



Systematic Pigment Use in the Middle Pleistocene of South-Central Africa

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The Hunters and Gatherers of New Guinea¹

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If humans may be characterized by the balance of their history on earth, then they are a hunter-gatherer species. As a result, scholars who have surveyed or theorized humanity, from Hobbes and Rousseau through Marx and Freud, have felt duty-bound to make at least a passing nod, if not a more lingering genuflection, towards some more or less fanciful notion of the foraging life. In anthropology, with the sweep of human history as its subject matter, hunters and gatherers have featured prominently as an assumed baseline in numerous theories of economic, social, political, and cultural evolution.

Unfortunately, ethnographic information on hunter-gatherer life is limited in proportion to its importance. Hunter-gatherer species we may be, but the record of non-hunter-gatherer societies is infinitely richer than that of foragers. From the 1966 Man the Hunter conference to the present, surveys routinely identify fewer than 100 or so hunter-gatherer groups upon which some ethnographic and/or historical data are available (e.g., Bailey et al. 1989:62–67; Hayden 1981:345, 354–55; Keeley 1988:382–83; Kelly 1995:4–5; Lee 1968:44–48; Murdock 1968:14).

None of these surveys has ever identified New Guinea as home to a hunter-gatherer group—even the recent, authoritative *Cambridge Encyclopedia of Hunters and Gatherers* (Lee and Daly 1999) includes no entry on a New Guinean society—so one might conclude that there are no hunters and gatherers among its 1,000 or so cultures. Certainly, this is the conventional wisdom: introductory textbooks routinely turn to New Guinea for eth-

nographic examples of horticulturalists and agriculturalists but never of hunters and gatherers. Rosman and Rubel (1989:27; see also Ayres 1980:736) are hardly alone in presuming that “the subsistence base for all New Guinea societies is root crop horticulture. There are no societies in New Guinea which only hunt, forage, and collect; every society is dependent to some extent on horticulture.”

In fact, close scrutiny of the New Guinea literature turns up many scattered references to “hunters and gatherers,” and in this article I seek to document that contact-era New Guinea was home to numerous foraging societies. My primary aim, as a Melanesian scholar, is to alert hunter-gatherer specialists to this substantial, largely unexploited body of comparative ethnographic data and to attract their attention to the significant opportunities that still exist for fieldwork in New Guinea among groups that continue to rely predominantly on foraged resources. Along the way, I seek to demonstrate the value of this overlooked ethnographic resource by sketching how it illuminates recent arguments connecting aquatic resources to the development of hunter-gatherer sociocultural complexity. In conclusion, I note that it also buttresses concern about the analytical utility of the concept of a hunter-gatherer “type.”

HUNTERS AND GATHERERS

Any attempt to identify New Guinea’s hunters and gatherers should begin by defining what constitutes a hunter-gatherer group, but this simple task quickly runs aground on a shoal of well-known difficulties (e.g., Barnard 1983:208–10; Ellen 1982:170–76; Harris 1989:16–23; Lee and DeVore 1968:4). According to common definition, hunters and gatherers are those who subsist by gathering wild plants and hunting wild animals, these activities usually being extended to include fishing. Yet these criteria beg a number of questions, not least the issue of what constitutes “wild.” The very presence of consuming humans on a landscape affects food resources, blurring the lines between wild and domesticated and, hence, between hunting and pastoralism and between gathering and cultivation (e.g., Harris 1977, Ingold 1974). It is unclear, moreover, whether “domestication” should mean breeding, nurturing, or both. Is it hunting or pastoralism if people capture and raise (but do not breed) the piglets of a wild sow they have killed, and is it gathering, pastoralism, or cultivation when wild palms are felled and chopped up to encourage “larvae plantations” (e.g., Clastres 1972:160–61, 166–67; Oosterwal 1961:70; Townsend 1969:51; Schwab 1940a:242)?

It is likewise unclear how groups should be classified that are hunters and gatherers in their procurement strategies but cultivators or pastoralists in their consumption patterns—subsisting, for example, by trading wild foods

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to neighbors in return for domesticated crops. And there are significant differences over whether the definition should be nonparametric or parametric. Must a group depend exclusively on foraging—however defined—to be considered a hunter-gatherer society, or is it sufficient that it depends for 50%, 75%, or some other percentage of its subsistence on wild resources (e.g., Barry 1968:208; Keeley 1988:377–78; Lee 1968:41; Murdock 1968:15; Service 1979:3, 13; Whiting 1968:336–37; Yesner 1990:728)? If the latter, should percentage dependence be measured in calories, protein, weight, labor invested, or what—bearing in mind that each of these measures could yield a different classificatory result?

If I have belabored these definitional difficulties, it is only to underscore the impossibility of definitively surveying “the hunters and gatherers of New Guinea.” For pragmatic reasons alone, I have chosen to identify as a hunter-gatherer group any that appears to derive at least 75% of its subsistence calories by procuring wild resources—“wild” meaning resources that living members have not themselves deliberately bred or planted. This decision is unavoidably arbitrary but not entirely so: for space reasons, I have ignored many New Guinea groups that derive 50–74% of their calories from wild resources, groups that the most liberal definitions include as hunter-gatherers.

THE HUNTERS AND GATHERERS OF NEW GUINEA

The most comprehensive sources on the subsistence regimes of New Guinea are the reports by the Human Geography Department of the Australian National University on the agricultural systems of Papua New Guinea. Unfortunately, these cover only the eastern half of the island; no equivalent exists for the western half, the Indonesian province of Irian Jaya. Other subsistence data are contained in an enormous corpus of published and unpublished ethnographic, missionary, and administrative writings, in particular the sections of early Australian and Dutch patrol reports on native subsistence.

In addition to the usual difficulties of interpreting these historical materials, several particular problems complicate the identification of New Guinea's hunters and gatherers. Although numerous lowland groups depend on sago for their staple, the literature often fails to specify whether the palms exploited are wild, planted, or both. Where the planting of sago is mentioned, it is a rare report that estimates in even rough terms the ratio of planted to wild palms and a rarer one yet that surveys variations in this ratio. (In several societies, some villages seem to have depended wholly on wild palms while others practiced some sago planting.) Caution must also be exercised with regard to claims that a society depended wholly on wild sago: sago planting is usually so casual and undemanding that, on brief visits, observers can easily overlook its presence.

The effects of Western contact pose special difficulties for evaluating the state of contact-era subsistence patterns. At an early point in New Guinea history, administrative and missionary agents began to pressure local

people into greater use of domesticated resources. Other contact-related developments inclined native people to accept them. Following pacification, and often under administrative pressure, for example, numerous groups abandoned their hilltop and swampland settlements and migrated to lower or firmer ground, often consolidating in large villages along coastlines, river banks, or newly constructed roads. By extending distances between settlements and traditional foraging reserves and by increasing population pressure, however, these moves enhanced the attractions of domestication (e.g., *Report* 1947:83, 129; cf. Ulijaszek and Poraituk 1983: 581–82; Dye and Dye Bakker 1991:2 n.2; Haberland and Seyfarth 1974:236, 241–42). The scale of such changes is often difficult to judge, but at contact most of New Guinea's hunter-gatherers probably depended to a significantly greater extent on foraging than they did subsequently.

These difficulties notwithstanding, it is possible to identify a large number of contact-era New Guinea hunter-gatherer groups. Table 1 and figure 1 catalogue those I have been able to identify with some confidence. Some 10–20 societies seem to have been almost entirely dependent on wild foods; another score or so derived at least 90% of their food by foraging, and a further score probably obtained 75–90% of their food in this way. These are conservative figures: if the ethnography of contact-era New Guinea—in particular, the prevalence of sago planting—were better known, table 1 probably would include as many as 100 societies.²

Table 1 is organized by the approximate percentage of their subsistence calories these foragers procured from wild resources and by three distinct subsistence strategies that, it transpires, they pursued. Every group depended for its main carbohydrate source on the starch of the wild sago palm (*Metroxylon* sp.). In its natural state, the sago palm grows in shallow freshwater swamps, taking 10–15 years to mature and reaching heights of 30–50 feet (Barrau 1958:151; Flach 1983:5; Ruddle et al. 1978: 5–10). The palm is felled shortly before maturity, the pith is hacked out and leached to extract its starch, and the dried flour is then stored—often for months—for future consumption (Ruddle et al. 1978:11–41). Yields from wild palms are typically less than from their cultivated congeners, but wild *Metroxylon* is nevertheless a productive means of provisioning a community. Hard data are scarce, but five to ten harvestable palms per hectare of stand per year appears to be a typical yield, requiring around 150 work hours to produce a million calories (pp. 61–67). Calories aside, however, sago starch is nutrient-poor, containing negligible fat and less than 0.3% of pro-

2. Major areas containing other possible foraging groups include the Upper Sepik (e.g., the Abau, Left May groups, May River Iwam, and Sepik Iwam), the West Sepik, north of the Sepik River (e.g., the Ak, Kwieftim, Nagatman), the floodplain of the Ramu River (e.g., the Anor, Giri, Rao), and the South Coast of New Guinea (e.g., the Suki, Lower Morehead). Conversely, there are no obvious hunter-gatherer groups in the provinces of Bougainville, Central, Chimbu, East New Britain, Eastern Highlands, Enga, Milne Bay, Morobe, New Ireland, West New Britain, and Western Highlands. For lack of survey data, no similar list can be compiled for Irian Jaya.

TABLE 1
The Hunters and Gatherers of New Guinea^a

Subsistence Staples	Approximate Percentage of Calories from Foraging		
	97–100	90–96.9	75–89.9
Sago, game, limited aquatic resources	Northern Irian Jaya Bonerif Iau Kwerba Sikaritai??	Northern Irian Jaya Bauzi? Berik Edopi? Isirawa Mander Soromadja?? Tause?	
	Sepik Arafundi (Lowland) Mianmin (Kime, Sebai groups)	Sepik Alamblak Bahinemo Bisis?? Bitara/Berinmo?? One?? Sanio-Hiowe Inland Warapu?? Watakataui Yabio??	Sepik ^b Ama/Sawiyano Changriwa?? Kwoma (Nukuma)? Mari?? Mekmek?? Sumariup??
	South Coast Sawuy? Siagha-Yenimu?	South Coast Kombai?	South Coast Mappi River
Sago, aquatic resources, limited game	Sepik Kaningara?? Kapriman Karawari Yimas?	Northern Irian Jaya Biak, Coastal? Waropen, Kai?	Northern Irian Jaya Waropen, Napan??
	South Coast Asmat (Central) Asmat (Casuarina Coast)	Sepik Kambot (Swampland)? Mongol?	Sepik ^b Kambot (High-ground)? Langam?? Miyak?? Yaul??
Sago and aquatic resources obtained largely by trade, limited game		South Coast Asmat (North) Boazi Jaquai Morigi Mimika, Western Zimakani??	South Coast Fly Estuary Kiwai??
		Sepik Murik Kwoma (Hill)	Sepik Kaunga? Sawos
			South Coast Koriki/Purari

SOURCES: *Alamblak*, Angoram Patrol Report, National Archives, Port Moresby (hereafter ANG) 6-54/55:n.p. and 12-59/60:n.p., Bruce (1974:169, 182–83), Edmiston and Edmiston (1989:2, 30–32), Haberland (1968:iv), Haberland and Seyfarth (1974:224–51); *Arafundi* (Lowland), ANG 6-54/55:n.p., Haberland (1966:37, 56–57, 59), Karawari Patrol Report, National Archives, Port Moresby 3-61/62:n.p.; *Ama/Sawiyano*, Guddemi (1992:43–44, 46–53); *Asmat, Casuarina Coast*, Trenkenschuh (1982a:56–57); *Asmat, Central*, Eyde (1967: preface, 6, 8–12, 18–40, 58–68, 71–72), Trenkenschuh (1982b:11–12; 1982c), van Arsdale (1975:85–86, 89, 94–96, 98–102, 105–10, 398–99; 1978:453, 459 n.2), Zegwaard (1959:1021); *Asmat, North*, Eyde (1967:117, 122); *Bahinemo*, Ambunti Patrol Report, National Archives, Port Moresby (hereafter AMB) 6-62/63:9, 11 and 9-62/63:9, Bakker (1994:49), Dye (1983:6), Dye and Dye Bakker (1991:2), Kawasaki (1998:81–82); *Bauzi*, Briley (1983:3; 1991:117), Sterner (1990:105); *Biak, Coastal*, Oomen (1959:39, 45); *Bisis*, ANG 6-54/55; n.p.; *Bitara/Berinmo*, AMB 6-62/63:9–10, Davidoff, Davies, and Roberson (1999: 203); *Boazi*, Busse (1987:54–55), Maunsell and Partners (1982:24); *Bonerif*, Oosterwal (1959:830; 1961:57–58, 62, 67, 70, 72–77); *Berik*, Kalmbacher (1983: 25); Oosterwal (1959:830; 1961: 57–58, 62, 67, 70, 72–77); *Changriwa*, ANG 18-49/50, Ag. Note:1; *Edopi*, Green (1986:69), Kim (1997:201); *Iau*, Bateman (1982:40), Miehle (1985:82 n.1); *Isirawa*, Erickson (1976:42 n.2; 1981:36); Oosterwal (1959:830; 1961:57–58, 62, 67, 70, 72–77); *Jaquai*, Boelaars (n.d.[1958]:16, 20, 24, 26–27, 39–40; 1975[1955]:13), Gajdusek and Salazar (1982:109, 111); *Kambot (Swampland and High-ground)*, ANG 19-49/50, Ag. Note: 1, 5-56/57:5, 7–8, table, 7-56/57:5, 8, and 3-59/60:2, Bjerre (1958:141), Territory of New Guinea (1931:97), Shack (1988:17–18, 48, 77–80). Schwab (1938:134; 1940a:242, 243; 1940b:259), Simpson (1955:61); *Kaningra*, ANG 6-54/55:n.p., Department of Human Geography (1993:22); *Kapriman*, AMB 9-29/30:7, ANG 6-54/55:n.p. and 12-56/57:3, Kumagai (1998:47), van den Broek D'Obrenan (1939:208); *Karawari*, ANG 11-49/50, Ag. Note: 1; Geo Note: 1-2; 18-49/50, Ag. Note:1; 6-54/55:n.p., Telban (1998: 19–24 and personal communication, 1999); *Kaunga*, AMB 2-49/50:3; *Kiwai, Fly Estuary*, Beaver (1920:153, 160, 214–15, 250), Maunsell and Partners (1982:24); *Kombai*, Venema (1989:40); *Koriki*, Report (1947:16, 83–86, 129–32), Chalmers (1895:105), Holmes (1924:28, 241–47, 255–57), Williams (1924:2–3); *Kwerba*, de Vries (1988:2, n. 2, 3), Oosterwal (1959: 830; 1961:57–58, 62, 67, 70, 72–77);

tein by dry weight (p. 57). Typically, therefore, New Guinea's hunters and gatherers supplemented sago with varying combinations of aquatic and terrestrial game, and it is on this score that the three subsistence strategies in table 1 are distinguished.

The first rank of table 1 lists groups that secured very little meat protein in any form and/or obtained most of it from terrestrial and arboreal rather than aquatic game. Few, if any, procured a significant portion of their diet through trade. The second rank lists groups that obtained meat protein largely (and through their own efforts) from rich aquatic resources rather than from terrestrial or arboreal game. Groups in the third rank are similar to those in the second except that they procured a large proportion of their sago or aquatic resources through trade.

Given the number of New Guinea foraging societies in table 1, it is a challenge to explain why they should have remained so long invisible to general anthropological attention. Suffice it to say that they provide hunter-gatherer scholars with a substantial new body of comparative ethnographic data and furnish continuing opportunities for fieldwork among groups that subsist more by foraging than perhaps any other contemporary groups in the world.

NEW GUINEA FORAGERS IN COMPARATIVE PERSPECTIVE

The comparative value of these groups lies in New Guinea's remarkable ethnolinguistic diversity and its status as the "Last Unknown." Most of the island's societies were pacified within just the past 30 to 80 years, and their ethnographic, historic, environmental, and demographic record is consequently as rich as any in the nonindustrial world. One of the more instructive points to emerge from these comparative data is their documentation and illumination of the contention that foraging supports considerable social and cultural variability and even highly complex lifeways (Arnold 1996; Kelly

1995; Price and Brown 1985). Although New Guinea's foragers exploited a similar suite of resources (sago, aquatic resources, game, and bush foods), they exhibited a striking range of cultural forms that appear to correlate strongly with the three subsistence types detailed in table 1.

Groups that secured very little meat protein in any form and/or obtained most of it from terrestrial and arboreal game markedly resemble the classic stereotype of the "simple" hunter-gatherer, typified by the !Kung, Inuit, Mbuti, and many Australian Aboriginal groups. At contact, their typical densities averaged 0.7/km², ranging from about 0.2 to 1.7/km². Their settlements were small, and they tended to be semi- to fully nomadic, spending most of their time in small, dispersed bush camps of 5 to 25 people but every few weeks or months congregating in a single large central settlement of between 30 and 150 people for defensive, social, or ritual purposes. Political life was relatively egalitarian: inequities in power and influence were uncommon, though status often rewarded fighting prowess, hunting ability, ritual expertise (including sorcery), and/or (occasionally) economic generosity. Ritual life was comparatively unelaborated, and there was little visual art, though nonvisual arts such as song were sometimes highly developed. Contradicting the common stereotype that war is attenuated or absent among hunters and gatherers, fighting was endemic.

Groups heavily dependent for meat protein, either directly or indirectly, on rich aquatic resources rather than terrestrial and arboreal game typically exhibited a cultural complexity that rivaled or surpassed that of many intensive agriculturalists. Among these groups, contact densities were higher, typically averaging 4.0/km² and ranging from about 1.1 to 9.4/km². Settlements were larger, typically one hundred to several hundred people. Located for defensive purposes on ridges, hilltops, or small tributaries just off major waterways, they were relatively permanent, with lifetimes of at least three

Kwoma (Hill), AMB 2-51/52:3 and 3-52/53:4, Bowden (1983:9, 11-12), Whiting (1941:5, 110-12, 115-19); *Kwoma (Nukuma)*, AMB 2-49/50:3 and 2-51/52:3; *Langam*, ANG 5-56/57:8; *Mander*, Oosterwal (1959:830; 1961:57-58, 62, 67, 70, 72-77); *Mappi River*, Eng (1983: 1-2, 6, 9-10); *Mari*, Toyoda (1998:65); *Mekmek*, ANG 18-49/50, Ag. Note:1; *Mianmin (Kime, Sebai)*, Gardner (1981:49); *Mimika, Western*, Pouwer [n.d. (1955):5, 12, 14, 34-35, 37, 39-45, 47, 49, 53-54], Wollaston (1912:101); *Miyak*, ANG 14-56/57:n.p.; ANG 18-49/50, Geo. Note:1; ANG 18-49/50, Ag. Note:1; *Mongol*, ANG 5-56/57:5, 7, 8, table; *Morigi*, Department of Human Geography (1993b: 19-20), Austen (1946); *Murik*, ANG 2-55/56:5; Lipset (1997:17-20, 39, 46-47); *Marienberg Patrol Report 2-30/31:3*, Microfilm no. 616, Pacific Manuscripts Bureau, Canberra; Schmidt (1922-23:702, 715-16); Kenneth H. Thomas, Notes on the natives of villages between Marienberg and the coast, visited during above patrol, Attachment to ANG 4-32/33, File 47, Thomas Archives, South Australia Museum, p. 10; *One*, Aitape Patrol Report, Somare Library, University of Papua New Guinea, Port Moresby (hereafter AIT) 2-24/25; 13, 17, 20, 28-29; *Sanio-Hiowe*, AMB 1-61/62b:2, 6-1962/63:9-10, and 2-68/69b:3-4; Townsend (1969:23, 47, 51, 55-56, 59-65; 1974: 230; 1990:746); *Sawos*, Schindlbeck (1980:103-14, 131-44, 154-95; 1981:12; 1983:5); *Sawuy*, Mills (1986:49); *Yost* (1988:60-61, 64); *Si- agha-Yenimu*, Gajdusek and Salazar (1982:109, 111); *Sikaritai*, Martin (1997:126); *Soromadja*, Oosterwal (1967:165); *Sumariup*, ANG 12-59/60:n.p.; *Tause*, Munnings and Munnings (1990:2, 15-21); *Warapu*, AIT 2-24/25:3, 6, 10, 28; *Waropen, Kai*, Held (1957: 10-11, 342, 345, 347-48, 350-54, pl. 3); *Oomen* (1959:39, 43, 45); *Waropen, Napan*, Held (1957:350); *Watakataui*, ANG 1-47/48:2-3 and 6-54/55:n.p.; *Yamada* (1997:1-3, 7-9, 21); *Yabio*, AMB 1-61/62:2 and 2-68/69:4, 5, Department of Human Geography (1993a:61); *Saito* (1998:95, 107, 111); *Yaul*, ANG 5-56/57:5, 7, 8, table; *Yimas*, ANG 11-49/50, Ag. Note:1; *Foley* (1991:11-13); *Zimakani*, Maunsell and Partners (1982:24).

*A single question mark denotes significant uncertainty about whether a group is placed in the correct column. Double question marks denote a group for which data are fragmentary; it follows that there is also significant uncertainty about whether it is placed in the correct column.

^bIn some Sepik cases, the sago staple is known to be entirely wild. In others, a minority of palms are planted, but it is difficult to estimate with confidence the ratio involved. Were this figure known, however, it would likely reveal that a number of these groups actually acquired 90% or more of their subsistence from wild resources.

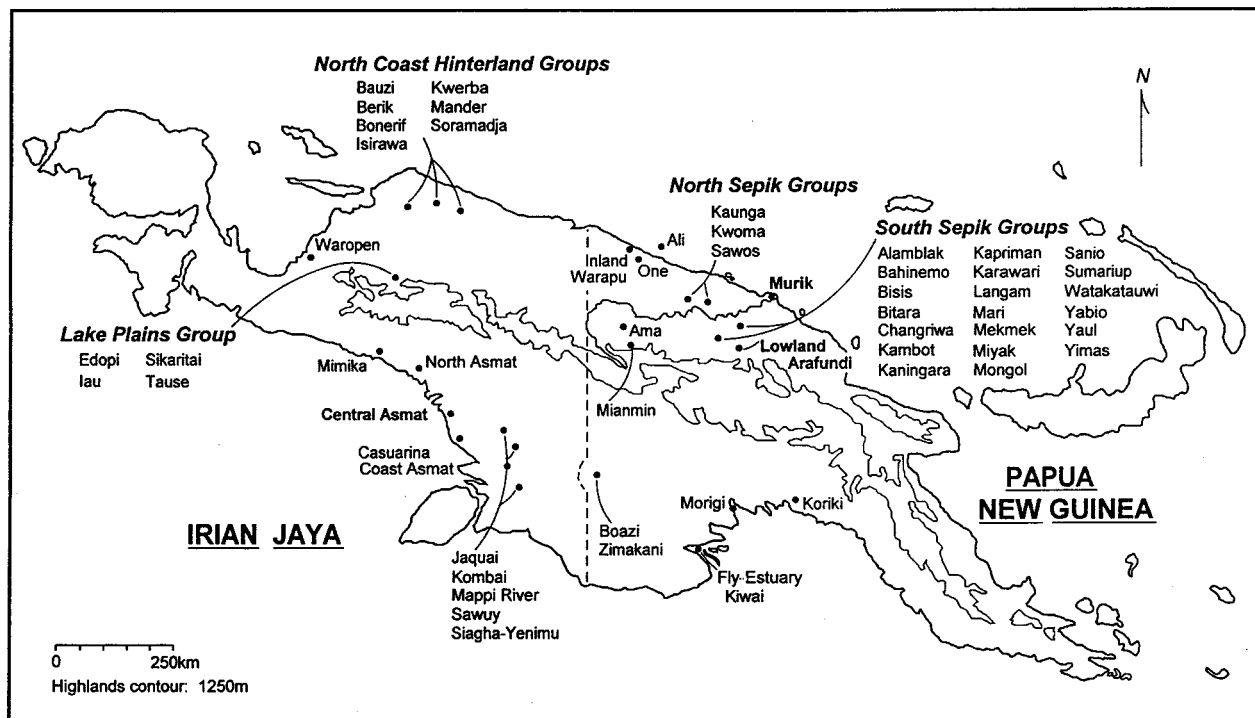


FIG. 1. New Guinea, showing the locations of contact-era hunter-gatherer groups.

years and, more usually, a generation or more. Hierarchy was often pronounced, some villages even exhibiting descent-group ranking. Leadership took various forms, including gerontocracy, big-manship, and small-scale chieftainship. Differences in both power and status were pronounced and depended on factors such as prowess in war, access to economic resources, and command of esoteric knowledge. Finally, in stark contrast to their simpler counterparts, these groups were remarkable for their highly developed ritual and visual art: some, such as the Asmat, Karawari, Kwoma, and Purari, are among the most famous of New Guinea's ritual artists. Nowhere was this productivity and proficiency more in evidence than in the monumental architecture of their elaborately carved and decorated spirit houses, which sometimes approached in size and artistry the spirit houses of the Ilahita Arapesh (whose construction required at least 10,000 man-days of work [Tuzin 1980:166 n. 45]). These structures were usually the ritual focus of highly developed initiation and headhunting cults that sometimes also involved cannibalism.

