Dating a Paleoindian Site in the Amazon in Comparison with Clovis Culture

Anna Roosevelt et al. (1) present important new data relative to the peopling of the New World. The radiocarbon ages from stratum 17 indicate that subsistence, based on plant gathering, occurred in Amazonia penecontemporaneously with big-game hunting by Paleoindians of the Great Plains. However, this finding does not necessarily indicate that “a distinct cultural tradition contemporary with the Clovis tradition” (1, p. 381) existed at the Pedra Pintada site.

Of the 56 radiocarbon samples described in the article (1), the 25 on specific seeds are the best material for accurate age determination because each represents a single year of growth. If these radiocarbon ages, in radiocarbon years before present (14C yr B.P.), are grouped stratigraphically instead of by excavated area (by unit), one finds little difference in the averages for each group if the values with standard deviations (sigmas) of more than 80 years are omitted from the averages, that is, the Initial Period is 10,410 ± 65, the Initial/Early Period is 10,350 ± 65, the Early Period is 10,330 ± 50, and the Late Period is 10,220 ± 50 (2).

By plotting the seed radiocarbon ages in order of decreasing age and indexed as to cultural period (Fig. 1), it is readily apparent that, except for five ages with large sigma values, the cultural periods cannot be distinguished by radiocarbon dating. The main occupation, in stratum 17, occurred between 10,500 and 10,200 14C yr B.P. The mixing of seeds of such a narrow age range across all of the cultural periods within stratum 17 suggests that there has been significant bioturbation. The five oldest ages with large sigma overlap at one sigma (Fig. 1) and average 10,970 ± 250. Only two are in excess of 11,000 yr bp and therefore within the Clovis age range, and only one of these is from the base of stratum 17.

As an alternative interpretation of the older ages, I suggest that they may represent seeds that were deposited in the cave by natural processes. Whereas Roosevelt et al. state that “[t]here is no prehuman biological material that could have mixed with the cultural remains” (1, p. 381), they offer no evidence of this. They state that “[d]isturbance and preservation in the dry sandy soil diminished with depth” and that the Paleoindian deposit contained only “one burrow” (1, p. 376). It is not uncommon to have evidence of bioturbation obliterated with depth as overlying strata protect and compact lower strata.

If the human occupation of the cave started approximately at 10,500 14C yr B.P., there remains nearly a millennium for progenitors of Monte Alegre Paleoindians to adapt to foraging in tropical forests in their progression from North America to South America (3). Fluted point finds in Central America and the El Inga-type fluted points from Ecuador and elsewhere in South America are compatible with this model.

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REFERENCES AND NOTES
2. For precise ages, see comment by R. E. Reanier.
3. Recent evaluation of Clovis radiocarbon ages places the earliest Clovis age at 11,500 B.P. [R. E. Taylor, C. V. Haynes Jr., M. Shuver, Antiquity 70, 515 (1996)].
4. Excluding date 1.

Table 1. Tests of within-group 14C date contemporaneity (6), where T is the test statistic, DF is degrees of freedom, and P is the statistical significance.

<table>
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<tr>
<td>All AMS dates</td>
<td>33.21</td>
<td>29</td>
<td>0.269</td>
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</table>

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with only slight differences in age between

site between
time for the former to have been derived

and were calculated according to equations (6) and (8) of (3). Exclusion of conventional dates from the Initial period results in a mean age of 10,420 ± 41 yr B.P.

period), are statistically indistinguishable (Table 1) (5). Weighted mean ages for the periods (Fig. 1) suggest an approximately

300-year-long Paleoindian presence at the site between ~10,500 and ~10,200 yr B.P., with only slight differences in age between periods. On the basis of present 14C evidence from Caverna da Pedra Pintada, the earliest Amazonian Paleoindians appear to be not contemporaneous with the earliest Clovis Paleoindians, but to be at least 1000 years younger (2), which would provide sufficient time for the former to have been derived from the latter, or from still earlier South American cultures (see A. Gibbons’ News & Comment article, 28 Feb., p. 1256).

