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GARDENING AND FARMING BEFORE A.D. 1000: PATTERNS OF PREHISTORIC CULTIVATION NORTH OF MEXICO

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ABSTRACT.—The beginnings of deliberate plant husbandry north of Mexico were not single processes in the Eastern United States and in the Southwest. Instead there were several periods of contact with Mesoamerica which resulted in the diffusion of specific plants into these areas, and they can be grouped into agricultural complexes. The first was the Early Eastern Mexican Agricultural Complex (Gourd Agriculture Complex) arriving in the East before 3000 B.C., resulting in gardens of bottle gourds and pepo gourds. The Eastern Agricultural Complex developed before 1000 B.C. and consists of 2 domesticated plants outside their modern range of distribution. The Upper Sonoran Agricultural Complex appeared in the higher elevations of the Southwest around 1000 B.C. with corn, gourds, and slightly later with beans. Corn and beans later diffused independently from the Southwest to the East where they were added to gardens and corn fields respectively. The Lower Sonoran Agricultural Complex is found in the more arid regions of the Southwest by A.D. 500 and although it includes several species of beans and squashes, cotton, and amaranth, only *Cucurbita mixta* and cotton became important outside areas where irrigation was almost mandatory. By A.D. 1000 prehistoric contacts with Mexico resulted in the Late Eastern Mexican Agricultural Complex with the arrival of tobacco and a domesticated chenopod. In contrast to the East, the indigenous Southwest Agricultural Complex began after Spanish contact and to date only the devil's claw is recognized. The Hispanic Agricultural Complex began when Spanish immigrants transported native tropical domesticates throughout their empire. Chili, tobacco, several squashes, and imported melons, wheat and many garden crops soon were grown beyond their pre-Columbian range. Each complex was grown initially in different ecological situations and had differential impacts on recipient cultures and subsequent cultural developments.

INTRODUCTION

In 1944, when Al Whiting published "The Origin of Corn: An Evaluation of Fact and Theory" (Whiting 1944), the archaeobotanical record was inconclusive in its support of any theory. Whiting assessed the competing ideas for the botanical and cultural beginnings of the domestication of maize, but had to conclude that although some had a higher probability of verification than others, none was sufficient without archaeological plant evidence. At that time the recovery of prehistoric plant remains was mostly happenstance. In the Southwest, for example, the first modern paleoethnobotanical report, Jemez Cave by Volney Jones (1935), had been published only in summary form, and Edgar Anderson had just begun to systematize archaeological maize and ethnographic examples in the Pueblo area (cf. Anderson and Blanchard 1942).

Despite these incipient beginnings, sufficient botanical evidence was accumulating from archaeological contexts, at least in the Southwest, that Carter (1945) was able to organize the available information into a scheme that would stimulate debate for the next decade. His hypotheses, too, remained subject to confirmation from the archaeological record. Sites such as Bat Cave (Mangelsdorf and Smith 1949) supplied the maize that botanists required from archaeologists to test their ideas. In the ensuing 35 years the recovery of archaeobotanical remains has become both sophisticated and commonplace. Whiting correctly emphasized that the archaeological record is the supreme measure of theories of the domestication of plants and as a consequence hypotheses proposed by Carter and others continue to be subjected to re-evaluation.

Today, in place of an emphasis on corn agriculture which typified the era when Whiting began his field studies, attention has turned to the intricate crop history of North America north of Mexico and the cultural and ecological position of each domesticated species within a particular subsistence pattern. The intent of this paper, then, is to delineate the crop complexes of the prehistoric United States based upon the ever increasing archaeobotanical record and to discuss the implications of their addition to prehistoric economies.

DISCUSSION

Prehistoric Agricultural Complexes

The concept of a prehistoric agricultural or crop complex implies a group of species with an apparent common geographic origin and a mutual association within particular environmental parameters in which the complex developed, although afterward an individual species may experience a separate geograhical distribution and history. The idea for geographical-based complexes originated with Linton (1924), but received continental application by Carter (1945), who recognized 2 distinct groups of crop plants in the Southwest, the Gila-Colorado and Plateau, each with separate origins and routes of diffusion. In addition he distinguished an Eastern Mexican Corridor as a source of agriculture in the East, which diffused to the Plateau, and a West Mexican Corridor (Carter 1945:12). Although the importance of each area relative to Linton's and Carter's theories has changed, nevertheless their insights are apparent in the agricultural complexes previously identified by Ford (1973) and expanded and elaborated upon in this paper.

1) Early Eastern Mexican Agricultural Complex (Gourd Agricultural Complex). Present evidence suggests that the first domesticated plants in the United States originated in eastern Mexico, probably diffused across Texas, and into the Southeast and the major river systems of the Midwest. This complex consists of *Lagenaria siceraria, Cucurbita pepo,* and perhaps *Cucurbita pepo* var. *ovifera.*

2) Eastern Agricultural Complex. Linton proposed this appellation, but it was Gilmore who in 1931 interpreted enlarged seeds of several indigenous species found in Ozark shelters as prehistoric domesticates. Jones (1936) further elaborated this theme with material from Newt Kash Hollow and suggested a possible independent origin of agriculture in the East. Although Mexican cultigens apparently precede these local domesticates, they did undergo a series of changes resulting in domestication, but they were never grown outside the East and the river valleys in the Missouri drainage. The domesticates are *Helianthus annuus* and *Iva annua.* There is a possibility that *Phalaris caroliniana* and *Chenopodium bushianum* were introduced and cultivated beyond their modern range without recognizable genetic modifications, however.

3) Upper Sonoran Agricultural Complex. Mountainous regions about 2000 m with sufficient precipitation for dry farming in southwestern New Mexico and southeastern Arizona were the first areas where crop plants from Mexico became established in the Southwest. This region coincides with the Upper Sonoran Life Zone in the Southwest and in the Sierra Madre Occidental of northern Mexico. These crops correspond to Carter's Plateau group, although he derived them from the eastern United States (Carter 1945:222). The crops in this complex are *Zea mays, Cucurbita pepo, Lagenaria siceraria,* and *Phaseolus vulgaris.* Corn and beans eventually were brought from the Southwest to the eastern United States.

4) Lower Sonoran Agricultural Complex. The crop plants constituting this group are tolerant of high temperatures but generally require supplemental moisture from irrigation. They probably were introduced from the Sonoran basin-and-range physiographic region of western Mexico characterized as the Lower Sonoran Life Zone into the Sonoran Desert region of southern Arizona. Despite its limited distribution, this complex, which is Carter's Gila-Colorado group, has the greatest variety of crops: *Gossypium hirsutum, Phaseolus acutifolius* var. *latifolius, Phaseolus lunatus,* perhaps *Phaseolus coccineous, Cnanvalia ensiformis, Cucurbita mixta, Cucurbita moschata,* and, *Amaranthus hypochondriacus.*

5) Late Eastern Mexican Agricultural Complex. Two plants, *Nicotiana rustica* and *Chenopodium berlandieri* var. *nuttalliae*, are found growing in Mexico and were part of the latest prehistoric record only in the East.

6) Southwest Agricultural Complex. The domestication of indigenous Southwestern plants has no recognizable archaeological history. Nevertheless, at least one native species, *Proboscidea pariflora,* is a domesticate today.

7) Hispanic Agricultural Complex. European contacts introduced many new crop plants of Eurasian and African origin to the Indians. In addition, these explorers brought previously unfamiliar domesticated plants from Mesoamerica and South America to the northern latitudes. The Spanish, in particular, had a profound impact on the distribution of crop plants, and their role will be described briefly.

Early Eastern Mexican (Gourd) Agricultural Complex (Fig 1)

Until recently it was common knowledge that agriculture was earliest in the Southwest and that corn had priority. This perspective has changed as a result of new excavations, and the East now appears to have received the first crops from Mexico, and its agricultural history was independent of the Southwest for at least 3000 years.

