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Lagenodelphis hosei.

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Lagenodelphis Fraser, 1956

Lagenodelphis Fraser, 1956:496. Type species *Lagenodelphis hosei* Fraser, by original designation.

CONTEXT AND CONTENT. Order Cetacea, Suborder Odontoceti, Family Delphinidae. Many cetologists also recognize the subfamily Delphininae, which includes this species (Barnes et al., 1985). The genus *Lagenodelphis* contains only one species, *L. hosei*, with no recognized subspecies.

Lagenodelphis hosei Fraser, 1956

Fraser's Dolphin

Lagenodelphis hosei Fraser, 1956:496. Type locality "mouth of the Lutong River, Baram, Borneo [Sarawak]."

CONTEXT AND CONTENT. See generic account above.

DIAGNOSIS. The skull of Fraser's dolphin (Fig. 1) is similar in some ways to that of common (*Delphinus delphis*), spinner (*Stenella longirostris*), clymene (*S. clymene*), and striped (*S. coeruleoalba*) dolphins, but has a broader rostrum than any of these species. Condylobasal length (CBL) of adults measured thus far ranged from 401–456 mm (Perrin et al., 1994). There are 36–44 slender, sharply-pointed teeth in each upper tooth row, and 34–44 in each lower row (Perrin et al., 1994).

The vertebral formula is 7 C, 15–16 T, 20–24 L, 34–39 Ca, with a total of 78–81 (Perrin et al., 1994). The atlas and axisare fused (Miyazaki and Wada, 1978*a*). There are 15 ribs; 4–5 of these are two-headed (Fraser, 1956; Miyazaki and Wada, 1978*a*). The phalangeal formula is I2, II9, III6–7, IV3, V2 (Fraser, 1956; Tobayama et al., 1973).

GENERAL CHARACTERS. Width of the rostrum, measured at its base, represents 27–31% of CBL (Hersh and Odell, 1986; Miyazaki and Wada, 1978*a*; Perrin et al., 1994); rostral length is 53–56% of CBL (Perrin et al., 1994). The rostrum is flattened, with the premaxillae only slightly raised above the adjacent maxillae (Fraser, 1956). There is a pair of deep palatal grooves, similar to those in *Delphinus* (Fraser, 1956). The premaxillae are in contact, or nearly so, along the dorsal midline (Fraser, 1956; Perrin et al., 1973), and there is distal fusion of the maxillae and premaxillae in adults (Perrin et al., 1994). The temporal fossae are relatively small (Perrin et al., 1994). The short mandibular symphysis represents <11% of CBL.

Fraser's dolphins are generally more robust than other small delphinids, with short beaks and small appendages (Fig. 2). They reach a maximum length of at least 270 cm (Bryden and Barry, 1980) and a maximum mass of 209 kg (Perrin et al., 1973). The beak is extremely short, but well-defined, as in dolphins of the genus *Lagenorhynchus*; in adults it ranges from 3 to 6 cm (Perrin et al., 1994), representing <3% of the total length (Ross, 1984). The subtriangular to weakly falcate dorsal fin, pointed flippers, and concave flukes are all relatively small, compared with those of other dolphins. The dorsal fin reaches a maximum known height of 22 cm (Perrin et al., 1973), and represents <9% of the total length. Flipper length and flukespan represent about 10–13% and 20–24% of the total length, respectively.

There is a dark bluish to brownish-gray dorsal cape, a pale gray flank, and a white to pinkish belly (Fig. 2). The lower sides may appear cream-colored in good lighting. The most conspicuous feature of the color pattern often is a wide dark gray to black stripe extending from the eye to the anus. This stripe is set off from the surrounding areas by thin pale cream-colored borders. There also is a dark chin-to-flipper stripe. In some large animals the eye-to-anus stripe may be so broad as to form a dark "mask" in the facial area (see Perrin et al., 1973:Fig. 1*f*). A "delphinid bridle" (terminology of Mitchell, 1970), consisting of an eye patch, eye stripe, blowhole stripe, and lip patch, is present (Perrin et al., 1973). The flippers, dorsal fin, and flukes are all dark gray, although in some individuals there may be a pale patch in the center of the dorsal fin (Perrin et al., 1973).