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REFERENCES AND NOTES
1. A. C. Roosevelt et al., Science 272, 373 (1996); all dates in this comment are given in uncalibrated 14C years before A.D. 1950 (yr B.P.).
4. The absence of high-precision tree-ring calibration of the 14C time scale for 14C ages older than ~10,000 yr B.P. precludes direct assessment of date contemporaneity caused by short-term fluctuations in Late Glacial concentrations of atmospheric 14C [2]; J. Haje,

dias, S. D. Ivy-Ochs, G. Bonani, Radiocarbon 37, 75 (1995). The term “dated” Clovis artifacts in this context are those directly dated by 14C methods, and not those dated by seriation of stratigraphic units or other means.
5. In a recent letter, A. R. Roosevelt [Science 274, 1823 (1996)] concluded that these 30 AMS dates were significantly different. Her analysis evidently used Ward and Wilson’s Case I (3), which is applicable to multiple dates from a single object and does not take calibration curve uncertainty into account. For situations like that at Caverna da Pedra Pintada, where there are multiple dates on different samples from several stratigraphic units, Ward and Wilson’s Case II (6) is applicable.
6. Tests follow Case II of (3) using the test statistic

\[ T^2 = \sum_{i=1}^{n} (A_i - A_j)^2 / \text{Si} \]

where \( A_i \) is the ith 14C date, \( A_j \) is the pooled mean of the dates, and \( \text{Si} \) is a variance estimate for the ith date that includes estimates of both 14C measurement and calibration curve uncertainty. Under the null hypothesis of equal dates, \( T^2 \) has a chi-square distribution with n−1 degrees of freedom (3). Calculations were facilitated by the program CALIB (revision 3.0.3C) of M. Stuiver and P. Reimer (Radiocarbon 35, 215 (1993)).

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Roosevelt et al. (1) do not provide sound chronological placement for a type of stemmed projectile point (yet unnamed) found widely throughout South America. They state that radiocarbon dates from the Pedra Pintada shelter support a 11,000 yr B.P. chronological placement for these typologically distinctive points with barb-like shoulders and contracting stems. Nevertheless, contextual evidence from other South American sites indicates that these points are early to mid-Holocene in age, and not associated with Late Pleistocene/Paleoindian occupations.

The two stemmed points in figure 1 of the article (1) were recovered from the middle Tapajos River area south of the Amazon. The fragmentary biface specimens found at the Pedra Pintada excavation [figure 6, A to C, in (1)] bear no resemblance to the Tapajos River projectile points [figure 1 in (1)]. Stemmed points do not appear to be present within the Pedra Pintada site. Assignment of these two points to their assemblage based on debitage and general lithic technology, rather than the presence of the point type itself, is not justified. The lithic techniques noted by Roosevelt et al. as diagnostic of the Pedra Pintada Paleoindian (and upper Paleolithic) assemblages are typical of many North and South American Archaic assemblages.

The two stemmed points [figure 1 in (1)] were described in detail in an article published 20 years earlier by M. Simoes (2). Projectile points, with distinctive barbed shoulders (Roosevelt et al.’s “wings”) and contracting stems have been found in Colombia (3), Venezuela (4), Guyana (5), and southern Brasil (6). Points with comparable shoulder and stem configuration are also found in Peru and Ecuador (for example, Paizan and El Ingla Long Stemmed types). Available evidence clearly supports a Holocene/Archaic age for them, not a Late Pleistocene/Paleoindian age as advocated by Roosevelt et al.

South of the Amazon, stemmed points with barbed shoulders are common in preceramic Vinikut phase assemblages along the Rio Parana. In light of pedological context and comparative relations with dated assemblages, Chmyz initially estimated their age at between 8,000 and 7,000 yr B.P. (6), an assessment later supported by an 8,000 yr B.P. date from the Rio Paranapanema region (7). Artifacts identical to Roosevelt et al.’s “limaces” (a term heavily laden with French Paleolithic connotations and thus not appropriate in this context) are also common in the Vinikut and later mid-Holocene Piraju phase, where they are called plano-convex scrapers. They are not exclusive Late Pleistocene/Paleoindian artifacts, as implied by Roosevelt et al. In the Lagoa Santa region, Hurt recovered a similar point from between two strata with radiocarbon dates of 9,028 ± 120 B.P. and 9,720 ± 128 yr B.P. in the Cerca Grande Rock Shelter #6 (8). The two stemmed points I recovered [both were well flaked and thin, not “thick and percussion flaked,” as noted by Roosevelt et al. (1, p. 375)] from the Cabeira site on the Orinoco River were stratified above an earlier (though still Holocene) preceramic component (9). More recently, a radiocarbon date of 6,000 yr B.P. was obtained from the Middle Magdalena River area in Colombia from a context containing stemmed points with barbed shoulders (10). If the dates given by Roosevelt et al. were correct, they would have to relate to a complex, lacking points, comparable to that described by Proux from Minas Gerais several years ago (11).

