ECONOMY AND ENVIRONMENT OF MALYAN,

A THIRD MILLENNIUM B.C. URBAN CENTER

IN SOUTHERN IRAN

Volume I

by
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For my parents,

Abraham and Mildred Miller

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CHAPTER I

INTRODUCTION

One of the primary tasks of archaeology is to identify and explain the political, social, and economic changes that collectively define cultural evolution. Many aspects of these changes are reflected in human/land relationships. As used in this study, the phrase "human/land relationships" refers to land use patterns adopted by human populations in the pursuit of subsistence (e.g., agriculture and herding) and other maintenance activities (e.g., fuel collection) which have had an effect on the natural environment. The identification of prehistoric land use and food procurement strategies can make an important contribution to the goal of understanding cultural evolution. Since it is possible to infer characteristics of environment, economy, and diet from plant remains, one of the most effective means for studying ancient human/land relationships is through paleoethnobotanical analysis. In addition to establishing a descriptive baseline for human/land relationships, changes in plant use through time may provide evidence for sociocultural change.

Human/land relationships can be considered one aspect of the broader category of the relationship between culture and environment. Historically, three major views of the relationship between culture and environment have been environmental determinism, environmental possibilism, and cultural/human ecology; for a brief history and references, see Vayda and Rappaport (1968). The environmental determinist view maintains that varying environmental conditions are necessary and sufficient to explain cultural similarities and differences. In contrast, the environmental possibilist view holds that environmental conditions are necessary but insufficient to explain cultural variability, because the environment merely limits cultural possibilities. The popularity of the environmental determinist view diminished soon after the turn of the century, and gained support in American anthropology only for specific culture historical explanations (e.g., Quimby 1960: 19). The environmental possibilist view was a dominant perspective in American anthropology (including archaeology) through the 1950s, and is exemplified by the idea that natural environmental potential could set limits to cultural development (Meggers 1954).

The third view, cultural ecology, focuses on the interaction between culture and environment. As the first major proponent of the ecological perspective, Julian Steward (1955) stressed the interrelated roles of environment and the "cultural core" in the development of civilization; the cultural core is the "constellation of features [social, political, and religious patterns] which are most closely related to subsistence activities and economic arrangements (Steward 1955: 37). Overall, "cultural ecological adaptations" to the natural environment were seen as "creative processes" (ibid.: 30). Although Leslie White did not incorporate the active role for the natural environment in his theory of cultural evolution that Steward did, he felt that the technological level at which a society interacts with its natural environment is the cultural variable which is at the interface between "environment" on one side and "society" on the other (1959).

During the 1960s and early 1970s, although culture generally remained the unit of analysis, somewhat less emphasis was placed on the primacy of natural environmental variables in schemas developed to explain cultural evolution. Instead, there was increasing recognition of the complexity of the relationship between culture, environment, and cultural evolution. For example, Sahlins and Service comment,

> "The total result of the adaptive process [i.e., cultural evolution] is the production of an organized cultural whole ... which copes with the dual selective influences of nature on the one hand and the impact of outside cultures on the other." (1960:48)

Service (1971 [1962]: 53) and Carneiro (1970) explicitly included cultural and social factors as part of the environment affecting and directing culture change.

Concurrently, a human ecology approach to anthropology was taken, in which human populations, rather than cultures, were the units of analysis (Vayda and Rappaport 1968; Barth 1956, 1961; Rappaport 1967; Flannery 1965).

The trend in recent ecological anthropological studies is to view "culture and ideology as systems which mediate between actors and environments through the construction of behavioral alternatives" (Orlove 1980). One way in which these concerns have been incorporated into archaeological studies is through emphasis on the importance of sociocultural constraints on information processing and decision-making for the regulation of the economic, social, and political subsystems of emerging complex societies (cf. H.T. Wright 1977, 1978; Johnson 1973; Flannery 1972; Flannery and Marcus 1976).

Clearly not all aspects of the total environment are equally important for understanding changes in sociocultural systems. "Total environment" includes natural as well as sociocultural variables (Service 1971 [1962]: 53), and for a given human population, the "effective environment" is understood to represent those aspects of the total environment which are recognized by western scientists such as ecologists or archaeologists, but which may or may not be recognized by the population under study. As changes in the effective environment occur, the human population may alter its activities accordingly. Although the effective environment of a particular population cannot be identified *a priori*, it can minimally be said to include subsistence items and their conditions of growth, other utilized resources (water, forests, animals), and the conditions of social life (social organization, trade, other groups) and material features (technology). Changes in human/land relationships can be seen as a result of the dynamic interaction between a human population and its effective environment.

One direction cultural evolution may take is toward increasing complexity. The development of social complexity and the increase in scale[1] of a society often occur together. Ethnographically, changes in social scale refer to changes in population size and intensity of social interactions; larger scale societies have more status differentiation, greater differentiation of knowledge, and in general more overall heterogeneity than societies of smaller scale (Berreman 1978). As the scale of a society increases, one would expect an increase in intra- and interregional economic integration.

Any society must deal with organizational problems of the production and distribution of economically important goods. Large scale complex societies can support greater specialization of craft and subsistence production than smaller ones at least in part because they can afford the necessary infrastructure (such as roads and security) (cf. Sahlins 1972:85). Archaeologically, settlement pattern studies provide evidence for the degree of economic and/or political specialization and integration (cf. Johnson 1972:

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[1] Barth defines scale as "size in the sense of both the number of members or parts, and the spatial extension" (1978:253).

770, 1973; C.Smith 1976a:36; Sanders et al. 1979: 17). Economic specialization in state systems often seems to be a result of deliberate state policy to facilitate control of the population (H.T. Wright 1977).

The economic strategies prevalent in a given cultural system are intimately related to many facets of social and political organization. In this study, propositions will be developed which relate increases in the scale and complexity of a society to its subsistence base. Concentrating on developing an understanding of human/land relationships, ethnobotanical evidence will be used to consider propositions about the natural environment and agricultural economy of Malyan, the site of an early urban center excavated by the University Museum, University of Pennsylvania. The examination of agricultural production and distribution in one local subsystem of the Greater Mesopotamian sociopolitical network will help elucidate the nature and role of agricultural development in the development of early civilizations.

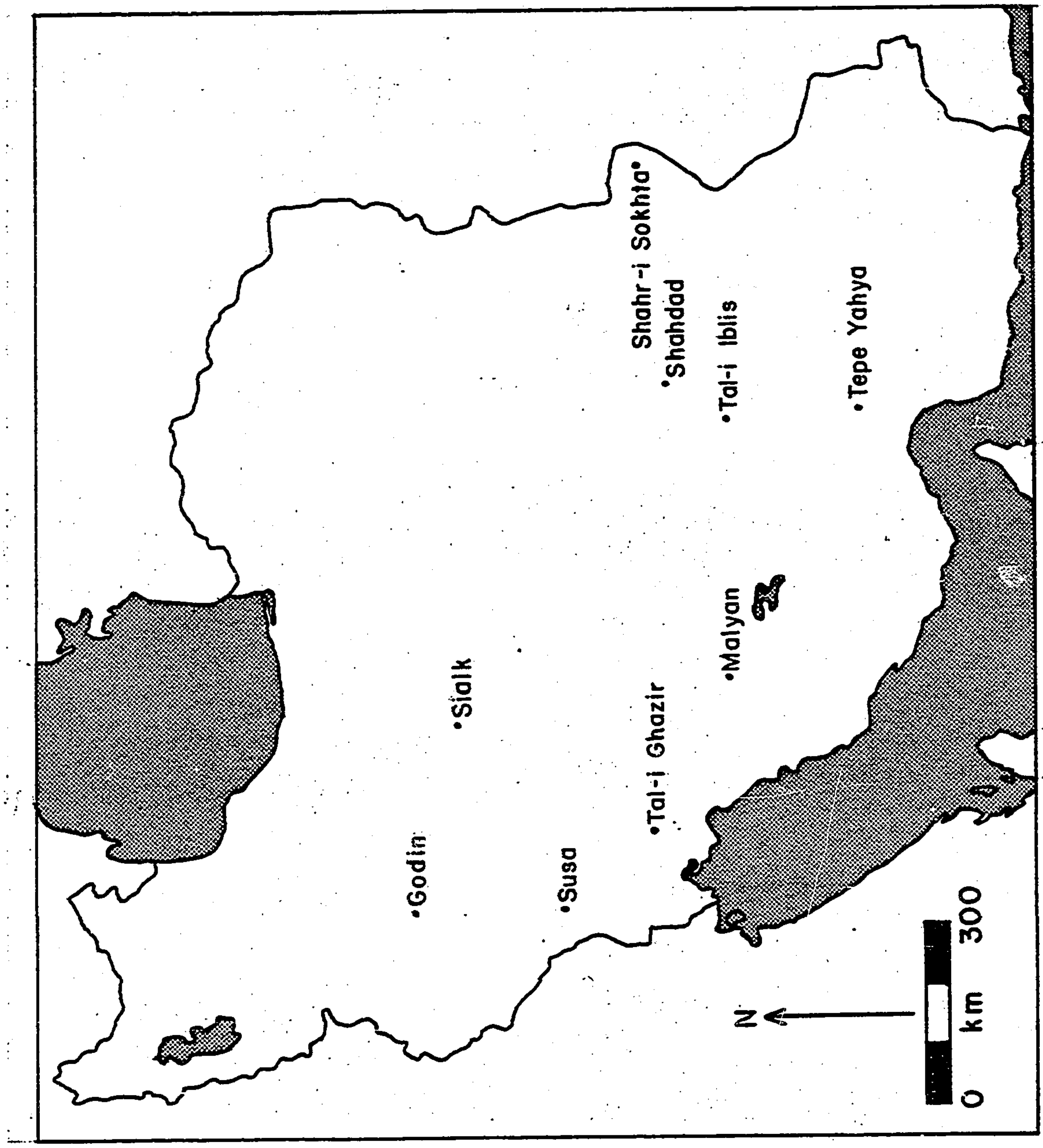
The Growth of Complex Social Systems in the Third Millennium: Iran and Mesopotamia

The archaeological potential of Greater Mesopotamia for the study of cultural evolution has long been recognized. A developmental continuum of societies is attested, from the foraging groups and early village farming communities of the early Holocene to the historic empires.

The fourth millennium B.C. saw the initial development of complex urban societies in lowland Iraq and Iran (Adams 1981; Wright, H.T. 1977; Johnson 1973). These communities had been and continued to be in contact with simpler, less urbanized societies on their borders. Documentation of communication and trade during the fourth and third millennia suggest that Greater Mesopotamia is the unit of analysis most appropriate to the study of trans-regional economies (Kohl 1978). At the time of the first civilizations of the fourth millennium, it included the Tigris-Euphrates basin, the adjacent Taurus-Zagros mountain arc to the north and east, and the upland regions of the adjacent Irano-Anatolian plateau. Eventually the northern Levant to the west and the inner Helmand basin to the east were brought into a sphere of complex political systems (Fig. 1.1).

Mesopotamia proper is an area lacking timber, stone, and metals. The Zagros mountains lie to the north (Kermanshah), east (Luristan), and southeast (Fars) of this region. These upland areas contained some of the raw materials used by the lowland societies, especially timber and minerals. Additional raw materials were transported from as far away as Afghanistan (lapis lazuli; Herrmann 1968). In recent years, archaeological survey and excavation has been aimed at understanding local as well as trans-regional developments at Susa, in Khuzestan (Le Brun 1971), Godin Tepe, in the Kangavar valley, Kermanshah (Young 1975); in the Mahidasht, Kermanshah (Levine 1976); Malyan,

Fig. 1.1.
Archaeological Sites Mentioned in the Text


Shahr-i Sokhta
Shahdad
Tal-i Iblis
Tepe Yahya
Malyan
Sialk
Tal-i Ghazir
Godin
Susa
N
0 km 300

in the Kur basin, Fars (Sumner 1972); Tepe Yahya, in the Soghun valley, Kerman (Lamberg-Karlovsky 1972, 1974), and Shahr-i Sokhta, in the Helmand valley, Seistan (IsMEO n.d.).

Actual trade goods and the stylistic attributes of manufactured items can be used both to document intersocietal connections as well as, in the latter case, to date them. During the fourth and third millennia, relative chronologies are based upon glyptic art (seals and sealings), pottery shapes and styles, linguistic evidence, and carved chlorite and steatite bowls (Porada 1965, Dyson 1965, Kohl 1978; Fig. 1.2). Other traceable trade goods include Gulf shells and lapis lazuli. Clay seals, sealings and bullae are considered the administrative by-products of trade and exchange (Wright 1972), and work is being done to trace clay sources from which some of these items were made (Blackman 1980). Even when the place of origin is unknown, products found archaeologically outside of the regions in which they naturally occur can also be presumed to have been imported.

Malyan, located in the Kur basin, was part of an expanding complex social system of the late fourth and third millennia. The basin is one of the larger intermontane valleys of the southern Zagros mountains, and is adjacent to lowland Mesopotamia and southwestern Iran, where some of the early states developed. In addition, it is on the southern east-west route between the Indus valley and Mesopotamia. Its cultural development followed that of the mid-fourth millennium societies of the lowlands. There is ample evidence for human occupation of the basin for millennia prior to the social/political changes under discussion. There is also evidence for interactions between the Kur basin and the more complex lowland societies of Mesopotamia even before the establishment of Malyan. Therefore, we cannot determine the degree to which the lowlands influenced sociocultural development at Malyan.

Identification of Administrative Specialization

General evidence for increasing social complexity occurs throughout the ancient Near East in the form of written documents and other administrative artifacts (Wright 1972:104). Record-keeping, one of the major activities of the administrative subsystem of literate society, has long been recognized as one marker of a high degree of social complexity (Childe 1950). Numerical signs, and later pictographic writing, first appeared during the mid-fourth millennium in Mesopotamia and Khuzestan. In Mesopotamia, the pictographic system for writing Sumerian developed into cuneiform script. At Susa, numerical signs incised on clay bullae gave way to account tablets incised with Proto-Elamite pictographs (Vallat 1978). Proto-Elamite tablets, as yet undecipherable, are found throughout Iran, especially in the south (Susa, Tal-i Ghazir, Malyan, Tepe Yahya, Shahr-i Sokhta), but also in the north (Sialk) (Lamberg-Karlovsky 1978). Seals and seal impressions are also significant as chronological links between areas.

At Malyan, Proto-Elamite account tablets similar to those found at Susa (Stolper 1976), clay bullae, seals and sealings with Susian affinities were preserved from the Banesh period deposits (Pittman 1980). Cuneiform texts written in Sumerian and perhaps other languages as well occur in Kaftari deposits, including administrative and school texts:

> "It is evident, at a minimum, that a scribal school existed at Malyan in or before the Kaftari period, using pedagogical devices original to Mesopotamia but employed wherever cuneiform was taught, and correspondingly that Kaftari scribes at Malyan produced administrative documents of Mesopotamian form and in Mesopotamian language." (Stolper 1976:93)

Urbanism

Patterns of urbanism in the Near East have been established by archaeological survey (Adams 1965, 1972, 1981; Gibson 1972; Johnson 1973; Young 1975; Sumner 1972; Alden 1979; et al.). In the highland and plateau regions, the degree of urbanization and population concentration was not as great as in Mesopotamia, and urbanism developed later. For example, by the late Uruk, there were centers ranging from 25 to more than 80 ha in lower Mesopotamia (Adams 1981:71), a phenomenon that did not occur in the Kur basin until the Late Banesh period.

During the Kaftari period, ties to the west are represented by "glyptic art, so closely paralleled at Susa, and the occurrence of economic, religious, and school texts, written in Mesopotamian languages" (Sumner 1974: 173). The development of Malyan as a very large urban center at this time suggests it may have functioned as a center of economic and political control (cf. C. Smith 1976a,b; see below).

Trade and Economic Specialization

The nature of late fourth millennium trade is not fully understood. However, Kohl (1978) emphasizes the social nature of trans-regional trade at this time (i.e., luxury goods were an important trade item). Potts (1978) and Beale (1978) suggest possible cult uses for some of the items (chlorite bowls and beveled rim bowls) in the late fourth to third millennium assemblages. In any case, economic specialization in non-subsistence activities appears to have increased, with craft, mercantile, and presumably administrative specialists as well supported by the agricultural population and perhaps pastoralists. Texts dated to the third millennium document highland-lowland trade in timber, minerals, and hides. Lowland peoples might have been exchanging manufactured items and perishable goods (e.g., cloth, grain, oils, fish, and leather) for highland raw materials, but direct evidence is lacking (Crawford 1973). Later, during Old Babylonian times (early second millennium), exports from Mesopotamia included textiles, dates, oil, and grain, according to texts (Leemans 1950). Unfortunately, intelligible archival records have not been found from the earlier periods.

Although the evidence found so far is tenuous, some archaeologists have postulated that the development of full-time pastoral nomadism occurred at this time. The ongoing interactions between settled and nomadic peoples would have intensified the complexities of the political and economic system (Adams 1966, Wright and Johnson 1975, Lees and Bates 1974).

The role of Kur basin society in the economic system of Greater Mesopotamia is not fully understood, nor has its internal social development been fully explored. To date, research in the Kur basin has documented economically specialized settlements in the Early Banesh period (late fourth millennium; Alden 1979). During the subsequent Kaftari period, there is some evidence for increased long-range trade in the form of quantities of seashells from the Gulf, lapis lazuli from Afghanistan, and carnelian, and turquoise, possibly from the Iranian plateau (cf. Beale 1973).

Warfare

Another aspect of the interactions of ancient Near Eastern society was competition. The earliest state polities in Mesopotamia (Uruk through Early Dynastic times) can be characterized as interacting polities (Frankfort 1956:50, Adams 1972:742-743). Archaeological evidence shows that walled cities had appeared in Mesopotamia by the Late Uruk period (the end of the fourth millennium). Malyan seems to have been walled during the Banesh period (Sumner 1980b).[2] As C.J.Gadd (1971a: 121) has noted, "The

[2] Sites in Soviet Central Asia which are contemporaneous with Malyan are also walled (Masson 1972:270).

inscriptions of the third Early Dynastic period and the king-list which is the main authority for its history are all greatly pre-occupied with war". Several Mesopotamian texts mention wars or raids against the Elamites, as well (Gadd 1971a: 110, 111, 120; 1971b: 436; Hinz 1971: 648-650, 654). Thus, circumvallation of towns suggests some military activity was already prevalent by Early Dynastic times and textual evidence suggests that it remained a fact of political life thereafter (Adams and Nissen 1972:21; cf. Gadd 1971: 121).

In summary, during the fourth and third millennia, the social systems of lowland Iran and Mesopotamia increased in scale and complexity. Increasing status differentiation and economic specialization have been identified by archaeologists. In the lowlands, the growth of cities, their temple precincts, and intersociety competition, including warfare, also occurred (Childe 1952, Frankfort 1956, Adams 1966, Redman 1978). Interregional interaction in Greater Mesopotamia is recognized by stylistic motifs in glyptic art, language and traded items. The nature and degree of influence of the lowlands on the highlands is a matter of some debate, and was in any case variable through the third millennium. Nonetheless, there is general agreement that economic and sociopolitical complexity increased between the fourth and third millennium, and that this process happened over a broad area.

Fig. 1.2.
Time Line

Year B.C.	Mesopotamia	Khuzestan (Susiana)	Fars (Kur Basin)	
1700			Qaleh	
1800	Isin-Larsa (2017-1763)	Sukkalmah		
1900		Simashki	Kaftari (Elamite)	
2000	Ur III (2112-2004)	Ur III		
2100				
2200	Post-Akkadian (2193-2130)	Awan		
2300	Akkadian (2334-2193)	Suse IV b		
2400	Post-Early Dynastic	Suse IV		
2500	Early Dynastic III	Suse IV a	?	
2600	Early Dynastic	Suse III d	Banesh (Proto-Elamite)	Late
2700	Early Dynastic II	Suse III (Late Proto-Elamite)		
2800	Early Dynastic I	Suse III c		
2900		(Early Proto-Elamite) b		Late Middle
3000	Jemdet Nasr	(Early Proto-Elamite)		
3100		(Early Proto-Elamite) a		Early Middle
3200	Uruk Late	Suse II ≡ Uruk Late	Settlement at Malyan, ca. 3200 B.C.	Early
3300				Initial
3400	Uruk Middle	Suse II ≡ Uruk Middle		
3500				
3600	Uruk Early	Suse II ≡ Uruk Early	Lapui	
3700				
3800				

Distribution: Long-Range Trade and Local Exchange

Since all societies engage in material exchanges of one sort or another, the theoretical relevance of trade and exchange to cultural evolution lies in its political and social correlates. The response to an external stimulus for change is conditioned by the character of society at the time of contact. Thus Renfrew (1975: 36 ff.) points out that "trade will only be a major force for change if it enters into [...a...] positive [feedback] relationship with another subsystem". More specifically, Johnson has argued that, at least in the case of pristine state development, the organizational requirements of local exchange may contribute to state development insofar as coordinating local distribution and production taxes the information processing capabilities of the existing sociopolitical system (Johnson 1973).

Development of Trans-Regional Economies

Since the pristine states of Mesopotamia were involved in long-range trade with their neighbors, trade could have had an effect on secondary state developments (suggestion of Johnson 1973: 158, cf. Adams 1975: 463). There was peaceful trade, and some movement of personnel during the fourth and third millennia. It is of course true that the transfer of material over great distances occurred thousands of years prior to state formation (cf. G.A. Wright's (1969) analysis of the obsidian trade), but substantial quantities and varieties of material transported through an extensive trade network are not demonstrated until after primary state development (Wright and Johnson 1975).

An increased incidence of contact among diverse areas occurred during the late fourth millennium. For example, in the Middle Uruk layers of the lowland site of Farukhabad, "shifts in minor commodities suggest decreased exchange with northern Iraq ... [but] increased exchange with central Iran and the Gulf area" (Wright 1972: 102). Weiss and Young report an actual trade outpost of Susians in the central Zagros dated to the late fourth millennium (1975), but by the beginning of the third millennium, the major volume of east-west trade shifted to the route through southern Iran, presumably through areas like Tal-i Iblis and the Kur basin.

It is one thing to identify long-range trade, yet a persistent problem is measuring the importance of its role in social change. The quantity of trade can be viewed as a first approximation to its social importance, and the identification of types of items traded (utilitarian or non-utilitarian, and differential distribution of exotic goods within a region) may also help clarify its role. Two hypotheses related to the importance of trade are that

1) it involved non-utilitarian goods, and is a manifestation of some political control or influence, but not full economic integration, and
2) it involved utilitarian goods, and was of great economic significance, if not political.

The possibility that primarily cult or high status goods were the main trade items (Kohl 1978, Potts 1978, Beale 1978), prompted C.C. Lamberg-Karlovsky to aver that the "Susiana state...was generating and controlling developments in distant areas" such as Sialk, Godin, Malyan, and Yahya. He then suggests that the Susiana state over-extended itself, and "at Yahya the local inhabitants copied the emergent state system of Susiana throughout the third millennium" (Lamberg-Karlovsky 1978:118). Whereas the data of this study do not lend themselves to an evaluation of this hypothesis, they are of some use for assessing the second hypothesis.

It has also been suggested that third millennium society was engaged in trans-regional trade of bulk subsistence items (Kohl 1978), in particular that lowland granary regions provided basic foodstuffs to highland societies. Two models for this trade are that (1) it was a regular occurrence, strongly tying the lowland and highland economies, or (2) it was not regular, but was nonetheless important as insurance against famine (cf. Kohl 1978). There is at present no direct evidence for this proposition, and it will be shown that the observable increase in scale of at least one highland society, centered at Malyan, was supported by the development of its local resource base.

Local Exchange

The administrative requirements of local exchange have been considered a stimulus to pristine state development in the Uruk period in Khuzestan (Johnson 1973). Whether or not this was a contributing factor to the development of social complexity in the Kur basin is not known. As is the case with long-range trade, it is necessary to identify the existence of local exchange, gauge its magnitude, and determine whether there was differential access to the products of local economic activity. Archaeologically, the identification of local specialization implies local exchange. Thus, some economic interaction can be inferred from site specialization (e.g., for pottery manufacture) and settlement hierarchies.

The distribution mechanisms for agricultural commodities are less easy to trace. If large granaries in public buildings are excavated, one might reasonably infer a redistributive economy, but archaeological and ethnobotanical evidence is usually not so dramatic. Nonetheless, the agricultural self-sufficiency of the Kur basin as a whole (Chpater 6), and the differential distribution of the population within it (Sumner 1972, Alden 1979) provide support for the proposition that local exchange in agricultural commodities was of necessity regulated at a regional, supra-village level.

The Kur basin is on the land route between Mesopotamia to the west and Tal-i Iblis and Shahr-i Sokhta to the east. In the Kur basin, one can cite the presence of beveled rim bowls (lowland affinities) and Proto-Elamite tablets (trans-Iranian) as evidence of long-range contacts. Alden (1979) has found that during the Banesh period (Jemdet Nasr-Early

Dynastic), there was some local craft production (especially ceramics) in the Kur basin, but even within this region there was only limited development of economic integration as indicated by studies of settlement hierarchy. In at least one area of economic activity, however, Zeder (1980) has identified increasing centralization of herding during the course of the Banesh period (Kaftari animal remains have not yet been fully analyzed). The mid-third millennium saw a breakdown of the Proto-Elamite "Intercultural style" (Kohl 1978), which, in the Kur basin is associated with some sedentary population loss at the end of the Banesh period (Alden 1979). Despite this apparent demographic setback and loss of extra-regional connections, an increase in intra-regional economic integration, as well as an increase in foreign trade developed in the Kaftari period (cf. Sumner 1974). The scale and complexity of social organization in the Kur basin apparently increased in the latter half of the third millennium, with urbanization and population growth that was not to be surpassed until Islamic times (Sumner 1972:Fig. 5).

<u>Production: Demography and Agricultural Development</u>

Whether or not a society is involved in extra-regional trade networks, internal sociocultural forces may lead to increases in social complexity. As mentioned above, local exchange and distribution of goods is an important factor in social interactions and cultural evolution (cf. Johnson 1973). Equally important to an understanding of ancient society is the relationship between population and production, since the distribution of subsistence staples will depend on the organization and adequacy of local food production. The organization of a population for agricultural production will thus constrain the possibilities for social change.

Researchers do not agree on the relationship between agricultural production, population, and cultural evolution. With an increase in social scale and complexity, not only will more food have to be produced, but more food per agricultural household, because socio-economic differentiation creates a group of non-food producers, e.g., administrators or full-time craft specialists. In this section, a discussion of population growth as a cause of increases in agricultural production as well as increases in social complexity will be followed by a broader discussion which considers population growth to be just one of several possible stimuli to agricultural production.

Population and Agricultural Production

Population growth as an independent variable has been used to explain a number of developments in prehistory, but most especially agricultural origins (Smith and Young 1972, Cohen 1977) and state origins (Sanders 1972). In these explanations, population growth among human populations is assumed to be inevitable, and is only inadequately checked by cultural practices (e.g., inadequate nutrition, age of marriage) and natural causes (e.g., mortality and reduced fertility due to disease, famine, and other calamities). According to this theory, as the population grows, it will eventually experience economic stress, directly or indirectly related to food supply. Whatever the cause of population growth, in order to increase foodstuffs available to the population, technological and other cultural changes will occur.

Boserup (1965) pointed out that numerous technological improvements which require more labor per unit land have been known for generations prior to a given subsistence system becoming dependent on them. She suggested that the assumption of these techniques on a large scale results from population growth. It is not, however, just the need to feed a growing population that encourages technological changes. As population grows, technology and production techniques which would be useless on a small scale might become feasible and economical on a large scale. In short, society-wide technological progress (measured in increasing productivity per unit of land, which may or may not be associated with a decrease in labor productivity), is seen as a result of population growth.

Insofar as technological innovations might change the relations of production, concomitant social changes find their ultimate cause in population growth. For example, even a simple irrigation scheme, instituted to increase land productivity in order to support a growing population, could create differential land values (i.e., irrigated vs. unirrigated), encouraging inequality and then social stratification.[3] Another way in which population growth has been causally linked to cultural evolution is Carneiro's social circumscription theory, which posits that the centralization and social differentiation characteristic of complex societies is encouraged by competition for scarce (relative to population size) resources directly related to subsistence, especially land (1970).

"Demand for Labor"

The population arguments outlined above take growth as a cause of increased production. Although it is true that one reason for increasing production of subsistence items is to feed a larger population, it is not always the only one. Others have presented equally compelling arguments that take a variety of factors into account. If the proportion of non-food producers increases, those who are involved in agriculture may have to farm more efficiently. For example, labor could be allocated to different sectors of a growing complex economic system or changes in population structure could lead to a changing ratio of primary producers to consumers. Demographic variables might also have an effect. Thus, a population increasing naturally, with relatively few adults will have different food and labor requirements than one which experiences population growth by immigration. In

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[3] Hole (1966:609) and Adams (1966:72) provided this interpretation of the significance of the creation of differential land values in encouraging stratification, without recourse to any Boserupian arguments.

the latter case, increases in the number of adults simultaneously increases the numbers of consumers and producers (cf. Sauvy 1969: 73-74, 221).

Sahlins has argued that a social surplus may be necessary for political reasons as well (e.g., redistribution): "political life is a stimulus to production" (Sahlins 1972: 135). Power in traditional societies is frequently closely associated with numbers of followers. In an interesting discussion of power, population, and production in traditional India, local government was found to be "based upon prestige and numbers of followers" (Neale 1969:9), and "the village manager maximized the number of mouths he fed" (ibid.: 2), both literally and figuratively, by providing land for them. Elsewhere, Baganda chiefs experienced a similar need to maximize the number of their (peasant) retainers (Firth 1969, citing Mair). In short, there are a variety of reasons for a society to expand agricultural production, and the relationship between demographic changes and the agricultural economy may therefore be usefully viewed in the context of "demand for labor" (Coontz 1957, Cowgill 1975).

The Expansion of Agricultural Production

The productive base of a community at a relatively low level of technology is labor, land, and crops. Clearly, "land" referred to in this statement is usable agricultural land, which means it is arable and politically secure, and within a reasonable (culturally defined) distance from a settlement. "Labor" refers to agricultural labor, not simply all individuals of a certain age and sex within the population, since the third millennium societies considered in this study were societies which had at least some craft and administrative specialization.

There are a number of ways a society can increase the total number of hours spent in agricultural employment. For a stable population, at least some individuals will have to work more by an increase in:

1) work efficiency
2) the length of the working day and/or the number of working days per year
3) working life (from first employment to retirement).

Lastly, at the societal level, the proportion of the population engaged in productive labor may increase. In the case considered here, the last option is not likely to occur, since increasing economic and social complexity would require a greater variety of social roles to be filled. Another solution to the problem of insufficient agricultural production is population increase. If each agricultural worker produces more than his or her needs, agricultural surpluses will be enhanced by population increase. More workers can bring more land under cultivation or work cultivated land more intensively. If labor is the limiting factor for productivity, one would thus expect a population increase, holding technology constant.

At the household level, individuals may decide to have more children. In many agricultural societies, children become assets to their families at a young age (White 1975, cf. Ford 1979). Expansion of agricultural production would then be accomplished by clearing and planting more land, at the same level of technology, and productivity per man-hour would remain approximately the same. The archaeological evidence for this would be an expansion of area of settlement and land clearance.

Alternatively, if land is the limiting factor for productivity, one would expect intensification of land use. At any particular time, fields in one agricultural system will be cultivated with varying degrees of intensity (Boserup 1965:58, Wolf 1966), but a general increase in intensification might be traceable archaeologically by an expansion of irrigation and increase in settlement density.

Population in the Kur Basin

Evidence indicates that there was a substantial increase in the sedentary population of the Kur basin during the third millennium B.C. (Sumner 1972, Alden 1979). Although the Banesh period (first half of the third millennium) has been divided into five subperiods and there are survey based population estimates (Alden 1979), the chronology of the archaeological deposits at the site of Malyan and in particular of the Kaftari period (second half of the third millennium) is still fairly coarse. It is therefore not yet possible to determine whether population growth preceded or followed land clearance and agricultural expansion, but land clearance and agricultural expansion are now documented (Chapter 6).

Under many agricultural systems, increases in production are more readily attained by expanding the area under cultivation than by applying comparable amounts of labor to a relatively smaller area (cf. Mellor 1969: 210-211), a factor tending to encourage land clearance as the more desirable alternative as long as land of good quality is available. The Kur basin would probably have been such an area because of the large area of light forest which was available for conversion to pasture and agriculturally productive land. Initial land clearance would have been made easier by an absence of underbrush, and once cleared for fuel and cultivation, land is likely to remain free of arboreal vegetation.

Archaeological Background

Archaeological research in the Kur river basin has a long history. The most prominent site is the historic site of Persepolis, but archaeologists have investigated all prehistoric periods. The archaeological sequence was initially developed by van den Berghe (1952),[4] and was refined by Sumner (1972) , Alden (1979), Jacobs (1980), and Rosenberg (1979, 1980). Prior to the work of the Malyan and related projects during the 1970s, investigation has been concentrated on the excavation of several village sites

[4] See Sumner (1972) for more complete bibliography.

(Egami 1967, Egami and Masuda 1962, Egami and Sono 1962) and Persepolis. The Kur basin witnessed a long sequence of cultural development. There is evidence of human occupation at least as early as the Middle Paleolithic. The efforts of the Malyan Project have been directed toward excavating the late fourth to late second millennium B.C. occupation at the site of Malyan itself. The primary data for this study derive from the Banesh and Kaftari deposits (late fourth to early second millennium) at Malyan.

The Lapui and Earlier Banesh Periods:
Before the Establishment of Malyan

The early fourth millennium settlement patterns in the Kur basin was one of villages and several very small centers. The average size of the more than 100 Lapui (3900 B.C. - ca. 3400 B.C.) sites is 1.1 ha, and no site is greater than 4 ha (Sumner 1980b). The median site size is well below the mean (Sumner 1972), indicating a preponderance of small sites. In the Kur basin, Lapui red ware pottery appears at this time with no antecedent technical or stylistic affinities in the area (H.T.Wright 1981, p.c.). However, it is similar to late fifth millennium minority wares of Deh Luran and the Susiana plain, but the exact relation among these areas is not known (H.T. Wright 1982, p.c.; cf. Sumner 1972:58). During the Banesh period (ca. 3400 B.C. - ca. 2600 B.C.) the average size of the 26 village sites was 2 ha, and they ranged from less than a half ha to about 3 ha (Fig. 1.3). The first large center, Malyan (ca. 50 ha) appears at this time (Sumner 1980b). Alden (1979) has divided the Banesh period into five phases (Initial, Early, Early Middle, Late Middle, and Late), and this discussion of Banesh period settlement patterns follows his schema. Initial Banesh sites are generally located on Lapui sites, indicating continuity of occupation. Stylistic similarities with Khuzestan continue at this time, including the appearance of beveled rim bowls on Banesh sites (Sumner 1972:24). Settlements were sparsely distributed during Initial phase Banesh times.

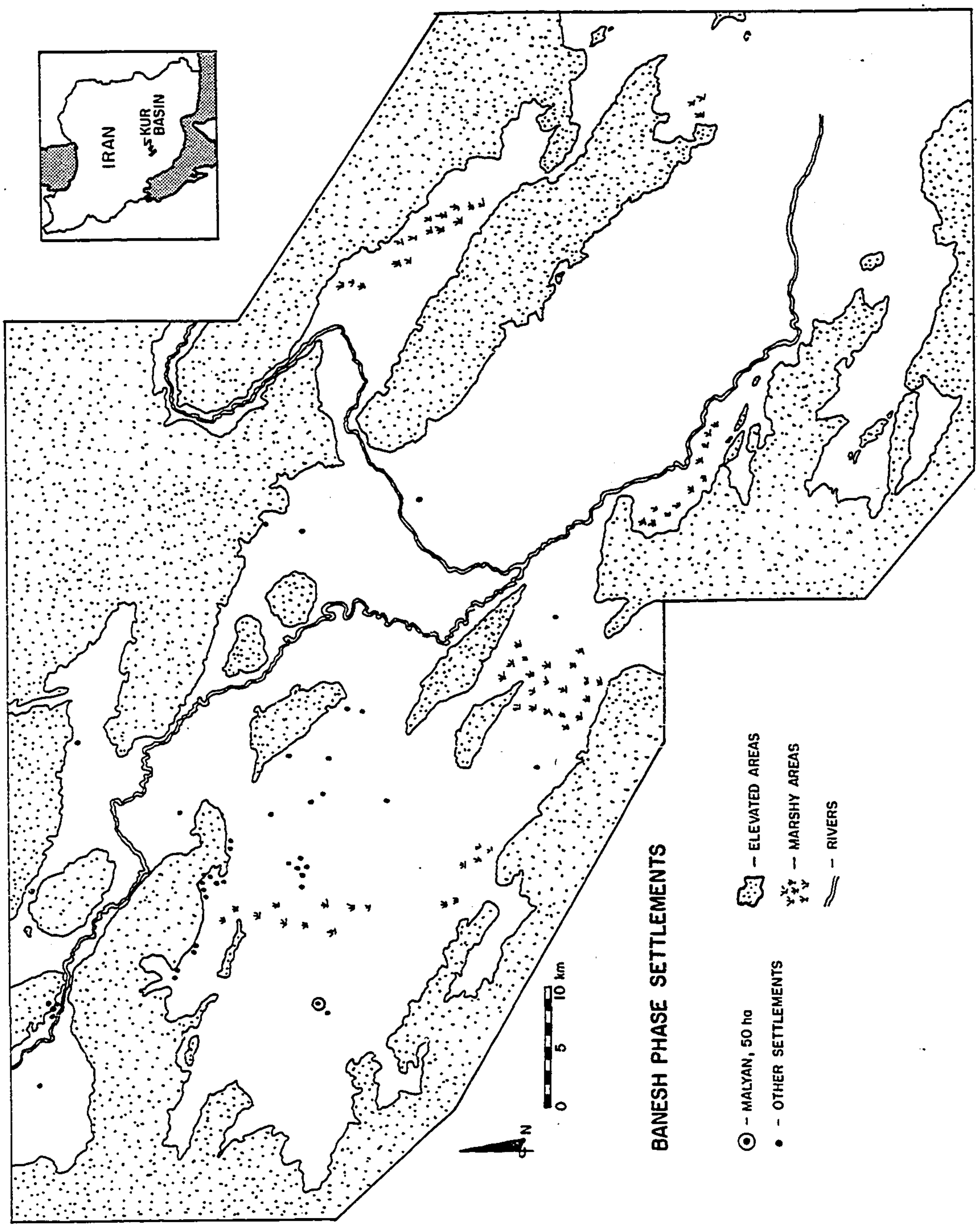
The Early phase saw some population growth and "significant changes in regional economic organization" (Alden 1979:160), with the appearance of four ceramic manufacturing sites and one site (8G38, with a comparatively large area of 2.7 ha) which, according to Alden, might have been "functioning as the distribution (market?) center for the Kur Basin during the Early phase" (1979: 160).

Banesh Malyan

During the subsequent Early Middle phase, some population redistribution took place. The center at 8G38 declined in importance, but Malyan seems to have attracted population from the surrounding settlements, resulting in a population size estimated conservatively at about 1000.[5] A great increase in population to about 4500 is postulated for Malyan during the Late Middle phase, with a stable

[5] I am following Alden's (1979) estimate of 100 people per hectare.

Fig. 1.3.
Banesh Settlement System
(Source: Sumner 1981)


IRAN
KUR BASIN
BANESH PHASE SETTLEMENTS
0 5 10 km
N
- MALYAN, 50 ha
- OTHER SETTLEMENTS
- ELEVATED AREAS
- MARSHY AREAS
- RIVERS

hinterland population. Finally, there is no evidence for population growth in the valley during the Late phase, though Malyan continues to be the single largest site in the valley with an area of about 50 ha.[6] According to Alden, the degree of economic control exerted over the valley as evidenced by the importance and centrality of one site changed through the Banesh period. He detects the beginning of a development of complex economic organization in the Early Banesh, continuing and increasing during the Middle phase Banesh, with movements of population explicable in terms of trade routes and trade relations with the lowlands of Khuzestan. It is noteworthy that Malyan, the population center of the valley, is far from both the geographical center and the main agricultural areas of today, but it is near the northwestern pass to Khuzestan. There is some evidence of construction of a town wall toward the end of the Banesh period (Sumner 1980b). Some trend toward economic reorganization is suggested for the Late phase (Alden 1979).

Kaftari Malyan

The Kaftari period (ca. 2400 B.C. - 1800 B.C.) has not yet been subjected to detailed chronological analysis (Fig. 1.4). Stylistically, Kaftari period ceramics and ceramic assemblages apparently developed from those of the Banesh period, and "close ceramic parallels outside the

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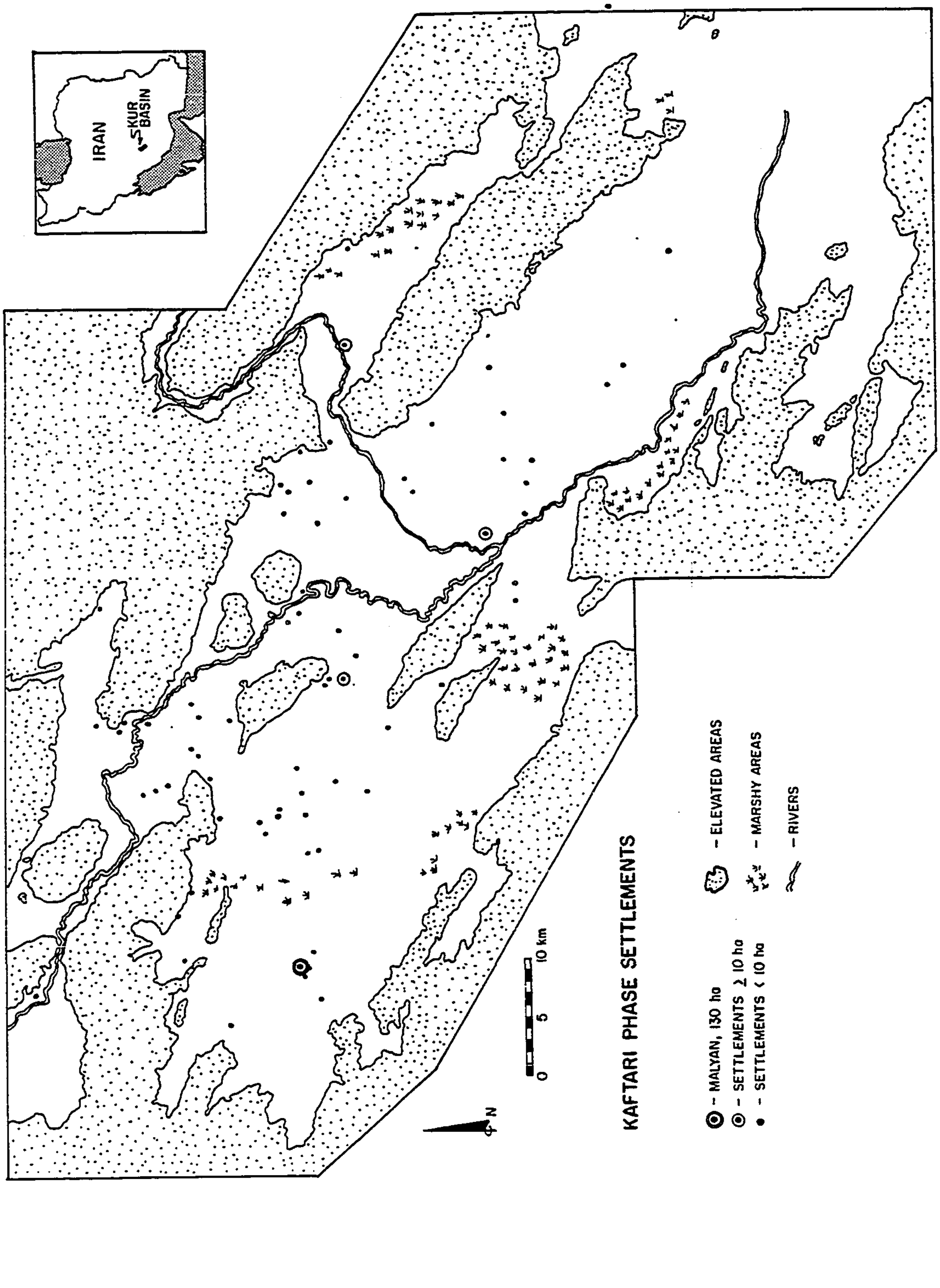
[6] It may in fact be a close grouping of four or so related settlements (Alden 1979:194).

K[ur] R[iver] B[asin] are rare," Sumner (1980b). At Malyan itself it is probable, though not proven, that there was continuous occupation between the Banesh and Kaftari periods (W. Sumner 1981, p.c.). In any case, the Kaftari occupation was greatly expanded over that of the Banesh period. The occupied area grew from 50 ha to at least 160 ha. Much of the town wall is still extant to a height of about 10 m above the present day plain; it encloses a total area of about 300 ha. There was also a skewed population distribution; after Malyan, the next largest site, the Marv Dasht Brick Kiln site, was a little over 10 ha (William Sumner 1981, p.c.). Excluding Malyan, the average site size is about 2.1 ha, and the 76 village sites from this time occupy a total of 160 ha (Sumner 1972).[7]

The site size distributions for the Banesh and Kaftari periods include many villages. In the former, a bimodal distribution is present, with modes at about 1.5 ha and at 50 ha. In the latter, the sites are "organized in a clear 4 level hierarchy: villages (3 Ha. or less), small towns (4-5 Ha.), towns (6-8 Ha.) and the city" (Sumner 1980b:5). Malyan, at ca. 160 ha, seems to be overwhelmingly the "central place". This settlement pattern is similar to that of a "solar central-place system", which suggests Malyan functioned as a center of political control (cf. C. Smith

[7] More recently, Sumner (1980b) has reported 83 Kaftari sites, but does not mention their average size.

Fig. 1.4.
Kaftari Settlement System
(Source: Sumner 1981)


IRAN
KUR BASIN
KAFTARI PHASE SETTLEMENTS
- MALYAN, 130 ha
- SETTLEMENTS ≥ 10 ha
- SETTLEMENTS < 10 ha
- ELEVATED AREAS
- MARSHY AREAS
- RIVERS
0
5
10 km
N

1976a,b).[8]

The extent of settlement expanded during the Kaftari period as well. Banesh communities had not been established in the lower and more saline eastern end of the Kur basin, southwest of the present city of Marv Dasht. In contrast, over 15 sites were established in the eastern part during the Kaftari period, and there was a general increase in site density to the northwest as well.

It thus appears that Malyan was established as a center (whether economic, political, or both has not been tested) during Banesh times, and it became truly preeminent during Kaftari times.

The Role of Ethnobotany

It is only since the 1960s that ethnobotanical research has become recognized as an integral part of archaeological projects. Prior to that time, and even today, if plant remains were seen, the observant excavator might have collected them and might have sent them to a specialist for analysis. The systematic search for botanical remains, for the purpose of answering specific questions about ancient societies in the Near East was only begun in the late 1950s (Helbaek 1960, 1969). "Problem-oriented" studies have generally been concerned with agricultural origins and early

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[8] Although geographers stress the number of functions rather than size in determining "centrality", in the absence of truly monumental excavation projects, archaeologists have to rely on site size as an approximate measure of the number of functions carried out therein.

village life (Helbaek 1960, 1969, 1970; van Zeist 1972; Stewart 1976; Hillman 1975). In this part of the world, ethnobotany has not yet quite come into its own as a useful part of the study of complex societies, fully integrated into the research design of projects, although numerous researchers are in the process of remedying that situation (Costantini n.d. at Shahr-i Sokhta; Willcox 1974 in Anatolia)

One reason for this neglect is that most archaeologists do not appreciate how many ways plants affect and are affected by human activities. A second reason is that the number of projects which could benefit from the presence of an ethnobotanist far outstrips the number of ethnobotanists. This is an unfortunate situation, since many, though not all of the interactions between plants and people can be inferred from archaeological plant remains, if suitable techniques of recovery are used.

Research Goals: Methodological, Substantive, and Theoretical

Archaeological methodology and the interpretation of archaeological data form the basis for substantive contributions to our understanding of the past generally, and ethnobotanical data are particularly well suited to the study of ancient land use patterns. Human activities affect the initial deposition of botanical material in settlements in a variety of ways (Chapter 4). Thus, plant remains can be treated as "artifacts;" types can be identified, differential spatial/temporal distributions can be determined, and ancient uses for plants can be inferred. The role of human populations in altering their botanical environment by means of plant collecting, land clearance, farming, herding, and other activities enables the ethnobotanist to address a variety of economic, environmental, and related questions. In order to use ethnobotanical data in this manner, however, one must develop a methodological and analytical framework which logically and consistently relates the botanical debris of civilization to human activities, and ultimately, to society.

The approach used in this study does not assume that ethnobotanical evidence "speaks for itself". Rather, our methodology and interpretations depend on our view of how people interact with their botanical environment. Therefore, ethnographic and historical evidence will be used to help develop an understanding of these interactions.

Once a suitable analytical framework has been established (Chapter 4), substantive goals can be pursued. In this study, different lines of ethnobotanical evidence from Malyan will be used to reconstruct the third millennium environment and to trace anthropogenic changes in it through time; an outline of the agricultural economy will be presented as well. In addition, an assessment of local self-sufficiency in agricultural production will be made.

A beginning assessment of the degree to which subsistence capabilities affect the growth of social complexity (that is, whether they promote, limit, or allow it) must begin with an understanding of human/land relationships. By focusing on some of the ways in which the increasingly differentiated population of the Kur basin supported itself and altered its environment, this study will contribute substantially to the discussion of the role of human/land relationships in the growth and spread of complex social systems.

CHAPTER II

ENVIRONMENT AND HUMAN GEOGRAPHY

The Provincial Level

Throughout its long history, the province of Fars in southern Iran has exhibited a cultural unity. Nevertheless, it is an area sufficiently large to include within its borders geographical and economic variety. The Zagros mountains act both to isolate and facilitate communication between populations within this broad territory. Numerous intermontane valleys are connected to the main avenues and centers of commerce and communication by dirt roads, and the movement of the Qashqai, Basseri, and Mamasani nomadic tribes links the uplands of northern Fars and the lowlands of southern and western Fars (Paydarfar 1974:15, Barth 1961:2). Prehistoric and early historic periods also saw movement of people and goods, from Khuzestan to the northwest and the Iranian plateau to the east (Chapter 1). It is therefore useful to look at the broad geographic characteristics of the lands surrounding Malyan, itself located on one of the larger intermontane valleys of the Zagros to see what resources these areas might have had to offer, and to understand the effect of the surrounding regions on local socio-cultural developments (Fig. 2.1).

Topography

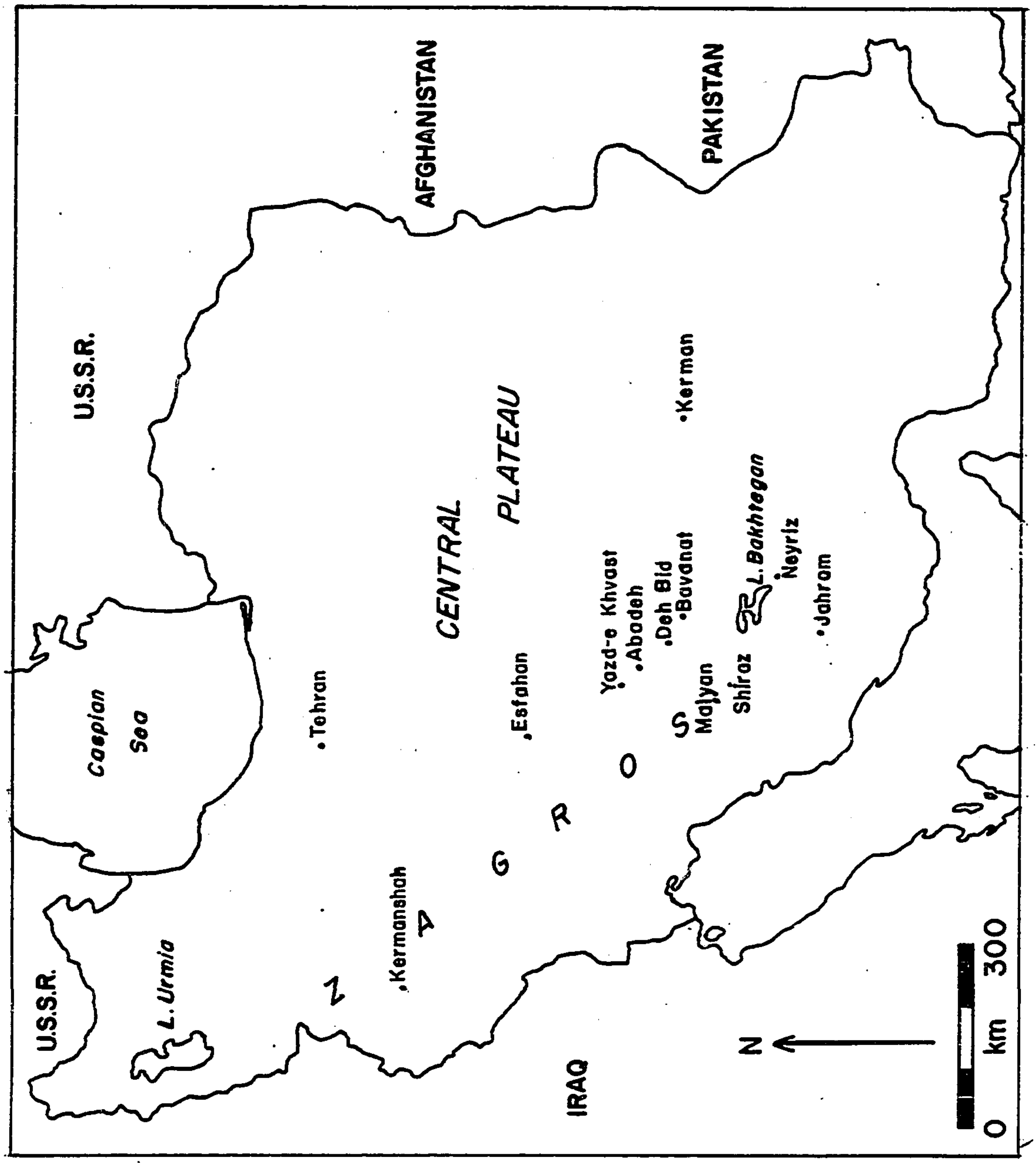
The topography of Fars is characterized by the alternation of the northwest-to-southeast running ridges and valleys of the Zagros mountains. From northeast to southwest, the elevation of the valleys decreases, reaching sea level on the Gulf coast. Erosion has left bare rock ridges in some places, and eliminated any depth of soil from much of the remaining slopes. The Kur basin is one of a number of flat or gently sloping valleys with ample soil, which lie between the overthrust plateau edge and the folded Zagros ridge and valley system (Fig 2.3).

Climate

Southern Iran has traditionally been divided into environmental regions largely on the basis of climate. Iranians distinguish the "frontier" (**sarhadd**), the "cold country" (**sardsir**), and the "warm country" (**garmsir**). The first corresponds to the summer pastures of the nomads and the last to the winter pastures (Monteil 1966:15). In the southern Zagros, the highest sections of the garmsir correspond to the upper limit of date cultivation.[1] Bobek(1952) defines a temperate clime on the basis of vegetation, unnamed in Persian, but understood to be a transitional zone between the garmsir and the sardsir. Classification of particular locations into one of these categories can be variable. The Arab geographers

[1] The upper limit of date cultivation ranges from 900 m (southwest of Shiraz) to 1200 m (southeast of Shiraz)

Fig. 2.1.
Iran


U.S.S.R.
AFGHANISTAN
PAKISTAN
CENTRAL
PLATEAU
Caspian
Sea
Tehran
Esfahan
Kerman
Yazd-e Khvast
Abadeh
Deh Bid
Bavanat
L. Bakhtegan
Neyriz
Jahram
Shiraz
Malyan
Z A G R O S
Kermanshah
L. Urmia
U.S.S.R.
IRAQ
N
0 km 300

traditionally placed the Kur basin, including the Beiza district,[2] in the cold country (Schwarz 1896:12, Ibn Hauqal 1964 [988]). In contrast, Shiraz is on the border between the hot and cold country (Schwarz 1896). On the basis of agricultural production, Bobek (1952) would place the Beiza district in the transitional zone, and a Qashqai (Bahman-Begi 1966 [1945]) places it in the sarhadd ("frontier", the region of the highest summer pastures).

Most of Fars, including even the mountainous regions, is governed by a Gulf Coast type ("Golfkustentyp") climate(Bobek 1952:70), with the bulk of the annual precipitation falling during the winter months (November to April). The southern and lower regions are characterized by desert to semi-arid conditions ("BW" and "BS" in the Koeppen system). Shiraz,the Kur basin and areas of the north and west are characterized by a relatively cool Mediterranean climate ("Cs" in the Koeppen system; Ganji 1955:271-283). Shiraz is near the southeastern limits of dry farming (Lockwood 1974:Fig. 4.9). A 43-year average for precipitation recorded in Shiraz is 355 mm/yr, falling mainly between November and April. Every five years that figure is greater than 435 mm or less than 230 mm. Every ten years it is greater than 495 mm or less than 175 mm (Abtahi et al. 1970). Shorter records available for Marv

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(Bobek 1952).

[2] Malyan, 46 km northwest of Shiraz, is located in the Beiza district.

Dasht give a relatively lower seven-year average of 235.4 mm (Kortum 1976:54, citing Irrigation Corporation of Iran); this figure is probably an underestimate, however. There is a rainfall cline in the Zagros, generally decreasing from northwest to southeast, and also from the mountains eastward to the central plateau (Great Britain 1945:157).

Average temperatures in Shiraz range from 5.4°C in January to 26.1°C in July. The thirteen year average minima and maxima are -5°C and 17°C in January; 12°C and 42°C in July (Ganji 1955:226,230). Since precipitation falls mainly in the winter, it is cold enough for snow. In the spring of 1977, the last snows melted from all but the highest mountaintops around the Kur basin in the beginning of April. Altitude differences tend to accentuate latitude differences with respect to temperature. Temperatures are somewhat lower on average on the Marv Dasht than in Shiraz, as the area is both further north and higher in elevation. Therefore effective moisture available to plants is greater.

Prehistoric Climate and Vegetation[3]

In general, the Pleistocene environment of west Asia was a cold, dry steppe (H.E.Wright 1977). Although the results of paleoclimatological research in the southwestern Zagros have been disappointing,[4] more definitive results

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[3] This discussion largely follows van Zeist and Bottema (1977).

[4] H.E. Wright has carried out the only paleoclimatological study to date in Fars province. Samples taken from several marshes near Shiraz yielded quantities of pollen

are available for the northern and central Zagros at lakes Zeribar and Mirabad (van Zeist and Bottema 1977). During the late glacial and early recent periods (ca. 20,000 to 10,000 B.P.), the limiting factor for the spread of trees was dryness. The pollen cores show a gradual increase in the per cent of arboreal pollen starting at about 10,000 B.C., and reaching a maximum at about 4250 B.C.[5] The major components of the modern forest analogs of the post-Pleistocene palynological spectra are oak (*Quercus*), maple (*Acer*), pistachio (*Pistacia*), and almond (*Amygdalus*). The last three are the major components of the xerophilous southern Zagros forests. The less important genera mentioned below are generally restricted to warmer climes (tamarisk), gallery forest (tamarisk, willow), and more cool moist environments (beech). Juniper is widely distributed in the northern Zagros; although it is not common today in the southern Zagros, it is reported to be an important component of the natural vegetation (Zohary 1963: 92-94).

Pistachio recolonized the northern and central Zagros first. Pistachio pollen declines in the sixth and fifth millennia, and by 4250 B.C., the vast majority of arboreal pollen is oak. Nowadays, under a given climate regime, as rainfall increases, oak forest replaces pistachio-almond

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insufficient for environmental reconstruction (1976, p.c.).

[5] MASCA calibrated radiocarbon dates (Ralph et al. 1973) are used in this study. The original report by van Zeist and Bottema uses the date 5500 B.P.(=4250 B.C., calibrated).

forest (Zohary 1963:6). Thus, a precipitation increase is suggested by 4250 B.C. The pollen of other species, including pistachio, maple, tamarisk (Tamarix), beech (Fagus), willow (Salix), and even juniper (Juniperus) are also present in low amounts.[6] Oak is presumed to have gradually spread down the Zagros from mountain refugia of western Syria, the Levant, and southwestern Anatolia from the end of the Pleistocene (van Zeist and Bottema 1977:81, cf. van Zeist and Woldring 1978). The rate of southeastward exansion of the oak forest cannot be estimated, because the Mirabad cores could not be fully dated. However, close parallels between the Zeribar and Mirabad pollen diagrams indicate that the modern vegetation and climate became established by 4250 B.C. at Zeribar, and perhaps at Mirabad as well. It is not known when the oak forest became established at its southeastern limit in the Kur basin, so post-Pleistocene migrations cannot be entirely discounted in the explanations of changing forest utilization to follow (Chapter 6).

Modern Vegetation

Throughout Iran, the distribution of vegetation is anthropogenic, and is characterized by severe deforestation. Presently forested areas are discontinuous. Evidence for the reconstruction of the natural vegetation comes from

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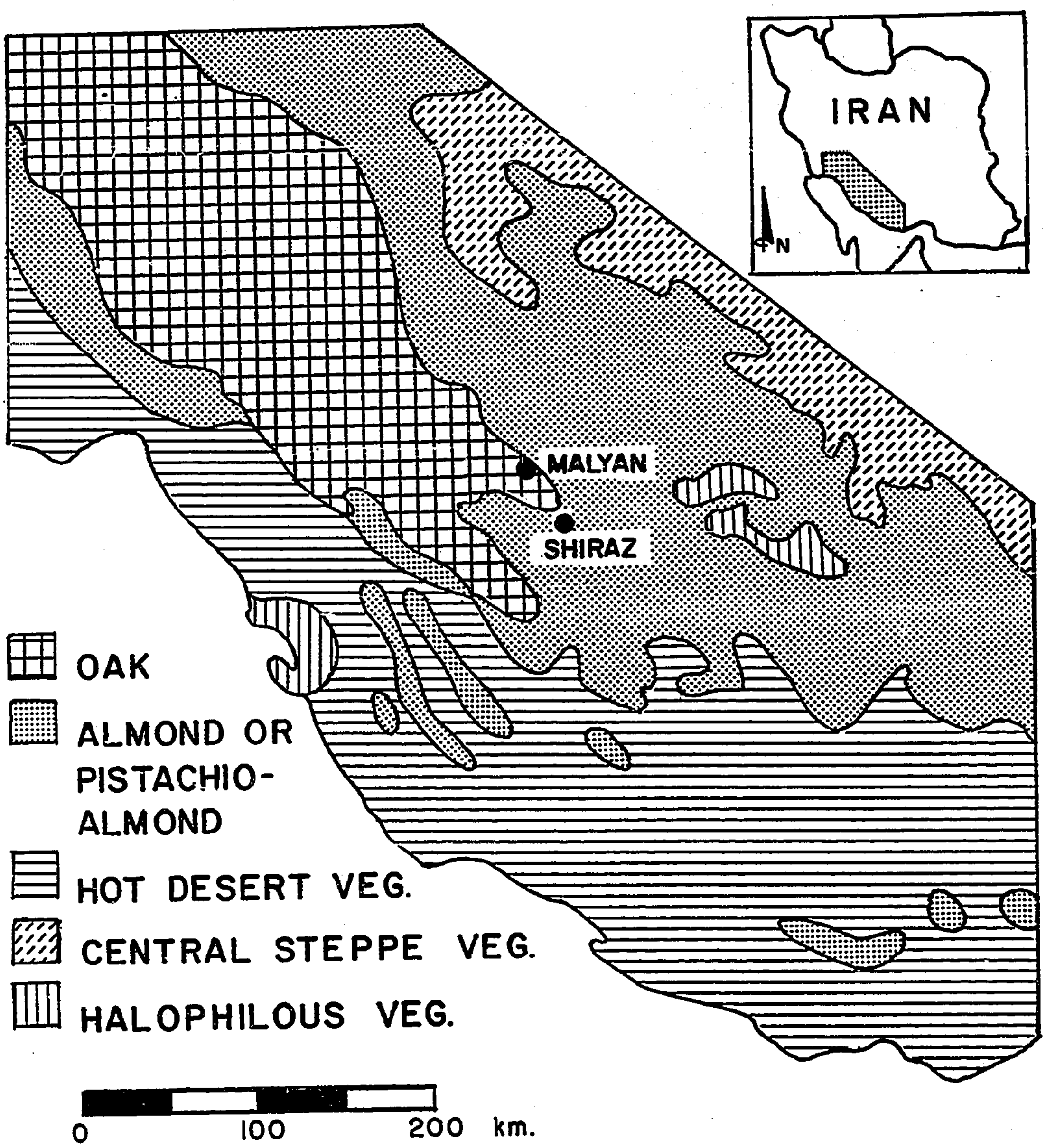
[6] Maple, pistachio and almond tend to be under-represented in pollen diagrams (Freitag 1977, van Zeist and Bottema 1977).

remnant forests of the less populous areas. Also, the parallel series of ridges and valleys, and microclimatological variation due to differences in insolation of slopes mean that different vegetation types will be interdigitated on the landscape. For these reasons, although vegetation zones can be defined, their boundaries cannot be drawn exactly. An idealized vegetation transect from the Gulf coast to the interior plateau (southwest to northeast) passes through several natural vegetation zones (Zohary 1963:85 ff.). Generally, the vegetation map prepared by Zohary(1963) shows sub-tropical Nubo-Sindian hot desert vegetation towards the coast (Fig. 2.2). Within this vegetation zone two important wild plants are jujube (Zizyphus) and caper (Capparis), while the date palm (Phoenix dactylifera) is cultivated. A narrow zone of almond or pistachio-almond steppe forest is reached as altitude increases (at about 750 m), followed by the Zagrosian xerophilous deciduous oak forest, which is in the higher mountains (at about 1250 m) (Zohary 1963:42 ff.). The eastern slopes of the Zagros are covered with the almond or pistachio-almond forest, and the interior has Artemisia steppe and desert vegetation. Local conditions may determine associations of halophytic vegetation, gallery forest or other poorly represented plant communities.

Note that Malyan is located in the zone of oak forest, but within a 50 km radius of the pistachio-almond forest, and within a 150 km radius of the sub-tropical vegetation.

Fig. 2.2.
Natural Vegetation of Southwestern Iran
(Source: Zohary 1963)


IRAN
N
MALYAN
SHIRAZ
OAK
ALMOND OR PISTACHIO-ALMOND
HOT DESERT VEG.
CENTRAL STEPPE VEG.
HALOPHILOUS VEG.
0
100
200 km.

It is conceivable that a fairly small climate change could alter the relative proportions and absolute numbers of the various species. However, vegetation changes reported in this study will be shown to have resulted from human activities.

Human Use of the Natural Environment

Fars today is populated by sedentary and nomadic peoples. The seasonal variation in the farmer's schedule is determined by the climatic extremes of winter and summer, rather than by any change of location. In contrast, the pastoral nomadic life of the tribes minimizes the effects of climatic variability, while maximizing mobility. There is some alternation of population between sedentary and nomadic lifestyles due to changes in the political or economic situation (Barth 1961; cf. Bates 1973, Irons 1975). On the whole though, these two groups remain distinct, and their interaction affects the economy of the province. The economic diversity within southern Iran makes local trade and exchange profitable. Also, major east-west trade routes pass directly through the province, or skirt its seaward edge.

The sedentary population of Fars consists primarily of peasants, although in this century there has been an increase in industrialization and consequent urbanization. The tremendous environmental variability within the province encourages diversity of agricultural production. The following list provides some indication of this diversity

(Table 2.1).

Table 2.1. Agricultural Products of Fars

Region	Products
Garmsir (to 1200+ m)	date palm, citrus fruits
Transitional (1200-2100 m)	cereals, rice, cotton, sesame, sugar beet, fruit and nut trees (pomegranate to 1500 m, fig, apricot, pear, almond, pistachio), grape, opium
Sardsir (2100-2800 m)	cereals, rice, cotton, potato, walnut, mulberry, apple, fruit trees (mostly as above), grape, opium
Sarhadd (>2800 m)	pasture (tree line), snow line at about 4500 m

Compiled from Bobek (1952), Demorgny (1913), personal observation

The nomads overcome environmental variability directly by their seasonal migrations between winter and summer pastures. Nowadays the strength of their impact on local life and economy depends on political factors. It is not known, however, whether full time pastoral nomads were an economic or political force in the ancient past.

The point of this discussion has been to show that environmental variability exists. But it is also important to note how it is utilized. Trade in vegetable products has been attested from garmsir to sardsir, and vice versa, before the era of mechanized transport. Kämpfer(1968 [1685]:88) noted a donkey and mule train near Yezd-e Khast(300 km north of Marv Dasht), headed north from Jahrom(220 km south of Marv Dasht), loaded with dates. He also reported how resin from pistachio trees is processed into a mastic (**kanderūn**) and shipped "throughout all of Persia"(1968 [1685]:95). An eighteenth century traveler, Cornelius LeBruyn, discusses several trees and shrubs growing and grown in Fars, and mentions several exports to Europe and the East Indies: grapes (Vitis vinifera; as preserves or raisins), almonds, and pistachios (1737:226). Cereal and melons (Brugsch 1863:200) and fruit (Morier 1812:151) were sent to Shiraz from Marv Dasht and Abadeh. A somewhat more substantial item is also reported: the wood of "wild cherry" (presumably almond), from the mountain range north of Lake Bakhtegan "forms a staple article of commerce" (Lovett 1872). Trade in staple crops between the warm country (Jahrom) and elsewhere was said to be necessary, as there was insufficient water for the self-sufficiency of that district in wheat (Triticum) and barley (Hordeum) (Abbott 1857:165).[7]

In summary, Fars is a mountainous province with an arid to semi-arid climate. Climate and vegetation follow altitudinal and latitudinal clines. The lower elevations are arid and sub-tropical. In the north, the higher elevations support an open oak forest, and rainfall agriculture is possible. In a southerly and downward direction, the sparse and more xerophilous pistachio-almond and pistachio-almond-maple forests grow; rainfall

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[7] Jahrom is in a low rainfall area, although much of the cultivated land is unirrigated today (Census 1970). In such circumstances, water sufficiency may become a function of man-made improvements and the political and economic choices in water distribution.

agriculture becomes increasingly difficult to impossible.

The rest of this chapter will focus on human use of the landscape in the Kur basin, and the factors that help determine it (Fig. 2.3).

The Kur River Basin

The Kur basin is about 120 km long, and its greatest width is 30 km. The average elevation of the plain is about 1600 m, though the highest mountain in the area reaches 3940 m (Abtahi et al. 1970). It is described as "largely a river alluvial plain, usually bordered by a piedmont plain near the mountains and some alluvial fans along the foot of the mountains and hills" (Abtahi et al. 1970:4). The basin gradually decreases in elevation from northwest to southeast, draining at its easternmost end into the very saline lake Bakhtegan. In addition to the mountains surrounding the valley, there are also a few mesas and uplifted surfaces within the valley itself which are essentially bare of soil and vegetation. The plain has "a warm, dry Mediterranean" climate; the mountains to the south and north are semi-arid to subalpine with cold winters (Bordbar 1972).

The basin is divided into several administrative subareas,[8] which are characterized by certain ecological and economic differences. Most of the plain is in the

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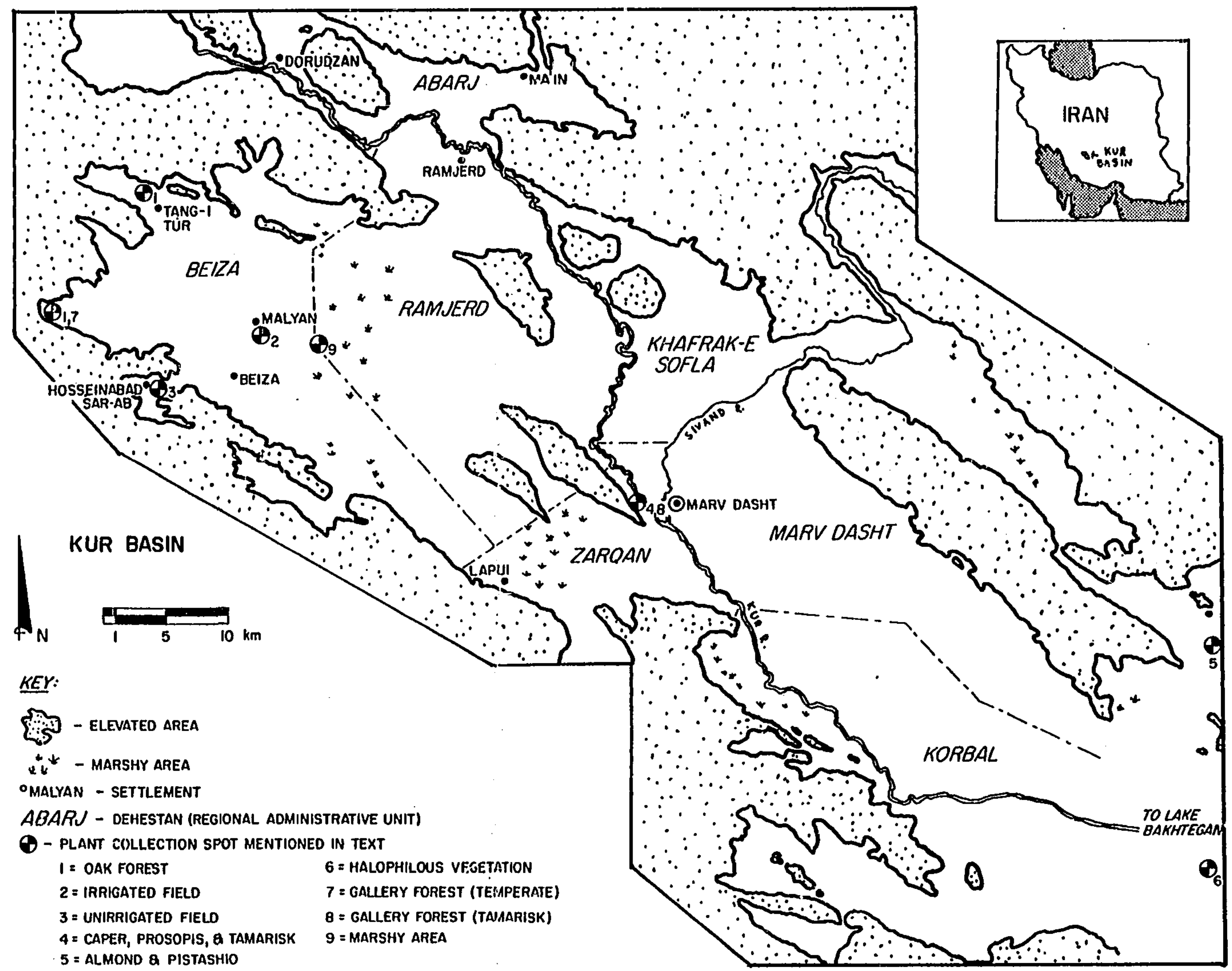
[8] Each of these subareas is called a "dehestan". Information about six dehestans (Beiza, Ramjerd, Abarj, Khafrak-e Sofla, Marv Dasht, and Korbal) was gleaned from the Village Gazetteer (Census 1970) and is analyzed

Fig. 2.3.
The Kur Basin


KUR BASIN
IRAN
KUR BASIN
DORUDZAN
ABARJ
MAIN
RAMJERD
TANG-I TUR
BEIZA
MALYAN
RAMJERD
KHAFRAK-E SOFLA
BEIZA
HOSSEINABAD SAR-AB
SIVAND R.
MARV DASHT
MARV DASHT
ZARQAN
LAPUI
KUR R.
KORBAL
TO LAKE BAKHTEGAN
N
1 5 10 km
KEY:
– ELEVATED AREA
– MARSHY AREA
MALYAN – SETTLEMENT
ABARJ – DEHESTAN (REGIONAL ADMINISTRATIVE UNIT)
– PLANT COLLECTION SPOT MENTIONED IN TEXT
1 = OAK FOREST
2 = IRRIGATED FIELD
3 = UNIRRIGATED FIELD
4 = CAPER, PROSOPIS, & TAMARISK
5 = ALMOND & PISTASHIO
6 = HALOPHILOUS VEGETATION
7 = GALLERY FOREST (TEMPERATE)
8 = GALLERY FOREST (TAMARISK)
9 = MARSHY AREA

drainage of the Kur river, and today the river provides much of the water available for irrigation. The river is cut deeply into the plain, and cannot be used for irrigation without either dams (LeStrange 1912:65)' or mechanical pumps (Kortum 1976:156). It takes a 40 km canal paralleling the river to bring water to the level of the fields at the base of the mountains in the Ramjerd district (W. Sumner 1981, p.c.). Malyan is located in the Beiza district, in a subdrainage basin not watered by the Kur. It has, however, at least six major fresh water springs (W. Sumner 1981, p.c.). The limestone substrate of several other areas bordering the plain contains fresh and brackish springs as well.

