not a major activity at the site.

What is difficult to know is what a model of nuclear household based herding for meat production would look like in the archaeological record. Such a social practice would be challenging for a number of reasons. Household herding for meat would create great herd instability as household cannot typically maintain large enough flock to be reproductively resilient to the slaughter of any but the oldest of individuals (Redding, 1981). Such a slaughter pattern would not produce sufficient caloric return on investment to be worth the effort of rearing animals for years before any benefits could be gotten. Thus, it seems likely that some other form of corporate would have to enact herd production within the villages of the PPNB. This is suggested by the seeming lack of evidence of herding at al-Khayran despite there being significant evidence of herd management within all PPNB village settlements.

Another intriguing possibility is that humans were not managing flocks in the MPPNB along the lines of what we typically call “herding.” Recently argued examples of a number of

different forms of human-animal interdependencies without herding have highlighted this possibility. There are examples of humans providing animals with shelter and some provisioning while allowing them to forage and reproduce in uncontrolled contexts (Redding and Rosenberg, 1998). This allows for people to exploit these animals on a low level and also to dispose of certain household waste, while the pigs benefit from the provisioning of food and shelter. There are also examples of people creating environments around settlements conducive to attracting certain more gregarious animals and through time creating a new gene pool of individuals with a greater propensity to interact with humans (Zeder et al., 2006). Other recent studies have shown how human hunting behavior can alter the regional socio-behavioral structure of animals to exploit a much wider population of animals through time from a single location (Redding, 2005). Each of these behaviors by humans would produce faunal assemblages different from those of purely wild-hunted populations. Thus, it is possible that humans were interacting with goat herds in such a manner as to transition from an emphasis on gazelle procurement to caprine procurement, but that these interactions were not the total control of herd movement, feeding, and reproduction associated with contemporary and historic pastoralism.

Question 3: What are the implications of these practices and the social, spatial, and temporal structures within which they were enacted for the structures and processes of regional economic systems?

Within the broader PPNB context, al-Khayran is fairly unique. It is the first field house identified in the region, as well as the first intensive habitation-site associated with a flint extraction locale other than village settlements (i.e., flint extraction sites not associated with villages do not contain significant evidence of on-site habitation). It is also unique in its combination of likely cultivated cereal harvesting and possible wild goat hunting. Unlike all

other M-LPPNB sites embedded within village settlement systems, there is no evidence of animal management.

While the nuclear family household and the land tenure and property rights associated with the household have been hypothesized based on the duration of occupation of residential structures within villages and the burial of individuals below residential structure floors (Banning, 2012), how these rights extended out into the landscape has only been narrowly touched on before. Most researchers who discussed the issue have thought it possible that individual households controlled farmland, although there was some debate about this given essentially a total lack of evidence for the southern Levant (Banning, 2012, 1998; Bogaard and Isaakidou, 2010; Bogaard, 2013, 2005; Kohler-Rollefson and Rollefson, 1990; Rollefson, 1997).

Rollefson (2004, 1997) has also argued for potential inequalities in the distribution of quality farmland; presumably based on soil fertility and water availability. However, he acknowledges that this is largely speculative based on a model of LPPNB mega-site growth through immigration that he and others have proposed (Gebel, 2004a; Rollefson, 2004, 1997). Recently, Peters (2013) has suggested that water sources may have been the first object outside of settlements for which ownership was asserted.

One final tentative discussion of potential control of landscape resources by unspecified subsets of village populations by Quintero and colleagues (Quintero and Wilke, 1995; Quintero, 2011, 1998, 1997, 1996, 1994; Rollefson et al., 2007) is that of pink-purple flint sources in northern Jordan. They argue that the finite availability of this flint within the landscape, as well as the uneven spatial distribution of it at 'Ain Ghazal, could suggest that craft specialists controlled not only the products of naviform reduction, but also the supply chains of raw materials. In this context, the naviform core production at al-Khayran is intriguing. There are

some hints that such a system could be in place at al-Khayran, with the likely overproduction of naviform cores as compared to the quantities utilized at the site. The assertion of access rights to the high quality flint source adjacent to the site also is suggestive of a complex and perhaps exclusive supply chain for naviform cores and the flints with which they can be produced.

The lack of herding at al-Khayran and its potential implications for animal husbandry systems in the PPNB are also an interesting topic. It has previously been difficult to identify which social units enacted which economic behaviors. Most researchers are of the opinion that the nuclear family was the basic economic unit in the MPPNB. The results from al-Khayran do largely support such a contention. As stated earlier, every site embedded within a village-based settlement system from the period has at least some evidence of herd management. However, it is not clear who managed the flock and how. Al-Khayran suggests that perhaps the social structures of herding were different from those of other economic realms. Because the nuclear family did not herd on-site, this suggests that if the family did have a small flock, herding itself was enacted by some (larger? communal? specialized?) social unit other than the household, at least at certain times. Such a possibility has recently been suggested (Makarewicz, 2013a); however this proposal was based purely on ethnographic parallels with no evidence for non-household-based labor groups involved in herding. The fact that al-Khayran could suggest such a possibility is worthy of future investigation.

One of the more interesting aspects of al-Khayran is the lack of evidence of other forms of practices and technologies which increase subsistence production such as terracing, irrigation, and the like. While the organization of production does seem to have been becoming more efficient during the PPNB, the emergence of a number of technologies which allow for increased subsistence production per unit of area, both over the short- and long- term, had not happened

yet. Water wells appear in the PPNC (Garfinkel et al., 2006). Check dams have been identified for the Pottery Neolithic (Kuijt et al., 2007). Of course, identifying such technologies can be difficult within open landscapes and the methods used during the ADAP pedestrian survey would only have been able to identify the structures, not their chronological placement. Both the water wells and check dams cited above were identified due to their association with village extensively excavated village settlements.

The earliest evidence of secondary product utilization for animal herds is also later (Fall et al., 2002; Makarewicz, 2013c). Household size expansion, which appears for the first time in the LPPNB allows for increased labor forces (Goring-Morris and Belfer-Cohen, 2013; Rollefson, 1997). Thus, we see that any number of potential mechanisms for increasing subsistence production through the utilization of infrastructure or changes in labor organization have yet to appear in the MPPNB, even under conditions of increasing production.

A final economic realm for which either communal or industrial (i.e., super-household) production has been proposed is plaster (Garfinkel, 1987a). While more recent experimental results have been used to question this proposal (Goren and Goring-Morris, 2008), al-Khayran presents rather definitive evidence to the contrary. Because the site was occupied by an individual household, those activities identified on-site would inevitably have been household-based economic behaviors. Not only are there plaster components within the architecture at al-Khayran, but a number of waste plaster nodules, seemingly from excess production, were encountered in several areas of the midden deposits surrounding the structures.

Question 4: What are the implications of the development of PPNB economic systems for the general relationship between the processes of village development and economic change?

The results from the 'Assal-Dhra' Archaeological Project serve to broaden view of the relationship between increasing subsistence production and productivity and village growth and development. A narrow set of variables – the most commonly cited one being domestication (Baker, 2008, 2005; Barker, 2006; Bar-Yosef and Meadow, 1995; Cauvin, 2000; Dow et al., 2009; Flannery, 1969; Garfinkel, 2003; Hayden, 2009; Hodder, 1990; Price and Bar-Yosef, 2010; Robson, 2010; Winterhalder and Golland, 1993) – have been viewed as the key to understanding both subsistence intensification in the early villages of southwest Asia and the social consequences of this increase. What al-Khayran highlights is that there is a great deal more to subsistence in these early villages than has previously been discussed. There are choices about settlement patterns, time management, economic relations, and cultural concepts, not to mention storage practices (Kuijt, 2008a), which are enacted by producers in these early villages well beyond domesticating plants and animals.

The complexity of structure and action in subsistence practices highlights several important points about subsistence change and village development. Firstly, it shows that the development of agriculture and domestication itself are both embedded in wider systems of economic change. While domestication is often viewed as a form of intensification (Cohen, 2009, 1977; Makarewicz, 2012), it is one part of a larger process of changing subsistence production. As Smith (2007) has advocated, a view of human-plant/animal interactions within a broader ecological system helps to highlight how domestication was not simply about human manipulation of target species, but about reformulations of human-environment interactions. Field houses highlight that choices commonly more associated with foragers, such as seasonality

and mobility (Kelly, 2007), are also key components of farming systems. Zeder (2011) has recently reviewed the evidence that humans were managing many aspects of their environment well before domestication, in order to improve subsistence production. Al-Khayran highlights not only how this is done through direct interaction with a wide range of target species all at once, as suggested by Smith (2007), but also that it is about new frameworks for human ecological action developing within subsistence systems.

The results from al-Khayran further illustrate how subsistence change has real consequences for social organization and economic relations. Changes in production, which had the effect of increasing subsistence yields, are predominantly social in nature in the PPNB, rather than technological or infrastructural. Thus, material innovations contribute significantly less to the accommodation of growing settlement populations than do social innovations. These novel social phenomena may restructure other realms of economic relations than those in which they were developed. The extension of land tenure from the village residence, to the field house, and possibly to flint resources is just one example. Other important social innovations which are inherently tied to subsistence production include the emergence of household production and the development of the nuclear family household (Flannery, 2002, 1972).

In many ways, al-Khayran shows the usefulness of looking beyond early villages within the “hearths of domestication” (Barker, 2006) – that is early villages in the areas where domestication first occurred – to villages elsewhere. Many of the concepts found to be useful when attempting to understand subsistence change in the PPNB have been derived from contexts well after agricultural economies have come to dominate. Subsistence change in the earliest villages of southwest Asia has much in common with subsistence change in peasant or smallholder communities everywhere (Netting, 1993, 1982). Thus, understanding the

development of agriculture as a part of general subsistence change is perhaps one of the most fruitful perspectives that can be taken from this study.

Finally, the specific production choices made by the inhabitants of al-Khayran show that the utilization of technological innovations is a context-specific and strategic choice, rather than an additive process. Stanish (2007) developed this argument when describing agricultural intensification and dis-intensification in the Titicaca Basin. He showed that once the full range of technological innovations which allowed for intensification had been developed, producers strategically used those that best served their needs based on changes in environmental and social conditions. This same process is apparent at al-Khayran with the choices about where to locate production loci, but also what production practices would be enacted at these loci. Thus, while the full suite of plant production technologies available to MPPNB producers were utilized, the inhabitants of al-Khayran apparently chose not to herd flocks on-site.

Conclusions

This study attempted to reach conclusions about what sorts of economic practice were occurring in west-central Jordan during the PPNB and what the implications of these practices were for our general understanding of the relationship between village development and economic change. Through the analysis of al-Khayran and its catchment, this dissertation has shed light on several new aspects of PPNB economics including the utilization of subsistence oriented field houses, the potential strengthening of property rights and their extension into realms not previously appreciated, and the innovative solutions that PPNB producers devised to face the challenges of increasing subsistence production during the growth and development of permanent villages in southwest Asia. These solutions were as much about social (Byrd, 2000,

1994; Flannery, 1972; Kuijt, 2000a) and behavioral innovations as they were about technological developments, such as domestication.

The study has also highlighted the ways that feedback between social structures and spatial and temporal practices created novel behavioral patterns in the early Neolithic. New forms of economic relations, such as strengthened property rights and household land tenure, and new production units, such as the nuclear family household, opened up space for new production behaviors, such as the use of field houses. These new behaviors, such as the field houses, opened spaces for new economic relations, such as access rights or even control of access to natural resources like flint and water sources. The development of agriculture and the domestication of plants and animals has certainly been one of the most profoundly impactful processes in human history over the long-term. However, within the Neolithic, these changes were just one part of the greater process of increasing subsistence production to accommodate growing villages.

This pressure to increase production and the methods through which it was done, such as domestication, intensification, and extensification, also had impacts in social and economic relations that were key aspects of early Neolithic village development trajectories. The segmentation of Neolithic economies along household lines and the development of concepts of property rights that could stretch beyond that which you could carry (Stiner and Feeley-Harnik, 2011) or that which was held by the community (Crothers, 2008) or that which was yours within the reproductive unit (Peterson, 2010, 2002) or that which was yours based on your role within the communal acquisition of subsistence good (Gowdy, 1999; Ingold, 1999; Lee, 1990; Waguespack, 2005) to such things as subsistence products, farmland, water sources, flint, and the like were highly significant developments in the period.

What is perhaps most interesting about these changes is that they did not simply last into the present as durable social structures off of which the growth of political and economic institutions developed. Rather, the logics behind such structures are what lasted. It is these ideas, as well as those egalitarian concepts that competed with them during the early Neolithic (Kuijt, 2009a, 2008b, 2000d, 1996), that have provided the underpinnings for the development or dissolution of later political and economic institutions (Flannery and Marcus, 2012; Marcus and Flannery, 1996; Shenk et al., 2010; Smith et al., 2010).

Following the PPNB villages, shrank in size and populations became largely dispersed (Kohler-Rollefson and Rollefson, 1990; Kohler-Rollefson, 1992; Kuijt, 2009a, 2004, 2000a; Rollefson and Kohler-Rollefson, 1992, 1989; Simmons, 2007). While it does seem likely that such things as land tenure did survive the reorganization, the pull of agricultural fields to create greater labor efficiencies (Chisholm, 1979; Stone, 1996) and the labor efficiencies and ecological benefits of a community division of labor between farming and herding (Bar-Yosef and Khazanov, 1992; Halstead, 1996; Khazanov, 1984; Kohler-Rollefson, 1992) overwhelmed the ideological and economic benefits of aggregation, such as the *communitas* produced through religious practice (Adler and Wilshusen, 1990; Adler, 1989; Kuijt, 2009a, 2008b, 2004, 2000a, 2000d) and the availability of multiple economic functions in a single locale in order to allow for greater complexity in agricultural practices (Stone, 1996).

Thus, we see that concepts are enacted within a material world of pressures and opportunities and that agents strategically use them for a variety of ends from survival to power and material comfort. Agents work through the material world and the world of social facts, such as economic relations and institutions, and they mobilize these concepts in the world towards their ends. As highlighted by Stanish (2007) and Flannery and Marcus (2012; Marcus and

Flannery, 1996), this is a dynamic process where concepts and practices are enacted situationally. In other words, both subsistence production behaviors and logics of social organization were durable, rather than the social and economic structures developed through these concepts and practices in the Neolithic.

This dissertation has also shown how important economic dynamics in smallholder villages are for understanding change both in the ethnographic present and in the deep past. In many ways it shows that socio-economic processes were stronger drivers of subsistence change through time in the PPNB than many of the other factors commonly highlighted, such as climate change, ideological shifts, and demographic pressures. While each of these factors was certainly relevant to changes in economic practices and the organization of production systems (economic change could not have happened without any of them), it is the same basic challenges of time and effort that all smallholders face, whether Neolithic villagers or peasant farmers in the late 20th century, that drives changing economic practices. By utilizing such concepts in order to understand the development of subsistence economies in the PPNB, we gain greater insight into how and why these changes occurred.