What is especially revealing about these differences in cultural complexity is the apparent absence of any significant correlation with dependence on cultivation. The Asmat, Kapriman, and Karawari, who derived little or none of their contact-era subsistence from domestication, were vastly more complex than the Ama, Bahinemo, Sanio, and Yabio, who procured 4–25% of their subsistence from domesticated resources. Indeed, the

complexity of many New Guinea foragers outstripped that of horticulturalists such as the Daribi, Mianmin, and Mountain Arapesh (Gardner 1981; Mead 1947; Wagner 1967), and even the intensive agriculturalists of the Central Highlands—the Chimbu, Kuma, and Melpa—seem to have boasted hardly more sociocultural complexity than the Asmat, Kapriman, and Karawari.

New Guinea's hunters and gatherers are unusual among modern foragers for their access to a particularly rich carbohydrate source, sago. For this reason, they provide especially useful ethnographic analogies for understanding the lifestyle of prehistoric foragers who inhabited more abundant environments than the marginal habitats of most contemporary groups. With New Guinea's simple and complex foragers depending equally on sago for their carbohydrate source, however, the nature of meat-protein resources emerges as the critical subsistence variable for understanding variations in their sociocultural complexity. Whereas simple foragers obtained only limited meat protein (e.g., Arafundi, Tor groups) or procured it primarily from terrestrial and arboreal game (e.g., Ama, Bahinemo), complex foragers could depend on concentrated aquatic resources either directly (e.g., Asmat, Kapriman, Mimika, Murik) or indirectly through trade (e.g., Sawos).

The importance of aquatic resources to sociocultural complexity among foraging groups has been incidentally noted for a long time (e.g., Murdock 1968:15; Service 1979:3) and more recently has generated increasing the-

oretical consideration, mostly with reference to maritime adaptations (e.g., Moseley and Feldman 1988:126; Pálsson 1988; Quilter and Stocker 1983; Renouf 1984; Yesner 1980). In the New Guinea case, the conjoint properties of subsistence and warfare—a badly neglected institution in hunter-gatherer studies—emerge as the important determinants of complexity. Everywhere in contact-era New Guinea, endemic warfare exerted defensive pressures to increase the size and compactness of settlements, principally against the threat of attack at night (Roscoe 1996). Counteracting these centripetal military pressures, however, were the demands of resource exploitation during the day, which favored dispersal and mobility in the interests of efficient exploitation. On the larger rivers and lakes inhabited by groups such as the Asmat, Kapriman, Karawari, and Murik, rich, localized aquatic resources allowed defensive nucleating tendencies to triumph over fissive subsistence pressures, producing large, permanent settlements. These in turn facilitated and possibly stimulated (through such scale-related factors as increased potential conflict in large settlements) the production of social and symbolic culture. The stunning visual art of these societies, for example, was a means by which individuals and kin groups within a settlement could assert and emotionally experience their identity, prestige, and dominance over others without resorting to the physical violence that would destroy them (Roscoe 1995).

By contrast, among peoples such as the Arafundi and Tor groups, who depended for meat protein on terrestrial game or small-scale fishing rather than on concentrated aquatic resources, fissive tendencies were more powerful. Game was scattered in comparatively low densities across the landscape, forcing hunters to disperse and pursue their quarry and producing smaller, more mobile settlements and a concomitant reduction in the possibilities and demands for complex social and symbolic culture.

NEW GUINEA HUNTER-GATHERERS TODAY

In something of an iconoclastic assessment of hunter-gatherer research, Burch (1998:201) has noted as a pressing practical issue that there are “few if any societies of foragers left in the world that have not been profoundly affected by, and to some extent integrated into, much larger-scale systems.” As a result, “hunter-gatherer research may soon become historically oriented rather than field oriented.” It would be naive to disagree: as many scholars have observed (e.g., Headland and Reid 1989:43; Kent 1992:52), virtually all modern hunter-gatherers now engage in nonforaging subsistence activities, with dramatic changes having taken place even among the standard exemplars of hunter-gatherer life. For some time now, the !Kung have been sedentized, procuring only 30% of their calories by hunting and gathering. For many years, the Efe of the Ituri Forest have obtained more than 60% of their calories from crop foods, primarily by working in the gardens of neighboring agriculturalists. Together with other BaMbuti groups, they

have increasingly become commercial hunters and, most recently, have had to wrestle with the chaos and dislocation of guerrilla war and Hutu refugee camps. Fieldwork to test optimal-foraging theories of hunter-gatherer life is frequently conducted among groups like the Cree and Inuit, who now have snowmobiles and satellite TVs and depend partly on wage labor and welfare payments, or the Aché, who have become sedentized around a mission station, spend only 25% of their days foraging, and procure a significant part of their subsistence from agriculture (Bailey and Aunger 1989:279; Hawkes, Hill, and O’Connell 1982:381–82; Hill et al. 1987:5; Lee 1993:153–67; Smith 1981:54; Winterhalder 1981:70).

Nevertheless, some hunter-gatherer groups have been considerably less affected and encapsulated by the industrial world than others, and this is a second reason that New Guinea’s foragers deserve the attention of hunter-gatherer scholarship. Because of their comparatively recent contact history and general inaccessibility, many of the island’s hunters and gatherers are among the least acculturated of contemporary foraging groups. To be sure, Western contact has had significant influences, but in comparison with better-known hunter-gatherer groups their acculturation is strikingly limited. Groups such as the Sanio-Hiowe, Lower Arafundi, Karawari, and Watakatawi maintain a largely hunter-gatherer lifestyle (e.g., Telban 1998; personal communication, 1999; Yamada 1997). They still procure a greater proportion of their subsistence by foraging than the 85% that characterized the !Kung when Lee (1993:156) first studied them in 1963. Indeed, in the early 1990s some of the Lower Arafundi group were still living wholly by hunting and gathering in rock caves at the base of the central cordillera (Telban, personal communication, 1999). In sum, it would be unfortunate if hunter-gatherer scholars prematurely resigned themselves to the archives when New Guinea continues to provide an array of viable field opportunities.

CONCLUSION: WHY HUNTERS AND GATHERERS?

I began this paper by noting a number of difficulties in distinguishing hunting and gathering from cultivation and pastoralism, and I should like in conclusion to return to this issue. For at least half a century, anthropology’s principal classification of human societies has been by their mode of subsistence: hunting and gathering, pastoralism, horticulture, and (intensive) agriculture. Hardly an introductory text exists that fails to reproduce this scheme, the rationale apparently being that these four modes primarily determine four main types of culture and social organization among the societies of the world. Thus, for hunters and gatherers, as Arcand (1981:39–40; see also Hamilton 1982) observes, the assumption is that “the fact of producing food solely from hunting and gathering must correlate in a significant way with other aspects of the society.”

Over the years, a number of scholars have cautioned that these notions are overly typological. In hunter-gatherer studies, the principal concern has been that life-

styles within the foraging mode of subsistence are far from the monolithic unity suggested by a "hunter-gatherer type" (e.g., Ember 1978:447; Kelly 1995; Kent 1996). Some, though, have also questioned whether lifestyles are necessarily so different *across* subsistence types. In forager studies, Feit (1994:422; see also Hallpike 1988: 165–66) goes so far as to suggest that "a universal concept of socially distinctive hunter-gatherer societies may not be a credible anthropological category."

The New Guinea data cast this concern into particularly sharp relief. To begin with, as noted earlier, there appears to be no clear correlation between dependence on wild or domesticated resources on the one hand and sociocultural form and complexity on the other. Many of the region's cultivators have a sociocultural complexity no greater than that of foragers dependent on hunting for their meat protein, while foragers with access to rich aquatic resources rival the sociocultural complexity of the most intensive agriculturalists in the Highlands.

Moreover, whether sago is wild or cultivated seems to be of minimal importance to understanding the social-cultural forms practiced by those dependent upon it. Although sago cultivation can sometimes require significant labor inputs in areas with limited swampland (e.g., Rhoads 1980:26), it usually involves minimal work in absolute terms and almost none in comparison with the labor of harvesting a palm. Planting out a sago sucker is seldom more than a few moments' work, and subsequent management involves little more than an occasional clearing of surrounding undergrowth over the next decade or two (Flach 1983:5; Kawasaki 1998:82; Schindlbeck 1980:143–44). The reward from planting can be a higher starch yield—some studies suggest that a cultivated palm can yield two to six times as much as a wild palm (Flach 1983:5, 8). But the overall differences in labor investment and yield—rough figures from the Sepik suggest that exploiting wild as opposed to planted sago may require as little as four minutes' extra work/person/day³—and the minimal impact on mobility patterns seem far too small to have the kinds of social-cultural effects that would warrant classifying wild sago gatherers and sago cultivators as two qualitatively different types, foragers and cultivators. Indeed, the Angoram and Iatmul, who depend heavily on cultivated sago, are culturally very similar to the Asmat, Kapriman, and Karawari, who exploit the same resource suites but depend entirely on wild palms.

In asserting that the wild or domesticated nature of subsistence resources is of limited value to understanding sociocultural forms, I do not mean to endorse the proposition that subsistence and the material world are but subsidiary influences on hunter-gatherer life (cf. Lourandos 1997). Rather, the New Guinea data indicate

that categorizing societies and analyzing their social forms on the basis of whether they exploit wild or domesticated food resources may be of less value than attending to the conjoint consequences of the physical properties of these resources and the manner of their exploitation. We have known for a long time, of course, that the contours of the resource/exploitation interface significantly influence other realms of culture. This was Steward's point, and it is the basis of optimal-foraging theory and behavioral ecology (e.g., Kelly 1995:62–63; Winterhalder and Smith 1981, 2000). Yet, this idea is usually only applied *within* subsistence types—to explain, for example, diversity within the hunter-gatherer type—when it deserves to be more rigorously pursued *across* subsistence types (e.g., Dyson-Hudson and Smith 1978).

In New Guinea, for example, access to rich aquatic resources seems to be a significant determinant of sedentism and social and cultural complexity. What appears to matter, however, is not that fish are wild rather than domesticated but that they provide a large, localized, stable, and rapidly regenerating food mass. In this respect, they resemble large herds of pigs (and, to a somewhat lesser degree, sweet-potato crops on rich agricultural land), and their exploitation may have similar consequences for sociocultural form. Conversely, dependence on small game seems to be a significant determinant of mobility, small settlements, and limited social and cultural complexity. What matters, however, is not that the game is wild but that it is scattered thinly; in this respect, it appears to have social-cultural sequelae similar to those of cultivating scattered pockets of thin soil. In other parts of the world, dependence on large, mobile game animals and dependence on rich fishing grounds appear to be associated with significantly different social-cultural forms, even though both resources are wild. Conversely, even though they involve domesticated and wild resources respectively, herding of large domesticated animals such as reindeer and camels has social-cultural consequences rather more akin to those of hunting large game animals than to those of exploiting rich fishing grounds. What appears to matter in relating sociocultural realms to environment and ecology, in sum, is not the wild as opposed to domesticated nature of exploited resources but rather their patchiness, spatial and temporal stability, perishability, and abundance and the technologies, capital and labor investment, and social strategies (e.g., individual or cooperative) required to raise and/or harvest them.

To describe the peoples of the world as "foragers," "pastoralists," "horticulturalists," and "agriculturalists" is innocuous enough if these categories are used merely as crude, "hand-waving" guides to general areas on what is a multidimensional continuum of human social and cultural forms. Indeed, it is hard to imagine how this spectrum could be discussed without some such broad categorization, and since they represent anthropology's received categories it is equally difficult to avoid them and remain intelligible—witness their liberal use in this article. If we must refer to peoples and social lives

3. Townsend (1969:43) calculates that the Sanio Hiowe expend 157 hours of work (travel time excluded) to produce one million calories from wild sago. Among the Abelam, who plant their sago, the equivalent figure is 154 hours (Lea 1964:121–22). Thus, to feed an average Sanio-Hiowe hunter-gatherer, who consumes 1,900 calories of sago per day (Townsend 1969:77), it would take 22 minutes of work/day for wild sago and 17 minutes for planted sago.

by capacious and radically underdetermined subsistence categories, however, it might be less misleading and more useful to describe them as *practicing*, for example, "hunting and gathering" — *among other things* — rather than referring to them as "hunters and gatherers," thereby surrendering to the Western tendency to reduce people to, or essentialize them as, their socioeconomic occupations (doctor, lawyer, forager, farmer).

References Cited

- ARCAND, B. 1981. The Negritos and the Penan will never be Cuiva. *Folk* 23:37–43.
- ARNOLD, JEANNE E. 1996. Archaeology of complex hunter-gatherers. *Journal of Archaeological Method and Theory* 3: 77–126.
- AUSTEN, LEO. 1946. Notes on the food supply of the Turamarubi of Western Papua. *Mankind* 3:227–30.
- AYRES, WILLIAM S. 1980. Comment on: Maritime hunter-gatherers: Ecology and prehistory, by David R. Yesner. *CURRENT ANTHROPOLOGY* 21:736.
- BAILEY, ROBERT C., AND ROBERT AUNGER. 1989. Net hunters vs. archers: Variation in women's subsistence strategies in the Ituri Forest. *Human Ecology* 17:273–97.
- BAILEY, ROBERT C., GENEVIEVE HEAD, MARK JENIKE, BRUCE OWEN, ROBERT RECHTMAN, AND ELZBIETA ZECHENTER. 1989. Hunting and gathering in tropical rain forest: Is it possible? *American Anthropologist* 91:59–82.
- BAKKER, EDIE. 1994. Return to Hunstein Forest. *National Geographic* 185(2):40–63.
- BARNARD, ALAN. 1983. Contemporary hunter-gatherers: Current theoretical issues in ecology and social organization. *Annual Review of Anthropology* 12:193–214.
- BARRAU, JACQUES. 1958. *Subsistence agriculture in Melanesia*. Honolulu: Bernice P. Bishop Museum.
- BARRY, HERBERT, III. 1968. Regional and worldwide variations in culture. *Ethnology* 7:207–17.
- BATEMAN, JANET. 1982. Iau kinship and marriage. *Irian* 10(3): 34–74.
- BEAVER, WILFRED N. 1920. *Unexplored New Guinea: A record of the travels, adventures, and experiences of a resident magistrate amongst the head-hunting savages and cannibals of the unexplored interior of New Guinea*. London: Seeley, Service.
- BJERRE, JENS. 1958. *The last cannibals*. London: Pan Books.
- BOELAARS, J. n.d. (1958). *Papoea's aan de Mappi*. Utrecht-Antwerpen: De Fontein.
- . 1975 (1955). The Jaqai: Thoughts about the past, present, and future of a people. Translated by H. Hockmuller and F. Trenkenschuh. *Asmat Sketch Book* 3:9–40.
- BOWDEN, ROSS. 1983. *Yena: Art and ceremony in a Sepik society*. Oxford: Pitt Rivers Museum.
- BRILEY, JOYCE E. 1983. "The Bauzi view of ritual and magic," in *Gods, heroes, kinsmen: Ethnographic studies from Irian Jaya, Indonesia*. Edited by William R. Merrifield, Marilyn Gergerson, and Daniel C. Ajamaseba, pp. 3–23. Jayapura and Dallas: Cenderawasih University and the International Museum of Cultures.
- . 1991. Controls of red and white in the Bauzi cycle of reproduction. *Irian* 19:116–35.
- BRUCE, LESLIE. 1974. "Alamblak kinsmen: To give is better than to receive (and you'll get it back)," in *Kinship studies in Papua New Guinea*. Edited by R. Daniel Shaw, pp. 169–86. Ukarumpa, PNG: Summer Institute of Linguistics.
- BURCH, ERNEST S. 1998. "The future of hunter-gatherer research," in *Limited wants, unlimited means: A reader on hunter-gatherer economics and the environment*. Edited by John Gowdy, pp. 201–17. Washington, D.C.: Island Press.
- BUSSE, MARK WILLIAM. 1987. Sister exchange among the Wamek of the Middle Fly. Ph.D. diss., University of California, San Diego, Calif.
- CHALMERS, JAMES. 1895. *Pioneer life and work in New Guinea 1877–1894*. London: Religious Tract Society.
- CLASTRES, PIERRE. 1972. "The Guayaki," in *Hunters and gatherers today: A socioeconomic study of eleven such cultures in the twentieth century*. Edited by M. G. Bicchieri, pp. 138–74. New York: Holt, Rinehart and Winston.
- DAVIDOFF, JULES, IAN DAVIES, AND DEBI ROBERSON. 1999. Colour categories in a Stone-Age tribe. *Nature* 398:203–4.
- DEPARTMENT OF HUMAN GEOGRAPHY, AUSTRALIAN NATIONAL UNIVERSITY. 1993a. *Agricultural systems of Papua New Guinea, working paper no. 2: East Sepik Province*. Canberra.
- . 1993b. *Agricultural systems of Papua New Guinea, working paper no. 5: Gulf Province*. Canberra.
- DE VRIES, JIM. 1988. Kwerba supernatural beliefs. *Irian* 16: 1–16.
- DYE, SALLY. 1983. *What disrupts Bahinemo marriage*. Melanesian Institute for Pastoral and Socio-Economic Service, Working Papers in Melanesian Marriage and Family Life 6.
- DYE, T. WAYNE, AND EDITH DYE BAKKER. 1991. The response of Bahinemo foragers to imposed land tenure changes: An emic perspective. Paper presented at the annual meetings of the American Anthropological Association, Chicago, Ill.
- DYSON-HUDSON, RADA, AND ERIC ALDEN SMITH. 1978. Human territoriality: An ecological reassessment. *American Anthropologist* 80:21–41.
- EDMISTON, PATRICK, AND MELENDIA EDMISTON. 1989. *Alamblak background study*. Ukarumpa, PNG: Summer Institute of Linguistics.
- ELLEN, R. 1982. *Environment, subsistence, and system*. Cambridge: Cambridge University Press.
- EMBER, CAROL. 1978. Myths about hunter-gatherers. *Ethnology* 17:439–48.
- ENG, JOAN. 1983. *Sago and nutrition in Bomakia*. Jayapura: Irian Jaya Development Information Service Center.
- ERICKSON, CAROL J. 1976. Isirawa kinship and exchange marriage. *Irian* 5(1):22–44.
- . 1981. Spirit alliances and possession among the Isirawa. *Irian* 9(1):33–54.
- EYDE, DAVID BRUENER. 1967. Cultural correlates of warfare among the Asmat of South-west New Guinea. Ph.D. diss., Yale University, New Haven, Conn.
- FEIT, HARVEY A. 1994. "The enduring pursuit: Land, time, and social relationships in anthropological models of hunter-gatherers and in subarctic hunters' images," in *Key issues in hunter-gatherer research*. Edited by E. S. Burch and L. J. Ellana, pp. 421–39. Oxford: Berg.
- FLACH, M. 1983. *The sago palm*. FAO Plant Production and Protection Paper 47.
- FOLEY, WILLIAM A. 1991. *The Yimas language of New Guinea*. Stanford: Stanford University Press.
- GAJDUSEK, D. CARLETON, AND ANDRES M. SALAZAR. 1982. Amyotrophic lateral sclerosis and Parkinsonian syndromes in high incidence among the Auyu and Jakai people of West New Guinea. *Neurology* 32:107–26.
- GARDNER, DONALD STANLEY. 1981. Cult ritual and social organisation among the Mianmin. Ph.D. diss., The Australian National University, Canberra, Australia.
- GREEN, IVOR. 1986. Dou kinship terms. *Irian* 14:68–77.
- GUDDEMI, PHILLIP V. 1992. We came from this: Knowledge, memory, painting, and "play" in the initiation rituals of the Sawiyano of Papua New Guinea. Ph.D. diss., University of Michigan, Ann Arbor, Mich.
- HABERLAND, EIKE. 1966. Zur Ethnographie der Alfendio-Region (Südlicher Sepik-Distrikt, Neuguinea). *Jahrbuch des Museums für Völkerkunde zu Leipzig* 23:33–67.
- . 1968. *The caves of Karawari*. New York: D'Arcy Galleries.
- HABERLAND, EIKE, AND SIEGFRIED SEYFARTH. 1974. *Die Yimar am Oberen Korowori (Neuguinea)*. Wiesbaden: Franz Steiner.

