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Front cover photo:

Balaenoptera musculus stranded at Tirur beach on 18-10-1986 (total length 13 m)

Back cover photo:

A live *Sousa chinensis* caught in the gill net operated off Calicut

THE MARINE MAMMALS OF INDIA

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Introduction

The marine mammals are one of the important biotic constituents of marine environment. Hershkovitz (1966) has reported 87 species of cetaceans from all the world oceans. The marine mammals of India are comprised of whales, dolphins and dugongs. They are represented by 21 species. Our information regarding the cetaceans are restricted mainly to the strandings and occasional observations on their behaviour. As the Indian Ocean is declared as a sanctuary for the whales, the study of whales and dolphins, some of which are declared as endangered species, has attracted international attention. Many countries have intensified their research on the whales and dolphins of the Indian Ocean. The study of the sirenians (dugongs) has also received international importance due to their endangered status.

Larger cetaceans also require special attention as some of the species like the sperm whale *Physeter macrocephalus* frequent the Indian and Sri Lankan coasts on its migration towards the southern part of the Indian Ocean for breeding. Alling *et al.* (1982) basing their centre of observation in Colombo, Sri Lanka, have carried out extensive research on the species. James and Soundararajan (1982, 1984) studied the osteology of the sperm whale and summarised the stranding of whales along the Indian coasts. However, there are vital areas on the biology of the whales which require immediate attention.

Though there is no fishery for the dolphins and whales along the Indian coasts, the smaller cetaceans like dolphins and porpoises are caught in large numbers in the gill nets. Recently, Mohan (1985a) has pointed out that about 30-40 dolphins are caught along the Calicut coast annually by the gill nets though there is no definite statistics available. Cochin, Calicut, Malpe, Karwar, Goa and Bombay are some of the centres where dolphins are caught in good numbers.

The same species occurring along the Indian coasts has been referred to by various authors by different names due to the lack of any osteological studies on the species. Mohan (1985b) has studied the comparative osteology of the dolphins and came to the conclusion that the commonly occurring dolphins of the Indian coasts are *Stenella longirostris* Gray, *Tursiops truncatus aduncus* Ehrenberg, *Delphinus delphis* Linnaeus and *Sousa chinensis* (Osbeck).

The position of the dugongs along the Indian coasts is alarming as indicated by the recent reports (Silas and Fernando, 1985). Though dugongs have been declared as an endangered species they are caught in Gulf of Mannar and Palk Bay. The efforts taken by the Tamil Nadu State Fisheries Department to stop their capture have not succeeded so far. No detailed scientific investigation has been carried out on the species regarding the population dynamics, reproduction and other vital biological parameters. Our information on the species is mainly on its seasonal occurrences (Mohan, 1980), food and feeding habits, behaviour in captivity and osteological features (Jones, 1967; Nair *et al.*, 1975; James, 1979). It may be stated that the population dynamics of the dugongs found along the coast of northern Australia and Madagascar coasts has been investigated in detail (Ligon, 1976; Anderson, 1980). It is essential that such studies are undertaken so as to evolve meaningful conservation measures to safeguard the species from extinction.

CLASSIFICATION OF CETACEANS

Order	:	Cetacea
Sub-order	:	Mysticeti (Baleen whales)
Family	:	Balaenopteridae
		<i>Balaenoptera musculus</i> Linnaeus
		<i>Balaenoptera acutorostrata</i> (Lacepede)
		<i>Balaenoptera physalus</i> Linnaeus
		<i>Balaenoptera borealis</i> Lesson
		<i>Megaptera novaeangliae</i> Borowski

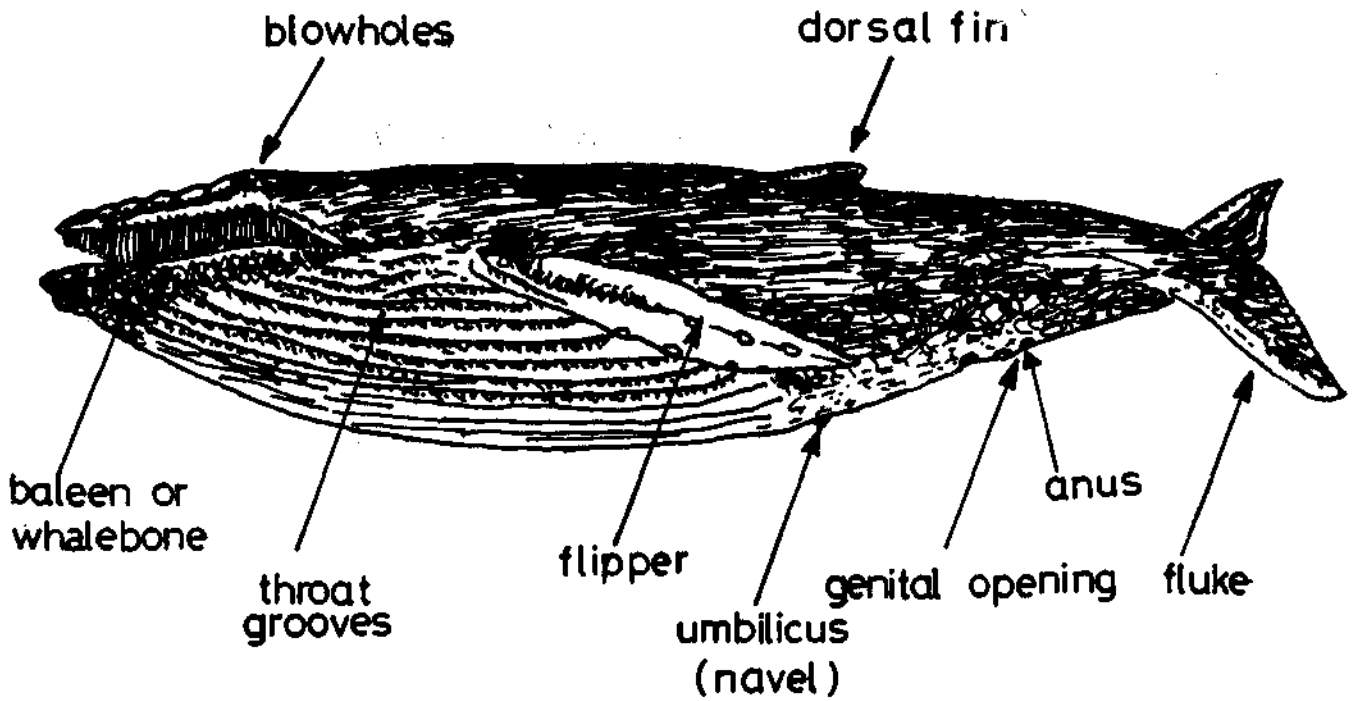


Fig. 1. Diagnostic characters of a whale.

- | | |
|-----------|--|
| Family | : Balaenidae |
| | <i>Eubalaena glacialis</i> Muller |
| Sub-order | : Odontoceti (Toothed whale) |
| Family | : Physeteridae |
| | <i>Physeter macrocephalus</i> |
| | Linnaeus |
| | <i>Kogia breviceps</i> Blainville |
| Family | : Hyperodontidae |
| | <i>Ziphius cavirostris</i> G. Cuvier |
| Family | : Delphinidae (Dolphins and Porpoises) |
| | <i>Neophocaena phocaenoides</i> |
| | G. Cuvier |
| | <i>Orcinus orca</i> Linnaeus |
| | <i>Grampus griseus</i> G. Cuvier |
| | <i>Pseudorca crassidens</i> Owen |
| | <i>Orcella brevirostris</i> Gray |
| | <i>Globicephalus macrorhynchus</i> |
| | Gray |
| | <i>Tursiops truncatus aduncus</i> |
| | Ehrenberg |
| | <i>Sousa chinensis</i> Osbeck |
| | <i>Stenella longirostris</i> (Gray) |
| | <i>Delphinus delphis</i> Linnaeus |
| Family | : Susuidae |
| | <i>Platanista gangetica</i> (Ruxburgh) |
| Order | : Sirenia |
| Family | : Dugongidae (Dugongs) |
| | <i>Dugong dugon</i> (Muller) |

Brief descriptions of the commonly occurring marine mammals along the Indian coasts with their salient features are presented below to facilitate field identification. Please refer to Fig. 1 for diagnostic characters of a whale.

1. *Balaenoptera musculus* Linnaeus (Blue whale)
(Fig. 2 & front cover photo)

Throat grooves 80-100, extending to umbilicus; baleen plates jet black; flippers whitish below and grey above.



Fig. 2. *Balaenoptera musculus* Linnaeus (Blue whale).

Feeds on euphausiids and shrimps. Breeding season from February to March, gestation period 9 to 10 months. Reaches a maximum length of 26 m.

Distributed in Arctic, Antarctic, Pacific and Indian oceans, but found in more numbers north of 35° N; recorded along the coasts of India by its strandings (along the coasts of Bengal, Gujarat, South Kanara and Tamil Nadu).

2. *Balaenoptera acutorostrata* Lacepede (Minke whale) (Fig. 3)

Dorsal fin small, markedly falcate, curved backwards; usually greyish black above and whitish below; flipper with a prominent white band; baleen plate white with a black streaking.



Fig. 3. *Balaenoptera acutorostrata* Lacepede (Minke whale).

Feeds on copepods, krill (*Euphausia superba*) and other zooplankton like *Calanus tonsus* and the anchovies like *Engraulis mordax*. Present estimate of this species about 3 lakhs (Ohsumi and Masaki, 1974).

Calving interval slightly more than a year; length at birth 2.8 m; gestation period about 10 months; pairing season extends from December to May in North Atlantic, January to June in North Pacific and spreads over a very long period in southern hemisphere; lactation period about 6 months; grows to 9 m in length.

Distributed in North Atlantic, Arctic and Indian oceans; in India recorded from strandings at Tuticorin (Gulf of Mannar).

3. *Balaenoptera physalus* Linnaeus (Fin whale) (Fig. 4)

Throat grooves 50 to 90, extending to umbilicus; body greyish black above and white below; flipper uniformly grey dorsally, white ventrally; dorsal fin small, falcate.



Fig. 4. *Balaenoptera physalus* Linnaeus (Fin whale).

Feeds on krill and anchovies. Length at birth about 7 m; sexually matures at 3rd year at about 20 m; pairing season extends to seven to eight months, peak season May to August; period of gestation about a year; reproductively active upto 20 years and sexually at its peak at 10 years; occurs in schools of 200 to 300 in numbers; grows to 24 m in length.

A highly hunted whale especially in northern Pacific and Antarctica. Once abundant in Nova Scotia and around New Foundland and Labrador.

Distributed in Atlantic, Pacific and Indian oceans from Equatorial waters towards northern and southern hemispheres. In India reported by its strandings from Bombay and Surat (James, 1983).

4. *Balaenoptera borealis* Lesson (Sei whale) (Fig. 5)

Throat grooves 32-60, distinct and terminating about half way between tip of flippers and umbilicus; baleen plates black but a few partly white; body grey to bluish grey above; dorsal fin deeply concave on the posterior margin; flippers usually small and measures about 1/4 of the total length; grows to 19 m in length.

Feeds on sardines, euphausiids and copepods. Breeds in early spring but mating is performed all through the year; gestation period for 10-11 months.



Fig. 5. *Balaenoptera borealis* Lesson (Sei whale).

Distributed in all the oceans of the world; most abundantly found in Norwegian coast. Population off South Africa depleted due to increased fishing. The skeleton of a specimen measuring 13 m, stranded at Dhanushkodi Island in 1983 was collected by R. S. Lal Mohan and kept in Regional Research Centre of CMFRI, Mandapam Camp; reported from Palk Bay also.

5. *Megaptera novaeangliae* Borowski (Humpback whale) (Fig. 6)

Throat grooves 19 to 20, extending from chin to navel; body stockier than the other whales; flipper long and black dorsally and white ventrally and measures 1/4 to 1/3 of the total length; irregular knobs and protuberances on head and flippers; dorsal fin small; whale bone grey-black or white; grows to 16 m in length.

