



FAUNA *of* AUSTRALIA



20. FAMILY DERMOCHELYIDAE

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Pl. 2.7. *Dermochelys coriacea* (Dermochelyidae): the leatherback turtle, shown stranded on the shore after capture in a fishing net, a form of mortality that is increasing; these turtles rarely breed in Australia. [H. Cogger]

DEFINITION AND GENERAL DESCRIPTION

The Dermochelyidae (leatherback turtles) is one of only two families surviving from the past diverse marine turtle faunas. It is represented by a single extant species, *Dermochelys coriacea* (Pritchard & Trebbau 1984). The family is characterised by large paddle-like flippers which lack claws, the absence of keratinised epidermal scutes except in hatchlings, separate ribs, a mosaic of small, polygonal dermal bones covering the body, a strongly ridged carapace, and pronounced tooth-like cusps on the upper jaw. These turtles can be readily identified from photographs and reliably distinguished on the basis of size, colour and the ridged carapace (Pls 3.7, 3.8). Their occurrence on nesting beaches can be recognised from the wide tracks, which may exceed two metres (Limpus & McLachlan 1979).

HISTORY OF DISCOVERY

Although a formal description of *D. coriacea* was first given by Vandelli in 1761 from a specimen collected in Italian waters, the species had been recorded pictorially at least as early as 1554 (Fretey & Bour 1980). Together with other marine turtles, the species was well known to early mariners. For example, Dampier described four marine turtle species in 1717, including the trunk-turtle (*D. coriacea*) which had rank flesh (Masefield 1906). In Australia, the species was known to Aborigines before European contact, and it was represented occasionally in Aboriginal art and rituals (McCarthy 1955). Backhouse described a specimen of *D. coriacea* from Moreton Bay, Queensland in 1843. The low level of breeding by this species in south-east Queensland was documented by Limpus & Grove (1974) and Limpus & McLachlan (1979) provided the first detailed review of the widespread feeding distribution and limited breeding of the species in Australia.

MORPHOLOGY AND PHYSIOLOGY

In general anatomy, *Dermochelys coriacea* resembles the cheloniid turtles. However the physiology and function of this species has received little study.

External Characteristics

Dermochelys coriacea is the largest living turtle (up to 916 kg; Morgan 1989) and the next largest living reptile after the large crocodylians. Adults are usually at least twice the size of other marine turtles (Hirth 1980). The elongate carapace tapers posteriorly and bears five longitudinal ridges formed by rows of enlarged dermal bones (Deraniyagala 1939; Pritchard 1971). The dorsal surface of adults is black, with small, light coloured spots (Pritchard & Trebbau 1984). The front flippers are the longest of any marine turtle (Pl. 3.7, 3.8). Other external features are compared with those of cheloniids in Chapter 19.

Body Wall and Skeletal System

The smooth skin lacks keratinised scutes and protuberances. A mosaic of small dermal bones overlies the carapace and plastron, and the deposits of subepithelial fat, 60 to 70 mm thick (Deraniyagala 1939; Brongersma 1969; Goff & Lien 1988). The general skeletal structure and cranial morphology has been described by Deraniyagala (1939), Gaffney (1979a) and Pritchard & Trebbau (1984). The carapace is largely cartilaginous and characterised by a reduction in bone compared with other turtles. Neural, costal or marginal bones

