

Anthro Notes

National Museum of Natural History Bulletin for Teachers

Vol. 15 No. 2 Spring 1993

A QUIET REVOLUTION: ORIGINS OF AGRICULTURE IN EASTERN NORTH AMERICA

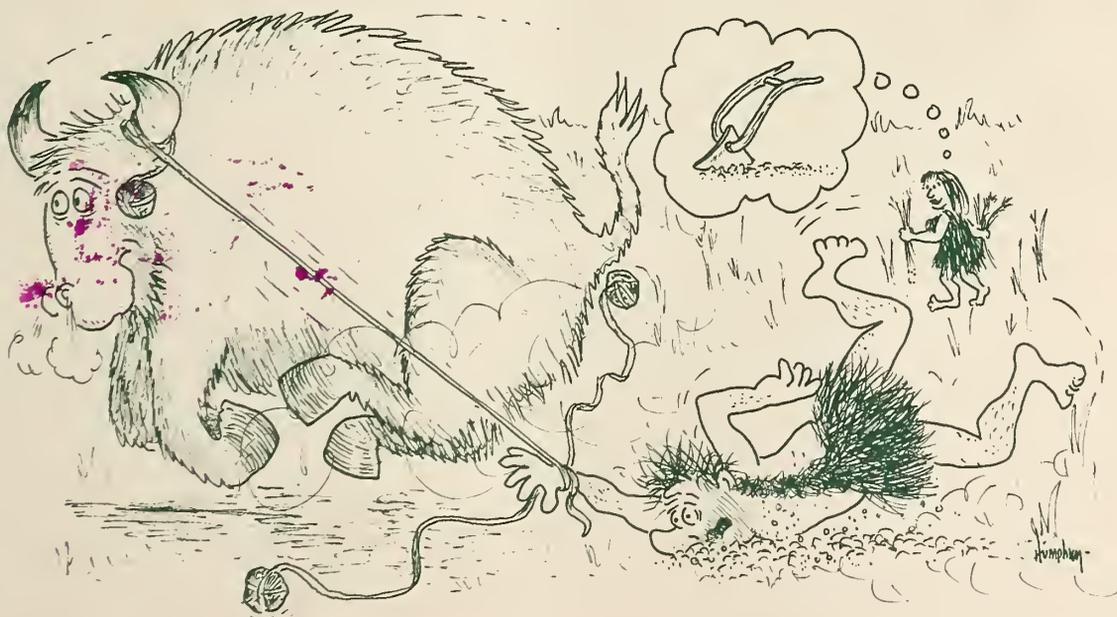
"Long before the introduction of maize, farming economies and an agrarian way of life had been established in eastern North America."

"Documenting the origins of agriculture in North America emerged from revolutionary improvements in collecting ancient seeds combined with the application of new, sophisticated technologies - and the puzzle's missing pieces finally fell into place."

-- Bruce D. Smith

Today we take the domestication of plants and animals for granted, but the fruits, vegetables, grains, milk products, and meats we eat everyday come from long ago human

intervention in the life cycles of wild plants and animals. Plant domestication can be defined as the human creation of a new form of plant--one that is distinguishable



THE TRANSITION FROM HUNTING AND GATHERING TO DOMESTICATION

from its wild ancestors and its wild relatives living today, and one that is dependent on human intervention--harvesting and planting--for survival. Plant domestication is not simply a physical change. It is a revolutionary alteration in the relationship between human societies and plants, enabling relatively few people to create food for large human populations. The beginning of agriculture thus marks a clear watershed and defines one of the major ecological changes in the history of the planet.

Many textbooks today still assert that agriculture in the New World originated in Mesoamerica, and that maize and squash spread from Mexico to eastern North America. Only then, textbooks explain, did Native North Americans learn to cultivate maize and squash and also beans and a few indigenous seed crops such as sunflower. The growing of corn, squash and beans thus enabled eastern Native North Americans to build larger settlements and more complex societies that depended on maize agriculture imported from Mesoamerica where larger-scale societies had also developed.

