Marine turtles – the ultimate tool kit: A review of worked bones of marine turtles

Jack Frazier

Worked bones of marine turtles have been recorded from the Arabian Peninsula, Caribbean Islands, North America, Mexico and the Yucatan Peninsula, South America, Pacific Islands, and Southeast Asia. In addition to cut marks and burning, these bones have been drilled, shaped, worked into squares and disks, and made into a variety of implements, as well as funerary offerings. Suggested explanations for these cultural modifications, aside from butchery and cooking, include use as net gauges, weaving tablets, game or divination counters, manual tools such as scrapers, adzes, spades, bivalve openers, and even use as a shaving implement, not to mention ornaments and diverse forms of funerary objects. The articulated shells served as covers to funerary urns, and, as they do today in some places, vessels for cooking the turtle directly over an open fire. The interment of marine turtle remains with human burials in various sites indicates that these animals held a special religious significance in numerous prehistoric coastal cultures. This paper makes a first attempt at compiling and summarising information on worked bones of marine turtles, calling attention to some of the basic questions in interpreting the findings and at the same time soliciting additional information and interpretations from colleagues.

Jack Frazier, Conservation and Research Center, National Zoological Park, Smithsonian Institution, 1500 Remount Road, Front Royal, VA 22630, USA; kurma@shentel.net

Introduction

There are seven living species of marine turtles, and the largest of them can grow to two metres in total body length, reaching nearly a tonne in body weight (Pritchard & Mortimer 1999). In addition to the axial skeleton that is common to most tetrapods, these chelonians are encased within a bony shell, composed of dorsal carapace and ventral plastron, which form specialised components of the axial skeleton. An individual marine turtle has as many as 280 bony elements, of different shapes and sizes, many of which comprise the shell (Figs. 1, 2; see also Summers 1990, Fig. 12; Mosseri-Marlio 2000b, Pls. 1–7; 2002, Fig. 6; Wyneken 2001, 43–58; <http://www.euroturtle.org> [Education][Bone kit]). Many of the bones are large and distinctive, and relatively robust, so they are commonly preserved in archaeological sites and routinely subject to archaeological retrieval.

These animals have been exploited by humans for millennia, providing valued sources of meat, oil, and horny shell to diverse coastal societies around the world. 'Tortoise shell'[1] was an important commodity for international trade by the first century AD – at least in the

[1] Written variously 'tortoiseshell', 'tortoise-shell', or 'tortoise shell', this term today is used to refer to the keratinous shell, or scutes, of hawksbill turtles, *Eretmochelys imbricata*. However, green turtles, *Chelonia mydas*, raised in captivity on high-protein diets produce relatively thick scutes, which can be used in the same way as tortoiseshell from 'wild' hawksbill turtles; and there is evidence that in ancient times the scutes of land tortoises may have been used (Casson 1989). Nearly all turtles – and all marine turtles in the family Cheloniidae – have a shell comprised of a dorsal 'carapace' and a ventral 'plastron'. This shell is composed of a bony structure covered by a horny, or keratinous, structure. The term 'turtle shell', or 'shell' is often found in the archaeological and ethnographic literature. However, this is an imprecise and ambiguous term, for it could refer to the entire shell, both carapace and plastron, with both bony and horny layers, or it could equally well apply to only the carapace, only the plastron, only the bony shell, only the keratinous shell, or any combination of these parts. In many cases it is clear from the context (e.g. Hiroa 1930, 495 ff.; 1950, 231, 238; 1964, 290, 324, 328, 329, 546, 548–550, Figs. 224, 225, 338; Beaglehole & Beaglehole 1938, 197;

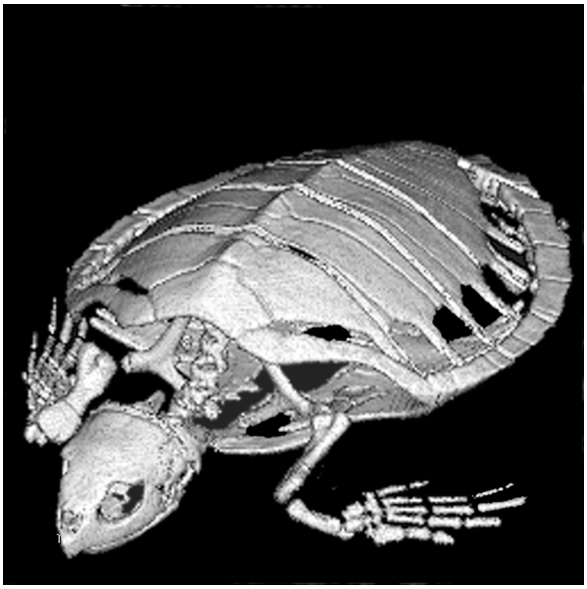

Fig. 1. *Computed tomography (CT) of an immature ridley turtle (*Lepidochelys kempii*) showing the three parts of the skeleton: the skull, axial, and appendicular skeletons, as well as the spatial relationships of the bones. Cartilage (at the ends of many bones) is not detected by this imaging technique so bones appear loosely articulated. The arrangement of the forelimbs is such that the shoulder joint is inside the shell; the elbow flexes so the forearm and hand (i.e. antebrachium and manus) move from an anterolateral position to a medial position. Lines crossing the posterior skull and carapace are image-processing artefacts (from Wyneken 2001, Fig. 82; image provided by Dawn Witherington and Jeanette Wyneken).*

Indian Ocean region (Casson 1989), and it may have been fundamental in the development and maintenance of prehistoric institutions of international commerce (Frazier 2003; 2004). An enormous diversity of objects has been made from tortoise shell, in a variety of cultures (e.g. Thode-Arora 2001; Frazier 2003; 2004). However, 'worked bone' of marine turtles (bone that shows signs of modification by humans, i.e. 'cultural modification') has received far less attention by scholars. Given the relatively large number of bones per turtle, together with the diversity of their shapes and sizes, one might expect a wide variety of uses for the bony parts of these reptiles. Archaeological remains of marine turtles have been documented from coastal sites around the world, and records of worked bone are widely distributed – in time and space – illustrating a variety of modifications and suggested uses, including considerable ceremonial/religious significance in some cases. Because the information on worked bone is very disperse,

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Métraux 1971, 187) that the term 'shell' was used to refer to the keratinous shell – ***not*** to the bony shell, for it is the keratinous shell, or tortoise shell, that can be moulded and worked into artefacts that are small and/or delicate, such as fishhooks, finger rings, combs, and ornate nose pieces (e.g. Thode-Arora 2001). In other cases (e.g. Chazine 1982, 298, 299, 301; Mosseri-Marlio 2000a, 33–34; 2000b, 95–96; 2002, 203 ff.; Salvatori in press a) it seems that the term 'shell' has been used to refer to bony fragments of the carapace or plastron. Emory (1975, 199, 200, 211, Figs. 163a–c, 165a, 168c, 176c, 179b) reports 'turtle shell' hooks, even specifying that they are made from the 'entroplastron' [sic.] (the name of a specific bone in the plastron) or 'breastplate', but in describing these hooks as amber, yellow, or black in colour, it is clear that he is referring to keratinous 'tortoise shell' – not to bone.