- HALLPIKE, C. R. 1988. *The principles of social evolution*. Oxford: Clarendon.
- HAMILTON, ANNETTE. 1982. "The unity of hunting-gathering societies: Reflections on economic forms and resource management," in *Resource managers: North American and Australian hunter-gatherers*. Edited by Nancy M. Williams and Eugene S. Hunn, pp. 229–47. Boulder: Westview Press.
- HARRIS, DAVID R. 1977. "Subsistence strategies across Torres Strait," in *Sunda and Sahul: Prehistoric studies in Southeast Asia, Melanesia, and Australia*. Edited by Jim Allen, Jack Golson, and Rhys Jones, pp. 421–63. London and New York: Academic Press.
- . 1989. "An evolutionary continuum of people-plant interaction," in *Foraging and farming: The evolution of plant exploitation*. Edited by David R. Harris and Gordon C. Hillman, pp. 11–26. London: Unwin Hyman.
- HAWKES, KRISTEN, KIM HILL, AND JAMES F. O'CONNELL. 1982. Why hunters gather: Optimal foraging and the Aché of Eastern Paraguay. *American Ethnologist* 9: 379–98.
- HAYDEN, BRIAN. 1981. "Subsistence and ecological adaptations of modern hunter/gatherers," in *Omnivorous primates: Gathering and hunting in human evolution*. Edited by Robert S. O. Harding and Geza Teleki, pp. 344–421. New York: Columbia University Press.
- HEADLAND, THOMAS N., AND LAWRENCE A. REID. 1989. Hunter-gatherers and their neighbors from prehistory to the present. *CURRENT ANTHROPOLOGY* 30:43–66.
- HELD, G. J. 1957. *The Papuas of Waropen*. The Hague: Martinus Nijhoff.
- HILL, KIM, HILLARD KAPLAN, KRISTEN HAWKES, AND A. MAGDALENA HURTADO. 1987. Foraging decisions among Aché hunter-gatherers in Eastern Paraguay. *Ethology and Sociobiology* 8:1–36.
- HOLMES, J. H. 1924. *In primitive New Guinea: An account of a quarter of a century spent amongst the primitive Ipi & Nambau groups of tribes of the Gulf of Papua, with an interesting description of their manner of living, their customs & habits, feasts & festivals, totems & cults*. New York: Putnam.
- INGOLD, T. 1974. On reindeer and men. *Man*, n.s., 9:523–38.
- KALMBACHER, CAROL. 1983. "Came, female cannibal culture hero," in *Gods, heroes, kinsmen: Ethnographic studies from Irian Jaya, Indonesia*. Edited by William R. Merrifield, Marilyn Gregerson, and Daniel C. Ajamaseba, pp. 23–41. Jayapura and Dallas: Cenderawasih University and the International Museum of Cultures.
- KAWASAKI, IPPEI. 1998. "Pigs, two women, and an island: A reality of subsistence in Bahinemo mythology," in *Fringe area of highlands in Papua New Guinea*. Edited by Shuji Yoshida and Yujio Toyoda, pp. 79–91. Senri Ethnological Series 47.
- KEELEY, LAWRENCE H. 1988. Hunter-gatherer economic complexity and "population pressure": A cross-cultural analysis. *Journal of Anthropological Archaeology* 7:373–411.
- KELLY, ROBERT L. 1995. *The foraging spectrum: Diversity in hunter-gatherer lifeways*. Washington, D.C., and London: Smithsonian Institution.
- KENT, SUSAN. 1992. The current forager controversy: Real versus ideal views of hunter-gatherers. *Man*, n.s., 27:45–70.
- . Editor. 1996. *Cultural diversity among twentieth-century foragers: An African perspective*. Cambridge: Cambridge University Press.
- KIM, YUN HWA. 1997. "Edopi kinship, marriage, and social structure," in *Kinship and social organization in Irian Jaya: A glimpse of seven systems*. Edited by Marilyn Gregerson and Joyce Sterner, pp. 199–220. Jayapura and Dallas: Cenderawasih University and Summer Institute of Linguistics.
- KUMAGAI, KEICHI. 1998. "Migration and shifting settlement patterns among the Kabriman people of East Sepik Province, Papua New Guinea," in *Fringe area of highlands in Papua New Guinea*. Edited by Shuji Yoshida and Yujio Toyoda, pp. 43–60. Senri Ethnological Series 47.
- LEA, D. A. M. 1964. Abalam land and sustenance. Ph.D. diss., The Australian National University, Canberra, Australia.
- LEE, RICHARD B. 1968. "What hunters do for a living, or, How to make out on scarce resources," in *Man the hunter*. Edited by Richard B. Lee and Irven DeVore, pp. 30–48. Chicago: Aldine.
- . 1993. *The Dobe Ju/'hoansi*. Fort Worth: Harcourt Brace.
- LEE, RICHARD B., AND RICHARD HEYWOOD DALY. 1999. *The Cambridge encyclopedia of hunters and gatherers*. Cambridge and New York: Cambridge University Press.
- LEE, RICHARD B., AND IRVEN DEVORE. 1968. "Problems in the study of hunters and gatherers," in *Man the hunter*. Edited by Richard B. Lee and Irven DeVore, pp. 3–12. Chicago: Aldine.
- LIPSET, DAVID. 1997. *Mangrove man: Dialogics of culture in the Sepik Estuary*. Cambridge: Cambridge University Press.
- LOURANDOS, HARRY. 1997. *Continent of hunter-gatherers: New perspectives in Australian prehistory*. Cambridge: Cambridge University Press.
- MARTIN, DAVID L. 1997. "The social functions of polygyny in relation to Sikaritai kinship and marriage," in *Kinship and social organization in Irian Jaya: A glimpse of seven systems*. Edited by Marilyn Gregerson and Joyce Sterner, pp. 121–67. Jayapura and Dallas: Cenderawasih University and Summer Institute of Linguistics.
- MAUNSELL AND PARTNERS. 1982. *Ok Tedi environmental study*. Vol. 5. *Population and resource use: Ethnobiology*. Melbourne.
- MEAD, MARGARET. 1947. The Mountain Arapesh: 3. Socio-economic life; 4. Diary of events in Alitua. *Anthropological Papers of the American Museum of Natural History* 40:159–419.
- MIEHLE, HELEN. 1985. What's in a name? A descriptive study of Iau personal names. *Irian* 13:66–84.
- MILLS, A. JOHN. 1986. My row of birds: A short history of the Sawi village of Kamur, an analysis of their kinship system, and a description of related marriage customs. *Irian* 14:46–67.
- MOSELEY, MICHAEL E., AND ROBERT A. FELDMAN. 1988. "Fishing, farming, and the foundations of Andean civilization," in *The archaeology of prehistoric coastlines*. Edited by Geoff Bailey and John Parkington, pp. 125–34. Cambridge: Cambridge University Press.
- MUNNINGS, PETER, AND MARY JANE MUNNINGS. 1990. *Between two worlds: A photo documentary of the Tause culture of Irian Jaya, Indonesia*. Jayapura: Uncen-SIL Cooperative Program.
- MURDOCK, GEORGE PETER. 1968. "The current status of the world's hunting and gathering peoples," in *Man the hunter*. Edited by Richard B. Lee and Irven DeVore, pp. 13–20. Chicago: Aldine.
- OOMEN, H. A. P. C. 1959. Poor-food patterns in New Guinea. *Nieuw-Guinea Studiën* 3:35–46.
- OOSTERWAL, G. 1959. The position of the bachelor in the Upper Tor territory. *American Anthropologist* 61:829–39.
- . 1961. *People of the Tor: A cultural-anthropological study on the tribes of the Tor territory (Northern Netherlands New-Guinea)*. Assen: Royal van Gorcum.
- . 1967. "Muremarew: A dual organized village on the Mamberamo, West Irian," in *Villages in Indonesia*. Edited by Koentjaraningrat, pp. 157–88. Ithaca: Cornell University Press.
- PÁLSSON, GÍSLI. 1988. "Hunters and gatherers of the sea," in *Hunters and gatherers 1: History, evolution, and social change*. Edited by Tim Ingold, David Riches, and James Woodburn, pp. 189–204. Oxford: Berg.
- POUWER, JAN. n.d. (1955). *Enkele aspecten van de Mimika-cultuur (Nederlands Zuidwest Nieuw Guinea)*. 's-Gravenhage: Staatsdrukkerij- en Uitgeversbedrijf.
- PRICE, T. DOUGLAS, AND JAMES ALLISON BROWN. 1985. *Prehistoric hunter-gatherers: The emergence of cultural complexity*. Orlando: Academic Press.
- QUILTER, J., AND T. STOCKER. 1983. Subsistence economies and the origins of Andean complex societies. *American Anthropologist* 85:545–62.
- RENOUF, M. A. P. 1984. Northern coastal hunter-fishers: An archaeological model. *World Archaeology* 16:18–27.
- Report of the New Guinea Nutrition Survey Expedition*. 1947. Sydney: Pettifer, Government Printer.

- RHOADS, JAMES W. 1980. Through a glass darkly: Present and past land-use systems of Papuan sagopalm users. Ph.D. diss., The Australian National University, Canberra, Australia.
- ROSCOE, PAUL B. 1995. Of power and menace: Sepik art as an affecting presence. *Journal of the Royal Anthropological Institute*, n.s., 1:1-22.
- . 1996. War and society in Sepik New Guinea. *Journal of the Royal Anthropological Institute* 2:645-66.
- ROSMAN, ABRAHAM, AND PAULA G. RUBEL. 1989. "Stalking the wild pig: Hunting and horticulture in Papua New Guinea," in *Farmers as hunters: The implications of sedentism*. Edited by Susan Kent, pp. 27-36. Cambridge: Cambridge University Press.
- RUDDLE, KENNETH, DENNIS JOHNSON, PATRICIA K. TOWNSEND, AND JOHN D. REES. 1978. *Palm sago: A tropical starch from marginal lands*. Honolulu: University Press of Hawaii for the East-West Center.
- SAITO, HISAFUMI. 1998. "We are one flesh: Unity and migration of the Yabio," in *Fringe area of highlands in Papua New Guinea*. Edited by Shuji Yoshida and Yukio Toyoda, pp. 93-112. Senri Ethnological Series 47.
- SCHINDLBECK, MARKUS. 1980. *Sago bei den Sawos (Mittelsepik, Papua New Guinea): Untersuchungen über die Bedeutung von Sago in Wirtschaft, Sozialordnung und Religion*. Basel: Ethnologisches Seminar der Universität und Museum für Völkerkunde.
- . 1981. "Sawos (New Guinea, Middle Sepik): Burning patterns into the skin," in *Publikationen zu Wissenschaftlichen Filmen, Ethnologie, Series 11, no. 3*, pp. 12-17. Göttingen: Institut für den Wissenschaftlichen Film.
- . 1983. Kokospalme und Brotfruchtbaum: Siedlungs-Vorstellungen der Sawos und Kwanga, Sepik-Gebiet, Papua-Neuguinea. *Geographica Helvetica* 38:3-10.
- SCHMIDT, J. 1922-23. Die Ethnographie der Nor-Papua (Murik-Kaup-Karau) bei Dallmannhafen, Neu-Guinea. *Anthropos* 18-19:700-732.
- SCHWAB, IGNAZ. 1938. Winterfreuden in Moskitania. *Steyler Missionsbote* 65:134-35.
- . 1940a. Jagderlebnisse auf einer Missionsfahrt. *Steyler Missionsbote* 67:242-43.
- . 1940b. Ein alter Haudegen. *Steyler Missionsbote* 67: 259-60.
- SERVICE, ELMAN R. 1979. *The hunters*. Englewood Cliffs: Prentice-Hall.
- SHACK, KATHRYN WETHERELL. 1988. Effects of agricultural development and resettlement on nutritional status and dietary intakes of mothers and children: A study of three ethnic groups in lowland Papua New Guinea. Ph.D. diss., University of California, Davis, Calif.
- SIMPSON, COLIN. 1955. *Islands of men*. Sydney: Angus and Robertson.
- SMITH, ERIC ALDEN. 1981. "The application of optimal foraging theory to the analysis of hunter-gatherer group size," in *Hunter-gatherer foraging strategies: Ethnographic and archaeological analyses*. Edited by Bruce Winterhalder and Eric Alden Smith, pp. 36-65. Chicago and London: University of Chicago Press.
- STERNER, JOYCE K. 1990. The role of women in traditional Irian Jaya societies as exemplified among the Bauzi and Kertengban. *Irian* 18:102-8.
- TELBAN, BORUT. 1998. *Dancing through time: A Sepik cosmology*. Oxford: Clarendon.
- TERRITORY OF NEW GUINEA. 1931. *Report to the League of Nations for 1929-30*. Canberra: Government Printer.
- TOWNSEND, PATRICIA KATHRYN WOODS. 1969. Subsistence and social organization in a New Guinea society. Ph.D. diss., University of Michigan, Ann Arbor, Mich.
- . 1974. Sago production in a New Guinea economy. *Human Ecology* 2:217-36.
- . 1990. On the possibility/impossibility of tropical forest hunting and gathering. *American Anthropologist* 92:745-48.
- TOYODA, YUKIO. 1998. "To which bird do you belong? Totemic belief among the Mari, Papua New Guinea," in *Fringe area of highlands in Papua New Guinea*. Edited by Shuji Yoshida and Yukio Toyoda, pp. 61-77. Senri Ethnological Series 47.
- TRENKENSCHUH, F. 1982a. "The Asmat people of the Casuarina coast," in *An Asmat sketch book no. 1*. Edited by Frank A. Trenkenschuh, pp. 55-59. Hastings. Nebr.: Crosier Missions.
- . 1982b. "The physical environment of Asmat," in *An Asmat sketch book no. 1*. Edited by Frank A. Trenkenschuh, pp. 11-12. Hastings, Nebr.: Crosier Missions.
- . 1982c. "Asmat sago gathering practices," in *An Asmat sketch book no. 1*. Edited by Frank A. Trenkenschuh, pp. 45-53. Hastings, Nebr.: Crosier Missions.
- TUZIN, DONALD F. 1980. *The voice of the Tambaran: Truth and illusion in Ilahita Arapesh religion*. Berkeley: University of California Press.
- ULIJASZEK, S. J., AND S. P. PORAITUK. 1983. "Subsistence patterns and sago cultivation in the Purari River," in *The Purari: Tropical environment of a high rainfall basin*. Edited by T. Petr, pp. 577-88. The Hague: Dr. W. Junk.
- VAN ARSDALE, PETER WAYNE. 1975. Perspectives on development among Irian Jaya's Asmat: Cultural and demographic correlates of induced change. Ph.D. diss., University of Colorado, Denver, Colo.
- . 1978. Activity patterns of Asmat hunter-gatherers: A time budget analysis. *Mankind* 11:453-60.
- VAN DEN BROEK D'OBRENAN, CHARLES. 1939. *Le voyage de "La Korrigane"*. Paris: Payot.
- VENEMA, HANK. 1989. Sago grub festival. *Irian* 17:38-63.
- WAGNER, ROY. 1967. *The curse of Souw: Principles of Daribi clan definition and alliance in New Guinea*. Chicago: University of Chicago Press.
- WHITING, JOHN W. M. 1941. *Becoming a Kwoma: Teaching and learning in a New Guinea tribe*. New Haven: Yale University Press.
- . 1968. "Discussions, Part 7," in *Man the hunter*. Edited by Richard B. Lee and Irven DeVore, pp. 336-39. Chicago: Aldine.
- WILLIAMS, F. E. 1924. *The natives of the Purari Delta*. Port Moresby: Government Printer.
- WINTERHALDER, BRUCE. 1981. "Foraging strategies in the boreal forest: An analysis of Cree hunting and gathering," in *Hunter-gatherer foraging strategies: Ethnographic and archaeological analyses*. Edited by Bruce Winterhalder and Eric Alden Smith, pp. 66-98. Chicago and London: University of Chicago Press.
- WINTERHALDER, BRUCE, AND ERIC ALDEN SMITH. 1981. *Hunter-gatherer foraging strategies: Ethnographic and archaeological analyses*. Edited by Bruce Winterhalder and Eric Alden Smith. Chicago and London: University of Chicago Press.
- . 2000. Analyzing adaptive strategies: Human behavioral ecology at twenty-five. *Evolutionary Anthropology* 9:51-72.
- WOLLASTON, A. F. R. 1912. *Pygmies and Papuans: The Stone Age to-day in Dutch New Guinea*. London: John Murray.
- YAMADA, YOICHI. 1997. *Songs of spirits: An ethnography of sounds in a Papua New Guinea society*. Translated by Jun'ichi Ohno. Boroko, PNG: Institute of Papua New Guinea Studies.
- YESNER, DAVID R. 1980. Maritime hunter-gatherers: Ecology and prehistory. *CURRENT ANTHROPOLOGY* 21:727-35.
- YOST, JIM. 1988. Traditional Sawi religion. *Irian* 16:50-113.
- ZEGWAARD, GERARD A. 1959. Headhunting practices of the Asmat of Netherlands New Guinea. *American Anthropologist* 61:1020-41.

Cranial Vault Modification and Ethnicity in Middle Horizon San Pedro de Atacama, Chile¹

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During the first few years of life, the bones of the skull are quite malleable and with persistent shaping by adult caretakers will eventually retain a form created through manipulation. The permanently modified head that results is not only an aesthetic feature; it also conveys social information. Cranial vault modification must be performed during infancy. As a result, it is not associated with rites of passage and contrasts in this respect with other forms of body modification that mark important social transitions (Brain 1979:91). Instead, early in life, cranial vault modification becomes a fundamental part of a person's identity. It serves as a powerful, constant, and visually salient symbol of social identity.

In some important respects our bodies are a creation of the society within which we exist. It is this interaction between society and the body that is critical in understanding the social context of body modifications. Cranial vault modification has long been viewed by anthropologists as a cultural feature, "one that marks territory or social boundaries, reaffirms ethnicity, and maintains and strengthens exchange networks" (Gerszten 1993:87). It can serve as a permanent symbol of within-group solidarity and of cultural differences between groups.

Since patterns of body modifications are cultural artifacts, they can change in response to external influences. This suggests a possible bioarchaeological approach to a controversy regarding the cultural influence of the Bolivian altiplano state of Tiwanaku (A.D. 400–1000) on people living in the Atacama Desert of

northern Chile (fig. 1). Tiwanaku exerted a noticeable influence in the Atacama during the Middle Horizon (A.D. 500–1000), but the extent of that influence is unknown. It has been debated whether there was a colonizing force of Tiwanaku peoples or merely the sharing of an iconographic or ideological system and occasional traders. Cranial vault modification and grave associations are reflections of this interaction and can be analyzed to help determine the nature of the contact situation.

THE ISSUE OF TIWANAKU INFLUENCE

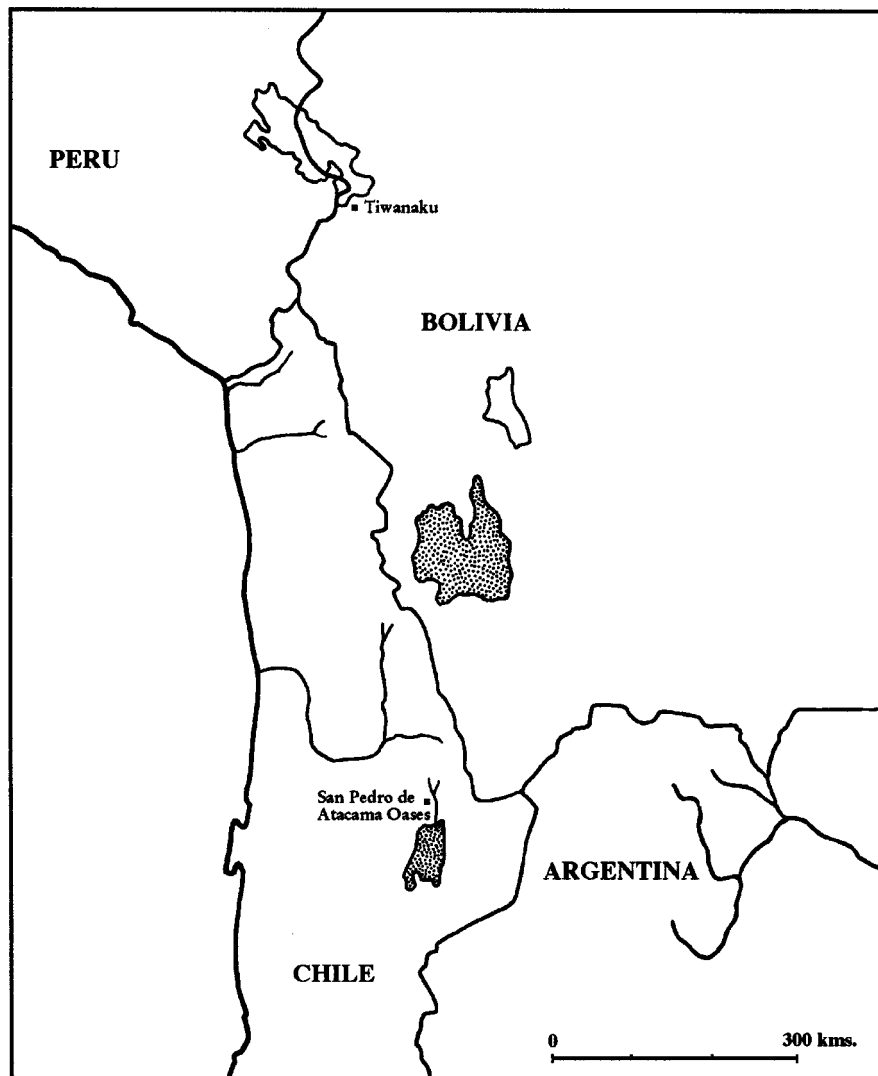
An analysis of the distribution of cranial vault modification has the potential to address unresolved questions about the expansion of the Tiwanaku state into northern Chile (Berenguer, Castro, and Silva 1980; Berenguer and Dauelsberg 1989; Browman 1980; Kolata 1993:275–80; Nuñez and Dillehay 1995:98–106; Orellana 1985; Rodman 1992; Serracino 1980; Thomas, Benavente, and Massone 1985; Torres and Conklin 1995). The Tiwanaku are known to have frequently employed a pronounced form of annular modification that produces a morphology strikingly different from that of the undeformed skull (figs. 2 and 3). Annular vault modification is produced by wrapping the head with cloths to direct the growth of the head into a conical form (Dembo and Imbelloni 1938:265–67). Cranial deformation was so widespread among the Tiwanaku that early scholars referred to annular forms as Aymara, after the language spoken in the Lake Titicaca basin (Imbelloni 1924–25, Latcham 1938, Marroquin 1944). Recently, the variability of head shape in the Tiwanaku area has been commented upon, and research shows that other forms of cranial modification coexisted with annular forms in the urban core of Tiwanaku (Blom et al. 1998).

If the Tiwanaku had a strong colonial presence in the San Pedro de Atacama oases, it seems likely that the pattern of cranial vault modification observed among its inhabitants would be affected. As Barth writes, in a discussion of ethnicity, "ethnic groups in contact imply . . . the persistence of cultural differences" (1998:16). Ethnic groups must self-identify, and, furthermore, cultural differences are often strengthened when people of different ethnicities interact (Jones 1995:71). Since the use of vault modification as a group identifier was a common practice in antiquity, it provides a useful tool for analyzing ethnicity in the pre-Columbian Andes. In this instance it could be reflected in a strengthening of the local form of cranial vault modification or an assimilation of the foreign style.

To obtain a better understanding of the social interactions that occurred between the Tiwanaku and the peoples of San Pedro de Atacama and to explore the relationship between cranial vault modification and group identity in northern Chile, skeletal materials from two sites, Toconao Oriente (100 B.C.–A.D. 300) and Solcor 3 (A.D. 400–900) (fig. 4) were examined. Cranial deformation was a long-standing practice among the Atacameños. Some of the earliest collections from the area evi-

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FIG. 1. *The Andes.*

dence it, and the practice continued through the Middle Horizon into the period of Inka occupation. These facts suggest that it was a cultural feature inherent to Atacameño identity and not a product of the enforced regulation of a foreign group.

Certain scholars have argued for a physical presence in the form of colonies or traders from Tiwanaku. Rodman (1992) examined textiles from the Coyo Oriental cemetery in San Pedro de Atacama, which is contemporary with Solcor 3. She argued not only that a "strong Tiwanaku influence did disrupt the San Pedro cultural sequence, but [that] there were most likely people physically present whose original home was the Bolivian altiplano" (1992:336). She also posits that locals and foreigners were buried together in the Coyo Oriental cemetery (1992:335). Kolata supports this idea and notes in the Atacama "the presence of substantial colonies of

altiplano people from the Tiwanaku core area around Lake Titicaca" (1993:277). Berenguer and Dauelsberg argue that San Pedro de Atacama is well within the Tiwanaku orbit, and, moreover, that people from Tiwanaku, including those representing the authority of the state, were present there (1989:161). These interpretations have a common base in models of European colonialism.

Torres and Conklin (1995) counter that the relationship of San Pedro de Atacama with Tiwanaku was one of exchange of goods and ideas but not of the physical presence of Tiwanaku colonists. They instead put forth a model of the reciprocal exchange of ideas and artifacts modified and used in locally applicable ways by both populations (Torres and Conklin 1995:104). Similar interpretations have been offered by Mario Orellana, building upon the seminal work of David Browman (1980).



FIG. 2. *Annular vault modification from Tiwanaku, Bolivia.*

He interprets the Tiwanaku state as a loose confederacy with a network of long-distance trade based on both economy and ideology in which San Pedro de Atacama was enmeshed (Orellana 1985:252). More recently, Browman has argued that the interaction was related to trade caravans and that the appearance of "*ethnic altiplano types*" reflects the presence of occasional merchants and caravaneers rather than direct control (1997:234). These models do not include the physical presence of colonists or settlers from Tiwanaku and instead focus on exchange networks.

CRANIAL VAULT MODIFICATION AS AN INDEX OF TIWANAKU INFLUENCE

These contrasting ideas present different understandings of the Tiwanaku and their role in San Pedro de Atacama. The models can be evaluated through mortuary analysis and an examination of the practice of cranial vault modification. My working hypothesis was that the rise in Tiwanaku influence on the Atacameño culture should be reflected in an augmentation of the complexity of the symbolic systems used to maintain social boundaries between segments of the population. I expected to see an increase in the elaborateness of the practice of cranial vault modification as evidenced in the varying forms of deformation, owing to the growing interaction between the Tiwanaku and Atacameño populations.

To explore this hypothesis, collections from the Toconao Oriente and Solcor 3 cemeteries of San Pedro de Atacama were studied for evidence of temporal variation in patterns of cranial vault modification and correlations between cranial vault modification and burial associations, especially the presence of exotic objects derived from Tiwanaku. The results were compared with data from Middle Horizon sites considered Tiwanaku "colonies." Changes in the ethnic composition of the San Pedro de Atacama oases were also examined through the comparison of Solcor 3 with the pre-Tiwanaku site of Toconao Oriente. The presence of artifacts with Tiwanaku iconography at the later site of Solcor 3 suggested that some Tiwanaku influence would be visible there.

If the population of Solcor 3 had been colonized by a group from Tiwanaku, it would be expected that a cultural trait such as cranial deformation and the pattern of grave associations would be disrupted and therefore differ from those of the Toconao Oriente collection of purely local individuals. However, if Tiwanaku merely exerted a cultural influence, it should not be manifest as drastic changes in the local patterns. Additional evidence of a colonization event or of the acculturation of the Atacameño population would be an increase in goods from Tiwanaku or displaying Tiwanaku iconography. If no shifts in the local patterns are visible or they are minor and sporadic in nature, the relationship between



FIG. 3. *Normal skull, Solcor 3, Chile.*

Tiwanaku and San Pedro de Atacama may have been characterized by trade and exchange rather than colonization.