What relevance does the Pedra Pintada site have for Clovis? Most Paleoindian specialists do not consider Clovis subsistence to be strictly a “big-game” adaptation. Clovis subsistence was a broad spectrum economy, varying with geographic locale, that included plants, fish, and possibly avian species as well as mammals (12). The statement (1) that anthropologists did not expect pre-horticul
tural groups in Amazonia is not appropriate, because the references in question deal with Insular Southeast Asian groups. Mengers (13) argued that the lowland tropics must have great time depth to allow for the linguistic diversification notable in the area. Finally, particulate decomposition of the shelter’s “friable sandstone” roof and back wall, coupled with high rates of tropical weathering, argue
strongly against preservation of painted rock art from 11,000 yr B.P.

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REFERENCES
7. ———, “Relatorio das Pesquisas Arqueologicas Realizadas nas Areas das Ulinas Hidroeletricas de Rosana e Taquaru” (CESP, Sao Paolo, Brasil, 1984).

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Response: Haynes and Reanier analyze the Monte Alegre dates (1) by criteria that Clovis dates (2) cannot fulfill. The 10,000-year age difference is thus an artifact of a comparison that treats precision, accuracy, means, and context differently for Monte Alegre and Clovis. Comparison of a Monte Alegre with North American dates, by consistent criteria establishes the contemporaneity of the Monte Alegre culture with the Clovis tradition.

The 11 excavation units at Monte Alegre (1), a deposit about 30 cm thick in about 2 m of stratified deposits, produced about 30,000 exotic lithic specimens and 56 14C assays (not 37, as Reanier states) between 11,145 ± 135 and 10,000 ± 60 yr B.P. The dates’ standard errors (SEs) of 50 to 310 years were equal to or less than the “minimum overall band of uncertainty” for late Pleistocene dates (3, p. 4).

The majority of the samples (n = 26) were coccosid palm endocarps from shallow hearths and lenses. The fruits had been neatly cracked open for their kernels and burned; none had the marks diagnostic of fruit eaten by fauna (4). Eleven samples were wood charcoal, which can have inherent age older than an occupation (3, pp. 43–47), but these dated in the range of the seed dates. Nineteen AMS check-dates on humic acids extracted from the seeds and charcoal showed no carbon contamination. Sources of geological carbon were absent, and the sand below the deposit was devoid of natural carbon that could have been dated mistakenly. Disturbances were detectable because of contrast between the dark cultural deposit and pale, culturally sterile deposits above and below. Strata merged in some places as a result of bedrock slope and human activities (Fig. 1), but the only biological intrusions were a burrow, a few insect larvae, and small roots.

Periods and sub-periods were defined by the stratigraphic distribution of lithic raw materials and dated samples [tables 1, 3, and 4 in (1)]. Ages comparable to Clovis and the earlier part of Folsom predominated in the initial occupation (Figs. 1 and 2). The four Clovis-age dates from 11,145 ± 135 to 10,875 ± 295 yr B.P. were the only dates from the bottom part of stratum 17 (initial A period). Their time-depth and cultural character are corroborated by the weighted average of the associated thermoluminescence lithic and optically stimulated luminescence sediment dates [table 4 in (1)]: 13,865 ± 445 calendar yr B.P., which falls in the calibrated range of Clovis dates (2). Twelve Folsom-age dates from 10,655 ± 285 to 10,250 ± 50 yr B.P. came from the middle of stratum 17 (initial B period).

Quartz crystal lithics predominated at the beginning of the initial period, but by its end, chalcedony predominated (Fig. 2). The main occupation, however, took place during the Early through Late periods, represented in middle and upper stratum 17 and in stratum 16. It produced the majority of chalcedony lithics (n = ~27,000) and 40 later Folsom-age dates from 10,470 to 10,000 yr B.P. The 14C dates in initial B period are from late periods overlapped, but only eight were notably out of stratigraphic order, and none of these were from initial A levels. The 14C dates and lithic frequencies of the different periods and sub-periods were significantly different (X2 test) (Fig. 1) (5).

The weighted average of the beginning occupation’s four dates, 11,075 ± 110 yr B.P., falls early among the averages of date series from documented Clovis sites (Fig. 3) [note 4 in (1); 6]. The weighted average of initial B dates, 10,420 ± 20 yr B.P., falls in the Folsom range (Fig. 3).

