This page intentionally left blank.

Journal of the Washington Academy of Sciences,
Volume 78, Number 3, Pages 245–253, September 1988

Identification and Implications of A Hiatus in the Archeological Sequence on Marajó Island, Brazil

Betty J. Meggers*

Smithsonian Institution, Washington, D.C. 20560

and

Jacques Danon

Observatório Nacional, Rio de Janeiro, Brazil

ABSTRACT

Thermoluminescence and carbon-14 dates define the durations of five successive archeological complexes or phases on the island of Marajó, providing a chronology extending from about 3400 B.P. to European contact at the mouth of the Amazon. A hiatus between the end of the Mangueiras Phase about 2800 B.P. equates with a drastic decline in tree pollen in a core obtained from Lago Ararí on the eastern half of the island. Changed environmental conditions would have reduced the suitability of the region for slash-and-burn agriculture, as well as altered the wild food resources. The existence of similar lacunae of comparable age in archeological sequences in other parts of the neotropical lowlands suggests that population disruptions attributable to climatically induced subsistence stress account for the farflung and disjunct distributions of cultural traits and languages.

The growing evidence that short-term oscillations in climate correlate with the rise and fall of civilizations, geographical expansions and displacements of human groups, changes in population density, and other historical phenomena has led some historians and archeologists to suggest a causal relationship e.g.[8,9,14,15,16,18,19,20,31,39] In South America, coincidences between climatic and demographic changes during the Holocene have been noted on the coast of Ecuador,[7] in the Andean highlands,[10,11,12,17] and in Colombia,[35] to cite representative examples.

Climatic change has also been postulated as the impetus for the population

* To whom correspondence should be sent.

movements implied by the widespread and disjunct distributions of cultural elements and language families in the neotropical lowlands,[23,24,25,28] but evidence correlating local archeological sequences with paleoenvironmental changes has been lacking. The recent discovery of a hiatus in the archeological sequence at the mouth of the Amazon that coincides with a vegetational change supports the hypothesis.

The Archeological Sequence

Prior to 1948, the archeology of Marajó Island at the mouth of the Amazon was known only from museum collections. These consisted mainly of large vessels with elaborate painted and excised decoration removed from earth mounds constructed by prehistoric inhabitants on the eastern half of the island (Fig. 1). Survey on the north coast during 1948 revealed sites representing four previously unrecognized groups or phases, characterized by smaller settlements and simpler pottery.[27] Thirteen village sites were recorded, of which five were assigned to the Ananatuba Phase (PA-JO-7,8,9,10,13), one to the Mangueiras Phase (PA-JO-5), two to assimilation of Ananatuba Phase villages by the Mangueiras Phase (PA-JO-7,13), two to the Formiga Phase (PA-JO-4,6), and two to the Aruã Phase (PA-JO-2/3,11). Similar reconnaissance a few months later on the upper Rio Anajás in the center of the island revealed another site of the Mangueiras Phase (PA-JO-16), as well as two groups of large mounds of the previously reported Marajoara Phase (PA-JO-14,15).