Soils

The soils of the western 60% of the Kur river basin (ca. 193,000 ha) have been mapped (Abtahi et al. 1970). Fine to medium textured alluvial soils characterize much of this portion of the plain (about 38%). Brown soils make up 23%, solonchaks about 6%, and low humic gley soils about 27%. There are a number of hills and rock outcrops, and a small

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below.

' A dam across the Kur river in the Ramjerd district was built at least as early as the Bakun period (fifth millennium). A nineteenth century observer commented that when it fell into disrepair, "the inhabitants of Ramjerd used to construct a temporary dam of woodwork with great trouble and at much expense; but every year their work was swept away by the spring floods, and the canals remained empty to the end of the year, and in consequence, Ramjerd had no gardens" (Houtum-Schindler 1891).

amount of marshy land. About 25% of the land is classified as strongly saline, and about 16% is slightly to moderately saline.

The land in each dehestan can be characterized as follows (Fig. 2.2): Generally, the Beiza district has deep alluvial soils on the plain, though the soil of alluvial fans is shallower and very gravelly. The Ramjerd district is located on the river alluvial plain. Deep alluvial soil covers much of this area, but there are numerous patches of strongly saline solonchaks, moderately saline soil, and poorly drained soil. Separating Beiza from Ramjerd is saline land and seasonal marsh; Malyan lies one or two kilometers from this area. Soils of the Abarj district are alluvial, with good to low permeability. Khafrak-e Sofla has deep brown soils of the river alluvial plain, with a few moderately saline patches. The soils of Korbal are deep, fine-to-medium textured brown soils. They are moderately to strongly saline in the southern part of the district, and salinity increases as one approaches Lake Bakhtegan. Much of the highly salinized land would not be suitable for agriculture anyway, as it is very poorly drained. These lands are concentrated toward the south and east; at the easternmost edge of the basin are the salt flats bordering Lake Bakhtegan.

Salinity and poor drainage are problems in some areas. Dividing Beiza from Ramjerd is saline land, used for grazing. It is quite saline in Marv Dasht dehestan, north of the lower course of the Kur river. The land immediately around the Kur and the Sivand is not saline. Heavy earth moving equipment has been used to provide drainage canals in the Beiza and Ramjerd areas in recent years, though poor drainage is still a limiting factor for agriculture in the center of the plain.

Vegetation

Human use of the environment has altered the vegetation of the plain and surrounding mountains tremendously over the millennia of occupation. The mountains have been largely deforested for a long time, at least in the more populous regions.[10] Virtually all cultivable areas on the plain itself are farmed. The factors limiting the expansion of agricultural area are poor drainage and soil salinity. Even these marginal areas have economic significance as pasture. The Kur river basin near Marv Dasht city is a funnel for both the Basseri and the Qashqai tribal migrations (Barth 1961), and consequently the entire plain is heavily grazed in the spring and fall.[11] Camelthorn (Alhagi camelorum), licorice (Glycyrrhiza glabra), and Euphorbia spp. grow, in addition to grasses (Myers 1973).

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[10] Wells commented that "firewood (was) a little scarce near Persepolis" (1883). Morier noted that with two exceptions, "there is nothing like a shrub of any consequence, much less a tree, to be seen" between Shiraz and Persepolis (1818).

[11] Pelly (1864: 178) remarks that 6000 mares would graze in the Beiza district during these seasons. This is when the nomads pass through the area.

The Kur basin straddles the border between the Zagrosian oak forest and the pistachio-almond and pistachio-almond-maple forests. Consequently there is some interdigitation of species, with oak-covered mountains bordering warmer valleys of almond (Zohary 1963:43). Within these broad areas a variety of trees is found growing wild along streams and wadis; near villages, groves of timber or orchard trees are planted. There is also a distinctive halophytic vegetation in some areas.

Mountains at the western end of the valley (near Tang-i Tur and along the Kur above Dorudzan in Kam Firuz harbor a light forest of primarily oak; other types include pistachio, maple, and almond in fairly small quantities (App. G). The virtual absence of ground cover is due to grazing; this area sees the passage of thousands of Qashqai nomads and their camels, donkeys, horses, and flocks of sheep and goat, as well as the animals of more locally based shepherds. One can see evidence of browsing in the height to which pistachio trees are nibbled by camels. Forested areas such as this provide, in addition to grazing land, firewood, wild fruits, nuts and other tree products, and medicinal plants. Wild bitter almond (Amygdalus scoparia), also associated with the pistachio-almond forest has been seen growing along the lower and south-facing slopes of the oak forest.

A degraded pistachio-almond, or, less commonly, pistachio-almond-maple forest grows on the eastern end of the plain. Fuel-collecting and grazing take place here. The areas of Pistacia eurycarpa and Amygdalus scoparia (bitter almond) seem to be "very resistent [sic] to heavy grazing. Goats will eat the small Amygdalus [almond] trees and the trees will take a very low shrub growth form" (Myers 1973:9).

Shrubby tamarisk and a few other species (such as Halocnemum strobilaceum) grow in the saline, poorly drained soils of the eastern end of the valley approaching Lake Bakhtegan.

Wild riparian vegetation is not very common due to the paucity of perennial, or even intermittent, streams in non-populated areas. The species I have observed in the western portion include: eastern sycamore (Platanus orientalis), willow (Salix excelsa), hackberry (Celtis caucasica), and Vitex pseudo-negundo; species of poplar (Populus), ash (Fraxinus), and others are also reported (Sabeti 1966, Zohary 1963). On the Kur river, near Marv Dasht, the vegetation was quite different, with tamarisk and Lycium depressum shrubs.

In contrast to the wild stream side vegetation, fast-growing willow, poplar, and ash are frequently planted along natural or qanat-fed streams,[12] and are grown under varying amounts of care, from haphazard to aligned plantings, walled or unwalled, and generally ditched.

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[12] A qanat is an underground canal built to tap an aquifer; the earliest qanats are mentioned in Assyrian texts of the seventh century B.C. and were in use during the

Finally, planted groves of trees, orchards, and vineyards form part of the landscape; timber trees (willow, poplar, ash), fruit trees (apple (Malus), pomegranate (Punica granatum), cherry (Prunus spp.), apricot (Prunus armeniaca), fig (Ficus carica), quince (Cydonia)), and grapes are grown, for sale or local consumption. Grapes are the only fruit seen growing occasionally without irrigation. Walnuts (Juglans), especially near Ma'in (Fryer 1912:228, Ibn Batoutah 1877 [1325]: 52) and almonds are also reported (Census 1970).

Agriculture in the Kur River Basin

Although the environment of the valley is not totally homogeneous, the basic agricultural patterns are fairly uniform. The same crops are grown throughout most of the area. They include wheat, barley, rice (Oryza sativa), alfalfa (Medicago sativa), cotton (Gossypium), sugar beet (Beta vulgaris), and grapes (Census 1970). People keep flocks of sheep, herds of goats, and some cows, oxen, donkeys, horses, and mules. There is environmental and geographic variability, and each dehestan is distinctive in some ways.

Census of 1966. The Village Gazetteer (Census 1970) contains a plethora of data collected for the national Iranian census in 1966. For each province, every village is listed, along with population, economic, and agricultural

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Achaemenid period (English 1966: 160, n.10).

data. The quality of the data is quite uneven, however. For some villages, missing data entries are a problem. For many, estimated acreages and animal populations are recorded in unlikely round numbers. Despite this drawback, analysis of these data show some of the broad differences within the Kur basin, as well as the overall similarities. Some of the economic aspects of village life can be tentatively quantified.

Data from six of the dehestans of the Kur basin were compiled (Beiza, Ramjerd, Abarj, Khafrak-e Sofla, Marv Dasht, and Korbal). Khafrak-e Olya was omitted because it is far from Malyan, and Zarqan was omitted because there were very few villages listed. Among the examined dehestans, villages with very incomplete data were omitted from consideration as well. Finally, a few obvious inaccuracies were kindly corrected by W. Sumner, who has personally traversed most of the Kur basin.

Water sources (Table 2.2). Two areas are heavily dependent on the Kur river for irrigation, Ramjerd and Korbal. Abarj and Beiza get most of their water from qanats and springs. Khafrak-e Sofla is largely dependant on deep wells, and Marv Dasht relies on qanats and deep wells. Thus, the only water available to ancient Malyan other than rainfall would have been from a spring-fed irrigation system.

Household Economy (Tables 2.3,2.8). The household economy in the Kur basin is tied to the national economy.

Table 2.2. Water Sources of the Villages of the Kur Basin

Dehestan	No. Villages	River	Deep Well	Qanat	Spring	Well
Abarj	25	6	7	-	15	1
Beiza	77	-	8	45	42	-
Khafrak-e Sofla	18	5	13	4	-	-
Korbal	85	63	20	1	2	4
Marv Dasht	14	1	6	8	3	-
Ramjerd	53	44	6	4	2	1

Source: Village Gazetteer (Census 1970).
N.B.: Some villages have multiple water sources.

All villages produce some non-subsistence crops for market, notably sugar beet. Furthermore, rice is one of the dietary staples which is not produced in large enough quantities for regional self-sufficiency. Nonetheless, a beginning understanding of household requirements can be gained from a perusal of the summary statistics of Table 2.3.

Table 2.3. Per Capita Allocation of Agricultural Production, Kur Basin

	Abarj	Beiza	Khafrak-e Sofla	Korbal	Marv Dasht	Ramjerd
No. Villages	25	77	18	85	14	53
Tot. Pop.	10131	23391	8908	28630	3399	12844
Av. Household size	4.7	4.9	5.2	5.0	5.5	5.0
ha Barley/ person	.05	.13	.03	.07	.23	.29
ha Wheat/ person	.29	.37	.22	.43	.59	.82
ha Grain/ person	.34	.50	.25	.50	.82	1.11
No. Animals/ person	3.7	2.3	1.9	1.9	2.6	2.5

Source: Village Gazetteer (Census 1970).

The comparatively large household size in Marv Dasht dehestan is probably related to proximity to the city of Marv Dasht. That city is on the highway between Shiraz and the north (Isfahan and Tehran), and is near several factories. A number of villagers from this area may commute to the city or to the factories.

The area of land per capita under grain cultivation is quite low compared to estimates for the ancient population made below (Chapter 6). Yields per hectare are probably high because of improved grain varieties and the greater availability of irrigation water due to mechanical pumping. Also, in contrast to third millennium Malyan, a substantial proportion of human subsistence needs is met by rice.

Grain Crops (Table 2.4). The major grain crop in the Kur basin is wheat. Approximately 75% of the cultivated grain land is in wheat. Barley follows in importance, with 20% of the cultivated grain acreage. Rice accounts for only 5% of the area of grain cultivation, mostly in the well irrigated Korbal district, and is not included in the following discussion because it was not grown during the ancient period under consideration.

Wheat is grown primarily for human consumption, and barley for fodder. All districts grow more wheat than barley, whether irrigated or unirrigated. Wheat is less drought-resistant than barley (Nuttonson 1957:7), and is more likely to be irrigated. Conversely, barley is more often associated with rain-watered fields than is wheat

(Table 2.5). With the exception of the Marv Dasht district, the Beiza district grows proportionally the most barley. The Marv Dasht district grows slightly more barley, probably because of a limited water supply and much greater amount of soil salinity, whereas in the Beiza district the determining factor is probably just the limited supply of water for irrigation.

Animals (Table 2.6). Sheep and goat are the most numerous domesticated animals and kept primarily for milk and meat. Cows are also kept for milk. The large work animals are donkeys, oxen, horses, and mules. Depending on local conditions, all can be allowed to graze. If pasture is poor or insufficient, the larger animals (especially cows) are stall-fed year round. All animals must be stall-fed through at least the snowy part of the winter.

A correlation analysis might be expected to bring out some of the relationships between animals and land use.[13] The correlation coefficient $\underline{r}$ can be used as a descriptive statistic. Its value lies between -1 and +1. The greater the value of $\underline{r}$, the greater the degree of association between variables.

There is a positive correlation between equids (horses, donkeys, and mules) per village and village population size, and to a lesser extent between sheep and goat per village and village population size. The number of cows and oxen is

[13] Correlation matrices and other descriptive statistics were calculated with the aid of the MIDAS statistical program of the University of Michigan Computing Center.

Table 2.4. Grain Acreage in the Kur Basin (ha)

Dehestan		Barley		Wheat		Water Regime		Grain Crop		Total ha
	No. Villages	Dry	Irrig.	Dry	Irrig.	Dry	Irrig.	Barley	Wheat	
Abarj	25	210	305	233	2676	443	2981	515	2909	3424
Beiza	77	1470	1603	2824	5773	4294	7376	3073	8597	11670
Khafrak-e Sofla	18	140	470	200	3992	340	4462	610	4192	4802
Korbal	85	48	1932	205	12153	253	14085	1980	12358	14338
Marv Dasht	14	320	456	370	1619	690	2075	776	1989	2765
Ramjerd	53	1247	2522	1418	9137	2665	11659	3769	10555	14324
Totals	272	3435	7288	5250	35350	8685	42638	10732	40600	51323

Source: Village Gazetteer (Census 1970).

Table 2.5. Grain Acreage and Water Regime, the Kur River Basin (per cent of area)

Dehestan	Dry		Irrigated	
	% ha Barley	% ha Wheat	% ha Barley	% ha Wheat
Abarj	47	53	10	90
Beiza	34	66	22	78
Khafrak-e Sofla	41	59	11	89
Korbal	19	81	14	86
Marv Dasht	39	61	22	78
Ramjerd	46	54	22	78

Source: Village Gazetteer (Census 1970).

Table 2.6. Livestock Population in the Kur Basin (Total No./ Per Person)

Dehestan	No. Vil-lages	Donkey, Horse, Mule	Goat, Sheep	Cow, Ox, Calf
Abarj	25	1499 (.15)	33430 (3.30)	2354 (.23)
Beiza	77	2508 (.11)	44009 (1.88)	7613 (.33)
Khafrak-e Sofla	18	1031 (.12)	13773 (1.55)	2063 (.23)
Korbal	85	3224 (.11)	43881 (1.53)	8043 (.28)
Marv Dasht	14	451 (.13)	7940 (2.34)	551 (.16)
Ramjerd	53	2066 (.16)	26234 (2.04)	4257 (.33)

Source: Village Gazetteer (Census 1970).

correlated with human population, but less than is the case for the other animals. One might also expect there to be relatively high correlations between population (human and/ or animal) and area of cultivated grain, but these expectations are not always met (Table 2.7).

Table 2.7. Correlation between Animals, Population, and Land in Wheat and Barley per Village

	Horse, Donkey, Mule	Goat, Sheep	Cow, Calf, Oxen	Oxen only	Human Population
Abarj: No. villages=25, r(.05)=.3961					
Pop.	.9628	.5508	.2246	.3361	-
Grain	.3252	.0152	.4811	.7532	.2479
Beiza: No. villages=77, r(.05)=.2242					
Pop.	.9070	.8827	.4481	.6731	-
Grain	.4737	.5149	.4467	.6668	.5708
Khafrak-e Sofla: No. villages=17, r(.05)=.4821					
Pop.	.9573	.7997	.7709	.2243	-
Grain	.8941	.5906	.8618	.1586	.9019
Korbal: No. villages=84, r(.05)=.2146					
Pop.	.4278	.5947	.4226	.3273	-
Grain	.3552	.2071	.1660	.1278	.5251
Marv Dasht: No. villages=10, r(.05)=.6319					
Pop.	.9672	.6758	.6355	.8182	-
Grain	.9834	.4833	.6617	.9214	.9536
Ramjerd: No. villages=53, r(.05)=.2706					
Pop.	.8665	.5674	.6774	.4976	-
Grain	.5367	.2719	.4057	.2985	.5973

Source: Village Gazetteer (Census 1970). No. villages considered is less in Tables 2.2-2.6 because oxen were not listed separately in the Village Gazetteer.

A number of variables are not taken into account by a simple correlation analysis. These include the amount of grazing land (pasture and fallow) available to the animals and the degree of market involvement. For example, the lack

Table 2.8. Household Economy, Kur River Basin

Av. per Household	Abarj	Beiza	Khafrak-e Sofla	Korbal	Marv Dasht	Ramjerd
ha barley	.24	.65	.35	.34	1.25	1.48
ha wheat	1.36	1.80	2.43	2.15	3.21	4.14
ha grain/hh	1.60	2.45	2.78	2.49	4.46	5.62
sheep/goat	15.7	9.2	8.0	7.6	12.8	10.3
lg. anim	.8	2.1	1.8	2.0	1.6	2.5
anim/hh	16.5	11.3	9.8	9.0	14.4	12.8
av. hh size	4.7	4.9	5.2	5.0	5.5	5.0
No. Villages	25	77	18	85	14	53

Source: Village Gazetteer (Census 1970).

of correlation between sheep/goat and grain area in the Abarj district is probably related to the very large amount of pasture available in that area. The effect of sharecropping on grain production and the local economy also cannot be determined from the Village Gazetteer.

Examination of the 1966 census data did not reveal many unambiguous regularities in the relationship between crop area, human populations, and animal population. Nonetheless, it is possible to come away with some appreciation of quantitative aspects of subsistence economy in the Kur basin (Table 2.8). Korbal and Ramjerd are most dependent on the Kur river for irrigation, and the Beiza district on qanats and springs. Wheat and barley are the main crops. Sheep and goat are the major domesticated animals, followed by cows, donkeys, oxen, horses and mules.

The number of animals is generally more highly correlated with the size of the human population than with the area cultivated. The "average" family of five in the Kur basin would cultivate on average 2-4 ha of wheat and less than a hectare of barley. They would own 7-15 sheep or goats and 2 cows or draft animals.

CHAPTER III

ENVIRONMENT AND ETHNOGRAPHY, MALYAN AND VICINITY

The territorial limits of environment and land use at the local level are defined by the activities of the members of the community. In most contexts, this includes Malyan, both the village and its fields, as well as nearby pasture. In the recent past, it would have also incorporated non-contiguous areas exploited by villagers whose use would not have necessitated interactions beyond that of the social relationships of villagers. The latter areas include the mountain forests at the north and west end of the plain, which are traversed by seasonally transitory nomads, and used by people from other villages as well.

Immediately around Malyan, the landscape is totally anthropogenic. It is not uniform, however. Most of this land is cultivated. A variety of crops with differing water requirements are grown in the fields surrounding the village, a portion of the fields lie fallow, and there are protected gardens and groves. Areas utilized directly for pasturage include the poorly drained center of the plain, disturbed areas along roads, streams and ditches, and uncultivated parts of the archaeological site of Malyan.

The villagers of Malyan are mostly subsistence farmers.

Cultivated acreage is primarily devoted to cereal and sugar beet production. Planted in the fall, sugar beet is raised as a cash crop. Fodder crops are grown, including the straw of cereals, barley grain, and alfalfa. Smaller quantities of sesame, sunflower, bitter vetch, lentils, beans, melons, maize, and a few garden crops such as tomatoes, potatoes, onions, and herbs are grown. A number of families have planted grapes, and there are a few apple trees.

It should not be forgotten that Malyan is a twentieth century peasant village. Obviously, the organization of production is the result of modern technology and recent socio-economic conditions, so direct comparisons to ancient agricultural practices cannot be supported. Firstly, production is geared only partially toward subsistence; landlords who own much of the arable land hire villagers as wage laborers or use them as sharecroppers. Some of the landlords' harvest is destined for local consumption, but some is sent out to the larger markets in Marv Dasht and Shiraz. A sugar beet factory was built near Marv Dasht in 1935 (Kortum 1976:224), and much of the land (both landlord and peasant owned) is devoted to this revenue producing crop. Secondly, several crops are relative newcomers from an archaeological point of view. Clearly this is the case for species of New World origin, such as maize, sunflower, and tomato, but even some of the Old World crops, such as pomegranate and apple, are not common archaeologically for the earlier periods we are here concerned with (Chapter

5).[1] Thirdly, irrigation practices of today, dependent as they are on qanats in the Beiza district, and mechanical pumps elsewhere, cannot be considered the norm of the third millennium B.C.

The ethnographic field work upon which the remainder of this chapter is based was carried out primarily in the spring of 1977, with additional work during the three archaeological field seasons (Fall 1974, Fall 1976, and Summer 1978).

Ethnobotanical Field Work at Malyan

The present-day village of Malyan has a population of about 435, divided into 93 households (Census 1970). Most villagers grow a portion of their own food and keep at least a few anaimals for work or milk. Many villagers (men, women, and children) engage in locally available agricultural wage labor, and a smaller number have been employed by the Malyan Project for archaeological work. The village is located directly on the archaeological site of Malyan, straddling a small section of the ancient town wall. It was an obvious choice as a base for the ethnobotanical field work which needed to be done for several reasons. First, much of the basic plant collecting could be conveniently carried out concurrently with my immediate

[1] Helbaek (1966) reports pomegranate from seventh century B.C. Nimrud, and Hopf (1969) reports it from the Middle Bronze Age (second millennium B.C.) of Jericho. Apple, found frequently in European Neolithic contexts, is reported for mid-third millennium B.C. Ur (Ellison et al. 1978).

paleoethnobotanical responsibilities during the three excavation seasons. Second, in the course of the first two field seasons, I became acquainted with a few Malyanis, and was therefore able to arrange a two-month stay in the village during the spring of 1977 (March 18-May 28).

The purpose of the ethnobotanical field work was to obtain information about present-day agricultural practices and local plants and their uses. The ethnobotanical information provided below was obtained by interviewing various people. Information about crops was asked of a few farmers. Most of the information about field weeds and medicine was provided by an older woman of my acquaintance, but men, women, and children who I happened to meet while collecting were subjected to my frequent and repetitive queries about plants and their uses.

Most of the household activities reported here were observed primarily in the household in which I was living, but visits to a few friends and acquaintances in the village did not reveal any major differences in the basic activities reported below.

Crops

A short description of some of the crops raised today and their conditions of growth follows. Most of the information about planting practices and yield is from local consultants. Personal observation, combined with explanatory queries to local consultants, provided the details about household activities as they related to plant utilization.

Subsistence Crops

Wheat (gandom)

According to consultants, the seed stock of the wheat grown at Malyan comes from "emrikå," that is, the United States. Some herbarium specimens have been tentatively identified at the Royal Botanic Garden, Kew as bread wheat (*Triticum vulgare* =*T. aestivum*), and some as emmer (*T. dicoccum*).

Winter wheat is planted at the beginning of the month of Mehr (autumn, September 21), sown broadcast or sown in furrows by machine. It is irrigated after fourteen days, and then again in the spring, by which time it is about 10 cm tall. If the rains are insufficient, it may be watered a third or fourth time. It is harvested at the beginning of the month of Tir (summer, June 21). For comparison, Lambton (1953:366) reports:

> "In south Persia wheat and barley are sown between the first week in November and the first week in January. Barley is reaped about 15-20 April and wheat about the end of April to the beginning of May. In the uplands of the province of Fars the harvest begins roughly one month later, and on the plateau generally some 2 1/2 months later."

It is also possible to plant wheat in the beginning of spring; in this case, it is irrigated after one month, and is harvested 15 days after the beginning of autumn. No spring planting of wheat was actually observed in 1977.

Farmers said that seed is sown at a rate of 25-30 man (ca. 75-100 kg) per ha.[2] and will yield, in an average year at a rate of 15:1, ranging from 10:1 in a bad year to 20:1 in an exceptionally good year. For comparison, in the foothills south of Malyan, at Hosseinabad sar-e Ab, a farmer reported planting 15 **man** (ca. 45-50 kg/ha) for an unirrigated field, contrasted with 25 **man**/ha for an irrigated one. The yield for an unirrigated field would be 15:1, ranging from 10:1 to 30:1. Kortum (1976:211) cites farmers of the Kur Basin who report yields for irrigated wheat of 10 to 15-fold, and of 5-fold for unirrigated wheat. He also notes the correspondence of these figures with ones reported by Lambton (10 to 25-fold, irrigated; 5 to 12-fold, unirrigated) and Bobek (10 to 25-fold, irrigated; 5 to 8-fold, unirrigated). The rate of yield mentioned by the Hosseinabad farmer may be a bit high, but note that the actual harvest would be fairly small, since planting is sparse. Dry farmed crops suffer "total or partial failure ... considerabl[y]" more often than irrigated ones (Lambton 1953:364).

Barley (jo)

Barley grown at Malyan is the two-row variety, Hordeum distichon. It is sown a month after wheat (at the beginning of the month of **Abàn**, October 23), broadcast or by machine in furrows, and is irrigated right away. In the beginning of May, which is forty days after the Persian New Year (**No**

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[2] One man=ca. 3.3 kg (cf. Lambton 1953:409).

Ruz, March 21), it is irrigated again. Barley is harvested 35 days later, a few weeks before wheat. No fields of six-row barley were ever observed. One man said it was rarely planted, and others said never. Sometimes, small patches of barley are planted, and harvested as a green fodder several times in the course of the growing season.

Irrigated barley is planted 25 man/ha or less, and yields range from 15-20:1 to 25-30:1. At Hosseinabad sar-e Ab, 15 man (45-50 kg) per ha are planted for an unirrigated field , yielding 10-12:1 to 40:1, with an average of 15:1.

Summer Crops

Lentil (adas)

Lentils (Lens esculentum) are planted around the first of March, 20 days before No Ruz. The field is irrigated after 40 days; a second watering takes place 15 days later, and every 15 days thereafter, until the end of the spring. The crop is harvested at the beginning of the summer, after there have been about six waterings. Productivity estimates for lentil were not obtained.

Sesame (konjed/konjit)

Sesame (Sesamum indicum) is planted in the beginning of May, 40 days after the Persian New Year, and is irrigated at that time. A second watering takes place after 15 days, and again every 11 days until the beginning of the month of (Mehr, September 23), a total of about 13 times. Thus, it is a labor intensive crop. Productivity estimates for sesame were not obtained.

Perennial Crops

Grape (angur)

The vine (Vitis vinifera) is cultivated for its fruit. It requires a substantial input of labor initially, as the ground must be softened to a depth of about a meter. Cuttings are set in the soil in the beginning of spring, about 1.5 m apart, in rows separated by ditches that are a meter deep and a meter wide. Until the plants are two years old, they are irrigated every 15 days except in winter. In the third year, they receive one watering two months after New Year's, at the end of May, and a second watering in the beginning of autumn, after the harvest. This pattern continues thereafter. Although grapes are produced the second year, they are neither good nor of large size until the fourth year. One plant is good for about 14 years.

Other Fruits

Figs (anjir; Ficus carica), apricots (zardålu; Prunus armeniaca), and cherries (ålbålu; Prunus sp.) were said to be planted and cared for like grapes. Pomegranates (anår; Punica granatum) is cultivated in essentially the same manner, though it is irrigated once a month (except in winter) until the tree is four years old, when it starts producing fruit.

Alfalfa (yunjah)

Alfalfa (Medicago sativa) is planted in the autumn or spring. If the former, the land is plowed first, planted, and then a few days later is irrigated. A second irrigation is delivered six days later, and then every 11 days thereafter until the beginning of winter. In the spring, it is irrigated twice (15 days apart), and then cut for use as fodder. One planting will be good for six years, as alfalfa will sow itself if it is cut after flowering. No information about spring planting was obtained. The first year, alfalfa and barley are sown together.

Garden Crops

Some families have kitchen gardens within their household compounds. Typical crops include onions, potatoes, tomatoes, and herbs (e.g. basil, mint, dill). In general however, these products are purchased.[3]

Cash Crops

Sugar Beet (choqandar)

By far the most extensively grown cash crop is the sugar beet (Beta vulgaris). The seed, as well as chemical fertilizers, are supplied by the sugar beet factory. Sugar beet harvesting is back-breaking work, and wages paid by the large landowners for this harvest are the highest for any agricultural labor.

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[3] Data on garden crops was obtained by casual observation, and was not gathered systematically.

Sugar beet fields are plowed first, then planted in the beginning of the spring (broadcast or in rows by machine). After a month, they are weeded by hand; twenty days later they are weeded again. In mid-spring, about 45 days after planting, the fields are irrigated if there has been no rain, although this is not usually a problem. From this point, the fields are irrigated every 15 days until the beginning of **Abàn** (October 23), about 11 times altogether. The harvest takes place throughout the latter part of the fall.

Poppy (**xashxàsh**)

Opium poppy (Papaver somniferum) is not presently grown at Malyan, as it is illegal. Its culture is not forgotten, however. Poppy can be planted in the autumn and spring.

Autumn sowing: Within 15 days of planting at the beginning of autumn, the poppy field is irrigated. A second watering is provided after two months, at which time the field is weeded. One month later, the fruit capsule is scored to obtain the opium; this is done three times, every three or four days.

Spring sowing: For an early spring planting of poppy, the ground is plowed first. It is irrigated ten days after planting. Weeding takes place 15 days after planting, and again 15 days after that. It flowers two months after planting and the sap is collected 15 days later.

Non-agricultural Household Activities Involving Plants

Fodder Procurement

Fodder is provided to the animals with varying amounts of direct labor input. At one end of the spectrum, the animals are brought to unimproved pasture land or fallow fields and field stubble. Other fodder is carried back to the village by women or donkeys for the stall-fed animals. Some fodder is obtained as a by-product of cash crop production: sugar beet fields are weeded and thinned anyway, and sugar beet tops are edible as well. Some fodder is produced as a by-product of food production, e.g., the straw of harvested wheat, as well as the vegetative parts of the other, less extensively grown food plants. Two major crops, barley and alfalfa, are grown exclusively for fodder, and are harvested as needed during the growing season; bitter vetch (*Vicia ervilia*), maize (*Zea mays*) and clover (*Trifolium* sp.) are also grown. It is possible for villagers to purchase barley as it grows in the soil from one of the local landowners, and harvest it in plots of 3 x 3 m^2. This is an option for those who do not have enough land to feed their animals as well as themselves.

In the late spring and summer, some of the fodder crops and weeds are set out on the house roofs to be cured for use in winter.

In general, cattle are kept in the village, and fodder is brought to them all year round. One farmer said that although the cows used to go out to pasture, they no longer do so because all the available land is planted. In contrast, sheep and goats are brought to pasture, as they can eat smaller plants, those that are less than about 20 cm high. The same man commented that for five cows, one plants a hectare of **yunjah** (Medicago sativa), but most of their fodder comes from **alaf** (herbaceous field plants).

Food Procurement

The three sources of food derived from plants are subsistence farming, purchase, and collection of wild plants. Animal products, in the form of milk, meat, chicken, and eggs also form part of the diet, and are either purchased or home-grown.

Most crops grown for home use may alternatively be sold for cash. Flat bread (**nun**), served at every meal, is made from the flour of home-grown wheat. Some farmers grow fruit, especially grapes and melons, apples and pomegranates. Vegetables (lentils, chickpeas, potatoes, onions) and herbs are also grown.

Wild plants are collected for food as well. The young shoots of some field weeds are ingredients in some traditional dishes: wild garlic (Allium sp.; **sirmuk**) and a mustard green (Cardaria draba; **sozȧ**) are greens used to flavor rice; the young leaves of Chenopodium album (**salmak**) are used in a yogurt and rice pudding. These are available only in the early spring. The seeds or fruits of some plants (Astragalus hamosus, Vicia sp., Lathyrus sp. and Solanum nigrum) are eaten as snack foods when chanced upon in fields. Wild mint (Mentha longifolia; **podonak** or **nàna**) is collected and dried for use as an herb, typically for **duq**, a yogurt based drink. A wooden handled metal sickle is used for digging up weeds, cutting alfalfa, and cutting those crops that are hand-harvested.

The major purchased staple is rice (**berenj**). Relatively little rice is planted on the plain as a whole, and none is grown at Malyan. It is generally bought in Shiraz, and is the basis of the main daily meal. Tea and sugar (**qand**) are bought too. Vegetables grown by some people for home use are bought by others in the city, or occasionally in one of the small stores in the village: eggplant, onions, and various greens (**sabzi**), including radishes, scallions, mustard greens. At least one product,"**lizak**," probably a wild leek, was brought by a man from a village near the mountains at Tang-i Tur, and obtained by at least one village family in exchange for grain.

The mountains do not provide much food for the Malyanis. As mentioned above, some mountain products are traded to the village by residents of those areas. In season (fall),men will collect the nuts of the **ban** or **baneh** tree, Pistacia eurycarpa, a product also collected for sale in Shiraz. One farmer said villagers used to collect acorns in the mountains, and people are also familiar with the wild almonds (Amygdalus scoparia; **majak**) that grow in that area.

Medicines

There is no strong distinction between food and medicine. Classification of foods, medicines, and ailments into the categories "cold," "warm," and "cool" (neutral), common to Persian culture generally, is certainly practiced at Malyan.[4] Thus, for example, saffron, a "warm" substance, may be used as a spice for rice, but will be specifically added to tea (along with other "warm" ingredients) to help relieve suffering of rheumatoid joints or other "cold" ailments. Home remedies include substances of plant and animal origin, as well as inorganic materials, used alone, or (more typically) in combination. Several medicinal plants are available locally, found growing in fields. Licorice (Glycyrrhiza glabra; **mak=mahak**), an otherwise noxious weed that is generally avoided by animals, is appreciated for its long tap root; it is "warm," and is used for infusions as a remedy for colds. Other plants used include **dineshk** (Peganum harmala), **xȧk shir** (Descurainia sophia), and **shȧtara** (Fumaria vaillantii). Along with **mak**, these plants are collected in one's own fields, frequently by children, either for home use or for sale to the **dokkan** (store) of the village at a standard rate; the store will sell the plants then to the "**araq**" factory in Shiraz, where

[4] The hot and cold categorization apparently diffused from classical Greek and Arab thought: "Foods and remedies are all either cold or hot by nature, whereas man's temperament may be hot, cold, dry, or humid. To maintain the equilibrium of the temperament, therefore, you must choose foods whose nature is opposed to your temperament ... the same is true of remedies." (Massė 1954: 329)

these things are made into medicines.[5]

Some herbal remedies are purchased from the Qashqai nomads who collect them during their trek in the mountains.

Grain Processing

For the most part, harvested grain is nowadays threshed mechanically in a "**kåmbin**" (i.e., factory-made combine), and stored in gunny sacks within the residential compounds. When wheat is needed for flour, a sack (containing ca. 50 kg) will be processed by a woman of the household. Three stages of cleaning take place. A little at a time, grain will be tossed on a tray and poured from head height on to a cloth, allowing winnowing of bits of chaff. It is then screened; dirt, small weed seeds, and **didak** (rotted grain) are culled in this manner. The most noxious weed seeds and **didak**, which will make the flour go bad, are removed from the screened grain manually. The largest grains and weed seeds stay in the screen, which has a variable mesh of about 30 per 10 cm, or 2 mm openings. These larger grains are set aside. That which goes through the screen is re-winnowed and re-screened several times, and is set aside for the chickens. The larger grains left after these winnowings can be separated from the smaller ones when

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[5] The unprocessed seeds of Peganum harmala are sold in the Shiraz bazaar and are used as incense for general well-being. The seeds of Descurainia sophia are made into an infusion; although **xåk shir** is said to be a generally useful medicine, the seed is particularly used for curing "cold" diseases. The vegetative part of Fumaria vaillantii is used as an infusion, particularly for a "cold" illness.

tossed on a metal tray with practiced technique. The very smallest grains and similarly-sized weed seeds are left lying about for the chickens and wind to dispose of. It would take one woman several hours to clean a 50 kg sack of wheat. The cleaned grain is then ground into flour at the local motor-driven mill.

Other foods, such as rice and lentils, are processed as needed for meals in small quantities; small stones are culled and tossed into the courtyard.

Cooking and Heating

Cooking and heating are of particular interest to the paleoethnobotanist, as much of what we study is preserved only due to the presence of the fire of these two activities.

Not all plant food that is consumed at Malyan is cooked, but the staples of the diet are. Three types of cooking have been observed, defined on the basis of fuel and locus of fire.

First, bread-baking is considered. Malyan flat bread is made by women. The dough is made with flour, water and salt, and may be kneaded indoors. It is baked outdoors (with one exception seen) on a **towa**, a convex iron plate, about a meter in diameter, placed over an outside hearth. Ashes are rubbed on the under side of the plate to prevent burning of the bread. A very fast fire is provided by straw, with which the fire is fed as one by one the flat breads are rolled out and transferred to the griddle. This activity may take a few hours, every few weeks. Only once was the baking of bread seen within a house; it was a windy day, and the baking of **nun shirini**, ("sweet bread"), a New Year's specialty, could not be put off due to the approach of the holiday.

The boiling of rice is a daily activity, and except in severe weather, takes place in a sheltered area out of doors. The rice is boiled, then drained and rinsed in basketry, and returned to the pot for a final steaming and to make **tadiq**.[6] A slower, steady fire is appropriate, and is typically made of dung cakes, or a mixture of wood and dung. In cold weather, this type of fire is used indoors as well, for heat.

Nowadays, most other cooking takes place on portable kerosene stoves ("**aladin**," after the brand name). The use of the **aladin** stove has meant that in several households old hearth pits (chàla) are no longer in use, and are covered up with rugs or filled in. The stove is kept indoors, and, when the hearth is not used for heating, it may well be placed in that depression. Eggplant, potatoes and onions, and occasionally meat are typical side dishes that may accompany the main meal of rice, and are cooked on this type of fire. The kerosene stove is also used to heat rooms with non-functioning hearths, and even in warm weather is kept

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[6] "Tadiq" is the crust formed in the bottom of a rice pot which has been greased with cooking fat. It is formed from the bottom layer of the rice itself, or from thinly sliced potatoes placed on the pot bottom.

lit much of the day for keeping the tea hot.

Several types of fuel are available to Malyanis, and choice is determined in part by the function to be performed. Dung cakes (pacho) provide most of the traditional fuel for most cooking and heating. LeBruyn (1737:228) comments that the highways of Fars between Isfahan and Shiraz were quite clean, as the dung was collected for fuel, and he mentions its cooking use.[7] Typically, dung cakes are made during the dry months by women out of a mixture of cattle dung, straw, and water, rolled into balls and then flattened to dry. Heat production from dung is steady, but of relatively low caloric output (cf. Anon. 1930).

Most fires are dung-cake fueled, or fueled with a mixture of pacho and wood (either locally collected, chila=brush; or hizom=firewood, from the mountains). In the Ramjerd district, households reported using animal dung (49%) and wood (33%) as their primary fuel source (Paydarfar 1974:76). From interviews with Malyanis, it would appear that for ordinary purposes of heating and cooking, wood is preferred, and the only reasons it is not used more frequently are that 1) it is now illegal to cut trees in the forests, and 2) it costs money to buy. Fires of straw or other dried herbaceous plants (sesame, e.g.) are used for bread-baking, and kerosene is used for supplementary cooking

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[7] Hooper and Field (1937) report that lumps of goats' droppings are "said to be rubbed on the chest for Bronchitis" in Tehran.

and heating.

Cleaning and Garbage Disposal

A typical compound consists of a lower story with storage rooms and animal stalls around an open courtyard and an upper story with the kitchen, living room and storage rooms, each opening on to the roof of the rooms below. The open air portion of the second story may or may not itself be roofed. Dust and debris from this area are generally swept daily into the lower courtyard. Periodically, the lower courtyard is swept; the sweepings are concentrated in a pile and are eventually trucked out to the fields as fertilizer.[8] In one household, hearth sweepings were dumped in an empty shortening can, and when the can was full, it was dumped outside with the rest of the courtyard sweepings. Frequency of sweepings is variable, and some courtyards are generally less tidy than others. People living just inside the town wall are often seen dumping sweepings outside the wall, which results in an accumulation of debris there. The brooms are made locally of Juncus sp. (**xonk**), which is gathered by children in the marsh east of Malyan.

Construction

Houses of mud brick construction are the norm at

[8] When dung is dried, soluble nutrients (nitrogen) are lost and non-soluble nutrients (phosphoric acid, potash, lime) are retained despite burning, so the fertilizing value is no less than that of the application of dry dung to the fields (Anon. 1908).

Malyan, though in recent years stone has become a more common building material. Traditional Iranian building techniques have been described elsewhere (Wulff 1966:108-11, 114). What is significant for us here is the particulars insofar as they relate to plant use.

Plants are incorporated into construction activities in both walls and roofing. The sun dried mud brick is tempered with straw. Roofing material consists of beams, mats, and brushwood, covered with a layer of mud. Beams, primarily of willow (**bid**) and poplar (**senobar**), grown locally, are laid on the walls. Straw mats are placed on the beams. Freshly cut brush is laid on top of the mats; two common species used are willow (Salix excelsa) and licorice (Glycyrrhiza glabra). The brush is piled to a height of about 20 cm. Should a room be abandoned, beams are removed for use elsewhere.

Methodological Consequences

A working assumption among paleoethnobotanists is that there are two ways for plant remains to be carbonized in fireplaces, either intentionally (as fuel, or perhaps incense), or by chance (typically food remains, and presumably also impurities in food such as weed seeds, or general environmental noise, pre- or post-depositional). The potential for the preservation of food remains is a direct consequence of the method of food preparation. Thus, if grain is parched before milling, as among the Tibetans (Ekvall 1968:68), some will probably be preserved. If whole grain is used in boiling, care will be taken not to spill it in the fire, but a few grains may escape. If it is ground into flour, it may never come near the fire until it is in a form unrecognizable with standard techniques.

Before it is possible to understand ancient social processes on the basis of the archaeological record, it is necessary to understand the nature of archaeological deposition. Both ethnographic and experimental analogy can be helpful in delimiting some probable, or at least plausible, material correlates of prehistoric economic activities. In the next chapter, some general assumptions about human behavior will be used to develop test implications for hypotheses about social changes, but I am here concerned with some activities specific to present-day Iranian village life that provide some insight for the development and interpretation of the paleoethnobotanical record.

It has earlier been suggested that the Banesh and Kaftari periods at Malyan witnessed an expansion of agricultural production (Chapter 1). It is not clear whether this was done by means of the intensification of land use or the bringing of previously unoccupied or uncultivated lands into production. Identifying the specific archaeological manifestations of these processes is neither obvious nor easy. The settlement pattern clearly shows an increase in the number of occupied villages and size of occupied area in the valley; we can safely assume that most of the inhabitants of those villages were engaged in agriculture, though clearly some villages would have people engaged at least part time in craft production for export (Alden 1979:83 ff.).

Ethnographic data suggest ways in which the expansion of agricultural production is likely to occur: decrease in fallow, clearing of land not previously in cultivation, drainage and/or irrigation projects, manuring, and switching to varieties with higher yields. We would expect at least some of these practices to have a direct effect on vegetation surrounding a village, and thus on the assemblage of species found archaeologically. Relatively direct effects of irrigation on seeds will also be examined. Land clearance will be discussed below (see Chapter 6). Identification of some modern hearth and midden material will also be used to provide a base line against which to measure carbonized archaeological material.

Identifying Irrigation Practices

What are the material correlates of irrigation? The presence of irrigation agriculture has been confidently inferred for several prehistoric areas on the basis of actual canals or aligned villages (Adams 1965, Sanders et al. 1979:260 ff.). When research is restricted to excavation at a particular ancient city, and previous surveys (Sumner 1972, Alden 1979) and modern hydrologic conditions (Kortum 1976:41) do not support the existence of major canals in the third millennium near Malyan, we must seek evidence elsewhere.[9]

Consequently, indicators of irrigation will be sought in the following three sets of data:

1) field weeds

2) seeds of field weeds

3) size and shape of the actual cultivated grains.

Distinguishing characteristics of modern material will be established, and the relevance of the modern material to archaeological applications will be discussed. The crops that are produced by irrigation will be different in some respects from those in the same area that are unirrigated. The weeds might be different, and the crops themselves might have different growth potential. In order to identify differences in vegetation, actual fields were examined first, both irrigated and not. Then, an attempt was made to see if weed seeds actually occurring in harvested grain varied depending on the moisture regime. Thirdly, measurements of modern grains grown under irrigated and unirrigated conditions were made.[10]

Field Weeds. The assemblage of weeds in a given field reflects a number of influences: seed source, season of sowing and harvest, environmental conditions. Modern conditions are not completely analogous to ancient ones

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[9] There does seem to have been river irrigation in the basin at least as early as the Bakun period (fifth millennium), however (W. Sumner 1981, p.c.).

[10] Hans Helbaek (1959) is a pioneer of this sort of analysis.

because of the first influence, seed source. Some field weeds have been able to expand their geographical range by traveling with imported cultigens. For example, some New World weeds (e.g., Amaranthus sp.) as well as cultigens (e.g., potato, tomato) now grow or are grown at Malyan. Seasonality of weeds and crops is not considered here (see App. E: GGX98). Using field weeds to determine the differences between irrigated and unirrigated areas will be discussed.

The cultivated fields of Malyan are all irrigated. During the autumn of 1976, the fields and uncultivated land around town were examined, and collections were made. Botanizing resumed in late March, 1977, while the weeds and crops were still seedlings, and continued until the end of May. Additional collections were made during the summer of 1978 (July and August), and during and after the harvest. Collections in Malyan fields and environs were quite comprehensive, as only three new genera and an additional three species of weeds were found during the last field season: Foeniculum vulgare?, Trachyspermum sp., Panicum sp., Agropyrum intermedium, Galium humifusum, and Centaurea calcitrapa.

It was of course necessary to find unirrigated fields to examine as well. Due to the difficulty of transportation, coverage of unirrigated fields was not as complete as at Malyan. About 6 km to the southwest of Malyan is a narrow band of piedmont; the road passes by the edge of this area. One field of barley right next to the road, and just across from the irrigated plain, was examined. An exploratory hike led to the fields of the village of Hosseinabad sar-e Ab in late April, 1977, some of which are on the plain, and irrigated, and some of which are in the foothills, and unirrigated. The grain in these latter fields was considerably less dense than that at Malyan. It was planted in strips of about 20 m and more, alternating wheat and barley. An area of 20 m x 10 m each in the wheat and barley was paced out, and weeds within were censused. The results of the field census are listed in Appendix F.

As is their nature, most weeds did not seem to be restricted to the wettest fields, the driest fields, or the unirrigated areas. Nonetheless,there do seem to be some differences in composition of weeds among fields, depending on degree of irrigation. Different crops receive different moisture regimes: alfalfa and sugar beet are irrigated fairly frequently, wheat is less well irrigated, and barley even less. Some weeds were common in one area, but virtually never seen elsewhere.

Appendix J lists plants that occur in distinguishable microenvironments: dry vs. moist, cultivated vs. uncultivated, etc. The differences are of potential use in determining the environmental zones from which identified archaeological specimens originated. One would not however expect a direct translation from frequency of field occurrences to frequency of archaeological occurrences. Crops are not brought indiscriminately into a settlement. Some are threshed in or near the fields, with weed impurities left behind. Some weeds would not be ripe at the same time as the crops. Animal fodder (straw, alfalfa) might be expected to most closely approximate weed composition of the field at the time of harvest, since all the vegetative parts are useful for the animals. Unfortunately, the vegetative parts are not likely to be preserved archaeologically.

The seeds of all weeds growing in a field will not be found as contaminants in harvested and stored grain samples. First, only seeds that have ripened at harvest time but not yet dispersed will be found. Secondly, plants produce different amounts of seeds. Thirdly, samples of grain from many different fields would have to be examined in order to discern the full range of variability contained within the fields. Finally, identification to species for many genera is either not possible or extremely difficult. The difficulties of identification increase with archaeological specimens, as color is lost in carbonized material, and some distinctive surface features are abraded or burned away. Archaeological seed counts cannot be interpreted as directly proportional to the field population of plants the counts represent.

Seeds of Field Weeds in Grain Crops. Dennell (1974) has pointed out that the stage of crop processing at which archaeological preservation takes place affects seed size and assemblage composition of the recovered botanical remains.[11]

Therefore, it seemed advisable to examine modern grain which had already undergone some processing analogous to that of the grain found in archaeological contexts. To remove the variable of crop processing stage, I decided to compare samples of grain at one particular stage of processing, namely, after threshing and winnowing, but before cleaning. This is the point at which grain enters the village in large burlap or woven plastic sacks for storage. I had more access to grain from irrigated fields, but some grain samples were obtained by purchase at Hosseinabad sar-e Ab. In particular, stored grain samples (wheat and barley) were obtained at Malyan and at Hosseinabad sar-e Ab. The grain from Malyan was irrigated. It is not clear that all the grain examined from Hosseinabad sar-e Ab was unirrigated.

As mentioned earlier, the aim of the experiment was to compare irrigated and unirrigated wheat and barley at a comparable stage in processing. Some problems resulted from indeterminable differences between store-bought and donated samples. A store-keeper may not know for certain whether a particular sack contains irrigated or unirrigated grain. The degree of cleaning prior to storage is variable;

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[11] Note that Hubbard disputes the significance of processing stage for explaining average size differences between samples of cultigens (1976).

purchased grain has a greater percentage of impurities. There is a certain amount of random variation in weed assemblage and grain size; this could be accounted for with appropriate statistical tests if the assumptions of random, unbiased sampling have been met. These problems were very detrimental to the original goal, but do point out certain pitfalls to be avoided in the future. As will be explained below, the two samples of modern barley obtained both appear to come from the same population (irrigated), on the basis of size and weed composition. The samples of wheat from Malyan look quite different from each other, as well as looking quite different from the wheat from Hosseinabad sar-e Ab.

All weed seeds and other grain impurities were removed from 250 g samples of grain from Malyan and Hosseinabad and identified. Additional grain (250-500 g) was examined to provide a supplementary presence/absence list (App. H).

There is much overlap in the proportion of weed species shared by the grain samples of both wheat and barley obtained at both Malyan and at Hosseinabad sar-e Ab, approximately one-third of the genera (or species, where distinctive). Of the approximately 42 to 43 types total, most are present in Hosseinabad sar-e Ab or Malyan samples, and most are present in the wheat (Table 3.1) and barley (Table 3.2) samples.

The choice of 10 seeds as a cut-off point is arbitrary, but was chosen to focus attention on the most common

Table 3.1. Common Weed Seeds found in Samples of Harvested Wheat

	Malyan B Irrigated (% of total weed seeds)	Hosseinabad Unirrigated(?) (% of total weed seeds)
Silene	17	<1
Vaccaria	36	58
Compositae	0	8
Convolvulus	2	0
Cephalaria	6	<1
Aegilops	0	<1
Hordeum (cultivated)	16	25
cf. Lathyrus	7	0
Vicia ervilia	<1	2
Vicia sp.	4	<1
Reseda	6	3

Compiled from data presented in App. H. The Malyan wheat sample contained 444 weed seeds per 250 g of wheat, including 70 cultivated barley grains. The Hosseinabad wheat sample contained 717 weed seeds per 250 g of wheat, including 182 cultivated barley grains. The species represented by less than 10 seeds in both samples are not reported in this table with the exception of Aegilops; Aegilops was present in the larger sample from which the 250 g sample of Hosseinabad wheat was drawn.

species. Since the number of seeds produced by weeds is quite variable, consideration will also be given to Aegilops, one of the few modern weed seeds that also occurs archaeologically. It produces few seeds per stem, and so would tend to be numerically under-represented in harvested grain with respect to the quantity growing in the field. The choice of 10 as a cut-off point eliminates those types which might be expected just by virtue of proximity to one type of field or the other.

The number of types that seem to differentiate irrigated from unirrigated assemblages is quite small, and

Table 3.2. Common Weed Seeds found in Samples of Harvested Barley

	Malyan Irrigated (% of total weed seeds)	Hosseinabad Unirrigated(?) (% of total weed seeds)
Silene	16	7
Vaccaria	10	67
Cruciferae (cf. Hirschfeldia)	2	<1
Myagrum	3	0
Aegilops	0	<1
Triticum	38	15
Vicia ervilia	0	2
Vicia sp.(as above)	2	<1
Papaver	<1	5
Reseda	23	7
Galium	2	<1
Unknown type	0	<1

Compiled from data presented in Abb. H. The Malyan barley sample contained 557 weed seeds per 250 g of barley, including 209 wheat grains. The Hosseinabad sample contained 922 weed seeds per 250 g of barley, including 125 wheat grains. The species represented by less than 10 seeds in both samples are not reported in this table with the exception of Aegilops; Aegilops is included since it is one of the seeds found archaeologically.

does not include many of the types found archaeologically. The seeds which seem to distinguish irrigated fields are Convolvulus, cf. Lathyrus, and Vicia sp. Aegilops and the indeterminate composite distinguish the unirrigated fields.

The barley sample purchased at Hosseinabad seems in retrospect to have been irrigated, primarily on the basis of seed size and weight (see below). Experiments exploring differences in weed composition between irrigated and unirrigated barley could therefore not be done with this sample. The presence of two Aegilops seeds from the irrigated Hosseinabad barley sample is therefore interpreted as an accidental occurrence.

Analysis of the field weed composition of harvested grain samples shows that one might expect some differences in species depending on the water regime of the crop in question. Most weeds are not useful indicators of irrigation, however. The archaeological implications of these results are that it should be possible to detect whether a grain sample has been irrigated if a sample of archaeological grain is large enough to reflect the variability of the fields. Also, as Dennell has already observed, quantity of field weed contaminants is a function of crop processing stage and technique.

Grain size. It has been found that breadth and thickness of barley are more responsive to irrigation than is length, whereas length is fairly uniform within a given variety, regardless of irrigation (Harlan 1914:29). Therefore, length, breadth, and thickness of modern wheat and barley samples from Malyan and Hosseinabad sar-e Ab were measured, and T:B and L:B ratios were calculated. The first three variables are measures of size, the last two of shape. The lemma and palea of the barley grains were peeled off prior to measurement. This makes the results more applicable to archaeological analogy, as the glumes tend to be burned off the archaeological samples.

One might expect differences in the absolute size of the grains, with the irrigated grains being larger in general. Also, as the pressures of natural selection would presumably be greater for the unirrigated crop, one might predict tighter clustering around the mean for these measurements of size and shape.

Barley (Table 3.3, Figs. 3.1-3.2, App. H): Nowadays barley is used for animal fodder. Relatively little culling of stored grain takes place, so the store-bought and donated samples are roughly comparable; The weed seed assemblage associated with the Hosseinabad sample was similar to that of the Malyan barley. Data in Appendix H show the number of weed seed contaminants to be relatively close. The virtually identical measures and histograms for barley strongly suggest that the barley bought in the store at Hosseinabad was in fact irrigated. The variance of the Malyan barley measures was not significantly different from that of Hosseinabad (α=.05). Further tests were therefore abandoned.

Table 3.3. Measurements of Modern Barley (mm)

	Malyan (N=200)					Hosseinabad (N=200)				
	L	B	T	T/B	L/B	L	B	T	T/B	L/B
min.	6.2	2.1	1.5	.60	1.94	5.3	2.3	1.5	.60	1.94
av.	7.6	3.2	2.4	.74	2.39	7.5	3.3	2.4	.73	2.34
max.	8.8	3.7	2.9	.90	3.38	9.0	3.7	2.9	.84	3.00
SD	.525	.266	.255	.038	.222	.585	.257	.244	.039	.201

Wheat (Table 3.4, Figs. 3.3-3.6, App. H): The modern wheat samples raised some interesting questions about

Fig. 3.1.
Barley: Length, Breadth, Thickness

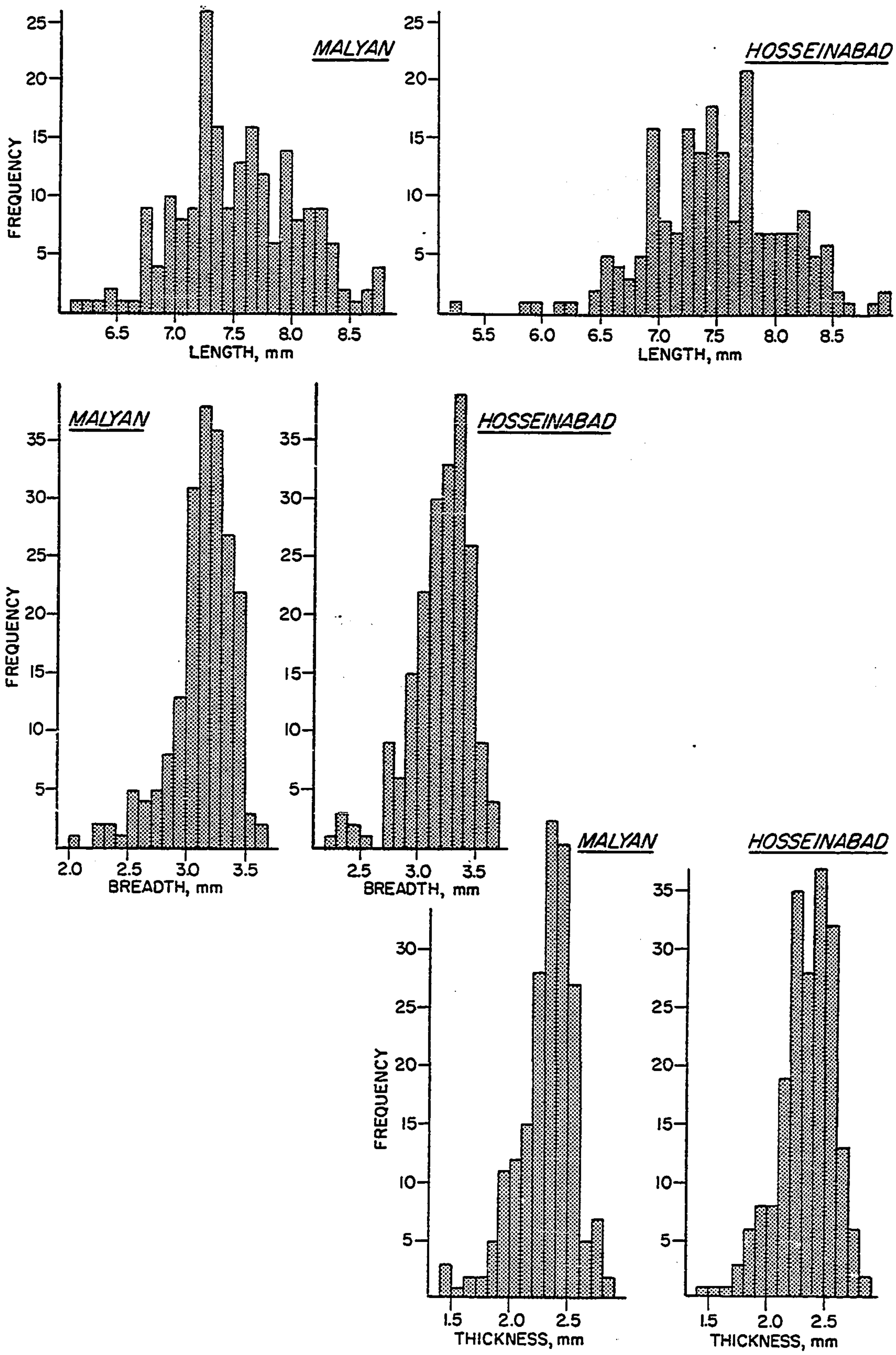
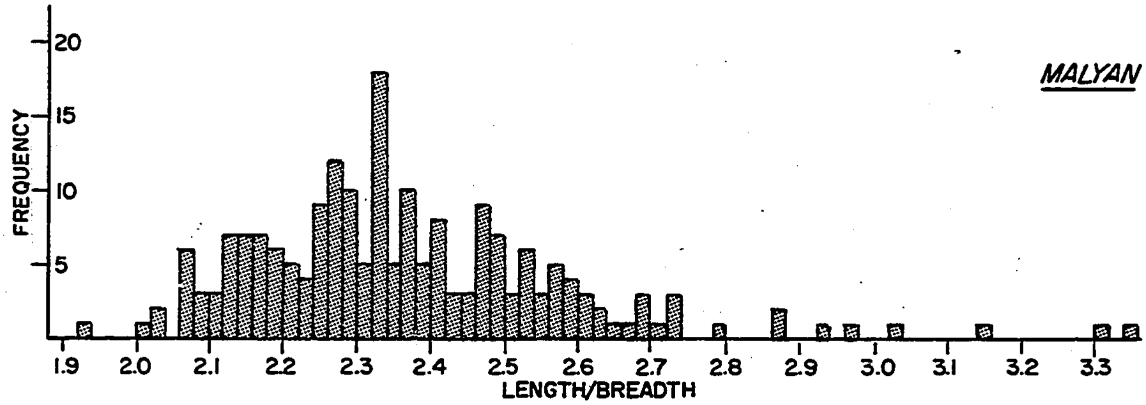
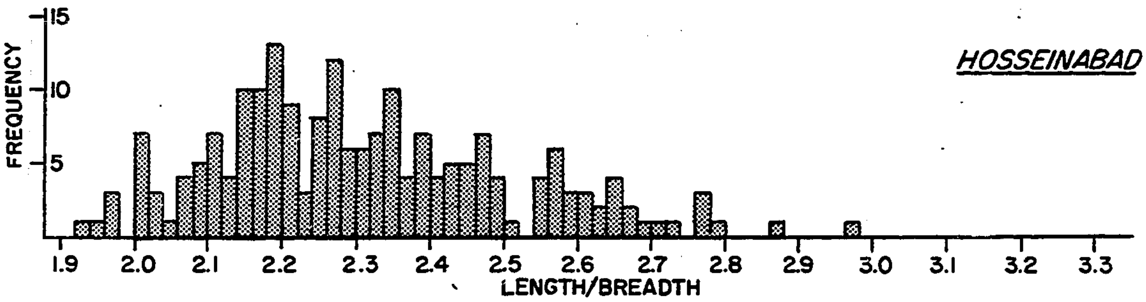
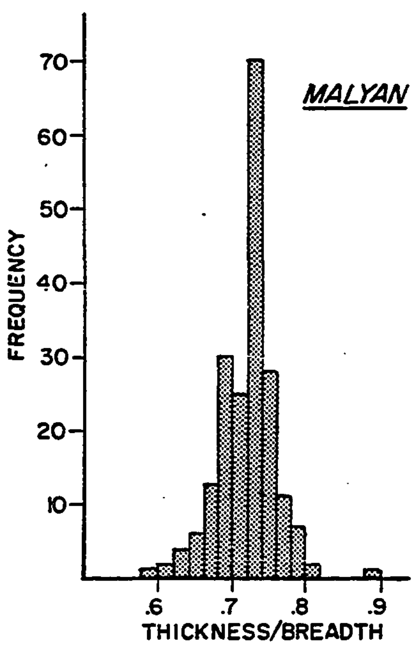
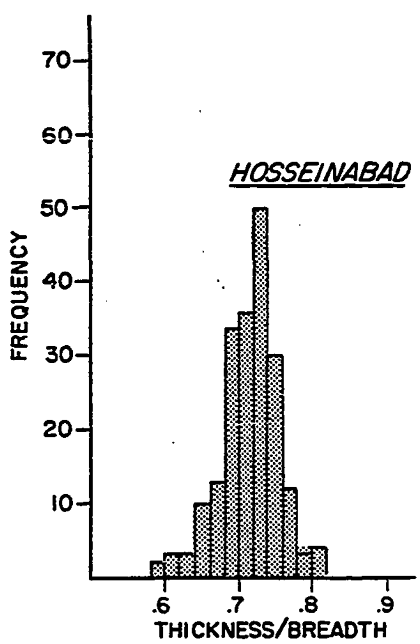

MALYAN
HOSSEINABAD
FREQUENCY
LENGTH, mm
MALYAN
HOSSEINABAD
FREQUENCY
BREADTH, mm
BREADTH, mm
MALYAN
HOSSEINABAD
FREQUENCY
THICKNESS, mm
THICKNESS, mm

Fig. 3.2.
Barley: L/B and T/B


MALYAN
FREQUENCY
20
15
10
5
1.9
2.0
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
LENGTH/BREADTH


HOSSEINABAD
FREQUENCY
15
10
5
1.9
2.0
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
LENGTH/BREADTH


MALYAN
FREQUENCY
70
60
50
40
30
20
10
.6
.7
.8
.9
THICKNESS/BREADTH


HOSSEINABAD
FREQUENCY
70
60
50
40
30
20
10
.6
.7
.8
.9
THICKNESS/BREADTH

processing differences. In addition to a sample from Hosseinabad sar-e Ab, three 200-grain samples from Malyan known to have been irrigated were measured. Malyan "A" was provided by a friend, and was therefore quite well cleaned; there are few weed seed contaminants, the average grain weight is high, and the grains are quite plump. Malyan "B" was deemed most suitable for comparison with the Hosseinabad wheat for the purpose of testing the hypothesis that the two samples would be different. The average grain weight and the relatively high number of weed seed contaminants in Malyan "B" suggested it had been processed to a similar degree. (Malyan "C" seems intermediate between A and B).

For Hosseinabad and Malyan "B", the mean and variance of all the measures are significantly different (α=.05); The wheat from Hosseinabad is less plump than that from Malyan. Also, the prediction that irrigated wheat would tend to exhibit greater variance of the size and shape characteristics holds (App. H.2).

The alternative explanation for these measurements highlights the importance of taking context/processing into account. Differences between samples may be more a function of provenience than ecology, in this case the store vs. donation from private stocks of acquaintances. If the donated grain had been carefully threshed, winnowed, and pre-sifted, a relatively higher percentage of plump grains would have been present, and sifting would reduce the variance. Conversely, relatively carelessly threshed grain,

Table 3.4. Measurements of Modern Wheat (N=200 per sample)

	Malyan "A"					Malyan "B"				
	L	B	T	T/B	L/B	L	B	T	T/B	L/B
min.	4.9	2.2	2.1	.74	1.60	4.3	1.7	1.8	.78	1.40
av.	6.5	3.2	3.2	.98	2.00	6.1	2.9	2.9	1.00	2.11
max.	7.3	3.8	3.8	1.35	3.00	7.4	3.7	3.6	1.20	3.40
SD	.44	.29	.31	.074	.164	.16	.35	.36	.076	.235

	Malyan "C"					Hosseinabad				
	L	B	T	T/B	L/B	L	B	T	T/B	L/B
min.	4.4	1.9	1.8	.79	1.60	5.0	2.4	2.1	.78	1.80
av.	6.3	3.1	3.0	.98	2.09	6.5	3.0	2.7	.90	2.15
max.	7.5	3.7	3.8	1.20	2.80	7.5	3.5	3.1	1.11	2.60
SD	.54	.35	.36	.076	.190	.41	.19	.19	.054	.137

or grain from which the largest examples had been removed, would have relatively more thin, narrow grains. Length would be less severely affected, and variance would be less affected as well. Also, purchased wheat and barley would be expected to have higher numbers and amounts of impurities than donated grain.

Despite the impossibility of controlling for processing, it was noted that the wheat sample Malyan "B" was closest in weight and weed assemblage to Hosseinabad wheat, and the proposed relationships between irrigated and unirrigated grain are supported.

Thus, for archaeological analyses, one ought to be able to compare average grain sizes through time or space to

Fig. 3.3.
Wheat: Length

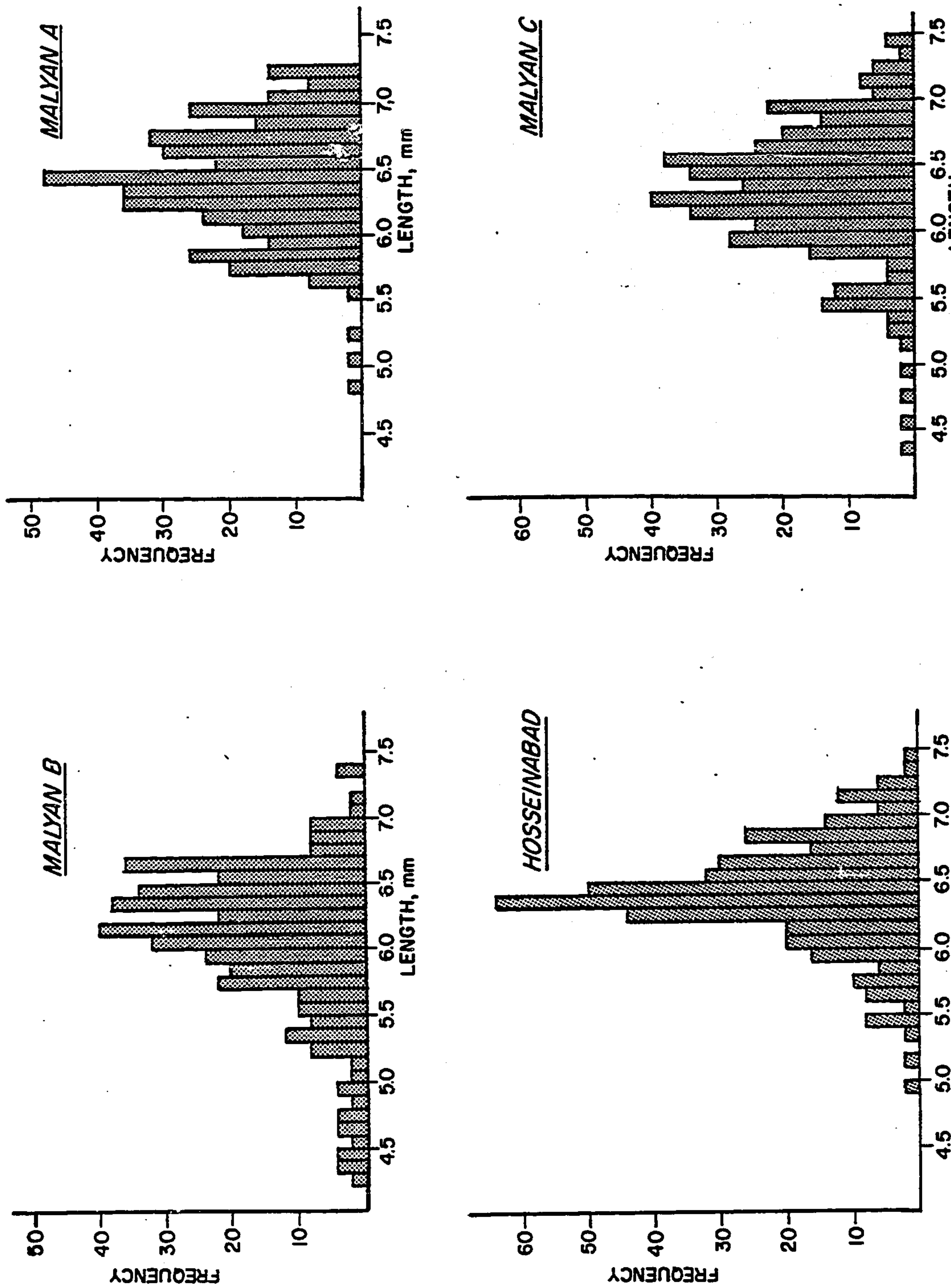
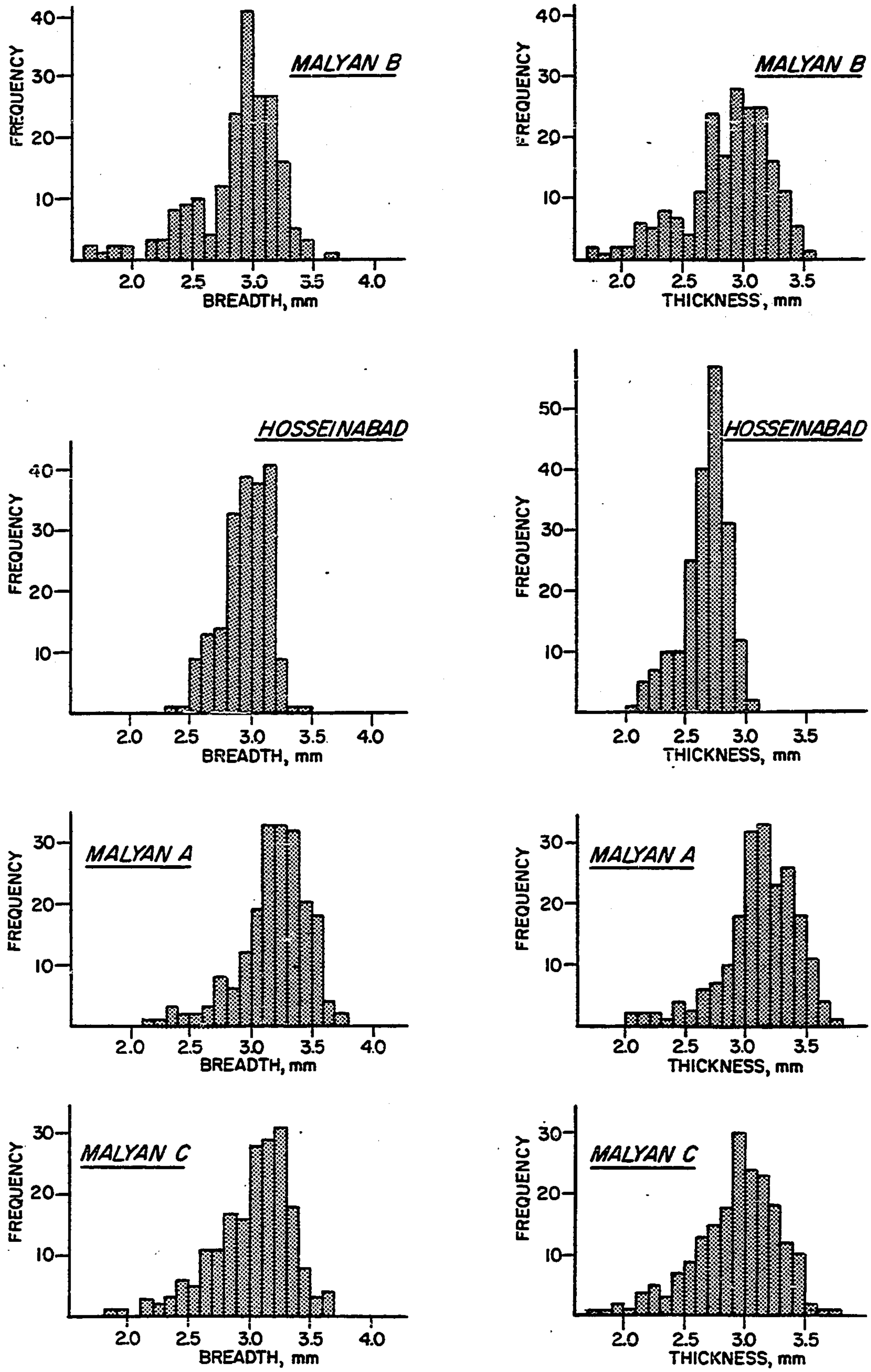

MALYAN A
MALYAN B
MALYAN C
HOSSEINABAD
LENGTH, mm
FREQUENCY

Fig. 3.4.
Wheat: Breadth, Thickness



MALYAN B
FREQUENCY
BREADTH, mm
THICKNESS, mm
HOSSEINABAD
MALYAN A
MALYAN C

Fig. 3.5.
Wheat: L/B

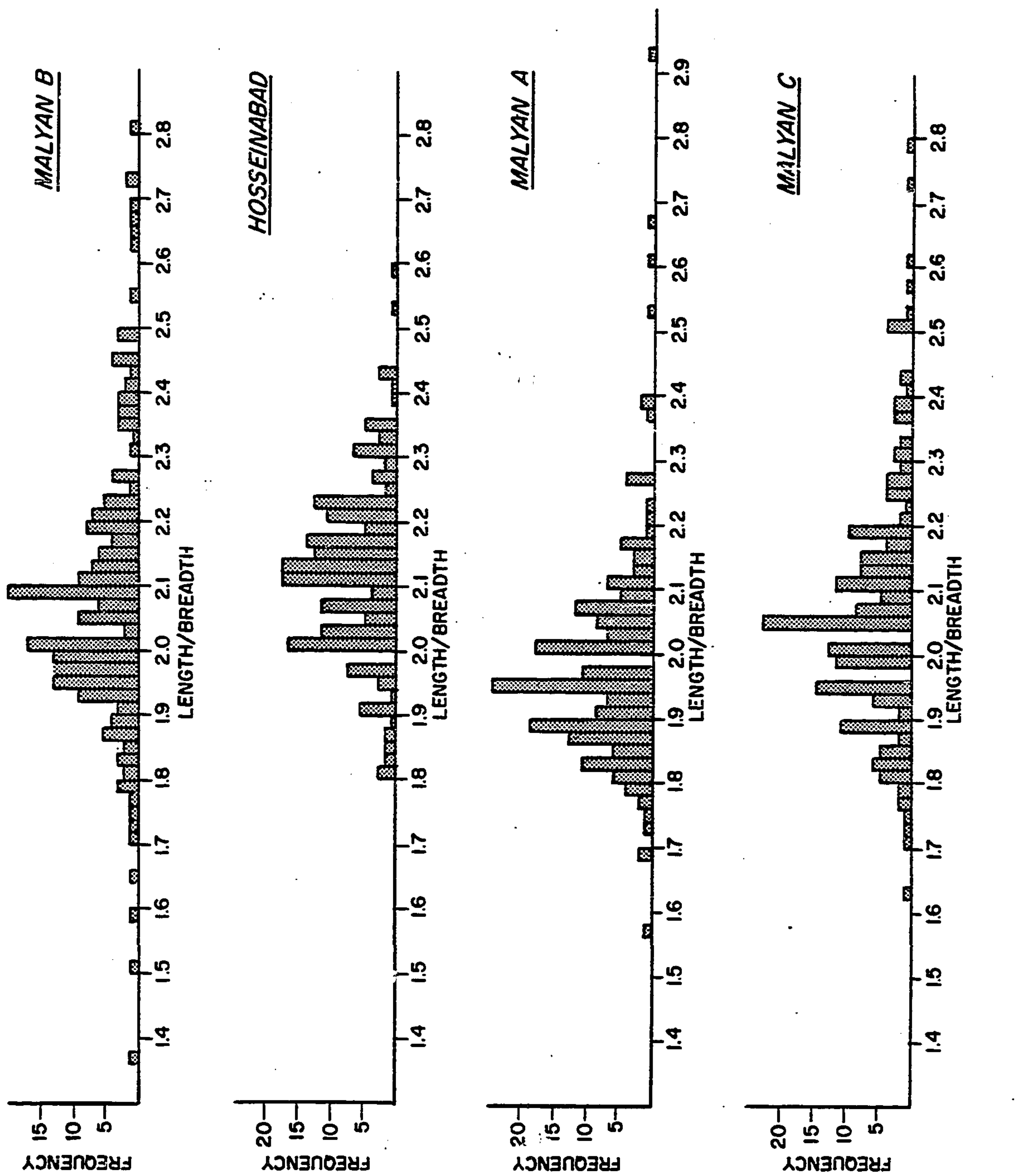
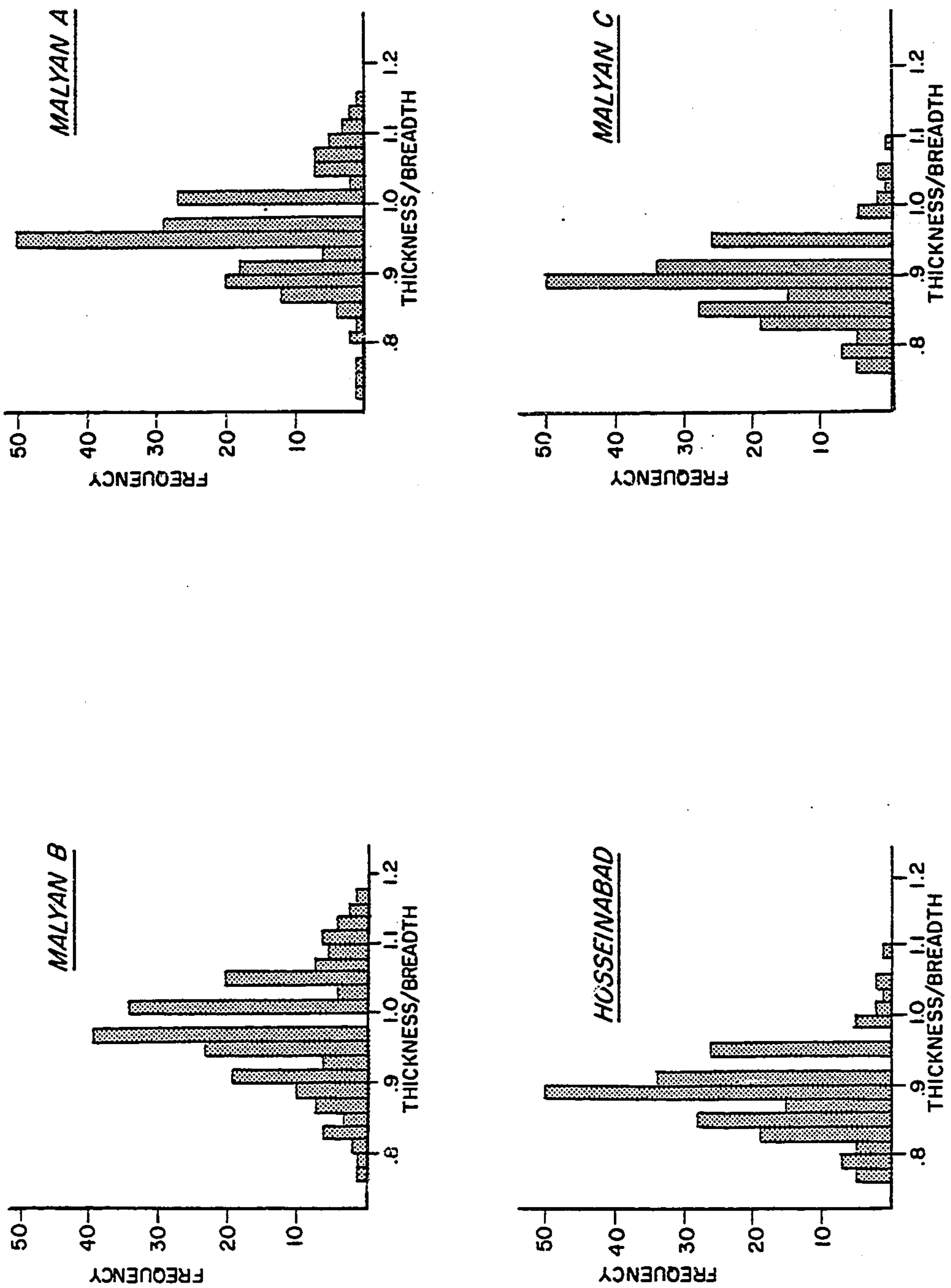

MALYAN B
HOSSEINABAD
MALYAN A
MALYAN C
LENGTH/BREADTH
FREQUENCY

Fig. 3.6.
Wheat: T/B


MALYAN A
MALYAN B
MALYAN C
HOSSEINABAD
FREQUENCY
THICKNESS/BREADTH
10 20 30 40 50
.8 .9 1.0 1.1 1.2

detect changes in irrigation practices. The limitations of this type of analysis are several. First, "populations" of at least 100 grains per sample are required. The ideal archaeological situation would be that of a burnt storeroom, for example. Secondly, the measurements of modern varieties cannot be automatically used for comparison. Therefore, in order to determine whether an archaeological sample was irrigated, contrasting archaeological samples of the same variety would be necessary. The number of carbonized grains recovered at Malyan was small, so it was not possible to use this method. Nevertheless, the method does have potential value for analysis of certain types of archaeological deposits.

