

Stenella coeruleoalba. By Frederick I. Archer II and William F. Perrin

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Stenella Gray, 1866

- Clymene* Gray, 1864:237. Type species *Delphinus euphrosyne*. Subgenus of *Delphinus* Linnaeus. Not *Clymene* Lamarck, 1818 or *Clymene* Savigny, 1822, both polychaetes.
- Stenella* Gray, 1866b:213. Type species, *Steno attenuatus*. Subgenus of *Steno* Gray.
- Euphrosyne* Gray, 1866b:214. Type species, *Clymene euphrosyne*. Subgenus of *Clymene* Gray. Not *Euphrosyne* Miegen, 1800, a dipteran.
- Clymenia* Gray, 1868a:6. Type species *Delphinus longirostris*. Not *Clymenia* Savi, 1818, a genus of Vermes (worms); or Munster, 1834, a mollusk; or Orsted, 1844, a worm.
- Micropia* Gray, 1868a:6. Type species *Clymenia stenorhyncha* (= *Delphinus microps* Gray).
- Prodelphinus* Gervais, 1880:604. A substitution for *Clymenia* Gray.
- Fretidelphis* Iredale and Troughton, 1934:65. Type species *Delphinus roseiventris* Wagner (= *Delphinus longirostris* Gray).

CONTEXT AND CONTENT. Order Cetacea, Suborder Odontoceti, Superfamily Delphinoidea, Family Delphinidae, Subfamily Delphininae (Barnes, 1990). The genus *Stenella* currently contains five extant species (Mead and Brownell, 1993): *S. attenuata*, *S. clymene*, *S. coeruleoalba*, *S. frontalis*, and *S. longirostris*. *S. attenuata*, *S. frontalis*, *S. coeruleoalba*, and *S. longirostris* were originally placed in *Clymenia* (Flower, 1884) but were later moved to *Prodelphinus* (Flower, 1885) as the previous name was occupied. Oliver (1922) elevated the name *Stenella* to generic status as it has priority over *Prodelphinus*. The genus probably represents an artificial assemblage, and its taxonomy requires further work (LeDuc, 1997; Perrin and Hohn, 1994; Perrin et al., 1981). A key follows (Perrin et al., 1987, 1989):

1. Ramus arcuate 2
 Ramus sigmoid 3
2. Spinal blaze present; caudal peduncle uniformly colored ventrally and dorsally; ventral background white; total number of vertebrae 67-72; rostrum broad distally; pre-narial triangle narrow (0.6-9.9 mm at 60 mm length); teeth larger (3.2-5.3 mm) and less numerous (30-42)
 *S. frontalis*
 Spinal blaze absent; caudal peduncle colored light ventrally and dark dorsally; ventral background gray; total number of vertebrae 78-84; rostrum narrow distally; pre-narial triangle wide (2.1-15.6 mm at 60 mm length); teeth smaller (2.6-4.1 mm) and more numerous (34-48) *S. attenuata*
3. Basal width of rostrum <33% length of rostrum
 *S. longirostris*
 Basal width of rostrum >33% length of rostrum 4
4. Condylbasal length <415 mm; greatest preorbital width <180 mm *S. clymene*
 Condylbasal length >430 mm; greatest preorbital width >180 mm *S. coeruleoalba*

***Stenella coeruleoalba* (Meyen, 1833)**

Striped Dolphin

- Delphinus coeruleo-albus* Meyen, 1833:610. Type locality "Rio de la Plata" (South Atlantic Coast of Argentina or Uruguay).
- Delphinus Styx* Gray, 1846:39. Type locality "S. Atlantic: South Africa."
- Delphinus Euphrosyne* Gray, 1846:40. Type locality unspecified.
- Delphinus Hølbollii* Nilsson, 1847:595. Type locality "Greenland."
- Delphinus lateralis* Peale, 1848:35. Type locality 13°58'N, 161°22'W, North Pacific.

- Delphinus tethyos* Gervais, 1853:150. Type locality "Valreas, mouth of the Orb river, Hérault, France."
- Delphinus marginatus* Pucheran, 1856:545. Type locality "Dippe" [France].
- Delphinus mediterraneus* Loche, 1860:475. Type locality Algeria.
- Delphinus aesthenops* Cope, 1865:200. Type locality unspecified.
- Delphinus crotaphiscus* Cope, 1865:200. Type locality unspecified.
- Tursio Dorcides* Gray, 1866a:400. Type locality unspecified.
- Clymene dorides* Gray, 1866b:214. Renaming of *Tursio Dorcides* Gray.
- Clymenia euphrosynoides* Gray, 1868a:6. Renaming of *Delphinus euphrosyne* Gray.
- Clymene similis* Gray, 1868b:146. Type locality "Cape of Good Hope", South Africa.
- Clymene Burmeisteri* Malm, 1871:63. Type locality "Brazil."
- Clymenia novae-zelandiae* Hector, 1873:159. Type locality "Wai-kanae" [New Zealand].
- Prodelphinus Petersii* Lütken, 1889:40. Type locality Indian Ocean.
- Delphinus amphitriteus* Philippi, 1893:7. Type locality "29°15'S in the Atlantic Ocean."