Contrary to this long-held belief, new research shows that eastern North America can now be unequivocally identified as a fourth major independent center of plant domestication, along with the Near East, China, and Mesoamerica (Smith, 1989:1566). In fact, eastern North America provides the clearest record available of agricultural origins anywhere in the world, providing new understanding of the processes involved in this key transformation in human history.

PUZZLE PIECES

What were the domesticated food crops that Native American farmers grew in eastern North America? When and how did their domestication occur? Why has it taken so long to recognize the contribution Native North Americans made to the origins of agriculture in the history of humankind? The understanding of plant domestication in eastern North America is a story that can be visualized as a puzzle, with some pieces

in place long before the full picture emerged.

Some pieces were discovered in the 19th century: Ebenezer Andrews excavated the first cache of stored indigenous seeds in Ash Cave, Ohio in 1876. Many pieces emerged in the 1930s and 1950s, but several key pieces came together recently, in the 1980s and 1990s, as new evidence came to light and new technologies for dating and analysis were applied.

The "Quiet Revolution" is a story of several transformations: 1) of Native North Americans slowly changing their way of life from foraging to farming; 2) of a new generation of archaeologists transforming their discipline with new questions, discoveries, and technologies; and 3) of one Smithsonian scientist working to put some of the final puzzle pieces in place. Archeologist Bruce Smith, who relishes puzzles, theoretical challenges, and the opportunity to turn conventional wisdom on its head, found these pieces in some unlikely places: an old cigar box containing thousands of tiny ancient seeds, and an Arkansas river valley where a bunch of small, wild, lemon-sized gourds grow.

EARLY NATIVE AMERICAN FARMERS

The following facts now are indisputable. By 2,000 B.C. in the eastern Woodlands, Native Americans were planting and harvesting at least four indigenous seed plants, marking the beginning of their transition from foragers to farmers. Maize arrived from Mexico about A.D. 200, but for six hundred years thereafter corn was not a major food source. After A.D. 800, intensive maize agriculture spread quickly and widely throughout the Eastern Woodlands as corn became a major staple of the diet. Why corn did not become widespread until after A.D. 800 remains a mystery; at first it may have been used only for religious and ceremonial purposes.

With new tools, archaeologists have documented three major turning points or periods of transition in the development of Native North American domestication:

TRANSITION ONE: 3000 B.C. - 2000 B.C.

Native North Americans discovered that wild seed plants growing along river floodplains could be controlled; that plants could be harvested and used as food, with seeds stored and replanted in prepared garden plots the next year. Four indigenous plants underwent this transition to full domesticates, with clear morphological changes taking place in their seeds. Three additional cultigens appear as food crops as Native Americans began to harvest these previously wild sources of food. The highly nutritious seeds from these seven plants could be variously boiled into cereals, ground into flours, or eaten directly.

Each of the seven indigenous plants involved--chenopod, marshelder, squash, sunflower, erect knotweed, little barley, and maygrass--had its own particular course of development. Most began as wild plants growing along river floodplains that Native North Americans first gathered and used. They gradually brought these plants under their control as they harvested them and planted their seeds the following year. By 2,000 B.C., there is evidence of indigenous crop domestication occurring over a broad geographical area, on lands today known as Tennessee, Arkansas, Illinois, Kentucky, Ohio, Missouri and Alabama. After a slow beginning for each crop, the over-all shift to domestication occurred rather abruptly, with several spring and fall crops introduced together, some high in oil and some in starch. As Bruce Smith wryly comments:

If domestication occurred in some other part of the world, and involved grains such as wheats or barleys, such an abrupt, broad scale, and highly visible transition to an increased economic presence of seven domesticated and cultivated plants would quickly be acknowledged as marking a major shift toward farming economies. But in eastern North America...where the indigenous crops in question have little name recognition, this transition is still often brushed aside as involving minor crops of little

economic import, in all likelihood grown only in small garden plots (Smith: 1993:14).

TRANSITION TWO: 250 B.C.- A.D. 200

Food production economies emerged. Greater amounts of seeds appeared in the diet, and seed crops became the focus of more intensive cultivation, as farmers planted them away from their original habitats. Maize first appears in small amounts.