In summary, based on modern botanical and ethnobotanical analogy, indicators of irrigation for archaeological deposits are weed seeds which are restricted to wet (irrigated) or dry (unirrigated) fields. Actual grain size and shape reflect irrigation practices, but large numbers of well preserved, measurable grains would be necessary for the determination of irrigation practices on the basis of archaeological grain remains.

Hearth and Midden Analysis

Finally, as archaeologists, we can ask what are the implications of modern garbage disposal for the interpretation of the archaeological record. In order to better understand the nature of debris accumulation, a few modern hearth and sweeping samples were taken:

1) Tang-i Tur shepherd/nomad hearth (8/20/78). A shallow (<0.5 m), charcoal-filled pit, about 1.0 to 1.5 m in diameter, was chanced upon in the Tang-i Tur pass. (A pit of similar size, presumably older and once charcoal-filled, was spotted nearby).

2) Hearth at Malyan (4/14/77). The previous evening's fire had been built of (cow) dung cakes and chila (small pieces of firewood, obtained locally). That evening, rice had been cooked. Occasionally, straw fires are built in this particular hearth for bread-baking, but the contents are cleaned daily. The hearth has a plastered bottom. This household owns one of the small groves of poplar and willow at Malyan, and therefore has access to local wood; generally (though not in this instance), this household's hearth fires are made exclusively of dung cakes. The hearth is located outside, but on the second story of the courtyard, so it is not subject to direct "contamination" from the courtyard below.

3) Ash sample, presumably hearth sweepings, taken soon after disposal, from dump area at the base of the outer village wall (8/22/78).

4) Uncarbonized debris, presumably courtyard sweepings, taken soon after disposal, from the dump area at the base of the outer village wall (8/22/78). Virtually all plant materials found in courtyards are brought

in, as fodder, fuel, or in dung.

Results(see App. I):

1) Tang-i Tur: This hearth site in the oak forest contained only oak charcoal. There were no stray seeds.

2) Hearth at Malyan: Charcoal consisted of willow/ poplar, but most of the carbonized material was dung. It is likely that the presence of seeds is due to dung as well. First, of the 71 seeds, 3 (ca. 4%) were actually found embedded in burnt dung. Second, at least one type, Rumex (the most common), is most common in wet areas adjacent to streams. The other seeds, primarily weedy, in theory might have been brought in with the harvested fodder, especially since grain is not in evidence in this sample.

3) Ash sample: This includes the charcoal of at least three species of wood, two of which come from the mountains, and has proportionally many more weed seeds and greater variety than the hearth sample. Of 673 seeds, 16 are cultigens. Twenty (ca. 3%) were actually found embedded in goat dung, including 16 Astragalus. Many of the weeds represented could easily have been brought in with straw. It is less likely that they occur in the ash sample by way of grain impurities.

4) Sweepings sample: This was virtually all uncarbonized material, with straw and dung providing most of the volume. There were no carbonized seeds. About 750 uncarbonized seeds, one of which was embedded in dung were seen. Less than 25 were cultigens. There are a few fruit seeds, and an assortment of weedy species.

These findings support the hypothesis that plant materials may well be preserved by fire unintentionally, but are much less likely to be preserved accidentally. Specifically, material that becomes carbonized due to ordinary household activities has probably been placed in a fire. The most important source of carbonized weed seeds, and even of cultigens, seems to be animal fodder, perhaps transformed into dung or dung-cakes. Furthermore, the modern debris most analogous to archaeological general soil matrix tends to have a low density of carbonized remains, except for primary hearth deposition and secondary dumping of hearth sweepings.

In summary, a description of the Malyan village economy has been presented. There is no uninterrupted cultural continuity between the ancient urban center and the modern village. Nonetheless, subsistence activities in both cases revolve around a wheat/barley and sheep/goat agricultural economy in the moderately dry Kur basin. Therefore, an understanding of the agricultural constraints and economic and household practices operating today can provide considerable insight into and testable propositions about certain aspects of the ancient economy.

CHAPTER IV

ETHNOBOTANICAL CONSIDERATIONS

The Interpretation of Ethnobotanical Data

The interpretation of ethnobotanical data from archaeological sites is one of the more difficult aspects of the analysis. From research design to economic and environmental reconstructions to cultural and "processual" explanations of change, there are no totally standard methods. Of course all sites are different, and are excavated in different ways. In light of the variability of depositional contexts within a site, a flexible approach to the recovery of ethnobotanical material must be developed.

The substantive goals of this analysis are:

1) For the Banesh and Kaftari periods, to provide as complete a reconstruction of the environment and economy of Malyan as permitted by botanical data.
2) To explain the changes and stability discovered by (1) above, especially in terms of human use of the botanical environment.

There are interpretative problems separating the research design, the recovery of individual seeds and charcoal, and these two goals.

Standard ethnobotanical data provide evidence for ancient environments, diet, and economy. On a more abstract level, one can infer the path through which items extracted from the natural environment pass, from entry into the social system to final archaeological deposition. This movement is conditioned by social interactions and the institutional arrangements of the society under consideration. Inferences about the social movement of goods must then be drawn from the points at which these objects become incorporated into the archaeological record, which is no simple task. It is to be expected that the pattern of archaeologically preserved plant remains on any site will bear some interpretable relation to these essential sociocultural conditions. And of course, as sociocultural conditions change, so does the archaeological record. Thus, ethnobotany can be used to monitor the magnitude and types of changes in those aspects of the developing cultural system that articulate with the botanical environment.

To help make the connections between the archaeological research and the interpretation, a variety of bridging arguments are necessary. Botanical survey and ethnobotanical data will be used to help establish interpretations of plant remains. A discussion of some numerical and qualitative considerations of data interpretation will conclude this chapter.

Inferences based on Modern Village Life

From one perspective, an Iranian peasant village can be viewed as an ongoing system of plant use. Certain aspects of this system are analogous to archaeological situations. Although cultural continuities cannot be assumed over 5000 years, there are many economic continuities; reliance on wheat and barley agriculture, and sheep and goat herding has defined the subsistence system for millennia. As great as the differences are between village (modern) and urban (ancient) economies, the household activities considered here (cooking, heating and eating) take place regardless of settlement size and rank. Previous chapters have dealt with some methodological consequences of ethnobotanical information for archaeological analysis. This section will consider some processes of archaeological deposition of botanical materials.

While plants themselves are an integral part of the maintenance of the economy, especially as food, shelter, and fuel, likely loci of archaeological preservation are few. In order for plant parts to be preserved archaeologically, normal decay must be slowed or stopped and mechanical breakage must be minimized. The most common circumstance of archaeological preservation at Malyan is carbonization, and secondarily mineralization. No dried or waterlogged deposits were ever discovered archaeologically, and will not be considered further. Thus, the source of preserved plant remains is deposits primarily whose contents have come into contact with fire, and secondarily those which absorbed dissolved minerals from the surrounding soil matrix.

Carbonization occurs when plant parts which have been burned in the absence of oxygen are reduced chemically to carbon. Bacteria and other soil organisms do not eat the carbonized material, and identifications can be based on morphology alone. In the presence of oxygen, the burning plant material will become unidentifiable ash, useless for paleoethnobotanical analysis. The only other major means of preservation at Malyan was the mineralization of seeds, particularly from latrine deposits. Although modern latrine deposits have not been examined for reasons of health and comfort, phosphate mineralization is reported for archaeological fecal deposits (Green 1979: 283).

Few authors try to explain the presence of seeds of field weeds as well as cultigens in archaeological samples (Dennell 1974, van Zeist and Bakker-Heeres 1979). With the exception of burnt buildings (Dennell 1974) and possibly burnt funerary offerings (Ellison et al. 1978:169), the circumstances of seed carbonization are generally ignored. When cultigens and weed seeds are found in place in storage jars in burnt buildings, there can be little doubt that the grain was a harvested crop and the field weeds were threshing impurities (Dennell 1974). Unfortunately, archaeological contexts cannot always be that readily interpreted.

Observation of modern household activities focused on how preservable plant material is likely to enter the archaeological record. It was noted that botanical material was rarely accidentally carbonized, though it was sometimes unintentionally carbonized (Chapter 3). In particular, it suggested an explanation for the carbonization of seeds. Namely, many seeds become carbonized because they are contained in dung-cakes used as fuel. Several arguments supporting this proposition are:

1) One of the most likely ways for material in a settlement to become carbonized is by its intentional inclusion in a controlled fire.
2) The material most frequently burned intentionally is fuel (dung-cake and wood).
3) Seeds do pass through the digestive systems of sheep, goats, and cows, and modern courtyard sweepings yielded several examples of seeds embedded in dung.
4) There are few sources of seeds which are likely to blow into a hearth accidentally in a Near Eastern village or town which houses herbivores; animals will eat all the vegetation in their reach.

Archaeological support for the proposition is:

1) Some flotation samples contained burnt dung; weed seeds were sometimes found embedded in the dung (Table 5.16).
2) A substantial number of the carbonized seeds are from plants of no obvious economic importance except as fodder.
3) If dung is neither burned nor transported,

courtyards where animals are kept could accumulate dung to great depths.[1] In contrast, the excavated areas at Malyan showed relatively little accumulation of organic debris compared to mud brick collapse.

The idea that many seeds (cultivated and wild) originated in dung fuel is important, but cannot be used indiscriminately. First, the proposition presumes an economic system based on domestic animals or other large herbivores.[2] In addition, it is a probabilistic proposition. We cannot know which particular seeds represent dung, even if most of them are thought to have come from that source. The relatively sparse distribution of carbonized seeds at Malyan, with relatively high proportions of weed seeds compared to cultigens fits expectations for dung fuel. Since animals must be stall-fed at least part of the year, the presence of cultigens in dung is not unexpected. In addition, the straw used in the manufacture of dung-cakes is a possible source of cultigens. On the other hand, there were surely cooking accidents, and no doubt some food was processed near or in fires. Not

---

[1] For example, in medieval Novgorod, locally available pine was burned for fuel, and it was probably too damp for the successful manufacture of dung cakes. Street and courtyard levels were raised at a high rate (1.9 - 2.1 cm/yr, Thompson 1967). This figure can be calculated from the section drawing (Thompson 1967: Fig. 14); level 15 (representing a dung accumulation of 14 years) is about 26.8 - 29.9 cm deep.

[2] R.I. Ford (1981, p.c.) has pointed out that Native Americans of the Great Plains used bison dung as fuel.

every seed found archaeologically passed through an animal's gut first. For this reason, it is important to consider the archaeological context of carbonized plant remains, and a judicious use of ethnographic analogy can direct the questions one asks about the sources of one's data. The ramifications of the interpretation of carbonized seeds as dung at Malyan will be discussed in Chapter 6.

The flow of plant materials through the present-day village of Malyan is schematically presented in Figure 4.1. Our ultimate concern is the identification of likely loci of archaeological preservation of plants. Sources of plant material external to the village are fields, gardens, the mountains, and the cities of Shiraz and Marv Dasht. Food, fuel, fodder, and construction material are all brought in to the village, having undergone varying amounts of processing outside the village. Some material is stored, and other items are used immediately. Activities involving fire, such as grain parching or charcoal manufacture, would take place prior to storage; however, evidence for ancient practices of this sort remain to be discovered. At Malyan today, no processing activities using fire were ever observed except for cooking/baking and heating.

Accidental burning of plant material might also occur. Small scale roof fires are fairly common (W. Sumner 1981, p.c.); many ceilings are black with soot above hearths, though I never noticed burnt construction materials in either inhabited buildings or in one building which had been destroyed by an earthquake.

There is at present no industrial activity requiring fire such as pottery manufacture or smelting at Malyan. In contrast, the ancient city of Malyan did seem to house some craft/industrial activities at various points in its history, and might as a result have been subject to some localized conflagrations at manufacturing areas.

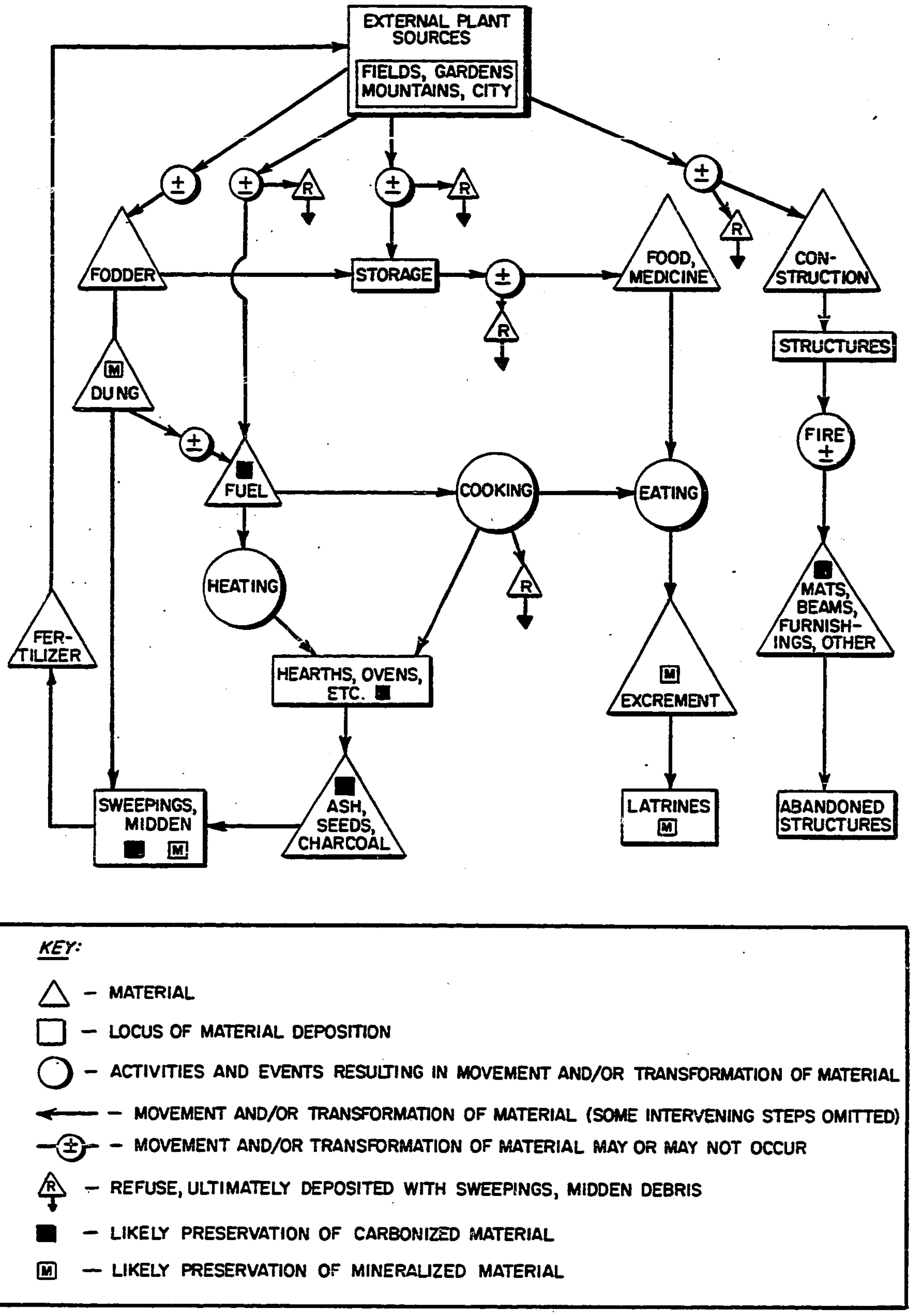
Nowadays, fodder and fuel are the bulkiest botanical items regularly brought into household compounds. Fodder supplies are are consumed by the animals and transformed into dung. In turn, dung is either transformed into dung-cake fuel or accumulated in temporary midden areas, to be trucked out to the fields as fertilizer. Fuel is also provided by the relatively unprocessed vegetal materials, wood and straw. Food is regularly brought in and processed as needed; residues of food and food processing are not as voluminous as those of fodder and fuel, however.

In the absence of burnt structures, the final resting places of macroscopic plant remains within the village are middens and latrines (Fig. 4.1). Hearths are cleaned regularly, so carbonized remains found in an abandoned hearth would be representative of no more than a few fires. Although organic material is plentiful in general midden deposits, carbonized material seems to be quite sparsely distributed, unless it occurs as a result of ash dumping.

Sources of Archaeological Carbonized Material

Even the partial comparability between ancient and

Fig. 4.1.
Flow of Plant Material through the Present-day Village


EXTERNAL PLANT SOURCES
FIELDS, GARDENS MOUNTAINS, CITY
±
R
FODDER
STORAGE
FOOD, MEDICINE
CON-STRUCTION
STRUCTURES
M
DUNG
FIRE ±
FUEL
COOKING
EATING
HEATING
MATS, BEAMS, FURNISH-INGS, OTHER
FER-TILIZER
HEARTHS, OVENS, ETC.
EXCREMENT
SWEEPINGS, MIDDEN
ASH, SEEDS, CHARCOAL
LATRINES
ABANDONED STRUCTURES
KEY:
— MATERIAL
— LOCUS OF MATERIAL DEPOSITION
— ACTIVITIES AND EVENTS RESULTING IN MOVEMENT AND/OR TRANSFORMATION OF MATERIAL
— MOVEMENT AND/OR TRANSFORMATION OF MATERIAL (SOME INTERVENING STEPS OMITTED)
— MOVEMENT AND/OR TRANSFORMATION OF MATERIAL MAY OR MAY NOT OCCUR
— REFUSE, ULTIMATELY DEPOSITED WITH SWEEPINGS, MIDDEN DEBRIS
— LIKELY PRESERVATION OF CARBONIZED MATERIAL
— LIKELY PRESERVATION OF MINERALIZED MATERIAL

modern economy proposed above cannot be assumed automatically, and it is therefore necessary to consider alternative explanations for the carbonized material found archaeogically. First, sources of carbonized seeds other than dung will be considered, and then types of fires other than household heating and cooking will be considered.

Modern samples suggest that carbonized seeds often come from dung that is used as fuel. Nonetheless, potential and actual carbonized seed sources other than dung cannot be ruled out, including:

> Food residues, spat into a fire (e.g., nutshells, grape seeds, other fruit pits)
>
> Food processing near fires
>
> Cooking accidents (e.g. wheat, barley, other cultivated and cooked foods)
>
> Ambient weed seeds blown (or dropped) into fire (e.g. from sheep or goat hair, roofing debris, settlement weeds, or the debris from the cleaning of grain and other crops.

Conditions which favor the archaeological preservation of seeds in large part depend on the manner in which particular plants were used. For example, food is generally meant to be consumed, not carbonized, yet some seeds are most likely to represent food. This is particularly the case for nutshells, grape seeds, and other fruit pits. When one considers the fragility and low density of carbonized material in ordinary household refuse, it is clear that short of a major conflagration, conditions which favor the preservation of some quantity of seeds are regularly occurring activities. Food processing regularly occurring in or near fires might be expected to produce carbonized remains, though none of the archaeological samples fit those expectations.[3] Cooking accidents are not likely explanations for the plant distribution on the site of Malyan either; the few in situ hearth deposits found do not exhibit the unusually high grain proportions that would be expected if a cook's hand had slipped. Nowadays, non-medicinal weed seeds destined for human consumption are not common. Edible weeds are generally eaten as sprouts by villagers, and when they get larger and go to seed are considered to be fit only for the animals. With respect to ambient weeds, e.g., from courtyards where animals live, relatively few weeds will actually survive to maturity. Household activities which are likely to produce botanical debris, such as grain cleaning, are intermittent, and even if the by-products of these activities are swept into a hearth and deliberately burnt, they would be a relatively minor source of seeds in household garbage. In contrast, cooking (and heating in the winter) happen daily and require fuel. For these reasons, it is deemed likely, though not determinable for individual seeds, that most seeds come from dung-cake fuel.

When found, burnt buildings can provide carbonized evidence of construction material, furnishings, and stored contents of rooms. However, if a settlement has no evidence

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[3] Samples which do fit this description have been reported from Jaffarabad, Iran (Miller 1977) and Bulgaria (cf. Dennell 1974:283).

for general burning of buildings, it can generally be presumed that the source of charcoal is from contained/ controlled fires, and the interpretation of charcoal as fuel is highly probable. It is reasonable to suppose that a population center the size of ancient Malyan supported a greater variety of activities and served a larger number of functions than the modern village. In an urban setting, possible fire types include:

1) cooking (roasting, baking, boiling, etc.; cf. V168, Hearth 29)[4]
2) heating (hearths in residential areas, such as ABC and TUV)
3) craft production
   a) ceramic manufacture (cf. Qaleh Operation BB33)[5]
   b) metallurgy (cf. U168, Hearth 227, Nicholas 1980:192, 699 ff.)
   c) charcoal manufacture (more likely in forested areas at outskirts of town, and not identified archaeologically at Malyan to date)
4) garbage burning (perhaps H5 lot 154, Kaftari midden)
5) miscellaneous (ritual, medicinal) (cf. V168, Feature 38, App. E).

The determination of fire type will depend on archaeological

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[4] Explanation of Malyan provenience designations appears at the end of this chapter.

[5] Operation BB33 contained a number of Qaleh period pottery kilns, and much of the pottery was misfired refuse; one of the kilns had little charcoal, but much dung ash.

context (architecture, hearth/oven/kiln type); suitability of fuel for the hypothesized tasks can provide corroborative evidence. In the case of generalized midden and post-abandonment room fill, there will be uncertainty about the type of fire in which the charcoal originated. However, as Nicholas (1980) has demonstrated, even tertiary trash deposits help determine the range of economic activities likely to have been carried out within a building level. Interpretations requiring a perspective broader than that of one site, such as environmental reconstruction or analysis of regional interaction networks, have to be based on a clear understanding of the "cultural filter" applicable to each archaeological deposit.

Complete economic and environmental reconstruction is not possible with only macroscopic plant remains. But, knowing the limitations of preservation at Malyan, the available data are relevant to the use of forests, groves, and pasture, the agricultural and pastoral economy, trade networks for botanical products, range of land exploitation, and, as there is some time depth to the deposits, patterns of change in these human/plant relationships.

Sampling, Statistical Inference, and the Validity of the Analysis

The goals of the sampling strategy for the Malyan Project were three:

> "First: To establish a chronological framework as a prerequisite for all further work.
> "Second: To begin an investigation of culture changes during the early urban period lasting from the mid-

> third through the second millennium B.C. and,
> "Third: To begin an investigation of variability within the city during several periods of occupation." (Sumner 1980a)

Decisions about the number and placement of the 10 x 10 m^2 excavation units were directed by these goals and influenced by considerations of time and expense (W. Sumner 1981, p.c.). Within each operation, the ethnobotanical goals mentioned at the beginning of Chapter 4 clearly fit within this framework.

Excavated deposits were not equally sampled for flotation. For logistical reasons and the "law of diminishing returns", flotation of all excavated soil was not done. Probabilistic sampling within the excavated area was not done either, so ethnobotanical sampling is non-random. A variety of contexts was sampled, however. Virtually all primary deposits, most secondary deposits (pits, trash), and deposits expected to be sterile (mud brick collapse) were examined.[6]

All archaeological interpretations are based on inference, since archaeological materials are static and society and behavior are dynamic. Additional uncertainties of interpretation are introduced by the impossibility and inappropriateness of the total recovery of archaeological remains. Thus, the goal of a sampling strategy is to provide representative and unbiased samples. The statistical inference procedures designed to establish

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[6] Criteria for distinguishing primary and secondary deposits appear in Appendix A.

confidence levels for sampling procedures were not applied at Malyan (Sumner 1980a). It is therefore not possible to infer with a specified level of confidence the quantities or relative proportions (of architecture, artifacts, etc.) of the site contents. Nonetheless, a representative and unbiased sampling was sought. Thus, the credibility of the ethnobotanical analysis rests on the following:

1) Numerous deposits were sampled.
2) Numerous deposit types were sampled.
3) In the analysis, minor differences are given less weight than consistent and major differences among the samples.
4) Different types of material and analysis nearly always support each other.

Paleoethnobotanical Analysis

As is true of artifacts in general, and botanical remains in particular, the quantity of material recovered is not necessarily proportional to use or importance in the ancient economic system.[7] It might even be inversely related, as that which was useful to ancient peoples was consumed, and that which was discarded by them might have been preserved archaeologically. Differential preservation of plant parts is a function of differential use and methods of disposal by ancient peoples, as well as of the sturdiness

[7] Dennell (1978: 15-31) provides a very thorough discussion of the meaning and analysis of archaeological deposits of botanical materials which considers the question of economic significance.

of both utilized and unutilized parts (Munson et al. 1971). The separation of usable from unusable plant parts by ancient peoples (grain, straw and chaff, for example) is the first step in the creation of the archaeological record. The residue of ancient plant procesing is expected to have high proportions of material left unused by ancient peoples. How then can quantities of cultigens divided into their component parts and other botanical materials in different archaeological samples be meaningfully compared? There are at least as many approaches to these questions as there are ethnobotanists.

The interpretation of the number and weight of seeds in ethnobotanical samples is not a simple reflection of relative amount of material. First, plants produce different quantities of seeds; differential breakage of variously sized seeds means that in some cases, number cannot be determined, as only fragments remain. This is particularly the case with nutshells and cereals. Secondly, there is no direct relationship between weight (or number, for that matter) of seeds and usability of the plant or its fruits or seeds. With small quantities of seeds, weight measurements, even if accurate, would be uninterpretable. Seeds swell differentially on carbonization (within and between taxa), and soil particles adhering to the surface of seeds distort weights. Solutions to these problems will be approached in the analysis which follows.

Paleoethnobotanical Methodology

Hand-Picked Material

In the field, large chunks of charcoal seen in place or caught in 1/4"-mesh screen were submitted to the field laboratory. Charcoal from many of these samples was separated out for radiocarbon dating prior to ethnobotanical analysis, and charcoal for ethnobotanical analysis was collected with varying degrees of alacrity between 1974 and 1978. The wood of some species may fracture into small pieces more readily than others, and smaller pieces are less likely to be collected by hand than larger ones. For these reasons, the absolute quantities of charcoal reported here do not faithfully reflect the potentially recoverable charcoal at Malyan. On the other hand, estimates of absolute quantities of either charcoal or the forests the charcoal originated in are not crucial to the environmental and economic reconstructions. The interpretations presented in Chapter 6 are based on relative quantities of charcoal and changes in the relative quantities through time. In addition, finely screened flotation samples provide some corroborative evidence for the economic importance of the various taxa.

For laboratory analysis, each charcoal sample was cleaned and weighed. Up to 20 pieces per sample of varying size were then identified and weighed.[8] Where there were

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[8] See Appendix L for details of laboratory techniques and identification.

several samples per deposit, the combined number of identified pieces is frequently higher. Unidentifiable pieces weighing less than .01 g were not recorded.

First, we may ask what is the relationship of the percentage of the identified charcoal taxa to that of the total charcoal recovered? Sampling was not random, but was aimed at achieving representativeness. An attempt was made to identify both large and small pieces. Nevertheless, easily identified and unique woods (such as oak, and the single conifer, juniper) would tend to be over-represented. Using counts alone, though faster for analysis, would tend to provide an over-estimate of the rare taxa. Weights alone would be better, but one large chunk might mask the importance of a variety of taxa that happened to be broken into smaller pieces. In general, weights do provide a more accurate estimate of <u>quantities</u> of a given species, though cross-checking with counts balances the view. This is particularly true of the flotation samples (see below), where many pieces are quite small (.01-.03 g), and the recorded weights are probably not very precise due to the coarseness of the scales and adhesions of clay. In any case, a correlation analysis comparing counts and weights of identified charcoal was carried out for both the flotation samples and for the hand-picked samples, and very high correlations are characteristic (Table 4.1).[9]

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[9] Casparie et al. (1977) prefer volume measurements in ml. This measure seemed too difficult to apply consistently, however. For example, many small pieces would settle

Table 4.1. Correlation of Counts and Weights of the Major Woods

Tree	Correlation Coefficient	
	Flotation carb. dens.>1.5g/10 l N=88, df=86 R@ .05=.2096	Hand-picked N=75, df=73 R@ .05=.2272
Juniper	.9047	.7883
Almond	.8313	.8364
Maple	.8195	.9692
Pistachio	.8004	.8535
Oak	.7737	.9101
Poplar	.8986	.7486

Next, what is the relation of the percentage identified to the amount of charcoal or wood used at the site (or at least, in the excavated areas) for fuel? Some woods burn faster or more completely than others, so in any given fire remains may be under-represented. If a certain type was used primarily as kindling, it too would be under-represented. The relationship between the charcoal and the forest/arboreal vegetation in general is also not obvious. These are not however strictly statistical problems, and will be dealt with in connection with the actual data (Chapter 6).

Carbonized Material obtained by Flotation

Soil samples collected in the field were generally

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more than a few large pieces, though they might represent the same 'volume' of charcoal.

about 10 liters.[10] In many cases, several such samples were derived from a given stratigraphic unit. For the laboratory analysis, data from several soil samples taken from a single stratigraphic unit were combined due to the low densities of carbonized remains, especially seeds. Thus, absolute quantities of seeds and charcoal are less meaningful than relative densities of material for comparison between samples. In addition to density of carbonized material, other quantitative measures used are the proportion of seeds to charcoal, charcoal counts and weights, and seed counts and weights and ubiquity. Qualitative analysis will compare characteristics of different species: their possible uses and distribution on the site.

Density of carbonized material per soil unit provides an indication of the depositional history of the material. The fragility of carbonized remains is such that, if the material has been redeposited several times, it would lose its integrity and density. The converse, that primary deposits of carbonized remains will be well preserved is not necessarily true, due to post-depositional disturbances such as root growth, soil insects, and soil moisture changes.

Weights and counts of identified pieces of charcoal were used. If available, up to 20 pieces per 10 liter soil sample were identified.

Analysis of seeds is complicated by the fact that

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[10] See Appendix K for description of flotation and laboratory technique.

different seeds find their way into a deposit in a variety of ways. Unlike wood, it is not as obvious to assume use as fuel, though in the absence of compelling evidence to the contrary, I have argued that most carbonized seeds at Malyan represent animal fodder transformed into dung, which was then made into dung-cake fuel. The ratio of seeds to charcoal, especially in the high density deposits, might provide a clue to the nature of the deposits (e.g., trash, primary hearth debris, or stored grain). It might be interpreted as a relative (though not absolute) measure of dung compared to wood/charcoal used as fuel[11].

For convenience seeds that tend to be found whole were counted, and seeds that tend to be found fragmented were weighed. For each sample, seeds as a group were weighed prior to sorting by taxon. One adjustment was made for cereals; if only one or two were present, but did not weigh even .01 g, they were recorded as .01 g, because laboratory experience has indicated that a well-preserved carbonized cereal grain weighs, to the closest .01 g, about .01g (cf. Helbaek 1969:388, 1000 carbonized grains weigh 9.0 g). It was felt that this adjustment would more accurately reflect the presence and relative importance of the grains in question vis-a-vis the sample they were in.

Because seed counts were so low, most are combined for

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[11] Clearly not all weed seeds on all archaeological sites, or even on all Near Eastern archaeological sites, represent dung or dung-cake fuel. Each investigator must consider each deposit of archaeological plant remains on its own merits.

purposes of analysis into 'ecological groups' (cf. Helbaek 1969). Even though many identifications are only to genus, approximate ecological designations were assigned based on present day plant distributions (Table F.1).

Uncarbonized Plant Remains

Several samples taken for flotation from latrine deposits were filled with uncarbonized, mineralized seeds (cf. Green 1979). Since very few seeds could be recovered by the standard flotation procedure, the entire heavy fraction of these samples was saved and examined at 7x magnification in the laboratory. Many seeds were very eroded or distorted almost beyond recognition; others were countable, but encrusted with the surrounding matrix. The most numerous taxa, fig (*Ficus*) and grape (*Vitis*) were not countable, as there was much fragmentation. Consequently, about 100 whole, clean mineralized seeds were weighed, and an estimated count was obtained by weighing the remaining clean seeds and fragments. The number of encrusted seeds could then be added to the estimated count.

The processes by which seeds were deposited in latrines were quite different from those responsible for seed deposition in the other samples, and the counts and weights of these seeds are not included in the summary analyses of the other flotation samples. The meaning of the data from the uncarbonized latrine material will be compared to that of the carbonized material in Chapter 6.

Results of the ethnobotanical investigations at Malyan are presented in the next two chapters. Our understanding of the past is colored by our interpretative framework and methods of analysis. An attempt has been made in Chapter 4 to specify how paleoethnobotanical remains are related to the ancient society which produced them. With a suitable interpretative framework, valuable information can be gleaned from the bits of charcoal and seeds with which the paleoethnobotanist works. Research at Malyan yielded the following results:

1) The presence of numerous species, both cultivated and wild, is documented.
2) Gross patterns of stability in the crop complex and changes in the arboreal vegetation are attested to.
3) An increase in the radius of effective economic interrelationships (and control?) is attested to.
4) Hypotheses about changing economic and social arrangements can be tested with these three classes of information.

Excavations at Malyan

The site of Malyan is about 2 km in diameter (Fig. 4.2). It is not a steep mound relative to its extensive area. Within the bounds of the mound are a variety of surface and subsurface features, such as smaller mounds, possible boulder alignments, and magnetic anomalies. The major occupations are Banesh and Kaftari, though there is a Middle Elamite public building and traces of Sassanian occupation.

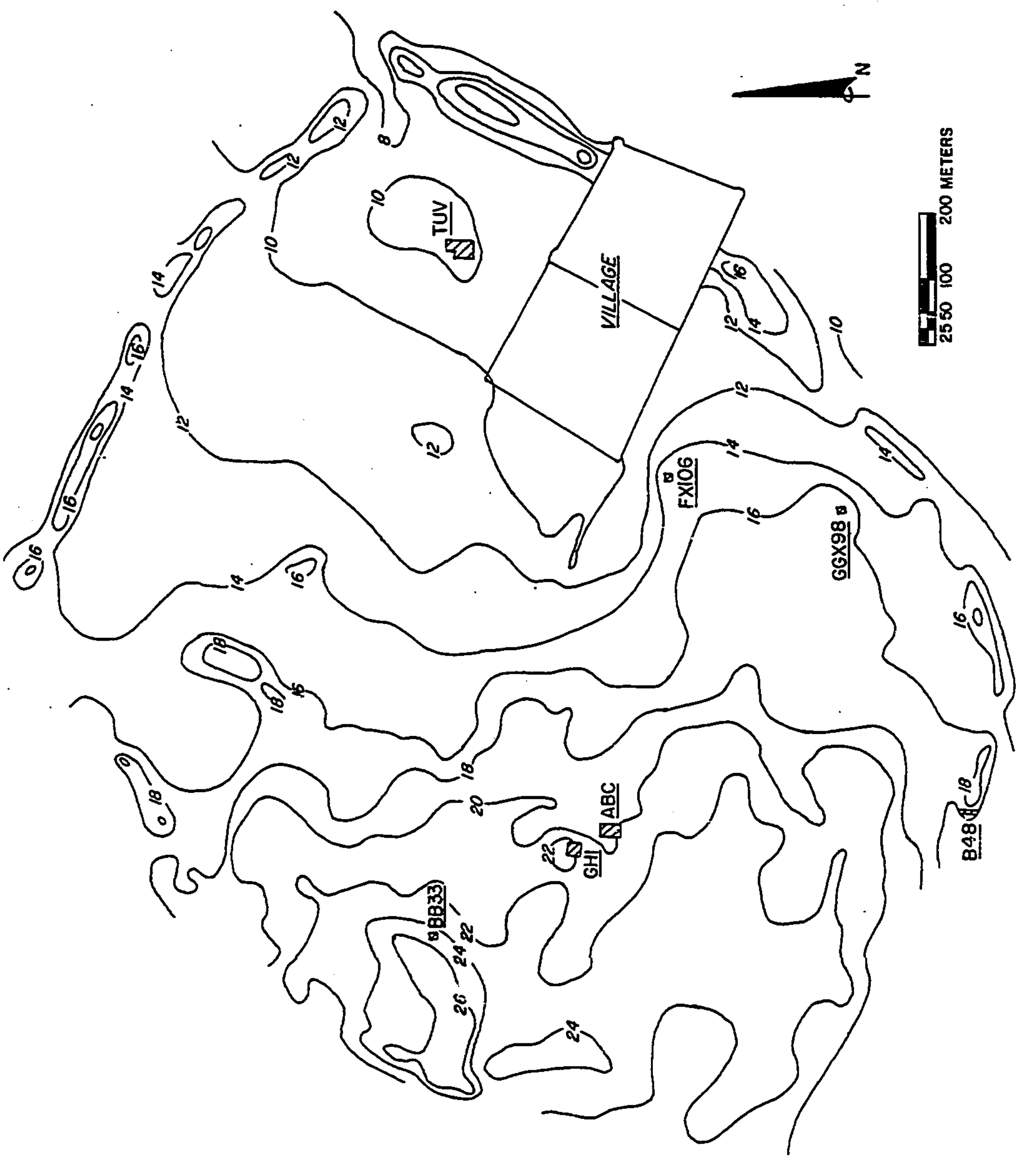
Surface collections of pottery were used to identify areas likely to be of Banesh and/or Kaftari date.

The basic units of excavation were 10 m by 10 m squares, each of which was given a grid designation. One or more such contiguous squares was given an "Operation" designation (thus, Operation TUV contains excavated grid squares T168, U166, U168, V168, etc.). Once architecture was uncovered, grid square designation was important primarily for bookkeeping purposes, as one series of feature numbers and stratum numbers was used for an entire operation.

Details of the various excavation units containing Banesh and Kaftari period material can be obtained elsewhere (Sumner 1980a,b; Nicholas 1980; Nickerson 1980). A short summary of operations from which botanical remains were recovered follows.

TUV: TUV is a small mound, chosen because it had only Banesh material on the surface, with no Kaftari overburden. It is about 3 ha, with a maximum exposure of 455 sq m for any one building level (Nicholas 1981). The uppermost three building levels were studied. At least one room had walls with black and white-painted plaster. A number of functional classes of artifacts have been found at TUV, documenting copper and perhaps shell working, chipped stone tool manufacture, cooking, and information processing activities (Nicholas 1981). It was probably a small, dependent settlement of ABC Malyan during Banesh times (Nicholas 1980, 1981).

Fig. 4.2.
Malyan
(Source: Sumner 1980b)


N
200 METERS
25 50 100
VILLAGE
TUV
FX106
GGX98
B48
ABC
GHI
BB33
8
10
12
14
16
18
20
22
24
26

<u>ABC</u>: This operation is in a depression surrounded by mounds. It was chosen for a deep sounding to obtain the chronological sequence. The Kaftari levels were generally midden-like, with no substantial architecture. Initial excavations of Kaftari and upper Banesh levels were completed before ethnobotanical work had commenced. However, some Kaftari samples are available from ABC pits which extended downward into Banesh levels, and also from baulks left standing. There is a distinct break in occupation between Banesh and Kaftari periods. The Banesh levels contain four building levels, several of which had foundations directly superimposed on the wall stubs of the previous structures. Some rooms showed evidence of multi-colored wall paintings. In some cases, abandoned rooms had brick packing. Most rooms had been swept clean of debris prior to rebuilding. It is in the center of the "main Banesh city ... [T]he recovered architecture is best described as 'large-scale,' while many of the small finds associated with these structures suggest that the function of this area was elitist in nature" (Nicholas 1981).

<u>GHI</u>: GHI contained Kaftari and Qaleh deposits: "Five building levels have been uncovered including several very substantial structures with elaborate hearths, wells, socketed doors and thick walls" (Sumner 1980b). As at ABC, a deep sounding was excavated. Very early Kaftari pottery was found which in some ways resembles a Banesh assemblage (Wm. Sumner 1981, p.c.). There was some clearly Banesh

pottery at the deepest levels reached, and sterile soil was never attained.

GGX98: Operation GGX98 is represented by just one 10 m by 10 m square. The deposits are all Kaftari. Some architecture was found, but many of the botanical remains come from a large pit, originating above and not associated with the architectural levels.

FX106: Operation FX106 is also represented by just one square. It is located on a steep mound. "Part of a building with signs of extensive repairs and rebuilding was found, dating from Kaftari times" (Sumner 1980b), but botanical preservation was poor.

BY8: BY8 was excavated in an attempt to further understanding of the town wall. Previous to this excavation, it was thought that the wall was built in Kaftari times. The first phase of the wall was built by the inhabitants of the smaller Banesh settlement at Malyan.

CHAPTER V

DESCRIPTION AND IDENTIFICATION OF PLANT MATERIALS

This chapter contains ecological and economic information about present day exemplars of the archaeological taxa, followed by a description of their archaeologically known characteristics. Dimensions given are of archaeological specimens, not modern carbonized comparative material. Unless otherwise indicated, measurements are of carbonized material. Where applicable, length (or greatest diameter), breadth, thickness (dorsal to ventral side of grains), length to breadth index, and thickness to breadth index are provided, with range (L, B, T, L:B, T:B). The archaeological importance of the taxa is discussed in Chapter 6, with special reference to Tables 6.8, 6.9, 6.10.

Plants of Streamsides and Ditches near Fields (Table 5.1)

Cyperaceae

Sedges typically are plants of moist ground. Three genera were collected around Malyan: _Carex_, _Cyperus_, and _Scirpus_, though no seeds were available. _Scirpus_ was not found archaeologically.

Carex: The one species collected, _C. divisa_, was seen growing along irrigation ditches and in the poorly drained pasture east of Malyan. Carex is one of the most ubiquitous seeds in Banesh and Kaftari samples. It was probably a constituent of dung used as fuel. The seed of Carex is distinguished from that of Cyperus by its relative flatness. Under 7x magnification the cell structure is visible.

Cyperus: Only C. longus grows along streams and ditches. Cyperus is much less common than Carex archaeologically, though it appears regularly throughout the sequence. Seeds identified as Cyperus are triangular to oval in shape, with one flat side and one rounded side, frequently with a crest running vertically. On many specimens, the cell structure of the surface is visible at 7x magnification.

Table 5.1. Plants of Streamsides and Ditches near Fields (seed dimensions in mm)

	N	L	B	T	L:B L x 100/B	T:B T x 100/B
Carex	81	1.6	1.1	0.6	151	57
		1.3-2.0	0.8-1.4	0.4-0.9	130-200	36-100
Cyperus	21	1.8	1.5	0.9	127	61
		1.6-2.2	1.2-1.9	0.6-1.0	100-162	46-83
Cynodon	1	1.3		0.6		
	1	1.3		0.7		
	1	1.1		0.6		
cf. Phalaris	1	1.1		0.6		
Setaria	1	1.7	1.6	1.2		
	1	1.7	1.7	1.2		
Trifolium	1	1.2	0.8			
Polygonum	6	1.3	0.9	0.7		
		1.0-1.8	0.6-1.3	0.5-1.0		
Rumex	1	1.5	1.1			
	1	1.8	1.4			
Potentilla	1	1.4	1.1	0.9		
	1	1.0	0.9	0.6		

Gramineae

Several identifiable weedy grasses grow in relatively damp environments at Malyan.

Cynodon: *Cynodon dactylon* was observed growing in the wetter irrigated fields (sugar beet), especially near streams and ditches (cf. Bor 1968:455). The seeds ripen in the fall. This grass is recognized as a useful fodder plant (Bor 1968:455), and its only use today at Malyan is as forage. Its presence in the samples is presumed to be related to the use of dung as fuel.

cf. *Phalaris*: Two genera were collected, *P. paradoxa*, near irrigation ditches, and *P. minor*, beside the Kur river, 55 km from Malyan (cf. Bor 1968:361 ff.). *P. paradoxa* is said to be difficult to eliminate from fields, as the upper spikelets are easily dispersed by wind and the lower ones "are kept on the rachis until harvest time" (Zohary 1962:226). The seeds ripen in the spring. It is considered a good forage plant (Bor 1968). As above, it is presumed to represent a constituent of dung.

Setaria: *Setaria verticillata* was seen growing in the relatively damp irrigated fields (sugar beet) and near streams and ditches. It tends to be a weed of summer crops (Bor 1968). It is not economically important at Malyan, though it can be used for forage (Bor 1968:503). The caryopses ripen in the fall. *Setaria* is among the seeds presumed to have entered the archaeological site of Malyan encased in dung. The seed is fairly flat and round, and the archaeological specimens are distinguished from *Panicum* by having the radicle shield greater than halfway up the length of the caryopsis (W. van Zeist 1975, p.c.).

Leguminosae

Trifolium: At least two types of clover were occasionally seen, both growing under damp conditions; a large-leafed clover, cultivated as fodder, and *T. fragiferum*, also considered a good fodder plant (Townsend 1974). The pods of the latter ripen in the late summer. Very few seeds identified as clover were recovered archaeologically and are presumed to represent dung. On the basis of published illustrations and limited comparative material, *Trifolium* is difficult to distinguish from *Melilotus*, but as the former is more common than the latter near Malyan today, *Trifolium* is the designation.

Polygonaceae

Polygonum: Three species of *Polygonum* were found growing near Malyan; *P. aviculare*, *P. equisetiforme*, and *P. lapathifolium*. The latter two grow along ditches, and *P. aviculare* and *P. equisetiforme* were also seen growing in an irrigated garden. *Polygonum* sp. was also growing in a cool moist poplar grove. The achenes ripen in the fall. Nowadays *Polygonum* serves as fodder. Seeds identified as *Polygonum* are triangular in outline, widest at the base. At times, they are difficult to distinguish from those of *Cyperus*.

Rumex: Three species of *Rumex* are found today growing in the well-irrigated alfalfa fields (*R. crispus* and *R. dentatus*) and in and near ditches (*R. conglomeratus*). *Rumex* was also found growing in a cool moist poplar grove. The achenes ripen in the fall. Today, *Rumex* is collected as fodder, and presumably represents a constituent of dung archaeologically. Seeds identified as *Rumex* have a sharp edged tetrahedral shape, being widest towards the base.

Rosaceae

Potentilla: *Potentilla reptans* is today fairly rare. It was seen in an irrigated grove, growing right next to a qanat-fed stream (cf. Townsend and Guest 1966:128). It fruits in summer and fall (Townsend and Guest 1966). Inclusion in the archaeological samples presumably represents dung.

Weeds of Irrigated fields (Table 5.2)

Boraginaceae

Lithospermum: *Lithospermum* is tentatively identified archaeologically, although it was never seen growing in the fields. It is frequently encountered as a modern seed in rodent burrows. The seeds of borages tend to turn gray or white with age, and Helbaek (1970) says that they carbonize white. It is possible that those reported here are modern. (Caches of chalky white *Lithospermum* seeds submitted for analysis were tested; if internal seed matter was present, the seed was presumed to be modern).

Chenopodiaceae

Chenopodium: A few seeds tentatively identified as *Chenopodium* were found archaeologically. At the present time, two species are found growing in irrigated fields at Malyan, *C. album* (salmak), which is common, and *C. vulvaria* (salmak-e gowak), which is not. When young, *C. album* leaves are an ingredient of âsh-e duq, a yoghurt and rice pudding, along with *Silene conoidea* and turmeric; when mature, the foliage is fed to animals. The local name for *C. vulvaria* implies that it is used for fodder.[1] One woman commented that *C. album* grows in vetch and alfalfa fields (both of which are relatively well irrigated), but not in wheat. The achenes ripen in the fall.

Table 5.2. Weeds of Irrigated Fields
(seed dimensions in mm)

	N	L	B	T
Chenopodium	1	1.2		
Lolium	1	3.5	1.3	0.6
Hyoscyamus	1	1.4	1.4	0.8
	1	1.4	1.2	0.6
Solanaceae	1	1.4	1.2	0.6
Avena	1	3.2	1.0	0.7

Gramineae

Avena: Wild oats occur only rarely in the fields today. One example, growing as a weed, has been tentatively identified as the cultivated species, *A. byzantina*.

[1] The suffix "-e gowak" means roughly "of cows."

Presumably Avena would represent fodder. Archaeologically, it is also quite rare, occurring in two Kaftari samples. It is distinguished by shape, round cross-section, and awn scar.

Lolium: The only species of Lolium observed growing was L. perenne, and it was not very common. In general, Lolium prefers relatively moist habitats (in fields or wild) (Bor 1968). Except for L. temulentum, Lolium is considered a good forage grass (Bor 1968:92), and presumably represents dung archaeologically.

Papaveraceae

Fumaria: Fumaria vaillantii was seen primarily in irrigated fields. It has some economic value due to its medicinal uses; the plant is collected and sold to the araq factory in Shiraz, where it is made into medicine, and it is also processed at home as needed by putting into a covered pot of boiling water.[2] It could easily have been used as fodder or graze. Its seeds are dispersed in the summer. The seed is distinctively lens shaped, with low surface relief and a double circular scar at the stem attachment. It is quite common to see recent caches of these tan seeds in an excavation. For example, the baulk of Operation BY8 contained a distinct cross-section of an insect chamber filled with Fumaria seeds about 1.90 m below the modern ground surface.

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[2] Fumaria parviflora "is prepared like tea to relieve pains in the back in pregnancy" (Hooper and Field 1937).

Solanaceae

Hyoscyamus and an indeterminate solanaceous seed type that resembles *Solanum* or *Physalis* are found arhaeologically at Malyan. All six solanaceous species found growing in the area today (*Datura stramonium*, *Hyoscyamus pusillus*, *H. reticulatus*, *Physalis angulata*, *Solanum nigrum*, and *Xanthium strumarium*) are found primarily in irrigated fields and along ditches.

Hyoscyamus: The two species flower in the spring, and presumably are in fruit in the summer. *H. reticulatus* was recommended by one Malyani as being "good for nothing."[3] The archaeological designation is based on shape, reticulate surface relief and size (Fig. 5.1).

Solanaceae: Both *Physalis angulata* and *Solanum nigrum* ripen in the fall. The former is said to be no good for the animals, the foliage of the latter is fine for animals, and the fruits for people (as a field snack food). The tentatively identified archaeological seeds may represent dung. They are flat and oval; one measurable specimen is 1.4 mm long, 1.2 mm wide, and 0.6 mm thick.

Cultigens of Irrigated Fields

Leguminosae

Lens: Lentils are occasionally grown at Malyan

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[3]Hooper and Field (1937) report the use of its vegetative parts as fodder, and the medicinal use of its seeds, which contain the alkaloid hyoscyamine; "the smoke of the seed is inhaled for a toothache" (ibid.).

nowadays, although they are more commonly purchased. They are an ingredient of **dami**, or **dam poxt**, a mixture of rice and lentils. For agricultural practices related to this crop, refer to Chapter 3. It fruits in the summer. Archaeologically, lentils presumably represent a food crop, though the lentil plant is a useful fodder (Townsend 1974:544 ff.). There are large and small seeded varieties (Zaitschek 1959). In general, lentils reported from archaeological sites tend to be smaller than those purchased nowadays, either locally or in the United States, even when corrections are made for shrinkage resulting from burning. Renfrew (1973:115) lists a series that range in size from about 2 - 6 mm in diameter. Other authors report seeds smaller than those of today: 2.7, 2.9 mm (Behre 1970:66); 2.8 - 4.2 mm, with a diameter to thickness ratio of 0.60 to 0.72 (Zaitschek 1959:51); 2.8 - 4.3 mm (van Zeist and Heeres 1973:31); 2.1 - 3.0 mm (van Zeist 1972:11); 1.9 - 3.5 mm (newly domesticated, Hopf 1962:104). Eight measurable lentils from Malyan have maximum diameters averaging 2.7 mm (2.3 - 3.0 mm), placing them with a small seeded variety.

Pisum: Peas are occasionally grown at Malyan. For agricultural practices related to this crop, refer to Chapter 3. Archaeologically, Pisum is rare and only tentatively identified. The testa is destroyed. The maximum diameter of the seeds is small (2.3; 2.5 mm), compared to ranges of 2.5 - 5.5 mm for archaeological specimens from a number of sites enumerated by Renfrew

(1973:112), and 3.2 - 4.6 mm mentioned by van Zeist and Heeres (1973:27).

Medicago: Cultivated for fodder at Malyan today, *Medicago sativa* is one of the most frequently irrigated crops. It is said to go to seed in the summer (Townsend 1974). Nowadays, it is planted close to the village, as daily trips to collect it are necessary to feed the cows. *Medicago* occurs in some of the archaeological samples and probably represents a weedy species, rather than cultivated alfalfa (Table 5.3).

Table 5.3. Carbonized *Medicago* from Malyan (seed dimensions in mm)

L	B	T
1.9	1.4	1.2
2.9	1.6	1.4
2.1	1.5	0.8

One sample, H5 lot 157, contained a pod fragment of a wild *Medicago* that has a coiled, barrel shaped, non-spiny fruit, such as *M. turbinata* (cf. Townsend 1974: Pl. 17.6).

Weeds of Unirrigated Fields (Table 5.4)

All modern fields at Malyan are irrigated. Some weeds of unirrigated fields were collected in the piedmont, five to eight kilometers south of Malyan.

Gramineae

Aegilops: One species of *Aegilops*, *A. crassa*, was

Table 5.4. Weeds of Unirrigated Fields (seed dimensions in mm)

	N	L	B	T	L:B	T:B
Aegilops	14	4.5 (2.9-5.4)	2.4 (1.5-2.8)	1.6 (1.0-2.0)	186 (140-230)	67 (52-78)
Eremopyrum	1	2.9	1.0	0.9	290	90
	1	3.1	0.9	0.8	344	89
Hordeum	1	3.2	1.7	1.1	188	65
	1	2.9	0.9	0.6	322	67

rarely encountered: one plant at Malyan, near a garden path, and a few plants in unirrigated wheat and barley fields. Seeds were not collected, but Aegilops probably fruits during the summer. Most species, including A. crassa, are found under 1200 m (Bor 1968). Bor comments, "The genus Aegilops, a formidable object to some grazing animals because of the awns, is devoured with avidity by goats" (1968:174). Archaeologically, Aegilops at Malyan is presumed to be a constituent of dung used as fuel. Glume bases were also identified (Table 5.5). There is an unusually high concentration of both seeds and glume bases of Aegilops in the midden of the H5 deep sounding, lots 147 and 154.

Table 5.5. Number of Flotation Samples containing Aegilops

Period	Grain only	Glume Base only	Grain and Glume Base
Banesh	6	0	1
Kaftari	1	12	5

Eremopyrum: E. bonapartis was occasionally seen growing, primarily on waste areas of the mounded archaeological site of Malyan, but also in a few irrigated fields. According to Bor (1968), it is a plant of the dry wastelands, usually at altitudes under 400 m. It ripens in the late spring. The keels of the palea are "armed with forwardly directed curved spines," though it might be "avidly grazed by stock" (Bor 1968: 229). The dorsal side of the archaeological specimen is sharply keeled.

Hordeum: Two species of wild barley were collected at Malyan, Hordeum glaucum (very common along paths) and H. geniculatum (fairly common along paths); Hordeum bulbosum was present but rare in unirrigated fields. H. glaucum is not eaten by stock, though the other two species can be (Bor 1968). Presumably representing dung contents, wild barley is rare archaeologically. Perhaps these small grains are extreme examples of cultivated Hordeum since they occur in such low densities.

Weeds of Fields, Field Edges, Roadsides, and other Disturbed Areas

There remain a series of plants that are not specific to one type of field or wet environment as presented above, but are more generally distributed. The plants discussed in this section are weedy herbs, but apparently not restricted to a particular moisture regime.

Caryophyllaceae

Silene: Two species of Silene were collected in fields, S. conoidea and S. spergulifolia. The former is common in irrigated fields and present in non-irrigated fields, the latter is common in unirrigated fields. In addition to being suitable as fodder, the young shoots of S. conoidea are collected in the spring for āsh (stew) and dug ba (a yoghurt based drink). The fruits ripen in the spring and summer. Neither archaeological exemplar was measurable.

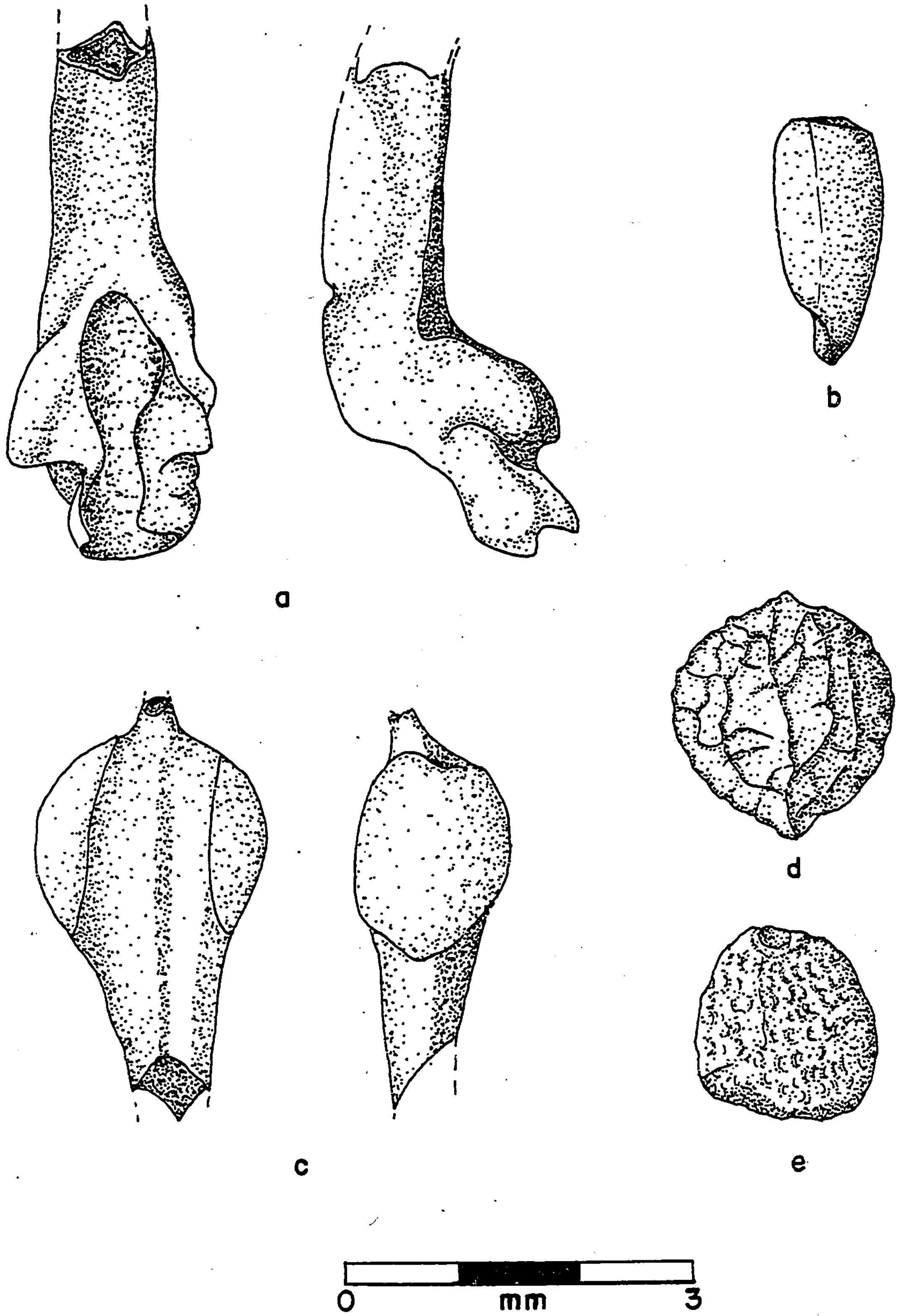
Vaccaria: Vaccaria pyramidata is a common weed of irrigated and unirrigated fields. It is also harvested with the grain, and is not entirely lost during threshing. It is collected for fodder. One woman, asked about its use, responded,"You're the weed-ologist." Fruits ripen in spring and early summer, and presumably represent dung. The seeds are spherical, with a nubbly surface texture. One measurable archaeological seed is about 1.2 mm in diameter.

Chenopodiaceae

Atriplex: Two species of Atriplex occur in various areas near Malyan: A. tatarica was found as a weed on the edge of the marshy area and on waste areas of the tepe. A. turcomanica grows on the tepe. The former is eaten by animals, and (presumably when a sprout) by people. Elsewhere in the valley, two other species, A. leucoclada and A. portulacoides were seen growing in saline, poorly drained land. Archaeologically, Atriplex is distinguished from Chenopodium by the presence of an annular ridge around the perimeter of the seed. This specimen measures about 1.4

Fig. 5.1.
Seeds

a. Ceratocephalus (H5 lot 157)
b. Centaurea (H5 lot 199)
c. "Cruciferae A" (H5 lot 147)
d. Neslia (V168 lot 136)
e. Hyoscyamus (H5 lot 114)


a
b
c
d
e
0
mm
3

mm in diameter.

Compositae

Centaurea: *Centaurea* is represented by four common species at Malyan today: *C. calcitrapa*, *C. depressa*, *C. phyllocephala*, and *C. solstitialis*. The genus is common in and around fields, and probably ripens in late summer and fall. The archaeological specimens do not look like *C. depressa*. They are smooth and nearly cylindrical, though beaked at the base, and seem to be most like *C. solstitialis* (cf. Brouwer and Stählin 1975, *C. calcitrapa* or *C. solstitialis*; Fig. 5.1). One seed is 1.8 mm long and 0.8 mm in diameter; the other is 2.3 mm long. Many species of *Centaurea* are spiny, and are not chosen by animals. Since composites are adapted to seed dispersal by wind, presence in the samples could represent accidental inclusion by wind (cf. Minnis 1978:362). Alternatively, they could have resulted from accidental inclusion in fodder or food grain.

Cruciferae

Several seeds are tentatively identified as members of the mustard family (Cruciferae). Along with legumes and composites, they are among the most numerous families in and around the fields at Malyan. Consequently, only broad ecological requirements can be postulated, and ripening times range from early spring to late fall. As crucifers are eaten by animals, these seeds are presumed to represent dung.

Unknown crucifer (Cruciferae "A"): One type of mustard frequently occurring attached to its silique is found at Malyan archaeologically. It does not appear to be any of the ones collected to date (Fig. 5.1).

cf. Lepidium: Two species of Lepidium, L. sativum and L. latifolium grow at Malyan today. It is not very common, and was only seen at the edge of a garden. It ripens in late summer and fall. The one excavated seed is about 1.1 mm long, 0.9 mm wide, and 0.6 mm thick.

Neslia: Neslia apiculata occurs in moderate amounts in grain fields, both irrigated and unirrigated. Presumably it can be eaten by animals. It ripens in the late spring and summer. Its archaeological presence may represent dung (Fig. 5.1). One archaeological exemplar is about 1.8 mm long and 1.6 mm broad.

Euphorbiaceae

A number of spurges presently grow in the area, occupying a variety of ecological niches. Some are palatable to animals and some are not. The types include Euphorbia spp., Chrozophora tinctoria, and Ricinus communis (cultivated). Clearly not either of the latter two, the one archaeological spurge seed is probably Euphorbia sp.; it is 1.4 mm long, 0.8 mm wide, and 0.7 mm thick.

Gramineae

A number of weedy grasses of indeterminate genus are present archaeologically. One can assume these seeds represent plants of open ground. The grasses which presently grow at Malyan tend to ripen in late summer and fall, though there certainly are genera which ripen earlier.

Bromus: Four species of Bromus, B. danthoniae, B. hordeaceus, B. sterilis, and B. tectorum have been found on waste areas of the tepe, in irrigated fields, in gardens, and in the marshy area near Malyan. Although most species do not provide good forage, several species (B. cf. danthoniae and B. tectorum) are eaten by sheep, goats, and mules (Bor 1968). Bromus ripens in the late spring. Archaeologically, its presence presumably represents dung. Archaeologically, it is rarely found whole, and fragments are somewhat tentatively identified by their thin, concave cross section.

Panicum: Panicum miliaceum is rarely seen today. Panicum spp. are said to be drought resistant, though their habitat is frequently damp (Bor 1968). It is suitable as fodder. It ripens in the summer. Archaeologically it is rare as well, occurring in one Kaftari sample. It is distinguished from Setaria somewhat arbitrarily; the radicle shield of the former occupies less than half the length of the round to oval grain (W. van Zeist 1975, p.c.), and that of the latter occupies "about three-quarters of the dorsal side" (Renfrew 1973:102). One measurable specimen is 1.7 mm long and 1.3 mm wide.

Labiatae

There are only a few seeds tentatively identified as members of this family. Plants in this family are found in a variety of habitats. It will be assumed that these seeds represent field weeds.

Ajuga: Ajuga was not actually seen growing around Malyan, though it did show up in a sample of irrigated barley (App. H) and a courtyard sweepings sample (App. I). Archaeologically, Ajuga is rare, occurring only once. The specimen is a distinctive seed, 2.3 mm long, 1.4 mm wide, and 1.5 mm thick.

Leguminosae

Indeterminate leguminous seeds have been identified archaeologically which could have originated in a variety of habitats.

Astragalus: Astragalus is very common in Iran, and has a large number of species. Some species are palatable to animals, and some are not (Townsend 1974). Growing at Malyan are A. hamosus, A. kotschyanus, A. campylorrhynchus, as well as several indeterminate species. A. hamosus is mentioned particularly as a good forage species, and the pods, imported from Iran, are sold by herbalists in Iraq (Townsend 1974). A. campylorrhynchus is recognized as being "like xenj-e gorba" (i.e., A. hamosus) by Malyanis. Astragalus is found in fields (irrigated and not) and on waste areas. The numerous species reported by Townsend (1974) tend to fruit in spring and summer. Archaeologically, Astragalus occurs sporadically, and probably represents fodder. It is noteworthy that it has been found actually embedded in dung collected from a modern courtyard sample (App. I).[4]

Vicia: Vetch is a common field weed. Four species have been identified at Malyan, one of which is cultivated (V. ervilia). The other three are V. sativa, V. peregrina, and V. narbonensis. V. narbonensis pods are collected on occasion as a snack food when green, and one woman commented that people eat the seeds of V. sativa (**holâr**) also, though this species was fairly rare in the fields. V. peregrina is generally not eaten. The pods of the vetches ripen in the late spring and summer. V. narbonensis has nearly spherical seeds. Archaeologically, vetch is rare. Two measurable seeds were 2.0 mm and 2.1 mm in diameter.

Malvaceae

Malvaceous plants collected at Malyan today include Alcea cf. kurdica, Malva neglecta, and Hibiscus trionum.[5] The seeds of the last named cannot however be confused with those of the other two. Alcea and Malva generally occur in the wetter fields (sugar beet, alfalfa), though they are found elsewhere. The flowers of Alcea are collected for medicinal purposes, and also as a flavoring for bread and sweets.[6] Like Fumaria, Alcea is collected and sold to the

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[4] Hooper and Field (1937) mention the use of A. hamosus as a suppurative, astringent, and as a plaster for reducing swellings.

[5] The seeds of Hibiscus trionum are said by Malyanis to be good to eat.

[6] "The mallows have mucilaginous and cooling properties,

araq factory in Shiraz. Malva is fairly common, in fields and along paths. It flowers from spring to fall. Seeds were never collected at Malyan, so identification remains somewhat tentative. Both plants could have been consumed by animals and are presumed archaeologically to represent dung. The state of preservation of the archaeological specimens is not that good, and these seeds are only distinguished from the seeds of Silene by their smooth surface texture. One measurable seed was 1.1 mm long, 1.1 mm wide, and 0.6 mm thick.

Ranunculaceae

Adonis: Adonis aestivalis is not a very common field weed. It could be used as forage. It probably ripens during the summer. Archaeologically probably represents dung.

Ceratocephalus: Ceratocephalus falcata occurs in irrigated and unirrigated fields and waste areas on the tepe, but is not common. No ethnographic information was obtained about this plant; presumably it is eaten by animals. It has an unmistakeable shape (Fig. 5.1). The seeds are quite thin, and are quite fragile in carbonized form.

Rubiaceae

Galium: Several species of Galium were seen growing:

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and are given for coughs" (Hooper and Field 1937). The greens of Malva are eaten by poor people in Khuzestan (H.T. Wright 1981, p.c.).

G. ceratopodum, a common field weed, G. humifusum, and G. tricornutum. G. ceratopodum is eaten by the animals. Its fruits ripen in the spring. Archaeologically, Galium is also fairly common. It may represent inclusion in dung. The seed is distinctive - spherical, with a slightly depressed hole at the stem attachment. Seven measurable seeds are about 1.9 mm (1.2-2.5 mm) in diameter. The hole is about 0.6 mm (0.4-0.9 mm) in diameter.

Umbelliferae

A number of umbelliferous weeds grow in irrigated and unirrigated fields. There are also some cultivated ones, such as dill (shevet). They tend to ripen in the summer; no members of the family were collected during the fall seasons at Malyan. In view of the well-known culinary uses for seeds of this family, it is not assumed that the presence of the seed represents dung, though of course it might. All archaeological specimens were unmeasurable.

Valerianaceae

Valerianella: One tentatively identified species was seen growing, V. cf. oxyrrhyncha. It is a field weed, eaten by animals. It ripens in the summer. Archaeologically it probably represents dung.

Cultigens

Gramineae

Hordeum: Two-row barley (Hordeum distichon) is commonly cultivated at Malyan. See Chapter 3 for details of present day agricultural practices. Nowadays, it is used only as fodder. Barley may be harvested green twice in a season, or it may be allowed to go to seed.

Table 5.6. Barley Distribution at Malyan

Period	No. Samples containing			Total No. Samples
	Grain only	Rachis Fragment only	Both Grain & Rachis Frag.	
Banesh	20	1	5	26
Kaftari	38	2	9	49

Six-row barley (Hordeum vulgare) is reported as an occasional crop by Malyanis; the grain is fed to the oxen, to give them extra strength. The example of six-row barley actually observed was growing in the midst of a field of two-row barley, as a weed. Hordeum vulgare could probably also be grown as an unirrigated crop (cf. Bor 1968:254). See Chapter 3 for details of present day agricultural practices.

Barley is mentioned by Strabo (ca. first century A.D.) as one of the foods eaten by boys who were in military training at Persepolis (1930:Book 15.3). Barley is found in ancient latrine deposits at Malyan, further suggesting at least some human consumption (App. E). Thus, archaeologically, barley could represent either dung or human food, depending on the context.