MATERIALS AND METHODS

The Toconao Oriente collection (100 B.C.–A.D. 300) consists of the skeletal remains and grave goods of 99 individuals. This site is located at the southern extreme of the San Pedro de Atacama oases and represents the earliest known permanent occupation of this area (Le Paige 1971). The oases appear to have been somewhat isolated, and there is no archaeological evidence from burial goods, architecture, or settlement patterns indicating widespread interactions between the inhabitants of Toconao Oriente and people living elsewhere in the Andean region (Le Paige 1971, Llagostera and Costa n.d.). The remains of 92 individuals from Solcor 3 (A.D. 400–900) are from a later San Pedro de Atacama group that lived during a period of prosperity, increased trade, more foreign interaction, and considerable Tiwanaku influence (Bravo and Llagostera 1986). Archaeological evidence suggests that access to wealth and the complexity of the local material culture increased in concert with the expansion of contacts with the Tiwanaku.

Both cemeteries are located near the present-day town of San Pedro de Atacama in the Atacama Desert of northern Chile, a series of oases at the confluence of two rivers, the Salado and the San Pedro, at 2,450 m above sea level. Pre-Columbian agriculturists and pastoralists lived there in small villages clustered around the lower course of the rivers. Solcor 3 is within the main cluster of oases, while Toconao Oriente is 46 km to the south, where most of the early occupation of this area is found. The cemetery of Toconao Oriente was excavated in the 1960s by Father Gustavo Le Paige. The Solcor 3 cemetery was one of the major burial locations of the Middle Horizon in the Atacama. Individuals at both sites were buried in cylindrical pits in seated positions with arms and legs flexed and their grave goods surrounding them (Le Paige 1971; Bravo and Llagostera 1986:323). They were fully wrapped in textiles and often tied together with ropes. In using these mortuary arrangements the people of Toconao Oriente and Solcor 3 followed a funerary custom that was well-established in their population and not influenced by outside groups (Bravo and Llagostera 1986:324).

The samples under consideration in this study are housed at the Museo Arqueológico R. P. Le Paige in San

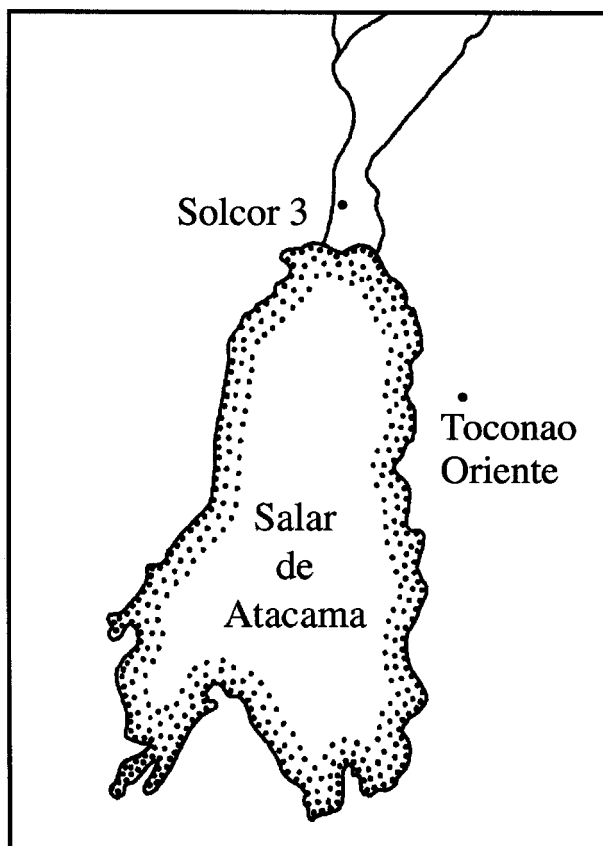


FIG. 4. San Pedro de Atacama, Chile.

Pedro de Atacama. The aridity of the Atacama Desert has allowed for excellent preservation of both skeletal remains and grave goods. Many of the skeletons from Solcor 3 are in a nearly complete state. Of the sites in the San Pedro oases, it provides very strong evidence of an interaction with Tiwanaku. Toconao Oriente was excavated during a time when only material culture, skulls, and particularly interesting skeletal remains were collected. As a result, mainly crania were available for study.

Each skull was examined visually for the presence of cranial deformation. Since vault modification relies on the visibility of the deformation as a social signifier, skulls lacking clear signs of deformation were scored as unmodified. The type of deformation was recorded using the classification system of Dembo and Imbelloni (1938) and subsequent researchers in the Andean area. Three types of deformation were observed: annular, tabular erect, and tabular oblique. As previously mentioned, annular forms involve the tight binding of the head to create a marked circumferential constriction. The more directed pressure of a tabular form results from the use of boards or stiff pads on the anterior and posterior of the skull. This appears as a flattening from front to back with compensatory expansion of the parietal region. The tab-

ular form has an erect and an oblique variant, differing in the angle of pressure placed on the back of the skull. For erect forms, the plane of pressure is perpendicular to the base of the head. In oblique variants, the plane of pressure parallels that on the frontal bone, at a roughly 45° angle from the base of the head. Despite what appears as a clear-cut classification, there is noticeable variation within any given type of cranial modification that could be the result of the deliberateness and length of the deformation process. The skull, while malleable, may not always respond to pressures in the same way.

The contents of each grave were also recorded. Some of the individuals were buried in group graves, and in these instances it was not often possible to separate the belongings of one person from the others in the tomb. Artifacts were examined to see if there was an association between the presence of cranial vault modification and artifact type. Objects clearly and exclusively evidencing Tiwanaku iconography were examined at the Solcor 3 cemetery. Subsequently, these artifacts were analyzed to determine whether Tiwanaku objects revealed a pattern in their distribution or if certain objects were overwhelmingly associated with particular individuals. Together with information about vault modification, these data provide a basis for exploring the social context of cranial deformation.

RESULTS

The frequencies of modified skulls at Toconao Oriente (45.5%; 45/99) and Solcor 3 (57.6%; 53/92) do not differ significantly ($\chi^2 = 2.82$, n.s.; table 1). This indicates that the prevalence of cranial deformation does not vary markedly through time in the oases. The ratio of males and females with cranial deformation also does not vary significantly either within sites (Toconao Oriente: $\chi^2 = 0.09$, n.s.; Solcor 3: $\chi^2 = 1.86$, n.s.; table 1) or between them ($\chi^2 = 2.22$, n.s.; table 1). This suggests that a desire to mark gender-based social differences was not a determining factor in the decision to shape a child's head.

At Toconao Oriente, tabular forms account for nearly 90% of the modified individuals (40/45; table 2). Twenty-three males and 12 females display tabular erect deformation, while 4 males and 1 female have tabular oblique

TABLE 1
Cranial Vault Modification at Toconao Oriente and Solcor 3

	Modified		Unmodified	
	<i>n</i>	%	<i>n</i>	%
Toconao Oriente				
Males	28/60	46.7	32/60	53.3
Females	17/39	43.6	22/39	56.4
Total	45/99	45.5	54/99	54.5
Solcor 3				
Males	25/49	51.0	24/49	49.0
Females	28/43	65.1	15/43	34.9
Total	53/92	57.6	39/92	42.4

TABLE 2
Types of Cranial Vault Modification at Toconao Oriente and Solcor 3

	Tabular Erect		Tabular Oblique		Annular		Frontal	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Toconao Oriente								
Males	23/28	82.1	4/28	14.3	0/28	0.0	1/28	3.6
Females	12/17	70.6	1/17	5.9	4/17	23.5	0/17	0.0
Total	35/45	77.8	5/45	11.1	4/45	8.9	1/45	2.2
Solcor 3								
Males	17/25	68.0	3/25	12.0	4/25	16.0	1/25	4.0
Females	14/28	50.0	4/28	14.3	10/28	35.7	0/28	0.0
Total	31/53	58.5	7/53	13.2	14/53	26.4	1/53	1.9

forms. There are 4 individuals, all females, with annular deformations (table 2). At Solcor 3, tabular forms are again the most frequent (38/53; table 2), constituting 41.3% of the sample and 71.7% of the deformed. The distribution of the type between the sexes is relatively even, with 18 females and 20 males displaying some form of tabular deformation. The annular form accounts for 15.2% of the population and slightly over 26% of the modified (14/53; table 2). Of these individuals, 10 are female and 4 are male.

There is a significant difference in the presence of annular forms between the cemeteries, with 4 incidences at Toconao Oriente and 14 at Solcor 3 ($\chi^2 = 6.98$, $p \leq 0.01$; table 2). Additionally, there is a significant difference between the sexes in individuals with annular deformation at both sites, since it is more common in females (Toconao Oriente: $\chi^2 = 6.41$, $p \leq 0.05$; Solcor 3: $\chi^2 = 4.04$, $p \leq 0.05$; table 2). One case was found at each cemetery that involved only the alteration of the frontal bone. Both of these individuals were male. The degree of cranial deformation was ranked on each skull from 1 to 4, independently for both the anterior and posterior portions. No skull with the annular form of deformation received a score of 4 for either aspect, although these scores were common among those with tabular forms. Therefore, no pronounced forms of annular modification were seen in either collection.

There were 11 objects with Tiwanaku iconography in the graves examined from Solcor 3, the largest number of objects of foreign influence found in this cemetery. The majority of these are snuffing paraphernalia ($n = 7$), while one is a ceramic, two are textiles (a tunic and the embroidered border of a bag), and, finally, one is an engraved camelid bone container (table 3). This small quantity suggests that their presence was the result of exchange. No tomb containing exclusively or even predominantly Tiwanaku mortuary goods existed in Solcor 3. Two of these objects, the bone container and the bag with a Tiwanaku border, belonged to a female (tomb 113; table 3). The remainder of the objects belonged to males. This is not surprising, given that many of the items are components of the snuffing complex that is overwhelm-

ingly associated with men (Torres et al. 1991:641). The ceramic piece could not be identified to owner, as it was not directly related to either of the bodies in that tomb (tomb 20; table 3).

Five of the ten individuals found with Tiwanaku objects displayed tabular erect deformation, including the female and the other individual with two objects (tomb 107, table 3). One individual had an annular deformation, and four are unmodified (table 3). Therefore, Tiwanaku objects are associated with all forms of head shape including unmodified. As a result, no pattern is evident in the relationship between the presence or type of cranial vault modification and Tiwanaku artifacts in the population from Solcor 3 ($\chi^2 = 0.19$, n.s.). Moreover, there is not a higher proportion of Tiwanaku goods in the graves of those individuals with annular deformations ($\chi^2 = 0.09$, n.s.).

DISCUSSION

The lack of a sex difference in the presence of cranial vault modification at Toconao Oriente and Solcor 3 suggests that cranial deformation was used to reinforce group differences not related to gender. Therefore, to what extent can the pattern of cranial deformation seen at Solcor 3 be explained by the presence of peoples from the Tiwanaku state? The Atacama area is generally characterized by tabular deformation, an idea that is reinforced by the data from Toconao Oriente and Solcor 3. Foreign objects from Tiwanaku were present in the graves of Solcor 3, and they serve as evidence of cultural interaction between the Chilean Atacama and the Bolivian altiplano.

The proportion of the population displaying cranial vault modification remained constant over time in the San Pedro oases at near 50%. This stands in sharp contrast to the results obtained by others in studies of Tiwanaku and its colonies. Hoshower et al. (1995) investigated cranial deformation at the site of Omo M10 southern Peru. This site has long been believed to have been a Tiwanaku colony (Moseley et al. 1991). The skeletal remains showed an overwhelming presence of cranial vault modification (32/33; 97%), much higher than any seen throughout time in the Atacama, despite the relatively small sample size. This rate is significantly different from that at Solcor 3 ($\chi^2 = 17.29$, $p \leq 0.001$). Blom et al.'s investigation of the Tiwanaku colonization of the Moquegua Valley showed equally high numbers for the Tiwanaku period at Moquegua (241/286; 84%) and for the Tiwanaku period at the site of Tiwanaku itself (30/36; 83%) (Blom et al. 1998:250). Again, both of these are significantly different from the distribution at Solcor 3 ($\chi^2 = 28.62$, $p \leq 0.001$; $\chi^2 = 7.51$, $p \leq 0.001$, respectively). The practice of cranial deformation was never as common in the San Pedro de Atacama sites as it was in the altiplano and in sites considered colonies. Cranial vault modification did not attain a significantly higher frequency during the period of Tiwanaku influence. Moreover, large portions of the population did not

TABLE 3
Relationship of Tiwanaku Objects to Cranial Vault Modification

Tomb (Catalog #)	Sex	Cranial Vault Modification	Tiwanaku Objects	Date B.P.
5 (1049)	M	Unmodified	Snuff tray	(TL) 1,060 ± 120
6 (1078)	M	Unmodified	Snuff tray	
20 (1455)	M	Annular	Ceramic ^a	(C ¹⁴) 1,220 ± 60
20 (1456)	M	Tabular erect	Ceramic ^a	
69 (2476)	M	Tabular erect	Snuff tray	
79 (2761)	M	Unmodified	Snuff tube	
103 (3599)	M	Tabular erect	Snuff tube	
107 (13118)	M	Tabular erect	Snuff tray and tunic	
113 (13120)	F	Tabular erect	Bag and bone container	
107 (13156)	M	Unmodified	Snuff tray	(C ¹⁴) 1,470 ± 60

^aOne Tiwanaku polychrome ceramic was found with the two individuals buried in tomb 20.

have modified heads, implying that they were not forced or influenced to adopt the practice.

Recent research has indicated that cranial vault modification in the Bolivian altiplano is not solely comprised of annular forms (Blom et al. 1998, Hoshower et al. 1995). At Tiwanaku, annular forms coexisted with the tabular forms more common in the lowlands. Nevertheless, the classic strong annular forms of the altiplano would be distinct in the Atacameño area and among the few moderately shaped annular forms that do exist. It is apparent that none of these exist in the Solcor 3 population. Blom et al.'s research also revealed the exclusive use of tabular oblique forms in Moquegua (1998:250). This homogeneity contrasts sharply with the variety of forms seen in Solcor 3, again suggesting the lack of a centralizing colonial authority.

Tabular forms have been repeatedly documented as the most common in the area and are considered characteristic of the Atacama (Cocilovo and Zavattieri 1994, Latcham 1938, Munizaga 1969). They are also the most frequently represented type at Solcor 3, indicating that the modification served as a sign of ethnic or community identity. The lack of any striking annular vault modification, together with the predominant use of the tabular erect form, helps in refuting the notion that there was a large physical presence of Tiwanaku peoples in San Pedro de Atacama.

The sex difference in annular forms at both Solcor 3 and the earlier site of Toconao Oriente, with significantly more women demonstrating annular modification, could suggest a different hypothesis for the presence of these forms in the Atacama. Costa and Llagostera (1994) have argued, at the later site of Coyo 3, where they found marked differences in facial morphology between males and females, for the possibility of female exogamy. A similar situation could account for the disparity at Toconao Oriente and Solcor 3. It is possible that women from areas that had different cranial vault modification practices were brought into this community, with their shaped heads remaining a permanent indicator of their foreign origin.

The increase in the proportion of individuals with annular deformation from Toconao Oriente to Solcor 3 could, however, reflect a cultural influence from the Tiwanaku state. Individuals at Solcor 3 may have used cranial vault modification as a signifier of membership or alliance with this prestigious group. The shaped head could be interpreted as identification with this distant center, bestowing prestige and authority on certain lineages (Helms 1992:161). Nevertheless, these annular forms are the minority in both the Toconao Oriente and Solcor 3 populations. The prevalence of tabular forms in the face of foreign influence is intriguing. It may have been an effort to create group cohesion or a sense of group identity through cranial vault modification. When viewed this way, head shaping could be interpreted as an attempt to preserve a distinct local identity during a time of foreign influence and expansion. This reinforces Barth's (1998) idea that groups in contact maintain their cultural differences. Cranial vault modification could thus have served as a symbolic mechanism through which ethnic boundaries were maintained and local identity was strengthened.

Examination of absolute dates together with diagnostic ceramics has allowed the identification in the Solcor 3 cemetery of early and late phases (Berenguer et al. 1988, Bravo and Llagostera 1986). Seventy-one of the 92 burials can be classified in this manner, with 23 dating to the pre/early Tiwanaku phase (ca. A.D. 400–500) and 48 to the later phase of definite cultural contacts between the two sites (ca. A.D. 500–900). However, there is no significant difference in either presence ($\chi^2 = 0.04$, n.s.) or type ($\chi^2 = 6.12$, n.s.) of modification between these two phases. Moreover, when broken down by sex, the data still show no significant temporal shifts in presence or type (Females: $\chi^2 = 0.09$, n.s., and $\chi^2 = 5.49$, n.s.; Males: $\chi^2 = 0.01$, n.s., and $\chi^2 = 3.91$, n.s., respectively). This adds more support to the idea that the relationship with Tiwanaku was not colonization but exchange.

Analysis of foreign objects at Solcor 3 yielded no relationship to cranial vault modification or to evidence of Tiwanaku individuals. The tombs contained generally

redundant grave assemblages, regardless of head shape. No tomb contained more than two Tiwanaku objects. The two individuals buried with two Tiwanaku objects (tombs 107 and 113, table 3) appear to be associated with each other and to one other individual (tomb 112, [Beta-32447, C14] 1,170 \pm 60 B.P.), since they share several objects, particularly basketry styles, not found elsewhere in the cemetery. Both 107 and 113, however, bear the local tabular erect form of head shape; the individual in tomb 112 is unmodified. While this grouping does display the highest percentage of Tiwanaku objects in Solcor 3, it also contains the only other foreign objects found in the cemetery; a Nascoïd textile bag from south coastal Peru (tomb 112) and a basket with polychrome wool decorations from the Aguada culture of northwestern Argentina (tomb 107). This demonstrates that these individuals were involved in more extensive trade networks and could explain the number of Tiwanaku objects in their tombs. A foreign population settling away from their home would be expected to bring more than mere traces of their heritage, and individuals with several, if not exclusively, foreign items should exist if this were a colonial event. This would be particularly true of representatives of the state. The distribution of these foreign goods at Solcor 3 supports the idea of exchange networks and influence from Tiwanaku rather than colonial power.

Solcor 3 itself is structured according to local tradition, and no grave shows signs of foreign influence. Tomb structure does not vary from the early to the late occupations and thus does not reflect a foreign intrusion. All of the individuals in the Solcor 3 cemetery were buried in the same fashion as those from Toconao Oriente. This style of burial occurs in the San Pedro oases throughout antiquity, and there is no deviation from this established pattern at Solcor 3. The individuals buried with foreign goods, regardless of head shape, were buried according to local practices. These data would also suggest that there was no substantial Tiwanaku colonial presence at Solcor 3.

CONCLUSION

Group identity can be constructed using the body as a medium. Cranial vault modification is a deliberate alteration of the natural state of the body that functions to convey social information. This is of particular interest in the analysis of cranial deformation at Solcor 3, given the period of foreign influence. Ethnicity, as defined by Barth, "has a membership which defines itself, and is identified by others, as constituting a category distinguishable from other categories of the same order" (1998:11). Through cranial vault modification, the body can be made into a symbol of ethnic or community identity, with members of a particular group sharing this physical characteristic that differentiates them from others.

Cranial vault modification is not merely an aesthetic choice but a social signifier of great importance. Meskell, elaborating on Foucault, argues that the body is a me-

dium for the display of social relations and, moreover, that "bodies are transformed into objects of knowledge" (1998:149). What is critical is the acknowledgment that the shaped and altered body carries an indelible symbol of membership in a social group. When viewed in this way, cranial vault modification can reveal much about the social life of the people who practiced it.

This analysis has shown that cranial vault modification in the pre-Columbian Atacama was a complex cultural phenomenon. It may be the result of a number of social forces that interacted with the behavior of the Atacameño people. The Toconao Oriente and Solcor 3 data revealed a remarkable consistency in the use of cranial vault modification through time in the San Pedro de Atacama oases. This is evidenced in both the frequency of cranial vault modification and in the continued lack of a sex difference in the practice. There is a significant sex difference among the individuals with annular modifications. This supports the notion that the population of Solcor 3, which overwhelmingly used a tabular form of vault modification, may have practiced female exogamy, perhaps with peoples from the nearby highlands or the extreme north coast of Chile. Tabular forms remained the most common type of deformation throughout the human occupation of this area. The transition from early to late phases in the Solcor 3 cemetery does not show a disruption in the practice. These facts imply a continuity in the ethnic group that occupied these oases. Nevertheless, differences documented from Toconao Oriente to Solcor 3 do suggest a reaction to the influence of the Tiwanaku state.

The material culture does not reflect a shift of great magnitude or an assimilation of this foreign group and ideology into Atacameño identity. The lack of any artifacts displaying a hybridization of Atacameño and Tiwanaku iconography or style points to a more distant relationship. The small number of foreign artifacts also speaks to long-distance trade. Furthermore, no individuals bearing signs of colonial power are archaeologically visible. This raises the question of whether the change in the pattern of cranial deformation was the result of direct control or of the emulation of a prestigious foreign group. Given the information gleaned from analyses of mortuary goods and tomb structure, it does not appear that large numbers of colonists or emissaries from the Tiwanaku state were buried at Solcor 3. However, by incorporating a different style of cranial modification the local population may have been strengthening and making overt its ties to this prominent outside group. Direct control of the oases by the Tiwanaku state seems unlikely given the lack of visible Tiwanaku individuals or a homogenization of the custom. Nevertheless, the modification data and the presence of foreign goods indicate a relationship between these two societies.

There is evidence demonstrating the cultural influence of the Tiwanaku state, both in grave goods and potentially in cranial vault modification. The strengthening of the relationship with Tiwanaku during the Solcor 3 period was mirrored in the rise of annular deformation in the population. In this case, the body was modified

to demonstrate this social relationship. Perhaps Tiwanaku was regarded as a prestigious foreign power with which alliances were forged and trade networks were established. Some members of this community may have emulated the foreign pattern to add an exotic or distant element to their identity, while the persistence of tabular forms may have aided in boundary building and the creation of a distinct identity. The Atacameños, using their material culture in concert with the typical, local form of cranial vault modification, maintained a separate cultural identity during this period of foreign influence.