The emergence of indigenous crop economies, not maize, parallels in time the prehistoric North American societies that archaeologists term "Hopewellian." Ohio, Illinois and states farther south are dotted with remains of farming communities that existed between 250 B.C. and A.D. 200, many of them marked by Hopewellian features such as large geometric earthworks, conical burial grounds, elaborate mortuary decorations and beautifully molded pipes, bowls, icons and other objects.

Members of Hopewell farming societies lived in single-household settlements of perhaps a dozen individuals. They settled in river valleys--ideal locations for small fields--and crafted hoes and other tools suited for small-scale land clearing. Studies of modern wild crop plants that were grown by the Hopewell farmers indicate these plants had high potential harvest rates and yields. For example, a 200 square foot field, planted equally with marsh elder and chenopod, could have been harvested by five people in little more than a week. Even more impressive, nutritional analyses indicate that a field of this size and content would have provided half the caloric requirements of a household of ten for a period of six months.

TRANSITION THREE: A.D. 800 - A.D. 1100

Food-producing economies based on these indigenous seed crops flourished from about A.D. 200 until about A.D. 800. This early farming served as a preadaptation for a rapid and broad-scale shift to large field agriculture after A.D. 800 when a new, nonindigenous crop plant--maize--was

introduced. Maize came to dominate the fields and diets of Native North American farmers extending from what is now northern Florida to Ontario in Canada, from the Atlantic Coast to the Great Plains. **Archaeologists now know that maize appeared in Native North American villages more than 2,000 years after indigenous plants were domesticated and well after the rise of Hopewell societies.**

Even more dramatic is the coincident emergence of a second major episode of social transformation known as the Mississippian chiefdoms. From A.D. 800 up until European contact, the river valleys of the Southeast and the Midwest became dominated by the fortified villages of Mississippian chiefdoms. These societies exhibited considerable social inequality and organizational complexity. This complexity is reflected in raised burial mounds surrounding central plazas that were occupied by privileged individuals who enjoyed more ceremonial burials than the general populace.

RESISTANCE TO NEW THEORIES

If Native North Americans domesticated indigenous seed plants deliberately and independently between 3,000 B.C. and 2,000 B.C. in the Eastern Woodlands, why has it taken so long for their contribution to be recognized?

Perhaps it is because these domesticated crops are so little known. In contrast to maize and beans, they did not become important foods in the diets of North Americans living in modern times; only squash and sunflower are used today. Furthermore, the seed crops come from plants with difficult to pronounce scientific names or obscure identities and use. They include *Curcubita pepo* (squash); *Iva annua* (marshelder or sumpweed); *Helianthus annuus* (sunflower); and *Chenopodium berlandieri* (chenopod or goosefoot) as well as three cultigens whose seeds do not reflect the same distinct morphological changes that would enable archaeologists to call them full domesticates--erect knotweed, little barley, and maygrass.

The obscurity of most of these seed crops in today's world, and the rich descriptions early settlers left of Indians growing corn, beans and squash go far to explain why it is so difficult to change people's conceptions of the origins of Native American agriculture:

School children across America learn that Indians of the East grew maize, beans, and squash...south-eastern tribes made more than ninety different dishes from corn. More importantly, maize [or corn] is an ever-present dietary element in modern America. We consume corn oil and margarine, corn on the cob, creamed corn, popcorn, caramel corn, corn nuts, corn flakes, corn fritters, and corn... We know what we eat (Smith: 1993:5-6).

SCIENTISTS AS DETECTIVES

In the early 1980s Smith was increasingly convinced that it was eastern Native Americans who discovered farming, and that seed crops other than maize explained the appearance of Hopewell societies. But how could he find evidence to strengthen this idea and convince those who still did not believe it that Native North Americans independently discovered agriculture?

Smith knew the answer must lie within ancient plant remains. By the 1960s and 1970s, several investigators had confirmed long held suspicions that two local plants were domesticates--sunflower and marsh elder. Various other plants had been proposed as likely candidates for early domestication, among them a chenopod that was found in such abundance in archaeological sites that it seemed unlikely it was merely gathered in the wild. To Smith, *Chenopodium* seemed a particularly good potential domesticate to study because he could compare any ancient seeds he found to seeds from the modern Mexican domesticate, *Chenopodium berlandieri*, and also compare the ancient seeds to modern wild chenopods in the eastern United States. These comparisons would show whether or not the ancient seeds carried the clear markers of domestication.

