New Ideas about the Origin of Agriculture Based on 50 Years of Museum-Curated Plant Remains

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A COMMITMENT to the perpetual storage and curation of archaeological plant remains was not commonplace in American museums of anthropology until quite recently. The historical bias against maintaining archaeological plant specimens undoubtedly derives from two sources.[1] First, museums have been accustomed to preserve obvious artifacts of human manufacture. These antiquities were regarded as cultural whereas animal bones and vegetable fragments and charcoal were considered environmental or subsistence evidence. Today, of course, these organic remains are recognized as products of human cultural behavior, because every culture classifies its biological world and selectively hunts or gathers from a range of possibilities. Thus these biological discards are evidence of past cultural principles guiding human extraction from nature. Furthermore, some of these remains are actually artifacts; that is, they represent plants and animals whose genetic composition or natural distribution was so altered by human selection and behavior that they could not survive in place or would not exist at all if it were not for human maintenance. Second, these plant remains are so fragile and heterogeneous in composition that many museums were, and continue to be, ill-prepared for their permanent curation. In both cases, theoretical predilection and benign neglect have led to incalculable loss of irreplaceable research data.

Archaeological plant remains are indispensible to many problems of anthropological significance. They are evidence of past natural environments and can be used to reconstruct biological communities, climatic patterns, and edaphic conditions. Despite differential preservation and post-depositional destruction of much evidence, samples that do survive are useful for reconstructing qualitative aspects of paleonutrition. They also may be evidence for a variety of crafts and technological skills if preservation is sufficient. And, finally, they are indicators of human manipulations of individual species and are evidence of plant cultivation in new habitats and even genetically controlled domestication.[1]

Deliberate efforts to encourage archaeologists to recover excavated plant remains are about 50 years old. During this half-century the practice has slowly been adopted until today virtually every scientific excavation saves some archaeobotanical evidence by sieving or with some form of water separation or flotation apparatus.[2] Unfortunately, the habit was not developed early enough in the history of American archaeology that rock shelters and their fine desiccated specimens could be scientifically excavated. Although much was lost, several museums did preserve some material before these shelters were totally vandalized, and it is in these institutions where these plant fragments can be re-examined to validate previously identified specimens, to discover new cultigens, and to test ideas about agricultural developments north of Mexico. The new conclusions about prehistoric agricultural origins in this region that have resulted from recent studies of these older collections are the subject of this paper.

HISTORY OF ARCHAEOLOGICAL PLANT PRESERVATION

Before 1930 a few archaeologists did conscientiously save plant remains from their excavations, but they were then faced with the difficulty of finding a botanist who was willing or able to identify charred fragments or dried and wilted prehistoric discards. One attempt to resolve this dilemma was made by Dr. Carl E. Guthe, who was chairman of the National Research Council Committee on State Archaeological Surveys, Division of Anthropology and Psychology, when he mailed a notice on September 17, 1930,[3] to most archaeologists inviting them to send their archaeological botanical specimens to the newly founded Ethnobotanical Laboratory, Museum of Anthropology, University of Michigan (UMMA) for Dr. Melvin R. Gilmore to identify. An almost identical announcement was published in 1931 in the *American Anthropologist*.[4] Gilmore, whose actual title was curator in the Division of Ethnology, arrived at

Michigan in 1929 after having been a curator in several museums. He was a trained ethnobotanist, but had had little experience identifying archaeological plant remains. The demand for his service was instant, and in order to maintain this service he was joined in 1931 by a student, Volney H. Jones, whose botanical talents had been directed to ethnobotany by Dr. Edward Castetter at the University of New Mexico. Almost immediately upon his arrival Jones undertook all the identifications of archaeological plant specimens as Gilmore's poor health prohibited full dedication to the development of new skills, curation, and written reports that Guthe's bold and magnanimous solicitation warranted. The complexity of this unrestricted invitation and the demands it imposed upon an individual botanist have been expounded upon by Jones.[5] Gilmore[6] did recognize the difficulty Guthe's request created for the proper identification and interpretation of plant material from *anywhere* in the continental United States, and he published instructions for archaeologists that would lessen the task. It is a testimony to Gilmore and Jones that the Ethnobotanical Laboratory has a collection of very important plants of known provenience that have been continuously curated, which after 50 years continues to be available for reexamination.

