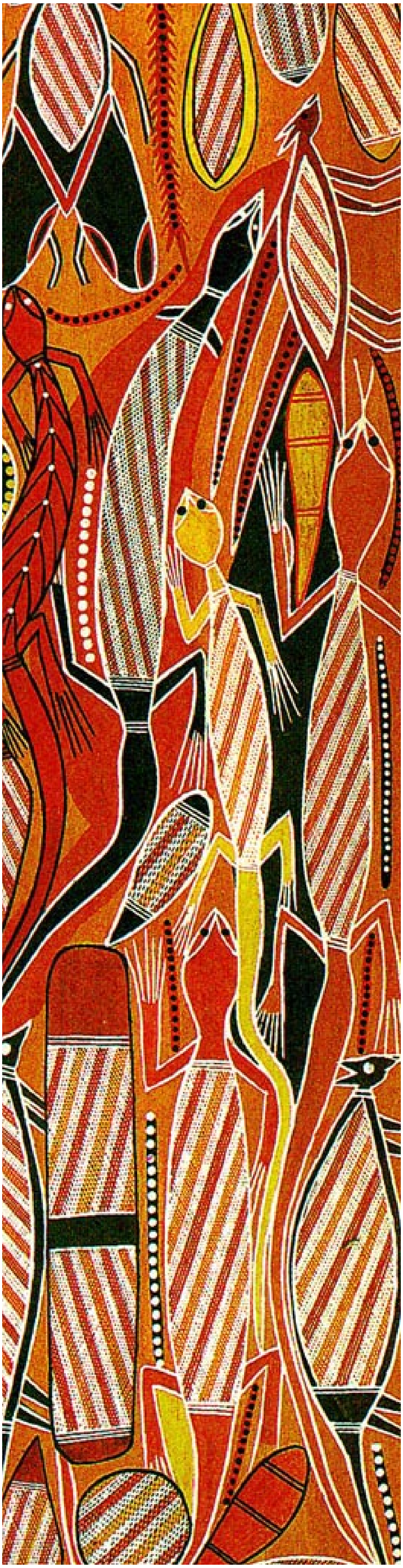

FAUNA *of* AUSTRALIA

49. PHYSETERIDAE

J.L. BANNISTER

DEFINITION AND GENERAL DESCRIPTION

The Physeteridae (sperm whales), one of the six families of toothed whales (Suborder Odontoceti, Order Cetacea), includes the largest and in some ways the most specialised animals of the suborder. Odontocetes differ from the other cetacean suborder, Mysticeti (the baleen whales, distinguished by their highly specialised filter-feeding apparatus), by the presence of teeth in both upper and lower jaws or the lower jaw only. Physeterids possess a characteristic spermaceti organ and functional teeth only in an underslung lower jaw.

HISTORY OF DISCOVERY

The family contains only two genera: *Kogia* Gray, and *Physeter* Linnaeus. Kogia includes two species, the Pygmy Sperm Whale (*K. breviceps*) (Blainville 1838) and the Dwarf Sperm Whale (*K. simus*) (Owen 1866). Physeter is monotypic, containing only the Sperm Whale (*Physeter macrocephalus*). Considerable controversy has occurred over the sperm whale's specific name. Recent authors, including Honacki, Kinman & Koeppl (1982) following Husson & Holthuis (1974), have favoured Physeter macrocephalus. Schevill (1986b), however, came down firmly on the side of *Physeter catodon*, the name by which the species was known for much of this century until 1974.

That there are two species of *Kogia* was confirmed by Handley (1966). Most previous authors had considered only a single genus and species, although up to seven specific names occur in the literature. Handley confirmed that there should be only *Kogia breviceps* and *K. simus,* based particularly on differences in dental formula, the relative length of the mandibular symphysis and other skull features; the Dwarf Sperm Whale is also a much smaller animal than the Pygmy Sperm Whale.

MORPHOLOGY AND PHYSIOLOGY

The Sperm Whale with its massive head, blunt snout, underslung jaw, no true dorsal fin, short flippers and very large triangular flukes (Fig. 49.1), is quite unmistakable. It is also the largest odontocete, males reaching at least 15 m and possibly more than 18 m in length, and females up to 12 m. A thickened patch of skin on the anterior part of the dorsal hump in adult females seems to be a secondary sexual character.