Cucurbita pepo L. and *Lagenaria siceraria* (Mol.) Standl. The evidence for squash and bottle gourd in the eastern United States dates back at least 4500 years and is derived from several contrasting archaeological contexts. Carbonized rind fragments of squash have been recovered through flotation at Koster, surprisingly dated between 6000 and 7000 B.P. (Asch and Asch 1979), at Carlston Annis and Bowles on the Green River in Kentucky (Marquardt and Watson 1977), and at Bacon Bend (21-2400B.C) and Iddins (1500 B.C.) in eastern Tennessee (Ferguson 1978:760). Iddins also yielded gourd. Uncharred, water saturated squash and gourd seeds and rind fragments have been excavated at Phillips Springs dated to 2000-2300 B.C. (Chomko and Crawford 1978; Kay 1979). Elsewhere, desiccated squash and gourd rind and seeds from the yellow flowered egg-gourd (*C. pepo* var. *ovifera*) were excavated in 1978 from early Late Archaic contexts at the Cloudsplitter Rockshelter, Kentucky.

The only comparable plant assemblage in northeastern Mexico is from the Tamaulipas excavations by MacNeish (1958, 1971). The Infiernillo and Ocampo phases, dated between 9000-5000 years ago, both contain squash and gourd and show the absence of corn. Although in Ocampo chili peppers and domesticated beans are present, neither is found north of the lower Rio Grande. The Mexican crop complex was introduced by diffusion from band to band and was grown in gardens as a complement to a pre-existing hunting and gathering economy based on climax forest products (Ford 1974, 1977a). The horticultural disturbance of the native plant communities formed a fertile bed for pioneer annuals and eventually late in the eastern Archaic for 2 tropical farm weeds, purselane (*Portulaca oleracea*) and carpetweed (*Mollugo verticillata*) (Chapman et al. 1974).

Squash and gourd husbandry were disseminated northward and westward during Late Archaic and Early Woodland times. Squash is reported dating back to 1000 B.C. at Sparks Rockshelter (Applegarth 1977), to 870 B.C. at Meadowcroft (Adovasio et al. 1978:649), and from Riverton (Yarnell 1976). Squash and gourd are both reported from 600 B.C. contexts in Salts Cave (Watson et al. 1969) and Newt Kash Hallow (Jones 1936). By 500 B.C. squash was grown at Leimback in northern Ohio (Shane 1967) as evidenced by rind fragments and at the Schultz site in Michigan as evidenced by a *pepo* seed from a sealed, uncharred vegetation lens (Wright 1964) and by a *ovifera* seed cast in an Early Woodland sherd (Ozker 1977). A "Mandan" variety squash seed found in a Woodland context has been identified from Boney Spring, Missouri (King and McMillan 1975).

The importance of the Eastern Mexican Agriculture Complex changed by Middle Woodland times in the Midwest. Prior to this period both squash and gourd were used for containers and the seeds were eaten. However, with an increase in the variety of uses for ceramic vessels, the seeds probably were still consumed, but more squash may have been selected for its edible fleshy quality rather than for a hard rind. Gourd rind remains now predominate (Ford 1980), and a gourd shaped pot was found in the Brangenberg Mound (Struever and Vickery 1973:1205).

Cucurbita pepo var, *ovifera* Alef. The history for the domestication of the egg gourd is not known. Morphologically it is similar to wild *Cucurbita texana* Gray of southern Texas, but whether it is ancestral to the domesticated form is a moot question (Cutler and Whitaker 1961:478). Remains of this small seeded, hard rind squash have been found in Cloudsplitter, the Schultz site, and at several very late prehistoric sites in the East. Otherwise, its actual importance to the prehistoric cultures is unknown.

The Early Eastern Mexican Agricultural Complex was the basis of plant husbandry in the East and continued to be grown until historic times. By A.D. 250 squash agriculture reached westward to Trowbridge in the Kansas City area (Johnson 1976:14) and afterward into the tributaries of the Missouri and into the Northeastern States (Yarnell 1964).

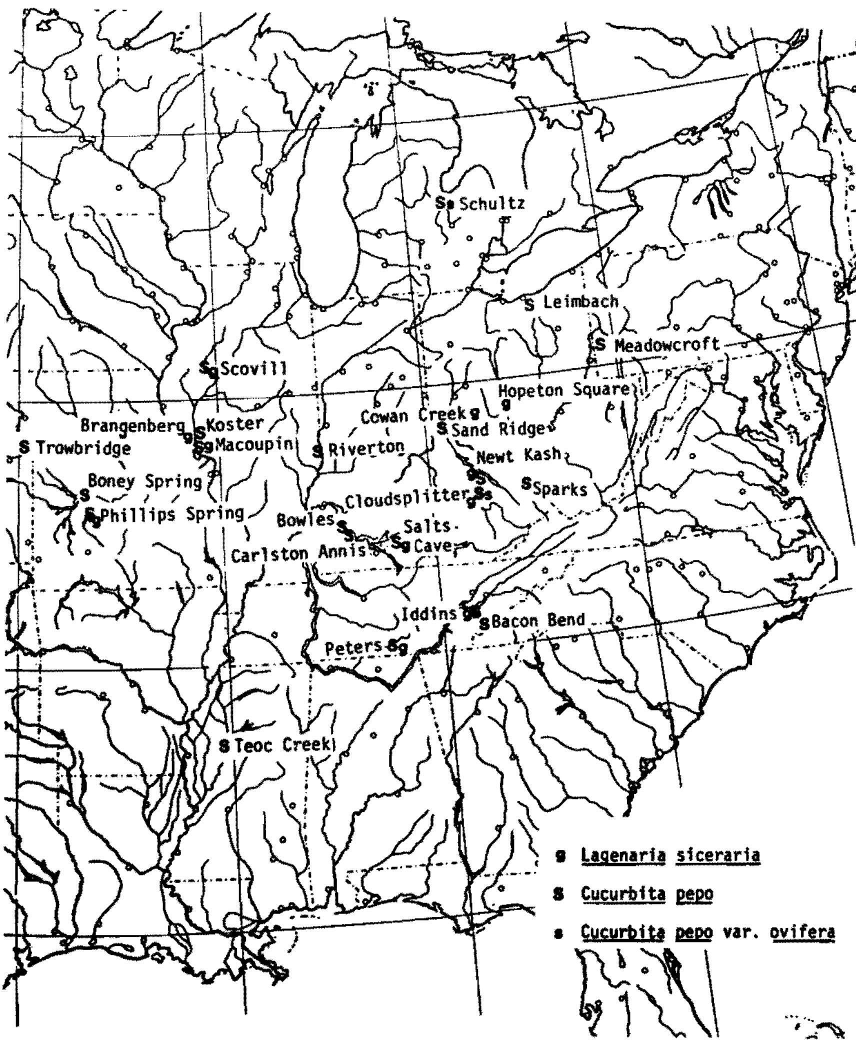

FIG. 1.— Early Eastern Mexican Agricultural Complex (Gourd Agricultural Complex).

Eastern Agricultural Complex

It now appears that the domestication of native plants in the East followed the introduction of tropical cultigens from Mexico. At the Koster site archaeological sumpweed shows no demonstrative change until long after garden horticulture began (Asch et al. 1972) and at Cloudsplitter evidence of squash precedes any seeds of native small seed cultigens.

Helianthus annuus L. Yarnell (1978) recently reviewed the archaeobotanical evidence for the increase in achene size as an indicator of the domestication of the sunflower starting in the Late Archaic. The earliest evidence for this 3500 years of development is derived from Salts Cave and Mammoth Cave in Kentucky and the Higgs Site in Tennessee. Increasing size is recognized in achenes from Middle and early Late Woodland contexts in the same geographical area. The sunflower apparently was another garden plant whose dietary importance was quite differential and localized in the East until Late Woodland times. No sunflower has been found in Ohio Hopewell sites, and it is reported from only one Late Woodland site, Sand Ridge, in Ohio (Featherstone 1977) until after A.D. 900. Then, apparently accompanying the evolution and diffusion in Late Woodland or Mississippian time of field agriculture, it became more important, and further selection produced achenes twice as large as those from Middle Woodland sites, especially in the Plains and Ohio River valley (Yarnell 1964, 1978).

