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Prehistoric Agriculture in Tropical Highlands

Settlement patterns in western Panamá reflect variations in subsistence adaptations to the tropics.

Olga F. Linares, Payson D. Sheets, E. Jane Rosenthal

Studies of the origin and dispersal of New World food plants have involved comparisons between two ancient and successful agricultural systems. Vegeculture, or the cultivation of starchy tubers and rhizomes, also known as root crops (manioc, yams, sweet potatoes, and so forth), may have been established in the northern South American tropics by the third millennium B.C. (*1*). Seed culture, or the selection and propagation of seed-bearing plants (maize, beans, or cucurbits), had its beginnings in Mesoamerica and possibly in parts of Andean South America in at least the sixth millennium B.C. (*2*). Recent archeological evidence suggests several centers of origin, in different periods and widely separated areas, for the most important cultivars (*3*).

The problem of agricultural dispersals is as complex as that of plant origins. Nonetheless, more serious thought has been given to the plant domestication processes, and to the evolution of subsistence systems (*4*), than to the factors influencing the adoption, modification, and success of new agricultural products and techniques. In fact the two processes, domestication and dispersal, are often equated. Yet it is important to remember that very different human selection pressures may be involved in these processes. We are reminded of this by Harris's argument (*5*) that ecosystem manipulation may have been involved in vegecultural origins, while ecosystem breakdown may have encouraged the replacement of vegeculture by seed culture by 500 B.C., in parts of northern South American tropics (*6*).

In this article we explore the introduction of seed culture into a small and somewhat marginal tropical area, where environmental conditions were in some ways favorable, in other ways rigorous. Our concern with settlement subsistence adaptations in highland Panamá may appear parochial, but it is deliberate. An understanding of complex interactions between environmental and subsistence factors in the past can only be achieved, slowly and patiently, by many case studies conducted in diverse but small and manageable areas.

This article deals with archeological developments in the upper drainage of the Río Chiriquí Viejo, in Volcán Barú, at elevations between 1200 and 2300 meters. In spite of their fertility, Central American tropical montane valleys above 1000 m were probably too cold, humid, and forested to have served as early centers of manioc or maize domestication. Apparently these valleys were also outside the aboriginal range of cold-adapted root crops such as potatoes. These factors, plus the scarcity of fish in these incident rivers and the distance from marine faunal resources, were responsible for the persistence of a hunting-gathering population until a well-developed seed complex, based on protein-rich varieties of maize and beans, facilitated human occupation by agriculturalists. The paucity of archeological sites dated before 1000 B.C. in a number of wet and cold tropical highland habitats of lower Central America may be due to the marginality of these environments for initial agricultural developments. Conversely, the explosive success of seed culture here may be related to its late introduction into lightly populated or altogether empty areas, where it met little resistance from other forms of established cultivation.

In the rich but circumscribed volcanic valleys of the Continental Divide on the Pacific side of western Panamá (Fig. 1), the spread of maize-growing peoples, probably from the adjacent lowlands and middle-altitude elevations, initiated processes leading to rank differences, social fission, warfare, and competition within and among villages. Despite the readiness of some archeologists to attribute most Central American sociopolitical developments to influences from Mesoamerica (*7*), we believe that such processes are best understood as local, although by no means uncommon or irreversible, responses to a competitive situation where ecological restrictions were being eliminated by new subsistence opportunities.

Natural Zones of the Barú Region

Volcán Barú, in the Province of Chiriquí, is the highest of several peaks in the Panamanian portion of the Talamancan Range, which extends northwest into Costa Rica and beyond.

Major events during the Pleistocene

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Table 1. Comparison of environments of Cerro Punta and the southwest (lower Barriles) zones. Most of the data are from (*29*).

Environment	Cerro Punta	Southwest (lower Barriles)
Elevation (m)		
Maximum	2375	1340
Minimum	1800	1200
Temperature (°C)		
5-year mean	15.3	No data, but must be warmer
Range of mean	1.8	
Mean annual rainfall, 1971 (mm)	2012	3099
Mean annual rainfall, 1962–1970 (mm)		
Maximum	3464	3677
Minimum	1767	1877
Mean monthly rainfall, 1971 dry season (mm)		
January	147	84
February	43	36
March	30	30
Vegetation	Evergreen forest	Deciduous forest

and Recent periods created the conditions that eventually attracted settlers to this area (*8*). To begin with, a massive lava flow from Barú dammed the Rio Chiriquí Viejo at Bambito, thereby beginning the alluvial sedimentation of the Cerro Punta basin. As the Bambito dike eroded through, numerous feeder streams and the river itself began forming the terraces of the "lower southwest" or Barriles area. A final collapse of the old crater wall caused the rapid alluviation of the fan known as Los Llanos, and forced the Río Chiriquí Viejo to follow a roundabout channel, skirting the basin known as El Hato.

As a result of Barú's activities, at least five distinct microenvironments are found today within an area of about 100 square kilometers (Fig. 2 and Table 1).

1) Cerro Punta is a highland basin filled with rich and gently sloping alluvial sediments. At present, 7 or 8 km² of this basin are arable and hospitable to agriculture. Rainfall is distributed throughout the year, enabling vegetation to grow during most months. Although little of the original vegetation remains, the piedmont spurs on which the archeological sites are found were probably once covered with a lush evergreen forest having a canopy 24 m or so above ground and one or two understories (*9*).

2) Bambito is topographically much more dissected than Cerro Punta, having suffered much more erosion in the form of deeply entrenched *quebradas*. The Río Chiriquí Viejo ranges from 100 m below the main terrace edge to deeper than 300 m below it. Only approximately one-third of the terraces are habitable and flat. In terms of climate, vegetation, and soils, it is most similar to Cerro Punta.

3) Los Llanos is the name given to the rapidly deposited fan composed of pumice, unsorted gravels, and boulders that lies between the small town of Paso Ancho and the western flanks of Volcán Barú. Because of its geological recency and effective drainage, there has been little chance for a rich humic horizon to develop. As a result, it has never supported any other vegetation than the grasses, low scattered scrub trees, few bushes, and sparse lichens and mosses that grow on it now.