CONTEXT AND CONTENT. Context as above. *S. coeruleoalba* currently contains no subspecies. All above names are therefore treated as synonyms.

DIAGNOSIS. *Stenella coeruleoalba* is distinguishable from other delphinids by its unique color pattern (Fig. 1), composed of a light colored spinal blaze, an eye-to-anus stripe with subtending accessory stripe, and a flipper stripe (terminology of Perrin, 1972). The flipper stripe usually starts below the level of the eye as a thin band which quickly widens as it approaches the insertion of the flipper. In the field the species is most likely to be confused with *Delphinus delphis*, *Lagenodelphis hosei*, *S. longirostris*, or *S. clymene*. Striped dolphin skulls can be identified by the presence of a sigmoid ramus, a relatively long preorbital process, very shallow palatal grooves (may be absent in some specimens), and a dorso-ventrally flattened rostrum (Fig. 2; Perrin et al., 1981). Nasal sac anatomy of striped dolphins differs from that of other *Stenella* in that there is slightly greater asymmetry of the premaxillary, nasofrontal, and vestibular sacs; a larger accessory sac (>1 cm); and large diagonal membrane musculature (Mead, 1975).

GENERAL CHARACTERS. The general body plan of *S. coeruleoalba* is similar to that of most small oceanic delphinids: a largely fusiform body with a long beak (well demarcated from the melon), falcate dorsal fin, and long, slim flippers. It is a relatively robust dolphin; the longest recorded specimen reaching 2.56 m



FIG. 1. *Stenella coeruleoalba* from the eastern Pacific near California. Photograph courtesy of B. Smith.

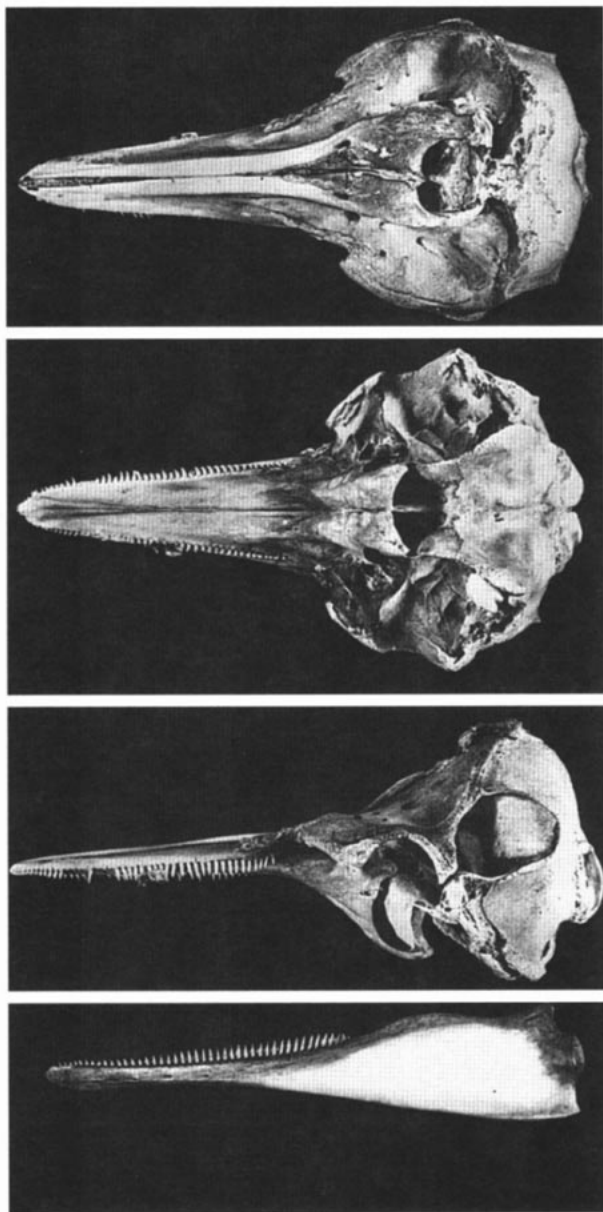


FIG. 2. Dorsal, ventral, and lateral views of cranium and lateral view of mandible of *Stenella coeruleoalba* from eastern tropical Pacific (male, condylobasal length, 413 mm, body length, 214 cm, Southwest Fisheries Science Center WFP-050).

(from the western Pacific—Okada, 1936) and the heaviest specimen weighing 156 kg (from the southwestern Indian Ocean near South Africa—Ross, 1984). Mean maximum body length in western Pacific striped dolphins is 236 cm for males and 220 cm for females (Kasuya, 1972, 1976; Miyazaki, 1984). Males measure ca. 2 cm longer than females in the Mediterranean (Calzada and Aguilar, 1995).

Striped dolphins from southwestern Mediterranean are 5–8 cm shorter than their eastern Atlantic conspecifics (Calzada and Aguilar, 1995). Geographic variation in skull size also occurs, with the relative order in size as follows: Mediterranean < eastern Pacific < eastern Atlantic and western Atlantic < western Pacific (Archer, 1996). The western Pacific population may be further subdivided into inshore and offshore forms (Miyashita, 1992). Within the Mediterranean, striped dolphins in the north are ca. 3 cm shorter than those in the south (Calzada and Aguilar, 1995).