References Cited

- BARTH, FREDRIK. 1998. "Introduction," in *Ethnic groups and boundaries*. Edited by Fredrik Barth, pp. 9–38. Prospect Heights: Waveland Press.
- BERENGUER, JOSÉ, VICTORIA CASTRO, AND OSVALDO SILVA. 1980. Reflexiones acerca de la presencia de Tiwanaku en el norte de Chile. *Estudios Arqueológicos* 5:81–93.
- BERENGUER, JOSÉ, AND PERCY DAUELSBERG. 1989. "El norte grande en la órbita de Tiwanaku," in *Culturas de Chile: Prehistoria desde sus orígenes hasta los albores de la conquista*. Edited by Jorge Hidalgo L., Virgilio Schiappacasse F., Hans Niemeyer F., Carlos Aldunate del Solar, and Ivan Solimano R., pp. 221–26. Santiago: Editorial Andrés Bello.
- BERENGUER, JOSÉ, ALVARO ROMÁN, ÁNGEL DEZA, AND AGUSTÍN LLAGOSTERA. 1988. Testing a cultural sequence for the Atacama Desert. *CURRENT ANTHROPOLOGY* 29:341–46.
- BLOM, DEBORAH E., BENEDIKT HALLGRIMSSON, LINDA KENG, MARÍA C. LOZADA, AND JANE E. BUIKSTRA. 1998. Tiwanaku "colonization": Bioarchaeological implications for migration in the Moquegua Valley, Peru. *World Archaeology* 30:238–61.
- BRAIN, ROBERT. 1979. *The decorated body*. London: Hutchinson.
- BRAVO, LEANDRO, AND AGUSTÍN LLAGOSTERA. 1986. Solcor 3: Un aporte al conocimiento de la cultura San Pedro, período 500 al 900 d.C. *Chungará* 16–17:323–32.
- BROWMAN, DAVID L. 1980. "Towards the development of the Tiahuanaco (Tiwanaku) state," in *Advances in Andean archaeology*. Edited by David L. Browman, pp. 327–49. The Hague: Mouton.
- . 1997. "Political institutional factors contributing to the integration of the Tiwanaku state," in *Emergence and change in early urban societies*. Edited by Linda Manzanilla, pp. 229–43. New York: Plenum Press.
- COCILOVO, JOSÉ, AND MARÍA ZAVATIERRI. 1994. Biología del grupo prehistórico de Coyo Oriental (San Pedro de Atacama, Norte de Chile). 2. Deformación craneana artificial. *Estudios Atacameños* 11: 135–44.
- COSTA, MARÍA ANTONIETTA, AND AGUSTÍN LLAGOSTERA. 1994. Coyo-3: Momentos finales del período medio en San Pedro de Atacama. *Estudios Atacameños* 11:73–108.
- DEMBO, ADOLFO, AND JOSÉ IMBELLONI. 1938. *Deformaciones intencionales del cuerpo humano de carácter étnico*. Buenos Aires: J. Anesi.
- GERSZTEN, PETER C. 1993. An investigation into the practice of cranial deformation among the pre-Columbian peoples of northern Chile. *International Journal of Osteoarchaeology* 3: 87–98.
- HELMS, MARY. 1992. "Long-distance contacts, elite aspirations, and the age of discovery in cosmological context," in *Resources, power, and interregional interaction*. Edited by Edward Schortman and Patricia Urban, pp. 157–74. New York: Plenum Press.
- HOSHOWER, LISA M., JANE E. BUIKSTRA, PAUL S. GOLDSTEIN, AND ANNE D. WEBSTER. 1995. Artificial cranial deformation at the Omo M10 Site: A Tiwanaku complex from the Moquegua Valley, Peru. *Latin American Antiquity* 6: 145–64.
- IMBELLONI, JOSÉ. 1924–25. Estudios de morfología exacta. 3. Deformaciones intencionales del cráneo en Sudamérica. *Revista del Museo de La Plata* 28:329–407.
- JONES, SIÂN. 1995. "Discourses of identity in the interpretation of the past," in *Cultural identity and archaeology: The construction of European communities*. Edited by Paul Graves-Brown, Siân Jones, and Clive Gamble, pp. 62–80. London: Routledge.
- KOLATA, ALAN. 1993. *The Tiwanaku: Portrait of an Andean civilization*. Cambridge: Blackwell.
- LATCHAM, RICARDO. 1937–38. Deformación del cráneo en la región de los atacameños y diaguitas. *Anales del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"* 39:105–23.
- LE PAIGE, GUSTAVO. 1971. "Tres cementerios indígenas en San Pedro de Atacama y Toconao." *Actas del Congreso Nacional de Arqueología Chilena*, pp. 163–87. Santiago: Museo Nacional de Historia Natural.
- LLAGOSTERA, AGUSTÍN, AND MARÍA ANTONIETTA COSTA. n.d. *Patrones de asentamiento en el período agroalfarero de San Pedro de Atacama (norte de Chile)*. Proyecto FONDECYT 90/0081. MS.
- MARROQUIN, JOSÉ. 1944. El cráneo deformado de los antiguos aimaras. *Revista del Museo Nacional* 13:15–40.
- MESKELL, LYNN. 1998. "The irresistible body and the seduction of archaeology," in *Changing bodies, changing meanings: Studies on the human body in antiquity*. Edited by Dominic Montserrat, pp. 139–61. New York: Routledge.
- MOSELEY, MICHAEL, ROBERT FELDMAN, PAUL GOLDSTEIN, AND LUIS WATANABE. 1991. "Colonies and conquest: Tiahuanaco and Huari in Moquegua," in *Huari administrative structure: Prehistoric monumental architecture and state government*. Edited by William Isbell and Gordon McEwan, pp. 121–40. Washington, D.C.: Dumbarton Oaks.
- MUNIZAGA, JUAN. 1969. "Deformación craneana intencional en San Pedro de Atacama." *Actas del Congreso Nacional de Arqueología Chilena*, pp. 129–34. La Serena: Museo Arqueológico de La Serena.
- NUÑEZ, LAUTARO, AND TOM DILLEHAY. 1995. *Movilidad giratoria, armonía social y desarrollo en los Andes Meridionales: Patrones de tráfico e interacción económica*. Antofagasta: Universidad Católica del Norte.
- ORELLANA R., MARIO. 1985. Relaciones culturales entre Tiwanaku y San Pedro de Atacama. *Diálogo Andino* 4:247–57.
- RODMAN, AMY OAKLAND. 1992. Textiles and ethnicity: Tiwanaku in San Pedro de Atacama, Chile. *Latin American Antiquity* 3:316–40.
- SERRACINO, GEORGE. 1980. Tiwanaku desde San Pedro de Atacama. *Estudios Arqueológicos* 5:95–106.
- THOMAS W., CARLOS M., ANTONIA BENAVENTE A., AND CLAUDIO MASSONE M. 1985. Algunos efectos de Tiwanaku en la cultura de San Pedro de Atacama. *Diálogo Andino* 4: 259–75.
- TORRES, CONSTANTINO M., AND WILLIAM CONKLIN. 1995. "Exploring the San Pedro de Atacama/Tiwanaku relationship," in *Andean art: Visual expression and its relation to Andean beliefs and values*. Edited by Penny Dransart, pp. 78–108. Hampshire: Avebury.
- TORRES, CONSTANTINO M., DAVID B. REPKE, KELVIN CHAN, DENNIS MC KENNA, AGUSTÍN LLAGOSTERA, AND RICHARD EVANS SCHULTES. 1991. Snuff powders from pre-Hispanic San Pedro de Atacama: Chemical and contextual analysis. *CURRENT ANTHROPOLOGY* 32:640–47.

Are Peasants Risk-Averse Decision Makers?¹

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For decades, researchers studying small-scale, subsistence-oriented farmers have sought to explain why these “peasants” seem slow to acquire new technologies, novel agricultural practices, and new ideas from the larger societies that have engulfed them. The early work on this question suggested that this “cultural conservatism” resulted from things like a rigid adherence to tradition or custom (Hoffman 1996), a cognitive orientation toward a “limited good” (Foster 1988), or ignorance and lack of education. In response to such explanations, much of the subsequent debate on this issue has focused on showing that this seeming conservatism actually results from rational cost-benefit analysis in which individuals make risk-averse decisions because of their uncertain and precarious economic situations (e.g., Turner 1996, Netting 1993, Gladwin 1979, Ortiz 1979, Schluter and Mount 1976, Scott 1976, Norman 1974, Johnson 1971, Wharton 1971, Lipton 1968). To inform this approach, we have combined comparative experimental field studies with economically oriented ethnography among two groups of small-scale farmers, the Mapuche of Chile and the Sangu of Tanzania. Our experiments, which were designed to measure risk preferences directly, indicate that both the Mapuche and Sangu are *risk-preferring* (not risk-averse) decision makers in the standard economic sense—suggesting that subsistence farmers more generally may not be risk-averse either. Furthermore, while sex, age, land holdings, and income do not predict risk preferences and wealth is—at most—only marginally predictive, what does seem to predict risk preferences in our monetary gambles is “cultural group.” Although such experimental findings carry important caveats, they suggest that standard views of risk-averse decision making may not be the best theoretical tools for understanding “peasant conservatism” or the behavioral patterns often attributed to “rational risk aversion.”

Our discussion proceeds as follows: First, we sketch

two standard models of risk preferences that seek to capture what researchers mean when they describe behavior as “risk-averse.” Second, we introduce the ethnographic field sites where the experimental and ethnographic research was performed and describe the methods used. Third, we report the basic experimental results. Fourth, we examine our results in light of the standard approaches to risk and discuss some caveats and challenges to interpreting our experimental risk data. Finally, we briefly introduce a theoretical alternative to generalized, risk-averse cost-benefit decision making that can generate patterns of adaptive risk-managing behavior without requiring individuals to make complex, risk-averse calculations.

WHAT RESEARCHERS MEAN BY “RISK AVERSION”

Many economic anthropologists have used the term “risk aversion” without definition, in imprecise ways, or in ways that may deviate from its standard usage in economics textbooks (Cashdan 1990, Chibnik 1990). Consequently, in order to clarify exactly how our evidence addresses previous work on risk and peasants, we have delineated two categories that seek to capture the ways in which anthropologists and peasant researchers have employed “risk aversion.”

Decreasing marginal utility. Economists have attempted to capture the concept of risk aversion by formalizing the idea that as individuals get more and more of something they value each additional increment less and less. If we were giving you eggs, you might value the first two or three eggs quite highly (especially if you are planning breakfast), the 6th and 7th a bit less, and the 49th and 50th hardly at all. Mathematically, economists describe such individuals as having concave utility functions—as their wealth increases, the additional value (additional “utility”) of an additional unit of wealth decreases. In this approach, individuals select among alternative practices or options by computing the expected utility associated with each option and then choosing the one with the higher expected utility. When at least one of the choices presents variable (risky) outcomes, individuals who are maximizing expected utility will sometimes make choices that offer lower average incomes but less income variation because their utility curves give greater values to initial gains than to subsequent gains. From this perspective, farmers are risk-averse because of the concave shape of their utility curves. In contrast, risk-neutral farmers would have straight-line utility curves and always prefer the option with higher expected income/wealth. Risk-prone farmers would have convex utility curves (accelerating upward instead of decelerating downward) and prefer options with more variation, even when the expected income from a high-variance option is less than from a low-variance option. Although this approach has been developed primarily by economists, anthropologists continue to make use of it (e.g., Kuznar 2001, Winterhalder, Lu, and Tucker 1999).

Risk and uncertainty. Many economists (e.g., Knight

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1921) and anthropologists (e.g., Chibnik 1990, Cancian 1989) have worried about the difference between risk and uncertainty (or ambiguity). Traditionally, risk involves known probabilities, such as the chance of getting "heads" on flipping a coin. In contrast, uncertainty involves choices with unknown probabilities, such as the chances of finding a book entitled *The Internet's Swan Song* in the library today. In the real world, pure risk and absolute uncertainty are two poles of a continuum, and we are almost always somewhere in the middle. Even in coin flipping, where the probabilities of the two outcomes seem "known," there is always some unknown chance that the coin is a trick coin or unbalanced because of random variation in minting or design differences. At the other end of the continuum, in sowing a novel seed, for example, farmers at least know how similar seeds usually perform and what the upper and lower bounds of production are, so they are never completely uncertain. This continuum can be incorporated into the expected utility framework described above, as long as individuals compute subjective probabilities or probability distributions based on what they know and then use these to maximize their expected utility. As we will show, our data indicate that Mapuche farmers treat risky and uncertain bets in similar ways (cf. Cancian 1989) and that wealth predicts neither risk nor ambiguity preferences.

Satisficing or safety-first. Researchers have also hypothesized that farmers, nonhuman animals, and foragers make decisions (i.e., select among alternative actions) in order to minimize their chances of falling below some subsistence minimum—which may be culturally or biologically defined, depending on the researcher (Winterhalder 1990; Winterhalder, Lu, and Tucker 1999; Real and Caraco 1986; Johnson 1971; Schultz 1964:31). Intuitively, these well-studied models propose that when individuals face a choice between economic strategies, they will select the strategy that gives them the lowest probability of falling below some "subsistence threshold" or "economic minimum," regardless of the expected yields generated by alternative strategies. For example, suppose that a farmer must choose between two crops, a traditional crop that provides a very reliable yield (with little variation) and a green-revolution technology that produces a higher average yield but is quite sensitive to fluctuating local conditions and the nuances of farmers' techniques (thus producing more variation in yields from year to year). Depending on the details, "safety-first" farmers may prefer the lower-yielding but more reliable traditional crop because the green technology's higher variation in yields may increase their chances of not being able to feed their families. Such models predict that wealthier individuals—those above the subsistence threshold—should be risk-averse while those below the threshold should be risk-seeking. These models are common both in studies of risk-sensitive foraging (Stephens and Krebs 1986) and in the analysis of capital assets and portfolio composition (Nicholson 1995). Roumasset (1976) has a discussion directly related to farming risk.

ETHNOGRAPHIC CONTEXT

Before digging into the research methodology and results, we provide a brief ethnographic sketch of the three cultural groups discussed. We assume that the reader is sufficiently familiar with the lifeways of the fourth group, undergraduates at the University of California, Los Angeles, that no ethnographic description is warranted.

The Mapuche. This description of the Mapuche derives from Henrich's work in the farming communities of Carrareñi, Cautinche, and Huentelar, around the rural town of Chol-Chol. In this cool, wet, Mediterranean climate, Mapuche households live on widely scattered farms that range in size from 2 to 38 hectares, with an average size of around 9 hectares. All households practice a form of three-field cereal agriculture using steel plows and two-ox teams. Most households subsist primarily on wheat (consumed in the form of bread), but many also produce oats, used only as animal feed. Households supplement their diets with seasonably available vegetables (e.g., tomatoes, onions, garlic, and chiles), legumes (e.g., peas, lentils, and beans) and livestock (chickens, cows, horses, sheep, and pigs), as well as some store-bought foods (e.g., salt, sugar, rice, noodles). Cash income to buy these foods and other goods such as cooking oil, chemical fertilizers, and school supplies derives from a number of other sources, including (listed in decreasing degree of importance) selling livestock (mostly cows and pigs), selling lumber (fast-growing pines and eucalyptus trees), performing part-time wage labor, and selling cottage crafts (often traditional Mapuche clothing).

Mapuche households are socially and economically quite independent. Although goods are frequently exchanged between neighboring households (which are almost always recognized as kin in some fashion), these are usually straight cash-for-goods transactions, though interest-free credit is readily extended. Families buy meat, vegetable seed, and homemade wine (*pulco*) from one another. Labor is most commonly exchanged reciprocally between friends and relatives. Group labor parties or *mingacos*, traditionally used during planting and harvesting, have become quite rare, except among elderly households. Land is rarely bought or sold (and it is now illegal for a Mapuche to sell land to a non-Mapuche). However, many land-poor households sharecrop on the land of neighboring Mapuches, though land is never rented. Sharecroppers receive access to one or two hectares of land for a year in exchange for 50% of the yield. If chemical fertilizers or other inputs are employed, the costs are split 50/50.

The Huinca. The Mapuche commonly use the term "Huinca" to refer to the non-Mapuche Chileans who inhabit the lands and towns that surround them. We have adopted this term to distinguish the Mapuche from the non-Mapuche inhabitants of the small, rural town of Chol-Chol. We used the Huinca as a control group with regard to influences of the regional economy and the local environment. All the Huinca in the study group grew up in Chol-Chol. Most work in low- or minimum-wage jobs, often in construction, on road crews, or as

well-diggers and painters. A few were older high-school students or "preuniversity" students, although no one was younger than 17 years. Although the Huinca and the Mapuche have intermixed, interacted, intermarried, and interbred for hundreds of years, the Huinca/Mapuche distinction remains quite salient throughout the region. Everyone knows and agrees on who is a Huinca and who is a Mapuche.

The Sangu. The Sangu are agro-pastoralists in southwestern Tanzania. They originated from Bantu peoples that intermixed in the region during the late 1800s and early 1900s, when they united under a hereditary chief and began raiding their neighbors for wealth and livestock (Shorter 1972, Wright 1971). Most now live in sedentary agricultural communities, where farmers produce corn (and some rice) and raise cattle on an average parcel of one acre for an average family of six people. Cattle are the greatest measure of wealth, though some farmers do sell rice (which they then use to buy corn). Wage work is very scarce and desirable. Until recently, the Sangu have had little market contact, but now they use the market to sell grain and buy most living and farming supplies.

There is great diversity in lifestyle among the Sangu. Since 1997, McElreath has been working with two Sangu communities: Utengule and Ukwaheri. Utengule residents live in very closely spaced settlements, with homes often less than 10 m apart, and the vast majority of households farm corn and rice and own no livestock. A small number make a living off transport between Utengule and the road (about 10 miles) or by selling imported goods in the market. Most people under 25 years of age in Utengule have had some primary schooling, and many of them can read and write at a basic level. Ukwaheri ("place of blessings") is less a town or village than a region of interrelated communities. Ukwaheri lies about 35 km north and east of Utengule, in the dry region of the plains. Household compounds are very scattered: distances of 1–2 km are the norm. Most residents own some livestock, and those with larger herds (typically > 20 cattle) practice transhumance. Access to markets is much more restricted in this area, and family sizes can be considerably larger than in Utengule, as wealthy herders marry as many as five or six wives, each mothering an average of four or five surviving children. Very few people of any age in Ukwaheri region can read or write anything beyond their own names.

METHODS AND RESULTS

We conducted two binary-choice lottery experiments: the titration experiment, with Mapuche, Huinca, and Sangu, and the variance experiment, with Mapuche, Sangu, and University of California, Los Angeles, undergraduates.

The titration experiment. The titration experiment is designed to compute the *certainty equivalent* or indifference point for a risky option. By asking participants to choose among a series of binary choices involving some sure amount of money (option A) and a fixed risky

bet (option B), one can home in on the approximate point at which participants become indifferent between a fixed amount of money and a risky bet and thereby assign a value to the risky option (the fixed amount value = the "certainty equivalent"). Risk-neutral expected-value theory predicts that this certainty equivalent will be the expected value of the risky option. The point above 1,000 pesos at which respondents switch to preferring the sure thing determines their indifference point and provides a measure of their risk preference. If, for example the risky bet is a 50% chance at 2,000 pesos (and 50% at 0 pesos), then risk-neutral individuals should be indifferent between 1,000 pesos with certainty and this 2,000-peso gamble. Risk-averse individuals will prefer the 1,000-peso option over the 2,000-peso gamble. In contrast, risk-seeking people will prefer the risky bet and not become indifferent until the sure bet rises above 1,000 pesos (higher than the expected value of the risky bet). Economists and psychologists have performed many such experiments with university undergraduates and generally found them to be moderately risk-averse (e.g., Holt and Laury 2000).

Here we discuss the procedure using the peso amounts for the Mapuche. The money amounts used in the Mapuche/Huinca and Sangu experiments were equivalent to one-third of a day's wage (the expected value of the risky gamble) in the local economy. Our experimental procedure used a sequence of three binary choices (A or B) to estimate an individual's indifference point. First, Mapuche and Huinca participants faced a choice between 1,000 pesos (40% of a day's wage) for sure (option A) and a 50% chance at 2,000 pesos (and a 50% chance at 0). (The corresponding choices for Sangu participants were 400 shillings and a 50% chance at 800 shillings.) If the participant picked the risky bet (option B) in the first round, we would "sweeten" option A in the next round by increasing it from the 1,000 pesos to 1,500 (with option B remaining the same). If the participant picked the safe bet (option A) in round 1, we would "sour" option A, reducing it to 500 pesos—the idea being to "sweeten" or "sour" the safe bet until the participant switched from the risky to the safe bet or vice versa. Round 2 was administered much like round 1. If the participant picked the risky bet on round 2, we would increase the value of the safe bet by 300 pesos in round 3 (to either 1,800 or 800, depending on the participant's previous choices). If the participant picked the safe bet on round 2, we would decrease the value of option A to either 1,300 or 300 pesos—again depending on the previous choices. Indifference points were recorded as the amount halfway between the sure bet in round 3 and the nearest known decision point. For example, if a participant picked A in round 1, round 2 became a choice between 500 pesos for sure and a 50% chance of 2,000 pesos. If the participant then picked B, round 3 became a choice between 800 pesos for sure and the 2,000-peso gamble. If the participant then picked B again, the indifference point was recorded as 900 pesos (he picked A when it was 1,000 pesos and B when it was 800 pesos). After round 3 was completed, participants flipped the

coin for any risky bets and Henrich paid them the total amount owed. (McElreath, working with Sangu, played the bets as participants made their choices and paid after each round.) When all rounds were complete, we interviewed participants about why they had made particular choices.

Figure 1 shows the results of the titration experiment for the Mapuche and Huinca. The horizontal axis gives the eight possible indifference points between zero and 2,000 pesos. The vertical axis is the frequency of individuals who arrived at each indifference point. Risk neutrality would lead to an average of 1,000 (the expected value of the 2,000-peso gamble is 1,000 pesos). Comparing Mapuche farmers with their Huinca neighbors shows that Mapuche are *risk-prone* relative to both risk neutrality and the relatively risk-averse Huinca. Most Mapuche indifference points are well above 1,000, although a few Mapuche are quite risk-averse. The mean indifference point for the Mapuche is 1,400 pesos (with standard deviation of 474). This means that, on average, Mapuche farmers are indifferent between 1,400 pesos and a 50% chance of 2,000 pesos. In contrast, over 80% of Huinca indifference points are below 1,000 pesos and therefore *risk-averse*. The mean indifference point for the Huinca is 790 pesos (with standard deviation of 354). The Mapuche and Huinca data are very unlikely to arise from the same underlying distribution (Mann-Whitney test, $p < 0.0001$). Regression analyses yield a similar finding. Table 1 shows the results of a multivariate regression analysis on the Mapuche and Huinca titration dataset. This linear model includes age, sex, head of household (as a dummy variable), and cultural group (Mapuche = 1, Huinca = 0). It shows that, controlling for these other variables, cultural group is the only large and well-estimated predictor of risk preferences. However, it remains unclear exactly which of the many differences between the Huinca and Mapuche our cultural-group

TABLE 1
Regression of Economic Variables on Indifference Points for Mapuche and Huinca Datasets Combined

Economic Variable	Std.β	Significance
Household head ^a	0.15	0.39
Age	0.13	0.48
Sex ^a	-0.035	0.79
Cultural group ^a	0.63	< 0.0001

^aDichotomous variables. For sex, male = 1; for cultural group, Mapuche = 1, Huinca = 0.

variable represents. These data indicate that the difference does not arise from differences in the controlled variables, wealth or income (see below), but the cultural-group variable may be picking up differences related to occupation (farming versus wage labor), settlement pattern (town versus scattered households), or primary school education. Research is currently under way to explore these possibilities.

The above findings are consistent with previous experimental work using a large sample ($n = 175$) of U.S. undergraduates, business-school students, and university faculty using a similar methodology. Holt and Laury (2000) found that age, sex, income, and wealth failed to predict any significant proportion of the variation in risk preferences across their high-stakes sample. The only individual-level variable that did predict high-stakes risk preferences, controlling for age, sex, wealth and income, was "being Hispanic" (mostly Cubans from Miami), which predicted substantially less risk aversion. This result is similar to our findings regarding the cultural-group variable, although all these subjects were very risk-averse compared with the Mapuche.

The Sangu titration data reveal similar patterns. Sangu are risk-prone in an absolute sense and compared with Huinca, although slightly less risk-prone than Mapuche. Standardizing to the expected value of the risky game, the mean indifference point for the Sangu is 1.37 (standard deviation 0.56), compared with 1.4 (1,400/1,000) for Mapuche and 0.79 for the Huinca. As for U.S. students, Huinca, and Mapuche, neither sex nor age predicts risk preference (see table 2). (Wealth and income effects are discussed below.)

Kuznar (2001) employs a method somewhat similar to our titration experiment and shows Andean Aymara pastoralists to be risk-averse. His method has two important differences, however. First, instead of real money he uses hypothetical stakes that may fail to focus informants' attention on the economic issues of the experiment. Instead, when actual economic stakes are 0 (hypothetical), all kinds of other concerns come to predominate in the decision process. Informants may be concerned with what the ethnographer will think of them or what other people will infer about them from their decisions. We put large stakes on the line to focus the informants' attention on the game payoffs rather than on exogenous

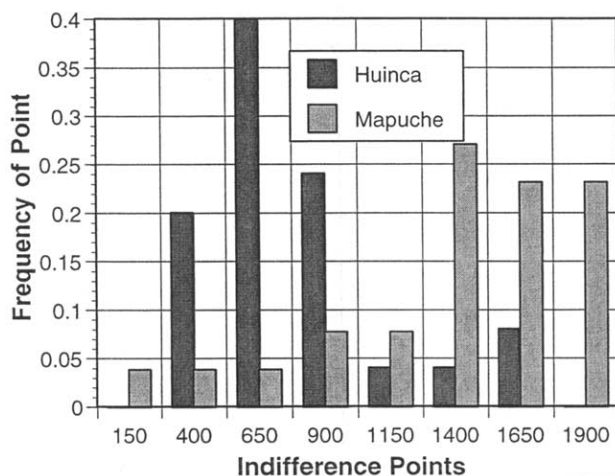


FIG. 1. Results of the titration experiment for Huinca ($n = 25$) and Mapuche ($n = 26$).

TABLE 2

Regression of Economic Variables on Indifference Points for Mapuche, Huinca, and Sangu Datasets Separately

Economic Variable	Mapuche (<i>n</i> = 24) Std. β (<i>p</i> Value)	Huinca (<i>n</i> = 24) Std. β (<i>p</i> Value)	Sangu (<i>n</i> = 42) Std. β (<i>p</i> Value)
Total land owned	-0.065(0.83)	—	—
Age	-0.26(0.32)	-0.075(0.78)	-0.23(0.17)
Sex ^a	-0.22(0.32)	0.20 (0.47)	-0.23(0.17)
Animal wealth per household member	0.47 (0.12)	—	0.32(0.86)
Income	—	-0.12(0.69)	—
Acres of corn cultivated	—	—	0.36(0.07)
Acres of rice cultivated	—	—	-0.14(0.39)

^aDichotomous variable.

social concerns. This does not by any means eliminate such exogenous factors, but it should reduce their impact on decision making and give us a better chance at measuring risk aversion (as opposed to, for example, what the informant thinks the ethnographer wants him to say). Further, Holt and Laury (2000) have demonstrated that hypothetical risk-measuring methods yield quite different results from those found in identical paid experiments. For this reason, the use of hypothetical stakes is considered unacceptable in experimental economics (Hertwig and Ortmann 2001). Second, Kuznar uses live-stock amounts instead of money gambles, and it is possible that different currencies tap into different sets of decision rules.