4) Below Bambito and next to Los Llanos is found the Intermediate region around Paso Ancho and Tisingal. Topographically, very little of this area is river terrace. Generally it is com-

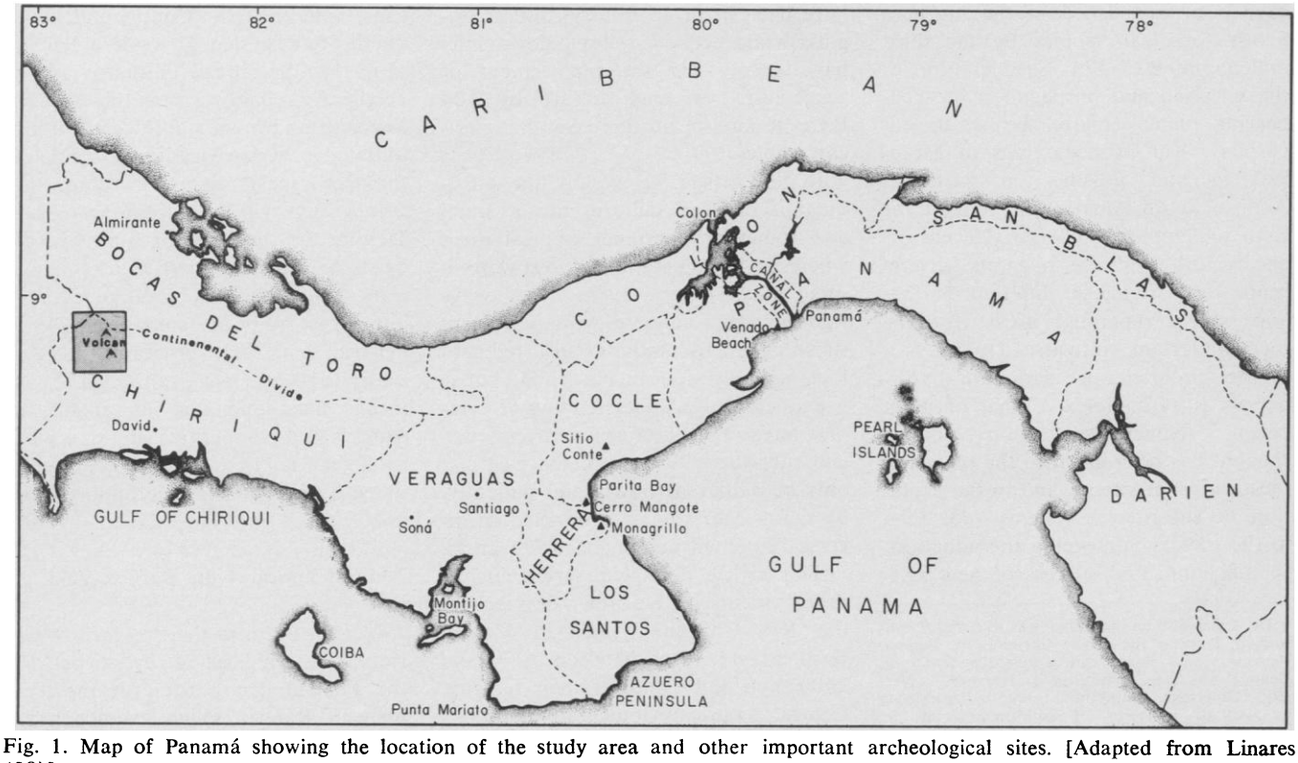


Fig. 1. Map of Panamá showing the location of the study area and other important archeological sites. [Adapted from Linares (*28*)]

posed of gently rolling or hilly terrain, approximately half of which is flat and well drained enough to be classified as habitable. The soils are as fertile as those of other regions. A prosperous coffee culture now thrives in this zone.

5) Finally, we have the southwest or "lower Barriles" area around El Hato. This is the smallest and southernmost of the zones we will be considering here. There are four river terraces of the Río Chiriquí Viejo in this area, the largest or uppermost (the oldest) of which supports massive zones of prehistoric occupation. The environment, including the climate, is more seasonal here than in the other areas. Rainfall is as high, but a few months of the year are fairly dry. Although overgrazing has recently led to an invasion of shrubby weeds and imported grasses, the area once supported a semideciduous forest similar to the forest further south on the Pacific coastal belt, with only a slight shift in species due to an increase in elevation and a slightly moister period.

Climatically and vegetationally the southwest area is quite different from Cerro Punta. Although the mean an-