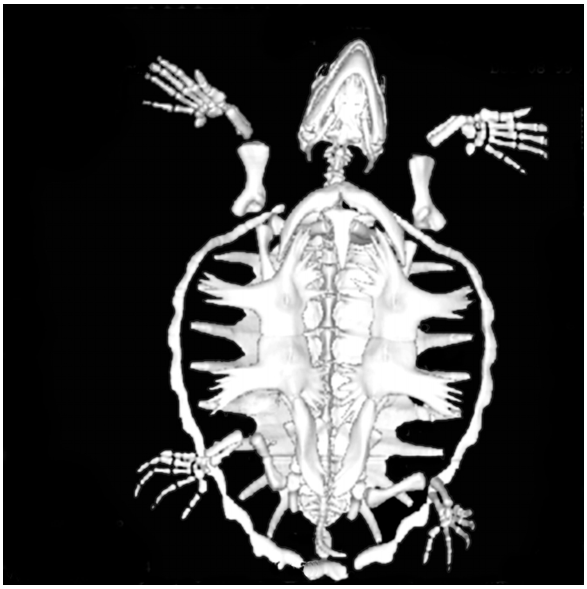

Fig. 2. *CT of an immature ridley turtle (*Lepidochelys kempii*) showing individual plastron bones, not fused in immature turtles. The processes from the lateral plastron elements do not yet articulate with the peripheral bones. The hyoid apparatus (the body of the hyoid and both bony hyoid processes), which is usually lost in skeletal preparations, can be seen in the throat region. The distal phalanges of the flippers were outside the field of view in this CT scan so the ends of these parts of the flippers are omitted (from Wyneken 2001, Fig. 83; image provided by Dawn Witherington and Jeanette Wyneken).*

and there appears to be far less available in the literature than one might first assume, an initial attempt has been made at compiling and interpreting the relevant information, and calling attention to this issue (Table 1).

Summary of culturally modified marine turtle bones

Published information on culturally modified marine turtle bones is dispersed and sparse; much information has never appeared in reports, much less publications, and is known by word-of-mouth. Published accounts vary from detailed descriptions with illustrations, measurements, and identifications to the species level (e.g. Carlson 1999, 127, Fig. 19; O'Day 2001, 7); to reports including measurements and illustrative photos but identifications only at the general level of 'turtle' (e.g. Gilliland 1975, 217); to indefinite reports of 'turtle' bone, carapace or shell with no further details (Higham 1989, 77, 82, 165, 168, Figs. 2.29, 2.30, 3.45; Higham & Bannanurag 1990, 39 ff.; Higham & Thosarat 1998, 48, 55, 56, 59, 62, 80, 81, 108, 110, 125); to passing comments such as 'Turtle bone is rare and when present is often worked…' (Davidson 1968, 58) or 'partly worked' bone was found (Mudida in Horton 1996, 388). Hence, numerous attempts have been made to contact authors, investigators, and museum staff to obtain more information and clarifications; responses have varied from detailed explanations, unpublished manuscripts, papers in press, photos, and reprints – to no reply whatsoever.[2]

[2] The author would be very grateful for additional information on culturally modified bones of marine turtles, including publications, reports, photos, artifacts, and other sources.

Species of marine turtles involved in culturally modified bones

Virtually all marine turtle bones found in archaeological contexts (Frazier 2003; 2004), whether culturally modified or not, have been identified as belonging to the family Cheloniidae, and at least four of the six species in this family have been listed in reports of worked bone: *Caretta caretta*, loggerhead; *Chelonia mydas*, green turtle; *Eretmochelys imbricata*, hawksbill; and *Lepidochelys kempii*, Kemp's ridley (Table 1). There is a comment that bones of olive ridleys, *Lepidochelys olivacea*, from Anuradhapura, Sri Lanka (800–250 BC) 'were probably used for making ornaments and utensils' (Chandraratne 1997, 9), but no evidence of cultural modification was provided. Although olive ridleys are widespread, one of the most abundant of marine turtles, and they are mentioned in zooarchaeological studies, the lack of records of culturally modified bone may be due to a bias, rather than a manifestation of some biological or anthropological phenomenon: there may be a paucity of sampling effort in tropical areas where this species nests and is most accessible. Flatback turtles, *Natator depressus*, are known only from northern Australia and waters immediately to the north and west, so the lack of archaeological records is likely to result from the relatively small geographic range and limited sampling effort. A dearth of reference collections may also contribute to the lack of archaeological records of species such as the flatback. The most common species listed, or implicated, in reports of worked marine turtle bone is *Chelonia mydas*. The only archaeological records of the leatherback turtle, *Dermochelys coriacea* (family Dermochelyidae) seem to be from Cerro Brujo, Bocas del Toro, Panama (600–900 AD) (Wing 1980, Table 1) and St. Thomas, US Virgin Islands (300–700 AD) (Wing *et al*. 2002, Table 4.3); no records of prehistoric, culturally modified bone are known for this, the largest of marine turtles.

Types of modifications found on marine turtle bones and interpretations for their use

Reports of burns and cut marks on marine turtle bones are widespread from Arabia and the Caribbean basin (Table 1). As mentioned in earlier reviews on marine turtle bones (Frazier 2003; 2004), the oldest published records are from Arabia. Third millennium BC sites at Ra's al-Hadd, Oman, have relatively large numbers of burned turtle bones, interpreted as evidence of prehistoric industries that rendered body fat to oil for a variety of uses (Mosseri-Marlio 1998; 2000a; 2000b; 2002).

At the other 'extreme', marine turtle bones seem to have had important ritual/religious value in several sites around the world. At Ra's al-Hamra, near the Batinah coast of Oman (3800–3300 BC), one of the oldest known cemeteries in Arabia, remains of marine turtles are found on the ancient surface of the site; and shallow graves often include animal remains, usually fish or turtle (Cleuziou & Tosi 2000). 'The shell of the green turtle (*Chelonia mydas*) was more common in the graves than the remains of any other animal, and thus seems to have had particular significance for the ancient inhabitants of Ra's al-Hamra.' (Potts 1990, 71; see also Biagi *et al*. 1984, 47, 48). At least 121 graves have been excavated, several of which contained more than one burial. Bones of marine turtles (reported as *Chelonia mydas*) were found in nearly half of the graves: in 10 cases a skull of *Chelonia mydas* was lying near to the human skull, 56 graves had a shell (carapace?), and 21 had fragments of 'shell' (carapace and/or plastron?) in the grave. One pit, directly above a grave, had 12 turtle crania; in some cases entire turtle crania were found lying on an interred human skull, and it was assumed that several graves were each covered by a turtle carapace. In some graves a piece of carapace, plastron, or mandible was found lying in contact with the skeleton, for example on top of a hand or covering the human skeleton (Salvatori 1996, 207; in press a; in press b). At Nil Kham Haeng, a major copper-producing village site in Central Thailand, a burial dated at ca. 700 BC, had, as part of the grave goods, the entire carapace of a marine turtle over the head and torso of the interred individual (V. Pigott *in* *litt*. 8 March 2004). Some of the most remarkable grave goods at Khok Phanom Di, southern Thailand, are turtle 'ornaments' and other objects,[3] reported from at least 14 graves as well as numerous other contexts (Higham & Bannanurag 1990, 39 ff.). Moreover, there was a general trend in some prehistoric Thai sites for only male graves to contain 'turtle' bones, some of which were carved (Higham & Thosarat 1998, 62, 80, 98, 118). Two precolombian Maya graves in Champotón, Campeche, Mexico, had marine turtle bones associated with the human bones (Götz 2004, 3–5). There are also sites in the Caribbean where marine turtle remains have been found in association with human interments; for example, a preceramic site at St. Michielsberg, Curaçao (Haviser 1985, 65). At Malmok, Aruba (0–900 AD), it was estimated that about 10% of the graves had a carapace either over or under the burial (Boerstra 1973; Versteeg 1990, 18). In addition, turtles themselves seem to have been ceremonially buried, such as at the Golden Rock Site, St. Eustatius (500 AD) (Schinkel 1992, 171), at Tanki Flip, Aruba (1000–1250 AD) (Bartone & Versteeg 1997, 48, 49, 63, Fig. 94), and at Tutu, St. Thomas (300–700 AD) (Righter 2002). A carved turtle bone with an anthropomorphic face was found at Santa Barbara site, Curaçao (J. Haviser *in litt*. 14 May 2004). A marine turtle carapace (1330–1650 AD), placed in an east-west alignment at Miami Circle, Brickell Point, Miami, Florida, is thought to have been a ritual offering (Carr & Ricisak 2000, 281; R. Wheeler *in litt*. 18 April 2004). At Playa Vicente Mena, Chile (1000–600 AD), two large ceramic funerary urns were each covered with a carapace (Frazier & Bonavia 2000). Moreover, ethnographic information from numerous sites is consistent with the special place of marine turtles in various human societies. Representations of these reptiles were important to the Calusa of SW Florida at the time of the Spanish Conquest (Schaffer & Ashley 2003). The Comcáac ('Seri') of Sonora, Mexico, buried their dead under two turtle shells, and food offerings of turtle parts were also included in graves (McGee 1898, 291* [4]); the leatherback turtle is deeply revered as a special being (de Grazia & Smith 1970, 6, 60, 61; Smith 1974, 154; Felger & Moser 1991, 42, 166; Nabhan 2003, 249 ff.). In many Pacific island cultures of the recent past, marine turtles were habitually reserved for high status individuals, namely chiefs or religious leaders (Rolett 1986), and they were 'considered to be food that could only be eaten when shared with the gods on the *marae*' (Emory 1975, 4). The Manus of New Guinea are reported to eat marine turtle on 'every social event of any consequence in the village' (Spring 1981, 169). Marquesas islanders, after being converted to Christianity, substituted green turtles for humans in ritual sacrifices; and turtles were also important in ceremonies on numerous other Pacific islands (Rolett 1986).

