Shell Artefact Production at 32,000–28,000 BP in Island Southeast Asia

Thinking across Media?

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The evolution of anatomical and behavioural modernity in *Homo sapiens* has been one of the key focus areas in both archaeology and palaeoanthropology since their inception. Traditionally, interpretations have drawn mainly on evidence from the many large and well-known sites in Europe, but archaeological research in Africa and the Levant is increasingly altering and elaborating upon our understanding of later human evolution. Despite the presence of a number of important early modern human and other hominin sites in Southeast Asia, evidence from this region has not contributed to the global picture in any significant way. Indeed, the acknowledged simplicity of lithic assemblages has led generations of scholars to assume that Southeast Asia was far from the cutting edge of behavioural evolution. Comparison of sophisticated shell tools from levels dated to 32,000–28,000 b.p. in eastern Indonesia with lithic artefacts recovered from the same levels and an assessment of raw-material procurement suggest that using lithic technologies as markers of behavioural complexity may be misleading in a Southeast Asian context and, indeed, may be hampering our efforts to assess behavioural complexity in global and comparative frameworks.

The study of Palaeolithic cultural material to understand human socio-cognitive evolution and the “dawning” of consciousness is one of the oldest and most fundamental pursuits in archaeology. It is also, arguably, the one that presents the most complex theoretical and methodological issues. Aside from matters regarding the preservation of such ancient material and the often ephemeral nature of deposits, Palaeolithic archaeologists face the interpretational conundrum that early modern *Homo sapiens* and other species of hominin may have thought, learned, and interacted quite differently from us (S. Binford 1968; L. Binford 1985; Klein 2000). It is indeed this very observation that has underpinned research into one of the central topics of debate in Palaeolithic research—whether the transition to “modern human behaviour” was a revolutionary event (e.g., Mellars 1989, 2005) or a gradual process (e.g., d’Errico 2003; McBrearty and Brooks 2000).

The favouring of one of these hypotheses over the other

has frequently rested upon the identification of particular material “markers” or behavioural proxies evidencing social and cognitive complexity, such as the capacity for symbolic expression (in the form of art and personal bodily ornaments such as beads and pendants [see Wadley 2001]), specialized “logistical” (*sensu* L. Binford 1980) hunting strategies, the development of specialized and stylistically variable blade-based lithic industries, and the use of non-lithic materials for tool production (see, e.g., Mellars 1989; Henshilwood and Marean 2003; McBrearty and Brooks 2000 for discussions). Such markers have largely been established from our relatively detailed understanding of the Upper Palaeolithic record in Europe, an area characterized by extensive and often complex stone and organic toolkits, parietal and portable art and personal bodily ornaments, and modern-human coexistence with another species of hominin (*H. neanderthalensis*) (Gamble 1999; White 1982). The appropriateness of the use of the European situation as a heuristic baseline has been questioned by some, particularly by those considering the regional dimensions of the Near Eastern and African Palaeolithic records (e.g., Henshilwood and Marean 2003; d’Errico 2003; McBrearty 2003; Hovers and Belfer-Cohen 2006; Hovers et al. 2003; Shea 2003). For example, numerous small mollusc shells perforated for use as beads or pendants at the sites of Ksar ‘Akil (Lebanon) in the eastern Mediterranean basin of the

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northern Levant and Üçağizli Cave in Turkey, dated to between ca. 41,000 and 39,000 b.p., suggest the presence of modern symbolic behaviour in the Levant several thousand years before its appearance in Europe (Gülec, Kuhn, and Stiner 2002; Kuhn et al. 2001). Recent claims for a perforated *Nassarius gibbosulus* marine gastropod shell in 100,000–135,000-year-old deposits at Skhul in Israel could imply an even earlier origin for the use of ornaments in western Asia (Vanhaeren et al. 2006). In East Africa there is abundant evidence for ostrich-eggshell bead manufacture 40,000 years ago at Enkapune Ya Muto rockshelter (Twilight Cave) in the central Rift Valley of Kenya (Ambrose 1998; Klein and Edgar 2002, 11–15), while more than 30,000 years earlier distinct evidence for non-figurative art production (i.e., geometric engravings on stones and bones) and body ornamentation (shell beads) is found at Blombos Cave and other Middle Stone Age sites in South Africa (d'Errico and Henshilwood n.d.; d'Errico, Henshilwood, and Nilssen 2001; d'Errico et al. 2005; Henshilwood et al. 2002; Cain 2006). Thus, while the major facets of the debate have emerged from studies of the European Upper Palaeolithic record, the question of ascribed “markers” and their universal applicability continues to be problematic.

As is pointed out by Henshilwood and Marean (2003), the ability to survive and prosper in particular African environments, especially those of a tropical or subtropical nature, requires rather different skills and knowledge from making a living in a periglacial Europe. Therefore, from a material perspective, adaptations that could be taken to reflect modern human behaviour may be expressed in quite different ways. While Henshilwood and Marean's argument stems from a consideration of the African archaeological data and has been criticized as “Afrocentric” as opposed to “Eurocentric” (e.g., Zilhão 2003), there is perhaps a more fundamental issue at play. Gamble (2003) points to the essentialist character of any “trait-list” approach, resulting in the assumption of universal “solutions.” Indeed, if problems are not universal we cannot expect the solutions to be so. In this respect, the underlying question may be what “universals” we can ascribe to shifts in biology and cognitive capabilities and what influences local circumstances and histories exert on the expression of these through time and across space.

It is in this light that Pleistocene shell and lithic artefacts from eastern Indonesia are examined in this paper. Evidence from the Southeast Asian Palaeolithic period has, historically, not been drawn into these discussions in any significant way, despite the regional presence of deep archaeological sequences representing both *H. erectus* and early modern human lifeways (see, e.g., de Vos 1995). This picture has become all the more complex with the recent discovery of the new hominin species *H. floresiensis* in Liang Bua Cave on Flores, eastern Indonesia (Morwood et al. 2004, 2005). When one considers that the Island Southeast Asian region has been occupied by at least three known species of hominin—two of which temporally overlapped and possibly interacted—as well as presenting evidence for the first known open-water crossings in world pre-

history (Davidson and Noble 1992) and a demonstrated ability to survive and prosper in tropical rain-forest environments (Barker 2005), it is clear that there is great scope for engagement with major theoretical and conceptual debates surrounding the arrival, emergence, and evolution of particular hominin cultures, capabilities, and vulnerabilities and for consideration of the degree to which universal as opposed to local explanations are likely to further our knowledge of the process of becoming “human.”

In order to engage with these issues in the Island Southeast Asian region, the results of a recent analysis of shell and lithic artefacts from the eastern Indonesian site of Golo Cave are presented here. The material in question dates to ca. 32,000–28,000 b.p. and represents, together with nearby Wetef Cave (see Bellwood et al. 1998; Irwin et al. 1999), the earliest cultural material thus far recovered from the Maluku region of Indonesia. The significance of the identification of flaked shell tools of such antiquity could be interpreted in a number of ways, but we see potential interpretations as falling into one of two major theoretical camps. On the one hand, the manufacture of formal tools from raw materials other than stone has been interpreted as a marker of modern human behaviour (Henshilwood and Marean 2003; Mellars 1989; see also McBrearty and Brooks 2000, 503–6), with examples customarily being manufactured from bone, ivory, or antler. We take it that the general rarity of shell tools (as opposed to ornaments) from Palaeolithic contexts globally is responsible for their apparent exclusion from trait lists. On the other hand, the use of flakeable shell could be seen as a local solution to the problem of poor lithic resources in Island Southeast Asia, where shell is frequently understood to be a substitute material for stone and the resultant artefacts are implicitly assumed to be functionally equivalent (e.g., Alba 1998, 64; Poulsen 1970, 36; see also comments in Ronquillo 1998, 73, and Davidson 1971, 68–69). From this perspective, necessity is seen as the mother of invention, and the fact that shell is worked (or presumed to be worked) in the same manner as stone diminishes the potential significance of the adoption of a new raw material (see, e.g., Cleghorn 1977). In conceptual terms, shell exists merely as a type of stone. In order to assess the status and “meaning” of shell as a raw material for artefact production, we investigate how tool production in both shell and stone was approached by the earliest inhabitants of Golo Cave. This allows us to gauge the extent to which preparation, intent, and the practices of working the two materials coincide and in what respects—if any—they diverge.