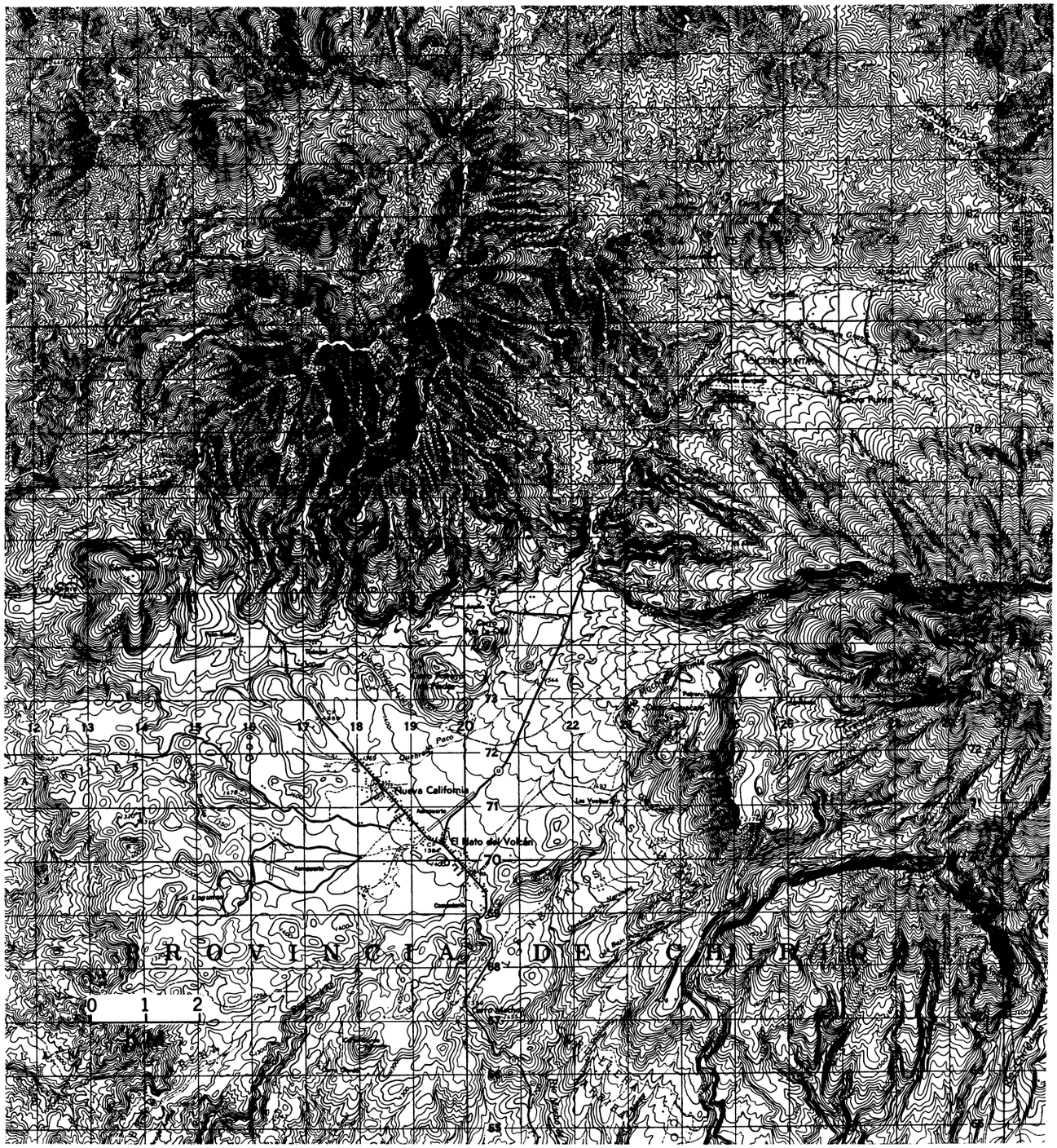


Fig. 2. Topographic map of the Volcán Barú area in the Chiriquí highlands showing elevations, natural features, and modern villages and towns; scale 1 : 20,000. (The vertical and horizontal numbers are metric grid designations taken from topographic maps of Panamá.) Each line is 1 km apart. [Courtesy of the Instituto Geográfico Nacional Tomás Guardia, Panama City]

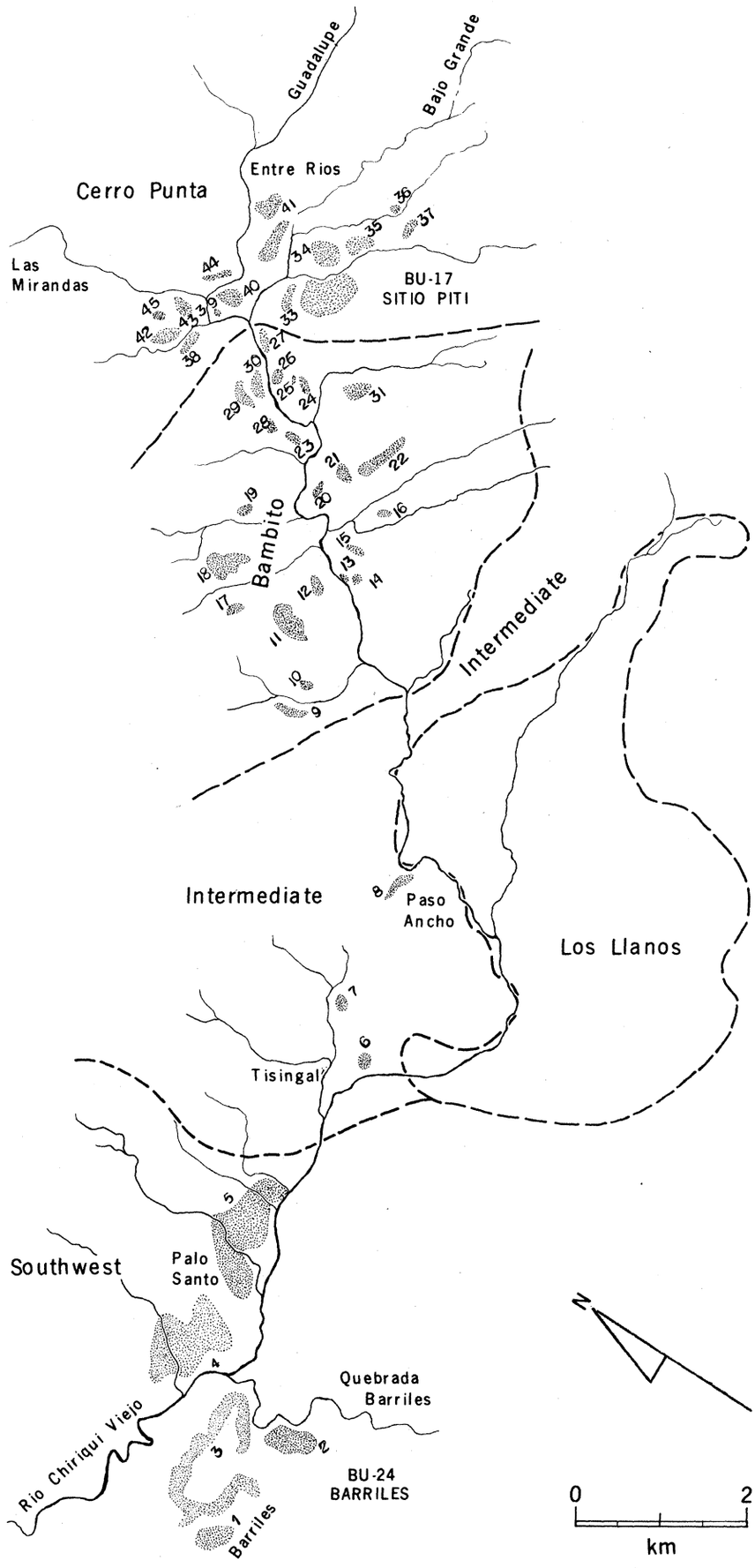


Fig. 3. Volcán Barú survey area, showing the distribution of archeological sites. The numbers indicate the site locations and the stippling their size.

nual rainfall is greater in some years (mostly because the southwest is not in the rain shadow), the basin of El Hato is considerably warmer, and in the dry season considerably drier, than Cerro Punta. These factors make the southwest area better suited for a seasonal crop such as maize.

Zonation and Settlement Patterns in the Barú Area; Archeological Survey

Our intensive survey during the dry season of 1972 covered an area of 62 km^2 in the upper drainage of the Río Chiriquí Viejo at elevations ranging from 1200 to 2400 m. Survey procedures involved recording, measuring, and sondage-testing the sites encountered (*10*). It is important to note that the survey area contains the uppermost limits of known aboriginal occupation of the Río Chiriquí Viejo drainage. Settlement further north seems to have been arrested by a dense cloud forest, which is still uninhabited.

The 45 habitation sites we encountered (Fig. 3) ranged in elevation from 1200 to 2000 m. In order to assess the significance of the relative sizes of sites we ranked them on a scale ranging from value 1, including the smallest sites, to value 5, including the largest, with the principal factor in assigning site rank being the areal extent of occupational debris (*11*). Our survey showed that, rather than being evenly distributed, the number and the size of sites varied markedly between each of the five natural zones outlined above (Table 2).

1) Despite the availability of rich agricultural land, only half of the arable land in the Cerro Punta basin had been occupied. Most of the 14 sites encountered were also small, except for a few larger sites clustered in the center of the valley. Of these, Sitio Pití (discussed below) was the largest and most internally differentiated.

2) Aboriginally Bambito was characterized by numerous small villages at elevations between 1800 and 1900 m. There was nothing here comparable to the Cerro Punta cluster of fairly large sites. The villages were placed either at the ends of plateaus—the dissected remnants of major terraces overlooking the Río Chiriquí Viejo (Fig. 4)—or at the bottom of the canyon, or even on the lower river terraces. Those along the river were the smallest. Practically all cultivable land was occupied.