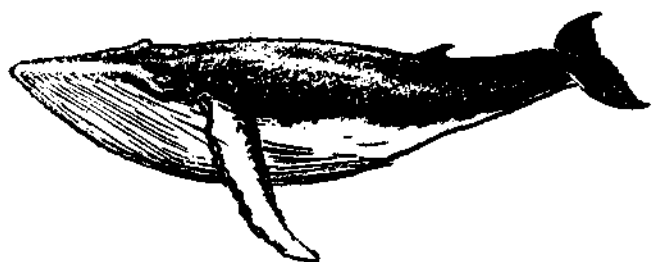


Fig. 6. *Megaptera novaeangliae* Borowski (Humpback whale).

Feeds mainly on krill and fishes. Calving and pairing takes place in winter; migrates to warmer waters for breeding. Length at birth about 5 m. Depleted in all the oceans and particularly vulnerable due to slow swimming behaviour. A widely distributed species occurring in all oceans; often seen along coastal waters; recorded from Kerala coast.

6. *Eubalaena glacialis* Muller (Black right whale)
(Fig. 7)

The baleen plates much longer than in other species; upper jaw with a few horny protuberances; throat grooves and dorsal fin absent; grows to 16 m in length.

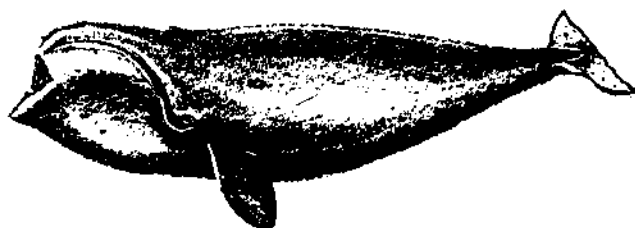


Fig. 7. *Eubalaena glacialis* Muller (Black right whale).

A much hunted species, population depleted in many areas; abundant before 150 years in southern hemisphere but later ruthlessly exploited in South Atlantic and Pacific seas. During 1846 to 1851, 300-400 whaling ships engaged in pursuit of these whales. A protected species according to International Whaling Commission.

Distributed in Atlantic, Pacific and Indian oceans.

7. *Physeter macrocephalus* Linnaeus (Sperm whale)
(Fig. 8)

Resembles a gigantic tadpole with head forming massive conspicuous part of body; lower jaw weak and disproportionately small with 18-28 large and powerful teeth on each side. No teeth on upper jaw; dorsal fin absent and replaced by a series of low ridges. Flippers broad and rounded. Body black dorsally and silvery grey ventrally. Grows to 21 m in length.



Fig. 8. *Physeter macrocephalus* Linnaeus (Sperm whale).

Feeds on squids and fishes. Period of gestation about 10 to 12 months; length at birth about 4 m. A much hunted whale. There are about 2,000 sperm whales in North Atlantic. In North Pacific its population is 50% above the maximum sustainable yield.

Widely distributed throughout great oceans though prefers warm waters of tropical and sub tropical regions. Reported from Madras, Pamban, Manauli Island, Krusadi Island, Mangalore and Karwar coasts.

8. *Kogia breviceps* Blainville (Pygmy sperm whale)
(Fig. 9)

Body black above and greyish white below; dorsal fin small and falcate; flippers smoothly curved on forward margin and located well anteriorly; body extremely robust and rapidly tapering near the tail; head more or less square in shape; lower jaw narrow and inferior in position, located well behind tip of snout; grows to 3.5 m in length.

Feeds mostly on cephalopods and fishes. Occurs in small schools of three to six individuals. Hunted with hand harpoons along Japanese coast at the rate of three to six every year.

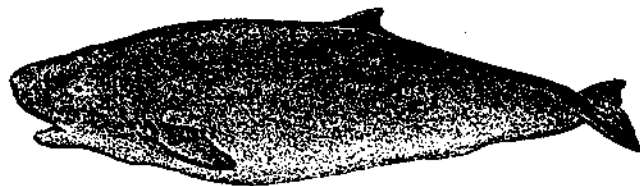


Fig. 9. *Kogia breviceps* Blainville (Pygmy sperm whale).

Found in Atlantic, Pacific and Indian oceans; in temperate and tropical waters. Not a common species along the Indian coast. A pregnant *Kogia breviceps* of length 3 m reported from India (Waltair coast).

9. *Ziphius cavirostris* G. Cuvier (Cuvier's beaked whale)
(Fig. 10)

Beak short; body purplish black above, brown on sides and white below; dorsal surface of head behind beak slopes backwards at an oblique angle from snout; distance from tip of snout to blowhole about 1/10 of total length; teeth not usually visible in females; often 20-30 teeth found in very young animals; characterised by a single pair of teeth on jaw in adult males; grows to a length of 7 m.

Feeds mainly on squids and deep sea fishes. Size at sexual maturity of male about 5.4 m and that of female about 6.1 m; length at birth 2 to 3 m.

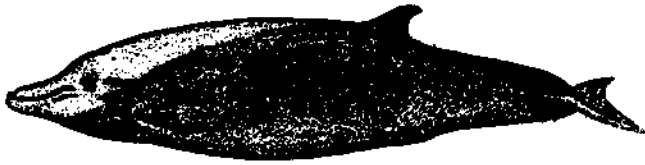


Fig. 10. *Ziphius cavirostris* G. Cuvier (Cuvier's beaked whale).

Primarily an oceanic form found in groups of three to five animals; taken in small numbers along the Japanese coast. According to Nishwaki (1972) annual catch of the species from 1965 to 1970 ranges from 13 to 16. No information is available on its stock position. A widely distributed cetacean; reported from coasts of Europe, America, Africa, Australia and Japan; known from Lakshadweep islands.

10. *Neophocaena phocaenoides* G. Cuvier (Black porpoise) (Fig. 11)

Forehead rounded and almost protuberant in profile; dorsal fin absent; minute tubercles or horny scales present dorsally; body black except for dark grey patches between flippers; teeth conically spade-shaped unlike conically pointed teeth of dolphins; 15-19 teeth on each side of upper and lower jaws. Grows to a length of 1.8m.

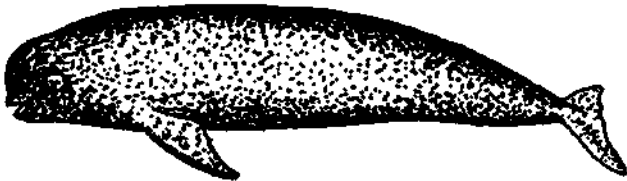


Fig. 11. *Neophocaena phocaenoides* G. Cuvier (Black porpoise).

Feeds on small squids, shrimps and fishes. Males somewhat larger than females. The young born around October. Indo-Pakistan sub-species are known as *Neophocaena phocaena phocaenoides* and Sino-Japanese sub-species is known as *Neophocaena phocaena asiae-orientalis*. Found in small groups of 40 to 50; subdivided into 5-10 animals. Accidentally caught in the gill nets along the Indian coasts.

Distributed from Cape of Good Hope to Japan. In China ascends to Yangtsee River to nearly 1,400 km from sea. It is abundant along the coast of Bombay and tends to frequent rivers and estuaries. In India reported from all along the coasts.

11. *Orcinus orca* Linnaeus (Killer whale) (Fig. 12)

Body stream lined; flippers rounded; dorsal fin conspicuous, situated almost midway; flipper length about 1/9 of the body length in young animals and 1/5 in old animals; colour well marked and distinctive; dorsal surface black, belly white; an oval white patch on sides of head just above and behind eye; chin white, lateral white patch a very constant feature; 10 to 12 large powerful conically pointed teeth on each side of upper and lower jaws; attains 9 m in length.

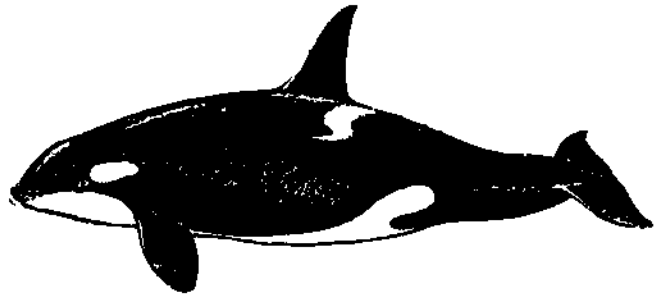


Fig. 12. *Orcinus orca* Linnaeus (Killer whale).

Feeds on fishes, cephalopods, birds, larger marine mammals and turtles. Gestation period about 12 months; female sexually matures at about 5 m length; male matures at 6.7 m. The length at birth about 2.5 metres; fully grown male about double the size of the female; killer whales travel in groups; exhibit a high degree of group hunting co-operation particularly in feeding on large marine mammals. Easily trained in captivity and shown in oceanaria. Distributed in all seas from Arctic to Antarctic; more common in cooler waters. In India recorded from Okhamandal in Gujarat coast.

12. *Grampus griseus* G. Cuvier (Risso's dolphin) (Fig. 13)

Body robust, head bulbous, flipper long pointed. Body light grey to dark, scarred with numerous scratches; not beaked; forehead vertically creased in centre; dorsal fin less than 38 cm, erect and distinct; fluke deeply notched. Teeth three to seven pairs on lower jaw only.

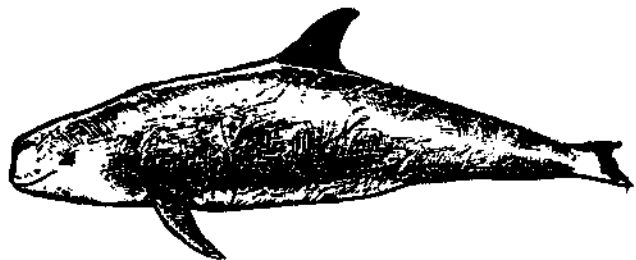


Fig. 13. *Grampus griseus* G. Cuvier (Rissos dolphin).

Feeds on fishes and squids. Longevity about 24 years. Males attain sexual maturity at 3 m length. Maintained in captivity.

Large schools have been seen in Newfoundland; form a small-scale fishery in Newfoundland, Antilles, Japan and Indonesia. An oceanic species distributed in North Atlantic, Mediterranean, Coast of Newfoundland and Cape of Good Hope. Reported from the coast of Sri Lanka.

13. *Pseudorca crassidens* Owen (False killer whale) (Figs. 14, 30)

The body elongate and slender. Head narrow, gently tapering from blowhole forward. Snout projects a little beyond the tip of lower jaw; dorsal fin small, tip directed backwards, with posterior border concave. Flippers tapering, characterised by a broad hump in the front margin near the middle, about 1/10 of the body length. Body entirely black, teeth large, pointed with 8 to 11 pairs in upper and lower jaws. Attains a length of 5.5 m.



Fig. 14. *Pseudorca crassidens* Owen (False killer whale).

Feeds mainly on fishes and cephalopods. Attains maturity at 4.25–4.5 m; breeding season fairly extensive. Not hunted but about 30 to 50 taken annually in tuna long line fisheries in the Pacific.

Distributed in Atlantic, Pacific and Indian oceans. In India recorded from Cape Comorin, Tiruchendur, Madras, Trivandrum, Pozhikara (Kanyakumari District) and Calicut.

14. *Orcella brevirostris* Gray (Irrawaddy dolphin) (Fig. 15)

Head convex from blowhole to upper tip; mouth horizontal. Flippers long, broadly triangular, two times its breadth; centre of dorsal fin behind middle of body. Dorsal fin small, falcate with rounded ends. 12 to 19 teeth on each side of upper and lower jaws; small and sharply conical in young animals; flat in older animals. Attains a length of 2.4 m.

Feeds on fishes and crustaceans. The length at birth about 0.8 m. No information on the statistics of the stock or the possible future exploitation; kept in captivity successfully.



Fig. 15. *Orcella brevirostris* Gray (Irrawaddy dolphin).