Between these two 'extremes' of direct consumption and ceremonial/religious value, marine turtle bones show evidence for a variety of other uses (Table 1). Carlson (1999) described turtle roasting hearths from Grand Turk, Bahamas (700 to 1100 AD), where she found bones of marine turtles, and other animals, in the remains of circular hearths; she postulated that the turtles were roasted over open fires, using the upturned carapace as a vessel. A carapace and its associated axial skeleton at Tutu, St. Thomas, US Virgin Islands (300–700 AD) could have been used as a meal and cooking vessel at the same time (Righter 2002, 42, 65–66, Figs. 1.17c, 1.19, 1.27d). There are indications that at Julfar, north of Ras al Khaimah, UAE (700 to 1600 AD), an upturned carapace of *Chelonia mydas* was used as a vessel (Desse & Desse-Berset 2000, 89,

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[3] Again, these are only identified as 'turtle', but given that marine animals comprised a major part of the faunal remains, and several of the turtle artifacts – which were incomplete shells – measured more than 30 cm, it is likely that at least some of these artefacts were from marine turtles.

[4] Pagination in McGee's paper is normal through page 128, after which each page number is accompanied by an asterisk (e.g., '129*', '291*', etc.) until the last page of his article (344*). The asterisk distinguishes McGee's pages from those in the paper that immediately follow his, by James Mooney on 'Calendar history of the Kiowa Indians', where pages run from start to finish, 129 through 445, without asterisks.

Fig. 13). Likewise, it was suggested that carapaces at El Meco, Mexico (300 to 1500 AD), were used as vessels, and even that turtle crania served this purpose (Andrews 1986, 68, 69). Ancient historic information provided by the Greek writer Agatharchides of Cnidus, in the third century BC, describes primitive *'Chelonophagi'* peoples from the Red Sea using marine turtle 'shells' for a variety of purposes, including vessels, boats, and construction of shelters (Burstein 1989, 85–87); the Maya at the time of the Spanish Conquest used marine turtle 'shells' as vessels (Piña Chan 1978, 46) as well as shields (Díaz 1963, 34; 2000, 33; Smith 1974, 157). Contemporary peoples on Socotra Island (south of the Arabian Peninsula) have used marine turtle carapaces for construction purposes, including chicken hutches (Doe *et al.* 1992, Pl. 62). A carapace was made into a large shield by aborigines from Queensland, Australia (Etheridge 1895), and there is also evidence that Guarani on the Atlantic coast of South America made shields of marine turtle carapaces (Frazier 2003). At least until the end of the 19th century, the Concaác (Seri) of Sonora, Mexico, used turtle carapaces to cover their brush shelters, as well as to serve as 'umbrellas', 'bucklers', trays, containers, cisterns, fire windbreaks, cradles, and coffins (McGee 1898, 111, 187*, Pl. VII; Smith 1974, 140, 151), and sledges for children (de Grazia & Smith 1970, 32). Until recently, inhabitants of the Tuamotu Archipelago used shells (carapaces) of marine turtles as platters and also sledges (Emory 1975, 17, Fig. 24). These ethnographic accounts support interpretations of prehistoric turtle 'shells' being used as vessels, shields, for construction, and for other purposes. However, as Righter (2002, 65–66) discussed, there are other possible interpretations, including ceremonial burial or discard of useless carcasses.

A specimen from Umm an-Nar, Abu Dhabi, UAE (ca. 2700 BC) – '12 mm thick, square-shaped part of a turtle shell pierced by a sub-central foramen' – was thought to be a 'weaving tablet' (Hoch 1995, 250). Smoothed, rectangular bones, often called 'bone tablets' or 'polished rectangles', are documented from various places in Florida and the Caribbean basin. Wing (1965, 23) analysed faunal material from Cushing's (1897) extensive collections from Key Marco, SW Florida, a site conforming to Glades III culture, estimated to date from about 1200–1400 AD (Griffin 2002, 153), and reported on 17 cut, smoothed, and polished rectangles made of turtle bone; these averaged about 1.75 x 2.25 inches (4.4 x 5.7 cm), and seven were identified as Cheloniidae. This was followed by Gilliland's detailed analysis of Cushing's (1897) Key Marco collections, in which she reported that there were 57 whole and 12 fragmentary specimens of turtle bone rectangles, characterized by a similar form; worn surfaces, particularly around the edges; and glossy and smooth surfaces which indicates that these bones were frequently handled (Gilliland 1975, 217; see also Cushing 1897, 376). She postulated that these bone rectangles were used as either counters, perhaps for games, or in divination rituals. However, identifications were only given as 'turtle', and most of these artefacts are ***not*** from marine turtles, but rather from smaller, aquatic or terrestrial chelonians (Wing 1965, 23; R. Wheeler *in litt*. 3 August 2003).

In this regard, Walker (2000) has developed a strong case that these 'polished rectangles' served as net gauges, also called 'mesh measure', 'mesh spreader', 'mesh stick', 'mesh tool', 'net paddle', 'net spacer', and 'paddle'. She argued that these were used to maintain the desired mesh size of nets during their manufacture, and showed that there were significant differences in the dimensions of the rectangles, that conformed to predictions about environmental conditions, the sorts of fishes that would be available, and the mesh sizes that would be needed to catch them. Ethnographic support for her interpretation comes from Uvea, Polynesia (Burrows 1937, 104–105) and Hawaii (Summers 1999, 80, Fig. 161), where net gauges were made from peripheral and other bones of marine turtles. However, not all bone tablets have been interpreted as net gauges; those from Barbados – that did not show polished edges or surfaces – were thought to be scrapers, used for working relatively soft materials (Wing 1991, 141–143, Fig. 81).

