Corn's Slow Path to Stardom

By JANET RALOFF

Archaeologists rewrite the history of maize — and New World civilization

From humble origins as a lowland tropical grass, corn developed into the western world's preeminent grain. Wherever this "gift of the gods" was introduced, it edged out native crops to become an indispensable part of the diet. Because its unparalleled yields allowed communities to grow far beyond what hunter-gatherers or nascent agriculture could feed, most archaeologists viewed corn as having largely fueled pre-Columbian growth — and civilization — throughout the Americas.

But new findings are drastically altering researchers' notions about the time frame over which that revolution occurred. Moreover, new dates for corn's emergence from Mesoamerica do not support the widely held view that corn — or maize, as this grain is called outside the United States — suddenly exploded into stardom wherever it appeared. Indeed, the dogma that this cereal fostered the settlement of nomads by launching agriculture is going the way of myth. Archaeological evidence now suggests that most of the ancients who first embraced maize were already horticulturists — even farmers.

Corn, while unique in the strength of its impact and the complexity of its domestication, no longer appears unique in the speed at which it moved from botanical curiosity to dietary staple.

When Columbus reached the New World, corn was the most widely grown plant in the Americas, observes Frances B. King, a paleoethnobotanist at the University of Pittsburgh. The grain's range extended from what is now southern Canada to lower South America. Some tribes cultivated it at sea level, others at elevations exceeding 11,000 feet.

"Columbus had no way of knowing that maize was far more valuable than the spices and gold he had hoped to find, or that it represented — as it still does today — the most remarkable plant-breeding accomplishment of all time," King maintains.

Through human intervention, this versatile plant has developed into several hundred races, or varieties. Their heights vary from 2 to 12 feet, and their maturity ranges from little more than 2 months to almost a year. Their ears vary not only in color — from blue and maroon to yellow and white — but also in size, from 1 to 18 inches. Some maizes thrive in areas receiving more than 170 inches of rain per year, others where annual precipitation averages just 5 inches.

Unlike other cereals, maize bears little resemblance to its wild ancestors. In fact, it deviates from the appearance of its immediate ancestors more than any other cultivated plant known, says Dolores R. Piperno of the Smithsonian Tropical Research Institute in Balboa, Panama.

Images: Piperno/Smithsonian Tropical Research Inst.

By backcrossing a number of corn varieties in the 1930s, cereal breeder Paul C. Mangelsdorf of Harvard University attempted to "arrive at some sort of model of what that [progenitor] maize was supposed to look like," says archaeologist Nikolaas J. van der Merwe, also of Harvard. The suspected parent — some extinct, pod-bearing popcorn — wrapped each seed in a chaff-like glume, the same type of wrapper that encases individual wheat seeds, Van der Merwe says.

Though this theory of corn's ancestry won some following among archaeologists for several decades, "I don't think Mangelsdorf was ever very widely believed among geneticists," says John Doebley, a plant biologist at the University of Minnesota in St. Paul. And in the early 1970s, even archaeologists abandoned Mangelsdorf's hypothesis in favor of one initially proposed in 1939 by Nobel laureate geneticist George Beadle.

The shift occurred because several new lines of genetic evidence emerged to point, as Beadle had, to teosinte — a decidedly nonextinct Mexican grass — as corn's most likely ancestor, Doebley says.

In fact, paternity and maternity tests conducted in the late 1980s by Doebley and his co-workers show that just a few genes control most of the traits distinguishing corn from teosinte (pronounced tay-o-SIN-tay). "I would say that five is a good number," Doebley says. But additional genes — perhaps dozens — likely offer subtle refinements that influence how the major genes work, he adds.

Having mapped where the operant genes reside, Doebley's team is now cloning them with the hope of eventually investigating their expression within plants. Thus far, he says, it appears that the hundreds of maize varieties existing today may trace back to a single race of teosinte growing in the lowlands that drain western Mexico's Balsas River.

Whereas corn sets its seed kernels on cobs, seeds of Balsas teosinte grow in two brittle, cobless rows within an enclosed husk. Moreover, teosinte encases each of its

Plant geneticists now suspect that corn, in its many forms, descends from Balsas teosinte, pictured here. Teosinte's cobless, double row of seeds grows within a single husk.

seeds within a hard shell, which shields the seed in the ground over winter. Growing corn, whose seeds have no similar protection from rot, requires harvesting the ear, removing the kernels, and then protecting those seeds until they can be safely sown the following spring.

Indeed, contends King, what most distinguishes corn from other grains is its dependence upon people. "No other cereal species has so completely lost its natural ability to disperse its seeds or to propagate itself without human intervention," she says.