Haynes and Reanier accept only the AMS dates with SEs of 80 years or less, but all Clovis period SEs exceed 80 years (6–8). Similarly, Haynes’ procedure of discarding all the cave dates on charcoal or organic acids would eliminate nearly all accepted Clovis and Folsom dates. More than half of Clovis dates are on charcoal, and the rest are on organic acids from plants or bone, which Haynes has characterized as unreliable (2, p. 365; 9).

Haynes and Reanier’s beginning age for Clovis is based on sites with abundant geological and radiometric evidence for pre-human carbon (6, pp. 1825), and all North American dates earlier than 11,000 yr B.P. were run on samples subject to effects from too-old carbon (6, p. 1825; 7). Also, there is no adjustment for the old wood problem of charcoal, the most common Clovis material.

Haynes and Reanier’s elimination of the four Clovis-age dates as outliers, and their use of averages for the cave periods, are inconsistent with their age for Clovis, which is based only on outliers (Fig. 3) (6, 7). There are only three dates at ~11,500 yr B.P. from documented Clovis sites, and all have low-precision, problematic materials, or doubtful context. No documented Clovis date series has a weighted average as early as 11,500 yr B.P. Those with SEs comparable to the SEs of the Amazonian Clovis-age dates all have means of less than 11,000 yr B.P. and thus are younger than Haynes’ range for Clovis (Fig. 3) (2, 6, 7). Moreover, although Haynes states that the average of the five earliest cave dates with large errors is 10,970 ± 250 yr B.P. and thus younger than the range of Clovis, this is incorrect. The calculated weighted average of the five cave dates in question is 11,023 ± 100 yr B.P., and thus within his range for Clovis.

Haynes and Reanier also say the Clovis-age cave dates were stratigraphically associated with later dates. However, these were the only dates in their levels. All later dates were from later levels with different lithic frequencies (Figs. 1 and 2) (1). Reanier argues that the earliest cave date of 11,145 ± 135 yr B.P. was run on the same sample as a high-precision date of 10,392 ± 78 yr B.P. However, the two dates were run on different palm samples, from different plotted locations, with different lithic associations in unit 5 (Fig. 1). Like the other Clovis-age cave dates, the earliest date was associated with a majority of quartz crystal in the lower part of stratum 17, and the date of 10,392 yr B.P. was associated with a majority of chalcedony in the middle part of that stratum.

Haynes and Reanier delete the early dates (1) for various reasons and then argue that the remaining dates overlap so much that they are statistically the same. This “overlap” in their figures is the result of lumping early and late initial dates and the inclusion of a single unit whose initial and early deposits were merged due to sloping bedrock [J, table 1, unit 7 in (1)]. The results of Reanier’s calculations are primarily the product of the large calibration curve error inherent in the period before den- drochronological dating, not of a lack of difference in 14C dates of the periods. Given this imprecision, which Reanier acknowledges, the chi-square test provides a more valid means of evaluating significance (5). Also, his deployment of dates violates the criterion of his test (his reference 3), that each group
compared should be from a single component. In stratigraphy, dates, and lithic distributions, initial A and B assemblages represent distinct phases of occupation. The overlap of dates in the cave’s later periods is not unique, but a salient characteristic of the contemporary North American Paleoindian dates, and is apparently related to global carbon cycles (2).

As for the evidence Haynes cites for the hypothetical Clovis migration, there are no Pleistocene dates for fluted points in lower Central America or northern South America. The only two dated northern South American sites with El Inga fluted points are Holocene; the only two dated Mesoamerican fluted point sites have a single Folsom-age date and five Holocene dates (9). All these dates are on humic acid, all have SEs greater than 80 years, and all would be eliminated by Haynes and Reanier’s criteria.

The hypothesis of Clovis as progenitor is not supported by its dates. As Haynes himself has written (10, p. 96)

Large standard deviations, inherent ages in wood charcoal dates, and a notoriously poor record for bone dating at most [North American] sites make attempts to construct isochrons of geographic movements (time-space relationships) for a particular cultural complex highly questionable.

Barse’s discussion of Monte Alegre contradicts the stratigraphy of lithics and $^{14}$C dates there, as well as at other South American sites. We cited the published type definitions for the Lower Amazon triangular bifacial points (1, p. 386), which are stemmed or concave-based, often with downturned wings. (Barse prefers the term “barb-like” to “wings,” but such functional terms are not appropriate for prehistoric stone tools of unknown function.) Barse cites the same finds as evidence for Holocene age, but only Monte Alegre has been $^{14}$C dated [references 2 and 5 (p. 171, plate 36A and p. 10, plate 1) in the comment by Barse].

