On the Pleistocene settlement of South America

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Australia and the Americas provide the two case-studies of the late human settlement of a continent by, it seems, Homo sapiens sapiens. *At one time the corollaries of first occupation of the Americas, at perhaps 12,000 b.p., were a similarly late settlement of Australia and the need for a land-bridge across the Bering Straits. But now the pattern of occupation in New Guinea and its offshore islands proves that a long sea-crossing was made there before about 40,000 b.p. Here an Australian researcher looks across the Pacific to the evidence that has been offered for a Pleistocene occupation in south America, of a date comparable with that in Sahul.*

In recent years the debate concerning the first settlement of the Americas (cf. Bray 1988; Dillehay & Collins 1988; Dillehay 1988) has been fuelled by several important discoveries in South America. The continuing lack of Pleistocene evidence of a pre-Clovis human presence in North America is perplexing. In this paper I shall briefly review the strength of the South American main body of evidence, and then examine a hypothesis addressing the North American dilemma in this debate.

Human occupation traces are reportedly between 13,000 and 16,000 years old at Sítio do Meio, Lagoa Santa, Alice Boër and Lapa Vermelha in Brazil, and at Muaco and Taïma-Taïma in Venezuela (for references see Guidon & Delibrias 1985; Gruhn 1988; mindful of Dillehay's (1988: 97) admonitions in this journal, I shall keep my references to published commentary very brief). Older finds have been reported from Pedra Furada and Caldeirão do Rodrigues in Brazil, Pikimachay in Peru, and from Monte Verde in Chile. By far the most extensive proof of American Pleistocene settlement has been provided by Guidon and I suggest that an economical way of assessing the principal issues of the 'Palaeoindian debate' (Bray 1988) is by focusing on the key sites, i.e. those that produced the earliest dates.

Archaeological work at São Raimundo Nonato

The Archaeological Mission of Piauí (northeastern Brazil) is located in São Raimundo Nonato, a remote town of some 6000 inhabitants in a now drought-stricken region (FIGURE 1). Jointly funded by French and Brazilian agencies, the mission owes both its existence and success entirely to its dynamic founder and Director, Prof. Niède Guidon, a pupil of the late Leroi-Gourhan. Among her achievements is the creation of the state's first national park, the Parque Nacional da Serra da Capivara, north of the town. This 100,000-ha area of sandstone escarpments includes hundreds of rock art and archaeological sites. No research had been conducted in the region until 1970, when Guidon began a survey of rock art. Realizing the need to establish an archaeological context for the numerous sites (275 are now recorded) she commenced excavations in 1978, and within nine years excavated an estimated 1360 cubic metres of sediment, often at extremely remote sites. With her international team of specialists she has assembled a wealth of data about the area's rock art, prehistory, geology, topography, paleontology and social anthropology. She is assisted by a permanent staff of several researchers, plus large teams of students as well as of local labourers.

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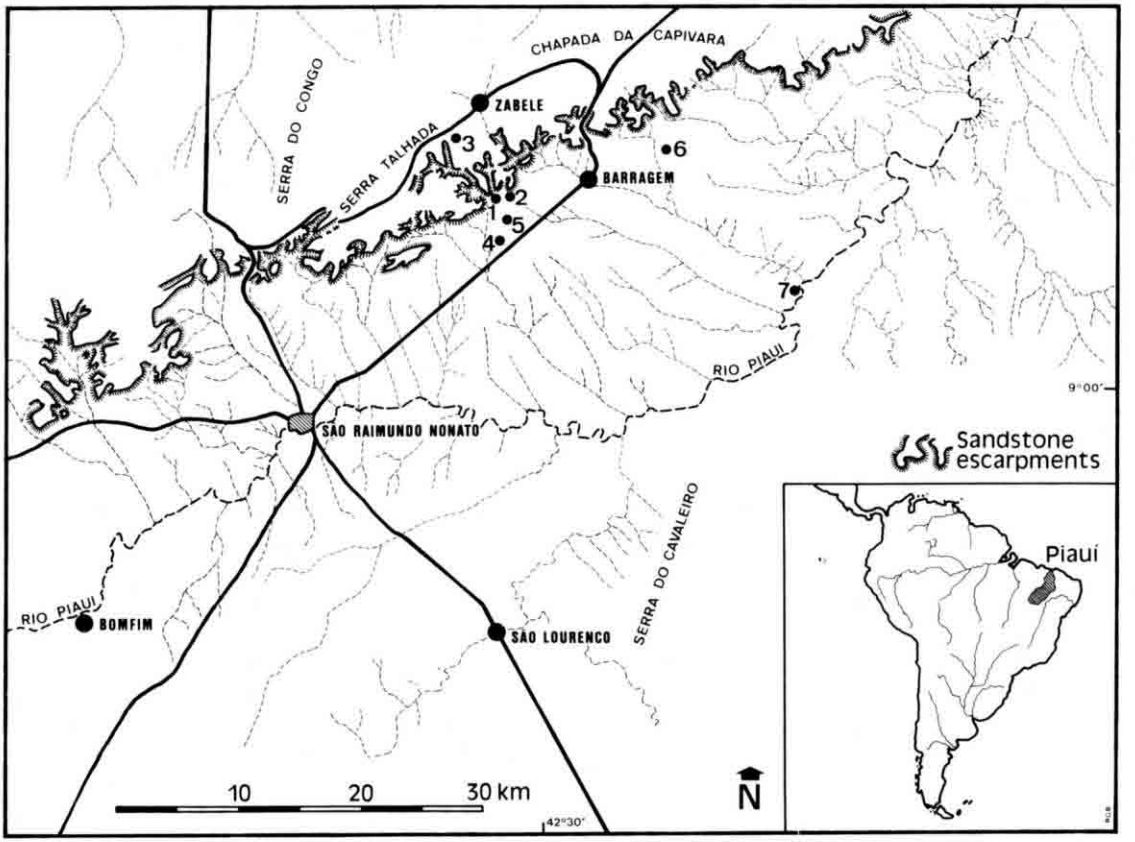

