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Morphology of the Clymene dolphin (*Stenella clymene*) in the northern Gulf of Mexico

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Introduction

In 1846, John Edward Gray described a new species of dolphin, *Delphinus metis* (later renamed *Stennella clymene*), based on a single skull collected from an unreported location in the Atlantic Ocean (Gray, 1846). Unfortunately, the external appearance of the specimen was not documented. In the ensuing 135 years, most cetologists did not recognize the 'Clymene' dolphin as a valid species. For example, Flower (1883) and True (1889), in their monographs on the Delphinidae both placed it in the synonymies of other species. Perrin *et al.* (1981) recognized the species as valid, redescribed it, and provided the first descriptions of its external morphology and coloration. Since its redescription, there have been but a handful of papers published on this species (Perrin & Mean, 1994; Robineau *et al.*, 1994; Mullin *et al.*, 1994; Simões-Lopes *et al.*, 1994; Jefferson *et al.*, 1995). The present paper provides new data on external and skeletal morphology of this species from the northern Gulf of Mexico.

Materials and methods

Various sets of photographs and external measurements were available from 48 Clymene dolphins stranded in Texas, Louisiana, and Florida (however, for many of these only total length was available). Measurements were taken by various personnel (thus interobserver variability may be a significant factor) associated with the Texas Marine Mammal Stranding Network and the Southeast United States Marine Mammal Stranding Network in Florida, following Norris (1961). Specimens were included in adult external morphometric series, based on approximate total lengths at sexual maturity (171 cm for females and 176 cm for males) presented in Jefferson *et al.* (1995).

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All skeletal measurements and meristics were taken by the author (thus eliminating interobserver variability), using vernier callipers and dial callipers, following Perrin (1975). Criteria for including specimens in adult series were the presence of distal rostral fusion of the maxillae and premaxillae (but see Perrin & Heyning, 1993) and complete fusion of epiphyses to all thoracic vertebrae (Dailey & Perrin, 1973).

Results and discussion

Coloration

Clymene dolphins have a three-part color pattern, consisting of a dark gray cape, light gray sides, and white belly (Fig. 1). Generally, a dark line is visible that separates the light gray side and white belly (Fig. 1; Mullin *et al.*, 1994). The color pattern of the facial area is diagnostic (Perrin *et al.*, 1981).

The most distinctive aspects of the facial color pattern of the Clymene dolphin are the 'moustache' marking (terminology of Perrin *et al.*, 1981) and the distinct eye stripe (part of the 'bridle' of Mitchell, 1970). The moustache was present in photographs of all 11 specimens in which it could be evaluated, although its placement was variable. In some specimens, the moustache was located in the middle of the rostrum, well forward of the melon apex (Fig. 2a). In others, it was further back, contacting the apex (Fig. 2b). The eye stripe extended onto the rostrum and ran forward of the moustache in some individuals (Fig. 2a), while in others it joined the moustache without running past it (Fig. 2b). No clear patterns related to sex or maturity were observed in the location of the moustache or the placement of the eye stripe in relation to the moustache, although a larger sample size may well reveal age-related or sexual patterns.

External morphology

Clymene dolphins are sexually dimorphic. The average length of adult males (184.9 cm) was

Figure 1. Color pattern of Gulf of Mexico Clymene dolphins, showing band separating light gray side and white belly: 187 cm female stranded in Texas on 11 March 1985 (C206) (a); animal photographed in the offshore Gulf of Mexico on 5 June 1992 (Photograph by B. E. Curry) (b).

greater than that of adult females (177.3 cm), a highly significant difference ($t=4.369$, $df=46$, $P<0.001$; Table 1). Males are also heavier than females (Jefferson *et al.*, 1995). For measurements other than total length, the sample sizes were too small for statistical analyses, but only two measurements appear to show obvious sexual dimorphism. These are distance from the tip of the upper jaw to the center of the genital slit (No. 13) and to the center of the anus (No. 14). The means for males were lower than those for females, for both measurements. This is not surprising, since the urogenital slits are located further forward on males of most species of small cetaceans.

