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Irrawaddy Dolphin

Orcaella brevirostris (Gray, 1866)

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Genus and Species

This tropical dolphin (Fig. 1) is little known despite its essentially coastal and riverine distribution and sometimes local abundance (e.g. see Heinsohn *et al.*, 1980; Tas'an and Leatherwood, 1984). Common names include Irrawaddy dolphin and Pesut Mahakam.

The taxonomy has a confused history. The generic name *Orcaella* was first used by Gray (1866) for a skull of *Phocaena* (Orca) *brevirostris* from Vizagapatam (Bay of Bengal) based on a description by Owen which was read to the Zoological Society of London in 1865. Owen (1869) published the original description and scientific name of his specimen. Anderson (1871) classified two specimens from the upper reaches of the Irrawaddy River in Burma as a separate species which he named *Orcella (sic) fluminalis*, claiming that this species occurs exclusively in fresh water and lives in the Irrawaddy and its tributaries north of Bhamo. Anderson (1879) drew

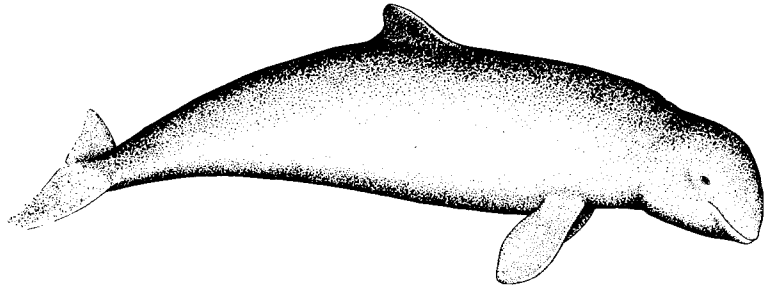

FIG. 1 The Irrawaddy dolphin, *Orcaella brevirostris*. Drawing by Geoff Kelly.

attention to the "streaked" skin of *O. fluminalis* which is not characteristic of *O. brevirostris*. Anderson also claimed that the dorsal fin of *O. fluminalis* is "rather smaller, lower and more falcate" than *O. brevirostris*.

Van Beneden and Gervais (1880), and Thomas (1891) could find no difference beween the river animals and those from the Bay of Bengal, and Norman and Fraser (1948) questioned whether there are two distinctive species. However, Ellerman and Morrison-Scott (1951) accepted *O. fluminalis* as a sub-species of *O. brevirostris*. R. Lloze (unpublished thesis, 1973) captured specimens from the non-tidal fluviatile reaches of the Mekong River (Kampuchea) in order to investigate the status of *O. fluminalis*. His study of these specimens and measurements from 24 crania from museums in Europe, Australia, and the USA provided statistical evidence that his freshwater specimens belong to the species *brevirostris*. Pilleri and Gihr (1974) summarized the taxonomic history of the genus and discussed the systematics of the forms of *Orcaella* from both the Irrawaddy River and marine habitats, and concluded that all the criteria quoted by Anderson (1879) as proof of the difference between river and marine forms are variable and therefore untenable. The present consensus is to recognize *O. brevirostris* as the only species in this genus (Mitchell, 1975; Honacki *et al.*, 1982).

Affinities

There is no general agreement about the systematic position of *Orcaella*. One view typified by Rice (1984) places *Orcaella* in the Globicephalinae (a subfamily of the Delphinidae) along with several other delphinids having a round forehead; i.e. *Feresa*, *Globicephala*, *Orcinus*, *Peponocephala*, and *Pseudorca*. This grouping is based on the morphology of the air sinus system (Fraser and Purves, 1960) and nasal tract (Mead, 1975). Mead, however, did not examine any specimen of *Orcaella*.

Nishiwaki (1963) classified *Orcaella* in the monotypic family Orcellidae (*sic*) on the basis of the progress of fusion of the cervical vertebrae and the shape of the rostral region. However, the former is unlikely to be a reliable taxonomic character as it seems to have arisen separately in several different lineages of toothed whales (Kasuya, 1973; Barnes, 1985).

Kasuya (1973) used the morphology of the typano-periotic bones to classify *Orcaella* into the monotypic subfamily Orcaellinae which he placed with the monotypic subfamily Delphinapterinae in the family Delphinapteridae. This grouping of *Orcaella* close to *Delphinapterus* has been followed by some taxonomists. However, unlike Kasuya, Gaskin (1982), Barnes (1984) and Barnes *et al.* (1985) have also included *Monodon* in the *Delphinapterus–Orcaella* group. Barnes (1984) suggested that the family Monodontidae should include three subfamilies—Orcaellinae, Delphinapterinae and Monodontinae. He also pointed out that monodontids were apparently significantly more diverse in the past, and that the temperate distribution of the fossil delphinapterid *Denebola brachycephala* and the Indo-Pacific distribution of *Orcaella brevirostris* suggest that there may have been a considerable number of warm and temperate adapted monodontids in the late Tertiary.

