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Throwing and human evolution

BARBARA ISAAC

'L'arme dont on s'est le plus souvent servi est peutêtre celle dont on a le moins parlé, sur laquelle on a le moins écrit' (Florance 1909:52)

Abstract

Ability to throw was probably achieved at an early stage in human evolution but has received little scholarly attention. Although this ability is poorly developed in apes, anatomical studies suggest that the hand of *Australopithecus afarensis* was adapted to throw with precision and force. Archaeological evidence and early ethnographic observations are cited in order to demonstrate the importance of the throwing skill in human evolution.

Résumé

La capacité de lancer a probablement paru assez tôt au cours de l'évolution humaine, mais les savants y ont accordé peu d'attention. Bien que cette habileté soit peu dévelopée parmi les grands singes, des études anatomiques suggèrent que la main d'*Australopithecus afarensis* était adaptée à lancer avec précision et force. L'auteur cite les indices archéologiques et les anciennes observations ethnographiques afin de démontrer l'importance dans l'évolution humaine de cette capacité de lancer des objets.

Introduction

In sport, hunting and warfare, from the hand thrown beachball to the air launched rocket, the use of missiles is a commonplace of human behaviour. The apparently simple ability to throw overarm with force and accuracy is a skill uniquely developed in the human animal and one which was probably practised in deepest antiquity. Yet the lack of any evidence convincing to archaeologists results in the human ability to throw being rarely discussed or even referred to in most accounts of human evolution.

In recent years various skills and behaviours have come under close examination because it has been thought that they might have contributed to the transformation of protohominids into humans. Examples include the adoption of bipedal locomotion (Washburn and Moore 1980:77; White 1980:176; McHenry 1982:154); the use of sharp-edged tools (Tobias 1968:375; Washburn and Moore 1980:122); and the incorporation of provisioning or foodsharing into social behaviour (Isaac 1978:106; Lovejoy 1981:344). The skilled overarm throwing of missiles deserves a similar scrutiny, since it is possible that it developed into a

behaviour of adaptive importance with repercussions far beyond the simple scoring of a hit. Modern humans develop this skill and the concomitant behaviour to a higher degree than any other animal, excelling in controlled arm and body movements that are co-ordinated with an accurate visual perception and mediated by a very versatile ballistic sense, all of which must be founded on an intricate neurophysiological basis. This behaviour has been manifest in the use of spearthrowers, and bows and arrows since about 10,000 years ago, more recently in slings, and ultimately in the development of guns and rockets.

Given that we are unlikely to retrieve indisputable evidence of the very earliest stages of throwing skill through traditional archaeology, is there anything useful that can be contributed circumstantially? As it happens, it is possible to collect a limited amount of information on the history and prevalence as well as the convincing power of this capability in modern humans. Several specific questions should be kept in mind: first, what is the available recorded evidence for the prevalence of throwing in hunting and warfare? Second, what does this human capability amount to, in terms of range, accuracy and power to stun, critically injure or to kill? Third, how far do our closest living relatives share in this ability? Fourth, what is the neurological and fossil anatomical evidence? Finally, what archaeological evidence is there from different periods in time that this behaviour actually occurred and that it was adaptively significant? This paper briefly takes up these questions in an effort to stimulate interest as well as the further compilation of relevant data. In particular, it endeavours to present forgotten or overlooked evidence for the effectiveness of the well-thrown stone. There are two reasons for the need to do this: throwing is, on the one hand, taken as commonplace and hence is not subject to careful reporting in ethnography; on the other hand, modern city dwellers and scholars are less and less aware of the potential of this skill, and therefore unable to utilize it in their modelling of the evolutionary past.

For the last one hundred years or so, the throwing of unmodified stones and the wielding of sticks has been mentioned in passing in various accounts of aggression among peoples without highly developed technologies (Lane Fox 1868:95). Darwin wrote, 'I can see no reason why it should not have been advantageous to the progenitors of man to have become more erect or bipedal. They would thus have been better able to defend themselves with stones or clubs, to attack their prey, or otherwise to obtain food' (1871:52). These ideas still merit attention in modern texts (Wilson 1978: Fig. 27.5; Washburn and Moore 1980:71), but as long ago as 1870 J. G. Wood complained that his readers were not aware of the deadliness of the possible assault: '. . . even at the present day it is difficult to make some persons believe in the stone throwing powers of the Australian' (1870:41).

When searching for first-hand accounts of successful stone-throwing, either in hunting or in war, the impression is gained that even when it was observed, it was not recorded, as it was so much a part of 'normal' human behaviour. This is exemplified by Hough, who made an exhaustive survey of hunting methods in the Americas: 'Skill in throwing rocks may also be mentioned in connection with the capture of game' (1919:285). No description followed.