Background

Golo Cave is located on Gebe Island, between Halmahera and the western end of New Guinea, in Maluku Utara Province, eastern Indonesia (fig. 1). The site was excavated in 1994 and 1996 by a mixed-institutional team of Australian and Indonesian archaeologists led by Peter Bellwood. Preliminary reports on the Maluku project have appeared in print (see Bell-

wood et al. 1998, 2000; Irwin et al. 1999; Flannery et al. 1998; Pasveer and Bellwood 2004), and details on excavation techniques, chronology, and general results are drawn from these publications. For the purposes of this discussion, it is worthy of note that, according to faunal and sea-bed contour evidence, Gebe Island was not land-bridged either to nearby Halmahera or to New Guinea at any time during the Pleistocene. Human settlers must have crossed at least 40 km of sea to reach it. Birdsell (1977, fig. 1) regarded Gebe as a likely stepping-stone on his route 1A from the Sunda Shelf islands (Sumatra, Java, Borneo, Bali) to New Guinea and Australia, the latter both regions in which the first human settlers would appear to have been *H. sapiens* rather than archaic species such as *H. erectus* or *H. floresiensis*. There is currently no archaeological evidence to suggest that either of these pre-modern human populations ever reached Maluku.

Golo is a cave in uplifted coral located 8 m above sea level and 60 m inland from the north-western coast of Gebe Island. A total of 7 m² was excavated to bedrock, and all deposits were dry-sieved (3 and 5 mm). The cultural deposits in the main 5-m² excavation area extend to 240 cm, and, while discerning layers was difficult during the excavation itself (prompting the decision to excavate in arbitrary 5-cm spits),

Figure 1. Map of Eastern Island Southeast Asia and Gebe Island showing the location of Golo Cave (adapted from Irwin et al. 1999, fig. 4).

four major occupation/utilization phases have been recognized (see tables 1 and 2). These four phases contain varying cultural materials, as follows:

Table 1. Radiocarbon Determinations for Golo Cave

Lab Code	Material	Provenance	Age b.p.	Calibrated Age BP (1 sigma)	Calibrated Age BP (2 sigmas)
ANU-9448	Charcoal	Square M5 (45–55 cm)	3,230 ± 80	3,244–3,691 (1.000)	2,970–3,890 (1.000)
ANU-9449	Marine shell	Square M4 (50–55 cm)	7,400 ± 10	7,743–7,965 (1.000)	7,640–8,097 (1.000)
ANU-9769	Marine shell	Square M5 (135–140 cm)	10,540 ± 70	11,435–11,474 (0.073718) 11,626–11,940 (0.926282)	11,371–12,023 (1.000)
ANU-9512	Marine shell	Square M5 (145–150 cm)	11,480 ± 70	12,928–13,060 (1.000)	12,880–13,115 (1.000)
ANU-11053	Marine shell	Square M5 (185–190 cm)	19,080 ± 140	22,126–22,374 (1.000)	21,965–22,519 (1.000)
ANU-9768	Marine shell	Square M5 (195–200 cm)	9,260 ± 80	9,956–9,984 (0.099468) 9,991–10,189 (0.900532)	9,797–10,250 (1.000)
ANU-11007	Marine shell	Square LM6 (205–210 cm)	21,780 ± 160	25,614–25,995 (1.000)	25,459–26,000*
WK-4629	<i>Turbo marmoratus</i> operculum (artefact?)	Square LM6 (210–215 cm)	32,210 ± 320 ^a	–	–
ANU-9447	<i>Turbo</i> sp. operculum	Square M5 (230–235 cm)	31,030 ± 400 ^a	–	–
WK-17764 AMS	<i>Drupa clathrata</i> (marine shell)	Square M4 (200–205 cm)	28,740 ± 474 ^b	–	–
WK-17761 AMS	<i>Turbo marmoratus</i> operculum (artefact)	Square LM6 (210–215 cm)	28,251 ± 305 ^{a,c}	–	–

Source: Recalibrated from Bellwood et al. (1998) with the addition of recently acquired determinations.

Note: Calibrated using Calib 5.0.1 with the marine 04 calibration data set for shell and the intcal data set for charcoal. A ΔR value of 0 has been used for shell samples as has been recommended for this region (F. Petchy, personal communication, 2007). Numbers in parentheses indicate relative area under the probability distribution.

* Limit of reliable calibration.

^aBeyond reliable calibration.

^bResults of X-ray diffraction 98.60% ± 0.35 aragonite.

^cResults of X-ray diffraction 97.50% ± 0.25 aragonite.

Table 2. Distributions of *Turbo marmoratus* Operculum Artefacts and Lithic Artefacts by Depth

Depth (cm)	Midden Shell ^a (g)	Worked <i>T. marmoratus</i> operculum (n)	Lithic Artefacts (n)	Lithic Artefacts (g)
0–10	600	—	—	—
10–20	890	1	1	4.52
20–30	2,150	—	—	—
30–40	3,050	—	1	654.4
40–50	3,800	—	8	41.37
50–60	2,085	—	12	324.28
60–70	1,875	—	6	49.99
70–80	1,275	—	7	59.4
80–90	1,050	—	5	474.1
90–100	1,350	—	2	53.1
100–110	775	1	1	51
110–120	800	—	2	7.6
120–130	575	—	3	21.3
130–140	550	—	1	5.5
140–150	825	—	4	28.5
150–160	775	—	—	—
160–170	600	—	—	—
170–180	950	1	4	300.1
180–190	550	—	2	25.6
190–200	350	1	—	—
200–210	325	4	1	10.4
210–220	690	2	12	328.2
220–230	1,050	4	25	200.9
230–240	375	3	3	420.8

^aWeight of a single square (M5) as an indication of the amount of shell recovered from throughout the sequence. Midden weights sourced from Bellwood et al. (1998).

1. Phase 1, 33,000 to (?)21,000 b.p., the lowest occupation, directly on the bedrock at approximately 190 to 240 cm below ground level, with moderate densities of shell (including the tools discussed in this paper), burnt coral, and flaked lithic artefacts but no animal bone.

2. Phase 2, (?)21,000 b.p. to early Holocene, which, following a 40-cm zone with very sparse signs of human occupation, extends up to 80 cm below ground level and contains two small circular coral block settings, with shells and flaked lithic artefacts in small quantities. Animal bone appears at the top, possibly disturbed downward from the Phase 3 deposit above. *Tridacna* and *Hippopus* shell adzes also occur.

3. Phase 3, Holocene, prior to 3,000 b.p., extending from 80 cm up to about 20 cm below ground level, which contains high densities of midden shell and lithic artefacts and many cuscus (*Phalanger* sp.) and wallaby (*Dorcopsis* sp.) bones, the latter (and indeed perhaps both) translocated from Misool Island or elsewhere in West Papua (Flannery et al. 1998).

4. Phase 4, post-3,000 b.p., the uppermost 20 cm of deposit, with clear stratigraphic definition, diminished occupation density, caching of *Cassia cornuta* adzes, sparse pottery, and almost no lithic artefacts or animal bone. An extended burial was placed in a grave cut from its base, backfilled with soil liberally sprinkled with red ochre.

Five radiocarbon dates have been run on marine shells from Phase 1, including one AMS radiocarbon date directly on one of the shell artefacts discussed here, and all are concentrated in the time period 29,000–32,000 b.p. with the exception of one date of 21,780 b.p. from the top of this phase (see table 1). Another date of $9,260 \pm 80$ b.p. at 195–200 cm is clearly out of order and can only be explained through downward disturbance of younger materials.

Phase 2 has three ¹⁴C dates in good order between 19,000 and 10,000 b.p. There is a complete absence of animal bone below the upper part of the deposit, which makes it unlikely that any major disturbance came down from the Holocene layers above. Given the excellent preservation of the shell in both Phases 1 and 2, this absence of bone is unlikely to be related to soil conditions and is taken as reflecting a lack of original deposition. Considering the paucity of native vertebrate fauna on Gebe Island (see Flannery et al. 1998), this absence is perhaps not as surprising as it may initially appear.

For logistical reasons, only one full sample of shell from the lower portion of one square (M4) was brought back to Canberra for study. Other material was sorted and counted on site, examined for obvious artefacts (none were observed at that time), and then stored both in the cave and in the Muzium Kraton Sultan in Ternate. At the time, the possibility that the operculum fragments discussed here were artefacts was not recognized, and owing to subsequent political instability in this region of Maluku Utara it has not been possible to return or to conduct further field research. Nearly half of the sample of knapped shell discussed here was retrieved from the midden sample returned to Canberra, so it can be expected that a number of artefacts and manufacturing by-products are present in the samples left in Indonesia. We hope eventually to be able to recover these samples.

The Golo Shell Artefacts and Pleistocene Shell Knapping

Shell artefacts were recovered from throughout the Golo sequence and show distinct temporal patterning, with different raw materials and technological approaches being employed at different points in the past. As noted above, adzes in various species of giant clam, including *Tridacna gigas* and *Hippopus hippopus*, and the “helmet shell” *Cassia cornuta* were recovered from Middle to Late Holocene levels (see Golson 2005 and Szabó 2005 for discussions of chronology and technological approaches), as well as worked pieces of mother-of-pearl deriving from the black-lipped pearl oyster (*Pinctada margaritifera*), the chambered nautilus (*Nautilus pompilius*), and the large green snail *Turbo marmoratus*.