Appendix 1: Archaeological Surveys in West-Central Jordan

	Survey Name	Lithics Collection	Number of Epi/PPN Sites
1	Albright Surveys	No	n/a
2	Archaeology and Environment of the Dead Sea Plain	Yes	n/a
3	Arab Potash Company Survey	Yes	?
4	Archaeological Survey of the Karak Plateau	No	1 Keb (Source: DAAHL)
5	Edh-Dhra' Survey	No	n/a
6	Eastern Dead Sea Archaeological Survey	Yes	1 Nat
7	Ghor es-Safi Survey	Yes	1 PPNB
8	Glueck Surveys	No	n/a
9	Karak Resources Project Regional Survey	Yes	Unanalyzed
10	Limes Arabicus Survey	Yes	33 Epi; 34 PPN
11	Mazra'a Zara al Djenubie Survey (Swedish Dead Sea Expedition)	Yes	1 PPN
12	Northwest Ard al-Karak	Yes	At Least: 2 Lithic Sites; 1 Epi
13	Southern Ghors and Northeastern Araba Survey	Yes	2 Keb; 3 PPN; 1 PPNB
14	Survey on the Southeastern Plain of the Dead Sea	Yes	At Least:
15	South Ridge of Wadi 'Isal	Yes	1 PPNA/EPPNB
16	Tafileh-Ghor Feifeh Archaeological Rescue Survey	Yes	n/a
17	Tannur Dam Survey	Yes	1 PPNA/LPPNB
18	Tuwaneh Survey	No	n/a
19	Wadi Araba and the Dead Sea Valley Survey	Yes	1 PPNA; 2 PPNB
20	Wadi 'Assal Roman Road Survey	No	n/a
21	Wadi al-Hasa North Bank Survey	Grab Sample	13 Epi; 29 PPN
22	Wadi el Hasa Survey	Grab Sample/Few Further Collections	93 Epi; 5 Keb; 6 Nat; 124 PPN; 1 PPNA/EPPNB; 6 PPNB
23	Wadi al-Mujib Archaeological Survey	Yes	1 Epi; 2 PPNB
24	Wadi ash-Shuquayfat Survey	Yes	At Least: 1 PPN; 1 Neo?

Appendix 2: List of Early Neolithic Sites

West-Central Jordanian Pre-Pottery Neolithic B Sites Identified through Survey (“MEGA Jordan,” n.d.)			
Site Name	Period	Long	Lat
WHS - 0565	PPNB	35.84178	30.88354
WHS - 0610	PPNB	35.80103	30.88780
WHS - 0924	PPNB	35.88568	30.87883
WHS - 1020	PPNB	35.86334	30.90193
West-Central Jordanian “Pre-Pottery Neolithic” Sites Identified through Survey (“MEGA Jordan,” n.d.)			
Site Name	Period	Long	Lat
JMHAYSIN	PPN	35.83279	31.26961
LAS - 037	PPN	35.99924	31.21098
LAS - 218	PPN	35.88964	31.28828
LAS - 591	PPN	35.84972	31.28848
LAS - 603	PPN	35.91499	31.16816
LAS - 604:A	PPN	35.92848	31.15097
LAS - 607	PPN	35.89791	31.12678
LAS - 627	PPN	35.97730	31.22104
LAS - 639:B	PPN	35.97005	31.23641
LAS - 643	PPN	35.95351	31.26899
LAS - 644:A	PPN	35.95766	31.25993
LAS - 646	PPN	36.00492	31.38953
LAS - 696	PPN	35.92293	31.39002
LAS - 698	PPN	35.92670	31.33136
LAS - 827	PPN	35.96671	31.07409
MZDS - AREA 1	PPN	35.54843	31.32842
NUMEIRA	PPN	35.53021	31.13050
SAFI	PPN	35.47718	31.01740
SGNAS - 177	PPN	35.59189	30.89626
SGNAS - 182	PPN	35.44772	30.96243
Tirsa	PPN	35.99343	31.39952
WHNBS - 006	PPN	35.96405	30.83972
WHNBS - 008	PPN	35.96356	30.84376
WHNBS - 021	PPN	35.95075	30.84330
WHNBS - 027	PPN	35.93950	30.83931
WHNBS - 034	PPN	35.93781	30.84224
WHNBS - 035	PPN	35.93846	30.84176
WHNBS - 036	PPN	35.93717	30.84269
WHNBS - 037	PPN	35.93925	30.84155
WHNBS - 041	PPN	35.94092	30.83929

WHNBS - 046	PPN	35.93196	30.84679
WHNBS - 051	PPN	35.93328	30.84868
WHNBS - 053	PPN	35.94271	30.85101
WHNBS - 056	PPN	35.93779	30.85700
WHNBS - 060	PPN	35.93279	30.85431
WHNBS - 068	PPN	35.92794	30.85178
WHNBS - 069	PPN	35.92682	30.85739
WHNBS - 071	PPN	35.91825	30.86502
WHNBS - 073	PPN	35.91906	30.86669
WHNBS - 121	PPN	35.93712	30.87673
WHNBS - 157	PPN	35.91407	30.90374
WHNBS - 158	PPN	35.91347	30.90395
WHNBS - 369	PPN	35.86981	30.89984
WHNBS - 370	PPN	35.86941	30.90003
WHNBS - 384	PPN	35.83996	30.92542
WHNBS - 442: A-B	PPN	35.87080	30.90288
WHNBS - 442: D	PPN	35.87098	30.90298
WHNBS - 469	PPN	35.87212	30.91386
WHNBS - 471	PPN	35.87117	30.91460
WHS - 0062	PPN	35.64133	30.95835
WHS - 0063	PPN	35.63927	30.96287
WHS - 0122	PPN	35.67477	30.95189
WHS - 0144	PPN	35.65502	30.97813
WHS - 0194	PPN	35.64986	30.87622
WHS - 0221	PPN	35.69683	30.9655
WHS - 0227	PPN	35.69267	30.96897
WHS - 0234	PPN	35.71356	30.96169
WHS - 0237	PPN	35.70517	30.95899
WHS - 0246	PPN	35.69115	30.87519
WHS - 0248	PPN	35.67750	30.86532
WHS - 0256	PPN	35.70909	30.90667
WHS - 0259	PPN	35.69968	30.90762
WHS - 0260	PPN	35.69986	30.90775
WHS - 0318	PPN	35.74474	30.92185
WHS - 0326	PPN	35.74586	30.93808
WHS - 0329	PPN	35.74595	30.94892
WHS - 0334	PPN	35.74803	30.94711
WHS - 0360	PPN	35.73732	30.90568
WHS - 0372	PPN	35.75417	30.92633
WHS - 0374	PPN	35.75525	30.92724
WHS - 0376	PPN	35.75525	30.92904

WHS - 0389	PPN	35.76875	30.91453
WHS - 0392	PPN	35.76985	30.92176
WHS - 0393	PPN	35.76985	30.92267
WHS - 0395	PPN	35.75624	30.91912
WHS - 0397	PPN	35.76771	30.91548
WHS - 0402	PPN	35.76976	30.90732
WHS - 0404	PPN	35.75929	30.90739
WHS - 0408	PPN	35.75716	30.89838
WHS - 0441	PPN	35.72778	30.87776
WHS - 0443	PPN	35.73927	30.87950
WHS - 0445	PPN	35.72768	30.86691
WHS - 0446	PPN	35.74554	30.87947
WHS - 0447	PPN	35.75080	30.88124
WHS - 0449	PPN	35.74872	30.88669
WHS - 0451	PPN	35.74771	30.89028
WHS - 0464	PPN	35.78759	30.91717
WHS - 0481	PPN	35.79489	30.90811
WHS - 0482	PPN	35.79591	30.90722
WHS - 0483	PPN	35.79905	30.90630
WHS - 0484	PPN	35.80218	30.90808
WHS - 0487	PPN	35.79383	30.90813
WHS - 0488	PPN	35.79277	30.90633
WHS - 0489	PPN	35.79381	30.90452
WHS - 0490	PPN	35.79065	30.90093
WHS - 0492	PPN	35.78955	30.89371
WHS - 0507	PPN	35.80421	30.89453
WHS - 0508	PPN	35.80213	30.89638
WHS - 0509	PPN	35.80214	30.89637
WHS - 0510	PPN	35.79583	30.89639
WHS - 0511	PPN	35.79586	30.89731
WHS - 0513	PPN	35.79899	30.89999
WHS - 0514	PPN	35.79270	30.89369
WHS - 0523	PPN	35.77798	30.87935
WHS - 0553	PPN	35.84335	30.88264
WHS - 0556	PPN	35.83760	30.88538
WHS - 0559	PPN	35.83814	30.88493
WHS - 0560	PPN	35.83864	30.88221
WHS - 0561	PPN	35.83864	30.88176
WHS - 0563	PPN	35.83863	30.87816
WHS - 0564	PPN	35.84281	30.87769
WHS - 0572	PPN	35.91636	30.85746

WHS - 0575	PPN	35.90067	30.85437
WHS - 0580	PPN	35.91788	30.85070
WHS - 0584	PPN	35.91689	30.85746
WHS - 0586	PPN	35.91164	30.85703
WHS - 0587	PPN	35.91165	30.85523
WHS - 0589	PPN	35.90533	30.84759
WHS - 0591	PPN	35.91584	30.85610
WHS - 0595	PPN	35.91008	30.85611
WHS - 0596	PPN	35.90262	30.83948
WHS - 0597	PPN	35.90688	30.84490
WHS - 0601	PPN	35.90588	30.85436
WHS - 0603	PPN	35.90533	30.84974
WHS - 0609	PPN	35.79842	30.88737
WHS - 0611	PPN	35.80313	30.88735
WHS - 0622	PPN	35.92202	30.84706
WHS - 0623	PPN	35.92101	30.84797
WHS - 0629	PPN	35.80733	30.89092
WHS - 0649	PPN	35.80689	30.90490
WHS - 0676	PPN	35.82043	30.89998
WHS - 0747	PPN	35.92123	30.87863
WHS - 0748	PPN	35.81579	30.90668
WHS - 0760	PPN	35.92020	30.88091
WHS - 0765	PPN	35.87394	30.84641
WHS - 0785	PPN	35.91071	30.87059
WHS - 0790	PPN	35.92124	30.88045
WHS - 0797	PPN	35.91073	30.87193
WHS - 0805	PPN	35.86473	30.87532
WHS - 0809	PPN	35.86367	30.87217
WHS - 0812	PPN	35.86420	30.87488
WHS - 0813	PPN	35.86107	30.87714
WHS - 0816	PPN	35.84958	30.87540
WHS - 0818	PPN	35.85951	30.87261
WHS - 0836	PPN	35.85850	30.87718
WHS - 0889	PPN	35.89508	30.87876
WHS - 0892	PPN	35.86648	30.90148
WHS - 0914	PPN	35.83193	30.89487
WHS - 0915	PPN	35.83923	30.89304
WHS - 0919	PPN	35.87638	30.89329
WHS - 0922	PPN	35.88464	30.87792
WHS - 0925	PPN	35.88566	30.87794
WHS - 0927	PPN	35.87726	30.87123

WHS - 0934	PPN	35.82620	30.89671
WHS - 0938	PPN	35.84764	30.89705
WHS - 0939	PPN	35.85078	30.89793
WHS - 0940	PPN	35.87418	30.88115
WHS - 0941	PPN	35.82515	30.89761
WHS - 0981	PPN	35.90970	30.87510
WHS - 0994	PPN	35.88826	30.87610
WHS - 1007	PPN	35.80179	30.93154
WHS - 1015	PPN	35.84254	30.92910
WHS - 1035	PPN	35.81799	30.92740
WHS - 1051	PPN	35.90178	30.86205
WHS - 1054	PPN	35.80548	30.93242
Excavated PPNB Villages and Associated Sites			
Site Name	Periods	Latitude	Longitude
Abu Ghosh	MPPNB	31.805367°	35.108333°
Ain el-Jammam	LPPNB	30.095789°	35.569315°
Ain Ghazal	M-LPPNB	31.986944°	35.976111°
al-Basit	LPPNB	30.330035°	35.482094°
al-Khayran	M/LPPNB?	31.157539°	35.598147°
Aviel	LPPNB	32.537567°	35.009621°
Ba'ja	LPPNB	30.413356°	35.461259°
Basta	LPPNB	30.228095°	35.533799°
Beidha	MPPNB	30.370833°	35.447778°
Beisamoun	MPPNB (?)	33.072364°	35.581417°
el-Hemmeh	LPPNB	30.966667°	35.731111°
es-Sifiye	(M?)-LPPNB	31.438803°	35.825406°
Ghuwayr I	MPPNB	30.608017°	35.512494°
Jericho	MPPNB	31.871019°	35.444328°
Kfar HaHoresh	M-LPPNB	32.701091°	35.277139°
Kharaysin	LPPNB (?)	32.209428°	36.000768°
Khirbat al-Hammam	(M?)-LPPNB	30.983494°	35.666561°
Metzad Mazal	LPPNB	30.990361°	35.312254°
Mishmar Ha-emeq (?)	MPPNB	32.607464°	35.143572°
Motza	M-L(?)PPNB	31.793333°	35.168953°
Munhatta	MPPNB	32.610334°	35.545808°
Nahal Dishon Mines	Neolithic (?)	33.051316°	35.439517°
Nahal Hemar	MPPNB	31.141667°	35.205556°
Rabud (?)	LPPNB (?)	31.430906°	35.022028°
Ramat Tamir	LPPNB	31.001549°	35.300584°
Sheikh 'Ali (?)	PPNB (?)	32.701326°	35.562870°

Tel Tif'dan	LPPNB	30.670742°	35.376580°
Tell Abu Suwwan	(M?)-LPPNB	32.265557°	35.885948°
Wadi Hamarash 1	MPPNB	31.014692°	35.542139°
Wadi Shu-eib	(M?)-LPPNB	31.973343°	35.727128°
Yiftahel	MPPNB	32.755208°	35.227836°

Appendix 3: Late PPNA-Early LPPNB Village Sites with Radiocarbon Dates

Site	Early Date	Late Date	Notes	References
Jericho PPNA	9300	8320	Long Chronology of Many Levels and Stages	(Burleigh, 1983, 1981)
ZAD 2	8800	8450		(Edwards et al., 2004)
Motza Layer VI (EPPNB)	8600/8550	8200/8150		(Khalaily et al., 2007; Yizhaq et al., 2005)
Ain Ghazal Phase 1 (MPPNB)	8400/8300	8000		(Rollefson, 1998c; Rollefson et al., 1992)
Shkarat Msaied	8340	7960		(Hermansen et al., 2006)
Nahal Hemar Layer 4	8210	7780		(Bar-Yosef and Alon, 1988)
Motza Layer V (MPPNB)	8150	7650		(Khalaily et al., 2007; Yizhaq et al., 2005)
Abu Ghosh	8075±113			(Khalaily and Marder, 2003b)
Beidha	8050	7650		(Byrd, 2005a; Rambeau et al., 2011)

Ghuwayr 1	8000	7450		(Simmons and Najjar, 2006)
Ain Ghazal Phase 2 (MPPNB)	8000	7600		(Rollefson, 1998c; Rollefson et al., 1992)
Yiftahel Area A Stratum III and IV	7960	7000		(Garfinkel, 1987b; Garfinkel et al., 2012)
Jericho PPNB (MPPNB)	7950	7580		(Burleigh, 1983, 1981)
al-Khayran Phase 001	7856±341		Two Dates from a Single Event	
Nahal Hemar Layer 3B	7820	7570		(Bar-Yosef and Alon, 1988)
Wadi Hamarash 1	7700	7500 (?)		(Sampson, 2012, 2010b)
el-Hemmeh LPPNB	7670±70		One Date; Possible Old Wood Effect	(Makarewicz et al., 2006)
Khirbet Hammam	7520±50	7143±48	Possible MPPNB Habitation that is Undated	(Peterson, 2007)
Ain Ghazal Phase 3 (LPPNB)	7510	6700/6600		(Rollefson, 1998c; Rollefson et al., 1992)
Ba'ja	7097±34	6785±99		(Gorsdorf, 2000)

Nahal Hemar Layer 3A	7450	7080		(Bar-Yosef and Alon, 1988)
Tell Tif'dan Stratum II + (WFD 11)	7200±50			(Moreno, 2009)
Tell Abu Suwwan (Earliest)	7185±285		Possible MPPNB Habitation that is Undated	(Al-Nahar, 2010b)
Basta All (LPPNB)	7180	7040		(Benz, n.d.)
es-Sifiye	7060	6820	Possible MPPNB Habitation that is Undated	(Mahasneh and Bienert, 2000; Mahasneh, 2004)

Appendix 4: Campbell (2009) Data

'Ain Ghazal

Table 6.1

Population estimates for 'Ain Ghazal, based on total site area and ethnographic analogy (section 5.6). Those site size estimates that are used in these analyses are highlighted in grey.

