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Preceramic Occupations in the Orinoco River Valley

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Two sites in the Orinoco Valley containing preceramic remains from excavated contexts are described. Radiocarbon dating and stylistic comparisons indicate that the northern tropical lowlands were inhabited at the onset of the Holocene, suggesting a time depth of 9000 years before the present for tropical forest-savanna adaptations in northern South America.

PRECERAMIC SITES HAVE LONG BEEN assumed to exist in the northern tropical lowland interior of South America, although evidence has been restricted to surface manifestations in Guyana (*1*) and Venezuela (*2*). Recent excavations conducted along the Orinoco River in the vicinity of Puerto Ayacucho, Territorio Federal Amazonas, Venezuela, revealed preceramic occupations in well-stratified contexts at two sites, Culebra and Provincial (Fig. 1). These two sites were located during the course of a project aimed at developing a regional cultural sequence for the Orinoco between the Atures Rapids and Meta River (*3*). Although both contained ceramic components, only the preceramic occupations will be discussed. These early Holocene sites demonstrate that tropical forest-savanna adaptations in the interior lowlands of northern South America date to at least 9000 years B.P. The preceramic phases are followed by a lengthy ceramic period. Excavations at these two sites and three others in the area documented an early series of Barrancoid phases beginning at ~1000 B.C., followed in time by Saladoid (A.D. 200 to 300), Ronquin (A.D. 500 to 700), and Arauquin (A.D. 1200 to 1400) related phases (*3*).

The Culebra site is located near the confluence of the Cataniapo River with the Orinoco, 12 km south of Puerto Ayacucho. The Cataniapo enters into the Orinoco River midway through the Atures Rapids, the upper limit of large boat traffic on the river. The site is situated on an alluvial terrace bordered by sporadic granite outcrops. It is in a woody savanna setting surrounded by tropical gallery forest. Two preceramic components, Atures I and Atures II, were encountered during the test excavations at the Culebra site.

The earliest component, Atures I, was encountered in a 1 by 2 m excavation unit in the northern portion of the site between 85 and 100 cm below the surface. Contextually, it was in a sandy clay loam paleosol, the occupation coinciding with the upper boundary of the soil horizon. Forty centimeters of sterile sandy loam separated Atures I from the earlier of the two ceramic components in the unit (Fig. 2A). The Atures I assemblage is characterized by two flake scrapers, a core fragment, and waste flaking debris (Table 1A). The predominant lithic material used was transparent crystalline quartz, although several quartzite flakes were also present. The scrapers show retouch or use wear along either the lateral margin, distal end, or both (Fig. 3, A and B). The quartz was obtained locally from cobbles in the bed load of the Orinoco River. Many flakes, one flake scraper, and the core fragment exhibit cobble cortex.

Atures II, the second preceramic component, was encountered in two separate excavations: a 2 by 2 m unit in the southern part of the site and a 1 by 2 m unit along its eastern edge. It was in a buried A horizon just below the earlier of the two ceramic components at the site, stratified above the paleosol containing the Atures I component (Fig. 2A). Atures II contained crystal quartz

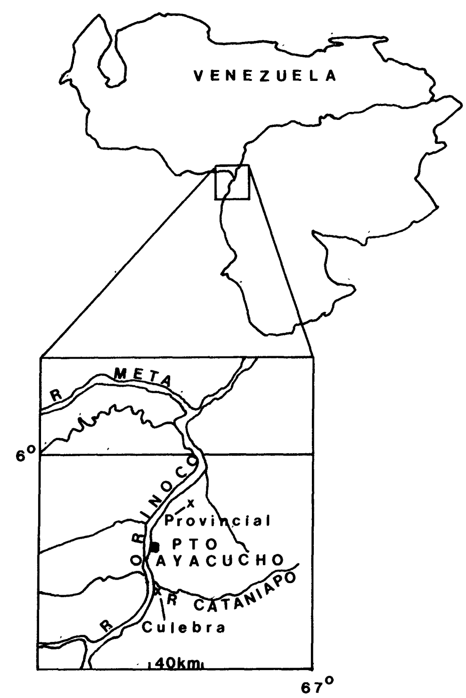

Fig. 1. Study area and its location within Venezuela.