The UMMA Ethnobotanical Laboratory was not the only museum where botanists could locate archaeological plants if they desired to study either prehistoric distributions of taxa or domesticated forms. The Botanical Museum at Harvard University also was receiving collections of archaeological plants, although its largest collections grew after Dr. Paul Mangelsdorf arrived to continue his classic studies on the domestication of maize (*Zea mays*). The Department of Anthropology at the University of Arkansas had an extensive collection from the Ozark Bluff Dwellers, which was studied by Gilmore as a result of his association with Mr. Mark Harrington, who, as his colleague at the Museum of the American Indian in New York, had excavated several dry shelters in these mountains[7] and of his later friendship with S. Dellinger. A decade later as interest in aboriginal plant domestication by botanists expanded, the Missouri Botanical Garden in St. Louis, under the leadership of Dr. Edgar Anderson, began to build extensive archaeological plant collections. This activity was continued by Dr. Hugh Cutler until his recent retirement; the collections have now been distributed elsewhere. The past two decades have witnessed the establishment of several prominent centers where archaeological plants are curated and with specialists who continue the work first initiated by Gilmore and Jones.[1,8]

CURATORIAL PROCEDURES

A commitment to the curation of archaeological plant specimens is not an easy undertaking. The diversity and heterogeneity of the remains requires special cabinets and constant attention. The capacity to identify them, although not a prerequisite to proper curation, adds additional problems and often unmet costs.

Since the UMMA Ethnobotanical Laboratory has had the longest experience curating these specialized anthropological collections for future research, it exemplifies the problems and solutions. The archaeological specimens that were sent in response to Guthe's announcements included desiccated plants from dry shelters in the East and pueblos in the Southwest and charred (carbonized) fragments from open sites. The museum had to be equipped to house these materials as well as pressed plants and other modern, taxonomically specific comparative material for validating identifications. Fortunately, the museum building was only two years old in 1930 and space was not a constraint as it is today. The Ethnobotanical Laboratory had large wooden Kewanee museum storage cabinets with rubberized gaskets. Each site was assigned an Ethnobotanical Laboratory Report number, the collections which were not returned upon request were accessioned, and the specimens were catalogued individually with storage in their own cardboard box in drawers. Since both dehydrated and charred plants occupied the same cabinet, constant fumigation was practiced in all occupied storage cabinets to prevent insect infestation in the dried plant boxes. Paradichlorobenzene was used as a constant deterrant, and semi-annually, a lethal mixture of carbon tetrachloride and ethylene dichloride was used to kill any insects or larva. The gaskets had to be replaced eventually, but the original cabinets are still in use. Pressed plants were stored in wooden herbarium cabinets.

Originally the collections were stored sequentially according to their UMMA Ethnobotanical Laboratory number, but as the number of collections grew they were organized according to anthropological cultural topics (e.g., smoking materials), botanical anatomical categories (e.g., wood, seeds, corncobs), and various cultigens (e.g., *Cucurbita, Helianthus*). Both archaeological and modern comparative materials were combined, and curation practices continued as initiated at the inception of the Laboratory.

Today curation follows the procedures outlined above except that OSHA-approved fumigants are employed and most of the recent charred material is stored in a separate storage area. Otherwise, the first domesticates brought into the laboratory are still available for study.

The literal flood of plants which has inundated all laboratories in the past two decades was anticipated by Cutler,[9] and although the financial support and cooperation he sought from archaeologists are still sporadic, at least vital data are not wantonly discarded as was once the practice.

PREVIOUS AGRICULTURAL STUDIES WITH THE COLLECTIONS

The ethnobotanical collections preserved at Michigan have been the source of several historical studies into the development of agriculture in prehistoric North America. Corn, beans, and cucurbits, which were originally derived in prehistoric times from Mexico, and native sunflowers have been investigated by visiting scholars to the Ethnobotanical Laboratory.