	MPPNB			LPPNB			PPNC		
<i>Estimated Density</i>	if... 3.01 ha	3.9 ha	4.7 ha	7.8 ha	9.2 ha	10.6 ha	9.7 ha	11.6 ha	13.5 ha
low *	259	333	406	671	793	914	837	997	1158
middle **	419	539	657	1089	1284	1481	1355	1616	1876
high ***	860	1106	1349	2234	2634	3037	2780	3314	3848

	PN			
<i>Estimated Density</i>	if... 7.5 ha	10.5 ha	13.5 ha (main area only)	17.6 ha (includes East Field & north scatter)
low *	647	903	1158	1511
middle **	1049	1462	1876	2447
high ***	2151	3000	3849	5020

* based on a total site area of 116.3 m² per person; analogous to Tell i-Nun, southwest Iran (Jacobs, 1979).
 ** ...71.8 m² per person; analogous to Shahabad, central Iran (Kramer, 1979).
 *** ...35 m² per person; analogous to Marib, north Yemen (van Beek, 1982).

Table 6.2

Assigned suitability classes for predominant parent materials within an effective 5 km of 'Ain Ghazal. Again, 4: ideally suited, 3: moderately suited.

Surface geology	Suitability...				
	barley	einkorn	emmer	pea	lentil
Phosphorites, oyster beds, alternating limestones and marls, silicified limestones, cherts.	4	4	3	4	4
Fluvatile deposits, eoalian sands, loess-like sediments, mantle rocks.	4	4	4	4	4
Limestones, locally sandy, marls, dolomites.	4	4	3	4	4

Crop	Suitability level	Under current average rainfall levels		Under current average rainfall levels plus 50 mm		Under current average rainfall levels plus 175 mm	
		Area (in dunums)	Percentage (of 5 km area)	Area (in dunums)	Percentage (of 5 km area)	Area (in dunums)	Percentage (of 5 km area)
Barley	3	41465	73 %	30974	55 %	1516	3 %
	4	7084	13 %	17586	31 %	47045	83 %
Wheat A *	3	13594	24 %	20647	37 %	37411	66 %
	4	1405	3 %	3074	5 %	9392	17 %
Wheat B **	3	37069	66 %	30986	55 %	1525	3 %
	4	7078	13 %	17550	31 %	47652	84 %
Cereals A	3	7953	14 %	6291	11 %	--	--
	4	1401	3 %	3059	5 %	9360	17 %
Cereals B	3	36842	65 %	30800	55 %	1510	3 %
	4	7064	13 %	17478	31 %	46791	83 %
Field Pea	3	7128	13 %	18163	32 %	49903	88 %
	4	--	--	--	--	--	--
Lentil	3	30361	54 %	44551	79 %	50548	90 %
	4	--	--	--	--	872	2 %
All Crops A	3	--	--	--	--	--	--
	4	--	--	--	--	145	.5 %
All Crops B	3	--	--	--	--	--	--
	4	--	--	--	--	870	1.5 %

Table 6.4 Total areas for different suitability levels (3, moderately suitable, 4, ideally suitable) surrounding 'Ain Ghazal, according to the ecological requirements of the main crop varieties. Percentages refer to the proportion that each area value represents of the space within the arbitrary 5 km path-distance operation. * 'Wheat A' refers to the suitability of the lesser tolerant variety of wheat, namely einkorn. ** 'Wheat B' alternately, refers to the suitability areas for emmer.

Table 6.5a (MPPNB), Table 6.5b (LPPNB), Table 6.5c (PPNC), Table 6.5d (PN, Yarmukian)
 Absolute areas required (in dunum), and percentage of the total available arable land (see Table 6.4) to sustain 'Ain Ghazal's inhabitants if they followed a diet where **80% of their total caloric needs** were derived from cultivated cereals. %a refers to current rainfall levels, %b refers to current rainfall levels plus 50mm, %c refers to current rainfall levels plus 175mm.

		Worst-Case-Scenario: If diet was 80% cultivated cereals											
		1106			639			333					
Estimated population level:		area *	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c
Ideally suitable land required		4531	64	26	10	2208	31	13	5	1364	19	8	3
Moderately suitable land required		6796	18	22	450	3312	9	11	219	2046	6	7	136

		Worst-Case-Scenario: If diet was 80% cultivated cereals											
		2634			1284			793					
Estimated population level:		area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c
Ideally suitable land		10790	153	62	23	5260	75	30	11	3249	46	19	7
Moderately suitable land		16185	44	53	1072	7890	21	25	523	4873	13	16	323

		Worst-Case-Scenario: If diet was 80% cultivated cereals											
		3314			1616			997					
Estimated population level:		area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c
Ideally suitable land		13576	192	78	29	6620	94	38	14	4084	58	23	9
Moderately suitable land		20364	55	66	1349	9930	27	32	658	6126	17	20	408

		Worst-Case-Scenario: If diet was 80% cultivated cereals											
		3849			1876			1158					
Estimated population level:		area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c
Ideally suitable land		15768	223	90	34	7696	109	44	16	4744	67	27	10
Moderately suitable land		23651	64	77	1596	11526	31	37	763	7116	19	23	471

Table 6.6a (MPPNB), Table 6.6b (LPPNB), Table 6.6c (PPNC), Table 6.6d (PN, Yarmukian)
 Absolute areas required (in dunum), and percentage of the total available arable land (see Table 6.4) to sustain Ain Ghazal's inhabitants if they followed a diet where 50% of their total caloric needs were derived from cultivated cereals. %a refers to current rainfall levels, %b refers to current rainfall levels plus 50mm. %c refers to current rainfall levels plus 175mm.

MPPNB												
If diet was 50% cultivated cereals												
Estimated population level:			1106			539			333			
area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c	
Ideally suitable land required	2832	40	16	6	1380	20	8	3	853	12	5	2
Moderately suitable land required	4248	12	14	281	2070	6	7	137	1279	4	4	85
LPPNB												
If diet was 50% cultivated cereals												
Estimated population level:			2634			1284			793			
area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c	
Ideally suitable land	6744	96	39	14	3288	47	19	7	2030	29	12	4
Moderately suitable land	10116	28	33	670	4931	13	16	327	3046	8	10	202
PPNC												
If diet was 50% cultivated cereals												
Estimated population level:			3314			1616			997			
area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c	
Ideally suitable land	8485	120	49	18	4138	59	24	9	2553	36	15	6
Moderately suitable land	12727	35	41	843	6206	17	20	411	3829	10	12	254
PN (Yarmukian)												
If diet was 50% cultivated cereals												
Estimated population level:			3849			1876			1158			
area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c	
Ideally suitable land	9855	140	56	21	4803	68	28	10	2865	42	17	6
Moderately suitable land	14782	40	48	979	7205	20	23	477	4447	12	14	295

Table 6.7a (MPPNB), Table 6.7b (LPPNB), Table 6.7c (PPNC), Table 6.7d (PN, Yarmukian) Absolute areas required (in dunum), and percentage of the total available arable land (see Table 6.4) to sustain 'An Ghazal's inhabitants if they followed a diet where 30% of their total caloric needs were derived from cultivated pulses. %a refers to current rainfall levels, %b refers to current rainfall levels plus 50mm, %c refers to current rainfall levels plus 175mm

		...if diet was 30% cultivated pulses											
MPPNB		1106			539			333					
Estimated population level:		area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c
Moderately suitable land (field pea)		2588	36	14	5	1261	18	7	3	779	11	4	2
Moderately suitable land (lentil)		2588	9	6	5	1261	4	3	3	779	3	2	2
LPPNB		2634			1284			793					
Estimated population level:		area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c
Moderately suitable land (field pea)		6163	87	34	12	3004	42	17	6	1855	26	10	4
Moderately suitable land (lentil)		6163	20	14	12	3004	10	7	6	1855	6	4	4
PPNC		3314			1616			997					
Estimated population level:		area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c
Moderately suitable land (field pea)		7754	109	43	16	3781	53	21	8	2333	33	13	5
Moderately suitable land (lentil)		7754	26	17	15	3781	13	9	8	2333	8	5	5
PN (Yarmukian)		3849			1876			1158					
Estimated population level:		area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c
Moderately suitable land (field pea)		9006	126	50	18	4389	62	24	9	2709	36	15	5
Moderately suitable land (lentil)		9006	30	20	18	4389	15	10	9	2709	9	6	5

Table 6.8a (MPPNB, above) Table 6.8b (LPPNB, below) Herds within a 1.25 hour-walk from 'Ain Ghazal. Proposed herd sizes for different human population levels, the area required to support them at different stocking rates, and the proportion of the moderately and ideally suitable land that these figures represent. All areas in dunum.

MPPNB

Estimated population level:	if 20% of caloric requirements came from domestic sheep / goat herds.								
	Under current rainfall levels plus 50 mm								
	1106	%		539	%		333	%	
Number of animals required:	2323			1132			699		
Estimated total herd size *	6968			3396			2098		
Area required (in dunum) at a stocking rate of .25 ha / sheep or goat, or 4 animals ha ⁻¹ :	17420	57	45	8489	28	22	5245	17	13
or ...at stocking rate of .6 ha / sheep or goat, or 1.6 animals ha ⁻¹ :	43549	141	112	21223	69	54	13112	43	34
or ...at stocking rate of .8 ha / sheep or goat, or 1.25 animals ha ⁻¹ :	55742	181	143	27165	88	70	16783	54	43

Under current rainfall levels plus 175 mm									
	1106	%		539	%		333	%	
	17420	37	31	8489	18	15	5245	11	9
	43549	93	77	21223	45	38	13112	28	23
	55742	119	99	27116	58	48	16783	36	30

LPPNB

Estimated population level:	if 20% of caloric requirements came from domestic sheep / goat herds.								
	Under current rainfall levels plus 50 mm								
	2634	%		1284	%		793	%	
Number of animals required:	5531			2696			1665		
Estimated total herd size *	16594			8089			4996		
Area required (in dunum) at a stocking rate of .25 ha / sheep or goat, or 4 animals ha ⁻¹ :	41496	113	84	20223	55	41	12490	34	25
or ...at stocking rate of .6 ha / sheep or goat, or 1.6 animals ha ⁻¹ :	103714	337	268	50568	164	130	31224	101	80
or ...at stocking rate of .8 ha / sheep or goat, or 1.25 animals ha ⁻¹ :	132754	431	341	64714	210	166	39967	130	103

Under current rainfall levels plus 175 mm									
	2634	%		1284	%		793	%	
	41496	89	73	20223	43	36	12490	27	22
	103714	222	184	50568	108	90	31224	67	55
	132754	284	235	64714	138	115	39967	85	71

Note: For the moderate rainfall levels (blue series) the percentage columns are first: proportion of moderately suitable land (therefore not including ideally suited land for cultivation, or wholly inappropriate land); second: proportion of all non-ideal land (therefore all moderately and wholly inappropriate land to cultivation). For the higher rainfall levels (green series) the percentage columns are first: proportion of all ideally suited land to cultivation (this is because most of the landscape can be characterized as such under this scenario; therefore no moderately suitable or wholly inappropriate land); second: proportion of all land within the boundary established here.

Table 6.8c (PPNC, above) Table 6.8d (PN, below) Herds within a 1.25 hour-walk from 'Ain Ghazal. Proposed herd sizes for different human population levels, the area required to support them at different stocking rates, and the proportion of the moderately and ideally suitable land that these figures represent. All areas in dunum.

PPNC

Estimated population level:	If 20% of caloric requirements came from domestic sheep / goat herds.								
	Under current rainfall levels plus 50 mm								
	3314	%		1616	%		997	%	
Number of animals required:	6959			3394			2094		
Estimated total herd size *	20878			10181			6281		
Area required (in dunum) at a stocking rate of .25 ha / sheep or goat, or 4 animals ha ⁻¹ :	52196	169	134	25452	83	65	15703	51	40
or ...at stocking rate of .6 ha / sheep or goat, or 1.6 animals ha ⁻¹ :	130489	354	264	63630	173	129	39257	107	79
or ...at stocking rate of .8 ha / sheep or goat, or 1.25 animals ha ⁻¹ :	167026	453	338	81446	221	165	50249	136	102

Under current rainfall levels plus 175 mm									
	3314	%		1616	%		997	%	
52196	112	92	25452	54	45	15703	34	28	
130489	279	231	63630	136	113	39257	84	70	
167026	357	296	81446	174	144	50249	107	89	

PN

Estimated population level:	If 20% of caloric requirements came from domestic sheep / goat herds.								
	Under current rainfall levels plus 50 mm								
	3849	%		1876	%		1158	%	
Number of animals required:	8083			3940			2432		
Estimated total herd size *	24249			11819			7295		
Area required (in dunum) at a stocking rate of .25 ha / sheep or goat, or 4 animals ha ⁻¹ :	60622	197	156	29547	96	76	18239	69	47
or ...at stocking rate of .6 ha / sheep or goat, or 1.6 animals ha ⁻¹ :	151554	492	389	73868	240	189	45596	148	117
or ...at stocking rate of .8 ha / sheep or goat, or 1.25 animals ha ⁻¹ :	193990	630	498	94550	307	243	58363	189	150

Under current rainfall levels plus 175 mm									
	3849	%		1876	%		1158	%	
60622	130	107	29547	63	52	18239	39	32	
151554	324	268	73868	158	131	45596	97	81	
193990	415	344	94550	202	167	58363	125	103	

Note: For the moderate rainfall levels (blue series) the percentage columns are first: proportion of *moderately suitable land* (therefore not including ideally suited land for cultivation, or wholly inappropriate land); second: proportion of *all non-ideal land* (therefore all moderately and wholly inappropriate land to cultivation). For the higher rainfall levels (green series) the percentage columns are first: proportion of all *ideally suited land* to cultivation (this is because most of the landscape can be characterized as such under this scenario, therefore no moderately suitable or wholly inappropriate land); second: proportion of *all land* within the boundary established here.

Basta

Table 7.2

Population estimates for LPPNB Basta based on different estimates of the site's total extent and ethnographic analogy. Columns highlighted in grey (8 ha, 9.8 ha, and 11.1 ha) are the areal estimates used for the analyses to follow.

Estimated Density	If extent was... 6.9 ha	8 ha	9.8 ha	11.1 ha	14 ha
low *	590	689	839	943	1204
middle **	956	1117	1360	1527	1950
high ***	1962	2290	2789	3132	4000

* based on a total site are of 116.3 m² per person; analogous to Teil i-Nun, southwest Iran (Jacobs, 1979).

** ...71.8 m² per person; analogous to Shahabad, central Iran (Kramer, 1979).

*** ...35 m² per person; analogous to Marib, north Yemen (van Beek, 1962).

Table 7.3

Major surface geological associations and parent material suitability levels for the cultivation of particular crops. Codes associated with descriptions refer to Figure 7.4.