Sexual dimorphism in total length and mass has not been demonstrated. Adult males appear to have larger, more erect, dorsal fins than do other age and gender classes (Perrin et al., 1994). Some individuals with prominent post-anal humps have been observed;

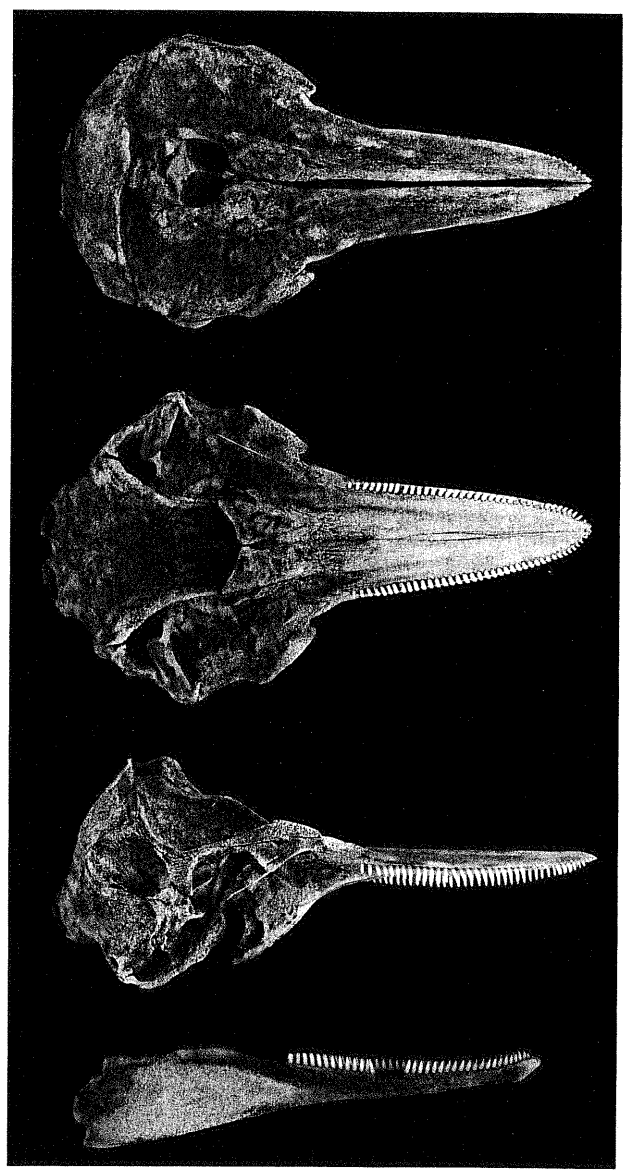

FIG. 1. Dorsal, ventral, and lateral views of the cranium, and lateral view of the mandible of a 206-cm adult female Fraser's dolphin from the eastern tropical Pacific (Southwest Fisheries Science Center LGP 179). Condylobasal length is 401 mm. Photos courtesy of W. F. Perrin.

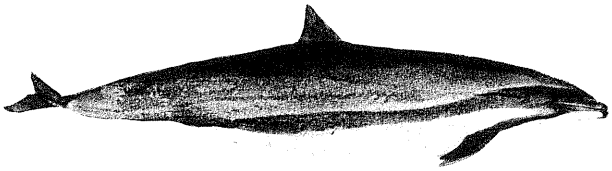

FIG. 2. Adult female Fraser's dolphin (236 cm) from South Africa (PBB71/3, SAM 36322), showing body shape and color pattern. Photo by P. B. Best.

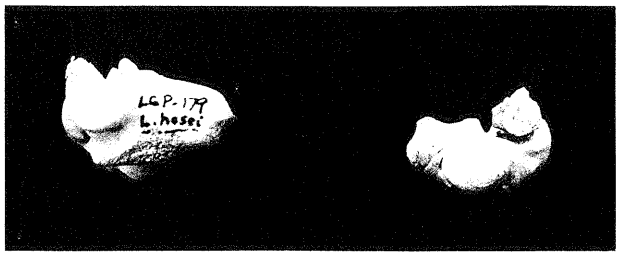

FIG. 4. Tympanoperiotic bones of Fraser's dolphin from a cranially adult female (SWFSC LGP 179): right tympanic bulla with periotic attached (left) and left periotic (right).

based on what is known of other species with this feature, these are probably adult males (see Perrin et al., 1973:Fig. 1*g*; Tobayama et al., 1973:Plate 1). In young animals, as is true in many species of small cetaceans, the color pattern is muted. In particular, the dark eye-to-anus stripe is barely visible in young and small juveniles. The development of this stripe is highly variable; in some adult-sized animals it is very faint or thin. There may be sexual dimorphism in the color pattern of the urogenital area (Miyazaki and Wada, 1978*a*).