FIGURE 1. *The region of São Raimundo Nonato, in southern Piauí, Brazil. Sites mentioned in the text are:*

1 *Toca do Boqueirão do Sítio da Pedra Furada*
2 *Toca do Sítio do Meio*
3 *Toca do Baixão do Perna I*
4 *Toca de Cima dos Pilão*
5 *Toca do Buraco do Sansão*
6 *Toca do Serrote do Artur*
7 *Caiçaras*

The first of a series of papers by Guidon and her co-workers dealt largely with the rock art of the area (e.g. Guidon 1975a; 1975b), but in 1981 the results of an extensive excavation campaign began to appear, with the publication of radiocarbon dates from eleven rockshelters. Already at that time, Pleistocene dates were available from Toca do Sítio do Meio (four dates from 12,200 to 14,300 b.p.), Toca do Boqueirão do Sítio da Pedra Furada (about 17,000 and 25,000 b.p.) and Toca do Caldeirão do Rodrigues (18,600±600 years b.p.). Early Holocene dates were reported from another five sites, and some 15,000 rock painting motifs had been recorded in about 200 shelters (Guidon 1981).

But these and other reports (Guidon 1984a; 1984b; 1985; 1986; Guidon & Andreatta 1980; Silva Rocha 1984) received scant attention outside of South America, although some (e.g. Maranca's 1983 attempt to create a site taxonomy) are of universal applicability. It was not until the publication of two recent papers (Guidon & Delibrias 1985; 1986) that the project began attracting wider international attention.

The 1986 paper provides a series of 17 radiocarbon dates for Pedra Furada, ranging up to 32,160±1000 years b.p., but still none from Layer A, which contains the lowest occupation traces. The first date from that layer only became available in October 1987, when charcoal from a hearth was found to be more than 39,200 years old (Beta-22858, count rate statistically indistinguishable from background). Since then, a date of about 42,000 b.p. has also been secured (Guidon, pers. comm. August 1988). Thus the most recent work has pushed back even further into the Pleistocene, and the crucial issue now is the reliability of this evidence.

Pedra Furada

Few archaeological sites are quite so clear cut and perfect and I am concerned that several factors weakening the postulates for Guidon's principal site, Toca do Boqueirão do Sítio da Pedra Furada, are not addressed in the publications. The site lies at the base of a huge overhang, the concavity of which soars up to a height of some 40 m, projecting 18 m from the shelter's deepest part. The huge shelter is about 40 m wide, and is located at the foot of a line of vertical sandstone buttresses of about 100 m height, the southern escarpment of Serra Talhada. On either side of it is a vertical chute extending the full height of the cliff, providing drainage paths from the plateau above (FIGURE 2). The upper facies of the sandstone formation is a conglomerate rich in cobbles of quartz, which erode and are swept down the chutes, each one experiencing a free fall of between 30 and 50 m. Huge deposits of these well-rounded cobbles have accumulated over tens of millennia, containing numerous impact-fractured specimens. Among them are many flakes with good cutting edges, and other items reminiscent of tool types. While this abundance of silica would have provided a rich source of raw material for early inhabitants of the site, it does pose a vexatious problem in the interpretation of the lithic assemblage recovered from the excavation.

