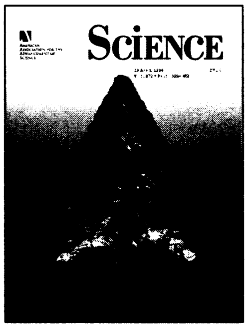
LETTERS

Cultural relations

Describing a field trip to China, a writer says that it "was scientifically productive and enjoyable." In another letter, Chinese scientists are praised for "adhering to their . . . independence from interference" in disclosing a case of plagiarism. And the excavation of a Paleoindian site in the Brazilian Amazon is discussed in light of radiocarbon dating, statistical procedure, and the larger archaeological record of Early Americans. (Right, quartz spear point, 6.4 centimeters long, discovered at that site.)



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Plagiarism in China

I am glad that the Chinese scientific community *finally* succeeded in disclosing a case of plagiarism (News & Comment, 18 Oct., p. 337). The case was an open secret, of which I became aware when I was conducting research in Beijing in early 1996. I talked with the two authors who disclosed the case in the *Journal of Dialectics of Nature*. From what I learned then, it appears that there was pressure not to publicly discuss the case. The article was first submitted to another journal for publication. I was told later by one of the authors that three journals declined to publish it.

I applaud the Chinese scientists for adhering to their upright attitude toward scientific research and, most important, to their independence from interference.

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U.S.-Chinese Collaborations

Jeffrey Mervis, in his article "Both sides point finger in tiff over China dig" (News & Comment, 1 Nov., p. 715) about a conflict between Chinese and American geoscientists working in western China, reports an unfortunate occurrence, from which readers might conclude that systemic impropriety on the part of Chinese scientists and institutions was to blame.

I do not presume to know the details of the incident, but I emphatically urge caution against generalizing that such incidents are characteristic of fieldwork in China or that they in any way typify relations between U.S. and Chinese scientists. I spent a month in China doing fieldwork at the same time (and, in fact, on a very similar subject) as Lucas, Geissman, and Molina-Garza, and I was fully and generously hosted by my Chinese colleagues. I did not spend one yuan. Both the individual scientists and the institutions I worked with were extremely gracious, and the trip was scientifically productive and enjoyable.

It would be wrong to impugn the Chinese scientific community on the basis of this unfortunate incident. Let us hope that an amicable and mutually satisfying resolution to this dispute can be found and that ongoing and future U.S.-Chinese collaborations will not be imperiled by escalation into inappropriate venues.

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Paleoindians in the Brazilian Amazon

Anna C. Roosevelt *et al.* (Article, 19 Apr., p. 373) present results of excavation of Caverna da Pedra Pintada at Monte Alegre, an important early site in the Brazilian Amazon. A valuable critical review of other putatively pre–Clovis age [earlier than about 11,200 carbon-14 years before the present (B.P.)] South American sites is buried in the footnotes of their article. Ironically, after questioning the validity of these dates, Roosevelt *et al.* advance the culture disclosed at Monte Alegre as a Clovis contemporary, with the stated implication that North American Clovis was not "the sole source" of human migration into South America: "Clovis is evidently just one of several regional traditions."

However, they state, lithic manufacture techniques of the Monte Alegre culture "resemble those of other Paleoindian and upper Paleolithic cultures." Obviously, the South American Paleoindians must have descended from *some* North American culture which was not initially adapted to tropical forest environments and which was ultimately derived from Northeast Asia. Clovis, ubiquitous in North America and attested as far south as Costa Rica (*1*), is the best candidate.

The central question is, Is the Monte Alegre culture really as old as Clovis? If not, was there enough intervening time for a Clovis-derived culture to traverse 5000 miles to Amazonia and be transformed there into a locally adapted, forest-foraging community, manufacturing small-stemmed points?