Among many peculiarities, the structure of the huge head, about a third of the body length of the adult male, is quite remarkable (Figs 49.2 & 49.3). The asymmetrical skull lacks the left nasal bone and rises behind into a massive crest, moulded into a basin holding the spermaceti organ. The single blowhole

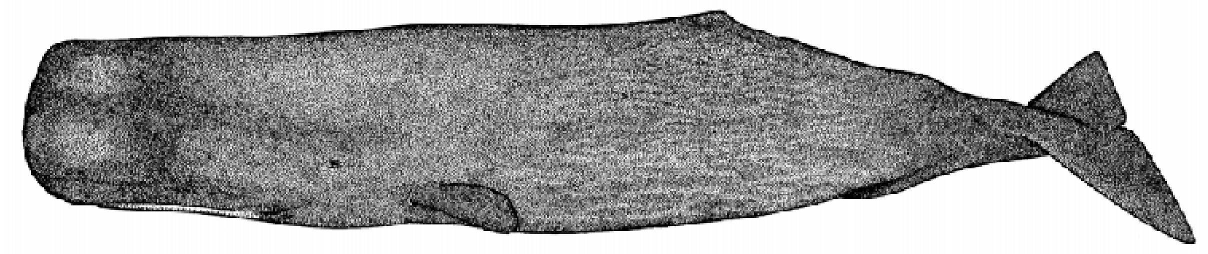

Figure 49.1 Side view of the Sperm Whale, *Physeter macrocephalus*. (© G.J.B. Ross) [G.J.B. Ross]

lies at the front of the head, on the left. Much of the head is occupied above by an oil reservoir containing clear oil (‘spermaceti’) and below by a mass of fibrous and elastic tissue containing oil. The function of the oil has long been a source of conjecture. It may well act hydrostatically, water drawn through the blowhole cooling the oil and changing its density to allow rapid diving to great depths, heating of the oil through a copious blood supply then assisting a rapid ascent (Clarke 1979). Dives of more than an hour and to depths of up to 2800 m are well documented.

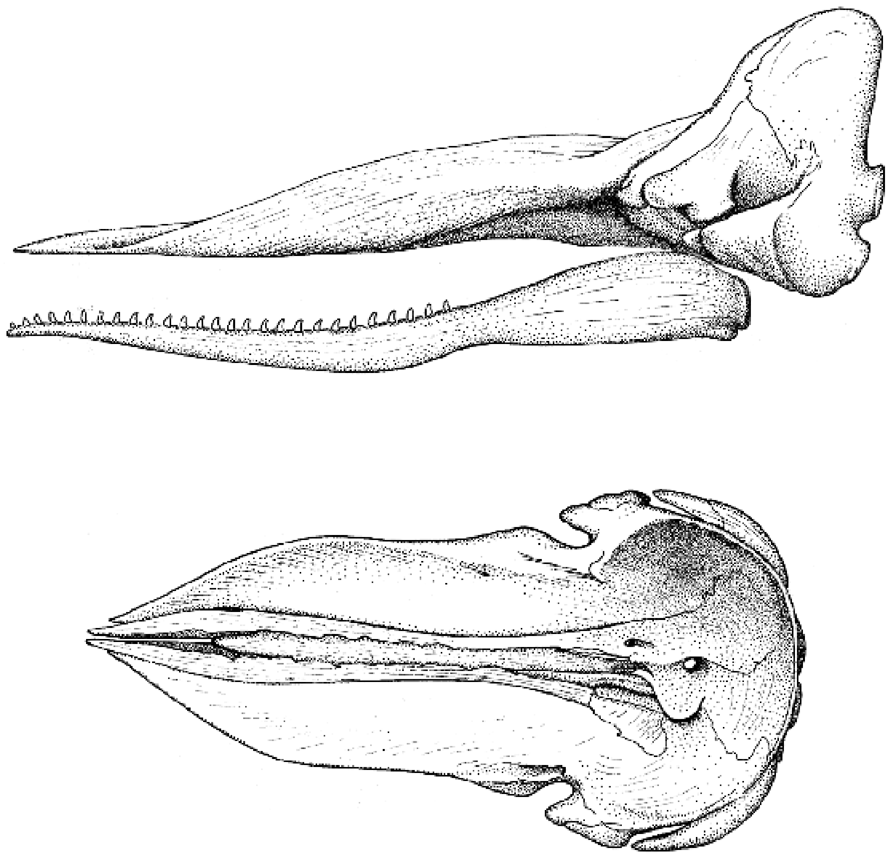

Figure 49.2 Lateral and dorsal views of the skull of the Sperm Whale, *Physeter macrocephalus*. (© ABRS) [M. Thompson]