Averages and ranges of selected cranial measurements (in mm) are as follows: condylobasal length, 428 (348–486, $n = 199$); rostral length, 252 (158–292, $n = 200$); width of skull across preorbitals, 191 (109–219, $n = 226$); length of upper toothrow, 220

(176–249, $n = 199$); length of ramus, 371 (314–418, $n = 201$). Tympanic bullae are without bilateral compression and have a high and straight ventral keel (Kasuya, 1973). Sternum has from two to four segments that articulate with an equal number of pairs of sternal ribs. The 26–31 chevron bones are associated with caudal vertebrae ($n = 19$). Phalangeal formula is I 0–3, II 7–10, III 5–8, IV 2–7, and V 0–2 ($n = 121$ —Archer, 1996; Calzada and Aguilar, 1996). Adult size of cranial bones is achieved at ca. 3 years of age, whereas that of postcranial bones is achieved ca. age 7 (Archer, 1996; Ito and Miyazaki, 1990; Perrin et al., 1994).

Dorsal cape of *S. coeruleoalba* is often a muted blue or bluish-gray, whereas eye-to-anus and flipper stripes are darker blue or bluish-black coloration. The lateral and ventral fields and the spinal blaze that invades the dorsal cape can range from white to gunmetal-gray. The spinal blaze can be all but absent in some specimens; however, the ventral field is usually a lighter color than the lateral field. The appearance of these colors will vary depending on quality of light or clarity of water and tend to fade quickly after death. In some conditions the usually blue or black coloration may even appear brownish (Norris and Prescott, 1961). A dark stripe subtending the eye-to-anus stripe is usually present (Sylvestre, 1985). In some individuals the subtending stripe may be distinct from the eye-to-anus stripe at its origin near the eye, whereas in others the two fuse farther behind the eye only to bifurcate further posteriorly (Fraser, 1974). In the ventral field a faint secondary stripe may also be present, usually at the same level as the primary subtending stripe (Fraser and Noble, 1970).

DISTRIBUTION. The range of striped dolphins extends across the warm-temperate to tropical waters of the world (Fig. 3; Perrin et al., 1994). The species is well documented in both the western and eastern Pacific off the coasts of Japan and North America. Across the northern Pacific, most records are below about 43°N. Whether the distribution across this region is continuous is not known. A long-term series of sighting cruises conducted by the National Marine Fisheries Service has documented the range in the eastern tropical Pacific, a bilobate extension which reaches westward to approximately 160°E and a southern boundary around 15°S. Scattered records of the species exist from the South Pacific as well as northern New Zealand and eastern Australia (Perrin et al., 1994).

In the Atlantic the species has been recorded along the coast of South America, the Caribbean Sea and northern Gulf of Mexico, and along the North American eastern seaboard, with the northern limit a function of the meanderings of the Gulf Stream. As a result, a few of the more northerly records, such as those from Canada, Greenland, and Iceland may be extralimital (Bloch et al., 1996). *S. coeruleoalba* is frequently found in the eastern Atlantic south of the United Kingdom along the coasts of France, Spain, and Portugal. Offshore, the species has been recorded from the Azores and Canary Islands (Perrin et al., 1994).

The striped dolphin is the most frequently occurring dolphin in the Mediterranean Sea. It is well documented from the coasts of Spain, France, Italy, and Greece (Perrin et al., 1994). Records from countries bordering the southern and eastern Mediterranean are not as abundant, perhaps as a result of decreased sighting effort (Marchessaux, 1980). Nevertheless, the species is known from the coasts of Morocco and Algeria and is thus expected to occur throughout the Mediterranean (Boutiba, 1994). In the Indian Ocean the species is found along the coast of South Africa and southeast of Madagascar, the southern tip of India, around the Maldives, Sri Lanka, the coast of Somalia, and in the east from western Australia (Balanace et al., 1996).

FOSSIL RECORD. In a survey of fossil cetaceans from Japan, Oishi and Hasegawa (1994) list material assigned to *Stenella kabatensis* from the late Miocene. Mandibles and periotics of a late Miocene to Pliocene form assigned to either *Delphinus* or *Stenella* have been reported from the eastern north Pacific (Barnes, 1976). In light of concerns over the taxonomic stability of the genus *Stenella*, the relationship of these specimens to any extant species should be considered questionable.