Fordyce (1984) cautioned against regarding *Orcaella* as representing an Australian white whale. He examined skulls and earbones of *Orcaella*, but remained unconvinced of monodontid affinities, pointing out that the skulls exhibit many (unspecified) features which suggest delphinid affinities.

A feature of the Monodontidae emphasized by True (1889) is the backward extension of the pterygoids in the form of broad plates across the optic canal to articulate with the squamosals. In contrast, the arrangement of these bones in *Orcaella* is more typical of the family Delphinidae in which the pterygoids do not articulate with the squamosals. However, it is doubtful whether the common possession of this primitive character indicates a phylogenetic relationship between *Orcaella* and the delphinids.

We conclude that the phylogenetic status of *Orcaella* needs further study, preferably in the context of a revision of the entire superfamily Delphinoidea including recently discovered fossil specimens.

External Characteristics and Morphology

Orcaella has a high, anteriorly convex forehead which overhangs the mouth. There is no beak. The blowhole is left of the midline. With only the first two cervical vertebrae fused, the neck of *Orcaella* is flexible and usually obvious particularly from the side, strikingly like the situation in *Delphinapterus* (Leatherwood and Reeves, 1983). Neck creases may be

present. The flippers are relatively large (about one-sixth as long as the body) with a gently curved leading edge. An obvious feature of the flippers is their relatively great breadth. The dorsal fin is small (8–10 cm high in an adult of body length 2.1 m or more) and triangular with a bluntly rounded tip, and a barely concave rear margin. The fin is situated behind the middle of the body. The flukes are notched and have a shallow concave trailing edge. The colour has been variously described as dark bluish grey, slate grey, battleship grey, or light grey. The ventral surface is usually lighter than the dorsal surface. Anderson (1879) reported that the colour of *O. fluminalis* was like that of *O. brevirostris* except that it was "streaked somewhat as in Risso's dolphin." Other regional colour variations have not been documented.

Anderson (1879) included measurements for two males of body lengths 2.19 m (86.05 in.) and 2.29 m (90 in.), and two females, one immature (1.8 m or 71 in.), the other gravid (2.09 m or 82.5 in). Pilleri and Gihr (1974) listed the measurements of three other animals, the largest being a 2.75-m male from Thailand. Two mature animals from the Mahakam River, Kalimantan measured 2.2 m (male) and 2.11 m (female), respectively (see Tas'an, A. Irwandy, Sumitro, and S. Hendrokusumo, unpublished report, 1980, which also includes details of the morphometrics of these animals). The two females from the Mekong River measured by R. Lloze (unpublished thesis, 1973) had body lengths of 1.90 and 2.0 m and weighed 80 and 87 kg, respectively. Body lengths are available for 15 animals from the Townsville area in northern Australia. The largest male was 2.35 m; the largest female 2.32 m (G. E. Heinsohn and H. Marsh, unpublished data). The smallest confirmed mature female was 2.17 m long and weighed 190 kg.

In the Asian parts of its range, the Irrawaddy dolphin is most likely to be confused with the finless porpoise, *Neophocaena phocaenoides*, which is smaller and lacks a dorsal fin. In northern Australia, *Orcaella* is often confused with the seacow, *Dugong dugon*, which lacks a dorsal fin and is a more robust shape.

Distribution

The Irrawaddy dolphin occurs in tropical and sub-tropical coastal waters and some major river systems of the Indo-West Pacific Region from the Bay of Bengal to the east Australian coast, between about 25° latitude north and south. Available records are summarized in Fig. 2. The range is likely to be more continuous than illustrated as the distribution is poorly documented. For example, although the species is common in northern Australia, it was not recorded until 1948 when two anthropologists found the skulls of animals that had been eaten by Aborigines in Arnhem Land