Iva annua L. Unlike sunflower, when Jones (1936) first proposed the aboriginal cultivation of marsh elder or sumpweed, its use was unknown in the ethnobotanical literature. Since then, its botanical status as a domesticate has been established (Blake 1939), its prehistoric distribution beyond its modern range has been described (Black 1963), and its archaeological stages of domestication have been clarified (Yarnell 1972, 1978). Most recently Asch and Asch (1978) have discussed its ecological needs and its nutritional contribution to the prehistoric diet. Its history as a recognized domesticate, *Iva annua* var. *macrocarpa* Jackson, begins in the Late Archaic in Illinois and the Kentucky shelter area and continues in the central Midwest until historic contact. Although it may have been grown in some localities in the absence of other crops, e.g., Fisher-Gabert in Missouri (Robinson 1976:103), it appears to have been supplemental to other crops even when grown in Mississippian fields where its fruits were several times as large as their wild ancestor's.

Chenopodium bushianum Allen. The status of lambs-quarters in the East was ambiguous until Asch and Asch (1977) provided the systematics for most archaeological finds, eliminated *C. album*, an Old World introduciton in historic times, from contention, and demonstrated that no archaeological seeds have been found that are larger than the normal range of natural variability within native seed populations. However, this does not lead to the conclusion that it was not deliberately tended and cultivated in the gardens and fields where it volunteered or was planted. In fact, evidence from Cloudsplitter Rockshelter suggests that, indeed, it may have been planted in that part of Kentucky since an extensive ecological survey and herbarium search has failed to locate it today within miles of the site. Nevertheless, the seeds and even the inflorescence are recovered in quantity from the deposit suggesting its cultivation without concomitant domestication.

Phalaris caroliniania Walt. A similar situation applies to maygrass. Its presence in the Kentucky shelters and sites in eastern Tennessee beginning with the Late Archaic is beyond modern distribution established for it in a review by Cowan (1978). It is rarely recovered outside Kentucky or the Southeast, and has only been found at 2 sites north of the Ohio River (Featherstone 1977). In Arkansas archaeobotanical remains are within its present range. Cowan believes maygrass to be another starchy, small seed annual which attained garden status in the Late Archaic and was brought by humans to the northern limits of its maximal range.

Other plants at one time or another were considered to be native domesticates. Giant ragweed, *Ambrosia trifida*, whose large seeds from the Ozarks, thought by Gilmore to be domesticated, are actually the product of natural hybridization where clines of different seed sizes converge (Payne and Jones 1962). *Amaranthus* spp. is not a common seed in eastern sites and those found are not unusual in any botanical or cultural sense. *Polygonum erectum* was collected in quantity in the Illinois River valley and may have a local status similar to maygrass and chenopod (Asch and Asch 1978). Other plants found in quantity were simply extensively collected or were tended in the course of preparing gardens or fields, but none demonstrates genetic changes or dependence upon humans for the survival of the species (Yarnell 1977:870). To date archaeobotanical evidence demonstrates that only sumpweed and sunflower underwent actual genetic modification while chenopod and maygrass probably were introduced by humans to new environments and maintained there by them.

Upper Sonoran Agricultural Complex (Fig. 2)

Since 4 plants — corn, squash, gourd, beans — were first cultivated below the frost line in southern Mexico, they have been called the Tropical Agricultural Complex. For several thousand years, however, they were not the staple of any prehistoric diet, despite widespread transmission to many areas. In northern Mexico they were grown by nomadic hunters and gatherers who probably learned about each through visitations and through marriage with people from bands who cultivated one or more of these crops. Here an early form of Chapalote-type maize is recognized from an undated preceramic horizon in Swallow Cave, Chihuahua (Mangelsdorf and Lister 1956). Unfortunately, other early agricultural sites in northern Mexico are even less well-documented than this one.

Zea mays L. When maize first entered the southwestern United States remains debatable. A reassessment of Bat Cave maize gave it a post-2300 B.C. chronological placement (Mangelsdorf et al. 1967), but considering the interpretive problems caused by the excavator employing arbitrary stratigraphic units and by the pooled carbon samples for dating from within these 12 inch levels, the most reliable date is A.D. 198 on cobs from the top levels. Cultural evidence does support a preceramic date for most of the site without it necessarily dating before 1000 B.C. Similar difficulties confuse the interpretation of maize pollen from Cienega Creek. At one time a series of solid carbon dates yielded an age as early as 2200 B.C. (Haury 1957; Martin and Schoenwetter 1960). The redating of the deposits by the carbon dioxide gas proportional technique, however, produced dates for the lowest bed (D-1) averaging 500 B.C. (Michael Berry, personal communication, 1979). Other reputed early agricultural sites are equally problematical or have not been adequately published to permit a thorough evaluation. Stratigraphic difficulties caused by arbitrary excavation procedures plague LoDaisKa (Irwin and Irwin 1959), and a description of the stratigraphic association of the cobs from Fresnal Shelter (Wimberly and Eidenbach 1972) and of the maize pollen from En Medio in the Arroyo Cuervo region (Irwin-Williams and Tompkins 1968) as they relate to their assigned dates is lacking. Consequently, available evidence, as meager as it is, from Bat Cave, Tularosa Cave, and the undated deposit beneath the 490 B.C. (Ford 1975) level in Jemez Cave suggest that corn was introduced into the Southwest about 1000 B.C.

The phenotypes of the earliest maize reflect considerable genetic diversity. Although the "tiny" Bat Cave cobs have been reidentified as terminal portions from larger cobs (Mangelsdorf 1974: Figs. 14.1, 14.2), nonetheless the assemblage of preceramic cobs from this site demonstrates a greater range in size and an overall lower productivity than later Pueblo maize. Similar variability is evident in the desiccated cobs from Jemez Cave (Jones 1935), Tularosa Cave (Cutler 1952), and Cordova Cave (Kaplan 1953a). All early corn north of Mexico belongs to the Chapalote series (Winter 1973: 442), a small cob, popcorn.

A major developmental process which occurred in the first millenium B.C. was the introgression of this initial Chapalote type corn with teosinte. No teosinte fruits or plant parts have been found in the southwestern United States so it undoubtedly happened in northern Mexico, and corn with this germ plasm passed from one field of these high elevation hunters and gatherers to the next. The result was that by 500 B.C. even greater variation in row number, cob length, and cupule structure appears in cobs from Bat Cave

(Mangelsdorf et al. 1967), Tularosa Cave (Cutler 1952), and Jemez Cave. Some of the hybrid cobs were larger and more productive than those grown before introgression while others from the same population were less so.

A second influence on early Southwestern maize development is more controversial. This is the presence of 8-rowed corn or Harinoso de Ocho. This corn provided a higher yield, a greater range of adaptability, and easier grinding because of its large flour kernels. Harinoso de Ocho or Maiz de Ocho (Galinat and Gunnerson 1963: 121) is reputed to have originated in South America as the Cabuva race of Columbia, a derivative of Confite Morocho pop corn of Peru (Mangelsdorf 1974:687). However, Brown, in his review of Mangelsdorf (Brown 1974:687), rejects this putative ancestry of 8-rowed maize in North America. Despite its uncertain paternity, an 8-row maize genetic element does interbreed with preceramic maize within centuries of the appearance of teosinte introgressed maize.