Smith began to look for one good-sized collection of whole, well-preserved chenopod seeds clearly stored by ancient farmers. The seeds had to come from an undisturbed site, and they had to date to a time before maize was introduced in eastern North America. If Smith could find even one such collection, and if all the seeds showed the tell-tale sign of domestication--the thin, somewhat rectangular seed coat identified with a scanning electron microscope--then he would have definitively added another indigenous seed crop to the list and put one of the final puzzle pieces in place.

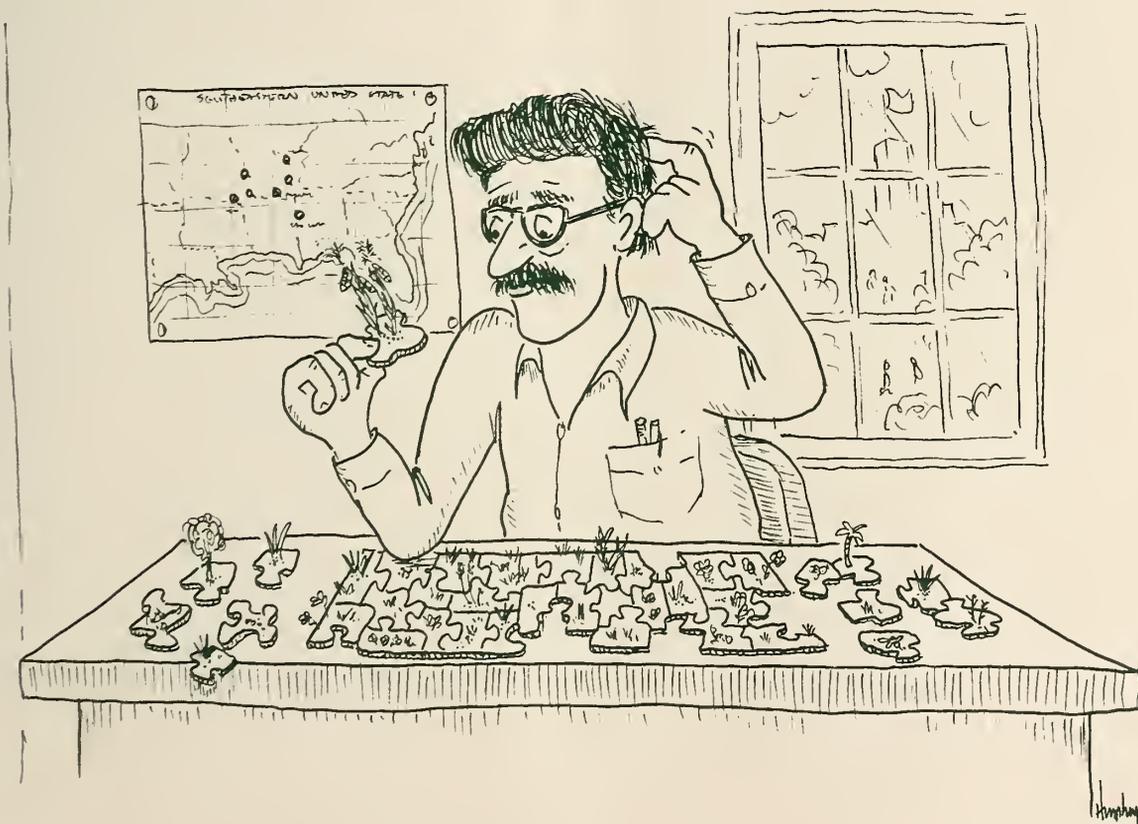
RUSSELL CAVE

Smith began to search old archaeological reports for references to seeds excavated from storage contexts. One collection seemed particularly promising: Russell Cave, Alabama. Fortunately, Russell Cave had been excavated in 1956 by Carl Miller, then with the River Basin Surveys of the Smithsonian Institution. Smith knew that the large amounts of uncatalogued material from these surveys were down the hall from

his office in the National Museum of Natural History. If seeds still existed, he might have some chance of re-discovering them.