Distributed from Bay of Bengal to North Australia and coast of Indo-China; enters large rivers and can live permanently in fresh water; found to ascend nearly 900 miles up in the Irrawaddy river. In India reported from Waltair coast (Norman and Fraser, 1937).

15. *Globicephalus macrorhynchus* Gray (Short-finned pilot whale) (Fig. 16)

The head somewhat thick and bulbous. In old males the forehead overhangs the mouth to several inches. Flippers 1/16th of the body length or less and sickle shaped. Tail dorso-ventrally thickened in front of fluke; dorsal fin low. Body colour almost entirely black; 7–9 teeth on each side of upper and lower jaws and confined to front portion of the jaws. Attains 5.3 m.

Feeds mainly on fishes. Female attains sexual maturity at 3.0 to 3.2 m and male at 3.8 m; calving interval about three years; length at birth about 1.4 m; extended breeding and calving season; kept in captivity successfully.

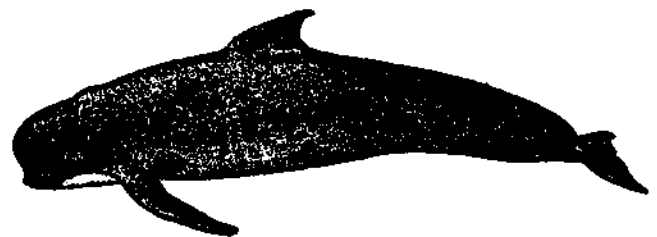


Fig. 16. *Globicephalus macrorhynchus* Gray (Short-finned pilot whale).

Caught in large numbers along the South American coast. Nearly 3,000 caught annually in early 70s. Distributed in Atlantic, Pacific and Indian oceans. Mass strandings in India reported near Calcutta in 1852 and in Tuticorin (Alagarswami *et al.*, 1973).

16. *Tursiops truncatus aduncus* Ehrenberg (Bottle-nose dolphin) (Figs. 17, 25)

Characterised by a long well defined snout and a bulbous forehead. Dorsal fin broad at base, tail falcate. Flippers moderate in size, tapering to a point. Teeth numbering 24 to 28 on each side of upper and lower jaws. Colouration usually dark grey-brown on the back and light grey on the belly. Larger specimen pigmented on the ventral side. Grows to 3.7 m in length.

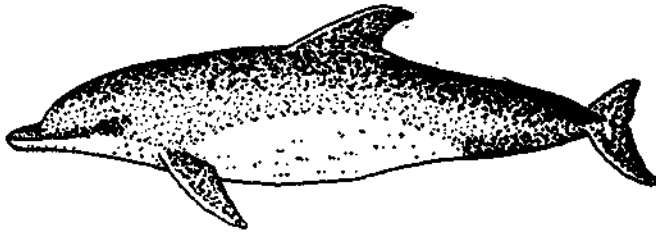


Fig. 17. *Tursiops truncatus aduncus* Ehrenberg (Bottle-nose dolphin).

Feeds mainly on inshore fishes like sardines and mackerels. Age at maturity ranges from 5 to 12 years in females and 10 to 12 years in males; females attain sexual maturity at 2.2 to 2.4 m and males 2.5 to 2.6 m. Calving interval about two years, longevity about 25 years; length at birth 1.0-1.2 m; gestation period about 12 months, pregnant females recorded from Calicut (Mohan, 1982); easily caught and trained in the oceanaria. Caught in large numbers in live-capture fisheries in U.S.A., Japan and Adriatic Sea. Small numbers caught in West Africa, Sri Lanka, India and Indonesia. More than 2,000 taken in the tropical Pacific tuna fishery.

Distributed in Indian, Pacific and Atlantic oceans. Recorded from all along Indian coasts with more numbers along the west coast between Bombay and Trivandrum; occurs as an incidental catch in gill nets.

17. *Sousa chinensis* (Osbeck) (Hump-back dolphin) (Figs. 18, 23, 24 and back cover)

Beak long and forehead bulbous; characterised by a hump on its back; dorsal fin with a little elevation and posterior border feebly indented; flippers recurved and distinctly broad at base. 34 to 37 teeth on each side of upper and lower jaws. The colour uniformly lead grey; longitudinal blotches on ventral side in larger specimens; grows to 3.2 m.

Feeds mainly on fishes; kept in captivity in oceanaria in Australia; once kept in a polyethylene lined pond at

Calicut (Mohan, 1983). Found to migrate to estuaries in search of food; a pregnant female recorded from Calicut (Mohan, 1982).

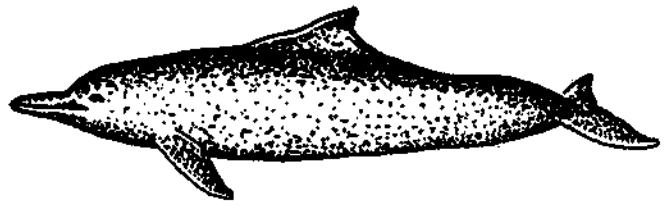


Fig. 18. *Sousa chinensis* (Osbeck) (Hump-back dolphin).

Distributed from Cape of Good Hope to coast of China; occurs along the Indian coast often; caught in gill nets in Goa, Mangalore and Calicut.

18. *Stenella longirostris* Gray (Spinner dolphin) (Figs. 19, 27-29)

Body slender, dorsal fins moderately falcate to triangular and very erect. Tip of snout distinctly black and dark grey to black dorsally; yellowish brown laterally and white ventrally. 44-51 teeth on each side of upper and lower jaws. Teeth small, slightly curved inward. Occurs in herds of several hundred individuals; seen jumping over the waves. Attains a length of 2.5 m.

Feeds mainly on pelagic fishes and squids. Length at birth about 0.8 m. Females usually give birth to a single calf. Successfully maintained for several years in oceanaria; considered as an indicator species of tuna schools; caught in tuna purse seines; about 50,000 caught in early 1970's as incidental catches in the tuna fishery in Pacific. About 40 dolphins caught in the gill net fishery annually at Calicut coast during 1976-1980 (Mohan, 1985).

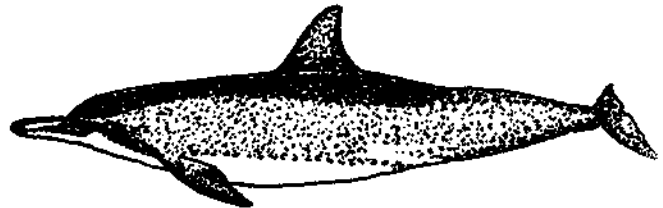


Fig. 19. *Stenella longirostris* Gray (Spinner dolphin).

Distributed in Atlantic, Pacific and Indian oceans. Reported along the Indian coasts.

19. *Delphinus delphis* Linnaeus (Saddle-back dolphin) (Fig. 20)

Characterised by a well defined narrow beak and with distinct colourations. Beak acute than *Tursiops*

aduncus. Dorsal fin moderately developed and tapers backwards with a concave hind margin. Flippers moderate in size, tapering; body black dorsally, lower surface white, upper and lower jaws with 62-65 teeth on each side; grows to 2.5 m.

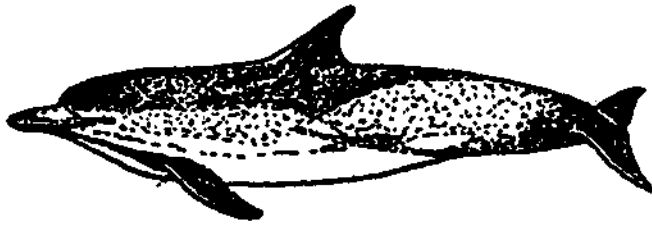


Fig. 20. *Delphinus delphis* Linnaeus (Saddle-back dolphin).

Feeds on fishes and squids, length at birth about 0.8-0.9 m. Male attains a length of about 2.5 m. Sexually matures at about 4 years. Gestation period estimated to be about 10-11 months; trained and kept in oceanaria.

Found to aggregate with tuna fishes in Pacific Ocean. Nearly 10,000 dolphin killed incidentally in the tuna fishery of eastern tropical Pacific (Leatherwood *et al.*, 1976). Distributed from east coast of Africa to Japan and along the coast of Australia. Recorded along the Indian coasts. In India caught incidentally in the gill nets in Bombay, Goa, Mangalore, Calicut and Cochin.

20. *Platanista gangetica* Roxburgh (Gangetic dolphin or Susu) (Fig. 21)

Forehead rises rather steeply to upper surface of head; snout long; dorsal fins almost ridge like. Tail flukes broad; posterior border with a notch in middle; flippers short and broad at their outer end. Eyes very small and animal almost blind. Teeth small about 28-30 on each half of upper and lower jaws. Body lead black and ventral surface pale white.

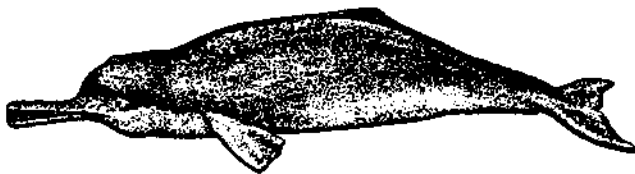


Fig. 21. *Platanista gangetica* Roxburgh (Gangetic dolphin or Susu).

Feeds mainly on fishes, shrimps and molluscs by ploughing its snout into the mud. Male attains sexual maturity at about 2.1 m and female at 2.5 m; length at

birth 0.7-0.8 m. Breeding seasons from April to July; gestation period about 8-9 months.

Kept in captivity in Japan; caught incidentally in the seine nets in River Ganges. A highly endangered species and requires urgent protection. Distributed in Ganges, Brahmaputra and Karnaphuli river systems.

21. *Dugong dugon* Muller (Sea cow) (Fig. 22)

The body spindle shaped, divisible into a head, trunk and tail. Head relatively small, characterised by a muzzle, and a broad flat horse-shoe shaped extension of the upper lip which overlaps sides of mouth; large numbers of hairs and bristles on the muzzle; eyes small; dorsal fins absent; flippers round towards the end. Dentition with incisors and molars. In male incisors long and pointed. Skin of dugong thick and hairs present on the surface. Tail strengthened by a low ridge mid-dorsally and mid-ventrally and caudal fluke crescentic.

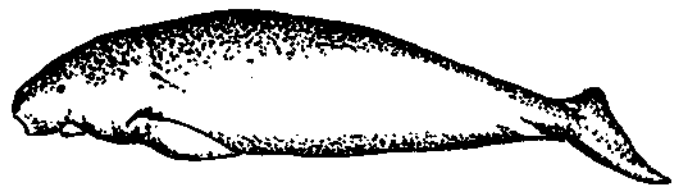


Fig. 22. *Dugong dugon* (Muller) (Sea cow).

Distributed from east coast of Africa to Japan with a concentration of population in Torres Strait along northern coast of Australia. In India, found in the Gulf of Mannar, Palk Bay, Gulf of Kutch and Andaman islands.

The size at maturity about 2.3 m in females. The length at birth about 90 cm. Dugongs are usually monogamous; grows to a length of about 3 m; longevity estimated to be ranging from 35-45 years; herbivorous animals feeding on sea grasses like *Cymodocea serrulata*, *Halophila ovalis* and *Enhalus koenigi*.

Sluggish animals inhabiting the coastal waters; benthic in habit; a voracious feeder. Once observed 25 kg of sea grass in the stomach (personal observation by Lal Mohan). Dugongs are kept in oceanaria and can be easily acclimatised. Captured by gill nets along the coast of Gulf of Mannar and Palk Bay. Considered as a delicacy along the Gulf of Mannar coast. About 20 to 60 numbers caught in Gulf of Mannar and Palk Bay (Mohan, 1980).



Fig. 23. *Sousa chinensis* in polythene lined pond at Calicut.