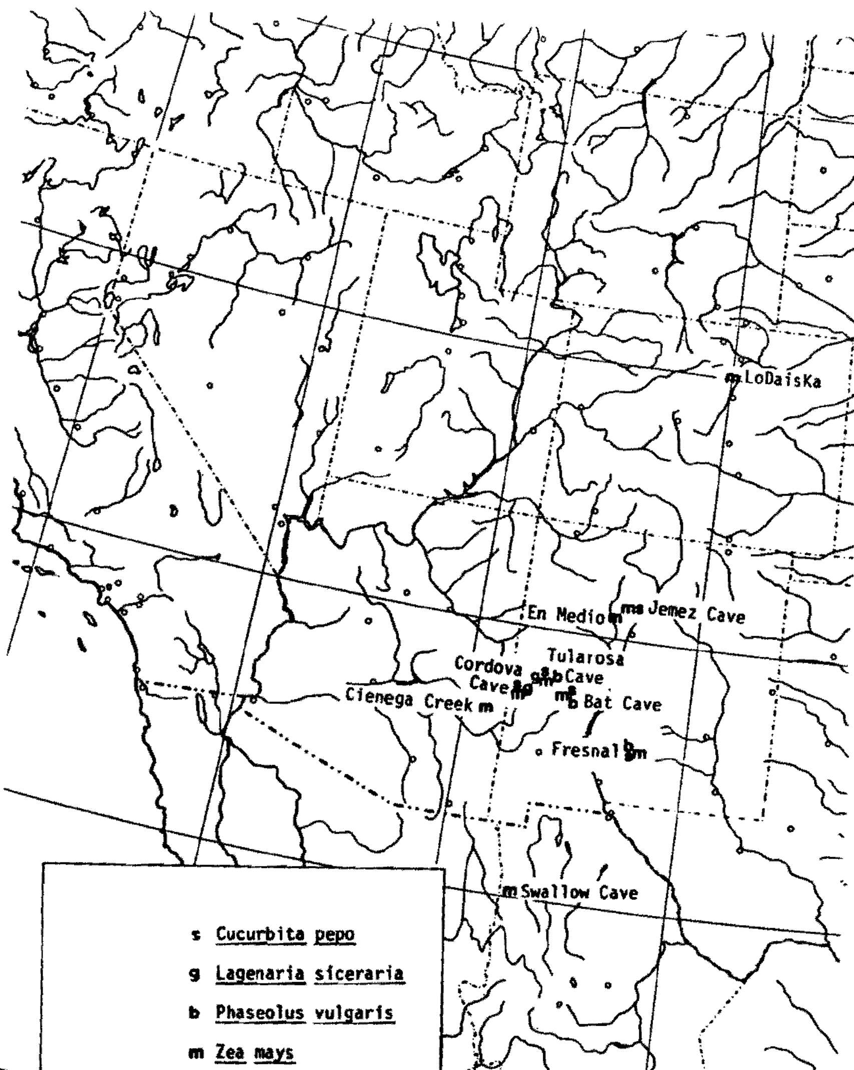

FIG. 2.—Upper Sonoran Agricultural Complex.

From the genetic variability present by 300 B.C. in the Upper Sonoran early maize, all further corn types in the Southwest could be bred. Its potential development was not immediately appreciated by these casual nomadic farmers. Productivity remained variable and seasonal security appears to have been more important than future surplus. Factors other than the presence of a certain type of maize have to be considered for the beginnings of more sedentary communities, increased population sizes, and other cultural developments. If Jemez Cave is illustrative, from 900 B.C. or so until a few centuries A.D., small groups of farmers occupied the shelter for a few weeks to plant and later return to harvest whatever grew. Selective breeding is not evident, competition with field weeds was permitted, and some years the corn was picked before maturity. Maize simply augmented their fall season diet.

With the spread of maize and the beginnings of more sedentary life-ways, corn production is for a surplus and different morphological types can be identified as a result of cultural and natural selection. In the Hohokam area of southern Arizona, for example, the corn did not have to be of Mexican derivation despite the argument for Mexican intrusion (Haury 1976:117). The earliest Vahki phase maize has been identified by Cutler and Blake (1976:365) as Chapalote, the earliest type in the Southwest; Reventador, a by-product of Chapalote crossing with teosinte; and Onaveno, the flint type of Pima-Papago corn which is thought to be a derivative of a Chapalote series corn crossing with 8-rowed maize. Even the drought resistance required for successful reproduction in this desert environment could have evolved north of Mexico. The so-called Pima-Papago corn found in the Hohokam area and elsewhere resulted form Chapalote crossing with 8-rowed maize and consists of flint (Onavena) and flour (Maiz Blando) types which are single gene mutations that can occur anywhere (Anderson 1945:82). Even at Casas Grandes all of these Southwest corn varieties continued to occur (Cutler and Blake 1974:309).

Similar *in situ* developments are detectable elsewhere. In the Rio Grande valley at BR-45, dated to 18 B.C., Maiz de Ocho and Pima-Papago are recognizable (Galinat et al. 1970:328). Chapalote, however, continued as a popular type as late as A.D. 1450 at Rainbow House, Bandelier National Monument (Mangelsdorf and Galinat 1966). In southwestern Colorado Chapalote and Pima-Papago are present from Basketmaker to the abandonment of Mesa Verde, although the relative frequency of various types changed over time (Jones and Fonner 1954; Cutler 1963; Cutler and Meyer 1965). This generalization applies to Glen Canyon as well (Cutler 1966:13). Much more research is required before we can explain the emergence of recognizable morphological types and the reason why some sites have very few types of maize while others at the same time were growing a wide variety.

If the previously described varieties or races of corn had multiple origins in the Southwest proper, the question of continued Mexican sources of new corn types or genetic material must be considered. Certainly it was possible, and the absence of teosinte in the American Southwest provides one clue. Sites such as Cebollita Cave in which the earliest corn, dated A.D. 1050, is Chapalote, but younger maize from here (Galinat and Ruppé 1961) and from Richard's Cave near Montezuma Castle have comparable degrees of apparent teosinte introgression (Galinat et al. 1956). Their cob morphology is better explained by problems, perhaps heat stress, during pollination and growth rather than by any teosinte derived genes.

Fremont Dent maize poses an interesting problem. Cutler (1966:16), following Anderson (1948), proposes that the distinctive pyramidal cob and kernal form are evidence for the diffusion of a Mexican race, Conico Norteno, through western Arizona into the Fremont area 1000 years ago. If true, then this would represent affirmation of Mexican contact. Winter (1973), however, disputes this explanation for several reasons. First, Fremont Dent is actually earlier than the dates given by Cutler and dent corn in Zion and northwestern Arizona could have moved southward, not northward. Second, he concurs with Galinat and Gunnerson (1963) that the effect of early teosinte germ in Chapalote type corn crossing with 8-rowed corn could have produced a variety of mutant forms some of which have been selected for further breeding. The consequence was diversification within the Fremont corn types and an *in situ* rather than an exogenous source for this distinctive maize. Otherwise, dent corn does not appear in the Southwest until the reconquest of New Mexico following the Pueblo Rebellion (Cutler and Blake 1969a).

Cucurbita pepo L. In the Southwest the first squash is as early as corn. It is present in the bottom midden level at Bat Cave (Dick 1965), and with the possible exception of Cordova Cave (Kaplan 1963a:355), it is in all preceramic sites where cobs are found. The earliest examples are of one variety; however, by A.D. 900 several varieties were grown. Whether these were developed locally or represent further contacts with Mexican agriculturalists is unresolved.

This squash was grown everywhere in the Southwest (Cutler and Whitaker 1961:471), including Casas Grandes (Bohrer and Fenner 1974) (Fig. 5), and continued to be grown even with a minimum of care in a variety of climatic situations. Its edible seeds and flesh rendered it an important fruit throughout Southwestern prehistory.

Lagenaria siceraria. The bottle gourd which produces an edible seed and durable rind useful for containers apparently was transmitted into the Southwest after corn and squash; 300 B.C., dates for Tularosa and Cordova caves, is generally given for its arrival. Like squash it was not found at every preceramic agricultural site. For example, it was not present in Bat Cave (Smith 1950) or in Jemez Cave (Ford 1975). Its eventual distribution was conditioned by local climate and cultural practices. Where the growing season in more northern latitudes was cool and short, the gourd could not grow successfully. Thus, it is missing in many Glen Canyon sites (Cutler 1966) and is rare in Mesa Verde (Cutler and Meyer 1965). Thick rinds of *C. pepo* and *C. mixta* were used for containers in these areas. Although gourd rind fragments have been found in many sites throughout the Southwest (Cutler and Whitaker 1961:473), the absence of peduncles and seeds suggests that it may have not been grown that widely and that trade may account for its presence in some localities.