On the basis of characteristics of the lithic industry, Roosevelt *et al.* divide the Monte Alegre "Paleoindian" occupation of Caverna da Pedra Pintada into three sequential phases—Initial, Early, and Late—and 56 radiocarbon dates are assigned to one phase or another. In fact, with few exceptions, the dates associated with all phases are indistinguishable, generally falling in the interval of 10,600 to 10,100 B.P. The most precise dates (50- to 70-year sigmas) for the Initial occupation actually overlap with four of the Early dates, around 10,600 to 10,350 years B.P. The four dates that appear to fall within the Clovis range (11,145 to 10,875 B.P.) have larger standard erorrs (135 to 310 years) and are most plausibly interpreted as statistical outliers [as suggested by C. Vance Haynes, Ken Tankersley, and Dena Dincauze (A. Gibbons, News, 19 Apr., p. 346)].

Previous discussion of the chronological relationship of Monte Alegre and Clovis has not taken into account the recent evidence of major carbon-14 anomalies in this period. Roosevelt *et al.*, noting that precise calibration of radiocarbon dates in this range is not yet feasible, present their dates in uncalibrated form, while parenthetically observing that the estimated calendrical dates may range from about 14,200 to 10,500 B.P. Data presented by Edwards *et al.* (*2*) suggest that there is a radiocarbon "plateau" extending from about 12,300 to 11,000 calendrical years ago, when atmospheric ratios of carbon-14 to carbon-12 dropped by 15%. Apparent radiocarbon ages of about 10,400 to 10,000 B.P. fall somewhere within this actual span, but cannot be readily distinguished or pinpointed. This might explain why the dates for the Monte Alegre Initial, Early, and Late phases appear contemporaneous. In contrast, Clovis-associated dates of about 11,200 B.P. calibrate to about 13,000 to 13,500 calendrical years ago. Thus, there may have been an interval of anywhere from 700 to 2000 years between Clovis and the Initial phase of Monte Alegre. Because the Clovis culture seems to have exploded across the whole of North America and into Central America within the space of a few hundred years, this seems to provide enough time for their descendants to have reached Amazonia and to have adapted to local environments.

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1. M. J. Snarskis, *Am. Antiq.* **44**, 125 (1993).
2. R. L. Edwards *et al.*, *Science* **260**, 962 (1979).

For more than 25 years, Brazilian archaeologists have been documenting the presence of late Pleistocene people (11,300 to 10,000 years B.P.) at several sites in the eastern tropical lowlands of South America (*1*). Roosevelt *et al.* state this, but appear to broadly dismiss these sites as uncertain human localities. Several sites are far less dubious than they imply. In short, Roosevelt *et al.*'s finding is not unique; it merely adds another site locality to the terminal Pleistocene archaeological record of eastern Brazil.

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1. A. Prous, *Arquiv. Museu Hist. Nat.* (*Belo Horizonte*) **12** (1991); *Anthropologie (Paris)* **90**, 257 (1986); P. Schmitz, *Estud. Atacamen.* **8**, 16 (1987); *J. World Prehist.* **1**, 53 (1987); E. Miller, *Estud. Atacamen.* **8**, 37 (1987).

Roosevelt *et al.* jeopardize the credibility of their data by saying they have produced evidence that "changes understanding of the migrations and ecological adaptations of early foragers." It has long been recognized that the Paleoindian diet consisted mainly of plants and small animals (*1*). South American lithic assemblages dating from before 11,000 years B.P. are numerous, diverse, and distinct from Clovis (*2*). There is no evidence that the neotropical rainforest was uninhabitable before the advent of agriculture, a moot issue because paleoenvironmental data increasingly support more open vegetation in central Amazonia before about 8000 years B.P. (*3*).

The features described for Pedra Pintada by Roosevelt *et al.*—including lithics, hearths, plant remains, modern terrestrial and aquatic fauna, and rock art—are also found in the earliest levels of Boquete Rock Shelter in Minas Gerais, also dated at about 11,000 years B.P. (*4*). The excavations at Pedra Pintada expand the spatial distribution of this early cultural tradition.

