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The San Pablo Corn Kernel and Its Friends

There is evidence for intensive maize agriculture in the Early Formative stage of Ecuador.

Carlos Zevallos M., Walton C. Galinat, Donald W. Lathrap
Earl R. Leng, Jorge G. Marcos, Kathleen M. Klumpp

It is generally assumed by students of New World agricultural systems that agriculture first achieved a high level of productivity in Mesoamerica and the Central Andes, the two regions ultimately to attain high civilization. Research programs directed toward the problems of agricultural origins have been concentrated in those zones (*1*). Certain evidence, however, does not fit comfortably with such general assumptions. Pottery of more than rudimentary competence was widespread in the moist tropical zones of northern South America before 2000 B.C., far earlier than it appeared in either Mesoamerica or Peru. This pottery occurs in archeological contexts that indicate large populations and stable settlement (*2*). It has been suggested that the economic basis of these earlier ceramic-using populations was maritime-oriented and it has even been hypothesized that the precocious appearance of pottery was due to early Japanese influence (*3*, *4*). It is in the context of these long-standing attitudes held by most New World archeologists that our data take their significance.

In this article we discuss a range of direct evidence indicating the existence of intensive maize agriculture in Ecuador at a very early date. There are several approaches to the problem of determining the subsistence of past societies. At one extreme one can present the actual physical remains which indicate the utilization of particular foodstuffs. At the other extreme one can study the pattern of location of ancient settlements, the spacing among such settlements, and the resources available within the catchment area (the region supporting each settlement). We think that the second approach, which was exemplified recently by Flannery and his associates (*5*), is more desirable in the long run, but there is a sentiment on the part of some scientists that discussions of ancient agriculture should be confined to the data at hand rather than be expanded to a consideration of past agriculture practices as total systems. Some scholars still feel that a systems approach involves unwarranted speculation (*6*). In deference to the latter point of view, we confine this article to seven pieces of data that can be considered as being fairly close to direct observations replicable by others.

These seven primary observations are: (i) A charred kernel of maize is included within the fabric of a sherd from Valdivia V-VI. (ii) Valdivia pottery is sometimes decorated with appliqué forms most economically interpreted as representations of cobs of *Zea mays*. (iii) Sherds of rims from Valdivia III pots are frequently stamped with actual corn kernels. (iv) Hand mills are the most obvious and common food-processing devices in all Valdivia sites. (v) The presence of quantities of a small marine snail, *Cerithidia pulchra*, which is ecologically specific to the mangrove swamp, is best interpreted in terms of lime production, which in turn suggests the use of lime in food preparation. (vi) The number of bell-shaped storage pits in sites from the Ecuadorian Formative stage is compatible with the storage of dried *Zea mays* in quantity. (vii) Charred corncobs have been recovered at the highland site of Cerro Narrío from a context which must predate 2000 B.C.

Archeologists and other students of agricultural origins have frequently bemoaned the quality and quantity of hard evidence that can be brought to bear on the problem (*6*), yet there has been a tendency to ignore evidence that fails to support widely held assumptions about the most likely centers of agricultural intensification. The most important piece of evidence (the charred kernel of corn) in our argument was discovered in 1961; it was made readily available to archeologists at the International Congress of Americanists in Mexico City in 1962, was discussed at length in a monograph published in 1971 (*7*), and is now on view in an exhibition which is touring the United States and Ecuador (*8*). In spite of its availability, it has had no impact on recent general discussions of the history of South American culture (*4*); nor is it mentioned in a recent review of the evidence on agricultural origins (*9*). We hope with this article to overcome this pattern of neglect.