Subsequent investigations by Hilbert[27] west of Lago Ararí and on the upper Rio

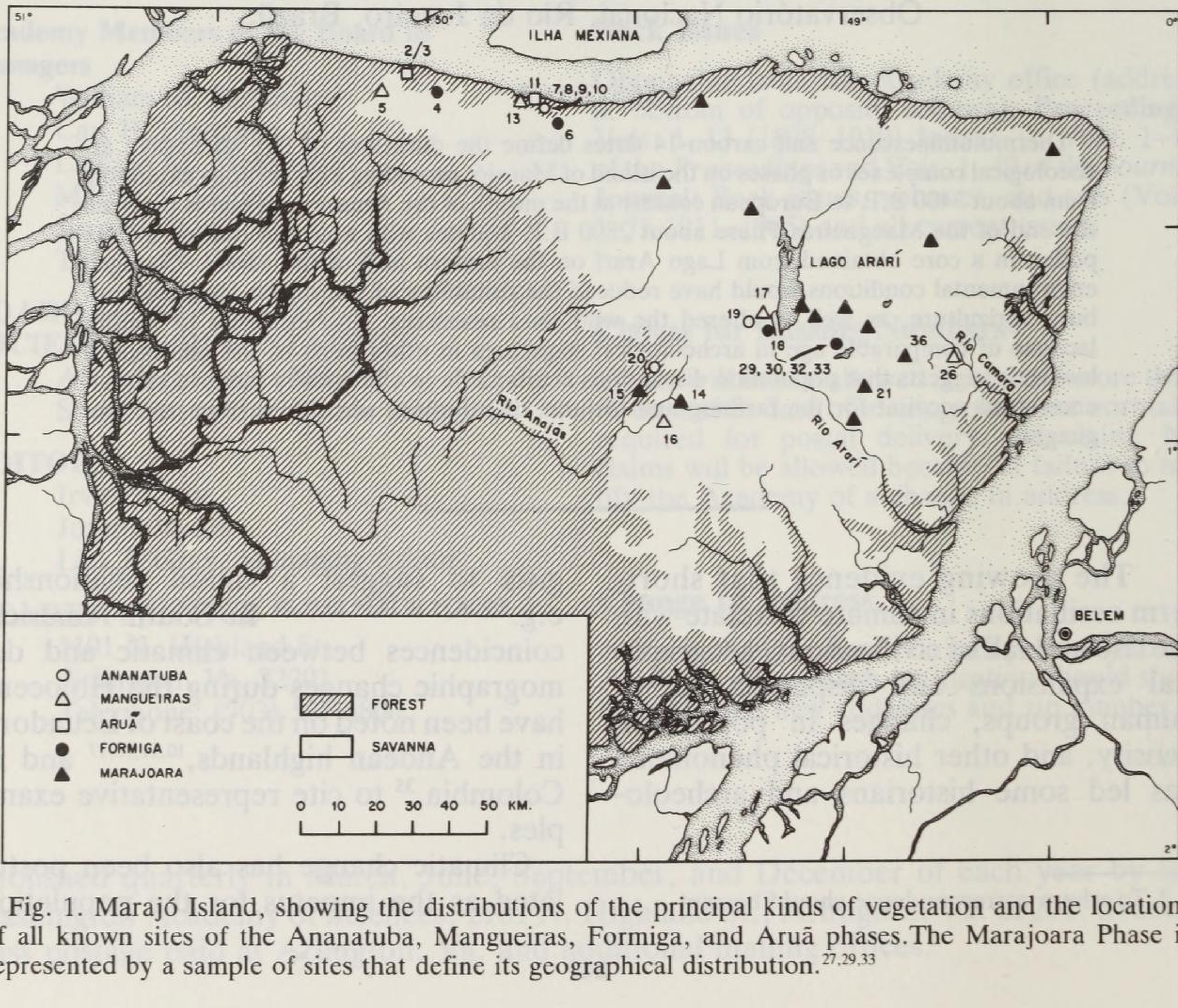

Fig. 1. Marajó Island, showing the distributions of the principal kinds of vegetation and the locations of all known sites of the Ananatuba, Mangueiras, Formiga, and Aruã phases. The Marajoara Phase is represented by a sample of sites that define its geographical distribution.[27,29,33]

Anajás produced two more sites of the Ananatuba Phase (PA-JO-19,20), one of the Mangueiras Phase (PA-JO-17), and one of the Formiga Phase (PA-JO-18). Survey east of Lago Ararí by Simões[33] added 17 sites, including one of the Ananatuba Phase exhibiting Mangueiras Phase contact (PA-JO-26), four of the Formiga Phase (PA-JO-29,30,32,33), and 12 of the Marajoara Phase.

Pottery from surface collections and stratigraphic excavations in these sites was classified into plain and decorated types and their relative frequencies were calculated. The trends of increasing or decreasing popularity of the various types observed in the stratigraphic samples permitted establishing a relative chronology for each phase. In the absence of carbon-14 determinations, the inception of the Ananatuba Phase, the earliest in the relative sequence, was estimated after the beginning of the Christian Era.[27] The phases were inferred to be sequential and to have replaced one another.

Carbon-14 Dates

Carbon-14 dates obtained subsequently for two of the phases showed that the time depth for the introduction of pottery making had been drastically underestimated. A level corresponding to the Ananatuba-Mangueiras transition produced a date of 2930 B.P. ± 200 years, implying that the Ananatuba Phase began prior to this time[34] (Table 1).

Three dates from Marajoara Phase sites extended from 1470 B.P. ± 200 years to 1260 B.P. ± 200 years. Two others were rejected, one as too early to fit the relative chronology (SI-202) and the other as too recent (SI-200). Since the Marajoara Phase sites are artificial mounds and occur in the vicinity of sites and fields of earlier phases, the SI-202 date may represent earlier charcoal introduced during construction. The recent date, 500 B.P. ± 500 years, has so large a statistical error that it is meaningless.

Thermoluminescence Dates

Additional dates were required to evaluate these results and to expand the absolute chronology to the other three phases. The availability of pottery fragments from most of the excavations made thermoluminescence an obvious technique for obtaining them. Thirty-six potsherds were selected from 10 sites representing all of the phases. Dating was done at the Centre de Faibles Radioactivités, Gif-sur-Yvette, using the fine-grain method.[13] Well reproducible thermoluminescence glow curves yielded good plateau responses. Internal doses were calculated from the concentrations of U, Th, and K of the samples obtained from gamma spectrometry measurements. Environmental doses were evaluated from gamma spectrometry of soil samples taken from Marajó Island. Errors were calculated as described by Aitken and Alldred,[5] and the overall accuracy of the ages was estimated at about seven to ten percent depending on the sample. It should be noted that all ceramics from Marajó are tempered with crushed sherd, minimizing possible errors stemming from differential composition.