Other presumed uses of marine turtle bones include spatulas and tool handles from Macabou, Martinique (Allaire 1977,[5] cited in Carlson 1999); spatulas from Hanamiai, Marquesas (1025–1850 AD) (Rolett 1998, 231); scrapers or adze-like tools with beveled cutting edges at Hanamiai, Marquesas (Rolett 1998, 94, 229, 231, Figs. 9.9, 9.10, 9.12); 'scrapers'[6] from Vaio'otia site, Huahine Island, Society Archipelago (Sinoto & McCoy 1975, 159) as well as from Pukarua, Reao, Tumatus Archipelago (Sinoto 1978, 159–160, Fig. 29); spades and scrapers at Ana'a, Reao, Takapoto, and Takaroa atolls, Tuamotus Archipelago (1050–1900 AD) (Chazine 1982, 291, 297–303, Figs. 9, 10, 12, 21, 22, 26–42; 1990, Fig. 10; *in litt*. 21 & 23 February 2004; Nitta 1982, 417); and digging tools on Temoe Atoll, Mangareva group (Weisler in press). It is relevant that a turtle-bone adze from historic times at Truk Island, Micronesia, is described and illustrated by Rolett (1998, 229, Fig. 9.11); at the end of the 19th century on Funafuti Atoll, Ellice Group, adzes, awls, scoops, fishhooks, mattocks, and axe-like implements were made of turtle bone (Hedley 1899, 251–253, 261, 264, 266, 292); in the first half of the 20th century on the Tuamotu Archipelago, spades for digging sand were made of bones from the plastron,[7] and bone awls for sewing pandaus-leaf thatch were also fashioned[8] (Emory 1975, 36, 38, 56, Figs. 13b, 31a). Distinctive hafted axe-like implements, with blades made of turtle bone (probably pleurals – expanded ribs) are documented from Maty Island, Manus, Papua New Guinea. These axe-like tools were thought to be used for constructing boats or mixing breadfruit paste (Lupu *et al*. 1975, 176), or for lopping Pandanus fruit from the tree and splitting coconuts – not as battle axes, as had been described earlier (Hedley 1899, 252 and fn). The use and preparation of 'tortoise-shell axes' is described in the ethnographic literature for Guiana Indians by Roth (1924, 75–76), although it is unclear if the later were from marine turtles. Aboriginal peoples in the Torres Straits used 'a turtle-bone' to perforate the base of the tail of a 'sucker fish' (*Echeneis* or *Remora*) so that they could tie a line to the fish for catching turtles (Haddon 1912,[9] cited in Gudger 1919a, 462; 1919b, 522).

There are also archaeological reports from the Key Marco, SW Florida of 'hollow shaving-blades or rounding-planes' made from the mandible of a *Caretta caretta* (Cushing 1897, 377–379); and giant clam (*Tridacna*) openers made of coracoid bones of *Chelonia mydas* were found on Reao, Eastern Tuamotus (11th century AD) (Chazine 1982, 292, Figs. 12, 13, 15a, 16; 1990, Fig. 10; 2001; *in litt.* 21 & 23 February 2004). In some cases, such as a smoothed carpal or tarsal bone (apparently from a marine turtle) that has a 'twisted' appearance, it is unknown what function the modified bone might have had (Walker 1992, 239, 241, Fig. 12). This is not to mention relatively recent artefacts, such as bone disks made during the 18th and 19th centuries by African slave craftsmen in the Caribbean, used for button blanks (Klippel & Schroedl 1999).

As mentioned above, marine turtles have been interpreted as significant funerary objects in several archaeological sites. Unspecified turtles were reported from a variety of sites in Thailand, mainly as grave goods; 'carapace ornaments', 'carved carapace ornaments', and bangles made from turtle carapaces were reported from several sites (Higham & Bannanurag 1990, 39 ff.),

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[5] L. Allaire. Later Prehistory in Martinique and the Island Caribs: Problems in Ethnic Identification. PhD thesis. Yale University, New Haven, 1977.

[6] J. M. Chazine (*in litt.* 18 April 2004) feels that these tools are not 'scrapers', but rather 'spades' used for agricultural digging.

[7] Emory reports that these spades were made from plastron bones, but although his illustration (1975, Fig. 13b) supports this interpretation, it is not clear from the text description (1975, 36, 38) if pleural bones, from the carapace, were also used.

[8] Emory's illustration (1975, Fig. 31a) indicates that the instrument was made from a rib, but this is not certain.

[9] A. C. Haddon. 1912. Reports Cambridge Anthropological Expedition to Torres Straits, IV, 163–165, Fig. 221.

particularly in association with male graves (Higham & Thosarat 1998, 48, 55, 56, 68, 80). Although it was not specified what type of turtle was involved, in at least one case, 'sea turtle' was reported; and in several cases, distinctively marine animals were reported together with the turtle, suggesting that the reptile may have been marine (Higham & Bannanurag 1990, 39 ff.; Higham & Thosarat 1998, 55, 56, 80, 81, 98, 126). Marine turtle bones found inside two ceramic vessels at Tanki Flip, Aruba, were interpreted as being cashes with ritual significance (Bartone & Versteeg 1997, 48, 49, 63, Fig. 94). Several phalangeal elements of marine turtles from the Miami Circle have been modified with cuts and holes, which has given rise to the suggestion that they were used as pendants; however, some archaeozoologists believe that the perforations may have been caused by marine invertebrates (R. Wheeler *in litt.* 12 June 2003). Ornaments, ritual objects, and toys made from marine turtle bones do not seem to be common, although there are ethnographic records of an ornament from Easter Island (Métraux 1971, 230, Fig. 27) and ritual objects and toys used by the Comcáac peoples of Sonora, Mexico (Felger & Moser 1991, 44, 162, Figs. 3.8, 13.4, 13.5). Aboriginal peoples in the Torres Straits burned turtle bones, broke them up, and threw them into the sea before going out fishing with sucker fish for turtles (Haddon 1912, cited in Gudger 1919a, 462; 1919b, 522). In many West African countries crania and bones, as well as skin, scales, blood, and fat, are frequently used for various traditional medicines, and for voodoo (Fretey *et al.* in press).

Another form of cultural modification includes scars and damage left by capture techniques. Large holes in pleural bones of *Chelonia mydas* (Fig. 3) from Coralie site, Grand Turk, Turks and Caicos (now called 'Chuuk'), Bahamas Archipelago, are thought to be from harpoons or spears used to capture the turtles (Carlson 1999, 127, Fig. 19). Nonetheless, many capture techniques, even highly specialized ones, do not involve making any marks on bony parts (e.g. Conte 1988, 19 ff.).

Fig. 3. *Pleurals of two Chelonia mydas from Coralie site, Grand Turk, Turks and Caicos, Bahamas Archipelago, showing roughly circular perforations (from Carlson 1999, Fig. 19; photo provided by Lisabeth Carlson). Forensic analysis found that 'the bone displayed a depressed fracture; a puncture wound produced by some blunt instrument', hence, the holes are thought to be from harpoons or spears used to capture the turtles (Carlson 1999, 127, Fig. 19).*

Numerous examples of modified bones from Mesoamerica, Caribbean and Pacific islands, are described in unpublished reports, or publications that are difficult to obtain (e.g. Allaire 1977, cited in Carlson 1999; Chazine 1982; 1990; Richardson & Pohl [1982]; Carr 1989; Carlson 1999; O'Day 2001; Peres 2001; Carder 2003; Götz 2004). In addition, there are many more specimens of culturally modified bones of marine turtles that are awaiting analysis, or at least basic description. For example, the extensive material from the Miami Circle, Florida, (760 BC – 1650 AD, see Carr & Ricisak 2000, Tables 1, 2) contains many remains of marine turtles (Carr & Ricisak 2000, 281, 282; Wheeler 2000, 305, 308), some of which show signs of cultural modification (R. Wheeler *in litt.* 19 February; 18 April 2004). The voluminous materials from Thailand (e.g. Higham 1989; Higham & Bannanurag 1990; Higham & Thosarat 1998) are likely to provide rich and unique marine turtle artefacts.

Basic questions of interpretation

When interpreting reports on worked bones of marine turtles, several basic questions need to be carefully considered: 1) is the bone actually from a marine turtle? 2) is the modification to the original osteological state of the bone due to human industry (i.e. is the modification 'cultural')? 3) how was the bone obtained by the worker(s) who modified it? 4) how was the artefact used? (Although some authors provide extensive hypothetical discussions, archaeological studies alone are poorly suited to ask questions such as: what was the 'purpose' or 'motivation' behind the cultural modification?)

Is the bone from a marine turtle?