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3. A. S. Barbosa, in *Prehistoria Sudamericana*, B. J. Meggers, Ed. (Taraxacum, Washington, DC, 1992), pp. 150–155; C. M. Clapperton, *Quaternary Geology and Geomorphology of South America* (Elsevier, Amsterdam, 1993), p. 205; T. Van Der Hammen and M. L. Absy, *Palaeogeogr. Palaeoclim. Palaeoecol.* **109**, 259 (1994).
4. A. Prous, *J. Soc. Am.* **77**, 77 (1991).

Response: The preceding letter writers represent opposite views of the peopling of the Americas. Feidel suggests that Clovis big-game hunters dating to about 11,200 years B.P. were the earliest Paleoindians and ancestors of all others (*1*). Dillehay and Meggers suggest that there were both Clovis-age and pre–Clovis-age human occupations in South America (*2*).

We took a middle ground in our article. Although we found all pre-Clovis South American sites problematic, we found (p. 383) evidence for occupations of the same age as Clovis and Folsom, but with different cultures and ecological adaptations, which is not compatible with Clovis as the sole ancestor. The cave at Monte Alegre in Brazil is in the Amazon's equatorial lowlands, a region which many researchers had thought uninhabitable by primary hunter-gatherers (*3*).

Feidel, ignoring other eastern South American sites, argues against the contemporaneity of the Amazonian culture with Clovis. He suggests that Monte Alegre is 700 to 2000 years younger and could be its descendant. This age gap, however, is based on a statistically questionable comparison favoring a greater age for Clovis than for the Amazonian culture.

Feidel drops as outliers the four earliest Amazonian dates between 11,145 and 10,875 years B.P. because of their "large" standard deviations, from 135 to 310 years, and accepts eight "more precise" dates with errors of less than 80 years, which are between about 10,600 and 10,400 years B.P. He states that the dates of the different Amazonian periods are the same, but, on the contrary, they are significantly different ($n = 30$, $t = 66.27$, $P < 0.00097$), according to Ward and Wilson's test of contemporaneity (4), as are the lithic frequencies ($n = 30{,}420$; $\chi^2 = 9558.59$; df, 12; $P < 0.00001$).

Along with Tankersley, Dincauze, and Haynes, whom he cites, Feidel does not acknowledge that the oft-quoted age of Clovis of about 11,200 years B.P. is based on a small selection of early outlier dates with a much larger standard error range than that of the Amazonian dates, so dropping only the Amazonian dates because of their "large" errors applies a different standard for North and South American dates.

Accepted Clovis dates of 11,200 years B.P. or earlier have errors of from 200 to 600 years, with one exception (5). Dates with errors of 100 years or less are much younger, from 10,980 to 10,600 years B.P. (a charcoal date with inherent age), similar to those in the Folsom range; the only Clovis date with an error under 80 years is 10,840 years B.P. ± 70 years (SMU-42, also a charcoal date). These significantly different older and younger Clovis date sets are not from different stratigraphic contexts within sites, whereas the early Amazonian dates are. The only apparent difference is that the earlier dates were run primarily on problematic samples of inadequate size and questionable human association, or with inherent or geological carbon effects (5, 6).

Calibrating dates to correct for changes in atmospheric carbon isotopes does not change the picture (5, 7). Although Feidel gives a calibrated range of 13,500 to 13,000 calendar years ago for Clovis, that is not the calibration for the accepted age-range of Clovis, which is 11,200 to 10,900 carbon-14 years B.P. and calibrates between 13,000 and 12,800 calendar years ago. The earliest Monte Alegre calibrated dates with "large" errors are 13,054 to 12,799 calendar years ago, compared with 13,107 to 12,728 calendar years ago for Clovis dates with comparable errors. Monte Alegre dates with errors under 80 years begin at 12,486 calendar years ago, compared with the single Clovis date of that precision, 12,766 calendar years ago (another charcoal date with inherent age).