FORM AND FUNCTION. The dental formula is 38–59 (upper) and 37–55 (lower) with an average tooth diameter of 3.7 mm at alveolar height (Archer, 1996). Vertebral formula is 7 C, 13–16 T, 15–25 L, 31–43 Ca, total 71–82 ($n = 44$). In most specimens, the first two cervical vertebrae are fused, although in some older

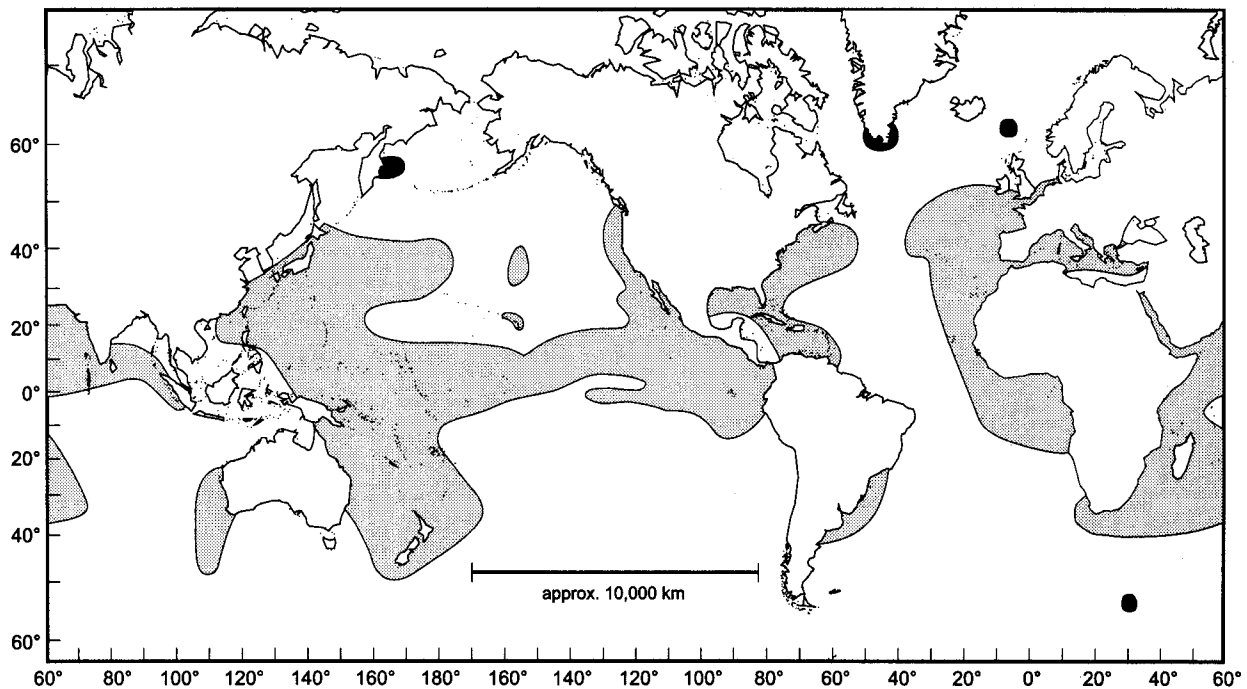


FIG. 3. Distribution of *Stenella coeruleoalba* (Perrin et al., 1994). Darker shading represents extralimital records. Map prepared by H. Orr.

or injured animals up to seven may be fused. There are 14–16 vertebral ribs and 5–11 sternal ribs ($n = 19$).

The eye has a large rete mirabile near the optic nerve, a honeycomb structure in the photoreceptor layer, and a region of "giant" ganglion cells (Vismara et al., 1991). Overall thickness of the retina is 200 μm , and is of adult size at birth (Zaniboni et al., 1991). Diameter of the auditory nerve is 6–6.3 mm, and the nerves which operate eye musculature measure 1–1.5 mm (Gihl and Pilleri, 1969). Myelination of acoustic nerves occurs in embryos 51–74 cm long (Hosokawa et al., 1969). Papillar projections as well as taste-buds occur on the tongue of both fetal and juvenile specimens. Both features tend to become reduced as the animal reaches maturity (Yamasaki et al., 1978). The larynx has a single midline fold and one pair of lateral folds (Reidenberg and Laitman, 1988). Maximum auditory sensitivity occurs around 60 kHz, and maximum frequency detectability is ca. 120–140 kHz (Bullock et al., 1968).

The stomach is multi-chambered, with differentiation of the forestomach and main stomach occurring after the fetus has attained 12 cm in length (Miyazaki et al., 1981). The spleen is small and non-lobulated (Gihl and Pilleri, 1969). One 166-cm male had a kidney composed of 368 reniculi (Gihl and Kraus, 1970). Aselli's pseudopancreas is fluted with delineated tissue masses (Pilleri and Arvy, 1971). Sexual differentiation of the gonads occurs in embryos 12–26 mm long, which represents 1.5–2 months of gestation (Sinclair, 1969). Mean total body weight is 157.5 kg (males) and 135.9 kg (females). Selected mean weights of adult tissues and organs are as follow: muscle, 87.4 kg (males) and 74.6 kg (females); blubber, 24.7 kg; bone, 18.6 kg (males) and 14.5 kg (females); viscera, 13.8 kg; brain, 935 g; heart, 1.2 kg; lung; 2.3 kg; kidney (left), 362 g; pancreas, 157 g; intestine, 2.96 kg; spleen, 43.9 g (males) and 26.7 g (females—Miyazaki et al., 1981). Mean brain weight is 0.72% of mean body weight.