Several reports of worked marine turtle bone involve distinctive pieces, which in a number of cases have been identified to species (Table 1). Nonetheless, marine turtle artefacts are notoriously difficult to identify to species (mainly because they are often highly fragmented, or because diagnostic features were obliterated by the process of modification), and it is not uncommon for specimen identities to be left at the family level (viz. Cheloniidae), and in some cases it has not been possible to identify chelonian bone more precisely than the level of order (see review in Frazier 2004). In some archaeological reports one is presented with indefinite, but tantalizing, descriptions of 'turtle' bones, ornaments, and other artefacts, (e.g. Gilliland 1975; Higham & Bannanurag 1990; Higham & Thosarat 1998), and although some are likely to be marine species, the data have limited value without more precise identifications. Ignoring the problem of unpublished data, there are probably many bony parts of marine turtles that have been culturally modified, but have not been reported as 'marine turtle'. Hence, it is likely that among the specimens that have been reported, the problem of taxonomic, or specific identification results in a marked under-documentation of culturally modified marine turtle bone. Given the fragmentary or highly modified condition of many specimens, it may be necessary to confirm taxon, particularly species, identification through histological or molecular analyses.[10]

Is the modification to the bone from human action?

Modifications to the original state of a bone may result from various causes, in addition to human industry. In the case of marine turtles, the bones can be eroded – or even perforated – during life by species of barnacles that are known only from these reptiles (Ross & Newman 1967). In addition, attacks by large predators, such as crocodilians, hyenas, large felids, and sharks could also leave perforations in bone, even relatively thick bone. Post-mortem and post-depositional

[10] The first meeting of the Archaeozoology and Genetics Working Group of The international Council for Archaeozoology, 14–15 June 2004, Paris, discussed issues involving molecular analysis (Zelder 2004).

modifications could be caused by scavengers, such as dogs, other carnivores, rodents, and possibly certain invertebrates, marine or terrestrial, with the ability to perforate or remove bony tissue. Holes made by burrowing barnacles or the teeth of large predators, or scavengers may be mistaken for wounds from a spear, harpoon, some type of drilling, or other forms of human modification, thus resulting in false reports of worked bone.

Marks left from invertebrate burrowers were found on turtle bone from Paradise Park, Jamaica (S. O'Day *in litt.* 13 February 2004); and depressions in phalangeal elements of marine turtles from the Miami Circle – which some people have concluded were used as pendants – are thought to be the work of marine invertebrates (R. Wheeler *in litt.* 12 June 2003). In addition, several marine turtle humeri from Brickell Point site (which includes the Miami Circle feature) have holes with conical bases and of varying depth; and it is suspected that these may have been made by burrowing marine invertebrates (R. S. Carr *in litt.* 17 July 2003). A fragment of a cheloniid ulna found in grave 4 at Champotón, Mexico, had pitting identified as bite marks, probably of a dog or other small carnivore (Götz 2004, 3–4, Table 1). The modification to the cheloniid ulna from the Granada Site, Florida (Richardson & Pohl [1982], 108, Pl. 20.d) is remarkable for the smooth, cylindrical hole that does not perforate the bone (Fig. 4), and there is no clear explanation of how this modification would have been manufactured or how it might have been 'useful' to a person. Indeed, Richardson & Pohl ([1982], 108) noted that '[t]he hole does not show the usual marks of drilling seen on other objects in the Granada collection'.

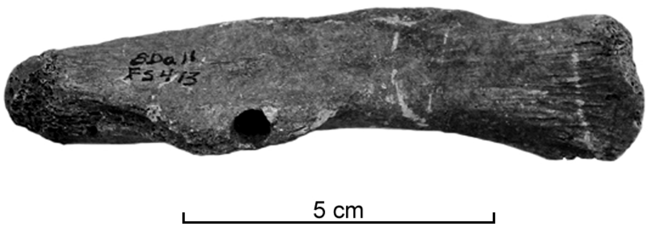

Fig. 4. *Right ulna of cheloniid marine turtle from Granada Site, Florida, showing drilled hole. (Originally illustrated in Richardson & Pohl [1982], 108, Pl. 20:d; specimen on loan from the Florida Bureau of Archaeological Research, Division of Historical Resources, Florida Department of State, catalogue no. 78A.101.473.1.). The smooth, cylindrical hole does not perforate the bone; Richardson & Pohl ([1992], 108) noted that '[t]he hole does not show the usual marks of drilling seen on other objects in the Granada collection'.*

The holes in two pleurals that Carlson (1999, 127, Fig. 19) found in Coralie, Turks and Caicos, are 1cm or more in diameter (Fig. 3), and appear to be too large for burrowing barnacles, or the teeth of large predators, which should also leave more than one hole. Moreover, she had the bone analysed by a forensic scientist who concluded that 'the bone displayed a depressed fracture; a puncture wound produced by some blunt instrument'. Hence, her interpretation of the holes having been made by harpoons is strongly supported by additional analyses.

On the other hand, there is little question that some forms of modification are from human agency. Deep, ragged incisions in a coracoid (pectoral girdle) from Paradise Point, Jamaica (± 850 AD) (Fig. 5) were evidently produced by hacking with a stone implement (O'Day 2001, 7; *in litt.* 3 June 2003). Simple smoothed and shaped bone tablets (e.g. Wing 1965; 1991; Gilliland 1975, 217;

Hoch 1995, 250, 251; Walker 2000, 32 ff.), or parts of bones that show shaping and junction with other elements, evidently for tool use (e.g. Allaire 1977, cited in Carlson 1999; Rolett 1998, 299, 231; Weisler in press), or bones with clearly aligned perforations (Sinoto 1978, Fig. 29; Chazine 1982, 332–336; 1990, Fig. 10-6; Nitta 1982, 417), show clear signs of human agency.

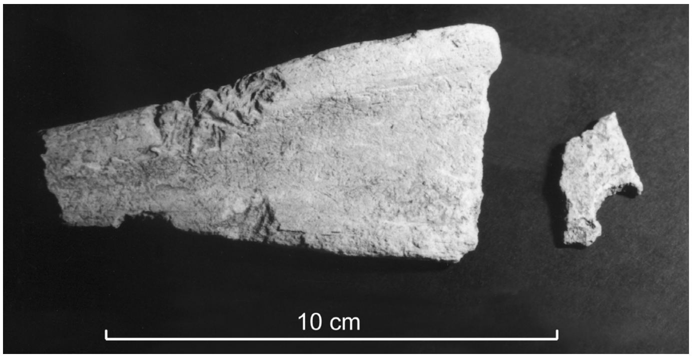

Fig. 5. *Right coracoid process (pectoral girdle) of a* Chelonia mydas *from site Wes 15A, an Ostionan deposit, at Paradise Point, Jamaica (± 850 AD) showing deep, ragged incisions (from O'Day 2001, 7, Fig. 1; photo provided by Sharyn Jones O'Day). The bone is deeply scared; the marks are on various surfaces; and they are distant from where cuts would be made for dismembering the carcass: hence, it seems that these are not just accidental cuts made during butchery, but rather that the bone may have been used as an anvil and/or a hammer.*

Burns and cut marks, the most commonly reported forms of cultural modification, are not usually questioned as being evidence of cultural modification – although they were probably made incidentally from butchery and cooking, and not intentionally for working the bone. If the cut marks show a pattern (for example, many marks together in the same orientation, or marks occurring repeatedly on the same place on the same skeletal element), it is unlikely that these signs could derive from something other than human agency. Likewise, a combination of both cut marks and burns or the occurrence of the bone(s) in a 'cultural layer' with cooking stones, charcoal, hearths, other clearly identified food bones and other food remains would be unlikely to occur without human agency. Nonetheless, scratches might be left on bones by agents other than humans, and fires can start without humans. Scratch marks that occur with no clear pattern and on skeletal elements not normally used for butchery or artifact manufacture should be questioned.