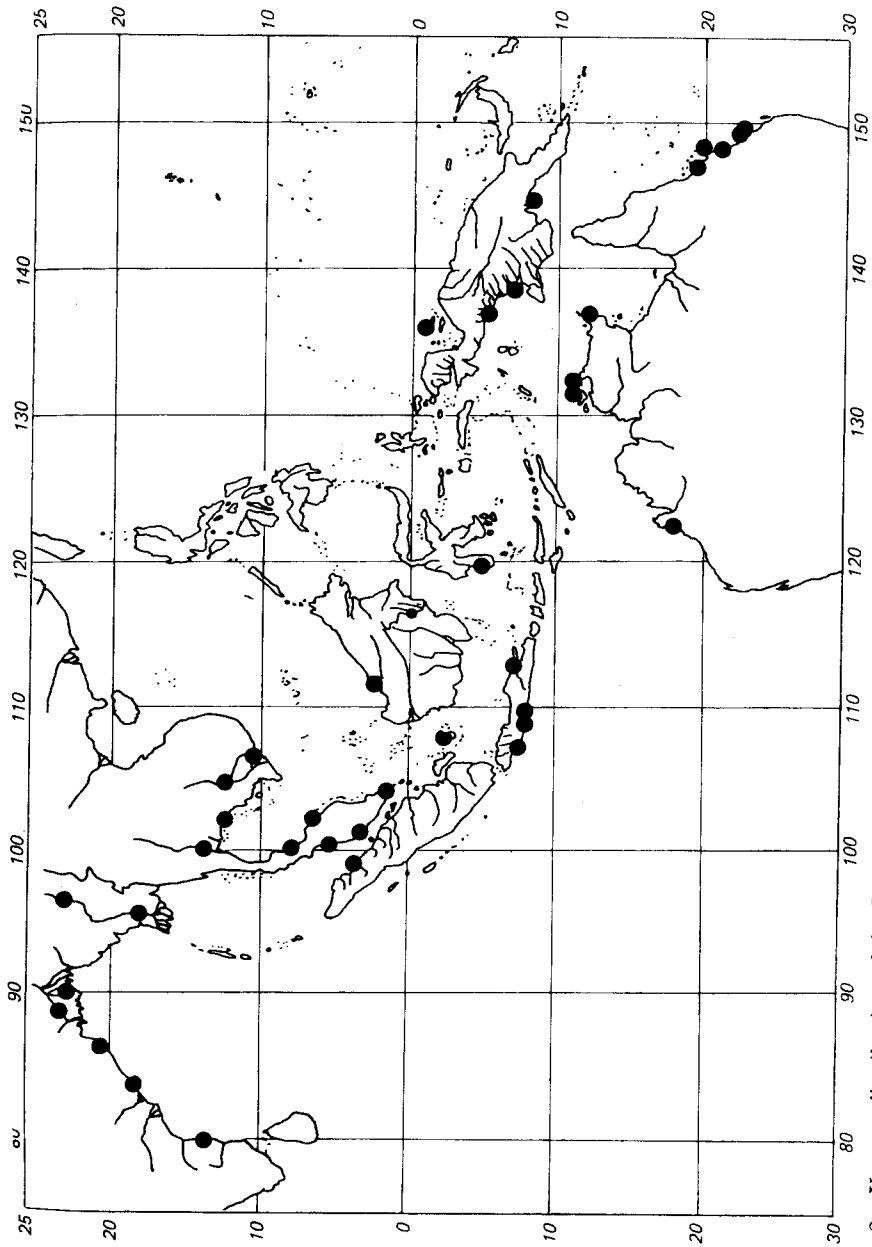

FIG. 2 Known distribution of the Irrawaddy dolphin, *Orcaella brevirostris*. Circles are specimen localities. Based on Morzer Bruyns (1966) with additional data from Dawbin (1972), R. Lloze (unpublished thesis, 1973), Pilleri and Gihr (1974), G. E. Heinsohn (unpublished report, 1979), Tas'an and Leatherwood (1984), Bayliss (1986). Unpublished records from the Western Australian Museum, the Queensland Museum, D. Humbree and H. Marsh have also been included.

(Johnson, 1964). Dawbin (1972) was the first to record *Orcaella* from the east coast of Australia and from the Gulf of Papua. G. E. Heinsohn (unpublished report, 1974, see also Mitchell, 1975) reported the occurrence of *Orcaella* in the Townsville area on the basis of animals drowned in local shark nets.

Irrawaddy dolphins are apparently riverine, estuarine, and coastal. There are some populations which are restricted to fresh water, and it is doubtful whether they venture very far offshore. Animals are found long distances from the sea in some of the great rivers of Asia, including the Irrawaddy and Mekong. Anderson (1879) and U Tin Thein (1977) recorded the presence of the dolphins at Bhamo (Burma) about 1300 km along the