Three Ananatuba Phase TL results are slightly older than the uncalibrated carbon-14 determination, extending from 3410 B.P. ± 300 to 3060 B.P. ± 270 years, but overlap when the plus/minus ranges are considered (Table 1). Mangueiras Phase occupations are superimposed on those of the Ananatuba Phase at two sites, one on the north coast (PA-JO-10) and the other near the east coast (PA-JO-26). The TL date of 3000 B.P. from the transitional level at PA-JO-10 is close to the carbon-14 date of 2930 B.P. ± 200 years obtained for the transition at PA-JO-26. The youngest TL date for the Mangueiras Phase is 2870 B.P. ± 190 years and corresponds to the abandonment of the most recent site in the existing seriated sequence for the phase.

The oldest date for the succeeding Formiga Phase is 1940 B.P. ± 230 years.

Table 1.—Carbon-14 and thermoluminescence dates for phases in the archeological sequence on Marajó Island. Parenthesis indicates acceptable only within the plus or minus range.

Date BP	Span	Lab. No.	Site	Phase
550 ± 500	50–1050	SI-200	PA-JO-21	(Marajoara)
600 ±		TL		Aruã
630 ± 70	560–700	TL-48	PA-JO-21	Marajoara
800 ±		TL-88		Aruã
928 ± 90	838–1018	TL-162	PA-JO-36	Marajoara
1000 ±		TL-140		Marajoara
1113 ±		TL	PA-JO-6	Formiga
1200 ±		TL	PA-JO-6	Formiga
1200 ±		TL-160		Marajoara
1260 ± 200	1060–1460	SI-199	PA-JO-21	Marajoara
1340 ±		TL	PA-JO-6	Formiga
1370 ± 200	1170–1570	SI-387	PA-JO-36	Marajoara
1430 ±		TL	PA-JO-6	Formiga
1470 ± 200	1270–1670	SI-386	PA-JO-36	Marajoara
1550 ± 170	1380–1720	TL-120	PA-JO-30	Formiga
1570 ± 175	1395–1745	TL-131	PA-JO-33	Formiga
1630 ± 185	1445–1815	TL-130	PA-JO-33	Formiga
1660 ± 188	1472–1848	TL-117	PA-JO-29	Formiga
1705 ± 200	1505–1905	TL-126	PA-JO-32	Formiga
1730 ± 200	1530–1930	TL-161	PA-JO-36	(Marajoara)
1853 ± 204	1649–2057	TL-132	PA-JO-33	Formiga
1862 ± 210	1652–2072	TL-127	PA-JO-32	Formiga
1940 ± 230	1710–2170	TL-125	PA-JO-32	Formiga
2020 ± 280	1740–2300	SI-202	PA-JO-21	(Marajoara)
		(hiatus)		
2870 ± 190	2680–3060	TL-76	PA-JO-26	Mangueiras
2930 ± 200	2730–3130	SI-385	PA-JO-26	Mangueiras
3000 ±		TL-47	PA-JO-10	Mangueiras
3012 ± 200	2812–3212	TL-81	PA-JO-26	Mangueiras
3040 ± 270	2770–3310	TL-69	PA-JO-26	Mangueiras
3060 ± 270	2790–3330	TL-79	PA-JO-26	Ananatuba
3132 ± 205	2927–3337	TL-80	PA-JO-26	Ananatuba
3400 ±		TL-34	PA-JO-7	Ananatuba
3410 ± 300	3110–3710	TL-78	PA-JO-26	Ananatuba

Eight samples from four sites between Lago Ararí and the east coast (PA-JO-29,30,32,33) form a progression to 1550 B.P. ± 170 years. Four samples from PA-JO-6 extend from 1430 to 1113 B.P., overlapping the Marajoara Phase duration. This site is on the north coast, outside the area occupied by the Marajoara Phase, allowing the possibility of coexistence. A chronological overlap is also implied by the presence of decorated sherds of Marajoara Phase origin in the upper levels at PA-JO-6.[27]

Three Marajoara Phase measurements, ranging from 1200 B.P. ± 200 to 928 B.P. ± 90 years are compatible with the relative chronology and the carbon-14 determinations. One appears too early at 1730 B.P. ± 200 years but is within the plus/minus range of the acceptable dates. The most recent date, 630 B.P. ± 70 years, may mark the end of the Marajoara Phase. The chronological overlap between the terminal Marajoara Phase TL measurement of 630 B.P. ± 70 years and the initial Aruã Phase TL measurement of 800 B.P. is compatible with archeological evidence for contact in the form of Marajoara Phase pottery at an early Aruã Phase site on the island of Mexiana.[27]

Chronological Hiatus

There is a gap of some 800 years between the medians and 400 years between the plus/minus durations of the terminal TL date for the Mangueiras Phase and the initial TL date for the Formiga Phase (Table 1, Fig. 2). Although sampling deficiencies may be responsible, several considerations make this unlikely. First, all sites known to the local population in each region were examined regardless of size and composition. Second, the non-Marajoara Phase sites consist of relatively small scatters of pottery fragments, few of them decorated, making it improbable that they would be encountered or recalled more readily than sites of unrecorded phases. Third, the number of sites representing the known phases makes it difficult to believe that a phase lasting 500 to 900 years would not have been encountered. The Formiga, Marajoara, and Aruã phases, with estimated durations of about 700 years, have the largest numbers of recorded sites. The Ananatuba Phase, with an estimated duration of about 400 years, is known from nine sites. Even the Mangueiras Phase, which has dates spanning less than 200 years, is represented at six sites.