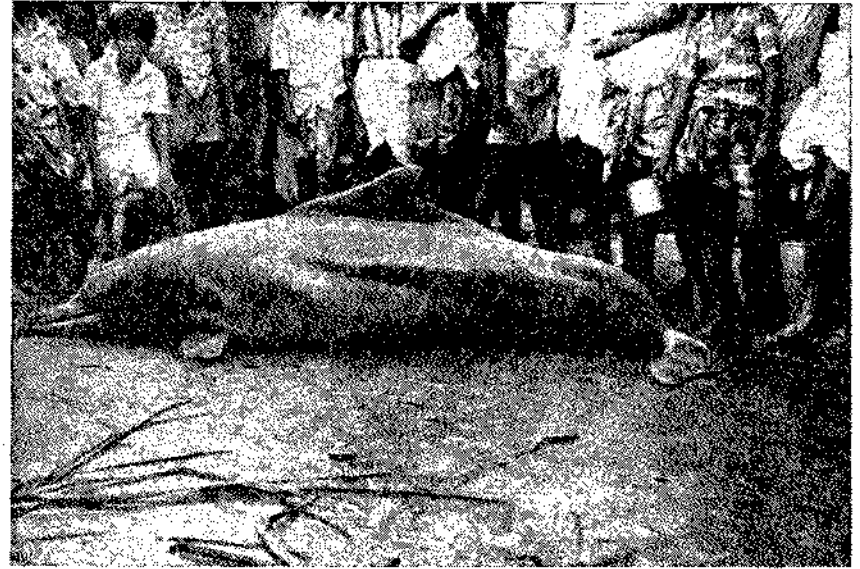


Fig. 24. *Sousa chinensis* caught in the gill net off Calicut on 2-9-'78. Male; length 2.7 m.



Fig. 25. *Tursiops truncatus aduncus* caught in the gill net off Calicut coast on 21-12-'78. Male; length 2.8 m.

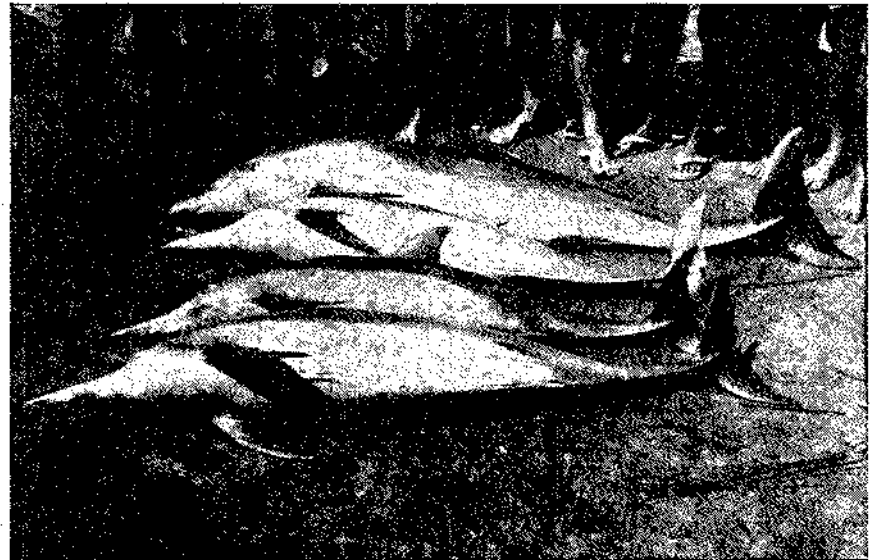


Fig. 26. By-catch of dolphins in the Calicut fish market on 11-1-'80.

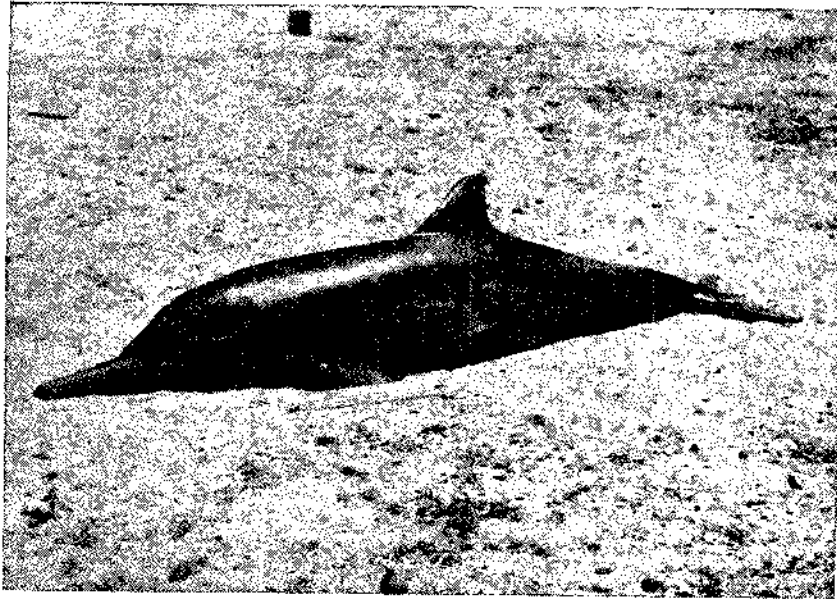


Fig. 27. Dorso-lateral view of *Stenella longirostris* caught off Calicut.

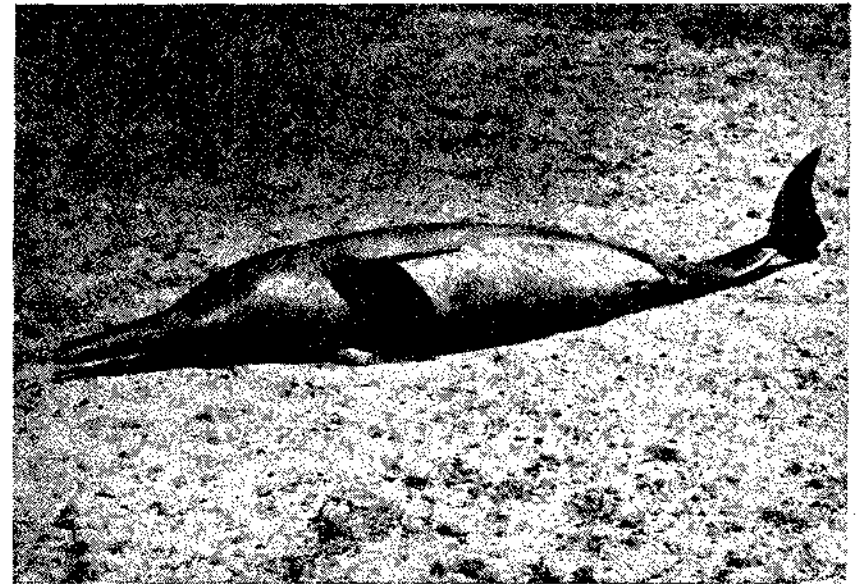


Fig. 28. Ventro-lateral view of *Stenella longirostris* caught off Calicut.



Fig. 29. *Stenella longirostris* got entangled in the gill net off Calicut on 19-9-'81. Male; length 2.1 m.

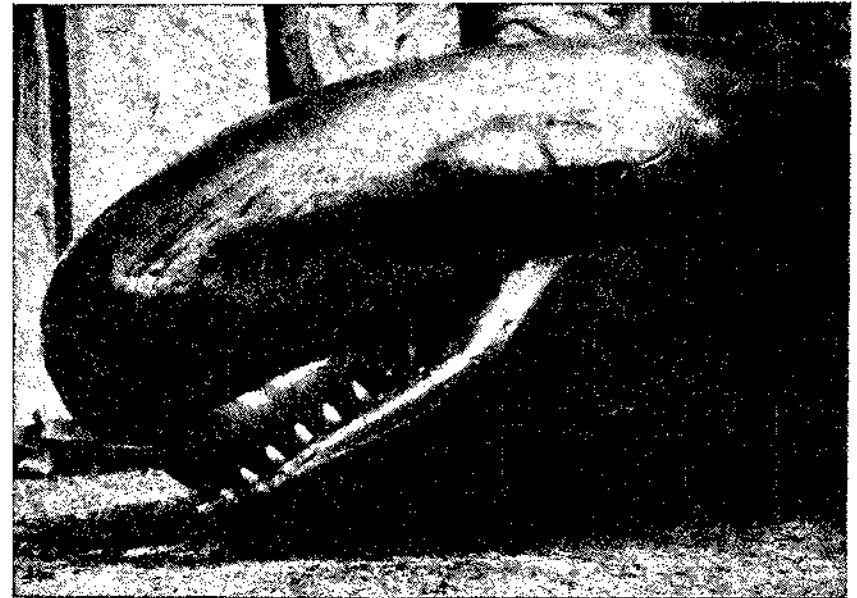


Fig. 30. *Pseudorca crassidens* landed at Puthiappa beach (Calicut) in July 1979 showing disposition of teeth on the lower jaw.

Key to the identification of marine mammals of India

1.	1a. Whale bone (baleen plates) absent; teeth present	2
	1b. Whale bone (baleen plates) present; teeth absent	16
2.	2a. Teeth differentiated into incisors and molars; lip with well developed muzzle, dorsal fin absent	...
 <i>Dugong dugon</i> (Sea cow) (Fig. 22)	...
	2b. Teeth uniform, not differentiated (toothed whales and dolphins)	3
3.	3a. Teeth on lower jaw only	4
	3b. Teeth on both jaws	7
4.	4a. Teeth strong; more than 8 pairs on lower jaw	5
	4b. Teeth strong; less than 8 pairs on lower jaw	6
5.	5a. Teeth 9-14 pairs on lower jaw, head 1/6 of body length; head conical, upper jaw much larger than lower jaw	...
 <i>Kogia breviceps</i> (Fig. 9)	...
	5b. Teeth 20-30 pairs on lower jaw; head massive, rectangular, 1/3 of body length; lower jaw short and smaller, upper jaw projecting; flippers rounded; dorsal fin all defined	...
 <i>Physeter macrocephalus</i> (Fig. 8)	...
6.	6a. Teeth 3-7 pairs on lower jaw, head bulbous, forehead with a vertical crease in centre, body with numerous scratches; flipper tapering	...
 <i>Grampus griseus</i> (Fig. 13)	...
	6b. Teeth one pair at tip of lower jaw in large males; (young animals may have more than one pair); forehead not distinct; dorsal fin well behind mid point of body; cleft of mouth short; well marked, white blotches in adults	...
 <i>Ziphius cavirostris</i> (Fig. 10)	...
7.	7a. Eyes rudimentary, not functional; skull with cranial crest; beak well marked; each jaw with 26-30 pairs of small pointed teeth	...
 <i>Platanista gangetica</i> (Fig. 21)	...
	7b. Eyes well developed, functional; cranial crest absent	8
8.	8a. Teeth spade-like, 15-19 on each jaw; dorsal fin absent; body dark black; beak absent	...
 <i>Neophocaena phocaenoides</i> (Fig. 11)	...
	8b. Teeth conical, pointed, 6-65 on each jaw	9
9.	9a. Teeth 6-15 on each jaw	10
	9b. Teeth 20-65 on each jaw	13
10.	10a. Body with large distinct white patches above the eye and base of dorsal fin; teeth strong, 10-12 pairs; dorsal fin erect and larger; flippers paddle shaped	...
 <i>Orcinus orca</i> (Fig. 12)	...
	10b. Body without large white patches above the eye and dorsal fin	11
11.	11a. Teeth 7-11 on each jaw; flippers tapering	12
	11b. Teeth 12-19 on each jaw; flippers paddle shaped; forehead bulbous; beak absent	...
 <i>Orcella brevirostris</i> (Fig. 15)	...
12.	12a. Teeth 7-10 on each jaw, flipper long, 1/5 to 1/7 of body length, forehead bulbous; outer margin of flippers without hump, dorsal fin not pointed	...
 <i>Globicephalus macrorhynchus</i> (Fig. 16)	...
	12b. Teeth 8-11 on each jaw; flippers 1/8 to 1/10 of body length, outer margin of flippers with hump	...
 <i>Pseudorca crassidens</i> (Fig. 14)	...
13.	13a. Teeth 24-28 on each jaw; beak distinct; adults with grey oval spots ventrally	...
 <i>Tursiops truncatus aduncus</i> (Fig. 17)	...
	13b. Number of teeth more than 30 in each jaw	14
14.	14a. Number of teeth 34-38 on each jaw; base of dorsal fin extended posteriorly; a dorsal hump present	...
 <i>Sousa chinensis</i> (Fig. 18)	...
	14b. Number of teeth more than 42 on each jaw	15
15.	15a. Number of teeth 45-51 on each jaw, a dark grey stripe from flipper to eye	...
 <i>Stenella longirostris</i> (Fig. 19)	...
	15b. Number of teeth 60-65 on each jaw; palate tested; dark grey band from base of flippers to base of lower jaw	...
 <i>Delphinus delphis</i> (Fig. 20)	...
16.	16a. Dorsal fin absent; surface of throat not grooved; chin not white; head 1/4 of body; upper border of lower lip much arched; 'bonnet' on head	...
 <i>Eubalaena glacialis</i> (Fig. 7)	...
	16b. Dorsal fin present; surface of throat grooved, upper border of lower lip not arched	17