Concentrated at a depth of from 195 cm to nearly the base of the deposits at 235 cm is a collection of knapped pieces deriving from the large, robust, calcareous operculum of *T. marmoratus* (see fig. 2). Technological analysis indicates that these opercula were being shaped by detaching flakes sequentially from the margin in a unidirectional fashion, gen-

Figure 2. Modern *Turbo marmoratus* shell with an unmodified archaeological operculum from a smaller shell. (photo P. Piper)

erating a steeply angled edge. These artefacts and associated working debris provide the earliest evidence for shell knapping and formal tool production in the region and, with the exception of claims for shell knapping at several Middle Palaeolithic sites in west-central Italy before 60,000 b.p. (Kuhn 1995; Stiner 1994), anywhere in the world.

We have considered the possibility that the opercula utilized as raw materials for tool production could have been collected from old reef or beach deposits, in which case the date of human working would be younger than the date of the shell. There is also the possibility of downward movement of artefacts in soft, dry cave deposits into older layers. We believe, however, that the 32,000–28,000 b.p. dates for the Golo Phase 1 *T. marmoratus* opercula artefacts discussed here are correct on the following grounds:

1. At least three of the five dates from the lower layers are on food shells, not used for making artefacts, and all have returned radiocarbon determinations between 32,000 and 28,000 b.p.
2. A further two direct AMS radiocarbon dates are on *T. marmoratus* opercula, one of $28,251 \pm 305$ b.p. on a definite artefact and the other of $32,210 \pm 320$ b.p. on another operculum submitted for dating in 1996, before the presence of working was recognized at the site.
3. The results of X-ray diffraction analysis demonstrate that the dated operculum artefact, together with one of the midden samples, has not been subject to aragonite-calcite recrystallization, which may distort the true age (see table 1).
4. All artefactual and non-artefactual shell from the Golo deposits returned to Canberra was checked for indicators of post-mortem introduction into the cave and taphonomic sig-

natures that would indicate disturbance and movement within the deposits. Such indicators include the muting of external sculpture produced by attritional processes such as sand-blasting and wave action and the presence of adhering organisms inside the apertures of gastropods and on the inner valve surfaces of bivalves. The presence of any of these would suggest natural deposition. In addition, wear indicative of coenobitid hermit crab use such as aperture abrasion and drag-marks and evidence for the action of underwater bioeroders such as boring sponges on interior and broken surfaces of shells would indicate the death of the mollusc and original deposition of the shell in littoral and/or underwater environments (see Szabó 2005, chap. 4). None of these indicators were recorded for the shell recovered from the lowest layers of the Golo deposits, with the exception of evidence for hermit-crab deposition of some *T. setosus*, *T. argyrostomus*, *Nerita costata*, and *N. undata* specimens.

5. Fragments of worked and unworked *T. marmoratus* shell, reduced whole shells, and opercula have been recovered from the earliest deposits at Golo Cave. The shells themselves show no indication of having been collected post-mortem, and the presence of both shells and opercula considerably strengthens the case that *T. marmoratus* specimens were collected and entered the cave in a live state. Further, the *T. marmoratus* shells themselves show signs of having been worked (see Szabó n.d.b).

6. The worked operculum artefacts are strongly concentrated at the base of the Golo Cave deposits. Numbers of artefacts and the depths from which they were recovered are presented in table 2. The radiocarbon determinations do not indicate major, unrecognized disturbance of the deposits, and we consider it unlikely that all of these artefacts have been downwardly displaced. The worked operculum fragment recovered from a depth of 10–20 cm (see table 2) is highly weathered.

7. No natural beach deposits underlie the Golo Cave cultural deposits, making mixing at the basal natural/cultural interface an unlikely scenario. The cultural deposits sit directly on the bedrock.

Turbo spp. opercula are paucispiral in structure, meaning that calcium carbonate is laid down in a continuous loose spiral around an off-centre nucleus (see fig. 2). As the operculum is enlarged to fit the expanding shell aperture, earlier spirals are partially reabsorbed. While this process results in a smooth operculum surface, relict growth stages are visible upon fracture, and this internal structure has a substantial impact upon flake propagation, termination, and general morphology. *Turbo* spp. opercula are composed of the aragonitic form of calcium carbonate, and observations under $40 \times$ microscopy indicate that this aragonite is laid down in a prismatic structure, with bundles of elongate, prismatic crystals of aragonite similarly oriented perpendicular to the surface of the shell (Currey 1988, 191). This means that force delivered to the outer surface of the operculum will travel down the bundles straight into the operculum itself, with little

Figure 3. Bending-initiated opercula flakes from Golo Cave. Scale bar 30 mm. (photo M. W. Moore)

lateral dissipation. Analysis of *Turbo* spp. opercular microstructure using scanning electron microscopy is ongoing.

A number of shaped operculum artefacts ($n = 7$), unreworked flakes ($n = 12$), a probable retouched piece ($n = 1$), and amorphous shatter fragments resulting from percussion ($n = 6$) were identified in the Canberra sample of the Phase 1 Golo shell assemblage. Only a single knapped operculum, two flakes, and a single amorphous fragment were identified from material above a depth of 195 cm, and these are considered to be reworked in the deposit. Negative scars on the dorsal surfaces of operculum flakes, on the knapped opercula and other modified specimens (see below), and on amorphous fragments are generally unidirectional and feature signs of an external blow in the form of slight crushing along the platform edge. The majority of these scars have been produced by direct freehand percussion. Other fracture surfaces are more difficult to interpret and may result from freehand percussion or a different knapping technique (i.e., block-on-block reduction, or "throwing"). A number of pieces not displaying diagnostic percussion characteristics but most likely the result of knapping are interpreted, on the basis of our informal knapping experiments, to represent non-flake debitage (i.e., angular shatter/amorphous blocky fragments [see Andrefsky 1998])

produced during percussion. These were likewise restricted to the lower reaches of the deposits.

Operculum flakes were invariably detached by bending-initiated rather than conchoidal fractures (see Cotterell and Kamminga 1979, 101–2; 1987, 689–91; Tsirk 1979; fig. 3). The prevalence of this fracture type seems to be strongly influenced by the internal operculum features discussed above; the operculum does not provide a homogeneous and isotropic knapping material and does not fracture conchoidally. The older partially reabsorbed surfaces are still clearly evident upon fracture and during flake propagation exert a substantial influence on the growth of the fracture front (fig. 4, *a*). This feature of *Turbo* spp. operculum structure can be seen to have influenced both flake termination and morphology in a number of the Golo examples (e.g., fig. 3, *d*).

Technological observations suggest that whole opercula were knapped in continuous series of subparallel unifacial flake removals initiated from the perimeter of the convex dorsal surface (see fig. 4, *a*). Interestingly, the order in which flakes were removed follows the natural whorl lines of the operculum itself, as if in mimicry of the natural form of the raw material. This practice and the resulting morphology may have had symbolic significance to the Golo knappers, but they

Figure 4. Knapped opercula from Golo Cave. A, whole operculum featuring continuous unifacial retouch along peripheral margin; B, operculum fragment with unifacial retouch around the periphery. Scale bar 50 mm. (photo M. W. Moore)

could also be fortuitous; a larger sample is needed to tease out any potential patterning in this regard.

Of 12 complete operculum flakes recorded in the assemblage, the dorsal surfaces of all but one have negative scars oriented in the same direction as the percussion axis. The dorsal scars clearly overlap; however, because of the irregular microstructure of the operculum it is difficult to infer the precise chronology of their removal. There are some clues: one bending flake features a single negative scar on the left margin, while the rest of its upper surface is the natural convex dorsal surface of the operculum core from which it was struck. The cross-sectional morphology of this flake indicates that it is derived from the relatively thin perimeter of the operculum, and therefore it appears to have been the last in a series of unifacial flake removals initiated from the dorsal perimeter of an operculum. The dorsal scar morphology of this flake implies that the shaped operculum artefacts were sometimes rotated clockwise during unifacial reduction.

This observation is supported by the morphology and orientation of scars on the shaped operculum shown in figure 4, *a*. The specimen consists of about two-thirds of a complete operculum with the long axis intact and the nucleus of the operculum present. The artefact features continuous subpar-

allel unifacial flake removals, initiated from the dorsal surface, around approximately one-third of the original circumference of the operculum. This modified object does not appear to be a "core." Rather, the serial placement and small dimensions of the flake scars suggest that it may have functioned as a form of retouched tool (i.e., a steep-edged "scraper"-like object with an edge angle of ca. 84° [see Inizan et al. 1999]). This possibility is currently being tested through microwear and residue analyses.