On the other hand, there are certain types of human modification to bone that would be 'invisible' to the archaeological record. For example, 'powerful' designs painted on large bones of *Dermochelys coriacea* by Comcáac (Seri) – no matter how colorful and vivid they may be in contemporary times (de Grazia & Smith 1970, 60; Smith 1974, 141; Felger & Moser 1991, 44, Fig. 3.8) – would be lost once the bones have weathered and aged. Similarly, un-worked bones used as toys, or made into dolls by wrapping them in cloth (Felger & Moser 1991, 162, Figs. 13.4, 13.5) would show no sign of cultural modification once the 'clothes' have deteriorated. Bones that were burned, broken, and thrown into the sea as a rite before turtle fishing (Haddon 1912, cited in Gudger 1919a, 462; 1919b, 522) would also be virtually 'invisible' to the archaeological record. Likewise, dried hyoid apparatus and plastron bones used as sacred offerings, such as done by Tuamotu islanders in the first half of the 20th century (Emory 1975, 41), or crania and other bones used for ceremonies and other rites, such as done in West Africa (Fretey *et al*. in press), would be difficult to interpret in the archaeological record.

How was the bone obtained?

It is often implicitly assumed that bones categorized as culturally modified, or worked, derive from animals that were hunted and killed by humans. In fact, it is not necessary to hunt or capture a marine turtle in order to have access to its bones, or even its articulated shell; these animals often strand on beaches after drowning and evidently also as a result of certain types of outbreaks of toxic marine organisms, such as 'red tide' (Milton & Lutz 2003). Moreover, in many places females that have crawled up onto a nesting beach become lost, entangled, trapped, or heat prostrated, and die before returning to the sea; in temperate waters marine turtles may be cold stunned and drift onto the shore (e.g. Milton & Lutz 2003). Hence, humans in a diversity of coastal environments could obtain marine turtle bones without hunting or capturing the animals alive.[11] In this light, it has been argued that whale bones in archaeological contexts may have derived from stranded whales (Bökönyi 1992, 48; 1998: 97). Furthermore, many capture techniques involve methods that would leave no sign in the archaeological record (e.g. Conte 1988, 19 ff.).

How was the modified bone used?

The area most subject to debate is interpreting the purpose, or cause, of the modification. In the case of patterned cut marks and burns, there seems little doubt that these would derive from slaughter and food preparation, although there could be other explanations such as scraping the remains of a dead animal to remove the keratinous shell from the bony shell (Carr 1989, 13). Modifications that involve shaping, smoothing, and drilling are often less obvious in their purpose. For example, what could be the purpose of producing a square-sided hole in a pectoral girdle, or a conical hole in an ulna, such as were done at the Granada Site, Florida (Richardson & Pohl [1982], 108)?

The interpretation of human modifications to bone could be totally mistaken if the marks are indistinguishable from the signs left by common, but infrequently observed/understood actions. For example, contemporary fishermen in Oman are reported to test the quality of a turtle before deciding to keep and slaughter it. An incision is made in the shoulder region to check the condition of blood, fat and meat; if unsuitable, the animal is released, and it was stated that 'many turtles have scars of previous encounters with fishermen' (Ross 1985, 464–465). Hence, a cut mark on certain bone fragments could derive from a test incision, and not from butchery. To more accurately interpret human-turtle interactions from the archaeological record, it is essential to have a basic understanding of both marine turtle natural history and human customs; unfortunately, a number of basic aspects of the natural history of these reptiles are still poorly understood, and customs of prehistoric human societies are next to impossible to know.

In this light, several artefacts made of turtle bone were in use by pre-industrial societies during historic times, and these give clear clues as to how to interpret archaeological worked bone that has a comparable appearance. Examples include hafted turtle bone adzes and axes from Micronesia (Hedley 1899, 251–253; Lupu *et al.* 1975, 176; Rolett 1998, 229, Fig. 9.11), turtle bone scrapers

[11] Although skeletal parts can be obtained relatively easily from scavenged carcasses, if bones are to be worked, they will be far more resilient if they are obtained 'green' (i.e. more or less fresh), so that they can be cured and dried properly. Bones that are simply removed from a decomposed carcass may be brittle and generally useless as tools or other items, especially if they are used with force.

from Hawaii used to make fibres for cordage (Stokes 1906, 106; Summers 1990, 27–44, Figs. 11, 13, 21–23; 1999, 21–22, Fig. 51), net gauges made of turtle bone at Uvea, Polynesia (Burrows 1937, 104–105) and Hawaii (Summers 1999, 80, Fig. 161), and a neck/belt ornament from Easter Island (Métraux 1971, 230, Fig. 27). Modifications that involve an artistic or spiritual value, such as grave goods, are open to a wide variety of interpretations, which contemporary societies may never be able to fully appreciate in terms of the original 'motivation'.

Biases introduced through research procedures

Another issue that bears on the interpretation of zooarchaeological data is the way that archaeologists treat culturally modified animal bones. It is not uncommon for worked bones to be kept together with 'cultural artifacts', and not included with other zooarchaeological remains (e.g. E. Wing *in litt.* 28 January 2002; N. Carder *in litt.* 15 February 2004). Other problems may arise from the large volume of animal remains that may be recovered; in many sites animal bones are simply too numerous to be dealt with fragment-by-fragment, so sampling strategies have to be used, and these can result in biases. For example, there have been cases in which animal bones have been sorted in such a way that just the more intact, readily recognized, or less massive bones have been retained or made available for study (e.g. Uerpmann & Uerpmann 2003; N. Carder *in litt.* 15 February 2004). In these cases, quantitative interpretations of relative numbers of bones – both culturally modified and otherwise – will be subject to errors. The lack of comparative collections – with specimens of the full range of species, size classes, and bones – is a common handicap; and as a consequence, many competent zooarchaeologists are unfamiliar with marine turtle remains – resulting in fewer, reliable species-level identifications than might be otherwise possible.

Temporal categorisation of cultural modifications to bones

The marks left on culturally modified bones can be categorised according to a temporal sequence: capture; slaughter and food preparation; modification ***for*** use; and modification ***by*** use. Examples of each respective category could include: spear and harpoon holes; burns and cut marks; drilling, shaping, and incising; and polishing, smoothing, chipping, and cracking. In theory, a single bone could show all four categories of modification, although this is unlikely to occur (see footnotes 11 & 12).

Conclusions and discussion

Marine turtle bones have been modified by diverse cultures since prehistoric times, in many coastal areas around the world; and although the oldest record of worked bone seems to be 2500 BC, it is likely that humans have been modifying turtle bone for many millennia before that. Clear evidence of wounds from capture techniques is rare, while signs of butchery and cooking are relatively widespread. Modifications of bones to produce tools of various types are common, but ornaments and 'artistic' pieces seem to be rare, although this may be due to a 'preservation bias'. Moreover, the information that is available in publications, and even unpublished reports, is a small part of what has actually been excavated.

It should also be kept in mind that while two objects may be made of the same material(s), and have similar appearances, this does not necessarily mean that they were constructed for the same purposes, or put to the same use(s). This is especially important if the objects come from different cultures or different periods of the same culture. The variety of interpretations for the use of objects made from marine turtle pleurals is a case in point: weaving tablet, counter, divination, net gauge, scraper, digging tool, axe, and adze.

In some cases a bone has been interpreted as ***either*** from a food item ***or*** from an implement designed and prepared by humans. However, marine turtles, with large, diverse, and numerous bones, could easily be eaten, and then after the meal the bones could be used to make implements, such as net gauges, counters, digging tools, or ornaments.[12] Moreover, an artefact may have been first modified for a certain purpose, say as a digging tool, but through time it could acquire other uses, such as a net gauge or counter, or even as an ornament or item with some ceremonial or religious value (S. O'Day *in litt*. 13 February 2004). For example, an oval shaped bone was evidently used as a neck or belt ornament during historic times on Easter Island (Métraux 1971, 230, Fig. 27), but the same piece of bone could easily have had an earlier function – such as a scraper or net gauge – before being made into, or used as, an ornament.