Moreover, interpretation of the site's stratigraphy is not facilitated by the burrows of a local rodent species that penetrate over 3 m

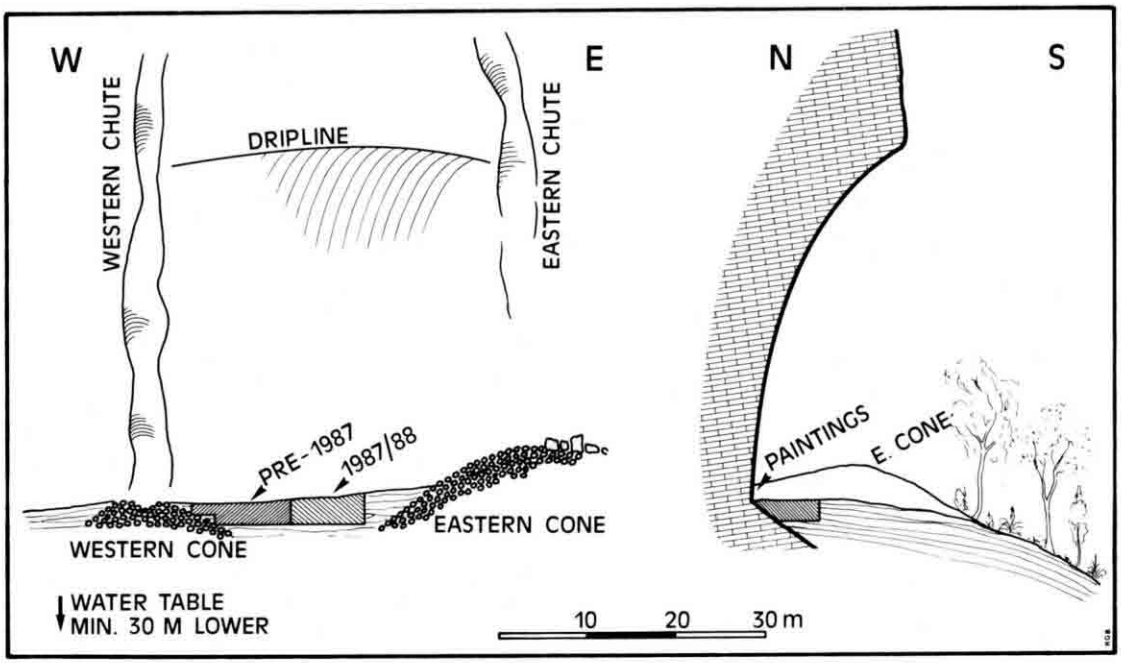

FIGURE 2. *Toca do Boqueirão do Sítio da Pedra Furada, schematic depiction of features mentioned in the text. The scale is approximate only. Locations of the pre-1987 excavations and the 1987/88 excavation are shown.*

deep into the deposit, consisting of circular tunnels of 10–15 cm diameter. The upper metre or so of the deposit is riddled with termite galleries. The lower strata are subjected to episodic waterlogging whenever channelled surface water cascades down on either side of the rockshelter. And finally, the properties of the sediment deposit are not conducive to the survival of osteal remains (pH = 4.9–5.7, combined with waterlogging).

Dating of Pedra Furada

Despite these significant problems with the interpretation of the site, Guidon's critics have concentrated on her sequence of charcoal layers, which does suggest that Dillehay's (1988: 97) disparaging comments about 'scholars from other disciplines' could be more effectively directed against armchair archaeologists. Guidon's interpretation of the site derives its main strength precisely from the series of radiocarbon dates. It is free from inversion, indicating that the post-depositional disturbances described above did not have as great an effect on the site's stratigraphical integrity as one could have feared. According to one objection, the groundwater in the area might be contaminated with 'older carbon' derived from subterranean coal deposits. I presume what is really meant by this argument is that phreatically mobilized coal dust has been deposited in the pores of the charcoal. Perhaps we could also be enlightened as to the quantity of coal required to be so deposited to increase the apparent age of charcoal by several hundred per cent; or why none of the specialists handling the samples noticed the postulated contamination; or why the samples still produced stratigraphically consistent dates; and how the coal travelled to the site, which is at least 30 or 40 m above the present watertable? Any moisture at the site, after all, is derived from the surface run-off from the plateau above, which has certainly not been in contact with a coal deposit. I observed no coal dust at the site, nor am I aware of the existence of coal deposits in the area.