Blood and blood components of striped dolphins have been studied. Hemaglobin has two fractions, which are similar to human HbS and HbF (De Monte and Pilleri, 1979a). Several blood parameters have been measured: white blood cell counts, $7,200 \times 10^6$ per mm^3 ; urea and uric acid concentrations, 1.126 and 1.85 mg/100 ml, respectively; total cholesterol, 214.8 mg/100 ml; total blood protein concentration, 8.3 g/dl, of which 2.03% was prealbumin, 25.38% albumin, and 72.39% globulins (De Monte and Pilleri, 1977, 1979b, 1982). Plasma is rich in triglycerides (De Monte and Pilleri, 1982). Blood types T' and O' occur, and isohemagglutination is weak (Yamaguchi and Fujino, 1952).

Analysis of the urine of two specimens indicated a mean pH

of 5.78, urea of 19.47 g/dl, creatinine of 5.8 mg/dl, and sodium, chlorine, and potassium concentrations of 188, 196, and 81 mEq/l, respectively (De Monte and Pilleri, 1970). Blubber lipid content is 60–70% in healthy individuals (Aguilar et al., 1991). Core body temperature of a specimen 25 minutes after death in water of 15°C was 34.6°C. Based on the observed rate of temperature decline, energy requirements to maintain body temperature were calculated to be 12.2 kJ/mg in 15°C water and 6.3 kJ/mg in 25°C water (Cockroft, 1991). Average respiratory rate was 5.24 breaths per minute (Lafortuna et al., 1993).

ONTOGENY AND REPRODUCTION. In the western north Pacific, mating occurs in winter and early summer, while in the Mediterranean a single mating and calving period in the autumn allows mothers to take advantage of relatively high, seasonal and regional oceanic productivity (Aguilar, 1991; Frontier and Viale, 1985; Miyazaki, 1984). Gestation lasts 12–13 months, with an average fetal growth rate of 0.29 cm/day. The calf is nursed for ca. 1.5 years on milk composed of 28% fat (Kawai and Fukushima, 1981). Females experience a resting period of 0.2–0.5 years, which produces an average reproductive cycle of ca. 3 years. A shortening from 4 to 2.8 years in the female reproductive cycle occurred during 1955–1977. Fecundity of females declines at ca. age 30. The oldest recorded pregnant female was 48.5 years old (Kasuya, 1972, 1985; Miyazaki, 1984).

Body length at birth has been estimated to be 100 cm in western north Pacific striped dolphins (Miyazaki, 1977). In the western Mediterranean, length at birth is ca. 92.5 cm and average weight is 11.3 kg (Aguilar, 1991). In the western north Pacific, both sexes rapidly increase in size for the first 2 years after birth, with lengths reaching 166 cm in the first year and 188 cm in the second year. Sexual dimorphism begins at 2–3 years of age, with males exceeding females in length by ca. 4 cm (Kasuya, 1976; Miyazaki, 1984). Males enter sexual maturity between 7 and 15 years of age, at an average body length of 220 cm, with social maturity being reached by the age of 17. Testis weight exhibits a large degree of monthly variation, with largest mean weights in October. Females become sexually mature between 5 and 13 years old, however; sexual maturity decreased from 9.7 to 7.4 years between 1956 and 1970, probably as a density-dependent response to reduced population levels caused by increased fishing (Kasuya, 1972, 1985; Miyazaki, 1984). Mediterranean striped dolphins become sexually mature at 12 years of age and reach vertebral physical maturity for males at 15–20 years and 13–18 years for females (Calzada and

Aguilar, 1996; Calzada et al., 1997). Mean length at sexual maturity for females in the western Pacific is 212 cm. (Miyazaki, 1984). In the southwestern Indian Ocean off the coast of South Africa, mean length at sexual maturity is 2.1 m for females and 2.1–2.2 m for males (Ross, 1984). Maximum estimated age for both males and females is 57.5 years (Kasuya, 1985).

ECOLOGY. Striped dolphins can usually be found outside the continental shelf, typically over the continental slope out to oceanic waters, often associated with convergence zones and waters influenced by upwelling (Au and Perryman, 1985; Ross, 1984). These regions are highly productive and thus are likely to be good feeding grounds. Off the coast of Japan, striped dolphins congregate at the periphery of the Kuroshio Current where warm water meets cold water and temperatures range from 19.8 to 25.5°C (Miyazaki et al., 1974). Similar congregations occur in the eastern tropical Pacific, when the thermocline forms under tropical surface water in the Intertropical Convergence Zone (Reilly, 1990). Distribution in the Indian Ocean has been correlated with the Agulhas Current and water warmer than 22°C (Ross, 1984). The current's southerly flow extends the range of *S. coeruleoalba* into higher latitudes (Ross, 1984). Western Mediterranean animals occur in slightly colder waters of 10–21°C, with a mode of 19°C (Forcada et al., 1990).

Fish in the family Myctophidae are the dominant prey item in stomachs from animals off the coast of Japan and South Africa, comprising 63% and 82.5%, respectively, of all fish recorded (Miyazaki et al., 1973; Ross, 1984). In the Northeast Atlantic cod is taken more frequently, accounting for 63% of the total fish found in 25 stomachs (Desportes, 1985; Fraser, 1953). Several studies have found from 50% to 100% of the stomachs examined from Mediterranean striped dolphins to contain only cephalopods, with the majority of the remaining samples containing a combination of cephalopods and fish. The most frequent prey taken were of the squid families Ommastrephidae and Histiotiuthidae (Desportes, 1985; Raduan and Raga, 1982; Wurtz and Marrale, 1991). Perrin et al. (1994) comprehensively listed families of prey items in the diet of *S. coeruleoalba*.