Barley occurs archaeologically both as grain and rachis fragments (Table 5.6). Six-row barley is identified in a sample if a substantial proportion of the barley grains are twisted. In theory, for each straight grain produced by the central floret there should be two twisted grains produced by the lateral florets. In practice this distinction is not always easy to make, and this investigator tends to underestimate twistedness. As the morphological distinction is at the level of sample, rather than the individual grain, determination is most secure if one has access to a conveniently burned granary; an individual straight seed could come from either six- or two-row barley.

Barley occurs consistently throughout the sequence. There are changes in the proportions of twisted grains to straight grains through time. At $\alpha=.05$, the proportion of twisted grains is significantly higher in the Banesh period than in the Kaftari period. This suggests that the relative amounts of 6-row barley decreased through time. Table 5.7 shows the number of straight and twisted grains, and Table 5.8 shows the number of samples containing twisted, straight, or mixed grains. The interpretation of the apparent decrease though time in the percentage of twisted grains will be discussed below (Chapter 6).

Only one Banesh sample, ABC-S lot 91 had one grain identified as naked six-row barley (H. vulgare var. nudum), on the basis of a rounded cross-section and a slightly wrinkled ventral surface.

Table 5.7. Barley Counts, Twisted and Straight Grains

	Twisted	Straight	Totals
Banesh	50	53	103
Kaftari	20	57	77
Totals	70	110	180

$X^2=8.52$ df=1 $X^2_{(95)}=3.84$

N.B.: Samples with highly distorted (indeterminately furrowed) grains were not considered for this test.

Table 5.8. Distribution of Twistedness of Barley

	Twisted Only	Straight Only	Mixed	Totals
Banesh	1	2	5	8
Kaftari	3	21	7	31
Totals	4	23	12	39

Table 5.9. Carbonized Hordeum vulgare (ABC lot 59)

	N	L	B	T	L:B	T:B
Straight	42	5.0 3.0-6.0	2.4 1.6-3.5	1.6 0.8-2.6	211 158-267	67 42-90
Twisted	20	4.8 3.5-5.5	2.2 1.4-2.7	1.5 0.7-2.2	220 185-306	68 50-85

Note: As might be expected, the straight seeds are larger than the twisted ones. However, the hypothesis of the equality of means must be accepted at $\alpha=.05$.

The carbonized barley grains at Malyan are relatively small compared to archaeological specimens reported elsewhere (Table 5.9; cf. *H. vulgare* from Greece (Renfrew 1966): av. L=5.5-5.9 mm, B=2.8-3.4 mm, T=2.2-2.4 mm, L:B=172-196, T:B=76-79; *H. distichon* from Greece (Renfrew 1966), Turkey (van Zeist and Bakker-Heeres 1975:243), and Jordan (van Zeist and Heeres 1973:27): av. L=5.6-6.6 mm, B=2.8-3.0 mm, T=2.0-2.7 mm, L:B=193-219, T:B=72-95.

Triticum: Two kinds of wheat were identified as crops at Malyan today (C. Townsend 1978, p.c.): *T. aestivum* (bread wheat) and *T. dicoccum* (emmer). For present day agricultural practices, see Chapter 3. Wheat is the staple crop of the area today, grown on irrigated and unirrigated land. The grain is used primarily for the traditional unleavened bread; the grains are sometimes roasted and eaten as a snack food (especially around No Ruz, March 21). The vegetative parts are used as fodder. The leaves of wheat are darker in color, and also tougher than those of barley (S. Miri 1977, p.c.). It is likely that three species are represented archaeologically in the samples: *Triticum dicoccum*, *T. aestivum*/*durum*, and *T. monococcum* (einkorn). Unfortunately, modern comparative material was inadequate, so identifications to species were based on published illustrations and measurement criteria. Numerous grain fragments were identifiable to genus only. Due to these problems, many specimens were not designated specifically.

Glume bases, probably of emmer and some of bread wheat, were preserved in addition to the caryopses (Table 5.10)

Table 5.10. Wheat Distribution at Malyan

Period	No. Samples containing			Total No. Samples
	Grain only	Rachis Fragment only	Both Grain & Rachis Frag.	
Banesh	4	6	3	13
Kaftari	8	4	4	16

Although grain fragments of wheat and barley are fairly easy to distinguish on the basis of the shape of the transverse section, there were fairly few measurable whole grains. Measureable grains of Triticum dicoccum at Malyan are small compared to those reported for Greece (Renfrew 1966) and Turkey (van Zeist and Bakker-Heeres 1975): av. L=5.1-6.5 mm, B=2.7-3.5 mm, T=2.2-3.1 mm, L:B=186-218, T:B=82-97. Triticum aestivum/durum from Jordan (van Zeist and Heeres 1973:27) and Turkey (van Zeist and Bakker-Heeres 1975:243) are about the same as at Malyan: av. L=4.2-4.9, B=2.1-3.3, T=1.9-2.8, L:B=154-206, T:B=82-92. Dimensions of Triticum monococcum from Malyan are also more or less within the range of those reported from Greece (Renfrew 1966, van Zeist and Bottema 1971:530): av. L=5.2-5.9, B=1.9-2.2, T=2.2-2.5, L:B=268-307, T:B=100-133 (Table 5.11).

Vitaceae

Vitis: Cultivation of the vine is widespread throughout the region. At Malyan, sufficient water is available for the irrigation of all the vineyards. Along

Table 5.11. Wheat Measurements (grain dimensions in mm)

	N	L	B	T	L:B	T:B
T. dicoccum	11	4.8 3.7-5.7	2.1 1.6-2.6	1.8 1.5-2.6	228 147-289	95 65-110
T. aestivum/ durum	5	4.7 3.9-5.4	2.9 2.4-3.0	2.6 1.9-3.1	164 130-187	87 79-94
T. monococcum	8	5.5 4.6-6.3	1.8 1.3-2.8	2.2 1.4-3.2	318 211-450	123 70-146

the south edge of the valley on the lower slopes (especially near Lapui), there are unirrigated vineyards. Under unirrigated conditions, the vines are spaced much further apart, and there are no meter deep drainage ditches as there are for the irrigated vines. Grapes are eaten fresh, and also may be made into a sweet syrup (shireh). Shiraz used to be well known as a wine-producing city, LeBruyn (1737) mentions numerous vineyards near Majien (Ma'in) in the eighteenth century, and one of the specialties of Beiza was grapes (Schwarz 1896:17). The fruit ripens in late summer/ early fall. The vines are pruned during the summer; wood left over from grafting of the stock could be used for firewood.

The grapes represented at Malyan are most probably cultivated. Compared to the seeds of the wild variety (V. vinifera ssp. sylvestris), the seeds of V. vinifera ssp. vinifera are relatively longer and thinner (Stummer 1911). The proportional increase in length is due largely to elongation of the stalk (Table 5.12).

Using this criterion, the Malyan grapes would seem to fit handily within the dimensions for the wild. However, several considerations suggest otherwise:

1) The natural occurrence of wild grape is not reported for southern Iran (cf. Sabeti 1966); indeed, the distribution of wild grape is restricted to the circum-Mediterranean area (Zohary and Spiegel-Roy 1975).

2) The grapes measured are mostly from latrine deposits. The most lignified parts of the pips are well preserved, but it is exactly the stalk area that is somewhat eroded, perhaps spuriously increasing the B/L index. Note however that one Banesh carbonized pip had a B/L index of 68 (ABC-S 1. 53), which seems to be close to the wild form.

3) By the third millennium B.C., grapes are known to have been cultivated (Zohary and Spiegel-Roy 1975).

4) For fifth to second millennium Greek specimens (Sitagroi), J. Renfrew (1973) traces the effects of cultivation. The examples from levels IV and III (Fifth to late fourth millennia, C. Renfrew 1971) are thought to have been cultivated, yet have a B:L index of about 70.

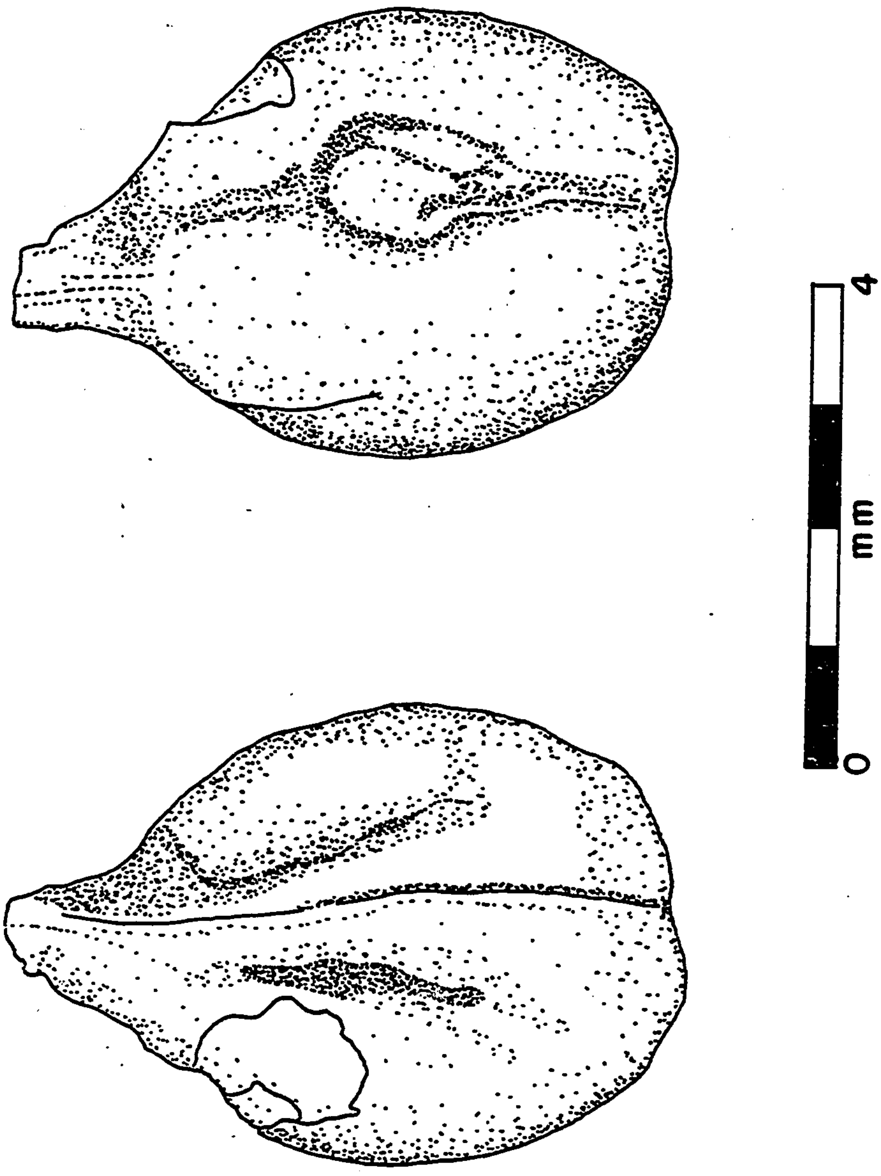
Both seeds and charcoal of <u>Vitis</u> are found archaeologically, though the former are much more common than the latter (Fig. 5.2).

Table 5.12. Grape Pip Measurements

Source	N	L (mm)	B (mm)	B:L Index (B x 100/L)		
				Mean	Mode	Range
Wild (fresh) (Stummer 1911)	100	-	-	67	64-65	54-83
Cultivated (fresh) (Stummer 1911)	105	-	-	58	54-55	44-75
Cultivated (fresh) rish-e bâbâ (Malyan)	84	6.8[1]	3.9[2]	57	56-57	39-75
Sitagroi, Phase III (wild?) (Renfrew 1973:130)	11	4.5[3]	-	81	-	66-90
Sitagroi, Phase IV (cultivated?) (Renfrew 1973:130)	11	5.3[4]	-	70	-	50-93
Malyan, Kaftari (ABC-S 1. 107) (cultivated?)	44	5.0[5]	3.7[6]	72	70	55-84

[1] 4.5-8.0 mm
[2] 2.2-4.5 mm
[3] 4.0-5.0 mm
[4] 4.2-6.0 mm
[5] 3.5-6.3 mm
[6] 2.7-4.3 mm

Fig. 5.2.
<u>Vitis vinifera</u> (ABC-N lot 110)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Trees of Planted Groves

Identifications of charcoal are based on comparison with modern, known charcoal, except for juniper (App. L). Published keys and pictures do not exist for this area (cf. Greguss 1959, Hajazi 1965).

Oleaceae

Fraxinus: Today, F. syriaca is seen growing near water and in planted groves. It needs a fairly moist environment. Leloup (1955) comments that in the Middle East it is found "near springs or perennial water courses" and it has "fast growth and...(yields) fine timber." Kämpfer (1968 [1685]) noted ash growing along the Kur river by Ma'in, which is in the mountains on the north side of the plain.

Salicaceae

Populus: Two kinds of poplar native to the area are P. nigra and P. alba (cf. Sabeti 1966). They are fast growing, and propagated from cuttings. In the valley today, they are found nearly always in planted groves. In the wild, they generally occur "on moist alluvial land along the banks of rivers and streams, and in swamps" (Leloup 1955); to grow well, they require year round moisture (ibid.). Poplar is the wood most commonly used for roof beams, and is grown primarily for that purpose. Dead or trimmed branches will be used for firewood.

Salix: Salix excelsa (cf. S. persica Boiss., Sabeti 1966) is native to Fars province and grows "along permanent water courses" (Leloup 1955). It is common in planted groves along the qanat-fed streams of the area, and is grown for use as roof beams. The leafy branches have also been seen as filler for roofs.

Trees and Shrubs of the Garmsir

Palmae

Phoenix dactylifera: The date palm is cultivated in southern Iran at elevations of less than 1200 m (Bobek 1952), or at least 100 km through the mountains from Malyan. Its primary use of course is for date production, though palm wood is used for construction and fuel in the areas in which it is cultivated (Fryer 1912).[7] Numerous valuable products are made from dates - fresh or dried fruits, wine, syrup. The date palm is represented at Malyan only by the fruit pit, not by the wood. The two date pits come from Kaftari deposits (a flotation sample and a hand-picked charcoal sample).

Rhamnaceae

Zizyphus: Several pieces of charcoal have been very tentatively identified as *Zizyphus* at Malyan. The most widespread and common species in southern Iran, *Z. spina-christi*, is drought and heat resistant, but very intolerant of frost; also, it regenerates quickly after cutting (Leloup 1955). Its fruits are also edible, though none were found

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[7] "The numerous uses of the date palm are proverbial" (Hooper and Field 1937).

archaeologically.

Two genera, Prosopis and Capparis, are found in the garmsir, but are also found within a 50 km radius of Malyan, and are discussed in another section.

Trees and Shrubs of the Pistachio-Almond Forest

Anacardiaceae

None of the common genera of the pistachio-almond forest are exclusive to it.

Pistacia: Pistachio is a component of the pistachio-almond forest as well as of the Zagrosian oak forest. Several species were observed: P. eurycarpa (=P. atlantica subsp. kurdica; **ban**), P. khinjuk (less common than the former in both areas), and isolated examples of P. vera. Pistachio is an economically important wild tree. Mastic is obtained in the late summer from exudations (LeBruyn 1737: 225). It was an important trade item; it was used medicinally and even today is chewed to clean teeth (cf. Kämpfer 1968 [1685]:94 (**kanderûn** = **kander-e rumi**); H. Eqbal 1978, p.c.). The fruits of the **ban** tree, P. eurycarpa, are collected in late summer and early fall for home consumption as a condiment, and also for sale in Shiraz. The wood is also useful as fuel. During the fall of 1976, camels of the Qashqai were observed eating its leaves. Archaeologically, it is represented by charcoal as well as nut shell fragments. Its shell is smooth, and the whole nut is elliptical in broadside cross section. At 50x magnification, there is no distinguishable structure in the cross section (Fig. 5.3a,b). Carbonized, the cross section averages 0.5 mm (0.3-0.7 mm;N=50;H5 l. 157). Measurements of modern examples of the seeds of *P. eurycarpa* appear in Table 5.13.

Table 5.13. Dimensions of Fresh *Pistacia eurycarpa*, N=50

L(mm)	B(mm)	T(mm)	L:B
6.9 5.5-7.8	7.9 6.2-9.0	5.2 4.0-6.7	83 70-101

Shell thickness is about 0.6 mm (0.4-0.9 mm).

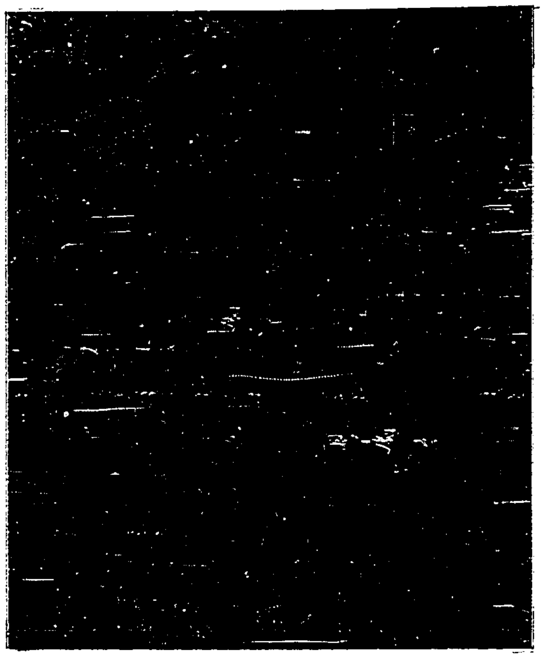
Rosaceae

Rosa: The rose is cultivated as an ornamental shrub throughout Iran today, and does quite well if irrigated in the warm temperate climate of southwestern Iran. The province of Fars was well known for the production and export of rosewater (Pelly 1863) which is used for flavoring sweets, and rose petals, used medicinally (Townsend and Guest 1966:142). Several wild rose species occur naturally in the southwestern Zagros (cf. Sabeti 1966), presumably along streams and other locally moist areas; wild rose was seen growing in just this type of environment a few kilometers south of Malyan. The fruits ripen in the late summer and fall. Tentatively identified rose seeds are rare at Malyan, occurring in one Kaftari sample. Measurements are listed in Table 5.14.

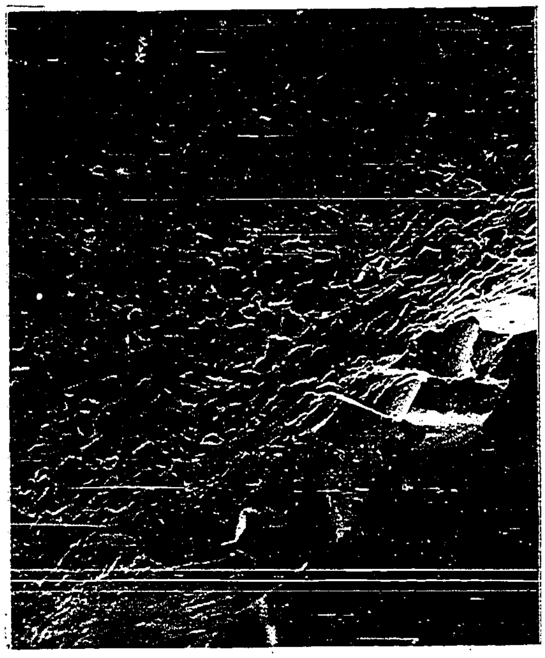
Fig. 5.3.
Nutshell (modern carbonized specimens)

a. *Pistacia eurycarpa* (cross section, 50x)
b. *Pistacia eurycarpa* (surface, 50x)
c. *Amygdalus scoparia* (cross section, 100x)
d. *Amygdalus scoparia* (surface, 50x)

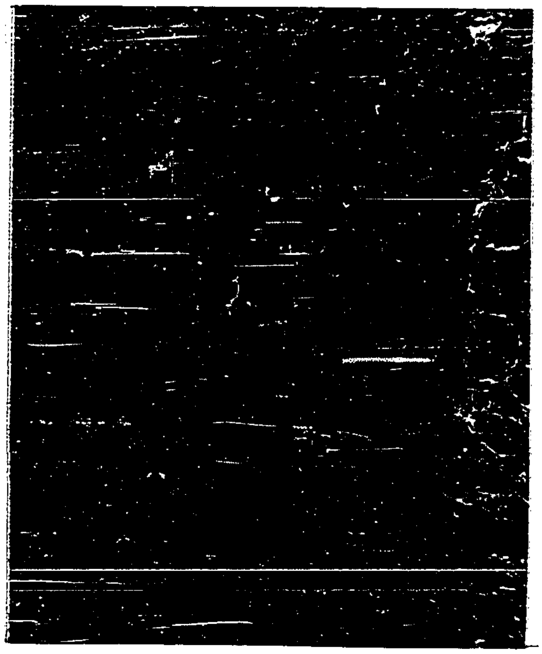
a



b



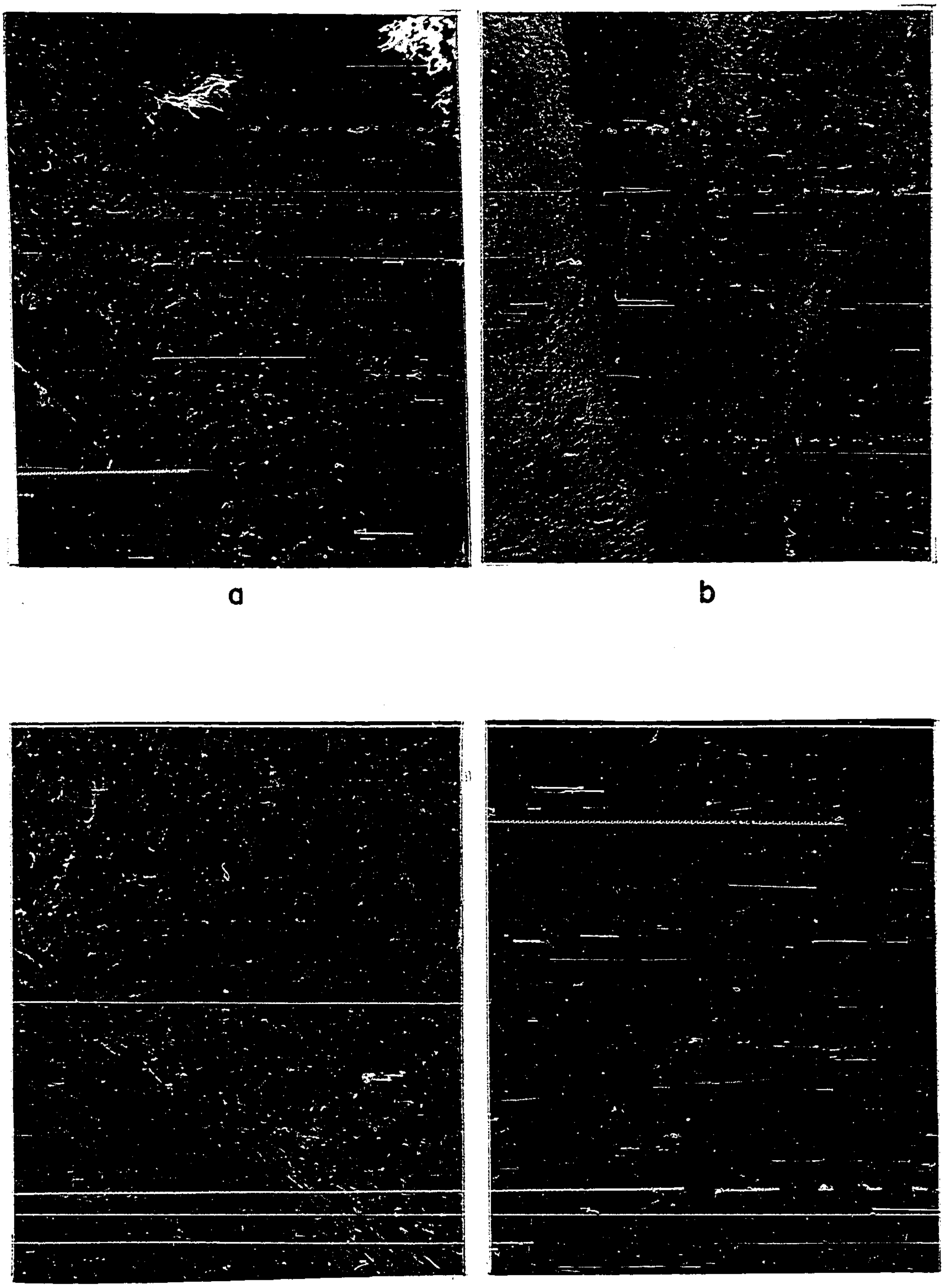
c



d

Fig. 5.4.
Nutshell (modern carbonized specimens)

a. *Amygdalus kotschyi*, herb. spec. #174 (cross section, 80x)
b. *A. kotschyi*, herb. spec. #174 (surface, 50x)
c. *Amygdalus kotschyi*, herb. spec. #170 (cross section, 80x)
d. *A. kotschyi*, herb. spec. #170 (surface, 50x)



a b c d

Table 5.14. Dimensions of cf. Rosa from ABC-N 1. 8, Pit 75/76

L (mm)	B (mm)	T (mm)
3.8	1.8	1.7
3.4	1.8	1.5
3.4	2.5	1.8
3.8	2.6	1.7
Mean		
3.6	2.6	1.7

Rubus: Rubus has been only tentatively identified at Malyan. It occurs naturally in northern Iran. It is generally not in the south (cf. Sabeti 1966), though some Rubus was observed in gallery forest just south of Malyan. It is archaeologically rare at Malyan, but the seeds occur in both carbonized and uncarbonized form.

Amygdalus: Several types of almond grow in the forests of Fars (cf. Sabeti 1966), although only two types were collected. These were Amygdalus scoparia (majak), in both the pistachio-almond forest and on the lower slopes of the oak forest, and A. kotschyi, seen only near Lake Bakhtegan in the pistachio-almond zone. The fruit of A. scoparia has a very strong almond taste and leaves a bitter aftertaste. Near Ma'in, Kämpfer (1968[1685]: 94) reported numerous wild bitter almond shrubs, "out of whose fruit and leaves...(the local inhabitants) press oil," or they are boiled and eaten with raisins. Lovett (1872) reported "extensive forests of wild cherry-trees [presumably almond] on the hills [near

Neyriz], the wood of which forms a staple article of commerce." Amygdalus arabica (=Prunus arabica) is "a principle source of firewood in the district" above 1000 m on the hills between Shiraz and Bushire (Townsend and Guest 1966:158), and the seeds and oil thereof are an article of commerce.[8] Almond (bådåm) was specifically mentioned as a fuel source by a woman of Malyan.

Almonds ripen in the late spring and early summer. Archaeologically, Amygdalus is represented by charcoal and nut shell, primarily fragmentary. The fruit of A. scoparia is drop shaped (with a rounded base, coming to a point at the distal end). The surface is smooth, and in fragmentary form cannot be distinguished from pistachio at low magnification. It does appear to be somewhat rougher, visibly so at higher magnifications (80x), but there is a lot of overlap between the two genera. However, the cross section, cut in any direction, appears to be reticulate at 50x magnification (Fig. 5.3c,d). Also, almond shells are thicker on average than pistachio shells, averaging 7-8 mm fresh (Table 5.15). Another type of almond found archaeologically resembles one of the modern specimens of A. kotschyi (Fig. 5.4a,b) collected. This type has an appearance closer to what we imagine almond to look like; it has a pitted surface, and in transverse cross section has lacunae. The shell is much thinner however than a

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[8] Amygdalus arabica is very similar to and easily confused with A. scoparia (Browicz 1969/70:178).

cultivated almond. Like the tentatively identified A. scoparia, at 50x magnification the cross section appears reticulate. Note that wild almonds are known to cross fertilize easily, and note further that one of the specimens identified as A. kotschyi had a shell with a surface rougher than A. scoparia, but without pitting (Fig. 5.4c,d). It also had no lacunae in the transverse cross section, but did have the reticulate appearance at 50x magnification. Almond charcoal is commonly found archaeologically.

Table 5.15. Dimensions of Fresh Amygdalus scoparia, N=19

L (mm)	B (mm)	T (mm)	L:B
12.0 11.1-13.8	7.8 7.3-8.2	6.9 6.3-7.8	153 142-168

Shell thickness is about 0.75 mm (0.5 - 1.1 mm).

Aceraceae

Acer: Maple (Acer monspessulanum (= A. cinerascens)) is a component of the oak forest of Fars, and also of the pistachio-almond-maple forest of the interior (Bobek 1952, Zohary 1963). It was not seen in great numbers, but it was seen with some regularity. It was mentioned by a villager as suitable for firewood. The charcoal is of moderate occurrence archaeologically.

Leguminosae

Prosopis: One species of mesquite, Prosopis farcta, was collected near Marv Dasht. It is more common in the garmsir; 1500 m is its upper limit (Townsend 1974:39). It was unfamiliar to a couple of boys from Malyan present on one collecting trip. According to Townsend it grows best on "deep alluvial soils, especially those with shallow ground water" (1974:41);"sheep and camel eat the pods: the seeds pass through...(the sheep) undamaged (1974:41).[9] Townsend reports Prosopis pods as a famine food for humans, and lowland use of the shrub for charcoal (1974). It fruits in the late summer and early fall. Both the seeds and tentatively identified charcoal of Prosopis have been found. It is assumed here that the seeds represent dung, and charcoal is fuel from relatively far afield. No complete seed has yet been found, but single cotyledons, and fragments with the distinctive acacia-like horseshoe shaped line have been found.

Capparicaceae

Capparis: Capparis spinosa was seen once. It is near its altitude limit in the Kur river basin, and was seen near the town of Marv Dasht. It was totally unfamiliar to the boys mentioned above. It is more typically a shrub of the garmsir. As indicated by its Latin name, the branches have wicked backward-curved spines, which would make it painful to collect for firewood, though root and root bark are used medicinally (Hooper and Field 1937). The fruits ripen in the summer, but no Capparis seeds were found

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[9] The pods and roots of P. stephaniana are used in the treatment of dysentery (Hooper and Field 1937).

archaeologically. In contrast, Capparis seeds have been found at Shahr-i Sokhta, a third millennium city in Sistan Province (Costantini n.d.). Not surprisingly, the charcoal of caper is rare at ancient Malyan.

Trees of the Oak Forest

Several trees of the oak forest also occur in the warmer pistachio-almond forest: maple, pistachio, Amygdalus scoparia, daphne, fig, and juniper.

Fagaceae

Quercus: One species of oak, Quercus aegilops var. persica, grows in the mountains south and west of Malyan, where it is the dominant tree. Even without the severe deforestation, it does not appear that oak would extend onto the plain. According to the distribution maps (Sabeti 1966, Zohary 1963, Bobek 1951) it is at the southwestern limit of its natural distribution. Almond and pistachio are more common at the head of the valley and on the south facing slope of the pass at Tang-i Tur. Oak leaves and acorns are eaten by goats (R. Redding 1981, p.c.). It is clear from the height of the foliage that camels prefer pistachio. An older man from Malyan said that acorns (**maqs**) are sometimes brought from the mountains.[10] Also, the oak bark (**jaft= pust-e balut**="skin of oak") is used to tan leather. Acorns ripen in the fall. No acorn

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[10] Acorns are roasted and made into flour by various people (cf. Hooper and Field 1937); they are "sometimes eaten raw" (Hooper and Field 1937).

shell was found at Malyan, though oak charcoal is common, especially in Kaftari levels.

Moraceae

Ficus: Fig (*Ficus carica*) grows wild and is cultivated. It is found in the warm forest as well as the oak forest. No charcoal of fig was found archaeologically, only seeds, particularly in non-carbonized form (latrine deposits). The seeds are small, oval, about 1.5 mm long, with a little beak at the stem attachment.

Thymeleaceae

Daphne: *Daphne acuminata* is a shrub present in both the warm forest and the oak forest. Charcoal tentatively identified as *Daphne* occurs rarely archaeologically at Malyan.

Rhamnaceae

Rhamnus: *Rhamnus* is not commonly seen. A specimen of *Rhamnus persica* was collected in the oak forest, and Sabeti (1966) reports it extends to the warmer areas of Persepolis and Kazerun. Some archaeological charcoal tentatively identified as *Rhamnus* was found.

Ulmaceae

Three ulmaceous genera occur in Iran: *Ulmus*, *Zelkova*, and *Celtis*. Only *Celtis caucasica* was actually seen in a gallery forest, which, according to Sabeti, is part of the dry area and steppe vegetation of the Zagros. Leloup comments that _C. australis_ has an edible fruit, and hard, rot-resistant wood (1955).

Archaeologically, some ulmaceous wood that looks like _Celtis/Zelkova_ (cf. Hajazi 1965:95) was seen. _Celtis_ seeds are also found throughout the sequence, and usually are white. Their antiquity is questionable, but the absence of _Celtis_ today helps confirm the antiquity of these specimens. There are some pieces of ulmaceous charcoal that appear not to be _Celtis_.

Verbenaceae

Vitex: _Vitex_ was seen along streams and dry stream beds at the edge of the oak forest, and also in the pistachio-almond forest. The species collected is _Vitex pseudo-negundo_ (according to Sabeti (1966), a species which is limited to the subtropical zone of southeastern Iran). Kämpfer mentions seeing agnus-castus trees (i.e. _Vitex agnus-castus_) by the river near Ma'in, and O. Soffert comments that it is a tree of the plains and lower mountain lands, and its fruits are used as a kitchen herb in the orient (Kämpfer 1968[1685]: 163,n. 39).

Cupresssaceae

Juniperus: Juniper is rare in the Kur basin today. However, its present disjunct but widely dispersed occurrence in southern Iran suggests that were it not for herding and fuel cutting activities, the area could support more juniper. One specimen of indeterminate species was collected by M. James Blackman in the oak forest. It has scaly leaves, not needles, and could be J. excelsa/J. polycarpos. Townsend and Guest (1966:93) comment that J. polycarpos "has been considered synonymous by some authors" with J. excelsa;[11] the former at any rate "is an excellent fuel and is said to yield good charcoal". J. excelsa, which, according to Sabeti (1966), is restricted to the northern part of Iran, grows in the dry calcareous mountains. He indicates that J. polycarpos grows all around the Central Plateau. Both have oval/scaly leaves. Leloup comments that the wood of J. excelsa is durable, and the tree grows up to 20 m (1955). Morier (1818:85) reports one large fir tree atop Kuh-i Istakr, near Persepolis, but does not describe it further. Juniper is quite common archaeologically, especially in the Banesh samples.

Archaeologically, juniper occurs in charcoal chunks and, in Operation H5, as twigs. Like J. excelsa, the twigs have opposite scales (Parsa 1950: vol. 5, p. 868); juniper twigs are not to be confused with Tamarix, which has scaly leaves whorled in threes).

Other Fuel

Dung: Much mention has been made of dung. The bulk of the weed seeds in fact are attributed to the presence of burnt dung used as fuel. That it was also at least occasionally used as a fuel in the past can be seen in

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[11] Riedl (1968) considers Juniperus excelsa M.B. to be synonymous with J. polycarpos C. Koch.

several deposits - most notably a Banesh jar from Operation TUV filled with burnt goat dung and burnt goat horns, and a pottery kiln of Operation BB33, from a later time period (Table 5.16). As explained in this section, the use of dung as fuel can also be inferred by the presence of certain seeds.

Table 5.16. Samples with Direct Evidence of Dung

Square	Lot	Feature		Embedded Seeds	Probable Dung
V168	45	MISC	38	-	+ (>50 l. ash)
ABCN	54	PIT	30	-	7 goat pellets, uncarb.
ABCS	89	MTRX	-	-	.03 g
H5	144	PIT	57	3 unkn.	.15 g
H5	154	MTRX	-	1 legum	.19 g
H5	155	MTRX	-	4 Carex 1 unkn.	21.94 g
H5	165	MTRX	-	-	.21 g
H5	180	MTRX	-	-	.71 g
H5	210	BURL	149	1 Cyperus	.02 g
GGX98	110	PIT	48	-	.03 g
GGX98	139	ROOM	64	-	1.35 g
GGX98	141	PIT	52	1 unkn.	.19 g

The identification of dung archaeologically is based partly on the amorphously fibrous structure of certain soft burnt substances found in flotation samples which resemble freshly burnt dung. In a few instances, actual goat pellets (not dung cakes) were found intact and in varying stages of decomposition. Occasionally, weed seeds from the archaeological samples were actually embedded in dung (Fig. 5.16). In aggregate, the carbonized weed seeds are taken to have originated in dung or dung-cake fuel, since most of the seeds recovered archaeologically are seemingly "non-economic" plants if fodder is not taken into account.

No quantitative analysis of the dung was attempted for two reasons. First, dung was not recognized until the second field season (1976); secondly, the distinction between burnt earth and burnt dung is sometimes equivocal, so only the most obvious examples were recorded. Density and soil content of dung are probably even more variable than differences between wood charcoals. Burnt dung was found in both Banesh and Kaftari contexts.

A description of the plant taxa recovered from the site of Malyan has been provided in this chapter. The interpretation of the distribution and quantity of the archaeological remains will be discussed in Chapter 6.

CHAPTER VI

EVALUATION OF RESULTS

General Description of the Distribution of Botanical Remains through Time and Space at Malyan

Density

Recovery of botanical remains required diligence during all the field seasons at Malyan. Densities of carbonized and non-carbonized botanical material were generally low. This was due to the fact that numerous control samples and obviously non-productive deposits were sampled.[1] Had sampling been restricted to heavy, clearly visible concentrations of charcoal and seeds, no more than about 25 buckets (250 l) of soil would have been processed, and probably far less. Instead, more than 10 times that volume from Banesh and Kaftari deposits was processed. Given the low visibility of carbon in the soil matrix, it is reasonable to ask what densities of carbonized remains are culturally meaningful with respect to general fill as well as in situ, functionally identifiable deposits, like hearths.

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[1] Highly acidic soil tends to break up carbonized material (R.I.Ford 1981, p.c.). Malyan soil is more alkaline, derived from the limestone bedrock of the Kur basin and surrounding mountains, so acidity is not a problem.

The mean density of carbonized material in the samples is about 4.5 g/10 l of soil. The median is much lower however, at about 1.5 g/10 l. That is, most samples have quite low densities (Fig. 6.1). Samples with less than 1.5 g/10 l will as a rule not be considered individually. Higher density samples, especially those from functionally specific deposits (e.g., hearths/ovens/kilns), will be considered more particularly to represent burning activities at that locus or deposition of debris which has retained the integrity of its associations.[2]

The average density, calculated for different types of features varies considerably (Table 6.1).[3] It is not surprising that hearths have relatively the highest, especially if one excludes those which, in the opinion of the excavator did not contain an in situ deposit. Next in carbon density are pit deposits, followed by general soil matrix. General soil matrix includes both trash deposits (soft, filled with sherds, bone, and charcoal), and nearly sterile mud brick fill. Both pits and trash probably represent intentional deposition of garbage (i.e., secondary use of the particular feature or area for dumping). Note too that sterile soil matrix unassociated with architecture

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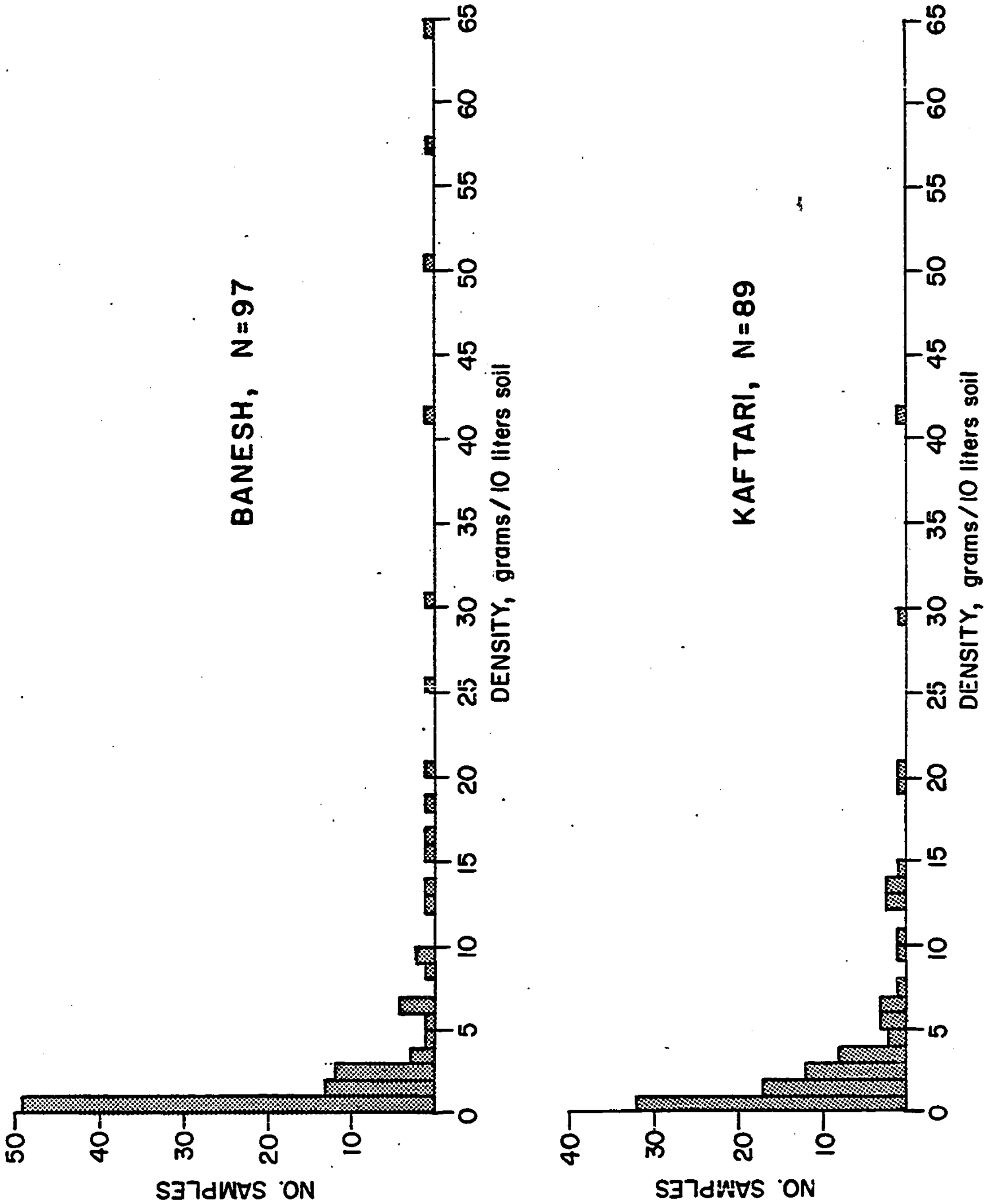
[2] Appendix E contains descriptions of some of the more unusual deposits.

[3] A number of feature types was distinguished. For purposes of analysis, similar types have been lumped together: Hearth: hearth (open fireplace), oven (roofed fireplace), kiln. Pit: pit, latrine, jube(ditch). Room: room, area, corridor, courtyard, kucheh (alley), bin. Matrix: midden, no architectural associations. Burial.

Fig. 6.1.
Density of Carbonized Material from Flotation Samples


BANESH, N=97
KAFTARI, N=89
DENSITY, grams/10 liters soil
DENSITY, grams/10 liters soil
NO. SAMPLES
NO. SAMPLES
0
5
10
15
20
25
30
35
40
45
50
55
60
65
10
20
30
40
50

was rarely sampled. The room deposits have relatively the lowest densities of carbonized material, presumably because post-abandonment deposition included much mud brick wall collapse.

Table 6.1. Average Density of Carbonized Material (g/10 l of soil)

Feature Type	# Samples	Average Density	Min. Density	Max. Density	S.D.
Banesh					
Hearth	18	17.86	.04	64.00	20.96
Pit	16	4.65	.16	31.52	8.07
Room	49	1.45	0.	25.00	3.77
Burial	3	2.79	.22	6.13	3.03
Jar	4	1.33	.36	2.42	.86
Matrix	6	2.84	0.	9.51	3.58
Kaftari					
Hearth	4	1.71	.55	3.23	1.20
Pit	28	4.37	.09	41.79	8.20
Room	32	3.18	.04	29.25	5.97
Jar	3	1.22	.50	1.70	.63
Matrix	21	5.07	.05	19.60	5.86

"Hearth" = hearth, oven, kiln
"Pit" = pit, latrine, ditch contents
"Room" = soil matrix associated with architecture
"Matrix" = soil matrix not asociated with architecture
Other: burial, jar contents

An examination of the aggregate of carbonized material from the Banesh and Kaftari periods suggests that roughly equivalent quantities of carbonized material were recovered from approximately equivalent soil volumes (Table 6.2). The distribution of samples among feature types was different in the two periods (Table 6.1).

Jar: jar, pot, drain contents.

Table 6.2. Flotation Sample Summary

Period	# Deposits Sampled	# 10 l buckets	Charcoal Tot. Wt.(g)	Seeds Tot. Wt.(g)	Carb. Material
Banesh	97	130.3	426.49	3.11	429.60
Kaftari	89	131.0	438.25	38.18	476.43

Seed/Charcoal Ratio

Seeds, which typically occur in low densities, are clearly differentially distributed by time period. There is a much greater number, and a greater percentage per soil and charcoal volume in the Kaftari samples.

Within the Banesh and Kaftari periods however there are no consistent differences between deposit types with respect to the seed/charcoal ratio (Table 6.3). Thus, the median seed to total carbonized material ratio for Banesh deposits is about .002, with 75 per cent of these ratios being less than .01. In contrast, the median for Kaftari deposits is .05, with only 7.5 per cent less than .01.[4] The mean seed/charcoal ratio also shows more consistent differences between time periods than between feature types (Table 6.4). It will be shown below that the increase in the seed/charcoal ratio is in part the result of the use of dung as fuel.

[4] These figures were determined for samples with densities of carbonized material greater than 1.5 g/10 l.

Table 6.3. Ratio of Seed Weight to Weight of Carbonized Material[1]

Feature Type	Square	Feature # or Lot	Seed (g)	Charcoal(g)	Seed Ratio S/(S + C)
Banesh Fireplaces					
HRTH	V168	29	.05	130.82	.0004
OVEN	V168	54	+	5.23	+
OVEN	V168	223	.04	2.87	.0014
HRTH	V168	240	.18	57.73	.0031
HRTH	V168	244	.03	16.64	.0018
HRTH[2]	V168	245	+	3.64	+
HRTH[2]	U168	254	0.	.13	0
HRTH[2]	V168	255	.01	.30	.0323
HRTH[2]	V168	266	0.	.75	0
HRTH	U166	305	.09	12.22	.0073
HRTH[2]	U166	314	0.	1.92	0
HRTH[2]	ABCS	81	0.	5.05	0
HRTH[3]	ABCS	91	1.58	1.83	.4633
HRTH[2]	ABC	339	0.	.60	0
HRTH[2]	ABC	343	0.	1.24	0
HRTH	ABC	345	.01	1.69	.0059
Banesh Pits					
MISC[4]	V168	38	+	1.59	+
PIT	V166	74	+	9.41	+
PIT	V164	163	.01	2.74	.0036
PIT	W168	191	+	47.28	+
PIT	U168	220	.01	.76	.0130
JUBE	V168	261	0.	1.16	0
PIT[2]	V168	277	.01	.90	.0110
PIT	U166	285	.07	2.93	.0233
PIT	ABCN	84	.06	25.81	.0023
Banesh Pottery					
POT	ABCN	-	.13	.62	.8267
Banesh Rooms					
ROOM	V168	32	0.	3.43	0
ROOM	V168	36	+	5.15	+
ROOM	V168	43	.02	5.20	.0038
ROOM	U168	219	.01	1.69	.0059
ROOM	U168	250	0.	5.00	0
ROOM	U168	258	0.	3.38	0
ROOM	U166	309	.03	1.53	.0192
AREA	V168	376	0.	2.41	0
ROOM	ABCS	31	.02	4.08	.0049
Banesh Burials					
BURL	U168	278	.03	.98	.0297

(continued)

Table 6.3. (cont.)

Feature Type	Square	Feature # or Lot	Seed (g)	Charcoal(g)	Seed Ratio S/(S + C)
BURL	H5	149	.23	4.06	.0536
Banesh Trash & Matrix					
TRPL	U166	301	.09	9.42	.0095
MTRX[2]	V168 lot	136	.03	1.02	.0286
MTRX	H5 lot	199	.08	.87	.0842
Banesh Jar					
JAR	V168 lot	43	.01	8.47	.0012
Kaftari Fireplaces					
HRTH[2]	G5	106	.07	.90	.0722
HRTH	G5	124	.31	3.21	.0881
Kaftari Pits					
PIT	ABC	75	2.98	58.02	.0489
PIT	H5	47	.68	41.11	.0163
PIT	H5	48	.05	4.18	.0118
PIT	H5	52	.59	11.56	.0486
PIT	H5	57	.44	9.08	.0462
PIT	G5	93	.12	1.71	.0656
PIT	G5	112	1.11	1.01	.5236
PIT	H7	143	.09	6.71	.0132
PIT	G5	146	.20	4.04	.0472
PIT	FX106	41	.06	2.21	.0264
PIT	GGX98	48	.47	1.24	.2749
PIT	GGX98	52	2.94	30.85	.0870
PIT	GGX98	52	1.32	37.37	.0341
PIT	GGX98	65	.16	1.38	.1039
Kaftari Rooms					
ROOM	H5	33	.23	6.02	.0368
COUR	H5	37	.08	2.52	.0308
AREA	H5	50	.21	3.93	.0507
AREA	G7	89	.12	5.05	.0232
AREA	G7	89	.12	2.00	.0566
ROOM	H7	102	.05	1.65	.0294
ROOM	G5	116	.15	2.21	.0636
AREA	H7	122	.14	29.11	.0048
AREA	G5	130	.31	2.77	.1006
AREA	G5	145	.12	1.53	.0727
ROOM	GGX98	28	.38	10.80	.0340
AREA	GGX98	32	.26	1.43	.1818
ROOM	GGX98	45	1.05	2.71	.2793
Kaftari Trash & Matrix					
TRSH	ABCS lot	89	.86	9.68	.0816

(continued)

Table 6.3. (cont.)

Feature Type	Square		Feature # or Lot	Seed (g)	Charcoal(g)	Seed Ratio S/(S + C)
TRSH[2]	H5	lot	116	.11	1.20	.0840
MTRX	H5	lot	101	.21	7.36	.0277
MTRX	H5	lot	93	.08	2.21	.0349
MTRX	H5	lot	114	.06	5.53	.0089
TRSH	H5	lot	154	12.30	31.43	.2813
TRSH	H5	lot	165	.86	5.82	.1287
TRSH	H5	lot	180	.33	18.16	.0178
MTRX[2]	H5	lot	147	4.70	2.40	.6620
TRSH[2]	GGX98	lot	97	.03	.12	.2000
MTRX[2]	GGX98	lot	121	0.	.98	0
Kaftari Jar						
JAR	H5	lot	78	.02	.83	.0118

BURL: burial; COUR: courtyard; HRTH: hearth; JAR: jar contents; JUBE: ditch;
MTRX: soil matrix; POT: soluble pottery; TRPL: trash pile; TRSH: trashy soil matrix.

1 Samples with carbon density >1.5 g/10 l of soil; based on data in Table B.1
2 Less than 5 l of soil floated
3 Carbon density <1.5 g/10 l of soil or indeterminate; included due to large amount of seeds.
4 Contents of large jar installed in floor

Table 6.4. Mean Ratio of Seed to Carbonized Material Weight[1]

Feature	Banesh		Kaftari	
	N	Mean	N	Mean
Fireplaces	16	.0322	2	.0802
Pits	9	.0059	14	.0963
Rooms	9	.0038	13	.0742
Burials	2	.0417	-	-
"Matrix"	2	.0564	5	.1467
"Trash"	1	.0095	6	.1322

1 Based on data in Table 6.3.

Charcoal

Perhaps the most striking difference between Banesh and the later Kaftari levels is the substantial presence of juniper and poplar in the former, but not in the latter. In contrast, the earlier levels have relatively low percentages of oak and maple, compared to the later levels. During the entire time span, almond percentages remain fairly constant. Finally, there are very small quantities of caper and prosopis which appear only relatively late in the sequence (Table 6.5).

Charcoal from both the hand-picked and flotation samples supports this characterization. Differences in the relative quantities of the various taxa recovered by these two methods were insignificant. For both methods, the ratio between the quantity of each taxon found in the Kaftari and Banesh deposits was calculated (Table 6.6). A comparison of the two methods without concern for differential breakage <u>between</u> taxa gives consistent results for juniper, poplar, maple, and oak and both yield indices of similar orders of magnitude for almond and the elm type. The interpretation of pistachio quantities is somewhat uncertain in that the larger hand-picked samples show a relative increase through time, but the flotation samples register a slight decline.

Seeds

The seeds found archaeologically can be classified by economic function and ecological requirements, two related criteria. They include cultigens (crop and orchard),

Table 6.5. Summary Totals: Charcoal Counts

Taxon	Hand-Picked Samples				Flotation Samples			
	Banesh		Kaftari		Banesh		Kaftari	
	#	%	#	%	#	%	#	%
Dry Forest								
Juniperus excelsa[1]	243	32	45	5	118	14	4	+
Amygdalus sp.	101	13	159	17	372	43	322	30
Acer monspessulanum[1]	21	3	128	13	24	3	121	12
Almond/Maple	-	-	1	+	-	-	-	-
Pistacia sp.	65	9	197	21	148	17	141	13
Quercus aegilops[1]	45	6	235	25	55	6	269	26
Humid								
Populus sp.	162	22	10	1	48	6	24	2
Fraxinus sp.	-	-	13	1	3	+	2	+
Platanus orientalis[1]	-	-	-	-	-	-	1	+
Vitex sp.	-	-	18	2	-	-	-	-
Distant Vegetation								
Capparis spinosa	-	-	8	1	-	-	-	-
Prosopis	-	-	1	+	-	-	2	+
cf. *Zizyphus*??[2]	-	-	-	-	3	+	1	+
Miscellaneous								
Vitis vinifera	-	-	23	2	-	-	2	+
Daphne acuminata[1]	1	+	-	-	-	-	1	+
Rhamnus sp.	-	-	-	-	4	+	-	-
Ulmaceae	80	11	46	5	23	3	24	2
Diffuse Porous	-	-	-	-	14	2	39	4
Unknown	33	4	70	7	57	7	98	9
Totals[3]	751	100	954	100	869	101	1051	98

1 Identifications to species are based on phytogeographic grounds, not morphology (cf. Sabeti 1966).

2 *Zizyphus* is a lowland tree or shrub, and would not be expected on phytogeographic grounds. The identification of these small pieces is not sure on morphological grounds as well.

3 Based on data in Appendices C and D.

herbaceous plants, and wild fruits and nuts. The herbs include a variety of field weeds, associated with varying moisture regimes, as well as plants of wetter habitats (Table A.1).

As mentioned earlier, there are relatively more seeds

Table 6.6. Ratio of Kaftari to Banesh Charcoal Counts, by Taxon, for the Major Taxa

Type	Hand-picked Charcoal	Flotation Charcoal
Juniper	.19	.03
Almond	1.57	.87
Maple	6.10	5.04
Pistachio	3.03	.95
Oak	5.22	4.89
Poplar	.06	.50
Elm Family	.57	1.04
Total counts Kaftari/Banesh	1.27	1.21

See Table 6.5 for data on which this table is based.

in the Kaftari period deposits, compared to those of the Banesh. There are too few seeds to allow meaningful comparisons through time between most species. There are no unequivocal and gross differences between seed assemblages between periods, when grouped by economic/ecological type. The ordering of the relative importance of the various categories of plants is the same for both time periods (Table 6.7).

There are a few differences between time periods in the species distribution. One change that may prove to be significant is what appears to be an increase in the proportion of two-row barley compared to the six-row type (Chapter 5, '*Hordeum*'). Another noteworthy change is the limited presence, in the Kaftari period, of the legume *Prosopis* and date, although only very small numbers are recorded. There is a slight increase in the percentage contribution of the grass, *Aegilops* in the samples; the

Table 6.7 Totals by Period of Comparable Categories of Carbonized Plant Remains from Flotation Samples[1]

a. Weed Seeds (counts)

Period	*Prosopis*[1]	*Aegilops*[2]	Irrig Field[3]	Weed Indet.[3]	Wet Weed[3]
Banesh	0	4	9.0	61	94
Kaftari	3.5	62	107.5	222	1394

1 Non-local
2 Unirrigated Fields
3 Table A.1 lists plants included in irrigated field, wet area, and indeterminate source categories.

b.

	Fruit Seeds (counts)				Misc. Seeds (counts)		
Period	Date	Fig	Hack-berry	Grape	Rosa-ceae	Pulse	Unident.
Banesh	0	2	2	3.5	0	4	16
Kaftari	1	6	13	107.5	6	32.5	171

c. Nuts and Cereals (weight, g)

Period	Pista-chio	Almond, cf. *A. scoparia*	Almond (other)	Cereal (total)
Banesh	.03	.08	.10	2.10
Kaftari	1.78	2.39	2.58	20.23

d. Cereals (weight, g)

Period	Barley	Wheat	Indet.
Banesh	1.12	.09	.89
Kaftari	2.05	.16	18.02

1 Based on data in Appendix B.

percentage of nuts and fruits also seems to increase, especially of grapes. Fig and grape seeds are both preserved in large quantities in uncarbonized form in latrine deposits, but unfortunately no comparable deposits have been found for the Banesh period.

Ubiquity of the Taxa

Ubiquity is a measure of relative amounts of the different taxa. Although less precise than summaries of exact counts and/or weights of seeds and charcoal, some authors consider ubiquity a more accurate representation of the importance of the various taxa (Hubbard 1975). For the Malyan samples, presence/absence analysis and analysis by count and weight support each other (Table 6.8).

Considering how many fewer seeds there are in the Banesh samples, it is not surprising that only a few species appear in 10% or more of the samples. All taxa common in the Banesh period (*Hordeum*, *Carex*, *Amygdalus* spp., *Pistacia*, indeterminate cereal) are also common in the Kaftari period. It is noteworthy that among the genera which continue to be important through time, the only wild herbaceous plant is *Carex*, a marsh plant. In the Kaftari period, two categories which increase in importance (occurring in 10% or more of the samples) are the field weeds (Cruciferae "A", *Astragalus*, *Galium*, and weedy Gramineae, Leguminosae, and Solanaceae), and a cultivated fruit (grape). Among the identifiable glume bases, wheat is common in the Banesh samples, but barley and *Aegilops* are more common in the Kaftari samples.

The addition of field weed taxa in the Kaftari samples may suggest increased use of fields as a source of fodder. This hints at an expansion of agricultural production. The increasing importance of grape is discussed below.

The charcoal ubiquity measures (Tables 6.9, 6.10) also correspond to the absolute quantities of the various taxa. Juniper and poplar decline, oak and maple increase substantially, and pistachio and almond do not show a consistent trend.

Evidence for Vegetation Changes

As discussed in Chapter 4, archaeological botanical remains are usually a product of human activities. Therefore, before it is possible to infer environmental conditions from these materials, the conditions of deposition must be considered. It will be demonstrated that there was a trend toward deforestation between Banesh and Kaftari times based on changes in charcoal percentages and corroborated by seed data.

First, it is quite likely that virtually all charcoal from Banesh and Kaftari deposits excavated so far consists of the unconsumed remnants of fuel. To date no evidence has been found no evidence of uncontrolled burning of structures from these time periods. Nor, for that matter, do the various midden deposits conclusively exhibit extensive burning (as would be expected if garbage dumps had been burned over). Therefore, the charcoal is thought to derive from controlled fires whose purpose could have been variously:

Table 6.8. Ubiquity of Seeds

	Banesh (N=99)		Kaftari (N=89)	
	# samples	% samples	# samples	% samples
Cereals				
Hordeum	21	21	46	52
Triticum aestivum	2	2	5	6
T. dicoccum	3	3	1	1
T. monococcum	3	3	5	6
Triticum sp.	4	4	12	13
Cereal indet.	37	37	77	87
Glume Bases				
Hordeum	4	4	14	16
Triticum	11	11	7	8
Aegilops	1	1	17	19
Fruits, Nuts				
Lens	3	3	15	17
Pisum	0	0	2	2
cf. Elaeagnus	0	0	5	6
Ficus	2	2	5	6
Phoenix[1]	0	0	1	1
Rubus	0	0	1	1
Celtis	2	2	8	9
Vitis	6	6	29	33
Pistacia	10	10	50	56
Amygdalus sp.	15	15	43	48
A. cf. scoparia	17	17	44	49
Weeds (gen'l)				
Caryophyllaceae	0	0	1	1
Silene	0	0	2	2
Vaccaria	1	1	3	3
Chenopodiaceae	0	0	1	1
Atriplex	1	1	1	1
Chenopodium	1	1	1	1
Centaurea	1	1	1	1
Cruciferae	3	3	4	4
cf. Lepidium	0	0	1	1
Neslia	1	1	1	1
Cruciferae "A"	2	2	12	13
Euphorbiaceae	0	0	1	1
Bromus	3	3	6	7
Eremopyrum	2	2	2	2
Hordeum	1	1	2	2
Lolium	1	1	4	4
Panicum	1	1	0	0
labiatae	0	0	1	1
Ajuga	0	0	1	1
Astragalus	2	2	17	19

(cont.)

Table 6.8. Ubiquity of Seeds (cont.)

	Banesh (N=99)		Kaftari (N=89)	
	# samples	% samples	# samples	% samples
Vicia	0	0	3	3
Adonis	0	0	4	4
Ceratocephalus	0	0	1	1
cf.Delphinium	0	0	1	1
Galium	6	6	22	25
Hyoscyamus	1	1	4	4
cf.Valerianella	1	1	0	0
Irrigated				
Avena	0	0	2	2
Medicago	2	2	4	4
Malvaceae	2	2	4	4
Fumaria	1	1	0	0
Solanaceae	1	1	9	10
Wet Area				
Cyperaceae	0	0	6	7
Carex	21	21	45	51
Cyperus	8	8	20	22
Cynodon	0	0	1	1
Phalaris	1	1	0	0
Setaria	0	0	21	24
Trifolium	0	0	3	3
Polygonum	0	0	5	5
Rumex	1	1	5	5
Potentilla	0	0	2	2
Other				
Gramineae	5	5	18	20
Aegilops	6	6	6	7
Leguminosae	4	4	21	24
Prosopis	0	0	4	4
Rosaceae	0	0	2	2
Umbelliferae	1	1	2	2
Unknown	12	12	44	49

[1] Another date pit (Phoenix) was found in the screen from a Kaftari sample, GGX98 lot 77.

1) cooking

2) residential heating

3) fuel for craft production (metallurgy, ceramics).

Furthermore, the charcoal filled deposits found in situ in

Table 6.9. Ubiquity of Charcoal (Flotation)

	Banesh N=99		Kaftari N=89	
	# samples	% samples	# samples	% samples
Juniperus	34	34	11	12
Amygdalus	57	57	58	65
Acer	12	12	35	39
Pistacia	33	33	37	42
Quercus	19	19	55	62
Populus	18	18	13	15
Fraxinus	3	3	2	2
Platanus	0	0	1	1
Prosopis	0	0	1	1
Zizyphus??	1	1	1	1
Vitis	0	0	2	2
Daphne	0	0	1	1
Rhamnus	2	2	0	0
Ulmaceae	13	13	11	12
diffuse porous	10	10	12	13
unident.	21	21	33	37

Table 6.10. Ubiquity of Charcoal (Hand-picked)

	Banesh N=40		Kaftari N=35	
	# samples	% samples	# samples	% samples
Juniperus	26	65	3	9
Amygdalus	21	53	17	49
Acer	4	10	14	40
Pistacia	18	45	17	49
Quercus	9	23	24	69
Populus	14	35	5	14
Fraxinus	0	0	1	3
Vitex	0	0	1	3
cf.Capparis	0	0	3	9
Prosopis	0	0	1	3
Vitis	0	0	4	11
Daphne	1	3	0	0
Ulmaceae	16	40	9	26
unident.	11		15	43

most pyrotechnic installations are probably the result of residential cooking and heating,[5] since the hearths (open) and the ovens (roofed) are associated with apparently residential structures. Therefore, in the absence of evidence to the contrary, it is presumed the carbonized material so far excavated was burned in fires whose primary function was cooking or heating. Furthermore, it is presumed that all of the wood charcoal represents fuel.

Although the forest cover cannot be reconstructed directly from the debris of ancient fuel use, charcoal from archaeological sites can provide evidence for the ancient arboreal vegetation as long as the role of fuel use as a cultural filter is taken into account. Since many aspects of human use of plants are constrained by the function of the activities or processes involving the plants, observation of modern fuel use can provide a model which suggests the fuel choices people are likely to make in a given environment.

Characteristics of Modern Plant Use

The effect of human activity on vegetation will of course largely depend on the uses to which particular plants

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[5] There was a small charcoal filled Banesh pit found quite near the surface of TUV which had a few droplets of copper/bronze slag. Another Banesh hearth at TUV (Feature 227) had a liquid trapping depression built in, but there was no charcoal found in situ. There are later deposits (Qaleh and Middle Elamite) which are clearly ceramic kilns; in one a large amount of burnt dung was found, but this deposit post-dates the periods under consideration.

are put. Wood for example, is brought to a settlement for a variety of purposes, such as construction and fuel, and trees of both forests and gardens are cut and used differentially. Cultural preferences for particular wood resources are largely determined by purpose and availability (cf. Heizer 1963, Metzger and Williams 1966), which depend on the different physical and biological properties of trees. Knowledge of these properties can therefore be used to interpret variation through time and space in the relative proportions of different species on an archaeological site.

Wood is a bulky commodity. If it is the primary fuel for cooking and heating, supplies must be replenished regularly. For example, in traditional Near Eastern societies, woody fuel use averaged over a year is estimated at about 1.5 to 2 kg/person/day (Thalen 1979). Transport costs are therefore a significant factor in choice of wood (Chisholm 1962, Forest Research Institute 1972)[6], and one would expect that, other things being equal, trees closest to home will be utilized first. Present-day villagers at Malyan used to travel in winter with donkeys and on foot to the mountains 15 or 20 km away for wood. Only dead wood was collected. They particularly mention almond (_Amygdalus_ sp.), oak (_Quercus aegilops_ var. _persica_), pistachio (_Pistacia_ cf. _eurycarpa_), and maple (_Acer monspessulanum_) as

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[6] In India, "65 km by bullock cart [is]...the maximum distance...over which...[fuel wood] would be worthwhile to transport" (Forest Research Institute 1972:618).

having been important. Poplar (Populus alba and P. nigra), grown for use as roof beams, is available in the village and sometimes is used to supplement dung-cake fuel.

Most woods are suitable as fuel, but variable heat production, smokiness, and sparking will affect their desirability for particular tasks. The major species found archaeologically at Malyan are juniper, oak, almond, pistachio, maple, and poplar (Table 6.5). Most are quite suitable for cooking and heating, although the physical characteristics of these woods are variable. Oak burns hotter than maple and juniper (Graves 1919). Pistachio, a resinous wood, is favored for charcoal manufacture in Morocco (Mikesell 1961:100). Almond is probably a good fuel wood too, but specific information about its heat production could not be found. Poplar is quite porous and burns rather quickly, and is therefore somewhat less desirable, although it is a good kindling wood.

The biological characteristics of the trees will affect their availability. Juniper, for example, is a fairly slow-growing, xerophilous tree (Pabot 1960:7, 27) and does not compete well with shading (cf. Fitter and Jennings 1975). It is a poor self-pruner (R.I.Ford 1981, p.c.), but might be adversely affected by a combination of fuel-cutting and grazing (cf. Thalen 1979). Poplar on the other hand, is fast-growing, a good self-pruner (R.I.Ford 1981, p.c.), and when cut, readily puts up new shoots. Unlike juniper, it has a high water requirement, and in the arid climate of southwestern Iran, is restricted to stream sides, irrigated groves, and other areas with a high water table.

Forest Utilization at Ancient Malyan

Wood found on an archaeological site has been selected by people, so the composition of the charcoal assemblage is not directly analogous to any ancient vegetation communities. However, a change in wood use might represent a change in the relative availability of the economically important species.[7] As discussed earlier (Chapter 2), modern climatic conditions seem to have prevailed in Iran by the late fifth millennium when the present day "natural vegetation" would have been established. The explanation for changes in the archaeological assemblage therefore cannot be sought exclusively in climatic change.

A change in local availability of various tree species could be affected by a factor other than climate. Applying least-effort considerations, those trees used first, especially in a time of non-mechanized transport, would be closest to the site. Keeping use constant, charcoal percentages should reflect species availability within the shortest radius from the site. During Banesh times, the two major fuel woods seem to have been juniper and poplar. Therefore, in the relatively thinly populated valley of Banesh times, juniper may have been a major component of a

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[7] Alternatively, changes in the charcoal assemblages could reflect changes in the uses of the wood or cultural preference.

forest that extended from the lower slopes down onto the plain, while poplar was collected in the poorly drained marshy area to the east of the site.

The juniper population was subsequently permanently reduced, and in fact, between Banesh and Kaftari times, was nearly completely removed from the useful environment. As mentioned earlier, the choice of slow-growing juniper as fuel uses up a nearly non-renewable resource, particularly if trees are cut down rather than pruned. Note further that juniper would have grown on land otherwise suitable for agriculture, whereas poplar would not have interfered with cultivation. Textual corroboration for deforestation is provided by Hansman (1976), who has identified the ancient territory of Elam, east of Sumer, as "the land of the cut-down ERIN trees." During the third millennium, the Sumerian epic hero Gilgamesh must travel through this territory in order to obtain ERIN wood, which Hansman identifies as Juniperus excelsa.

Like juniper, the importance of poplar for fuel seems to decrease between Banesh and Kaftari times. It may have grown naturally on marshy land that today is completely treeless and used for pasture. Since poplar is easily cultivated, its usefulness for construction and its regenerative powers are such that it never disappeared from the environment.

During Kaftari times, the major woods used for fuel were those characteristic of the modern oak forest.

Nowadays, the plain is approximately at the southeastern limit of oak forest, so it is possible that oak in the archaeological samples represents a mountain wood. If in fact juniper was a forest tree primarily of the lower slopes and plain,[8] the increase in the percentage of oak at the expense of juniper at Malyan suggests that an increased radius of procurement was necessary to provision the city. The other main genera, almond, pistachio, and maple, all interdigitate with oak in this part of Iran, depending on local climatic conditions. As these genera are dominant in associations of the warmer and drier climes to the south and east, they may have been associated with juniper on the once forested plain. It is possible that they initially spread at the expense of juniper, but, due to fuel-cutting and agricultural expansion, were eventually restricted to the more distant mountains, along with oak, where they are found today.

Finally, the miniscule amounts of wood that may have come from the eastern half of the plain are mentioned only to illustrate the following point: One would not expect large amounts of wood from far away to be used regularly as fuel. It is however consistent with our knowledge of the settlement pattern that the few pieces we do have coming from at least 30 km away (caper and prosopis) come from the

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[8] The altitudinal range of Juniperus excelsa in southern Iran is from 1500 to 3400 meters (Pabot 1960), but it is rare in the present-day oak forest in the mountains north and west of Malyan. J. excelsa is more xerophilous than oak, and it does not reproduce as quickly (Pabot 1960).

later levels, when settlement on the plain does seem to be more oriented toward the southeast.

The seed data corroborate this explanation for the changes in charcoal percentages. Namely, the absolute number of seeds and relative quantity by weight of seeds compared to charcoal increases substantially between Banesh and Kaftari times. Most of the seeds recovered are not of major and direct economic importance, if their role as fodder is left out of consideration. Therefore, their presence is most easily understood as a constituent of dung. This in turn suggests that there was an increase in the proportion of dung used as fuel, though it is not possible to reconstruct absolute quantities or relative percentages of dung vis-a-vis wood use.

Economic Development

Having established a description of the environmental background, an attempt will be made to describe economic processes, insofar as they intersect with plant remains and uses. First, as with environmental reconstruction based on the recovery of plant remains, economic reconstructions inferred from botanical evidence will necessarily be restricted to aspects of economic activities that have some effect on plants and plant use. Fortunately, many economic activities share this relationship.

Limits of Agricultural Production

The extent of ancient field area at Malyan cannot be directly determined on the basis of surface traces, such as irrigation canals (cf. Adams 1981). It is, however, possible to determine that the growth of Malyan could have been supported by the agricultural production of its hinterland without the importation of basic foodstuffs. Clearly, the possibility of self-sufficiency does not prove that Malyan did not import grain from elsewhere. It also does not answer the question of whether nomads created periodic increases in grain demand.

Two variables to be considered are the area of cultivable land available to the inhabitants and the potential yield for a given set of agricultural practices. The amount of available land will depend on the maximum distance farmers are willing to travel to fields, the proximity of other settlements, topography, and the quality of the land itself. Yields will vary consistently under different moisture regimes (rainfall or irrigation) and crop choice. There will also be year-to-year variations resulting from climatic factors, blights, and pests. Plausible estimates for these variables can be made based on modern ethnographic data, ancient texts, and archaeological data.

Basing population estimates on 200 people/ha of occupied site, about 20 ha/person were available in the surveyed 10 x 10 km^2 quadrats which had Banesh occupation, and about 5 ha/person during the Kaftari period (Sumner

1972:244).[9] These figures would of course double if Alden's estimate of only 100 people/ha of occupied site were used. These figures represent 120,000 ha of land in the Banesh period, about 73,500 ha of which are cultivable and about 8,700 ha of which are at present moist meadow. In the Kaftari period, the occupied quadrats represent a total of 250,000 ha, 153,000 ha of which are cultivable and 38,400 ha of which are meadow.[10]

Sowing densities and yield averages for irrigated and unirrigated grain crops were given in Chapter 3. It is likely that the 10- to 40-fold yields mentioned by local farmers for unirrigated crops are high. Kortum (1976:211) reports estimates of average yields of unirrigated grain in the Kur basin at 5:1. At the Turkish village of Hasanoglan, 5- to 6-fold yields are average for dry land, and 7- to 8-fold yields for moister unirrigated land (Yasa 1957). Ancient texts from Nuzi mention yields of 1.7 to 7.5:1 for probably unirrigated barley, and of 3.2 to 8.5:1 for emmer (Zaccagnini 1975). Nuzi, which is in the dry steppe region of northeastern Iraq, lies at about the 250 mm precipitation isohyet (Guest 1966:fig. 5), which is much drier than Malyan. Thus, yields of 5:1 seem to be a conservative

[9] The figure for the Kaftari period is an underestimate, since it was calculated using 300 ha as the area for Kaftari Malyan, rather than the presently accepted 130 ha.

[10] These are approximate figures based on topographic (Sumner 1972:8, Fig. 2) and land use (Bordbar 1972, Justin and Courtney 1966) maps.

estimate. Farmers in the Kur basin today plant about 15 man (45-50 kg)/ha for dry-farmed wheat and barley. Thus, the yield, less seed corn, would be about 200 kg/ha/year. Traditional agricultural methods suffer one year in five of crop failure, enjoy success one year in five, and experience three years in five of "indifferent" yields (Lambton 1953:367).

Some estimates for grain consumption needs have been made (Johnson 1973:137). If the only calorie source were barley bread, .829 kg barley/day (2900 cal/day), or about 300 kg barley/year would feed an active adult male. Using figures for the Hasanoglan village economy (Yasa 1957), about 220 kg/person/year of wheat are produced, and 63 kg/person/year of barley. The barley however is fed only to the animals. Clearly, there are numerous unknown quantities for ancient Malyan, such as age and occupation structure of the population, and the number and type of animals that had to be fed. Nonetheless, 250 kg/person/year is not an unreasonable estimate for human grain needs, or 1.25 ha/person/year in the Kur basin. The traditional agricultural system requires a minimum fallow every other year, so a population would need about 2.5 ha/person. Animals could eat straw, as well as graze on fallow land and the natural pasture.

With an estimated population of 4500 (Alden 1979), or even 9,000, and no other settlement within a 10 km radius, Banesh Malyan had no land shortage. The total population of the basin ranged from 5650 (Alden 1979:78) to 11,300 (at 200 people/ha), so 15,000 to 30,000 ha of cultivable land would have been necessary. For the Kaftari period, population estimates based on site area range from 13,000 (at 100 people/ha) to 26,000 (at 200 people/ha, Sumner 1972). If the lower population estimate is accepted, 32,500 ha of cultivable land would have supported the Kaftari population of Malyan. At 200 people/ha of occupied site, 65,000 ha would have been necessary. The population of the Kur basin would have been about 30,000 to 60,000 (with 288 ha of Kaftari settlement[11]), requiring 75,000 to 150,000 ha of cultivable land. The preceding estimates for land requirements are based on the assumptions of a grain yield of 5:1 and the absence of irrigation. These two assumptions are not warranted by the agricultural and archaeological facts, which suggest that even <u>less</u> land would have been required by the Kur basin population.