The search for evidence has shown that where it does exist, the record would seem to be mostly dual in character: first, the ethnographic listing and very rare description of the capture of small game, and second the descriptions of the confrontation of explorers and settlers by indigenous peoples. Throwing rather than stick-wielding is to be considered here, since not only does it need greater skill, but the aggressor gains safety according to the

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distance he can put between himself and his target, as Lane Fox (1868:122) and others have pointed out.

The ethnographic and historic record

Where the killing of game by throwing stones is recorded in modern times, it is sometimes an opportunistic event, other times organized and usually directed against small animals and birds. Oswalt in his *Anthropological Analysis of Food-getting Technology* (1976:21) gives a referenced list of peoples who are known to hunt by the simplest methods. A perusal of his sources, as well as of other accounts, leads to some general conclusions: such as that the American Indian is more likely to organize a drive with numbers of people involved, and that this is usually directed against ground-living animals such as rabbits; whereas more casually,

> The Australian aboriginal makes adequate use of any suitably shaped piece of stone he happens to find while in pursuit of game; both in the Musgrave Ranges and the northern Kimberleys stones are used in their natural shape for hurling into a flying flock of birds, for shying at a bounding wallaby, for bringing down nuts of the baobab, and for precipitating fledgelings out of a nest' (Basedow 1925:360).

Goodale (1957:7–16) gives a blow-by-blow account of an aboriginal food gathering sortie which includes such hunting. Similarly in Tanzania, Tomita (1966:161–2) describes the Hadzapi: 'They throw stones and knock the rock hyrax off the tree and kill it with sticks after it falls'. However the behaviour has not been observed by the most recent workers amongst the Hadza (Vincent pers. comm.)

These ethnographic instances are well known and are presumably what prehistorians have in mind, together with the fossil evidence (M. D. Leakey 1971:259) when it is stated that early man probably hunted small animals (L. S. B. Leakey 1960:57; Isaac and Crader 1981:94–5). Yet in none of the modern descriptions of game hunted and killed is there any information on the size of missiles, the distance thrown or, except rarely, the scoring success. Nor are the targets very large or formidable. What does an inspection of more ancient accounts, particularly of warfare, give, apart from a glimpse of much more lethal accomplishments than those described above?

When the Portuguese first discovered the Canary Islands in the early fourteenth century, their most sophisticated weapon was the crossbow. It did not procure safety against the Guanches' weapons, only horn-tipped wooden lances and stones on three of the islands (Hooton 1925:11). For instance, the Bethencourt MS of 1482, which is probably a fair transcript of earlier eyewitness accounts, describes an incident that took place at the beginning of that century. Despite the time lapse there is no reason to doubt its accuracy: it fits too well with many such incidents, both in the Canaries and later elsewhere in the world.

> In hardly any time at all they had so badly beaten us that they had driven us back into shelter with heads bloodied, arms and legs broken by blows from stones: because they know of no other weaponry, and believe me that they throw and wield a stone considerably more skilfully than a Christian; it seems like the bolt of a crossbow when they throw it: and they are very nimble people: they run like hares.

Of the battle of Laguna in 1494, Espinosa reported: 'It happened that when the cross-bow men shot their bolts they did little harm, for the Guanches never remained in one place, but

kept moving about, so that it was difficult to take sure aim. . . . They hurled stones with much more effect breaking a shield in pieces, and the arm behind it' (1594; trans. Markham 1907:102). Given that this observation was also written down one hundred years after the event, and might therefore be doubted for accuracy, it is interesting to note that this method of evasion by continual movement was also observed amongst the Tasmanians and the Hottentots (cf. quotations from Wood, and also Kolb below.)

It was reported that, on one of the Canary Islands, the Ghomenites trained their children to face one another without moving from a set space. At first balls of clay were thrown, which they were to avoid by body movements; then stones, then javelins without points, and finally with points (Viera according to Bertholet 1841:166). Similar training is reported for the Australian Aborigines of the Cambridge Gulf: boys '. . . pick sides and stand face to face on a bank about half a chain apart. Upon a given signal they commence bombarding each other with mud balls! . . . The lads endeavour to dodge the mud balls thrown by their adversaries with as little movement as possible. . . . The climax is not reached however until a hit is recorded . . .' (Basedow 1925:75).

If the Portuguese with their crossbows were at risk of injury, so surprisingly were more recent explorers with their muskets. La Pérouse (1799:80) gives an account of a terrifying attack off the Navigators Islands (Tutuila, Samoa) during his voyage of 1785–88, wherein 12 of the 61 man watering crew were killed and many others wounded (Fig. 1). The attack followed the pattern of others, such as the one when Cook was killed (Beaglehole 1967:535); the sailors were first assailed by stones and then, when disabled, finished off with clubs. It is not possible to allocate specific injuries to clubs or to stones, but in the La Pérouse account, it would seem that most of the survivors had escaped with injuries from stones only: '. . . the enormous stones hurled by the savages maimed one or other of our people at every moment, and whenever a wounded man fell into the water on the side of the savages, he was immediately despatched with clubs and paddles' (La Pérouse 1799:95). The force of missiles is described: '. . . a shower of stones, so much the more difficult to avoid, as being thrown with uncommon force and address, they produced almost the same effect as our bullets, and had the advantage of succeeding one another with greater rapidity' (*ibid.*:86). The injuries of the survivors of this incident were fractured limbs and fingers, broken heads (one man needed trepanning) and a contused eye.