As briefly as possible we will place the data to be discussed in their spatial and temporal contexts: two archeological cultures, Valdivia and Early Cerro Nar-

Dr. Zevallos is professor of anthropology at the Universidad Estatal de Guayaquil, Guayaquil, Ecuador. Dr. Galinat is professor of agronomy at the University of Massachusetts Suburban Experiment Station, Waltham 92154. Dr. Lathrap is professor of anthropology at the University of Illinois at Urbana-Champaign, Urbana 61801. Dr. Leng is in the production division of the Office of Agriculture, Agency for International Development, Washington, D.C. 20523. Mr. Marcos and Ms. Klumpp are graduate students in the department of anthropology at the University of Illinois at Urbana-Champaign.

río, which existed through part of all of the time span from 4000 B.C. to 2000 B.C. calendrical years. The great antiquity of Valdivia is supported by a very large and unusually consistent series of carbon-14 dates (*3, 10*), with only one assay presenting problems in interpretation (*3*). The age of this culture is not a matter of controversy. On the other hand, the problems of the economic pattern and of the origins of Valdivia culture have given rise to an unusually lengthy and acrimonious debate (*3, 11*). Norton has presented the best summary of the evidence relating to these problems, and we concur with his conclusions (*12*). The location of the Valdivia sites is not uniquely or even typically coastal. The sites are located with reference to the availability of land suitable for floodplain agriculture. This statement applies even to Valdivia site G-31 itself. The earliest securely dated Valdivia site, Loma Alta, is well away from the coast. The large size, deep midden accumulation, and temporal stability of most of the Valdivia sites strikes us as prima facie evidence for a developed agricultural economy, especially in view of the molluscan, fish, and mammalian remains that occur as relatively minor constituents of the midden. Such remains indicate that those food resources did not supply the bulk of the caloric intake for the large, sedentary communities. Among the designated Valdivia sites of any size, only El Encanto (*13*) could be classified as a shell midden, and this on close inspection appears to be a preceramic site with a thin veneer of subsequent Valdivia occupation. We will not present here all the carbon-14 dates or discuss their interpretation. The date clusters calibrated for the bristlecone pine correction indicate that the basal occupation at Loma Alta was 3550 B.C. (*14*), that Valdivia II was 3050 B.C. (*15*), and that Valdivia III was 2920 B.C. The Valdivia Machalilla transitions appear to have occurred at 2160 B.C., although relevant dates are less numerous.

Two of us quite independently, Zevallos in 1962 (*16*) and Lathrap in 1970 (*17*), concluded that the immediate origins of Valdivia culture were to be sought in the Guayas Basin, and that the known Valdivia sites on the coast and in the coastal river valleys were relatively late and marginal with reference to the problem of Valdivia origins. The recovery of Valdivia material from the Guayas Basin, and even from the Andes, makes this hypothesis progressively more appealing (*18*). We are all in agreement with Norton (*12*) that the evidence now available is destructive to the hypothesis of a Japanese origin for Valdivia. The theory of a Jomon ancestry for Valdivia pottery should receive no further scientific consideration.

Table 1. Comparison of large archeological maize kernels with mean of surviving race of Ecuadorian maize, *Kcello ecuatoriano* (*22*).

Dimensions (mm)		
Length	Width	Thickness
	Surviving race	
12.4	10.4	5.5
	Archeological race	
11.00	8.90	5.0
11.17	9.00	6.1
11.10		5.6

Early Cerro Narrío and other closely related cultural materials are widespread in the south highlands of Ecuador. Indeed, sites producing such materials are the most common type of archeological remains in that zone. Lanning first suspected the great antiquity of Cerro Narrío, and Braun, through a restudy of Cerro Narrío materials, has produced a precise alignment between the chronology at Cerro Narrío and the chronology of the Santa Elena Peninsula showing extensive overlap between Cerro Narrío and Valdivia (*19*). Recent carbon-14 assays run by the British Museum completely confirm Braun's alignment (*18*). The date of 3928 ± 60 B.P., which calibrates to around 2500 B.C., comes from the end of the long Early Cerro Narrío occupation.