It is interesting that girth at anus did not show evidence of sexual dimorphism. Males might be expected to have significantly greater anal girths than females, reflecting the presence of the post-anal hump of adult males. Such a hump is visible in photos of a 186-cm male shown in Perrin *et al.* (1981: Fig. 1A) and Ulmer (1981: p. 9) (USNM 504408), and unpublished photos of an approximately 180-cm male reported by Caldwell & Caldwell (1975) (R-1-SLS).

Skeletal morphology

Skeletal morphometrics and meristics were taken on 69 Gulf of Mexico specimens (Table 2). Extensions of known ranges were found for 18 measurements and three counts. Craniometric data are not presented separately for males and females, because only four adult females were available for analysis (data from 51 known males, however, were available).

Tooth counts taken from fully fleshed specimens (field counts) were compared with those taken later from the same specimens after preparation of the skull (skull counts). Both field and skull counts included teeth present plus empty sockets or alveoli. Skull counts averaged 5.6 ± 2.67 ($n=5$) teeth higher for the upper tooth rows and 3.8 ± 1.32 ($n=5$) teeth higher for the lower rows. This indicates that a large number of teeth are missed in field counts (presumably teeth that have been lost and those small, often

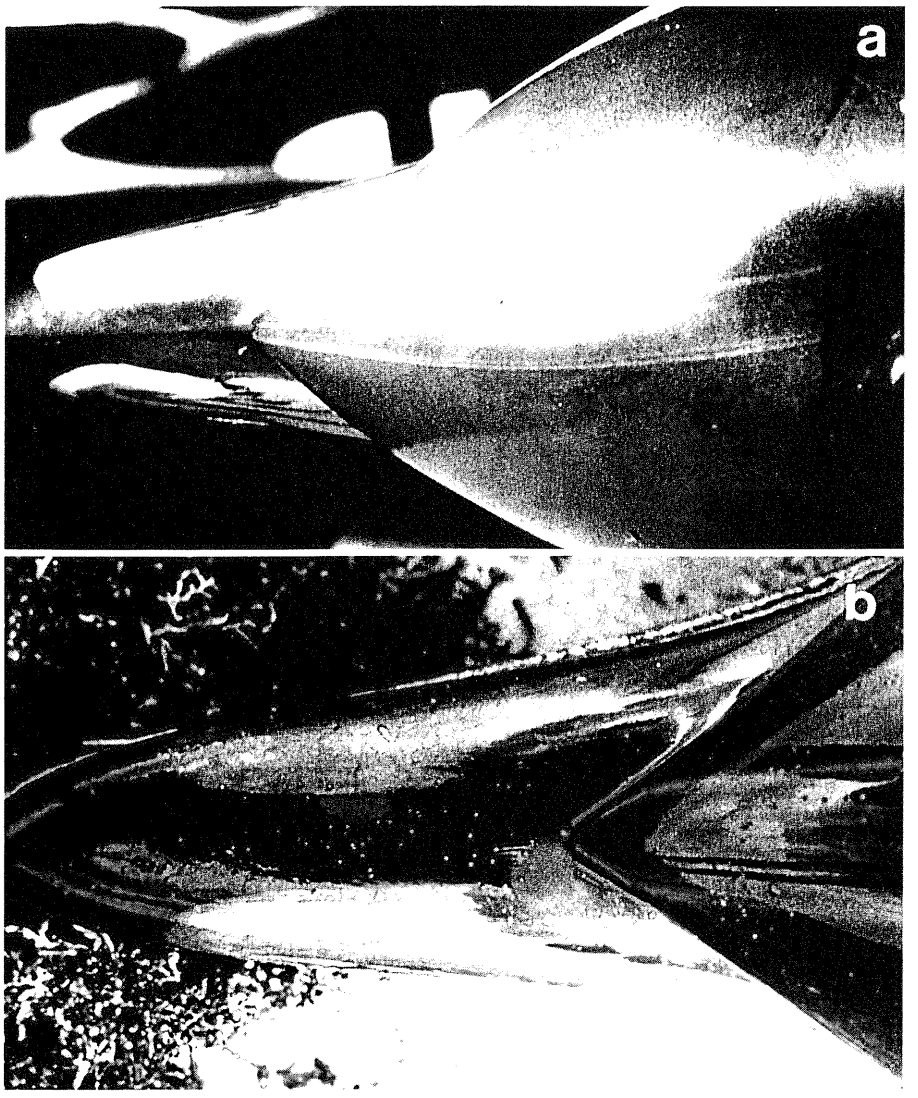

Figure 2. Variation in the locality of the moustache marking and in the extent of the eye stripe in *S. clymene*: moustache is in middle of rostrum and eye stripe extends beyond moustache (a); moustache contacts melon apex and eye stripe does not extend beyond moustache (b).

buried, teeth near the tip of the rostrum) and that observers can add 4–6 to field counts to approximate actual numbers.

Perrin *et al.* (1981) showed that a scatterplot of length of upper toothrow vs. preorbital width could be used to separate adult skulls of *S. clymene* from those of *S. coeruleoalba* and *S. longirostris*. The present data agree with this (Fig. 3); however, one must be careful in using the same analysis with skulls of immature *S. coeruleoalba*, which approach the *S. clymene* cluster. Two other characters were found to be useful in distinguishing *S. clymene* and *S. coeruleoalba* skulls. As mentioned by Perrin *et al.