The concept of 'culturally modified' bone could be interpreted in a broad sense. Skeletal remains of marine turtles found in graves, in association with human remains, often together with other 'grave offerings', could be regarded as having been modified culturally by virtue of their context (i.e. physical ***position***): although they nest on beaches, marine turtles do not normally occur alongside humans in the terrestrial environment! Hence, even if no physical modification has been recorded for a bone, if its context shows cultural influence, it could be categorised as 'culturally modified'. This interpretation, of course, would be open to numerous contextual settings (or physical locations), other than association with human graves. For example, how would one categorise the complete skull of *Chelonia mydas* found by Wing & Steadman (1980, 328) in Cenote Xlacah, Dzibilchaltun, Mexico? The decision would need to take into account several points: 1) marine turtle skulls are very rarely reported in archaeological studies (Frazier 2003; 2004); 2) Dzibilchaltun is about 20 km from the sea, and if a marine turtle were to be used as a food source, the head would be one of the last parts to be transported this distance; 3) cenotes (sinkholes) were often used by the Maya for ceremonial offerings; and 4) on the basis of the vertebrate faunal remains at Dzibilchaltun, as well as other studies, Wing & Steadman (1980, 328) concluded that 'much of Maya religion and ritual involved marine life.' In this light, the Cenote Xlacah skull would need to be classified as 'culturally modified'. Clearly, this broad interpretation of the term would lead to seemingly endless possibilities, leading ultimately to arguments that any bone in an archaeological context is culturally influenced/modified.

Hence, this paper has focused on 'worked bone' (bone showing physical signs of cultural modification). Nonetheless, it is notable that marine turtle bones have been significant grave goods in several cultures, in different parts of the world. Because funerary objects – whether or not the bones have been physically modified – are clearly the product of cultural modification, a preliminary summary is included herein (Table 2).

Finally, it is important to emphasize that this paper has focused on various modifications to marine turtle ***bones***. However, these animals not only provide diverse shapes and sizes of bones, but also other parts that may be useful to humans, such as skin and scutes, not to mention meat, oil, and eggs. Although these body parts are normally outside the realm of archaeology, any thorough analysis of cultural modification to marine turtles must take other body parts of the same animals into account, thus integrating with other disciplines such as biology and ethnography.

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[12] For the reasons explained in footnote 11, in general it is unlikely that a cooked bone would be useful for manufacturing artifacts requiring the use of force. However, it would be possible to capture, slaughter, and cook a turtle so that certain bones are removed, and later used for working; simple items that require little if any working, such as net gauges and counters, could be produced from bones that had been cooked lightly.

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Table 1. *Preliminary summary of records of worked bones of marine turtles (see Table 2 for other records of 'culturally modified' marine turtle bones).*

Site	Taxon α	Estimated date	Bony element	Type of modification	Source
ARABIAN PENINSULA AND INDIAN OCEAN					
Umm an-Nar, Abu Dhabi, UAE	*Cc*?	2500 BC	shell fragment 12 mm thick, square-shaped part of shell	burn; with hole (weaving tablet)	Hoch 1995, 250, 251
Khok Phanom Di, Thailand	turtle [large size]	2390–1225 BC	carapace, shell	hole in carapace, ornament, pendant	Higham & Bannanurag 1990, 39 ff.
Tell Abraq ('Magan'), UAE	chl (*Cm*?)	2200–300 BC	carapace fragments	burns	Potts 2000, 60
Qala'at al-Bahrain, Bahrain	*Ei*	2150–1900 BC	humerus	cut marks	Uerpmann & Uerpmann 1994, 419; 1997
HD 1 & HD 6, Ra's al-Hadd, Oman	*Cm*?	ca. 2000 BC	'shell' **β**	cut marks, burns	Mosseri-Marlio 1998; 2000a, 32; 2000b, 95; 2002, 204–205
Nil Kham Haeng, [various] Thailand	sea turtle, ['turtle'] ?	ca. 700 BC [various]	carapace [carapace]	over skull of burial [ornament, carved, bangle]	Higham & Thosarat 1998, 98, 118 [55, 56, 62, 80, 81, 125]
Dembeni, Mayotte Is., Comoro Archipelago	chl	800–1100 AD	fragments	burn	Redding & Goodman 1984
Shanga, Kenya	[chl]	750–1400 AD	'large carapace fragment'	'partly worked'	Mudida in Horton 1996, 388
AMERICAS (Caribbean, Yucatan, Florida)					
SW Florida, USA	chl	50–1500 AD	pleurals?	smoothed tablet 'net gauge'	Walker 2000, 32 ff.
Isla Cerrito, Mexico	chl?	100 BC–1500 AD [900–1200 AD]	'shell' **β**	cut marks, scrapes, burns	Carr 1989, 13
Key Marco, Florida, USA	*Cc*	{1200–1500 AD}	mandible	shaving blade or plane	Cushing 1897, 377–379 {Griffin 2002, 153}
Marco Is., Florida, USA	chl	{1200–1500 AD}	'shell' **β**	7 smoothed & polished squares/ rectangles	Wing 1965, 23 {Griffin 2002, 153}
Key Marco, Florida, USA	chl (*Cm*?)	'<1400–1500' {1200–1500 AD}	plastron [& carapace]	rectangles, smoothed	Gilliland 1975, 217 {Griffin 2002, 153}
Barbados	chl	180–1300 AD	pleurals (carapace)	smoothed tablet 'scraper'	Wing 1991, 141–143, Fig. 81, Table 28: 7

Site	Taxon α	Estimated date	Bony element	Type of modification	Source
El Meco, Mexico	chl	300–600 AD	fragments carapace & crania	cut, burn, used as vessels?	Andrews 1986, 68, 69
Tutu, St. Thomas, US Virgin Islands	*Cm*	300–700 AD	carapace & axial skeleton in 'hearth'	used as vessel? burns??	Righter 2002, 42, 65–66, Figs. 1.17c, 1.19, 1.27d
Granada Site, Florida, USA	*Lk,* chl *Cc* or alligator	750–1500 AD	pectoral girdle right ulna bone	square hole, drilled, drilled	Richardson & Pohl [1982], 105, 107–108, Pl. 20.d **(Fig. 4 herein)**
Coralie, Grand Turk, Turks & Caicos, Bahamas	*Cm*	800–1200 AD	carapace	burns (turtle hearths) round holes (harpoons?)	Carlson 1999, 127, Fig. 19 **(Fig. 3 herein)**
Paradise Park, Jamaica	*Cc* and/or *Cm*	±850 AD	pectoral girdle	cut marks, burning	O'Day 2001, 7 **(Fig. 5 herein)**
Snake Island & Safety Harbor, Florida, USA	chl (*Cm* or *Lk*?)	900–1725 AD	scapula, nuchal, costal, marginal, plastron fragment	5 cut/possible cut, 11 burn; 1 hole	Peres 2001, 124, App. G.
Macabou, Martinique	chl	1100–1450 AD	tibia	cut; 'purposefully worked'	Fraser 1981, 51–53
Buck Key, Florida, USA	chl? *Cc* or *Cm*?	1200–1350 AD	carpal or tarsal	'twisted', smoothed γ	Walker 1992, 239–241, Fig. 12
Sandy Grove, Anguilla, BWI	chl	1000–1500 AD	203 fragments of long bones, crania, vertebra, etc.	1 cut, 2 burned	N. Carder 2003; *in litt.* 15 February 2004
Macabou, Martinique	?	?	long bones	'spatulas, tool handles'	Allaire 1977, cited in Carlson 1999
Ensenada de Muertos, Baja California Sur, Mexico	chl	prehispanic ?	long bones & carapace fragments	burns, found near hearths	E. Lizárraga Ceballos *in litt.*10 February 2004
the Miami Circle, Florida, USA	chl	500 BC–1500 AD	5 phalanges, 1 carpal?	cut, perforation, hole, & depressions **δ**	Wheeler, unpublished *in litt.* 12 June 2003; Carr & Ricisak 2000, Tables 1 & 2
Santa Barbara, Curaçao	?	?	?	carved anthropomorphic face	J. Haviser *in litt.* 14 May 2004