3) Los Llanos was the only region completely devoid of sites. Despite the high rainfall it was essentially a cultural desert.

4) Although the Intermediate region covers a large fertile area, we found sites to have been small and far between. There were only three habitation sites plus two anomalous sherd concentrations and one petroglyph in the entire area. The three sites encountered range in elevation from 1380 to 1540 m.

5) Even though the southwest region was the smallest of the five surveyed in 1972, it was by far the most densely settled, with large, dense zones of continuous occupational debris, some of them, including Barriles, 100 m wide and 3 km long. As with Bambito and Cerro Punta, there was a marked preference here to settle on the major high-stream terrace of the Río Chiriquí Viejo. Most of the occupation debris of all five occupation sites completely surveyed was found within approximately 20 m of the 1300-m contour line.

Table 2. Distribution of archeological sites by number and size class (*8*) in each of the five natural zones of the Volcán Barú area in Chiriquí, Panamá.

Zone	Number of sites in size class					Total number of sites	Size class to which most sites belong
	1	2	3	4	5		
Cerro Punta	3	5	4	2	0	14	2 or 3
Bambito	8	8	6	1	0	23	1 or 2
Intermediate	0	3	0	0	0	3	2
Los Llanos	0	0	0	0	0	0	0
Southwest	0	0	0	0	5	5	5

Stratigraphy and Dating

In order to clarify the chronological and cultural relationships between the areas surveyed, in 1972 we excavated sites in each of the two most contrasting zones, the southwest region around El Hato and the Cerro Punta valley.

Excavations at Barriles (Bu-24) in El Hato show a thick layer of cultural material occurring in a rich humic zone capped by a recent pumice cover. On the basis of the artifact analysis and radiocarbon dating, we know that this is a two-component site with a long and continuous two-phase span of occupation at the beginning (from before 60 B.C. to A.D. 800), followed by a reoccupation above the pumice zone dated to after A.D. 1200 (Table 3).

The site stratigraphy of Sitio Pití (Bu-17) in Cerro Punta was also revealing. A distinctive lens of cultural material, thinner than the one at Bu-24, was also capped by a pumice layer embedded in a brown soil matrix. This sterile pumice layer at Bu-17 represented the last eruption of Volcán Barú. Numerous post molds outlining a single dwelling gave dates clustering around A.D. 300, while other localities at the same site had earlier and later dates (Table 3). Nowhere in Cerro Punta did we find more recent occupations.

Our excavations show that Barú, which was long considered to be an extinct Pleistocene volcano, was recently active and that this activity was responsible for the almost complete depopulation of this area some centuries before the Spanish Conquest.

Cultural Remains

Barriles was visited in 1950 by Stirling (*12*), who described a section of the site no longer in existence. This section consisted of a raised area made of massive boulders, stone slabs arranged into "rectangular floors," and a row of stone statues at one end. The enormous statues, now housed at the Museo Nacional de Panamá, are notable for their iconography (Fig. 5 and cover). Squat individuals are portrayed carrying on their shoulders other specially dressed personages who hold human heads in their outstretched arms. In addition, some statues support massive grinding stones (*metates*) and round tables (mortars?) decorated around the rims with trophy heads (Fig. 6). They were found in shaft tombs, where they constituted the only grave offerings. Less spectacular graves contained enormous lidded clay containers without bones inside (*chica* jars?). Additional low-relief carvings portray individuals carrying small cups in their hands, or wielding stone axes above their heads (Fig. 7). Some of these appear on large stone "drums," from which we get the name Barriles, meaning barrels. Thus, whatever its specific meaning and symbolic function, Barriles sculpture associates symbols of rank and warlike attributes with maize agriculture (*13*). This association is common among many tropical New World societies where fermented maize was made into an important ritual drink.

However, we should note that the

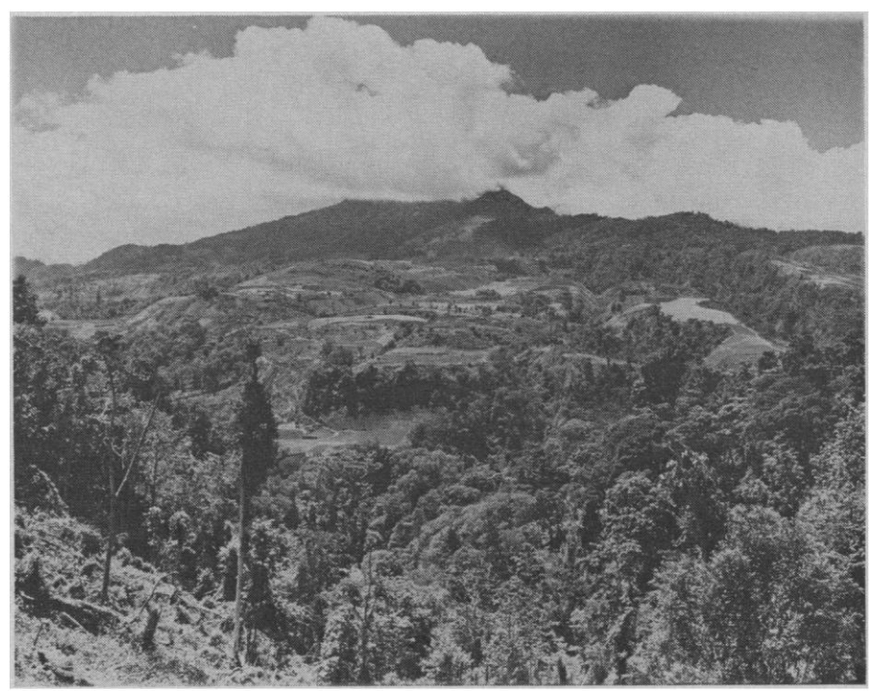


Fig. 4. View of the Río Chiriquí Viejo terraces at Bambito. These terraces sustained the major zones of pre-Hispanic occupation.

oldest radiocarbon date we obtained at Barriles (60 ± 275 B.C.) probably does not represent the first occupation of this basin. Further, it was associated not with the "ceremonial area" described above, but with another part of the site quite a distance away. Although the bulk of the Barriles occupation overlaps the one at Cerro Punta, it also slightly postdates it. Hence the evolution of symbols of stratification and rank at Barriles was late in the sequence, after migrations into other basins had occurred. This fact, together with the sparseness of the occupations in the intermediate area, suggests that new opportunities, rather than social constraints, were behind the splitting up of these highland groups. Further, if this hypothesis is correct, the sparsely occupied land between these two zones may have served as a buffer zone between valleys (*14*).