DISTRIBUTION. Fraser's dolphin is found primarily in tropical and subtropical oceanic waters of the world (Fig. 3). The majority of records are from 30°N to 30°S. Strandings in temperate regions are considered extralimital and are usually associated with anomalously warm water temperatures (van Bree et al., 1986; Perrin et al., 1994; Praderi et al., 1992). The range of this species is well-documented only in the eastern and central tropical Pacific (Perrin et al., 1994) and around the central Visayas, Philippines (Leatherwood et al., 1992); in all other areas there are only sporadic records. There is no fossil record for this genus.

FORM AND FUNCTION. There has been very little research on the anatomy and physiology of Fraser's dolphins. Width of the rostrum and skull are apparently broader in males than in females (Miyazaki and Wada, 1978*a*), and the sternum has three pieces (Tobayama et al., 1973). The teeth resemble those of *Delphinus* and *Stenella* (Ross, 1984). The tympanoperiotic bones (Fig. 4) show some affinity to those of *Stenella*, but are most similar to those of *Lagenorhynchus* (Fraser, 1956). In adults there is some sexual dimorphism in the structure of the pelvic bones (van Bree et al., 1986).

The facial anatomy of this species is similar to that of other delphinids (Mead, 1975). The lower lobe of the lung may be more squared-off than that of other species, but this observation is based on only one specimen (Tobayama et al., 1973).

ONTOGENY AND REPRODUCTION. Almost nothing is known of the reproductive biology of this species. Available information suggests a length at birth of about 1 m (Perrin et al., 1994). As expected, this tropical dolphin does not show strong evidence of seasonality in calving. Although a summer breeding peak has been suggested for off South Africa, based on sightings of young (Ross, 1984), this conclusion should be viewed with caution because there were no records from other seasons. Sexual maturity in both genders was found to occur at about 230 cm length and 7 years of age in the eastern North Atlantic Ocean (van Bree et al., 1986). Sparse data from other areas seem to support this assessment (Miyazaki and Wada, 1978*a*; Perrin and Reilly, 1984; Praderi et al., 1992; Robison and Craddock, 1983; Ross, 1984), although adult females as short as 206 cm in length have been recorded (Perrin et al., 1994). The gestation period is unknown, but based on what is known of other delphinid species, it is probably 10–12 months (Perrin and Reilly, 1984). The length of lactation also is unknown.

ECOLOGY. There is no known predation, but killer whales (*Orcinus orca*), false killer whales (*Pseudorca crassidens*), and large sharks are probably at least occasional predators. Circular wounds, thought to be caused by cookie-cutter sharks (*Isistius brasiliensis*), have been found on dolphins of this species (Perrin et al., 1973).

Fraser's dolphins often are found with other species of cetaceans, particularly melon-headed whales (*Peponocephala electra*), with which they have been seen in the eastern and western tropical Pacific, Philippines, and Gulf of Mexico (Au and Perryman, 1985; Hammond and Leatherwood, 1984; Leatherwood et al., 1992, 1993; Miyazaki and Wada, 1978*b*; Perrin et al., 1994). They have also been observed with sperm whales (*Physeter catodon*), short-finned pilot whales (*Globicephala macrorhynchus*), false killer whales, Risso's dolphins (*Grampus griseus*), pantropical spotted dolphins