Geological association	Suitability level ¹			
	Barley	Einkorn	Field Pea	Lentil
(1) Talus, fans.	4	4	4	4
(2) Sandy limestone, marls, cherts, limestones.	4	4	3	3
(4) Massive, brownish weathered, locally bedded sandstones of continental environment, with red shales.	2	2	2	2
(5) Argillaceous sandstones, sandy dolomites, sandy limestones, locally limestones & marls, varicoloured sandstones, massive white sandstones.	3	3	2	2
(6) Nodular limestones, clays & marls with gypsum, thick bedded limestones, locally dolomites.	3	3	3	3
(7) Phosphonites, oyster beds, alternating limestones & marls, silicified limestones, cherts.	4	4	4	4
(8) Limestones, locally sandy, marls, dolomites.	4	4	4	4
(9) Fluvial gravels, mantle rock.	3	3	4	4
(10) Chalky marls, bituminous limestones & marls.	3	3	3	3
(11) Limestones with cherts, nummulitic limestones, chalky, sandy & conglomeratic limestones.	4	3	4	4

Table 7.6a

Total areas for different suitability levels (2: less reliable than 'moderately' suitable 3, but not entirely incapable of supporting each crop; 3: moderately suitable, not ideal) surrounding Basta, according to the ecological requirements of the main crop varieties. Percentages refer to the proportion that each value represents **within a 1.25 hour walk** from the settlement.

Crop	Suitable level	Rainfall 50 mm above current		Rainfall 100 mm above current		Rainfall 175 mm above current	
		Area	%	Area	%	Area	%
Barley	2	17728	26%	--	--	--	--
	3	42173	62%	60307	88%	60307	88%
Wheat	2	--	--	17916	26%	--	--
	3	--	--	42004	62%	60307	88%
Cereals Intersect	2	--	--	--	--	--	--
	3	--	--	42004	62%	60307	88%
Field Pea	2	--	--	--	--	11523	17%
	3	--	--	--	--	49137	72%
Lentil	2	48452	71%	60307	88%	11479	17%
	3	--	--	--	--	49187	72%
All Crops	2	--	--	17916	26%	--	--
	3	--	--	--	--	49187	72%

Table 7.6b

Total areas for different suitability levels and percentages of the total area **within a 1.5 hour walk** from the settlement.

Crop	Suitable level	Rainfall 50 mm above current		Rainfall 100 mm above current		Rainfall 175 mm above current	
		Area	%	Area	%	Area	%
Barley	2	31377	32%	--	--	--	--
	3	56140	57%	87964	89%	87964	89%
Wheat	2	87140	88%	31726	32%	--	--
	3	--	--	55827	56%	87964	89%
Cereals Intersect	2	--	--	--	--	--	--
	3	--	--	55827	56%	87964	89%
Field Pea	2	--	--	--	--	22200	22%
	3	--	--	--	--	66316	67%
Lentil	2	63763	64%	87964	89%	22202	22%
	3	--	--	--	--	66316	67%
All Crops	2	--	--	31726	32%	--	--
	3	--	--	--	--	66316	67%

Table 7.6c

Total areas for different suitability levels and percentages of the total area **within a 2 hour walk** from the settlement.

Crop	Suitable level	Rainfall 50 mm above current		Rainfall 100 mm above current		Rainfall 175 mm above current	
		Area	%	Area	%	Area	%
Barley	2	63245	37%	--	--	--	--
	3	84385	49%	148310	86%	148310	86%
Wheat	2	133283	77%	64171	37%	--	--
	3	180	0%	83552	49%	148310	86%
Cereals Intersect	2	--	--	--	--	--	--
	3	118	0%	83552	49%	148310	86%
Field Pea	2	--	--	--	--	46393	27%
	3	--	--	--	--	104756	61%
Lentil	2	95531	56%	148310	86%	46393	27%
	3	--	--	--	--	104756	61%
All Crops	2	--	--	64171	37%	--	--
	3	--	--	--	--	104756	61%

Table 7.7a (top), Table 7.7b (middle), Table 7.7c (bottom)

Total area of land required to support different estimated population levels at LPPNB Basta, assuming an 80% cultivated cereal contribution to the diet (upper row), and 50% proportion (lower row). Areal amounts refer to 'moderately suitable' land required only, and percentages are the proportion of land within a 1.25 hour-walk from the settlement. All areal values in dunum.

Population ...if site 8 ha	2290			1117			689					
	area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c
Moderately suitable land required A*	12508	30	30	21	610	14	15	10	3763	9	9	6
Moderately suitable land required B	7818	19	19	13	3813	9	9	6	2352	6	6	4

Table 7.7b

Population ...if site 9.8 ha	2789			1360			839					
	area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c
Moderately suitable land required A*	15234	36	36	25	7428	18	18	12	4583	11	11	8
Moderately suitable land required B	9521	23	23	16	4643	11	11	8	2864	7	7	5

Table 7.7c

Population ...if site 11.1 ha	3132			1527			943					
	area	%a	%b	%c	area	%a	%b	%c	area	%a	%b	%c
Moderately suitable land required A*	17107	41	41	28	8341	20	20	14	5151	12	12	9
Moderately suitable land required B	10592	25	25	18	5213	12	12	9	3219	8	8	5

%a: refers to the proportion of available land that is suitable for barley cultivation under rainfall levels 50 mm above current values. %b: refers to the proportion of available land that is suitable for cereal cultivation (cereals intersect.) Table 7.6a) under rainfall levels 100 mm above current values. %c: refers to the proportion of available land that is suitable for cereal cultivation (cereals intersect.) Table 7.6a) under rainfall levels 175 mm above current values.

Table 7.8a (top), Table 7.8b (middle), Table 7.8c (bottom)

Total areas and proportions of moderately suitable land for pulse cultivation required to sustain different estimated population levels at LPPNB Basta, assuming that cultivated pulses contributed 30% of the community's total caloric needs. All percentages refer to the proportion of available land within either a 1.25 hour-walk (a), a 1.5 hour (b) and a 2 hour-walk (c) under rainfall levels 175 mm above current levels. It is only under these high rainfall levels that any of the available landscape is suitable for reliable pulse cultivation (see Tables 7.6a – 7.6c).

Table 7.8a: Assuming that Basta's extent was 8 ha

<i>Estimated population level</i>	2290		1117		689	
Rainfall level	area	%c	area	%c	area	%c
Moderately suitable land (pulses)						
...percentage within 1.25 hours	4691	10%	2288	5%	1411	3%
...within 1.5 hours	4691	7%	2288	3%	1411	2%
...within 2 hours	4691	3%	2288	2%	1411	1%

Table 7.8b: Assuming that Basta's extent was 9.8 ha

<i>Estimated population level</i>	2789		1360		839	
Rainfall level	area	%c	area	%c	area	%c
Moderately suitable land (pulses)						
...percentage within 1.25 hours	5713	12%	2786	6%	1718	3%
...within 1.5 hours	5713	9%	2786	4%	1718	3%
...within 2 hours	5713	5%	2786	3%	1718	2%

Table 7.8c: Assuming that Basta's extent was 11.1 ha

<i>Estimated population level</i>	3132		1527		943	
Rainfall level	area	%c	area	%c	area	%c
Moderately suitable land (pulses)						
...percentage within 1.25 hours	6415	13%	3128	6%	1932	4%
...within 1.5 hours	6415	10%	3128	5%	1932	3%
...within 2 hours	6415	6%	3128	3%	1932	2%

Table 7.10a (top), 7.10b (middle), and 7.10c (bottom)

Potential sheep / goat herd sizes for various population levels (note that only the three highest population estimates from Table 7.2 are evaluated), the area required to support them at different stocking rates, and the proportion of both the 'moderately' suitable land and 'all' land that this area represents within a 1.25 hour walk from the settlement. All areal values are in dunum (1000 m²).

Estimated population level:	If 20% caloric requirements were derived from domestic herds.								
	Under rainfall 50 mm above current levels (percentage of moderately suitable land for barley)								
	3132	%		2789	%		2290	%	
Number of animals required:	8577			5857					
Estimated total herd size *	19732			17571					
Area required at stocking rate of .25 ha / sheep or goat, or 4 animals ha ⁻¹ :	49329	117	72	43927	104	64	36068	86	53
or ...at stocking rate of .8 ha / sheep or goat, or 1.6 animals ha ⁻¹ :	123323	292	181	109817	260	161	90169	214	132
or ...at stocking rate of .8 ha / sheep or goat, or 1.25 animals ha ⁻¹ :	157853	374	231	140566	333	206	115416	274	169

...rainfall 100 mm above current levels (percentage of moderately suitable land for cereals)									
	3132	%		2789	%		2290	%	
Area required at stocking rate of .25 ha / sheep or goat, or 4 animals ha ⁻¹ :	49329	117	72	43927	105	64	36068	86	53
or ...at stocking rate of .8 ha / sheep or goat, or 1.6 animals ha ⁻¹ :	123323	294	181	109817	261	161	90169	215	132
or ...at stocking rate of .8 ha / sheep or goat, or 1.25 animals ha ⁻¹ :	157853	376	231	140566	335	206	115416	275	169

... rainfall 175 mm above current levels (percentage of moderately suitable land for cereals)									
	3132	%		2789	%		2290	%	
Area required at stocking rate of .25 ha / sheep or goat, or 4 animals ha ⁻¹ :	49329	82	72	43927	73	64	36068	60	53
or ...at stocking rate of .8 ha / sheep or goat, or 1.6 animals ha ⁻¹ :	123323	204	181	109817	182	161	90169	150	132
or ...at stocking rate of .8 ha / sheep or goat, or 1.25 animals ha ⁻¹ :	157853	262	231	140566	233	206	115416	191	169

Note: For the lower rainfall levels (blue series) and moderate rainfall levels (grey series) the percentage columns are first: proportion of moderately suitable land for barley cultivation in **bold**, second: proportion of all land (therefore all moderately and wholly inappropriate land for cultivation) in *italics*. For the higher rainfall levels (green series) the percentage columns are first: proportion of all moderately suitable land for all cereal cultivation; second: proportion of all land within the boundary established here. Refer to Table 7.6a for the areas and proportions of arable land on which these figures are based.

Table 7.10b

Potential sheep / goat herd sizes for various population levels (note that only the three highest population estimates from Table 7.2 are evaluated), the area required to support them at different stocking rates, and the proportion of both the 'moderately' suitable land and 'all' land that this area represents within a 1.5 hour-walk from the settlement. All areal values are in dunum (1000 m²).

Estimated population level:	If 20% of caloric requirements came from domestic sheep / goat herds.									
	Under current rainfall levels plus 50 mm (percentage of moderately suitable land for barley)									
	3132	%		2789	%		2290	%		
Number of animals required:	6577			5857						
Estimated total herd size *	19732			17571						
Area required at stocking rate of .25 ha / sheep or goat, or 4 animals ha ⁻¹ :	49329	88	<i>50</i>	43927	78	<i>44</i>	36068	64	<i>35</i>	
of ...at stocking rate of .6 ha / sheep or goat, or 1.6 animals ha ⁻¹ :	123323	220	<i>125</i>	109817	196	<i>111</i>	90169	161	<i>91</i>	
of ...at stocking rate of .8 ha / sheep or goat, or 1.25 animals ha ⁻¹ :	157853	281	<i>160</i>	140566	250	<i>142</i>	115416	206	<i>117</i>	

... current rainfall levels plus 100 mm (percentage of moderately suitable land for cereals)									
3132	%		2789	%		2290	%		
49329	88	<i>50</i>	43927	79	<i>44</i>	36068	65	<i>36</i>	
123323	221	<i>125</i>	109817	197	<i>111</i>	90169	162	<i>91</i>	
157853	283	<i>160</i>	140566	252	<i>142</i>	115416	207	<i>117</i>	

... current rainfall levels plus 175 mm (percentage of moderately suitable land for cereals)									
3132	%		2789	%		2290	%		
49329	56	<i>50</i>	43927	50	<i>44</i>	36068	41	<i>36</i>	
123323	140	<i>125</i>	109817	125	<i>111</i>	90169	103	<i>91</i>	
157853	179	<i>160</i>	140566	160	<i>142</i>	115416	131	<i>117</i>	

Note: For the lower rainfall levels (blue series) and moderate rainfall levels (grey series) the percentage columns are first: proportion of moderately suitable land for barley cultivation in **bold**, second: proportion of all land (therefore all moderately and wholly inappropriate land for cultivation) in *italics*. For the higher rainfall levels (green series) the percentage columns are first: proportion of all moderately suitable land for all cereal cultivation; second: proportion of all land within the boundary established here. Refer to Table 7.6a for the areas and proportions of arable land on which these figures are based.

Table 7.10c

Potential sheep / goat herd sizes for various population levels (note that only the three highest population estimates from Table 7.2 are evaluated), the area required to support them at different stocking rates, and the proportion of both the 'moderately' suitable land and 'all' land that this area represents within a 2 hour-walk from the settlement. All areal values are in dunum (1000 m²).

Estimated population level:	If 20% of caloric requirements came from domestic sheep / goat herds.								
	Under current rainfall levels plus 50 mm (percentage of moderately suitable land for barley)								
	3132	%		2789	%		2290	%	
Number of animals required:	6577			5857					
Estimated total herd size *	19732			17571					
Area required at stocking rate of .25 ha / sheep or goat, or 4 animals ha ⁻¹ :	49329	58	29	43927	52	26	36068	43	21
or ... at stocking rate of .6 ha / sheep or goat, or 1.6 animals ha ⁻¹ :	123323	146	72	109817	130	64	90169	107	53
or ... at stocking rate of .8 ha / sheep or goat, or 1.25 animals ha ⁻¹ :	157853	187	92	140566	167	82	115416	137	67

If 20% of caloric requirements came from domestic sheep / goat herds.									
... current rainfall levels plus 100 mm (percentage of moderately suitable land for cereals)									
	3132	%		2789	%		2290	%	
Area required at stocking rate of .25 ha / sheep or goat, or 4 animals ha ⁻¹ :	49329	59	29	43927	53	26	36068	43	21
or ... at stocking rate of .6 ha / sheep or goat, or 1.6 animals ha ⁻¹ :	123323	148	72	109817	131	64	90169	108	53
or ... at stocking rate of .8 ha / sheep or goat, or 1.25 animals ha ⁻¹ :	157853	189	92	140566	168	82	115416	138	67

If 20% of caloric requirements came from domestic sheep / goat herds.									
... current rainfall levels plus 175 mm (percentage of moderately suitable land for cereals)									
	3132	%		2789	%		2290	%	
Area required at stocking rate of .25 ha / sheep or goat, or 4 animals ha ⁻¹ :	49329	33	29	43927	30	26	36068	24	21
or ... at stocking rate of .6 ha / sheep or goat, or 1.6 animals ha ⁻¹ :	123323	83	72	109817	74	64	90169	61	53
or ... at stocking rate of .8 ha / sheep or goat, or 1.25 animals ha ⁻¹ :	157853	106	92	140566	95	82	115416	78	67

Note: For the lower rainfall levels (blue series) and moderate rainfall levels (grey series) the percentage columns are first: proportion of **moderately suitable land for barley cultivation** in bold, second: proportion of *all land* (therefore all moderately and wholly inappropriate land for cultivation) in italics. For the higher rainfall levels (green series) the percentage columns are first: proportion of **all moderately suitable land for all cereal cultivation**; second: proportion of *all land* within the boundary established here. Refer to Table 7.6a for the areas and proportions of arable land on which these figures are based.

Jericho

Table 8.1

Jericho population estimates in relation to different PPNB settlement extents.

Area	if... 2.7 ha	3.4 ha	4 ha
low *	235 people	292	344
mid-range**	380	474	558
high***	803	1000	1178

* based on a total site are of 116.3 m² per person; analogous to Tell i-Nun, southwest Iran (Jacobs, 1978).