Paleoenvironmental Reconstruction

A pollen profile obtained from Lago Ararí, in the vicinity of the archeological

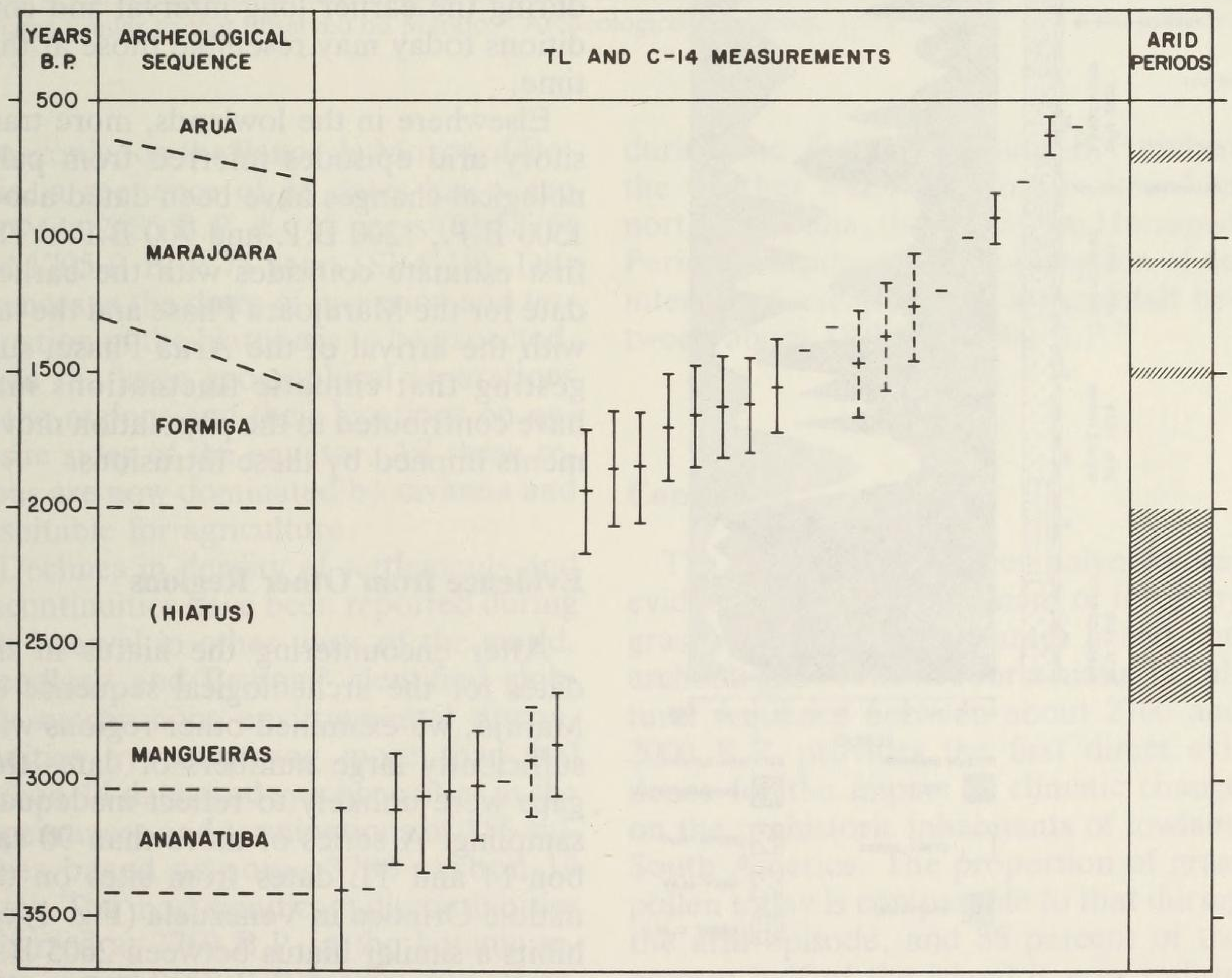

Fig. 2. Comparison of the archeological sequence on Marajó Island with episodes of aridity since the end of the Pleistocene inferred from pollen profiles. A hiatus of about 800 years between the end of the Mangueiras Phase and the beginning of the Formiga Phase correlates with a dry interval between about the same time. Broken lines indicate carbon-14 dates; solid lines, TL dates. TL dates with no plus-minus ranges represent measurements for which average (internal and external) doses were used for calculating ages. Unacceptable results on Table 1 are not included.

sites, reveals dramatic changes in the vegetation[4] (Fig. 3). A carbon-14 date of 2590 B.P. ± 100 years (Beta-2289) identifies the portion of the sequence of interest here. Tree pollen constituted some 70 percent of the sample earlier, but by this date the proportion had declined to about 30 percent. After an increase, it continued to decline to about 15 percent and the dominant vegetation consisted of herbs and grasses. The dates and ecological considerations make it likely that the Ananatuba Phase arrived when forest was dominant. The terminal Mangueiras Phase date correlates with the increasing abundance of grasses, which would have diminished the possibilities for slash-and-burn agriculture and affected the kinds and abundances of many wild foods.