This exercise has demonstrated that Banesh Malyan could have been agriculturally self-supporting. Kaftari Malyan would have required a sustaining area of 325 to 650 km^2, or an area centered at Malyan described by a radius of about 10.2 to 14.4 km. Within this radius are several Kaftari village sites, which further supports the presumption that Malyan was not merely a self-sufficient peasant village writ large. Animal protein could have been supplied by meat and

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[11] Total Kaftari settlement area excluding Malyan is 158 ha (Sumner 1972:190), plus 130 ha for Malyan).

milk products of herds local to the Kur basin. The figures presented do not suggest that the Kur basin was dependent on external sources for basic vegetal foodstuffs, and it is reasonable to suppose that the Kur basin was a viable economic unit.

Subsistence

A high degree of integration between the agricultural and pastoral economies of Malyan can easily be inferred from a variety of sources, and not merely by analogy with modern Near Eastern peasant populations. Remains of the typical Near Eastern domesticates, sheep, goat and cattle, are found with the remains of cultivated plants throughout the site. Some carbonized weed seeds are actually found in dung, and if the interpretation of carbonized seeds as burnt residue of dung-cake fuel is accepted, then of course a direct relationship between these aspects of subsistence is demonstrated.

Most of the seed evidence is therefore directly relevant to the pastoral economy, and only indirectly related to the human subsistence economy. Sources of animal fodder during the Banesh period included plants of marshy areas and weeds of unirrigated and of irrigated fields. Wheat and barley (straw as well as grain) were also fed to animals. Both six- and two-row barley were used.[12] Although the relative importance of different land uses

[12] As mentioned earlier, the particular exemplars of cultivated grains which were carbonized as dung or as

(irrigated, unirrigated, meadow) as reflected in dung remained the same through time, several changes in the source of livestock diet seem to have occurred in the Kaftari period. Firstly, the category "probable meadow plant" ("wet weed", Table A.1) makes a relatively greater contribution. Secondly, compared to the general weedy plant category, weeds clearly of irrigated fields increased proportionately. Thirdly, there seems to be a shift away from 6-row barley toward 2-row, though the proportion of wheat to barley is constant. Finally, the livestock diet included a new genus, Prosopis.

As a first approximation for estimating land use, let us assume that changes in the proportions of weed seeds representing different types of land use correspond to changes in the relevant categories of land use. It cannot of course be said that if 30 per cent of the weed seeds are from irrigated plants, then 30 per cent of the land used to feed livestock was irrigated, but the first best guess is that if the number of irrigated weed seeds increases with respect to other field weeds, then the relative amount of fields under irrigation is greater by some as yet unknown amount. If this is a valid assumption, a corresponding argument is that there was an increasing use of the uncultivable meadow/marsh land southeast of Malyan as pasture (Table 6.6), since the proportion of sedges and other wet area weeds increases dramatically in the Kaftari

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accidental burnings of human food cannot be determined.

period.

The territory effectively utilized by the Malyanis increased through time as well. This interpretation is supported by the presence of Prosopis only in Kaftari samples, which nowadays grows at least 30 km away to the southeast.[13] The herding system cannot be reconstructed from 3.5 Prosopis seeds. Note however that unherded, free-ranging goats travel on average 8.3 km/day (5.6 to 11 km) (Cory 1927). On average, sheep and goat retain seeds in their gut for 32.7 and 22 hours respectively (Huston 1978), though digestion may take as long as three or four days (R. Redding 1981, p.c.). Apparently, they may be sent out for several days to pasture, and retain seeds eaten some time before. Under this circumstance, feces excreted at Malyan could have contained seeds consumed several days, or 30 km before.[14] It is therefore suggested that there was a substantial expansion in the pasture area utilized by Malyan animals, or in the average distance to pasture travelled by herds.

Changes in the relative proportions of cultivated plants, especially barley, also support the proposition that the area under agricultural production expanded in Kaftari times. It is difficult to generalize about barley, since

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[13] As mentioned above, Prosopis appears to be at the upper margin of its natural range in the southeastern half of the Kur basin.

[14] Goats eat oak mast and mesquite (i.e. acorns and Prosopis) when available (Cory 1927:17).

there were already numerous varieties of cultivated barley all over the world, including the Near East even before the development of modern plant-breeding practices in this century (Harlan 1957:77-80). However, in order to understand why there might have been a shift in emphasis from six-row to two-row barley, it is necessary to consider the possible uses and the characteristics of these two major types.

The major economically important difference between two-row and six-row barley is that the latter has a higher protein content relative to starch than does the two-row form, which makes six-row more suitable for food and fodder. In contrast, the high starch content of two-row barley makes it well suited to malting (Hutcheson et al. 1936). Textual evidence from Mesopotamia has some bearing on this issue. There was a shift from food to drink in the use of barley between the Sargonid period (mid-third millennium) and the Third Dynasy of Ur (late third to early second millennium) (Oppenheim 1950). One might suggest that a similar shift, reflected in a changing pattern of barley use, occurred earlier in the Kur basin between Banesh and Kaftari times, but there is no other evidence that beer-brewing took place at Malyan.

There are other characteristics of these plants to consider as well. One might expect the grain yield of six-row barley, with three times as many grains per spikelet, to be greater than two-row barley under comparable conditions, but this does not appear to be the case. Yields of two varieties each of two- and six-row barley types were not correlated with type (Thayer and Rather 1937). In one test of three varieties (2 six-row and 1 two-row), the two-row barley was found to yield slightly less in general. However, at lower rates of seeding, it outyielded both of the six-row varieties tested (Bonnett and Woodworth 1931). Considering that in the Kur basin today, unirrigated grain fields are seeded less densely than irrigated ones, this might confer a yield advantage on two-row barley under dry conditions. In the Near East generally, in areas where both two- and six-row barley are grown, the latter is irrigated and the former is not (Harlan 1968). This also suggests that two-row barley requires less water than six-row barley. The choice of wheat as a crop would not be at issue here, as it is less drought-resistant than either two- or six-row barley (Nuttonson 1957:7). In fact, if irrigable land was being turned over to wheat, barley could continue to be grown on unirrigated land for hay, fodder, and food at relatively low drought risk. Thus, if agricultural land was being cleared for extensive rather than intensive agricultural practices (i.e., it remained unirrigated), one would expect that two-row barley would be the preferred grain in the newer, unirrigated fields.

Finally, if one compares the field weed seeds alone, there is some increase in the percentage of seeds which originated in irrigated fields. These results are not conclusive, as most of the identified weedy taxa cannot be assigned exclusively to irrigated or unirrigated fields. In any case, the weed seed assemblage is quite different from that in modern refuse samples and grain samples from Malyan today which are derived from irrigated fields (Apps. H, I).

There is little evidence directly relevant to the question of change in human subsistence between Banesh and Kaftari times. Two Kaftari latrines provided mineralized examples of fruits and nuts, grains, and weeds (Table 6.11). In this case, it seems reasonable to consider the grain to be human food (App. E). Without at least one comparable sample from the Banesh period, not to mention a broader sampling from both periods, it is not possible to evaluate changes in dietary patterns through time. In contrast to the carbonized material of Banesh and Kaftari deposits, the ABC latrine had more wheat than barley (Table 6.11). It is therefore likely that wheat was more important for the human diet than is indicated by the carbonized remains.

Of the other foods represented in the latrine deposits, grape, nut, and fig also appear in carbonized form, though fig is rare. Raspberry and the possibly edible cucurbit are never found in carbonized form. This is perhaps not totally surprising, because it is a bit easier to spit out a grape seed or a nut shell fragment into a hearth than it is to separate seeds of raspberry or fig from the fruit.

Indirect evidence of food consists of carbonized nutshells, grape, lentil, date, and the grains. Although

Table 6.11. Uncarbonized Seeds from Kaftari Latrines

Food Taxa			Non-Food Taxa[1]		Taxa of Indeterminate Use[2]	
Type	#	wt.(g)	Type	#	Type	#
ABC-N, Feature 30 (40 l soil)						
Lens	4		*Carex*	25	Cucurbit	6
Ficus	208		*Setaria*	2	Unident.	146
Rubus	32		*Juniperus*	twig		
Vitis	c.1200					
Hordeum		.83				
Triticum		1.49				
Cereal indet.		2.25				
Amygdalus		.03				
Nut shell		.03				
G5, Feature 146 (10 l soil)						
Ficus	300		Boraginaceae	1	Unident.	17
Rubus	3		Composite	1		
Celtis	1		Cruciferae	2		
Vitis	65					
Hordeum		.02				

[1] The seeds of taxa included in this category are not likely to have been eaten, because of their small size and difficulty of harvest.

[2] The category "unidentified taxa" includes a number of different types, many of which are encrusted beyond recognition or description.

the presence of particular exemplars of wheat and barley and grain straw and rachis fragments have been explained as a constituent of dung, there is no reason to doubt that (as corroborated by the latrine sample) people were growing these grains for their own use as well.

It is noteworthy that there is a large increase in the density of both nutshell and grape seeds in the Kaftari period deposits (Table 6.12). The relative quantities of pistachio and the two types of wild almond are constant through time but, the proportion of pistachio relative to almond increases (Table 6.7). Note that wild bitter almond (Amygdalus scoparia) has a bitter after-taste and wild pistachio does not. If as suggested, the almond, pistachio (and juniper?) forest was being cut down near Malyan, nuts would have to be brought in from afar. Unlike wood, nuts are easy to transport in useful quantities. Almonds and pistachios would have been plentiful in the environment in areas located at equal distances from Malyan; indeed, they frequently co-occur. It thus seems that, given a choice, pistachio was preferred over bitter wild almond. Pistachio charcoal shows an increase in the Kaftari period hand-picked samples, but a slight decline in the flotation samples, and it is therefore difficult to relate nut eating habits to tree or wood availability.

The importance of grape increases substantially (Table 6.12), perhaps reflecting a growing importance of viticulture. Although grapes can be grown with or without

Table 6.12. Quantity of Carbonized Nutshell and Grape Seeds

Period	# bkts[1]	Total Nutshell (g)[2]	Nutshell Density[3]	Total Grape (#)	Grape Density[3]
Banesh	130.3	.221	.002	3.5	.027
Kaftari	131.0	6.833	.052	107	.817

1 1 bucket = 10 l of soil
2 Includes nutshells unidentifiable to genus
3 Density per 10 l bucket

irrigation, their culture implies significant investment in labor and land for a crop which does not bear fruit for a number of years.

Socioeconomic Differences

On a complex site like Malyan, socio-economic differences could be reflected in people's refuse as well as architecture. M.A. Zeder has found faunal evidence which suggests the residents of Kaftari operations FX106 and H5 had access to meat resources through different channels of distribution. This difference may be associated with differences in socioeconomic status of the residents of the two areas (M.A. Zeder 1981, p.c.). Unfortunately, botanical preservation at FX106 was poor, and the other Kaftari buildings and deposits have not yet been fully analyzed for indications of social differentiation. Within the Banesh period, ABC might represent a higher status residential area than TUV, since the buildings were more substantial, underwent several rebuildings, and contained multi-colored painted frescoes. In any case, TUV could be considered a "satellite" of the main part of Malyan (Nicholas 1980: 439-440). Unfortunately differential preservation of botanical remains from the various excavated areas precludes an analysis of intrasite differences at the present time.

In the case of fuel use, functional considerations as well as status considerations have to be taken into account. The charcoal found in the Malyan is interpreted as the remains of fuel. One might expect fuel to be differentially distributed along several dimensions. First, choice of fuel might depend on the purpose of the fire, as would the choice of fireplace type (hearth, oven, kiln). Several fireplace deposits containing carbonized plant remains were found at Malyan. Two were Banesh roofed ovens, and the rest were open hearths, mostly from the Banesh period. Differences between periods were much greater than differences between fireplace type, but the sample is quite small. One might have expected indoor open hearths to have relatively less non-resinous (sparking) woods, but this does not seem to be the case (App. C, D).

In addition, choice of fuel might reflect social differences, if one social group had greater access to a preferred fuel. Based on modern preferences and the burning qualities of the woods involved, almond and maple would seem to be preferred for fires. Poplar is not a particularly favored fuel. Juniper might not be suitable for indoor heating and cooking due to sparking (R.I.Ford,1981 p.c.). If modern preference is a guide, dung would be less favored where wood is available. The expectation of differential access to favored fuels is not met at Malyan in the Banesh period, but here too the sample sizes are so small that we cannot be certain.

Extent of Economic Interaction

Corroborating the proposition that a larger interaction network was in operation in Kaftari times, one notes the appearance of two date pits from Kaftari contexts. Dates do not grow above about 1200 m in this part of Iran, and today are cultivated at least 150 km away. Clearly this evidence is insufficient to prove major economic ties to the warm country. Nonetheless, the date pits are consistent with other archaeological evidence for an increasing sphere of interaction (Sumner 1974).

Increasing economic interaction within the Kur basin is suggested by the botanical data. First, a fairly large area was necessary just to feed the population. Second, an increasing radius of herding and nut collection has been suggested.

A Further Reflection

In general, negative evidence is not very strong, especially when one is dealing with the low degree of preservation as at Malyan. Nonetheless, it is noteworthy that no evidence of acorn use is found at all. Even if people were not collecting acorns for food, goats are fond of acorns (R. Redding 1981, p.c.). In addition, there is reason to believe that oak was more heavily used in the winter/spring than in the summer/fall (App. E: GGX98, pit 52). This evidence suggests that:

1) Herds belonging to Malyan were not pastured in the area of oak forest, though this area was at least as close to the site as the southeast half of the plain.
2) People at Malyan, though utilizing wood from the oak forest, especially in the Kaftari period, were not

utilizing acorns.

If this pattern is substantiated after further research, one might suggest an explanation for it would be that nomads would have passed through this area en route to the lowlands in the fall, when the acorns would be ripe, precluding similar use of this area by settled people. By winter, the area would once again be vacated and available for fuel-cutting by the local inhabitants until late spring. In contrast to the situation in the oak forest to the north and west, perhaps the greater population and the greater number of settlements south and east of Malyan afforded sufficient protection for the use of the resources of the plain and of the almond and pistachio forest. Thus, nomadism might prove to be related to the pattern of forest utilization and to the observed expansion of the settlement and herding area to the southeast of Malyan.

Summary

In summary, numerous changes in natural vegetation and land use can be inferred from the archaeological record of third millennium Malyan, along with a continuing development of the traditional subsistence pattern. Based on the ethnobotanical and other evidence presented above, it is possible to develop a picture of the agricultural economy and landscape around Malyan.

During Banesh times, the population of Malyan lived in at least one walled settlement and a satellite community within a kilometer of the main occupation area. There were no other settlements in the vicinity, so land within a 10 km radius of the settlement was available for farming, pasture, and fuel cutting. The settlement of Malyan was supported by a mixed economy based on wheat and barley agriculture and sheep and goat herding. Most cultivated land would have been planted in wheat and barley in the fall, and harvested at the beginning of the summer of the following year. There was some irrigation, probably primarily for wheat and pulse crops. Fuel for cooking, heating in the winter, and metallurgy was available in the open mixed forest of the plain, where juniper, pistachio,, almond, and maple were available. Over time, the complementary need for both fuel and agricultural land would have encouraged people to cut down these trees; some of the useful nut trees (pistachio and almond) were probably spared, but juniper and maple were eventually eliminated from the plain. The areas of high water table to the south and east of Malyan supported poplar groves, as well as more open marshy areas suitable for pasture. Animals were pastured in these marshy areas, in harvested fields, and in the remaining areas of open forest. A predominantly oak forest (with some representation of pistachio, maple, and perhaps juniper) grew in the mountains at the northwest end of the Kur basin, but would have been only rarely visited by people from Malyan.

The Kaftari landscape was quite different, and showed greater disturbance by human activities. Although there was great population expansion to a number of villages and small towns toward the southeast, Malyan remained the major population center on the plain, more than tripling in size. As the valley population grew, land clearance for agricultural production apparently expanded. There might have been a slight increase in irrigation at Malyan during Kaftari times (although the evidence is tenuous), and irrigibality seems to have been a factor in the location of settlement on the plain. However, most cleared agricultural land was probably unirrigated, and the preferred crop on the new unirrigated fields was probably two-row barley. Tended vineyards would have been planted relatively close to the city, with the grain fields further out. Poplar was no longer growing, untended and freely available east of Malyan. Rather, the marshy area became more completely pasture. Flocks were pastured further afield, as much as 30 km away to the southeast, but shepherds seem to have avoided the oak forest at the northwest end of the Kur basin. As the plain became deforested, winter fuel-cutting activities extended to the oak forest, and dung-cakes became a common source of fuel. Two date pits from the Kaftari period are evidence for contacts beyond the Kur basin.

CHAPTER VII

CONCLUDING REMARKS

This study has focused on the land use patterns and agricultural system of the growing complex society centered at Malyan during the third millennium B.C. The methodological, substantive, and theoretical goals were set forth in the first chapter. Chapters 2 and 3 provided the geographical background necessary for the subsequent archaeological analysis. The methodological/analytical approach to the ethnobotanical data on which the study is based was elaborated in Chapter 4, and was followed by the presentation of the data. Chapter 6 contains the presentation of the substantive results: an outline of the ancient environment, agricultural economy, and the significance of extra-regional contact. The integration of data from a variety of botanical, ethnographic, historical, and archaeological sources has given support to the analytical structure within which the paleoethnobotanical data were interpreted. Finally, this chapter will draw together the theoretical conclusions concerning land use and cultural complexity, and discuss approaches to future ethnobotanical work in ancient complex urban societies.

Ethnobotany and Archaeological Research

Although the interpretation of all archaeological data is based on inference, the meaning of ethnobotanical data can seem particularly elusive. Plant remains are small, fragile, and usually unevenly distributed within a site. They are found embedded in the soil matrix of the site, the very material which is removed to reveal architecture, features, and artifacts. The original circumstances of deposition are therefore difficult to determine with confidence.

There is no definitive, "right" way to analyze plant remains. What I have done in this study is point out the utility of using as many lines of evidence as possible to help in the interpretations. Thus, botanical, ethnographic, historical, and ethnoarchaeological sources were utilized, in order to develop a baseline against which relevant archaeological interpretations could be compared. In addition the paleoethnobotanial data were tabulated in several different ways, including count per sample, count and weight per unit volume, and ubiquity. The estimates of the relative quantity of the various taxa were fairly consistent. Thus, although it was not appropriate to use statistical inference, it is nevertheless possible to have some confidence in the representativeness of these estimates.

The concern for understanding depositional circumstances of both charcoal and seeds led to the identification of many seeds as constituents of dung used as fuel, a finding which may prove relevant in other archaeological contexts as well, wherever the dung of herbivores might have been used as fuel.

Environment and Agricultural Economy of the Kur Basin

Ethnobotanical evidence for vegetation and land use is heavily weighted towards taxa that were directly or indirectly used by the population of Malyan. With that caveat, it seems that during the Banesh period, the site of Malyan was located amidst a fairly xerophilous juniper-almond-pistachio vegetation. A high water table in the area east of the site supported arboreal vegetation (poplar), as well as herbaceous marsh plants.

Growth of the Kaftari period population led to an expanded area of land exploitation, both for fuel and agriculture. The open oak forest to the west was cut for fuel after the arboreal vegetation of the plain had been cleared.

In both the Banesh and Kaftari periods, the basic subsistence grains were wheat and barley.

Implications for the Development of Secondary Complex Society

Based on the data from this study, two conclusions may be drawn which have bearing on questions about the causes and consequences of social complexity. First, since expansion of agricultural production was possible, and in fact continued during the latter half of the third millennium, agricultural scarcity per se, or population pressure on the productive capacity of available, arable land, does not seem to have preceded the growth of social complexity in the Kur basin. Second, despite clear evidence for foreign contact and influence in the Kur basin, even preceding the establishment of Malyan as a population center, it is not likely that the basin was dependent on external sources for its basic subsistence grain needs. What the ethnobotanical evidence provides however is limited documentation for the importation of one generally perishable commodity, namely dates.

Directions for Future Research

Our understanding of ancient land use patterns would have been immeasurably enhanced if a greater variety of the components of the complex urban social system had been available for study. Ideally, the ethnobotanical analysis of Malyan would be complemented by a consideration of the economy and environment of some village and town sites of the Kur basin. Such an analysis would refine our knowledge of the environment and would provide a fresh perspective on the nature of intra-regional economic integration. Perhaps it will one day be possible to carry out this work.

Finally, although the environmental or economic underpinnings of society may not represent sufficient "causes" of social phenomena, there are many ways in which they articulate with cultural processes. As anthropologists, we hope to reach an understanding of these processes; one of many approaches is ethnobotany.

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ECONOMY AND ENVIRONMENT OF MALYAN,

A THIRD MILLENNIUM B.C. URBAN CENTER

IN SOUTHERN IRAN

Volume II

by
Naomi Frances Miller

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APPENDICES

APPENDIX A

EXPLANATION OF TERMS AND ABBREVIATIONS USED IN DATA TABLES, APPENDICES B, C, D

The basic excavation unit at Malyan was a square, 10 m x 10 m. Each excavated portion of the site, whether a single 10 m x 10 m square or a series of contiguous ones is an "Operation". All excavated soil can be uniquely assigned to a lot number. Features may be comprised of one or several lots, but some lots are not associated with any feature. Each lot was assigned a deposit code , a two-digit number which indicates the nature of the deposit within which a lot occurs.

Each flotation sample listed in these tables represents one deposit, though data from several arbitrarily defined lots are sometimes combined for purposes of analysis. The data are grouped by feature type.

Abbreviations:

DC = Deposit Code (see below)

Bkts = Buckets (1 bucket = ca. 10 l of soil)

Dens. carb. = Density of carbonized material, determined in g/10 l of soil

Sum carb. = Total weight (seeds and charcoal) of carbonized material

Period:

B = Banesh

K = Kaftari

Q = Qaleh

Feature Types[1]:

AREA: Area; soil within an area defined by one to three walls

BIN : Bin; classified with "rooms" because there were no macroscopic differences in soil from surrounding room fill

BURL: Burial

COUR: Courtyard

CRD : Corridor

HRTH: Hearth (open fireplace)

JAR : Jar contents; same as surrounding matrix

JUBE: Jube (ditch)

KILN: Kiln

KUCH: Kucheh (alley)

MTRX: Soil matrix not found in association with architecture, and not trashy (not an official Malyan feature type)

OVEN: Oven (roofed fireplace)

PIT : Pit (includes possible wells and three latrines)

PLAT: Platform

POT : Unusual soluble pottery which contained carbonized material

ROOM: Room (soil within area defined by four walls)

TRPL: Trash pile

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[1] Source: Malyan Project site supervisor instructions.

TRSH: Trash (soil matrix not found in association with architecture) (not an official Malyan feature type)

UNKN: Unknown feature

"+": present; "++" ca. .005 g

Malyan Deposit Codes[2]:

1. Primary Deposits

11 = Undisturbed floor deposit.

12 = Undisturbed surface deposit, courtyard, open area.

13 = Burial deposit.

14 = Cache.

15 = Cluster; a group of objects apparently deposited together, not on a surface or floor.

16 = Collapsed second-story floor deposit.

17 = Artificially deposited pebble/cobble layer.

2. Secondary Deposits

21 = Trash deposit on floor or surface, the result of bad housekeeping.

22 = Trash in pit or well.

23 = Amorphous trashy deposit.

24 = Disturbed burial.

25 = Disturbed floor or surface deposit.

26 = Trash deposit in room, post-abandonment.

27 = Ceiling collapse.

28 = Kiln, hearth or oven contents or other container (see # 52).

29 = Removal of floor or living surface.

3. Tertiary Deposits

---

[2] Source: Malyan Project site supervisor instructions.

31 = Surface pick-up.

32 = Disturbed top soil.

33 = Rodent burrow.

34 = Amorphous bricky fill.

35 = Bricky fill below tops of identified walls.

36 = Feature removal (actual material of which feature is made).

37 = Arbitrary floor cleaning lot, no trash component.

38 = Balk removal.

39 = Dump.

40 = Unknown.

41 = Clean-up.

42 = Non-bricky fill within identified walls.

43 = Rocky-trash fill, <u>not associated</u> with mud-brick walls.

44 = Surface wash.

45 = Sandy fill.

46 = -

47 = Mixed fill with some brick component <u>not within</u> identified walls.

48 = Mixed fill with some brick component within identified walls.

49 = Material redeposited in antiquity.

50 = Sterile natural soil deposit.

51 = Brick packing.

52 = Contents of pot, drain, or other container (see # 28).

Botanical Data Organization

Catalogs of flotation (Table B.1) and hand-picked charcoal (Table D.1) samples contain provenience and summary botanical information. Data tables of seeds from flotation samples (Tables B.2, B.3, B.4) are organized by category of botanical analysis, and where necessary taxa are designated by abbreviations (Table A.1). Appendices C and D contain charcoal data from flotation and hand-picked samples respectively.

In an attempt to make the data tables more legible, subtotals of the different plant categories appear to the left of the first entry in each sample. Thus, for example

3 Galium-2
  Lolium-1

means that 2 Galium seeds and 1 Lolium seed were found, for a total of 3 seeds in the "weed" category".

Table A.1. List of Taxa Found Archaeologically

Taxon	Analysis Category	Abbreviation
	Seeds	
Anacardiaceae	Nutshell	
Pistacia (pistachio)		
Boraginaceae	Irrigated Field	borag
cf. Lithospermum	Irrigated Field	borag
Caryophyllaceae	Weed	caryoph
Silene	Weed	
cf. Vaccaria	Weed	Vac
Chenopodiaceae	Weed	chenopdac
cf. Atriplex	Weed	Atrplx
Chenopodium	Weed	Cheno
Compositae	Weed	comp
Centaurea	Weed	Centaur
Cucurbitaceae	Weed	cucurb
Cruciferae	Weed	crucif
Lepidium	Weed	Lepid
Neslia	Weed	

(cont.)

Table A.1. List of Taxa Found Archaeologically (cont.)

Taxon	Analysis Category	Abbreviation
Seeds(cont.)		
Cruciferae, unknown	Weed	Crucif A, Cruc A
Cyperaceae	Wet Area	cyperac
Carex	Wet Area	
Cyperus	Wet Area	
Elaeagnaceae cf. Elaeagnus	Fruit	Elaeag
Euphorbiaceae	Weed	euphrb
Gramineae (weedy)	Weed	gram
Aegilops	Other (dry)	Aeg (wt. g)
Avena	Irrigated Field	
Bromus	Weed	
cf. Cynodon	Wet Area	
cf. Eremopyrum	Weed	Eremopy
Hordeum	Weed	
Lolium	Weed	
cf. Panicum	Weed	
Phalaris	Wet Area	
Setaria	Wet Area	
Gramineae (cereals)	Cereal	
Hordeum distichum (2-row barley)	Cereal	
H. vulgare (6-row barley)	Cereal	
Hordeum sp.(barley)	Cereal	
Triticum aestivum (bread wheat)	Cereal	
T. dicoccum (emmer)	Cereal	
T. monococcum (einkorn)	Cereal	
Triticum sp.(wheat)	Cereal	
Labiatae	Weed	labiat
Ajuga	Weed	
Leguminosae	Other	legum
Astragalus	Weed	Astrag
Lens (lentil)	Pulse	
Medicago	Irrigated Field	Medic

(cont.)

Table A.1. List of Taxa Found Archaeologically (cont.)

Taxon	Analysis Category	Abbreviation
	Seeds(cont.)	
Pisum	Pulse	
Prosopis	Other (non-local)	Pros
cf. _Trifolium_	Irrigated Field	Trifol
Vicia	Weed	
Malvaceae	Irrigated Field	malvac
Moraceae	Fruit	
Ficus (fig)		
Palmae	Fruit	
Phoenix (date)		
Papaveraceae	Irrigated Field	Fumar
Fumaria		
Polygonaceae	Wet Area	Polyg
Polygonum		
Rumex	Wet Area	
Ranunculaceae	Weed	
Adonis		
Ceratocephalus	Weed	Cerato
cf. _Delphinium_	Weed	Delph
Rosaceae	Other	rosac
Amygdalus cf. _scoparia_ (wild bitter almond)	Nutshell	
Amygdalus sp. (other wild almond)	Nutshell	
Potentilla	Wet Area	Potent
Rubus (raspberry)	Fruit	
Rubiaceae		
Galium	Weed	
Solanaceae	Irrigated Field	solnac
Hyoscyamus	Weed	Hyoscy
Ulmaceae	Fruit	
Celtis (hackberry)		
Umbelliferae	other	
Valerianaceae	Weed	Valer
cf. _Valerianella_		
Vitaceae	Fruit	
Vitis (grape)		

(cont.)

Table A.1. List of Taxa Found Archaeologically (cont.)

Taxon	Analysis Category Abbreviation
Charcoal	
Aceraceae	
Acer cf. *monspessulanum* (maple)	
Anacardiaceae	
Pistacia (pistachio)	
Capparidaceae	Cap
Capparis cf. *spinosa* (caper)	
Cupressaceae	
Juniperus cf. *excelsa* (juniper)	
Fagaceae	
Quercus cf. *aegilops* var. *persica* (oak)	
Oleaceae	Frax
Fraxinus (ash)	
Platanaceae	Plat
cf. *Platanus orientalis* (platane)	
Rhamnaceae	Rham
cf. *Rhamnus*	
cf. *Zizyphus*?? (jujube)	Zizy
Rosaceae	
Amygdalus sp. (almond)	Amyg
Salicaceae	
Populus (poplar)	
Thymeleaceae	Daph
cf. *Daphne acuminata*	
Ulmaceae	
Vitaceae	
Vitis cf. *vinifera* (grape)	

APPENDIX B

DATA FROM FLOTATION SAMPLES: SEEDS

Table B.1. Catalog of Flotation Samples

Square	Lot	Period	Feature Type	#	DC	# Bkts	Charcoal wt(g)	Seed Wt (g)	Sum Carb. (g)	Dens. Carb. g/10 1
Operation TUV (Banesh)										
Hearths:										
U166	95	B	HRTH	305	36	2.0	12.22	.09	12.31	6.15
U166	112	B	HRTH	314	21	.03	1.92	0.	1.92	64.00
U168	98	B	HRTH	227	36	.5	.02	+	.02	.04
U168	109	B	HRTH	254	28	.05	.13	0.	.13	2.60
V168	62	B	HRTH	52	28	.5	.04	+	.04	.08
V168	65	B	HRTH	29	28	6.5	130.82	.05	130.87	20.13
V168	66	B	OVEN	54	28	1.0	5.23	+	5.23	5.23
V168	76	B	OVEN	223	28	1.0	2.87	.04	2.91	2.91
V168	102	B	HRTH	240	28	1.0	57.73	.18	57.91	57.91
V168	103	B	HRTH	244	28	1.0	16.64	.03	16.67	16.67
V168	114	B	HRTH	245	28	.2	3.64	+	3.64	18.20
V168	117	B	HRTH	255	28	.05	.30	.01	.31	6.20
V168	130	B	HRTH	266	28	.05	.75	0.	.75	15.00
Pits:										
T168	21	B	PIT	299	22	.8	.13	0.	.13	.16
U166	18	B	PIT	101	22	1.5	1.22	0.	1.22	.81
U166	57	B	PIT	130	22	3.0	.99	+	.99	.33

(cont.)

Table B.1. Catalog of Flotation Samples (cont.)

Square	Lot	Per-iod	Fea-ture Type	#	DC	# Bkts	Char-coal wt(g)	Seed Wt (g)	Sum Carb. (g)	Dens. Carb. g/10 l
U166	69	B	PIT	285	22	1.0	2.93	.07	3.00	3.00
U168	19	B	PIT	199	22	7.0	5.45	+	5.45	.78
U168	26	B	PIT	195	22	1.0	.37	0.	.37	.37
U168	127	B	PIT	269	49	.33	.10	0.	.10	.30
U168	147	B	PIT	220	22	.5	.76	.01	.77	1.54
V164	24	B	PIT	163	22	.75	2.74	.01	2.75	3.67
V166	28	B	PIT	74	22	.7	9.41	+	9.41	13.44
V168	45	B	MISC	38	52	1.0	1.59	+	1.59	1.59
V168	127	B	JUBE	261	52	.5	1.16	0.	1.16	2.32
V168	136	B	PIT	277	22	.25	.90	.01	.91	3.64
W168	5	B	PIT	191	22	1.5	47.28	+	47.28	31.52
W168	9	B	PIT	194	22	.75	.68	+	.68	.91
Rooms:										
T168	37	B	MISC	315	37	1.0	.06	0.	.06	.06
T168	43	B	MISC	315	42	.5	.06	.02	.08	.16
T168	46	B	AREA	395	34	.5	.01	0.	.01	.02
T168	50	B	ROOM	320	35	1.0	.11	0.	.11	.11
U166	97	B	ROOM	309	37	.75	1.53	.03	1.56	2.08
U166	104	B	CRD	313	37	.25	.09	0.	.09	.36
U166	110	B	ROOM	306	26	.4	.41	+	.41	1.03
U166	111	B	ROOM	306	26	.1	.08	0.	.08	.80
U166	114	B	ROOM	306	21	2.0	.59	0.	.59	.29
U166	123	B	KUCH	307	21	2.0	.69	.08	.77	.38
U166	136	B	ROOM	309	21	.1	.03	0.	.03	.30
U168	30	B	COUR	30	35	1.7	.76	+	.76	.45
U168	82	B	ROOM	225	51	1.0	.10	+	.10	.10
U168	83	B	ROOM	225	37	1.0	.41	+	.41	.41

(cont.)

Table B.1. Catalog of Flotation Samples (cont.)

Square	Lot	Per-iod	Fea-ture Type	#	DC	# Bkts	Char-coal wt(g)	Seed Wt (g)	Sum Carb. (g)	Dens. Carb. g/10 l
U168	93	B	ROOM	219	26	1.0	1.69	.01	1.70	1.70
U168	111	B	ROOM	250	26	1.7	5.0	0.	5.00	2.94
U168	138	B	ROOM	258	26	.5	3.38	0.	3.38	6.76
U168	158	B	ROOM	258	35	.05	1.24	.01	1.25	25.00
U168	154	B	ROOM	289	42	1.0	.38	.03	.41	.41
U168	159	B	ROOM	258	37	.05	.40	0.	.40	8.00
U168	172	B	ROOM	215	21	1.0	.42	+	.42	.42
V164	21	B	ROOM	158	37	1.0	.22	+	.22	.22
V166	25	B	ROOM	69	21	3.0	2.00	.04	2.04	.68
V166	36	B	ROOM	69	37	1.0	.88	.02	.90	.90
V168	34	B	ROOM	36	35	2.0	5.15	+	5.15	2.58
V168	53	B	ROOM	39	25	1.0	.44	+	.44	.44
V168	54	B	ROOM	32	25	1.5	3.43	0.	3.43	2.29
V168	55	B	ROOM	43	37	2.0	5.20	.02	5.22	2.61
V168	56	B	BIN	42	37	1.0	1.32	+	1.32	1.32
V168	57	B	ROOM	25	25	1.5	.32	+	.32	.21
V168	60	B	ROOM	45	37	1.0	1.19	+	1.19	1.19
V168	123	B	AREA	376	35	1.0	2.41	0.	2.41	2.41
Burials:										
U168	140	B	BURL	278	13	.5	.98	.03	1.01	2.02
V168	143	B	BURL	274	13	1.0	.22	0.	.22	.22
Matrix:										
U166	93	B	TRPL	301	23	1.0	9.42	.09	9.51	9.51
U168	60	B	UNKN	-	40	1.0	.54	.01	.55	.55
U168	108	B	UNKN	-	22	1.0	1.46	+	1.46	1.46

(cont.)

Table B.1. Catalog of Flotation Samples (cont.)

Square	Lot	Per-iod	Fea-ture Type	#	DC	# Bkts	Char-coal wt(g)	Seed Wt (g)	Sum Carb. (g)	Dens. Carb. g/10 l
V168	135	B	MTRX	--	36	.25	1.02	.03	1.05	4.20
Jars:										
U168	39	B	JAR	--	36	.4	.44	+	.44	1.10
V168	43	B	JAR	--	52	3.5	8.47	.01	8.48	2.42
V168	49	B	JAR	--	52	1.0	1.43	0.	1.43	1.43
V168	48	B	JAR	--	52	.5	.18	0.	.18	.36
Operation ABC (Banesh)										
Hearths:										
ABCS	53	B	HRTH	91	28	4.0	1.83	1.58	3.41	.85
ABCS	80	B	HRTH	81	28	.1	5.05	0.	5.05	50.50
ABC	20	B	HRTH	339	28	.05	.6	0.	.60	12.00
ABC	23	B	HRTH	343	28	.03	1.24	0.	1.24	41.33
ABC	27	B	HRTH	345	28	1.0	1.69	.01	1.70	1.70
Pit:										
ABCN	148	B	PIT	84	22	2.6	25.81	.06	25.87	9.95
Soluble Pottery:										
*ABCN	152	B	POT	-	99	-0.	.13	.62	.75	-0.
Rooms:										
ABCN	15	B	ROOM	3	48	1.0	.18	+	.18	.18
ABCN	16	B	ROOM	21	42	2.0	.05	0.	.05	.02
ABCN	42	B	ROOM	?	37	2.0	.47	.02	.49	.24
ABCN	61	B	ROOM	31	29	1.5	.05	0.	.05	.03
ABCN	68	B	ROOM	40	21	6.0	3.27	.01	3.28	.55

(cont.)

Table B.1. Catalog of Flotation Samples (cont.)

Square	Lot	Per-iod	Fea-ture Type	#	DC	# Bkts	Char-coal wt(g)	Seed Wt (g)	Sum Carb. (g)	Dens. Carb. g/10 l
ABCN	76	B	ROOM	31	37	10.0	1.96	.01	1.97	.20
ABCN	82	B	ROOM	42	37	1.0	.04	0.	.04	.04
ABCN	137	B	ROOM	65	37	1.0	.14	0.	.14	.14
ABCS	48	B	ROOM	39	37	2.0	.02	.01	.03	.01
ABCS	51	B	ROOM	31	23	2.5	4.08	.02	4.10	1.64
ABCS	54	B	ROOM	52	37	2.0	.05	.02	.07	.03
ABCS	77	B	PLAT	74	21	5.0	.70	+	.70	.14
ABCS	87	B	ROOM	80	21	2.0	.02	0.	.02	.01
ABC	13	B	ROOM	?	21	1.0	.90	0.	.90	.90
ABC	24	B	ROOM	342	35	1.0	.09	0.	.09	.09
ABC	29	B	ROOM	346	35	1.0	0.	0.	0.	0.
ABC	48	B	AREA	369	40	.5	.02	.04	.06	.12
Jar:										
*ABCN	153	B	JAR	-	52	?	.09	.07	.16	?
Matrix:										
ABC	50	B	MTRX	370	40	.5	0.	0.	0.	0.
Operation ABC (Kaftari)										
Pits:										
ABCN	8	K	PIT	205	22	4.4	5.11	.34	5.45	1.24
ABCN	a 54	K	PIT	30	22	4.0	1.59	.01	1.60	.40
*ABCN	b 54	K	PIT	30	22	-0.	-0.	-0.	-0.	-0.

(cont.)

Table B.1. Catalog of Flotation Samples (cont.)

Square	Lot	Period	Feature Type	#	DC	# Bkts	Charcoal wt(g)	Seed Wt (g)	Sum Carb. (g)	Dens. Carb. g/10 l
ABCN	88	K	PIT	134	22	1.0	.21	+	.21	.21
ABCN	144	K	PIT	82	22	1.0	.60	.1	.70	.70
ABCS	45	K	PIT	195	22	.5	.21	0.	.21	.42
ABC	38	K	PIT	75	22	4.7	58.02	2.98	61.00	12.98
Matrix:										
ABCN	109	K	MTRX	-	34	14.5	9.05	.67	9.72	.67
ABCS	20	K	MTRX	-	34	10.5	2.22	.02	2.24	.21
ABCS	89	K	TRSH	-	23	4.8	9.68	.86	10.54	2.20
Jar:										
*ABCN	127	K	JAR	-	52	?	.07	+	.07	?
Operation GHI (Banesh)										
Burial:										
H5	210	B	BURL	149	13	.7	4.06	.23	4.29	6.13
Matrix:										
H5	189	B	TRSH	-	23	1.0	1.12	.06	1.18	1.18
H5	199	B	TRSH	-	23	.6	.87	.08	.95	1.58
Operation GHI (Kaftari)										
Hearths:										
G5	110	K	HRTH	124	35	.7	.60	.1	.70	1.00
G5	111	K	HRTH	106	28	.3	.90	.07	.97	3.23
G5	125	K	HRTH	124	28	1.7	3.21	.31	3.52	2.07
G5	165	K	KILN	160	28	.2	.11	+	.11	.55

(cont.)

Table B.1. Catalog of Flotation Samples (cont.)

Square	Lot	Per-iod	Fea-ture Type	#	DC	# Bkts	Char-coal wt(g)	Seed Wt (g)	Sum Carb. (g)	Dens. Carb. g/10 l
Pits:										
G5	48	K	PIT	93	22	1.0	1.71	.12	1.83	1.83
G5	84	K	PIT	112	22	1.0	1.01	1.11	2.12	2.12
G5	a 159	K	PIT	146	22	1.0	4.04	.2	4.24	4.24
*G5	b 159	K	PIT	146	22	1.0	-0.	-0.	-0.	-0.
G7	152	K	PIT	150	22	1.5	2.15	.13	2.28	1.52
H5	42	K	PIT	24	22	1.0	.41	.02	.43	.43
H5	48	K	PIT	25	22	1.0	.15	.02	.15	.15
H5	57	K	PIT	26	22	1.0	.86	.02	.88	.88
H5	59	K	PIT	27	22	1.0	1.11	.01	1.12	1.12
H5	65	K	PIT	21	22	.5	.37	.02	.39	.78
H5	115	K	PIT	47	22	1.0	41.11	.68	41.79	41.79
*H5	a 117	K	PIT	48	22	1.0	4.18	.05	4.23	4.23
*H5	b 117	K	PIT	48	22	1.0	-0.	-0.	-0.	-0.

(cont.)

Table B.1. Catalog of Flotation Samples (cont.)

Square	Lot	Per-iod	Fea-ture Type	#	DC	# Bkts	Char-coal wt(g)	Seed Wt (g)	Sum Carb. (g)	Dens. Carb. g/10 l
H5	125	K	PIT	52	22	2.0	11.56	.59	12.15	6.07
H5	144	K	PIT	57	22	1.0	9.08	.44	9.52	9.52
H7	143	K	PIT	143	22	1.0	6.71	.09	6.80	6.80
Rooms:										
G5	19	K	ROOM	81	37	1.0	.19	+	.19	.19
G5	21	K	ROOM	81	36	.5	.27	.01	.28	.56
G5	25	K	AREA	88	42	1.0	.28	.04	.32	.32
G5	26	K	AREA	88	37	1.0	.52	.04	.56	.56
G5	57	K	AREA	88	42	.7	.39	.02	.41	.59
G5	126	K	ROOM	116	37	1.0	2.21	.15	2.36	2.36
G5	141	K	AREA	130	37	1.0	2.77	.31	3.08	3.08
G5	153	K	AREA	145	37	1.0	1.53	.12	1.65	1.65
G7	30	K	AREA	88	37	1.0	.50	.04	.54	.54
G7	37	K	AREA	89	42	1.2	.13	+	.13	.11
G7	54	K	AREA	88	29	.7	.12	.03	.15	.21
G7	128	K	AREA	89	21	1.0	5.05	.12	5.17	5.17
G7	132	K	AREA	89	23	1.0	2.00	.12	2.12	2.12
G7	165	K	AREA	186	21	1.0	.59	.06	.65	.65
H5	75	K	COUR	37	35	1.0	2.52	.08	2.60	2.60
H5	78	K	ROOM	33	42	2.0	6.02	.23	6.25	3.12
H5	139	K	AREA	50	37	2.0	3.93	.21	4.14	2.07
H7	140	K	ROOM	102	42	1.0	1.65	.05	1.70	1.70
H7	148	K	ROOM	158	42	1.0	29.11	.14	29.25	29.25

(cont.)

Table B.1. Catalog of Flotation Samples (cont.)

Square	Lot	Period	Feature Type	#	DC	# Bkts	Charcoal wt(g)	Seed Wt (g)	Sum Carb. (g)	Dens. Carb. g/10 l
Matrix:										
G5	65	K	MTRX	-	35	1.0	1.03	.04	1.07	1.07
H5	52	K	MTRX	-	37	1.0	1.01	.06	1.07	1.07
H5	93	K	MTRX	-	36	1.0	2.21	.08	2.29	2.29
H5	a 101	K	MTRX	-	42	1.0	.43	+	.43	.43
H5	b 101	K	MTRX	-	42	1.0	7.36	.21	7.57	7.57
H5	114	K	MTRX	-	35	1.0	5.53	.06	5.59	5.59
H5	116	K	TRSH	-	23	.1	1.20	.11	1.31	13.10
H5	147	K	MTRX	-	34	.5	2.40	4.7	7.10	14.20
H5	154	K	TRSH	-	23	3.2	31.43	12.3	43.73	13.67
H5	155	K	TRSH	-	23	1.0	3.19	.28	3.47	3.47
H5	165	K	TRSH	-	23	1.0	5.82	.86	6.68	6.68
H5	171	K	TRSH	-	23	.2	.25	.02	.27	1.35
H5	180	K	TRSH	-	23	1.7	18.16	.33	18.49	10.88
Jars:										
G7	189	K	JAR	-	23	.2	.25	.04	.29	1.45
H5	78	K	JAR	-	52	.5	.83	.02	.85	1.70

(cont.)

Table B.1. Catalog of Flotation Samples (cont.)

Square	Lot	Per-iod	Fea-ture Type	#	DC	# Bkts	Char-coal wt(g)	Seed Wt (g)	Sum Carb. (g)	Dens. Carb. g/10 l
Operation GHI (Qaleh)										
Hearth:										
G5	32	Q	HRTH	67	28	1.0	1.55	.02	1.57	1.57
Rooms:										
H5	21	Q	ROOM	20	37	2.0	.29	0.	.29	.14
H5	26	Q	COUR	9	37	1.0	+	+	.00	.00
H5	29	Q	ROOM	12	37	2.0	.45	.03	.48	.24
H7	14	Q	BIN	61	35	2.0	.38	.07	.45	.22
H7	28	Q	ROOM	62	37	3.5	.41	.02	.43	.12
H7	34	Q	BIN	74	35	.4	.02	+	.02	.05
H7	57	Q	AREA	179	37	1.0	.05	+	.05	.05
H7	40	Q	MISC	180	23	1.0	.46	.05	.51	.51
Operation FX106 (Kaftari)										
Rooms:										
FX106	14	K	AREA	9	37	2.0	.28	0.	.28	.14
FX106	19	K	ROOM	14	37	.25	.01	+	.01	.04
FX106	59	K	AREA	9	35	.05	+	+	.00	.04
Pits:										
FX106	44	K	PIT	24	22	1.0	.20	.01	.21	.21
FX106	50	K	PIT	26	22	1.0	.09	.02	.09	.09
FX106	109	K	PIT	41	22	1.0	2.21	.06	2.27	2.27
Jar:										
FX106	67	K	JAR	-	52	.1	.05	0.	.05	.50

(cont.)

Table B.1. Catalog of Flotation Samples (cont.)

Square	Lot	Per-iod	Fea-ture Type	#	DC	# Bkts	Char-coal wt(g)	Seed Wt (g)	Sum Carb. (g)	Dens. Carb. g/10 l
Operation GGX98 (Kaftari)										
Rooms:										
GGX98	37	K	ROOM	18	25	1.0	1.31	.02	1.33	1.33
GGX98	60	K	ROOM	28	25	.5	1.84	.04	1.88	3.76
GGX98	66	K	ROOM	28	11	2.5	8.96	.34	9.30	3.72
GGX98	69	K	AREA	32	25	.5	1.43	.26	1.69	3.38
GGX98	86	K	AREA	71	37	1.0	1.96	.08	2.04	2.04
GGX98	108	K	ROOM	45	21	1.0	2.71	1.05	3.76	3.76
GGX98	119	K	AREA	32	29	2.1	2.19	.77	2.96	1.41
GGX98	125	K	AREA	54	42	1.0	2.31	.12	2.43	2.43
GGX98	133	K	ROOM	59	37	1.0	1.96	.2	2.16	2.16
GGX98	139	K	ROOM	64	35	1.0	20.20	.46	20.66	20.66
Pits:										
GGX98	110	K	PIT	48	22	1.0	1.24	.47	1.71	1.71
GGX98	115	K	PIT	52	22	6.0	30.85	2.94	33.79	5.63
GGX98	141	K	PIT	52	22	3.0	37.37	1.32	38.69	12.90
GGX98	151	K	PIT	65	22	1.0	1.38	.16	1.54	1.54
Matrix:										
GGX98	18	K	MTRX	-	37	1.0	.15	+	.15	.15
GGX98	19	K	MTRX	-	37	1.0	.05	0.	.05	.05
GGX98	97	K	TRSH	-	43	.1	.12	.03	.15	1.50
GGX98	121	K	MTRX	-	36	.05	.98	0.	.98	19.60
GGX98	16	K	MISC	7	28	.5	.19	+	.19	.38

(cont.)

Table B.1. Catalog of Flotation Samples (cont.)

Square	Lot	Per-iod	Fea-ture Type	#	DC	# Bkts	Char-coal wt(g)	Seed Wt (g)	Sum Carb. (g)	Dens. Carb. g/10 l
Operation BY8 (Kaftari)										
Pit:										
BY8	13	K	PIT	1	22	1.5	.68	.02	.70	.47
Matrix:										
BY8	16	K	MTRX	-	34	1.0	.69	+	.69	.69

* = Sample or sample part not included in general analysis of flotation samples in Chapter 6.

1.ABCN lot 54(b): Kaftari Pit 30, uncarbonized material from latrine deposit.

2.ABCN lot 148(b): Banesh soluble pottery found in Pit 84 for which density of carbonized material could not be determined.

3.ABCN lot 153: Banesh jar contents, soil volume data missing.

4.ABC lot 127: Kaftari jar contents, soil volume data missing.

5.G5 lot 159(b): Kaftari Pit 146, uncarbonized material from latrine deposit.

6.H5 lot 117(b): Kaftari Pit 48, uncarbonized material from latrine deposit.

-0. = information not relevant
? = information not available

Table B.2. Cereals and Glume Bases (wt., g)

Square	Lot	Hordeum	Triticum aestivum	T. dicoccum	T. monococcum	Triticum sp.	Cereal Indet.	Hordeum glume bases	Triticum glume bases	Aegilops glume bases
TUV (Banesh): HEARTHS										
U166	95	.04	0.	0.	0.	0.	.06	+	0.	0.
U168	98	+	0.	0.	0.	0.	+	0.	0.	0.
V168	65	.01	.01	0.	0.	0.	.03	0.	+	0.
V168	66	0.	0.	0.	0.	0.	+	0.	0.	0.
V168	76	.02	0.	0.	0.	0.	.02	0.	0.	0.
V168	102	.06	.02	0.	0.	.01	.09	+	+	0.
V168	103	0.	0.	0.	0.	0.	.02	0.	0.	0.
V168	117	0.	0.	0.	0.	0.	.01	0.	0.	0.
TUV (Banesh), PITS										
U166	57	0.	0.	0.	0.	0.	+	0.	0.	0.
U166	69	.01	0.	0.	0.	0.	.01	0.	.01	0.
U168	19	0.	0.	0.	0.	0.	0.	0.	+	0.
U168	147	0.	0.	0.	0.	0.	+	0.	0.	0.
V164	24	.01	0.	0.	0.	0.	0.	0.	0.	0.
W168	5	0.	0.	0.	0.	0.	+	0.	0.	0.
TUV (Banesh), ROOMS										
T168	37	0.	0.	0.	0.	0.	.02	0.	0.	0.
U166	97	.01	0.	0.	0.	0.	.02	+	0.	0.
U166	110	0.	0.	0.	0.	0.	+	0.	0.	0.

(cont.)

Table B.2. Cereals and Glume Bases (wt., g)

Square	Lot	*Hordeum*	*Triticum aestivum*	*T. dicoccum*	*T. monococcum*	*Triticum* sp.	Cereal Indet.	*Hordeum* glume bases	*Triticum* glume bases	*Aegilops* glume bases
U166	123	0.	0.	0.	0.	0.	+	0.	0.	0.
V166	25	0.	0.	0.	0.	0.	+	0.	0.	0.
V168	34	+	0.	0.	0.	0.	+	0.	0.	0.
V168	56	0.	0.	0.	0.	0.	+	0.	0.	0.
TUV (Banesh), MATRIX										
U166	93	+	0.	0.	0.	0.	.07	0.	+	0.
V168	135	.03	0.	.01	0.	0.	0.	0.	0.	0.
TUV (Banesh), JAR CONTENTS										
U168	39	0.	0.	0.	0.	0.	+	0.	0.	0.
V168	43	0.	0.	0.	0.	0.	+	0.	+	0.
V168	48	0.	0.	0.	0.	0.	+	0.	0.	0.
TUV (Banesh), MISC. FEATURE										
U168	108	0.	0.	0.	0.	0.	+	0.	0.	0.
ABC (Banesh), HEARTHS										
ABCS	53	.80	0.	.05	.10	.08	.31	+	+	0.
ABC	27	0.	0.	0.	0.	0.	+	0.	0.	0.

(cont.)

Table B.2. Cereals and Glume Bases (wt., g)

Square Lot	Hordeum	Triticum aestivum	T. dicoccum	T. monococcum	Triticum sp.	Cereal Indet.	Hordeum glume bases	Triticum glume bases	Aegilops glume bases
ABC (Banesh), PIT (with soluble pottery)									
ABCN 148	.04	0.	0.	0.	0.	.01	0.	+	0.
*ABCN 152	.33	0.	.05	.01	+	.13	0.	+	+
*ABCN 153	0.	0.	0.	0.	0.	.07	0.	0.	0.
ABC (Banesh), ROOMS									
ABCN 42	.01	0.	0.	0.	0.	.01	0.	0.	0.
ABCN 68	0.	0.	0.	0.	.01	0.	0.	0.	0.
ABCN 76	.01	0.	0.	0.	0.	+	0.	0.	0.
ABCS 48	.01	0.	0.	0.	0.	0.	0.	0.	0.
ABCS 51	.01	0.	0.	0.	0.	.01	0.	0.	0.
ABC 48	+	0.	0.	0.	0.	.04	0.	0.	0.
ABC (Banesh), JAR									
*ABCN 127	0.	0.	0.	0.	0.	+	0.	0.	0.
ABC (Kaftari), PITS									
ABCN 8	.12	0.	0.	.01	.01	.07	0.	0.	0.
ABCN a 54	0.	0.	0.	0.	0.	.01	+	+	0.
*ABCN b 54	.83	0.	0.	0.	1.49	2.25	0.	0.	0.
ABCN 88	0.	0.	0.	0.	0.	+	0.	0.	0.

(cont.)

Table B.2. Cereals and Glume Bases (wt., g)

Square	Lot	*Hordeum*	*Triticum aestivum*	*T. dicoccum*	*T. monococcum*	*Triticum* sp.	Cereal Indet.	*Hordeum* glume bases	*Triticum* glume bases	*Aegilops* glume bases
ABCN	144	.02	0.	0.	0.	0.	.01	0.	0.	0.
ABC	38	.41	.06	.01	.01	.03	.32	+	+	.01
ABC (Kaftari), MATRIX										
ABCN	109	.15	0.	0.	0.	0.	.12	0.	0.	0.
ABCS	20	0.	0.	0.	0.	0.	.01	0.	0.	+
ABCS	89	.13	0.	0.	0.	.01	.70	0.	0.	0.
GHI (Banesh), BURIAL										
H5	210	.03	0.	0.	0.	0.	.11	0.	+	0.
GHI (Banesh), MATRIX										
H5	189	.02	0.	0.	0.	0.	.01	0.	0.	0.
H5	199	0.	0.	0.	.01	0.	.01	0.	+	0.
GHI (Kaftari), HEARTHS										
G5	110	0.	0.	0.	0.	0.	.03	0.	0.	0.
G5	125	.02	0.	0.	0.	0.	.14	0.	0.	+
GHI (Kaftari), PITS										
G5	48	0.	0.	0.	0.	0.	.03	0.	0.	0.

(cont.)

Table B.2. Cereals and Glume Bases (wt., g)

Square	Lot	*Hordeum*	*Triticum aestivum*	*T. dicoccum*	*T. monococcum*	*Triticum* sp.	Cereal Indet.	*Hordeum* glume bases	*Triticum* glume bases	*Aegilops* glume bases
G5	84	.02	0.	0.	0.	0.	.02	0.	0.	+
G5	111	.01	0.	0.	0.	0.	.02	0.	0.	0.
G5	a 159	.01	0.	0.	0.	0.	.05	0.	0.	0.
*G5	b 159	.02	0.	0.	0.	0.	0.	0.	0.	0.
G7	152	0.	0.	0.	0.	0.	.02	0.	0.	0.
H5	42	.01	0.	0.	0.	.01	0.	0.	0.	0.
H5	48	+	0.	0.	0.	0.	+	0.	0.	0.
H5	57	+	0.	0.	0.	0.	+	+	0.	0.
H5	59	0.	0.	0.	0.	0.	.01	0.	0.	0.
H5	65	0.	0.	0.	0.	0.	.01	0.	0.	0.
H5	115	.05	0.	0.	0.	0.	.26	0.	0.	+
H5	a 117	.01	0.	0.	0.	.01	.02	+	0.	0.
H5	125	.03	.01	0.	0.	0.	.08	0.	0.	0.
H5	144	.03	0.	0.	0.	.01	.13	0.	0.	0.
H7	143	+	0.	0.	0.	0.	.03	+	0.	+
GHI (Kaftari), ROOMS										
G5	19	0.	0.	0.	0.	0.	+	0.	0.	0.
G5	21	0.	0.	0.	0.	0.	.01	0.	0.	0.
G5	25	0.	0.	0.	0.	0.	.02	0.	0.	0.
G5	26	0.	0.	0.	0.	0.	.03	0.	0.	0.
G5	57	0.	0.	0.	0.	0.	.02	0.	0.	0.
G5	126	.01	0.	0.	0.	0.	.07	0.	0.	+
G5	141	.01	0.	0.	0.	.01	.11	0.	0.	+
G5	153	.01	0.	0.	0.	.01	.06	0.	0.	0.

(cont.)

Table B.2. Cereals and Glume Bases (wt., g)

Square	Lot	*Hordeum*	*Triticum aestivum*	*T. dicoccum*	*T. monococcum*	*Triticum* sp.	Cereal Indet.	*Hordeum* glume bases	*Triticum* glume bases	*Aegilops* glume bases
G7	30	0.	0.	0.	0.	0.	.01	0.	0.	0.
G7	54	0.	0.	0.	0.	0.	.01	0.	0.	0.
G7	128	.01	0.	0.	0.	0.	.02	0.	0.	0.
G7	132	.01	0.	0.	0.	0.	.03	0.	0.	0.
G7	165	+	0.	0.	0.	0.	.03	0.	0.	0.
H5	75	.01	0.	0.	0.	0.	+	0.	0.	0.
H5	78	0.	.02	0.	0.	0.	.07	0.	0.	0.
H5	139	.01	0.	0.	0.	0.	.08	0.	0.	+
H7	140	0.	0.	0.	0.	0.	.02	0.	0.	0.
H7	148	.02	0.	0.	.01	0.	.06	+	0.	+
GHI (Kaftari), MATRIX										
G5	65	0.	0.	0.	0.	0.	.02	0.	0.	0.
H5	52	0.	0.	0.	0.	0.	+	0.	0.	0.
H5	93	0.	0.	0.	0.	0.	.05	0.	0.	0.
H5	a 101	0.	0.	0.	0.	0.	+	0.	0.	0.
H5	b 101	+	0.	0.	0.	0.	.02	0.	0.	0.
H5	114	+	.01	0.	0.	0.	.03	0.	0.	0.
H5	116	+	0.	0.	0.	0.	.08	0.	0.	0.
H5	147	.33	0.	0.	0.	.01	2.91	.01	.01	.32
H5	154	.23	.03	0.	.03	.03	8.11	.02	.01	.79

(cont.)

Table B.2. Cereals and Glume Bases (wt., g)

Square	Lot	*Hordeum*	*Triticum aestivum*	*T. dicoccum*	*T. monococcum*	*Triticum* sp.	Cereal Indet.	*Hordeum* glume bases	*Triticum* glume bases	*Aegilops* glume bases
H5	155	0.	0.	0.	0.	0.	.23	0.	+	.01
H5	165	.02	0.	0.	0.	0.	.61	+	+	0.
H5	171	0.	0.	0.	0.	0.	.01	0.	0.	0.
H5	180	.04	0.	0.	0.	.01	.12	0.	0.	0.
GHI (Kaftari), JAR CONTENTS										
G7	189	.01	0.	0.	0.	0.	.01	0.	0.	0.
H5	78	.01	0.	0.	0.	0.	+	0.	0.	0.
GHI (Qaleh), HEARTH										
G5	32	0.	0.	0.	0.	0.	.02	0.	0.	0.
GHI (Qaleh), ROOMS										
H5	29	.01	0.	0.	0.	0.	.01	0.	0.	0.
H7	14	0.	0.	0.	0.	0.	.05	0.	0.	0.
H7	28	0.	0.	0.	0.	0.	.01	0.	0.	0.
H7	34	0.	0.	0.	0.	0.	+	0.	0.	0.
H7	57	0.	0.	0.	0.	0.	+	0.	0.	0.
GHI (Qaleh), MISC. FEATURE										
H7	40	0.	0.	0.	0.	0.	.02	0.	0.	0.

(cont.)

Table B.2. Cereals and Glume Bases (wt., g)

Square	Lot	Hordeum	Triticum aestivum	T. dicoccum	T. monococcum	Triticum sp.	Cereal Indet.	Hordeum glume bases	Triticum glume bases	Aegilops glume bases
FX106 (Kaftari), PITS										
FX106	44	++	0.	0.	0.	0.	++	0.	0.	0.
FX106	50	+	0.	0.	0.	0.	+	0.	0.	0.
FX106	109	.01	0.	0.	0.	0.	.02	0.	0.	0.
FX106 (Kaftari), ROOM										
FX106	59	0.	0.	0.	0.	0.	+	+	0.	0.
GGX98 (Kaftari), PITS										
GGX98	110	.01	0.	0.	.01	0.	.31	+	+	0.
GGX98	115	.08	0.	0.	0.	0.	.98	+	0.	+
GGX98	141	.11	0.	0.	0.	++	.76	+	0.	+
GGX98	151	.02	0.	0.	0.	0.	.06	0.	0.	0.
GGX98 (Kaftari), ROOMS										
GGX98	37	0.	0.	0.	0.	0.	.01	0.	0.	0.
GGX98	60	0.	0.	0.	0.	0.	.01	0.	0.	0.
GGX98	66	.01	0.	0.	0.	0.	.08	0.	0.	0.
GGX98	69	0.	0.	0.	0.	0.	.02	0.	0.	0.
GGX98	86	0.	0.	0.	0.	0.	.02	0.	0.	0.
GGX98	108	.03	0.	0.	0.	0.	.21	0.	0.	+

(cont.)

Table B.2. Cereals and Glume Bases (wt., g)

Square Lot	Hordeum	Triticum aestivum	T. dicoccum	T. monococcum	Triticum sp.	Cereal Indet.	Hordeum glume bases	Triticum glume bases	Aegilops glume bases
GGX98 119	.01	0.	0.	0.	0.	.25	0.	0.	.03
GGX98 125	+	0.	0.	0.	0.	.05	0.	0.	0.
GGX98 133	0.	0.	0.	0.	0.	.06	0.	0.	0.
GGX98 139	0.	0.	0.	0.	0.	.20	+	0.	0.
GGX98 (Kaftari), MATRIX									
GGX98 97	.01	0.	0.	0.	0.	.02	0.	0.	0.
BY8 (Kaftari), PIT									
BY8 13	0.	0.	0.	0.	0.	+	0.	0.	0.
BY8 (Kaftari), MATRIX									
BY8 16	0.	0.	0.	0.	0.	+	0.	0.	0.

Table B.3. Seeds of Edible Species

Square	Lot	Lens (#)	Pisum (#)	Misc. Fruits (#)	Ficus (#)	Vitis (#)	Amygdalus sp. (g)	A. scoparia (g)	Pistacia (g)	Nutshell (g)
TUV (Banesh), HEARTHS										
U166	95	0	0	0	1	0	0.	0.	0.	0.
V168	62	0	0	0	0	0	0.	0.	+	0.
V168	103	0	0	0	0	0	+	0.	0.	0.
TUV (Banesh), PITS										
U166	69	1	0	0	0	1	0.	.01	0.	0.
U168	147	0	0	0	0	0	+	0.	+	0.
U168	19	0	0	0	0	0	+	0.	0.	0.
V166	28	0	0	0	0	0	0.	+	0.	0.
V168	136	0	0	0	0	.5	.01	0.	0.	0.
TUV (Banesh), ROOMS										
T168	37	0	0	0	0	0	0.	+	0.	0.
U166	123	0	0	1 Celtis	0	0	0.	0.	+	0.
U168	82	1	0	0	0	0	0.	0.	0.	0.
U168	93	0	0	0	0	0	+	+	0.	0.
U168	158	0	0	0	0	0	+	+	0.	0.
V166	25	0	0	1 Celtis	0	0	0.	++	++	0.
V166	36	0	0	0	0	0	.01	.01	0.	0.
V168	53	0	0	0	0	0	+	0.	0.	0.
V168	55	0	0	0	0	0	0.	.01	.01	0.

(cont.)

Table B.3. Seeds of Edible Species (cont.)

Square	Lot	Lens (#)	Pisum (#)	Misc. Fruits (#)	Ficus (#)	Vitis (#)	Amygdalus sp. (g)	A. scoparia (g)	Pistacia (g)	Nutshell (g)
V168	56	0	0	0	0	0	0.	+	0.	0.
V168	57	0	0	0	0	0	0.	+	0.	0.
V168	60	0	0	0	0	0	+	0.	0.	0.
TUV (Banesh), BURIAL										
U168	140	0	0	0	0	0	+	.02	0.	0.
TUV (Banesh), MATRIX										
U168	60	0	0	0	0	0	.01	0.	0.	0.
U166	93	0	0	0	0	0	+	+	0.	0.
TUV (Banesh), JAR CONTENTS										
V168	43	0	0	0	0	0	0.	+	0.	0.
TUV (Banesh), MISC. FEATURE										
U168	108	0	0	0	0	0	0.	+	0.	0.
ABC (Banesh), HEARTHS										
ABCS	53	0	0	0	0	1	0.	0.	0.	0.
ABC	27	0	0	0	0	0	0.	0.	0.	+

(cont.)

Table B.3. Seeds of Edible Species (cont.)

Square	Lot	Lens (#)	Pisum (#)	Misc. Fruits (#)	Ficus (#)	Vitis (#)	Amygdalus sp. (g)	A. scoparia (g)	Pistacia (g)	Nutshell (g)
ABC (Banesh), PIT (with soluble pottery)										
ABCN	148	0	0	0	0	0	0.	0.	+	0.
*ABCN	152	0	0	0	0	0	0.	0.	+	0.
*ABCN	153	0	0	0	1	1	0.	0.	0.	0.
ABC (Banesh), ROOMS										
ABCN	42	0	0	0	0	.5	0.	0.	0.	0.
ABCS	54	0	0	0	0	0	.02	0.	0.	0.
ABC (Kaftari), PITS										
ABCN	8	0	0	2 Celtis	0	0	0.	0.	+	0.
ABCN	a 54	1	0	0	0	0	0.	0.	0.	0.
*ABCN	b 54	4	0	32 Rubus	208	1200	0.	.03	.03	0.
ABCN	144	0	0	1 Celtis	0	0	0.	0.	0.	0.
ABC	38	4.5	0	0	3	5.5	.51	.89	.03	0.
ABC (Kaftari), MATRIX										
ABCN	109	1	0	5 Celtis	0	4	0.	+	+	+
ABCS	20	0	0	1 Celtis	0	0	0.	0.	+	0.
ABCS	89	1	0	0	1	1.5	0.	+	+	0.

(cont.)

Table B.3. Seeds of Edible Species (cont.)

Square	Lot	Lens (#)	Pisum (#)	Misc. Fruits (#)	Ficus (#)	Vitis (#)	Amygdalus sp. (g)	A. scoparia (g)	Pistacia (g)	Nutshell (g)
GHI (Banesh), BURIAL										
H5	210	2	0	0	0	0	0.	++	++	0.
GHI (Banesh), MATRIX										
H5	189	0	0	0	0	.5	.01	++	++	0.
H5	199	0	0	0	0	0	.03	++	++	0.
GHI (Kaftari), HEARTHS										
G5	125	0	0	1 Celtis	0	1.5	.01	.02	++	0.
G5	165	0	0	0	0	.5	0.	0.	0.	0.
GHI (Kaftari), PITS										
G5	48	0	0	1 Celtis	0	0	.01	++	++	0.
G5	84	0	0	0	0	.5	++	++	0.	0.
G5	111	0	0	0	0	.5	0.	.02	+	0.
G5	a 159	0	0	0	0	.5	.05	.07	+	0.
*G5	b 159	0	0	4 Rubus-3 Celtis-1	300	65	0.	0.	0.	0.
G7	152	0	0	0	0	0	0.	++	++	0.
H5	42	0	0	0	0	0	0.	0.	+	0.
H5	48	.5	0	0	0	0	0.	0.	0.	0.
H5	57	0	0	0	0	0	+	+	0.	0.
H5	59	1	0	0	0	0	+	0.	+	0.

(cont.)

Table B.3. Seeds of Edible Species (cont.)

Square	Lot	Lens (#)	Pisum (#)	Misc. Fruits (#)	Ficus (#)	Vitis (#)	Amygdalus sp. (g)	A. scoparia (g)	Pistacia (g)	Nutshell (g)
H5	65	0	0	0	0	0	.01	0.	.01	0.
H5	115	0	0	0	0	0	.32	0.	0.	0.
H5	a 117	0	0	0	0	0	++	++	.01	0.
H5	125	2	0	0	0	2	.20	.11	.08	0.
H5	144	0	0	0	0	.5	.01	.08	.02	0.
H7	143	0	0	0	0	0	.02	.02	0.	0.
GHI (Kaftari), ROOMS										
G5	21	0	0	0	0	0	0.	0.	+	0.
G5	25	0	0	0	0	0	.02	0.	+	0.
G5	26	0	0	0	0	0	+	0.	0.	0.
G5	57	0	0	0	0	0	0.	0.	0.	+
G5	126	0	0	0	0	.5	+	++	++	0.
G5	141	0	0	1 Celtis	0	2	0.	.03	.03	0.
G5	153	0	0	0	0	1	0.	0.	.01	0.
G7	30	0	0	0	0	0	.01	.01	0.	0.
G7	54	0	0	0	0	1	++	++	++	0.
G7	128	0	0	0	0	0	.03	.01	.01	0.
G7	132	0	0	0	0	1	.01	++	++	0.
G7	165	0	0	0	0	0	0.	.02	0.	0.
H5	75	.5	0	1 Celtis	0	.5	+	0.	0.	.04
H5	78	0	0	0	0	.5	.03	.01	.03	0.
H5	139	0	0	0	0	1	.04	0.	.03	0.
H7	140	0	0	0	0	0	.02	.01	0.	0.
H7	148	0	0	0	0	0	++	.01	++	0.

(cont.)

Table B.3. Seeds of Edible Species (cont.)

Square	Lot	*Lens* (#)	*Pisum* (#)	Misc. Fruits (#)	*Ficus* (#)	*Vitis* (#)	*Amygdalus* sp. (g)	*A. scoparia* (g)	*Pistacia* (g)	Nutshell (g)
GHI (Kaftari), MATRIX										
G5	65	0	0	0	0	0	.01	.01	0.	0.
H5	52	0	0	0	0	0	.03	+	+	0.
H5	93	0	0	0	0	0	0.	+	0.	0.
H5	b 101	0	0	0	0	0	0.	.04	.06	.01
H5	114	1	0	0	0	0	0.	.01	0.	0.
H5	116	0	0	0	0	0	0.	0.	.01	0.
H5	147	0	0	1 cf. Elaeagnus	0	1	0.	0.	+	0.
H5	154	9	1	3 cf. Elaeagnus-1 Phoenix-1 Rubus-1	3	71	0.	.07	.55	0.
H5	155	0	0	0	0	.5	+	0.	.02	0.
H5	165	0	0	1 cf. Elaeagnus	1	1	0.	.01	.02	0.
H5	171	0	0	0	0	0	0.	0.	0.	.01
H5	180	0	0	0	0	1.5	.02	0.	.01	0.
GHI (Kaftari), JAR CONTENTS										
G7	189	0	0	0	0	0	0.	0.	+	0.
GHI (Qaleh), ROOMS										
H5	29	0	0	0	0	0	0.	.01	0.	0.
H7	14	0	0	0	0	0	.01	.01	.01	0.
H7	28	0	0	0	0	0	0.	+	0.	0.
H7	57	0	0	0	0	0	0.	0.	0.	+

(cont.)

Table B.3. Seeds of Edible Species (cont.)

Square Lot	Lens (#)	Pisum (#)	Misc. Fruits (#)	Ficus (#)	Vitis (#)	Amygdalus sp. (g)	A. scoparia (g)	Pistacia (g)	Nutshell (g)
GHI (Qaleh), MISC. FEATURE									
H7 40	0	0	1 Celtis	0	0	0.	0.	.01	0.
FX106 (Kaftari), PIT									
FX106 109	0	0	0	0	0	.02	0.	0.	0.
GGX98 (Kaftari), PITS									
GGX98 110	0	0	0	0	.5	.06	0.	.03	0.
GGX98 115	2.5	1	0	1	1	.06	.54	.06	0.
GGX98 141	.5	0	2 cf.Elaeagnus	0	0	.02	.08	.27	0.
GGX98 151	0	0	0	0	2	.01	++	++	0.
GGX98 (Kaftari), ROOMS									
GGX98 37	0	0	0	0	0	0.	0.	+	0.
GGX98 60	0	0	0	0	0	.02	.02	0.	0.
GGX98 66	.5	0	0	0	.5	.07	.03	.02	.03
GGX98 69	0	0	0	0	0	.02	.02	.01	0.
GGX98 86	0	0	0	0	0	.02	.02	++	0.
GGX98 108	3	0	0	0	1	.75	.03	.02	0.
GGX98 119	0	0	0	0	1.5	.08	.05	.22	0.
GGX98 125	0	0	0	0	0	.01	.01	.02	0.
GGX98 133	0	0	0	0	0	.03	0.	.06	0.
GGX98 139	1.5	0	1 cf.Elaeagnus	0	1	.02	.08	.07	0.

(cont.)

Table B.3. Seeds of Edible Species (cont.)

Square	Lot	Lens (#)	Pisum (#)	Misc. Fruits (#)	Ficus (#)	Vitis (#)	Amygdalus sp. (g)	A. scoparia (g)	Pistacia (g)	Nutshell (g)
GGX98 (Kaftari), MATRIX										
GGX98	97	0	0	0	0	0	0.	+	0.	0.
BY8 (Kaftari), PIT										
BY8	13	1	0	0	0	0	0.	0.	.01	0.

Table B.4. Weed Seeds

Square	Lot	Weed (general) (#)	Irrigated Field (#)	Wet Area (#)	Carex (#)	Other Plants (#)	Un-ident. (#)
TUV (Banesh), HEARTHS							
U166	95	0	0	5 Cyperus	3	0	3
V168	65	1 Cheno	0	1 Cyperus	8	0	0
V168	76	1 Galium	0	1 Cyperus	0	0	0
V168	102	0	0	0	0	1 gram	1
TUV (Banesh), PITS							
U166	57	0	0	0	1	0	0
U166	69	2 Galium	1 borag	2 Rumex-1 Phalaris-1	23	1 gram .5 Aeg(+)	0 0
U168	19	0	0	0	0	0	1
U168	147	0	0	0	1	0	0
V166	28	0	0	0	2	0	0
V168	45	0	0	0	1	0	0
V168	114	1 Galium	0	0	0	.5 Aeg(+)	0
V168	136	1 Neslia	0	0	0	1 legum	1
W168	5	0	0	0	1	0	0
W168	9	1 crucif	0	0	0	0	0
TUV (Banesh), ROOMS							
U166	93	1 Crucif A	1 malvac	0	5	2 legum-1 Aeg-1(+)	1
U166	97	0	0	6 Cyperus	1	0	0
U168	30	0	0	0	0	0	1

(cont.)

Table B.4. Weed Seeds (cont.)