** ...71.8 m² per person; analogous to Shahabad, central Iran (Kramer, 1979).

*** ...35 m² per person; analogous to Marib, north Yemen (van Beek, 1982).

Tables 8.5a (top, barley), 8.5b ('wheat'), 8.5c (lentil), 8.5d (field pea)
 Total areas for different suitability levels (4: ideally suitable, 3: moderately suitable, 2: unreliable, 1: unsuitable) surrounding Jericho, according to the ecological requirements of the main crop varieties, under rainfall levels 50 mm above current values. Proportions of land within a 1.25 hour walk from the site are highlighted in blue (according to the same format as the total suitability area tables for 'Ain Ghazal and Basta). All areas in dunum (1000 m²).

Suitable level	Barley					
	Within 10 km (Euclidean)		... 5 km (Euclidean)		... 1.25 hour walk	
	area	percent	area	percent	area	percent
4	55041.7	18%	15408.2	19%	10286.1	18%
3	132429.6	42%	49816.2	60%	37275.6	64%
2	49355.4	16%	6318.0	8%	5030.8	9%
1	77173.3	24%	11722.2	13%	6020.5	9%
total	314000		83264.6		58613	

Table 8.5b

Suitable level	Wheat					
	within 10 km (Euclidean)		... 5 km (Euclidean)		... 1.25 hour walk	
	area	percent	area	percent	area	percent
4	34501.1	11%	9641.5	12%	6422.6	11%
3	115240.4	37%	41010.4	49%	30424.6	52%
2	82456.6	26%	20884.5	25%	15738.7	27%
1	81801.9	26%	11728.2	14%	6027.1	10%

Table 8.5c

Suitable level	Lentil					
	within 10 km (Euclidean)		... 5 km (Euclidean)		... 1.25 hour walk	
	area	percent	area	percent	area	percent
4	36872.6	12%	10312.8	12%	6549.9	11%
3	153697.2	49%	46415.8	56%	31803.8	54%
2	82941.7	26%	22770.2	27%	17697.5	30%
1	40488.5	13%	3765.8	5%	2561.8	5%

Table 8.5d

Suitable level	Field Pea					
	within 10 km (Euclidean)		... 5 km (Euclidean)		... 1.25 hour walk	
	area	percent	area	percent	All values are the same as for Lentil	
4	35324.9	11%	10106.5	12%		
3	148598.9	47%	45612.9	55%		
2	89585.9	28%	23779.2	29%		
1	40490.3	14%	3766.0	4%		

Table 8.6

Total areas for 'ideally' and 'moderately' suitable land when areas for a) all four crops and b) cereals are combined. This refers to the suitability areas that overlap, therefore excludes any part of the landscape that was suitable to only one crop type. In other words, those areas of the map that intersect when placed over one another.

	Cereals intersect			
	Ideal (4)		Moderate (3)	
	all crops	just cereals	all crops	just cereals
10 km (Euclidean)	30626.8	34472.0	93892.7	94737.3
5 km (Euclidean)	9463.6	9635.9	34712.0	35261.0
5 km (1.25 hour walk from site)	6259.7	6418.4	26049.8	26571.8
Total area within 1.25 hours: 58613 dunum.				

Table 8.7a (above), 8.7b (below)

Total area of land required to support different estimated population levels at MPPNB Jericho, assuming an 80% cultivated cereal contribution to the diet (Table 8.7a, above), and 50% proportion (Table 8.7b, below). Areal amounts refer to both ideally or moderately suitable land required, and percentages are the proportion of land within a 1.25 hour walk from the settlement. All areas are in dunum.

<i>Estimated population level:</i>	If diet was 80% cultivated cereals, assuming rainfall levels 50 mm above current values.							
	2000		1500		700		300	
Ideally suitable land required	8193	37%	6145	27%	2868	13%	1229	6%
Moderately suitable land	12290	67%	9217	50%	4301	24%	1843	10%

<i>Estimated population level:</i>	...if diet was 50% cultivated cereals.							
	2000		1500		700		300	
Ideally suitable land required	5121	23%	3840	17%	1792	8%	768	3%
Moderately suitable land	7680	42%	5761	32%	2688	15%	1152	6%

Table 8.12a (above), **Table 8.12b** (below) Herds within a 1.25 hour walk from Jericho. Proposed herd sizes for different human population levels, the area required to support them at different stocking rates, and the proportion of moderately suitable 'pasture' that these figures represent (blue figures; the green figures represent the proportion of all land available within this distance); under a scenario where rainfall levels are 50 mm above current values. All areas are in dunum.

Table 8.12a

	If 20% of diet from herded sheep / goat		
	2000	1500	700
Estimated population level:			
Number of animals required:	4200	3150	1470
Estimated total herd size (number of animals required * 3)	12600	9450	4410
Area required (in dunum) at stocking rate of .25 ha / sheep or goat, or 4 animals ha ⁻¹			
or ... at stocking rate of .6 ha / sheep or goat, or 1.6 animals ha ⁻¹ ;	31500	23630	11030
or ... at stocking rate of .8 ha / sheep or goat, or 1.25 animals ha ⁻¹ ;	75600	56700	26460
	100800	75600	35280
		54%	40%
		121%	91%
		290%	218%
		387%	290%
			42%
			19%
			45%
			60%

Table 8.12b

	If 10% herded sheep / goat diet, the remainder of required calories from hunted animals		
	2000	1500	700
Estimated population level:			
Number of animals required:	2100	1575	735
Estimated total herd size (number of animals required * 3)	6300	4725	2205
Area required (in dunum) at stocking rate of .25 ha / sheep or goat, or 4 animals ha ⁻¹			
or ... at stocking rate of .6 ha / sheep or goat, or 1.6 animals ha ⁻¹ ;	15750	11810	5510
or ... at stocking rate of .8 ha / sheep or goat, or 1.25 animals ha ⁻¹ ;	37800	28530	13230
	50400	37800	17640
		27%	20%
		60%	45%
		145%	110%
		193%	146%
			21%
			9%
			51%
			68%
			30%

Appendix 5: Knapped Stone Finds from al-Khayran

Category	Type	Top Layer	Phase 02: Floor Clearing	Deposits between Phases	Phase 01: Floor Clearing	Type Total	Category Total
Cores							20
	Unused Naviform Core	0	0	0	1	1	
	Exhausted Naviform Core	19	0	0	0	19	
Hammer Stones							10
	Rounded Cobble Hammer Stone	6	2	0	2	10	
Direct Core Shaping							3614
	Cortical Flakes	1326	0	2	0	1328	
	Flakes	1850	0	6	3	1859	
	Chips	427	0	0	0	427	
Indirect Core Shaping							653
	Cortical Chunks	260	0	1	1	262	
	Chunks	391	0	0	0	391	
Core Preparation							154
	Back Trimming Flakes	37	0	0	0	37	
	Crested Blade/Ridge Removal	71	0	0	1	72	
	Other Platform Production Spall	11	0	0	0	11	
	Other Façade Production Spall	33	0	0	1	34	
Tool Blank							1365
	Blades	689	0	1	19	709	
	Cortical Blades	167	0	1	4	172	
	Bipolar Blades	415	0	3	14	432	
	Cortical Bipolar Blades	51	0	0	1	52	
Core Maintenance							186
	Hinge Removal	69	0	0	1	70	

	Other Façade Maintenance	103	0	0	2	105	
	Platform Rejuvenation	11	0	0	0	11	
Tool Production							5
	Burination	5	0	0	0	5	
Informal Tools							793
	Retouched Flake	11	0	0	0	11	
	Side Retouched Blade	120	0	0	1	121	
	End Retouched Blade	13	0	0	0	13	
	Use-Wear Flake	95	0	0	0	95	
	Side Use-Wear Blade	420	0	0	12	432	
	Side and End Use-Wear Blade	52	0	0	0	52	
	End Use-Wear Blade	13	0	0	0	13	
	Sickle Blade	47	0	0	6	53	
	Denticulate Blade	3	0	0	0	3	
Formal Tools							45
	Lunate	1	0	0	0	1	
	el-Khiam	2	0	0	0	2	
	Helwan	7	0	0	0	7	
	Byblos	1	0	0	0	1	
	Jericho	1	0	0	0	1	
	A45	9	0	0	1	10	
	Nahal Hemar Knife	0	0	0	1	1	
	Burin	3	0	0	0	3	
	Perforators	19	0	0	0	19	
Total							6845

Appendix 6: Resource Locations for al-Khayran

al-Khayran Local Catchment Resource Location		
	Latitude	Longitude
Cultural Resources		
al-Khayran	31.157539°	35.598147°
Midden Deposit	31.139114°	35.622667°
Water Sources		
al-Khayran Seep	31.156881°	35.598275°
SP-01	31.157047°	35.604616°
SP-02	31.153636°	35.603830°
SP-03	31.147906°	35.616922°
SP-04	31.144697°	35.621705°
SP-05	31.143636°	35.623731°
SP-06	31.140853°	35.621297°
SP-07	31.139992°	35.624372°
SP-08	31.140190°	35.626446°
SP-09	31.136614°	35.623972°
SP-10	31.128769°	35.636975°
SP-11	31.134633°	35.644642°
SP-12	31.147997°	35.626181°
SP-13	31.149231°	35.632547°
SP-14	31.153608°	35.628942°
SP-15	31.150494°	35.638494°
SP-16	31.157919°	35.642689°
SP-17	31.157689°	35.648767°
SP-18	31.176806°	35.628411°
SP-19	31.180806°	35.625317°
SP-20	31.180664°	35.618319°
Flint Sources		
FS-01	31.156139°	35.599031°
FS-02	31.186606°	35.549628°
FS-03	31.133178°	35.611186°
FS-04	31.212094°	35.615358°
al-Khayran Regional Catchment Resource Location		
	Latitude	Longitude
Cultural Resources		
al-Khayran	31.157539°	35.598147°
el-Hemmeh	30.966667°	35.731111°

es-Sifiye	31.438803°	35.825406°
Khirbat al-Hammam	30.983494°	35.666561°
Wadi Hamarash 1	31.014692°	35.542139°
Basalt Sources		
BA-01	30.973233°	35.730283°
BA-02	31.216019°	35.840919°
Bitumen Sources		
BI-01	31.166000°	35.544311°
BI-02	31.188847°	35.544008°
BI-03	31.270967°	35.540481°
BI-04	31.448764°	35.582742°

Appendix 7: Phytolith Report, Prepared by Sarah Elliott

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AL-KHAYRAN EXCAVATIONS, WEST CENTRAL JORDAN: PHYTOLITH ANALYSIS REPORT

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INTRODUCTION

This report summarises the findings of the phytolith analysis undertaken by Quaternary Scientific (University of Reading) in connection with archaeological excavations at the Pre-Pottery Neolithic B (PPNB) site of al-Khayran in West-Central Jordan. The lithic assemblages suggest that the site is likely to be dated to the earlier portion of the middle PPNB, however the architecture suggests late middle PPNB or even late PPNB, radiocarbon dating of the site is on-going. Three sediment samples were taken and submitted for phytolith extraction and analysis. The site itself has been heavily damaged, with the second phase being less than 10cms below the present day ground surface. This ground surface has recently been used as a farm field and has occasionally undergone plough-based agriculture. The site itself is small and was not very intensively occupied in the Neolithic. Excavators have suggested the site being a seasonal field house or possibly a single nuclear family. Features such as hearths and storage bins which are seen on other Neolithic sites in the area are not present at al-Khayran. Two of the samples came from the refuse piles abutting the solitary structure on the site, which are a mixture of the remains from the first and second phase of this structure. The third comes from a very well cleaned floor on the inside of the first phase of the structure with virtually no refuse on it (Table 1).

Table 1: Samples details, al-Khayran, West-Central Jordan

Sample	Context	Description
<D13 C4 Level 2>	008	Trash and cobble mix North of Eastern Phase 002 Wall
<D12 C2-3 Level 2>	010	Trash and cobble mix east of Eastern phase 001 wall
<D12 B2 Floor>	7	On floor

METHODS

An introduction to Phytoliths

Phytoliths form within a plant in a number of different locations, conforming to cell shape or intercellular spaces (Rovner, 1983). Phytoliths can be identified to specific parts of plants; stems, leaves or husks. Differential parts are not represented from macrobotanical remains. Phytolith deposition is archaeologically important due to their preservation properties and representation of plant use/exploitation in the immediate area within a wide range of contexts (Rovner, 1983). Phytoliths make an important contribution to the archaeological record because other plant remains often only survive once charred. Monocotyledons (monocots) and dicotyledons (dicots) can both be identified by their phytolith assemblages. Monocotyledons are a group of plants, which include grasses, whose seed has the embryo of one flowering leaf, whereas dicotyledons ('woody types' such as shrubs and trees) have the embryos of two flowering leaves (Jenkins and Rosen, 2007). Any given species of grass produces a wide array of morphologically distinct types (Rovner, 1983). On the other hand dicots do not produce uniquely shaped phytoliths (Tsartsidou *et al.*, 2007). It is important to bear in mind when analysing assemblages that grasses (monocots) produce on average twenty times more phytoliths than dicotyledons (Albert *et al.*, 2002).

Grasses produce phytoliths, which are morphologically distinct to a certain family and can be categorised into C4 and C3 species. This enables the analyst to make an inference about climate. At high temperatures and relatively low CO₂ concentrations (e.g. high light environments, therefore warm, humid climates), plants can most efficiently fix carbon to form carbohydrates through C4 photosynthesis rather than through the ancestral and more widespread C3 pathway (moist, wet conditions in well-watered habitats - they are inefficient at using water; Vicentini *et al.*, 2008). These phytoliths which help enable the identification of different species of grass and can give us more detail about the vegetation and climate are short celled phytoliths. The shapes of the individual opal phytoliths from grasses are indicators of C3 and C4 photosynthetic pathways (Twiss, 1992). Bilobes most frequently form in panicoid grasses (C4 grasses), which prefer warm and humid climates (Twiss, 1992; Barboni *et al.*, 1999). Rondels most frequently form in pooid grasses (C3 grasses), and they prefer moist and wet environments (Barboni *et al.*, 1999). The poideae include cereal grains; barley, rye, oats and wheat (Twiss, 1992).

The two different photosynthetic pathways in grasses is the same as all higher plants are: (1) the three carbon photosynthetic pathways (the Calvin-Benson Cycle) and (2) the four photosynthetic pathway (the Hatch-Slack Cycle; Twiss 2001). These two different pathways convert carbon dioxide, and the different pathways result in significant physiological and anatomical difference, and are referred to as C3 and C4 grasses. The C3 and C4 photosynthetic pathways tend strongly to have different numbers and shapes of short celled phytoliths and indicate different environments of growth (Piperno 1988). Therefore depending on which phytoliths are found in the samples it is possible to infer which pathways they came from and subsequently which type of environment they may originate from.