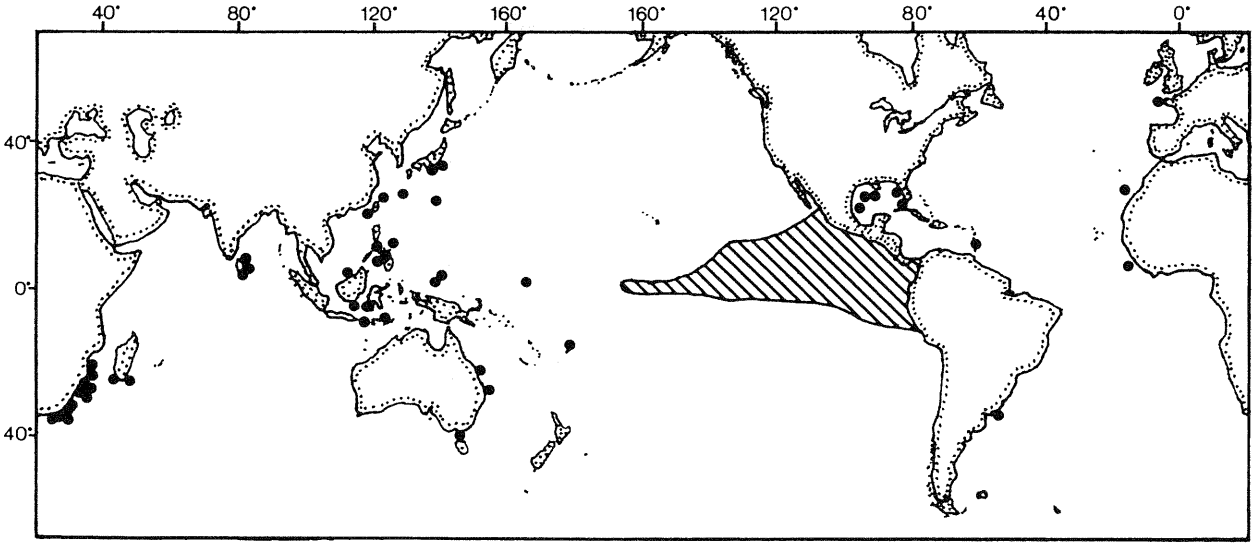

FIG. 3. Distribution of Fraser's dolphin, modified from Perrin et al. (1994) to include additional records from South Africa (Findlay et al., 1992), and the Gulf of Mexico (Leatherwood et al., 1993). The range in the eastern tropical Pacific is shaded because it is well-known.

(*Stenella attenuata*), spinner dolphins, and striped dolphins (Leatherwood et al., 1992; Perrin et al., 1994).

The only record of ectoparasites from this species is of *Xenobalanus* sp. on a live-stranded Fraser's dolphin from Florida (Leatherwood et al., 1993). Internal parasites recorded from Fraser's dolphins include: *Phyllobothrium delphini* and unidentified cestodes in the blubber (Testa and Dailey, 1977; Tobayama et al., 1973; van Bree et al., 1986); *Monorygma grimaldi* in the urogenital musculature and colon mesenteries (McColl and Obendorf, 1982; van Bree et al., 1986); *Anisakis simplex* and unidentified nematodes in the stomach (McColl and Obendorf, 1982; Tobayama et al., 1973; van Bree et al., 1986); *Tetrabothrius* sp. in the stomach, pylorus, and duodenum (McColl and Obendorf, 1982; Tobayama et al., 1973); *Bolbosoma* sp. in the intestines (Tobayama et al., 1973); *Strobicephalus triangularis* and unidentified Tetrabothriidae in the digestive tract (Raga, 1985; van Bree et al., 1986); unidentified trematodes in the liver (McColl and Obendorf, 1982); *Campula* sp. in the pancreas (McColl and Obendorf, 1982); *Stenurus ovatus* in the lungs (McColl and Obendorf, 1982); ova of unidentified trematode in the blowhole sinuses (McColl and Obendorf, 1982); and unidentified nematodes in the ear cavities (Miyazaki and Wada, 1978*a*).

There are many records of sightings of Fraser's dolphins in the eastern tropical Pacific, due largely to the intensive research effort associated with the tuna/dolphin fishery in that area. Fraser's dolphins are much less common than the main dolphin targets of the tuna fishery; pantropical spotted dolphins are about 50 times more common, and spinner dolphins about 23 times more common (Barlow and Holt, 1986). Based on line transect analysis of sightings during a series of research cruises, there are estimated to be about 289,000 Fraser's dolphins in the eastern tropical Pacific (Wade and Gerrodette, 1993). There are no estimates of abundance available for other areas; however, Fraser's dolphins have been reported to be common around the central Visayas, Philippines (Hammond and Leatherwood, 1984; Leatherwood et al., 1992), and appear to be at least moderately common off South Africa (Gambell et al., 1975; Findlay et al., 1992).