Fig. 1. Photograph of a charred corn kernel embedded in a Valdivia V-VI sherd from the excavations at the San Pablo site. [Photograph by D. Minor, University of Illinois]

The Charred Corn Kernel

During 1959 and 1960 Zevallos and Holm excavated the pure Valdivia site known as San Pablo (*20*). While studying the materials in 1961, Zevallos encountered a large pot sherd comprising about one-quarter of a shallow bowl. In terms of shape and surface finish the bowl conformed to Valdivia V or VI ceramic standards; it could not be assigned to any other point in the ceramic sequence for the south coast of Ecuador. The precise provenience of the sherd is cut M, unit 146, 70 to 80 centimeters below the surface (*7*). There are no later materials at the San Pablo site, so that the possibility of intrusion is minimal. Embedded within the outer surface of the sherd is a piece of charcoal contained within a slightly larger space or negative cast. Certainly few charred plant remains come to us with such secure chronological and cultural credentials.

The nature of the piece of charcoal and the space which surrounds it are such that these can only be the remains of a kernel of maize (*Zea mays*) which had been included in the moist paste of the pot as the pot was being manufactured and which was fully carbonized as the pot was fired. No other kind of plant remains could conceivably have produced these results.

When the object was examined in 1974, Galinat observed that the imprint of the kernel together with portions of its carbonized remains have preserved beautifully the essential botanical characteristics of a kernel of maize. The embryo, the scutellum, the endosperm, the angular abscission layer, and the primary root of a typical kernel that has been in the process of germination for about 3 days are all clearly discernible. Enough of the carbonized endosperm has been fragmented away from the nongerminal face of the kernel to reveal an elevated ridge of the embryo largely encased in and flanked by the inward bulge of its scutellum in similar proportions to those illustrated by Kiesselbach (*21*). The bold circular sweep of the endosperm perimeter bounded by aleurone and pericarp are also apparent and reveal a kernel whose size and proportions suggest a racial identification to be considered below. The kernel may have been shelled from near the butt or tip of the ear as is suggested by the slightly angular slope of the abscission layer (Fig. 1).

A similar conformation of the embryo and scutellum area were produced experimentally by the firing of clay test tiles, each containing a germinated ker-

nel of maize of a size comparable to the San Pablo specimen. An attempt was made to position the kernel with reference to the surface of the block of clay so that it would be comparable to the San Pablo specimen. When the tiles were fired at a sufficiently high temperature to produce a ceramic, the kernel was totally charred and always showed the characteristics of the San Pablo specimen; that is, the root and oil-rich section of the kernel completely burned away, while the starchy section of the kernel and the embryo remained as hard charcoal.

Effigies of Maize

The Valdivia site of San Pablo and other Valdivia sites have produced pottery with a distinctive style of appliqué decoration. A vertical strip of appliqué is affixed to the shoulder of pots with everted rims. The vertical strip is further modified by several vertical rows of punctations or short horizontal gashes. The whole appliqué element is nested in a mass of fine incisions forming a triangle. We agree with Zevallos's earlier proposal that this design is best interpreted as a representation of a cob of maize still partially encased in its husk (*7*).

This decorative concept is by no means rare, and on occasion is combined with a schematic representation of the human face. This combination may indicate some concept of an anthropomorphic maize deity.

The most spectacular example of this style of ceramic decoration is shown in Fig. 2. The six appliqué strips which adorn the sides of this pot have certain peculiarities. Each strip is carefully formed so as to present three equal faces to the viewer, the same effect as that produced when an octagon is viewed directly from one face. The incisions indicating the individual kernels of corn are arranged in very neat rows, so that the whole effect can be seen as a convention to depict an eight-rowed corncob with orderly arrangements of kernels. The ceramic representation should be compared to even-rowed, large-kernel corn, with a row number of eight (*22*).

Deliberate Impressions Made with Corn Kernels

When the current excavations of the large Valdivia site, OGCh-12, Real Alto, started in August 1974, parts of the site had already been vandalized by pothunters and it was possible to make large sherd collections from the back dirt piles of these illegal excavations. Several rim sherds with treatment typical of Valdivia III have clear, multiple impressions of corn kernels as a decorative technique.