* (1981), the palatal grooves of *S. clymene* are distinct (at least 0.5 mm deep, generally greater than 1.0 mm) out to at least 1/2 length of the rostrum; whereas in *S. coeruleoalba*, any evidence of palatal grooves disappears by 1/3 length of the rostrum. In addition, in all skulls of Atlantic *S. coeruleoalba* examined (as well as those from photographs of Atlantic striped dolphins in the literature) there was a

Table 1. External morphometics (in cm) of adult and adult-sized Clymene dolphins from the Gulf of Mexico. For each measurement, the first line is the absolute measurement, and the second line represents the measurement as a proportion of the total length. Ranges from the literature are presented for comparison (taken from Perrin *et al.* 1981 and Perrin & Mead, 1994)

Measurement (No. in Norris, 1961)	Females		Males		Range from Literature (n)
	Mean (n)	Range	Mean ± S.D. (n)	Range	
Total length (1)#	177.3 ± 5.58 (16)	171–190	184.9 ± 5.88 (32)	176–197	176–197* (27)
Tip of upper jaw to center of eye (2)	29.5 (4) 0.170	29–31 0.16–0.18	28.7 ± 1.28 (6) 0.158 ± 0.0092	27–30 0.15–0.17	28–33* (4)
Tip of upper jaw to apex of melon (3)	10.2 (3) 0.057	9.5–11 0.05–0.06	10.4 ± 1.11 (11) 0.055 ± 0.0067	8.5–12 0.04–0.06	9–12* (23)
Tip of upper jaw to end of gape (4)	25.7 (3) 0.147	25–26 0.14–0.15	24.9 ± 1.30 (11) 0.136 ± 0.0049	22–27 0.13–0.14	21–28 (24)
Tip of upper jaw to center of blowhole (9)	29.0 (4) 0.165	28–30 0.16–0.17	29.3 ± 1.89 (6) 0.162 ± 0.0097	27–32 0.15–0.17	28–32* (8)
Tip of upper jaw to anterior insertion of flipper (10)	42.5 (4) 0.240	41–43 0.23–0.25	42.6 ± 1.77 (11) 0.234 ± 0.0102	38–45 0.22–0.25	40–45* (7)
Tip of upper jaw to umbilical scar (12)	80.0 (3) 0.463	66–89 0.39–0.51	87.0 ± 4.05 (6) 0.475 ± 0.0057	82–93 0.47–0.48	79–93* (8)
Tip of upper jaw to center of genital slit (13)	114.3 (3) 0.653	103–122 0.60–0.69	115.3 ± 5.80 (10) 0.626 ± 0.0215	104–127 0.60–0.66	116–134* (6)