In 1816 a Captain Kelly was more fortunate, escaping with no reported injuries: he noticed that the chief who had met him on the beach had ordered his men

> . . . . to collect pebble-stones about the size of hen's eggs, and put them between their legs as they sat, for the purpose we apprehended, of making an attack on us. . . . He then ordered his men to give us a volley of stones, which they did, he giving the time in most beautiful order, swinging his arms three times, and at each swing calling 'Yah! Yah! Yah!' And a severe volley it was. . . . I fired amongst them, which dispersed them (Falkinder 1932:91).

Wood in his *Natural History of Man* (1870:41) gives a clear description of the Aborigines' ability:

> Many a time, before the character of the natives was known, has an armed soldier been killed by a totally unarmed Australian. The man has fired at the native, who, by dodging about has prevented the enemy from taking correct aim, and then has been simply cut to pieces by a shower of stones, picked up and hurled with a force and precision that must be seen to be believed. . . . To fling one stone with perfect precision is not so easy a matter as it seems, but

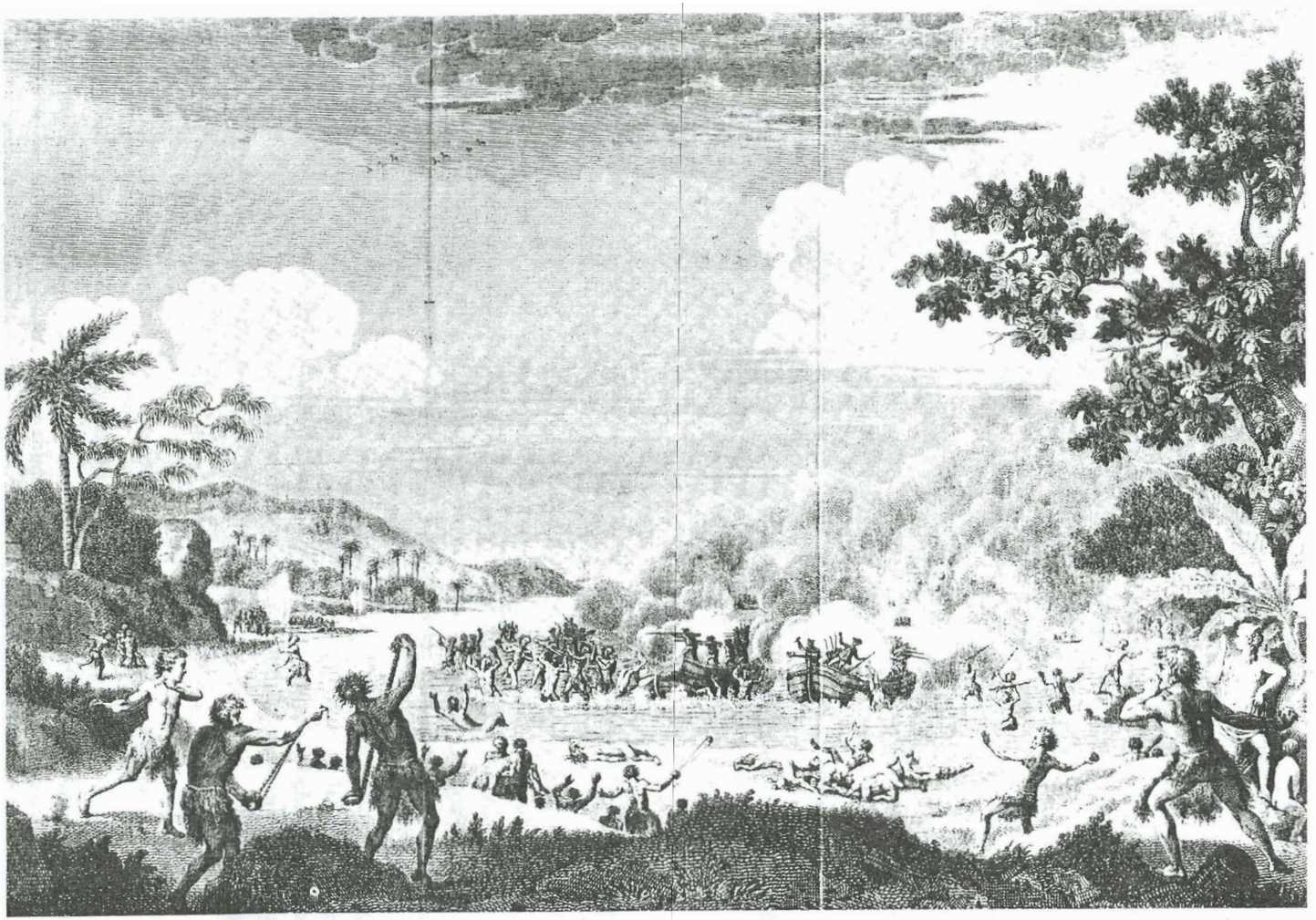

Figure 1 The massacre of La Pérouse's watering crew in Samoa (after La Pérouse 1799). The artist shows slings as well as stone-throwing, although the text provides no evidence for the use of slings.