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Table 1. Atures I and II artifact assemblages.

	Quartz cores	Unmodified flakes			Flake scrapers, quartz	Quartz shatter	Projectile points
		Quartz	Quartzite	Chert			
A				*Atures I*			
	1	134	10		2	5	
B				*Atures II*			
	1	270		2	9	44	2

flake scrapers and debitage similar to that of Atures I (Table 1B). Two flake scrapers have incurving blade margins and could be considered spokeshaves (Fig. 3, C and D). Two contracting stem projectile points were also recovered. One was manufactured from a pinkish chert; the other, a proximal fragment, was made from a grayish black, grainy chert (Fig. 3, E and F). Both materials are foreign to this part of Venezuela. The chert may be from the interior of the Guiana Shield, since Roth (*4*) described similar points of pink chert from surface contexts in British Guiana.

The Provincial site, 25 km north of Puerto Ayacucho, is situated at the end of a long sandy ridge of eolian origin overlooking a relict channel of the Orinoco River (Fig. 1). The site is in an open savanna area bordered by tropical forest. Test excavations were initiated to check for cultural material on a paleosol, a buried B horizon 85 to 110 cm below the surface, discovered during a bucket auger transect across the ridge. Excavations revealed two preceramic components stratified below a Barrancoid Tradition ceramic occupation. The earlier one was found in the first 10 cm of the paleosol. The second was stratified above the paleosol, separated by approximately 15 to 20 cm of sterile sandy loam (Fig. 2B). Because of the low quantity of artifacts, these two occupations were designated Preceramic Components A and B, with A being the earlier.

Preceramic Component A, found in a 2 by 2 m unit, consisted of a small charcoal-laden hearth situated in the upper part of the paleosol. Associated with the hearth were a ground stone axe fragment, a granite hammerstone, a pitted nutting stone of granite, and three crystal quartz flakes. Charcoal from the hearth returned a radiocarbon date of 9020 ± 100 years before present or 7070 B.C. (Beta-22638, uncorrected), which is currently the oldest (and only) date in the Orinoco River area from an unambiguous preceramic cultural context.

Preceramic Component B was located from 55 to 59 cm below the surface. It was not on or within a distinguishable surface; rather, it is midway through an unweathered sandy loam C horizon capping the earlier paleosol. This component was characterized by a hearth consisting of a tight cluster of fire-cracked granite and ironstone. Artifacts were limited to one crystalline quartz flake and two quartz shatter fragments. The highly dispersed charcoal in the level was not adequate for a radiocarbon assay. How much time had elapsed between components A and B is unknown.

Heretofore, no preceramic components with intact subsurface contexts have been described from the northern tropical lowlands of South America. Thus, comparisons have to be drawn from other regions. Flake scraper assemblages similar to Atures I and II were documented by Hurt *et al.* (*5*) from the El Abra rock shelter near Bogotá, Colombia, dating from between 10,450 and 6810 B.C. The El Abra assemblage contains a number of unifacial flake tool categories,

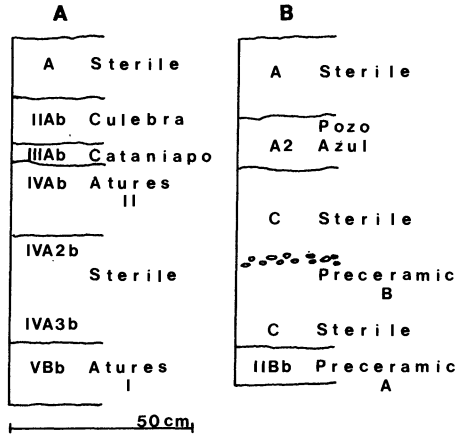

Fig. 2. (**A**) Profile of the Culebra site showing the location of archeological components. Atures I is in the buried B horizon, an ancient alluvial soil. It is capped by a more recent, although weathered profile of alluvial origin, the top part of which contains the Atures II component. There is a stratigraphic unconformity between the VBb horizon and the overlying IVA3b. Cataniapo in the IIIAb layer refers to a Saladoid ceramic component; Culebra, in the IIAb horizon, indicates a Ronquin-related ceramic component. (**B**) Profile from the Provincial site. Preceramic Component A, with the radiocarbon date of 7070 B.C., is in the IIBb paleosol. It is capped by a thick C horizon of eolian origin. Midway through this layer is Preceramic Component B. Pozo Azul in the A2 layer refers to a Barrancoid Tradition ceramic component.