Phaseolus vulgaris L. The appearance of the common bean in the Southwest is after corn, squash, and perhaps gourd, but the date is uncertain. Part of the confusion results from the dating of level IV in Bat Cave in which beans first are found, of Tularosa and Cordova caves where beans are found in all levels, and of Fresnal shelter which yielded beans in preceramic levels. A 300-500 B.C. date may be generally acceptable. Beans were not present in Jemez Cave (Jones 1935) or En Medio (Irwin-Williams and Tompkins 1968). Common beans are found initially in the Mogollon area, and Kaplan (1956) defines the greatest number of his types in this cultural region. Elsewhere common beans were grown by the Hohokam before later species of beans (Bohrer 1970), and they continued to be part of Sonoran Desert sites into historic times (Cutler 1956) (Fig 4). At the higher elevations they were introduced northward into the Durango Basketmaker II after A.D. 400 and westward, and at most Pueblo sites they were the only beans raised.

Kaplan (1965a) has stressed the complementarity of the high lysine amino acid in beans with corn protein. The dietary significance of the Upper Sonoran Crop Complex would have been realized by sedentary communities and pueblos with large populations in Pueblo III time as vegetable protein became increasingly important. Despite their late preceramic presence in the Southwest, common beans increased in frequency in sites with pottery. Kaplan suggests this is a consequence of improved cooking technology and more efficient utilization of their nutritional value.

Eastward Diffusion of Corn and the Common Bean (Figs. 3, 6)

Because squash and gourd husbandry was widely practiced in the East, the only Upper Sonoran Complex crops which are detectable as introductions from the Southwest are corn and the common bean. Available evidence continues to support the established contention that they diffused independently of each other (Yarnell 1964).

Historically, the most frequently asked questions have been when did corn enter the eastern United States? How many types were introduced? How significant was corn agriculture in the cultural development of the Midwest?

Present evidence supports the conclusion that corn was present in the East sometime after 500 B.C. Corn remains, which are awaiting description, have been dated at 340 B.C. and 375 B.C. at Meadowcroft Rockshelter (Adovasio et al. 1978:649). A small cob of Chapalote-like flint corn from Daines II Mound near Athens, Ohio, has a date of 280 B.C. (Murphy 1971), and several cobs are dated 80 B.C. at Jasper Newman in Illinois (Struever and Vickery 1973: 1200). A fragmentary cob is associated with late Early Woodland pottery at Hornung in northern Kentucky. By A.D. 450 examples are found from Ohio Hopewell sites (Culter 1965), including the recently excavated Hopeton Square and Edwin Harness Mound (Ford 1980), from Illinois (Struever and Vickery 1973; Cutler and Blake 1973:26-27), and from the Peters site in southern Tennessee (Ferguson 1978:760). Further west corn is present at Renner and Trowbridge, 2 Kansas City Hopewell sites, around A.D. 250 (Johnson 1976:14).

Perhaps Jones (1968:85) answers the second question best by stating that "...all aboriginal corn types of North America north of Mexico were derived from a highly diverse gene pool in the Southwest." Indeed, the early corn in the Midwest is as diversified as that in New Mexico at the same time (Ford 1980). It has elements identified with Chapalote derived maize as well as Maiz de Ocho. With this range of variation present, it is not necessary to postulate successive introductions of new corn types. As corn was introduced into the northern latitudes, natural and cultural selection favored attributes of rapid germination in cool, moist soil and quicker maturation for a shorter growing season. There is no reason that the Northern Flint (Brown and Anderson 1947), which came to dominate the Upper Missouri and Northeast (Yarnell 1964) and which later was introduced into the Mississippi Valley and the Southeast, could not have evolved in the upper Midwest as suggested by a reduction in row number frequencies from 12- and 14-row to 8-row (Cutler and Blake 1969b).

The significance of maize in the subsistence economies of the Midwest is not appreciable until after A.D. 800. Although direct evidence is absent, corn appears to have been

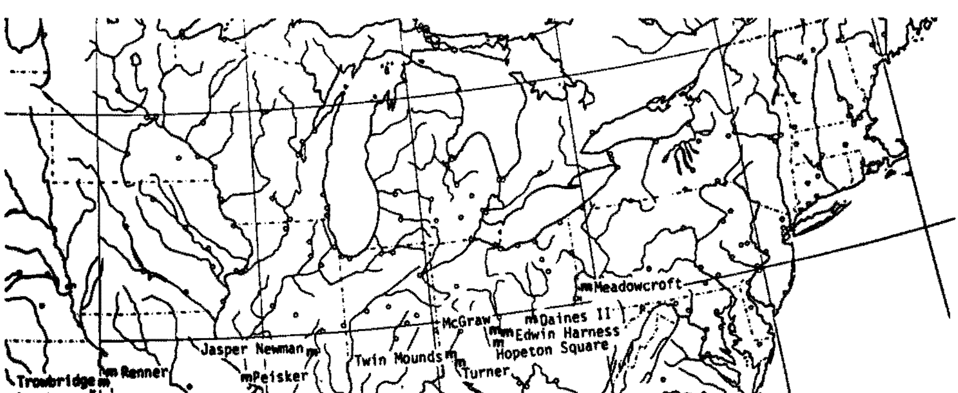

FIG. 3.—Eastward diffusion of maize from the Southwest.

introduced from the Southwest across the southern Plains and into the Midwestern riverine area. In this region gardening was well established and corn apparently was added to the squash, gourd, sunflower, and sumpweed that were already being sown. Initially, it was another garden crop contributing added security against failure of native nut meats and seeds, and did not become a staple until the Late Woodland period (Ford 1977a). The cultural changes which selected for corn as a major subsistence crop with the emergence of Mississippian cultures are presently the focus of extensive investigations (cf. Braun 1977). Ecologically, gardens became secondary to field agriculture in the production of staple calories for the expanding Mississippian populations. As corn became more important, no single race of corn accounts for this transition. In fact, although corn types or races became more distinct through cultural selection and increased dependency, several races continued to be raised simultaneously as Cutler and Blake (1969b) have shown for Cahokia. Even with the high productivity of Maiz de Ocho in the northern latitudes here, too, earlier types of Chapalote-like small flint corn continued to be cultivated as evidenced by maize from Hardin Village (Hanson 1966:169) and Upper Missouri sites (Cutler and Agogino 1960).

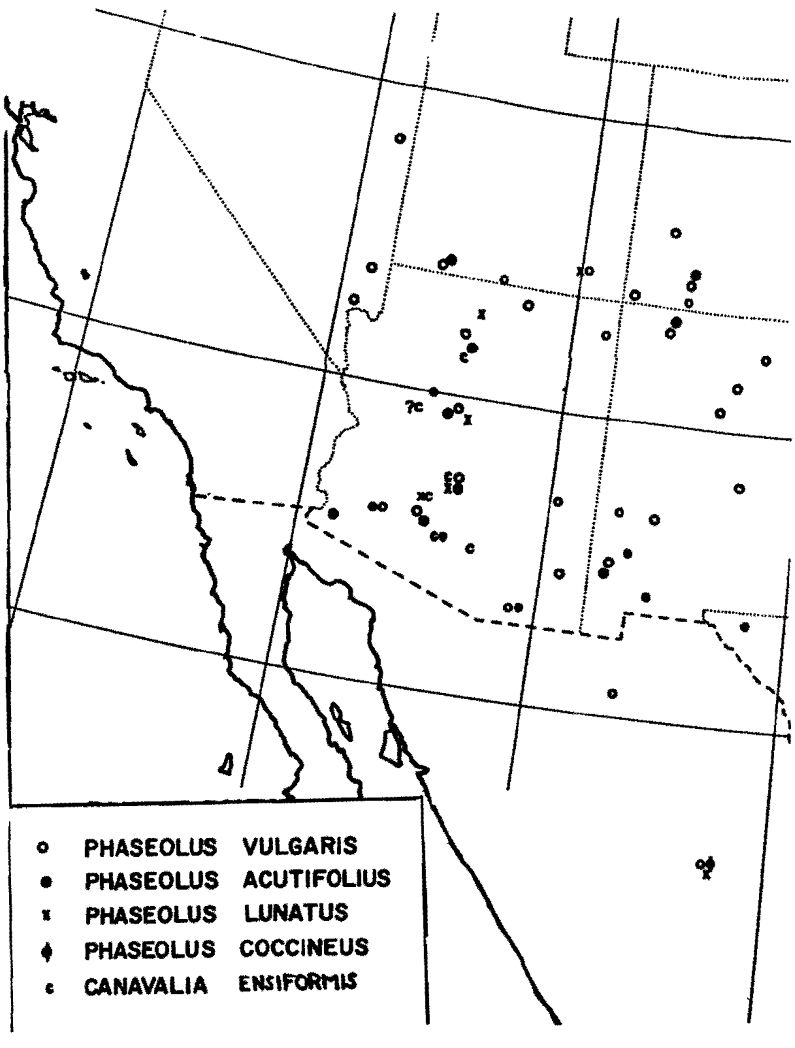

FIG. 4.—Lower Sonoran Agricultural Complex: beans.