While there is no evidence for the intentional retouching of operculum flakes, at least some by-products of the flaking process appear to have had flakes removed from them. One roughly square (seen in plan view in figure 4, *b*) artefact features continuous subparallel unifacial retouch, initiated from the curved dorsal surface of the operculum, along three adjoining edges. Because of the absence of diagnostic features (such as a detachment scar) it is not possible to determine whether this artefact was made on a flake, a flake fragment, or something else. The cross-sectional morphology, however, indicates that it is derived from the thin outer edge of an operculum. We interpret it to be a piece detached from the peripheral margin of an operculum that was intensively retouched along the edges. The retouched portions of the object

form edge angles of ca. 80°, offering support to our identification of the possible “scraper”-like object mentioned above. Furthermore, the small size of the steep retouching scars on this artefact and the frequent step terminations imply that the knappers may have been concerned more with shaping the edges of the object than with regular flake production. In this respect, and with regard to the other knapped opercula in the assemblage, the reduction procedure follows a “shaping” process rather than a “debitage” process (see Inizan et al. 1999, 43, 59).

In a comparative analysis of shell-working techniques practiced across the Island Southeast Asian and western Pacific regions in prehistory (Szabó 2005; see also Szabó n.d.b), reduction by direct freehand percussion was found to be associated with initial stages of working only and was not used as either a technique applied in isolation or a technique for intentional flake production. Rather, a range of techniques such as cutting, grinding, freehand abrasion, and secondary or indirect percussion were applied in specific combinations to different raw materials (see Szabó n.d.b). Such matching of working techniques to raw materials appears to be driven partially by the robustness, fracture tendencies, and microstructure of the shell selected for working and dates to at least the terminal Pleistocene/early Holocene (Szabó n.d.b). The application of direct freehand percussion alone to produce finished artefacts is therefore anomalous in the region (but see Brown 1993 for reports of *Eucrassatella* spp. fossil-shell knapping between 18,500 and 15,000 BP at Mannalargenna Cave, Tasmania) and technologically seems to have more in common with lithic artefact production techniques. To investigate the relationship between shell and stone flaking at Golo Cave, a technological analysis of the lithic artefacts was undertaken.

The Lithic Artefacts

Because flaked shell was found only in the lowest levels of the Golo deposits, we will discuss only the stone technology from the earliest Pleistocene levels (Phase 1 and lower Phase 2) in the cave. (Counts of lithic artefacts recovered throughout the sequence are given in table 2.) A total of 51 stone artefacts were recovered from the levels located between ca. 150 and 240 cm below the surface. While this assemblage is small, a number of trends are apparent.

The most common artefact category recorded in the assemblage was flake shatter ($n = 14$) derived from a range of metavolcanic rocks (see Andrefsky 1998 and Inizan et al. 1999 for discussions of relevant terminology). Simple unretouched flakes ($n = 11$) produced by direct freehand percussion (fig. 5, *a*), and undiagnostic knapped pieces or fragments ($n = 13$) were also common. Intentional retouch or evidence of curation was not observed, although one large (maximum dimensions 56.27 × 55.19 × 16.58 mm) metavolcanic flake featured extensive unifacial and bifacial micro-flaking along the right lateral edge and a small portion of the left lateral

edge at the distal end. This edge damage is interpreted to be a consequence of flake utilization. A single hammerstone, a water-worn ovate volcanic cobble (122.3 g), was also recovered, although another object may also have been used as both an anvil and a hammer.

Only three definite cores were recorded in the assemblage (fig. 5, *b* and *c*). All are single platform cores manufactured on amorphous debitage pieces, with the scars resulting from freehand blows. At least two other flakes in the assemblage also have scars that, in morphology, seem to relate more to flake production than to intentional retouch. Technically speaking, these artefacts may be classified as cores, but it is not always clear whether flake removal was the final technical modification prior to discard. These are listed in table 3 as “modified flakes.”

In most cases, knapping involved only brief episodes of relatively noninvasive freehand unifacial removals. Fewer than three or four flakes are recorded on cores, and the smallest core features a single negative scar (fig. 5, *b*). Interestingly, medium-sized flakes (ca. 21–50 mm in maximum dimension) often display multifaceted platforms, little or no cortex, and complex arrangements of multidirectional dorsal scars. Most of these artefacts appear to be derived from relatively intensively worked multiple platform cores, none of which occur in the Golo assemblage. These multiple platform cores were presumably abandoned outside the cave.

Measurements of flakes and flake scars show interesting discrepancies with each other, with flakes being considerably and consistently larger than the negative scars on cores and formed objects. This incongruity in the maximum dimensions of flakes and core scars suggests that flakes measuring more than 21–30 mm in size were probably not struck inside the cave itself, or, if they were, the cores with these scars were not discarded inside the cave and/or were subsequently reduced considerably in mass. The very small proportion of flaked stone material recovered from the lowest levels of Golo Cave would tend to support the first possibility. Furthermore, given the large size of some of the flakes recovered, if cores with negative scars of this size were being intensively reduced on-site, one would reasonably expect to find a correspondingly large proportion of knapping by-products in the assemblage. This is not the case. Since all deposits were dry-sieved through 3-mm and 5-mm meshes, it is unlikely that small flakes were overlooked. The archaeological evidence implies that medium-sized to large flakes (> 21–30 mm) were carried into the cave from cores struck elsewhere. Such a conclusion, based on similar evidence, has been drawn by Hiscock (2005) for the Late Pleistocene to Late Holocene sequence of lithic artefacts recovered from Liang Lemdub, Aru Islands, eastern Indonesia, and this pattern is common to Late Pleistocene sites in Island Southeast Asia (Moore and Brumm 2007).

The virtual absence of lithic debitage or any other flaked artefacts measuring less than 21 mm in maximum dimension is more problematic. There are several possible explanations: (1) Taphonomic factors biased the assemblage towards the

Figure 5. Stone artefacts from Golo Cave. A, large unretouched coarse-grained metavolcanic flake, with projection at right lateral margin (dorsal) showing a pre-detachment scar; B, single platform core on chertlike debitage fragment; C, single platform core showing several unifacial removals on fine-grained metavolcanic debitage fragment and water-rolled cortex; D, unretouched metavolcanic flake. Scale bar 50 mm.

representation of flakes measuring more than 21–30 mm in length. (2) Flakes measuring less than 21–30 mm in length were transported away from the cave. (3) Cores with small scars were brought into the cave, but small flakes were not removed from them. At this stage it is not possible to provide a definite answer, but one would reasonably expect to find a significant proportion of small flakes and shatter in areas where stones were knapped (e.g., Schick 1986).

In sum, the earliest stone technology in Golo Cave ca. 32,000 years ago was very simple. The metrical data suggest that medium-sized and large flakes and flake fragments (> 21 mm in maximum dimension) were brought into the cave from cores struck elsewhere. Smaller flakes (< 20 mm in maximum dimension) were probably manufactured inside the cave itself, although some may also have been transported from reduction areas located elsewhere on the landscape. The

Table 3. Lithic Artefact Types in the Golo Cave Pleistocene Assemblage

N	Type	Percentage
11	Flakes	21.6
2	Modified flakes	3.9
1	Utilized flake	2.0
14	Flake shatter	27.4
3	Single platform cores	5.9
13	Undiagnostic pieces/fragments	25.5
3	Blocky fragments	5.9
2	Cobble fragments	3.9
1	Hammerstone	2.0
1	Possible anvil/hammerstone	2.0
51		100.0

medium-sized and large flakes and flake fragments functioned as single platform cores for the removal of flakes by direct freehand percussion using a hard hammer. Smaller pieces of flake and non-flake debitage also appear to have been used as single platform cores for the extraction of very small (< 20 mm) non-invasive unifacial flakes (but see above). The primary goal of knapping seems to have been the production of simple, sharp-edged flakes, most likely for use as unretouched cutting/scraping tools. There is no evidence for the deliberate shaping of objects into formal tool types, and intentional retouch on flakes is absent.

Raw-Material Acquisition

In the Asia-Pacific archaeological literature, it is frequently assumed that shell is used as a raw material for tool production only when reliable sources of stone are lacking. This implies that shell is merely a "substitute" material and that tools made of stone and shell are functionally equivalent. It further implies that suitable shell is more easily obtainable than knappable stone on Southeast Asian and Pacific islands.

Lithic artefacts recovered from the deepest Golo deposits were produced on a varied and rather low-quality selection of volcanic, metavolcanic, and chertlike rocks. While the western end of Gebe Island is predominantly raised coral, the rest of the island is made up of an assortment of volcanic and metamorphic rocks overlain in part by nickel-rich deposits (Bellwood et al. 1998, 252; Irwin et al. 1999, 365). Irwin et al. (1999, 370) suggest that the central and eastern parts of Gebe, where concentrations of volcanics and metamorphics occur, were the likely source areas for the raw materials utilized for lithic artefact production at Golo and Wetef Caves. Given the location of Golo Cave in the western limestone area of Gebe Island, lithic raw materials would presumably have been transported a minimum distance of several kilometres. Given that the island is only some 45 km long, however, the distances covered would not seem to have been inordinately great, regardless of the exact source area or areas.

Nevertheless, a degree of mobility and planning in the procurement and transport of raw materials is implied.