> the Australian will hurl one after the other with such rapidity that they seem to be poured from some machine; and as he throws them he leaps from side to side so as to make the missiles converge from different directions upon the unfortunate object of his aim.

The above account is strikingly similar to that of Peter Kolb on the Hottentots (1719:256):

> The most curious fact here is that it is impossible for a spectator to even understand how such a Hottentot can hit the target, or even how he aims, because he does not stand still even for a moment. He is constantly moving, sometimes backwards or sideways; he stands upright one moment and is bending down the next, dancing to and fro all the time, quite unexpectedly throwing the stone from his hand, and in spite of his grimaces, hits his chosen goal so accurately that one must say that the best marksman could not have hit the bulls eye more accurately.

It is not surprising to find that Fuegians were also skilled, as Darwin had observed (1871:49): '. . . to throw a stone with as true an aim as a Fuegian in defending himself, or in killing birds', and as Wood describes in another incident where a Fuegian had been shot:

> He was mortally wounded . . . however he instantly recovered himself, and snatching stones from the bed of the stream in which he was standing began to hurl them with astounding force and quickness. He used both hands, and flung stones with such truth of aim that the first struck the master, smashed his powder horn to pieces, and nearly knocked him down. The two next were hurled at the heads of the nearest seamen, who just escaped by stooping as the missiles were thrown . . . (1870, 2:518)

At the fourth attempt to throw, the man fell dead.

All the events described above refer to encounters between man and man. I know of one published instance of a successful encounter between a human and a larger animal, but the quacha was already wounded in the leg, and was finally dispatched with a knife by a Bushman, after he had felled it with a stone (Campbell 1815:145). This incident was somewhat similar to one reported to me by a Tanzanian camp attendant, which happened prior to 1984 when he and two friends surprised a zebra. Picking up a stone, he threw it with such force at the skull that the zebra fell to its knees kicking. The three men were then able to dispatch it with a knife. As the incident was described, it took place at a distance of 30–40 m, and the stone was estimated to be of a fist's size. The successful hunter had grown up as a herdsboy and claimed that his own particular tribe, the Iraqw, were especially skilled in throwing.

There is probably much to be learnt of human agonistic and aggressive behaviour in these incidents, but the primary interest to us here is that, given the motivation or provocation, the damage that can be inflicted by one man, or a group of men, on creatures equivalent in size to a medium antelope is considerable.

The distance thrown, the size of missiles, accuracy and force

I had hoped to find more exact information on these parameters, but there are few data, apart from qualitative judgements such as likening to the force of a crossbow bolt (Bethencourt 1482:108), resulting in the breaking of shields (Espinosa 1594:108), or a powder horn at a range 'beyond that of a musket' (Wood *loc. cit.*). This latter is surprising, and it is just possible that the seamen were hit by sling stones. One of the most informative details comes from Vogel (1716:76) when he describes the Hottentots:

> In addition, they also know how to throw very accurately with stones and how to defend themselves with long sticks. Indeed they are so practised at this that they know how to

> intercept and parry to the side, ingeniously with the stick, a stone which someone throws at them. It is also not rare for them to hit a target the size of a coin with a stone at 100 paces.

After quoting Vogel, Kolb adds his own piece of information, '. . . this does not happen just once, as if it were a blind shot, but ten or more times with never a miss' (1719:526).

In 1868 a team of Australian aboriginal cricketers toured England (Mulvaney 1967:31). Their skills need not surprise us, but they are worth noting: cricket balls (225 g) are recorded as being thrown 105 and 130 m, and frequently between 88 m and 102 m. Wisden (Cricket Book of Records) notes a throw of 129 m in 1884 on Durham Sands. The accuracy of the aim was not recorded, but the thrower was English, not Aboriginal. It is regrettable that Colonel Lane Fox, who was writing his lecture on Primitive Aggression that same year, 1868, and who observed the aboriginal display, did not make occasion to record in greater detail the aborigines' skills.