Phaseolus vulgaris is the only domesticated bean to reach the prehistoric eastern United States, and it did so by a still undefined route from the Southwest after A.D. 800 (Yarnell 1976:272). By A.D. 1000 (Fig. 6) beans are found in confirmed archaeological contexts from the Mitchell site in South Dakota (Benn 1974:66) eastward to the Blain village in Ohio (Kaplan 1970:228) and the Roundtop site near Binghamtom, New York (A.D. 1070±80) (Yarnell 1976:272). (A single charred "bean" was found at Renner in an A.D. 1-500 context, but its disintegration prevented botanical confirmation [Wedel 1943:26]). With the addition of the common bean the trinity of corn, squash, and beans was complete in the East, and it was undoubtedly incorporated immediately into the field agriculture mode of production (Ford 1974).

Lower Sonoran Agricultural Complex

Unlike the previous complexes which were transmitted to or developed by seasonally nomadic bands, this crop group was introduced to the sedentary canal irrigation farmers of the Sonoran Desert. Although a precise Mexican region for its origin has not been specified, contact, most likely trade, brought cotton, amaranth, and several species of beans and squash to the hot river valleys occupied by the Hohokam and their neighbors. From southern Arizona there was differential introduction of some species to other archaeological areas where the Upper Sonoran Agricultural Complex was already established, but only the green striped cushaw squash attained relative importance as a subsistence item in these regions.

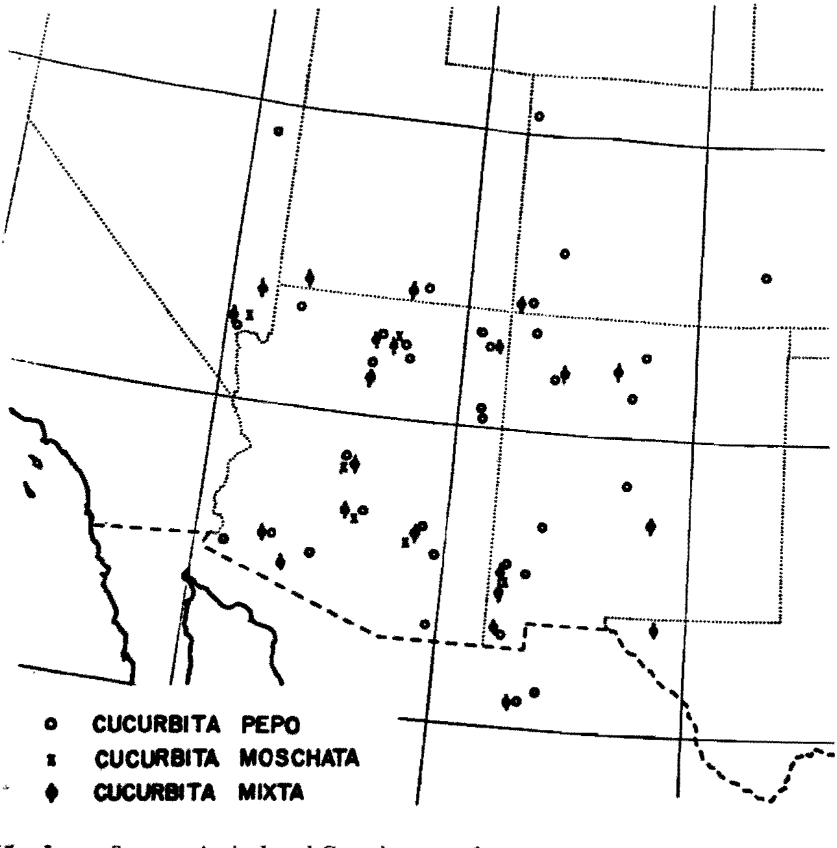

FIG. 5.—Lower Sonoran Agricultural Complex: squash.

Gossypium hirsutum var. *punctatum (Gossypium hopii).* Cultivated cotton and loom weaving first appeared in the Hohokam area at an unresolved date. If Haury's (1976:332-337) Snaketown sequence as suggested by several radiocarbon dates and alternative interpretation of the archaeomagnetic data is employed, then cotton first appears after A.D. 500 which is reasonable since this date reduces the lag between its beginning at Snaketown and its initial eighth century appearance in the Kayenta area (Bohrer In Press). An absence of seeds and plant parts outside southern Arizona supports the hypothesis that cotton textiles and cordage were traded northward to the Anasazi and eastward to the Mogollon for several centuries before they were grown in these areas. Cotton was continually traded throughout the Southwest with certain later sites such as Antelope House (Magers 1975) proposed as production centers. Cotton was grown in the Mimbres area after A.D. 1100 (Paul Minnis, personal communication) and may have been grown as far north as Glen Canyon (Cutler 1966). Most sites with abundant evidence in the form of seeds, bolls, and textiles are dated after A.D. 1100 (Bohrer In Press).

Phaseolus acutifolius Gray var. *latifolius* Freeman (Fig. 4). The tepary bean is associated with the Hohokam and the Pima and Papago (Castetter and Bell 1942). Its adaptation to an arid environment has recently been reviewed by Nabhan and Felger (1978). The history of the tepary bean is somewhat confused because wild forms extend from southern Arizona throughout western and southern Mexico. Until the discovery of tepary beans in the Abejas Phase, dated 5000 years ago, in Tehuacan (Kaplan 1971), archaeobotanical evidence from the Southwest pointed to that area for its domestication. Kaplan, however, recognized 8 varieties in the Southwest, indicative of endemism, which suggests multiple origins including the Southwest and western Mexico, for this domesticate.

The best guess for the beginning of tepary bean husbandry in the Southwest is about A.D. 500. By A.D. 760 it was in the Durango Basketmaker area (Kaplan 1963b:47). The first authenticated tepary from Snaketown actually dates shortly later (Jones 1942:32), and a similar A.D. 900-1100 date is applied to teparies from Punta del Agua (Bohrer et al. 1969:4), but this late occurrence is assumed to be a site sampling problem. After A.D. 1100 teparies occur as far east as the El Paso area (Ford 1977b), in the Mogollon region (Cosgrove 1947), Kiet Siel, at Zion in Utah (Kaplan 1956), and are frequently found in Lower Sonoran sites—Tonto (Bohrer 1962), Tuzigoot and Montezuma Castle (Kaplan 1956), and Babocomari (Jones 1951:16). Tepary has not been found archaeologically in the upper Rio Grande Valley, at Mesa Verde (Kaplan 1965b), or in Glen Canyon and northward in Utah.

Phaseolus lunatus L.(Fig. 4). The sieva bean poses still another question about origins and diffusion into the Southwest. This small lima bean was domesticated independent of its larger relative, the lima bean, of South America (Kaplan 1971:418). It is found in Tamaulipas before 1100 years ago and in northern Durango after A.D. 600, although the type (L-6) is not found in the Southwest (Brooks et al. 1962:359). Gasser (1976:23) reports a possible sieva bean from Pueblo Grande, and like the others excavated at Tonto (Bohrer 1962), Montezuma Castle (Kaplan 1956), and the 2 Anasazi finds, none date before A.D. 1100. Sieva beans have not been recovered in Mogollon sites, and overall this bean is rather rare in the Southwest.