The locating and collecting of *T. marmoratus* and associated opercula can be seen to involve quite different processes. *T. marmoratus* is the largest member of the gastropod family Turbinidae, often attaining a maximum diameter of 20–25 cm. The operculum alone commonly weighs ca. 500 g. It inhabits subtidal (i.e., not intertidal) areas and lagoons on dead coral and rocky ground (Pradina and Makatipu 2001, 9). *T. marmoratus* is locally common across its natural range, which takes in the Indian Ocean and the Pacific Ocean as far east as Fiji (Cernohorsky 1972, 45). Its presence outside of this range is the result of recent translocations linked to the mother-of-pearl industry (Pradina and Makatipu 2001, 9).

As discussed above, the non-weathered and non-beach-rolled state of the *T. marmoratus* opercula and shell present in the lower Golo assemblage suggests that shells were collected live as opposed to being gleaned opportunistically from strand deposits. Given the massiveness of the shell and operculum, it is highly unlikely that either would be recovered washed up on the strandline without signatures of taphonomic alteration. Their condition further indicates that, unlike the giant clam (*Tridacna* spp.) used for adze manufacture (see Szabó 2005 for examples from Duyong Cave and Kamuanan Shelter, Philippines, and Pamwak Shelter, Admiralty Islands), subfossil and/or fossil deposits were not being exploited. Given the ecology of *T. marmoratus*, this would suggest that the shells were gathered by diving in shallow subtidal reef or lagoonal zones. This indicates that the Golo shell artefact producers were familiar with coral reef environments and the shell species that inhabited various niches within the reef system.

Interestingly, the results of the shell midden analysis show that reef and lagoon environments were *not* being exploited on any regular basis for the gathering of subsistence shell, at least while Pleistocene foragers inhabited Golo. A total of 53 species have been identified in the lowest layers of Golo in association with the operculum artefacts. Six of these are terrestrial snail species, which are probably self-introduced into the deposits. The vast majority of the marine species inhabit rocky upper intertidal and "splash" zones. Such specimens constitute 88% (MNI) of the Golo shell midden. The common turbinids (Turbinidae) of the reef flat are sparsely represented, the members of the Trochidae (top shells or trochids) not being represented at all. Furthermore, in most instances small/intermediate-sized *Turbo* spp. shells identified in the midden show evidence of having been deposited by hermit crabs (*Coenobita* spp.) rather than humans.

In terms of collecting environments, there is an important distinction between the upper-intertidal and splash-zone gathering strategy evidenced by the midden shell and the probable shallow diving required to obtain *T. marmoratus*. It further demonstrates exploitation of two quite different inshore systems—rocky shores and coral reefs. Not only does this show a thorough knowledge of littoral and near-shore

environments but it reveals that the Pleistocene inhabitants of Golo Cave had very specific ideas of what they wanted in shell as a working material and would go to some lengths to obtain it. This does not seem to match what we would expect to see if shell were little more than an expedient or “substitute” raw material as a response to poor or locally absent stone resources.

Discussion

The fashioning of tools from non-lithic materials—most commonly bone, antler, and ivory in Old World contexts—has long been considered a marker of modern human behaviour argued to occur at the time of the Middle to Upper Palaeolithic “revolution,” roughly 40,000 to 50,000 years ago (e.g., Mellars 1989; Henshilwood and Marean 2003). The main idea underpinning this argument is that Upper Palaeolithic modern humans tailored their manufacturing techniques to suit the specific properties of different raw materials—an expression of ingenuity and cognitive and behavioural sophistication thought to be unique to our species (Villa and d’Errico 2001). Thus materials such as antler, ivory, and bone, which generally have quite different structural, chemical, and tensile properties from stone, were cut, sawn, ground, chiselled, carved, scraped, abraded, polished, and so on, into shape—techniques not commonly applied to stone (at least during the Palaeolithic period). Upper Palaeolithic craftspeople, therefore, approached the manufacture of tools made from diverse raw materials in entirely different ways. They did not simply work organic materials as though they were stone, that is, by knapping them. Indeed, it is the occurrence of objects such as the knapped equid, bovid, and proboscidean bones at Olduvai Gorge (Leakey 1971, 235–46) and the knapped proboscidean bone bifaces in the central Italian Middle Pleistocene (see Gaudzinski et al. 2005) that has led some researchers to argue that non-modern hominins were incapable of conceiving of specific techniques for working material other than stone (e.g., Mithen 1996; Noble and Davidson 1996; but see d’Errico and Backwell 2003).

Our first impression of the flaked shell artefacts was that they represented the direct transference of lithic techniques to the medium of shell and therefore not only constituted a form of incipient shell working in Southeast Asia but potentially signalled a regional “threshold” in the development of human behaviour. The deliberate knapping of shell some 32,000–28,000 years ago at Golo Cave seemed to be prelude to the more sophisticated manufacturing techniques applied much later in the sequence, such as the Early to Middle Holocene production of edge-ground adzes in various species of giant clam and the shell fishhooks produced from the gastropod *Trochus niloticus* (for details see Szabó 2005, n.d.a, n.d.b; O’Connor and Veth 2005). The combined results of the lithic and shell artefact analyses, as well as the shell midden analysis, however, have forced a revision of this interpretation. It is now possible to view the knapping of opercula in the

Late Pleistocene levels at Golo Cave less as a preface to more sophisticated technological approaches than as convincing evidence for technological complexity in itself (fig. 6).

To begin with, it is clear from the deliberate selection of *T. marmoratus* opercula, their targeted procurement outside of normal collecting zones, and the ways in which they were worked that the Pleistocene inhabitants of Golo had a working environmental knowledge of local marine niches, practiced knowledge of their chosen raw material, and very clear ideas about what they wanted to fashion and how this was to be achieved. It can further be seen that, although both stone and shell were worked with direct percussion, the creation of artefacts in the two materials was underwritten by quite different intentions, approaches, and goals. As the technological analysis indicates, the opercula were knapped into shape using continuous series of freehand blows, resulting in modified objects with a specific pattern of unifacial retouch and, arguably, “imposed form” (*sensu* Mellars 1989). There is also some evidence that flakes or other fragments detached from operculum cores were intensively retouched into shape. By contrast, stone at Golo Cave was expediently knapped, and the intention appears to have been the production of simple, sharp-edged flakes. These flakes were presumably used and discarded on the spot; none were retouched. Combined with the complex raw-material procurement strategy and the in-depth knowledge of local environmental conditions it implies, the evidence that Golo knappers at 32,000–28,000 b.p. varied their technological processes according to the specific properties of different raw materials suggests that these people displayed behavioural and cognitive adeptness equivalent to that of contemporaneous modern human populations elsewhere in the world.

A logical correlate of this argument would be that shell knapping in non-modern hominin contexts must also imply the presence of modern human behaviour, so we must state our argument quite clearly. There is apparent archaeological evidence for the knapping of marine bivalves at the Middle Palaeolithic cave site of Grotta dei Moscerini (occupied ca. 110,000–60,000 BP) in the coastal Latium region of west-central Italy (Kuhn 1995; Stiner 1994). In light of the arguments made in this paper, the presence of deliberately knapped shells may also indicate that Neanderthals in west-central Italy were cognitively similar to the Golo knappers or, conversely, that the Golo knappers may not have been fully modern. A brief examination of the evidence suggests, however, that the situation is not so straightforward.

Three shellfish taxa dominate at Grotta dei Moscerini: the soft-shore clam species *Callista chione* and *Glycymeris* spp. and the rocky-shore mussel *Mytilus galloprovincialis* (Kuhn 1995, 78; Stiner 1994, 180). Molluscan remains were few but occurred in all lithic-bearing layers (Kuhn 1995, 150; Stiner 1994, 182). A number of *C. chione* fragments were fractured and burnt in a manner suggestive of human processing for consumption, “as well as being sometimes retouched by percussion” (Kuhn 1995, 78; Stiner 1994; Vitagliano 1984; Palma

Figure 6. *Chaînes opératoires* for *T. marmoratus* operculum and lithic artefact from procurement to discard.

di Cesnola 1965). Descriptions of these objects are limited, but it appears that the clamshells were chipped around the inner valve surface of the ventral margin by percussion (Stiner 1994, 187–88). Such artefacts have also been recorded at other coastal Mousterian sites in Italy, including Barma Grande in Liguria and Grotta del Cavallo, Grotta dei Giganti, and Grotta di Ulozzo C in Puglia (Kuhn 1995, 59; see also Stiner 1994, 187).

Attention has long been drawn to bivalve fragments displaying edge-chipping in archaeological deposits, and such items have been interpreted in a variety of ways. Generally, edge-chipping is seen as evidence of utilization (e.g., Best 1984, 455–59; Cooper 1988, 33–35), deliberate modification (as in the case of the Mousterian evidence discussed above), or, occasionally, processing of bivalves for consumption (e.g., Prummel 2005; Best 1984, 155–58). Various other analysts are reluctant to favour either deliberate knapping of edges or use-wear for the interpretation of chipped ventral margins, referring to them simply as “artefacts” (e.g., Lima, de Mello, and da Silva 1986; Barton and White 1993). We also choose to err on the side of caution and not attribute edge damage to either utilization or deliberate modification in the form of knapping in the absence of investigations into shell structure and breakage.

