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 sigmas overlap at one sigma (Fig. 1) and average 10,970 ± 250. Only two are in excess of 11,000 yr B.P. 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. Shuiver, Antiquity 70, 515 (1996)].
4. The suite of 14C dates from the important Brazilian Paleoindian site studied by Roosevelt et al. (1) does not support their conclusion that Clovis (2) and Amazonian Paleoindians were contemporaneous. Roosevelt et al. assigned 37 14C dates to cultural periods (Fig. 1) that they established independently by means of changes in stratigraphy and lithic raw material [table 3 in (1)]. Multiple dates are available for each of the cultural periods (except the Middle period, which lacks dates), and it is possible to test the hypothesis that dates from a given cultural period are statistically the same (3, 4). This hypothesis cannot be rejected at the α = 0.05 level of significance for any except the Initial period (Table 1). For these periods, weighted means of the 14C dates are estimates of their true 14C ages (Fig. 1) (3).
5. By plotting the seed radiocarbon ages in order of decreasing age and indexed as to cultural period (1), the following 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 sigmas overlap at one sigma (Fig. 1) and average 10,970 ± 250. Only two are in excess of 11,000 yr B.P. and therefore within the Clovis age range, and only one of these is from the base of stratum 17.
6. 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.
7. 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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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>
<thead>
<tr>
<th>Group</th>
<th>T*</th>
<th>DF</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial period</td>
<td>38.53</td>
<td>11</td>
<td>0.00006</td>
</tr>
<tr>
<td>Initial period*</td>
<td>16.49</td>
<td>10</td>
<td>0.086</td>
</tr>
<tr>
<td>Initial/Early period</td>
<td>3.50</td>
<td>7</td>
<td>0.835</td>
</tr>
<tr>
<td>Early period</td>
<td>15.71</td>
<td>13</td>
<td>0.265</td>
</tr>
<tr>
<td>Late period</td>
<td>1.91</td>
<td>2</td>
<td>0.385</td>
</tr>
<tr>
<td>All AMS dates</td>
<td>33.21</td>
<td>29</td>
<td>0.269</td>
</tr>
</tbody>
</table>

*Excluding date 1.
period), are statistically indistinguishable
(Table 1) (5). Weighted mean ages for the
dates are calculated according to equations (6) and (8) of (3). Exclusion of conventional dates from the
Initial results in a mean age of 10,420 ± 41 yr B.P.

17 May 1996; accepted 10 January 1997

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 bifacial 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
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 same two 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), Ven-
ezuela (4), Guyana (5), and southern Brasil
(6). Points with comparable shoulder and
stem configuration are also found in Peru and
Ecuador (for example, Paiajen and El Inga
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 prece-
ramic Vinitu phase assemblages along the Rio
Parana. In light of pedological context and
comparative relations with dated assemblages,
Chmyz initially estimated their age at be-
tween 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 Vinitu and
later mid-Holocene Pirajuí 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 radiocar-
don 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 Calebra site on the
Orinoco River were stratified above an earlier
(though still Holocene) preceramic compo-
nent (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, com-
parable to that described by Prous 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. Meggers (13)
argued that the lowland tropics must have
great time depth to allow for the linguistic
diversification notable in the area. Finally,
particular decomposition of the shelter’s “fri-
able sandstone” roof and back wall, coupled
with high rates of tropical weathering, argue

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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 Ushinas Hidrelaticas de Rosana e Taquaruçu” (CESP, Sao Paulo, Brasil, 1984).

Response: Haynes and Reanier analyze the Monte Alegre dates (1) by criteria that Clovis dates (2) cannot fulfill. The 1000-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 Monte Alegre with North American sites 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 coccsid 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. Dusts 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 through 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 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). Haynes 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 dendrochronological 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 14C 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 14C 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 a supposed lack of stems, but these are present [figures 6A and
The paucity of artifacts from the two prece-
monic components at the Provincial site makes it
difficult to establish good correlation with other
South American preceramic phases.

Barse cites the Casitas and Canaima as-
semblages 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 radio-
carbon dates. In the case of the Colombian
sites, the excavator documents a majority of
Pleistocene dates for the points (15), not pri-
marily 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 Minnisinik.