This species is distributed mainly in upwelling-modified water with variable conditions in the offshore eastern tropical Pacific (Au and Perryman, 1985). In the central Visayas, Philippines, Fraser's dolphins are seen near shore, along the outer continental shelf or slope, and in deep oceanic waters (Leatherwood et al., 1992). Most South African records are from the summer months, and Fraser's dolphins have a localized occurrence associated with the Agulhas Current (Ross, 1984; Findlay et al., 1992). Habitat studies have not been reported elsewhere.

Single and mass strandings of Fraser's dolphins have been documented, and several live strandings have been recorded (Anonymous, 1972; Tobayama et al., 1973). Lungworms and trematode ova (possibly *Nasitrema* sp., a known mortality factor that parasitizes the pterygoid sinuses and middle ears) in the blowhole may have been a factor in the stranding of two specimens from Australia (McColl and Obendorf, 1982).

Fraser's dolphins are thought to feed primarily on mesopelagic fish and squid, but they also take shrimps, cuttlefish, isopods, and some benthic fish (Caldwell et al., 1976; Robison and Craddock, 1983; van Bree et al., 1986). There appears to be little evidence of surface feeding, which correlates well with the scarcity of reported associations with birds and tuna in the eastern tropical Pacific (Au and Pitman, 1986, 1988), but Fraser's dolphins have been seen feeding near the surface in association with birds off southeastern Africa (Ross, 1984). Most of the fish from the stomachs of three individuals taken in the eastern tropical Pacific indicated that the dolphins had been feeding at depths of 250–500 m and preyed upon certain species selectively (Robison and Craddock, 1983). Fraser's dolphins may feed at night on vertically migrating organisms (Tobayama et al., 1973). The prey items documented include fishes of the families Malacosteidae, Serrivomeridae, Argentinidae, Bathylagidae, Opisthoproctidae, Gonostomatidae, Sternoptypchidae, Photichthyidae, Chauliodontidae, Stomaitidae, Alepocephalidae, Paralepididae, Evermannellidae, Scopelarchidae, Scopelosauridae, Myctophidae, Neoscopelidae, Bregmacerotidae, Melanonidae, Melamphaidae, Diretmidae, Anoplogasteridae, Chiasmodontidae, Nomeidae, Coryphaenoididae, Moridae, Gadidae, Brotulidae, and Macrouridae (Perrin et al., 1994; Robison and Craddock, 1983; Sekiguchi et al., 1992; Tobayama et al., 1973; van Bree et al., 1986). Squid families represented in stomach contents include Chiroteuthidae, Histioteuthidae, Octopoteuthidae, Gonatidae, Loliginidae, Ommastrephidae, and Onychoteuthidae (Sekiguchi et al., 1992; Tobayama et al., 1973).

Fraser's dolphins are at least occasional victims of direct fishing. They are killed in drive fisheries in Japan (International Whaling Commission, in press) and Taiwan (Hammond and Leatherwood, 1984), although part of a school of dolphins captured in 1991 in Japan was released, partly due to public outcry. Fraser's dolphins are taken by harpoon and spear in Sri Lanka (Leatherwood and Reeves, 1989), the Lesser Antilles (Caldwell et al., 1976), Fiji (Baker, 1990), and the Philippines (International Whaling Commission, in press). Specimens have been observed for sale in fish markets in Taiwan (Tobayama et al., 1973) and the Philippines (Dolar, in press). Some direct fishing also occurs in Indonesia (Barnes, 1991; Perrin et al., 1994), and a few have been taken for scientific research in the western Pacific (Miyazaki and Wada, 1978*a*) and off South Africa (Ross, 1984).

Incidental catches are known in some areas as well. Relatively small numbers are taken in tuna purse seines in the eastern tropical Pacific (Perrin et al., 1973). A total of 773 was estimated to have been killed between 1971 and 1977 (Horwood, 1981; T. D. Smith, in litt.), and 125 were observed taken between 1986 and 1989 (Hall and Boyer, 1989, 1990, 1991; Whalen et al., 1988). Some also are taken in purse seines in the Philippines, and in trap nets in Japan (Dolar, in press; International Whaling Commission, in press). Catches in gillnets occur in South Africa (Cockcroft, 1990), Sri Lanka (Leatherwood and Reeves, 1989; Prematunga et al., 1986), Japan (International Whaling Commission, in press; Uchida, 1985), the Philippines (Dolar, in press; International Whaling Commission, in press; Leatherwood et al., 1992), and probably elsewhere.