Phytolith analysis

The three samples were processed in the Geoscience Building, University of Reading using the following methodology:

1. Each sample was screened through a 0.5 mm mesh to remove any coarse sized particles.
2. Approximately one gram of dried raw sediment was weighed out.
3. Calcium carbonates were dissolved using a dilution of 10% hydrochloric acid and then washed in distilled water three times.
4. Clay was removed using a settling procedure and sodium hexametaphosphate (Calgon) as a dispersant. Distilled water was added and the samples left for seventy-five minutes before pouring off the suspense. This was repeated at hourly intervals until the samples were clear. Samples were then transferred into crucibles and left to dry at a temperature of less than 50 °C.
5. After drying, samples were placed in a muffle furnace for two hours at 500 °C to remove organic matter.
6. Phytoliths were then separated from the remaining material using a heavy liquid calibrated to a specific gravity of 2.3. Phytoliths were transferred to centrifuge tubes and washed three times in distilled water. They were then placed in small Pyrex beakers and left to dry.
7. Approximately two milligrams of phytoliths per sample were mounted onto microscope slides, using the mounting agent Entellan.
8. Microscope slides were examined under a Leica DMEP transmitted light microscope at magnifications ranging from x 200 to x 400. Full counts were attained by counting a minimum of 200 identifiable phytoliths (where applicable). The phytoliths were counted and categorised into types. Phytoliths were further classified as deriving either from woody (dicotyledon) or non-

woody (monocotyledon) taxa. The stems and leaves of all monocots produce smooth long cells, the dendritic long cells come from the husks of plants. Making a comparison between smooth long cells and dendritic long cells can give an indication of crop processing. Platey and sheet phytoliths are a common type of phytolith found in most species of dicots (shrubs and trees). Multi-cells enable identification to genus level (e.g. *Hordeum*, *Tritium*, *Avena*).

9. The results are based on a full count and scan; a minimum count of two hundred phytoliths per slide (where applicable) was carried out. Count size, the number of phytolith specimens tallied on a slide, is the last in the long series of steps of sub-sampling that occurs when a soil assemblage or a plant sample is processed and analyzed for phytoliths (Strömberg 2009). An insufficient phytolith count can result in misrepresentation of plant assemblage per sample. Various studies have been carried out to date on sufficient numbers of phytoliths counted to accurately represent the phytolith assemblage (Ball *et al.* 1996 and 1999, Pearsall and Piperno 1990, Piperno 2006, Albert and Weiner 2001). Hundreds, thousands and sometimes millions of phytoliths can be produced per sample; to count all would not be advisable or realistic. Therefore the most common value lies between 200 and 400 phytoliths counted per slide (e.g. Alexandre *et al.* 1997; Carter 2000; Blinnikov *et al.* 2002). In addition to a minimum count of 200 phytoliths (at x400 magnification) a scan is carried out at a magnification of x200 to look for rare morphotypes and to count the multicelled conjoined phytoliths.

RESULTS AND INTERPRETATION OF THE PHYTOLITH ANALYSIS

The results of the phytolith analysis (Table 2) suggest that phytoliths were poorly preserved across all three samples analysed; indeed, the majority of each slide had to be studied to reach a minimum count of 200 phytoliths. In order of concentration, the sample from <D12 C2-3 Level 2> had the least phytoliths, whilst the sample from <D12 B2 Floor> had the most phytoliths. All three samples yielded similar results, with the three most prevalent types of phytoliths being plateys, sheets and smooth elongates (smooth long cells).

All samples are characterised by high concentrations of dicotyledon (ca. 80-85%) phytoliths, and lower concentrations of monocotyledons (ca. 10-15%), with the highest values of monocotyledons recorded in the sample from <D12 C2-3 Level 2> (Table 2; Figure 1). Considering that monocotyledons can produce up to 20 times more phytoliths than dicotyledons, this assemblage suggests an overwhelming dominance of woody material in these contexts. However, it must be

highlighted that the low quantity of monocots could be due to differential preservation of remains within the samples.

Each sample is dominated by platey phytoliths which are a common type of phytolith found in most species of dicots (shrubs and trees). Also of interest are the presence of a low concentration of: (1) short celled rondel phytoliths which are produced in the leaves and stems of C3 pooidae grasses, and are adapted to more temperate climates (Jenkins and Rosen 2007), and (2) bulliform and keystone phytoliths which frequently form in reeds (Jenkins and Rosen 2007); (Table 3).

Finally, the low numbers of common phytoliths such as hair/trichomes, in combination with the presence of degraded remains suggest poor preservation on the site. Phytolith surfaces become pitted as they degrade, an occurrence often consequent of wind damage/exposure at a site. In addition, some of the phytoliths identified have occluded carbon centres, this darkening represents burning of the phytoliths. Figures 3 to 5 illustrate selected phytoliths recorded in the three samples from al-Khayran.

Table 2: Phytolith analysis, al-Khayran, West-Central Jordan

	<D12 C2-3 Level 2> Trash and Cobble Mix	<D12 B2 Floor> On Floor	<D13 C4 Level 2> Trash and Cobble mix
SINGLE CELLED PHYTOLITHS			
Monocotyledons			
bulliform	4	12	9
hair/trichome		1	2
keystone	4	4	3
long sinuate	5		
long smooth	40	10	19
rondel	3	2	1
Dicotyledons			
platey	135	132	134
globular granulate		2	2
sheet	39	26	21
silica aggregate	44	2	17
smooth globular	8		
Block	3	7	2
Total Counted:	285	198	210
MULTI-CELLED PHYTOLITHS			
leaf/stem (monocot)	1	1	2
polyhedron (dicot)			1
Burnt	13	8	2
Degraded	8	17	11
Rows counted	19	8	12
Rows scanned	0	8	0
Total rows available	19	16	12

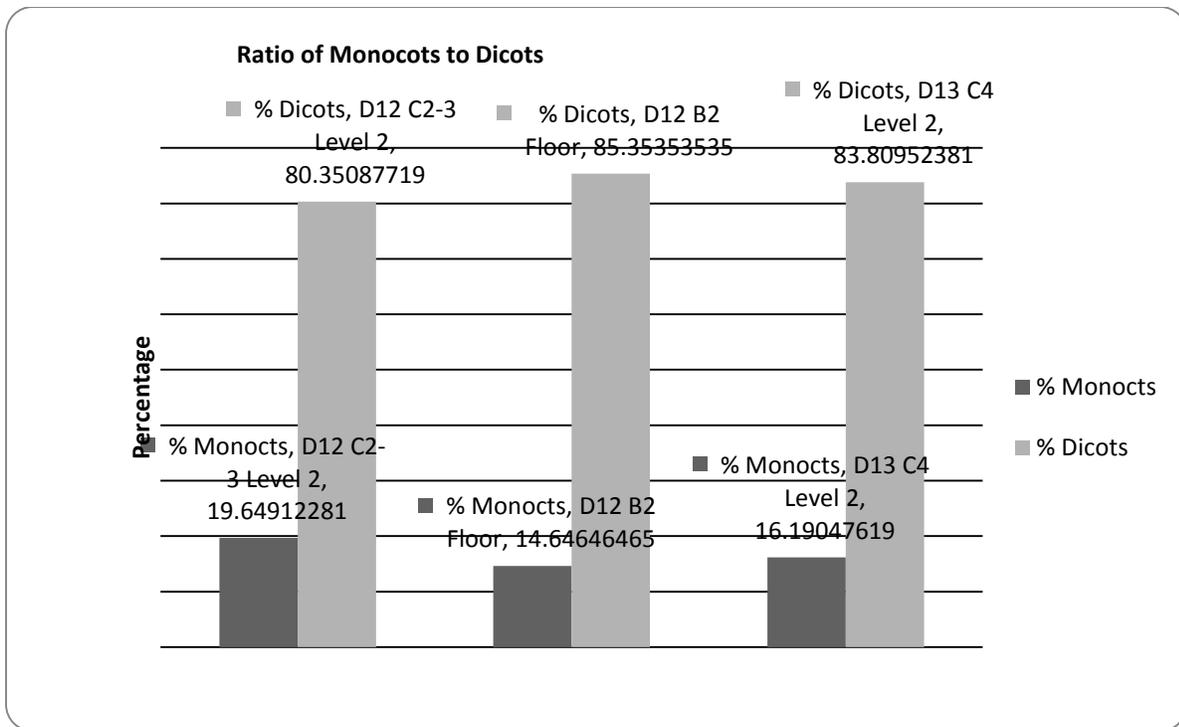
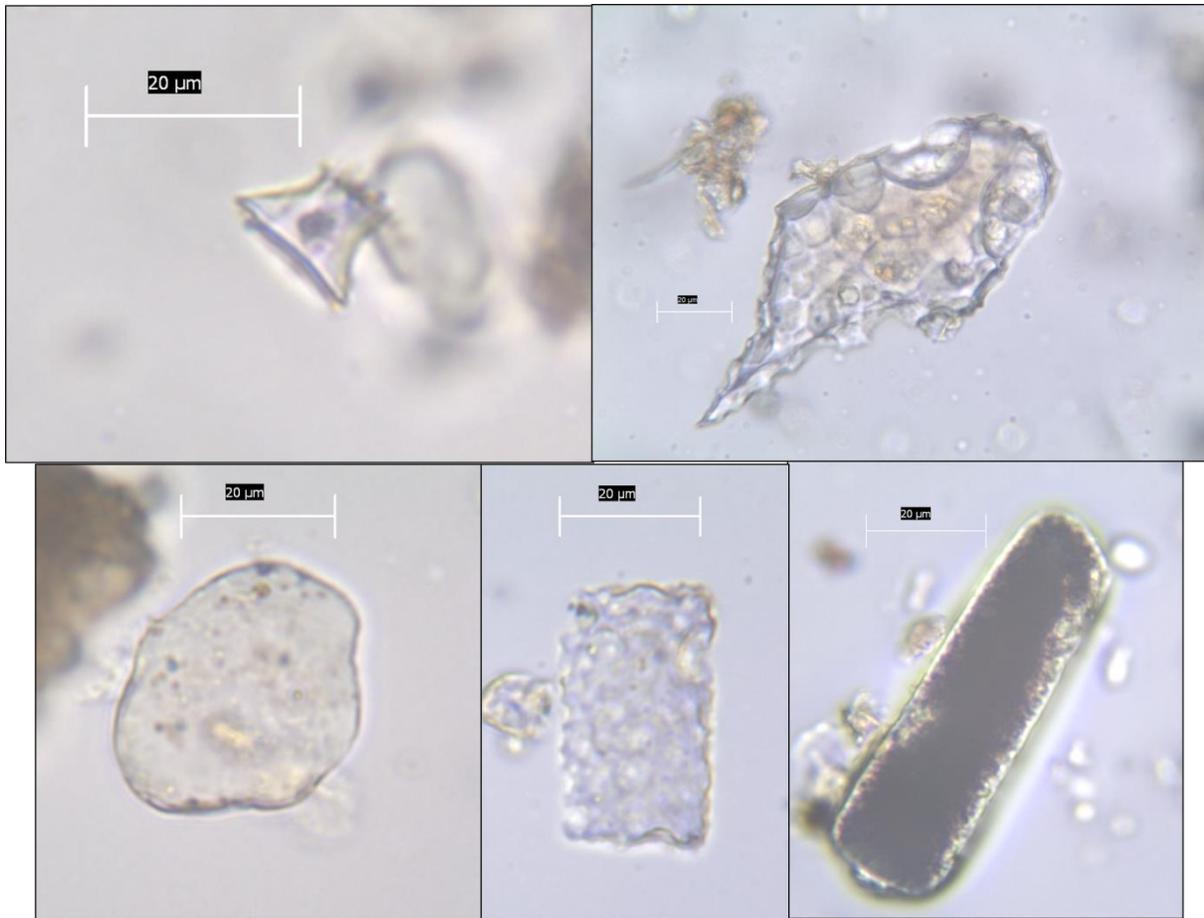


Figure 2: Ratio of single celled phytoliths from Monocotyledons and Dicotyledons, al-Khayran

Table 3: Phytolith analysis, al-Khayran, West-Central Jordan

	<D12 C2-3 Level 2> Trash and Cobble Mix	<D12 B2 Floor> On Floor	<D13 C4 Level 2> Trash and Cobble mix
Rondel	3	2	1
Bulliform	4	12	9
Keystone	4	4	3
Total Phytoliths Counted:	285	198	210



Key:

Top left: Rondel

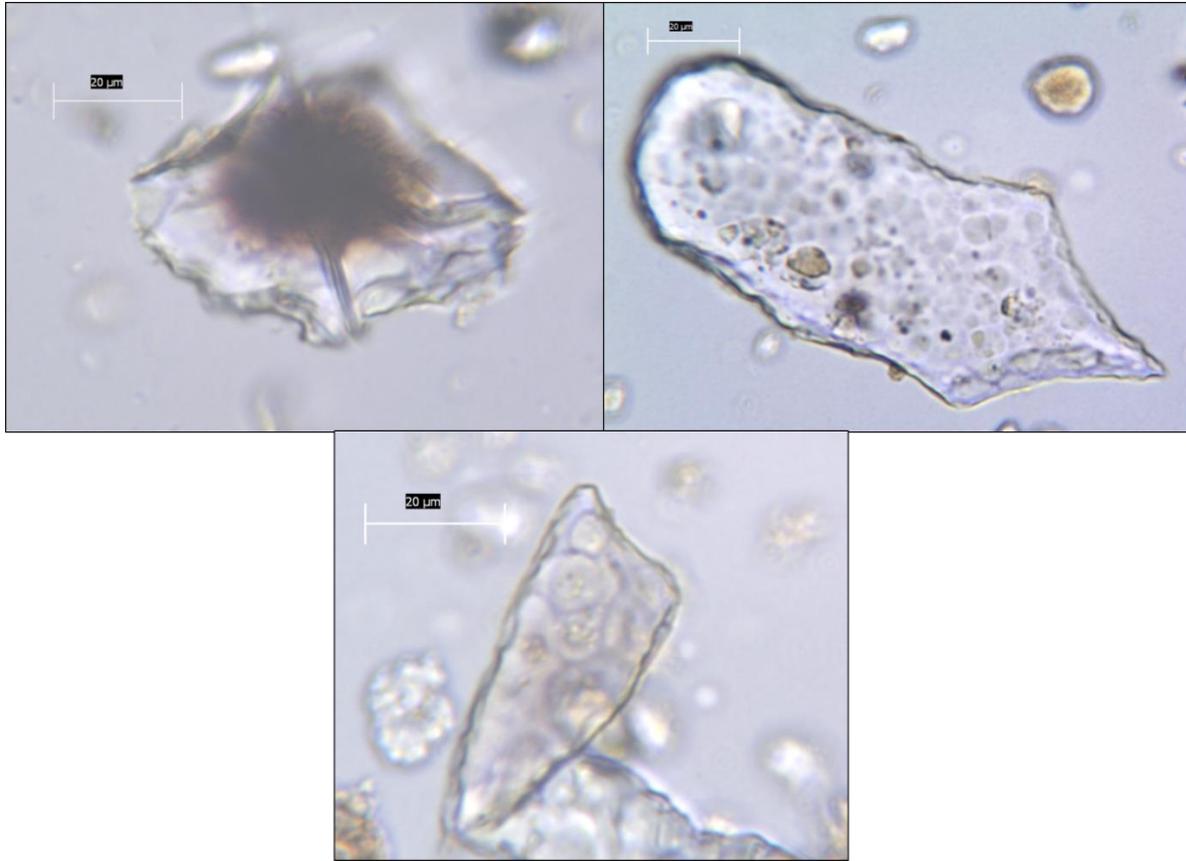
Top right: Degraded keystone

Bottom left: Platey

Bottom middle: degraded smooth elongate

Bottom right: Burnt smooth elongate

Figure 3: Phytoliths from sample <D12 C2-3 Level 2>



Key:

Top left: Burnt and Degraded bulliform

Top right: Degraded keystone

Bottom: Degraded trichome

Figure 4: Phytoliths from sample <D12 B2 Floor>



Key:

Top left: Rondel

Top right: Burnt leaf/stem multicell

Bottom left: Degraded Keystone

Bottom right: Smooth elongate

Figure 5: Phytoliths from sample <D13 C4 Level 2>

DISCUSSION AND CONCLUSIONS

The results of the analysis have indicated that phytoliths were only preserved in low concentrations at the site. Samples from other studied sites in the region such as: (1) the PPNA excavations at WF16, (2) the PPNB excavations at Ghuwayr 1, and (3) the Pottery Neolithic site of Tell Wadi Feinan have been much higher in concentration by comparison (Elliott, 2008).