A more reasonable objection, suggesting a natural origin of the charcoal, is particularly ironic, considering the tendency of many archaeologists in other continents (e.g. Australia) automatically to assume an anthropic involvement whenever they locate charcoal in a cave or rockshelter. The present vegetation of southern Piauí burns exceptionally poorly, and bush fires are a rare phenomenon in comparison to semi-arid environments elsewhere. However, the vegetation may have been significantly different during the late Pleistocene, and perhaps more fire prone. But this could not account for the massive charcoal strata characterizing the stratigraphy (Guidon & Delibrias 1986: Section 1) or for the structured hearths that occur even in the lower strata of Pedra Furada, as well as in several other shelters in the area. Moreover, I located clear evidence that charcoal was produced *in situ*, and could not have been introduced and deposited by water or other means. The sloping rock floor exposed by the excavation of Pedra Furada is of 'reddish yellow' colour range (refer Munsell 7.5YR chart), containing iron compounds in its surface layer. Where hearths have extended to this bedrock surface it has been discoloured to 7.5YR 4/6, or a similar value. I have observed such fire-caused discolouration of iron patinae at numerous sites (for a recent discussion of the relevant geochemical processes, see Bednarik 1987a) and consider that it is perhaps attributable to dehydration of goethite to haematite, which occurs at 130°C and even lower temperatures, depending on particle size and crystalline state. Irrespective of the actual conversion process responsible for the discolouration, clear evidence is provided at Pedra Furada that combustion occurred within the shelter, and thus at least some of the charcoal is not extraneous.

Dating of the rock art

The question of the age of the rock art at Pedra Furada remains unresolved, however. It has been proposed that a rock fragment found in a 17,000±400-year-old hearth bears two painted lines of red pigment (Guidon & Delibrias 1986), but several arguments would render the implied minimum dating of the rock art invalid. Firstly, episodic waterlogging of the ground is causing capillary moisture in the sandstone which deposits salts subcutaneously, 10–20 mm beneath the surface. Subflorescence is effecting blistering and lamellar exfoliation. Several square metres of painted rock surface have become detached through this fairly rapid spalling process, which is responsible for the continuing changes to the cross-sectional con-

tour of the shelter. Because the exfoliation does not occur below ground level, the rate at which the wall retreats can be estimated by the angle of the rock slope below ground relative to the age of the sediment strata. According to this rough but valid estimate, it would not be reasonable to attribute an age of more than a few millennia to the extant rock art.

Admittedly, this would not exclude the possibility that paintings also existed there during the Pleistocene, on a rock face that has long since fallen victim to exfoliation. But there are other doubts concerning the fragment bearing two red lines. Being a solitary specimen, it may have been displaced by rodent burrowing or termite activity, even if the bulk of the deposit has apparently remained stratigraphically sound. Furthermore, lines of red pigment need not be of a painting; there are numerous red pigment lines at the site which are not painted. Various mud-daubing insect species use the shelter and once their nest structures have disintegrated, interstitially lodged iron compounds remain on the rock. Microscopically these traces are indistinguishable from weathered paintings, their colours are as vivid and intense as those of paintings, and they often form patterns resembling paintings. One species builds nests divided into small parallel chambers, and the pigment imprints left by them are of oval shape with prominent internal barring – a motif often found in rock art.

The most important objection to the dating of rock art at Pedra Furada, however, concerns the ability of painted pigment to survive below ground level. In the very few known instances of such survival it was attributable to exceptional soil conditions, such as a very high soil pH (as in volcanic deposits; cf. Cave of One-Hundred Hands, Utah; Steinbring 1987: 9), or to extraordinarily dry conditions (as in southern Peru). It is highly unlikely that superficially applied iron compounds on a rock fragment in occasionally waterlogged, low-pH strata would remain *in situ* for 17,000 years.

The dating of a painting panel at another of Guidon's sites, Toca do Baixão do Perna I, is considerably more persuasive. This panel, one of the very few known in the Americas to have survived below ground level, is over 3 m long. It consists of almost 100 figurative motifs and extends up to 1.2 m below ground level. The covering sediment consists almost entirely of the very coarse quartz sand exfoliating from the shelter wall above and has remained extremely dry and well ventilated. As a result of these unusual conditions the pigment has survived reasonably well. The art panel reaches close to the upper limit of a massive layer of ash and chunky charcoal pieces. This horizon is up to 40 cm thick near the shelter wall, and includes an artificially scooped-out hearth pit containing several cracked, reddened and fire-blackened cooking stones among tightly packed charcoal. This very substantial occupation layer has produced a date of 9540±170 years b.p. (GIF-5414; Guidon 1981), signifying a period of intensive use of the site which almost certainly coincides with the production of at least some of the rock art. Not only is this the oldest *reliably* dated rock art in the Americas, it is perhaps also the *most* reliably dated, at the present time.