Known ranges of prey indicate that striped dolphins often feed in pelagic or benthopelagic zones along the continental slope or just outside in oceanic waters (Desportes, 1985; Ross, 1984). A majority of prey (74–80%) have luminescent organs, suggesting that striped dolphins may be feeding at great depths, possibly diving from 200–700 m to reach potential prey. They may also feed at night in order to take advantage of the diurnal vertical migrations made by many of their prey species (Miyazaki et al., 1973; Ross, 1984).

From the late 1930s to early 1940s, the size of the western Pacific stock of striped dolphins was estimated at >321,000. Japanese dolphin fishery operations from the late 1950s to the mid 1970s are believed to have caused a rapid decline in population size from ca. 237,000 to 153,000 (Kasuya and Miyazaki, 1982). Sighting data collected in 1983–1991 suggested the population during this period was 821,000 ($SE = 182,000$). This estimate may include a portion of a second population not affected by the fishery (Miyashita, 1992).

In the eastern tropical Pacific, population estimates from annual survey cruises in 1986–90 range from 813,000 to 2,251,000 ($SE = 282,000$ – $866,000$ —Wade and Gerrodette, 1992). The population off the coast of California was estimated to contain 19,000 individuals in 1991 (95% $CI = 8,000$ – $46,000$ —Barlow, 1995). Striped dolphins were the eighth most common cetacean sighted in the mid- and North Atlantic areas of the U.S. outer continental shelf, where the peak mean abundance was 4,319 (95% $CI = 331$ – $8,307$ —Winn, 1982). In the western Mediterranean striped dolphins may have displaced common dolphins, *Delphinus delphis*, as the most abundant cetacean during a population expansion in the 1970s (Viale, 1985). Using line-transect methods, Forcada et al. (1994) estimated the population in the western Mediterranean at 117,880 individuals (95% $CI = 58,379$ – $214,800$).

Stenella coeruleoalba has been diagnosed with gingivo-dental infection, fatal and nonfatal bone fracture, concussions, crystalline concretions of the lungs and other organs, inflammation of the cerebral cortex, squamous cell carcinoma of the skin, various cardiac pathologies, congested liver, lungs and adrenals, and acute stomach ulcers (Perrin et al., 1994). Microbial infections include *Toxoplasma gondii*, *Aspergillus fumigatus*, *Vibrio*, pox, and a *Herpes*-like

virus (pathology reviewed in Perrin et al., 1994). In 1990–1992 morbillivirus in the western Mediterranean Sea left over 1,100 animals dead on Spanish, French, and Italian coastlines (Aguilar and Raga, 1993).

Ectoparasites and commensals associated with striped dolphins include cyamid amphipods, *Synchyamus aequus* and *Isocyamus delphini*, from the blowhole (Raga and Carbonell, 1985; Raga and Raduán, 1982); a copepod, *Penella balaenopterae*, from the skin (Raga and Carbonell, 1985); barnacles *Conchoderma virgatum*, *C. auritum*, *Lepas pectinata*, and *L. cf. hillii* from around the teeth (Fernández et al., 1991); and barnacles, *Xenobalanus globicipitis*, attached to the trailing edges of the dorsal fin, flukes, and flippers (Pillari, 1970). *S. coeruleoalba* harbors a variety of endoparasites: cestodes *Monorygma* and *Phyllobothrium* in mesenteries and blubber (Dailey and Walker, 1978; Dollfus, 1973–1974), *Strobicephalus triangularis* and *Tetrabothrium foersteri* in the intestine (Raga and Carbonell, 1985; Ross, 1984), *Scollex pleuronectis* in bile and pancreatic ducts (although this species may be an earlier stage of *P. delphini*—Raga et al., 1992); trematodes *Campyla palliata* and *C. delphini* in the bile duct (Hörning and Pillari, 1969), *Nasitrema globicephalae* in the sinuses and brain tissue (Dailey and Walker, 1978; O'Shea et al., 1991), *Synthesium tursionis* and *Pholeter gastrophilus* in intestine and stomach (Dollfus, 1973–1974; Raga et al., 1985), and *Oschmarinella mascomai*, *Zalophotrema atlanticum*, and *Z. pacificum* in the liver (Abril et al., 1991; Raga et al., 1992); nematodes *Anisakis simplex* and *A. typica* in the stomach (Cowan et al., 1986; Dailey and Walker, 1978), *Crassicauda* in the muscle, mammary glands, and lining of the skull (Duguy, 1978; Fernández et al., 1991; Raga et al., 1987), and *Halocercus lagenorhynchi*, *H. delphini*, and *Skrjabinalius guevarai* in the lungs (Raga and Carbonell, 1985; Ross, 1984); and the acanthocephalan *Bulbosoma vasculosum* in the intestine (Raga and Carbonell, 1985).