The overall trend exhibited from the three samples indicates the dominance of trees/shrubs either in the vicinity of the site or directly deposited into these contexts. The results of the analysis are similar those of two previous investigations carried out at the PPNA site of WF16 in Southern Jordan, Wadi Faynan (Jenkins and Rosen 2007, Elliott, 2008). However, these results compared to results from the PPNB site of Ghuwayr 1 and the Pottery Neolithic site of Tell Wadi Feinan show marked differences. The concentration of phytoliths in samples from these latter sites is much higher than those from al-Khayran. In addition, the phytolith signatures from Ghuwayr 1 and Tell Wadi Feinan are dominated by monocotyledon phytoliths, and include the presence of multicelled phytoliths from cereals, specifically *Hordeum* (barley).

The difference in the phytolith concentration produced between the sites in Wadi Faynan (i.e. Ghuwayr 1 and Tell Wadi Feinan) and the new site of al-Khayran might be attributed to variations in preservation conditions. This is indicated by the frequent presence of degraded edges and pitted surfaces exhibited on the phytoliths from al-Khayran, in comparison to the good preservation recorded at the other sites. In addition, different phytolith types are known to degrade at varying rates; for example hair/trichome phytoliths, are nearly absent from the al-Khayran samples. The new site has been described as being heavily damaged, with occupation being very close to the modern surface, and today the site represents a modern farm field, occasionally utilised in plough-based agriculture. This utilisation is in contrast to the other sites discussed, which have not undergone any major form of activity since the date of the archaeology itself.

There are further potential reasons for the difference in concentration/preservation and assemblage between the new and previous sites. The first is the size of the former occupations. The sites of WF16, Ghuwayr 1 and Tell Wadi Feinan can be described as 'village' whereas the new samples from al-Khayran were from deposits that were not intensively occupied; indeed it has been suggested that the structure was a seasonal field house for a single nuclear family. The second consideration is the type of context from which the samples were taken. It has been demonstrated that archaeological contexts such as burnt deposits, storage areas, feature fills and

hearths, produce higher percentages of phytoliths (Jenkins *et al.*, in prep). Such contexts were not present at al-Khayran, and the samples were instead taken from refuse piles abutting the solitary structure (a mixture of remains from the first and second phase of the structure) and from a well cleaned floor surface.

It was noted in the results and interpretation of the analysis, that the sample from the floor (<D12 B2 Floor>) contained a higher concentration of remains than the other two samples. This may be because the floor surface (and therefore phytoliths in the sample) was protected by the material that collapsed in onto it, whilst the two samples from the refuse area were from an unprotected area, open to degradation and erosion. If this is the case, the floor sample would contain a better representation of the phytolith assemblage from the Neolithic plants, and thus a better representation of the plant activity and surrounding environment. Alternatively the higher concentration in the floor sample could suggest a higher concentration of plant material inside the house, perhaps including fuel, bedding and/or food, whilst the lower concentrations in the two refuse samples could be due to efficient use of plant materials.

The low concentration of phytoliths from C3 grasses (which are inefficient at using water; Vicentini *et al* 2008), in combination with the presence of bulliform and keystone phytoliths (indicative of the growth of reeds), strongly suggests the presence of a wet well-watered habitat. Indeed, as all three samples contained short celled rondel phytoliths, it can be inferred that the C3 pooidae grasses were growing within the vicinity of the site, and were probably the dominant grass type growing in a more temperate environment.

Many of the reed phytoliths show signs of being burnt. Some archaeologists argue that these darkened phytoliths provide evidence of fire histories (Parr, 2006) and that direct contact with fire induces darkening (charring; Piperno 1988, Kealhofer 2003). However, it is also recognised that some species are known to possess these properties naturally (e.g. Myrtaceae species and some Poaceae), although there are marked differences between the naturally dark phytoliths and phytoliths darkened by burning; naturally occurring colours have a transparent and opalescent appearance as opposed to the dull opaque finish of charred phytoliths (Parr 2006). The identified phytoliths do appear to exhibit the characteristics of burning as opposed to natural discolouration, but unfortunately there are not enough darkened phytoliths present to positively identify local burning of plant material. The relatively low abundance of burnt phytoliths could possibly suggest

burning adjacent to the site, or within the local vicinity, or perhaps represent fragments of burnt remains from a hearth or fire rather than a burnt deposit itself.

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Appendix 8: Macro-Botanical Report, Prepared by Chantel White

AL-KHAYRAN MACROBOTANICAL ANALYSIS REPORT

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Introduction

During the 2010 field season at al-Khayran, 14 flotation samples were processed for the recovery of charred macrobotanical remains. Preliminary analysis of the samples revealed a high charcoal fragmentation rate and poor preservation within the light fraction. A total of 39 liters of sediment was floated and analyzed, yielding wood charcoal fragments, carbonized seed fragments, *Lithospermum tenuiflorum* nutlets, and modern plant material.

The archaeological sediment samples were floated from three main contexts at alKhayran: the deposits overlaying the Phase 002 floor, the trash and cobble mix located north of the eastern Phase 002 wall, and the trash and cobble mix located east of the eastern Phase 001 wall (Table 1). While these samples contained very little in terms of identifiable plant remains, the context that yielded the highest number of archaeological charcoal was the trash and cobble mix north of the eastern Phase 002 wall (lab number AK-10-02). Here, 37 fragments of archaeological wood charcoal and one cereal grain fragment were recovered. Unfortunately, their high level of fragmentation and calcitic surface coatings made further identification impossible. The poor macrobotanical preservation at the site can be attributed to both the site's close proximity to the current ground surface and the local alkaline soil conditions, discussed in more detail in the *Taphonomy and Interpretation* section.

Lab No.	AK-10-01	AK-10-02	AK-10-03	AK-10-04	AK-10-05
Flot Nos.	001, 002	003, 004, 005	006, 007, 008	009, 010, 011	012, 013, 014
Area & Unit	B D12	B D13	B D12	B D12	B D12
Square	a1	c4	c2-3	a2	b2
Level	1	2	2	1	1
Elev. (masl)	745.31-745.23	745.27-745.27	745.44-745.36	745.46-745.41	745.44-745.40
Context	015	008	010	015	015
Volume (l)	5.5	7	7.5	9.5	9.5
HF char.	N	N	N	Y	N
Context	Deposits over Phase 002 floor	Trash and cobble mix north of eastern	Trash and cobble mix east of eastern	Deposits over Phase 002 floor	Deposits over Phase 002 floor

		Phase 002 wall	Phase 001 wall		
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Table 1. Assal-Dhra' Archaeological Project, al-Khayran Excavations, macrobotanical sample details.

Methods

The flotation samples were processed in Jordan post-excavation by site director Matthew Kroot, and the heavy fraction was then preliminarily sorted in the field. The collected light fraction samples (and wood charcoal present in the heavy fraction) were shipped to the Paleoethnobotany Laboratory at Boston University, USA, for microscopic analysis. Fourteen light fraction samples were examined using a Leica stereozoom microscope at magnifications of x10-x30. Samples with identical contextual information were combined together and received a unique lab sample number (e.g., AK-10-01, etc.) (Table 2). Samples were weighed and then sub-divided into >2 mm, 2>x>1 mm, 1>x>0.5 mm, and <0.5 mm fractions for microscopic analysis. When it became apparent that nearly all archaeological charcoal was present in the small 1>x>0.5 mm and <0.5 mm fractions, these became the primary focus of the analysis. Microphotographs of archaeological specimens were taken at x10-x50 using the Leica Microsystems' Digital Camera and Application Suite.

Results

Charcoal preservation at al-Khayran was found to be exceptionally poor (Table 2). The light fraction samples consisted primarily of modern botanical material, specifically rootlets, stems, and some modern seeds. Identified modern seed specimens included *Aizoon hispanicum*, *Heliotropium* sp., *Neslia apiculata*, and seed pod fragments from the Fabaceae (legume) family. These plant species are found as common components of shrub-steppe vegetation and have a wide distribution across west-central Jordan (Zohary 1973). Modern plant collection around al-Khayran, conducted by the ADAP team in 2007, also indicated a local prevalence of *Artemisia herba-alba* plants. However, the seeds produced by this species are exceedingly small and are unlikely to have been recovered during flotation efforts.

Insects including ants, beetles, and larvae were very common in the samples. The most ubiquitous were the remains of ants, particularly carapaces, eggs, and fecal matter. Recent work by Borojevic (2011) has shown that modern ants (i.e., *Messor* sp.) transport carbonized plant material both vertically and horizontally in archaeological contexts, and their presence in flotation samples can indicate potential stratigraphic mixing.

Additional modern material in the al-Khayran samples included modern charcoal, identified by the lack of a calcitic surface coating and fresh, sharp edges, as well as frequently incomplete carbonization (Figure 1). These modern charcoal remains were most likely accumulated from the activities of local Bedouin around the site. Temporary hearths are often built and used for daily tea nearby (personal observation), and a seasonal Bedouin encampment is close proximity to the excavation area. Additionally, the ground surface overlying the site has been ploughed for agricultural purposes in recent history, serving to further mix these archaeological contexts located in the plough zone.

AK-10-01

In the combined 001 and 002 flotation samples processed from the deposits overlaying the Phase 002 floor, 12.56 g of light fraction material was recovered. The majority of this material was modern in origin, yielding just three specimens of archaeological charcoal with a total weight of 0.003 g (Figure 2). Each of the wood specimens was very fragmented and at least partially covered by a calcitic surface coating.

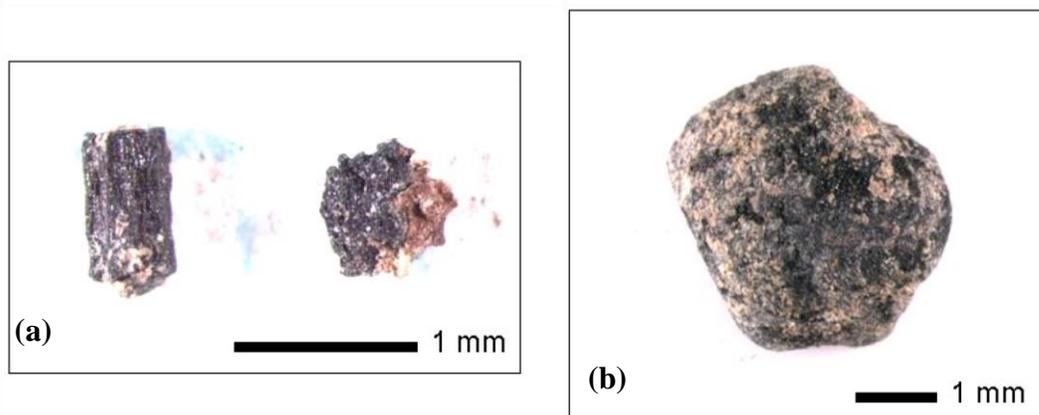


Figure 1. Modern and archaeological wood charcoal preservation. (a) On the left, modern wood with fresh edges and, on the right, archaeological wood with abraded edges and adhering calcitic concretion (AK-10-03). (b) Archaeological wood specimen with heavily abraded edges and calcitic coating (AK-10-04).

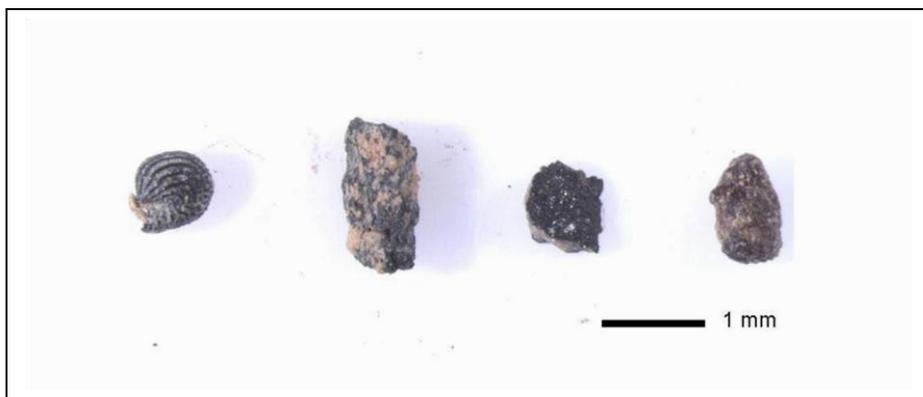


Figure 2. AK-10-01. Left to right: modern *Aizoon hispanicum*, and three pieces of archaeological wood charcoal. The second from right has been recently fragmented (hence the fresh break lacking a calcitic coating), although the internal cell structure has partially mineralized and is unidentifiable.

AK-10-02

This sample from the trash and cobble mix north of the eastern Phase 002 wall is comprised of the 003, 004, and 005 flotation samples. This context yielded the highest number of archaeological charcoal specimens at the site, although preservation levels remained poor. Of the 26.22 g of light fraction processed, archaeological charcoal was represented by just 0.035 g. Thirty-seven highly fragmented wood charcoal specimens were identified in the 0.5 mm sub-fraction, along with one cereal grain fragment. The cereal grain too was highly fragmented, and

this positive identification was based on the microscopic charred cell structure (i.e., a glassy, bubbled appearance) of the specimen (Figure 3). Additionally, a *Lithospermum tenuiflorum* nutlet was recovered which may be of archaeological origin (Figure 4). It appeared to have a partial calcitic coating on its surface.

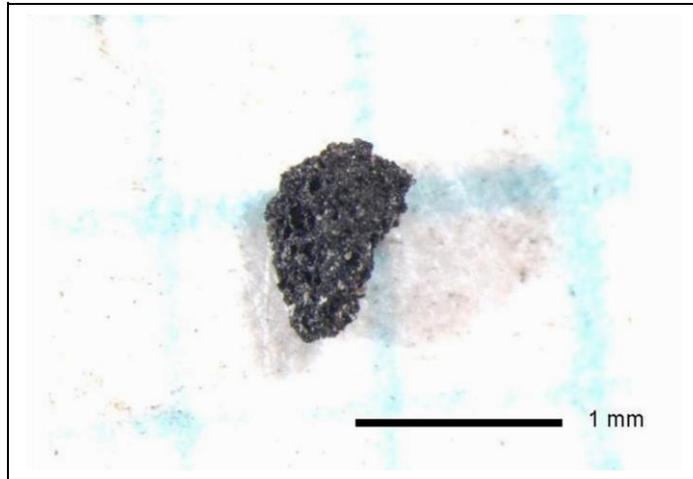


Figure 3. AK-10-02. Cereal grain fragment lacking testa and diagnostic features.

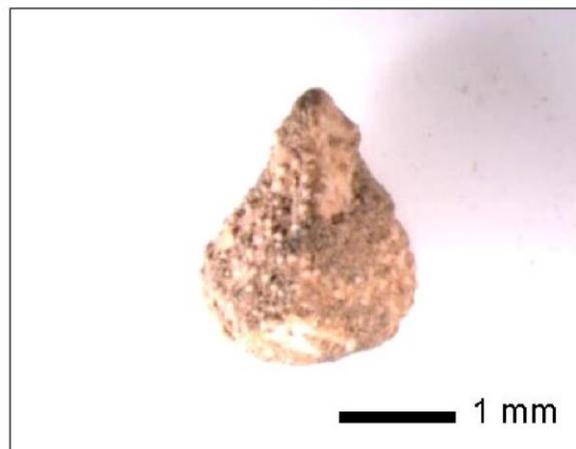


Figure 4. A *Lithospermum tenuiflorum* nutlet with adhering calcitic coating (AK-10-02).