Smith read everything Miller wrote about his excavation, but found only one brief paragraph describing seeds:

During the first season's work in Russell Cave, the charred remains of a small hemispherically-shaped basket were found filled with equally charred *Chenopodium* seeds. The seeds were later identified by experts in the US Department of Agriculture as belonging to this plant family. Their presence on the Early Woodland horizon, about 5,000 years ago, indicate that these people knew the potential of these wild uncultivated seeds as a staple food source, harvested them by means of seed beaters and baskets and converted them to food (quoted in Smith, 1993: 117). (Emphasis added.)



Could these "wild seeds" be, in fact, from domesticated plants? Could this basket be the "needle in the haystack" that Smith was trying to find? First, of course, he had to find the seeds. Unfortunately, there had been a tragic loss of the original storage basket during the excavation:

At about seven feet we came across the basket...made of coiled strands of grass fiber...[the basket was] filled with small seeds, probably some wild grain the cave men gathered and ate....Since it was late in the evening when we found the basket, I decided to wait until morning before trying to dig it out...but when we entered the cave the next morning, we were dismayed to find it gone...someone had vandalized the cave (quoted in Smith, 1993: 117).

Despite the basket's disappearance, Smith decided to search through the 38 drawers of uncatalogued Russell Cave materials. Towards the end of several days of endlessly sorting through lithic materials, Smith found an old cigar box (Tampa Nugget Sublimes) bearing the longhand inscription "Basket F.S. [field specimen] 23." He opened the box but found only an old, crumbled brown paper bag inside; but it too was labeled "F.S.23." This bag could be the way Miller stored the seeds that had spilled out from the missing basket. With apprehension and anticipation, Smith unfolded the paper bag and found exactly what he had hoped for: a bunch of very old, very dark, and very charred seeds! In fact, as he examined the plant remains, Smith estimated there to be perhaps 50,000 carbonized *Chenopodium* seeds! This spectacular discovery was exactly what he needed!

ARCHAEOBOTANY

Smith next turned to the new tools that were revolutionizing the field of archaeology and strengthening the subdiscipline of archaeobotany. By dating and analyzing the structure of the Russell Cave chenopod seeds as well as modern domesticated *Chenopodium* and its modern wild relatives, Smith could pinpoint the

time of chenopod domestication in eastern North America.

At this point, Smith's research incorporated innovative applications of new scientific technology. Most of the recent advances in understanding agricultural origins, in fact, depend upon four technological advances:

1) **Water Flotation Technology** that dramatically improves the recovery of small carbonized seeds and other plant parts from the archaeological context. The principle is simple: large amounts of excavated soil are mixed with water, allowing seeds, charcoal and other light materials to float to the top.

2) **Accelerator Mass Spectrometry (AMS)**, developed and brought into use since the mid-1970s that allows direct radiocarbon dating of individual seeds and other tiny samples. This technique enables archaeologists to date accurately the emergence of plant domestication.

3) **Scanning Electron Microscopy (SEM)**, that revolutionized the field of archaeobotany in the 1980s as it became widely used to study the micro-morphology of ancient seeds. Only with the SEM can seed coat thickness indicating domestication be measured since the SEM can magnify objects thousands of times.

4) **Stable Carbon Isotope Analysis** of human bone that allows scientists to document the consumption of maize. Maize, a tropical grass, has more carbon-13 relative to Carbon-12 than other food plants of temperate North America. This difference shows up in the bones of people who began to eat large quantities of corn after A.D. 800.

Using AMS dating and the SEM, Smith demonstrated without a doubt that the Russell Cave cache of *Chenopodium* was a very early collection of stored domesticated seeds, put aside for planting by early Native North American farmers at least 2,000 years ago, well before maize entered North America!

(continued on p. 13)

("A Quiet Revolution," continued from p. 6)

A NORTH AMERICAN SQUASH?