17. 17a. Flipper extremely long, 1/3 of body length, lower margin of flippers scalloped
 *Megaptera novaeangliae* (Fig. 6)
 17b. Flippers less than 1/5 of body length, not scalloped below the flippers; baleen plate black, white or partially white 18
18. 18a. Baleen plates black; throat grooves 80-100 extending to at least umbilicus, length of flippers 1/7 of total length *Balaenoptera musculus* (Fig. 2)
 18b. Baleen plates white or partially white; inner side of flippers white 19
19. 19a. Throat grooves about 50, extending to half way to umbilicus; flipper length 1/8 of total length *Balaenoptera acutorostrata* (Fig. 3)
 19b. Baleen plates white or slate coloured; inner side of flippers white 20
20. 20a. Baleen plates black with frayed white inner edge; flipper length 1/10 to 1/12 of total length; grooves 30-60 extending midway between flippers and umbilicus... .. *Balaenoptera borealis* (Fig. 5)
 20b. Baleen plates white along anterior third, frayed edge white; flipper length 1/9 of total length; throat grooves 60-90 extending to umbilicus; inner side of flippers white *Balaenoptera physalus* (Fig. 4)

Discussion

The marine mammals of Indian seas are attracting special attention due to the declaration of Indian Ocean as a sanctuary for the whales. Though whales and dolphins do not form a regular fishery along the coasts of India, there is no place for complacency as dolphins and dugongs are caught in the gill nets along the coasts. In the case of dolphins though the magnitude of destruction along the Indian coasts is not very high when compared to the eastern Pacific, there is all possibility that the dolphin catch may increase in the future due to the introduction of purse seines for pelagic fishes. It may be stated that in the case of dugongs though it is true that the Indian Wild Life Act 1972 has some effect on their fishing as indicated by the reduction of the number of dugong nets operated, there is still scope for better implementation of the Act. There is no fishery for the whales along the Indian coasts, and most of the records of the whales are due to its strandings. The recent studies made by Alling *et al.* (1982) show that the *Physeter macrocephalus* migrates to south of Sri Lanka for breeding and they are not disturbed in their habitats. However, close watch and vigilance are essential to safeguard the habitats of these whales.

Dugongs face serious threat as the fishing activities along the Gulf of Mannar and Palk Bay have increased recently to a great extent by the operation of the trawlers and this has affected the sea grass beds of these areas which form the main habitat for the dugongs. Naturally the destruction caused to the sea grass beds will affect the population of dugongs.

Further it will be essential to introduce animal husbandry methods and captive breeding to increase the population of the dugongs. It has been shown that

they can easily be reared in captivity. However, we may have to study the reproductive behaviour in relation to ecological factors. More studies are needed in this line. Eventhough many suggestions have been made to protect the animal, no comprehensive plan of action has been initiated.

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SOME OBSERVATIONS ON DOLPHINS IN MANDAPAM AREA WITH A NOTE ON THEIR FOOD*

Introduction

The dolphins are common in the Gulf of Mannar near Mandapam. Five of them were caught by the fishermen in trawler or gill net in the neighbourhood of Krusadai Island in the Gulf of Mannar in the winter months of 1980 to 1982. They were studied for the species identity and their stomach contents. Data regarding the date, place of collection weight, sex and essential body measurements of all specimens were recorded.

Observations on school of dolphins

Sighting of dolphin in singles or in pairs in the vicinity of Krusadai Island, particularly in the channel areas during winter months is very common. When the senior author was on board the vessel Cadalmin-II, conducting trawling operation in the area (9-79/IB) in depths ranging between 20 and 22 m on 7-12-'82, 15 nautical miles from the shore, 7 numbers of dolphins were observed following the cod end of the net. On 15-12-'82, while conducting trawling operation in the same area 15 to 30 dolphins were found at the net end during all the hauls. The species was identified to be *Tursiops aduncus*. In all the three trawl hauls the

silverbellies dominated with 87.2, 95.0 and 96.6% respectively.

Dolphins caught in trawl/gill nets

Three numbers of *T. aduncus* caught by the fishermen in their trawl net, one young common dolphin *Delphinus delphis* caught in a gill net operated from the non-mechanised boat and another *D. delphis* which was washed ashore just opposite to C.M.F.R.I. jetty were all brought to the laboratory to examine and study the stomach contents. The body measurements taken are given in the Table I.

On 12-11-'80 an adult dolphin (Fig. 1) measuring 182.5 cm and weighing 65 kg was caught accidentally in a trawl net while operating off Krusadi Island in the Gulf of Mannar. The colour of the specimen was black on the dorsal side and greyish white on the ventral side. The lower jaw was somewhat longer than the upper, and number of teeth on the upper jaw on one side was 25 and 24 on the lower jaw. It was identified as a male of *T. aduncus*. The stomach was cut open and found that the food was in a digested condition. The length of the small intestine measured 4.5 m.

On 26-11-'81 another adult specimen was caught in a trawl net while fishing at night (Fig. 2). It resembled the first one in colour and in the number of teeth.

*Prepared by S. Krishna Pillai and C. Kasinathan, Regional Centre of CMFRI, Mandapam Camp.

Table 1. The morphometric measurements (cm) of *Tursiops aduncus* and *Delphinus delphis* caught in Mandapam during winter months

1. Name of the species	<i>T. aduncus</i>			<i>D. delphis</i>	
	12-11-'80	26-11-'81	8-12-'81	20-2-'82	8-12-'82
2. Date of capture					
3. Total length (snout to notch of caudal flukes)	182.5	210.5	143.0	145.0	159.0
4. Tip of the snout to blowhole	30.0	34.0	24.5	29.0	30.5
5. Tip of the snout to centre of eye	30.4	34.5	24.0	29.5	29.5
6. Tip of the snout to anterior insertion of flipper	45.7	53.0	37.5	39.5	43.0
7. Tip of the snout to centre of anus	125.7	150.0	101.0	102.5	114.5
8. Notch of the flukes to posterior end of the dorsal fin	—	87.0	57.0	59.0	57.5
9. Notch of the flukes to centre of anus	53.3	61.5	44.0	41.0	46.0
10. Length of the fluke on the outer curvature	27.9	31.0	23.5	18.0	27.0
11. Length of the fluke on the inner curvature	22.8	26.0	18.0	17.0	20.0
12. Distance between the extremities of flukes	40.6	47.0	32.0	26.0	37.0
13. Width at insertion of fluke	10.1	16.5	—	9.0	16.5
14. Length of dorsal fin base	24.1	28.0	20.5	18.0	28.0
15. Vertical height of dorsal fin	20.3	26.0	15.0	10.1	13.5
16. Length of flipper from anterior insertion to tip	31.7	38.0	26.5	22.0	27.0
17. Length of flipper along the curve of lower border	24.1	28.0	19.5	11.0	20.0
18. Greatest width of flipper	11.4	14.0	10.5	9.0	10.5
19. Depth of body at anal region	53.3	63.0	39.0	44.0	25.0
20. Depth of body at origin of flipper	83.8	95.0	64.0	63.0	26.5
21. Depth of body at the origin of dorsal	100.3	122.0	72.0	72.0	44.0
22. Depth of body in the region of eye	72.3	78.0	55.0	50.5	27.0
23. Tip of the lower jaw to the centre of anus	125.7	151.0	105.5	103.0	111.0
24. Length of upper jaw	23.4	27.5	20.5	23.5	25.5
25. Length of lower jaw	24.1	29.0	20.7	24.0	25.0
26. Diameter of the eye	1.5	1.3	1.0	—	0.7
27. Distance between the genital opening and anus	15.3	9.0	5.0	10.0	6.0
28. Total number of teeth on one side of upper jaw	25	25	17	61	66
29. Total number of teeth on one side of lower jaw	24	24	17	58	60
30. Sex	Male	Female	Female	Male	Female
31. Weight in kg	65.0	130.0	26.5	25.0	46.0

Fig. 3 shows pattern of teeth on the upper and lower jaws. It was a female *T. aduncus* measuring 210.5 cm and weighing 130 kg. The stomach with the food weighed 2.6 kg and after removal of all the food items the stomach alone weighed 2.00 kg. The stomach content of the dolphin included fishes namely *Saurida tumbil*, *Sphyræna* spp., *Ilisha* spp., *Trichiurus* spp., *Polyne-mus* spp., Anchovies and *Stolephorus* spp., and their total displacement volume measured 1,014 ml.

On 8-12-'81 another young female dolphin was caught in a trawl net near Mandapam which was identified as *T. aduncus*. It measured 143 cm in length and weighed 26.5 kg in weight (Fig. 4). Only 17 numbers of teeth were counted on one side of both the jaws and rest of the teeth were in developing stage embedded in

the sockets on the jaws. The stomach was cut open and only yellowish fluid was observed.

On 20-2-'82, a young dolphin was washed ashore just opposite to C.M.F.R.I. jetty. It was 145 cm in length and weighed 25 kg (Fig. 5). It was distinguished from *T. aduncus* by the presence of long jaws with rows of small conical teeth; 61 in upper half jaw and 58 in lower half jaw (Fig. 5). The colour on the dorsal side was grey while the belly was white. It was identified as a male of the common dolphin *Delphinus delphis*.

On 8-12-'82 a young dolphin of 159 cm in total length, weighing 46 kg was accidentally caught in a gill net operated from a non-mechanised boat in between Thonithurai and Krusadai Island near Mandapam. It was tied by a rope on its caudal peduncle and was brought



Fig. 1. *Tursiops aduncus* caught on 12-11-'80 in the trawl net from Gulf of Mannar, Mandapam.

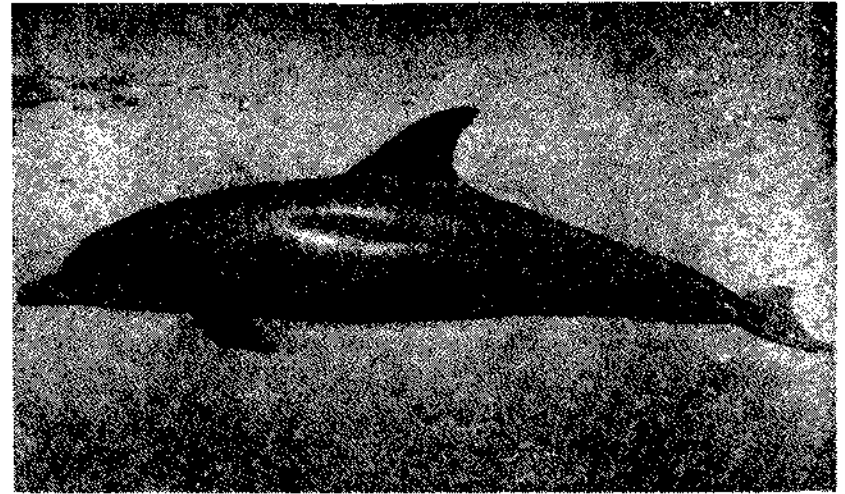


Fig. 2. *T. aduncus* caught on 26-11-'81 in the trawl net from Gulf of Mannar, Mandapam.