The variance experiment. The basic structure of the variance experiment is similar to that of the titration experiment. The goal of the experiment is to explore how variation in outcomes influences economic decisions when the expected value of the options is the same. The expected value (average return) of both options in all four rounds is the same (1,000 pesos for Mapuche, 400 shillings for Sangu, and \$15 for the undergraduates). What varies across rounds is the variance in outcomes.

In round 1, participants faced a choice between (in the case of the Mapuche) 1,000 pesos for sure and a 50% chance of 2,000 pesos. (The corresponding choices for Sangu participants were 400 shillings and a 50% chance at 800 shillings, for the university undergraduates \$15 and a 50% chance of \$30.) A coin was used to illustrate and generate a 50/50 chance. In round 2, participants chose between 1,000 pesos for sure and a 20% chance of 5,000 pesos (and an 80% chance of 0). In round 3, participants selected either 1,000 pesos for sure or an 80% chance of 1,250 pesos. In rounds 2 and 3, probabilities were illustrated using five cards (four with X's and one with a Z; the Sangu received red and blue cards in the same proportions instead). To play, participants selected one card. Round 4 had two possibilities: (1) 1,000 pesos for sure or a 5% chance of 20,000 pesos (and a 95% chance of nothing) and (2) 1,000 pesos or an "unknown chance" of 5,000 pesos. To illustrate the "unknown

chance," a new stack of cards was brought out, and participants were instructed that "some cards in the stack have X's (winners) and some are blank, but you don't know how many of each are in the stack"—this is an *ambiguous* bet, as opposed to a *risky* bet. The Sangu and the undergraduates received only risky bets in this round.

Figure 2 shows the frequency of risky bets (option B) for each of the five possible gambles in our three different groups: the Mapuche, the undergraduates, and the Sangu. The graph reveals substantial behavioral differences for the highest-variance gambles, 20% and 5%. Given a choice between 1,000 pesos for sure and a 20% chance of 5,000 pesos, 78% of Mapuche preferred the risky option, while only 20% of the undergraduates took the risky gamble ($p = 0.00044$). For the highest-variance gamble, 67% of Mapuche and only 20% of the undergraduates preferred the risky bet ($p = 0.05$). For the lowest-variance bet, with an 80% chance of winning, Mapuche were still significantly more risk-seeking than the undergraduates, who were approximately risk-neutral. Over 80% of Mapuche and only 55% of the undergraduates preferred the risky bet ($p = 0.078$).² Sangu risk preferences generally paralleled the Mapuche.³

The students' strong preference for the risky bet when the chances were 50/50 may at first seem puzzling, deviating as it does from their preferences on both sides of the 50/50 gamble and matching the preferences shown by the otherwise risk-prone Mapuche and Sangu. This strong preference of the students for 50/50 gambles replicates previous findings in similar laboratory research

2. These p values are cumulative binomial probabilities that give the chances of picking the undergraduate sample (or one with fewer risky picks) via a random draw from a distribution matching the combined Mapuche and undergraduate samples. If the undergraduate samples are compared with the distribution matching the Mapuche only, then the p values for the 80%, 20%, and 5% bets are 0.0084, 5.78×10^{-8} , and 6.22×10^{-5} respectively.

3. The Sangu results also provide a number of interesting puzzles, but for our purposes what they confirm is that another group of small-scale, partially market-integrated, culturally distinct people (living on another continent) behave quite similarly to the Mapuche and quite differently from the students.

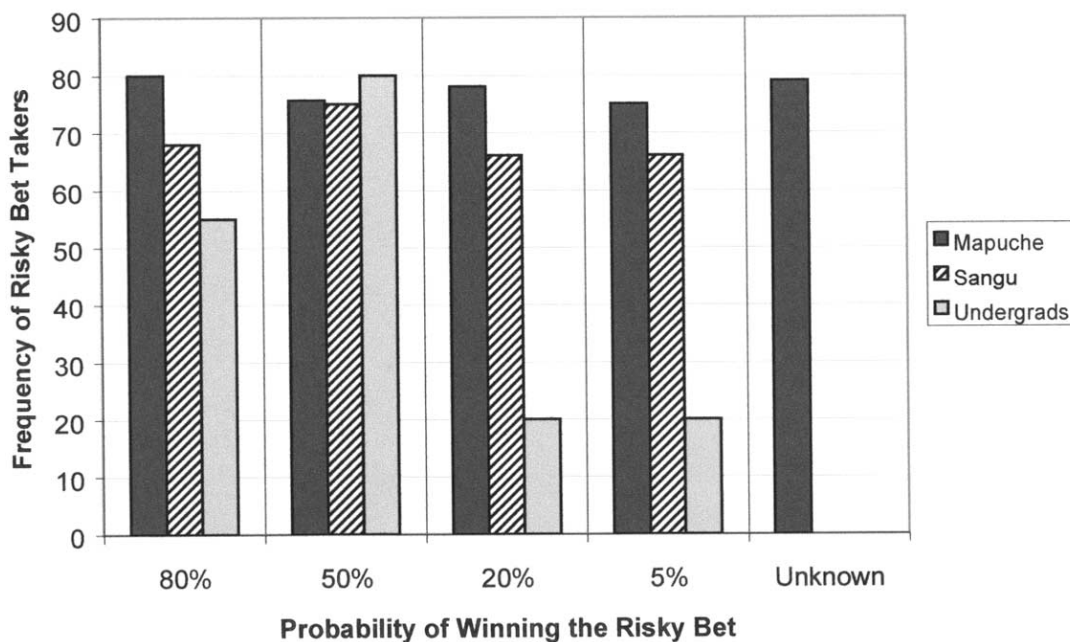


FIG. 2. Frequency of risky gambles with different amounts of outcome variance. Sample sizes are $n = 41$ for all Mapuche at 80%, 50%, and 20%, $n = 12$ for 5%, and $n = 29$ for unknown bet. For Sangu, $n = 76$ for 50% and $n = 38$ for other bets. For students, $n = 20$ for 80%, 50%, 20%, and 5%.

(Edwards 1953, Coombs and Pruitt 1960). Coombs and Pruitt (p. 273) suggest that their subjects may have preferred the 50/50 bets because "they are regarded as 'fair bets,' and perhaps because they are simpler bets, more easily comprehended than some of the others." In part, our postgame interviews and observations concur with their suggestion. When Henrich asked participants why they picked the risky bet on the 50/50 gamble, students often respond with something like "50/50 is a good chance" or "It's fair." However, in general, our evidence runs counter to the proposal by Coombs and Pruitt that participants understood the 50/50 gamble better than the other gambles. In round 1 of the titration experiments which involved the same 50/50 gamble, only 16% of the risk-averse Huinca picked the risky bet. This risk-averse behavior is quite consistent with the Huinca's generally risk-averse behavior in the titration experiment and with the pattern of risk aversion shown by the students in the variance experiment for the 20% and 5% gambles but quite different from the strong preference shown by the students in 50/50 gambles.

The bar at the far right of figure 2 shows the frequency of Mapuche farmers' taking the risky bet when they faced a choice between a guaranteed 1,000 pesos and an unknown chance at 5,000 pesos. Instead of displaying the ambiguity aversion found among typical student subjects (Camerer and Weber 1992), the Mapuche preferred this uncertain option over the certain option with about the same frequency as they preferred the other risky gambles. This finding calls into question the idea that am-

biguity aversion is standard component of our species-typical cognitive architecture (Rode et al. 1999). Perhaps undergraduates learn, as a consequence of growing up in a particular place, to fear uncertainty (and risk) in dealing with money.

DISCUSSION

In the following discussion we explore the relationship between economic/demographic variables and experimentally derived risk preferences, examine our results in light of the two risk models discussed earlier, present alternative interpretations of our results, and address some common concerns about methods and field measurement.

Economic/demographic variables. Although expected utility maximization does not make any predictions about the effect of wealth on risk preferences without some further specification of the shape of the utility curve, many economists and economic anthropologists have the intuition that wealthier individuals should be more risk-prone. If wealth were an important variable, then one might endeavor to explain the risk-preference differences between these groups as a consequence of their average differences in wealth. Without any further analysis, it is clear that the intuition that wealthier groups should be more risk-prone is not supported. To the contrary, if we compare the Mapuche and the Sangu with the undergraduates, the poorer groups are substantially more risk-prone than the richer undergraduates.

Additionally, the students and the Huinca are both risk-averse, but the Huinca are much poorer. Comparing the wealth of the Huinca and the Mapuche is difficult because the Mapuche have lower social status and less cash on hand than the Huinca but more wealth in land and animals. If land and animals can be converted into cash (which they can but not easily or quickly), the Mapuche are wealthier than the Huinca. However, both Mapuche and Huinca consider the Mapuche poorer and lower in social status.

Using the titration experiment data, table 2 shows the standardized regression coefficients and *p* values for a series of economic variables regressed on indifference points. For the Mapuche, age, sex, animal wealth per household member, and total land (owned by the household) are used to predict indifference points. Animal wealth per household member captures most of the stored wealth possessed by households except for their land (and land is difficult to sell because Mapuche can only sell to other Mapuche). None of these variables explain any significant proportion of the variation in indifference points, although animal wealth per household member is marginally significant (using just animal wealth makes the fit worse). For the Huinca, sex, age, and income fail to predict indifference points. Including a dummy variable for head of household in these regression models does not change the qualitative results. Further, regression analyses on the Mapuche that included numbers of cows, oxen, horses, and pigs as individual covariates yielded only negative results. In the Sangu data, total acres of corn per household has a sizable positive and marginally significant effect, so a small proportion of the variance in Sangu indifference points may be due to differences in the availability of subsistence (crop). However, many of the poorest members of the sample remain more risk-prone than Western subjects once wealth is accounted for, and if acres of corn are divided by household size the effect disappears.

Similarly, in analyzing the variance experiment data, we find that economic and demographic variables do not predict an individual's likelihood of taking the risky gamble (see table 3; later rounds are no different).

Our negative finding on the effect of wealth is consistent with previous experimental work using peasants, undergraduates, business-school students, and university faculty. Binswanger and Sillers (1983:9), summarizing risk experiments done among peasants in India (Binswanger 1980), the Philippines (Sillers 1980), El Salvador (Walker 1980), and Thailand (Grisley 1980), conclude that "neither wealth nor income had a significant effect on observed choices [which varied in their riskiness], despite large differences in the household wealth of respondents." Binswanger (1980) also found that tenant farmers were more risk-prone than landowners, not, as might be supposed, vice versa. Similarly, in both high- and low-stakes risk experiments among undergraduates, business-school students, and university faculty, Holt and Laury (2000) found no effect of income or wealth (controlling for age and sex) on risk preferences.

Additionally, among the Mapuche and the Sangu nei-

TABLE 3
Logistic Regressions Using Economic Demographic Variables to Predict an Individual's Likelihood of Taking the Risky Bet in the Variance Experiment, Round 1

Group and Variable	β	Standard Error	Significance
Mapuche			
Sex	-0.18	1.27	0.89
Age	-0.004	0.028	0.89
Animal wealth per household member	0.0017	0.0027	0.53
Land	-0.014	0.066	0.83
Sangu			
Sex	0.32	0.6405	0.84
Age	-0.014	0.0196	0.29
Cattle	0.0172	0.0184	0.11
Acres of corn	0.267	0.2138	0.20

ther round number (1, 2, 3, or 4) nor gamble variance has any measurable effect when examined in a fixed-effects regression. In contrast, the undergraduates were substantially less likely to take the risky bet as the variance in outcomes increased and as round number increased.

Risk models. According to the standard economic conception of risk aversion—as decreasing marginal utility—neither the Mapuche nor the Sangu are risk-averse. In fact, they are both quite risk-prone, relative to both expected-value theory and control populations. Taken at face value, these experiments provide a direct challenge to the standard approach to risk aversion. We address a variety of mitigating interpretations below.

Unfortunately, our experiments do not confront the safety-first or satisficing model as directly. Nevertheless, the predictions from some interpretations of the satisficing model are clearly not supported. This model predicts that individuals above some minimum threshold should behave risk-aversely. If this threshold is some physiologically defined minimum level of subsistence, then all four groups described in this paper as well above it. No one was starving or seemed concerned about not being able to obtain sufficient food in the coming year. If this is the case, then the Mapuche and the Sangu violate the risk-averse prediction of the safety-first model, while the Huinca and the students remain consistent with it. Contrary to the prediction, if any group runs the risk of falling beneath a minimum subsistence threshold it is the risk-averse Huinca. If instead this threshold represents some local, culturally evolved standard of wealth and success, then risk preferences *within* groups should be predicted by some measure of individual wealth. However, as we have seen, wealth does not predict experimentally measured risk behavior. Given these findings, the safety-first approach does not shed much light on our results. However, if Mapuche and Sangu are including other groups in their assessment of who is high-status, then very few individuals within these groups may feel they are above the relevant threshold.

Alternative interpretations. How are we to interpret these findings in the light of the substantial evidence (including our own) that a great deal of economic behavior is adaptive and does manage risk (Johnson 1971, Norman 1974, Wolgin 1975, Ellis 1988, Ortiz 1979, Roumasset 1976, Netting 1993)? We see two possibilities: (1) Small-scale farmers are risk-averse, cost-benefit decision makers in most economic/agricultural domains but—perhaps because of fun-seeking behavior or lack of experience with games—risk-prone in these particular gambles—gambles that involve substantial sums of money that could be used for food, fertilizer, and seed. (2) Small-scale farmers, among others, rely on cultural transmission mechanisms (e.g., social learning rules) to acquire economic practices and contextually specific decision-making heuristics that produce well-adapted risk-averse behavior without any risk-averse decision making on the individual level.

In defending the first possibility, some readers have suggested that the Mapuche may lack sufficient experience in situations suitable similar to these games to apply their cost-benefit, risk-averse decision making. Perhaps experience with similar situations is a factor in calibrating decision making. Unfortunately, we no comparative, quantitative data on different rates of exposure to similar situations, but many Mapuche and Sangu have experience in bingo, betting on board games (*baos*, among the Sangu), charitable lotteries (“door prizes” at bingo), and betting on horse races (Mapuche run their own), and therefore it is not at all clear that Huinca and undergraduates have more experience than they do with games of chance. And, although the Huinca have more experience in wage labor than the Mapuche and Sangu, the dichotomous variable “having done wage labor” is not a predictor of risk preferences in regression models for either experiment. Finally, without a theory of how “experience” affects decision making it remains unclear to us how such experience would lead to risk-averse, as opposed to risk-neutral or risk-prone, decision making. Risk aversion is not the “correct” (income-maximizing) answer in these games; it is simply a matter of taste.

Others have suggested that risk-averse decision makers may prefer the risky gambles because they get some “utility” or “fun” from playing them. Such individuals would avoid the “sure thing” because they like flipping coins or picking cards. There are two problems with this explanation, one empirical and the other theoretical. Henrich has performed many three-choice lotteries with both Mapuche and Huinca in which individuals had to choose among three gambles that varied in their mean returns and their variances. As in the experiments discussed above, Mapuche preferred the higher-variance (risky) options significantly more than the Huinca, which suggests that fun in “playing” versus “not playing” is not the answer—although it is possible to construct a theory in which the amount of “fun” increases with the size of the variance. Theoretically, such a “fun” proposal is still saddled with explaining why human groups vary in their preferences for “fun.” Why does “fun” affect Mapuche and Sangu choices but not Huinca

and student ones? It would be interesting to repeat the games with play money and see if anyone’s behavior changed.

Another concern about the games focuses on differences in the way people may perceive “losses” versus “gains.” Participants may receive more money than they had at the start, but they cannot finish with less money than they had at the start. We have several comments on this point. First, perceiving the money as a “gain” is merely a “framing effect.” In the variance experiment, for example, we could have given Mapuche participants 4,000 pesos on one day and returned the next week to administer the game. In this case, participants would have had to put down 1,000 pesos (or choose not to) for a chance at winning the various gambles. The payoff structure of this version of the game would have been identical to the one we actually used; it just “looks” different. This is not, of course, to belittle framing effects; in fact, we think that framing effects are often the most important variable. Second, from the point of view of the standard model of risk aversion in economics, framing effects should be irrelevant, so our criticism of that model stands. Third, we think that the decisions in our model bear some resemblance—in terms of the framing of gains and losses—to the actual cropping decisions that farmers make. In our games, farmers face a choice between a sure gain and a high-variance gain. Similarly, in selecting a particular wheat seed for sowing the following year, farmers often face a choice between their traditional seed (which approximates a “sure thing”) and high-tech seed that may produce a higher yield (bigger gain) but, if not dealt with properly, may yield substantially less. Sowing either seed will provide a “gain” relative to *not planting* (even in a bad year, fields usually yield something). Consequently, in terms of gains and losses, we think that these frames are somewhat similar for the participants. Finally, even if something about the gains-versus-losses framing did affect the results, the question remains why this framing affected different populations in different ways. If framing-as-gains made the Mapuche and Sangu risk-prone, why didn’t it also make the Huinca and the students risk-prone?

The second possibility, that small-scale farmers rely on cultural transmission mechanisms to acquire economic practices and contextually specific decision-making heuristics and not on a generalized, risk-averse cost-benefit decision-making process (as is often assumed in economically oriented anthropology), is consistent with a substantial amount of research from across the social sciences indicating that people solve problems by culturally acquiring the strategies, practices, mental models, beliefs, and preferences of others (Henrich n.d.). If, for example, people rely on prestige-biased cultural transmission (Boyd and Richerson 1985, Henrich and Gil-White 2001), in which they preferentially copy the behaviors, decision-making heuristics, ideas, and beliefs of prestigious or “successful” people, then quite sensible and adaptive behaviors that would effectively manage risk in the economically precarious context of peasants would spread without anyone’s applying generalized

risk-averse decision analysis. Such a process would equip farmers with context-specific heuristics or rules of thumb (Henrich n.d.), which may embody some notion of risk aversion or satisficing and thus generate risk-averse decisions in certain situations but actually bear little resemblance to classical approaches to risk aversion. In many economic contexts, small-scale farmers who persistently deployed risky practices would eventually experience catastrophic losses that would create a severe drop in their prestige (or their apparent degree of "success") if they managed to survive. Such results would stifle the spread of these risk-prone practices and any other transmissible traits of these unsuccessful farmers. In contrast, farmers whose practices or context-specific heuristics effectively managed risk and consistently avoided disastrous or catastrophic consequences would gradually accumulate wealth, wives, and children. This success would lead to prestige, which would cause their practices and cultural traits to spread more vigorously than those of others. In cultural evolutionary time and in response to historical circumstances, this process would diffuse risk-managing practices throughout the population without anyone's doing risk-averse decision making in the usual sense.

From this perspective, given that in many traditional economies cash transactions, banking, credit, and money management either are relatively new or have never been crucial to economic success (this is certainly true for the Mapuche and the Sangu), we should not expect cultural selection processes such as prestige-biased transmission (Henrich et al. 2001) to have evolved adaptive rules or preferences for dealing with such matters. For example, there is little doubt that historical factors such as the Huinca's persistent exploitation of the Mapuche's past ignorance of land values (which pervades Mapuche stories) have been inculcated into Mapuche practices, beliefs, and heuristics (such as "Don't buy on credit from Huinca") and consequently slowed the cultural evolution of rules for dealing with money. In contrast, Huinca townspeople and the undergraduates come from societies in which cash transactions, banking, credit, and money management have long been the key to economic prosperity and prestige. Consequently, we should expect them to have acquired culturally evolved rules and preferences about how to deal with money in risky situations, while we should expect the Mapuche and Sangu to have developed similar rules for agriculture and herding instead. Kuznar (2001) in fact finds risk-averse behavior in a somewhat comparable group of Aymara pastoralists, although the hypothetical nature of the gambles makes his results difficult to compare directly with our own.

But why should Mapuche and Sangu be risk-prone in these money gambles? Given that gambling games are prevalent and popular in many foraging groups throughout the world, that big-money lotteries have rapidly spread to most nations, that revolving-credit associations have spread throughout the "underdeveloped" world, and that people can become addicted to gambling just as they can to food, drugs, and sex, it could very well be

that humans have some predisposition toward taking risky monetary gambles. Consequently, Westerners or any cultural group that has long and intensely participated in a monetary economy are risk-averse in monetary gambles because they have acquired, via social learning, rules and preferences for dealing with risky monetary situations. The students, for example, seemed clearly tempted by the higher-payoff risky bets but believed that the "smart thing" was to take the sure money. Neither Mapuche nor Sangu possess such a belief. It would be profitable to see how such groups behave with similar gambles for other currencies, such as livestock (Kuznar 2001) or land.