Sixteen Fraser's dolphins were live-captured (intended for display in Hong Kong) in the Philippines between 1974 and 1975 (Hammond and Leatherwood, 1984), and one specimen caught in a gillnet in Japan was taken to an oceanarium, where it survived for 20 days (Uchida, 1985). Fraser's dolphins, like most oceanic species, do not survive well in captivity.

Very little work has been done on pollutant levels in tissues of Fraser's dolphin. Levels of organochlorines (PCBs and DDT) in the blubber and muscle of a single specimen from the eastern tropical Pacific have been reported. Overall, the levels were near the lower ends of the ranges reported for other dolphins from the same region (O'Shea et al., 1980).

There have been few studies in which workers have estimated ages of Fraser's dolphins. Based on dentinal growth layer groups (GLGs), the maximum known age of 10 specimens from the northeast Atlantic was 16 years (van Bree et al., 1986).

BEHAVIOR. Most sightings of Fraser's dolphins have been of groups of between 100 and 1,000 individuals (Perrin et al., 1994). Groups as small as three have been observed off Mexico (Aguayo and Sanchez, 1987), but these were likely part of a larger herd. Herds estimated at 2,500 individuals have been observed in the eastern tropical Pacific (Donovan, 1984). These large herds often include melon-headed whales. Social bonds among Fraser's dolphins appear tighter than those of dolphins of the genus *Stenella* (Perrin et al., 1994). Most groups contain mixed age classes, and several mass strandings included both mature and immature individuals of each gender (Praderi et al., 1992; van Bree et al., 1986). The largest known mass stranding consisted of at least 17 individuals (Hersh and Odell, 1986).

Fraser's dolphins are often seen in large, fast-moving herds, with individuals porpoising in low-angle, splashy leaps. They always "run" from approaching ships in the eastern tropical Pacific (as do most other dolphins that have been harassed by tuna seiners—Perrin et al., 1994), and they frequently evade vessels in the Philippines (Leatherwood et al., 1992). This behavior may be a direct result of chases involved in harpooning and purse seine fishing, and may not be their normal response to vessels. When escaping, they may reach speeds of 28 km/h or more, and can be elusive. At other times, they may move slowly (4–7 km/h), with little aerial activity (Alling, 1986). Although they never bow ride in the eastern tropical Pacific, in other areas they may do so, or at least some individuals may approach the bow briefly (Hammond and Leatherwood, 1984; Leatherwood et al., 1993; Miyazaki and Wada, 1978*b*). They have been

described as "often engaged in energetic aerial activity" off the Philippines (Hammond and Leatherwood, 1984:491).

Vocalizations of this species have been recorded in the Philippines, eastern tropical Pacific, Gulf of Mexico, and Caribbean Sea. Echolocation clicks and whistles similar to those of *Stenella* sp. have been described from recordings in the Gulf of Mexico (Leatherwood et al., 1993).

GENETICS. The karyotype has not been described and there is nothing known of the genetics of this species.

REMARKS. Fraser (1956) stated that Charles Hose found the type specimen, and Fraser named the species after him. Harrisson (1957), however, clarified that the type had in fact been discovered by Charles' brother, Ernest. The genus name, *Lagenodelphis*, refers to its morphological affinity with both *Lagenorhynchus* and *Delphinus*. Fraser's dolphin is the most recently discovered species in the family Delphinidae. This species was known for 17 years from only a single skeleton (Fraser, 1956), until it was "rediscovered" in the early 1970s by Perrin et al. (1973), who provided the first descriptions of its external appearance.

Other common names used for this species include: white porpoise, Sarawak dolphin, Hose's Sarawak dolphin, Fraser's Sarawak dolphin, Bornean dolphin, shortsnout dolphin, short-snouted whitebelly porpoise/dolphin, *malayziyskiy delfin* (Russian), *saravakskiy delfin* (Russian), *korotkolyuvyy delfin* (Russian), *delfin Freyzera* (Russian), *delfin Frazera* (Russian), *sarawak iruka* (Japanese), *dauphin de Fraser* (French), *delfin de Fraser* (Spanish), *delfin botella* (Spanish), and *mayahon* (in the Philippines).

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