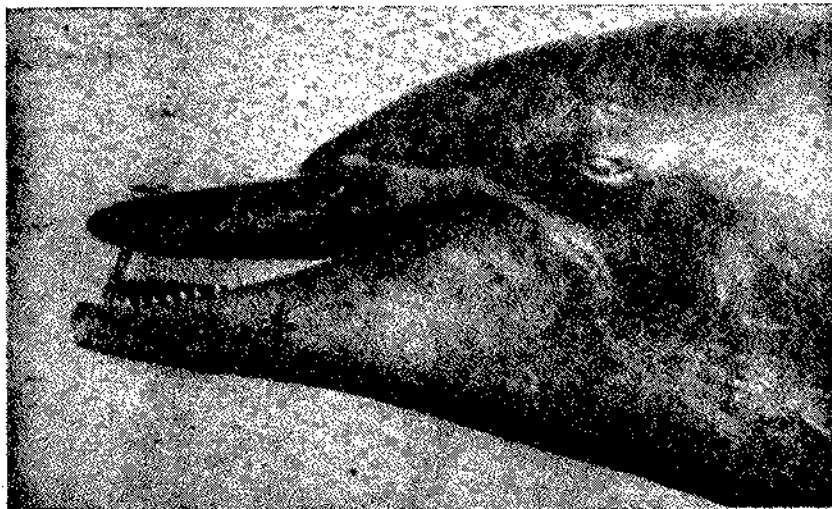


Fig. 3. Head of *T. aduncus* showing 25 numbers of teeth on each side of upper and lower jaws.

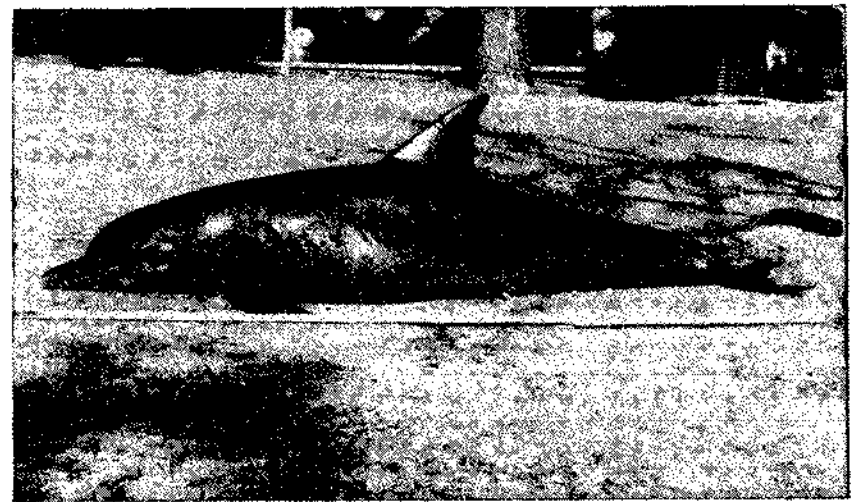


Fig. 4. Young of *T. aduncus* caught on 8-12-'81 in the trawl net from the Gulf of Mannar.

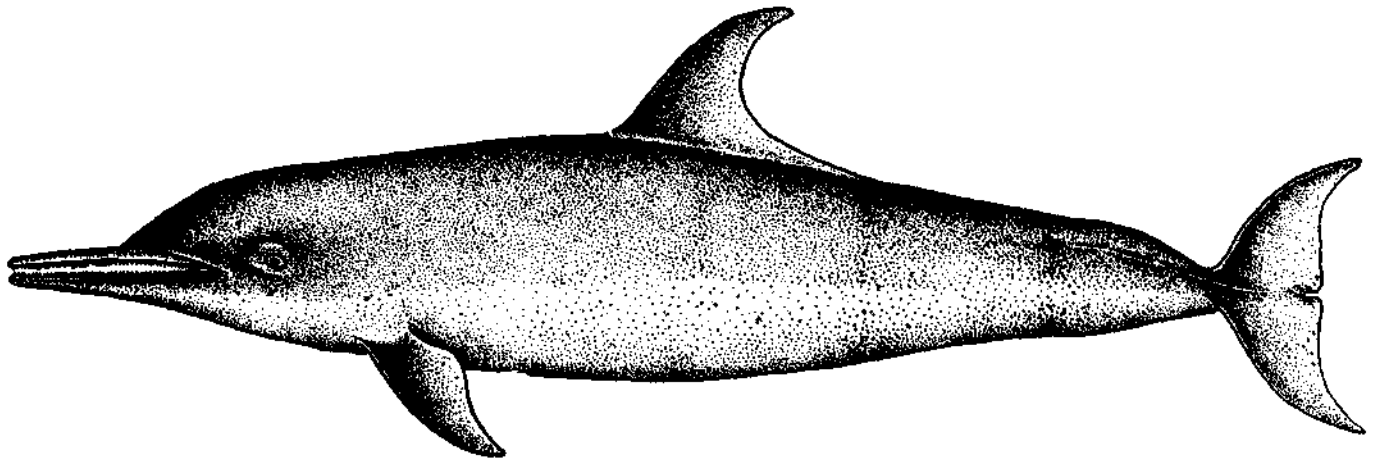


Fig. 5. Drawing of the common dolphin *Delphinus delphis* washed ashore near CMFRI jetty, Mandapam.

to the shore of Thonithurai in live condition. This young dolphin was kept alive near the shore at a depth of one metre for nearly 24 hrs. Attempt to bring it alive to the aquarium did not succeed.

The specimen had elongated jaws bearing small pointed conical teeth. The total number of teeth on

one side of the upper jaw was 66, and 60 in the case of lower jaw. It was also identified as the common dolphin *Delphinus delphis*. The analysis of the gut contents showed only yellowish fluid. The weight of the stomach was 450 g and after the removal of the yellowish fluid it weighed 400 g.



REPORT ON A SPERM WHALE *PHYSETER MACROCEPHALUS* LINNAEUS STRANDED ALONG THE GULF OF MANNAR COAST*

The sperm whale *Physeter macrocephalus* although is widely distributed in the world oceans, reports on its stranding along the Indian coasts are few. The following is a report on a sperm whale stranded at Hare Island, Gulf of Mannar.

The whale was stranded around 5-11-'86. However, an immediate visit to the place could not be made. Later, from an on-the-spot enquiry it was understood that the whale was cut open by some local fishermen for ambergris. The discarded carcass was later washed ashore at Seeniappa Dharga, about 3 km away from Hare Island. As it was in a highly decomposed and partly damaged condition the measurements of the skull (Fig. 1) and lower jaw (Fig. 2) alone could be taken which is given below.

1. Condylbasal length	...	252
2. Length of rostrum	...	172
3. Width of rostrum:		
a. at its base	...	91
b. at its middle length	...	74
4. Height of occipital condyle	...	32
5. Condylar width	...	20
6. Width of foramen magnum	...	18
7. Distance from upper edge of foramen magnum to occipital condyle	...	46
8. Length of lower jaw	...	200
9. Number of teeth sockets in the lower jaw	...	18
(All measurements in cm)		

James and Soundararajan (*J. mar. biol. Ass. India*, 21: 17-40, 1980) have given the skull length of a 810 cm long sperm whale as 213 cm. They have also estimated the length of another sperm whale to be 1,740 cm whose

Reported by M. Sivadas, S. Krishna Pillai and M. R. Arputharaj, Regional Centre of CMFRI, Mandapam Camp.

skull had a length of 445 cm. Following them, based on the skull length, the total length of the whale reported now has been estimated to measure between 950 and 1,000 cm.

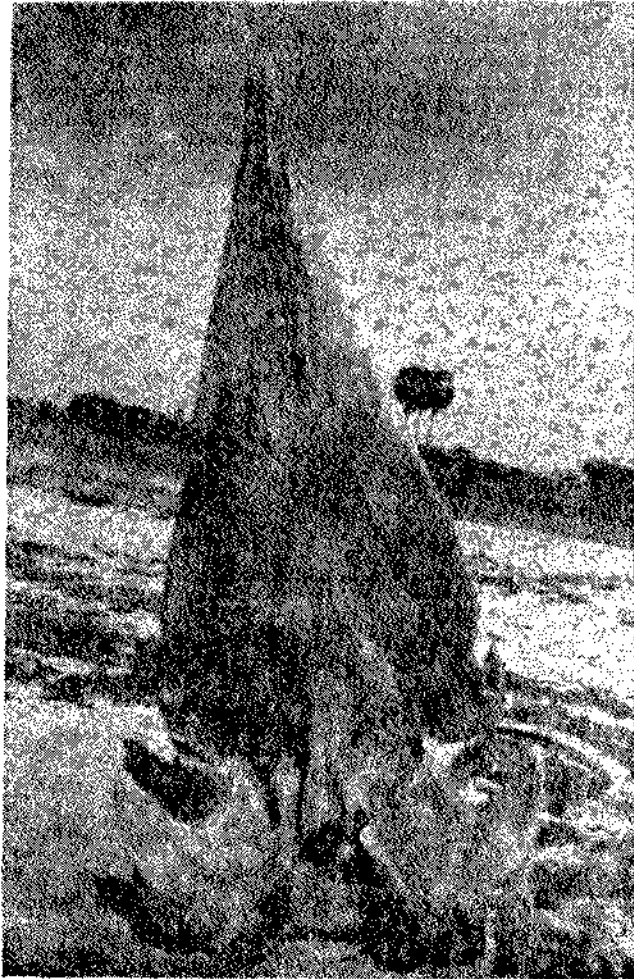


Fig. 1. Ventral view of the skull.

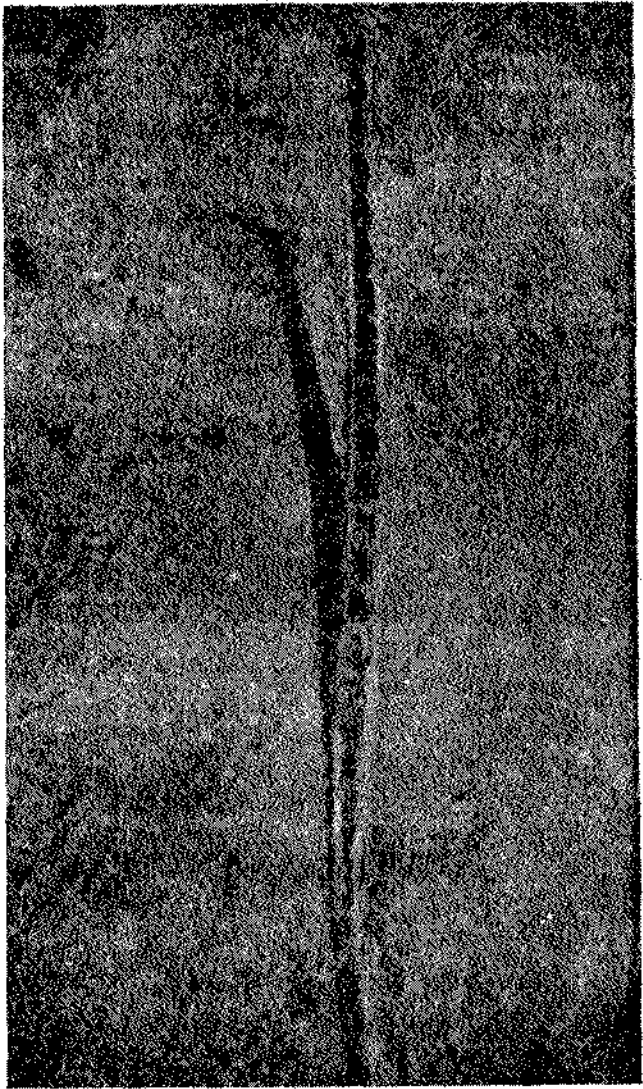


Fig. 2. Lower jaw showing teeth sockets.