Contaminants have been studied more intensively in this species than in any other cetacean. Mercury and selenium levels in the liver of western Pacific striped dolphins have been measured at 205 and 48.6 ω/g (Itano and Kawai, 1981). Levels of organochlorines from the same region were similar to those in other local small cetaceans and higher than those in the southern hemisphere (Tanabe et al., 1983). Annual intake of PCB and DDT from food was estimated at 12 mg and 23 mg, respectively (Fukushima and Kawai, 1981). Up to 90% of the total organochlorine load of the mother is transferred to the calf during lactation (Fukushima and Kawai, 1981; Tanabe et al., 1982). Blubber PCB levels as high as 2,500 ppm from western Mediterranean dolphins that died during the morbillivirus epizootic of 1990–1992 may be amongst the highest recorded values for any mammal (Aguilar and Borrell, 1994; Aguilar and Raga, 1993). High organochlorine loads in this population have been hypothesized to have caused an immunodepressive state, thus decreasing resistance to infection (Aguilar and Borrell, 1994; Borrell and Aguilar, 1992).

Reports of mass strandings of striped dolphins are rare, probably a result of their offshore distribution. A few mass strandings have been recorded from the Atlantic coasts of Spain, France, the Canary Islands, and western Australia (Perrin et al., 1994). Striped dolphins have been found with shark bites (Ross and Bass, 1971) and in the stomachs of killer whales (*Orcinus orca*—Nishiwaki and Handa, 1958). Parasitism and pollution are probably also major factors in natural mortality (Hammond, 1981; Jones, 1991). Based on demographic parameters known for spotted dolphins (*Stenella attenuata*), Kasuya and Miyazaki (1982) have tentatively estimated the natural mortality rate of mature western North Pacific striped dolphins to be from 0.07 to 0.08.

The western north Pacific population of striped dolphins has experienced its heaviest mortalities from directed Japanese drive and hand-harpoon fisheries. The oldest record of catches in the drive fishery is from 1888, although fishery activities have occurred since the beginning of the 15th century (Kishiro and Kasuya, 1993). Along the Izu coast, one of the two primary locations for the fishery, annual catches >21,000 were recorded in 1942 and 1959. In the 1940s and 1950s mean annual catch for this region alone was ca. 8,000–9,000 animals (Miyazaki, 1983). The total Japanese mean annual catch during the late 1950s to early 1960s was estimated at 14,000 (Kasuya and Miyazaki, 1982). Self-imposed quotas, lower encounter rates, and dissolution of a fishery cooperative in Izu caused annual catches to drop to ca. 1,000 in the early to mid 1980s. From 1990 to 1992 annual catches have varied from ca.

500 to 1,000 animals. These catches represent <10% of the post-World War II levels of abundance (Kishiro and Kasuya, 1993).

Striped dolphins have also been taken in the harpoon fishery for small cetaceans at St. Vincent in the Lesser Antilles (Caldwell et al., 1971). Small numbers are taken illegally by French and Spanish fishermen for human consumption in the Mediterranean (Collet, 1983; Duguy et al., 1983). From the 1950s to the 1970s, the French Navy conducted large-scale directed kills in an attempt to reduce the amount of fishing gear damaged by dolphins (Collet, 1983; Duguy and Hussenot, 1982).

Incidental catches have been recorded from gillnets in the northeastern Indian Ocean (Dayaratne and De Silva, 1990), tuna purse seines in the eastern tropical Pacific (Hall and Boyer, 1990), fisheries in the northeastern Atlantic (Northridge et al., 1991), drift-nets, purse seines, and other gear in the Mediterranean (Di Natale and Notarbartolo di Sciarra, 1994), various fishing gear off the coast of Japan (Anonymous, 1990), drift gillnets in the north Pacific (Hobbs and Jones, 1993), and occasionally anti-shark nets in Natal, South Africa (Cockroft, 1990). Probably, striped dolphins are incidentally taken in similar fisheries operations throughout their range.

Striped dolphins have not been successfully maintained in captivity. Four specimens caught in Japan did not feed well and all died after 1–2 weeks in captivity (Nishiwaki and Yagi, 1953). A mother and a calf, which stranded in South Africa, lived for 1 and 6 days respectively. Both were offered *Trachurus trachurus*; however, only the calf attempted to catch the fish, and it appeared to be unable to swallow it (Davies, 1962). Another dolphin held in South Africa was reported to have been easily hand fed (Tyler and Saayman, 1973).

BEHAVIOR. Schools vary in size and composition (Kasuya, 1985; Perryman and Lynn, 1994). Of 45 schools examined from off the coast of Japan, most (86%) contained <500 individuals (Miyazaki and Nishiwaki, 1978). The mean school size of 183 sightings was 121 animals, but five of the schools contained >500 animals. By eliminating the large schools, mean size decreased to 101 (Miyashita, 1992). Schools moving south with the retreating front of the Kuroshio Current are larger than those moving north earlier in the year. Estimates of mean school size from the eastern tropical Pacific were from 28 to 83 individuals (Wade and Gerrodette, 1992). Schools in the eastern north Atlantic more commonly have 10–30 individuals and rarely reach the hundreds (Perrin et al., 1994).