I should add, however, that Pleistocene art does in my view occur in Guidon's study area, but it consists of petroglyphs. Among the 14 art sites I have examined there, Caiçaras and Riacho Santana (older phase) are clear contenders for a Pleistocene antiquity. They feature completely repatinated, non-iconic petroglyphs. Motifs include circles, arcs, dissected circles, radial designs, parallel lines, zigzags, convergent line motifs, geometric outlines with internal barring, and various lattices and mazes. This repertoire is typical of prefigurative art in other continents (Bednarik 1984a; 1984b; 1986; 1987b; 1987c; 1988a; 1988b).

The lithics

The stratigraphy of Pedra Furada is hemmed in by the two cones of quartz cobbles on either side and it is likely that some of the lithic items from the excavations had not been deposited by human agency. While the upper occupation horizons contained many implements of exotic sedimentary silicas, the lithics of the lower strata are mostly of quartz, and probably originate from the local cobble deposits. The cleavage characteristics of quartz render a discrimination between naturally and artificially fractured specimens notoriously difficult, and while it is only to be expected that any early inhabitants would have made most extensive use of the local silica source, even to the point of excluding other materials, it must be conceded that the presence of fractured and apparently

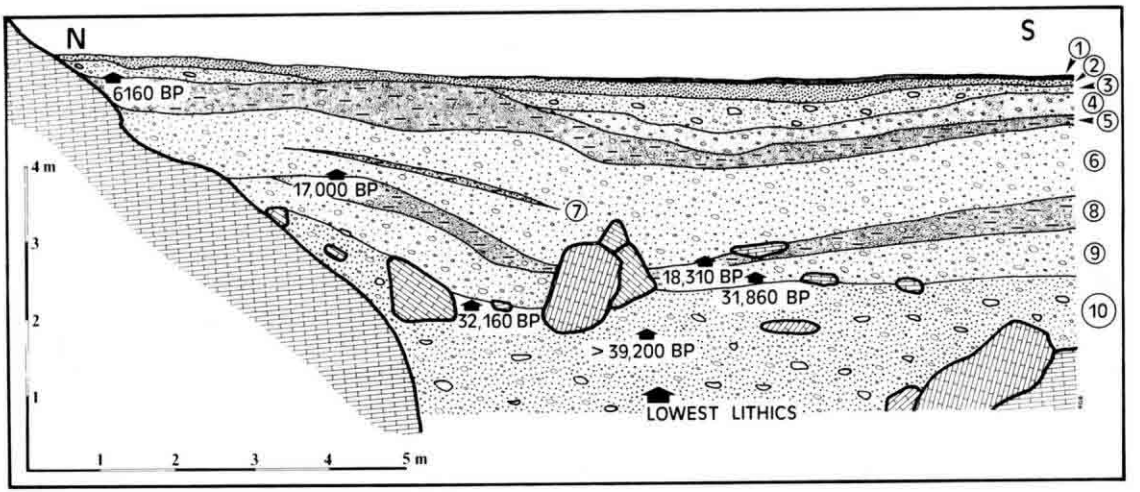

FIGURE 3. *Toca do Boqueirão do Sítio da Pedra Furada. North-south section through sediments, showing the locations of several recently obtained radiocarbon dates and of the lowest lithic artefacts found in 1987/88.*

The radiocarbon sample numbers are, in order of increasing age:
GIF-5863, GIF-5397, Beta-22086, Beta-22085, GIF-6653, Beta-22858.

Key to sediment strata:
Layer 1 Fine sand, silt, small gravel, charcoal, organic remains.
Layer 2 Medium sand, silt, termite structures.
Layer 3 Pebbles with medium gravel, medium sand.
Layer 4 Fine sand, silt, clay, small gravel, termite structures.
Layer 5 Fine sand, small and medium gravel, silt, ash, charcoal.
Layer 6 Medium and fine sand, small and medium gravel.
Layer 7 Medium sand, small gravel, fine sand, ash, charcoal.
Layer 8 Medium and fine sand, silt, small and medium gravel, ash, charcoal.
Layer 9 Medium and coarse sand, small and medium gravel.
Layer 10 Pebbles with medium gravel, small gravel, medium and coarse sand, large clasts and blocks.
(After Niède Guidon.)

trimmed quartz would, by itself, not provide adequate evidence of a human occupation.