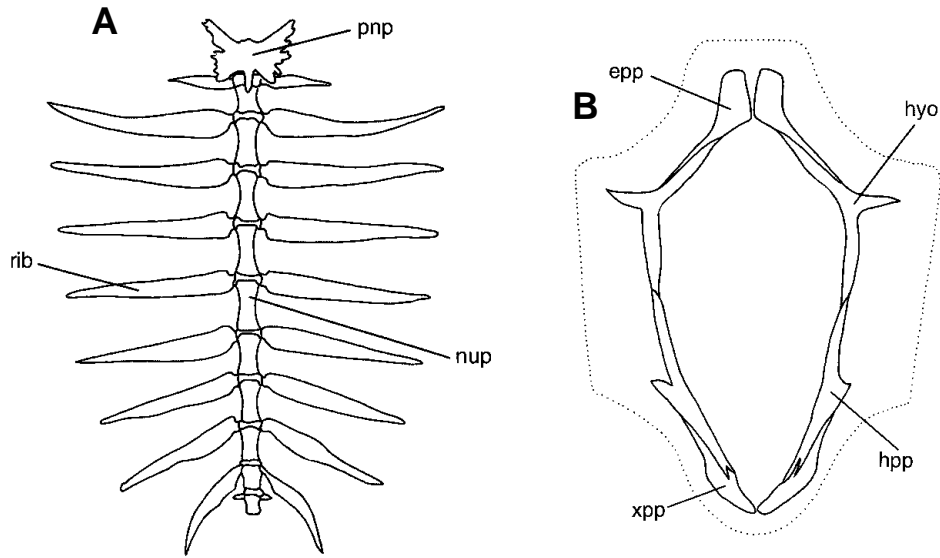


Figure 20.1 Skeleton of *Dermochelys coriacea*. **A**, carapace; **B**, plastron. **epp**, epiplastron; **hpp**, hypoplastron; **hyo**, hyoplastron; **nup**, neural plate; **pnp**, preneural plate; **rib**, rib; **xpp**, xiphoplastron. (After Pritchard & Trebbau 1984) [T. Wright]

are absent and the ribs are separated. The plastron lacks an entoplastron bone and the remaining four pairs of elongate bones which form a ring around the plastron provide little structural support.

The skeleton of *D. coriacea* remains extensively cartilaginous even in adults (Pritchard & Trebbau 1984). The epiphyses are vascularised perichondrally and transphyseally, and the medullary bone is not remodelled, features that are unique among extant reptiles (Rhodin, Ogden & Conlogue 1981; Fig. 20.2). These features may reflect adaptation to a marine diving lifestyle, because they occur also in cetaceans and sirenians, and to some extent in extinct marine reptiles such as ichthyosaurs and plesiosaurs (Rhodin *et al.* 1981).

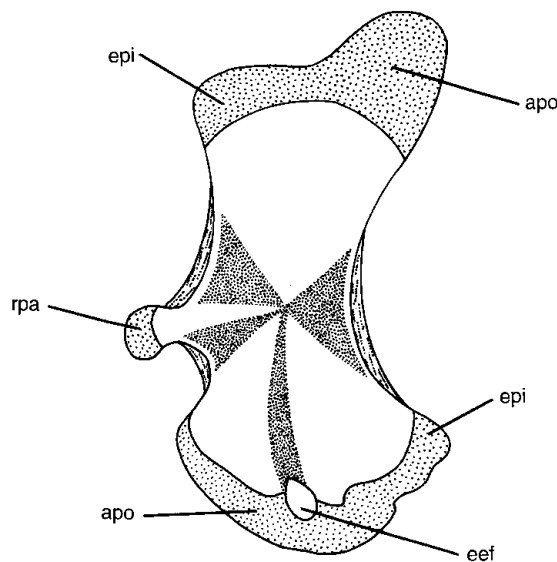


Figure 20.2 Longitudinal section of the humerus of *Dermochelys coriacea*, to show light-coloured endochondral bone and dark periosteal bone, the absence of a medullary cavity and poor differentiation of compact and cancellous bone. **apo**, apophysis; **eepi**, epiphysis; **eef**, ectepicondylar foramen; **rpa**, radial process apophysis. (After Rhodin, Ogden & Conlogue 1981) [D. Wahl]

Locomotion

These turtles are unable to support their bodies off the ground on land, and they haul themselves across beaches by pushing with all four flippers together. As adults, their terrestrial gait resembles that of the cheloniid turtles *Chelonia* and *Natator*. However, of all marine turtles, only hatchlings of *D. coriacea* move with this breast-stroking gait (Limpus & McLachlan 1979). The limited data suggest that *D. coriacea* swims at speeds (1.9 to 9.3 km hr⁻¹) comparable to those of other marine turtles and the great white shark, *Carcharodon carcharias* (Standora, Spotila, Keinath & Shoop 1984).