Excavations in Cerro Punta at Sitio Pití generally failed to reveal anything comparable to the mounded area at Barriles. Smaller carvings, however, were in the Barriles style and the bulk of the ceramics were also identical. Some pottery designs duplicated the motifs and themes (Fig. 8) appearing on Barriles stone carvings. More important, abundant carbonized remains of maize and beans, plus palm products, were recovered at Sitio Pití. The maize, found in several contexts, including house floors and hearths, is considered by Galinat (*15*) to be close to the *Chapalote–Nal-Tel*, a primitive race of maize from highland Mexico, modified by hybridization with the *Pollo* race from Colombia. The earliest date we have for it in Volcán is 430 ± 60 B.C. The beans, on the other hand, are plain red kidney beans (*Phaseolus vulgaris*) (*16*), now thought to have been independently domesticated in several parts of the New World.

Next to the botanical remains themselves, the most important evidence for the reconstruction of ancient subsistence patterns came from hundreds of tools and artifacts (*17*). In our collections, the chipped-stone assemblage consisted almost entirely of cores and flake tools used primarily for woodworking, among other tasks. Polished stone celts, the primary deforestation tools, were also extremely abundant. A careful study of their manufacture led us to conclude that these were made and resharpened at only some of the major hamlets, including Sitio Pití, and that one type was also used at only the major sites. Hence, celt making seems to have been at least a part-time specialization. All the surface-finished implements associated with food processing and preparation were included in the ground-stone category. Common among these were *metates*, used for grinding maize, and *querns*, used with a rotary motion for mashing soft substances. The ceramic types are generally similar to those from Barriles.

In short, our excavations in the southwest and Cerro Punta areas confirm the presence of a strong maize-bean complex unprecedented by any other agricultural system. However, carbonized seeds of the corozo palm (*Oribignya* sp.) and avocado (*18*), plus the generalized mashing stones that may have been used with secondary root crops such as the New World taro (*Xanthossoma* sp.) which, unlike manioc, does well at these altitudes, indicate that this was a diversified, predominantly agricultural economy. No traces of fishing or hunting were found anywhere.

Beyond these findings, the analysis of surface collections and posthole soundings from the three other natural zones revealed a striking uniformity in cultural materials over the entire surveyed

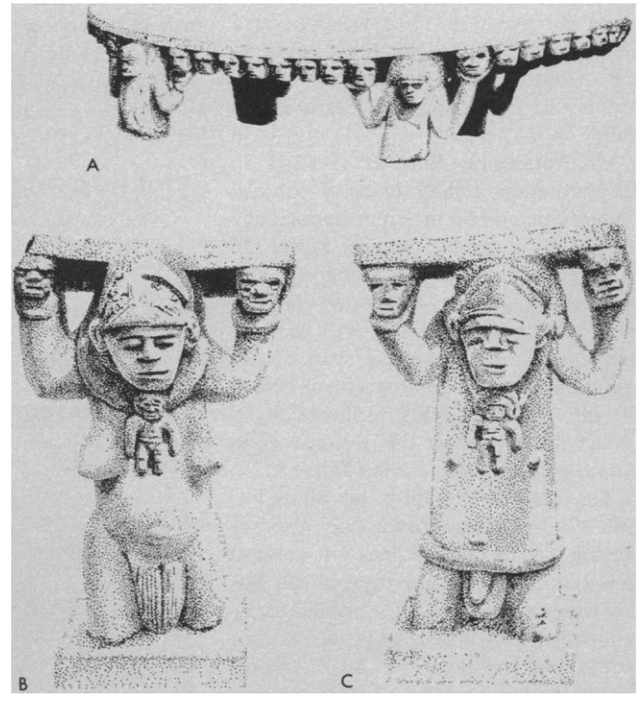
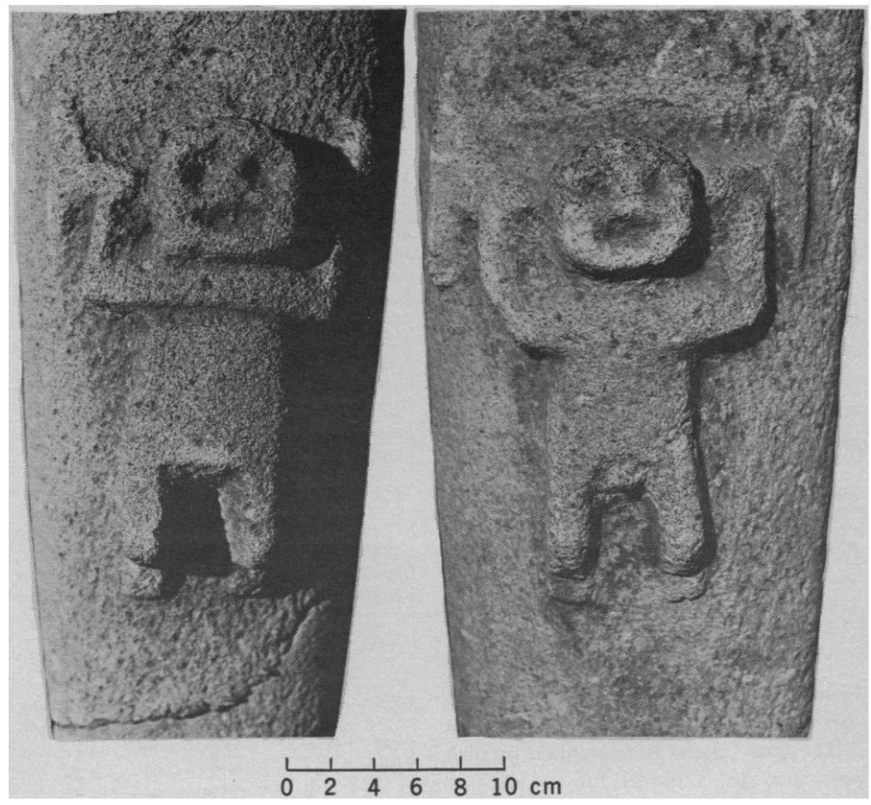


Fig. 5 (left). Details of stone supports for a giant *metate* (Fig. 6) found at Barriles (BU-24), Chiriquí, Panamá, and now in the Museo Nacional de Panamá, Panama City. The figures are 30 cm high. Fig. 6 (right). (A) Barriles (BU-24) "ceremonial *metate*" in the Museo Nacional de Panamá, Panama City (length, 2.20 m). (B and C) Stone supports from BU-24 (height, about 1 m; present location unknown).