There is similar paucity of data on the size and weight of stones thrown, apart from Captain Kelly's 'hen's eggs' since most were natural, casually obtained objects and often the observer was not anxious to stay around and collect specimens. A note by Lanning (1955:73) describing an already vanished practice of defence in Buganda, gives a photograph, but no weight, for the stone missiles he found associated with earthworks and rockshelters. They are of granite and amphibolite, apparently varying from 50 to 210 mm in maximum diameter, corresponding to weights calculated at approximately 170–1900 g. A range of 220–400 g is quoted for a second class of missile of baked clay which was still in use in another area in 1955 for scaring game from crops. These seemed from the photograph to be of similar size to the stone balls. The largest of the stone balls shown by Lanning seems unduly heavy, and La Pérouse made the similarly surprising claim that rocks of up to 1400 g were thrown 'with inconceivable vigour and address' (1799:121). This is difficult to believe, but a serendipitous discovery at the Pitt Rivers Museum, Oxford, brought to light ten 'war hand-stones' supporting La Pérouse's estimate. According to Wood, the Niue or Savage Islanders '. . . use a very curious weapon. On their island are a number of caves in the coral limestone. . . . From the roof hang vast numbers of stalactites. . . . The natives make oval balls about the size of cricket balls, which they hurl from the hand with wonderful force and accuracy, not using the sling . . .' (1870:395). Ten stones with a written identification of 'war hand-stones' were found in the Museum, one of which has the morphology of a slingstone (Fig. 2:J). Seven of the ten were identified by Glynn Isaac as made of stalagmite, one of a dark, fine-grained basalt, and two of fossilized tridacna shell. Except for the basalt item and the slingstone, they have been pecked and ground into a lemon shape presumably ballistically more effective than a sphere, as a directional spin can be imposed. There is no more information on how far and how forcefully these war hand-stones were thrown. Further examples are in the collections of the Museum of Mankind, London, the Peabody Museums of Harvard and Salem, and the Natural History Museum, Melbourne, Australia.

Throwing as a primate behaviour

The use of missiles is not limited to humans. Some monkeys and most non-human primates drop branches and fruit when reacting to observers (Hall 1963:481–2); they also throw branches or drop rocks (Schaller 1963:124–5; Goodall 1968:203). However the use of the word 'throw' is perhaps misleading and should be limited to the human action. When

Table 1 War hand-stones from Niue (illustrated in Fig. 2).

	Material	Weight in grams	Mean diameter in mm*
A	Basalt	280	60
B	Limestone	425	70
C	Limestone	950	86
D	Limestone	525	60
E	Limestone	775	90
F	Limestone	725	80
G	Limestone	1550	110
H	Shell	500	71
I	Shell	360	60
J	Limestone	80	50

* Mean diameter = (max L + B + Thickness)/3.

reading descriptions of what is called throwing by those who were observing the primates, the words 'lob', 'chuck' or 'shove' would seem to be more appropriate as the action is usually an underarm one. However, as the observers still use the word 'throw' it will be retained here.

Jane Goodall states that the directional aim of the chimpanzees is good but that the thrown objects lack force. One interesting point emerges from the data provided by field observers: in contrast to the carefully controlled and directed utilization of objects such as twigs to obtain food, dropping and throwing has almost invariably been noted in the adult animals as part of an ongoing agonistic display (cf. Schaller 1963; Goodall 1968:203, with exceptions noted). The displays have been interpreted as the release of tension or as the assertion of dominance. Baboons in the feeding area at Gombe had rocks tossed at them by the chimpanzees (Goodall 1971:191–2), as did the humans who were present; but this ineffectual use of missiles is too casual to be regarded as a carefully calculated skill, even though it may accidentally help in the acquisition of bananas. However, Goodall reported (1971:111) that Mike seemed to plan his charging displays against the other chimpanzees: 'Often, when he got up to fetch his cans, he showed no visible signs of frustration or excitement—that came afterwards when, armed with his display props, he began to rock from side to side, raise his hair and hoot'. Moreover, in the one possible exception to throwing as display, it was Mike who was seen to chuck a big rock at a bushpig after walking towards it at a normal speed (Plooij 1978:103–6). In this incident four bushpigs were surrounded by male chimpanzees (the females remained in the trees) and for some minutes there was little movement. Plooij comments that the chimpanzees seemed to have a problem in breaking through the defensiveness of the animals. Hugo was reported to use *wa'aa* calls and to raise his arm, after which Mike threw the rock. There seems to have been no immediate reaction by the pigs, and when they finally broke to run followed by the chimpanzees, the action was difficult to see. The subsequent capture of a piglet two minutes later might or might nor have resulted in further 'operant conditioning' of Mike to throw again next time. It might be appropriate to see the throwing described by Plooij not as an action meant to damage but as one meant to disturb, in the same way that Mike's noise making in camp disturbed and scattered his conspecifics.