In the western Pacific three types of schools occur: juvenile, adult, and mixed. Adult and mixed schools are further divided into breeding and nonbreeding schools. Juvenile schools may migrate closer to the coast than adult and mixed schools. Calves remain in adult schools until 1 or 2 years after weaning and then leave to join juvenile schools. Most subadult females rejoin nonbreeding adult schools; some join breeding schools directly. Males rejoin adult schools after reaching sexual maturity, with about equal numbers joining breeding and nonbreeding schools. Breeding schools contain subschools of fully adult females and apparently socially adult males. Socially mature males may leave the breeding school after most females have been impregnated. The breeding school thus evolves into a nonbreeding adult school and, after birth of the calves, a mixed nonbreeding school (Miyazaki and Nishiwaki, 1978). The breeding system is most likely polygynous.

Striped dolphins may school with common dolphins, *Delphinus delphis*, in the western Mediterranean (Forcada et al., 1994) and the eastern north Pacific (Barlow, 1995). Average speed for Mediterranean striped dolphins is estimated at 6.1 knots (Lafortuna et al., 1993). In the eastern Atlantic they have been observed traveling at a speed of 32 knots and may bow-ride (Di Natale, 1983). In the eastern tropical Pacific, they rarely approach ships (Au and Perryman, 1985), possibly due to previous chase and encirclement interactions with tuna purse-seiners. Striped dolphins perform aerial behaviors such as breaching, chin slaps, and a unique behavior termed "roto-tailing," in which they make high arcing jumps while violently and rapidly performing several rotations with the tail before reentering the water. Some of these behaviors may function in communication (Hayes et al., 1989).

GENETICS. Analysis of 15 loci from 10 enzymes in 40 western Pacific striped dolphins found only two loci to be polymorphic (Wada, 1983). Thus, the proportion of polymorphic sites and het-

erozygosity (H) is low at 13% and 0.0021 ± 0.008 (SE), respectively. Using a larger sample size ($n = 370$) and 19 loci, Shimura and Numachi (1987) reported a slightly higher percent polymorphism (26.3%) and heterozygosity (0.089 ± 0.160). Restriction-site analysis indicates a similar variation in the mitochondrial genome. Of 61 restriction sites examined in 44 dolphins stranded along the Mediterranean coast of Spain, 19.57% were polymorphic (García-Martínez et al., 1995). Heterozygosity was higher than in the previous two Japanese studies (0.7886), possibly as a result of the small sample size, while mtDNA diversity was low (0.0023).

Direct sequencing of the mitochondrial genome from 57 samples covering three populations (eastern Pacific, western Atlantic, and Mediterranean) has shown a high degree of haplotypic diversity (0.972). Average genetic distance between these populations was quite low (0.025), thus indicating a low degree of population divergence in this region (Archer, 1996).

REMARKS. *Stenella* is the Latin diminutive of the generic name *Steno*, and *Stenella* was originally created as a subgenus of *Steno* (Gray, 1866b). The specific name, *coeruleoalba*, refers to the bold blue and white of the color pattern, which may serve to break up body outlines or be used for intraspecific cohesion (Würsig et al., 1990). Previously, several species of striped dolphins were recognized under the names *S. styx* (Gray, 1846), *S. euphrosyne* (Gray, 1846), and *S. coeruleoalba* (Meyen, 1833). True (1889) believed that *S. styx* and *S. euphrosyne* were synonymous. Okada (1936) placed *S. euphrosyne* in synonymy with *S. coeruleoalba*, but Kellogg and Scheffer (1947) disagreed and provided characteristics that distinguish *S. euphrosyne* from *S. coeruleoalba*. The variation in color patterns among several nominal species of striped dolphins suggest they be combined into one, *Stenella coeruleoalba* (Fraser and Noble, 1970). Incongruities in previously-used formal definitions for *S. coeruleoalba* and *S. euphrosyne* suggest that all nominal species of striped dolphins are synonymous with *S. coeruleoalba* (Mitchell, 1970).

Additional common names for *S. coeruleoalba* include the following: Euphrosyne dolphin, Gray's dolphin, blue-white dolphin, Meyen's dolphin, longsnouted dolphin, Greek dolphin, harnessed dolphin, black-jawed dolphin, Gray's porpoise, Gray's longsnouted porpoise, streaker porpoise, streaker, whitebelly porpoise; *dauphin bleu et blanc*, *dauphin rayé*, *dauphin euphrosine* (French); *dolfijn van Gray*, *gestreepte dolfijn* (Dutch); *Streepdolfijn* (Afrikaans); *stribet delfin* (Danish); *strimmig delfin* (Swedish); *Stripedelfin* (Norwegian); *delfin listado*, *delfin azul*, *delfin rayado*, *delfin a rayas*, *delfin de betas*, *estenela* (Spanish); *boto*, *golfinho estriado*, *golfinho riscado* (Portuguese); *stenella striata*, *delfino dalle briglie*, *delfino eufrosine* (Italian); *blauweisser Delfin* or *Delphin*, *Streifen-delfin* (German); *polosatyy prodelfin* (Russian); *pliskavika prava*, *dupin pravi* (Yugoslav); *suji iruka* or *suzi iruka* (Japanese).

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