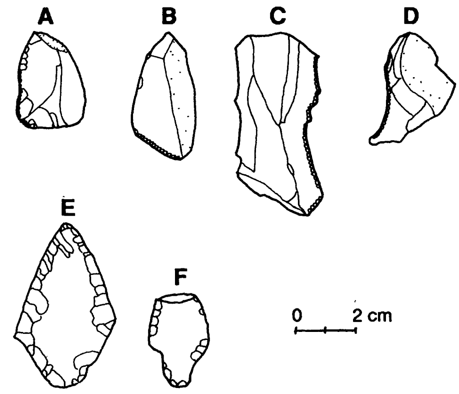

Fig. 3. (**A** and **B**) Flake scrapers from the Atures I phase. (**C** and **D**) Flake scrapers from the Atures II phase. (**E** and **F**) Projectile points from the Atures II phase. Note the incurved, spokeshave-like blade margins on (C) and (D).

although it lacks projectile points. North of El Abra, Urrego (*6*) has excavated two other rock-shelters, Nemocon and Sueva, both of which duplicate the El Abra sequence and contain a similar range of unifacial flake tools. Radiocarbon dates place the beginning of occupation at between 7000 and 6000 B.C. Despite the absence of projectile points in the assemblages of all three shelters, the abundant mammalian remains indicate a well-developed and generalized hunting orientation on the part of these early Holocene inhabitants of the Colombia highlands.

The Atures I and II flake scrapers also resemble those that Ranere (*7, 8*) described for the Talamanca and Boquete phases from rock-shelters in the Rio Chiriqui region of Panama. Dates range from ~4600 to 2300 B.C. for Talamanca and ~2300 to 300 B.C for Boquete. Both phases have been interpreted by Ranere as representing sophisticated adaptations to the tropical forest environment of Panama. Other flake scraper assemblages resembling Atures I and II include those of the Early and Late Las Vegas phases from the Santa Elena Peninsula of coastal Ecuador dating from between 8000 and 4600 B.C. and various assemblages of the East Brazilian Upland Tradition (*9*).

The Atures II projectile points are similar to those described by Rouse and Cruxent (*2*) for the Canaima Complex in the Rio Caroni drainage of eastern Venezuela, as well as to points of the Las Casitas Complex from the lowest terrace of the El Jobo site in northwestern Venezuela. Rouse and Cruxent place Las Casitas at between 5500 and 5000 B.C. (*2*). Cruxent recovered similar contracting stemmed points from the surface in the vicinity of the Atures Rapids during the early 1950s.

The paucity of artifacts from the two preceramic components at the Provincial site makes it difficult to establish good correlations with other South American preceramic phases. Nutting stones, such as recovered from Preceramic Component A, have been reported from both the Talamanca and Boquete phases from Panama, where they were hypothesized to have been used to crush palm nuts (*8*). It is probable that the nutting stone from Provincial was similarly used for processing palm nuts. Ground stone axes from other preceramic assemblages have dates comparable to or slightly later than that obtained from Preceramic Component A, such as the Cerca Grande complex in Brazil dated at 7600 and 7000 B.C. (*9*), the Siches phase in Peru dated between 6000 and 4000 B.C. (*10*), and the Late Las Vegas phase of Ecuador dated between ~6000 and 4600 B.C. (*11*).