Finally, Barse’s assertion, following Betty
Meggars (16), that the possibility of early
forager occupations in tropical rainforests
has been questioned for southeastern Asia,
but not for Amazonia, conflicts with the liter-
ature (17, 18). A recent synthesis con-
cludes, “humans have subsisted in tropical
rain forest independently of cultivated
foods only in Malaysia” (18, p. 281).

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Emilio Goeldi, Belém, Brazil 66000; James
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Botanical Garden, Bronx, NY 10458–5126,
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3. R. E. Taylor, Radiocarbon Dating; An Archaeological
4. A. Henderson, The Palms of the Amazon (Oxford
J. Terborgh, Five New World Primates (Princeton
Soule and B. A. Wilcox, Eds., Conservation Biol-
Patton, personal communication, 1996; J. Ter-
borgh, personal communication, 1997.
5. S. Bowman, Radiocarbon Dating (Univ. California
58–60. The results of the test of significance on the
dates were as follows*:

<table>
<thead>
<tr>
<th>Group</th>
<th>X^2</th>
<th>df</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial A</td>
<td>1.07</td>
<td>3</td>
<td>0.783</td>
</tr>
<tr>
<td>Initial B</td>
<td>14.56</td>
<td>10</td>
<td>0.149</td>
</tr>
<tr>
<td>Initial period</td>
<td>48.83</td>
<td>11</td>
<td>0.000001</td>
</tr>
<tr>
<td>Initial</td>
<td>22.50</td>
<td>10</td>
<td>0.013</td>
</tr>
<tr>
<td>Initial/Early</td>
<td>7.13</td>
<td>7</td>
<td>0.416</td>
</tr>
<tr>
<td>Early period</td>
<td>30.51</td>
<td>13</td>
<td>0.004</td>
</tr>
<tr>
<td>Late period</td>
<td>4.81</td>
<td>2</td>
<td>0.100</td>
</tr>
<tr>
<td>All AMS dates</td>
<td>66.26</td>
<td>29</td>
<td>0.0000097</td>
</tr>
</tbody>
</table>

*Tests 1 and 2 use all relevant radiocarbon determi-
nations; tests 3 through 8 parallel the groupings in
table 1 of the comment by Reanier. \( ^{1}\)With earliest date excluded.

7. The 11,680 ± 450 yr B.P. Barse’s date on an inadequ-
te sample. The Lehner 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 and from non-cultural 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-precision dates are two charcoal
samples, statistically indistinguishable from the
Amazono-
nian high-precision initial dates when 100 years for inherent age is subtracted (16).

9. J. B. Bird et al., Travels and Archaeology in South
China (Univ. Iowa Press, Iowa City, IA, 1988), p. 287;
M. Massone, An. Inst. Patagonia 17, 47 (1987); W.

10. C. V. Haynes et al., Ice Age Hunters of the Rock-
es, D. J. Stanford and J. S. Day, Eds. (Denver Museum
of Natural History and Univ. Colorado Press, Newot,

pologie 90, 257 (1986)] describes limaces and finely
flaked triangular bifacial points and bifacial reflec-
tions only in the lower levels of the site (1991, pp.
83–97, figure 8).

12. P. I. Schmitz [J. World Prehist. 1, 53 (1987)] de-
scribes the late Pleistocene Uruguayan phase (p. 88).
13. The most diagnostic artifacts are various forms of
...stemmed bifacial projectile points...pro-
duced from chalcedony and exhibiting pressure
reach”. See also T. Dillehay et al. [ibid. 6, 145 (1992)]
on the points and limaces from Brazil (pp. 168–167).

that his points are finely pressure-flaked and not
and 42, plates 3G and 6A.

15. C. E. Lopez [A. Oyuela-Caycedo and J. S. Ray-
mond, Eds., Advances in the Archaeology of the New
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.

17. R. Bailey et al., Ann. Anthrop. 91, 59 (1989); R. Bailey

(1993).

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

8 July 1996; accepted 7 March 1997

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

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Science 275 (5308), 1948-1952
DOI: 10.1126/science.275.5308.1948