One of the most creative botanists to consider ethnobotanical collections in museums for new research was Dr. Edgar Anderson. He was a visitor to the UMMA Ethnobotanical Laboratory and remembered the extensive collection of prehistoric cobs and modern Pueblo corn in the laboratory. When Brown and Anderson wrote their definitive paper on Northern Flint corn, they recognized the archaeological antecedents to the Iroquois and Missiouri River Valley corn which they collected. To illustrate the classic type in prehistory they selected the charred cobs from the Late Woodland Gibralter site in Southeastern Michigan, which were (and still are) curated in the laboratory.[10]

One of Anderson's students was Dr. Charles Heiser, now a famous botanist in his own right. When Heiser first undertook the study of the common sunflower (*Helianthus annuus*) as used by American Indians, Anderson referred him to Volney Jones and the Michigan collection. Heiser developed a model for the domestication of this indigenous annual plant after studying its distribution from herbaria collections and its archaeological manifestations in collections at Arkansas and at Michigan. The achenes and heads from Newt Kash Hollow Shelter, Kentucky, were particularly important for his work. These were first studied by Jones,[11] were subsequently stored in the Ethnobotanical Laboratory and at the University of Kentucky,[12] and were made available to Heiser.

The value of maintaining archaeological botanical collections is well exemplified by Kaplan's summary of cultivated beans in the prehistoric Southwest. He used plant collections from 10 museums, including the

UMMA Ethnobotanical Laboratory. The investigation was Dr. Kaplan's dissertation, and the published study remains a testimony to the preservation ethic that was slowly developing in the 1950s and the cooperation of museums, which was essential for the successful completion of his now classic study.[13]

The phylogeny, prehistoric distribution, and identification of the cucurbit family were in disarray in the 1950s. The problem had been recognized for sometime by botanical specialists, but was highlighted by the difficulties related to the identification by Whitaker and Cutler of plant remains excavated by MacNeish in Tamaulipas, Mexico.[14] To remedy the problem these botanists examined all major collections of squash and pumpkin (*Cucurbita* spp.) and gourd (*Lagenaria siceraria*) seeds, peduncles, and rinds in American museums. Both authors spent several days identifying each specimen in the UMMA Ethnobotanical Laboratory, which comprised a major portion of the material from the eastern United States and many specimens from the Southwest.[15] Without these well-curated collections of such diverse plant parts, particularly those at Michigan and the Missouri Botanical Garden, a study of this magnitude would have been impossible for at least another decade, and the archaeobotany of the cucurbits in the Americas would have remained speculative.

NEW IDEAS ABOUT THE ORIGIN OF AGRICULTURE

AN EASTERN AGRICULTURAL COMPLEX

Gilmore was the first to recognize that plants indigenous to the eastern United States may have been cultivated by prehistoric people. In the course of identifying specimens from the Ozark Bluff Dweller shelters at the Museum of the American Indian and later at the University of Arkansas, he found seeds of goosefoot (*Chenopodium*), pigweed (*Amaranthus* sp.), giant ragweed (*Ambrosia trifida*), marshelder (*Iva xanthifolia*), and canary grass (*Phalaris caroliniana*) stored with corn, squash, beans, and sunflower seeds, which were known to be cultivated.[7] Jones had the opportunity to investigate this idea further when, in response to Guthe's appeal, W.S. Webb sent him desiccated plant specimens from Newt Kash Hollow Shelter in Menifee County, Kentucky. His pioneering report[1] lent credence to Gilmore's idea that a large seeded goosefoot, perhaps the Mexican species *Chenopodium nuttalliae*, was cultivated along with *Ambrosia, Iva, Phalaris*, and *Helianthus*. He also concluded that this native complex was more important than the tropical American agricultural complex.[11] Jones was unable to substantiate *Amaranthus* as a possible native cultivar, and recent investigators also note its rare occurrence. The conclusions Gilmore and Jones reached about the other plants, however, were widely accepted until recently when each species was reexamined using existing museum collections as well as some new evidence.