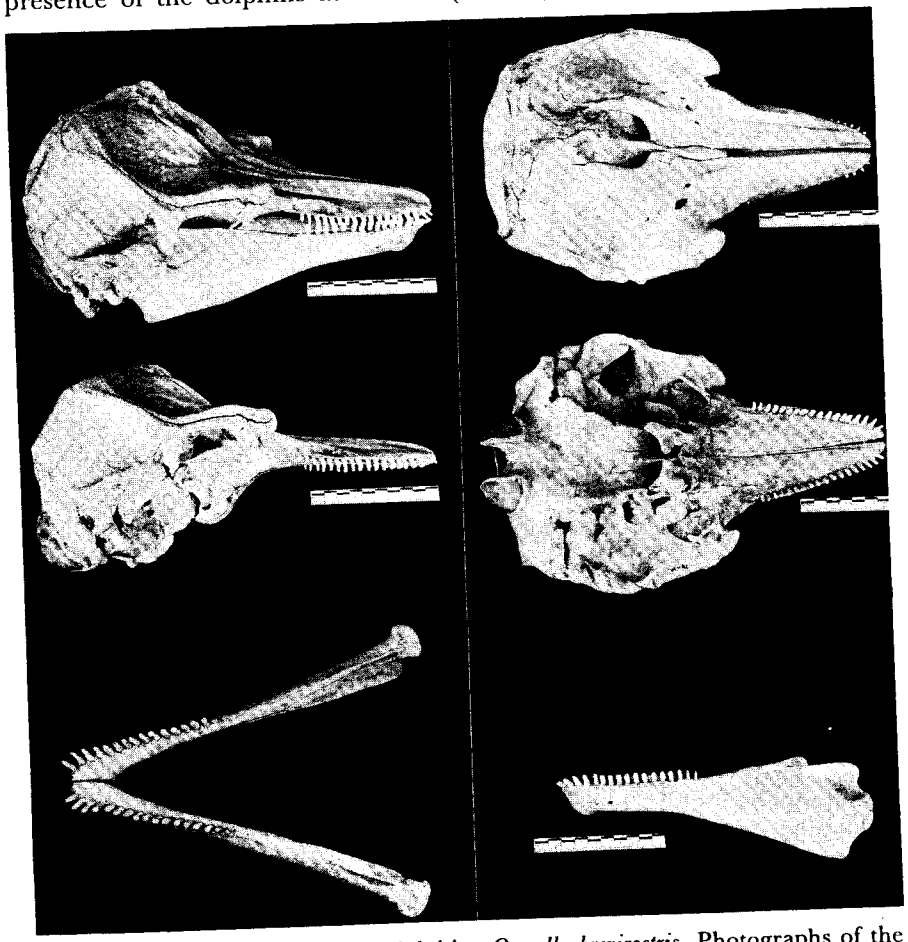

FIG. 3 Skull of the Irrawaddy dolphin, *Orcaella brevirostris*. Photographs of the skull of a 2.12-m male from Townsville, Australia. (Roger Yeldham photographs.)

Irrawaddy River from the mouth. Tas'an and Leatherwood (1984) described the distribution in Kalimantan (East Borneo). In this area, *Orcaella* used to be distributed in coastal waters near the mouth of the Mahakam River and upstream for at least 200 km. Substantial numbers still occur in some areas. For example, in Kalimantan in 1978 it was estimated that at least 100–150 animals inhabited the Semayang Lake, Pela River, and the adjacent Mahakam River. Similar groups are reported for Melintang and Jempang Lakes. However, the dolphins, presumably repulsed by the activity associated with the timber industry, do not now frequent the river below Muarakamen.

Internal Anatomical Characteristics

The skull (Fig. 3) is characterized by its globular shape, short rostrum, and broad facial region. The top of the braincase is formed anteriorly by the frontal bones, and posteriorly by the supra-occipital, these being widely separated by dorsal extensions of the parietals and a hastate interparietal. Other unusual features include the large crested mesethmoid which extends anteriorly beyond the level of the antorbital margins of the maxillaries, and the marked alate extensions of the palatines. In contrast to *Delphinapterus* and as in many delphinoids, the posterior ends of the maxillae rise above the plane of the rostrum. The premaxillae have a shallow concavity in front of the nares as in members of the Delphinidae. The mandibular symphysis is short relative to the length of the rami, a feature shared with *Monodon*, *Delphinapterus* and the Phocoenidae. The most complete description of the skull is given in Owen (1869). Selected cranial measurements of animals from several areas are presented in Table 1.

R. Lloze (unpublished thesis, 1973) reported that X-rays always reveal 68 teeth and that the dental formula is always (19–19)/(15–15). However, when 11 adult skulls from Townsville, Australia were examined visually, the number of teeth in a single upper jaw quadrant was found to vary from 17 to 20, while the corresponding number of lower teeth varied from 15 to 18, and the total tooth count from 66 to 77 (H. Marsh, unpublished data, 1985). The peg-like teeth have slightly expanded crowns and are about 1 cm long.

Nishiwaki (1963) and R. Lloze (unpublished thesis, 1973) reported that the vertebral column contains 62 or 63 vertebrae. Nishiwaki gave a vertebral formula of C_7, T_{13-14}, L_{13-14}, Ca_{27-28}; Lloze a vertebral formula of C_7, T_{13}, L_{16}, Ca_{26-27}. Again, data from Townsville indicate variability. The skeleton of a 1.94-m female (Accession No. James Cook University mm 1015) contains 59 vertebrae (C_7, T_{12}, L_{11}, Ca_{29}).