Phaseolus coccineus L. (Fig. 4). The scarlet runner bean has been confirmed from the Rio Zape in Durango (Brooks et al. 1962:364), but other finds, such as the charred cotyledon from Snaketown (Bohrer 1970), Kaplan has questioned (Nabhan 1977:147). Gasser (1976:23) has identified one runner bean from an unprovenienced collection from Pueblo Grande. An assessment of the literature supports Nabhan's (1977:147) conclusion that no uncontested prehistoric runner beans have been found in the Southwest and that those grown by the Hopi were probably introduced in historic times.

Canavalia ensiformis (L.) D.C. (Fig. 4). More archaeological jack beans have been identified in the Southwest than from any Mexican area despite the extreme distance from their putative southern Mesoamerican homeland. Sauer and Kaplan (1969) report an early find dated 320 B.C. from Dzibilchatun and another from Guila Naquita Cave in Oaxaca, although its A.D. 900 provenience is actually later than those from the Hodges site which may date as early as A.D. 700. It has also been confirmed from Punta de Agua (Bohrer 1962:106) and Pueblo Grande (Gasser 1976:23). The distribution of the jack bean is restricted to areas where irrigation farming was practiced, a requirement of this species when grown outside the tropics (Sauer and Kaplan 1969:417).

Cucurbita mixta Pang. (Fig. 5). The history of the green striped cushaw squash in northern Mexico is not very helpful for deciphering its introduction into the Southwest because it occurs in Durango (Brooks et al. 1962) and Chihuahua (Cutler 1960; Lister 1958) after A.D. 1000. It appears in southern Arizona by A.D. 900, perhaps as early as A.D. 700 (Cutler and Blake 1976:365), but is best documented several centuries later at Montezuma Castle and Tonto. Despite its preference for warmer climates than *C. pepo*, more *C. mixta* remains have been found outside the Lower Sonoran area than might be expected. This may be explained, in part, by its responsiveness to a controlled water supply. Although it is not a good dry farming crop, it grows extremely well when irrigated, and is reputed by Pueblo Indians today to produce more large fruits per plant than do other squashes. By A.D. 1000 it was found as far north as Glen Canyon and eastward into the Reserve, New Mexico Mogollon area (Cutler and Whitaker 1961:472). In the Glen Canyon and Mesa Verde provinces many of the rinds are thick suggesting their use as containers in these altitudes where gourd grow poorly (Cutler and Meyer 1965:151). It has been identified as far east as El Paso (Ford 1977b) and the Gallina area (Cutler and Blake 1973:51), and as far north as southern Nevada and Utah. *C. mixta* became the most widespread Lower Sonoran crop.

Cucurbita moschata Poir. (Fig. 5). The warty squash is also intolerant of cooler altitudes and has a high moisture requirement. It may not have been introduced into the Hohokam area as early as *C. mixta* and its eventual distribution was more restricted. Other than Montezuma Castle and Tonto, where it was the most abundant of the 3 species of squash recovered (Bohrer 1962:103), it has only been verified from 6 other sites with Kiet Siel in northern Arizona the farthest north and 2 in the Mogollon region (Cutler and Whitaker 1961:472) the farthest east.

Amaranthus hypochondriacus L. This pigweed has only been identified from Tonto (Bohrer 1962:107) in the United States. It is presumed to have been brought from Mexico as well, but the only other confirmed evidence of this species dates A.D. 500 in Tehuacan. *A. powellii*, which grows native in Arizoña, is regarded as its ancestor, and an indigenous domestication is not impossible. Charred amaranth seeds have been found in other Lower Sonoran Life Zone sites (cf. Bohrer et al. 1969:6), but remain unidentified to species.

The Lower Sonoran Agricultural Complex did not spread into southern Arizona as an interrelated crop group. Instead, it developed in the Lower Sonoran Life Zone and is most apparent in the fourteenth century desiccated plant remains from Tonto (Bohrer 1962). It certainly contributed subsistence variety to these desert adapted cultures, but the significance of many species to human survival remains unknown.

Late Eastern Mexican Agricultural Complex (Fig. 6)

After the initial diffusion of cucurbits from eastern Mexico, no other plants are recognized as originating from that source until very late in the prehistory of the eastern United States. Chili peppers, corn, cotton, 2 additional species of squash, 3 species of beans, and tobacco (*Nicotiana rustica)* were found in the Tamaulipas caves by A.D. 1(MacNeish 1971:578), but not in the East. When the final 2 plants were introduced, corn agriculture was already established and large sedentary communities dominated the settlement systems of the Southeast and Midwestern riverine areas.

Nicotiana rustica L. (Fig.6). This cultivated tobacco originated in South America but was grown extensively in Mexico. The only remains north of Tamaulipas are from Late Woodland contexts. The exact date of the Newt Kash material is questionable but assumed to be late (Jones 1936). The seeds from the Mitchell (Benn 1974:56) and Brewster (Stains 1972) sites are dated about A.D. 1000. When Europeans arrived, this tobacco was cultivated from the Plains to southern Canada and the east coast. The presence of pipes in contexts before A.D. 800 does not imply that tobacco was smoked since other plants were used ethnographically for producing ceremonial smoke (Yarnell 1964).

Chenopodium berlandieri var. *nuttalliae* Standl. (Fig. 6). The cultivated chenopod of Mexico has an origin independent from *C. quinoa* in South America (Heiser and Nelson 1974). It produces large seeds indistinguishable from the specimen reported by Gilmore (1931) from the Ozark Bluff shelters (Hugh Wilson, personal communication). It was not recovered in Tamaulipas and has not been found elsewhere north of Mexico. Without additional evidence its significance to the Late Woodland Bluff Dwellers is problematical. Today, it is a cultivated vegetable in the Mexican highlands, but chenopods are typically "double-harvested," that is, the greens are gathered early in the growing season and then the seeds are collected later when they ripen. Undoubtedly, this pattern extends back into the Archaic, and the addition of this domesticate was probably not at variance with established Late Woodland adaptations.

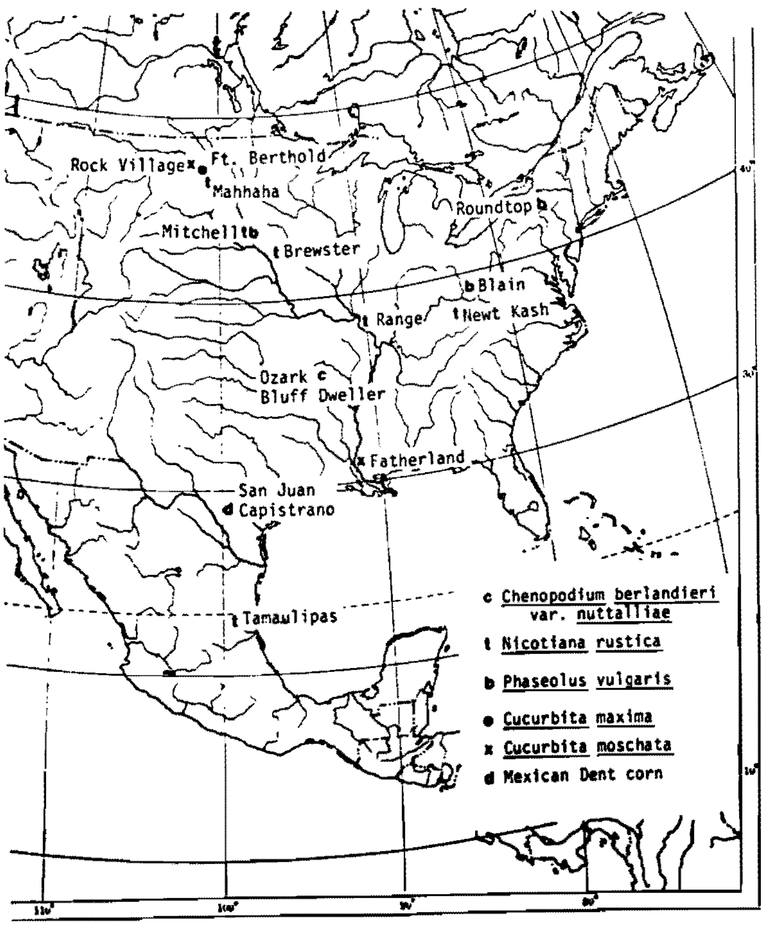

FIG. 6.—Late Eastern Mexican Agricultural Complex: sites in the east with beans, ca. A.D. 1000; Spanish introduced crops.