Adaptations to permit deep diving, shared by sperm whales with other cetaceans, include a nasal plug in the blow hole that is closed except during respiration, elongated and highly elastic lungs, a strong and rather horizontally orientated diaphragm and the ability, aided by the diaphragm, to replace up to 80–90% of the air in the lungs at each breath. Compared with land mammals, cetaceans are generally able to transport oxygen more efficiently across the lung membranes, have blood with a capacity to carry a higher proportion of oxygen and have a greater tolerance for carbon dioxide. When diving, blood flow can be restricted to all areas, apart from the heart and brain. The risk of nitrogen narcosis or compression sickness is reduced by diving with less than a complete lungful of air. Very deep divers, such as adult male sperm whales, repay their oxygen debt after diving by respiring rapidly at the surface, about every 10 seconds for 10–11 minutes, ‘having their spoutings out’. The animal may then dive for an hour or more.

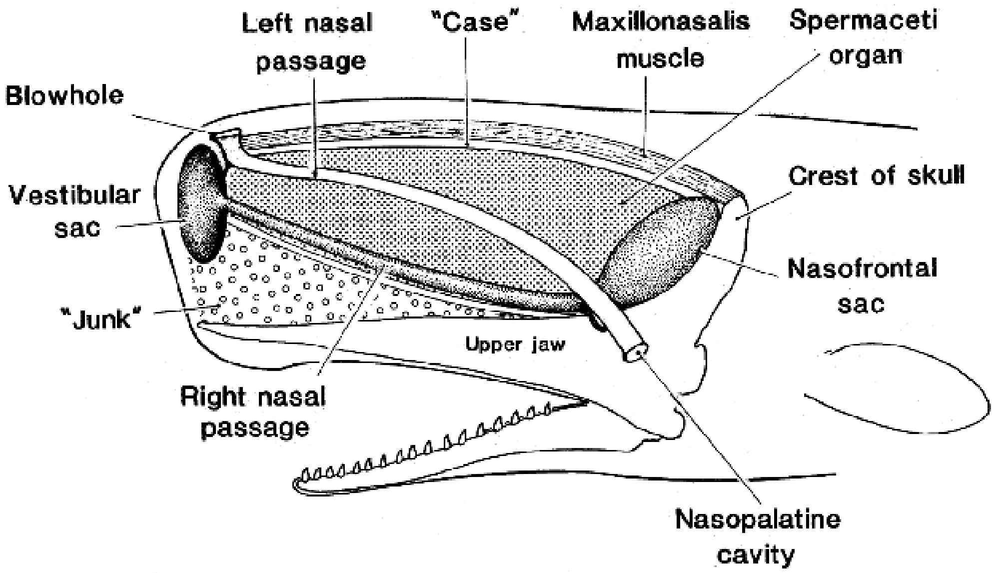

Figure 49.3 The anatomy of the head of the Sperm Whale, *Physeter macrocephalus*. (After Clarke 1979) (© ABRS) [M. Thompson]

Pygmy and Dwarf Sperm Whales, while possessing some of the distinguishing characters of Sperm Whales, are very much smaller than the latter (growing only to 3.5 m and 2.8 m, respectively), have a relatively much smaller head and a rather shark-like body, including a small though prominent dorsal fin. The shark-like appearance (Fig. 49.4) is enhanced by a gill-like crescent mark on the head just behind the eye. The single blowhole is in the normal cetacean position on top of the head, but slightly to the left of the midline.

The body colour of Sperm Whales is dark grey or blackish, frequently with a white splash ventrally and white skin around the lips. A distinct whorl of white marks on the head may enlarge in older males, together with other pale patches, to produce a much paler general colour, sometimes almost pure white, as the fictional 'Moby Dick'. *Kogia* species are dark blue-grey dorsally, fading to a lighter shade on the belly. The skin of Sperm Whales is often wrinkled longitudinally and is often heavily marked with circular squid sucker scars, particularly on and near the head.