I doubt that microscopic use wear study of the archaic lithics from Pedra Furada would resolve the contentious issue of their artefact status, and a taxonomic analysis would perhaps only conjure up the uncertainties of discriminating between variables/characteristics clusters that are attributable to natural patterning, and those due to anthropic factors. Most of the many hundreds of lithics from the lower levels resemble naturally fractured quartz; they may, or may not, be manuports; have been utilized; or have been modified. The most effective way of examining the question seemed to be to select the few 'most convincing' items from the lower horizons and to subject them to a thorough edge examination at various magnifications. Edge wear of microscopic scaling was observed, some of which was characteristic of human use rather than natural wear (the latter is more random and always related to specimen shape or edge contour). Several specimens from the lower strata were found to be heavily worn on working edges or points, while being almost free of 'incidental wear'.

Fabio Parenti, who excavated the eastern part of the Pedra Furada deposit in 1987 and 1988 (FIGURE 2), undertook a morphological study of 1000 naturally broken quartz cobbles from the

cone-shaped deposit. He found that very few had more than two flake scars, and only one specimen showed 'pseudo-retouch' (Parenti, pers. comm. August 1988). The eastern part of the deposit proved to be better stratified than the western half. It contained structural hearths, charcoal and lithics still half a metre below the layer (FIGURE 3) that has recently yielded a date of >39,200 years b.p. (Guidon, pers. comm. March 1988). From Parenti's drawings it is clear that the lithics from the lowest occupation stratum still include several items with distinct retouch, a skilfully produced blade and a core bearing about a dozen flake scars. Parenti describes four of the depicted artefacts as having been made from quartzite rather than quartz. This identification establishes the utilization of extraneous raw material during the earliest phase of occupation at Pedra Furada.

Other sites in southern Piauí

Pedra Furada's authenticity as an early man site does not, however, hinge upon that of the lithics, nor does it entirely depend on the charcoal strata and hearths. While the site may not be altogether ideal, Guidon has superior ones in her study area. In fact just 2 km to the east is the much smaller shelter Toca do Sítio do Meio, where she has already probed deep into the past. Charcoal from hearths has produced dates ranging up to about 14,300±400 years b.p., again being in sequence, and associated with cobble tools. At only 2 m depth she had to postpone further excavation due to several adjacent huge boulders weighing many tons, rendering further excavation unsafe. The apparent absence of water action and animal burrows and the excellent stratigraphy promise that this site could eclipse Pedra Furada in importance – if Guidon were to succeed with her plans of removing the surface boulders.

Both these sites are sandstone shelters, as are most others so far excavated in the region. The many limestone caves and shelters in Guidon's research area are often located at some altitude above the surrounding plain which would minimize the possibility of fluvial disturbance; their high-pH soils would provide osteal finds, and any non-calcareous stone found in them would necessarily have to have been introduced. Two excavations have already been conducted in limestone caves. At Toca de Cima dos Pilão, the presence of an upper industry identical to that of the upper levels of Pedra Furada (the Serra Talhada industry) has been established. Archaic implements appeared already at 60 cm depth, but of these only a very few have so far been recovered, and no charcoal has been detected. These tools are of multicoloured cherts and well made, thick, with steep-angled working edges and striking platforms (FIGURE 4). My observations at several sites suggest that such implements are far more representative of the archaic industries than the quartz cobble tools in the sandstone shelters.

A test pit 50 m into an extensive limestone cave, Toca do Serrote do Artur, where megafaunal remains had been located on the surface of the sediment (first *Camelus* find in the region; I have located large quantities of megafaunal remains in a nearby, 100-m deep vertical shaft, Toca do Buraco do Sansão), produced a thick chert tool closely resembling the first specimen in FIGURE 4, and after breaking through a travertine seal in the deposit, Guidon found three bone points beneath it.

Numerous lithics of archaic typology have come to light as random finds. For example, surface surveys at the two extremely old petroglyph sites Riacho Santana and Caiçaras produced several large, steeply trimmed implements, again similar to those at Cima dos Pilão. During my stay, some labourers encountered large stone tools while digging a deep well in clay, and delivered two large chopping tools to the Mission.