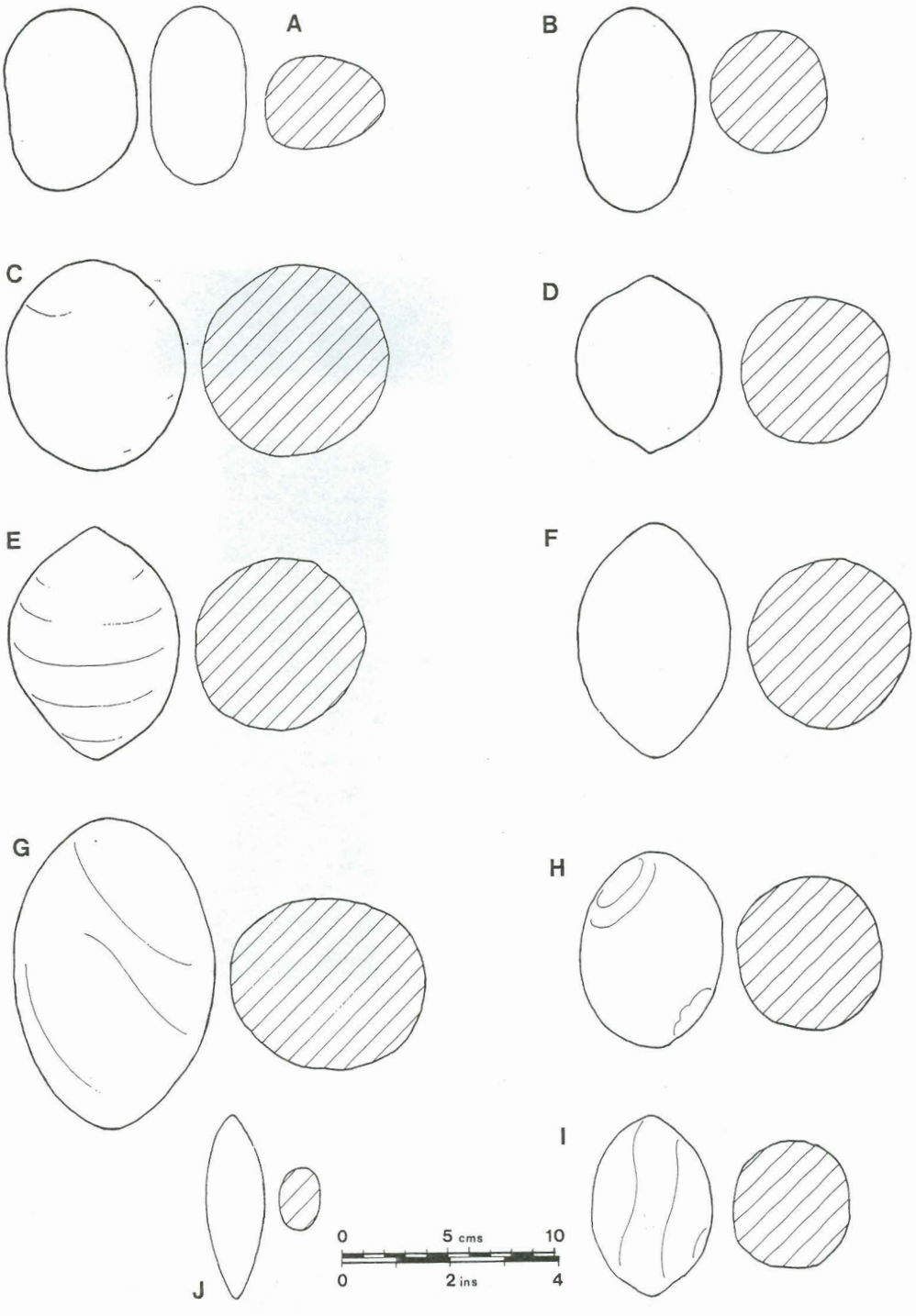

Figure 2 Throwing stones or 'war hand-stones' from Niue in the Pitt Rivers Museum, Oxford.

The anatomical and neurophysiological evidence

The difference between chucking casually obtained objects and hurling a volley of accurate, forceful missiles at a chosen target is so marked that it is tempting to see the human capability as something new, an adaptive behaviour profoundly altering the future of its practitioners. Moreover, this behavioural intensification is based on a physical difference, definitely anatomical and probably neurological, between humans and other primates as throwing machines. Mary Marzke has carefully studied the function of primate hands over a period of twenty years, identifying the details of structure that enable certain actions to take place at all and that enhance the precision of these actions when they do take place. She has then been able to turn to the fossil material and from its morphology assign certain functions to the *Australopithecus* hand that are important in their implications. To summarize her work briefly (Marzke 1983:205) she first defines modern human gripping postures, and then goes on to discuss the limitations on the grips of *A. afarensis* hands. Altogether, out of four power grips and four precision handling motions identified in modern humans, *A. afarensis* would have had the capability of using a hook grip for carrying, plus a pad-to-side and a 3-jaw chuck handling motion. The second of these implies an ability to manipulate small objects such as sharp flakes; the last allows for 'controlled rotation and translation of small spherical objects' . . . 'both aim and speed can be controlled with this grip'. (Marzke 83:207).