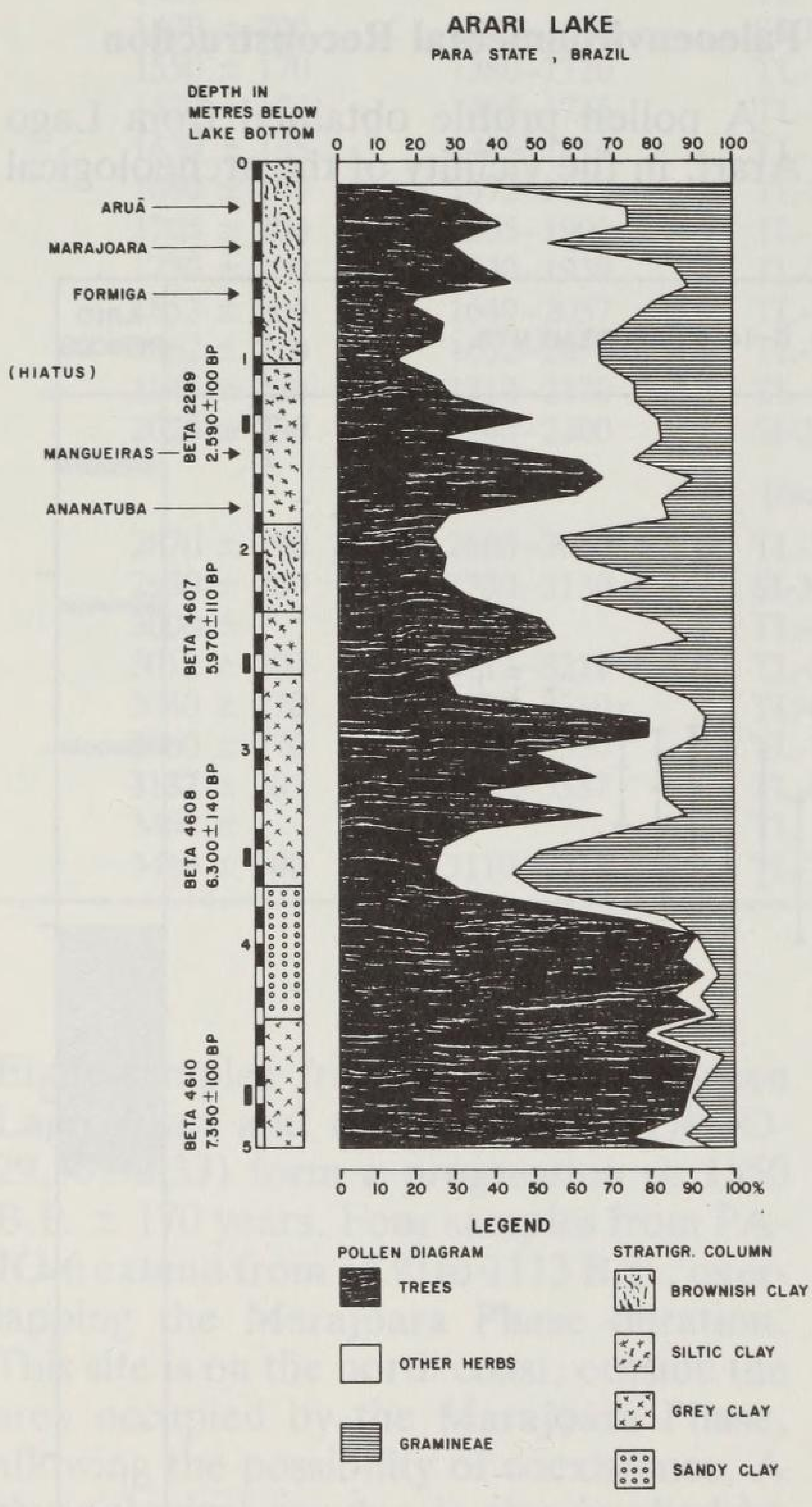

Fig. 3. Pollen diagram from a core obtained in Lago Arari showing fluctuations in arboreal vegetation and their estimated correlations with the inceptions of the archeological phases. A carbon-14 date of 2590 B.P. ± 100 years, obtained from a level in which tree pollen was declining, falls within the hiatus in the archeological sequence.[4]

After an interval of uncertain duration, forest pollen increases to about 40 percent. The initial date of 1940 B.P. for the Formiga Phase is compatible with evidence from pollen studies elsewhere in the lowlands for termination of this arid interval about 2000 B.P.[1,3,6,35] Somewhat later, tree pollen declines to about 30 percent, increases again to about 38 percent, and then declines to the present ratio of about 10 percent (Fig. 3). The latter frequency is comparable to what prevailed during the earlier long interval and conditions today may resemble those at that time.