Feeding and Digestive System

The jaws of *D. coriacea* are comparatively light in weight and lack the thick bone and crushing plates of cheloniid turtles. The sharp edged jaws are deeply notched, and suited to grasping and cutting soft-bodied prey (Pritchard 1971). The backwardly directed, flexible papillae that line the throat and oesophagus of marine turtles are best developed in *D. coriacea* and prevent the prey from sliding back out of the anterior gut (Pritchard 1971).

Circulatory System and Body Temperature

The cardiovascular system resembles that of other chelonians. It consists of a three-chambered heart, an arterial system, and a venous system that includes a well-defined renal portal system (Jackson 1979 and references therein). However, *D. coriacea* has a circulatory feature unique among reptiles, in the form of a single, well-defined bundle of closely packed veins and arteries at the base of each flipper. This functions as a countercurrent heat exchange system to reduce heat loss via the flippers (Greer, Lazell & Wright 1973).

Body temperatures are often well above those of the seawater. The core body temperature of breeding female *D. coriacea* off tropical nesting beaches in the Caribbean of South America was 30.6°C, some 3° warmer than the ambient water temperature and 1° to 2° warmer than the core body temperature of sympatric, nesting female cheloniid turtles (Mrosovsky & Pritchard 1971). A captive study by Frair, Ackman & Mrosovsky (1972) suggests that *D. coriacea* can maintain a core body temperature up to 18°C above an ambient water temperature of 7.5°C. Standora *et al.* (1984) demonstrated that an inactive subadult could maintain an elevated deep body temperature relative to ambient air temperature in the absence of an external heat source. This would be facilitated by the insulating subepithelial fat deposits, the large body size and hence low surface area to volume ratio, and the countercurrent heat exchange system. However, an endogenous heat source would be necessary, possibly utilising thermogenic brown fat tissue (Eckert 1992). Endogenous heat could be supplemented by heat generated during muscular activity and from radiation absorbed through the dark dorsal surface when the turtle basks at the ocean surface (Standora *et al.* 1984; Eckert 1992). This combination of adaptations enables *D. coriacea* to function in the low water temperature it encounters during deep dives and migrations to low latitudes.

Sense Organs and Nervous System

Visual cues are important for hatchlings to find the ocean for the first time (Mrosovsky & Shettleworth 1975). *Dermochelys coriacea* may vocalise when injured (Carr 1952). The sounds made by nesting *D. coriacea* are variable and most intense in the 300 to 500 Hz frequency range, as in other turtles. However, sound production may be of minor functional significance (Mrosovsky 1972).

Reproduction

The female has paired ovaries and paired oviducts. Copulation, sperm storage and egg production within the female are poorly documented. Mature ovarian follicles are 36 to 39 mm in diameter. The eggs are spherical with flexible calcareous shells averaging 82 g and 53 mm in diameter. Testes are abdominal and a single grooved penis is erectile from within the cloaca.

Embryology and Development

Dermochelys coriacea lays cleidoic eggs that follow typical turtle embryological development (Deraniyagala 1939; Ackerman 1980; Mrosovsky 1984; Miller 1985). Oviposition occurs at stage six (early to middle gastrulation) approximately eight days after fertilisation and subsequent albumen and shell deposition in the oviducts. For successful incubation, eggs require a temperature range of 25° to 33°C and a high humidity, low salinity, well-ventilated nest substrate that is not subject to flooding. Nest temperature determines incubation period (69 days at 29°C) and the sex of the hatchling.

NATURAL HISTORY

Life History

The breeding cycle of *D. coriacea* in Australia is typical of populations breeding elsewhere (Deraniyagala 1939; Hirth 1980; Limpus, McLachlan & Miller 1984c; Tucker & Frazer 1991). Age at sexual maturity has not been determined, although Pritchard & Trebbau (1984) predict maturity is reached in less than three years. Females do not normally breed in successive years. The egg laying season spans December to January, and within a single breeding season the individual female may lay as many as four clutches of 83 eggs per clutch over 9 to 11 days. Nests are 0.9 m deep and dug in the frontal sand dune of the supratidal region. Male breeding cycles have not been recorded.