If corn descended from teosinte, one would expect to find the earliest evidence for maize in teosinte's homeland. And the oldest pieces of corn found in Mexico so far are indeed ancient, dating back some 5,300 years, Piperno notes. But those pieces, retrieved from a highland site several decades ago, are almost 2,000 years *younger* than evidence of maize recently retrieved in Panama by Piperno's team.

Piperno studies phytoliths – microscopic silica structures that form within the cells of living plants. In the moist tropics, most plant materials rot quickly, making recovery of primitive corn kernels, ears, or husks all but impossible. But phytoliths, being mineralized, remain well preserved.

Piperno's new dates for Panamanian maize phytoliths – based on carbon isotope measurements of the lake sediments in which the phytoliths were found – threaten to push back corn's initial dispersal south of Mexico by 3,000 to 4,000 years. But they don't challenge Mexico as corn's birthplace. Rather, she argues, the new findings suggest that archaeologists have yet to identify Mexico's true cradle of maize breeding.

Doebley agrees. His genetic data, he says, pinpoint the Balsas River drainage – a lowland site – as "the most likely home of the ancestor to maize."

Piperno, who described her findings in February at the American Association for the Advancement of Science (AAAS) annual meeting in Boston, has analyzed more than 300 species of wild tropical grasses that produce phytoliths, which the plants shed as they decay. She has observed that phytoliths from these wild plants tend to be smaller than those from maize, which typically span about 13 microns. Moreover, maize produces cross-shaped phytoliths bearing a fairly distinctive three-dimensional structure, she says.

Corn's characteristic phytoliths have turned up, usually together with maize pollen, in prehistoric human settlements throughout Mesoamerica. At one site about 40 miles from central Panama's Pacific Coast, Piperno's team found evidence of human activity – essentially the conversion of a lowland tropical forest to slash-and-burn maize cultivation. Dating back 7,000 years, these excavated layers provide "the earliest date for slash-and-burn agriculture in the American tropics," she says.

Corn moved north from Mexico later than it moved south, although how much later remains a matter of controversy. At the AAAS meeting, Bruce D. Smith presented archaeological evidence indicating that the plant entered eastern North America "across the plains from the northern Southwest at A.D. 0 to 200." Moreover, "it arrived already well adapted to climatic conditions of the midlatitudes" and was initially adopted by peoples who already had some history of farming or gardening, says Smith, an archaeologist with the Smithsonian Institution's National Museum of Natural History in Washington, D.C.

Figuring prominently among the pre-maize crops, he says, were squashes; marsh elder, a relative of the sunflower; and lamb's quarter, a weedy plant also known as goosefoot. Such crops may have been cultivated for 2,000 years before corn's arrival, Smith maintains.

Overall, he says, archaeological evidence for maize in the East "remains almost invisible" until about A.D. 800. He concludes, therefore, that "the transition to maize agriculture was a much longer process than previously thought, with a developmental lag in both eastern North America and the Southwest."

How long? "Perhaps 1,000 years passed between [corn's] first introduction and its emergence as a major food," Smith estimates.

James Schoenwetter, an archaeologist at Arizona State University in Tempe, would push back even further the date of corn's initial dispersal into the continental United States, dramatically extending the lag between corn's appearance and its domination of northern agriculture.

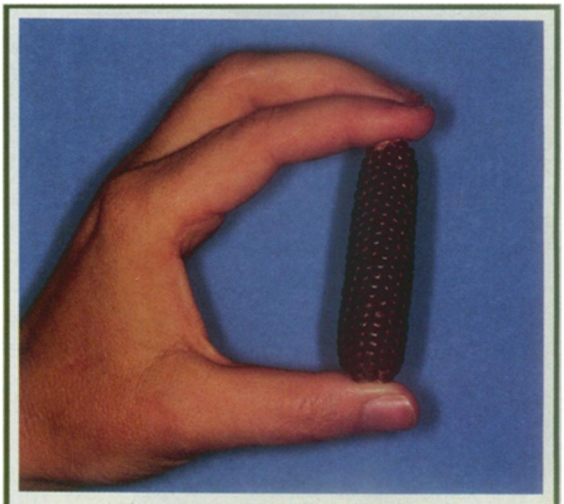
Sifting through soil collected from several well-dated archaeological sites in North America, Schoenwetter has detected maize pollen from well before the time of Christ. For instance, he reports finding low concentrations of the pollen at a New Mexico site associated with a desert hunter-gatherer society (the San Jose Oshara) that dates back perhaps 6,000 years. Significantly higher concentrations of maize pollen, suggesting a gardening culture, appear at a site further north in New Mexico and in a sediment layer (the San Juan Archaic) dating to roughly 4,000 years ago, he says. And in southern Illinois, Schoenwetter has detected diffuse signs of maize pollen at a small woodland village (the Koster site) dating back 5,500 years.