The diffusionists, however, still had one "ace in the hole" to prove their theory of Mesoamerican origins for North American agriculture. Mexico was clearly the hearth from which sprang today's New World pumpkins, squashes and gourds, members of the large species *Cucurbita pepo*, or so it was thought. In the late 1960s and early 1970s, a number of archaeological discoveries of domesticated *Cucurbita pepo* seeds in Mexico were dated to nearly 8,000 B.C., strengthening the belief that Mexico was the primary source of New World domestication. In addition, there were no documented wild *Cucurbita pepo* in North America, so it was logically assumed that all the prehistoric remains of *C. pepo* found in eastern North America, including some recently discovered charred rind fragments, dated as early as 7,000 years ago, must represent domesticated squash introduced from Mexico.

Smith and his colleagues were not convinced. The 7,000 year-old fragments of burned *Cucurbita pepo* rind could have come from wild gourds. Smith realized he needed to prove that these 7,000 year-old rind fragments were from wild rather than domesticated gourds, and he needed to locate modern closely related wild gourds proving that wild gourds had always existed in eastern North America. If he could do both, he would solve the puzzle and overturn the diffusionist theory that North American agriculture first was introduced from Mesoamerica.

Smith and his colleagues raised some interesting questions. If domesticated squash had been introduced 7,000 years ago in the East from Mexico and eastern hunters and gatherers had turned to farming, why was this the only crop they grew for the next 3,000 years? More importantly, if the squash had been domesticated for 3,000 years, why was it morphologically identical with wild gourds --small size, thin rind, and small seeds? Even more curiously, why would *Cucurbita pepo* materials from eastern North America

that were 4,000 years old (2,000 B.C.) exhibit clear morphological changes indicating domestication, but materials from the 3,000 years previous to that not show such signs? Smith noted, with satisfaction, that the morphological signs of domestication for *Curcubita* squash (larger seeds, thicker rind) appeared about 2,000 B.C., the same time period that similar changes signaled the domestication of three Eastern North American seed plants--sunflower, marsh elder, and chenopodium.

To Smith and his colleagues this fact suggested the real possibility that the 7,000 - 4,000 year old *C. pepo* rinds in the East resulted not from an introduced domesticate, but from an indigenous wild *C. Pepo* gourd that was domesticated along with the other three eastern plants about 4,000 years ago (2,000 B.C.). But if this were true, why were there no wild gourds left in eastern North America today?

At this point a stunning piece of evidence came out of the blue. A 1986 doctoral dissertation written by Deena Decker-Walters provided the first modern evolutionary and taxonomic analysis of the species *C. pepo*. Decker-Walter's research used isozyme analysis--a technique for measuring protein similarities (and indirectly genetic differences) between two species--to demonstrate that the *C. pepo* domesticates fall into two separate genetic groups.

The orange-skinned pumpkins introduced from Mexico are in one developmental lineage. But the green and yellow squashes are in a genetically quite different group, suggesting two distinct developmental histories and origins. It was possible that Native Americans in eastern North America had domesticated indigenous wild gourds (the ancestor of green and yellow squash) around 4,000 years ago. The 7,000 year old rind fragments showed no definite signs of domestication and hence probably came from wild plants. But if they did, why were there no modern wild gourds today?

(continued on p. 14)

IN SEARCH OF THE WILD EASTERN GOURD

The existence of modern wild gourds could prove once and for all that the second lineage--the summer and acorn squashes--came from indigenous plants. Not knowing much about wild gourds but willing to look for them, Smith and his colleague C. Wesley Cowan, from the Cincinnati Museum of Natural History, decided in 1990 to try to find them.

They first asked gourd and squash specialists about wild gourds in eastern North America. Several experts told them there were no wild gourds in the region, nor had there ever been any. Not dismayed, and following clues from earlier researchers, Smith and Cowan began to ask people who lived in the area. Much to their surprise, local people told them about free-living gourds in Arkansas, Kentucky, Missouri, Alabama, Illinois, Tennessee and Louisiana--a number one weed problem, they were told. Smith and Cowan went back once again to the "gourd experts" for confirmation. Once again, they were told these were not wild gourds: "Oh, those gourds, we know all about those gourds. They are not 'wild' but feral gourds that were derived from domesticated, ornamental gourds, which 'escaped' from cultivation and since World War II have become agricultural weeds" (unpublished lecture by Smith, April 1993).