Table 1. *Continued*

Measurement (No. in Norris, 1961)	Females		Males		Range from Literature (n)
	Mean (n)	Range	Mean ± S.D. (n)	Range	
Tip of upper jaw to center of anus (14)	134.7 (3) 0.763	130–140 0.74–0.78	132.7 ± 4.96 (11) 0.722 ± 0.0157	122–140 0.70–0.75	131–142* (6)
Girth at axillae (21)	88.5 (2) 0.505	85–92 0.48 ± 0.53	89.4 ± 5.37 (6) 0.490 ± 0.0404	80–95 0.43–0.53	82–95* (6)
Maximum girth (22)	95.7 (3) 0.540	91–100 0.52–0.57	94.7 ± 7.03 (6) 0.519 ± 0.0478	82–100 0.44–0.58	—
Girth at anus (23)	56.5 (2) 0.320	55–58 0.31–0.33	58.5 ± 4.99 (6) 0.321 ± 0.0389	49–63 0.26–0.37	56–68* (4)
Anterior length of flipper (29)	27.8 (4) 0.158	24–29 0.14–0.17	26.2 ± 1.74 (11) 0.143 ± 0.0103	25–29 0.13–0.16	23–29 (24)
Width of flipper (31)	8.05 (4) 0.045	7.4–8.6 0.04–0.05	8.30 ± 0.790 (11) 0.044 ± 0.0049	7.4–9.5 0.04–0.05	7–10 (26)
Height of dorsal fin (32)	17.5 (4) 0.100	14–19 0.08–0.11	17.0 ± 2.03 (11) 0.092 ± 0.0140	15–21 0.08–0.12	13–20* (20)
Width of flukes (34)	41.3 (4) 0.235	37–44 0.22–0.25	44.6 ± ± 3.27 (110 0.243 ± 0.0197	39–51 0.21–0.27	33–47* (26)

#For two specimens (C206 and C154), two different total lengths were recorded. For this analysis, the length recorded with the set of external measurements is used, so that proportions will be correct. This explains apparent discrepancies in total lengths of these two specimens.
*Extention of the known range.

Table 2. Skeletal morphometrics (in mm) and meristics of adult Clymene dolphins from the Gulf of Mexico. For each measurement, the first line is the absolute measurement, and the second line represents the measurement as a proportion of the condylobasal length (or proportion of the mandible length for height of the mandible and the length of the mandibular symphysis). Ranges from the literature are presented for comparison (taken from Perrin *et al.*, 1981 and Perrin & Mead, 1994)