References Cited

- BINSWANGER, HANS P. 1980. Attitudes toward risk: Experimental measurement in rural India. *American Journal of Agricultural Economics* 62:395-407.
- BINSWANGER, HANS P., AND D. A. SILLERS. 1983. Risk aversion and credit constraints in farmers' decision-making: A reinterpretation. *Journal of Development Studies* 20:5-21.
- BOYD, ROBERT, AND PETER J. RICHESON. 1985. *Culture and the evolutionary process*. Chicago: University of Chicago Press.
- CAMERER, COLIN, AND MARTIN WEBER. 1992. Recent developments in modeling preferences: Uncertainty and ambiguity. *Journal of Risk and Uncertainty* 5:325-70.
- CANCIAN, FRANK. 1989. "Economic behavior in peasant communities." in *Economic anthropology*. Edited by S. Plattner, pp. 127-70. Stanford: Stanford University Press.
- CASHDAN, ELIZABETH. 1990. "Introduction," in *Risk and uncertainty in tribal and peasant societies*. Edited by E. Cashdan. Boulder: Westview Press.
- CHIBNIK, MICHAEL. 1990. "Double-edged risks and uncertainties: Choices about rice loans in the Peruvian Amazon," in *Risk and uncertainty in tribal and peasant economies*. Edited by E. Cashdan. Boulder: Westview Press.
- COOMBS, C. H., AND D. G. PRUITT. 1960. Components of risk in decision making: Probability and variance preferences. *Journal of Experimental Psychology* 60:265-77.
- EDWARDS, W. 1953. Probability preferences in gambling. *American Journal of Psychology* 66:349-64.
- ELLIS, FRANK. 1988. *Peasant economics: Farm households and agrarian development*. New York: Cambridge University Press.
- FOSTER, GEORGE M. 1988. *Tzintzuntzan*. Prospect Heights, Ill.: Waveland Press.
- GLADWIN, CHRISTINA. 1979. Cognitive strategies and adoption decisions: A case study of nonadoption of agronomic recommendations. *Economic Development and Culture Change* 28:155-73.
- GRISLEY, WILLIAM. 1980. *Effect of risk and risk aversion on farm decision-making*. Champaign: University of Illinois Press.
- HENRICH, JOSEPH. n.d. "Decision-making, cultural transmission, and adaptation in economic anthropology," in *Economic anthropology: Theory at the turn of the century*. Edited by J. Ensminger. Alta Mira Press.
- HENRICH, JOSEPH, WULF ALBERS, ROBERT BOYD, KEVIN MC CABE, GERD GIGERENZER, H. P. YOUNG, AND AXEL OCKENFELS. 2001. "Is culture important in bounded rationality?" in *Bounded rationality: The adaptive toolbox*. Edited by G. Gigerenzer and R. Selten. Cambridge: MIT Press.
- HENRICH, JOSEPH, AND FRANCISCO GIL-WHITE. 2001. The evolution of prestige: Freely conferred deference as a mechanism for enhancing the benefits of cultural transmission. *Evolution and Human Behavior* 22:165-96.
- HERTWIG, RALPH, AND ANDREAS ORTMANN. 2001. Exper-

- imental practices in economics: A challenge for psychologists? *Behavioral and Brain Sciences* 24:383–451.
- HOFFMAN, PHILIP T. 1996. *Growth in a traditional society*. Princeton: Princeton University Press.
- HOLT, CHARLES, AND SUSAN K. LAURY. 2000. "Risk aversion and incentive effects." <http://www.people.Virginia.EDU/-cah2k/highpay.pdf>.
- JOHNSON, ALLEN. 1971. *Sharecroppers of the Sertão: Economics and dependence on a Brazilian plantation*. Stanford: Stanford University Press.
- KNIGHT, FRANK. 1921. *Risk, uncertainty, and profit*. Boston: Houghton Mifflin.
- KUZNAR, LAWRENCE A. 2001. Risk sensitivity and value among Andean pastoralists: Measures, models, and empirical tests. *CURRENT ANTHROPOLOGY* 42:432–40.
- LIPTON, MICHAEL. 1968. The theory of the optimizing peasant. *Journal of Development Studies* 4:327–51.
- NETTING, ROBERT M. 1993. *Smallholders, householders: Farm families and the ecology of intensive, sustainable agriculture*. Stanford: Stanford University Press.
- NICHOLSON, WALTER. 1995. *Microeconomic theory*. Fort Worth: Dryden Press.
- NORMAN, D. W. 1974. Rationalizing mixed cropping under indigenous conditions: The example of Northern Nigeria. *Journal of Development Studies* 11:37–51.
- ORTIZ, SUTTI. 1979. "The effect of risk aversion strategies on subsistence and cash crop decisions," in *Risk, uncertainty, and agricultural development*. Edited by J. Roumasset, J. Boussard, and I. Singh, pp. 231–46. New York: Agricultural Development Council.
- REAL, LESLIE, AND THOMAS CARACO. 1986. Risk and foraging in stochastic environments. *Annual Review of Ecology and Systematics* 17:371–90.
- RODE, CATRIN, LEDA COSMIDES, WOLFGANG HELL, AND JOHN TOOBY. 1999. When and why people avoid unknown probabilities in decisions under uncertainty: Testing some predictions from optimal foraging theory. *Cognition* 72: 269–304.
- ROUMASSET, JAMES A. 1976. *Rice and risk: Decision making among low-income farmers*. New York: North-Holland.
- SCHLUTER, M. G. G., AND T. D. MOUNT. 1976. Some management objectives of the peasant farmer: An analysis of risk aversion in the choice of cropping patterns, Surat District, India. *Journal of Development Studies* 12:246–61.
- SCHULTZ, THEODORE W. 1964. *Transforming traditional agriculture*. New Haven: Yale University Press.
- SCOTT, J. C. 1976. *The moral economy of the peasant: Rebellion and subsistence in Southeast Asia*. New Haven: Yale University Press.
- SHORTER, A. 1992. *Chiefship in western Tanzania*. Oxford: Clarendon Press.
- SILLERS, DONALD. 1980. *Measuring risk preferences of rice farmers in Nueva Ecija, Philippines: An experimental approach*. New Haven: Yale University Press.
- STEPHENS, DAVID W., AND JOHN R. KREBS. 1986. *Foraging theory*. Princeton: Princeton University Press.
- TURNER, CHRISTINA B. 1996. "Historical perspectives on long-term change: Compadrazgo choice patterns in rural Paraguay," in *Economic analysis beyond the local system*. Monographs in Economic Anthropology. Edited by R. E. Blanton, P. N. Peregrine, D. Winslow, and T. D. Hall, pp. 171–93. 13. University Press of America.
- WALKER, THOMAS S. 1980. *Decision making by farmers and by the national agricultural research program on the adoption and development of maize varieties in El Salvador*. Stanford: Food Research Institute.
- WHARTON, C. R. 1971. "Risk, uncertainty, and the subsistence farmer: Technological innovation and resistance to change in the context of survival," in *Studies in economic anthropology*. Edited by G. Dalton. Washington, D.C.: American Anthropological Association.
- WINTERHALDER, BRUCE. 1990. "Open field, common pot: Harvest variability and risk avoidance in agricultural and foraging societies," in *Risk and uncertainty in tribal and peasant societies*. Edited by E. Cashdan. Boulder: Westview Press.
- WINTERHALDER, BRUCE D., FLORA LU, AND BRAM TUCKER. 1999. Risk-sensitive adaptive tactics: Models and evidence from subsistence studies in biology and anthropology. *Journal of Archaeological Research* 7:301–48.
- WOLGIN, J. M. 1975. Resource allocation and risk: A case study of smallholder agriculture in Kenya. *American Journal of Agricultural Economics* 57:1–21.
- WRIGHT, M. 1971. *German missions in Tanganyika*. Oxford: Clarendon Press.

Systematic Pigment Use in the Middle Pleistocene of South-Central Africa¹

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In 1996, three pieces of iron oxide and one of iron hydroxide (hematite and limonite) were recovered from the archaeological site of Twin Rivers, central Zambia (Barham 1998). These minerals were described and their significance discussed as possible evidence for pigment use—and, by extension, symbol use—in the Middle Pleistocene. A speculative model was proposed that linked the emergence of distinctive regional variants of the Middle Stone Age in sub-Saharan Africa with language-based cultural groups. Symbol use (in addition to language) and ritual were the suggested mechanisms for creating and maintaining group identities. For the model to gain credibility, further evidence was needed for the association of systematic pigment use with the earliest Middle Stone Age industries. The four specimens from Twin Rivers were an inadequate sample on which to base such a model, but the intact sections contained more material that awaited excavation. When Twin Rivers was excavated in July–August 1999, a substantially larger sample of minerals was recovered, providing evidence for the systematic collection and processing of pigments. The proposed correlation between emerging regional styles of tool making and symbol use is strengthened by

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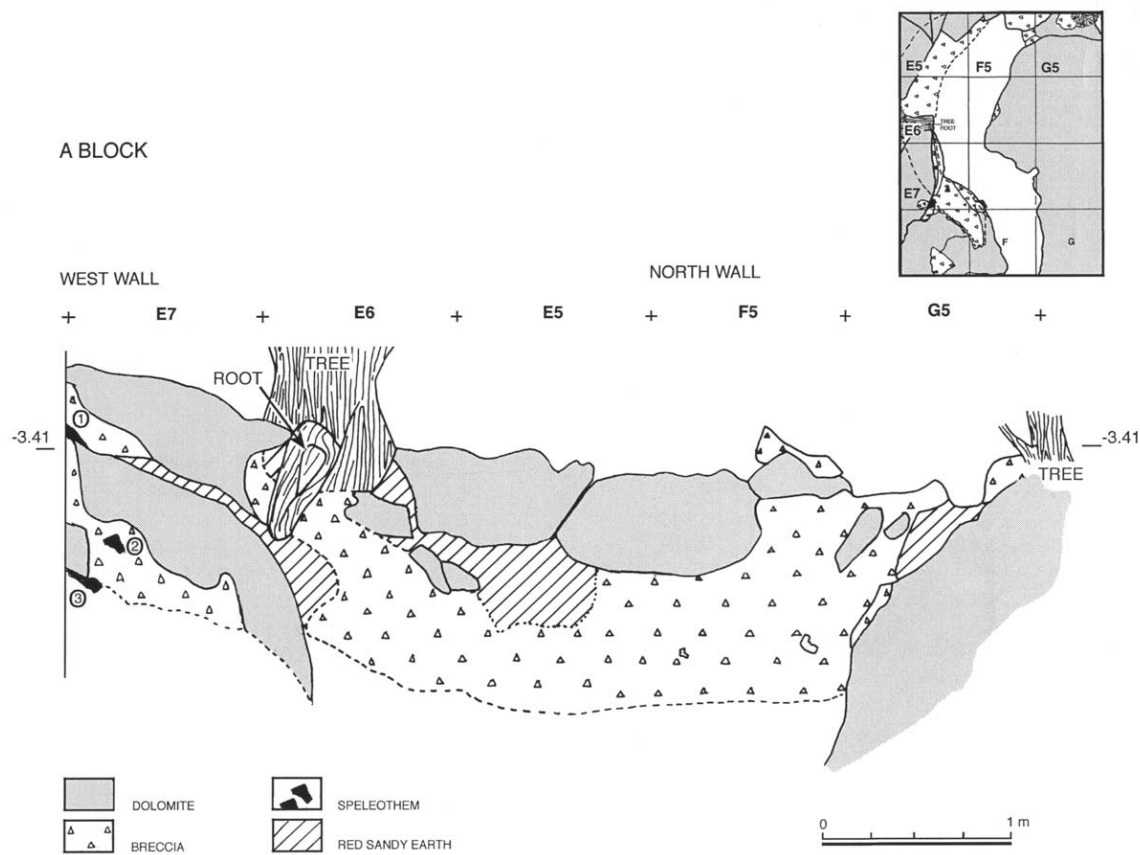


FIG. 1. Section of A Block (west wall) showing the location of dated speleothem in relation to breccia and loose sediment excavated in 1999. Corrected ages: sample 1, 266,000 B.P.; sample 2, > 400,000 B.P.; sample 3, > 400,000 B.P. (© Western Academic and Specialist Press 2000.)

this new information. Pigment use is shown to be a consistent feature of the African Middle Stone Age from the Middle to Late Pleistocene and part of the behavioral repertoire of *Homo heidelbergensis* [or *Homo helmei* [see McBrearty and Brooks 2000]] as well as that of anatomically modern humans.

TWIN RIVERS

The hilltop site of Twin Rivers was extensively excavated in 1954 and 1956 by J. D. Clark, with two main trenches, A Block and F Block (Barham 1998:fig. 2), providing the bulk of the artifactual material (Clark 1971, Clark and Brown 2001). The deposits in both blocks contained brecciated and loose sediments, which filled former phreatic cave passages that formed on top of and along the sides of the dolomite hill. Controlled blasting was originally used to excavate the breccia. The passages are now unroofed by solutional weathering and exposed as an irregular surface of boulders and breccia (Simms and Barham 2000). Flowstone near the top of F Block produced a mass spectrometric uranium-series date of $195,000 \pm 19,000$ B.P. (Barham 1998) which confirmed

the Middle Pleistocene age of the site based on a previous conventional uranium-series date of $230,000 \pm 35,000/28,000$ B.P. (Barham and Smart 1996). The artifacts recovered from the excavation of both A and F Blocks have since been attributed to the Lower Lupemban industry of the early Middle Stone Age of Central Africa (Clark and Brown 2001). In 1996, during cleaning of the F Block sections, a single piece of limonite was recovered from beneath a basal flowstone layer. In A Block three pieces of hematite were found in the section in 1996 beneath a band of speleothem dated to > 350,000 B.P. (Barham 1998:704). The heavily weathered speleothem was detrimentally contaminated.

The intact margins of A Block and F Blocks were sampled in 1999, and additional speleothem was collected for dating by thermal ionization mass spectrometry (TIMS) uranium-series. The full results of the dating program have been reported elsewhere (Gilmour, Debenham, and Barham 2000:172–83). In A Block, intact sediments filled a narrow wedge-shaped fissure (30 cm maximum width \times 60 cm maximum depth) formed between the cave passage wall and a breccia shelf (fig. 1).

Most of the retouched artifacts and debitage (total $n = 108,131$) recovered from A Block in 1999 came from this sediment sandwich and the remainder from the breccia. Two samples date the excavated deposits, and a third provides a minimum age for the formation of the cave passage. Sample 1 (TRAA1) comes from a breccia wedge between two dolomite blocks that degrades into the loose deposits excavated in 1999. A corrected age of 266,000 B.P. ($275,000 \pm 5,000$ B.P., uncorrected) confirms the Middle Pleistocene date of A Block. Sample 2 (TRA14A) is a fragment of speleothem incorporated into the breccia that underlies sample 1 and much of the excavated deposit. A corrected age of $> 400,000$ B.P. matches that of sample 3 (TRA2A) from the cave floor. These two infinite dates provide a minimum age limit for the deposit, and together the three dates bracket the Lower Lupemban in A Block between 266,000 and $> 400,000$ B.P. Other dates from A Block range from 225,000 to 160,000 B.P. for a probable former passage upslope from the excavated area (Simms and Barham 2000) and 192,000 years (TRA5A, $199,000 \pm 2,500$, uncorrected) for the speleothem previously reported as 350,000 B.P. (Barham 1998) from the uppermost intact deposits. The age reduction resulted from the application of correction factors based on clays incorporated in samples 1 and 2. The A Block deposits as a whole are older than 200,000 B.P.

The retouched artifacts from A Block are Middle Stone Age in character in that they represent elements of composite tools (Barham 2000). The blanks are struck from centripetal and blade cores, and the tool forms include scrapers, awls, burins, bifacial points, and distinctive backed pieces including tranchets and segments (fig. 2). A heavy-duty element typical of the Lupemban is represented by large flakes of quartzite and dolerite, a spheroid, and a portion of a lanceolate biface. The combination of light- and heavy-duty elements in A Block links this material to the much larger Lower Lupemban assemblage recovered from F Block in 1956 (Clark and Brown 2001).

In F Block, a small area of intact deposit ($150 \text{ cm} \times 100 \text{ cm} \times 25 \text{ cm}$) within a surviving dip-tube passage was excavated in 1999 (fig. 3). The dip tube was not an area of human occupation, and the artifact-bearing sediments accumulated as debris flows originating near the mouth of the former cave (Simms and Barham 2000:169). The passage contained red sandy sediment above and beneath a solid lens of manganese concretions. The manganese lens probably formed as a result of ponding in this branch of the cave. A dense concentration of largely quartz debitage ($n = 220,719$) and fragmentary bone was recovered beneath the concretion, including a fragment of a humeral shaft of a hominid with very thick cortical bone in comparison with that of recent humans (Pearson 2000:281). The manganese extended outside the dip tube and merged with tufa and breccia adhering to the walls of the main cave passage. U-series (TIMS) dates on speleothem stratified with breccia in the main passage range in age from $195,000 \pm 19,000$ B.P. at the top (Barham 1998) to 178,000–141,000 B.P. (corrected ages) near the

base of the sequence (Gilmour, Debenham, and Barham 2000:table 10.1). The apparent reversed chronology reflects the complex interstratification of deposits in F Block (see Clark 1971:fig. 3). The deposits excavated in 1999 are assumed to range in age between 200,000 and 140,000 B.P. by indirect association with the dated speleothem in the main passage. The artifacts recovered in 1999 are technologically and typologically similar to those from A Block and include radial flakes and cores, scrapers, awls, tranchets, and the tip of a pick (Barham 2000:204).

The Lupemban assemblages from A and F Blocks are the oldest dated Middle Stone Age deposits (Clark and Brown 2001, Barham 2001) in Central Africa and perhaps in Africa if the minimum age limit of $> 400,000$ B.P. can be confirmed (cf. Evernden and Curtis 1965, Mc Brearty 1999). The discovery of possible pigment use in association with such an early and distinct regional tradition of tool making has important implications for the evolution of human behavior in the Middle Pleistocene. At issue is whether the mineral oxides found at Twin Rivers were used as pigments in a systematic way that indicates a central role for colorants in the lives of *Homo heidelbergensis*.

MINERALS

A petrographic and geochemical analysis of the minerals collected in 1996 (Young 2000) confirms that the iron hydroxide (limonite) found in F Block is lateritic in origin but that the three specimens from A Block derive from mineralized veins and are not lateritic in origin. Two of the A Block pieces are hematite and the third is specularite. A survey of the hillsides in 1999 did not locate any sources of iron minerals with the exception of thin (2-mm) bands of specularite in quartz veins outcropping at the base of the hill. Geochemical analyses of the breccia in A Block show that the cave deposits are rich in manganese and poor in iron that could be liberated on weathering and an unlikely source of the pigments found at Twin Rivers (Young 2000:271). Local sources of hematite and limonite were found in lateritic outcrops within 2 km of Twin Rivers and were presumably available locally during the Middle Pleistocene. The specularite brought to the site derives from a different lithology, having weathered from quartz veins and as small crystals in schist (Barham 2000:184; Young 2000:270). Thick (5–8-cm) veins of specularite were located 22 km to the west, but thinner veins and specularite cobbles were found along the margins of the Lusaka dolomite plateau 5 km north and west of Twin Rivers. Assuming that the landscape has changed little in 300,000 years, the occupants of the hilltop site would have had relatively easy access to these iron minerals. Ferruginous sandstone also outcrops locally in the surrounding hills. A source of manganese dioxide was not located but is presumed to be local.

Specularite tends to be harder (6.5 Moh's scale) than the lateritic hematite, and its primary identifying feature is the colour and content of its streak. Specularite pro-

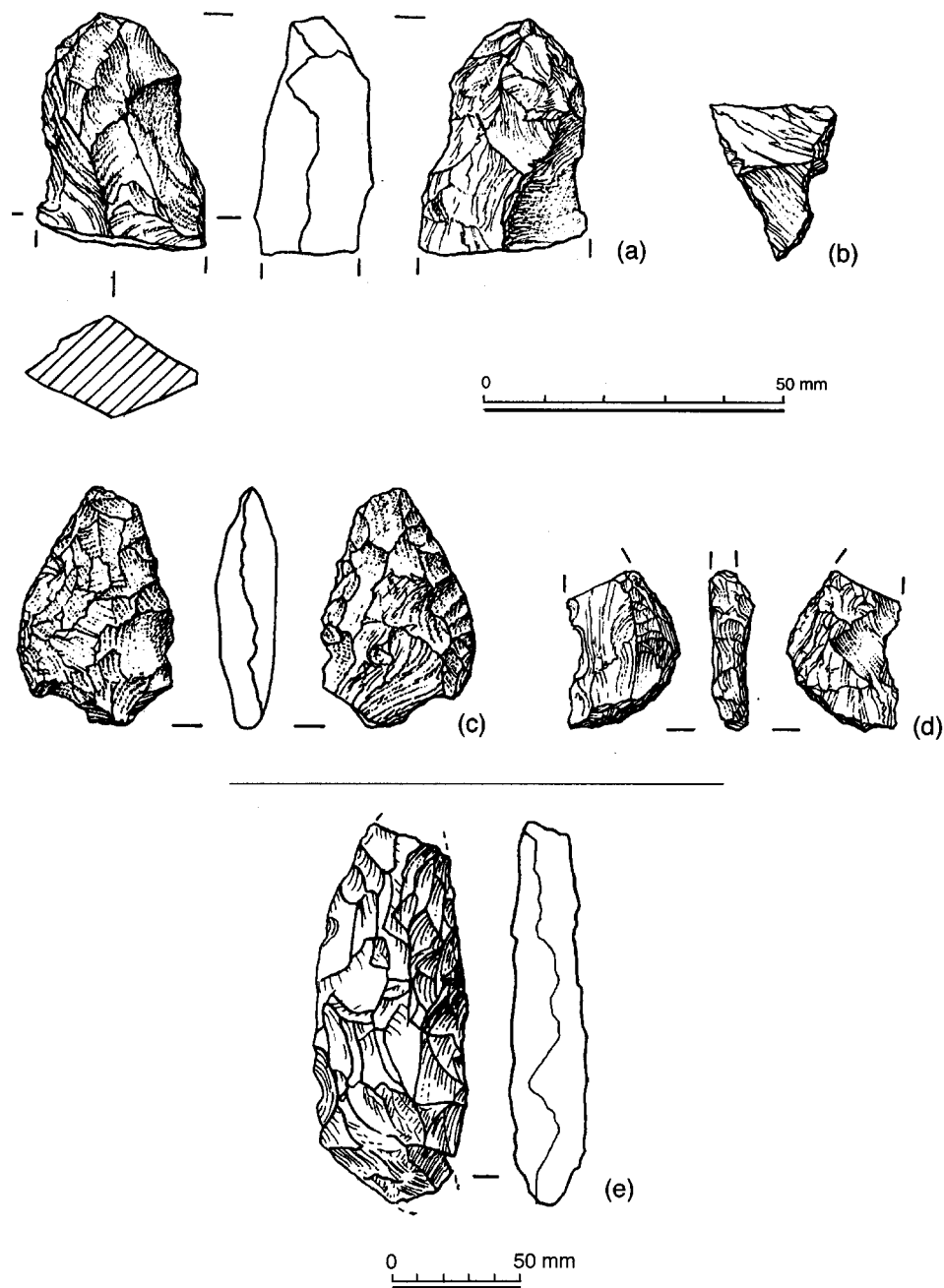


FIG. 2. *Lithic artifacts from Twin Rivers, Zambia (all vein quartz). a, tip of pick, F Block; b, tranchet, F Block; c, notched bifacial point or knife, A Block; d, segment, A Block; e, lanceolate, F Block (after Clark 1971). (a-d © J. Richards 2000.)*

duces a darker, purple shade of red (Munsell 10R 4-3/3-3) that sparkles because of its crystalline content. Given its hardness, specularite requires processing to reduce it to a powder. Hematite, in contrast, produces a strong red-to-brown streak (10R 5/8-4/8) with no obvious reflective properties. It varies in hardness from crumbly to brittle depending on the degree of consolidation of the

laterite outcrop. The soft, earthy variety of hematite is often called ochre (King 2000), but to minimize ambiguity the term is not used here. The local limonite is soft and creates a yellow-green streak (2.5Y 8/8). A similar colour occurs in the weathered cortex of dolerite, and only by breaking open samples can the two be distinguished. Red sandstone can be used as a source of

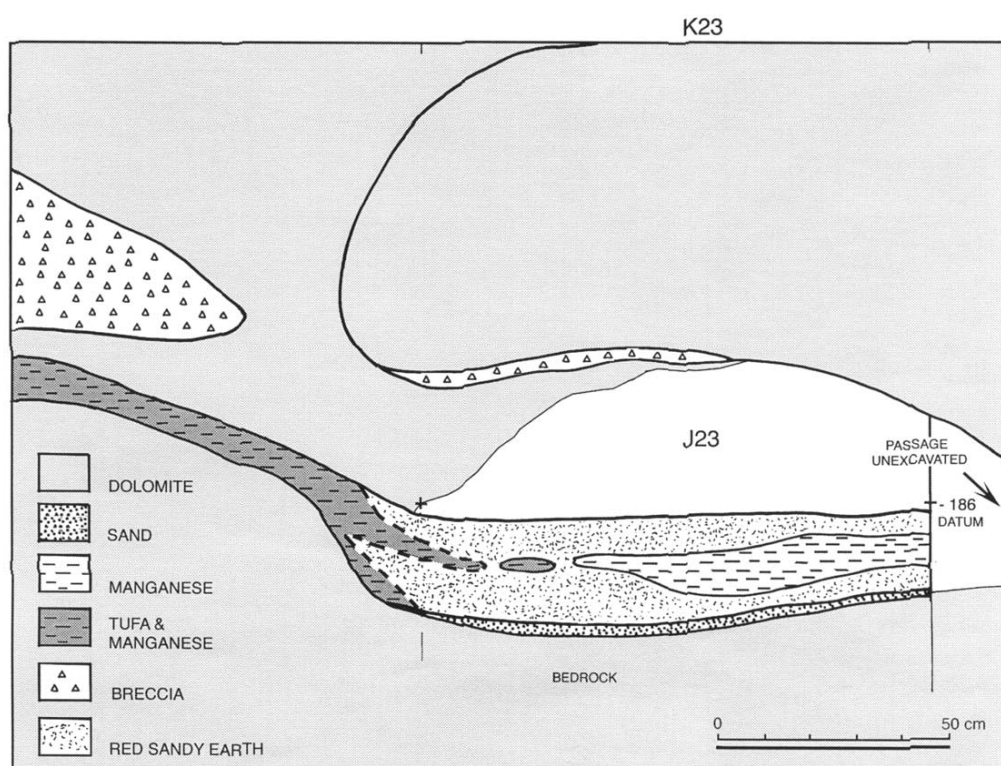


FIG. 3. Section through deposits excavated in F Block in 1999 showing near continuous band of manganese concretion that sealed the lower half of the deposit. (© Western Academic and Specialist Press 2000.)

colour when soaked in water (P. Vandiver, personal communication) and is included here as a possible pigment.

One hundred eighty pieces of hematite, specularite, limonite, ferruginous sandstone, and manganese dioxide, weighing a total of 1,404 g, were recovered from A Block in 1999 (table 1). Specularite accounts for 61.1% of the sample ($n = 110$), with hematite the next most common oxide (26.7%, $n = 48$), followed by limonite (7.2%, $n = 13$), ferruginous sandstone (4.4%, $n = 8$) and manganese dioxide (0.6%, $n = 1$). Specularite also dominates the sample by weight (88.7%) compared with hematite (1.8%), limonite (8.5%), and ferruginous sandstone (0.9%). The disparity between specularite and hematite is reflected in the average weight and size per piece, with specularite (15.4 g) significantly heavier than hematite (1.6 g). Among specularite pieces 31.5% are less than 10 mm in maximum dimension, compared with 76.1% of hematite pieces. The distinction in weight and size between specularite and hematite pieces also occurs in the sample of pigments from F Block.