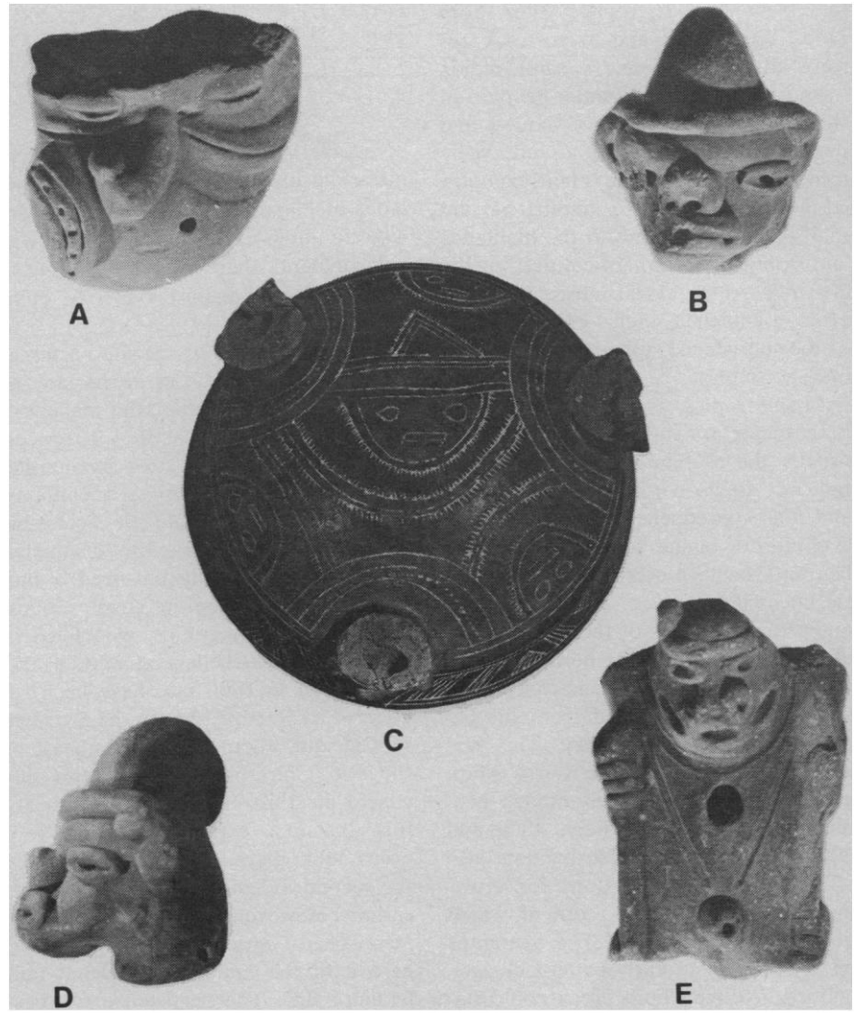


Fig. 7 (top). Details from stone tripod legs (90 to 95 cm in height) from the Barriles (BU-24) site; now at Museo Nacional de Panamá, Panama City. Fig. 8 (bottom). Pottery motifs from Sitio Pití (BU-17) in Cerro Punta, Volcán Barú area; now in the Museo Nacional de Panamá, Panama City. (A, B, D, and E), two-thirds actual size; (C), two-ninths actual size.

area. The 43 other villages in the Río Chiriquí Viejo system shared generally the same pottery types and lithic artifacts. Hence, indications are that the spread of agricultural villages in this area was fairly rapid, taking place in a few centuries. Even though groups split and colonized new areas, they still kept up contacts between themselves and perhaps exchanges in the form of tribute and craft specialization.

Summary

The earliest occupation along the upper reaches of the Río Chiriquí Viejo in western Panamá represents the growth and territorial expansion of maize agriculturalists well adapted to semideciduous forest habitats. Ecologically this makes sense, as maize is best adapted to periods of sunlight and relative dryness, attributes which in lower Central America are more typical of the middle altitudes and lowlands on the Pacific side than of the wet montane forests.

Shortly after the initial colonization, the entire Volcán area became at least thinly populated. Apparently the migrations of peoples into several valleys, including Cerro Punta, started well before maximum population densities and sociopolitical differences had evolved in the southwest area. The implications of our data thus accord better with the theory (*19*) that group fissioning and migrations may take place well below the carrying capacity of the land and for other than simple ecological reasons. Social factors, rather than strictly environmental ones, also seem to explain the general sparseness of occupation in the intermediate area. At present, the best explanation for the avoidance of these rich and well-placed lands seems to be a desire to keep social, and later political, distance from the larger villages to the southwest.

The small size of the Bambito villages seems to be a direct outcome of the broken, hill-terrace topography. The moderately larger villages at Cerro Punta are explainable by the flat basin

floor, which encouraged growth and expansion of the villages on it. Whether Sitio Pití would one day have become another Barriles is moot, however. Maize and beans do as well here now as in the valleys further south but the lowland root crops, such as manioc, do not survive at all. In fact, throughout Panamanian prehistory, maize became important just on the Pacific coastal side with its marked 5-month dry season (*20*), and even here it never replaced but simply complemented a well-established root crop culture that still flourishes today.

A massive eruption of Volcán Barú unquestionably terminated all human activities at Cerro Punta, around A.D. 600. Apparently, its effects were less severe in the southwest area, and this area was reoccupied in later periods.

Conclusions and Interpretations

In many ways Panamanian prehistory provides a model for the coexistence of various modes of agriculture in the New World tropics. Here root crops, seed crops, and even tree crops were all cultivated in the same region —and often by the same people—at the time of the Spanish Conquest and perhaps for several thousand years previously. Where one plant complex gained ascendancy over another, as did maize-bean agriculture in the highlands and root-tree crop agriculture in the Atlantic sector, local aspects of the ecology and their effects on other parts of the subsistence system must be taken into account.

In the tropics, as elsewhere, the limiting factor for human populations is usually the protein supply. This varies radically in its nature and abundance, and the consequences it has for the evolution of human adaptations. Where fish and shellfish were common, as in the meandering rivers and rich lagoon and estuary systems of the Pacific coast of central Panamá, numerous groups of plant gatherers and incipient cultivators could survive and from the beginning be fairly sedentary. This was apparently so among the Cerro Mangote and Monagrillo shell-midden peoples of Parita Bay between 4800 and 2000 B.C. (*21*). If these habitats also offered the right conditions for growing manioc and maize, both of which do best in climates with 3 to 5 months of dry season, an early pattern of agriculture involving both crops could become established. This seems to have occurred on the coastal Pacific lowlands of Panamá by 2000 B.C. (in Monagrillo times). In such well-endowed environments there was little selective pressure for or against a specific cultivation system.

Table 3. Radiocarbon dates from several excavated contexts in the Barriles (BU-24) and Sitio Pití (BU-17) sites (see Fig. 3). The dates were determined by two laboratories, Teledyne Isotopes (I) and Smithsonian Institution Radiation Biology Laboratory (SI). There is a marked discrepancy between the dates determined by the two laboratories for levels in the same excavation unit (compare samples I-7259 and I-7260 with SI-1833, SI-1834, and SI-1835); it is probably due to the presence of a hearth and associated disturbances and should be clarified by further excavation. However, another locality has a Teledyne date (sample I-5871) which is early, inclining us to accept the Smithsonian determinations at present.