NATURAL HISTORY

Life History

Because of the commercial importance of the Sperm Whale, considerable effort has been expended on attempts to estimate individual age, growth and mortality rates, gestation period, calving interval and the like. By contrast, very little is known of such matters in Pygmy and Dwarf Sperm Whales.

Based on apparent growth layers in the teeth, Sperm Whales seem able to live for more than 50 years. Sexual maturity in females is likely reached at about 10 years. While adult males may produce viable sperm from a similar age, they are probably prevented behaviourally from full reproductive participation until about 25 years old. Gestation lasts from 15–16 months, with a calf produced once every 3–5 years. The peak of conception in the Southern Hemisphere

occurs between October and December and of calving in February and March (Best, Canham & MacLeod 1984). Calculated values for adult mortality rates have been around 6%.

The Sperm Whale feeds mainly on oceanic squid, although in some parts of the world, for example, in the North Atlantic, the diet may contain a higher proportion of fish than elsewhere. Of the whales examined with food in the stomach in the Albany, Western Australia catch, 1.6% had been feeding on fish (Bannister 1968c). Where fish are found in small quantities they are often deep sea forms, angler fishes, for example. Studies of squid beaks retained in the stomach and collected during commercial whaling, have shown that females and small males feed on different components of the squid fauna from those sampled from large males. Retention of beaks from cold water species of squid in the stomachs of large males caught in warm latitudes has been taken to indicate movement of these animals from the Antarctic into warmer waters.

The considerable difference in size between adult males and females, together with observations of apparent nursery schools composed of adult females and younger animals of both sexes, of separate groups of ‘bachelor’ males and of large lone males in colder waters, has led to suggestions of a polygynous or harem breeding structure, where adult males control a group of females during the breeding season. Recent observations off the Galapagos Islands suggest that this may be erroneous; large breeding males probably accompany the female schools for only a few days at a time. Nevertheless, the major population unit seems to be the large nursery school, averaging some 20 to 30 animals. Occasionally, very much larger concentrations have been observed, some quite remarkable. One, in the Tasman Sea in February 1978, involved whales ‘spouting from horizon to horizon...’ observed over 7–8 hours in a stream some 70 miles wide (Paterson 1986). The significance of such a dramatic event is unknown and earlier explanations have included migrations towards feeding or breeding grounds or disruption from whaling operations.