Site	Taxon α	Estimated date	Bony element	Type of modification	Source
			PACIFIC		
Hanamiai, Tahuata, Marquesas	chl	1025–1850 AD	pleurals (carapace) scapula	‘Adzelike tools with bevelled cutting edges…found throughout the sequence’ spatula?	Rolett 1998, 94, 229, 231
Nukuoro, Polynesia	chl	1300–1800 AD	?	‘Turtle bone is rare, and when present is often worked…’	Davidson 1968, 58
Temoe Atoll, Mangareva (Mangareva group & Pitcairn group)	chl (*Cm*?)	1000–1800 AD	pleurals	‘digging tool’	Weisler in press
Vaito’otia, Huahine, Society Archipelago	chl	?	costal plate (pleural)	scraper	Sinoto & McCoy 1975, 159
Ana’a, Takapoto, and Takaroa Atolls, Tuamoutus	*Cm*	1700 AD ?		‘spade/scraper’	J.-M. Chazine *in litt* 23 February, 18 April 2004
Reao Atoll, Tuamoutus	chl	?	‘costal plate’ (pleural)	‘scraper’	Sinoto 1978, 159, 160, Fig. 29
Reao Atoll, Tuamoutus	*Cm Ei* ?	1050–1900 AD ?	pleurals, plastron bones (*Ei*); coracoid; crania; long bones, coracoids (only 1050 AD)	‘shovels’ or ‘spades’; ‘scrapers’ in marae shrine, in shrine next to maraes; *Tridacna* openers not in maraes	Chazine 1982, 297–303, 322, 325; 332–336; 1990, Fig. 10; 2001; *in litt* 21 & 23 February, 18 April 2004; Nitta 1982, 417

α Abbreviations: ‘*Cc*’ = *Caretta caretta*, ‘*Cm*’ = *Chelonia mydas*, ‘chl’ = Cheloniidae, ‘*Ei*’ = *Eretmochelys imbricata*, ‘*Lk*’ = *Lepidochelys kempii*; ‘*Lo*’ = *Lepidochelys olivacea*.

β Although the term ‘shell’ was used, it seems that the element referred to was in fact a part (or fragment) of the bony carapace and/or plastron – which together form the shell of a turtle – ***not*** a piece of keratinous shell (see footnote 1).

γ The bone in question (Walker 1992, 239–241, Fig. 12) has a contorted, or ‘twisted’ appearance, but this does not imply that the bone itself was twisted, rather that the shaping of the bone has left it with that appearance.

δ R. Wheeler (*in litt*. 12 June 2003) does not believe that the perforations present in some of the bones were caused by cultural modification, for ‘they do not exhibit the typical form, wear patterns nor microscopic evidence of production using native tools like shark teeth and chert flake burins.’ Instead, he feels that some of the perforations were caused by marine invertebrates.

Table 2. *Preliminary summary of marine turtles bones found in association with human burials.*

Site	Taxon α	Estimated date	Bony element	Type of modification	Source
ARABIAN PENINSULA AND ASIA					
Ra's al-Hamra, Oman	*Cm*	3800–3300 BC	crania, carapace, shell **β**	associated with human burials	Potts 1990, 71; Salvatori 1996, 207–209; in press a; in press b
Khok Phanom Di, Thailand	turtle [large size]	2390–1225 BC	carapace, shell	hole in carapace, ornament, pendant	Higham & Bannanurag 1990, 39 ff.
Nil Kham Haeng, Thailand	Sea turtle, ['turtle'] ?	700 BC [various]	carapace [carapace]	over skull & thorax of burial [ornament, carved, bangle]	Higham & Thosarat 1998, 98, 118; V. Piggot pers. com. [55, 56, 62, 80, 81, 125]
AMERICAN (Caribbean, Yucatan, Florida, South America)					
Malmok site, Aruba	*Cm*	200 BC–1000 AD	carapace	human burials directly over or under turtle **γ**	Versteeg 1990, 14–18, 32
Cenote Xlach, Dzibilchaltun, Mexico	*Cm*	?	entire skull	found in cenote	Wing & Steadman 1980, 328
Tutu, St. Thomas, US Virgin Islands	*Cm*	300–700 AD	carapace & axial skeleton in 'hearth'	used as vessel?	Righter 2002, 42, 65–66, Figs.1.17c, 1.19, 1.27d
Golden Rock site, St. Eustatius	*Ei*	500 AD	entire skeleton (upside-down), cranium fragmented; cranium + vertebrae	'cache' 'cache'	Van der Klift 1992, 74–75, 79 Schinkel 1992, 171
Playa Vicente Mena, Chile	chl	600–1000 AD	2 carapaces	each covers a large funerary urn	Frazier & Bonavia 2000
Tanki Flip, Aruba	*Sea turtle*	1000–1250 AD		2 caches in pottery	Bartone & Versteeg 1997, 48, 49, 63, Fig. 94
Offshore Island, Sao Paulo, Brazil	chl	?	Bones	associated with human burial	B. Gallo Nieto *in litt.* 2003
Campotón, Campeche, Mexico	*Cm; Ei;* chl *Ei*	?	radius; entoplastron & marginals; ulna epiplastron	associated with cranium of burial 4; near body; near body, ulna has tooth marks; vertical behind cranium of burial 5	Götz 2004, 3–5

Site	Taxon α	Estimated date	Bony element	Type of modification	Source
PACIFIC					
Reao, Tuamoutus	*Cm* ?	1700 AD ?	various bones; crania	'turtle oven mixed with human bones'; 'crania in small shrine next to marae''; cranium, long bones, coracoids in marae shrine	Chazine *in litt* 23 February 2004

α Abbreviations as in Table 1.
β Abbreviations as in Table 1.
γ Versteeg (1990, 18) concludes that '[t]he combined data indicate that circa 10% of all Malmok burials have sea turtle carapaces above or under the buried dead.'

Note added in press; Additional sources of information on worked bones of marine turtles:

Brigham, W. T. 1899. Hawaiian Feather Work. – Memoirs of the Bernice Pauahi Bishop Museum, 1: 1 (reprinted 1974 Kraus Reprint Co.; Milwood, New York). {50, Fig. 43: *turtle bone scrapers used on Hawaii at the end of the 19th century for making fibers from bark*}.
Brigham, W. T. 1908. The ancient Hawaiian house. – Memoirs of the Bernice Pauahi Bishop Museum (reprinted 1974 Kraus Reprint Co.; Milwood, New York). {189: *turtle bone scrapers used on Hawaii to making fibers for cordage*}.
Chittick, N. 1984. Manda: Excavations at an Island Port on the Kenya Coast. British Insititute in Eastern Africa. Nairobi. {215: *turtle bones common at Manda (1000–1500 AD); one 'has a hole in it which appears to be a spear wound which has partially healed'*}.
Emory, K. P. 1947. Tuamotuan religious structures and ceremonies. – Bernice P. Bishop Museum Bulletin, 191. {24, Fig. 7f: *reserved status of marine turtle meat; bone awls for sewing pandanus-leaf thatch*}.
Tosi *in litt*. 26 May 2004 {*the largest piece of bitumen found at Ra's al-Jinz is a cast from the inside of a turtle carapace, indicating that the shell was used as a vessel to store bitumen amalgam for boat repairs at sea*}.

MUINASAJA TEADUS 15

From Hooves to Horns, from Mollusc to Mammoth

Manufacture and Use of Bone Artefacts from Prehistoric Times to the Present

Proceedings of the 4th Meeting
of the ICAZ Worked Bone Research Group
at Tallinn, 26th–31st of August 2003

Edited by
Heidi Luik, Alice M. Choyke, Colleen E. Batey and Lembi Lõugas

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