TABLE 1 Selected absolute skull measurements of Irrawaddy dolphins[a]

Locality, collection number(s), other details, source	Vizapatam Harbour (Bay of Bengal); BMNH 1865-4-20-1-1454 A; type of *Phocaena brevirostris* Owen (R. Lloze, unpublished thesis, 1973)	Irrawaddy River (Burma); BMNH 1877-12.10.17-1454 B; type *Orcella fluminalis* Anderson (R. Lloze, unpublished thesis, 1973)	Mekong River (Kampuchea); Phnom-Penh (Faculty of Sciences; OBKMC 1 and 2) (R. Lloze, unpublished thesis, 1973)	Songkhala Region (Thailand); T563 and Exp. No. 17 1973, Pilleri and Gihr (1974)	Townsville (Australia); James Cook University MM 32, 61, 81, 82, 88, 92 (G. E. Heinsohn and H. Marsh, unpublished data—ranges)
Sample size	1	1	2	2	6
Condylobasal length (mm)	282	278	302, 307	294, 300	304–318
			Percentages as a function of condylobasal length		
Length of rostrum	42.6	41.7	47.0, 46.5	41.2, 40.0	44.0–45.5
Width of rostrum at base	36.9	38.1	34.7, 37.1	37.1, 35.0	37.5–39.5
Width of rostrum at mid-length	22.7	24.8	21.5, 22.1	21.1, 30.0	21.7–23.6
Width of rostrum at three-quarter length	15.2	15.8	15.2, 14.6	13.3, 20.0	14.5–15.9
Breadth across pre-orbital angles of supra-orbital process	57.1	61.5	56.5, 57.0	55.8, 56.7	57.0–60.5
Breadth across post-orbital angles of supra-orbital process	65.6	68.0	65.5, 63.1	66.0, 68.3	64.6–67.8
Zygomatic width	65.6	66.9	66.2, 66.1	66.0, 68.3	63.5–67.5
Parietal width	51.4	52.9	50.0, 50.4	54.1, 53.3	48.4–54.6
Maximum width of pre-maxillae	28.7	27.7	27.1, 27.3	27.9, 26.7	24.3–26.8
Length of upper left tooth row	34.8	30.9	37.4, 37.5	32.3, 32.3	33.3–35.3
Length of lower left tooth row	—	28.8	33.4, 33.2	30.3, 31.7	33.6–36.3
Length of left ramus	—	75.5	76.9, 77.5	76.5, 75.0	75.0–78.3
Coronoid height of left ramus	—	22.7	24.1, 24.4	24.8, 25.0	22.7–25.2
Length of symphysis	—	10.4	10.6, 10.1	9.9, 8.3	6.6– 9.6

[a]See also R. Lloze (unpublished thesis 1973) and Pilleri and Gihr (1974).

The flipper has five digits, the bones of which are I_{2-3}, II_{7-8}, III_{5-6}, IV_3, V_{0-2} (Nishiwaki, 1963; R. Lloze, unpublished thesis, 1973; H. Marsh, unpublished data, 1985).

Various aspects of the visceral anatomy have been described by Anderson (1879) and R. Lloze (unpublished thesis, 1973). An apical bronchus emerges from the lower right aspect of the trachea; tracheal rings are complete except for the first two. Myo-elastic valves are present in the peripheral bronchial tree. Enlarged pulmonary and gastric lymph nodes occur.

There is no cardiac sphincter; the stomach is subdivided into compartments communicating through narrow orifices like the arrangement found in delphinids. There is a large duodenal ampulla. The intestine is uniform throughout its length, has no caecum and there are anal tonsils.

Each lobulated kidney has 364–382 (mean = 372) renculi, usually clustered in groups of four, but occasionally with as many as 11 in one group. Glomeruli are 120–140 μm in diameter. A muscular, medullary sporta is present. There are three muscular folds in the very long (40–60 mm) cervix uterus.

Behaviour

Stomach contents, food, and feeding

Based on the analysis of stomach contents of two animals from the non-tidal regions of the Mekong River, R. Lloze (unpublished thesis, 1973) reported that *Orcaella* feeds on fishes and shrimps (Table 2). Fishermen from this area reported to Lloze that these dolphins also feed on fish eggs and fry. The fishermen also alleged that *Orcaella* sometimes catches large fish for sport by stunning them with a blow from their lower jaw. The dolphins then play with the fish like a cat with a mouse before discarding them. Tas'an and Leatherwood (1984) reported that the freshwater population in Semanyang Lake (Kalimantan) feeds principally on carp.