Discussion

The opponents of Guidon's premise of a Pleistocene settlement of South America lack an appreciation of the wealth of archaeological evidence she has at her disposal, and of the large database she has assembled with her multidisciplinary staff over some 18 years. They might care to consider the recent evidence from Monte Verde, west of Puerto Montt, south-central Chile. A minimum antiquity of 13,000 years b.p. had earlier been established there for human presence (Dillehay 1981; 1984), but more recently Dillehay has secured 11 stone tools from a level dated to 33,000 years b.p. via a hearth (Dillehay & Collins 1988).

Generally, evidence of archaic stone tool

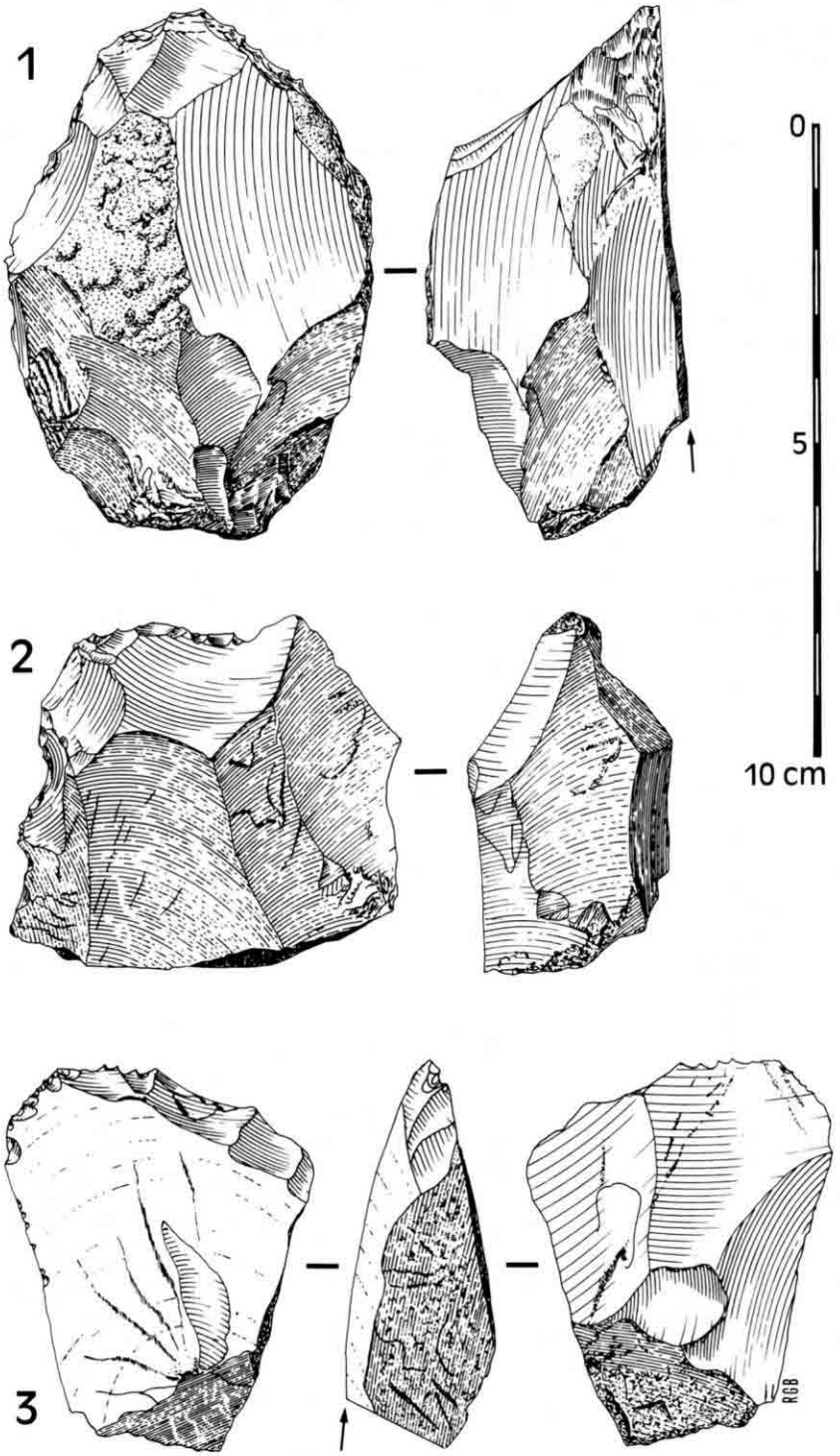

FIGURE 4. *Three lithic implements of multicoloured chert, from the lower deposit of the limestone cave Toca de Cima dos Pilão, in which no charcoal was found.*

industries is far more extensive in South America than the literature would suggest, although typological archaicness is not necessarily proof for a great age of implements. Elsewhere I shall discuss my observations at many sites in southern Peru and Bolivia, where fluted bifacial projectile points are preceded by massive quantities of 'Palaeoindian lithics' – which are indeed artefacts, in contrast to the 'naturefacts' I have seen at North American sites such as Calico Hills, California.