We documented bifacial triangular forms, stems, refined bifacial reduction flaking, and pressure-flaking among ten bifacial points and point fragments [figure 6 in (1)]. Barse says that the bifaces from the cave bear no resemblance to the Tapajos points [figure 1 in (1)]. He cites no differences except as supposed lack of stems, but these are present [figures 6A and
The paucity of artifacts from the two preceramic components at the Provincial site makes it difficult to establish good correlation with other South American preceramic phases.

Barse cites the Casitas and Canaima assemblages in Venezuela as evidence for an exclusively Holocene age of the points and limaces, but his sources state that the tools, which were surface finds, probably came into use in the Pleistocene and continued in the Holocene (14). (The only excavated, dated point he refers to is a late Holocene ceramic period percussion-flaked specimen unrelated to the preceramic types.) Similarly, Barse’s Peruvian and Ecuadorian examples are surface deposits lacking stratigraphically sealed radiocarbon dates. In the case of the Colombian sites, the excavator documents a majority of Pleistocene dates for the points (15), not primarily Holocene age.

Barse states that we did not acknowledge that most scholars believe that Paleoindians were broad-spectrum foragers. However, we cited numerous examples of this opinion for South America (1, pp. 373–374 and 382–383) and cited Meltzer’s synthesis of such evidence from North American sites (1, pp. 381 and 384), such as Minnissinw. Finally, Barse’s assertion, following Betty Meggers (16), that the possibility of early forager occupations in tropical rainforests has been questioned for southeast Asia, but not for Amazonia, conflicts with the literature (17, 18). A recent synthesis concludes, “humans have subsisted in tropical rain forest independently of cultivated foods only in Malaysia” (18, p. 281).

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REFERENCES AND NOTES

5. S. Bowman, Radiocarbon Dating (University of California Press/British Museum, Berkeley, CA, 1990), pp. 58–60. The results of the test of significance on the dates were as follows*: Group X 2 df P

<table>
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<th>Group</th>
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*Tests 1 and 2 use all relevant radiocarbon determinations; tests 3 through 8 parallel the groupings in table 1 of the comment by Reanier. 1With earliest date excluded.


7. The 11,480 ± 450 yr B.P. (J. D. Domingo, date on an inadequate sample. The Lehrer date of 11,470 ± 110 was on charcoal which has inherent age. The three dates from the Clovis type site of Blackwater Draw were on humic acid from non-cultivated pond plants. Two (11,630 ± 400 and 11,040 ± 500 yr B.P.), were not from the archaeological deposit, and the date of 11,170 ± 360 was from highly disturbed archaeological strata. See (2) and (6).

8. The only high-precession dates are two charcoal samples, statistically indistinguishable from the Amazonian high-precession initial dates when 100 years for inherent age is subtracted.


11. A. Pruss [J. Soc. Am. 77, 77 (1991); L’Anthropologie 90, 257 (1986)] describes limaxes and finely flaked triangular bifacial points and bifacial retouching flakes only in the lower levels of the site (1981, pp. 83–97, figure 8).

12. P. I. Schmitt et al., J. World Prehist. 1, 53 (1987) describes the late Pleistocene Uruguayan phase (p. 88). The most diagnostic artifacts are various forms of ... stemmed bifacial projectile points ... produced from chalcedony and exhibiting pressure retouch” See also T. Dillehay et al. ibid. 6, 145 (1992) on the points and limaces from Brazil (pp. 168–167).

13. B. Barre, Science 250, 1388 (1990). Barse argues that his points are finely pressure-flaked and not crude and percussion-flaked as we described them, but he has not described or illustrated them as such (p. 1389, figure 3, E and F).

14. I. Rouse and J. M. Cruzenet, Venezuelan Archaeology (Yale Univ. Press, New Haven, CT, 1963), pp. 29, 32, and 37, plates 5G and 6A.

15. C. E. Lopez [A. Oyuela-Caycedo and J. S. Raymond, Eds., Advances in the Archaeology of the Northern Andes (Institute of Archaeology, University of California at Los Angeles, in press); personal communication, 30 January 1997] notes that the sole Holocene date was located above the levels with most of the points.


20. Fig. 1 by J. Silva, Desert Archaeology, Tucson, AZ.

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