One hundred twenty-two pieces of hematite (48.4%, $n = 59$), specularite (41.0%, $n = 50$), sandstone (6.6%, $n = 8$), limonite (3.3%, $n = 4$) and manganese dioxide (0.8%, $n = 1$), weighing a total of 213 g, were recovered from F Block (table 1). The frequencies of specularite and hematite are roughly equal. By weight, specularite accounts for 87.0% of the sample, hematite 4.5%, ferru-

ginous sandstone 7.5%, and limonite 1.0%. Most of the hematite sample was smaller than 10 mm (95.2%), compared with less than half of the specularite sample (46.6%).

The disparity in size between the specularite and the hematite pieces may reflect the relatively soft, crumbly texture of the latter and the ease of reducing it to a powder. Specularite requires processing by rubbing, grinding, or scraping to create a powder. Macroscopic evidence for the processing of specularite occurs in A Block. Approximately 3.9% ($n = 7$) of the pigment sample as a whole shows evidence of modification in the form of striations or rubbed surfaces (fig. 4, *a-c*). All these specimens are specularite. Shallow U-shaped parallel striations (0.5 mm wide) (fig. 4, *b*), and facets or abrupt changes of contour (fig. 4, *a, c*) are visible. Specimen fig. 4, *c* combines facets with a concave interior (fig. 5) that may be the result of rubbing with a grindstone or against a rounded surface. Without microscopic analyses of the surface modifications combined with experimental replication, a human agency can only be assumed. In F Block, three pieces, two of specularite and one of hematite, show signs of rubbing (2.5%).

Additional evidence for the processing of specularite comes from a quartzite cobble excavated from A Block in 1954. The cobble measures 74 mm long and 57 mm wide and has a maximum thickness of 40 mm. (Quartzite

TABLE 1
Minerals from Twin Rivers

Block and Mineral	<i>n</i>	Weight (g)	% Total	% Weight	Modified
A					
Specularite	110	1,243.0	61.1	88.5	7
Hematite	48	31.0	26.7	2.2	0
Limonite	13	117.0	7.2	8.3	0
Sandstone	8	12.0	4.4	0.8	0
Manganese dioxide	1	0.5	0.6	0.2	0
Total	180	1,404.5	100.0	100.0	7
F					
Specularite	50	178	41.0	83.7	2
Hematite	59	15	48.4	7.0	1
Limonite	4	4	3.3	1.9	0
Sandstone	8	15	6.6	7.0	0
Manganese dioxide	1	1	0.8	0.4	0
Total	122	213	100.0	100.0	3
Total	302	1,617			10

does not occur naturally in the dolomite at Twin Rivers and would have been transported to the site.) Both ends are pockmarked from use, and all surfaces are stained yellow or contain traces of yellow sediment trapped in the interstices between quartz grains. A spread of yellow sediment was observed during the excavation of A Block (J. D. Clark, personal communication), and staining is visible on some artifacts curated at the University of California, Berkeley, including the cobble. Yellow staining can occur naturally in cave clays with the formation of iron hydroxides as secondary minerals (Hill 1976). Analysis of the major and trace element content of the A Block breccia by Young (2000:271) demonstrated that no fine-grained iron oxides occur that might be liberated on weathering. Additional analyses were undertaken to determine the probable source of the staining by comparing its chemical signature with that of the specularite, hematite, and limonite excavated at Twin Rivers in 1996 (Young 2000). Trace elements in the staining did not match those from lateritic sources and most closely approximated the profile for specularite. The staining occurred as a result of contact, either grinding or pounding, with an iron mineral which had been brought to the site. The processing would have taken place near the former entrance to the A Block passage, with the sediments transported into the cave as a gentle slurry (Simms and Barham 2000).

The extent of pigment use at Twin Rivers can be estimated from the volume of deposits excavated in the 1950s. Approximately 120 m³ of breccia and sediment were removed from F Block in 1956 (estimate calculated from Clark 1971:fig. 3). From the volume of deposit and weight of pigment excavated in F Block in 1999, an estimated 56.7 kg of pigment ($n = 29,792$) was brought to the site (Barham 2000:190). The calculation does not take into account fallen roof blocks, so it is something of an overestimate, but nonetheless it represents a substantial component of the archaeological assemblage. In A Block, approximately 4–5 m³ of deposit was excavated in 1954

(Clark and Brown 2001:309),² and by extrapolation from the 1999 excavations approximately 11.2–12.6 kg of pigment were brought to this cave ($n = 1,440$ –1,620) (Barham 2000:189). Clark and Brown (2001:table 2) record the presence of pigment in A ($n = 4$) and F Blocks ($n = 107$), including limonite and hematite “crayons” with facets (2001:fig. 20). The controlled use of dynamite in the 1950s to excavate the breccia would inevitably have affected the recovery of smaller pieces and of hematite in particular. Fine-fabric mesh screens (0.5 and 2.0 mm) were used to sieve all the loose deposit excavated in 1999. Bulk analysis of the sediment fraction less than 10 mm in size was undertaken. Representative sediment samples weighing 100 g were selected from each 10-cm excavation level and used to estimate the quantity of artifactual debris, including pigment, that might exist in the coarse fraction in each block. An additional 762 pieces of pigment (all types) are predicted for A Block and 130 for F Block. The pieces are typically hematite or fragments of specularite crystals between 2 and 4 mm in size that weigh less than 1.0 g (Barham 2000:appendix 7).

SUMMARY AND CONCLUSION

The collection and processing of iron and manganese minerals were intentional and repeated activities undertaken by Middle Pleistocene hominids at Twin Rivers. The sample of four specimens discovered in 1996 has been enlarged by the recovery of an additional 302 pieces, 3.0% of the total showing evidence of modification by grinding or rubbing. A much larger sample may have existed, as only the margins of A Block and F Block were excavated in 1999. Estimates of the quantity and weight of pigments excavated in the 1950s (and waiting to be extracted from the bulk sediments of 1999) suggest that thousands of pieces of pigment weighing in excess of 60

2. Block has been relabelled C Block by Clark and Brown. The original attribution is retained here and in Barham (2000).



FIG. 4. Modified specularite from A Block, 1999. Top, rubbed/ground surface; center, faint U-shaped parallel striations visible on rubbed convex surface; bottom, flat ground surfaces on exterior (see also fig. 5). Scale in millimetres. (© Western Academic and Specialist Press 2000.)

kg were introduced to the site. Geochemical analyses of the A Block breccia support an exogenous origin, with no evidence for *in situ* formation of iron oxides as a consequence of weathering. Surface surveys have located potential sources of pigments in laterites and quartz veins that outcrop locally within a 2–5-km radius of Twin Rivers. The Lupemban inhabitants are credited with collecting and transporting the pigments to the hill-

top site over the course of 100,000 or more years of intermittent occupation.

Iron minerals arguably have chemical properties that makes them valued ingredients in medicines (Velo 1984) and as possible preservatives of hides (Keeley 1980, Audouin and Plisson 1982), but historically these are secondary to their use as pigments (Knight, Power, and Watts 1995). The variety of iron and manganese minerals transported to Twin Rivers is at odds with purely func-

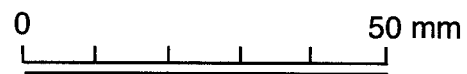
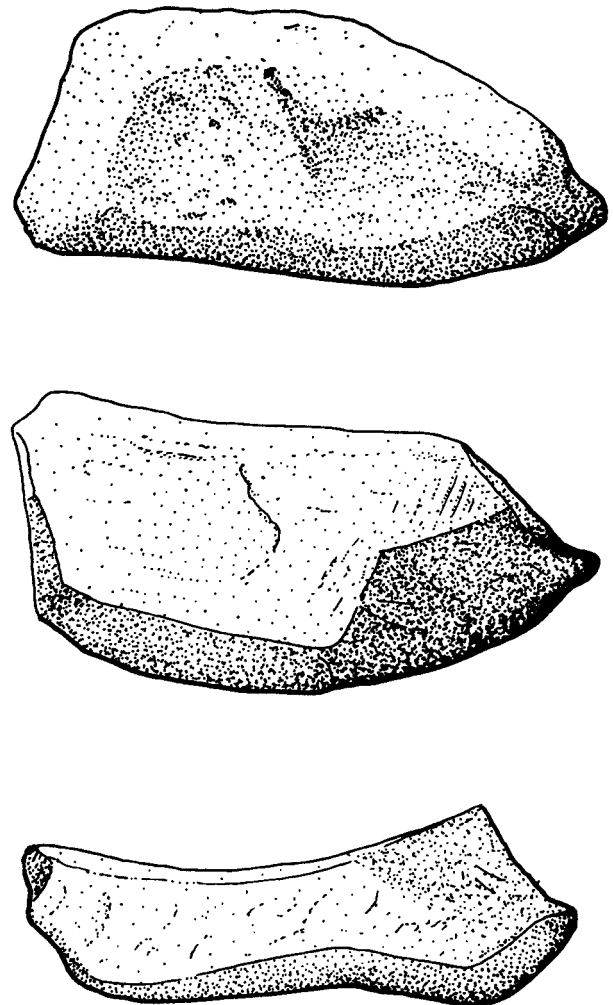


FIG. 5. Modified specularite from A Block with faceted exterior surfaces (see fig. 4, c) and concave interior probably created by rubbing against a rounded object. (© Western Academic and Specialist Press 2000.)

TABLE 2
Middle Pleistocene Pigment Finds

Site	Date B.P.	<i>n</i>	Reference
Terra Amata, France	300,000	75 pieces hematite	de Lumley (1969); cf. Wreschner (1985)
Maastricht-Belvedere, Netherlands	285,000	Red stains in soil	Roebroeks (1986)
Achenheim, France	250,000	1 hematite, rubbed	Thévenin (1976)
Becov, Czech Republic	220,000?	1 hematite, striated; ochre powder	Marshack (1981)
Hungsi, India	300,000?	Hematite pebbles, 1 striated	Bednarik (1992)
Nooitgedacht, South Africa	> 200,000	1 piece hematite, ground	Beaumont and Morris (1990)
Kabwe (Broken Hill), Zambia	300,000?	1 hematite; spheroid with red staining	Clark et al. (1947)
Kalambo Falls, Zambia	200,000?	Pigment, unspecified	Clark (1974:table 10)
Twin Rivers, Zambia	270,000–170,000	302 pieces, various colors	Barham (2000)
Kapthurin Formation, Kenya	> 285,000	104 pieces, F Block > 75 "red ochre"	Clark and Brown (2001) McBrearty (2001)

tional explanations for their use. Local laterites provide a ready source of relatively soft hematite and limonite that require minimal processing by comparison with specularite. Why select specularite as an additional source of iron when it comes in a less tractable form? The same question applies to the other materials used at Twin Rivers. Ferruginous sandstone yields its iron (and color) when soaked in water, and manganese dioxide is not a source of iron. These materials may have been used for different purposes, and this suggests that Middle Pleistocene hominids possessed an acute awareness of the physical properties of minerals available in the landscape, including color. A range of colors is represented in the Twin Rivers mineral sample, including yellow, brown, red, purple, pink, and blue-black. Specularite crystals also yield a purple powder that sparkles. From this selection a broad palette could have been mixed, but the social context of its use—whether functional, symbolic, or both—must remain speculative.

Chase (1991:199) argues that systematic or repetitive behaviors alone are insufficient grounds for recognizing prehistoric symbol use. Evidence is needed of complex behaviors learned through language rather than by observation and for behaviors that communicate a sense of shared group identity. The combined artifact assemblage from Twin Rivers of pigments and a variety of composite and heavy-duty tool types may meet these criteria. The technology of producing flakes and blades for hafting can be learned by observation, but the distinctive Lupemban lanceolate (see Clark 1970:fig. 23) is not the unintended outcome of resharpening and reuse. The lanceolate is restricted in its geographical distribution to Central Africa and in time to the latter part of the Middle Pleistocene (Barham 2000). This is arguably a tool type that is the product of the imposition of an arbitrary form on a raw material (e.g., Mellars 1989), and though not a symbol in its own right it may have involved the use of symbols (language) in its conception. The large lanceolate is emblematic of the industry and acts as an index

of tool-making standards in a regionally restricted population (e.g., Wynn 1993:402). Indices as such are the unintended consequences of a community's accepted range of appropriate technological solutions to particular problems. That range was both broader and more specialized than in the preceding Acheulian. The Lupemban combines heavy- and light-duty tools, including backed pieces, in a technologically diverse but distinctive industry. It is also the first regionally constrained style of making artifacts in Central Africa, perhaps linked to the interglacial distribution of tropical woodland savannas (Clark 1988, 1992; Barham 2000). At Twin Rivers, the use of pigments by makers of Lupemban tools adds an extra dimension of behavioral complexity to the interpretation of the site. The prevalence of pigments throughout the deposits suggests that the collection, processing, and use of minerals were public knowledge. Symbols and symbol-based behaviors are by definition arbitrary and depend on conventions to be successful (Deacon 1997).

Power and Aiello (1997) argue that pigment use originated in the Middle Pleistocene as part of a behavioral response to the reproductive stresses experienced by females as a consequence of an evolutionary expansion in brain size about 300,000 years ago. Pigments were used, according to this sociobiological model, to construct reproductive taboos that were enacted through rituals involving body painting and dance (1997:165). The merits of this hypothesis aside, the data from Twin Rivers are interpreted here as evidence for the systematic use of pigments that coincides with the emergence of a new archaeological entity, the Lupemban. The variety of tools associated with the Lupemban (Clark 1982), including a range of hafted forms, marks the transition from earlier conservative Acheulian technologies to more variable Middle Stone Age technologies. In East Africa, the technological continuum that is the shift from the Late Acheulian to the Middle Stone Age is also accompanied by pigment use. Hematite has recently been reported

from early Middle Stone Age deposits in the Kapthurin Formation, Kenya. At the site of GnJh-15, more than 70 pieces of "red ochre" with a total weight of more than 5 kg occur with an archaeological assemblage dated to > 285,000 (McBrearty 2001:92). In Zambia, a single piece of hematite was recovered with Late Acheulian (Sangoan) artifacts that are contemporary with the Kabwe (Broken Hill) hominid (Clark et al. 1947:23). The weathered piece of hematite was found in the cave breccia and is considered to be an intentional introduction in the absence of evidence that iron oxides occurred naturally in the cave. A small spheroid (60 mm diameter) with red staining covering much of its surface was also found at Kabwe (Clark et al. 1947:22) and thought to be evidence of the processing of hematite. Pigment has been reported from the Lupemban deposits at Kalambo Falls in north-eastern Zambia (Clark 1974:table 10), and judging from the U-series dates from Twin Rivers the Kalambo assemblage should fall within the 270,000–170,000 B.P. age-range. Other pigment finds are known from presumed Middle Pleistocene (Acheulian) contexts in southern Africa (Beaumont and Morris 1990, Knight, Power, and Watts 1995) but none in quantities suggestive of systematic collection. On the basis of the evidence from Twin Rivers and from the Kapthurin Formation, the collection and processing of mineral ores is a Middle Stone Age phenomenon with roots in the Late Acheulian. Pigment use remains a common feature of Middle Stone Age assemblages through the Late Pleistocene (Knight, Power, and Watts 1995) and continues uninterrupted to the historic present among hunter-gatherers in the Kalahari (Hewitt 1986). Pigment use also spans the evolutionary transition from archaic *Homo sapiens* (variously attributed to *H. heidelbergensis*, *H. rhodesiensis*, *H. helmei* [see McBrearty and Brooks 2000]) to *H. sapiens sapiens*.

In the broader context of the Old World Palaeolithic, the Twin Rivers pigment assemblage is the largest sample reported from a Middle Pleistocene context (table 2). Pigment use in the African Middle Stone Age is earlier than the Eurasian Middle Palaeolithic and distinctive in being *continuous*. Sporadic iron mineral use is reported from Late Acheulian contexts in Europe (Bednarik 1992), but there is no continuity in use through the Late Pleistocene. Neanderthals did collect and process mineral pigments but predominantly manganese dioxide rather than hematite (Combiér 1988, Couraud 1991, Mellars 1996) and not in the quantities seen in the contemporary southern African archaeological record (Knight, Power, and Watts 1995, Power and Watts 1996, Henshilwood et al. 2001). The behavioral differences in pigment use between Neanderthals and early moderns in Africa have their roots in the Middle Pleistocene. Central and East African hominids had incorporated color into their lives by 270,000 years ago, and this addition to their behavioral repertoire would remain a feature of the African archaeological record until the historical present.

References Cited

- AUDOUIN, F., AND H. PLISSON. 1982. Les ocres et leurs témoins au Paléolithique en France: Enquête et expériences sur leur validité archéologique. *Cahiers du Centre de Recherches Préhistoriques* 8:33–80.
- BARHAM, L. S. 1998. Possible early pigment use in south-central Africa. *CURRENT ANTHROPOLOGY* 39:703–10.
- . 2000. *The Middle Stone of Zambia, south-central Africa*. Bristol: Western Academic and Specialist Press.
- . 2001. "The emergence of regional identity in the Middle Pleistocene of central Africa," in *Human roots: Africa and Asia in the Middle Pleistocene*. Edited by L. Barham and K. Robson-Brown, pp. 65–80. Bristol: Western Academic and Specialist Press.
- BARHAM, L. S., AND P. SMART. 1996. An early date for the Middle Stone Age of central Zambia. *Journal of Human Evolution* 30:287–90.
- BEAUMONT, P. B., AND D. MORRIS. 1990. *Guide to archaeological sites in the Northern Cape*. Kimberley: McGregor Museum.
- BEDNARIK, R. G. 1992. Paleoart and archaeological myths. *Cambridge Archaeological Journal* 2:27–43.
- CHASE, P. 1991. Symbols and Paleolithic artifacts: Style, standardization, and the imposition of arbitrary form. *Journal of Anthropological Archaeology* 6:193–214.
- CLARK, J. D. 1970. *The prehistory of Africa*. London: Thames and Hudson.
- . 1971. Human behavioral differences in southern Africa during the later Pleistocene. *American Anthropologist* 73: 1211–36.
- . 1974. *Kalambo Falls prehistoric site*. Vol. 2. Cambridge: Cambridge University Press.
- . 1982. "The cultures of the Middle Palaeolithic and Middle Stone Age," in *The Cambridge history of Africa*, vol. 1, *From the earliest times to 500 B.C.* Edited by J. D. Clark, pp. 248–341. Cambridge: Cambridge University Press.
- . 1988. The Middle Stone Age of East Africa and the beginnings of regional identity. *Journal of World Prehistory* 2: 235–305.
- . 1992. African and Asian perspectives on the origins of modern humans. *Philosophical Transactions of the Royal Society of London B* 337:201–16.
- CLARK, J. D., AND K. BROWN. 2001. The Twin Rivers Kopje, Zambia: Stratigraphy, fauna, and artifact assemblages from the 1954 and 1956 excavations. *Journal of Archaeological Science* 28:305–30.
- CLARK, J. D., K. P. OAKLEY, L. H. WELLS, AND J. A. C. MC CLELLAND. 1947. New studies on Rhodesian Man. *Journal of the Royal Anthropological Society* 77:4–33.
- COMBIÉR, J. 1998. "Témoins moustériens d'activités volontaires," in *De Néandertal à Cro-Magnon*. Edited by J-B. Roy and A-S. LeClerc, pp. 69–72. Nemours: Musée de Préhistoire d'Ile de France.
- COURAUD, C. 1991. Les pigments des grottes d'Arcy-sur-Cure (Yonne). *Gallia Préhistoire* 33:7–52.
- DEACON, T. W. 1997. *The symbolic species: The coevolution of language and the human brain*. London: Penguin Group.
- EVERNDEN, J. F., AND G. H. CURTIS. 1965. Potassium-argon dating of Late Cenozoic rocks in East Africa and Italy. *CURRENT ANTHROPOLOGY* 6:343–85.
- GILMOUR, M., N. DEBENHAM, AND L. BARHAM. 2000. "Chapter 10, Twin Rivers, excavation and behavioural record—dating," in *The Middle Stone Age of Zambia, south-central Africa*, by L. Barham, pp. 172–83. Bristol: Western Academic and Specialist Press.
- HENSILWOOD, C. S., J. C. SEALY, R. YATES, K. CRUZ-URIBE, P. GOLDBERG, F. E. GRINE, R. G. KLEIN, C. POGGENPOEL, K. VAN NIEKERK, AND I. WATTS. 2001. Blombos Cave, Southern Cape, South Africa: Preliminary report on the 1992–1999 excavations of the Middle Stone Age levels. *Journal of Archaeological Science* 28:421–48.

- HEWITT, R. L. 1986. *Structure, meaning, and ritual in the narratives of the southern San*. Hamburg: Helmut Buske Verlag.
- HILL, C. A. 1976. *Cave minerals*. Huntsville: National Speleological Society.
- KEELEY, L. 1980. *Experimental determination of stone tool uses: A microwear analysis*. Chicago: University of Chicago Press.
- KING, R. J. 2000. Minerals explained 30: Hematite. *Geology Today* 16(4):158–60.
- KNIGHT, C. D., C. POWER, AND I. WATTS. 1995. The human symbolic revolution: A Darwinian account. *Cambridge Archaeological Journal* 5:75–114.
- LUMLEY, H. DE. 1969. A Paleolithic camp at Nice. *Scientific American* 220(5):42–50.
- MC BREARTY, S. 1999. "The archaeology of the Kapthurin Formation," in *Late Cenozoic environments and hominid evolution: A tribute to Bill Bishop*. Edited by P. Andrews and P. Banham, pp. 143–56. London: Geological Society.
- . 2001. "The Middle Pleistocene of East Africa," in *Human roots: Africa and Asia in the Middle Pleistocene*. Edited by L. Barham and K. Robson-Brown, pp. 81–92. Bristol: Western Academic and Specialist Press.
- MC BREARTY, S., AND A. BROOKS. 2000. The revolution that wasn't: A new interpretation of the origin of modern human behavior. *Journal of Human Evolution* 39:453–563.
- MARSHACK, A. 1981. On Paleolithic ochre and early uses of color and symbol. *CURRENT ANTHROPOLOGY* 22: 188–91.
- MELLARS, P. 1989. "Technological changes across the Middle-Upper Palaeolithic transition: Economic, social, and cognitive perspectives," in *The human revolution: Behavioural and biological perspectives in the origins of modern humans*. Edited by P. Mellars and C. Stringer, pp. 338–65. Edinburgh: Edinburgh University Press.
- . 1996. *The Neandertal legacy*. Princeton: Princeton University Press.
- PEARSON, O. 2000. "Appendix 8, Human remains from Twin Rivers," in *The Middle Stone Age of Zambia, south-central Africa*, by L. Barham, pp. 281–83. Western Academic and Specialist Press.
- POWER, C., AND L. AIELLO. 1997. "Female proto-symbolic strategies," in *Women in human evolution*. Edited by L. Hager, pp. 153–71. London: Routledge.
- POWER, C., AND I. WATTS. 1996. "Female strategies and collective behaviour: The archaeology of earliest *Homo sapiens sapiens*," in *The archaeology of human ancestry: Power, sex, and tradition*. Edited by J. Steele and S. Shennan, pp. 306–30. London: Routledge.
- ROEBROEKS, W. 1984. The Middle Palaeolithic site Maastricht-Belvèdère (Southern Limburg, the Netherlands). *Helinium* 24: 3–17.
- SIMMS, M. J., AND L. BARHAM. 2000. "Chapter 10, Twin Rivers, excavation and behavioural record—site formation," in *The Middle Stone Age of Zambia, south-central Africa*, by L. Barham, pp. 169–72. Bristol: Western Academic and Specialist Press.
- THÉVENIN, A. 1976. "Les civilisations du Paléolithique inférieur en Alsace," in *La préhistoire française*, vol. 1, *Les civilisations paléolithiques et mésolithiques de la France*. Edited by H. de Lumley, pp. 984–96. Paris: Centre National de la Recherche Scientifique.
- VELO, J. 1984. Ochre as medicine: A suggestion for the interpretation of the archaeological record. *CURRENT ANTHROPOLOGY* 25:674.
- WRESCHNER, E. E. 1985. "Evidence and interpretation of red ochre in the early prehistoric sequences," in *Hominid evolution: Past, present, and future*. Edited by P. V. Tobias, pp. 387–94. New York: Alan R. Liss.
- WYNN, T. 1993. "Layers of thinking in tool behavior," in *Tools, language, and cognition*. Edited by K. R. Gibson and T. Ingold, pp. 389–406. Cambridge: Cambridge University Press.
- YOUNG, T. P. 2000. "Appendix 5, Geochemical analysis of ferruginous materials from Twin Rivers," in *The Middle Stone Age of Zambia, south-central Africa*, by L. Barham, pp. 265–72. Bristol: Western Academic and Specialist Press.