This raises the key issue in the entire debate: the apparent absence of a pre-Clovis occupation in North America. My explanation of this apparent hiatus (Bednarik 1987d) is best illustrated by comparing the similarities between America and Australia. It is generally agreed that both regions must have been settled from the north, yet no trace has been found of the first settlers in either North America or northern Australia. In northern Australia one finds ground-edge axes at up to 23,000 years b.p., which have no counterparts in the probable catchment area of the first colonizers, Indonesia; while in North America the earliest human settlers used elaborate projectile points, which have no counterparts in the final Pleistocene of eastern Siberia. When and where did such innovations then evolve? Since the initial populations were probably very small in both cases, can they be assumed to have produced such dramatic technological innovations within a few centuries, simply because they had entered a new continent? It seems more plausible that a small, incipient population would have experienced the greatest difficulties maintaining the technological level of its parent culture; it far more likely resorted to subsistence technology, to improvising.

Australia does provide an answer, because here we know that the south of the continent had been settled very much earlier. Hundreds of proven or probable Pleistocene sites are known in Australia, and all of those exceeding 24,000 years in age are from a comparatively small area: the southern coastal region from Perth to Sydney, and the Murray–Darling drainage system, also in the south. In the Americas, all the reliable occupation dates prior to 12,000 b.p. come from South America. Both Australia and America appear to have been settled by people from eastern Asia, and, one must assume on the basis of current evidence, at about the same time: between 50,000 and 40,000 years ago, i.e. by an essentially Middle Palaeolithic people. In Australia, the generally favoured of three hypotheses of the initial settlement pattern (Flood 1983: 77–9) is that of Bowdler (1977), according to which the first colonizers moved south along the coasts of the continent, and then expanded their territory by following major river and lake systems. Most importantly, this would have occurred at a time when the sea level was considerably lower than it is today, therefore little, if any, of the evidence would have survived. I have suggested that the Americas were initially settled in the same pattern: by skirting the northern part of this new world and following the now submerged coastal zones. In both America and Australia, the hinterland of the northern half may not have attracted much settlement in the first 20,000 or 30,000 years, and when it was finally occupied it would have been by a people who had evolved indigenous technologies – industries that differed significantly from those of their Asian origins.

Recently Gruhn (1988) employed Bowdler's theory in a different but relevant context. To support the hypothesis that language diversification in America is greater in an area that has been occupied longer, she suggested that the greater linguistic diversity in northwestern Australia is attributable to the fact that this is where first landfall occurred in Australia. Gruhn apparently did not realize that the two alternative settlement models, those of Birdsell and Horton, are based on similar points of entry (Flood 1983: figure 6.1), and that Kimberley and Arnhem Land were at that time several hundred kilometres inland, separated from the sea by the now inundated Sahul Shelf. New Guinea, which has produced 40,000-year-old waisted axes (Groube *et al.* 1986), was connected to the mainland. Indeed, Gruhn's hypothesis is negated by the Australian evidence: the early occupation dates are all from the south of the continent, and the language diversification in the Kimberley is more likely to reflect factors other than duration of occupation (e.g. greater population density, or contact with Southeast Asia).

Nevertheless, the concept of an initially coastal occupation presents a valid model to satisfactorily explain the evidence as it currently stands. In both America and Australia, it

seems entirely plausible that first entry was by small numbers of people who were adapted to coastal economies. Hominids of the Lower and Middle Palaeolithic are generally credited with a penchant for near-coastal, riverine and lacustrine environments. Occupation of the less hospitable regions typically occurred in the Upper Palaeolithic, which is characterized by rising population densities, technological innovations and specialization, among other things. For a people occupying a new continent there may have been little incentive to shed their coastal economy and penetrate the hinterland until such time as coasts and major river courses were settled to capacity. In the case of North America, how much incentive would there have been for a coastal people, slowly expanding along the now submerged western coast, to attempt crossing the continuous high mountain ranges that extend all the way to the Mesoamerican isthmus, goading their southward movement ultimately towards South America?

Prehistory demonstrates time and again that the responses and adaptations of human populations to particular situations and conditions were not random, that they followed consistent patterns often leading to similar responses. Perhaps the behavioural patterns determining the settlement strategies of the first Americans were the same as those apparently characterizing the initial colonization of Australia.

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