Heinsohn *et al.* (1980) (see also G. E. Heinsohn, unpublished report, 1979) analysed the stomach contents of 10 *Orcaella* from coastal waters off Townsville, Australia. All stomachs contained fishes and in all cases fishes were the main food. Sixteen species of bony fishes from six orders and 13 families were found (see Table 2). In addition, all stomachs contained cephalopod remains (10 with squid, three with cuttlefish, and two with octopods), nine of the stomachs contained crustaceans (five with shrimps, two with isopods, and four with unidentified crustaceans). Some of the items of stomach contents may be incidental, e.g. isopods may cling to or enter carcasses; however, it appears that *Orcaella* is a generalist feeder, taking food both from the bottom and from within the water column.

TABLE 2 Fishes found in the stomachs of *Orcaella*

From two *Orcaella* from the non-tidal regions of the Mekong River, Kampuchea[a]

Order Siluriformes
- Family Pangasiidae
  - **Pangasius sanitvongsei* (Trey po pruy)
  - **Pangasius micronemus* (Trey pra)

Order Cypriniformes
- Family Cyprinidae
  - **Puntius javanicus* (Trey chpin)
  - **Cirrhinus auratus* (Trey pruol)
  - **Cirrhinus jullieni* (Trey riel)
  - **Dangilas siamensis* (Trey lenh)
  - **Thynnichthys thynnoides* (Trey link)

From ten *Orcaella* caught in the sea off Townsville, Australia[b]

Order Clupeiformes
- Family Engraulidae
  - **Stolephorus* sp. (Anchovy)
- Family Clupeidae
  - **Sardinella perforata* (Perforated scale sardine)
- Family Chirocentridae
  - **Chirocentrus dorab* (Wolf-herring)

Order Myctophiformes
- *Family Synodontidae (Grinner)

*Order Anguilliformes (Eels)

Order Beloniformes
- Family Hemirhamphidae
  - **Hemirhamphus* sp. (Garfish)

Order Pleuronectiformes
- Family Psettodidae
  - **Psettodes erumei* (Queensland halibut)

Order Perciformes
- Family Leiognathidae
  - **Leiognathus equulus* (Common pony fish)
  - **Secutor insidiator* (Pony fish)
  - **Leiognathus splendens* (Blacktip pony fish)
- Family Apogonidae
  - **Apogonichthyes* sp. (Cardinal fish)
- Family Nemipteridae
  - **Nemipterus* sp. (Butterfly bream)
- Family Pomadasyidae
  - **Pomadasys argyreus* (Silver javelin fish)
- Family Teraponidae
  - **Terapon puta* (Spiny-cheeked grunter)
- Family Sillaginidae
  - **Sillago* sp. (Whiting)
- Family Platycephalidae
  - **Platycephalus* sp. (Flathead)

[a]Data from R. Lloze (unpublished thesis, 1973).
[b]Data from G. E. Heinsohn (unpublished report, 1979).
* Indicates level of identification of individual specimens.

Swimming and diving capabilities

R. Lloze (unpublished thesis, 1973) noted that *Orcaella* can swim at 20–25 km hr^{-1} while being chased by a boat. P. Arnold (personal communication, 1985) reported that around Townsville (eastern Northern Australia), the dolphins are typically seen while surfacing slowly. The head may be arched upward exposing the blowhole. The animal then usually continues forward with a smooth slow roll. On deep dives, the tail-stock arches high so that the tail-stock and flukes break free of the water. Tail-slapping and partial jumps from the water with plunging re-entry have also been observed; however, animals have not been seen to leap entirely free of the water or to bow-ride. *Orcaella* is also sometimes seen in the wild moving backwards while in an erect position with the head and thorax out of the water (R. Lloze, unpublished thesis, 1973).

Nothing is known of the depths to which Irrawaddy dolphins can dive. Given their essentially coastal and riverine distribution, it seems unlikely that they have cause or opportunity to dive to considerable depths. R. Lloze (unpublished thesis, 1973) reported that, when not disturbed, an *Orcaella* typically respires three times in rapid succession and then dives for 30–60 sec, dive times being longer when the animals are frightened. Dive times have been recorded by Anderson (1879), Morzer Bruyns (1966), and R. Lloze (unpublished thesis, 1973); the maximum down time recorded is 12 min.

Like *Delphinapterus*, Irrawaddy dolphins can expel water from their mouths for distances of up to about 1.5 m in an especially coherent column of water that usually appears more cylindrical than the more diffuse spitting by delphinids (R. Lloze, unpublished thesis, 1973; Tas'an A. Irwandy, Sumitro, and S. Hendrokusumo, unpublished report, 1980; Jaya Ancol Oceanarium, Jakarta, Indonesia; Kamminga *et al.*, 1983).