Although Feidel points out that calibrations of the later Amazonian radiocarbon dates overlap because of isotope plateaus, he does not mention that this also applies to Clovis and Folsom and that the large errors of pre–11,000 years B.P. Clovis dates give their two-standard-deviation calibrated range more overlap with the later Amazonian dates than the earliest Amazonian dates have with them. Calibration shows no gap of 700 to 2000 years between Clovis and Monte Alegre.

As for the Clovis migration, there are no dated Pleistocene sites related to Clovis in Costa Rica, Panama, or northern South America, as we pointed out (p. 383). Who, then, were the ancestors? Given the evidence for open-water fishing at Monte Alegre, they could have been coastal people who traveled the often-suggested route along the now-submerged Pleistocene seacoasts of the Pacific. Aided by coastal resources and water craft, they could have moved south more rapidly than those on foot in the interior.

Dillehay essentially restates our conclusions (pp. 374, 382) about Brazilian sites dated at about 11,000 years B.P., but says that the dates of the sites are more certain than we stated. As we noted, however, even after 25 years, essential data (radiocarbon dates with standard errors, sample materials, and levels; lab numbers; geochemical and stratigraphic context; lithic drawings and tabulations by levels; biological identifications; and so forth) have not been published for many sites.

Meggers seems to say that our article is irrelevant because the questions about Paleoindian subsistence, South American cultures dated before 11,000 years B.P., and the habitability of the Amazon tropical forest for Paleoindians have already been resolved. She asserts that "Paleoindian diet consisted mainly of plants and small animals." But we argued in favor of such a diet (pp. 382–384), citing the same researchers as she does. If Meggers is saying that this view has long been the consensus, however, we disagree. The other idea put forth by Meggers, that there are numerous South American cultures distinct from Clovis that have been dated as older than 11,000 years B.P., is also much debated, as we discussed (p. 383) and as Feidel's letter indicates. Indeed, the articles cited by Meggers do not document occupations dated as older than 11,000 B.P. (8). Finally, Meggers's statement that the Boquete site is similar to Pedra Pintada mirrors our assessment (pp. 382–383) of such central Brazilian sites. However, as we pointed out, this is an arid upland area, so the sites could not resolve the long-standing questions about early human occupation of equatorial lowland rainforests (9).

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References and Notes

1. S. Feidel, *Prehistory of the Americas* (Cambridge Univ. Press, Cambridge, 1992).
2. T. Dillehay *et al.*, *J. World Prehist.* **6**, 145 (1992).
3. That the central Amazon was already a rainforest at the time is shown by palynological data cited by P. Colinvaux *et al.* [*Science* **274**, 85 (1996)] and data in our article (pp. 379–381) showing tropical forest species with stable carbon isotope ratios of closed canopy tropical rainforest, carbon-13/12 isotope ratios of −27 to −35 per mil, corrected for seed fractionation [L. L. Tieszen, *J. Archaeol. Sci.* **18**, 227 (1991)], not of open forest or savanna.
4. G. K. Ward and S. R. Wilson, *Archaeometry* **20**, 19 (1978).
5. L. Brown *et al.*, *Soc. Am. Archaeol. Meet. Abstr. (1997)*, in press; A. C. Roosevelt *et al.*, *ibid.*
6. The Clovis site (Blackwater Draw) samples were noncultural pond plants from sand at upwelling artesian springs in contact with geological carbon sources [J. J. Hester, *Blackwater Locality No. 1: A stratified early man site in eastern New Mexico* (Fort Gurwin Research Center, Southern Methodist University, Dallas, TX 1972)]. Water plants in the southwest are dated too old because they incorporate geological carbon metabolically [P. E. Damon, C. V. Haynes, A. Long, *Radiocarbon* **6**, 91 (1964)]. The Lehner, Lange-Ferguson, and Murray Springs samples were on charcoal, which has inherent age (p. 380) of about 300 years, to judge from the difference between high-precision bone amino acid and charcoal dates from Clovis (5) and Folsom [J. Hofman, *J. Field Archaeol.* **22**, 421 (1995)] sites. Bone dated to earlier