In a paper in press Marzke discusses not only the role of the respective grips and handling motions, but also looks at bipedality and the upright stance as an enhancement of success in tool use and throwing. In her own words, '. . . the advantage of the 3-jaw chuck grip is that it permits the control of small, light stones which can be thrown with greater velocity (and therefore over a greater distance) than larger, heavier stones. Controlled rotation of the trunk on the hindlimb increases the velocity still more by its contribution of trunk leverage to the leverage of arm, forearm, wrist and fingers.' She is therefore a strong proponent that '. . . throwing could have been an effective component of (*A. afarensis*') strategies for food acquisition and protection from predators' (Marzke 1983:84).

Unlike the skeletal evidence, the neurophysiology of the early hominids can only be guessed at. William Calvin has argued in several papers (1982, 1983) that the degree of precision required for successful targeting imposes severe requirements on hominid neural circuitry. He elaborates on the theme that '. . . precision timing can be an emergent property of circuits. Hominids with bigger-than-average brains might have been able to apply more timing neurons to throwing tasks, the success of the faster throws then selecting for encephalization trends (such as neoteny): bigger is faster is better for survival' (Society for Neuroscience 1982 Abstract Form). Calvin links this desirable increase in neurons to the detectable increase in brain size in hominids through the Pleistocene. He postulates several concomitant results, such as expansion into new ecological niches as a result of the more successful hunting of small animals, together with elaborated motor and communicative skills as a result of the increase in sequencing power.

The antiquity of the behaviour and its significance

In making a suggestion about a human behaviour of such adaptability and its success it is important to see whether it leaves predictable traces in the archaeological record so that we

can argue it actually happened. The presence on early archaeological sites of large numbers of unmodified stones of a type not usable for flaked tools has long puzzled archaeologists. Within the concentrations of very early stone artefacts excavated by Mary Leakey at Olduvai are many unmodified stones which appear to have been carried in by the toolmakers (M. D. Leakey 1971:261). Many of these 'manuports' are of a suitable size and shape for throwing. Use in defence or hunting might explain why so much energy was invested in carrying them from source. If the spheroids, sub-spheroids and cobbles from Beds I and Lower II at Olduvai are compared with the Niue war hand-stones, it is found that the mean diameters of the former range from 41 to 86 mm, while in the latter, the range is 60–110 mm, not including the putative slingstone. This would fit well with a smaller than modern human body and hand size. In Middle Bed II with the entrance of *Homo erectus* on stage, the range of sizes is not only more variable, 22–121 mm, but there is an increasing number of carefully finished spheroids, as well as more sub-spheroids compared with cobbles. On a cursory examination there is nothing to preclude the possibility that some of these manuports and artefacts could have been missiles. The quartz spheroids that persist into much later times in Africa and which are often found isolated from other artefacts could also be explained as throwing stones rather more effectively than as bolas stones, an interpretation favoured by L. S. B. Leakey (1948:48 and pers. comm.). In size, except for the smaller pieces from Middle Bed II, these spheroids approximate more to the Niue war hand-stones than to sling or bolas stones.

Even if the reader will accept that this tenuous archaeological evidence suggests the throwing of stones as a significant behaviour as far back as two million years ago, it is not possible to push the identification of missiles further back in time: no conventional archaeological sites exist on which they could be found. However, if we look at the record of the fossils (Marzke 1983:201) and at the Laetoli footprints (M. D. Leakey and Hay 1979:3), it can be concluded that, 3.6 to 3.75 million years ago, hominids were already perambulating the landscape with forearms freed from the task of full time and probably even intermittent locomotion whilst on the ground, almost two million years before the specific evidence that they were using their forelimbs for toolmaking. What were these creatures doing with their paws? It seems unlikely that they were not manipulating and utilizing simple objects as primates are known to do today, and that increased manipulation led to a differentiation in behaviour between hominids and pongids. At this point it is important to realize that it is improbable that there will ever be anything other than limited circumstantial evidence for hominid behaviour at these very early time ranges. There will however be more likely and less likely interpretations of the limited data that are available to us, and some explanations that will be more parsimonious than others. It is postulated here that certain apparent trends in human evolution become more readily understandable, and that the known facts articulate more coherently, if early hominids are seen as skilful and aggressive stone throwers (cf. Darlington 1975).

Prehistorians have long puzzled over how the apparently vulnerable naked ape was able to survive in the African savanna without even the benefit of large canines such as sported by male baboons and chimpanzees (Washburn and Moore 1980:76). This vicarious fear is partly a function of what a modern academic would see as his own predicament if set down in the middle of the Serengeti with no Land Rover to hand. Nonetheless the question is a real one. Lorna Marshall (pers. comm.) saw a small group of Bushmen clearing lions from a kill by throwing clods of earth. Such dominance suggests a long history of support by potent

weaponry: a frightened and cornered band of protohominids armed with rocks weighing 200 g would be formidable opponents. All carnivores avoid disablement which can lead to starvation. It is not being suggested here that protohominids were gratuitously aggressive towards the larger carnivores, rather that the use of stones would usually be defensive, occasionally aggressive, and subsequently predatory.