Stranding

The only report is of a group of three animals which stranded alive at Thale Sap in the Gulf of Thailand in 1971. The animals were transferred to a pond but died two days later (Pilleri and Gihr, 1974).

Group size

Irrawaddy dolphins are usually seen in small groups which usually consist of less than six animals but which may contain up to 10–15 animals (Anderson, 1879; R. Lloze, unpublished thesis, 1973; Morzer Bruyns, 1966; Tas'an *et al.*, unpublished report, 1980, G. E. Heinsohn, unpublished report, 1979).

Vocalizations

Kamminga *et al.* (1983) reported on the vocalizations of several captive Irrawaddy dolphins including one animal born in captivity; the others had been caught in the Makaham River of East Kalimantan. The animals emitted short time-duration bandwidth signals of about 25–30 μsec duration. The main sonar signal was elementary, consisting of only a few cycles of a dominant frequency of around 60 kHz with small deviations. The pulse trains were rather regular in nature and small changes in the repetition rate were observed mostly in the order of 40–60 Hz. No audible whistles or pure tones have been recorded.

Life History and Reproduction

Lloze (unpublished thesis, 1973) reported that, according to Kampuchean fisherman, the courtship season is from March to June at latitude 11°–12°N, the fishermen observing copulation almost daily during this period. Fights between males are also often observed. Coitus is preceded by much play including chases or jumps with the partners often leaping out of the water, belly to belly. During coitus, the other members of the herd cruise around the mating pair.

Tas'an *et al.* (unpublished report, 1980) assumed that the mating season extended from April to June in the Semayang Lake/Mahakam River area of Kalimantan (0°–1°S). Calves from animals caught in this area have been born in captivity in Jakarta (6°S) in July and December.

Anderson (1879) described a 210-cm (82.5-in.)-long female apparently from the Bay of Bengal in the region of the estuaries of the Ganges River (about 22°N) with a large 86-cm-long foetus weighing 10.5 kg in June. A 2.17-m-long female with a near-term foetus (91 cm long and weighing 9.9 kg) was caught off Townsville (19°S) in August (G. E. Heinsohn, unpublished data).

Marsh and Kasuya used dentinal layer counts to estimate the ages of 18 *Orcaella* from Townsville, Australia. Because of tooth wear, minimum age estimates only are available for five animals (of both sexes) with 19 or more dentinal layers. The greatest number of layers (28) was counted in the teeth of one animal of each sex (data listed in G. E. Heinsohn, unpublished report, 1979). By analogy with other Odontocetes, this suggests that Irrawaddy dolphins may live for at least 30 or so years.

The age of sexual maturity is unknown, but data from Townsville suggest that at least some animals reach an approximately adult size (2.1 m, see

External Characteristics and Morphology above) by the time they are 4–6 years old (G. E. Heinsohn, unpublished report, 1979).

A female was born in captivity in Jakarta after a gestation period estimated (from the time between last observed mating and parturition) to be 14 months. The neonate was 96 cm long and weighed 12.3 kg (Tas'an *et al.*, unpublished report, 1980). It was born 12 days after milk was first seen discharging from its mother. The tail was observed protruding from the genital slit more than 2 hr before the calf was born. The birth sequence was illustrated in Tas'an and Leatherwood (1984) (see also Figure 4). The calf started suckling 12 hr after birth and eating dead fishes at the age of 6 months. It was fully weaned by age 2 years (Tas'an, personal communication, 1985). During the 7 months after its birth, this calf increased in length by 57 cm (59%), and in weight by 32.7 kg (266%) (Tas'an *et al.*, unpublished report, 1980).

There is no information on the population dynamics of this species.

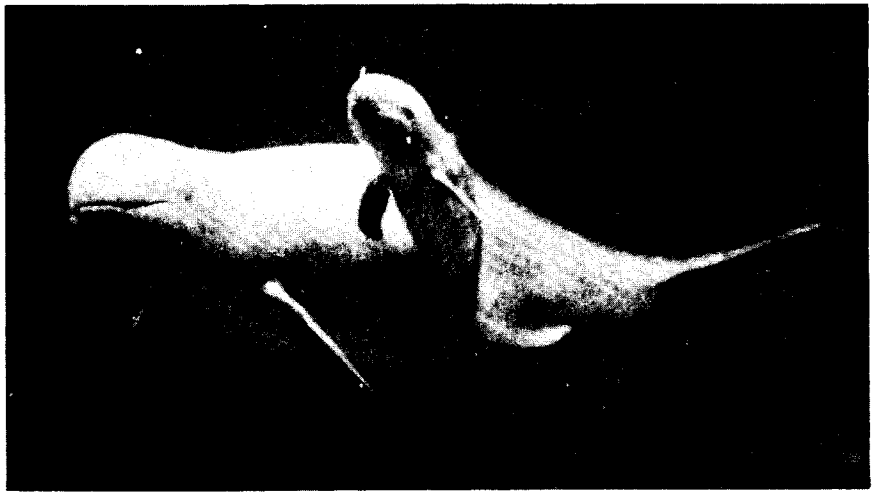

FIG. 4 Irrawaddy dolphin with her newborn calf which was born at the Jaya Ancol Oceanarium, Jakarta, Indonesia (Jaya Ancol Oceanarium photograph).