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idizing strength of Cu(II). This explains why certain added ligands such as Gly-His-Lys inhibit reduction of Cu(II) by APP (*1*) and why certain proteins that bind Cu(II) strongly may not show any reduction of Cu(II) even though they contain moieties that normally reduce $(BC)_2Cu(II)$.

In the case of APP, Multhaup *et al.* provide evidence that Cys[144] in APP is involved in the reduction of Cu(II)/BC (*1*). In the absence of BC, it is possible that this same Cys oxidation could occur according to a Cu(II)-catalyzed autoxidation process. If so, this reaction could generate the reactive oxygen species (ROS) discussed by Multhaup *et al.* (*1*), though the quantity of ROS would be limited to the small, stoichiometric amounts of Cys-containing protein present, in contrast to the larger amounts of ROS characteristic of cytotoxic redox cycling phenomena. In this regard, one should keep in mind that a Cu(II)-catalyzed autoxidation differs from stoichiometric reduction of Cu(II) in the presence of BC, especially in that $(BC)_2Cu(I)$ is inert to O_2-mediated reoxidation. The conclusion by Multhaup *et al.* (*1*) that neither superoxide nor H_2O_2 is involved in the reduction of Cu(II) by APP, as judged by the lack of effect of added superoxide dismutase or catalase, should not be a general interpretation—superoxide and H_2O_2 are not expected to interfere with the $(BC)_2Cu(II)$ reaction, but they could well alter the status of APP-bound copper in the absence of BC.

Also, the observation that Fe(III) is not reduced by either APP (*1*) or LDL (*2*) might appear contradictory based on the fact that the indicator ligand used in this case, bathophenanthroline disulfonate (BP), binds to Fe(III) as well as to Fe(II) and makes the potential even higher (*8*) than for $(BC)_2Cu(II)$. The lack of observed reduction of Fe(III) reflects the fact that the octahedral tris complex formed in this case, $(BP)_3Fe(III)$, is coordinatively saturated and thus kinetically incompetent in thiol oxidation. This is in contrast to $(BC)_2Cu(II)$, which effects rapid inner-sphere oxidations via pentacoordination (*6*, *7*).

In summary, batho-based ligands cannot be used to monitor reduction of Cu(II) and Fe(III) that occurs physiologically. In fact, there is at present no easy way to do this because the reduced metals would normally be reoxidized by O_2, and any indicator ligand that prevents this would concomitantly alter the iron/copper redox properties. In the cases mentioned above, one cannot thus conclude definitively that either APP or LDL is capable of spontaneous physiologic reduction of Cu(II). The same concern applies to a recent report that α-tocopherol acts as a prooxidant in human lipoproteins by reducing Cu(II) to Cu(I) (*9*); such action probably reflects merely the inclusion of BC to monitor the Cu(I) formed.

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4. K. Hegetschweiler and P. Saltman, *ibid.* **25**, 107 (1986).
5. F. Wang and L. M. Sayre, *ibid.* **28**, 169 (1989).
6. ———, *J. Am. Chem. Soc.* **114**, 248 (1992).
7. N. Al-Shatti, A. G. Lappin, A. G. Sykes, *Inorg. Chem.* **20**, 1466 (1981).
8. W. R. McWhinnie and J. D. Miller, *Adv. Inorg. Chem. Radiochem.* **12**, 135 (1969).
9. A. Kontush, S. Meyer, B. Finckh, A. Kohlschutter, U. Beisiegel, *J. Biol. Chem.* **271**, 11106 (1996).