The above correlations allow the Orinoco preceramic components to be placed in a provisional chronological framework. The earliest, supported by the radiocarbon date of 7070 B.C., is Preceramic Component A from Provincial, followed by Preceramic Component B. Taking into consideration the similarities with the other flake scraper assemblages noted above, Atures I and II are estimated to date between 7000 and 4000 B.C., with Atures I at the earlier end and Atures II at the later end of the period. Although lacking similar flake tools, Preceramic Component A and Component B are included within Atures I on the basis of their probable contemporaneity. These two components, located away from the Orinoco and containing different tool categories, may represent specialized extractive activities. The termination of Atures II could be later than estimated. The presence of several Barrancoid occupations in the Provincial area dated between 1000 B.C. and A.D. 1 (*3*) suggests that Atures II ended at the latest at ~1000 B.C.

The two preceramic complexes from the Provincial site and the Atures I and II phases from the Culebra site represent early Holocene adaptations to the tropical lowland environment of the Orinoco River. They may be part of a widespread, post-Pleistocene radiation into the tropical lowlands originating from the northern Andean region, given the similarities with tool kits from the Sabana de Bogota. The assemblages, in particular the flake scrapers from the Atures phases, reflect a tool kit designed for the manufacture of items from cane, wood, and bone, materials upon which most of the tropical forest culture's technological repertoire is predicated. These newly defined preceramic components belong to a Tropical Forest Archaic stage (*8*), representing early Holocene adaptations to tropical forest and savanna environments. Documenting the presence of these four preceramic components opens new avenues of inquiry in the archeology of the northern tropical lowlands. It demonstrates a respectable antiquity for the occupation of the Orinoco River valley and suggests that tropical forest-savanna adaptations were effected in the immediate post-Pleistocene period.

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Oxygen Isotope Effect and Structural Phase Transitions in La_2CuO_4-Based Superconductors

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The oxygen isotope effect on the superconducting transition temperature (α_o) varies as a function of x in $La_{2-x}Sr_xCuO_4$ and $La_{2-x}Ba_xCuO_4$, with the maximum α_o values ($\alpha_o \geq 0.5$) found for x near 0.12. This unusual x dependence implies that the isotope effect is influenced by proximity to the *Abma* → *P4₂/ncm* structural phase transition in these systems. Synchrotron x-ray diffraction measurements reveal little change in lattice parameters or orthorhombicity due to isotope exchange in strontium-doped materials where $\alpha_o > 0.5$, eliminating static structural distortion as a cause of the large isotope effects. The anomalous behavior of α_o in both strontium- and barium-doped materials, in combination with the previously discovered *Abma* → *P4₂/ncm* structural phase-transition in $La_{1.88}Ba_{0.12}CuO_4$, suggests that an electronic contribution to the lattice instability is present and maximizes at ~1/8 hole per copper atom. These observations indicate a close connection between hole doping of the Cu-O sheets, tilting instabilities of the CuO_6 octahedra, and superconductivity in La_2CuO_4-based superconductors.

ISOTOPE EFFECTS HAVE BEEN WIDELY investigated in the new high transition temperature (T_c) superconductors in order to clarify the role of electron-phonon interactions in the microscopic pairing mechanism (*1, 2*). The demonstration of an isotope effect on T_c played an important role in the development of the Bardeen-Cooper-Schreiffer (BCS) theory of phonon-mediated superconductivity (*1, 2*). In multielement systems such as the high T_c metal oxides, the effect of isotope mass change ΔM_i on the transition temperature ΔT_c can be written as

$$\frac{\Delta T_c}{T_c} = \sum_i \alpha_i \frac{\Delta M_i}{M_i} \qquad (1)$$

where the index i is summed over all the lattice sites in the structure. Since it is expected that high-frequency oxygen vibrations make the largest contribution to α, most isotope effect studies in high T_c systems have measured the oxygen partial isotope effect α_o. In general, the measured values of α_o have been greater than zero, but significantly smaller than the BCS limit of $\alpha = 0.5$, and therefore have not been conclusive in determining the importance of phonons in the pairing mechanism (*3, 4*).

An important fact which was not explicitly considered in the earlier high T_c isotope effect measurements is that these materials have complex phase diagrams which exhibit superconductivity over ranges of doping. Isotope effects have typically been measured only for materials with fixed compositions in

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