Shell as a raw material is not well understood, and the little experimental work that has been carried out has customarily been informal (e.g., Best 1984; Spennemann and Colley 1989). As a result, discussion of expedient shell working in particular tends to arrive at tentative, generalized, and sometimes overstated interpretations. While many analysts allow for the fact that shell is a very different raw material from stone in terms of structure and fracture tendencies (e.g., Toth and Woods 1989), shells of different molluscan taxa are implicitly or explicitly expected to have similar fracture properties.

One of the major reasons offered by Stiner (1994, 188) for considering the Moscerini *C. chione* valve fragments worked is that associated *Glycymeris* spp. valves do not show the same modifications to the ventral margin, thereby ruling out a taphonomic interpretation (i.e., trample damage). While this may very well turn out to be a good reason, it can only be confidently asserted after a comparative analysis of the fracture mechanics of the two taxa. Different species of bivalve have been demonstrated to respond in different ways to compressional and compactional loading forces (Zuschin and Stanton 2001), and differences between the genera *Glycymeris* and *Callista* in valve morphology and inflation, hinge morphology, and shell thickness across the body and at the ventral margin would suggest that breakage patterns will diverge. In short, there is no *a priori* reason to assume that similar taphonomic processes will produce similar damage in these or indeed any other types of shell.

Interpretational issues aside, the possibility that coastal Neanderthal populations were working shell does not present a problem for our argument. We do not seek to add “shell working” to the trait list signalling modernity; doing so would

further reinforce the essentialism we wish to avoid. We have sought to demonstrate that the Golo knappers were producing substantially more sophisticated artefacts in shell than in stone. This is not the case at Grotta dei Moscerini.

The stone technology at Grotta dei Moscerini offers an interesting contrast with the shell technology. The only known sources of consistent-quality stone in Middle Palaeolithic Latium were occasional flint pebble beaches where the maximum diameter of pebbles was only 8–10 cm (Kuhn 1995). Despite the limited distribution and small size of local pebbles, however, a “surprising diversity” of core forms was recorded in Pontinian (the Mousterian of Latium) assemblages, including Grotta dei Moscerini (Kuhn 1995, 83). Pontinian hominins produced at least 29 typologically distinct core types. These were the by-products of four distinct methods of flake blank production: bipolar reduction, centripetal or “radial” core reduction, successive parallel flake reduction (resulting in “pseudo-prismatic” cores), and prepared platform core reduction. Flakes struck from cores were often intensively retouched prior to discard. The degree of diversity and flexibility in core technology, Kuhn (1995, 120) argues, may have been a response to the small size of the local flint pebbles: “Although Mousterian populations were certainly constrained by their reliance on small pebbles, it appears that they could also take advantage of the opportunities offered by variation within the materials at hand, selecting stones because they were suitable for working in a particular manner, and not simply adopting different techniques according to the pebbles they happened to collect.”

The picture presented for coastal Mousterian sites differs considerably from that evidenced at Golo Cave. Australasian lithic assemblages have repeatedly been characterized as “amorphous” and expedient (see esp. White 1977; Veth et al. 1998). In this regard, the Golo Cave Pleistocene lithic assemblage is no exception. The general lack of specialized and curated lithic technologies in the region throughout the Pleistocene and also frequently the Holocene has fuelled decades of debate, with various explanations being advanced. Such explanations include a paucity of suitable stone for the development of specialized industries (e.g., Schick 1994; Schick and Toth 1993; Mellars 2006), a lack of functional or energetic advantages in diversifying and elaborating tool assemblages (e.g., White 1977), the absence of a need for complex lithic-based hunting technology (i.e., blades, points) because of the predominance of coastal marine and littoral economic adaptations (Mellars 2006), or simply cultural stasis (e.g., Movius 1948, 1949; see also Foley and Lahr 2003, 118). In the case of Island Southeast Asia, the most frequent explanation, drawn directly from ethnographic observations, is that organic materials (in particular bamboo) were used extensively for the manufacture of tools, thereby diminishing the importance of stone as a raw material (e.g., Harrison 1978, 43–44; Hutterer 1977, 1985; Pope 1984, 1985, 1989; Mellars 2006). Following directly from this, the rapid decomposition of such organic tools in tropical environments is argued to have

skewed our picture of prehistoric toolkits and tool-making abilities. Whilst organic tools are likely to have formed an important component of Pleistocene toolkits in Island Southeast Asia, direct forms of archaeological evidence (i.e., micro-wear/residue on stone artefact edges) for the so-called bamboo hypothesis are lacking, and the reliance on negative evidence tends to set a tone of special pleading. In this respect, the Golo shaped operculum tools *demonstrate* the co-existence of different tool-making approaches across media and, in doing so, add a key dimension to our limited understanding of Island Southeast Asian Pleistocene technology.

Buried in the Island Southeast Asian archaeological literature are references to other finds that may indicate that the working of non-lithic materials through percussive techniques was widespread if somewhat uncommon. In a discussion of the Bornean Palaeolithic, for example, Harrisson (1978, 44) mentions the discovery of an unprovenanced bifacially flaked object made from ironwood (*Eusideroxylon zwagerii*), an exceptionally hard tropical hardwood. In northern Luzon in the Philippines, Fox (1978, 82) reports the discovery of a "bifacial core tool" manufactured from the ivory tusk of a proboscidean. While the veracity of both of these finds requires confirmation, the point is nonetheless made that a focus on lithic artefacts as key markers of hominin "skill" and technological innovation or the development of behavioural or cognitive complexity may be misplaced in a Southeast Asian context.

Conclusion

With regard to modern-human-origins research, Gamble (2003, 639) has stated that "local rather than global is currently king." This comment was made in reaction to both the continuing composition of trait lists said to indicate the transition to modern human behaviour—however defined—and the synchronicity and essentialism inherent in such approaches. The Australasian region has not fared particularly well with regard to universal trait lists and stage models (see, e.g., Brumm and Moore 2005; Holdaway and Cosgrove 1997), and despite decades of discussion the reasons for this remain enigmatic. We suggest here that *expecting* the Australasian data to fit such models reinforces the essentialism that underpins much modern-human-origins research. This is not only unhelpful for our understanding of Asia-Pacific prehistory on both local and global scales but presents a dilemma for a global issue that seeks a universally applicable answer.

There has been a tendency in modern-human-origins research to compare the behavioural residues of various species of hominin in an effort to discern the unique features of our own species and the reason for our success. Such argument structures are not without precedent in other domains of anthropological inquiry and have come under fervent attack. We take Wolf's (1997, 5) view that history thus rendered has overtones of a "moral success story," in which "each runner in the race is only a precursor of the final apotheosis and not a manifold of social and cultural processes at work in their

own time and place." In terms of investigations into the development of behavioural modernity and modern human distinctiveness, such reasoning has the effect that other hominin taxa and modern human populations not deemed to be at the leading edge of evolution are interpreted not contextually or on their own terms but in comparison with an ideal. Such thinking is encapsulated in the trait list or, indeed, any such definition of the "truly modern."

With reference to the case presented here, we acknowledge that other hominins and/or modern human populations may have been producing tools in shell at equivalent or earlier time periods, but we do not see this as detracting from our case. The point we seek to make is that lithic technologies do not always provide the best proxy of behavioural or cognitive sophistication. Rather than accentuating the importance of the non-lithic artefacts of Island Southeast Asia in an effort to compensate for perceived deficiencies in technological progress, however, we would focus on the way human behaviour changed over time in the region and refined itself to operate in particular social and environmental contexts. If problems are not universal, we cannot expect the solutions to be so. As Boas (1940, 273) put it, "anthropological research which compares similar cultural phenomena from various parts of the world, in order to discover the uniform history of their development, makes the assumption that the same ethnological phenomenon has everywhere developed in the same manner."

In an Island Southeast Asian and western Pacific context, the importance of shell as a raw material for artefact production is well documented. The symbolic currency and prestige value of shell artefacts—most commonly discussed in relation to Neolithic (e.g., Kirch 1998) and ethnographic (e.g., Malinowski 1966 [1922]) cultural expressions—are defining features of the region. The Golo shell artefact assemblage demonstrates that the important place of shell as a raw material has considerable antiquity. It further makes plain that shell is not necessarily perceived as an equivalent material to stone and that the intentions that lie behind the working of the two materials are neither similar in process nor co-terminous.

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Comments

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This paper analyzes, in a rigorous and quite detailed way, the earliest evidence for the use of shell material (opercula of *Turbo marmoratus*) as the raw material for the manufacture of artefacts associated with *H. sapiens* found at the Indonesian site of Golo Cave. Szabó and her colleagues are to be congratulated on their work.