Square Lot	Weed (general) (#)	Irrigated Field (#)	Wet Area (#)	Carex (#)	Other Plants (#)	Un-ident. (#)
U168 158	0	0	0	0	0	1
U168 172	0	0	0	1	0	0
V164 21	0	0	0	1	0	0
V168 34	0	0	1 Cyperus	0	0	1
V168 55	0	0	0	1	0	0
V168 56	1 cf Valer	0	0	0	0	0
V168 57	0	0	0	1	0	0
TUV (Banesh), BURIAL						
U168 140	0	0	0	0	1 Aeg(.01)	0
TUV (Banesh), JAR						
V168 43	0	0	0	6	0	0
ABC (Banesh), HEARTHS						
ABCS 53	47 Vac-1 Crucif A-1 crucif-9 Bromus-18 Eremopy-2 Astrag-14 Galium-1 Hyoscy-1	5 Medic-1 malvac-3 Fumar-1	0	9	9 gram-8 Aeg-1(+)	2

(cont.)

Table B.4. Weed Seeds (cont.)

Square Lot	Weed (general) (#)	Irrigated Field (#)	Wet Area (#)	Carex (#)	Other Plants (#)	Un-ident. (#)
ABC (Banesh), ROOMS						
ABCN 15	0	0	0	1	0	0
ABCN 42	0	0	0	0	0	1
ABCN 76	0	0	0	2	0	1
ABCS 77	1 cf Atrplx	0	1 Cyperus	1	1 legum	0
ABC (Banesh), PIT with soluble pottery?						
ABCN 148	2 Bromus	0	0	2	0	0
*ABCN 152	10 Bromus-5 Eremopy-1 Lolium-1 Galium-3	0	2 Cyperus	0	5 gram-2 Aeg-3(?)	0
ABC (Kaftari), PITS						
ABCN 8	3 Bromus-2 Galium-1	1 Avena	1 Setaria	6	7 legum-2 rosac-5	4
ABCN a 54	11 Silene-1 Lepid-2 Bromus-7 Eremopy-1	1 malvac	4 cyperac-2 Potent-1	14	1 gram	147
*ABCN b 54	6 cucurb	0	2 Setaria	14	3 rosac	2

(cont.)

Table B.4. Weed Seeds (cont.)

Square Lot	Weed (general) (#)	Irrigated Field (#)	Wet Area (#)	Carex (#)	Other Plants (#)	Un-ident. (#)
ABCN 144	0	0	0	0	0	1
ABC 38	13 Vac-1 Crucif A-1 Bromus-2 Astrag-1 Galium-8	1 malvac	16 Cyperus-10 Setaria-5 Polyg-1	51	27 gram-21 legum-1 Pros-1 Aeg-3.5(.02)	6
ABC (Kaftari), JAR						
ABCN 127	0	0	0	25	0	2
ABC (Kaftari), MATRIX						
ABCN 109	7 Cheno-1 Bromus-1 Lolium-1 Astrag-2 Delph-1 Galium-1	0	3 Cyperus-1 Trifol-1 Potent-1	17	3 gram-1 legum-1 rosac-1	8
ABCS 20	0	0	2 Cyperus	1	1 legum	2
ABCS 89	16 Silene-1 Vac-1 Astrag-10 Galium-4	0	21 Cyperus-9 cyperac-2 Cynodon-3 Setaria-4 Polyg-2 Rumex-1	117	4 legum-3 umbel-1	23

(cont.)

Table B.4. Weed Seeds (cont.)

Square	Lot	Weed (general) (#)	Irrigated Field (#)	Wet Area (#)	Carex (#)	Other Plants (#)	Un-ident. (#)
GHI (Banesh), BURIAL							
H5	210	2 Astrag-1 Galium-1	2 Medic-1 solanac-1	2 Cyperus	6	3 gram-2 umbel-1	1
GHI (Banesh), MATRIX							
H5	189	1 crucif	0	0	0	1 legum	0
H5	199	1 Centaurea	0	0	0	0	0
GHI (Kaftari), HEARTHS							
G5	110	0	0	0	0	.5 Aeg(+)	1
G5	125	2 Crucif A	0	0	3	0	3
GHI (Kaftari), PITS							
G5	84	1 Galium	0	0	1	0	5
G5	a 159	0	0	0	1	0	1
*G5	b 159	3 crucif-2 comp-1	1 borag	0	0	0	17
H5	59	1 Galium	0	1 cyperac	0	0	0
H5	65	1 Astrag	0	0	0	0	0
H5	115	2 Astrag-1 Galium-1	0	0	3	3 gram-1 legum-2	5

(cont.)

Table B.4. Weed Seeds (cont.)

Square	Lot	Weed (general) (#)	Irrigated Field (#)	Wet Area (#)	Carex (#)	Other Plants (#)	Un-ident. (#)
H5	a 117	0	0	2 Cyperus	5	1 legum	6
*H5	b 117	0	2 solanac	3 cyperac	6	0	4
H5	125	3 Vac-1 Astrag-2	0	2 Cyperus	11	2 gram	6
H5	144	7 Eremopy-1 Hordeum-1 Astrag-1 Galium-4	3 Medic-1 malvac-1 solanac-1	12 cyperac-11 Setaria-1	68	9 gram-5 legum-4	9
H7	143	0	0	1 Cyperus	3	1 gram	0
GHI (Kaftari) ROOMS							
G5	21	0	0	0	0	0	1
G5	26	1 Vicia	0	0	0	0	0
G5	126	2 Panicum	0	1 Setaria	0	.5 Pros	5
G5	141	5 Cruc A-1 crucif-1 Adonis-1 Galium-1 Hyoscy-1	0	6 Cyperus-5 Setaria-1	13	5 gram-4 legum-1	5
G5	153	0	0	2 Setaria	1	0	4
G7	30	1 Vicia	0	0	0	0	0
G7	128	1 Galium	0	1 Setaria	1	1 gram	1

(cont.)

Table B.4. Weed Seeds (cont.)

Square	Lot	Weed (general) (#)	Irrigated Field (#)	Wet Area (#)	Carex (#)	Other Plants (#)	Un-ident. (#)
G7	132	0	0	0	1	0	0
G7	152	0	0	1 Setaria	3	0	0
H5	78	2 labiat-1 Galium-1	1 Avena	1 Setaria	3	1 legum	2
H5	139	3 Astrag-1 Galium-2	0	3 Cyperus-2 Setaria-1	7	0	0
H7	140	1 caryoph	0	0	2	1 gram	2
H7	148	5 Crucif A-2 Astrag-1 Galium-2	0	0	14	7 gram	1
GHI (Kaftari), MATRIX							
G5	65	0	0	0	2	1 legum	2
H5	52	0	0	0	0	0	1
H5	93	3 Astrag-1 Vicia-1 Galium-1	1 Medic	0	0	1 legum	0
H5	a 101	0	0	0	0	1 legum	0
H5	b 101	0	1 solanac	0	4	1 gram	0
H5	114	3 Bromus-1 Crucif A-1 Hyoscy-1	4 solanac	2 Setaria-1 Rumex-1	3	0	0
H5	116	5 Crucif A	0	11 Cyperus	4	0	2

(cont.)

Table B.4. Weed Seeds (cont.)

Square	Lot	Weed (general) (#)	Irrigated Field (#)	Wet Area (#)	Carex (#)	Other Plants (#)	Un-ident. (#)
H5	147	19 Cruc A-12 Bromus-1 Ajuga-1 Astrag-2 Galium-3	30 solanac	13 Cyperus-8 Rumex-5	179	27 euphrb-1 gram-3 lecum-3 Aeg-18(.09)	8
H5	154	60 Cruc A-40 crucif-1 Lolium-1 Astrag-4 Adonis-4 Cerato-7 Galium-3	41 Medic-10 Trifol-1 malvac-21 solanac-9	21 Cyperus-8 Setaria-9 Polyg-3 Rumex-1	320	109 gram-36 legum-34 umbel-1 Pros-1 Aeg-37(.4)	109
H5	155	0	0	0	2	0	2
H5	165	3 Centaur-1 Galium-2	0	4 Cyperus-2 Setaria-1 Polyg-1	4	10 legum-7 Pros-1 Aeg-2(.01)	12
H5	180	3 Galium	0	1 Setaria	3	2 legum	8
H7	40	0	0	0	0	0	3
GHI (Kaftari), JAR CONTENTS							
H5	78	1 Astrag	0	1 cyperac	0	0	0
GHI (Qaleh), ROOMS							
H5	29	0	0	1 Setaria	0	0	0

(cont.)

Table B.4. Weed Seeds (cont.)

Square Lot	Weed (general) (#)	Irrigated Field (#)	Wet Area (#)	Carex (#)	Other Plants (#)	Un-ident. (#)
H7 14	0	0	1 Rumex	0	0	0
H7 34	0	0	1 Cyperus	0	0	0
FX106 (Kaftari), PITS						
FX106 44	2 Galium	0	0	0	0	0
FX106 109	0	0	1 Cyperus	1	0	0
FX106 (Kaftari), ROOM						
FX106 19	0	0	0	0	0	2
FX106 (Kaftari), MATRIX						
FX106 59	0	0	0	1	0	0
GGX98 (Kaftari), PITS						
GGX98 110	0	1 solanac	0	10	1 gram	2
GGX98 115	17 Atriplex-1 Neslia-1 Crucif A-2 Lolium-2 Astrag-5 Galium-6	16 solanac	8 Cyperus-3 Setaria-4 Trifol-1	258	11 gram-5 legum-5 Aeg-1(+)	52

(cont.)

Table B.4. Weed Seeds (cont.)

Square Lot	Weed (general) (#)	Irrigated Field (#)	Wet Area (#)	Carex (#)	Other Plants (#)	Un-ident. (#)
GGX98 141	5 Crucif A-1 crucif-1 Astrag-1 Galium-2	2 solanac	4 Cyperus-1 Setar-1 Trifol-2	54	3 gram	30
GGX98 151	2 Astrag	0	0	5	0	1
GGX98 (Kaftari), ROOMS						
GGX98 16	1 Bromus	0	0	0	0	0
GGX98 37	1 Hyoscy	0	0	0	0	0
GGX98 60	0	0	1 Cyperus	0	0	0
GGX98 66	5 crucif-1 Lolium-1 Astrag-2 Hyoscy-1	2 solanac	1 Setaria	7	0	4
GGX98 69	1 Astrag	0	0	1	2 legum	0
GGX98 108	1 Adonis	0	2 Cyperus	10	0	5
GGX98 119	2 Crucif A	0	1 Setaria	0	2 gram-1 legum-1	6
GGX98 125	2 chenopdac-1 Adonis-1	0	1 Setaria	4	1 gram	3
GGX98 133	0	0	1 cyperac	2	1 legum	1
GGX98 139	2 Crucif A-1 Galium-1	4 Medic-1 solanac-3	1 Cyperus-1 Setaria-2	17	0	8
GGX98 (Kaftari), MATRIX						
GGX98 18	0	0	1 Polyg	0	0	0

APPENDIX C

DATA FROM FLOTATION SAMPLES: CHARCOAL

Table C.1. Charcoal from Flotation Samples, Counts

Square	Lot[1]	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare Genera	Diff. Por.[2]	Unident.
TUV (Banesh), HEARTHS											
U166	95		38					2			
U166	112		9						3 Zizy??		
V168	65	1	77		16			3			8
V168	66	1	5		7						
V168	76	10	3	5	2						
V168	102	1	23		9	1	1	3			2
V168	103		13		3	2					2
V168	114		3								8
V168	130	2	1				4				2
TUV (Banesh), PITS											
U166	18		5								
U166	57		3		2						
U166	69	9	1			3		1			4
U168	19	1	1		5	12					
U168	147		2		1		1	4			

(cont.)

Table C.1. Charcoal from Flotation Samples, Counts (cont.)

Square	Lot[1]	*Juniperus*	*Amygdalus*	Acer	*Pistacia*	*Quercus*	*Populus*	Ulmaceae	Rare Genera	Diff. Por.[2]	Unident.
V164	24		8		2						
V166	28		16								
V168	63	2	8								
V168	127	2	4		3	1					
W168	5	4		7	12						2
W168	9	2									
TUV (Banesh), ROOMS											
T168	43		1								
U166	97	1	8		1		1				1
U166	104		2								
U166	110		4								2
U166	114	1	2		1					1	4
U166	123	1	5			2	1				
U168	30		6								
U168	82		1						1 Frax		1
U168	83	1	5	1							
U168	93	5	2	2	4				1 Frax	2	2
U168	111	13	5		1		5				
U168	138	12	1				6			1	
U168	154	1	1								1
U168	158	1	1			2					
U168	172		1								
V166	25	4	5				3				
V166	36	1	1				2	1			
V168	34		14		3						3
V168	53	7	2						1 Frax	2	

(cont.)

Table C.1. Charcoal from Flotation Samples, Counts (cont.)

Square	Lot[1]	*Juniperus*	*Amygdalus*	*Acer*	*Pistacia*	*Quercus*	*Populus*	Ulmaceae	Rare Genera	Diff. Por.[2]	Unident.
V168	54		3								
V168	55	4	9	1	5						1
V168	56	2	2	1	1						
V168	60		1		1						
V168	123	2	8		3	1	3	2	1 Rham?		
TUV (Banesh), BURIAL											
U168	140	7	3					1			2
TUV (Banesh), JARS											
U168	39	2	1								
V168	43	9	6			3				1	3
V168	49		1		8		1			2	
TUV (Banesh), MATRIX											
U166	93	1	10	2	4	1	2				
U168	60						1				
U168	108	1	4	1	1			1			
V168	135		5	1							

(cont.)

Table C.1. Charcoal from Flotation Samples, Counts (cont.)

Square	Lot[1]	*Juniperus*	*Amygdalus*	*Acer*	*Pistacia*	*Quercus*	*Populus*	Ulmaceae	Rare Genera	Diff. Por.[2]	Unident.
ABC (Banesh), HEARTHS											
ABCS	53		1		2						
ABCS	80				3						
ABC	20					3					
ABC	23		4		2	1					
ABC	27						8			1	
ABC (Banesh), PIT (with soluble pottery)											
ABCN	148				34	2					
ABC (Banesh), ROOMS											
ABCN	16	2									
ABCN	42	1					5	1			
ABCN	61						1				
ABCN	68		3	1	3	5		2			1
ABCN	76		4			2	1	1		1	
ABCS	51		5		5				3 Rham		5
ABCS	77				1						
ABC	13		3		1						2
ABC	24					1				1	

(cont.)

Table C.1. Charcoal from Flotation Samples, Counts (cont.)

Square	Lot[1]	*Juniperus*	*Amygdalus*	*Acer*	*Pistacia*	*Quercus*	*Populus*	Ulmaceae	Rare Genera	Diff. Por.[2]	Unident.
ABC (Kaftari), PITS											
ABCN	8	3	6		1	13	2				3
ABCN	54	1									
ABCN	88										4
ABCN	144		2								
ABCS	45					1					
ABC	38		17	7	9	31	1	14	2 Vitis-1 Daphne-1	2	5
ABC (Kaftari), MATRIX											
ABCN	109	1	3		5	5	1				3
ABCS	20		2			7					2
ABCS	89	1	8	1	21	2			2 Frax-1 Plat-1		
GHI (Banesh), BURIAL											
H5	210		8	1	1	6		1		2	1
GHI (Banesh), MATRIX											
H5	189	4	4	1	1	3					
H5	199					4	2				

(cont.)

Table C.1. Charcoal from Flotation Samples, Counts (cont.)

Square	Lot[1]	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare Genera	Diff. Por.[2]	Unident.
GHI (Kaftari), HEARTHS											
G5	111			1		2				1	1
G5	125		9		4	2		1			
GHI (Kaftari), PITS											
G5	48		8								
G5	84		2				1				
G5	a 159		3	1		1	4				2
G7	152		2			1					
H5	42		1	1							
H5	57			1	4	1					1
H5	65					3					
H5	115		16			2					2
H5	a 117		5	3		8		1			1
H5	125	1	4	1	3	14					7
H5	144	2	3	1	4	6	2	1			1
H7	143			3	2	6		1			3
GHI (Kaftari), ROOMS											
G5	19				1						
G5	21		1				1				
G5	25		2		1						
G5	26				1	1					
G5	126		1			3					6

(cont.)

Table C.1. Charcoal from Flotation Samples, Counts (cont.)

Square	Lot[1]	*Juniperus*	*Amygdalus*	*Acer*	*Pistacia*	*Quercus*	*Populus*	Ulmaceae	Rare Genera	Diff. Por.[2]	Unident.
G5	141		3			1					1
G5	153		4			3					2
G7	30			1	3	1		1		2	
G7	37		1								1
G7	128		8	6	2	2					2
G7	132		5	3							
G7	165		4	1	5	1		1			
H5	75		2		2	3	1				
H5	78		7		7	6					
H5	139		3	3	1	2				8	
H7	140		2		1	1					2
H7	148			1		19					
GHI (Kaftari), JAR CONTENTS											
H5	78	1	2		2						
GHI (Kaftari), MATRIX											
G5	65	1	2	2	2	1					
H5	52		4	1	1	2	1				
H5	93		8		2	1					1
H5	a 101	1				1					
H5	b 101		5	5		6					4
H5	114		2	5	1	2				8	2
H5	116		1			2					
H5	147	2	3	2	1	3					5
H5	154		21	9	13	24			1 Frax	1	2

(cont.)

Table C.1. Charcoal from Flotation Samples, Counts (cont.)

Square	Lot[1]	*Juniperus*	*Amygdalus*	*Acer*	*Pistacia*	*Quercus*	*Populus*	Ulmaceae	Rare Genera	Diff. Por.[2]	Unident.
H5	155		3			1					
H5	165		4		4	7			2 Pros		
H5	180	1	9	9	6			2	1 Vitis		5
GHI (Qaleh), HEARTH											
G5	32				2	3					
GHI (Qaleh), ROOMS											
H5	21		1								1
H5	29		1		1	1					1
H7	14		4								
H7	28		1		1	1					
H7	57		1								
GHI (Qaleh), MISC. FEATURE											
H7	40		5		1						
FX106 (Kaftari), PITS											
FX106	44		1			1					
FX106	109		8	1	1	9					
FX106 (Kaftari), ROOM											
FX106	14									2	

(cont.)

Table C.1. Charcoal from Flotation Samples, Counts (cont.)

Square	Lot[1]	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare Genera	Diff. Por.[2]	Unident.
GGX98 (Kaftari), PITS											
GGX98	110		1			2					1
GGX98	115		32	16	10	20	5	1		7	9
GGX98	141		16	13	8	14	1	1		3	4
GGX98	151		2	2		2					
GGX98 (Kaftari), ROOMS											
GGX98	37		5	1	4						
GGX98	60		6	1	1				1 Zizy??	1	3
GGX98	66		16	2	4	5	3				9
GGX98	69			2		1					
GGX98	86		2			1	1				
GGX98	108		3	9		4					
GGX98	125		7	1	1	2				3	1
GGX98	133		4	3		3				1	
GGX98	139		11	2	2	3					2
GGX98 (Kaftari), MATRIX											
GGX98	18		1								
BY8 (Kaftari), PIT											
BY8	13		5		1	3					1

(cont.)

Table C.1. Charcoal from Flotation Samples, Counts (cont.)

Square	Lot[1]	*Juniperus*	*Amygdalus*	*Acer*	*Pistacia*	*Quercus*	*Populus*	Ulmaceae	Rare Genera	Diff. Por.[2]	Unident.
BY8 (Kaftari), MATRIX											
BY8	16		4			1					

[1] Samples with no identifiable charcoal:
T168, lots 21, 37, 46, 50
U166, lots 111, 136
U168, lots 26, 99, 109, 127, 159
V164, lot 21
V168, lots 48, 57, 62, 117, 136, 143
ABCN, lots 15, 54a, 82, 88, 127, 137, 152, 153
ABCS, lots 48, 54, 87
ABC, lots 29, 48, 50
G5, lots 57, 110, 159b, 165
G7, lots 54, 189
H5, lots 26, 48, 59, 117b, 171
H7, lot 34
FX106, lots 19, 50, 59, 67
GGX98, lots 16, 19, 97,119, 121

[2] Diff. Por. = diffuse porous

Table C.2. Charcoal from Flotation Samples, Weights (g)

Square	Lot[1]	*Juniperus*	*Amygdalus*	*Acer*	*Pistacia*	*Quercus*	*Populus*	Ulmaceae	Rare genera	Diff por[2]	Unident
TUV (Banesh), HEARTHS											
U166	95		2.56					.17			
U166	112		.73						.12 Zizy??		
V168	65	.03	8.66		2.43			.25			.65
V168	66	.03	.20		.35						
V168	76	.23	.10	.13	.11						
V168	102	.06	2.12		.91	.10	.06	.21			.14
V168	103		.70		.27	.12					.13
V168	114		.20								.26
V168	130	.02	.08				.06				.17
TUV (Banesh), PITS											
U166	18		.20								
U166	57		.11		.06						
U166	69	.23	.03			.09		.02			.12
U168	19	.02	.17		.61	.45					
U168	147		.05		.01		.01	.05			
V164	24		.55		.06						
V166	28		.39								
V168	63	.07	.18								
V168	127	.05	.08		.08	.02					
W168	5	.12		.66	.77						.27
W168	9	.03									

(cont.)

Table C.2. Charcoal from Flotation Samples, Weights (g)(cont.)

Square	Lot[1]	*Juniperus*	*Amygdalus*	*Acer*	*Pistacia*	*Quercus*	*Populus*	Ulmaceae	Rare genera	Diff por[2]	Unident
TUV (Banesh), ROOMS											
T168	43		.02								
U166	97	.01	.22		.04		.04				.02
U166	104		.04								
U166	110		.17								.05
U166	114	.01	.04		.09					.02	.09
U166	123	.01	.24			.04	.01				
U168	30		.21								
U168	82		.08						.01 Frax		.07
U168	83	.01	.06	.01							
U168	93	.07	.04	.05	.25				.03 Frax	.03	.04
U168	111	.49	.24		.14		.15				
U168	138	.42	.03				.20			.03	
U168	154	.04	.05								.02
U168	158	.03	.04			.06					
U168	172		.01								
V166	25	.03	.25				.03				
V166	36	.02	.01				.06	.02			
V168	34		.66		.10						.10
V168	53	.11	.03						.01 Frax	.02	
V168	54		.10								
V168	55	.07	.21	.01	.21						.02
V168	56	.12	.04	.01	.08						
V168	60		.02		.02						
V168	123	.05	.23		.10	.01	.20	.06	.05 Rham?		

(cont.)

Table C.2. Charcoal from Flotation Samples, Weights (g)(cont.)

Square	Lot[1]	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare genera	Diff por[2]	Unident
TUV (Banesh), BURIAL											
U168	140	.16	.09					.02			.05
TUV (Banesh), JARS											
U168	39	.04	.03								
V168	43	.11	.55			.02				.02	.15
V168	49		.04		.50		.03			.04	
TUV (Banesh), MATRIX											
U166	93	.02	.39	.04	.16	.02	.13				
U168	60						.01				
U168	108	.02	.19	.05	.05			.03			
V168	135		.20	.02							

(cont.)

Table C.2. Charcoal from Flotation Samples, Weights (g)(cont.)

Square	Lot[1]	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare genera	Diff por[2]	Unident
ABC (Banesh), HEARTHS											
ABCS	53		.01		.04						
ABCS	80				.11						
ABC	20					.12					
ABC	23		.22		.04	.03					
ABC	27						.18			.02	
ABC (Banesh), PIT (with soluble pottery)											
ABCN	148				4.03	.03					
ABC (Banesh), ROOMS											
ABCN	16	.02									
ABCN	42	.01					.03	.01			
ABCN	61						.01				
ABCN	68		.08	.03	.05	.04		.03			.02
ABCN	76		.18			.03	.01	.01		.01	
ABCS	51		.18		.65				.10 Rham?		.13
ABCS	77				.03						
ABC	13		.15		.01						.04
ABC	24					.01				.01	

(cont.)

Table C.2. Charcoal from Flotation Samples, Weights (g)(cont.)

Square	Lot[1]	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare genera	Diff por[2]	Unident
ABC (Kaftari), PITS											
ABCN	8	.03	.09		.01	.41	.05				.07
ABCN	54	.01									
ABCN	88										.13
ABCN	144		.06								
ABCS	45					.01					
ABC	38		7.12	.24	4.27	5.71	.03	1.72	.71 Vitis-.56 Daph-.15	.02	.31
ABC (Kaftari), MATRIX											
ABCN	109	.01	.06		.46	.08	.01				.13
ABCS	20		.04			.07					.09
ABCS	89	.01	.22	.01	1.10	.03			.06 Frax-.01 Plat-.05		
GHI (Banesh), BURIAL											
H5	210		.50	.02	.12	.30		.08		.05	.03
GHI (Banesh), MATRIX											
H5	189	.04	.15	.01	.01	.02					
H5	199					.11	.05				

(cont.)

Table C.2. Charcoal from Flotation Samples, Weights (g)(cont.)

Square	Lot[1]	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare genera	Diff por[2]	Unident
GHI (Kaftari), HEARTHS											
G5	111			.03		.09				.05	.06
G5	125		.21		.06	.10		.04			
GHI (Kaftari), PITS											
G5	48		.26								
G5	84		.03				.01				
G5	a 159		.17	.04		.02	.12				.15
G7	152		.08			.05					
H5	42		.01	.01							
H5	57			.03	.08	.01					.02
H5	65					.04					
H5	115		.56			.04					.05
H5	a 117		.27	.28		.26		.04			.23
H5	125	.03	.12	.07	.09	.48					.26
H5	144	.27	.16	.04	.23	.30	.09	.02			.02
H7	143			.25	.09	.23		.05			.09
GHI (Kaftari), ROOMS											
G5	19				.01						
G5	21		.01				.01				
G5	25		.02		.01						
G5	26				.06	.02					
G5	126		.03			.07					.24

(cont.)

Table C.2. Charcoal from Flotation Samples, Weights (g)(cont.)

Square	Lot[1]	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare genera	Diff por[2]	Unident
G5	141		.11			.03					.02
G5	153		.11			.07					.05
G7	30			.01	.02	.01		.02		.07	
G7	37		.01								.01
G7	128		.48	.34	.05	.10					.17
G7	132		.07	.06							
G7	165		.16	.05	.15	.03		.01			
H5	75		.05		.08	.03	.01				
H5	78		.23		.12	.09					
H5	139		.13	.06	.06	.08					
H7	140		.13		.03	.02					.05
H7	148			.04		1.07					
GHI (Kaftari), JAR CONTENTS											
H5	78	.01	.25		.08						
GHI (Kaftari), MATRIX											
G5	65	.01	.02	.02	.18	.01					
H5	52		.12	.02	.02	.06	.02				
H5	93		.23		.05	.01					.02
H5	a 101	.01				.01					
H5	b 101		.30	.28		.36					.11
H5	114		.10	.44	.06	.06				.47	.08
H5	116		.04			.12					
H5	147	.07	.16	.04	.02	.05					.15
H5	154	.07	1.39	.39	.90	.90			.02 Frax	.02	.05

(cont.)

Table C.2. Charcoal from Flotation Samples, Weights (g)(cont.)

Square	Lot[1]	Juni-perus	Amyg-dalus	Acer	Pist-acia	Quer-cus	Popu-lus	Ulma-ceae	Rare genera	Diff por[2]	Un-ident
H5	155		.10			.02					
H5	165		.11		.23	.27			.07 Pros		
H5	180	.05	.85	1.19	.38			.05	.04 Vitis		.23
GHI (Qaleh), HEARTH											
G5	32				.05	.23					
GHI (Qaleh), ROOMS											
H5	21		.06								.02
H5	29		.01		.01	.01					.02
H7	14		.04								
H7	28		.01		.01	.05					
H7	57		.01								
GHI (Qaleh), MISC. FEATURE											
H7	40		.20		.01						
FX106 (Kaftari), PITS											
FX106	44		.04			.01					
FX106	109		.51	.02	.03	.29					
FX106 (Kaftari), ROOM											
FX106	14									.04	

(cont.)

Table C.2. Charcoal from Flotation Samples, Weights (g)(cont.)

Square	Lot[1]	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare genera	Diff por[2]	Unident
GGX98 (Kaftari), PITS											
GGX98	110		.01			.02					.02
GGX98	115		2.01	.51	1.13	.81	.07	.05		.22	.19
GGX98	141		.72	.41	.53	.39	.03	.03		.12	.16
GGX98	151		.02	.03		.03					
GGX98 (Kaftari), ROOMS											
GGX98	37		.15	.03	.04						
GGX98	60		.35	.03	.02				.03 Zizy??	.02	.08
GGX98	66		1.33	.04	.18	.23	.07				.19
GGX98	69			.23		.02					
GGX98	86		.04			.05	.04				
GGX98	108		.13	.79		.15					
GGX98	125		.31	.01	.04	.12				.18	.13
GGX98	133		.21	.09		.06				.01	
GGX98	139		.45	.15	.13	.15					.11
GGX98 (Kaftari), MATRIX											
GGX98	18		.04								
BY8 (Kaftari), PIT											
BY8	13		.07		.01	.03					.04

(cont.)

Table C.2. Charcoal from Flotation Samples, Weights (g)(cont.)

Square Lot[1]	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare genera	Diff por[2]	Unident
BY8 (Kaftari), MATRIX										
BY8 16		.09			.01					

[1]Samples with no identifiable charcoal:
T168, lots 21, 37, 46, 50
U166, lots 111, 136
U168, lots 26, 99, 109, 127, 159
V164, lot 21
V168, lots 48, 57, 62, 117, 136, 143
ABCN, lots 15, 54a, 82, 88, 127, 137, 152, 153
ABCS, lots 48, 54, 87
ABC, lots 29, 48, 50
G5, lots 57, 110, 159b, 165
G7, lots 54, 189
H5, lots 26, 48, 59, 117b, 171
H7, lot 34
FX106, lots 19, 50, 59, 67
GGX98, lots 16, 19, 97,119, 121

[2]Diff Por = diffuse porous

APPENDIX D

HAND-PICKED CHARCOAL

Table D.1. Catalog of Hand-picked Charcoal

Square	Lot	Per	Feature Type	Feature #	DC	Wt. (g)	Identified		Other Lots(DC)[1]
							Wt.(g)	#	
TUV (Banesh)									
Hearths:									
U166	95	B	HRTH	305	36	5.19	4.79	21	
V168	102	B	HRTH	240	28	12.64	4.60	19	
V168	103	B	HRTH	244	28	2.41	2.13	10	
V168	114	B	HRTH	245	28	.96	.64	5	
V168	76	B	OVEN	223	28	1.43	1.11	10	
Pits:									
U168	141	B	PIT	196	49	10.29	6.30	20	
Rooms:									
V168	91	B	KUCH	307	35	21.95	11.48	40	55(42)
U168	135	B	ROOM	219	26	7.21	4.55	20	
U168	110	B	ROOM	250	23	13.41	9.42	32	111(26)
U168	133	B	ROOM	258	35	112.97	83.67	53	159(37)
U168	138	B	ROOM	258	26	40.02	30.46	20	
V166	54	B	ROOM	306	35	5.49	4.81	6	
V166	67	B	AREA	338	42	13.72	7.97	40	
V166	48	B	AREA	366	51	5.43	3.99	18	51
V166	66	B	AREA	367	34	4.75	2.66	20	

(cont.)

Table D.1. Catalog of Hand-picked Charcoal (cont.)

Square	Lot	Per	Feature Type	Feature #	DC	Wt. (g)	Identified Wt.(g)	Identified #	Other Lots(DC)[1]
V168	91	B	AREA	372	37	1.11	.91	3	
V168	132	B	ROOM	265	35	7.26	3.61	20	
V168	157	B	AREA	374	34	6.61	4.74	10	
V168	167	B	AREA	397	34	26.21	18.33	20	
V168	115	B	AREA	375	35	38.01	16.21	70	118,120(51)
V168	123	B	AREA	376	35	9.48	6.66	20	
Matrix:									
U166	105	B	MTRX	-	36	8.41	3.53	21	
V168	99	B	TRPL	241	23	17.96	17.58	22	
V168	137	B	MTRX	-	36	3.88	2.53	20	
V168	108	B	MTRX	-	36	2.53	2.49	3	
Misc.:									
U168	108	B	UNK	0	22	34.09	22.44	40	
V168	162	B	UNK	333	36	11.99	11.99	3	
ABC (Banesh)									
Rooms:									
ABC	3	B	ROOM	241	36	1.81	1.01	7	10
ABC	12	B	AREA	331	35	.80	.66	9	15
ABC	14	B	AREA	332	35	1.41	1.41	4	
ABC	25	B	AREA	281	36	.85	.59	3	
ABC (Kaftari)									
Pit:									
ABC	38	K	PIT	75	22	20.76	10.57	30	41

(cont.)

Table D.1. Catalog of Hand-picked Charcoal (cont.)

Square	Lot	Per	Feature Type	Feature #	DC	Wt. (g)	Identified Wt.(g)	Identified #	Other Lots(DC)[1]
GHI (Banesh)									
Matrix:									
H5	188	B	MTRX	-	23	10.13	19.74	20	[2]many
H5	208	B	MTRX	-	23	1.92	1.92	1	
GHI (Kaftari)									
Pits:									
H5	85	K	PIT	26	22	1.81	1.81	1	
H5	115	K	PIT	47	22	3.44	3.44	3	
H5	177	K	PIT	105	22	.52	.31	3	
H7	143	K	PIT	143	22	4.95	3.29	20	
Rooms:									
G5	102	K	ROOM	116	35	3.19	2.18	5	
G5	129	K	AREA	117	42	3.02	2.69	18	
G7	64	K	AREA	88	37	3.85	3.05	3	78(35)
H5	79	K	COUR	37	37	.29	.24	3	
H5	111	K	COUR	37	29	3.55	1.99	10	
H5	127	K	AREA	50	35	46.08	38.91	57	131
H7	124	K	AREA	122	23	2.25	1.80	26	
H7	132	K	AREA	122	37	2.03	1.49	13	
H7	148	K	ROOM	158	42	4.12	3.07	20	

(cont.)

Table D.1. Catalog of Hand-picked Charcoal (cont.)

Square	Lot	Per	Feature Type	Feature #	DC	Wt. (g)	Identified Wt.(g)	Identified #	Other Lots(DC)[1]
Matrix:									
G5	123	K	MTRX	-	36	4.21	2.75	7	
H5	114	K	MTRX	-	35	6.09	5.81	19	
H5	154	K	MTRX	-	23	29.31	21.93	57	[3]many
H5	166	K	MTRX	-	41	12.29	7.88	26	
H5	169	K	MTRX	-	23	41.58	35.34	88	[4]many
GHI (Qaleh)									
Room:H5	36	Q	ROOM	20	42	2.95	2.95	1	
FX106 (Kaftari)									
Pit:									
FX106	109	K	PIT	41	22	21.86	18.09	31	
Matrix:									
FX106	76	K	MTRX	-	34	6.47	6.07	8	
GGX98 (Kaftari)									
Pits:									
GGX98	77	K	PIT	[5]52	23	[6]81.61	45.58	164	[7]many
GGX98	145	K	PIT	[5]52	22	85.32	66.20	188	[8]many
GGX98	160	K	PIT	65	22	.75	.75	3	
Rooms:									
GGX98	60	K	ROOM	28	35	4.95	2.74	15	
GGX98	65	K	ROOM	28	23	14.70	9.98	27	66(11)

(cont.)

Table D.1. Catalog of Hand-picked Charcoal (cont.)

Square	Lot	Per	Feature Type	Feature #	DC	Wt. (g)	Identified Wt.(g)	Identified #	Other Lots(DC)[1]
GGX98	67	K	AREA	32	35	5.69	4.19	20	
GGX98	69	K	AREA	32	25	2.38	1.61	10	
GGX98	122	K	AREA	32	29	4.74	4.55	12	
GGX98	125	K	AREA	54	35	1.58	1.05	11	
GGX98	179	K	ROOM	64	35	3.20	2.71	15	
Matrix:									
GGX98	40	K	MTRX	-	23	.36	.36	1	
GGX98	64	K	TRSH	-	23	2.35	2.35	10	
GGX98	52	K	MTRX	-	34	1.38	1.14	9	
BY8 (Banesh)									
Rooms:									
BY8	132	B	ROOM	10	35	33.66	11.38	40	
BY8	138	B	ROOM	16	40	9.17	4.47	20	
Matrix:									
BY8	86	B	MTRX	-	45	.74	.64	7	
BY8	87	B	MTRX	-	45	9.33	5.58	20	
BY8	94	B	MTRX	-	36	3.25	2.28	20	
BY8	100	B	MTRX	-	45	.16	.14	4	
BY8	120	B	MTRX	-	45	1.88	.58	9	121(45)
BY8 (Kaftari)									
Pit:									
BY8	79	K	PIT	1	22	2.93	2.17	20	

Notes for Table D.1 on next page

Notes for Table D.1

[1] Some lots from the same feature or locus were combined for analysis. The first number represents additional lot numbers combined for analysis. The next number (in parentheses) represents the deposit code for the additional lot(s), if different from the rest of the sample.
[2] H5, stratum 25 contained lots 188, 190, 194, 195, 198.
[3] H5, stratum 22 contained lots 154, 156, 158, 163, 165, 167.
[4] H5, stratum 23 contained lots 169, 170, 174, 175, 176, 178, 180, 181, 182, 183, 184.
[5] GGX98 Pit 52 was divided into two major strata, 5 and 7.
[6] GGX98 lot 77 contained 1 carbonized date pit weighing .16 g.
[7] GGX98 Pit 52, stratum 5 Lots 83, 127 (Deposit Code 23); 112, 126, 129, 131, 165 (Deposit Code 22).
[8] GGX98 Pit 52, stratum 7. Lots 148, 152, 153, 156, 157, 161, 163, 167, 168, 178 (Deposit Code 22).

Table D.2. Hand-picked Charcoal, Counts

Square	Lot	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare Genera	Unident.
TUV (Banesh), HEARTHS										
U166	95		19				1	1		
V168	102		5		11	1				2
V168	103	2	1		3	4				
V168	114		4					1		
V168	76	9			1					
TUV (Banesh), PIT										
U168	141	14			1		5			
TUV (Banesh), ROOMS										
U166	91	9	14		2		8	4		3
U168	135	9	2		2			5	1 Daph	1
U168	110	6					26			
U168	133	21					32			
U168	138	6	1				13			
V166	54				6					
V166	67	8	9		5		12	4		2
V166	48		4		1	5		8		
V166	66	5						2		13
V168	91		2		1					
V168	132		7	12				1		
V168	157		7		3					

(cont.)

Table D.2. Hand-picked Charcoal, Counts (cont.)

Square	Lot	Juni-perus	Amyg-dalus	Acer	Pist-acia	Quer-cus	Pop-ulus	Ulma-ceae	Rare Genera	Uni-dent.
V168	167	6			13		1			
V168	115	39	2				25	2		2
V168	123	1	1		6		11			1
TUV (Banesh), MATRIX										
U166	105	21								
V168	99	22					2			
V168	137	2	13		1			1		3
V168	108	3								
TUV (Banesh), MISC. FEATURES										
U168	108	22					18			
V168	162	1								1
ABC (Banesh), ROOMS										
ABC	3	3	1		2	1				
ABC	12	2			2			5		
ABC	14				3	1				
ABC	25			3						
ABC (Kaftari), PIT										
ABC	38		6	1	3	13	2	2	3 cf. Cap	

(cont.)

Table D.2. Hand-picked Charcoal, Counts (cont.)

Square	Lot	Juni-perus	Amyg-dalus	Acer	Pist-acia	Quer-cus	Pop-ulus	Ulma-ceae	Rare Genera	Uni-dent.
GHI (Banesh), MATRIX										
H5	188	2	1			12	1	3		1
H5	208					1				
GHI (Kaftari), PITS										
H5	85				1					
H5	115		3							
H5	177					2				1
H7	43		20							
GHI (Kaftari), ROOMS										
G5	102					5				
G5	129					3		11		4
G7	64				1					2
H5	79							3		
H5	111		1			9				
H5	127	34		1	21	1				
H7	124			3	1	3			18 Vitex	0
H7	132								9 Vitis	4
H7	148					20				

(cont.)

Table D.2. Hand-picked Charcoal, Counts (cont.)

Square	Lot	Juni-perus	Amyg-dalus	Acer	Pist-acia	Quer-cus	Pop-ulus	Ulma-ceae	Rare Genera	Uni-dent.
GHI (Kaftari), MATRIX										
G5	123								7 Vitis	
H5	114		1	4	3	11				
H5	154		11	5	22	16			1 Vitis	2
H5	166	5	5		10	3				3
H5	169	6	12	16	17	22			6 Vitis	11
GHI (Qaleh), ROOM										
H5	36					1				
FX106 (Kaftari), PIT										
FX106	109		4		7	16			4 cf. Cap	
FX106 (Kaftari), MATRIX										
FX106	76			6				2		
GGX98 (Kaftari), PITS										
GGX98	77		22	30	36	30	4	11	13 Frax	18
GGX98	145		34	44	50	49		2		9
GGX98	160							2		

(cont.)

Table D.2. Hand-picked Charcoal, Counts (cont.)

Square	Lot	Juni-perus	Amyg-dalus	Acer	Pist-acia	Quer-cus	Pop-ulus	Ulma-ceae	Rare Genera	Uni-dent.
GGX98 (Kaftari), ROOMS										
GGX98	60		1			6	2	5	1 Pros	
GGX98	65		9	12	4	1	1		2 Acer/Amyg-1 Capparis-1	
GGX98	67		4	5	1	2		8		
GGX98	69		1	1		5				3
GGX98	122				5	5				2
GGX98	125				7	2				2
GGX98	179		15							
GGX98 (Kaftari), MATRIX										
GGX98	40			1						
GGX98	64		4			1	1			4
GGX98	52		2	1		4				2
BY8 (Banesh), ROOMS										
BY8	132	9					7	24		
BY8	138	1				19				

(cont.)

Table D.2. Hand-picked Charcoal, Counts (cont.)

Square	Lot	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare Genera	Unident.
BY8 (Banesh), MATRIX										
BY8	86		2	1				4		
BY8	87	13	1	5						1
BY8	94	7	1					12		
BY8	100					1				3
BY8	120		4		2			3		
BY8 (Kaftari), PIT										
BY8	79		4		10	6				

Table D.3. Hand-picked Charcoal, Weights

Square	Lot	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare Genera	Unident.
TUV (Banesh), HEARTHS										
U166	95		1.31				.05	3.43		
V168	102		1.31		2.68	.18				.43
V168	103	.32	.23		.86	.72				
V168	114		.61					.03		
V168	76	.95			.16					
TUV (Banesh), PIT										
U168	141	4.41			.99		.90			
TUV (Banesh), ROOMS										
U166	91	3.62	2.74		.43		2.57	.33		.79
U168	135	2.75	.35		1.00			.25	.12 Daph	.08
U168	110	1.64					7.78			
U168	133	32.32					51.35			
U168	138	8.16	1.73				8.77			
V166	54				4.81					
V166	67	1.44	1.60		1.59		2.55	.27		.15
V166	48		.93		1.25		.98	.83		
V166	66	.34						.49		1.83
V168	91		.63		.28					
V168	132		1.38	2.19				.04		
V168	157		4.52		.22					

(cont.)

Table D.3. Hand-picked Charcoal, Weights (cont.)

Square	Lot	Juni-perus	Amyg-dalus	Acer	Pist-acia	Quer-cus	Pop-ulus	Ulma-ceae	Rare Genera	Uni-dent.
V168	167	3.09			14.87		.37			
V168	115	8.41	.45				6.71	.11		.53
V168	123	.06	1.04		.71		4.60			.25
TUV (Banesh), MATRIX										
U166	105	4.53								
V168	99	16.45					1.13			
V168	137	.47	1.56		.15			.09		.26
V168	108	2.49								
TUV (Banesh), MISC. FEATURES										
U168	108	18.50					3.94			
V168	162	3.10								8.89
ABC (Banesh), ROOMS										
ABC	3	.33	.10		.50	.08				
ABC	12	.06			.39			.21		
ABC	14				1.36	.05				
ABC	25			.59						
ABC (Kaftari), PIT										
ABC	38		2.11	.48	1.31	3.48	.37	1.42	1.40 cf.Cap	

(cont.)

Table D.3. Hand-picked Charcoal, Weights (cont.)

Square	Lot	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare Genera	Unident.
GHI (Banesh), MATRIX										
H5	188	.55	.28			7.02	1.00	.57		.32
H5	208					1.92				
GHI (Kaftari), PITS										
H5	85				1.81					
H5	115		3.44							
H5	177					.20				.11
H7	43		3.29							
GHI (Kaftari), ROOMS										
G5	102					2.18				
G5	129					.35		1.78		.56
G7	64				.78					2.27
H5	79							.24		
H5	111		.19			1.80				
H5	127	34.50		.43	4.80	.28				
H7	124			.42	.08	3.26			1.04 Vitex	
H7	132								1.23 Vitis	.26
H7	148					3.07				

(cont.)

Table D.3. Hand-picked Charcoal, Weights (cont.)

Square	Lot	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare Genera	Unident.
GHI (Kaftari), MATRIX										
G5	123								2.75 Vitis	
H5	114		.31	1.06	1.89	2.00				
H5	154		4.51	.95	8.90	6.87			.60 Vitis	.10
H5	166	.31	4.06		2.88	.32				.31
H5	169	.84	3.84	4.90	16.19	4.01			3.84 Vitis	.96
GHI (Qaleh), ROOM										
H5	36					2.95				
FX106 (Kaftari), PIT										
FX106	109		1.55		4.79	7.16			4.59 cf.Cap	
FX106 (Kaftari), MATRIX										
FX106	76			5.37				.70		
GGX98 (Kaftari), PITS										
GGX98	77		7.54	11.94	13.33	7.20	.60	2.45	7.81 Frax	2.25
GGX98	145		20.04	14.01	16.22	11.02		.79		4.09
GGX98	160							.06		

(cont.)

Table D.3. Hand-picked Charcoal, Weights (cont.)

Square	Lot	Juniperus	Amygdalus	Acer	Pistacia	Quercus	Populus	Ulmaceae	Rare Genera	Unident.
GGX98 (Kaftari), ROOMS										
GGX98	60		1.81	1.48	.22	1.48	.31	.82		
GGX98	65		.89	.79	1.41	.17	.25		.27 Acer/Amyg-.07 Cap-.20	
GGX98	67		.30	.73	4.10	1.28		2.78		
GGX98	69		.29	.24		.74				.34
GGX98	122				4.27	.08				.20
GGX98	125				.77	.14				.11
GGX98	179		2.71							
GGX98 (Kaftari), MATRIX										
GGX98	40			.36						
GGX98	64		.94			.23	.24			.94
GGX98	52		.34	.42		.34				.14
BY8 (Banesh), ROOMS										
BY8	132	4.56					1.04	5.78		
BY8	138	.20				4.27				

(cont.)

Table D.3. Hand-picked Charcoal, Weights (cont.)

Square	Lot	Juni-perus	Amyg-dalus	Acer	Pist-acia	Quer-cus	Pop-ulus	Ulma-ceae	Rare Genera	Uni-dent.
BY8 (Banesh), MATRIX										
BY8	86		.41	.03				.20		
BY8	87	4.35	.05	1.13						.05
BY8	94	.78	.05					1.45		
BY8	100					.05				.09
BY8	120		.28		.12			.18		
BY8 (Kaftari), PIT										
BY8	79		.53		.91	.71				

APPENDIX E

UNUSUAL DEPOSITS

Latrine Deposits: ABCN, Pit 30; G5, Pit 146; H5, Pit 48 (Kaftari)

Three latrine deposits were identified primarily on the basis of greenish hue of deposit. Additionally, all three had uncarbonized seeds, with especially dense concentrations in ABCN, Pit 30 and G5, Pit 146 (Table 6.11).

ABCN, Pit 30 was about 1 m in diameter, and had vertical sides. Lots 54, 107, and 108 were sampled. There was an unusually high density and variety of rodent bones, including skulls; the rodents presumably fell to their deaths and their fragile bones remained intact for the archaeologist to excavate millennia later. The non-carbonized remains consisted primarily of food plants (especially grape seeds), and unlike the overall proportions of carbonized seeds from Malyan, there was more wheat than barley.

G5, Pit 146: Lot 159 was sampled. The uncarbonized remains consisted primarily of food plants. Located within a structure, it had few weed seeds proportional to the number of food taxa.

H5, Pit 48: Lot 117 was sampled. There were no cultigens among the non-carbonized remains.

The latrine in ABC (Feature 30), which was not found in association with architecture, had more weed seeds than the GHI latrine, but few in comparison with those of other taxa. Located in a relatively open place, miscellaneous debris would have been more likely to fall in (dung, for example). The very high density of rodent bones also is a further correlate to the outdoor location of the ABC latrine.

Pit with Soluble Pottery, ABCN ,Pit 84 (Banesh)

Feature 84 was a small rectangular clay-floored pit (170 x 95 x 45 cm) (J. Nickerson 1981, p.c.). Soil from lots 148, 149, 153, and 162 was floated. In addition, the sherd washers noticed that some of the pottery from this pit dissolved, releasing carbonized grain. Therefore, soft, soluble potsherds from lots 152 and 153 were floated separately. The pottery contained a very high proportion of carbonized seeds relative to total carbonized material (.8267) in contrast to that of the surrounding matrix (.0023) and most Banesh deposits (Table 6.3). The contents of a jar from lot 153 within Pit 84 had a relatively large proportion of seeds (cereal) compared to charcoal (.4375). Cereal grains and rachis fragments were found in the soil and the pottery matrix, pistachio and oak charcoal was found in the soil of the pit, and various weed seeds were dislodged from the pottery matrix.

It seems possible that Pit 84 was actually an ad hoc kiln, in which pistachio and oak wood and straw/dung were used as fuel to make the aforementioned soft straw-tempered pottery found therein.

Burnt-dung filled Jar: V168, Feature 38 (Banesh)

Feature 38 was a large jar (about 60 cm high, with a top diameter of 58 cm) set into a plastered pit next to Hearth 29 in Room 36 (Nicholas 1980:630). The bottom of the jar (lot 43) was filled with light gray ash to a depth of about 5 cm. The rest of the jar (lot 45) was filled with a soft tan fibrous substance that was probably the residue of burnt dung. The "carbonized material density" is fairly low, but it only includes charcoal and burnt seeds, not ash. Another unusual feature of the jar contents was a large number of burnt goat horn cores (M. Zeder 1974, p.c.).

These lots were classified as pit fill rather than jar contents because the jar was a permanent, built-in fixture in Operation TUV.

GGX98, Pit 52, Strata 5 and 7 (Kaftari)

GGX98, Pit 52 was a large trash pit, the excavated portion of which occupied about one quarter of the 10m x 10m Operation to a maximum depth of nearly 3 m. It contained two major strata (5 and 7). The upper stratum (5) is represented in the flotation samples by lots 115, 126, 127, 129, and 130, and the lower stratum (7) by lots 141, 145, and 163. Charcoal was picked out by hand from stratum 5, lots 77, 83, 112, 126, 127, 129, 131, and 165 and from stratum 7, lots 145, 148, 152, 153, 156, 157, 161, 163, 167, 168, and 178. Both strata were soft, trashy, and filled with ash lenses. At the bottom of the pit, several unbaked mud bricks standing on end in a loose herring-bone pattern were uncovered (John Nickerson, ms. in prep.).

There are clear differences between the flotation samples from the two strata, as well as the hand-picked charcoal (Tables E.1, E.2, E.3). It is not known how representative the sampling was for Pit 52, but the soil samples were scattered throughout the deposit. It was therefore assumed that the differences between strata were potentially meaningful, so analysis proceeded.

Most of the botanical material has so far been treated in a fairly general fashion. Pit 52 is one of the few places at Malyan where it is possible to delimit some of the circumstances of the depositional processes (cf. Wright et al. 1978). This test is significant because it shows that the same arguments used to bridge the gap between archaeological evidence and ancient cultural realities at the general level of the site can also be successfully applied to a single locus within it.

Ethnographic analogy suggests that the upper stratum (5) was formed in the summer/fall, since that is when weather permits mud-brick construction. The lower stratum would therefore be a winter/spring deposit. Carbonized remains are fairly well-preserved, which suggests fairly rapid deposition. Thus, Pit 52 is filled with a single year's refuse deposition.

A complex of propositions related to the seasonality of

Pit 52 include:

1) Relatively more fuel is burned in winter than than in summer, for heating as well as cooking fires.

2) More wood relative to dung is burned in winter.

   a) Wood generally provides more heat than dung (Forest Research Institute 1972: 160, Sagreiya and Venkataramany 1962).

   b) Wood is preferable to dung, but requires more effort to obtain. In the winter months the labor force is free of agricultural responsibilities, so wood would be more available in winter and early spring.

3) In the absence of full-time specialists in fuel procurement and production, wood from forest trees is more available in winter than summer. Locally produced wood (especially the trimmings from building materials) is more available in summer and fall.

4) Animals are stall-fed stored fodder (especially straw and grain) in winter, and are put out to graze in summer.

The test implications are:

1) Winter deposits will have a greater density of carbonized material than summer deposits.

2) With seeds interpreted as residue from burnt dung, there will be relatively more seeds (especially of fodder plants) in summer than winter.

3) Winter deposits will have more distant forest woods, which in the Kaftari period would have been almond, maple, pistachio, and oak. Summer deposits would have more cultivated woods or locally available woods, such as poplar.

4) Relatively more cereal grains will occur in winter deposits. Weed seeds of cultivated fields are not immediately interpretable, since they could occur as grain impurities, or represent weeds eaten fresh in summer or fall when most seeds ripen. Uncultivable, difficult to harvest plants would be more prevalent in summer deposits, representing plants grazed by animals. Sedges from the marshy area east of Malyan fit in this category.

Table E.1. GGX98, Pit 52: Differences between Strata 5 and 7

	Stratum 5 "summer/fall"	Stratum 7 "winter/spring"
# 10 l buckets floated	6	3
Density of carbonized material, g/10 l flotation samples	5.63	12.90
Proportion of seeds compared with total carbonized material	.0870	.0341
Seeds (wt.,g) per 10 l soil	.49	.43

These test implications are for the most part borne out by the archaeological evidence:

1) Density of carbonized material (Table E.1): Although

Table E.2. GGX98, Pit 52: Charcoal

Type	Stratum 5		Stratum 7	
	% counts	% weights	% counts	% weights
Flotation Samples				
Major Forest Trees:				
Almond	32.0	40.3	26.6	30.1
Maple	16.0	10.2	21.7	17.2
Pistachio	10.0	22.6	13.3	22.2
Oak	20.0	16.2	23.3	16.3
Other Types:				
Poplar	5.0	1.4	1.7	1.3
Elm Family	1.0	1.0	1.7	1.3
Unident.	16.0	8.2	11.7	11.7
Total on which %s are based	100 pcs	4.99 g	60 pcs	2.39 g
Hand-picked Samples				
Major Forest Trees:				
Almond	13.4	14.2	18.2	30.3
Maple	18.3	22.5	23.5	21.2
Pistachio	30.1	25.1	26.7	24.5
Oak	18.3	13.6	26.2	16.7
Other Types:				
Poplar	2.4	1.1	-	-
Elm Family	6.7	4.6	1.1	1.2
Ash	7.9	14.7	-	-
Unident.	11.0	4.2	4.3	6.2
Total on which %s are based	164 pcs	53.12 g	187 pcs	66.17 g

not randomly sampled, the excavator submitted soil from numerous spots within each stratum, and no areas of dense charcoal concentration were omitted. As expected, the 'winter' samples have a greater charcoal concentration.

2) There is about the same amount of seeds per 10 1

Table E.3. GGX98, Pit 52: Seeds

	Stratum 5	Stratum 7
Total wt. (g)	2.94	1.34
Cereal wt.,% of total	36.1	65.9
Nut wt., % of total	22.4	28.0
Weed Seeds, count	310	68
Cereal, count equiv.[1]	118	97
'Fodder' seed, count	428	165
Sedge count %,comp.to		
Weed Seed total	84.2	80.9
'Fodder' Seed total	61.0	33.3

[1] Approximation of cereal count based on estimate 9 g = 1000 carbonized cereal grains (Helbaek 1960).

bucket, but there are more seeds relative to charcoal in the 'summer' samples, as expected (Table E.1).

3) The evidence is for seasonality is equivocal. However, oak is consistently higher in the 'winter' samples, and poplar and ash are consistently higher in the 'summer' samples (Table E.2).

4) Cereals make up a greater proportion by weight of the seeds in the 'winter' samples. Comparing only weed seeds, sedges are slightly more important in the 'summer' samples. If the counts include other fodder (cereals), the importance of sedge as a fodder is much greater in the 'summer' samples than in the winter ones (Table E.3).

APPENDIX F

DISTRIBUTION OF WEEDS IN FIELDS

During the spring of 1977, several hours a day were spent in the field botanizing. Some fields and waste areas were visited repeatedly (generally to get flowers, fruits, and seeds from known patches as they ripened), and a series of plots were paced out and censused casually.

In general, areas about 10 m x 10 m were paced out, and 10 transects were walked, about a meter apart. Any plant seen on a particular pass was noted. Somewhat arbitrarily, the number of occurrences per 10 ten-meter long passes were scored:

1) 1-2 rare
2) 3-7 moderate
3) 8-10 common.

In some fields, only 6 passes were carried out. These were scored:

1) 1 rare
2) 2-4 moderate
3) 5-6 common.

A purely subjective scale of 1 - 3 had been used during the fall, as archaeological activity had limited the amount of time it was possible to spend in the field. These estimates also were designated rare, moderate, and common. Repeated visits to the same and similar fields ensured coverage for plants that became visible or identifiable at different times or at different stages of growth. Finally, some plants were seen which never happened to fall in a censused area. These are reported as present (+) and fairly common (++).

Table F.1. Distribution of Weeds in Fields

	Unirrigated		Irrigated		Moist		
						"Marsh"	
	Field	Waste/ Fallow	Wheat/ Barley	Sugar Beet/ Alfalfa	Stream/ Stream-side	Culti-vated	Uncul-tivated
Amaranthaceae							
Amaranthus retroflexus	m		m-c	m			
Amaryllidaceae							
Ixiolirion tataricum			r				
Berberidaceae							
Leontice leontopetalum	r	m	r-m				
Boraginaceae							
Anchusa arvensis			r-m	+			
A. hybrida			+				
Asperugo procumbens			+				
Buglossoides arvensis	+		r				
Heliotropium cf. rotundifolium				m-c			
Heterocaryum szovitsianum	m		r				
Lappula spinocarpos	r						
Nonnea caspica			r				
Caryophyllaceae							
Cerastium dichotomum			+				
Silene conoidea	r-m		m-c	r		+	
S. spergulifolia	c						
Vaccaria pyramidata	c		m-c	m			
Chenopodiaceae							
Atriplex tatarica		+				m-c	
A. turcomanica		+					

Table F.1. Distribution of Weeds in Fields (cont.)

	Unirrigated		Irrigated		Moist		
						"Marsh"	
	Field	Waste/ Fallow	Wheat/ Barley	Sugar Beet/ Alfalfa	Stream/ Stream-side	Culti-vated	Uncul-tivated
<u>Chenopodium album</u>				m-c			
<u>C. vulvaria</u>				r		+	
<u>Noaea mucronata</u>					++		
<u>Salsola</u> sp.							+
Compositae							
<u>Achillea eriophora</u>	r						
<u>A. santolina</u>	r-m	+	r			+	
<u>Anthemis</u> spp.		m-c	m-c			m	+
<u>Carduus pycnocephalus</u>				r			
<u>Carthamus oxycanthus</u>		+			+		
<u>Centaurea calcitrapa</u>					+		
<u>C. depressa</u>			c	r			
<u>C. phyllocephala</u>				+			
<u>C. solstitialis</u>				+			
<u>Cichorium intybus</u>		+			+		
<u>Cirsium alatum</u>					m		
<u>Echinops</u> sp.		+					
<u>Garhadiolus hedypnois</u>	r-m			r	+		
<u>Koelpinia linearis</u>	m	c			+		
<u>Lactuca serriola</u>					+		
<u>Picnomon acarna</u>		c			c		
<u>Scorzonera cana</u>							+
<u>Sonchus asper</u>				c			
<u>Taraxacum</u> sp.				+	+		

Table F.1. Distribution of Weeds in Fields (cont.)

	Unirrigated		Irrigated		Moist		
						"Marsh"	
	Field	Waste/ Fallow	Wheat/ Barley	Sugar Beet/ Alfalfa	Stream/ Stream-side	Culti-vated	Uncul-tivated
Convolvulaceae							
Convolvulus arvensis			m-c	r-m			
C. leiocalycinus		+					
Cruciferae							
Aethionema carneum	r						
Alyssum linifolium	m					r	+
Capsella bursa-pastoris			+	m			
Cardaria draba	r-m		m-c		c	c	
Conringia perfoliata			m	m	c	+	
Descurainia sophia		+	m	m	c	r	
Eruca sativa			r	r	m		
Erysimum repandum	r	c	m-c	m			
Euclidium syriacum	r		r			+	
Goldbachia laevigata							
var. *ascendens*	m		+				
Hirschfeldia incana			r-m	m			
Hymenolobus procumbens							+
Lepidium latifolium					c		
L. sativum					+		
Malcolmia africana			r				
Myagrum perfoliatum			m-c	m	c	m	
Neslia apiculata	r-m		m				
Rapistrum rugosum				+			
Sisymbrium irio			r	r	c		

Table F.1. Distribution of Weeds in Fields (cont.)

	Unirrigated		Irrigated		Moist		
						"Marsh"	
	Field	Waste/ Fallow	Wheat/ Barley	Sugar Beet/ Alfalfa	Stream/ Stream-side	Culti-vated	Uncul-tivated
S. septulatum		+	r-m	r			
Sterigmostemum sulphureum	r						
Cyperaceae							
Carex divisa							+(wet)
Cyperus longus					+		
Scirpus holoschoenus						+	
Dipsacaceae							
Cephalaria syriaca			+	m			
Elaeagnaceae							
Elaeagnus							
aff. *angustifolius*					+		
Euphorbiaceae							
Chrozophora tinctoria				m			
Euphorbia falcata				+			
E. sp. cf. *gedrosiaca*	r			r			
E. helioscopia				m			
E. heteradena	m		r			r	
E. microsphaera			r	m			
E. petiolata		+					
Ricinus communis				+(cult.)			
Geraniaceae							
Erodium cicutarium			r	r-m			+
Geranium dissectum				+	+		
G. tuberosum	r		r-m				

Table F.1. Distribution of Weeds in Fields (cont.)

	Unirrigated		Irrigated		Moist		
						"Marsh"	
	Field	Waste/ Fallow	Wheat/ Barley	Sugar Beet/ Alfalfa	Stream/ Stream-side	Culti-vated	Uncul-tivated
Gramineae							
Aegilops crassa	r						
Agropyron sp.					+		
A. intermedium					+		
Alopecurus arundinaceus							+
A. myosuroides			r	c			+
?*Avena byzantina*				r			
Boissiera squarrosa	r	+					
Bothriochloa ischaemum					+		
Brachiaria eruciformis				+			
Bromus danthoniae		+					
B. hordeaceus		+	m	r			
B. sterilis		+					
B. tectorum							+
Cynodon dactylon				+	c		
Echinochloa crus-galli			+				
Eragrostis minor				+	m		
Eremopoa persica				r		c	c
Eremopyrum bonaepartis		+		r		+	
Hordeum bulbosum	r						
H. distichon	crop		m-c			crop	
H. geniculatum					+	c	
H. glaucum		c	+	r-m			+
H. vulgare			r				

Table F.1. Distribution of Weeds in Fields (cont.)

	Unirrigated		Irrigated		Moist		
						"Marsh"	
	Field	Waste/ Fallow	Wheat/ Barley	Sugar Beet/ Alfalfa	Stream/ Stream-side	Culti-vated	Uncul-tivated
Lolium perenne				r			
Panicum miliaceum					+		
Phalaris paradoxa					+		
Poa bulbosa							
var. *vivipara*					m		
P. trivialis				r			
Polypogon fugax				r	+		
Puccinella bulbosa							+
Setaria verticillata				+	+		
Sorghum halepense					+		
Triticum sp.	crop		crop				
Iridaceae							
Iris spuria							+
Juncaceae							
Juncus inflexus					+		c
J. rigidus							c
Labiatae							
Lamium amplexicaule			m	r	m		
Marrubium alternidens		c			+		
M. vulgare	r	c			+		
Mentha longifolia					c		
Nepeta sp.			r				
Ocimum basilicum					crop		
Salvia macrosiphon	r		r				

Table F.1. Distribution of Weeds in Fields (cont.)

	Unirrigated		Irrigated		Moist		
						"Marsh"	
	Field	Waste/ Fallow	Wheat/ Barley	Sugar Beet/ Alfalfa	Stream/ Stream-side	Culti-vated	Uncul-tivated
Satureja hortensis					crop		
Sideritis romana				+			
Teucrium taylorii	c	m					
Leguminosae							
Alhagi camelorum	r	c					
Astragalus spp.	m	c	m				
Astragalus campylorrhynchus			r	+			
A. hamosus	r		r-m	r			
A. kotschyanus		+					
Glycyrrhiza glabra	m	c	m-c	r-m	c		
Lathyrus inconspicuus	r		m-c	r			
L. sativa			m	r			
Medicago sativa				crop			
Melilotus indica			+	r		+	
Ononis spinosa					c		
Pisum sativum ssp. *elatius* var. *pumilio*			r				
Sophora alopecuroides var. *tomentosa*		c	m-c	r		+	
Trifolium sp.			+	m			+
T. fragiferum					m		
Trigonella foenum-graecum		+	r-m	+		+	
T. monantha			r				

Table F.1. Distribution of Weeds in Fields (cont.)

	Unirrigated		Irrigated		Moist		
						"Marsh"	
	Field	Waste/ Fallow	Wheat/ Barley	Sugar Beet/ Alfalfa	Stream/ Stream-side	Culti-vated	Uncul-tivated
Vicia spp.			m-c				
V. ervilia	r-m		m-c	r			
V. narbonensis			m-c	m			
V. peregrina	r		m	r			
V. sativa			r	r			
Liliaceae							
Allium sp.			+	+			
Muscari sp.	r		r-m	+			
Ornithogalum narbonense	r		r				
Tulipa bifolia	r						
Malvaceae							
Alcea cf. *kurdica*	r			r			
Hibiscus trionum				m			
Malva neglecta		++		m-c	+	+	
Onagraceae							
Epilobium hirsutum					+		
Orobanchaceae							
Orobanche muteli				r			
Papaveraceae							
Fumaria vaillantii			m		c		
Hypecoum pendulum	m		m				
Papaver sp.			m-c	+	+	c	
P. macrostomum					+		
Roemeria hybrida	r-m	+					
R. refracta	c	+	m	r			

Table F.1. Distribution of Weeds in Fields (cont.)

	Unirrigated		Irrigated		Moist		
						"Marsh"	
	Field	Waste/ Fallow	Wheat/ Barley	Sugar Beet/ Alfalfa	Stream/ Stream-side	Culti-vated	Uncul-tivated
Pedaliaceae							
<u>Sesamum</u> <u>indicum</u>				crop			
Plantaginaceae							
<u>Plantago</u> <u>lanceolata</u>				m-c			
Plumbaginaceae							
<u>Psylliostachys</u> <u>leptostachya</u>							+
Polygonaceae							
<u>Polygonum</u> <u>aviculare</u>					+		
<u>P.</u> <u>equisetiforme</u>					c		
<u>P.</u> <u>lapathifolium</u>					+		
<u>Rumex</u> <u>conglomeratus</u>					+		
<u>R.</u> <u>crispus</u>				r	+		
<u>R.</u> <u>dentatus</u>				+			
Portulacaceae							
<u>Portulaca</u> <u>oleracea</u>			+	c			
Primulaceae							
<u>Anagallis</u> <u>arvensis</u> var. <u>coerulea</u>			+				
Ranunculaceae							
<u>Adonis</u> sp.	r		m				
<u>A.</u> <u>aestivalis</u>			r-m				
<u>Ceratocephalus</u> <u>falcatus</u>	r		r-m			+	
<u>Delphinium</u> <u>persicum</u>		+					

Table F.1. Distribution of Weeds in Fields (cont.)

	Unirrigated		Irrigated		Moist		
						"Marsh"	
	Field	Waste/ Fallow	Wheat/ Barley	Sugar Beet/ Alfalfa	Stream/ Stream-side	Culti-vated	Uncul-tivated
<u>Ranunculus arvensis</u>	r		m	c			
Resedaceae							
<u>Reseda lutea</u>	m-c	m	m-c	m	m		
Rosaceae							
<u>Potentilla reptans</u>					+		
Rubiaceae							
<u>Galium ceratopodum</u>	m		m-c	m-c	c	m	
<u>G. humifusum</u>					+		
<u>G. tricornutum</u>				+			
Scrophulariaceae							
<u>Misopates orontium</u>			r-m				
<u>Scrophularia xanthoglossa</u>		+					
<u>Veronica anagallis-aquatica</u>				r	m		
<u>V. campylopoda</u>			+				
<u>V. persica</u>			m	m			
Solanaceae							
<u>Datura stramonium</u>				c			
<u>Hyoscyamus pusillus</u>		r	+				
<u>H. reticulatus</u>		m	r	r		+	
<u>Physalis angulata</u>				m-c			
<u>Solanum nigrum</u>				m-c			
<u>Xanthium strumarium</u>					+		
Sparganiaceae							
<u>Sparganium erectum</u>					+		

Table F.1. Distribution of Weeds in Fields (cont.)

	Unirrigated		Irrigated		Moist		
						"Marsh"	
	Field	Waste/ Fallow	Wheat/ Barley	Sugar Beet/ Alfalfa	Stream/ Stream-side	Culti-vated	Uncul-tivated
Thymeleaceae							
Dendrostellera lessertii		c					
Umbelliferae							
cf. *Apium nodiflorum*					m		
Bifora testiculata	m						
Conium maculatum		m					
Foeniculum vulgare				+			
Scandix iberica	r		+				
S. pecten-veneris			r-m	r			
Torilis leptophylla			r	r	+		
Trachyspermum ammi				+			
Turgenia latifolia	m		r-m	r			
Valerianaceae							
Valerianella cf. *oxyrrhyncha*	r-m		c				
Verbenaceae							
Verbena officinalis					c		
Zygophyllaceae							
Peganum harmala		c					
Tribulus terrestris				c	+		

APPENDIX G

SOME TREES AND SHRUBS OF THE KUR BASIN

*=Dominant, (x)=seen, but not collected, (M)= reported by Myers (1973)

Oak Forest, collections near Tang-i Tur and Gallery Forest

*Quercus aegilops var. persica
Pistacia eurycarpa
Acer monspessulanum
Ficus carica
Amygdalus kotschyi
Amygdalus scoparia (lower and south facing slopes
Elaeagnus angustifolia
Rhamnus persica
Daphne acuminata
Atraphaxis spinosa
Juniperus cf. excelsa

Gallery Forest, collections at south west end of valley (30°6'N 52°12'E)

*Salix excelsa
*Platanus orientalis
Celtis caucasica
Rubus sp. (x)
Rosa sp. (x)
Vitex pseudo-negundo (at Tang-i Tur)

Salt Marsh/Salt Flats, collections at base of Kuh-i Rahmat and north shore of Lake Bakhtegan

*Halocnemum strobilaceum
*Tamarix spp.
Prosopis farcta
Alhagi camelorum (x)
Halostachys caspica
Anabasis sp. (M)
Salicornia sp. (M)

Pistachio-Almond Forest, collections at north of Lake Bakhtegan, base of Kuh-i Kum

*<u>Pistacia</u> <u>khinjuk</u>
<u>Pistacia</u> <u>vera</u>
*<u>Amygdalus</u> <u>kotschyi</u>
<u>Amygdalus</u> <u>scoparia</u>
*<u>Pistacia</u> <u>eurycarpa</u> (=<u>P</u>. <u>atlantica</u> subsp. <u>kurdica</u> (M)
<u>Acer</u> <u>monspessulanum</u>
<u>Daphne</u> <u>acuminata</u>
<u>Ephedra</u> spp.
<u>Atraphaxis</u> <u>spinosa</u>
<u>Artemisia</u> <u>herba-alba</u> (M)
<u>Astragalus</u> sp. (M)
<u>Acantholimon</u> sp. (M)

APPENDIX H

MODERN GRAIN SAMPLES

Table H.1. Weed Seeds from 250 g Grain Samples

	Barley				Wheat							
	Hossein-abad		Malyan		Hossein-abad		Malyan					
							A		B		C	
Av. wt. Barley/ Wheat, g/100	4.30		4.18		3.75		4.35		3.86		4.00	
#Weeds/250 g	797		348		535		49		374		82	
Amt. Wheat/Barley	125		209		182		1		70		23	
Total Seed Contam.	922		557		717		50		444		105	
	#	%	#	%	#	%	#	%	#	%	#	%
Borag:<u>Anchusa</u>									1	+		
cf. <u>Echium</u>					1	+			+			
cf. <u>Lithospermum</u>							1	2				
unk.	+				+							
Caryoph:<u>Silene</u>	57	7	90	16	2	+			75	17	3	3
<u>Vaccaria</u>	554	67	54	10	417	58	4	8	160	36	48	46
Comp:<u>Centaurea</u>			1	+	1	+						
unk.	+				57	8						
Conv:<u>Convolvulus</u>			2	+			30	60	11	2	14	13
Crucif:												
cf.<u>Hirschfeldia</u>	1	+	13	2	+				5	1	+	

Table H.1. Weed Seeds from 250 g Grain Samples (cont.)

	Barley				Wheat							
	Hossein-abad		Malyan		Hossein-abad		Malyan					
							A		B		C	
	#	%	#	%	#	%	#	%	#	%	#	%
Myagrum			15	3					+			
Neslia	9	1	2	+	+				+			
unk. 1	+				+				3	1	1	1
unk. 2	3	+			+				+			
unk. 3									3	1	1	1
unk. 4			5	1	1	+			1	+	+	
Dipsac:*Cephalaria*	1	+	3	1	2	+	11	22	25	6	2	2
Euphorb:unk. 1	4	+			2	+						
unk. 2	+		1	+					1	+		
Gram:*Aegilops*	2	+			+							
Bromus sp.	5	1										
B. danthoniae	1	+										
Hordeum distichon	-	-	-	-	182	25	1	2	70	16	23	22
Lolium											6	6
Oryza	+											
Setaria			1	+								
Triticum	125	15	209	38	-	-	-	-	-	-	-	-
Lab:*Ajuga*	+											
Leg:*Astragalus* 1 (no.574)	2	+							3	1	1	1

Table H.1. Weed Seeds from 250 g Grain Samples (cont.)

	Barley				Wheat							
	Hossein-abad		Malyan		Hossein-abad		Malyan					
							A		B		C	
	#	%	#	%	#	%	#	%	#	%	#	%
<u>Astragalus</u> 2									3	1		
cf. <u>Lathyrus</u>	2	+							31	7	2	2
<u>Lens</u>	6	1			8	1						
Legum:												
<u>Sophora</u>			2	+			3	6			+	
cf. <u>Trifolium</u>									5	1		
<u>Vicia ervilia</u>	14	2	+		11	2	+		1	+	3	3
<u>Vicia</u>(4 types)	1	+	11	2	1	+	+		17	4		
unk.					1	+	+		1	+		
Malvac:unk.	+											
Papav:<u>Papaver</u>(cult.)	45	5	1	+								
Plant:<u>Plantago</u>	2	+	1	+								
Ranunc:<u>Ceratocephalus</u>					+							
<u>Adonis</u>	+											
Resed:<u>Reseda lutea</u>	61	7	129	23	20	3			28	6	+	
Rubiac:<u>Galium</u>	4	+	11	2	5	1					1	1
Solan:<u>Hyoscyamus</u>	2	+	+						+			
unk.	1	+									+	

Table H.1. Weed Seeds from 250 g Grain Samples (cont.)

	Barley				Wheat							
	Hossein-abad		Malyan		Hossein-abad		Malyan					
							A		B		C	
	#	%	#	%	#	%	#	%	#	%	#	%
Umbel:unk. 1	1	+										
unk. 2	7	1										
Indet:1	10	1			6	1						
2					1	+						
3	1	+			+							
4			6	1								
5	2	+										
6	5	1										
Triticum rachis					<1g				<1g			
Hordeum rachis	<1g		<1g		<1g							
didak[1]			6	-	38	-	2	-	57	-	45	-

+ = seeds observed in additional sample examined
Hosseinabad barley, 310 g; Hosseinabad wheat, 205 g;
Hosseinabad wheat, 205 g; Malyan A wheat, 500 g;
Malyan B wheat, 445 g; Malyan C wheat, 390 g.