Jones was necessarily tentative about several of his conclusions because of an absence of stratigraphic control during the excavation and the nonexistence of an adequate dating technique. Radiocarbon dating remedied this situation so Jones submitted UMMA curated grass bedding associated with these possible cultigens for dating and found they dated to 640 B.C.[16] His second problem, the priority of cucurbit cultivation, was not answered until recently.[17] Thus, almost 20 years expired before an Early Woodland date could be assigned to the Kentucky material and an additional 25 years elapsed before the relationship between the priority of cucurbit-based gardens and later native cultigens was resolved.[1]

The first of these potential Eastern domesticates to receive modern botanical scrutiny and revision was the giant ragweed (*Ambrosia trifida*). The large achenes and lighter fruit colors, which contrasted with modern wild plants, caught the attention of Gilmore.[7] Willard W. Payne, who was concerned with aeroallergens and the taxonomy and distribution of *Ambrosia*, collaborated with Jones to reassess the status of the prehistoric giant ragweed as a possible domesticate. They discovered that the Ozark Plateau is an area where the small Western genotype and the larger achene in the Eastern genotype converge and could produce the variation in seed size noted by Gilmore and confirmed by these author's statistical examination of the Arkansas shelter collections housed at Michigan. Payne also noted that dry storage of seeds over winter does not lead to successful germination the next year and the light color did not characterize all archaeological achenes. The conclusion reached by Payne and Jones was that the giant ragweed certainly was collected for some cultural purpose but there was no botanical basis for assuming that it was a cultivated variety.[18] Thus on the basis of museum collections and botanical experimentation the giant ragweed should not be considered a member of the Eastern Agricultural Complex.

The second candidate represented in UMMA Ethnobotanical Laboratory collections to be restudied was *Iva*. After Gilmore had first identified the Ozark specimens, Jackson revised the genus to include the oversized archaeological achenes.[19] Black undertook a phytogeographic study of the archaeological achenes now designated *Iva annua* var. *macrocarpa*.[20] She noted at the time that they were reported only from Arkansas, Missouri, and Kentucky. More importantly, *Iva* was not found in modern plant collections from Kentucky. The achenes of the archaeological specimens also were larger than herbarium collections from elsewhere and were usually associated with cultivated primitive sunflowers. The totality of these lines of evidence, the exclusive archaeological existence of macrocarpa, its distribution, and its association with the sunflower substantiated Gilmore's and Jones's verdicts that domestication of *Iva* was represented in the dry shelters.[20] Yarnell had access to even more extensive collections than Black had. He performed a more detailed statistical study of the achenes and was able to reaffirm Black's conclusion. He also demonstrated that by applying proper chronological ordering to the museum collection, the evolution of larger sumpweed achenes under human selection could be traced from Early Woodland to Mississippian periods.[21] Like the sunflower, the sumpweed was a native cultigen.

Chenopodium presented a more complicated problem. Basic taxonomic confusion had credited at least two species as potential cultigens in the East. One was a small seeded *C. album*. The second a large seeded *C. nuttalliae*, known as a domesticate in Mexico but identified from the Ozark shelters by W.S. Safford in response to an inquiry from Gilmore. Nancy Asch and David Asch re-examined the collection in the UMMA Laboratory of Anthropology.[22] They followed the revision of the genus by Wahl rather than Fernald. They concluded that the small seeds are actually *C. Bushianum* and that all the seeds are within the range of modern seed collections. (*C. album* is a European species.) The large seeds from Newt Kash, some from the Ozarks, and the archaeological Prairie villages had been misidentified and are pokeweed (*Phytolacca americana*). Some large seeds from the Ozark shelters were different, however, and Safford's identification of these limited samples was correct. Today they are identified as *Chenopodium berlandieri* ssp. *nuttalliae* (*C. nuttalliae*).[23] Indeed, there are two goosefoots in the East. One, *C. Bushianum*, may have been encouraged and even tended by prehistoric Amerinds, but not domesticated. The second, appears to be an introduction from Mexico in the late prehistory of the East and was not cultivated to any great extent, if at all, beyond the Mississippian occupation (after A.D. 1000) in the Ozark shelters.[1] If these museum collections had not been properly curated for the past 50 years, deciphering this complex taxonomic situation and the true identity of the seeds would have been impossible because the evidence is exceedingly rare.