AK-10-03

Sampled from the trash and cobble mix east of eastern Phase 001 wall, this assemblage is comprised of flotation samples 006, 007, and 008. Four modern seeds of *Neslia apiculata* were identified in this sample, as well as one piece of modern charcoal. Of the 22.18 g of light fraction processed, just 0.003 g was archaeological plant material. These remains included three pieces of wood charcoal (one in the 1 mm sub-fraction, and two in the 0.5 mm sub-fraction), as well as two seed fragments (in 0.5 mm sub-fraction) (Figure 5). The seed fragments did not possess the ‘bubbly’ appearance of a cereal grain structure and could not be further differentiated.

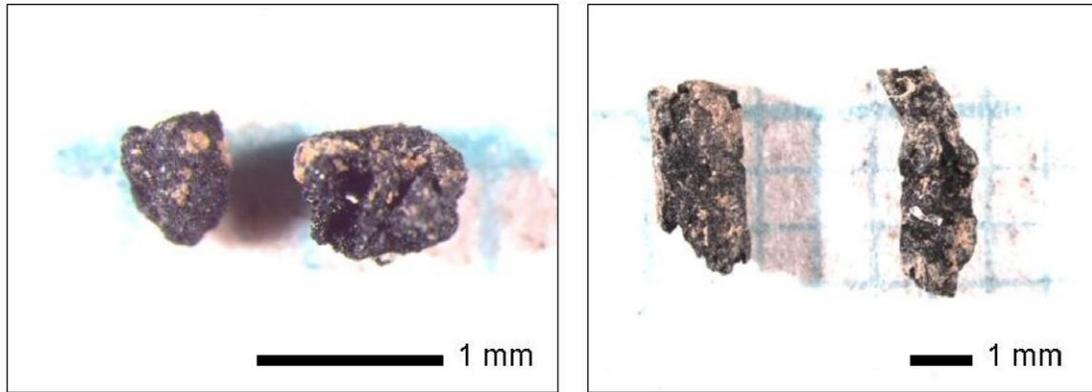


Figure 5. AK-10-03. Left: two seed fragments; right: two wood charcoal specimens.

Lab No.	AK-10-01	AK-10-02	AK-10-03	AK-10-04	Ak-10-05
Flot. Nos.	001, 002	003, 004, 005	006, 007, 008	009, 010, 011	012, 013, 014
Total Liters	5.5	7	7.5	9.5	9.5
LF Wt. (g)	12.56	26.22	22.18	10.96	
Modern wood and roots	Rootlets, modern charcoal	Rootlets, modern charcoal	Rootlets, modern charcoal	Rootlets, modern charcoal	Rootlets, modern charcoal
Modern identified seeds	<i>Aizoon hispanicum</i>	<i>Aizoon hispanicum</i> , <i>Heliotropium</i> sp., legume pod frag.	<i>Neslia apiculata</i>	--	--
Modern insect remains	Ant (<i>Messor</i> sp.) carapace, egg, and feces remains	Ant (<i>Messor</i> sp.) carapace, egg, and feces remains, beetle carapace	Ant (<i>Messor</i> sp.) carapace, egg, and feces remains, cf. scorpion (<i>Scorpiones</i> sp.) claw	Ant (<i>Messor</i> sp.) carapace, egg, and feces remains	Ant (<i>Messor</i> sp.) carapace, egg, and feces remains, beetle carapace
Archaeological wood	3 pieces (0.5 mm) with calcitic coating	37 pieces (0.5 mm) highly fragmented	3 pieces (1 and 0.5 mm)	4 pieces (0.5 mm) with calcitic coating	1 piece (0.5 mm)

<i>Archaeologica l seeds</i>	--	<i>Lithospermu m tenuiflorum</i> nutlet, 1 (0.5 mm) cereal frag.	2 (0.5 mm) seed frags.	<i>Lithospermu m tenuiflorum</i> nutlet	3 unID frags, most likely seeds (0.5 mm)
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Table 2. Details of the light fraction analysis, including identified modern plant material, modern insects, archaeological wood charcoal, and archaeological seeds.

AK-10-04

In this sample from the deposits over the Phase 002 floor, four archaeological wood specimens were recovered in the 0.5 mm fraction. These weighed just 0.004 g, while the total weight of the light fraction was 10.96 g. The archaeological wood charcoal was not further identifiable (Figure 6).

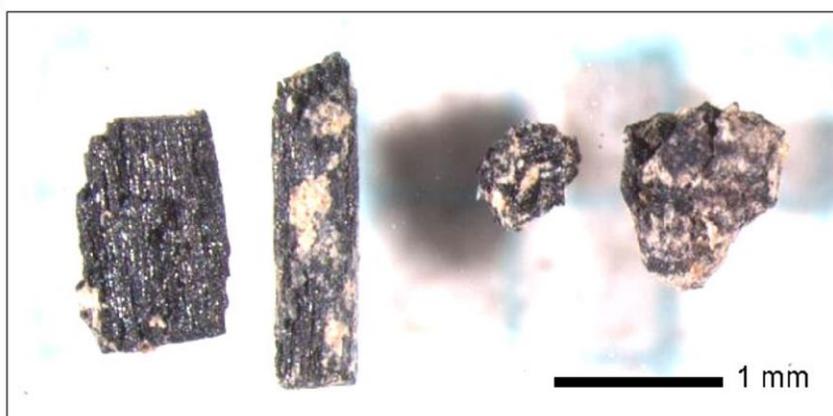


Figure 6. AK-10-04. From left to right: modern wood charcoal, (possible?) modern charcoal, and two abraded, calcite-coated archaeological wood charcoal specimens.

AK-10-05

Sampled from the deposits overlaying the Phase 002 floor, sample AK-10-05 yielded 16.29 g of light fraction material, 0.004 g of which was identified as archaeological in origin. In addition to one wood charcoal fragment, three potential seed fragments were identified, based on their homogenous cell structure (Figure 7). Unfortunately, no distinguishing features are visible (e.g., testa, shape).

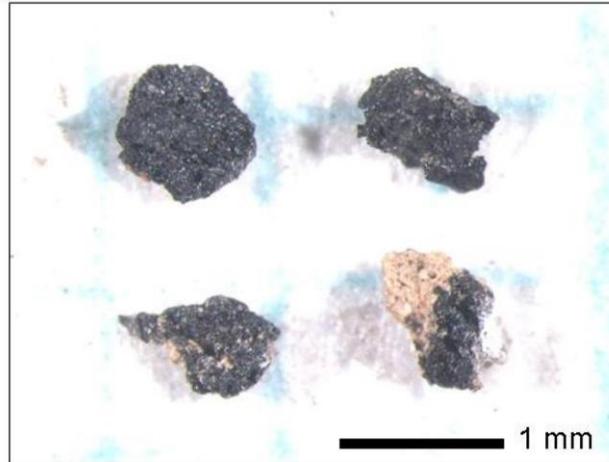


Figure 7. AK-10-05. Top right is most likely archaeological wood charcoal. Top left and bottom row are tentatively identified as seed fragments, but cannot be distinguished further.

Taphonomy and Interpretation

The flotation samples processed from al-Khayran contained very little carbonized macrobotanical material. It is clear from careful analysis in the field and in the lab that charcoal was only poorly preserved in both the light and heavy fractions. However, this does not mean that carbonized plant material was not present at some stage in the past. As Braadbaart et al. (2009: 1678) state, “The potential is great for charcoaled wood, seeds and fruits deposited in an alkaline soil to become unrecognizable and thus not recovered from archaeological assemblages.” In fact, plant material heated above 310 degrees Celsius (a common scenario in the macrobotanical carbonization process), and then exposed to alkaline soil conditions, routinely shows high incidence of fragmentation (Braadbaart et al. 2009).

The local conditions around al-Khayran suggest this may indeed be a basic environment with high pH soils. Nearby limestone features include the ridge along the wadi rim where many springs are located, indicating that groundwater too was percolating through this alkaline system. Excavations in 2007 at the site also revealed a calcrete-type formation just below the ground surface, formed through water percolation and the accumulation of calcium carbonate. Both faunal and macrobotanical remains analyzed from the 2010 season exhibit calcitic coatings indicative of alkaline conditions (M. Kroot, personal communication).

Microscopic analysis of charred plant specimens have been significantly altered since their deposition. This is indicated by the high incidence of calcitic coatings and the abraded, worn edges of all specimens. Seed fragments are all missing their testa (seed coat) and are warped beyond identification. The small size of specimens – nearly all samples were found in the smallest sub-fraction analyzed (0.5 mm) – indicates an extremely high fragmentation rate. Experiments by Cohen-Ofri et al. (2006: 437-438) have shown that charcoal degrades via oxidation into a material similar to humic acid, and that this process is accelerated in alkaline conditions. Braadbaart et al. (2009) therefore suggest that the lack of archaeological charcoal in alkaline environments is the result of chemical changes in the macromolecular structure of the charcoal, as well as other post-depositional processes. While a few pieces of charcoal were recovered at alKhayran, it is likely that most has degraded over time.

One of the most significant post-depositional processes affecting macrobotanical preservation at al-Khayran is clearly bioturbation. In all samples, high numbers of insect remains were found. In particular, harvester ant exoskeletons were prevalent, as well as their uncarbonized droppings. At Tell Kedesh in Israel, Borojevic (2011) has shown that carbonized plant remains of varying archaeological contexts were disturbed and mixed due to recent harvester ant activity. As such, it is difficult to say for sure whether the mineralized *Lithospermum tenuiflorum* nutlets are of archaeological origin or represent a modern intrusion. Any contextual interpretation of the macrobotanical assemblage necessitates a specimen-by-specimen radiocarbon dating regime, as it is likely that large amounts of mixing have occurred.

Additionally, the site architecture is located close to the modern ground surface within the modern agricultural plough zone. Recent human activities, including ploughing and stone reuse, have no doubt disrupted archaeological contexts. This is also apparent in the amount of modern plant material recovered in the samples: a few seeds, but most notably rootlets. Over 99% of the total weight of the light fraction was comprised of modern rootlet material. Such levels of bioturbation make it difficult for archaeological plant material to be preserved intact.

No contextual/spatial interpretations can be attempted given the low level of charcoal preservation, although it is interesting that AK-10-02 yielded a much higher number of specimens than the other samples. Given the level of calcitic coating and fragmentation, it is very likely this assemblage is archaeological in origin. Sampled from the trash and cobble mix north of eastern Phase 002 wall, AK-10-02 may represent what was a one time a rich archaeological context at al-Khayran. It is also the only context to provide an identifiable seed type (i.e., a Poaceae cereal grain). In nearly all the samples, wood charcoal preservation levels are significantly higher than that of seeds. This is because wood charcoal is more resilient and has a higher likelihood of surviving in an identifiable state. Of the four potential seed fragments identified here, only the cereal grain was recognizable.

In conclusion, it is unlikely that continued flotation sampling of the al-Khayran deposits will yield additional information until deeper, better preserved levels are reached. Future work at the site may, however, provide more information about local environmental conditions and a more detailed understanding of the post-depositional processes affecting preservation of archaeobotanical remains.

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Appendix 9: Faunal Finds from al-Khayran

Unit	Level	Element	Species	Age	Notes	Measure 1	Measure 2	Measure 3
CE-23	Floor Clearing	Vertebra (1-5 Above Lumbar) Side Blade Proximal Frag	Med Mammal	n/a				
		Long-Bone Shaft Frag	Med Mammal	n/a				
		Metacarpal Epiphysis Frag	Likely Ovicaprid	Fused				
CD-21	1	Long-Bone Shaft Frag	Med Mammal	n/a	2 Frag			
		Long Bone Shaft Frag	Med Mammal	n/a	4 Frag			
BW-19	1	Humerus, Proximal End Shaft Frag	Likely Ovicaprid	n/a				
		Single Shell	Bivalve	n/a	Ground Smooth, Pierced at Umbo (Bead)			
		Shell	Conical	n/a	Ground Smooth, Pierced at Apex (Bead)			
BT-19	1	Long-Bone Shaft Frag	Med Mammal	n/a	4 Frag			
BW-18	1	Long-Bone Shaft Frag	Med Mammal	n/a	2 Frag			
BW-22	1	Tibia, Proximal End Frag	Ovicaprid	Unfused				
		Rib (1st), Proximal End Frag	Ovicaprid	Unfused				
CF-18	1	Long-Bone Shaft Frag	Med Mammal	n/a	2 Frag			
BU-19	1	Humerus, Proximal End Frag	Ovicaprid	Fused				

		Metacarpal with Half Interior Articular Surface Frag	Ovicaprid	Fused	Small	16.9 Dp		
		Long-Bone Shaft Frag	Med Mammal	n/a	2 Frag			
		Rib Frag	Med Mammal	n/a				
BU-17	1	First Sternum Front End Frag	Ovicaprid	Unfused				
		Lower Orbit	Ovicaprid	Unfused				
BV-17	1	Femural Shaft Frag	Ovicaprid	n/a	9 Frag			
BV-19	1	Scapula, Proximal End Frag	Med Mammal	Unfused				
		Rib or Vertebral Fin Frag	Med Mammal	n/a				
		Long-Bone Shaft Frag	Med Mammal	n/a	2 Frag			
BU-18	1	Phalanx, Right Proximal (1st)	Ovicaprid	Fused	Large	41.4 GLpe	14.8 Bd	15.0 Bp
BU-24	1	Radius, Distal End Frag	Ovicaprid	Unfused	4 Frag			
BT-21	1	Rib (Btwn. 7&10) Proximal End Frag	Med Mammal	n/a				
		Rib Frag	Med Mammal	n/a				
		Rib Frag	Med Mammal	n/a				
		Rib Frag	Med Mammal	n/a				
		Long-Bone Shaft Frag	Med Mammal	n/a				
BT-23	1	Rib Frag	Med Mammal	n/a	2 Frag			
		Rib Frag	Med Mammal	n/a	2 Frag			
		Rib Frag	Med Mammal	n/a				
CF-21	Floor Clearing	Long-Bone Shaft Frag	Med Mammal	n/a	7 Frag			
BT-18	1	Long-Bone Shaft Frag	Med Mammal	n/a				

		Long-Bone Shaft Frag	Med Mammal	n/a				
		Long-Bone Shaft Frag	Med Mammal	n/a				
CB-24	1	Scapula, Proximal End Frag	Med Mammal	n/a				
		Long-Bone Shaft Frag	Med Mammal	n/a				
BT-22	1	Astragalus	Ovicaprid	Fused		30.5 GL1	21.6 Bd	17.2 D1
		Radius, Proximal End Frag Including Interior Half of Articular Surface	Ovicaprid	Fused	Small	13.3 Dp		
		Rib Frag	Med mammal	n/a				
		Rib, Proximal End Frag	Med mammal	n/a				
		Radius, Proximal End Frag	Med mammal	n/a				
BW-17	1	Proximal Left Phalanx	Ovicaprid	Fused	Small	36.1 GLpe	12.3 Bd	12.9 Bp
		Long-Bone Shaft Frag	Med Mammal	n/a				
		Long-Bone Shaft Frag	Med Mammal	n/a				
		Long-Bone Shaft Frag	Med Mammal	n/a				
		Long-Bone Shaft Frag	Med Mammal	n/a	2 Frag			
CE-21, 22, 23; CF-21, 22	Floor Sweeping	Long-Bone Shaft Frag	Med Mammal	n/a	Charred Bone Used for C14			
		Shell Frag	Mother of Pearl	n/a	Pierced in Center (Bead)			

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