Dermochelys coriacea makes transoceanic migrations between nesting beaches and feeding areas, and it regularly migrates further than any other species of marine turtle (Pritchard 1976; Meylan 1982). The species is long-lived and breeds over many years. Adults are presumed to return to the region of their birth to breed. Hatchlings disperse to open oceanic waters from the beaches and the adults maintain a solitary, totally pelagic lifestyle, although they may aggregate in areas of abundant food and off nesting beaches (Bustard 1972).

Ecology

Dermochelys coriacea is primarily an inhabitant of open waters. It is the deepest diving reptile, and reaches depths in excess of 315 m (possibly in excess of 1000 m), on dives of up to 37 minutes, presumably in search of zooplanktonic food (Eckert, Eckert, Ponganis & Kooyman 1989). On average, dives last 9.9 minutes to a depth of 62 m. Within Australia, it is recorded most frequently in the southern temperate waters (Limpus & McLachlan 1979) and it is the most frequently recorded turtle in New Zealand waters (McCann 1966).

The diet of *D. coriacea* consists primarily of large zooplanktonic invertebrates such as jellyfish and tunicates (for example, *Pyrosoma* and salps) as well as associated commensal fish and amphipods, and the fish prey of the jellyfish (Brongersma 1969). Surface living and deep water siphonophores (Cnidaria: Hydrozoa) are also eaten (Bacon 1969; den Hartog 1980). In Australian waters, the rhizostome jellyfish, *Catostylus mosaicus*, forms part of the diet (Limpus &

McLachlan 1979; R. & V. Taylor pers. comm.). Though primarily a water column feeder, *D. coriacea* will also feed on the ocean floor of the continental shelf (Limpus 1984).

The species ventures into cold temperate waters more often than any other marine reptile (Bleakney 1965; Goff & Lien 1988). As a summer migrant to the temperate North Atlantic waters, *D. coriacea* is regularly recorded in water at 9° to 15°C and it can remain active among pack ice in approximately 0°C water (Goff & Lien 1988). Specimens are usually obtained following accidental capture in fishing gear, such as shark nets and float lines to lobster pots.

Behaviour

Nesting behaviour is typical of all marine turtles (Pritchard 1971); the nesting female returns faithfully to her particular nesting beach to lay successive clutches of eggs in the same breeding season, and in successive breeding seasons (Eckert, Eckert, Adams & Tucker 1989).

Dermochelys coriacea must lay its eggs on warm beaches in order to obtain the necessary temperatures for hatching, and to produce a viable mixture of both sexes (Mrosovsky 1984; Miller 1985). Nesting usually occurs on open sand beaches and rarely on beaches fronted by rocky or coral reefs (Pritchard 1971).

Economic Significance

In some countries, *D. coriacea* is killed for its meat, oil and/or eggs, while elsewhere a high proportion of eggs are harvested commercially. In Malaysia, the decline in numbers of nesting turtles resulting from past overharvesting of eggs is threatening a significant tourist industry based on viewing the nesting turtles (Mrosovsky 1983).

Mortality has increased because of gut blockage following ingestion of plastic bags presumably mistaken for jellyfish (Balazs 1985).

BIOGEOGRAPHY AND PHYLOGENY

Distribution

Dermochelys coriacea occurs in all oceans. It feeds mostly in temperate waters and breeds at traditional nesting sites in the tropics (Pritchard 1971). Within Australia, it is seen mostly from southern Queensland to Victoria and in south-west Western Australia. The few nesting turtles in south-east Queensland may be waifs from the larger nesting population in New Guinea (Limpus & McLachlan 1979).

Affinities and Fossil Record

The marine turtles have their origins in the late Jurassic to early Cretaceous and the surviving families, Cheloniidae and Dermochelyidae, probably diverged in the early Cretaceous (Gaffney 1991). The fossil record for dermochelyids is poor. Four extinct genera are recorded. *Cosmochelys* and *Eosphargis* are known from the Eocene of Nigeria, and early Eocene of Europe, respectively. *Psephophorus* occurred in the Eocene-Pliocene of Europe, North Africa and North America, and *Pseudosphargis* in the late Oligocene of Germany. *Dermochelys* is not known from the fossil record (Pritchard & Trebbau 1984).