ON A BLUE WHALE *BALAENOPTERA MUSCULUS* STRANDED AT CHAPPA BEACH, NARAKKAL, COCHIN, SOUTHWEST COAST OF INDIA*

The news about the stranding of a whale at Chappa beach, Narakkal was received on 2-9-1985 and an immediate visit to the landing centre was made for further observations and studies. Local enquiries revealed that the carcass was noticed by the fishermen on 31-9-1985 itself. The whale, which was a male

was in an advanced state of decomposition. The abdomen was split open and the entire visceral organs were protruding out. The lower jaw was found missing. The blubber over the body was cut and removed by local people and fishermen, as it is believed that the fat in the blubber is a good cure for asthma and other bronchial diseases. The characteristic whale bone was found missing.

*Prepared by K.V. Somasekharan Nair and A.A. Jayaprakash,
Central Marine Fisheries Research Institute, Cochin.

The specimen was identified as a rorqual belonging to the genus *Balaenoptera*. The body was long and slender with a short and flat head. The presence of deep ventral grooves in the skin of the throat and chest extending upto the umbilicus and the ratio of the flipper length to the total length of the species (1:7.7) indicated



Fig. 1. Dorso-lateral view of the Blue whale *Balaenoptera musculus* (Linnaeus) stranded at Narakkal, Cochin.

that the whale could be *Balaenoptera musculus* (Linnaeus). The morphometric measurements of the whale taken are given in Table 1.

Table 1. Measurements of the Blue whale *Balaenoptera musculus* stranded at Narakkal, Cochin

Body parts measured	Length (cm)
Total length (snout to caudal fluke)	1,030
Tip of snout to centre of eye	201
Tip of upper jaw to anterior insertion of flipper	175
Tip of upper jaw to origin of dorsal fin	518
Distance between centre of eye and cleft of mouth	61
Length of flipper	133
Distance between extremities of caudal flukes	138
Length of upper jaw	170
Body diameter at the anterior side of the flipper	498
Anterio-posterior length of eye slit	15
Dorso-ventral diameter of eye	7
Approximate weight	6 tonnes



LIME REQUIREMENT OF POND SOILS FOR AQUACULTURE AROUND COCHIN BACKWATERS*

The use of lime in pond fish culture has been advocated by fish culturists over a large part of the world. It is frequently applied to improve the water quality, and several workers have described the favourable effects of liming and stressed its use for increased fish production. Liming increases the pH of bottom mud and thereby increases the availability of phosphorous added as fertilizer. The waters may also be cleared of humic stains of vegetative origin which restrict light penetration. The net effects of changes in water quality following liming is the increase in phytoplankton productivity which in turn, leads to increased fish production.

The application of lime to improve the fertility as well as production is already being practiced by traditional farmers and aquaculturists in the culture systems bordering the Cochin Backwaters and the Vembanad Lake. However, this is done without any scientific estimation of the actual requirement and hence the desired results are not always obtained.

*Prepared by Joseph Gilbert (Senior Research Fellow) and V. K. Pillai, Central Marine Fisheries Research Institute, Cochin.

In the present investigation soil samples were collected from different seasonal and perennial prawn culture fields during the premonsoon and monsoon seasons (Fig. 1). The samples were estimated for their lime requirement during both the seasons.

No comprehensive procedure for determining the liming rate was available till recent times. According to Boyd (*Alabama Univ. Bull.*, 459, 1974) the lime requirement is the amount of liming material needed to neutralize the acidity of bottom muds and increase the total hardness and total alkalinity to at least 20 mg/l. Therefore liming is indicated if either the total hardness or total alkalinity of the pond waters is below 20 mg/l.

The estimation of lime requirement for fish ponds is usually based on exchange acidity. However, in some tropical areas like India, Philippines etc. the soil in the brackishwater regions is prevalent with acid sulphate. In order to estimate the lime requirement correctly in such type of soils, the potential acidity is also to be analysed in addition to the exchange acidity. The

Table 1. Total lime requirement based on exchange and potential acidity

Station No.	Pre monsoon			Monsoon		
	Exchange acidity	Potential acidity	Total* (tons/ha)	Exchange acidity	Potential acidity	Total* (tons/ha)
1	2	3	4	5	6	7
1.	0.448	54.24	54.73	1.120	31.02	32.14
2.	1.512	very high	very high	0.784	55.30	56.08
3.	0.896	95.73	96.62	0.560	29.77	30.33
4.	0.280	74.45	74.73	0.056	34.03	34.08
5.	0.224	53.18	53.40	0.056	33.18	33.23
6.	1.400	52.12	53.52	2.016	44.67	46.68
7.	5.040	57.43	62.47	1.904	51.05	52.95
8.	3.752	55.31	59.06	2.072	55.30	57.37
9.	1.344	77.64	78.98	3.528	72.32	75.85
10.	1.008	75.51	76.52	3.360	68.06	71.42
11.	1.456	75.51	76.96	0.840	29.77	30.61
12.	0.784	76.58	77.36	0.560	31.54	32.10
13.	1.568	76.58	78.15	2.128	76.69	78.82
14.	1.400	75.51	76.91	2.016	77.78	79.79
15.	0.560	73.40	73.96	1.400	55.30	56.70
16.	0.728	74.50	75.23	1.232	51.05	52.28
17.	3.024	44.67	47.69	1.288	85.06	86.34
18.	2.800	52.12	54.92	1.680	87.25	88.93
19.	3.248	51.05	54.29	1.568	88.11	89.67
20.	3.192	55.31	58.50	1.904	89.32	91.22
21.	0.168	12.76	12.93	**	18.29	18.29
22.	0.168	10.63	10.79	**	17.43	17.43
23.	0.112	11.70	11.81	**	17.86	17.86
24.	0.784	65.94	66.72	**	46.79	46.79
25.	0.616	63.82	64.43	**	44.67	44.67
26.	0.840	64.68	65.52	**	47.65	47.65
27.	1.008	63.82	64.83	0.056	51.05	51.10
28.	1.400	74.45	75.85	0.672	42.54	43.21
29.	1.232	75.58	77.81	0.504	44.67	45.17
30.	1.120	74.45	75.57	0.560	38.28	38.84
31.	0.840	85.09	85.93	0.504	63.82	64.32
32.	0.728	84.03	84.76	0.448	64.94	65.42
33.	1.680	82.96	84.64	0.560	59.56	60.12
34.	2.856	21.27	24.12	**	19.14	19.14
35.	2.800	29.78	32.58	**	17.01	17.01
36.	2.912	26.59	29.50	**	21.27	21.27
37.	3.308	42.54	45.85	0.840	42.54	43.38
38.	3.640	44.67	48.31	1.624	43.06	44.68
39.	2.968	43.60	46.57	0.224	34.03	34.25
40.	3.304	69.10	72.40	0.840	80.83	81.67
41.	3.920	63.82	67.74	2.016	85.09	87.10
42.	3.192	59.45	62.64	1.400	89.34	90.74
43.	5.040	85.09	90.13	1.120	61.68	62.72
44.	5.600	86.15	91.75	0.840	59.56	60.40
45.	5.488	80.23	85.72	0.560	65.03	65.59

Table 1. (Contd.)

1	2	3	4	5	6	7
46.	3.864	42.54	46.40	0.840	59.56	60.40
47.	3.920	52.12	56.04	1.120	61.62	62.74
48.	2.576	42.54	45.11	1.008	64.03	65.03
49.	3.304	10.63	13.93	**	12.76	12.76
50.	3.752	12.76	16.51	**	14.88	14.88

* The lime requirement is calculated by considering the weight of soil of 15 cm depth per hectare.

** The stations showed no lime requirement by the exchange acidity method.

total lime requirement is calculated by adding both the values together. The lime requirement based on exchange acidity was estimated in the present study following the method developed by Pillai and Boyd (*Aquaculture*, 46:157-162, 1985) and the potential acidity following the method by Boyd (*Water quality management for pond fish culture*, Elsevier, 1982).

Table 1 gives the lime requirement for the soils in the different stations based on exchange acidity as well as potential acidity and also the total lime requirement. By the exchange acidity method, during pre-monsoon, it varied from 0.112 to 5.6 tonnes of lime per ha in Narakkal (St. 23) and Thuravor (St. 33) respectively. However, during monsoon, the requirement of lime was found to be less with eleven stations recording nil, and a maximum of 3.528 tonnes of lime/ha being observed in Chenoor (St. 9).

The lime requirement based on the potential acidity showed considerable variations in different stations. During the premonsoon period the values ranged from 10.63 tonnes/ha in Narakkal (St. 22) to 95.73 tonnes/ha in St. 3. During monsoon the values were 17.01 tonnes/ha in St. 35 to 89.34 tonnes/ha in St. 42.

The total lime requirement calculated by adding both the exchange acidity and potential acidity values ranged from 10.79 (St. 22) to 96 (St. 3) tonnes/ha during the premonsoon season. During the monsoon the range was from 12.76 to 91.22 tonnes/ha at St. 50 and St. 20 respectively.

From the present study it is evident that some soils around the Cochin estuarine area have acid sulphate problem. The lime requirement is found to be very high in these regions. Generally high liming rates are associated with low pH values. But in the present investigation most of the stations recorded pH values above 6.0. Statistical analysis showed no relationship between pH and the liming rates. This is due to the collection of soil samples submerged in water during both the seasons. Though the submerged samples showed high pH values (above 6.0) their potential acidity is high and requires higher liming rate. In such cases the high pH values are misleading. This explains the high potential acidity in soil samples even with normal pH during the present study.

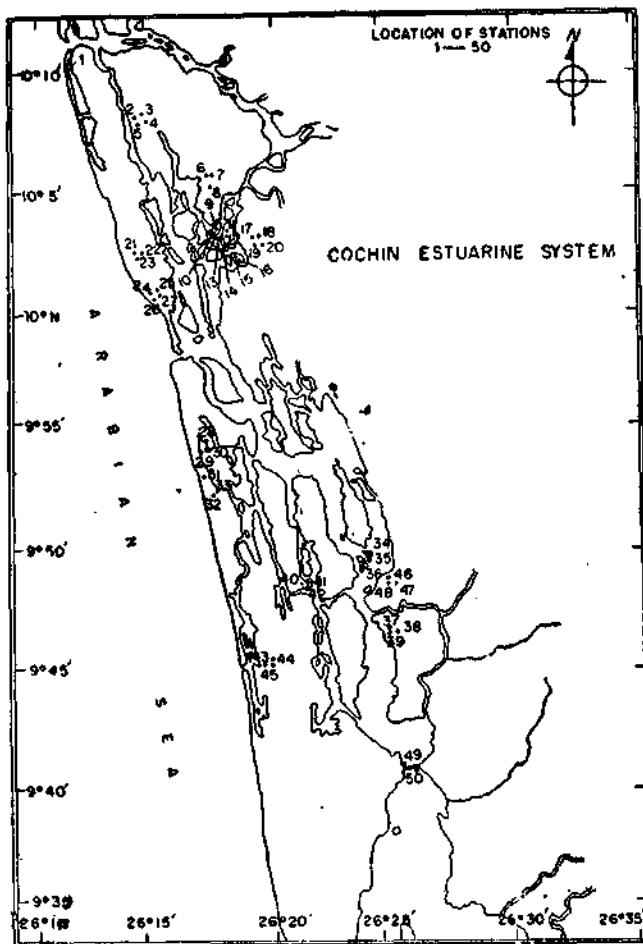


Fig. 1. Location of sampling stations.



SOME NOTES ON QUEENFISHES AND THEIR FISHERY ALONG THE INDIAN COASTS*

A large variety of fishes popularly called horse mackerels, shads, trevellies, queenfishes, pompanos, runners *etc.* comprise the family Carangidae which includes four well defined subfamilies *viz.*, Caranginae, Scomberoidae, Naucratinae and Trachinotinae. Among them, the subfamily Scomberoidae represented by the genus *Scomberoides* (- *Chorinemus*) is popularly known as queenfishes.