As they point out, the first evidence for the use of this kind of material was found in Mediterranean Europe and attributed to the Mousterian period (e.g., at Moscerini). Here shells of various bivalves (e.g., *Callista chione*) made into implements by means of percussion retouch around their edges have been recorded (Stiner 1994). However, none of these artefacts have been studied further by examining the wear marks of their use or by residue analysis to determine how they were used by the Neanderthal groups. According to Szabó et al., in the case of the objects from Golo Cave this type of analysis has been carried out, although the results are not yet available.

For a greater understanding of the role played by shells as a raw material for the manufacture of artefacts, other lines of experimental research could be pursued, such as gathering the raw material (belonging both to live animals and to dead individuals thrown up on beaches by the sea) and replicating the processes of manufacturing and use. Unfortunately, studies of this kind are very rare, especially for the earlier prehistoric periods.

In the case of Europe, evidence for the use of mollusc shells as artefacts in the Upper Palaeolithic is quite uncommon. Artefacts are made almost exclusively of lithic raw materials, and although bone and shell are abundant they are hardly ever worked. The use of molluscs for food began in the Early Upper Palaeolithic at sites on the Atlantic and Mediterranean coasts. Until the Holocene, it was mainly gastropods that were gathered; bivalves (generally only *Mytilus* sp.) were consumed less often. Except for a small number of species on the Atlantic and Mediterranean shores (e.g., *Callista chione*), most species have thin shells that would easily fracture if retouching were

attempted. In addition, many of the finds are affected by postdepositional factors (erosion, decalcification, precipitation of calcium carbonates, etc.) which impede their study. Judging from the signs of marine abrasion on their surfaces, the other species that have been recorded (mainly *Glycymeris* sp. and *Pecten* sp.) were not gathered as live animals on the shore. Furthermore, instead of reaching us as whole specimens in a good state of preservation, a large proportion of them have been turned into suspended objects of adornment by making a perforation in the umbo; sometimes holes produced by the action of sea water and sand were reused (Taborin 1993; Stiner 1999; Álvarez-Fernández 2006). Although no studies have been made of the wear marks on the valves, they were probably used as a kind of spoon or as containers for liquids or solids such as colorants (Álvarez-Fernández n.d.).

Therefore, in Europe, the use of shells of both marine and fluvial bivalves as artefacts is earliest documented in the Mesolithic, when the number and diversity of bivalve species at archaeological sites begins to increase. However, the working and perhaps the use of the shells are different from that identified by Szabó et al. at Golo Cave. At European Mesolithic sites there is no evidence of retouched shells or of flakes produced by retouching. In contrast, valves of *Mytilus edulis* with notched edges have been found at Mediterranean Mesolithic sites such as Châteauneuf-les-Martigues (Escalon de Fonton 1956) and in the Neolithic levels at Grotte de Campaufaud. At the latter site, the modifications that have been noted (abrasion, notches, traces of pigments, etc.) have been interpreted as evidence that they were used, for example, to scrape animal skins or smooth pottery surfaces or as containers (Vigié 1987). This interpretation is based on the results of experiments (Vigié and Courtin 1986). Implements made from shells have also been recorded for the Mesolithic of the Atlantic façade (*Lutraria lutraria* at Höedic, *Solen* sp. at Bergan-Dorchenn). The abrasion of their surfaces has been associated with working with animal skins. At Neolithic sites in this region, abraded valves have been found in connection with the smoothing of pottery (*Mytilus edulis* at Auzay and Er Yoh, *Tapes decussates* and *Callista chione* at Diconche) (Dupont 2006). Another use is ceramic decoration, especially the impressions made with the edges of *Cardium* sp. shells that define the Cardial Neolithic, characteristic of sites in the western Mediterranean.

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Szabó and colleagues rightly emphasize that the archaeological study of the evolutionary emergence of modern human behaviour "presents the most complex theoretical and methodological issues," but they do not tell us what they mean by

"modern human behaviour," and without a definition we will be forever boxing at shadows. They run through many of the traits that others of us have used without ever generating the theoretical insight that would join them together. In our original exploration of modern human behaviour, Noble and I (1991) pointed to many of the same traits but concluded that all of them could be attributed to "the greater information flow, planning depth and conceptualisation consequent upon the emergence of language." By these criteria, the most convincing part of Szabó et al.'s argument is the targeting of subtidal species obtained by diving, which required all three. It is not necessary to assert that some aspect of the knapping may imply symbolic significance. Such assertions should be subject to close scrutiny, because they are always difficult (Davidson 1990, 1991, 2002; Noble and Davidson 1993). They are not argued and do not work here.

Szabó et al. imply that essentialism is wrong—itsself an essentialist argument. The real question is whether there are different essences between points on a continuum—this is the essential conundrum of all evolutionary arguments. Denying essential differences implies that there was no fundamental change through evolution in biology or cognition. The alternative is to say that the changes observable in the empirical record of archaeology are only the product of some other force, usually one generated by social interactions, but this seems to be wrong. Humans, chimpanzees, and bonobos have a common ancestor, and to that extent they lie on an evolutionary continuum. At some time there was no essential difference between our ancestors and their ancestors. Both in the wild (Byrne et al. 2004; McGrew 2004; Whiten et al. 1999, 2001) and in the laboratory (Savage-Rumbaugh 1986; Savage-Rumbaugh et al. 1986; Savage-Rumbaugh, Shanker, and Taylor 1998), there are many more similarities between humans and these other primates than we once perceived. But the overwhelming outcome of decades of intense social interaction between humans and other apes has not changed the essential relations of difference between the people and the animals. The people control the experiments, raise funds to feed and care for the animals, teach and write about their work. So there are some essences that do make a difference—but for the archaeology of hominins we cannot be sure which ones made which differences and when. That will be a matter of empirical record, but what matters will depend on the nature of the theoretical debate. It has been suggested that there may have been two cognitive states seen only in hominins which formed an evolutionary bridge between apes and humans (Barnard et al. 2007), leading us to explore the empirical evidence that may enable us to pin down those theoretically identified cognitive states (Barnard and Davidson n.d.).

As with essentialism, trait lists are not intrinsically either valuable or to be dismissed—it depends on how they are used. They can be false friends, as Brumm and Moore (2005) have shown in highlighting the paucity of signs of symbolic behaviour in the archaeology of fully modern people in Aus-

tralia. But what are the issues here? No one doubts that all the people who have ever lived in Australia were fully modern people with fully modern behaviour—an essentialist assertion but not wrong—because they required the modern human behaviour of information flow, planning depth, and conceptualization to get here (Davidson and Noble 1992). This does not mean that all humans who have ever lived in Australia must have manifested their information flow, planning depth, and conceptualization through the manufacture of every item on some trait list used to provide empirical support for an archaeological argument about prehistoric behaviour. Most modern humans, for example, have never made a stone (or shell) tool of any sort, let alone a long parallel-sided one that we would call a "blade." Does that deny us the label "modern human"? We—and doubtless the earliest Australians—manifest our information flow, planning depth, and conceptualization in other ways, some of them not visible archaeologically.

In spite of these observations, the paper makes an important contribution in demonstrating modern human behaviour on an island on the northern route for colonization of Australia. The survival of *Homo floresiensis* until 20,000 years later on Flores, on the southern route, now makes it much more likely that humans got to Australia along that northern route (Davidson n.d.).

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I have examined thousands of turban shell opercula from Middle and Later Stone Age sites on the southern coast of South Africa, but I have never seen any that appear to have been flaked like those from Golo Cave. The reason may be that even the largest South African opercula are much smaller than those from Golo Cave. In addition, in contrast to the Golo people and other late Pleistocene Australasians, South African Stone Age people often produced highly formal stone artifacts, and these may have served the same function(s) as the Golo flaked opercula. As Szabó et al. point out, however, the Middle Stone Age inhabitants of Blombos Cave may have perforated tick shells, and Later Stone Age people certainly did. Later Stone Age people also worked shells of other species (Deacon 1984), and they often chipped the edges of sand mussel (*Donax serra*) valves. They may then have used the valves to scale fish (Schweitzer 1979). With the Golo observations in mind, the South African turban shell opercula may merit another look.

The South African Middle Stone Age opercula all antedate 50,000 years ago, and they are common in the layers that provided the incised ochre lumps and proposed shell beads from Blombos Cave. However, even if additional examination shows that some of the Blombos opercula were worked, this would not bear on the antiquity of "modern" human behavior unless the working produced far more elaborate shell artifacts than

those at Golo Cave. Golo Cave itself would bear more on the issue of "modern" behavior if it had produced artifacts in any material that antedated the widely accepted 60,000–50,000-year-old expansion of modern humans from Africa. This is because many archaeologists believe that only fully modern humans could have produced the watercraft that were needed to reach remote islands like the one on which Golo Cave is located. Szabó et al. do not argue otherwise, but their bottom line is unclear to me. Is it that the apparent simplicity of Golo and other Australasian Late Pleistocene stone artifacts could be misleading, since the Golo shell artifacts may imply greater technological sophistication? If so, do the tiny Golo samples truly support a meaningful contrast in sophistication between stone and shell working, and, if the contrast is real, might it not simply reflect differences in flaking quality between stone and turban shell opercula? Or do they believe that the Golo shell artifacts by themselves shed new light on the cognitive capacity of late Pleistocene Australasians?