Measurement (No. in Perrin, 1975)	Mean ± S.D. (n)	Range	Range from Literature (n)
Condylobasal length (1)	381.6 ± 13.81 (61)	345–415	354–409* (45)
Length of rostrum (2)	226.7 ± 10.31 (65) 0.596 ± 0.0100	204–247 0.575–0.613	206–290* (45)
Width of rostrum at base (3)	88.6 ± 4.03 (66) 0.232 ± 0.0103	81–98 0.209–0.260	80–100 (45)
Width of rostrum at 1/2 length (5)	51.4 ± 2.88 (66) 0.135 ± 0.0074	45–58 0.116–0.155	46–58* (45)
Width of premaxillae at 1/2 length (6)	25.5 ± 2.14 (66) 0.067 ± 0.0044	21–31 0.054–0.082	21–29* (14)
Width of rostrum at 3/4 length (7)	38.4 ± 2.51 (61) 0.101 ± 0.0062	33–44 0.085–0.116	35–48* (45)
Greatest preorbital width (10)	162.2 ± 4.93 (66) 0.426 ± 0.0139	150–172 0.394–0.452	150–179 (45)
Greatest postorbital width (11)	179.9 ± 5.81 (66) 0.472 ± 0.0157	165–198 0.432–0.500	165–195* (45)
Greatest width of external nares (13)	41.3 ± 2.18 (66) 0.108 ± 0.0059	36–47 0.093–0.121	40–48* (14)
Zygomatic width (14)	177.3 ± 5.90 (65) 0.465 ± 0.0150	164–197 0.429–0.493	164–192* (45)
Greatest width of premaxillae (15)	67.2 ± 2.99 (66) 0.176 ± 0.0078	60–75 0.159–0.191	60–75 (45)
Parietal width (16)	153.3 ± 6.35 (64) 0.402 ± 0.0172	135–169 0.344–0.438	130–151* (44)
Height of braincase (17)	94.7 ± 3.56 (64) 0.248 ± 0.0126	87–105 0.221–0.282	88–102* (14)
Internal length of braincase (18)	106.9 ± 3.71 (62) 0.280 ± 0.0099	100–116 0.264–0.303	99–114* (14)
Length of temporal fossa (19)	52.3 ± 3.20 (65) 0.137 ± 0.0076	46–59 0.121–0.154	45–61 (45)
Height of temporal fossa (20)	36.4 ± 3.47 (65) 0.096 ± 0.0089	31–45 0.078–0.115	32–46* (45)
Length of orbit (25)	47.7 ± 1.91 (66) 0.125 ± 0.0060	44–55 0.115–0.139	44–48* (13)
Length of preorbital process (26)	43.9 ± 2.75 (66) 0.115 ± 0.0062	38–51 0.104–0.131	43–50* (14)
Width of internal nares (27)	50.6 ± 2.45 (66) 0.133 ± 0.0068	45–55 0.115–0.149	47–55* (14)
Length of upper toothrow (32)	194.9 ± 9.05 (62) 0.511 ± 0.0134	176–211 0.477–0.535	183–210* (14)
Number of teeth UL (33)	44.5 ± 2.17 (56)	40–52	36–49* (52)
UR (34)	44.3 ± 2.18 (55)	39–51	

Table 2. *Continued*

Measurement (No. in Perrin, 1975)	Mean ± S.D. (n)	Range	Range from Literature (n)
LL (35)	43.5 ± 1.78 (60)	39–48	38–48 (50)
LR (36)	43.0 ± 1.93 (63)	39–48	
Length of mandible (38)	323.1 ± 11.58 (66)	297–347	295–347 (45)
Height of mandible (39)	57.8 ± 2.55 (66) 0.179 ± 0.0061	51–64 0.164–0.194	—
Length of mandibular symphysis	38.1 ± 2.80 (64) 0.118 ± 0.0085	33–49 0.102–0.152	—
Diameter of tooth (mid-lower toothrow)	3.16 ± 0.322 (66)	2.2–3.8	2.4–3.8* (48)
Depth of palatal groove (at 1/2 length of rostrum)	1.46 ± 0.488 (65)	0.5–2.9	1–2* (11)
No. of thoracic vertebrae (48)	13.4 ± 0.55 (5)	13–14	14–15* (6)
No. of lumbar vertebrae (49)	20.7 (3)	20–21	17–21 (5)
No. of caudal vertebrae (50)	33.0 (2)	32–34	31–35 (5)
Total no. of vertebrae (51)	74.5 (2)	73–76	70–75* (44)

*Extension of the known range.