Most typically this kind of rim, which Hill has designated the piecrust rim (*10*), is decorated with multiple impressions of the index finger and fingernail; but not infrequently a kernel of maize was substituted as the stamping device. In most cases it was clearly the edge of a kernel (as noted by all who have examined the sherds) which was pressed deeply into the moist clay of the rim (Fig. 3), but one example has broad side impressions of the maize kernels giving more extensive information on the shape and size of the individual seed (Fig. 4).

In each case the impression shows anatomical characteristics that are unique to maize, so that there can be no doubt

Fig. 2. Valdivia V vessel with modeled effigies of ears of maize. The appliqué elements are approximately 10 cm long. [Photograph by J. Alderson and A. Wise, courtesy of the Field Museum of Natural History]

Fig. 3. Valdivia III rim sherd from the Real Alto site with impressions made with a maize kernel. [Photograph by J. Alderson and A. Wise, courtesy of the Field Museum of Natural History]

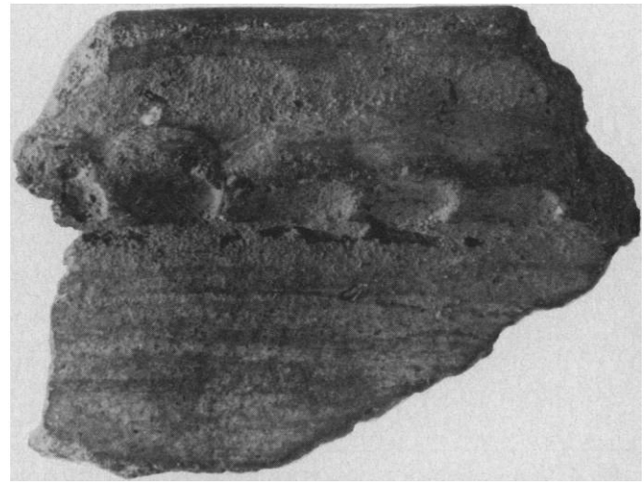

Fig. 4. Valdivia III rim sherd from Real Alto with broad side impressions made with maize kernel. [Photograph by J. Alderson and A. Wise, courtesy of the Field Museum of Natural History]

that a maize kernel was used. On stylistic grounds all of the sherds with maize kernel impressions can be dated to Valdivia III, and in the course of the ongoing excavation at the Real Alto site several more examples have been recovered from secure Valdivia III contexts. A calibrated date of 2920 B.C. is thus indicated.

When the single charred corn kernel, the maize effigies from Valdivia pots, and the sherds with kernel impressions are all juxtaposed, an interesting pattern emerges. In gross morphology the large, broad kernel carbonized within the bowl fragment conforms perfectly to the size and shape of the large, broad corn kernels most frequently represented on the impressed rims. The breadth and configuration of the kernels, each encompassing about a 45-degree arc, suggest a maize variety with a low row number, more specifically an eight-rowed cob. Because the relatively primitive eight-rowed flint corn *Kcello ecuatoriano* (*22*) would conform to all of the observed characteristics of the Real Alto corn, we compared all available measurements on the archeological materials with measurements of *Kcello ecuatoriano*. The metrical correspondences are as striking as the gross morphological similarities (Table 1).

A smaller number of rims had impressions made with much smaller kernels. Metrically these kernels show absolutely no overlap with the large, eight-rowed corn. The kernels are narrow and sharply angular. As shown in Table 2, this corn is similar in its dimensions to the races *Pojoso chico, Chococeño*, and *Canguil*, and the peculiar toothlike form of the kernels is highly compatible with such an identification. These small kernel races have row numbers of 14 to 22, and in all of their characteristics can best function as popcorn (*23*). This small-kernel corn may have been put to very different culinary uses than the large-kernel flint corn. Thus one may conclude from this evidence that two very distinct races of maize were deliberately maintained as two discrete botanical and cultural entities by the Valdivia III agronomists.

Table 2. Comparison of impressions of small archeological kernel with mean of surviving races of maize with high row number.