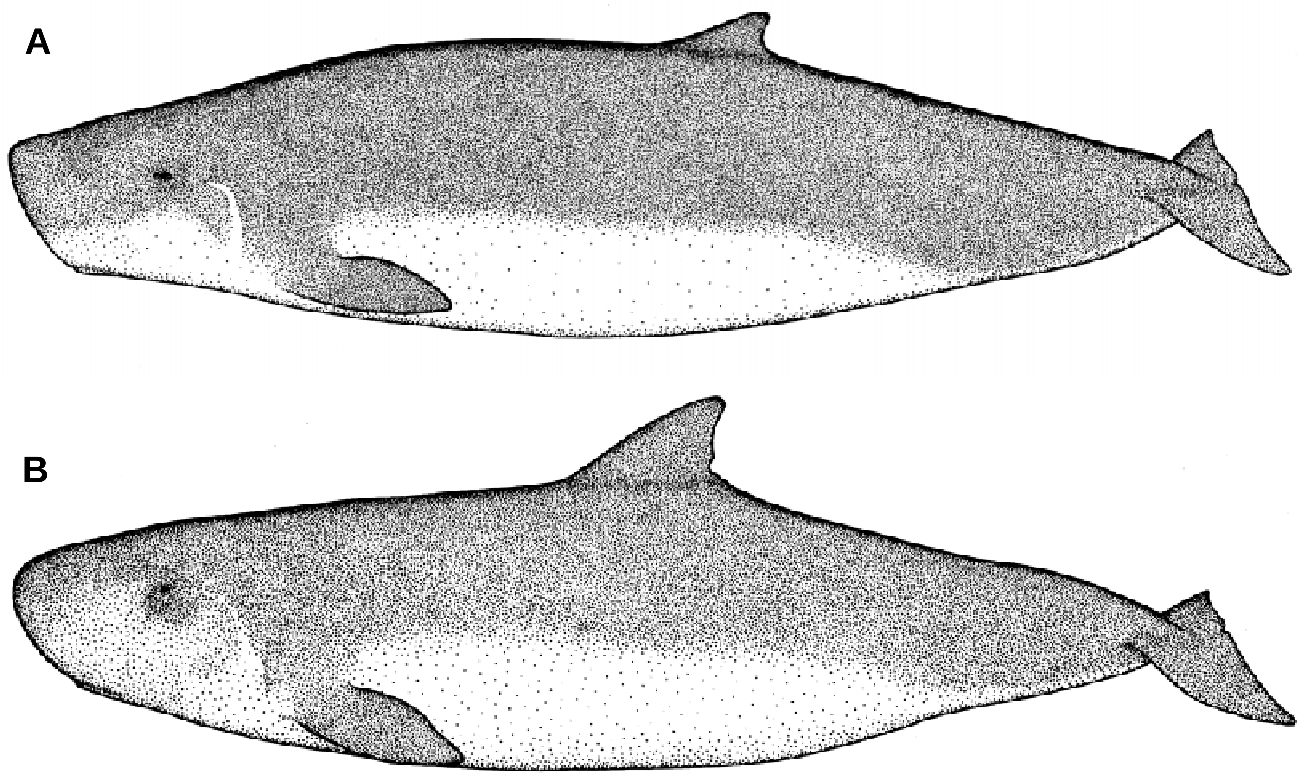

Figure 49.4 Side views of: **A**, Pygmy Sperm Whale, *Kogia breviceps*. **B**, Dwarf Sperm Whale, *Kogia Simus*. (© G.J.B. Ross) [G.J.B. Ross]

Records of Pygmy Sperm Whale foetuses and calves suggest a summer breeding season in New Zealand, perhaps later in Australia, where foetuses have been recorded in April and juveniles from April to September (Baker 1983).

Behaviour

Sperm Whales vocalise underwater, producing sounds probably both for echolocation and communication. The spermaceti organ has been implicated as a directional focus for such sounds. It has even been suggested that the distance between successive sounds is proportional to the size of the organ and, hence, to the length of the whale.

In common with other oceanic odontocetes that associate together in large groups, mass strandings of Pygmy Sperm Whales occasionally occur. More than 30 animals, mostly females and subadults, came ashore at Cheynes Beach, Western Australia in October, 1969. Twenty-six animals were stranded at Macquarie Harbour, Tasmania in January 1981. Of the former, one was towed out to deeper water alive; of the latter, seven were assisted out to sea by onlookers. Whatever the initial cause, it seems that once one individual of such a herd comes ashore the rest will come ashore successively, perhaps in an attempt to come to its aid, until all are stranded together. Without human assistance, the individuals cannot survive. For a successful rescue to occur, it seems that there should be no live animals left on the beach, or that those to be rescued must be removed a considerable distance from their companions.

Economic Significance

The Sperm Whale is renowned as the source of ambergris, a highly distinctive aromatic substance formed in the intestine around a nucleus of squid beaks. Once very highly prized, found floating on the ocean or drifted ashore, it was still used recently as a fixative for other perfumes. It was a valuable by-product in the Albany industry.

Sperm Whales have been economically important since at least the 18th Century; American whalers first operated off New England in about 1712. Gradually, the industry spread across the North Atlantic, past the equator and into the Pacific and Indian Oceans. The main product was the oil that was used in lighting. Reduction of stocks and the discovery of mineral oil led to a decrease in hunting after the mid-19th Century. There was a continuing small demand for the product in the first half of this century, but catches increased after that with more than 30 000 animals being taken worldwide in 1963. By then, the product was important as a source of high quality lubricant, as a base for cosmetics and for tanning high grade leather. The teeth, of low grade ivory, have long been the basis of ‘scrimshaw’ - carving or engraving by whalers at sea or more recently in cottage industries ashore. The major fishery ceased in 1979 after catches had fallen off under increasing controls.