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Response: We summarize our evidence for the reduction of copper(II) to copper(I) by APP. First, as shown previously by us (*1*), APP has a high affinity binding site for copper(II), which is located within residues 135 to 155 of APP. This binding site is conserved in the related protein APLP2.

Second, complex formation between copper(II) and a synthetic peptide representing this copper(II) site in the absence of bathocuproine resulted in cysteine oxidation. The oxidized peptide still binds copper as shown by LC-ESI-MS. Recent electron paramagnetic resonance (EPR) analysis (*2*) showed that the cysteine oxidation is accompanied by the disappearance of the copper(II) signal.

Third, EPR analysis revealed also that copper(II) was not reduced when bound to a peptide representing the copper binding site of APP in which only cysteine was replaced by serine. This shows the importance of cysteine in copper(II) reduction by the APP peptide and that no other reducing agents are required (such as molecular oxygen, possibly present in the buffer).

Fourth, our experiments performed with bathocuproine to measure copper(I) formation showed within seconds the characteristic change of absorbance at 480 nm. Such a rapid change has never been found by us when we incubated copper(II)-bathocuproine complexes in the reaction buffer, without APP or its copper-binding site peptide, even after overnight incubation.

In conclusion, our finding of an enzyme-like activity of APP in the reduction of copper(II) to copper(I) is not solely based on bathocuproine data and does not depend on copper(II)-bathocuproine complex formation.

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than 11,000 years B.P. from Clovis sites was analyzed for total collagen, considered an unreliable material, or have extremely large errors (of 450 to 600 years). The oldest, from Domebo, Oklahoma, were saturated with creek water draining a petroleum oil field [F. C. Leonhardy, *Domebo: A Paleoindian Mammoth Kill in the Prairie Plains* (Contributions of the Museum of the Great Plains, No. 1, Lawton, OK, 1965), pp. 3–9 and 14–26.] The dates for amino acid suites of well-preserved bones have smaller errors and postdate 11,000 years B.P. The Amazonian dates, in contrast, were for large samples of taxonomically identified, spatially plotted seeds of fruits used by humans for food. Seeds are short-lived plant parts and thus lack inherent age, and we tested them (p. 380) for contamination by blind tests of split samples of solids and solutes.

7. R. L. Edwards *et al.*, *Science* **260**, 962 (1979); M. Stuiver and P. Reimer, *Calib User's Guide, Rev. 3.0* (Quaternary Isotope Laboratory, University of Washington, Seattle, 1993); R. E. Taylor *et al.*, *Antiquity* **70**, 515, 1996. The calibration curve for the late Pleistocene is tentative, because a secure sequence of radiocarbon dated tree-rings is not yet available.
8. L. Nuñez *et al.* [*Lat. Am. Antiq.* **5**, 99 (1994)] attribute dates earlier than 11,000 years B.P. from Quereo, Chile, to contamination, and the Argentine pre–11,000 years B.P. date is discordant with the numerous associated later dates B.P., [H. G. Nami and T. Nakamura, *Ans. Inst. Pat. Ser. Cien. Hum.* **23**, 125 (1995)].
9. A. Prous writes [*J. Soc. Am.* **77**, 77 (1991)], "The climate is hot, almost semiarid, with . . . precipitation around 700 mm a year." In contrast, the rainfall in a 50-kilometer radius around Monte Alegre ranges from 2000 to 3000 millemeters a year, more than three to four times that at Boqueta.

Letters to the Editor

Letters may be submitted by e-mail (at science_letters@aaas.org), fax (202-789-4669), or regular mail (*Science*, 1200 New York Avenue, NW, Washington, DC 20005, USA). Letters are not routinely acknowledged. Full addresses, signatures, and daytime phone numbers should be included. Letters should be brief (300 words or less) and may be edited for reasons of clarity or space. They may appear in print and/or on the World Wide Web. Letter writers are not consulted before publication.