Sample number	Date	
	Years ago	Conversion
Lower Barriles (BU-24)		
I-7236	740 ± 150	A.D. 1210
I-6835	1130 ± 85	A.D. 820
I-6834	1220 ± 85	A.D. 730
I-6836	1515 ± 90	A.D. 435
I-7261	1535 ± 210	A.D. 415
I-7262	2110 ± 275	60 B.C.
Sitio Pití (BU-17)		
I-7260	1350 ± 85	A.D. 600
I-7259	1495 ± 85	A.D. 455
I-6523	1635 ± 90	A.D. 315
I-6537	1655 ± 90	A.D. 305
I-6536	1655 ± 95	A.D. 305
SI-1831	1685 ± 105	A.D. 265
SI-1834	2065 ± 75	115 B.C.
SI-1833, SI-1835	2380 ± 60	430 B.C.
I-5871	2685 ± 110	735 B.C.

However, if fish or marine resources were in small supply, as in the interior valleys of the highlands, the main way of obtaining protein at the preagricultural stage must have been by hunting (*22*). Especially in forested contexts, where the most edible or accessible species tend to be rapidly decimated (*23*), hunting usually enforced a mobile existence, often in small groups. Remains of such groups, who lived in caves and rock-shelters at middle altitudes (500 to 1000 m), have been recovered by Ranere (*24*) in the province of Chiriquí, about 60 km southeast of the Río Chiriquí Viejo localities discussed in this paper. Indications are that the first experiments with root crops took place in these habitats by the second millennium B.C. or perhaps earlier. However, the introduction of maize-bean agriculture was delayed here until the middle of the first millennium B.C. The persistence of vegeculture until this date may have been reinforced by the survival of the well-developed hunting pattern. Ethnographic examples from elsewhere in the tropics suggest that the growing of root crops is often a more casual affair than the raising of seed crops, involving less weeding and more freedom of movement (*25*). Archeologically, the persistence of a hunting-fishing vegecultural system can be documented in the humid Atlantic or Caribbean sector of Panamá from A.D. 900 to the present (*26*).

Once seed culture was introduced into the highlands of Panamá, possibly from nearby areas via the Pacific coastal plains, it lifted the constraints imposed by hunting. These constraints had been particularly severe because peoples of the humid American tropics seldom systematically bred local species suitable for food. The reasons for the absence of animal domestication here are probably complex, perhaps including the difficulty of feeding captive animals, the continuing survival of wild animals, and the unfavorable demographic characteristics of most of the potentially domesticable mammal and bird species (*27*).

To conclude, seed culture was the only system that permitted intensification from within. By eliminating the need to rely on outside protein sources, it helped men move away from a dependence on carefully balanced natural ecosystems. In western Panamá specifically, the introduction of maize agriculture increased human exploitation of special ecological niches and triggered important sociopolitical changes that led to larger and more internally ranked groupings. This development was checked by external factors, an eruption of Volcán Barú, and the shortage of time for recuperation before the arrival of the Spaniards.

References and Notes

1. This idea was first systematically put forward by C. O. Sauer [*Agricultural Origins and Dispersals* (American Geographical Society, New York, 1952); in *Actas y Memorias XXXIII Congreso Internacional de Americanistas, San José, 1958* (Lehmann, San José, 1959), vol. 1, pp. 215–229]. See also D. W. Lathrap, *The Upper Amazon* (Praeger, New York, 1970), pp. 45–66. J. K. Brown [*Ethnology* **9**, 160 (1970)] has tested Sauer's hypothesis. Following D. H. Janzen [*Science* **182**, 1218 (1973)] we define the tropics as "those regions lying approximately between the Tropic of Cancer and the Tropic of Capricorn." For a discussion of manioc (*Manihot esculenta*), see D. J. Rogers, *Econ. Bot.* **19**, 369 (1965). However, the antiquity of root-crop cultivation remains unproved because of poor archeological preservation.
2. D. S. Byers, Ed., *The Prehistory of the Tehuacan Valley* (Univ. of Texas Press,

Austin, 1967), vol. 1, pp. 179–260; J. R. Harlan, *Science* **174**, 468 (1971).