The queenfishes are distributed widely along the warm coastal waters of eastern Indian Ocean, western Indian Ocean and western central Pacific and are restricted to neritic waters near continental shelf. They form an important constituent in the marine fish landings of India especially along the Tamil Nadu and Andhra Pradesh coasts. However, very little is known about their fishery and biology. An attempt is made here to highlight some of the taxonomic characters for easy field identification and also to review in brief the status of fishery of this group of fishes.

These fishes possess a compressed elongate body and a blunt snout with a depression over eye. Dorsal and anal fin bases are approximately equal in length. Anal fin is with two detached spines, the characteristic of the family Carangidae, with 16-19 soft rays but without anal scutes. Lateral line is slightly wavy anteriorly and straight over most of its length (Fig. 1). The body colour is dusky green above with silvery golden yellow below. Based mainly on the nature of 5-8 blotches over the lateral line and also by the length of maxilla in relation to eye, four distinct species are recorded from Indian waters *viz.*, *Scomberoides commersonianus*, *S. lysan*, *S. tala* and *S. tol* as shown in

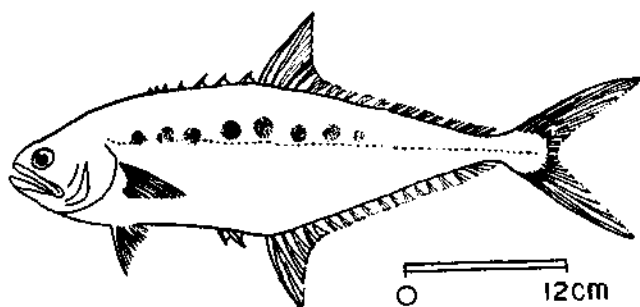
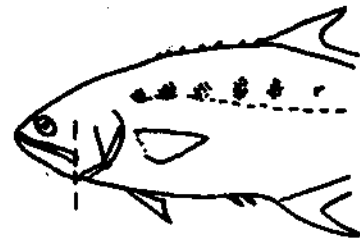


Fig. 1. The dominant species of the queenfish *Scomberoides commersonianus*.

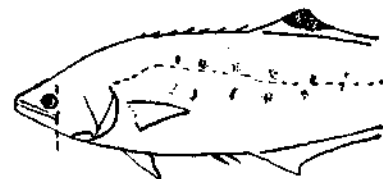
*Prepared by P. K. Mahadevan Pillai, M. Ayyappan Pillai and A. A. Jayaprakash, C.M.F.R.I., Cochin.

Fig. 2 (*Species identification sheets for fishery purposes, FAO, 1974*).

According to a recent study (Circular No. 710, FAO, 1985), during the period 1981-'84, the entire carangid fishes contributed to about 36,000 tonnes and 192,000 tonnes from the eastern Indian Ocean and western Indian Ocean respectively.



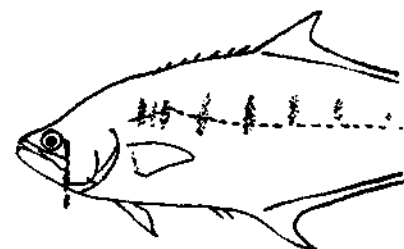
Scomberoides commersonianus



S. lysan



S. tol



S. tala

Fig. 2. Systematic characters of four species of queenfishes.

Fig. 3 represents the landings of queenfishes along the Indian coasts during 1971-'84 period. Trends in the landings indicate steady increase from 1978-'79 period to a maximum of 10,005 tonnes landed in 1983, although some minor fluctuations are seen in certain years. Tamil Nadu recorded maximum landings followed by Andhra Pradesh, Gujarat and Maharashtra contributing to 27, 22, 19 and 9 per cent respectively of the total queenfish landings in the country during 1971-'84 period.

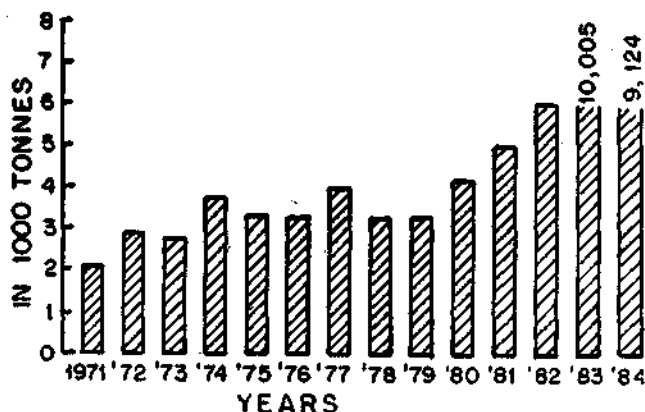


Fig. 3. The landings of queenfishes from Indian waters during 1971-'84.

Queenfishes are landed seasonally along the Kerala coast by the drift gill nets. During 1981-'85 period, a study was made on the trend of landings of these fishes at Cochin Fisheries Harbour. Some observations were also made in 1982 and 1983 on the various size groups contributing to the fishery.

The mechanised drift gill netters, operating off Cochin that land queenfishes, range from 7.62 to 9.14 m in length and are operated generally in the 20-50 m depth range confining to the surface and mid-depth zones (Silas, E.G. 1984, *Mar. Fish. Infor. Serv., T & E Ser.*, 55: 1-12). Among the queenfishes, *Scomberoides commersonianus* formed the major species that landed at Cochin Fisheries Harbour, the other species being *S. tol.*

Fig. 4 shows the average monthwise estimated landings of queenfishes during the five year period, 1981-'85 at Cochin Fisheries Harbour. Peak landing takes place during June, July, August and October.

The length frequency data on *S. commersonianus* collected during August, September and October of 1982 and '83 are shown in Fig. 5. The total length was measured from the tip of snout to the elongated lobe of caudal fin and the size of fish measured were in the

length range of 31 to 90 cm. In 1982 while the fishery comprised size groups ranging from 31-40 cm to 81-90 cm in the month of September the same was between 21-30 cm and 61-70 cm with a gap of size groups between 41-50 and 51-60 cm. In 1983, however, a single size group 71-80 cm predominated the fishery although the size groups in the fishery ranged between 31-40 cm and 81-90 cm.

The price of queenfishes at the Fisheries Harbour in the above three months of 1982 and 1983 was around Rs. 12-14 per fish which fell to Rs. 4-6 during the peak landing. From the monthly landings and price structures collected during the above period, it is estimated that a sum of Rs. 93,962 and Rs. 2,41,876 were realised in 1982 and '83 respectively from this fishery alone.

Apart from the fishery and biological investigations from Rameswaram Island by James (*Indian J. Fish.* 11 A (1): 269-276, 1964) information are lacking on queenfishes from the Indian waters. Adult queenfishes feed mainly on larger fishes whereas young ones subsist on smaller fishes and crustaceans. The reason for the landings of immature and juvenile queenfishes is attributed mainly to the selectivity of gear.

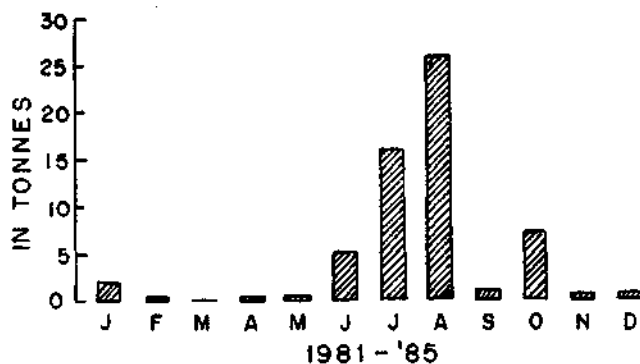


Fig. 4. Estimated average monthly landings of *S. commersonianus* from Cochin Fisheries Harbour during 1981-'85.

The fecundity studies on queenfishes, mainly *S. lysan* (James, 1964) indicated that the total number of eggs in mature ovary varied between 8 and 35 lakhs. These fishes spawn at least twice during the spawning season (April to August) along the Palk Bay and Gulf of Mannar coasts.

From the distribution and relative abundance of larval and early juvenile stages measuring 3 mm to 25 mm of *Chorinemus sanctipetri*, it is estimated that this species spawns during March-April period along the southwest coast of India (Premalatha, 1977, *Proc.*

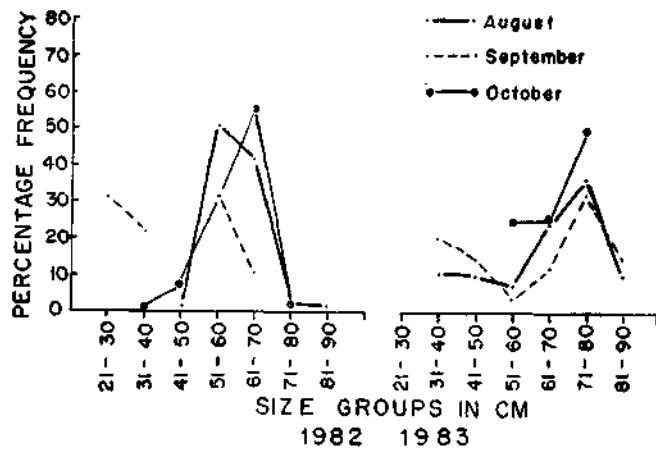


Fig. 5. Size groups of *S. commersonianus* landed at Cochin Fisheries Harbour during August, September and October of 1982 and 1983.

Symposium on Warmwater Zooplankton: 450-459). Due to lack of descriptions regarding the specific identity of early juvenile stages in other species of queenfishes, the above study assigning larval and juvenile stages to *C. sanctipetri* appears to be not valid. It is more likely that the species referred to is *S. commersonianus* the predominant species along the Kerala coast. Moreover, from the indicated spawning period *i.e.* March-April it appears that the queenfishes have a restricted spawning period. But the availability of young ones of queenfishes for a longer period in trawlers and drift gill netters at the Cochin Fisheries Harbour does not support this view.



HEAVY LANDINGS OF PRAWN (*METAPENAEUS DOBSONI*) BY PURSE-SEINERS AT PANAJI—GOA*

In Goa the purse-seiners are operated mostly in Panaji, Vasco-da-Gama, Balina, Colva, Cotbona, Betul and Talpona centres. Out of these Panaji and Cotbona are the major purse-seine landing centres, where more than 30 seiners are in operation. The area of fishing is northwest off Panaji-Calangute belt in 20-25 m depth zone.

On 19th September, 1984 during routine observations for the biological studies of pelagic fishes caught by purse-seines at Panaji, unusually heavy catches of penaeid prawns exclusively of *Metapenaeus dobsoni* were found landed by purse-seiners. The trend continued till 24th September, 1984 (Table 1A). On an average of 600-700 kg of prawns were landed by each boat/trip during six days of fishing.

In the subsequent year also instances of heavy landings of penaeid prawns were observed for purse-seine on three occasions. (Table 1B).

*Reported by G. M. Kulkarni, T. S. Balasubramanian and S. Kemparaju, Field Centre of CMFRI, Goa.

TABLE 1A

Date	No. of purse seines operated	Penaeid prawns (kg)	CPUE	Estimated value (Rs.)
19-9-'84	18	8,535.0	474.17	76,815.00
20-9-'84	22	12,100.0	550.00	1,08,900.00
21-9-'84	22	14,879.9	576.36	1,33,919.10
22-9-'84	24	21,360.0	890.00	1,92,240.00
23-9-'84	22	13,948.0	634.00	1,25,532.00
24-9-'84	18	3,970.0	220.00	35,730.00
6 days	126	74,792.9	593.59	6,73,136.10

TABLE 1B

16-5-'85	1	1,400.0	—	12,600.00
23-9-'85	1	320.0	—	2,800.00
1-11-'85	1	600.0	—	5,400.00
3 days	3	2,320.0	—	20,880.00