In addition to the postulated problem of vulnerability, there is a detectable change in the hominid condition at about two million years ago for which it is less easy to provide a full explanation without the assumption that hominids were able to inflict injuries on other creatures. Recent research has begun to produce evidence, albeit contested, that suggests a consumption of meat by Pleistocene hominids on a scale beyond that observed for non-human primates, at least from about 1.8 million years ago, the date of the first patterned association of stone tools and butchered bones (Bunn *et al.* 1980:133; Isaac and Crader 1981:94). However, although the occasional and casual predation of smaller animals by early hominids is regarded as likely by many authorities, there are seen to be difficulties in hominids acquiring larger parcels of meat, except perhaps by scavenging; and this is itself deemed a risky pursuit because of the competition it entails with larger, enraged carnivores. A band of hominids would be at less risk when scavenging if armed with rocks.

Glynn Isaac has argued (1984:10) that the comparatively sudden and widespread use of sharp-edged stones (i.e. flaked pieces and detached pieces) around two million years ago indicates a longstanding need for such edges, particularly in gaining access to readily removable parcels of meat. Not only would the protein from dead pachyderms become available before other animals could scavenge, but the most edible parts could be removed and consumed at a safer place. The problem with this argument is that it presupposes hominids were already familiar with the bonuses offered by larger carcasses and this would have been unlikely if they were defenceless primarily vegetarian gatherers occasionally acquiring a few birds, hares and neonates as primates do today. Increased success in scavenging through stone-throwing together with more effective hunting would seem to be a distinct possibility in the time ranges both before and after the appearance of flaked stone tools: it represents a behavioural threshold which, once crossed, opens up a new domain of different opportunities.

A final point should be made about the availability of missiles: most of the known early archaeological sites are associated with stream channels (Isaac 1976:500). These channels, or nearby outcrops exposed by erosion, supplied the raw materials for flaking into tools. Even more easily, they could have supplied the unmodified material for hand-thrown missiles. To adventure further into the obscurity of what might have happened, as opposed to what we can actually document, Washburn (in Hall 1963:492) made the interesting comment that:

> Unless a stick is well-selected and skilfully used an ape's teeth are far more effective. The agonistic-display origin of weapons solves this dilemma because if display fails, the ape may still fight or flee. The selection pressure maintaining the large teeth would not be relaxed until after the swinging branch display had evolved into effective behaviour. If young apes incorporated this bipedal, object-using display into their play repertoire, a background for skilful adult use would be laid.

After 'swinging branch display' we should perhaps insert 'and the ability to throw forcefully, well-directed stones'.

Any insights gained from the ethnographic and historical portion of this essay are not

strictly transferable to early Pleistocene hominids who were certainly smaller in stature and whose neural and motor skills may have been less developed than ours. However, modern observers have noted the skill of quite young children: 'Small birds like galalus, parrots, finches and pigeons are killed near the waterholes by the children, who hurl stones at every opportunity. The force and accuracy of this stone-throwing, even by children only 4 or 5 years old is remarkable, and accounts for a surprisingly large number of killed birds' (Gould 1967:49). The height of these children would have been comparable with that of Pleistocene hominids, but their musculature considerably less robust.

The astute reader will argue that none of the evidence presented here is more than circumstantial. With that point of view I cannot disagree. Nonetheless, this rehearsal of modern and historic instances is important because it may help the reader to cross an imaginative barrier, the one complained of by Wood and still found in the prejudices of many researchers today. They are not convinced because they have not seen with their own eyes that throwing fast and furiously can obtain a dinner, or disable an enemy.

Conclusions

Perhaps the main points to emerge from this review are:

1. Our closest living relatives, the apes, have some ability to project objects, but the range and accuracy attained is very much less than it is in humans. Apes show no sign of the inborn human propensity to take delight in acquiring throwing skill. This implies a prolonged use of ballistic abilities in human prehistory.
2. Although the throwing of stones can only be documented in recent times from remoter areas of the world, it is shown nonetheless to be a highly effective and even lethal ability, widespread amongst people who lacked firearms. We need more data from modern sources, and more observations on children and primates.
3. Anatomical studies of *Australopithecus afarensis* show that, unlike that of the pongids, the *A. afarensis* hand was adapted to throw with precision and force. These studies need to be extended.
4. Some of the evolutionary shifts made by early human ancestors are more easily comprehended if throwing is incorporated as an element of the new adaptive mode. It is a fact that stones usable as missiles do exist on the earliest archaeological sites.
5. We need predictive tests that field archaeologists might make, and careful and ingenious searches for archaeological and palaeontological evidence in the earlier ranges of human time before flaked tools were used and sites as we conventionally know them were created.

None of the conclusions is surprising, but I hope that this review will open up some telling but neglected topics for research.

It will have been noted by the reader that all historical instances so far quoted relate to throwing by males, with the honourable exception of the Australian Aborigines. The implications of this will not be pursued here, but they are not unimportant.

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