Elsewhere in the lowlands, more transitory arid episodes inferred from palynological changes have been dated about 1500 B.P., 1200 B.P. and 700 B.P.[1,2] The first estimate coincides with the earliest date for the Marajoara Phase and the last with the arrival of the Aruã Phase, suggesting that climatic fluctuations may have contributed to the population movements implied by these intrusions.

Evidence from Other Regions

After encountering the hiatus in the dates for the archeological sequence on Marajó, we examined other regions with sufficiently large numbers of dates that gaps were unlikely to reflect inadequate sampling. A series of more than 90 carbon-14 and TL dates from sites on the middle Orinoco in Venezuela (Fig. 4) exhibits a similar hiatus between 2605 B.P. ± 85 years (I-9519) and 1740 B.P. ± 100 years (QC-323); a series of 24 dates from the lower Orinoco has a hiatus between 2440 B.P. ± 75 years (SI-865) and 1470 B.P. ± 70 years (SI-864) interrupted by a single date.[26] At the opposite margin of

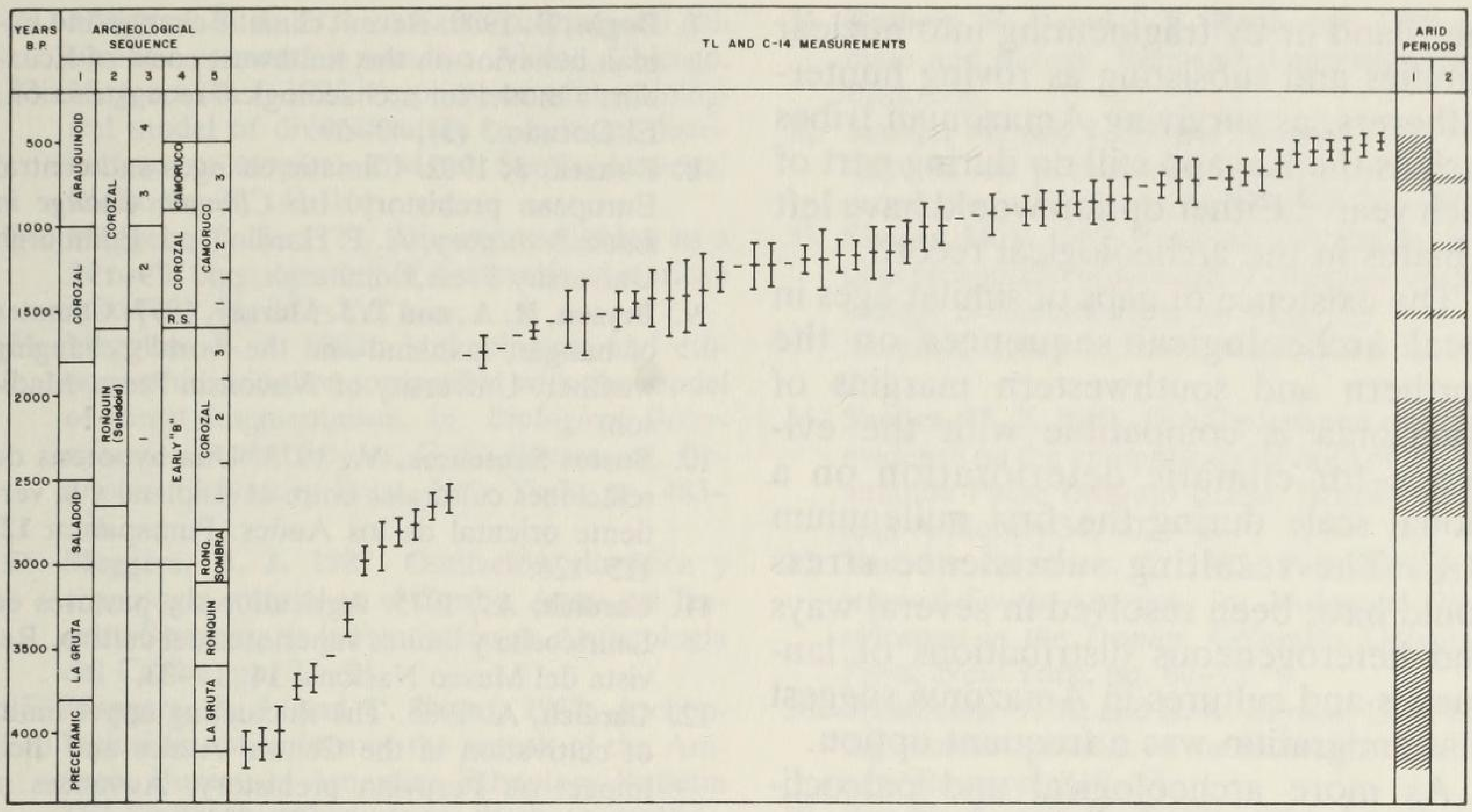

Fig. 4. Carbon-14 and thermoluminescence dates from archeological sites on the middle Orinoco, showing a hiatus similar to that observed on Marajó.[26] Archeological sequences: 1,[26] 2,[32] 3,[37] 4,[38] 5.[30] Arid periods: 1,[35] 2.[3]

Amazonia, on the llanos de Moxos of Bolivia, a sequence of 38 dates has a gap between 2685 B.P. ± 145 years (SI-5876) and 1705 B.P. ± 75 years (SI-4119). Differences in the dates of inception and termination of the hiatus are to be expected, given the large geographical separations of the regions and their locations on opposite sides of the equator. All these regions are now dominated by savanna and unsuitable for agriculture.