[1] didak=rotted grains which can spoil flour, and therefore must be removed before milling.

Table H.2. Modern Barley, Two-Sample T-Tests

	Malyan	Hossein-abad	Test Statistic	DF	Signif	Achieved Signif. of Equality of:[1] Mean	SD
			Length	(total=400)			
Mean	7.591	7.548	T= .764	398	.445		
Var	.2756	.3426	F=1.243	199, 199	.063		
N	200	200	Prob(1st Mean	>2nd|Data)=	.778	.446	.126
			Breadth	(total=400)			
Mean	3.187	3.243	T=-2.12	398	.035		
Var	.0709	.0662	F=1.072	199, 199	.312		
N	200	200	Prob(1st Mean	<2nd|Data)=	.982	.035	.624
			Thickness	(total=400)			
Mean	2.361	2.386	T=-1.02	398	.308		
Var	.0652	.0600	F=1.092	199, 199	.266		
N	200	200	Prob(1st Mean	<2nd|Data)=	.845	.309	.532
			Length/Breadth	(total=400)			
Mean	2.394	2.337	T= 2.72	398	.007		
Var	.0496	.0405	F=1.226	199, 199	.076		
N	200	200	Prob(1st Mean	>2nd|Data)=	.996	.007	.152

Table H.2. Modern Barley, Two-Sample T-Tests (cont.)

	Malyan	Hossein-abad	Test Statistic	DF	Signif	Achieved Signif. of Equality of:[1] Mean	Achieved Signif. of Equality of:[1] SD
Thickness/Breadth (total=400)							
Mean	.7398	.7353	T= 1.17	398	.241		
Var	.0015	.0015	F=1.025	199, 199	.430		
N	200	200	Prob(1st Mean	>2nd|Data)=	.879	.243	.861

[1] A number less than .05 in these columns means that there is a statistically significant difference between samples at alpha = .05; in general, the average dimensions of these seeds and their variances suggest there is no difference between the samples.

Table H.3. Modern Wheat, Two-Sample T-Tests

	Malyan	Hossein-abad	Test Statistic	DF	Signif	Achieved Signif. of Equality of:[1] Mean	SD
			Length	(total=400)			
Mean	6.129	6.450	T=-6.35	398	.000		
Var	.3384	.1725	F=1.962	199, 199	.000		
N	200	200	Prob(1st Mean	<2nd|Data)=	1.000	.000	.000
			Breadth	(total=400)			
Mean	2.926	3.004	T=-2.77	398	.006		
Var	.1216	.0369	F=3.293	199, 199	.000		
N	200	200	Prob(1st Mean	<2nd|Data)=	.997	.006	.000
			Thickness	(total=400)			
Mean	2.922	2.714	T= 7.15	398	.000		
Var	.1319	.0374	F=3.524	199, 199	.000		
N	200	200	Prob(1st Mean	>2nd|Data)=	1.000	.000	.000
			Length/Breadth	(total=400)			
Mean	2.113	2.151	T=-1.96	398	.050		
Var	.0550	.0188	F=2.932	199, 199	.000		
N	200	200	Prob(1st Mean	<2nd|Data)=	.975	.051	.000

Table H.3. Modern Wheat, Two-Sample T-Tests (cont.)

	Malyan	Hossein-abad	Test Statistic	DF	Signif	Achieved Signif. of Equality of:[1]	
						Mean	SD
Thickness/Breadth (total=400)							
Mean	1.001	.9045	T=14.66	398	.000		
Var	.0058	.0029	F=1.982	199, 199	.000		
N	200	200	Prob(1st Mean	>2nd|Data)	=1.000	.000	.000

[1] A number less than .05 in these columns means that there is a statistically significant difference between samples at alpha = .05; in general, the average dimensions of these seeds and their variances suggest there are differences between the samples.

APPENDIX I

MODERN REFUSE SAMPLES

Table I.1. Modern Refuse Samples

	Camp-fire	Hearth (carb.)	Ash (carb.)	Sweepings	
				uncarb.	carb.
Total sample wt.(g)	94.13	98.95	ca. 369	ca. 628	14.26
Wt. examined (g.)	17.71	86.32	ca. 369	ca. 628	14.26
Est. wt. w/out pebbles,soil	8.34	17	39	565	14.26
Est. wt. (g)					
Dung,burnt	.48	13.30	22.67	–	14.03
Dung,unburnt	0	0	6.65	ca. 417[13]	–
Charcoal	8.34	3.60	2.62	–	.26
Seeds,burnt	0	.10	.45	0	0
Seeds,unburnt	0	<.01	.35	3.32	–
Straw and leaves, uncarb.	0	0	6	145	–
Charcoal,#(g)					
Quercus	20(10.30)	0	2(.67)	0	0
Populus/*Salix*	0	12(.40)	4(.10)	0	0
Amygdalus	0	0	3(.07)	0	0
Diffuse porous	0	2(.11)	0	0	0
Unk.,cf.*Ficus*	0	0	1(.05)	0	0

Table I.1. Modern Refuse Samples (cont.)

	Camp-fire	Hearth (carb.)	Ash (carb.)	Sweepings	
				uncarb.	carb.
Seeds (cultigens)					
Cucurb:<u>Citrullus</u>	0	0	0	2	0
<u>Cucumis</u>	0	0	0	3	0
Gram:<u>Hordeum</u> <u>distichon</u>	0	0	10	5	0
<u>Triticum</u>	0	0	6	9	0
Legum:<u>Vicia</u> <u>ervilia</u>	0	1	0	0	0
Vitac:<u>Vitis</u> <u>vinifera</u>	0	0	0	3	0
Seeds (wild and weedy)					
Amaranth:<u>Amaranthus</u>	0	0	0	15	0
Borag:<u>Heliotropium</u>	0	0	25[1]	0	0
Caryoph:<u>Silene</u>	0	1	0	25	0
<u>Vaccaria</u>	0	0	0	ca. 100	0
unk.	0	0	5	2	0
Cheno:<u>Chenopodium</u>	0	0	27[2]	75	0
Comp:<u>Centaurea</u>	0	0	0	7	0
unk.	0	1	2+	1	0
Conv:<u>Convolvulus</u>	0	0	0	31	0
Crucif:cf. <u>Lepidium</u>	0	0	0	8	0
cf.<u>Rapistrum</u>(silique)	0	0	2	0	0
unk.	0	7[3]	5	17	0
Dipsac:<u>Cephalaria</u>	0	0	0	3	0
Gram:<u>Bromus</u>	0	0	0	1[5]	0
<u>Cynodon</u> <u>dactylon</u>	0	0	0	14[4]	0

Table I.1. Modern Refuse Samples (cont.)

	Camp-fire	Hearth (carb.)	Ash (carb.)	Sweepings	
				uncarb.	carb.
cf.*Digitaria*	0	0	0	1[5]	0
Hordeum glaucum	0	0	2[6]	11	0
Lolium	0	1	0	1.5	0
?*Polypogon*	0	0	0	2[7]	0
Setaria	0	0	1	112	0
weedy gram.	0	5	19	24	0
Lab:cf.*Ajuga*	0	0	0	1	0
unk.	0	0	1	1	0
Legum:*Astragalus*	0	1	482[8]	78[9]	0
Glycyrrhiza glabra	0	0	3[10]	0	0
cf.*Lathyrus*	0	0	3	0	0
Medicago	0	0	11	2	0
Sophora	0	0	3	7	0
Trifolium	0	0	14	0	0
Vicia sp.	0	0	3	0	0
unk.	0	3[2]	3[2]	0	0
Malvaceae:unk	0	1	12	11	0
Papav:*Fumaria*	0	0	0	.5	0
Papaver	0	1[2]	0	0	0
Plant:*Plantago*	0	0	3	4	0
Polygon:*Polygonum*	0	0	10[3]	8	0
Rumex	0	25[3]	3	41	0

Table I.1. Modern Refuse Samples (cont.)

	Camp-fire	Hearth (carb.)	Ash (carb.)	Sweepings	
				uncarb.	carb.
Ranunc:cf.*Adonis*	0	0	1	2	0
Resed:*Reseda*	0	0	9	1[2]	0
Rubiac:*Galium*	0	0	6	2	0
Solan:*Physalis*	0	0	1	105	0
unk.	0	0	2	4	0
Umbel:unk	0	0	0	2	0
Unknown	0	5	90[11]	0	0
Unidentifiable	0	18[2]	0	0	0g
Triticum internodes	0	9[12]	+	.44g	0g
Hordeum internodes	0	10[12]	+	.02g	0g
Insects	0	0	2	0	0

[1] Plus 125 uncarbonized
[2] Includes 1 embedded in dung
[3] Plus 1 uncarbonized
[4] Plus 3 inflorescences
[5] Plus 1 inflorescence
[6] Plus 2 uncarbonized
[7] Inflorescence
[8] Includes 16 from goat pellets
[9] Includes 4 types
[10] In one pod
[11] Includes 2 from goat pellets
[12] Number of internodes
[13] Includes 50 g identifiable goat pellets

APPENDIX J

WEEDS OF POTENTIAL DIAGNOSTIC VALUE

Table J.1. Weeds of Potential Diagnostic Value

Moist Areas	Dry areas
CHENO:*Noaea mucronata*	COMP:*Koelpinia linearis*
COMP:*Cirsium alatum*	LAB:*Marrubium* sp.
CRUCIF:*Conringia perfoliata*	*Teucrium taylorii*
Descurainia sophia	LEGUM:*Alhagi camelorum*
Eruca sativa	THYMEL:*Dendrostellera lessertii*
Myagrum perfoliatum	UMBEL:*Bifora testiculata*
Sisymbrium irio	*Conium maculatum*
CYPER:*Carex divisa*	ZYGO:*Peganum harmala*
Cyperus sp.	
GRAM:*Cynodon dactylon*	
Eragrostis minor	
LAB:*Lamium amplexicaule*	
Mentha longifolia	
LEG:*Ononis spinosa*	
Trifolium sp.	
MALV:*Hibiscus trionum*	
POLYGN:*Polygonum* sp.	
Rumex sp.	
SCOPH:*Veronica* sp.	
SOLAN:*Datura stramonium*	
VERB:*Verbena officinalis*	

Uncultivated	Cultivated
COMP:*Picnomon acarna*	CARY:*Silene conoidea*
ZYGO:*Peganum harmala*	*Vaccaria pyramidata*
	CHENO:*Chenopodium* sp.
	CRUCIF:*Neslia apiculata*
	LEGUM:*Lathyrus* sp.
	Trigonella sp.
	Vicia sp.
	PAPAV:*Hypecoum pendulum*
	RANUNC:*Adonis* sp.
	Ceratocephalus falcatus
	VALER:*Valerianella* sp.

(cont.)

Table J.1. Weeds of Potential Diagnostic Value (cont.)

Unirrigated	Irrigated
BORAG:*Heterocaryum szovitsianum*	BORAG:*Anchusa arvensis*
CARY:*Silene spergulifolia*	COMP:*Centaurea* sp.
CRUCIF:*Alyssum linifolium*	CONV:*Convolvulus arvensis*
EUPH:*Euphorbia heteradena*	CRUC:*Capsella bursa-pastoris*
GRAM:*Aegilops* sp.	*Hirschfeldia incana*
	DIPSAC:*Cephalaria syriaca*
	EUPH:*Euphorbia helioscopia*
	E. microsphaera
	GERAN:*Erodium cicutarium*
	GRAM:*Alopecurus myosuroides*
	Bromus hordeaceus
	LEGUM:*Trigonella* sp.
	PAPAV:*Papaver* sp.

Grain Fields	Wetter Fields
LEGUM:*Astagalus* sp.	BORAG:*Heliotropium* cf. *rotundifolium*
Sophora alopecuroides	CHENO:*Chenopodium* sp.
PAPAV:*Fumaria vaillantii*	COMP:*Sonchus asper*
	CRUCIF:*Lepidium sativum*
	EUPH:*Chrozophora tinctoria*
	PLANT:*Plantago lanceolata*
	POLYGON:*Polygonum* spp.
	SOLAN:*Physalis angulata*
	Solanum nigrum
	ZYGO:*Tribulus terrestris*

Poorly Drained Areas
GRAM:*Eremopoa persica*
Hordeum geniculatum
JUNC:*Juncus* sp.

APPENDIX K

EXTRACTION OF BOTANICAL REMAINS

I. The Soil Sample

A. Soil samples of about 10 liters (1 bucket) were taken from as wide a variety of loci as possible.

B. Each bucket of earth was gently sifted through 1/4-inch mesh, either in the field or at the field laboratory just prior to flotation.

1. Charcoal caught in the mesh was bagged separately, as were artifacts and bones.

2. Volume recorded was volume of sifted soil.

II. Flotation (Water Separation)

A. The flotation tank was a simple oil drum filled with water.

B. A little at a time (about 250 - 500 ml), soil was poured into a 9-inch soup strainer.

1. The strainer was carefully agitated in a circular and up-and-down motion, to let the soil strain out.

2. Floating material and charcoal caught on the side of the soup strainer (light fraction) was removed with a tea strainer.

3. Skimming continued until no black specks could be seen in the soup strainer.

C. The heavy fraction (i.e. that portion of sample left in the soup strainer) was examined by eye, and artifacts and bones were removed.

1. The heavy fraction of samples in which large amounts of botanical material sank were saved in their entirety and examined with a microscope in the laboratory.

D. The light fraction was put on small muslin squares and hung up to dry in the shade.

1. When dry, the light fraction was transferred to plastic bags.

E. Between samples, the flotation tank water was skimmed clean as completely as possible.

III. Laboratory Procedures

A. The field laboratory had no microscope and little electricity, so only preliminary sorting of rootlets, pebbles, and small clay lumps from the light fraction was attempted.

B. Identifications of seeds and charcoal were made possible with the help of modern identified comparative material from Iran, and published seed and charcoal manuals.

C. Seed and preliminary charcoal identifications were made with the help of a stereozoom binocular microscope (7 - 30x magnification); when necessary, charcoal was examined with a metallurgical microscope, using magnifications of

50 - 200x.

D. Samples were processed as received from site supervisors. For the final analysis presented here however, data from deposits from which several samples were submitted were combined, although botanical remains themselves are stored separately.

APPENDIX L

CHARCOAL IDENTIFICATION

Charcoal identification was based on visual comparison of archaeological charcoal with known wood types collected in Iran by the author. Descriptions of the main features of available modern Iranian woods follows, including some species not found archaeologically. A scanning electron microscope was used to provide pictures of the charcoal of known, modern comparative material.

Gymnosperms

Cupressaceae:

Juniperus (Fig. L.1)
(based on archaeological specimens of charcoal)
Rings: No resin ducts
Gradual transition between early and late wood
Rays: Uniseriate
Height: 2 - 10 cells, av. 4 - 5
Cross-field pitting: cupressoid

Angiosperms

Aceraceae:

Acer monspessulanum (Fig. L.2)
Rings: Ring porous
Vessels: Perforation plates: simple
Spiral Thickenings present
Rays: Thin: uniseriate, less than 7 cells high
Thick: 2- to 4-seriate, about 7 - 20 cells high

Anacardiaceae:

<u>Pistacia eurycarpa</u> (Fig. L.3)
Rings: Ring porous
Early pores sometimes with gummy inclusions
Vessels: Perforation plates: simple
Spiral Thickenings present in small vessels
Rays: Uniseriate and biseriate, mostly biseriate, and occasionally three cells wide
Height: up to 20 - 25 cells, usually less

<u>Pistacia khinjuk</u> (Fig. L.4)
Rings: Ring porous
Vessels: Perforation plates: simple
Spiral Thickenings present in small vessels
Rays: Predominantly biseriate
Height: up to 20 - 25 cells, usually less

<u>Pistacia vera</u> (Fig. L.5)
Rings: No good transverse section available, only 1 year
Vessels: Perforation plates: simple
Spiral Thickenings present
Rays: Uniseriate (possibly juvenile wood)
Height: up to about 15 cells

Capparidaceae:

<u>Capparis spinosa</u> (Fig. L.6)
Rings: Diffuse porous
Vessels: Perforation plates: simple
Spiral Thickenings absent
Rays: About 3- to 5-seriate
Height: up to about 20 cells

Elaeagnaceae:

<u>Elaeagnus angustifolia</u> (Fig. L.7)
Rings: Semi-ring porous
?Tyloses in some pores
Vessels: Perforation plates: simple
Some Spiral Thickenings present
Rays: 2- to 5-seriate (mostly 3- to 4-seriate)
Height: about 10 - 20 cells

Ephedraceae:

<u>Ephedra</u> sp. (Fig. L.8)
Rings: Ring porous
Vessels: Perforation plates: Ephedroid (Group of approximately circular holes)

Spiral Thickenings absent
Rays: 3- to 5-seriate
Height: more than 30 to 40 cells

Fagaceae:

<u>Quercus aegilops</u> var. <u>persica</u> (Fig. L.9)
Rings: Ring porous; large early wood pores
Late wood pores in radially oriented wavy lines, much smaller than early wood pores
Banded Parenchyma
Vessels: Perforation plates: simple
Spiral Thickenings absent
Rays: Thin: uniseriate, up to about 15 cells high
Thick: up to 15-seriate, up to over 100 cells high

Leguminosae:

<u>Prosopis farcta</u> (Fig. L.10)
Rings: Diffuse porous; late wood pores more sparsely distributed than those in early wood
Vessels: Perforation plates: simple
Intervessel pitting: alternate
Rays: Uniseriate and biseriate
Height up to more than 20 cells, though generally less (5 - 15)

Moraceae:

<u>Ficus carica</u> (Fig. L.11)
Rings: Diffuse porous
Growth rings not distinct
Pores in multiples, frequently nested
Parenchyma in wide tangential bands
Tyloses visible in some pores
Vessels: Perforation plates: simple
Spiral Thickenings absent
Rays: 1- to 4-seriate
Height: 20+ cells

<u>Morus alba</u> (Fig. L.12)
Rings: Ring porous
Tyloses in early pores
Vessels: Perforation plates: simple
Some Spiral Thickenings present
Rays: 3- to 5-seriate
Height: 10 - 30 cells

Oleaceae:

Fraxinus syriaca (Fig. L.13)
Rings: Ring porous
Tyloses in early wood
Parenchyma in late wood
Vessels: Perforation plates: simple
Spiral Thickenings absent
Rays: Uniseriate, about 3 - 5 cells high
Biseriate, less than 10 - 25 cells high

Platanaceae:

Platanus orientalis (Fig. L.14)
Rings: Diffuse porous, pores numerous
Vessels: Perforation plates: simple and scalariform
Spiral Thickenings absent
Rays: 2- to 5-seriate, usually 5-seriate
Height: usually more than 50 cells high

Polygonaceae:

Atraphaxis spinosa (Fig. L.15)
Rings: Ring porous
Late wood pores in wavy concentric bands
Gum(?) clogs some early wood pores
Vessels: Perforation plates: simple
Spiral Thickenings absent
Rays: Uniseriate
Height: 3 - 10 cells

Rhamnaceae:

Rhamnus persica (Fig. L.16)
Rings: Diffuse porous
Vessels: Perforation plates: simple
Spiral Thickenings absent
Rays: Uniseriate
Height: about 5 - 15 cells (usually 10 - 15)

Zizyphus spina-christi (Fig. L.17)
Rings: Diffuse porous; pores larger than in Rhamnus
Vessels: Perforation plates: simple
Spiral Thickenings absent
Rays: Uniseriate
Height: usually 10 - 20 cells
Gum(?) in rays

Rosaceae:

Amygdalus kotschyi (=Prunus kotschyi, herb. spec. #170; Fig. L.18)

Rings: Ring porous

Vessels: Perforation plates: simple
Spiral Thickenings present

Rays: Thin: uniseriate, 3 - 15 cells high
Thick: 2- to 5-seriate (usually 4- to 5-seriate), about 15 - 20 cells high

Amygdalus kotschyi (=Prunus kotschyi, herb. spec. #174; Fig. L.19)

Rings: Ring porous

Vessels: Perforation plates: simple
Spiral Thickenings present

Rays: Uniseriate, about 15 - 30 cells high
Biseriate, more than 30 cells high

Amygdalus scoparia (=Prunus scoparia, Fig. L.20)

Rings: Ring porous

Vessels: Perforation plates: simple
Spiral Thickenings present

Rays: Uniseriate, 2 - 8 cells high
2- to 4-seriate, more than 30 cells high

Salicaceae:

Populus alba (Fig. L.21)

Rings: Diffuse porous
Tyloses

Vessels: Perforation plates: simple
Spiral Thickenings absent

Rays: Uniseriate
Height: about 5 - 15 cells

Populus euphratica (Fig. L.22)

Rings: Diffuse porous

Vessels: Perforation plates: simple
Spiral Thickenings absent

Rays: Uniseriate
Height: about 5 - 30 cells, mostly 7 - 15

Populus nigra (Fig. L.23)

(see P. euphratica description, but shorter rays in tangential view)

Salix excelsa (Fig. L. 24)

Rings: Diffuse porous

Vessels: Perforation plates: simple
Spiral Thickenings absent

Rays: Uniseriate

Solanaceae:

Lycium depressum (Fig. L. 25)
Rings: Ring porous
Parenchyma in coalescent, diagonal bands; zig-zag pattern across length of growth ring
Some tyloses visible
Vessels: Perforation plates: simple
Spiral Thickenings present
Rays: Uniseriate
Height: about 2 - 25 cells, usually about 10 - 12

Tamaricaceae:

Tamarix tetragyna (Fig. L.26)
Rings: Semi-diffuse porous
Tyloses visible in pores
Vessels: Perforation plates: simple
Spiral Thickenings absent
Rays: Usually multi-seriate, 3- to 7-seriate (usually 5- to 6-seriate)
Height: generally more than 25 cells
Crystals

Thymeleaceae:

Daphne acuminata (Fig. L.27)
Rings: Ring porous
late wood pores arranged in radially wavy lines, predominantly radially oriented
Vessels: Perforation plates: simple
Spiral Thickenings present
Rays: Uniseriate
Height: 3 - 10 cells

Ulmaceae:

Celtis caucasica (Fig. L.28)
Rings: Ring porous
Late wood: pore multiples and parenchyma in wavy concentric bands
Vessels: Perforation plates: simple
Some Spiral Thickenings present
Rays: Thin: uniseriate, 3 - 5 cells high
Thick: 3- to 5-seriate, 5 - 20 cells high

Verbenaceae:

Vitex pseudo-negundo (Fig. L.29)

Rings: Semi-diffuse porous
Vessels: Perforation plates: simple
Spiral Thickenings absent
Rays: Uniseriate and some biseriate
Height: about 5 - 50 cells, usually about 10 - 15
Gummy inclusions

Vitaceae:

<u>Vitis vinifera</u> (Fig. L.30)
Rings: Semi-diffuse porous
Tyloses visible in some pores
Vessels: Perforation plates: simple and scalariform
Intervessel pitting: scalariform
Spiral Thickenings absent
Rays: Multiseriate; up to 10-seriate
Height: about 100 cells
Granular inclusions

Fig. L.1.
<u>Juniperus</u>

a. Transverse (80x)   b. Tangential (100x)
c. Radial (100x)   d. Radial (300x)

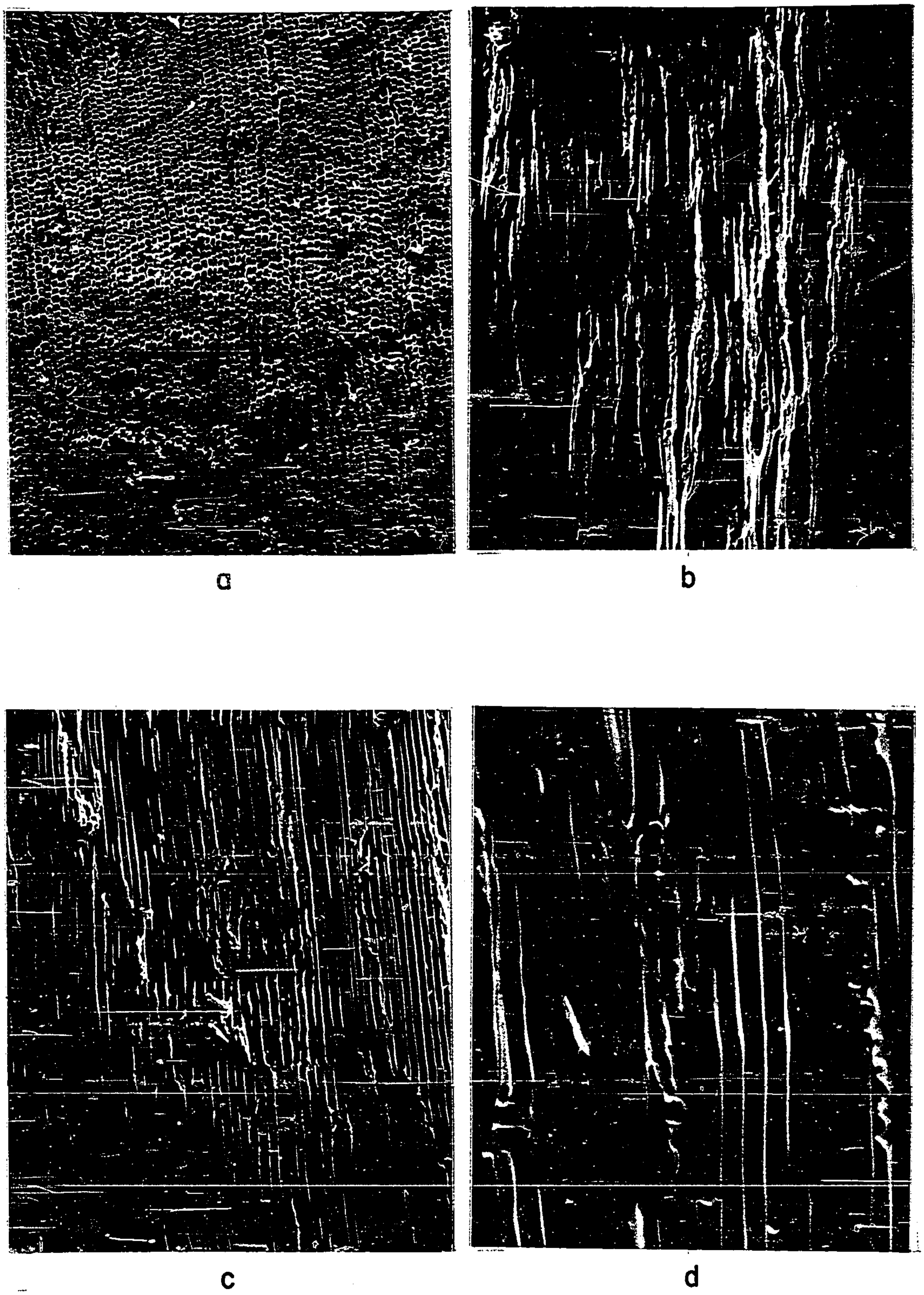
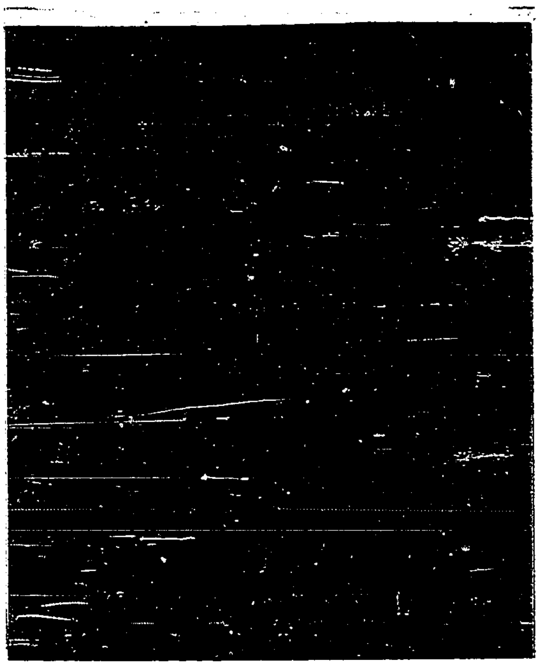


Fig. L.2.
<u>Acer</u> <u>monspessulanum</u>

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



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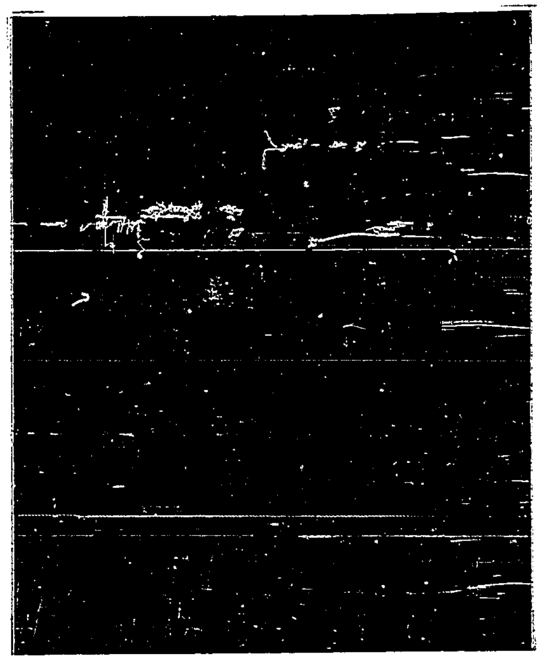
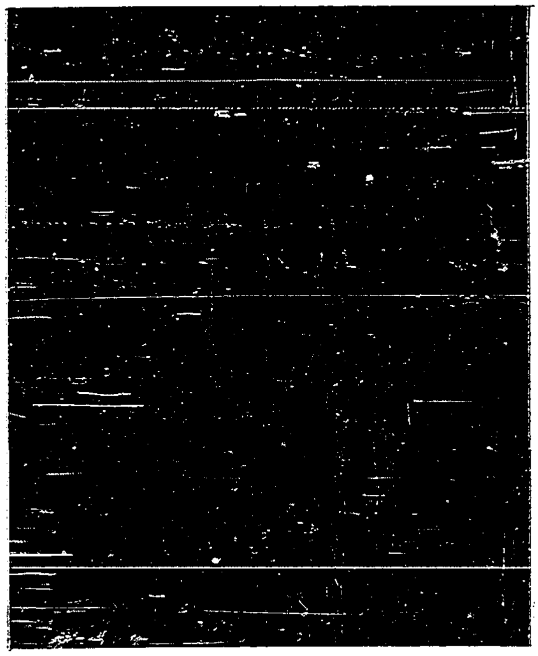


b



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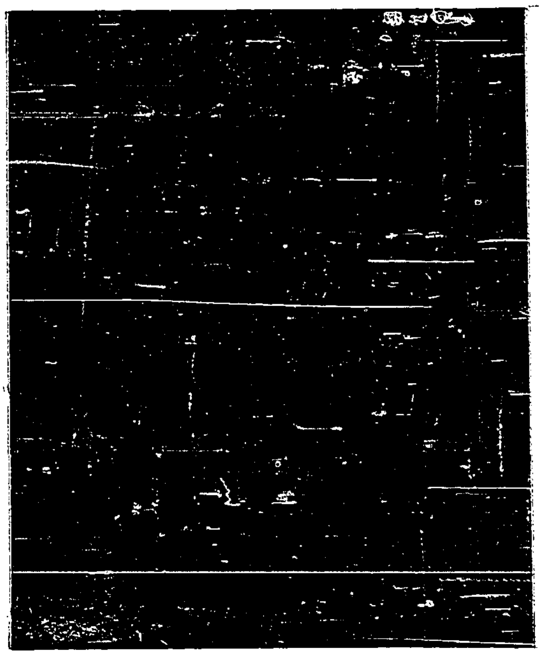
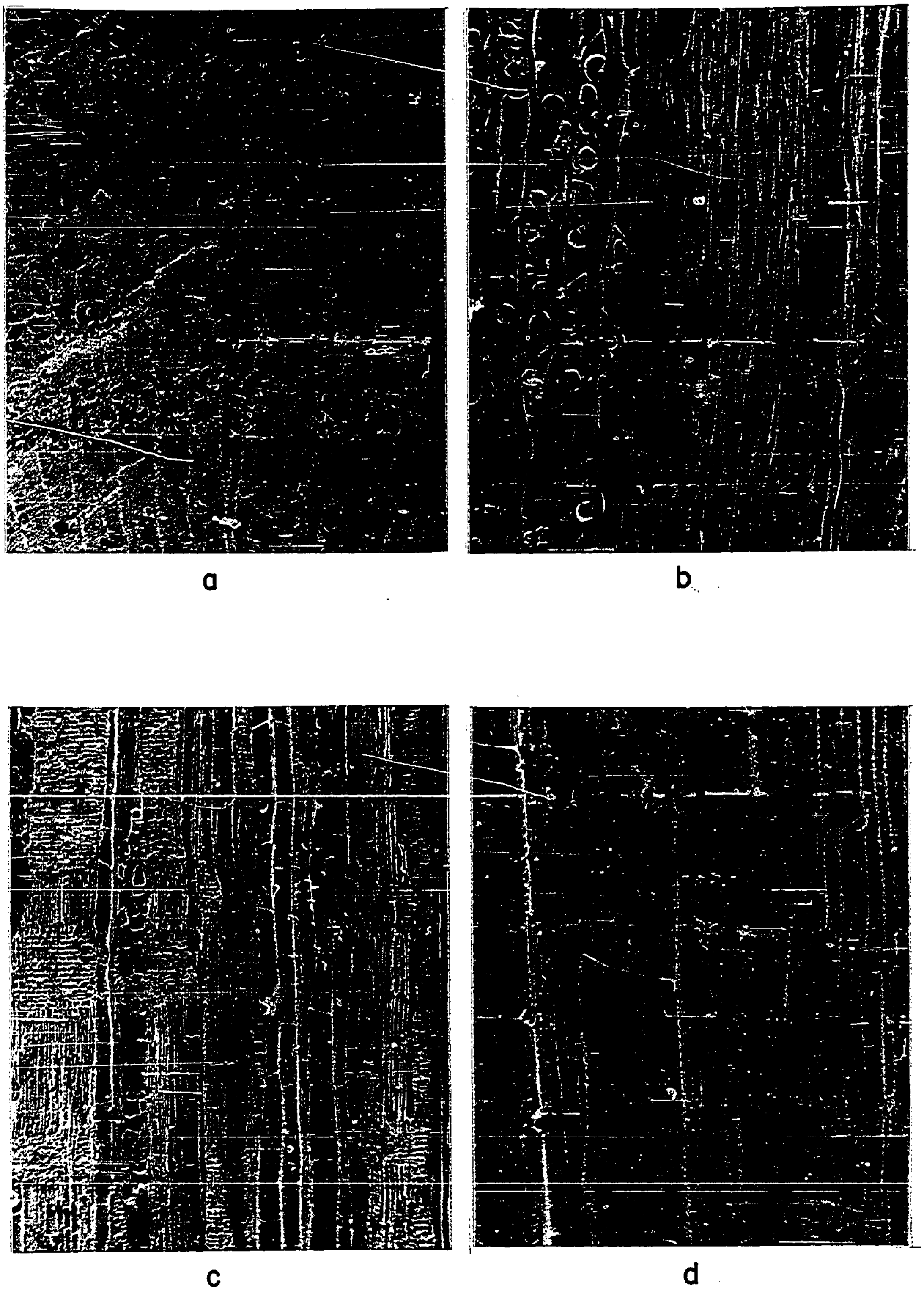


d

Fig. L.3.
<u>Pistacia eurycarpa</u>

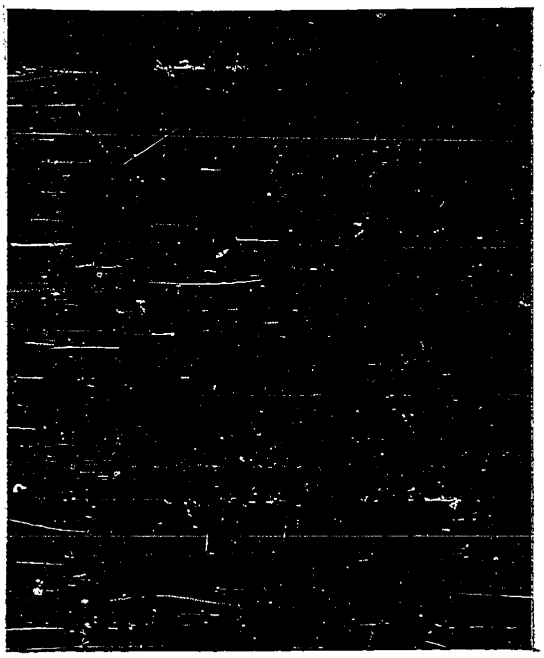
a. Transverse (50x) b. Tangential (80x)
c. Radial (80x) d. Radial (300x)



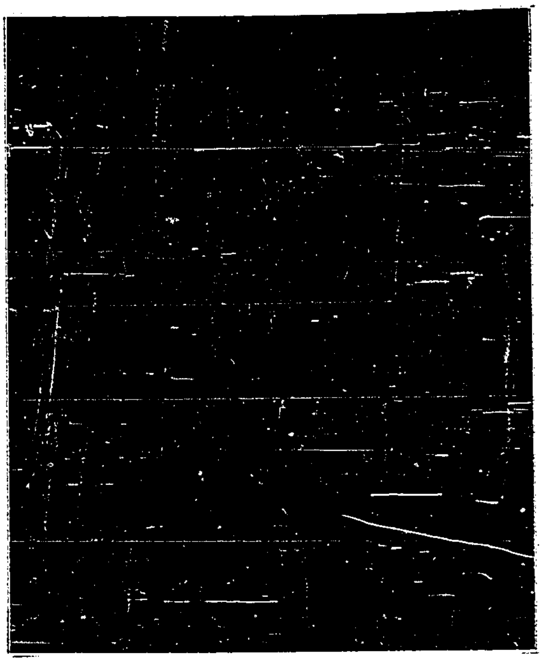
a b c d

Fig. L.4.
<u>Pistacia khinjuk</u>

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



a



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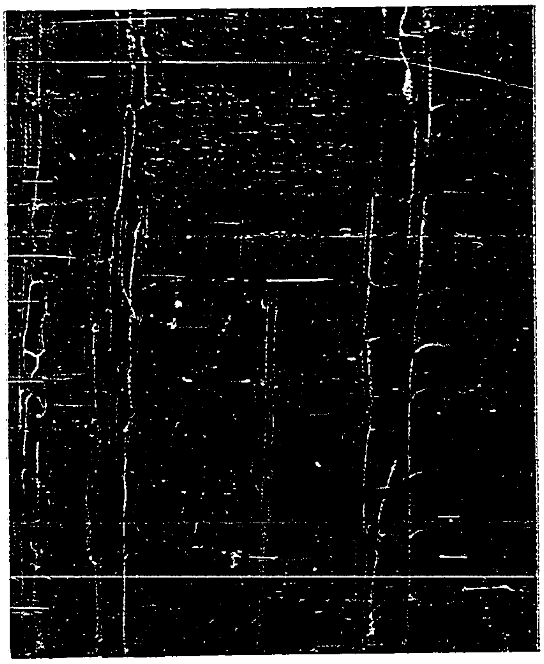

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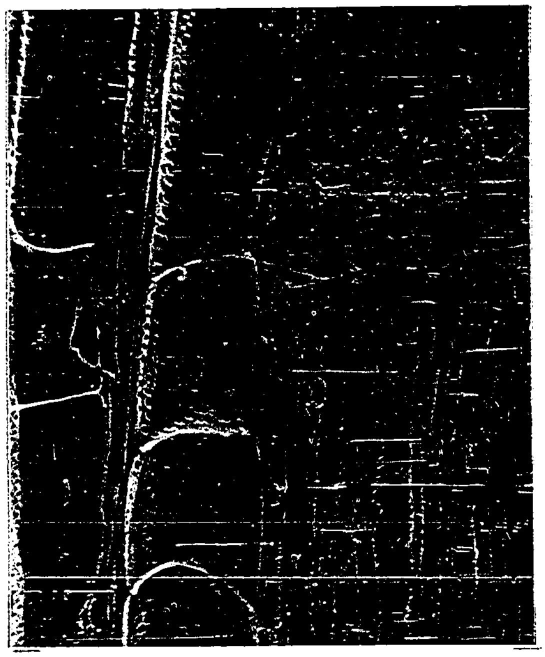
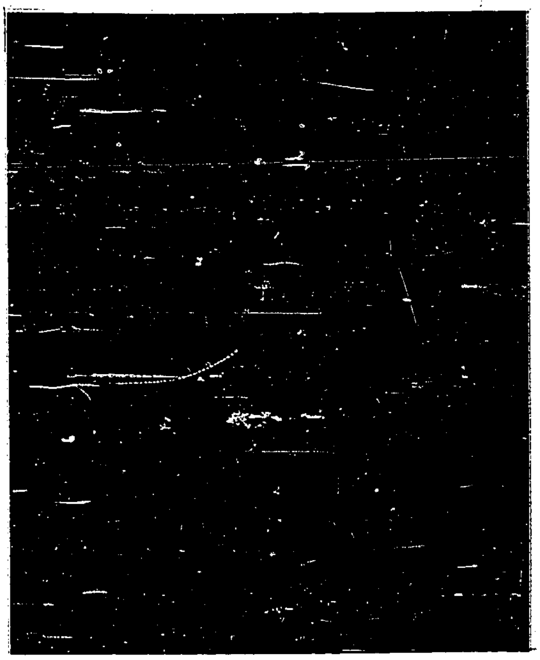


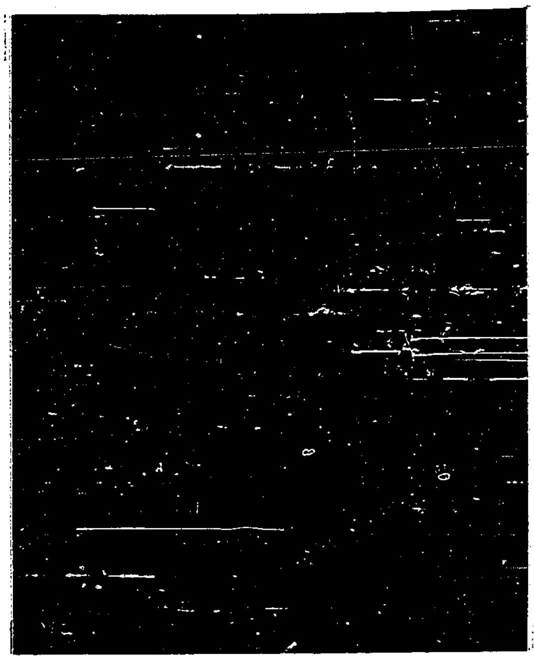
d

Fig. L.5.
Pistacia vera

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



a



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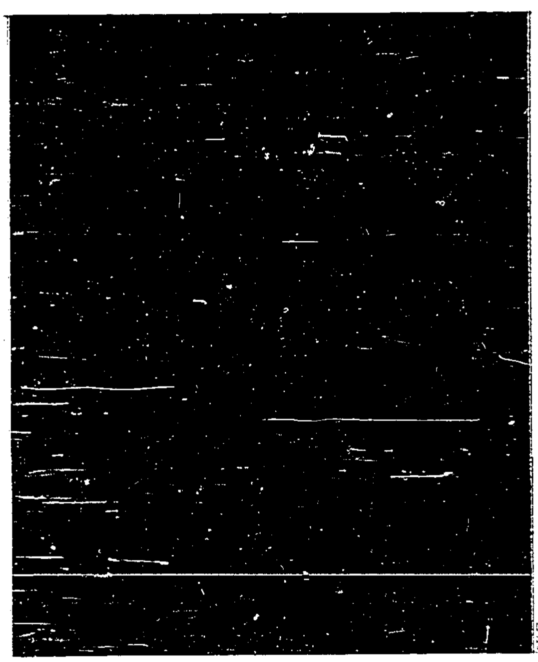
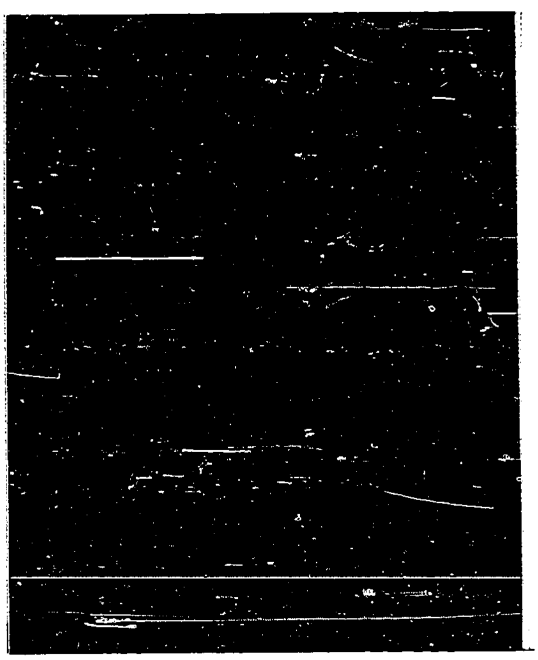


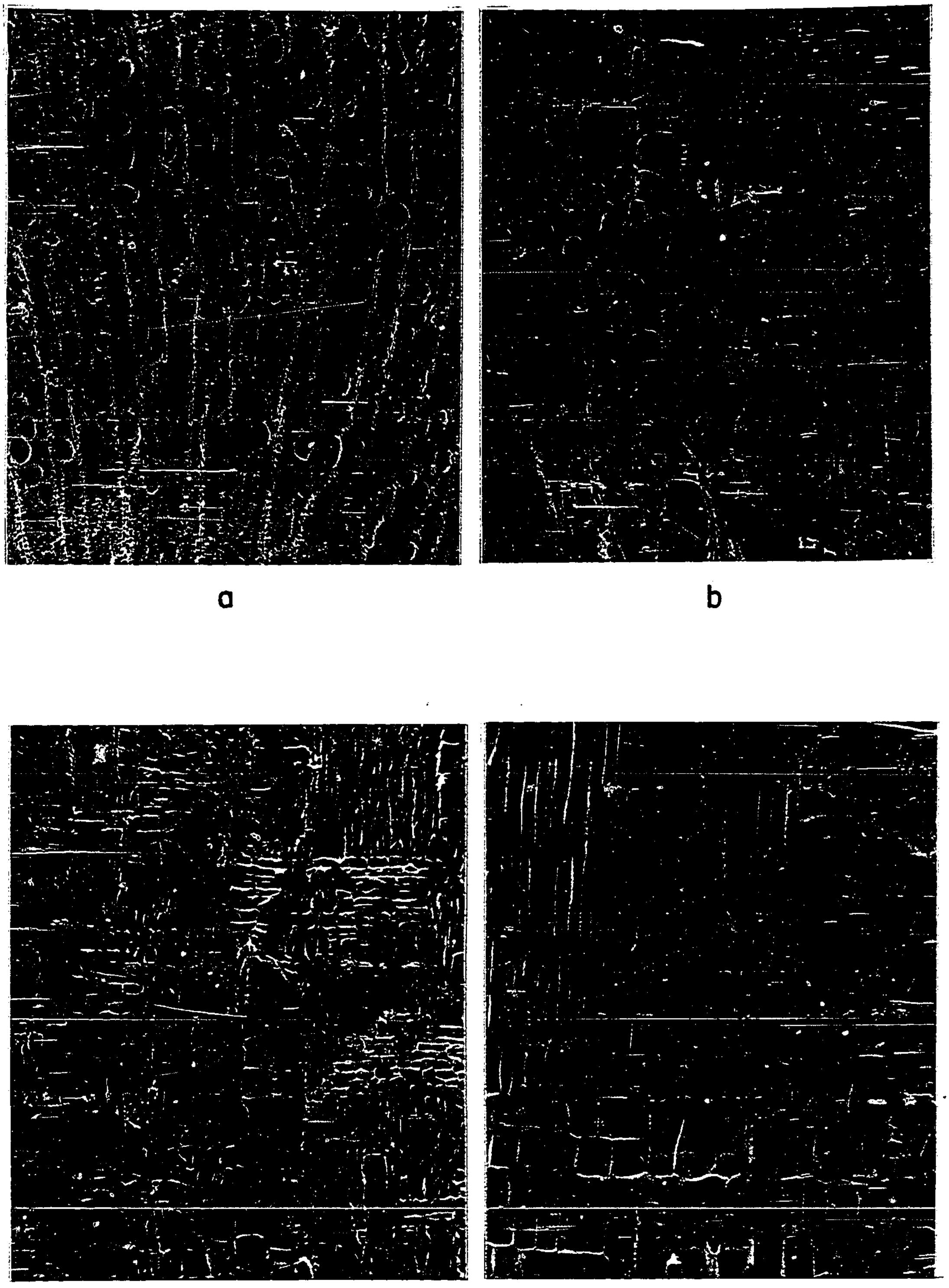
c



d

Fig. L.6.
Capparis spinosa

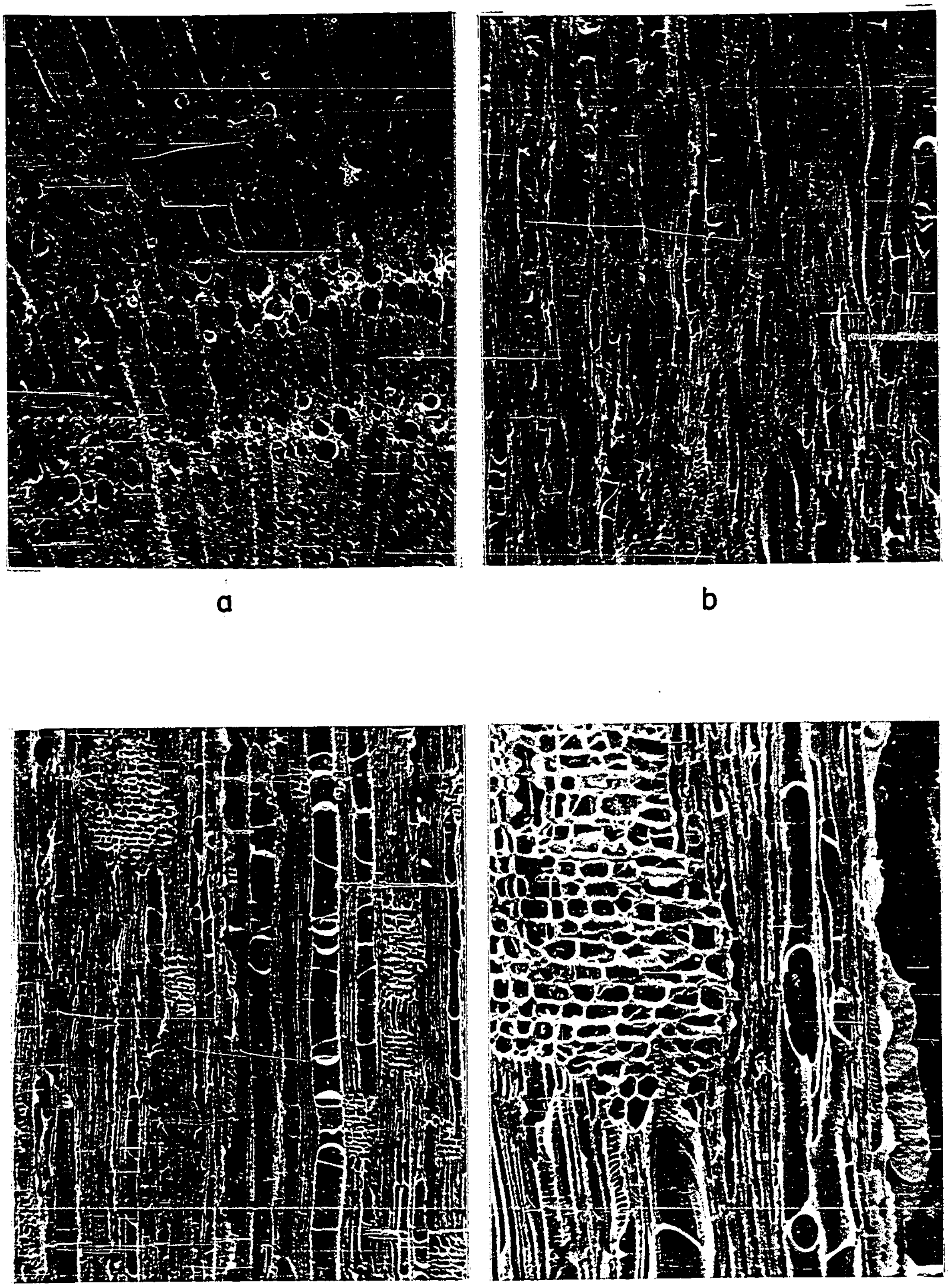
a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



a b c d

Fig. L.7.
Elaeagnus angustifolia

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)

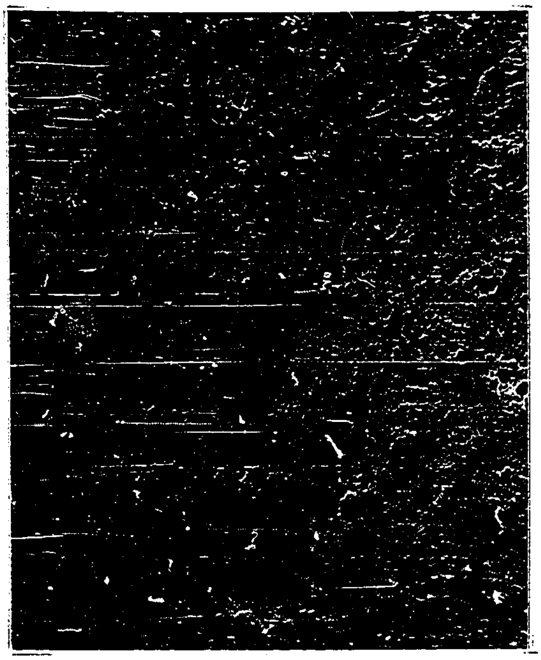


a b

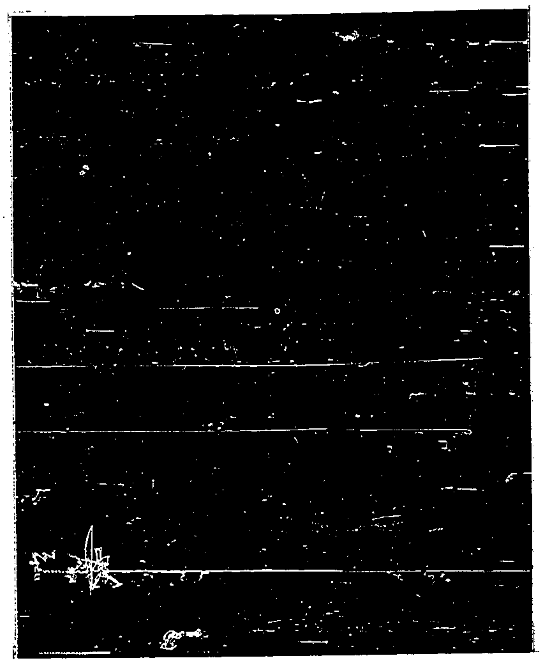
c d

Fig. L.8.
<u>Ephedra</u>

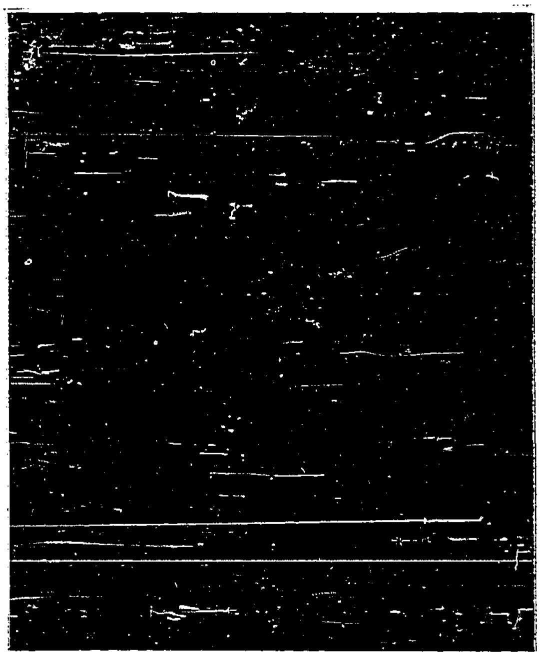
a. Transverse (60x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



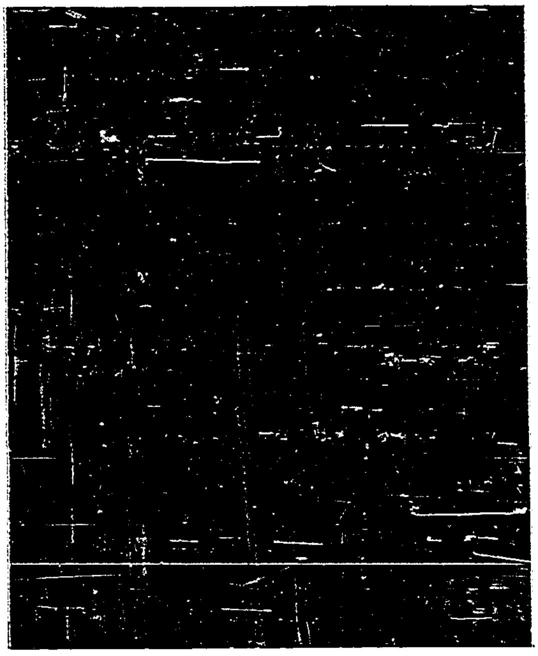
a



b



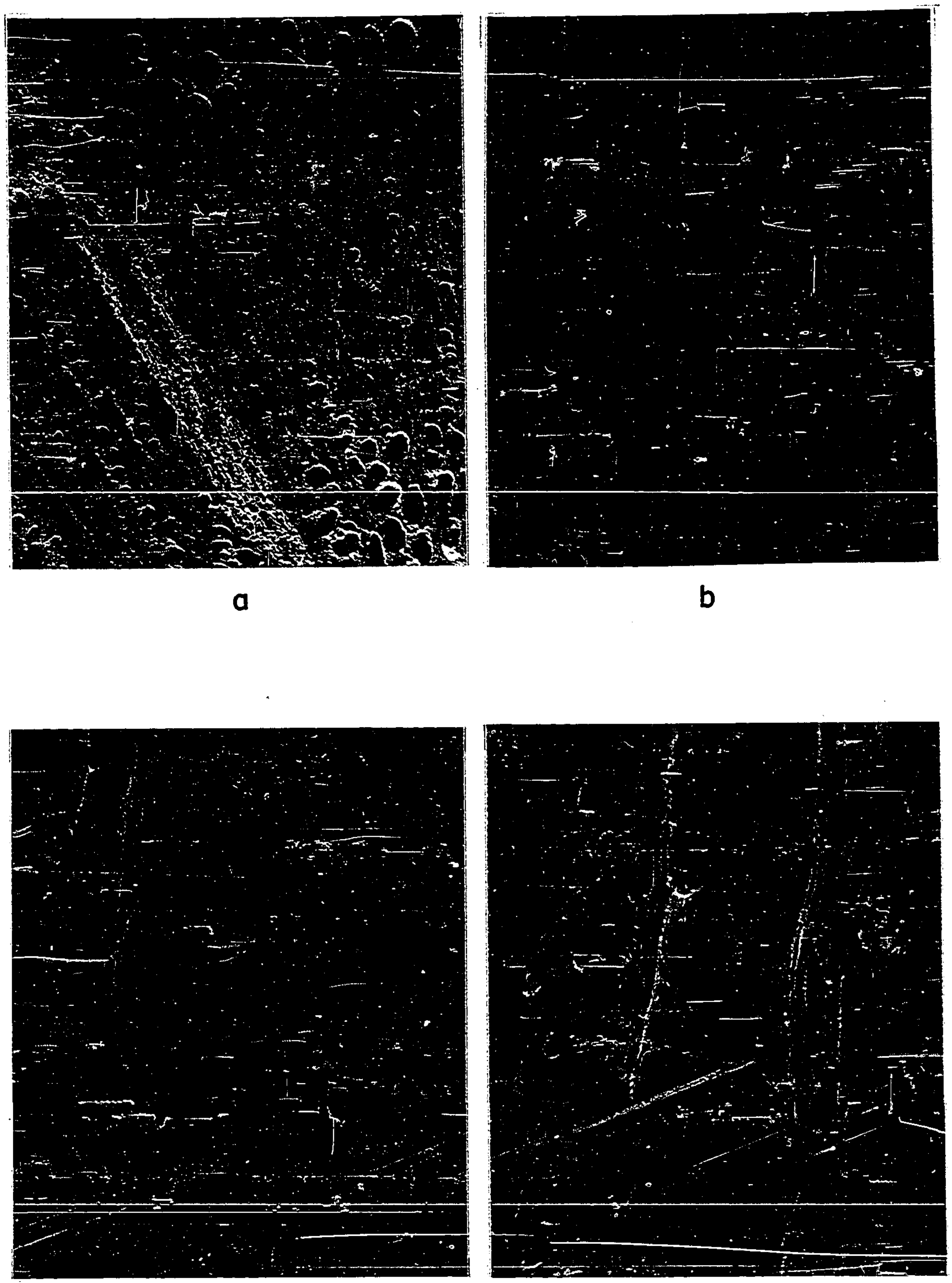
c



d

Fig. L.9.
Quercus _aegilops_ var. _persica_

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)

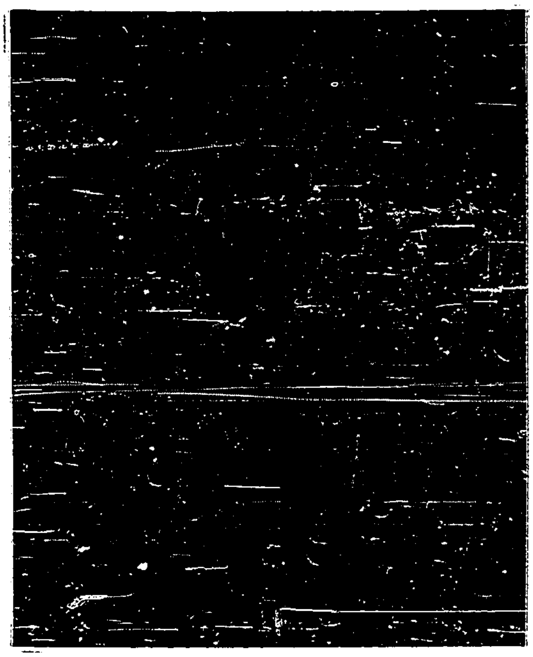


a b

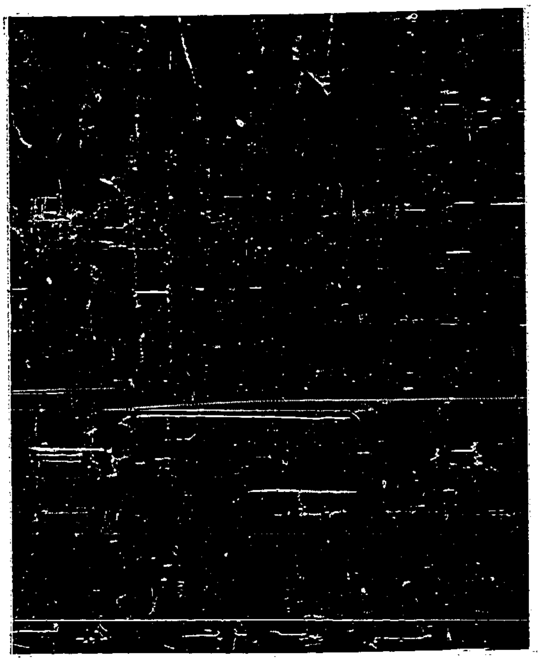
c d

Fig. L.10.
<u>Prosopis farcta</u>

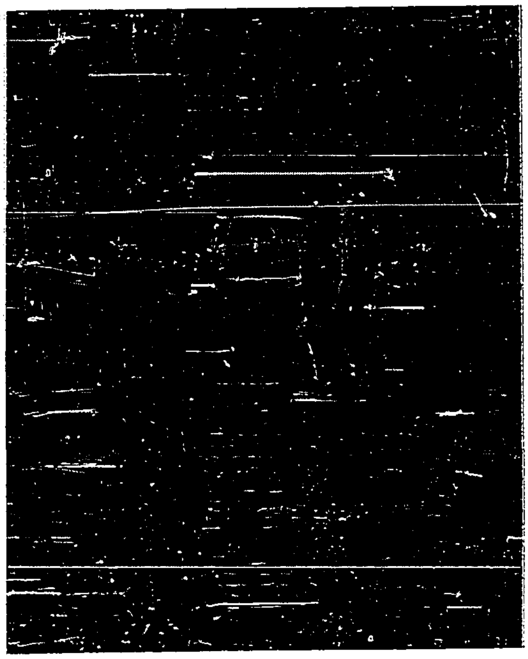
a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



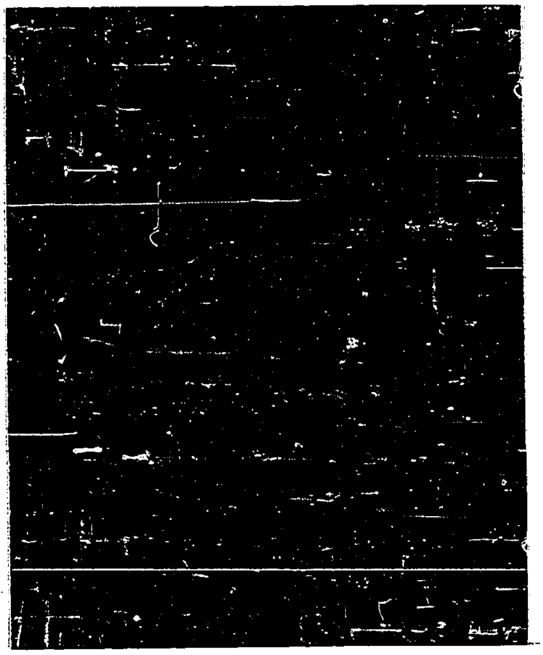
a



b



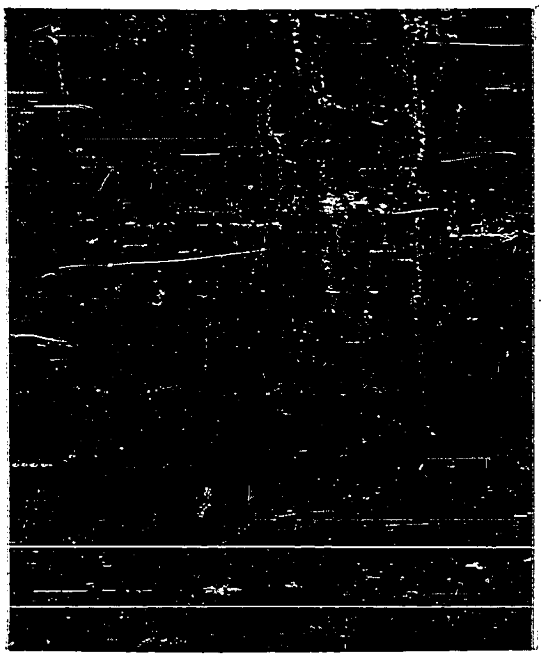
c



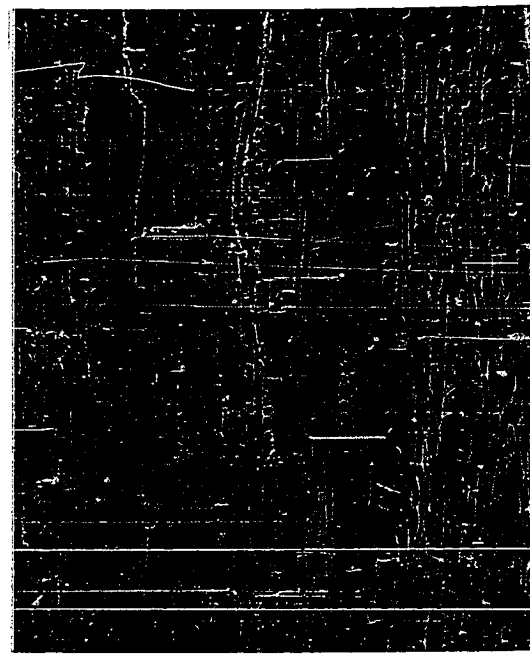
d

Fig. L.11.
Ficus carica

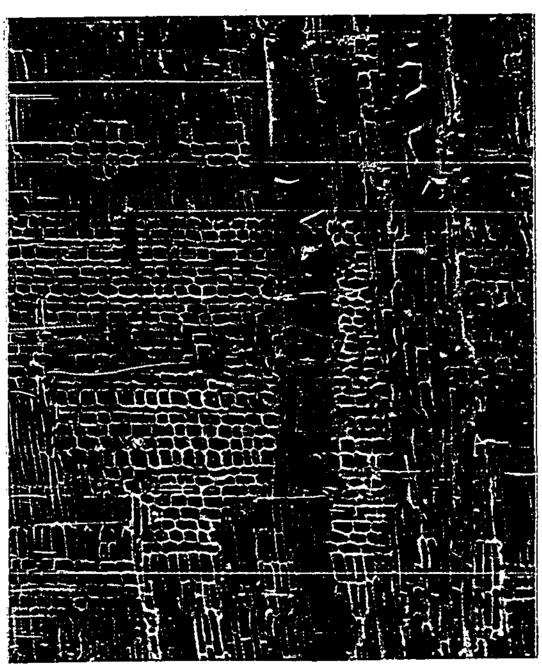
a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



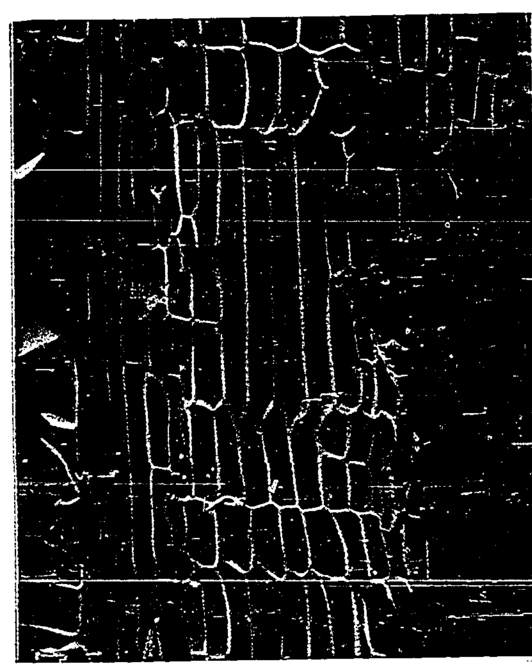
a



b



c



d

Fig. L.12.
<u>Morus alba</u>

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)

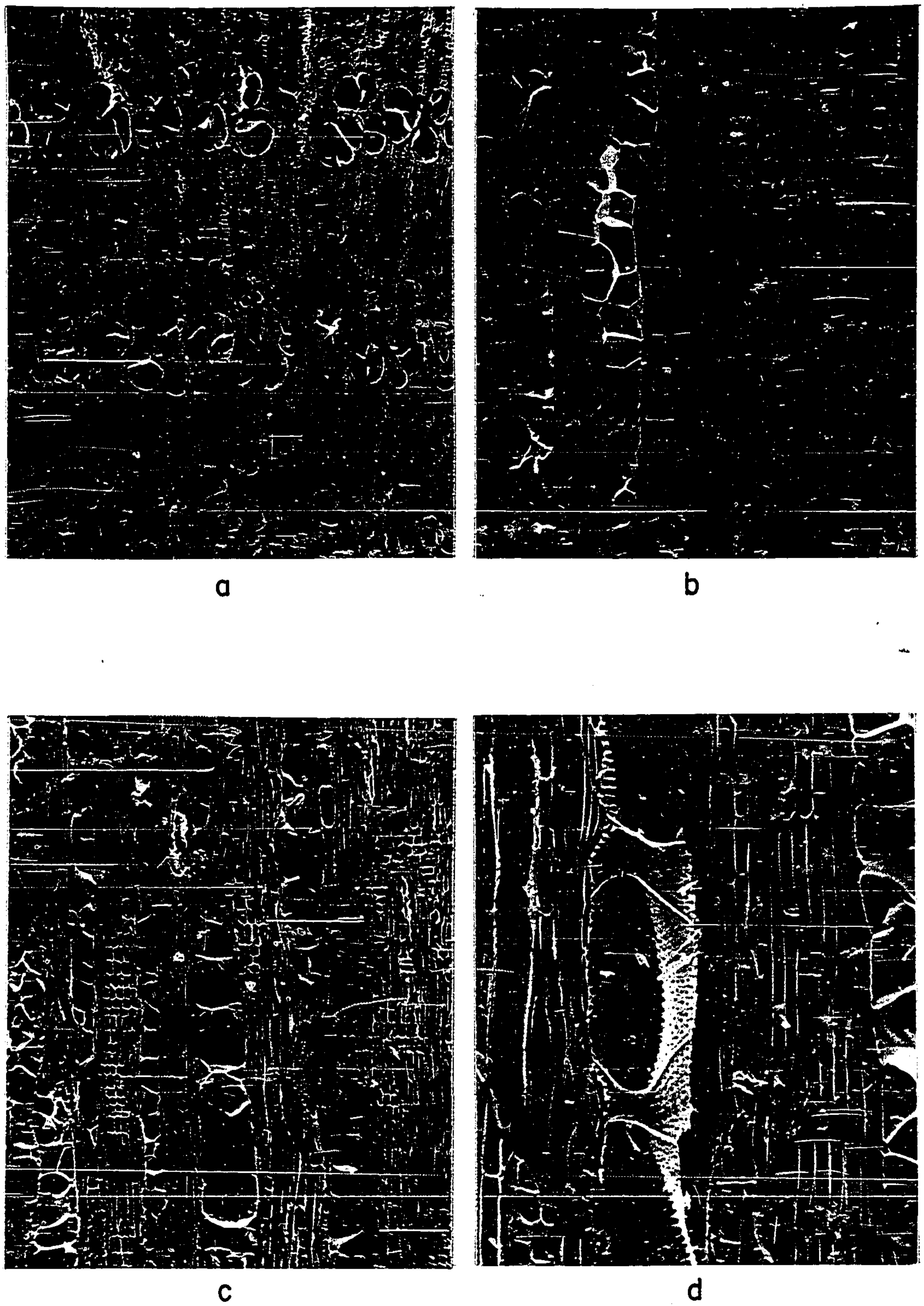
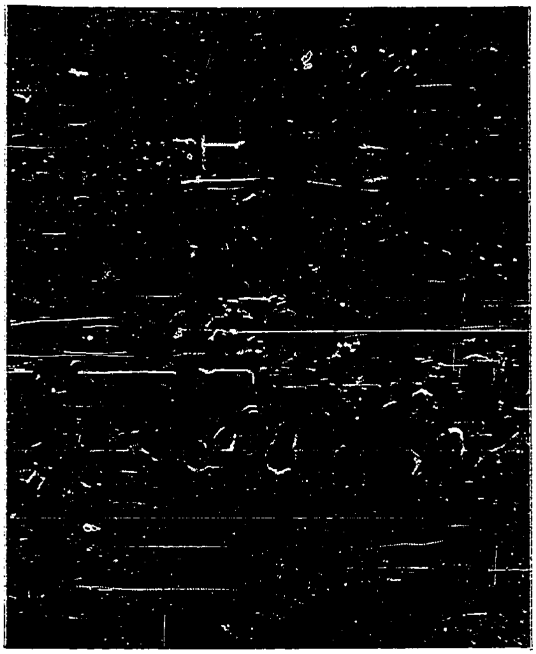
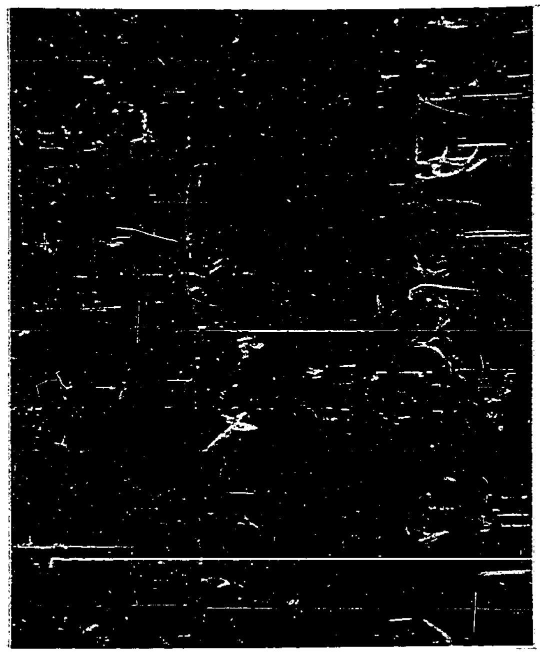

a
b
c
d

Fig. L.13.
<u>Fraxinus syriaca</u>

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



a



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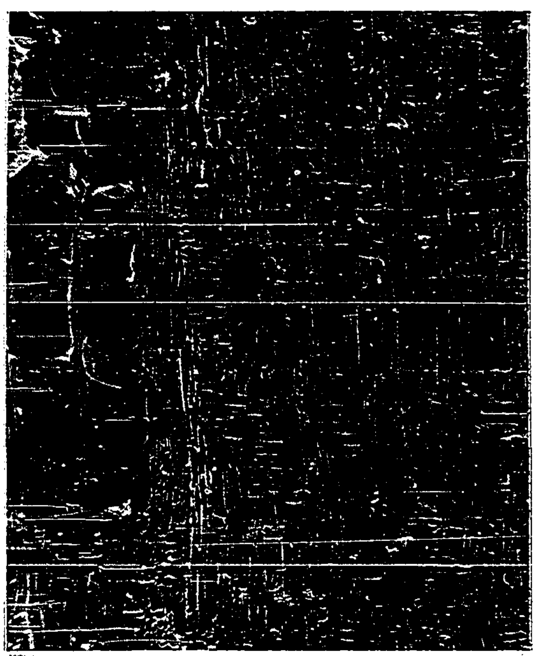
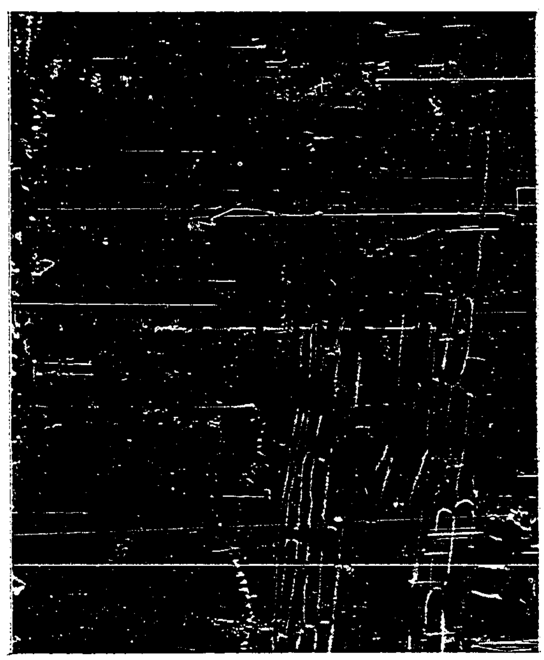