Off Australia, sperm whales were fished heavily by ‘open boat’ whalers in the early part of last century. Sydney and Hobart featured prominently as centres of the industry, both for export of oil, as ports of call for foreign vessels and the base of an indigenous industry. This century there was an industry based on Albany, Western Australia, with small catches taken from 1912 to 1915 and mainly bigger catches from 1955 to 1978. In the latter phase there was pelagic whaling, both in and north of the Antarctic, on animals from the same stock as those caught off Albany. For management purposes, based mainly on 19th Century catch data, nine Southern Hemisphere stock units have been recognised, of which one, Division 5, extends from 90°E to 130°E (from about a third of the way out into the Indian Ocean to the middle of the Great Australian Bight). Catch quotas were first introduced in 1971 and assessments were

attempted by sex and area using biological, catch and aircraft-spotter data from the Albany operation. Calculations of population size, based on abundance indices derived from the aircraft spotter records, showed that by 1978 males had fallen to 26% of their number in 1947 while females had been reduced to 91% (Kirkwood, Allen & Banister 1980). Under the regulations then in force through the International Whaling Commission, whaling should have ceased on the males, although it could have continued on the females. The pregnancy rate, obtained from Albany catch data, seemed to have been falling since the mid-1960s, presumably because of the considerable reduction in males. The populations of each sex would probably have continued to decline for some years. The 1978 Australian Inquiry into Whales and Whaling took this and other factors into account in its deliberations (Frost 1978). Australia adopted a non-whaling policy in 1979; pelagic capture of sperm whales also ceased by international agreement. Australia has played a major role in the Whaling Commission's deliberations, both in the Commission itself and its advisory Scientific Committee. Since 1976 Australia has provided one Chairman for the Commission and three for the Scientific Committee.

BIOGEOGRAPHY AND PHYLOGENY

Distribution

Sperm Whales are cosmopolitan and oceanic, particularly favouring deep water at the edges of continental shelves, off steep to oceanic islands and near deep-sea trenches. In autumn, both sexes move towards the equator and in spring towards the poles. Females and subadult young are restricted to warmer waters north of about 45°S in the Southern Hemisphere. 'Bachelor' males, in small groups, may be common in temperate and somewhat colder zones, but only the older more solitary males seem to penetrate far into much colder, for example, Antarctic, waters. The return of single adults and the bachelor males to warmer waters has been indicated both from squid beaks retained in the stomach (see above) and from films of Antarctic diatoms on the skin, recorded, for example, on whales caught off Albany, Western Australia.

Kogia species seem to be restricted to warmer waters and has been reported, mainly from stranded specimens, particularly from South Africa, Australia, New Zealand and the eastern seaboard of the United States of America. There is some evidence that Pygmy Sperm Whales may be more oceanic than Dwarf Sperm Whales. The latter feed mainly on squid, and the former have been recorded as feeding on squid, shrimps, crabs and fish. Earlier records of Pygmy Sperm Whales almost certainly included some Dwarf Sperm Whales; the latter has been recorded recently from South and Western Australia.

Phylogeny and Fossil Record

Like the mysticetes, living odontocetes seem to have arisen from primitive extinct toothed whales (Archaeoceti), first found in the Early Eocene. Very few archaeocetes have been described from Australia (Fordyce 1982a). Early odontocetes inhabited Australian waters during the Late Oligocene. The earliest physeterids are found in Argentinian Early Miocene deposits and no one has proposed a specific cetacean group from which they may have evolved (Barnes, Domning & Ray 1985). The latter authors assign Pygmy Sperm Whales to a separate family, the Kogiidae, and record only one fossil species, from Mexico. Four Australian physeterids have been described from the Miocene and Pliocene of Victoria and Tasmania, but all are represented only by isolated teeth; their relationships are uncertain and Fordyce (1984) believed their names could be nomina dubia.

KEY TO AUSTRALIAN PHYSETERID SPECIES

1 Whales with baleen plates present in the mouth; blowhole double . . . . Mysticetes

2 Whales with teeth present, sometimes rudimentary or absent, but no baleen; blowhole single . . . . Odontocetes 3

3 Odontocetes with functional teeth only in the lower jaw, and then more than 6 in each row. Blowhole on left hand side at front of head, or on top of head but slightly to the left of midline . . . . *Physeteridae* 4, 5

4 Adult head very large, box-like; blowhole at front left of head; dorsal fin a hump; total length 4 to 20 m; more than 18 teeth in each row . . . . *Physeter macrocephalus*

5 Animal shark-like; well-defined dorsal fin present; total length less than 4 m; 7 to 16 teeth in each row . . . . *Kogia* 6, 7

6 7 to 13 teeth in each row; dorsal fin more than 200 mm high and dolphin-like; body length less than 2.7 m . . . . *K. simus*

7 12 to 16 teeth in each row; dorsal fin small and low, less than 200 mm high; adult body length up to 3.4 m . . . . *K. breviceps*

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