Realizing they just might be on the trail of wild gourds, Cowan and Smith decided next to turn to herbaria to find out how long these gourds had been around in the United States. To their delight, a survey of herbaria yielded much new data, herbarium sheets showing gourds collected from across eleven states, from Texas north into Illinois and east along the Gulf coast to Florida. Even more interesting, the history of collecting of these free-living gourds extended long before WW II, well back into the 19th century, with a number of specimen sheets from the St. Louis area dating to the 1850s and 1860s. Smith and Cowan then questioned the experts where these 19th century gourds could have come from. They were told that early settlers

were growing ornamental gourds, and some had "escaped" back even in the 19th century. But where did the early settlers get these gourds if there were no wild gourds? The answer again came quickly back: from seed catalogs (unpublished lecture by Smith, April 1993).

Beltsville, Maryland is home to the National Agricultural Library, which houses the largest collection of seed catalogs in the country. Browsing through reams of seed catalogs in search of obscure Ozark gourds, Cowan and Smith discovered that, with few exceptions, *C. pepo* gourds did not begin to grace the pages of seed catalogs until well into the 1870s. This was several decades after gourds had been collected in St. Louis as evidenced in the old herbaria sheets.

More convinced than ever of the existence of wild gourds, Smith and Cowan decided to turn to the Ozark river floodplains. They chose the Buffalo River, unsettled until the 1850s, never much of a farming community, and since the 1950s a national scenic river--with virtually no cultivation of any kind carried out in its watershed for four decades.

Smith describes his and Wes Cowan's trip along the Buffalo River: "the canoeists and chiggers are gone, the valley empty and quiet, with only deep blue skies, bright yellow autumn sycamores, riffling cold waters across gravel bars, and the excited cries of discovery echoing off steep limestone cliffs." The Ozark gourds were all over the place, "in almost every stream or river we investigated, we found wild gourd vines climbing up into trees and bushes or stretching across gravel bars. These gourds had been hiding in plain sight for 150 years!" (unpublished lecture, April 1993).

THE PUZZLE COMPLETED

The two archaeologists found literally hundreds of gourds, each about the size of a hardball or smaller, ivory colored with occasional green stripes. Each gourd contained from 100 to 200 seeds, constituting an excellent food source, being 25% protein. Smith and Cowan turned their

gourds over to botanist Deena Decker-Walters, authority on *Curcubita* taxonomy, genetics, and evolution. She and Terrence Walters compared the isozyme profile of the Ozark Wild Gourd with other wild gourds and with a wide range of domesticated pumpkins and squashes belonging to the species *Cucurbita pepo*. They concluded that the Ozark Wild Gourd exhibited a unique genetic profile, confirmed it as a wild plant and not a "garden escape," and established it as the likely wild ancestor of eastern North American domesticated squashes, a lineage with a history quite separate from the pumpkins of Mexico!

Still surviving today in the Ozarks, it was this wild gourd that Native Americans living in eastern North America developed into different varieties of domesticated squashes between 3,000 and 2,000 B.C., at the same time that they domesticated sunflower, marshelder, and chenopod.

The puzzle finally was complete. The old diffusionist arrow showing domestication in eastern North America originally coming from Mesoamerica had been toppled. The textbooks could be revised and now should read:

Native North American women and men domesticated local plants, including the wild ancestor of squash and several highly nutritious seed crops, long before any domesticated plants were introduced from Mesoamerica. This revolutionary contribution of Native North Americans makes eastern North America one of the world's four major independent centers of plant domestication along with the Middle East, China, and Mesoamerica!

Ruth O. Selig

[AUTHOR'S NOTE: There was clearly no one "prehistoric genius" who discovered how to plant and harvest seeds, no prime mover of domestication. Similarly, no one scholar alone could have unraveled the entire story of the independent origin of agriculture in eastern North America. Although this article is based on writings, interviews, lectures and unpublished materials of Bruce

Smith, Smith's publications extensively document the contemporaneous work of numerous colleagues working on the puzzle of domestication in North America, particularly that of David and Nancy Asch, Wesley Cowan, Gary Crites, Deena Decker-Walters, Richard Ford, Gayle Fritz, Kris Grimillion, Fran King, Patty Jo Watson, and Richard Yarnell.]

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