Race	Dimensions (mm)			Kernel shape
	Length	Width	Thickness	
Pojoso chico (*23*)	8.80	7.30	4.80	Rounded
Archeological	7.00	5.00	4.00	Rounded
Chococeño	8.30	6.6	4.20	Rounded
Canguil	7.30	5.6	4.5	Outpointed kernels

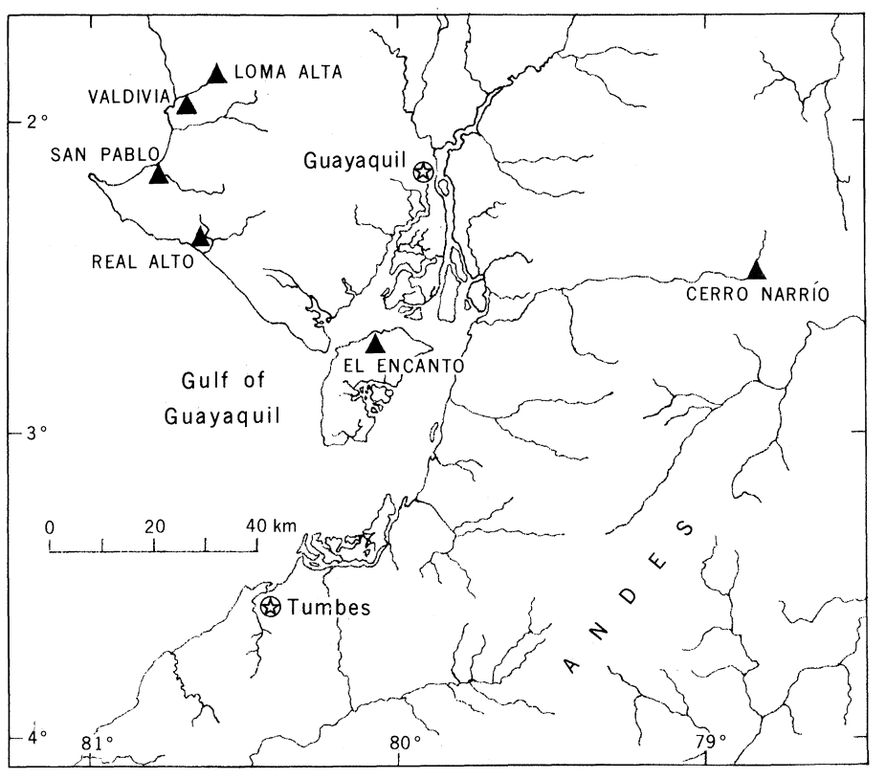

Fig. 5. Map of southern Ecuador showing the location of the archeological sites discussed.

Food Processing

Most Valdivia sites produce quantities of well-made, very intensively used hand mills (*manos* and *metates* in the standard nomenclature of New World archeology). A large, carefully constructed cairn of deliberately broken manos and metates has been excavated at Real Alto site, and metates are frequently associated with burials. It is clear that these hand mills were very important adjuncts to the daily food-processing routine. Hard-seed grasses occur in considerable abundance in the vicinity of Real Alto, but with the presence of a large-kernel corn fully documented it seems more rational to assign to the manos and metates the function of grinding corn kernels into cornmeal.

The question remains whether the hard dry kernels were attacked directly or first softened by boiling with lime, producing the product usually known as *masa*. The large amount of pottery used as cooking ware makes prior boiling a definite possibility and the use of lime as an adjunct to coca chewing is suggested as early as Valdivia III, so that the culinary use of lime is not unlikely.

The shell of *Cerithidia pulchra*, a small snail specific to the brackish waters of the mangrove, was encountered in some quantity. This is poor food since it is of bitter taste and the volume of shell is greater than the volume of edible tissue. This shell is still preferred by the local inhabitants as the material to be slaked for lime. Even though we are inferring coca mastication, the amount of lime which could be produced from the amounts of *C. pulchra* present seems to indicate a more extensive use in food processing. Evans *et al.* (*24*) observed concentrations of calcined shells compatible with this interpretation. We favor the hypothesis that lime figured in the preparation of maize as food.