A Southwestern Agricultural Complex

No indigenous southwestern plant species has archaeological evidence substantiating its domestication in prehistory. Despite the possible domestication of the grain amaranth and tepary bean in the Sonoran Desert region, all archaeobotanical remains are fully domesticated and no antecedent developmental stages have been excavated. A possible candidate is the devil's claw, and perhaps one or more of the intensively collected species was cultivated or had its range extended by prehistoric people.

Proboscidea parviflora Woot. and Standl. Devil's claw pods yield edible seed and important decorative material for baskets. A white seeded cultivated form is raised by Papago and Moencopi villagers, but Castetter and Bell (1942:113) argue that its domestication is a historic response by the Pima and Papago to a commercial demand for baskets. Yarnell (1977:872) is less certain because he feels a minimum of several centuries is required to selectively breed plants with larger pods and white seeds. In this instance, no archaeobiological data are available to support or refute either position, but it remains an interesting possibility.

Helianthus annuus L. The Hopi sunflower produces a large, purple achene which is used for dye and food. Although sunflower seeds have been found in several archaeological contexts, none exceeds an uncultivated, native *Helianthus* in size. In the absence of contradictory evidence, the most parsimonious explanation is that this cultivar was brought to the Hopi in historic times.

Agave parryi Engelm. Minnis and Plog (1976) have noted the disjunct distribution of agave north of its natural range is correlated with the presence of a nearby archaeological site. They suspect that prehistoric people may have extended its range intentionally or accidently. Archaeological evidence for its utilization at these sites has not been forthcoming, but this does not negate the potentially active role Southwestern Indians had in spreading this and other species beyond their modern range.

Recently, Yarnell(1977:872) has enumerated several native southwestern plant species, including *Cleome* and to which can be added *Chenopodium* and *Hordeum pusillum*, which archaeological evidence suggests were collected in quantity by prehistoric people and which may have been encouraged through tending and even planted by them. No evidence demonstrates the genetic changes and human dependency associated with plant domestication.

At present a Southwestern Agricultural Complex has not been demonstrated beyond the devil's claw. However, additional field research combined with botanical analysis may contribute additional species.

Hispanic Introductions

Field, garden, and orchard crops derive their origin in parts of the United States from Spanish contacts. Early Spanish traders, missionaries, and colonists brought several domesticates native to the New World to regions where they were not grown in precontact times. They also brought many European plants to the Southwest in the sixteenth and seventeenth centuries. Wheat, barley, peaches, apricots, plums, walnut, peas, chick peas, and melons are but a few of the crops adopted by the Indians.

Considering the contacts prehistoric Southwestern cultures reportedly had with Central Mexican cultures, it is surprising that the chili pepper, *Capsicum annuum* L., and tobacco, *Nicotiana rustica*, were unknown here until Hispanic times. No evidence of chili peppers has ever been found in unambiguous precontact contexts, not even at Casas Grandes. The history of tobacco in the Southwest is more complicated. The native western tobacco, *Nicotiana attenuata*, pioneers disturbed habitats, and Pueblo people still collect and smoke it on ceremonial occasions. Archaeologists have shown that it had a number of prehistoric usages, and plant parts and seeds were collected and stored (Yarnell 1977:871), but morphological analyses indicate no domestication. The Spanish brought *Nicotiana rustica* early in the historic period. An important archaeological specimen has been identified as *N. rustica* from the post-1680 reoccupation of the Bandelier cliff dwellings (Volney H. Jones, personal communication). On the basis of this find it appears that *rustica* was an early crop accepted from the Spanish and that it continued to be grown and used following the Pueblo Rebellion. It still is planted and used ceremonially in complementary relationship to *attenuata*.

Prior to contact the tribes of the Missouri River drainage and the eastern United States grew only *Cucurbita pepo*. However, shortly after contact their complement of cucurbits was completed with the additions of *C. moschata* and *C. maxima*. A peduncle of *Cucurbita moschata* was recovered in the early 1700s Historic Period at the Fatherland site in Mississippi (Cutler and Blake 1973:37) and at the Historic Hidatsa Rock Village site in North Dakota (Cutler and Blake 1973:53) (Fig. 6). *Cucurbita maxima* originated in South America, and is assumed to have been an Hispanic introduction into Mexico, the American Southwest, and the East where the only authenticated find is from Fort Berthold Village, A.D. 1845-1874, in North Dakota (Cutler and Blake 1973:53).

The Spanish were also responsible for the introduction of new corn types from Mexico. The large eared Cristalina de Chihuahua, which apparently evolved in northern Mexico (Cutler 1960), was recovered from a probable historic context at Casas Grandes (Cutler and Blake 1974) and northward in the historic Pueblos. Mexican Dent, an ancestor of the modern Corn Belt dent, also first appears in Spanish contact situations at Picuris in the Post-Rebellion deposits (Cutler and Blake 1969a). Mexican Dent had a profound impact on the maize of the Rio Grande Pueblos where the extremely long cobs found growing today are a result.

The Hispanic Agricultural Complex achieved widespread distribution and was continued during and after the Pueblo Rebellion. New maize types increased productivity and the great array of new annual and orchard crops intensified Pueblo use of arable land and brought relief from failure of prehistoric cultivars.

CONCLUSION

An assessment of crop history, patterns of crop association, and the geographical distribution of domesticates leads to an understanding of prehistoric plant husbandry and to future research activities. The exact date of the independent introduction from Mexico of the first cultivars in the East and the Southwest is less important than their integration into the prehistoric economies. In the East squash and gourd were grown in gardens and supplemented gathered foodstuffs from the forest. In the major river valleys starchy annual seeds were collected, and the exogenous origin of agriculture led to the domestication of sumpweed and sunflower at least. In the West, first corn and squash and later gourd and common beans were grown by nomadic hunters and gatherers as seasonal resources. Perhaps 1000 years passed before corn became an economic stable.

Even with the establishment of sedentary communities in the Midwest and the spread of corn from the Southwest, an agricultural field system did not evolve for many centuries. Again, there is no evidence that any cultivated species or new race of corn immediately changed the cultural patterns where they were introduced.

The sedentary villages of southern Arizona received a number of crops from Mexico, but these were merely added to an established agricultural pattern which had diffused from mountainous areas. What strategies were used for growing these crops and how they interacted in the subsistence system remain to be explained. To heed Whiting's appeal to the archaeological record, evidence must be obtained to answer these and similar questions.

The importance of changing cultural adapations for understanding plant breeding in prehistory is conspicuous in North America. The achenes of sunflower and sumpweed, for example, increased in size long after they were first domesticated, and they may have undergone their greatest increase in size following the beginnings of field agriculture, 2000 years after their domestication began. Corn demonstrates a similar pattern in both the Southwest and the East. The genetic variability and its adaptive potential was not appreciated by the casual horticultural practices of hunters and gatherers or even by the Midwestern Woodland cultures with their large gardens. However, as cultural pressures changed, the productivity and adaptability of maize was realized and new varieties were developed in both areas.

By A.D. 1000, with the possible exception of the devil's claw, all prehistoric agricultural crops and complexes were in the continent north of Mexico and major farming technologies were well-established. It was not until the arrival of Europeans that new crops were introduced and aboriginal economies underwent substantial change.

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