The last candidate for membership in the Eastern Agriculture Complex is maygrass. Cowan has re-assessed its status by examining the museum collection at Michigan and determining its natural occurrence as evidenced in herbaria collections. He concludes that, indeed, it was grown in prehistoric Kentucky beyond its modern range of distribution but no evidence of genetic changes are obvious in the inflorescence or seeds.[24] It remains a member of the complex but not as a genetically altered domesticate.

The availability of these museum collections has provided a new perspective on the Eastern Agriculture Complex. Several plants actually underwent genetic changes and became dependent upon human populations for their very existence as true domesticated plants. These include sunflower and sumpweed. Goosefoot and maygrass were undoubtedly cultivated and probably were transported to habitats beyond or more extensive than their natural distribution and ecosystemic position, but their cultivation did not lead to domestication. Giant ragweed and pigweed are probably not part of the complex, although the former deserves another study in light of recent excavations. The Mexican goosefoot appears too late in time, it was an introduced plant, and should not be considered part of this important complex which developed in Late Archaic and Early Woodland times.[1]

SOUTHWEST CORN

The origin of maize cultivation in the Southwest has been a subject of continuous debate. One collection of early maize which has been curated in the UMMA Ethnobotanical Laboratory for almost 50 years was excavated from Jemez Cave, a dry shelter in Sandoval County, New Mexico. The original excavators assigned a Pueblo IV date to it but did acknowledge some Basketmaker affinities. Jones studied the excavated plant collection and was always bothered by the primitive and phenotypically diverse cobs from the site.[25] A radiocarbon date of 490 B.C. (740 B.C. corrected date) gave credence to his suspicions, and Ford's excavation by natural stratigraphic levels rather than by the one-foot arbitary levels followed by the original excavators in 1934 substantiated both the date with cultural material and the presence of corn in all levels.[26] Berry has recently re-evaluated all the radiocarbon dates for putative early maize agriculture in the Southwest and has concluded that Jemez Cave is certainly one of the earliest agricultural sites in the Southwest.[27] Jemez Cave maize is currently being restudied and the data prepared for publication. Fortunately, excellent curation has preserved a collection that was long ignored by archaeologists of the Southwest who are interested in the earliest maize derived from Mexico.

CONCLUSIONS

The critical component of a museum is the collection: the material objects and their associated documentation. Museums of anthropology have a difficult curatorial task because of the heterogeneity of the material and the range of items prehistoric people collected for food, medicine, technology, commerce, and rituals. But these diverse expressions of human culture deserve curation that will have as its goal preservation in perpetuity. If museums fulfill this obligation, then they will be prepared for re-examination of otherwise forgotten collections.

No museum can predict what future scholars will want to learn. For 50 years a few museums have been curating plants from admittedly poorly excavated sites. Yet with new research tools such as radiocarbon dating, some of these problems can be overcome and new life can be given to the collections. The recent demand to study these plant collections and the new conclusions that have resulted are all the justification a museum needs for maintaining materials as mundane as plants. If we are as responsible with these same collections as our predecessors have been, then they will continue to be available whatever the next research question might be. No value can be attached to these specialized collections other than that they are irreplaceable. Yet without them many questions about human environmental adaptations and human creativity cannot be answered. All collections, including delicate plants, should be preserved with the assumption that the original research conclusions will be challenged at some time in the future, and curators should welcome the new hypotheses another generation of scholars ask about earlier collections. The UMMA Ethnobotanical Laboratory curators certainly have opened their collections in the past 50 years to archaeologists, ethnobotanists, botanists, geographers, and historians all with interesting results for the advancement of knowledge.

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