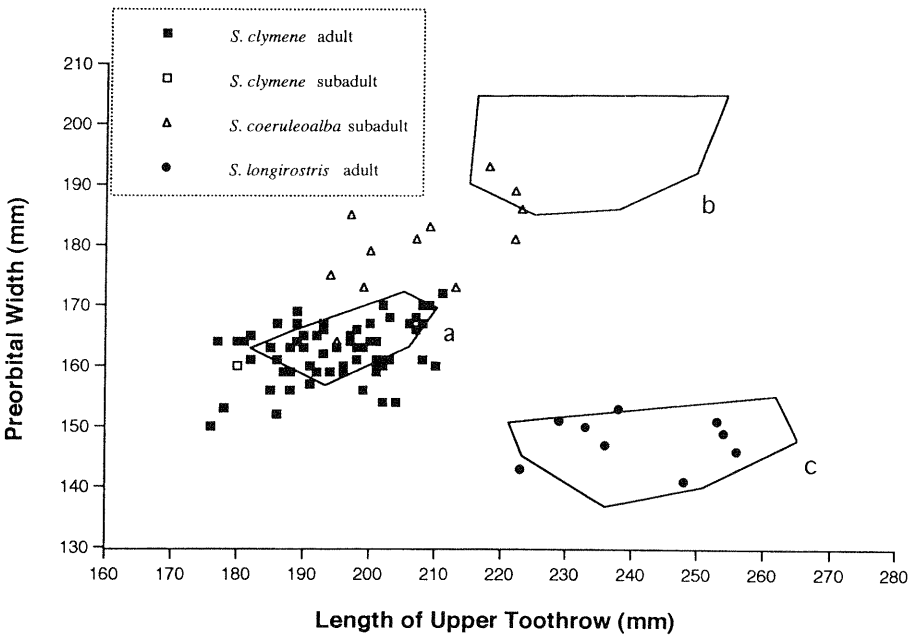

Figure 3. Scatterplot of length of upper toothrow vs. preorbital width, showing separation of *S. clymene* from *S. coeruleoalba* and *S. longirostris*. Polygons represent areas of clusters from Perrin *et al.* (1981): *S. clymene* (a), *S. coeruleoalba* (b), and *S. longirostris* (c).

raised and rounded area on the premaxillae at the proximal end of the rostrum (evident in lateral view—Fig. 4). This raised boss was not observed in skulls of Clymene or spinner dolphins (in which the entire rostrum is relatively flat in lateral view), and this was found to be one of the best characters for distinguishing striped dolphin skulls from those of the other two species.

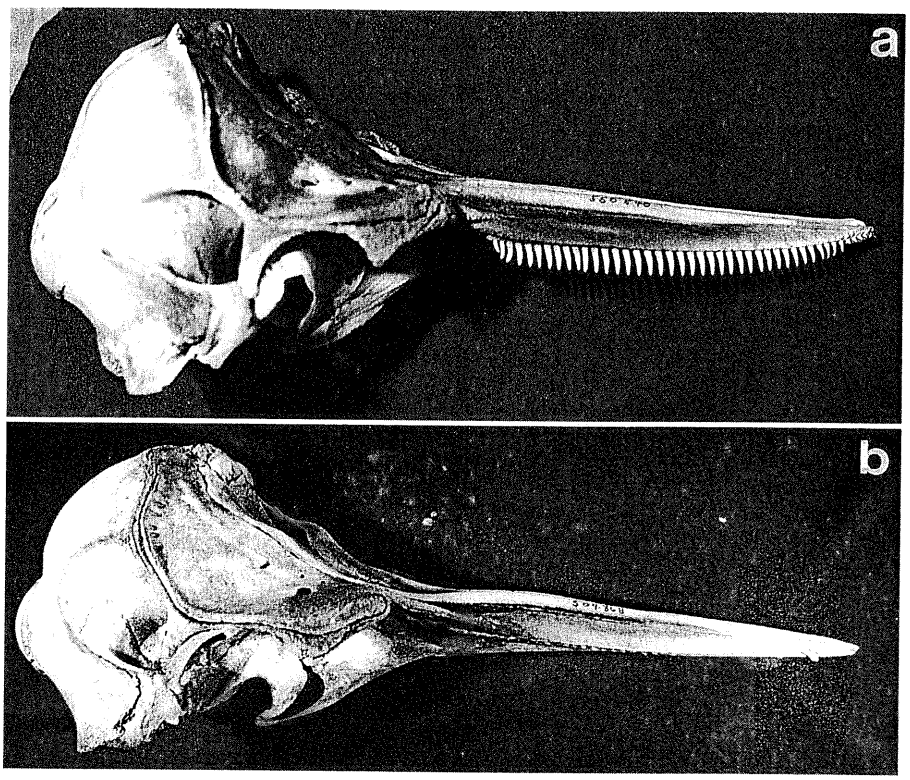

Figure 4. Lateral views of skulls of *S. clymene* (a) and *S. coeruleoalba* (b). A raised and rounded area can be seen at about 1/3 length of the rostrum in *S. coeruleoalba*; this is not present in *S. clymene*.

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