Diseases and Parasites

The only information on diseases is from captive animals. The results of six necropsies have been detailed by Tas'an *et al.* (unpublished report, 1980). Animals variously suffered from gastric ulcers, cirrhosis of the liver, heart weakness, and pulmonary infections. In most cases, the major problem appeared to have been caused by stress. Live animals have been examined

with fungal diseases of the skin, diarrhoea, respiratory disorders, and tonsilitis (Tas'an *et al.*, unpublished report, 1980).

Cobbold (1876) reported a single specimen of the trematode *Distoma lancea* (= *Amphimerus lancea*, *fide* Barker, 1911) from the duodenum of an *Orcaella brevirostris* collected in the "North-eastern Province of India". More recent citations of *Orcaella* as a host for *A. lancea* (e.g. Baylis, 1932; Dailey and Brownell, 1972) appear to be based entirely on this report. Price (1932) noted that Cobbold's illustration and brief description were "quite different" from descriptions of *A. lancea* based on specimens from the original host, a freshwater dolphin (?*Sotalia* sp.) from Brazil. This record needs confirmation, as does the record of unidentified "ascaroid" nematodes from the stomachs of *Orcaella* from the Townsville area in northern Australia (G. E. Heinsohn, unpublished report, 1979).

Human Effects

Relationship with man

There are reports from various parts of Asia of the relationship between *Orcaella* and the local fishermen. In some areas, the dolphins are reputed regularly to assist fishermen by driving fish into their nets (see Anderson, 1879; R. Lloze, unpublished thesis, 1973; U Tin Thein, 1977). In other areas (see R. Lloze, unpublished thesis, 1973; Tas'an *et al.*, unpublished report, 1980), the dolphins are apparently seen as competitors by the fishermen who sometimes fear them because they can damage their nets. Khmer and Vietnamese fishermen regard *Orcaella* as sacred animals, and release them if they become entangled in fishing nets. In contrast, Khmer-Islam fishermen kill them for food. The dolphins are reputed to have learnt to distinguish between the languages of these different communities, and are much more cautious about approaching the Khmer-Islam fishermen (R. Lloze, unpublished thesis, 1973).

Fishing and fishery effects

Haque (1982) reported that there is no organized fishery for Irrawaddy dolphins in Bangladesh because "of the favourable attitude of the fisherman for them", but that they are sometimes accidentally entangled in fishing nets. However, Irrawaddy dolphins were being eaten by Australian Aborigines in Arnhem Land in 1948 (Johnson, 1964).

Dawbin (1972) reported that Irrawaddy dolphins are taken in fishing nets in the Gulf of Papua. They are also the most common species taken

in shark nets set for bather protection near Townsville, Australia (G. E. Heinsohn, unpublished reports, 1974 and 1979). At least one Irrawaddy dolphin has been taken in a developing Australian-based gillnet fishery for sharks off the Northern Territory, Australia (Australian Progress Report to the International Whaling Commission, 1985).

Captivity

Animals have been held in captivity at the Cairns Oceanarium (Australia), and at the Jaya Ancol Oceanarium, Jakarta and the Surabaya Zoo (Indonesia). The programme at the Jaya Ancol Oceanarium has been particularly successful, two of the captive females having conceived and given birth to live healthy young (Tas'an and Leatherwood, 1984). Tas'an *et al.* (unpublished report, 1980) described the holding conditions at Jaya Ancol and the capture technique used. Some of the animals have been trained and proved quick to learn show behaviours.

Concluding Remarks

Further study of this genus would seem timely, in view of the availability of an established breeding colony of captive animals in Jakarta (Tas'an and Leatherwood, 1984), the regular sighting of wild animals off relatively accessible parts of northern Australia (Bryden, 1978; G. E. Heinsohn and H. Marsh personal observations; W. J. Freeland, personal communication, 1985), and the accumulation of skeletal material at James Cook University, Townsville, Australia. A review of the taxonomy of the genus, a study of the natural history of a wild population, and a comparative study of the biology of *Orcaella* and *Delphinapterus* should be particularly fruitful.

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