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Szabó et al. add support to the argument that modern human behaviour may best be distinguished in locally appropriate terms. It has been apparent for at least the last half-century that Asia was not going to present the same historical trajectory as Europe or Africa, but, apart from some studies of stone artefacts, the argument has been lacking technological details, one aspect of which this paper now supplies.

I have no quarrel with Szabó et al.'s basic argument; indeed, it is eloquent. They show that shell artefacts exist, are in situ, are dated ca. 30,000 BP, and are created through a different *chaîne opératoire* from that for artefacts flaked from stone. To someone who works in this part of the world, this is not a particularly surprising finding. People (*H. sapiens*) had worked their way along the coasts from Africa and made ocean passages to get to Sahul by at least 50,000 BP (Mellars 2006; Allen and O'Connell 2003). Shellfish use, including for food and artefacts, occurs well back into the Late Pleistocene in Near Oceania (Kirch 2000, Specht 2005, table 1). In New Ireland, shell and stone tools were used for the same tasks (Barton and White 1993); it will be interesting to see the result of use-wear and residue analyses farther west. What I want to do now is raise a couple of questions which arise from the paper.

First, and most obviously in the context of the paper's wider discussion, why are shell artefacts so recent? Szabó et al.'s review suggests that the only usable (as opposed to decorative) artefacts older than those in Golo may be the > 60,000 BP *Callista* shells from Italy (Stiner 1994). Even if those chipped edges result from use rather than retouching, I think they are dismissed a bit too vigorously. If we accept them, we are still

faced with stone tools for more than 2 million years and shell for only ca. 100,000. Shellfish in sites are certainly older than this. Is it just that appropriately aged and located sites are unknown? Or that researchers with Szabó's expertise have not examined the material? But if shells were incorporated into the human artefactual repertoire only about 100,000 years ago, how are we to explain this?

Second, more particularly and perhaps peripherally, there is the problem of why there are small cores with multiple flake removals but very few small flakes in the lower levels of Golo. Perhaps the answer is really local. Only 7 m² were excavated, but how big is the cave? Maybe flaking occurred in another area or out in front, with cores being conserved and carried back inside? Segregating flaking areas or cleaning up the debris afterward to protect feet is common among the New Guinea highland stone flakers I worked with (e.g., White and Dibble 1986).

I look forward to further research by this team, for it will surely show how different were the regional pathways to modernity.

Reply

While this paper is, at its core, about the discovery of new evidence for creative early human behaviour in eastern Indonesia, the implications touch upon a number of issues to do with the general characterization of "modernity" and the way in which we conceive of and define our own species. The commentaries presented here allow us to engage further with some of these issues in order to clarify and expand.

Klein comments that the Golo knapped opercula would bear more on the question of "modernity" had they been either more complex or earlier than 50,000–60,000 years ago. On the first count, we measure "complexity" relative to the lithic technologies utilized at the Golo site, which itself fits comfortably within more general Southeast Asian lithic traditions of the Pleistocene. Furthermore, we view the complexity of the operculum tools as being inherent in the process of production rather than something that is defined on the basis of finished artefact morphology. With regard to the second point, if the patterned use of watercraft is to be taken as the dominant signal of behavioural modernity in Australasia, then one would indeed expect the archaeological material recovered from ca. 30,000 years ago at Golo Cave to evidence "modernity" in some fashion. Many archaeologists, however, continue to use lithic artefact complexity as the primary proxy for behavioural sophistication (e.g., Foley and Lahr 2003), thereby arriving at significantly different conclusions with regard to the cognitive status of early Australasian humans. For those who do not necessarily equate simple lithic tools with "simple" humans in an Australasian context (e.g., Mellars 2006), there is a casting about for reasons that the lithic

technologies are not seen to "progress." To be momentarily subversive: if one takes the White (1977) line of reasoning that there is no need to elaborate tools beyond their effective ability to complete an assigned task, then one has to wonder why parts of the African and European lithic artefact record show such time-consuming elaboration. Were stone tools fulfilling something *other than* a simple, practical need in these contexts?¹

In relation to our "bottom line," Klein poses a series of questions that are easily answered here. First he asks whether we are saying that the simplicity of Australasian lithic technologies may be misleading because greater technological sophistication is evidenced by the shell tools, and the answer is yes. Following from this, he asks whether the small sample sizes reflect a meaningful dichotomy between stone and shell technologies and, if so, whether this simply relates to the relative qualities of the raw materials. We would answer yes to the first part of this question if the stone artefact assemblage did not fit so well with the results from other sites in the region. In short, there is no reason for us to suspect that there is greater complexity in lithic technologies than that seen at Golo. As to the second part, the Golo knappers may very well have believed shell to be more workable/suitable than the poor-quality local stone resources, but we feel that this still represents lateral and creative thinking on their part, and it is clear that reduction techniques were tailored to the very different structural and mechanical properties of shell (see also Szabó n.d.b). Raw materials do not dictate how they are to be worked or announce their suitability for particular tasks. Such technological decisions always rest with human workers. As to the last question, we have answered this above in pointing out that judgements on the cognitive capacity of early modern Australasian humans depend entirely on the yardstick one uses.

Álvarez-Fernández, reviewing the evidence for the use of shell as a raw material in Europe, points out that its use is relatively rare. Furthermore, the gathering of empty shells, with signs of littoral taphonomic alteration, would imply some opportunism in raw-material procurement. While not stating it in so many words, Álvarez-Fernández seems to be saying that the European worked-shell record differs from the evidence presented for Golo both temporally and technologically. Such dissimilarity is to be expected unless one maintains that shell-working skills were carried out of Africa and continue in an unbroken technological lineage in various corners of the world or that either *Turbo* opercula or early modern humans have an "essential" component that calls for such knapping.

White's comments reinforce those of Álvarez-Fernández with regard to the importance of local, contextual analysis. White goes on, however, to ask the very good question why evidence of shell-working is apparently so recent. We should

point out here that we do not dismiss the possibility of Neanderthal shell working but simply question the basis on which conclusions regarding it were drawn. This feeds into the critical point that methodologies for discerning and describing shell-working are woefully underdeveloped in the archaeological literature. Indeed, Stiner's (1994) research is one of the rare instances in which shell working is investigated in a systematic and thoughtful manner.

Shell is a complex and highly variable raw material, and its wide variety of microstructures and taphonomic proclivities translate to very different patterns of fracture and workability. As pointed out by Zuschin, Stachowitsch, and Stanton (2003, 33), "no particular shell parameter clearly defines strength, but thickness, microstructure type and degree of organic matrix have the strongest influence on pre- and post-mortality strength." For investigations into hominid shell working to proceed in a robust and systematic fashion will require more investigation of the specific natures of the raw material (putatively) being utilized as the basis for a clear and directly applicable methodology. White is therefore correct in suggesting that a lack of recognition of shell working may be skewing our picture of the use of shell as a raw material and that only when this issue is resolved can we comment upon the "early" or "late" incorporation of shell as a raw material in artefact production.

White also draws attention to the absence of small flakes despite the presence of cores with multiple small flake removals. This pattern is indeed intriguing, and it has been isolated elsewhere in the region (e.g., Hiscock 2005). Given the traditional tendency towards very small-scale excavations across cave sites in Australasia, White's hypothesis that spatial patterning is not being perceived may well hold water. In the case of Golo Cave, only further excavations will shed light on this question.

Davidson is right to emphasize definitions of "modern human behaviour," as this point must underpin any discussion of the subject and methodologies employed in its isolation. Indeed, our reason for placing "modern human behaviour" in inverted commas was its contentious and problematic nature. Davidson also raises issues surrounding essentialism, and we believe these two points to be intrinsically bound up with one another. Let us state here for the record that we do not believe that essentialism in itself is wrong: it is a matter of scale. While there must be defining features that allow us to distinguish ourselves from other species, so there are defining features that separate cultures and peoples at different points in time and space. The trick is not to conflate the two. Moving back to definitions of "modernity," the major characteristic for us is *behavioural flexibility*. This is, in itself, not distinct from the key traits of Noble and Davidson (1991) or McBrearty and Brooks (2000) and indeed encompasses them. It must be stated, though, that any particular trait may not be exclusively related to modern *Homo sapiens*; it is more likely to be a matter of degree. For example, we feel that it is difficult to argue that the ca. 400,000-year-old wooden spear assem-

1. This point was made by Tim Reynolds (personal communication to KS).