3. For a general discussion of this problem, see T. C. Patterson, *America's Past: A New World Archaeology* (Scott, Foresman, Glenview, Ill., 1973), pp. 41–64; S. C. Jett, *Am. Antiquity* **38**, 223 (1973). Although the idea that manioc came to Panamá from South America and maize from Middle America seems reasonable, it remains unsubstantiated.
4. See, for example, M. D. Coe and K. V. Flannery, *Science* **143**, 650 (1964); K. V. Flannery, A. V. T. Kirby, M. J. Kirby, A. W. Williams, Jr., *ibid.* **158**, 445 (1967); R. Spores, *ibid.* **166**, 557 (1969); W. A. Denevan, *ibid.* **169**, 647 (1970); P. Armillas, *ibid.* **174**, 653 (1971); R. E. Blanton, *ibid.* **175**, 1317 (1972); K. V. Flannery, *Annu. Rev. Anthropol.* **2**, 271 (1973).
5. D. R. Harris, *Am. Sci.* **60**, 180 (1972); in *Man, Settlement and Urbanism*, P. J. Ucko, R. Tringham, G. W. Dimbleby, Eds. (Duckworth, London, 1972), pp. 245–262; in *The Explanation of Culture Change: Models in Prehistory*, C. Renfrew, Ed. (Duckworth, London, 1973), pp. 391–417.
6. G. Reichel-Dolmatoff [*Am. Antiquity* **22**, 226 (1957); *Colombia* (Praeger, New York, 1965), pp. 61–79] presents the archeological evidence for the replacement of manioc by maize in Colombia; I. Rouse and J. M. Cruxent [*Venezuelan Archaeology* (Yale Univ. Press, New Haven, Conn., 1963), pp. 5–6, 53–54] discuss the replacement of manioc by maize in Venezuela; whereas A. Zucchi [*Am. Antiquity* **38**, 182 (1973)] argues that in the dry western llanos of Venezuela maize preceded manioc. Recently, some doubt has been expressed concerning the archeological evidence for the priority of manioc cultivation in South America [W. DeBoer, paper read at the 39th annual meeting of the Society for American Archaeology, Washington, D.C. (1974)]. In Mexico, in the arid uplands of Tamaulipas and Tehuacan, maize apparently did precede manioc by several millennia, but in the lowlands of the Pacific coast in Chiapas, manioc may have been cultivated before maize [M. P. Weaver, *The Aztecs, Maya and Their Predecessors* (Seminar, New York, 1973), pp. 40–46]; this evidence is not widely accepted, however; see K. V. Flannery, *Annu. Rev. Anthropol.* **2**, 273 (1973). In the Gatún Basin of the Panama Canal Zone there is some palynological indication that maize may have preceded manioc by several millennia [A. S. Bartlett, E. S. Barghoorn, R. Berger, *Science* **165**, 389 (1969)].
7. C. F. Baudez, *Central America* (Nagel, Geneva, 1970); D. Stone, *Pre-Columbian Man Finds Central America* (Peabody Museum Press, Cambridge, Mass., 1972).
8. A basic source on Panamanian geology is R. A. Terry, *Occas. Pap. Calif. Acad. Sci. No. 23* (1956). The reconstruction of events relevant to the human occupation of this area was done by R. E. Stewart (personal communication).
9. C. Earle Smith has reconstructed the vegetation of these areas (personal communication).
10. This meant walking the entire area, making a collection of surface artifacts, and plotting the distribution of occupation debris wherever it was encountered. Survey accuracy was greatly facilitated by having the area come recently under cultivation. But cultivation had not been practiced long enough—nor had plowing been deep enough—to alter the aboriginal distribution of cultural debris. In cases where exposure was poor—especially in the southwest region—we used a posthole digger to make numerous small soundings (sondages) to determine site boundaries and to record soil profiles. For the use of the posthole digger see R. E. Fry, *Am. Antiquity* **37**, 259 (1972).
11. Sites where the area of occupational debris was less than 200 m long were assigned a size class value of 1; between 200 and 300 m long, size 2; between 301 and 400 m long, size 3; between 401 and 700 m long, size 4; and more than 701 m long, size 5. The modal distribution indicates the size class in which most sites fall within each zone.
12. M. W. Stirling, *Natl. Geogr. Mag.* **97** (No. 2), 227 (1950).
13. For the view that maize agriculture was unimportant in neighboring Costa Rica see F. W. Lange, *Folk* **13**, 43 (1971). Our finds accord better with the argument of M. Coe [*Southwest. J. Anthropol.* **18**, 170 (1962)] that maize was an important subsistence item among these Panamanian-related groups.
14. B. H. Dahlin first formulated the buffer zone idea.
15. W. A. Galinat, in preparation.
16. L. A. Kaplan, identified our beans (personal communication).
17. P. D. Sheets, paper read at the 38th annual meeting of the Society for American Archaeology, San Francisco, California (1973); E. J. Rosenthal, unpublished manuscript (1972).
18. C. E. Smith made a preliminary identification of the bulk of the botanical material.
19. J. Stauder, *Southwest. J. Anthropol.* **28**, 153 (1972).
20. O. Linares and A. J. Ranere, *Archeology* **24** (No. 4), 346 (1971).
21. G. R. Willey and C. W. McGimsey III, *Pap. Peabody Mus. Archaeol. Ethnol.* **49** (No. 2) (1954); C. W. McGimsey III, *Am. Antiquity* **22**, 151 (1956); ———, M. B. Collins, T. W. McKern, paper presented to the 37th Congress of Americanists, Mar del Plata, Argentina (1966).
22. R. L. Carneiro [*Völkerkundliche Abh.* **1**, 9 (1964)] contrasts riverine fishing with hinterland hunting adaptations among the Amahuaca; D. W. Lathrap [in *Man The Hunter*, R. B. Lee and I. DeVore, Eds. (Aldine, Chicago, 1968), pp. 23–29] discusses this problem with reference to several Peruvian Montaña groups; J. Bamberger [paper presented to the 38th Congress of Americanists, Munich, Germany (1968)] argues against the idea of "ill-adjustment" among Ge hunting groups of central Brazil.
23. C. F. Bennett, *Ibero-Am.* **51**, 27 (1968).
24. A. J. Ranere, thesis, University of California, Davis (1972); in *Actas del Primer Simposio de Arqueologia en Puerto Rico*, J. Geijel, Ed. (San Juan, Puerto Rico, in press).
25. A. Leeds, in *The Evolution of Horticultural Systems in Native South America: Causes and Consequences*, J. Wilbert, Ed. (Sociedad de Ciencias Naturales, La Salle, Caracas, 1961), pp. 13–46; R. L. Carneiro, in *ibid.*, pp. 47–67; D. R. Harris, *Geogr. Rev.* **61**, 475 (1971).
26. O. Linares and A. J. Ranere, *Archeology* **24**, 346 (1971).
27. Compared to roughly equivalent species in the temperate zone, species in the tropics tend to have fewer young (compare peccaries with wild pigs, agouti and paca with rabbits, or curassows and guans with pheasants and quails). For a quantitative proof see J. Gliwicz [*Bull. Acad. Pol. Sci. Cl. II Ser. Sci. Biol.* **21**, 413 (1973)], who discusses the characteristics of a natural *Proechimys* population in the Panama Canal Zone.
28. O. Linares, *Smithson. Contrib. Anthropol.* **8**, 1 (1968), figure 2.
29. Dirección de Estadística y Censo, Contraloría General, *Estadística Panameña: Meteorología, Año 1971* (Panama, 1973).
30. Our 1970–1973 project, "Archaeological investigations in western Panama," was sponsored by NSF grant 2846 to O.F.L. The participation of graduate students, including E.J.R., for all three seasons and of B. Dahlin, S. Dahlin, and J. Sweeney for the Volcán season was facilitated by Ford Foundation traineeship grants to the University of Pennsylvania Museum. M. Camargo, D. Figueroa, and P. Quirós also participated. P. D. Sheets was field supervisor. Additional staff members and research associates included: A. J. Ranere, C. E. Smith, J. West, and R. E. Stewart. We wish to thank R. Torres de Araúz and her staff at the Museo Nacional for official cooperation, and the director of the Smithsonian Tropical Research Institute and his staff for granting facilities. R. McNealy drew Fig. 6 and R. McCarty Fig. 3. F. M. Sheets took the photographs in Figs. 5, 7, and 8 and on the cover and managed the field laboratory during the last Volcán season.

NEWS AND COMMENT

National Institutes of Health: The Politics of Taste and Smell

Scientists at the National Institutes of Health (NIH) are forever complaining about politicians and government bureaucrats meddling in the institutes' scientific affairs, though specific examples of intrusion often elude them (*Science*, 10 January). The matter of Robert I. Henkin and his taste and smell clinic in the National Heart and Lung Institute (NHLI), currently a subject of considerable controversy, seems to be a valid example of political interference. NIH wants to close the clinic. Political pressure has kept it open. In fact, the Senate has gone so far as to make the taste and smell clinic a line item in the appropriations bill.

On 10 July 1973, NHLI officials reached a decision to phase Henkin's clinic out of existence, setting 30 June 1974 as the date it would finally close. Even with the generally increased funds available for the war on heart and lung diseases, money for intramural programs at NHLI was tight and there was pressure to favor those programs that most closely fit in with the institute's mission. It was hard to explain why the taste clinic was of primary importance. Henkin says NIH administrators felt "taste and smell problems were not significant."

Furthermore, the institute's scientific brass had doubts about the quality of Henkin's research, particularly that having to do with using zinc to cure persons who had lost their sense of taste. All in all, NIH officials agreed that Henkin's taste and smell program, which Henkin says cost about $200,000 a year, could be sacrificed.

Nevertheless, a year and a half after that decision, Henkin is still at work, the doors of his taste clinic still open.