Declines in density of settlements and discontinuities have been reported during this interval in other parts of the world. Wendland and Bryson[36] identified globally synchronous environmental discontinuities by comparing more than 800 carbon-14 dates and synchroneities in the appearances and terminations of 155 cultures based on some 3700 carbon-14 dates. The most significant discontinuities occurred at 2760 B.P. in the botanic sequence and 2510 B.P. in the cultural sequence.

Tabulating densities of sites according to the principal cultural periods from Early Neolithic (5000 B.C.) through the Iron Age (A.D. 1000) showed a decline during the first millennium B.C. when the weather was cooler and moister.[8] In northwest India, the end of the Harrapan Period coincides with the inception of an interval of exceptionally low rainfall between about 3800 and 2000 B.P.[21]

Conclusion

The coincidence between palynological evidence for the replacement of forest by grasses and herbs on Marajó Island and archeological evidence for a hiatus in cultural sequence between about 2700 and 2000 B.P. provides the first direct evidence for the impact of climatic change on the prehistoric inhabitants of lowland South America. The proportion of grass pollen today is comparable to that during the arid episode, and 88 percent of the eastern half of the island is now judged unsuitable for agriculture.[29] Similar climatic conditions in the past would have reduced or eliminated food resources available earlier. The prehistoric population may have responded by abandoning the island or by fragmenting into nuclear families and subsisting as roving hunter-gatherers, as surviving Amazonian tribes such as the Kayapó still do during part of each year.[22] Either option would have left a hiatus in the archeological record.

The existence of gaps of similar ages in local archeological sequences on the northern and southwestern margins of Amazonia is compatible with the evidence for climatic deterioration on a global scale during the first millennium B.C. The resulting subsistence stress could have been resolved in several ways and heterogeneous distributions of languages and cultures in Amazonia suggest that emigration was a frequent option.

As more archeological and paleoclimatological data become available, it should be possible to detect local differences in the intensity of climatic fluctuations and their effects on prehistoric human adaptation. These data are not only relevant to understanding the past; they are critical for designing successful long-range programs of present and future land use.

References Cited

1. **Ab'Sáber, A. N.** 1982. The paleoclimate and paleoecology of Brazilian Amazonia. In: *Biological Diversification in the Tropics,* G. T. Prance, ed. Columbia University Press, New York, pp. 41–59.
2. **Absy, M. L.** 1979. A palynological study of Holocene sediments in the Amazon Basin. PhD Dissertation, Universiteit van Amsterdam.
3. **Absy, M. L.** 1982. Quaternary palynological studies in the Amazon Basin. In: *Biological Diversification in the Tropics,* G. T. Prance, ed. Columbia University Press, New York, pp. 67–73.
4. **Absy, M. L.** 1985. Palynology of Amazonia: the history of the forests as revealed by the palynological record. In: *Amazonia,* G. T. Prance and T. E. Lovejoy, eds. Pergamon Press, Oxford, pp. 72–82.
5. **Aitken, M. J. and J. D. Alldred.** 1976. The assessment of error limits in thermoluminescent dating. Archaeometry **14,** 257–267.
6. **Bigarella, J. J. and D. de Andrade Lima.** 1982. Paleoenvironmental changes in Brazil. In: *Biological Diversification in the Tropics,* G. T. Prance, ed. Columbia University Press, New York, pp. 27–40.
7. **Bogin, B.** 1980. Recent climatic change and human behavior on the southwest coast of Ecuador: a model for archaeological reconstruction. El Dorado 3 **(3),** 43–59.
8. **Bouzek, J.** 1982. Climatic changes and central European prehistory. In: *Climatic Change in Later Prehistory,* A. F. Harding, ed. Edinburgh University Press,Edinburgh, pp. 179–191.
9. **Bryson, R. A. and T. J. Murray.** 1977. Climates of hunger; mankind and the world's changing weather. University of Wisconsin Press, Madison.
10. **Bustos Santelices, V.,** 1978. Una hypótesis de relaciones culturales entre el altiplano y la vertiente oriental de los Andes. Pumapunku **12,** 115–126.
11. **Cardich, A.,** 1975. Agricultores y pastores en Lauricocha y limites superiores del cultivo. Revista del Museo Nacional **14,** 11–33.
12. **Cardich, A.** 1985. The fluctuating upper limits of cultivation in the Central Andes and their impact on Peruvian prehistory. Advances in World Archaeology **4,** 293–333.
13. **Courtois, L.; Beltrão, M. da C. M. C.; Danon, J.; Reyes, J. L.; Valladas, G.; Simões, M. F. and H. Valladas.** 1977. Thermoluminescent dating of archaeological pottery from Marajó Island (Brasil). Fifth International Conference on Luminescence Dosimetry, pp. 459–568. São Paulo.
14. **Dean, J. S.; Euler, R. D.; Gumerman, G. J.; Plog, F.; Hevly, R. H. and T. N. V. Karsltrom.** 1985. Human behavior, demography, and paleoenvironment on the Colorado Plateau. American Antiquity **50,** 537–554.
15. **Folan, W. J.; Gunn, J.; Eaton, J. D. and R. W. Patch.** 1983. Paleoclimatic patterning in southern Mesoamerica. Journal of Field Archaeology **10,** 453–468.
16. **Fromhold, J.** 1978. Migration dynamics on the northern Plains, A.D. 1600–1800. In: *Diffusion and Migration,* P. G. Duke et al, eds. The Archaeological Association of the University of Calgary, Calgary, pp. 173–185.
17. **Gambier, M.** 1976. Ecología y arqueología de los Andes Centrales argentino-chilenos. Revista del Museo de Historia Natural de San Rafael **3,** 185–199.
18. **Gunn, J. and E. W. Adams.** 1981. Climatic change, culture, and civilization in North America. World Archaeology **13,** 87–100.
19. **Hassig, R.** 1981. The famine of One Rabbit: ecological causes and social consequences of a pre-columbian calamity. Journal of Anthropological Research **37,** 172–182.
20. **Lamb, H. H.** 1968. The climatic background to the birth of civilization. The Advancement of Science **25,** 103–120.
21. **Lamb, W. W.** 1982. Reconstruction of the course of postglacial climate over the world. In: *Climatic Change in Later Prehistory,* A. F. Harding, ed. Edinburgh University Press, Edinburgh, pp. 11–32.