Storage Capacity

An unusual feature at Real Alto is the large number of carefully constructed, bell-shaped subterranean pits. When intact they have a depth of about 1 meter, a diameter at the base of about 1 m, and a mouth diameter of about 40 cm. These

cists, if topped with wood or pottery covers, could have served for the dry storage of large quantities of food, and a crop such as dried corn is an ideal candidate for such storage. The cists occur in long, even parallel rows and suggest an organized food storage capacity far larger than what would be justified by the needs of individual families. Planned, long-term storage organized on the community level is strongly suggested. Without substantiating data, pits with almost identical features have been accepted as corn storage facilities in the early farming communities of Mesoamerica (*5*). The combined capacity of these cists suggests the existence of efficient economic and agricultural systems producing more food than could be consumed locally. These cists date from an as yet undescribed phase transitional between Valdivia and Machalilla.

Further Charred Material

The intensive use of flotation techniques at Real Alto has not to date yielded a generous supply of charred plant remains other than wood charcoal. A secure Valdivia III context yielded what appears to be a small fragment of a corncob, but the identification is still tentative. At other times, careful troweling revealed charcoal structures which seemed to be corncobs but which disintegrated before any strategy for their preservation could be initiated. The lack of fragile charred plant structures is not surprising given the sandy, friable nature of the soil and the pattern of alternate rapid saturation and drying to which those soils were subjected every year. The recovery of plant structures is believed to be least likely in the kinds of soil present at Real Alto (*25*). Flannery has recently described what the archeologist should not do, that is, to allow his samples to desiccate rapidly (*5*). Natural conditions at Real Alto are such that destructive variations in humidity occur several times each year.

The excavations of Collier and Murra deep in the Early Cerro Narrío layers of the Cerro Narrío site did yield charred corncobs (*26*), but these are not now available for more detailed study of the race of corn involved. The location of Cerro Narrío and other similar south highland sites is such that only an efficient agricultural system could have supported the large stable populations suggested by the deep, extensive cultural deposits.

Discussion

Flannery notes that in Mesoamerica the earliest sites supported by efficient agriculture represent a major increase in community size and community stability over previous occupations. He also notes that such communities appear rather suddenly in Mesoamerica without much in the way of local antecedents. Flannery further argues that the appearance of a fully agricultural way of life is dependent on the development of efficient races of crop plants (*9*). It is in this context that the occurrence of large-kernel, eight-row flint corn in Ecuador, over 1000 years before maize of comparable efficiency occurs in either Mesoamerica or Peru, takes on special interest.

We believe that our data suggest that maize was first brought to a high level of productivity in some place in the moist tropics of northern South America. But our data shed no light on the problem of the zone or zones in which maize was first domesticated. We believe that the precocious occurrences of efficient maize agriculture in the coast and highlands of Ecuador had marked effects on the population growth rates and the development of more complex societies. We further suspect that the demographic imbalances triggered by the efficient level of agriculture in early Ecuador impinged on both Mesoamerica and Peru. Because we wish to avoid the level of speculation so deplored by scholars such as Harlan [see (*6*)], we will not elaborate on a model for the extent and nature of this impingement. For the same reason we will not speculate on how early, primitive, domesticated maize first got to Ecuador. The only point we will emphasize is that scholars working in Mesoamerica and Peru and speculating on the reasons for the sudden appearance of efficient agriculture in these zones should not remain in ignorance of the evidence from Formative Ecuador.

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15. The dates (B.P.) for Valdivia II are as follows: M 1322, 4620 ± 140; M 1317, 4480 ± 140; W 631, 4450 ± 200; SI 22, 4450 ± 90; HV 4838, 4260 ± 100; SI 18, 4230 ± 100; SI 16, 4220 ± 100; M 1318, 4170 ± 140; M 1321, 4100 ± 140.
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27. Calibration of the date clusters was performed by D. Coleman of Illinois Geological Survey. We thank C. Baries and R. Feldman for valuable editorial suggestions. The current excavations at Real Alto are being carried out by the University of Illinois in conjunction with the Museo del Banco Central de Ecuador and La Universidad de Guayaguil, supported by NSF grant 75-02954.