Other archaeologists at the AAAS meeting quizzed Schoenwetter about his conclusion that the pollen at the very early U.S. sites came from maize cultivated in those soils. Might excavation techniques, animals, or burrowing insects have moved the pollen down from soil layers that correspond to later habitation?

Schoenwetter acknowledges that "maize pollen identifications are not 100 percent accurate, and sample contamination always remains a possibility." Nonetheless, he expresses confidence in his evidence for maize cultivation in the continental United States at least 5,000 to 6,000 years ago. Indeed, in the 4,000-year-old San Juan Archaic soils from the Four Corners region of northwestern New Mexico, maize pollen concentrations "exceed those found in cornfields today," he told SCIENCE NEWS.

However, he adds, the lower concentrations of maize pollen he observed in soils from the oldest Mexican and U.S. sites suggest that "corn was not cultivated [there] as a garden crop, even a minor one."

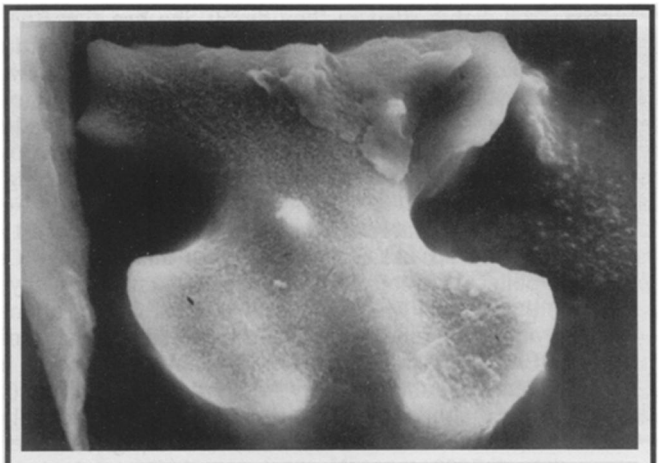
It's even possible that maize was not



No one knows precisely what the earliest corn looked like. But this modern ear represents a reasonable guess, according to Piperno.

originally cultivated as a foodstuff, he says. That idea is quite controversial, however. "There are no ethnographic analogs for this behavior," Schoenwetter concedes. He also notes that the theory may prove impossible to test.

On the other hand, King points out, Aztecs and other Mesoamerican peoples used dried corn silk as a tobacco substitute, warm cornmeal gruel as a poultice, and scorched cornmeal as a baby powder. Corn leaves and stems, high in sugar, may have served as a New World precursor to chewing gum, King notes. Evidence of the practice survives in the fibrous, corn-derived spitballs recovered at many pre-Columbian archaeological sites.



This scanning electron micrograph shows the distinctive, cross-shaped phytolith produced by maize.

Emerging dates for corn's development and dispersal have not radically altered the date at which corn appears to have begun dominating American agriculture. And that's important, notes Deborah M. Pearsall of the University of Missouri in Columbia, because archaeologists are concerned with identifying the food base for the important advances in societies — especially the development of complex political and social systems.

And until recently, Pearsall says, "the pat answer used to be corn."

But findings by Piperno and others indicate that maize was adopted south of Mexico "by what would seem to have been horticulturists," explains J. Scott Raymond, an archaeologist at the University of Calgary in Alberta. Corn's northward spread similarly shows "an introduction into either a hunter-gatherer or an early horticultural setting where people are already familiar with manipulating the environment," he says.

Thus, it appears that "the beginnings of [American] social and political complexity predate the importance of corn," Pearsall asserts.

This conclusion dovetails with recent reports of two American settlements dating to roughly 3,500 years ago. One flourished in Mexico without the need for agriculture (SN: 2/8/92, p.86); the other thrived in Peru with cultivation of cotton but not of edible crops (SN: 1/19/91, p.38).

The new studies, adds Raymond, are establishing a lag of 1,000 to 3,000 years between corn's arrival in the New World and its entrenchment as a dietary staple. As a result, "we no longer expect the spread of corn to be associated with a dramatic change [such as an immediate population increase] in the adopting cultures," he says.

Finally, says Raymond, the new work is sparking interest in other aspects of the archaeological record — especially those that might explain social and economic contexts affecting the spread of maize, the "single most important crop that the Americas contributed to the world." □