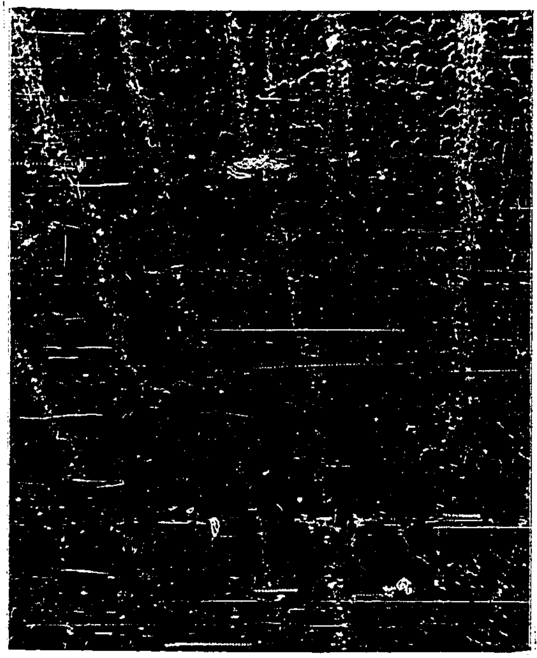
c



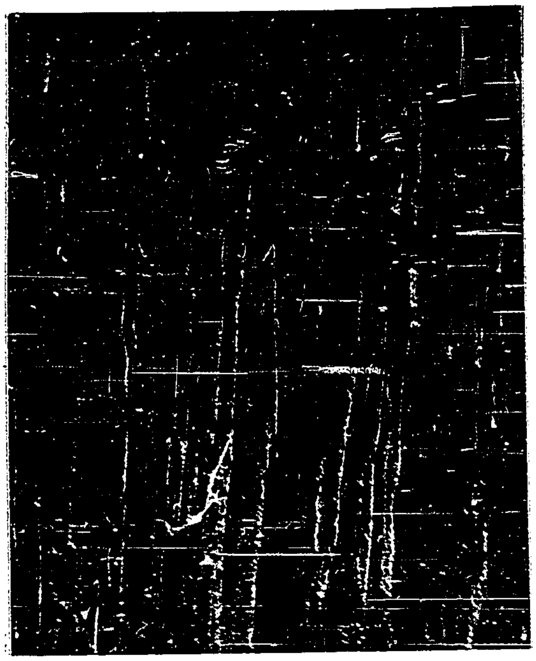
d

Fig. L.14.
<u>Platanus</u> <u>orientalis</u>

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



a



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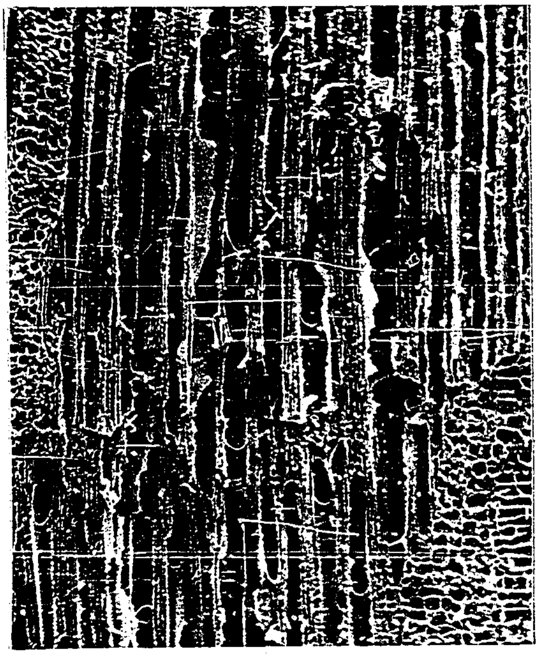

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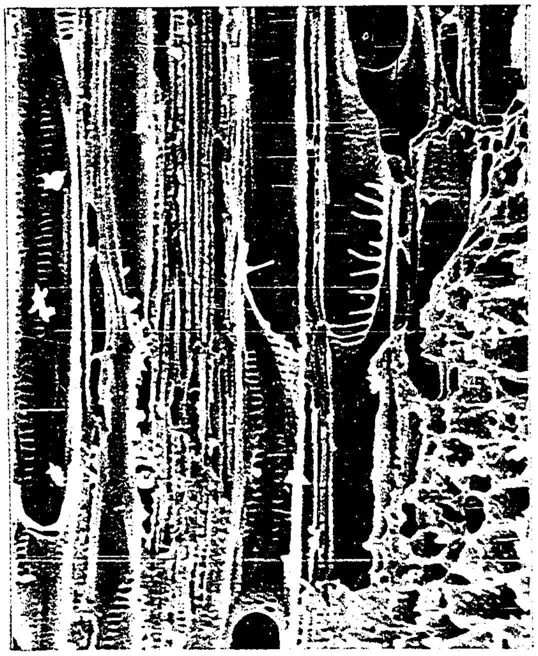
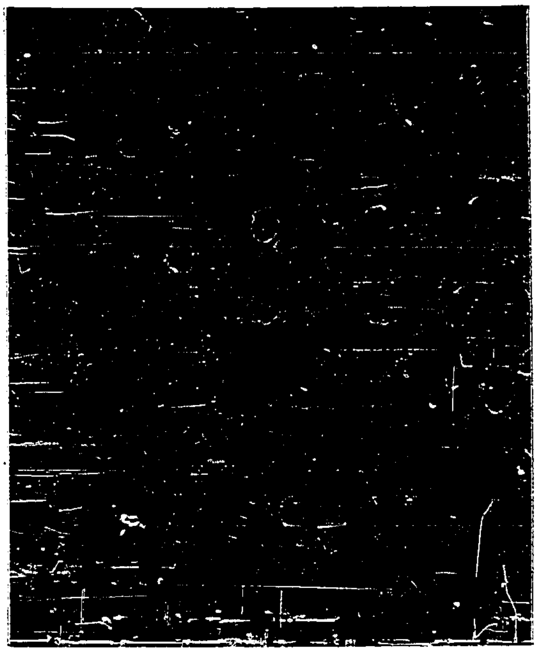


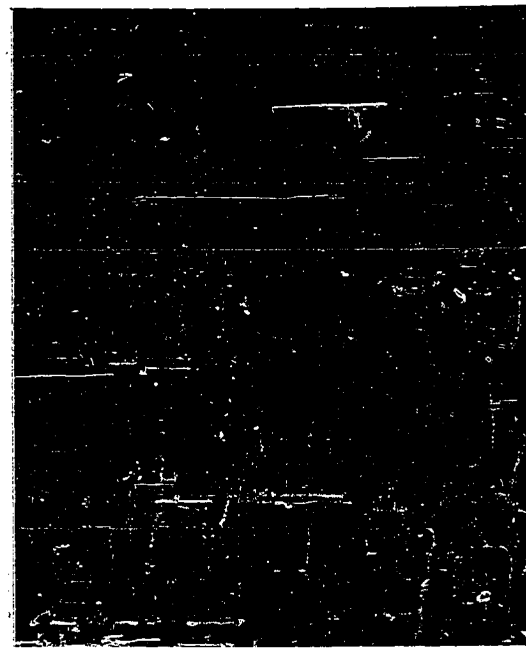
d

Fig. L.15.
<u>Atraphaxis spinosa</u>

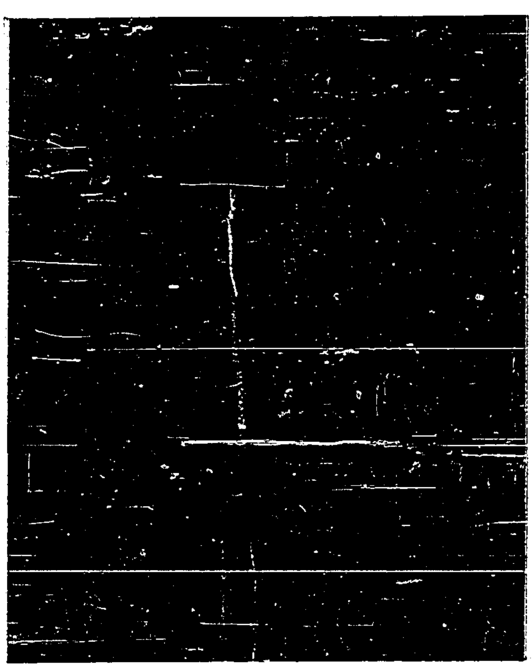
a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



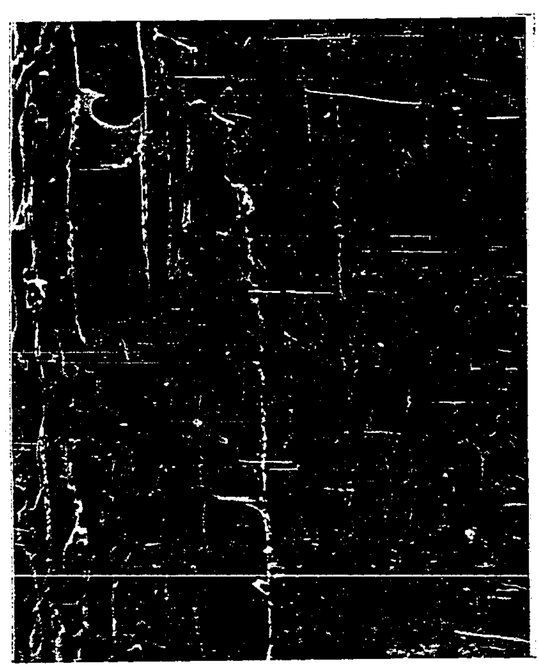
a



b



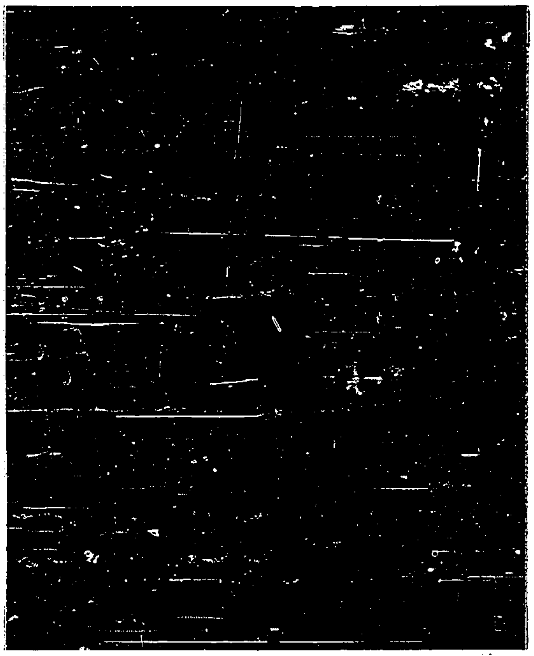
c



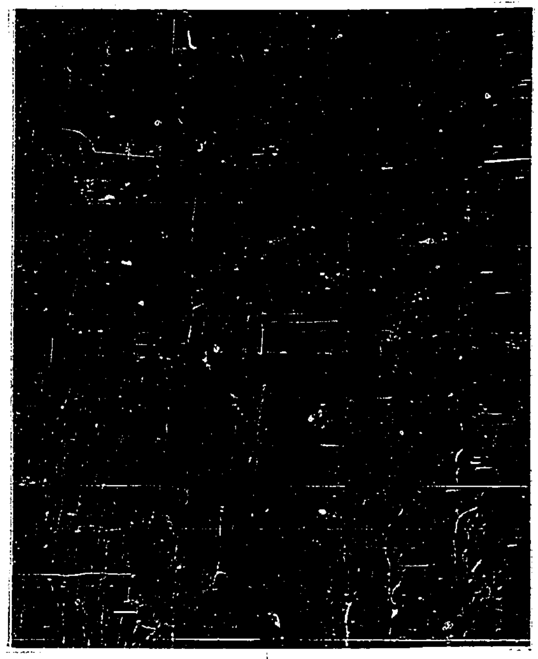
d

Fig. L.16.
<u>Rhamnus persica</u>

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



a



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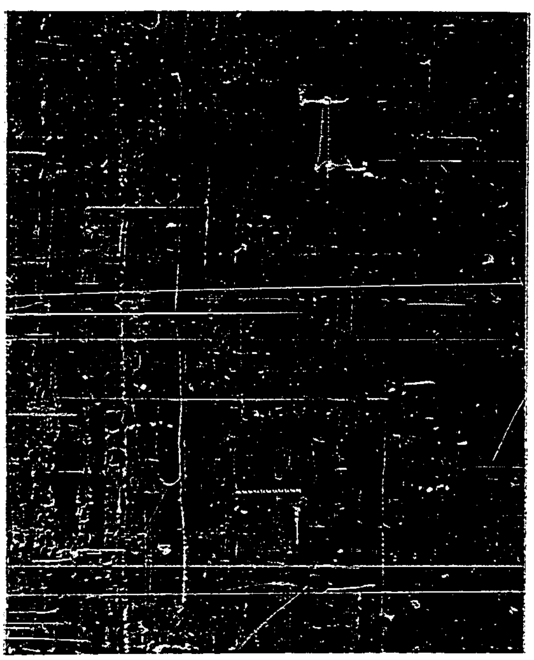
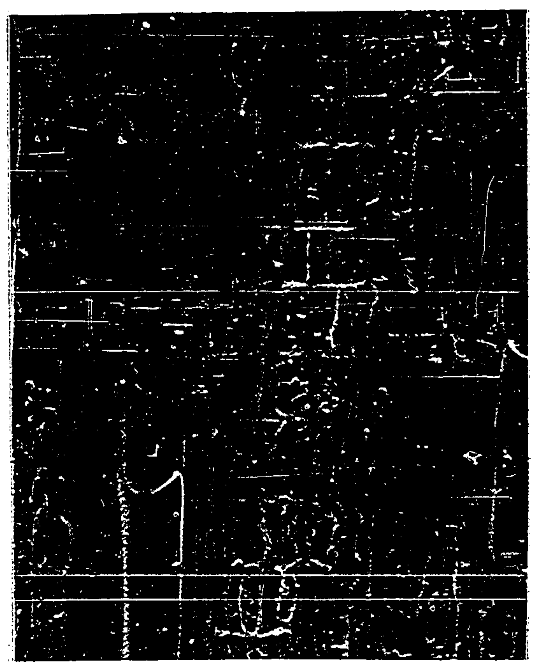


c



d

Fig. L.17.
Zizyphus spina-christi

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)

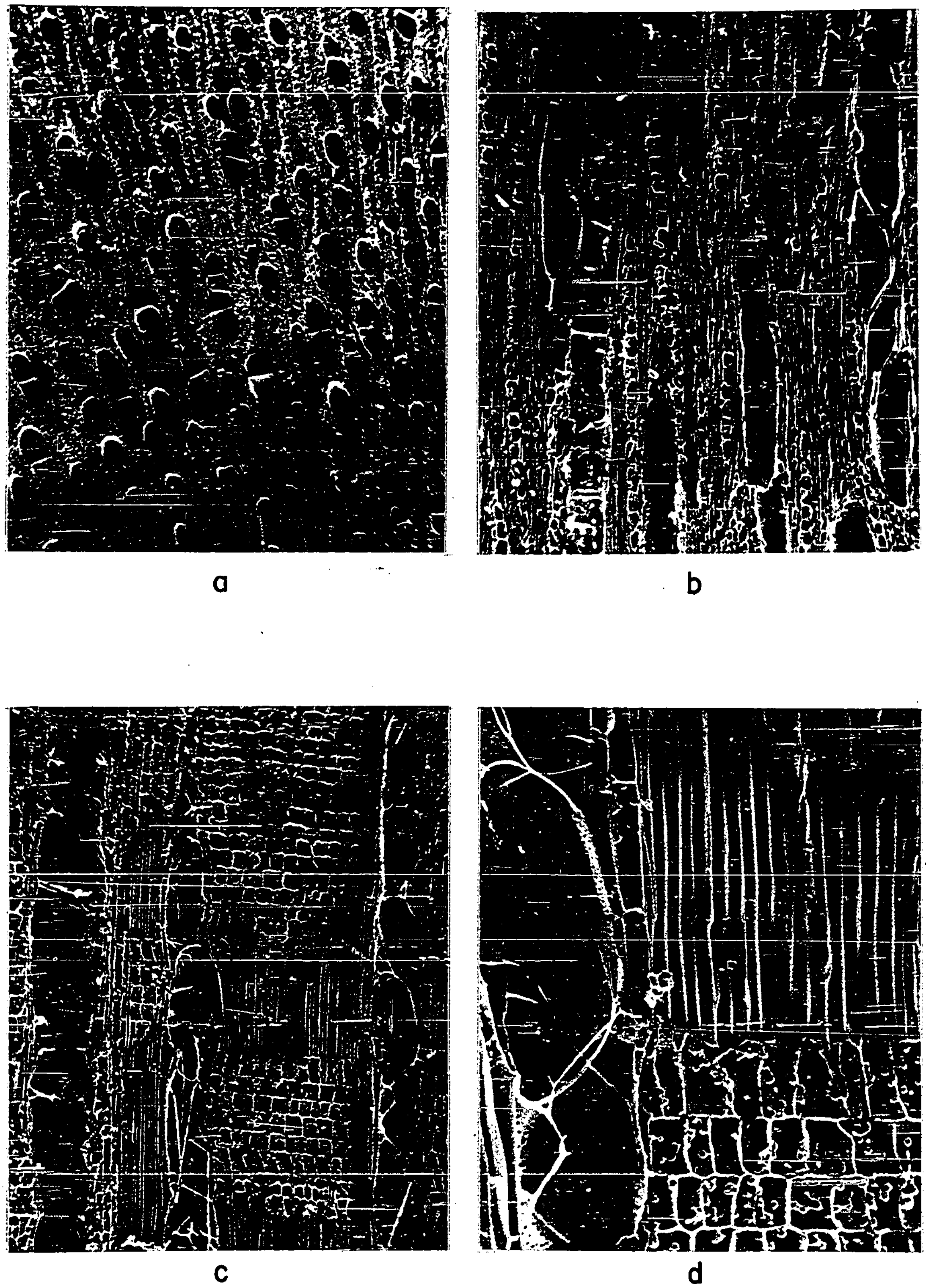
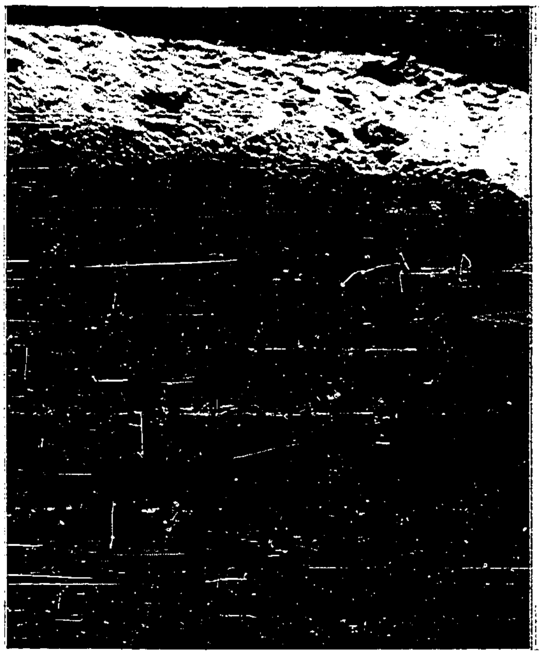
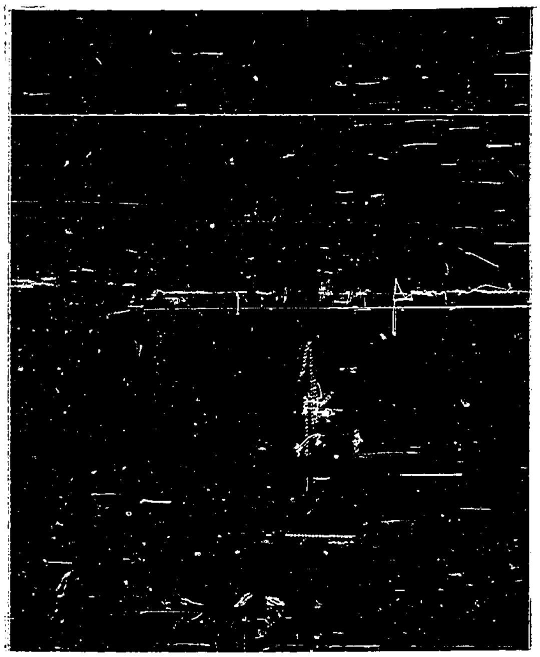

a
b
c
d

Fig. L.18.
Amygdalus kotschyi, herb. spec. # 170

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



a



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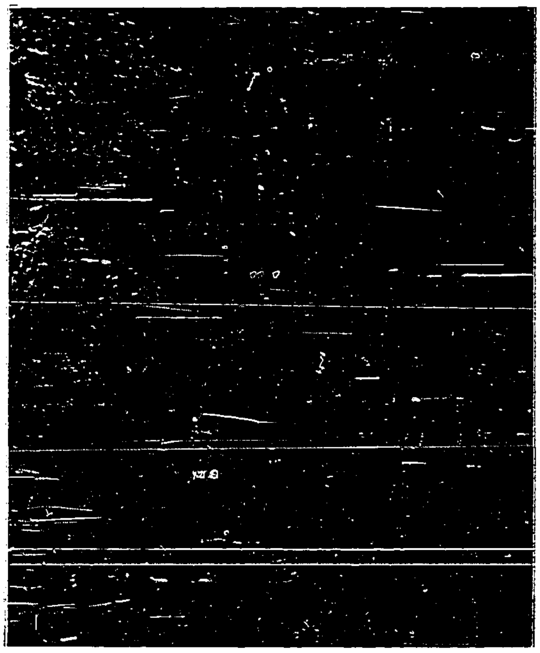
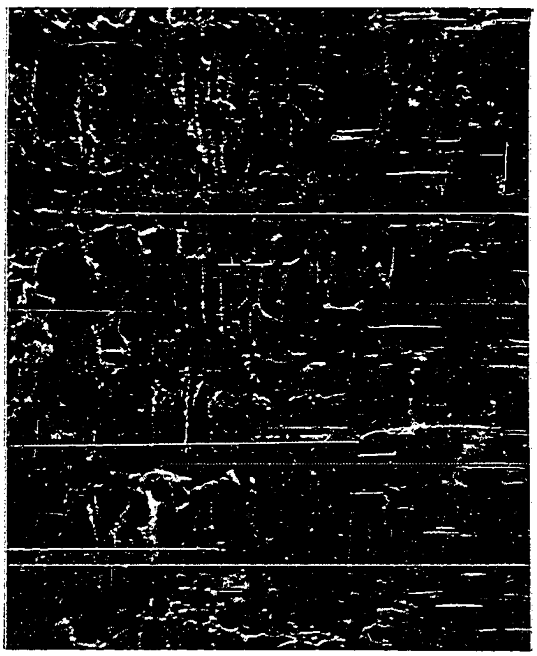


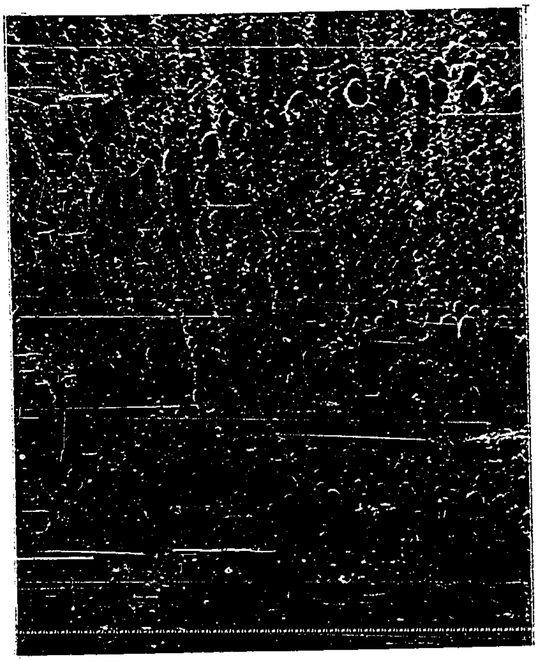
c



d

Fig. L.19.
<u>Amygdalus</u> <u>kotschyi</u>, herb. spec. # 174

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



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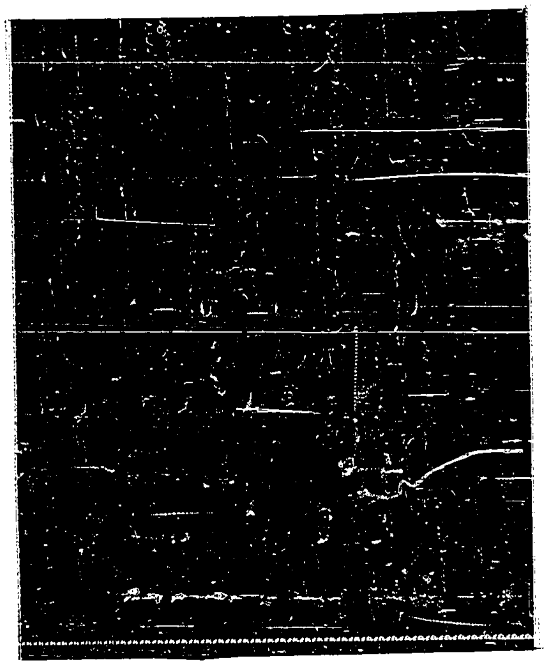
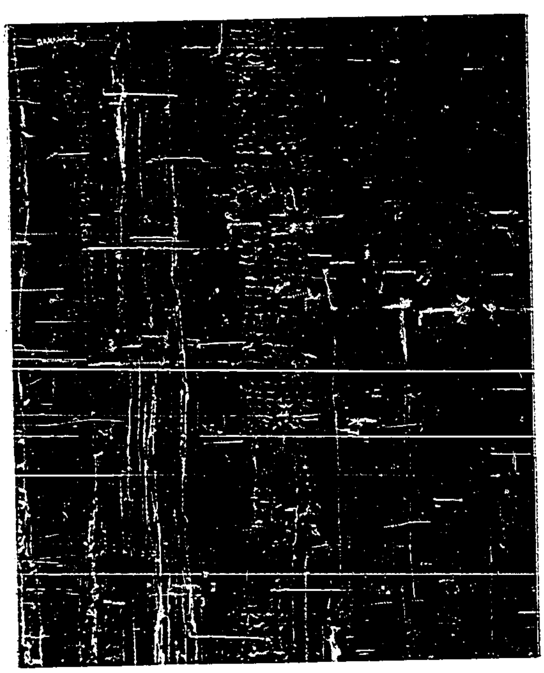


b



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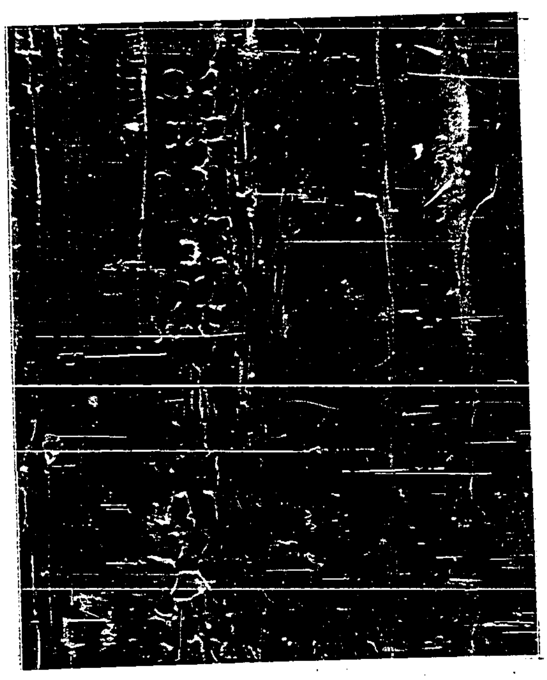
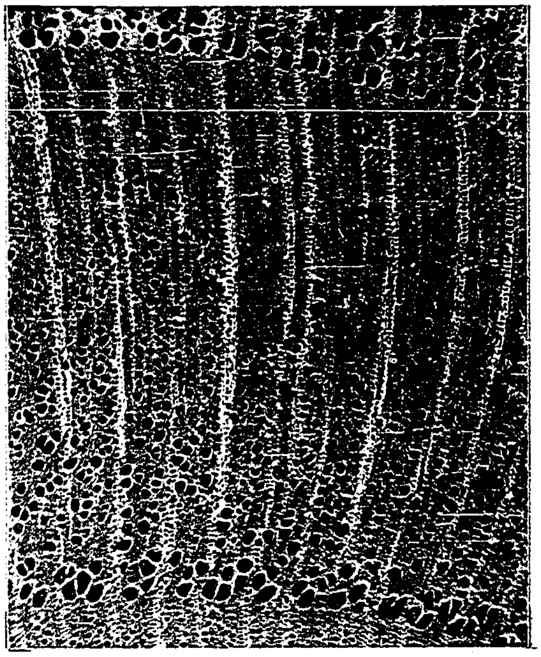


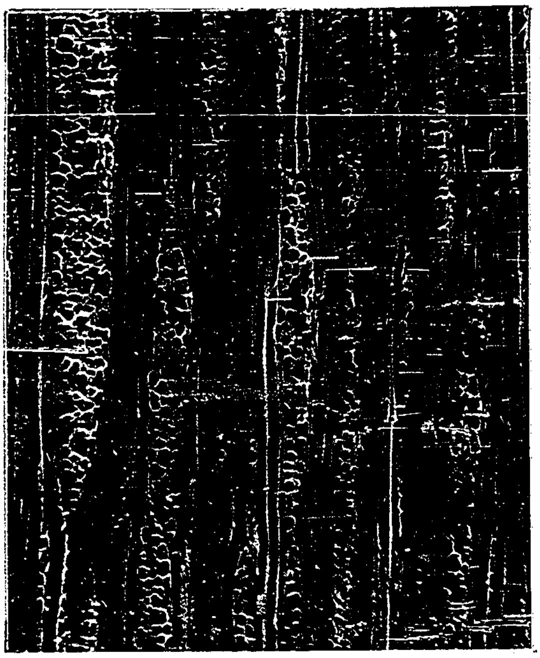
d

Fig. L.20.
Amygdalus scoparia

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



a



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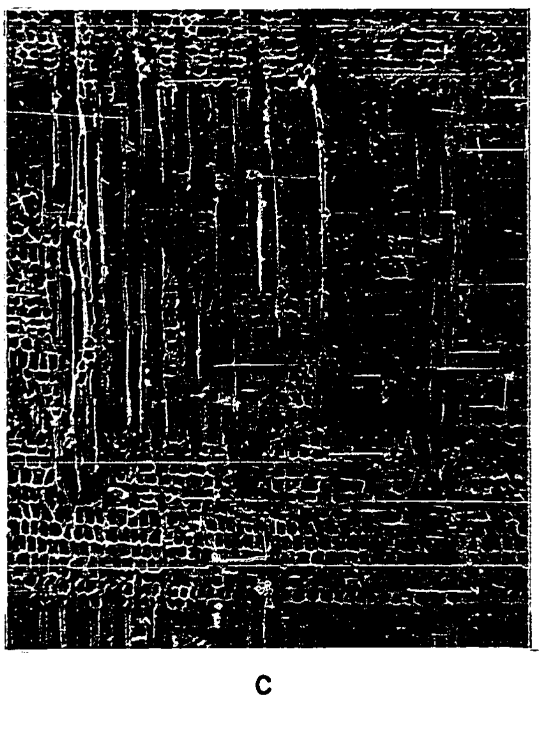

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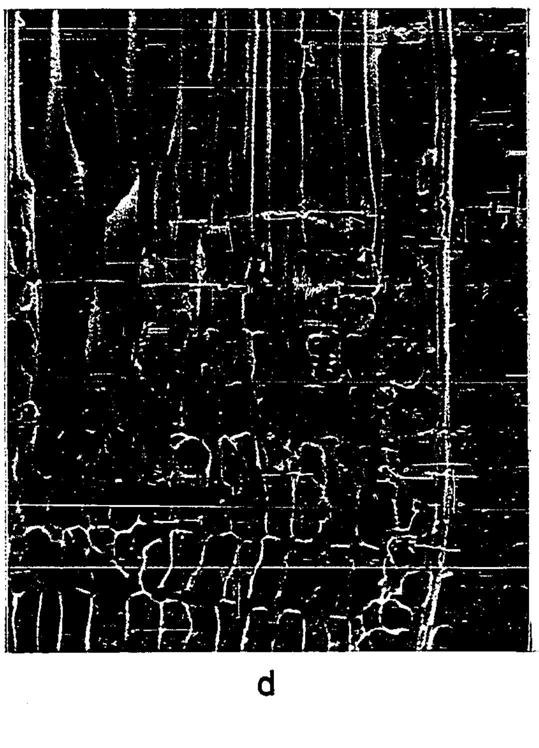
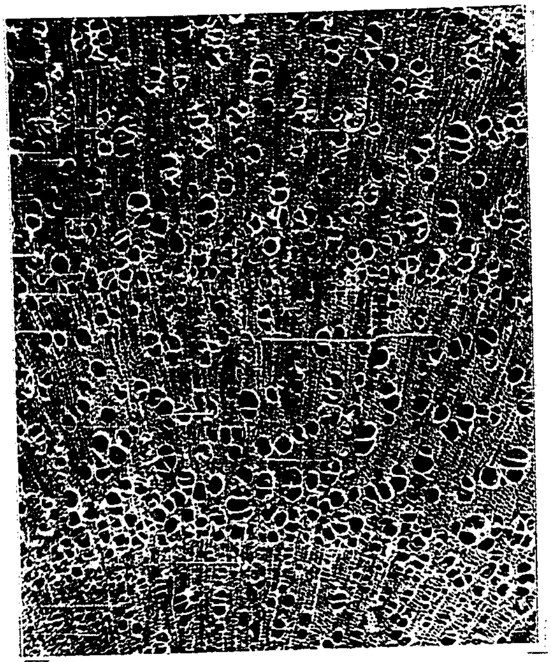


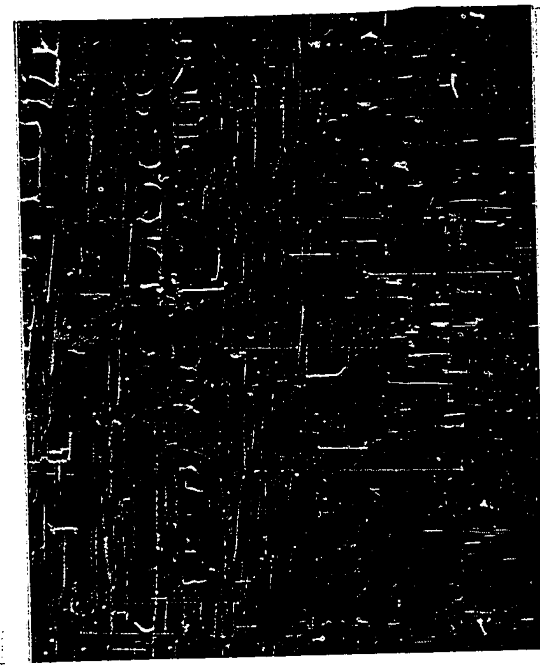
d

Fig. L.21.
Populus alba

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



a



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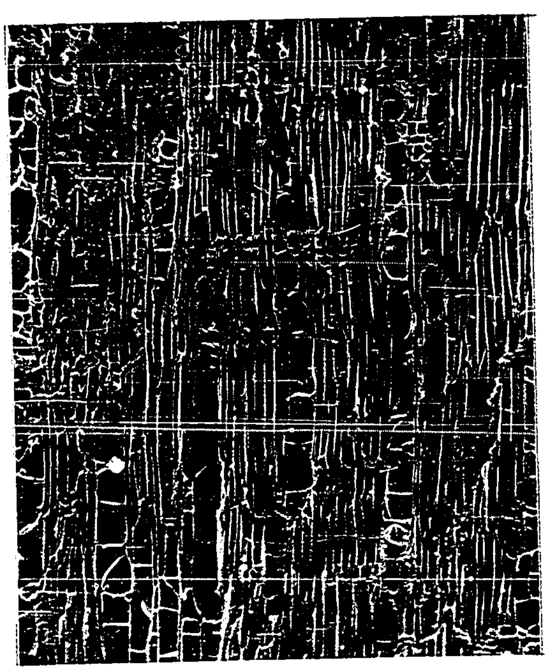

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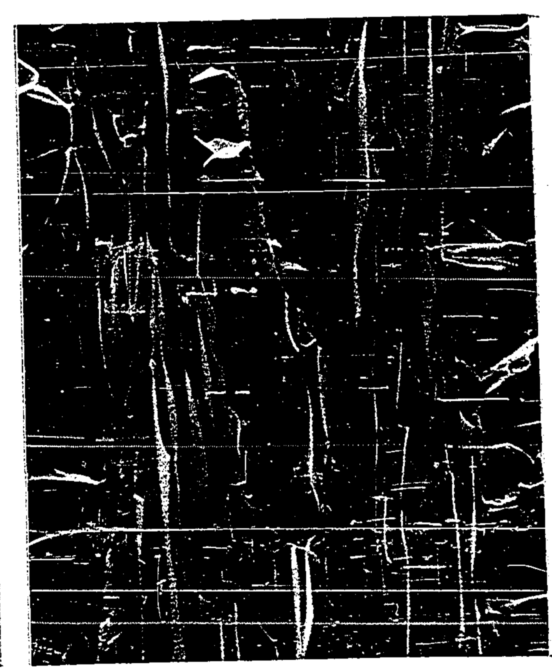
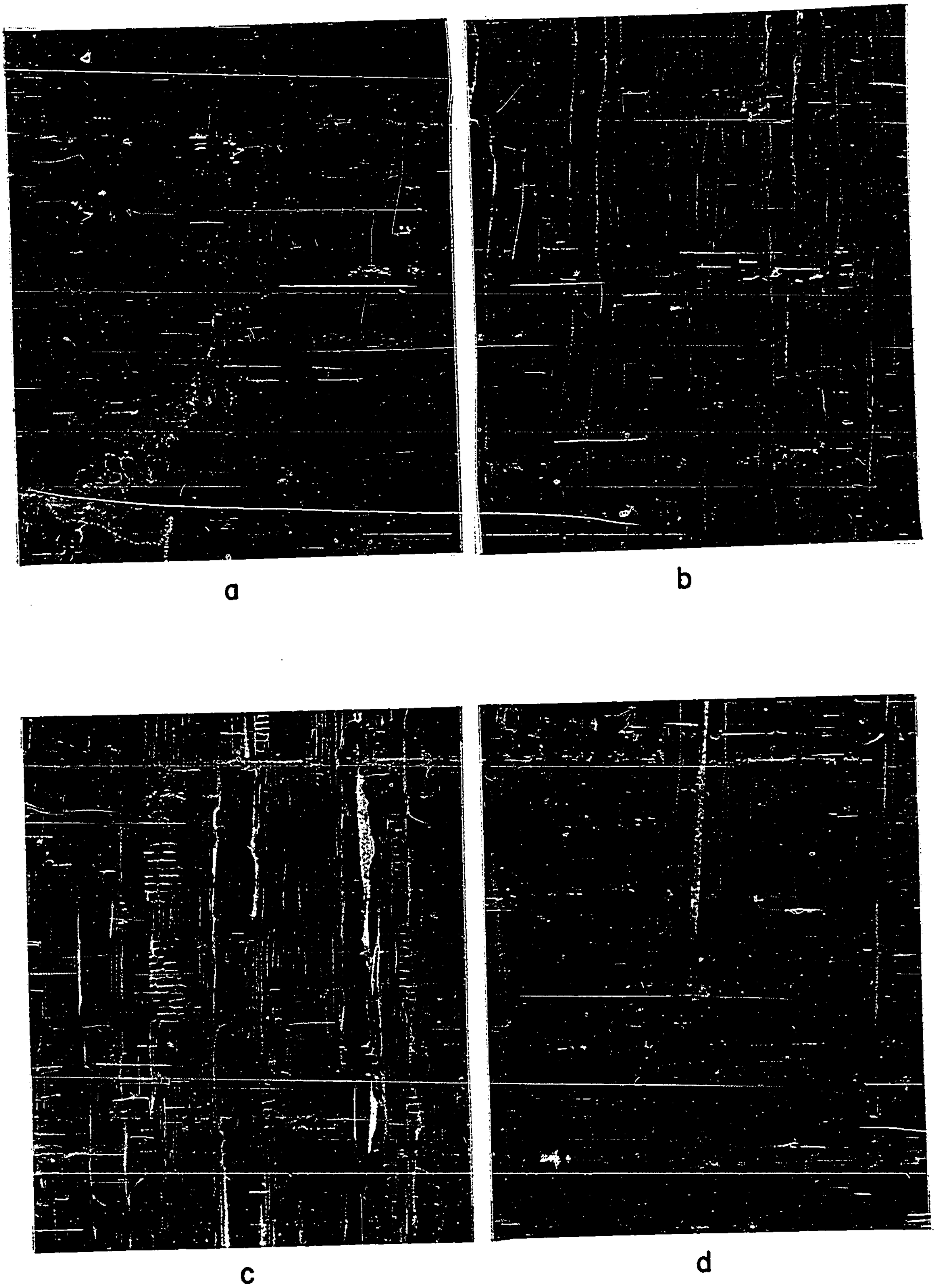


d

Fig. L.22.
Populus euphratica

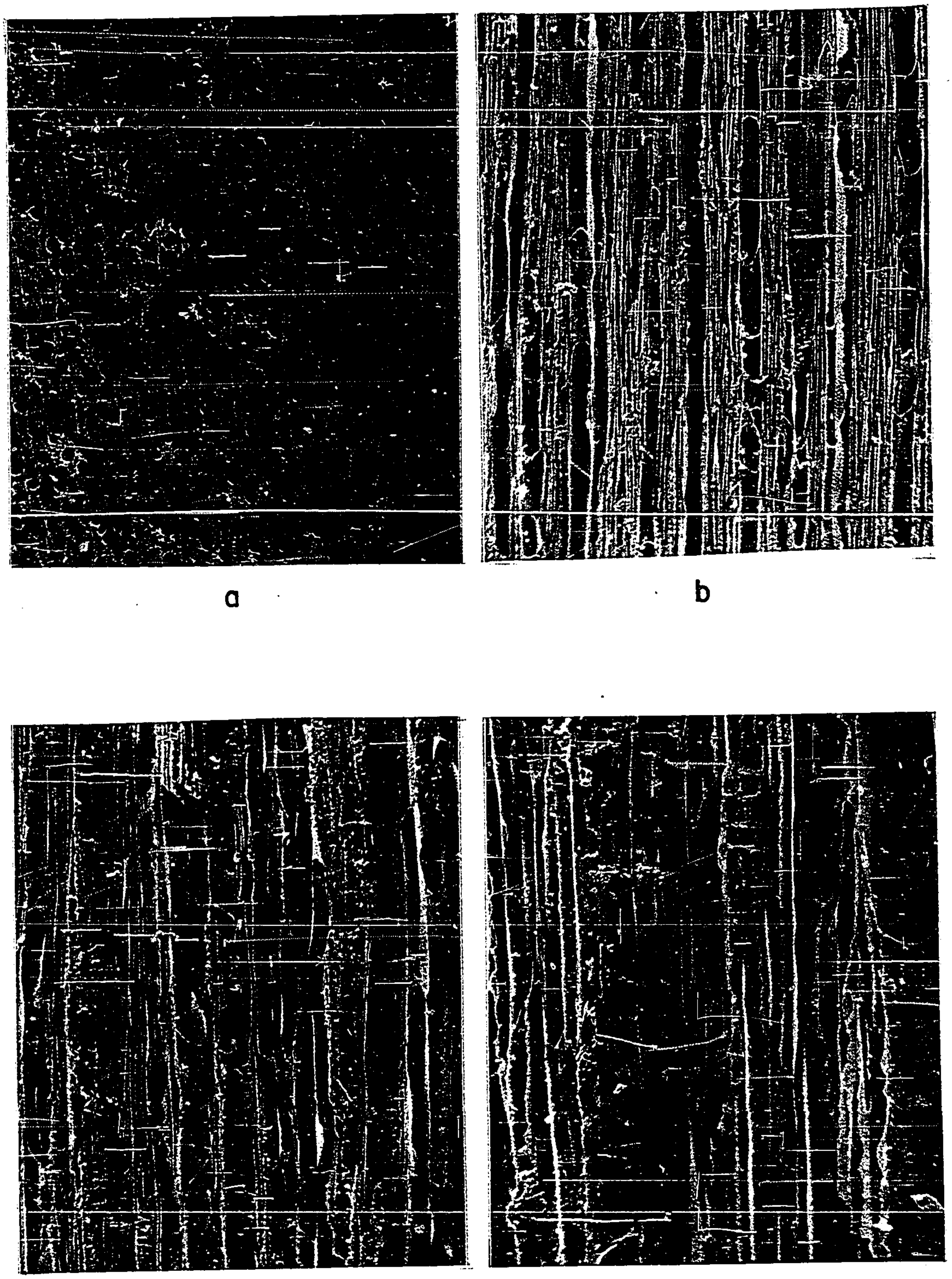
a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



a b c d

Fig. L.23.
<u>Populus nigra</u>

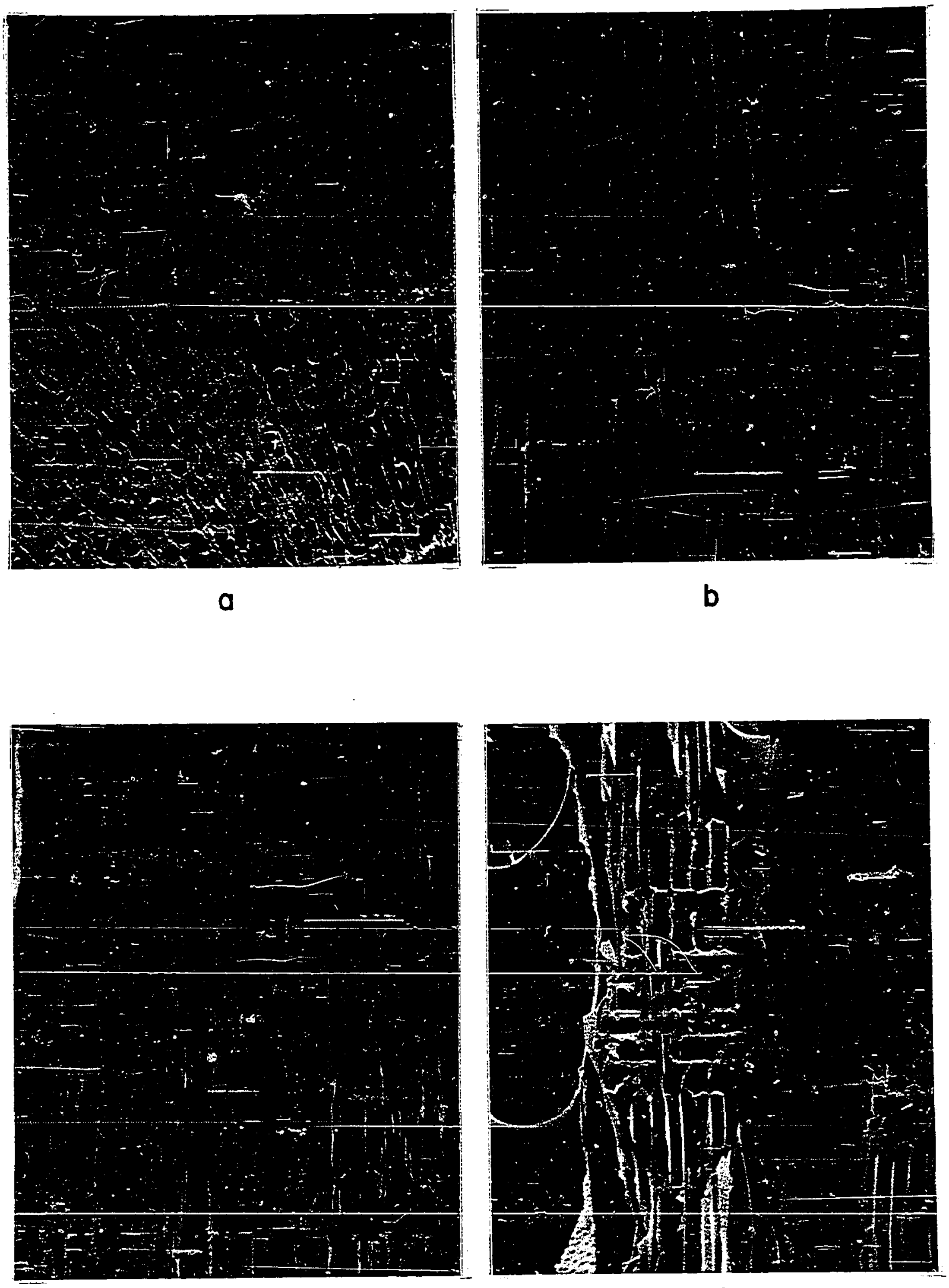
a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



a b c d

Fig. L.24.
<u>Salix</u> <u>excelsa</u>

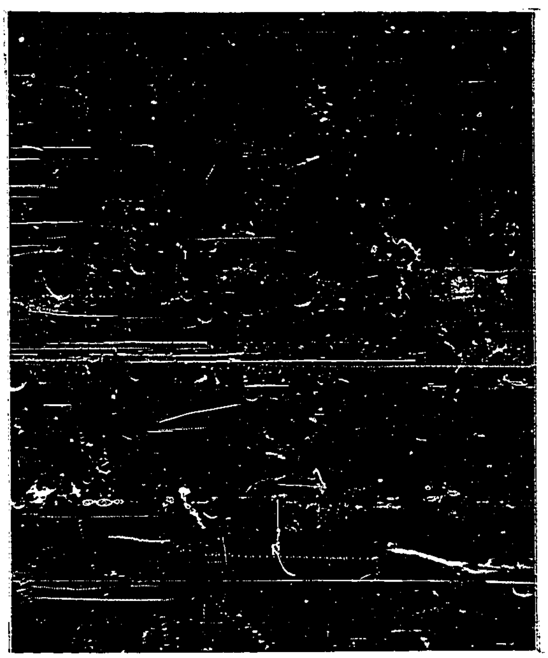
a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



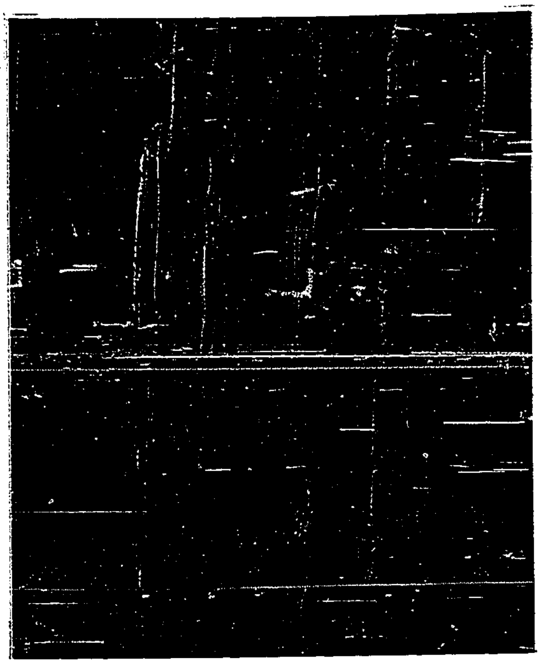
a b c d

Fig. L.25.
Lycium depressum

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)

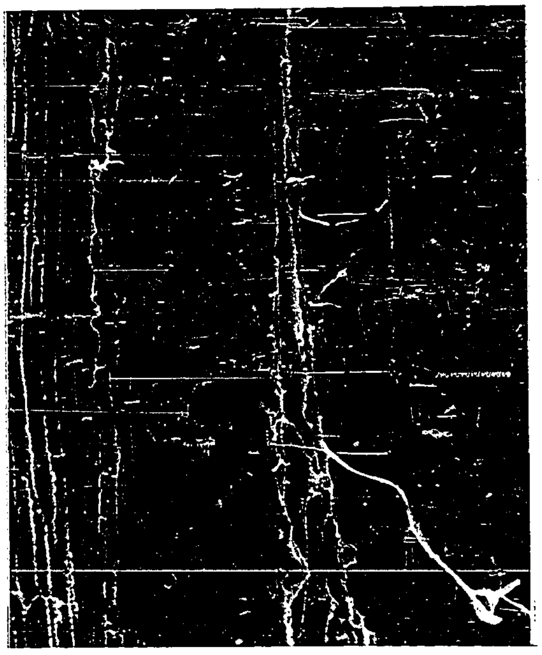


a



b

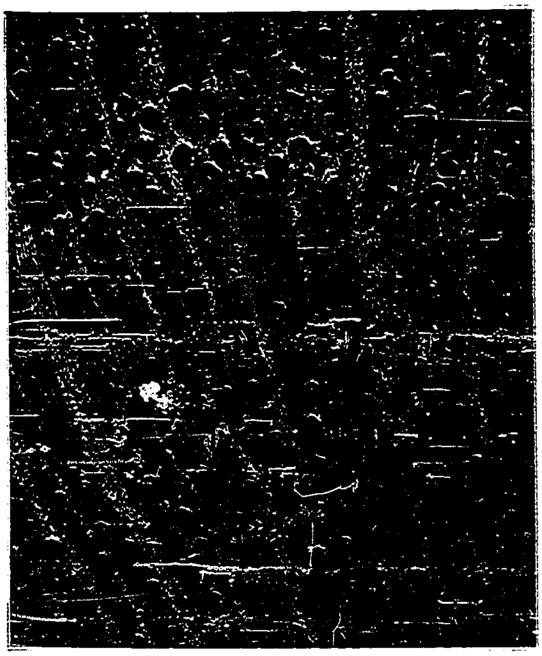
c

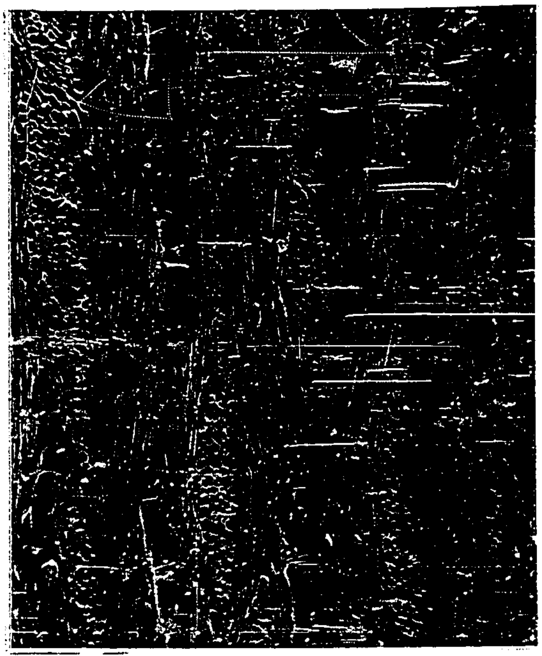


d

Fig. L.26.
<u>Tamarix tetragyna</u>

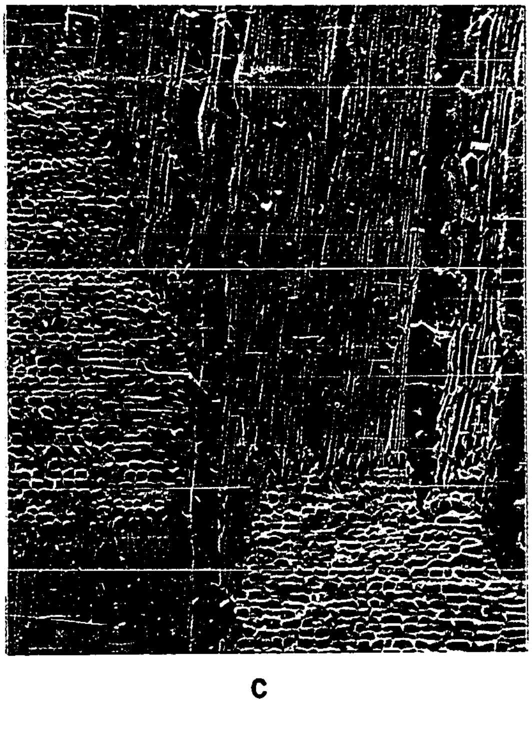
a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (600x)

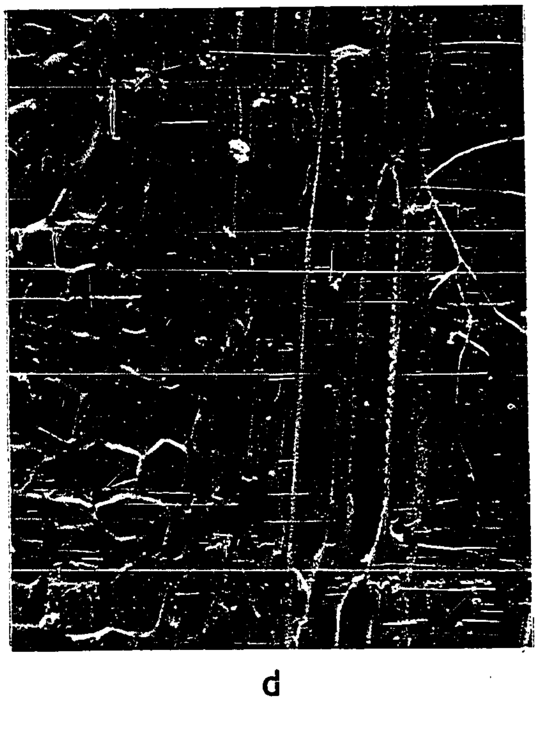




a

b





c

d

Fig. L.27.
<u>Daphne acuminata</u>

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)

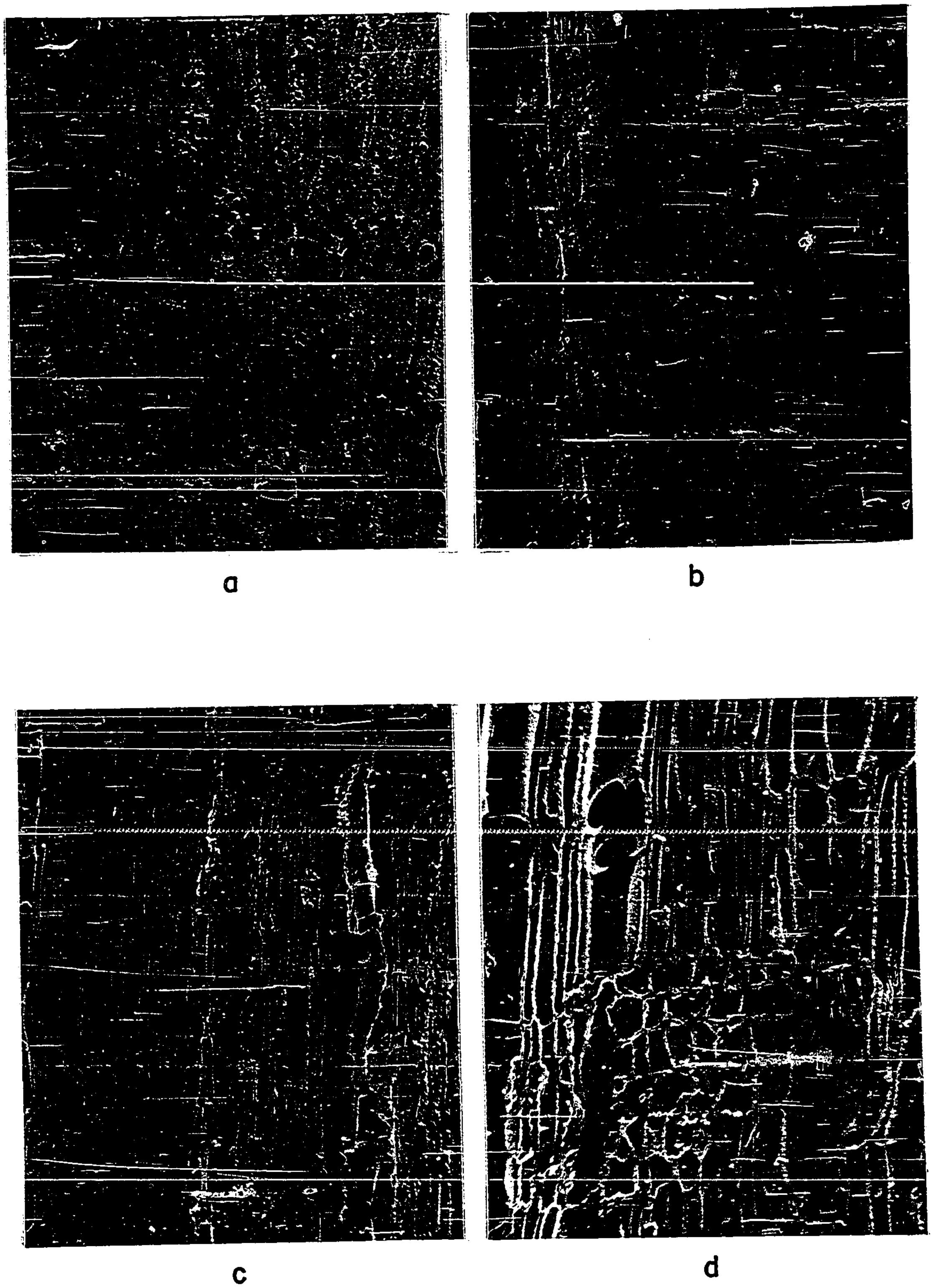
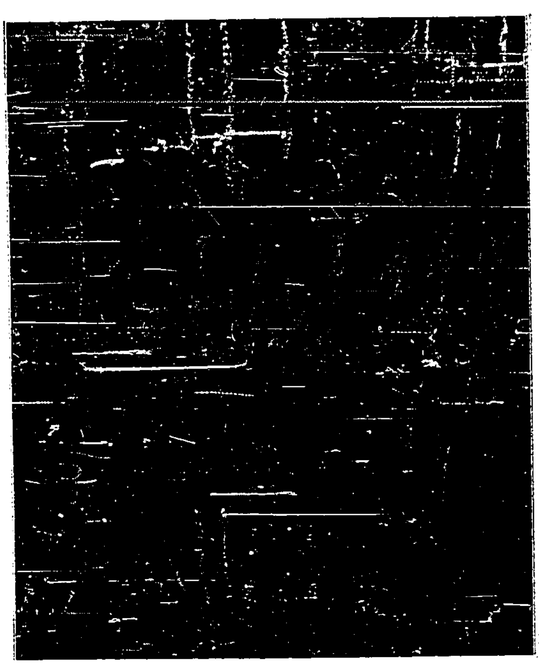
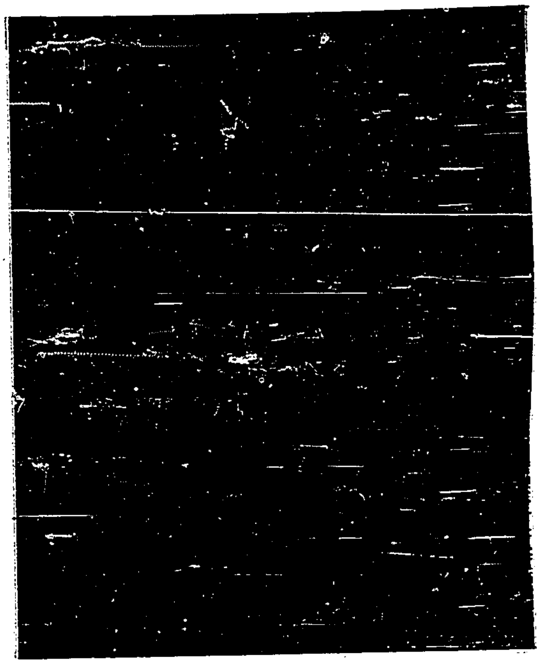

a
b
c
d

Fig. L.28.
<u>Celtis caucasica</u>

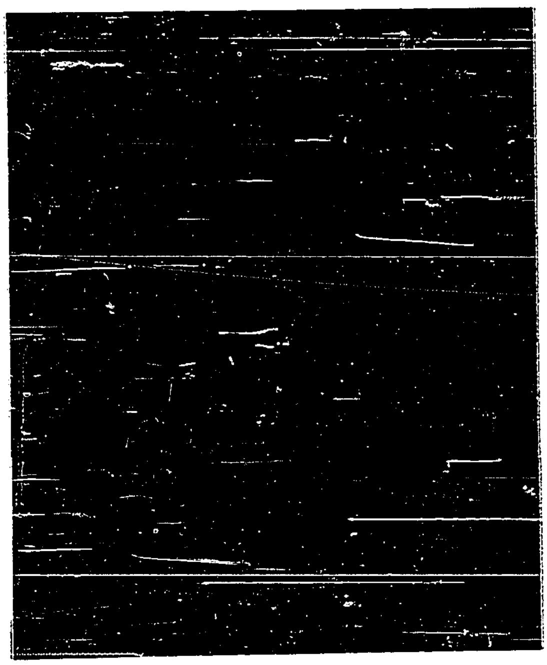
a. Transverse (50x) b. Tangential (150x)
c. Radial (100x) d. Radial (520x)



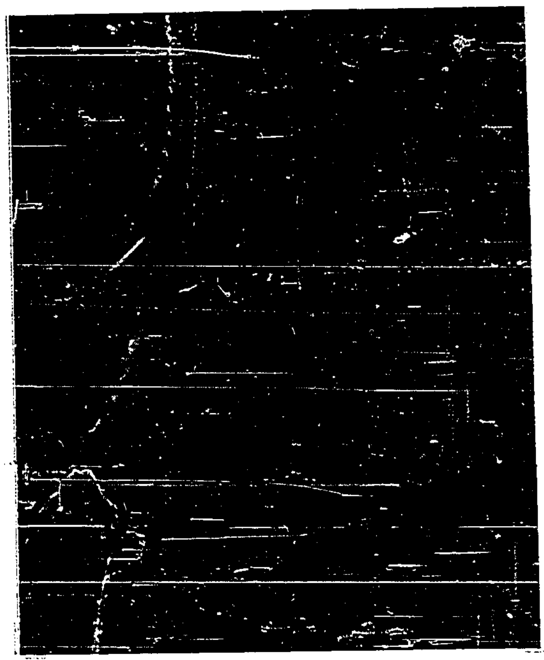
a



b



c

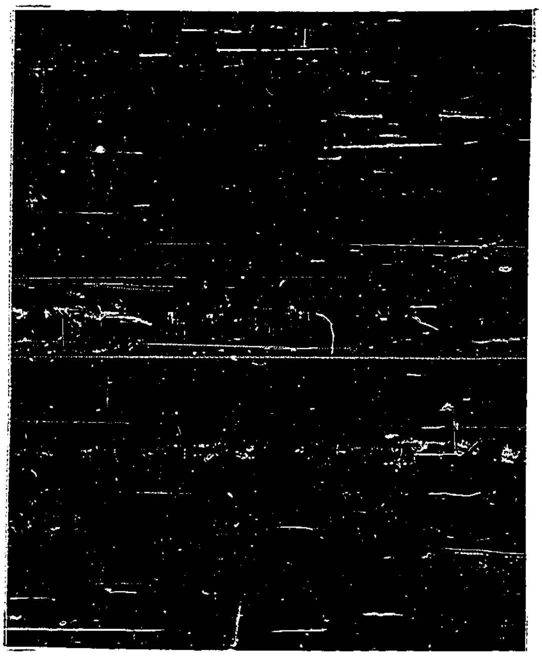


d

Fig. L.29.
Vitex pseudo-negundo

a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)

a



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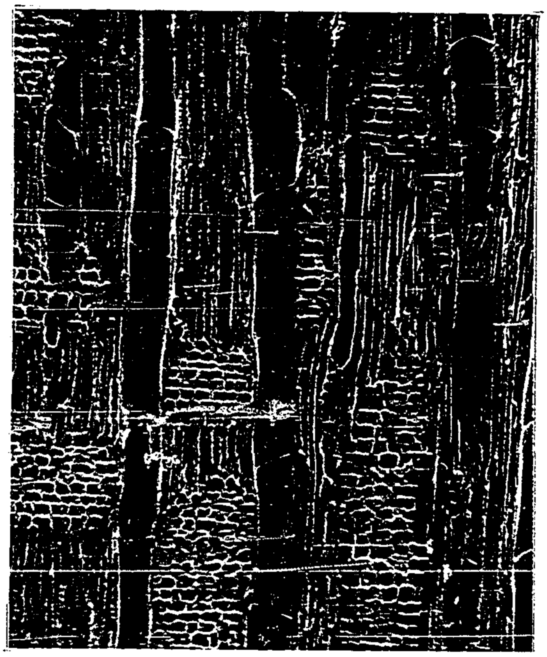
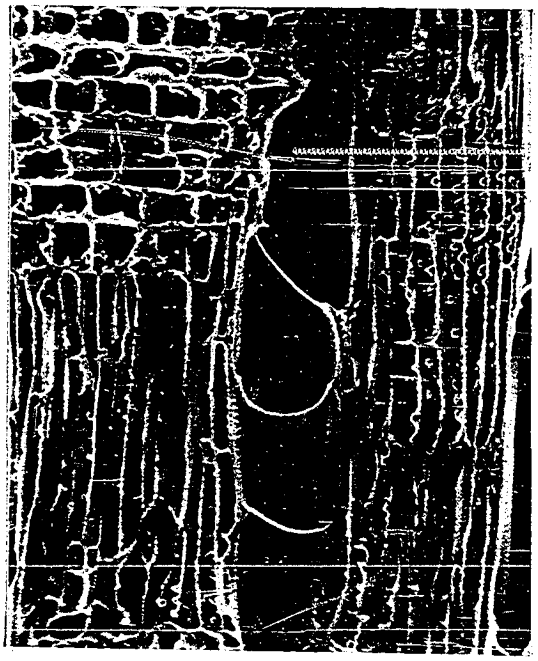


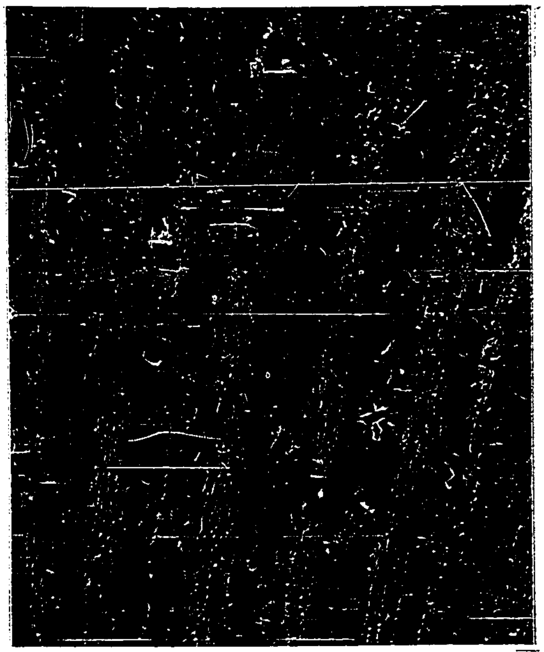
c



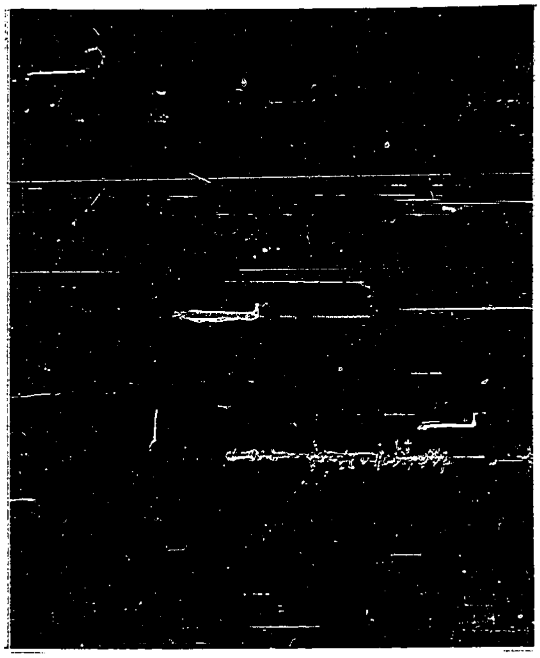
d

Fig. L.30.
<u>Vitis vinifera</u>

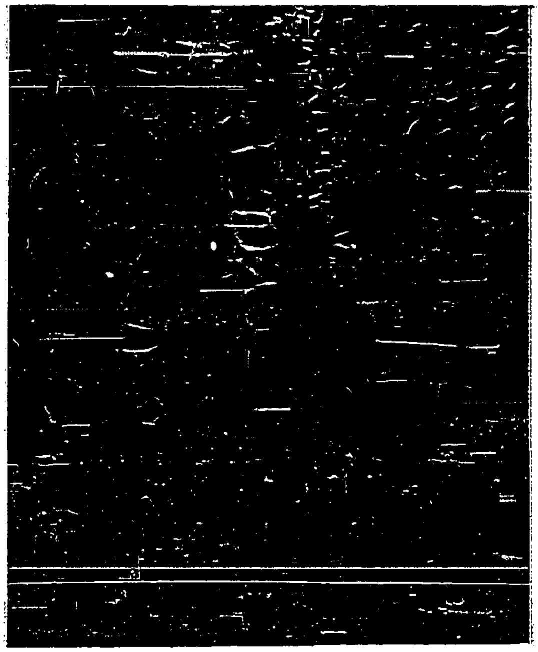
a. Transverse (50x) b. Tangential (100x)
c. Radial (100x) d. Radial (300x)



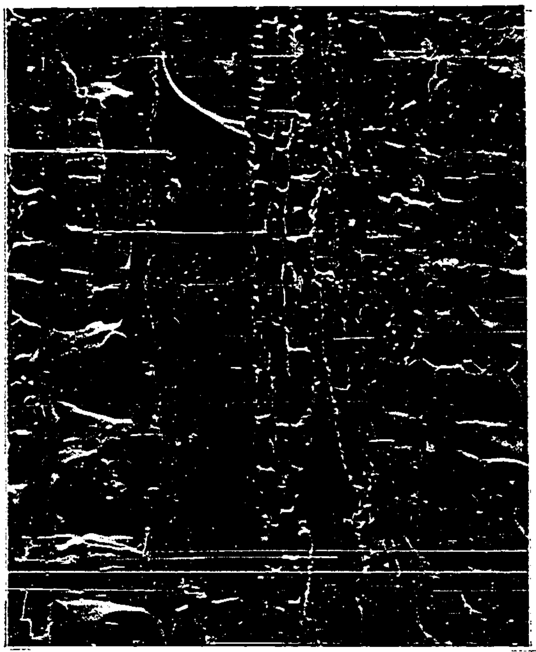
a



b



c



d