22. **Meggers, B. J.** 1971. Amazonia; man and culture in a counterfeit paradise. Aldine, Chicago.
23. **Meggers, B. J.** 1975. Application of the biological model of diversification to cultural distributions in tropical lowland South America. Biotropica **7**, 141–161.
24. **Meggers, B. J.** 1979. Climatic oscillation as a factor in the prehistory of Amazonia. American Antiquity **44**, 252–266.
25. **Meggers, B. J.** 1982. Archeological and ethnographic evidence compatible with the model of forest fragmentation. In: *Biological Diversification in the Tropics,* G. T. Prance, ed. Columbia University Press, New York, pp. 483–496.
26. **Meggers, B. J.** 1987. Oscilación climática y cronología cultural en el Caribe. Actas del Terceiro Simposio de la Fundación de Arqueología del Caribe, pp. 23–54.
27. **Meggers, B. J. and C. Evans.** 1957. Archeological investigations at the mouth of the Amazon. Bureau of American Ethnology Bulletin 167. Smithsonian Institution, Washington, D.C.
28. **Migliazza, E. C.** 1982. Linguistic prehistory and the refuge model in Amazonia. In: *Biological Diversification in the Tropics,* G. T. Prance, ed. Columbia University Press, New York, pp. 497–519.
29. **OEA.** 1974. Marajó; um estudo para o seu desenvolvimento. Secretaria Geral da Organização dos Estados Americanos, Washington, D.C.
30. **Roosevelt, A. C.** 1980. Parmana; prehistoric maize and manioc subsistence along the Amazon and Orinoco. Academic Press, New York.
31. **Rotberg, R. I. and T. K. Rabb, eds.** 1981. Climate and history. Princeton University Press, Princeton.
32. **Sanoja, M. and I. Vargas Arenas.** 1983. New light on the prehistory of eastern Venezuela. Advances in World Archaeology **2**, 205–244.
33. **Simões, M. F.** 1967. Resultados preliminares de uma prospecção arqueológica na região dos rios Goiapí e Camará (Ilha de Marajó). Atas do Simpósio sobre a Biota Amazônica **2**, 207–224.
34. **Simões, M. F.** 1969. The Castanheira site; new evidence on the antiquity and history of the Ananatuba Phase (Marajó Island, Brazil). American Antiquity **34**, 402–410.
35. **Van der Hammen, T.** 1982. Paleoecology of tropical South America. In: *Biological Diversification in the Tropics.* Columbia University Press, New York, pp. 60–73.
36. **Wendland, W. M. and R. A. Bryson.** 1974. Dating climatic episodes of the Holocene. Quaternary Research **4**, 9–24.
37. **Zucchi, A. and K. Tarble.** 1984. Los Cedeñoides: un nuevo grupo prehispánico del Orinoco medio. Acta Científica Venezolana **35**, 293–309.
38. **Zucchi, A., K. Tarble and J. E. Vaz.** 1984. The ceramic sequence and new TL and C-14 dates for the Aguerito site of the middle Orinoco, Venezuela. Journal of Field Archaeology **11**, 155–180.
39. **Zvelebil, M., ed.** 1986. Hunters in transition: Mesolithic societies of temperate Eurasia and their transition to farming. Cambridge University Press, New York.