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Biometric Measures Indicating Sexual Dimorphism in *Stenella coeruleoalba* (Meyen, 1833) (Delphinidae) in the North-Central Tyrrhenian Sea

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Abstract

Since 1985, the Centro Studi Cetacei (Cetacean Study Centre) in Italy has been committed to the recovery of cetaceans stranded along the Italian coastlines to estimate the abundance of species present and to identify causes of death, disease, and other information useful to the study of cetaceans. The current study analyzed some external morphometric parameters of striped dolphin (*Stenella coeruleoalba*), the most abundant small cetacean in the Mediterranean Sea, to identify features indicating sexual dimorphism. Identification and measurement of external dimorphic characteristics allowed for determination of the sex of those specimens for which gender was not immediately evident due to decomposition of their external genital organs. Specifically, a total of 37 specimens (19 males, 15 females, and 3 unsexed) of *S. coeruleoalba* that stranded along the north-central Tyrrhenian Sea coasts (Italy) from 1983 to 1991 were measured; 28 parameters of external morphology were examined; and values were analyzed using the parametric Student *t*-test and were subsequently validated by stepwise discriminant analysis. According to the data, the total length reached by individuals, which is greater in female specimens, was not a statistically significant parameter leading to gender confirmation—that is, the length reached by individuals was independent of sex. However, the distance between the genital slit and anus (greater in males as in other small odontocetes) and the distance between the umbilicus and anus (greater in females) were found to be statistically significant dimorphic characters. The distance between the genital slit and the median notch of the flukes, which is longer in males, was identified as significant by discriminant analysis only. Thus, it may be considered as a feature indicating sexual dimorphism, but further investigation is required.

Key Words: dimorphic characteristics, Italian coasts, external measurements, striped dolphin, *Stenella coeruleoalba*, Progetto Spiaggiamento Cetacei

Introduction

Established by the Museum of Natural History of Milan in October 1985 by several researchers from the Italian Natural History Museum and other Italian scientific institutions, the Centro Studi Cetacei (Cetacean Study Centre) (CSC), within the Società Italiana delle Scienze Naturali (Italian Company of Natural Sciences), is concerned with the recovery and study of cetaceans stranded along the Italian coasts in conjunction with the Spiaggiamento Cetacei project (Cetacean Stranding Project) (Cagnolaro, 1985, 1992).

According to data collected by the CSC, the striped dolphin (*Stenella coeruleoalba*, Meyen, 1833) is the most abundant species in the Italian seas, while it is almost absent in the North Adriatic Sea, probably because of the shallow water (Centro Studi Cetacei, 1986-2005; Fortuna et al., 2007). Samples of striped dolphins represent a great majority of cetaceans stranded along the Italian coasts (Borri et al., 1997) and are an important opportunity to study external morphometric features and comparative morphology in this dolphin species.

External Morphology

The striped dolphin is a delphinid with a slim body. The fin is relatively large and triangular; the flippers are falcate and pointed; and the fluke is thin (Cagnolaro et al., 1983). They have a typical body coloration pattern depicting dark grey-black shades on the sides of the back, a white ventral zone, and a dark beak. Three streaks part from the eye: the longest one reaches the ventral region; the second one (shorter) extends behind and above

the junction of the pectoral fin; and the third one reaches the base of the pectoral fin (Fraser & Noble, 1970; Mitchell, 1970; Rosas et al., 2002).

Male and female striped dolphins exhibit the same length at birth with measures ranging between 92.5 (Aguilar, 1991) and 100 cm (Kasuya, 1972; Miyazaki, 1977). As for the Mediterranean, Calzada et al. (1997) found males (18 y/200 cm) with greater asymptotic body length than females (15 y/194 cm), and Di-Meglio et al. (1996) found females with greater asymptotic length (194.75 cm) than males (191.20 cm). In the Atlantic, males presented greater asymptotic length (216.07 cm) than females (200.10 cm) (Di-Meglio et al., 1996). In the Mediterranean, females reach sexual maturity at 12 y (Calzada et al., 1996), while in Japanese waters they reach sexual maturity at 9 y (Miyazaki, 1977). Once sexual maturity is reached, the length of individuals can vary from 195 to 220 cm in males (Perrin & Reilly, 1984), with female lengths ranging from 187 (Calzada et al., 1996) to 216 cm (Perrin & Reilly, 1984).

External genital openings are located in a median-ventral position, with males having a protruded penis and females having nipples in two folds at the sides of the genital slit (Meek, 1918; Calzada et al., 1997; Aguilar, 2000). The distance between the genital and anal centres is larger in males indicating sexual dimorphism (Figure 3). In males, the distance between the two orifices is greater than the genital slit length. In females, the distance between the genital and anal centres is shorter (Cagnolaro et al., 1983).

Sexual dimorphism was studied using external morphological parameters on 37 specimens (19 males, 15 females, and 3 unsexed) of *S. coeruleoalba* stranded along the Italian coast between 1983 and 1991. The aim of this study was to find, through the analysis of external morphometric measurements, those biometric parameters that would facilitate sex recognition in the striped dolphin.

Methods

Between 1983 and 1991, external measurements were taken of 37 striped dolphins (see Supplemental Information on the *Aquatic Mammals* website: www.aquaticmammalsjournal.org/images/AM_40.1_Carlinietal_WebSupplemental_Appendix.pdf) stranded along the Italian coasts (i.e., north-central Tyrrhenian Sea), including eight specimens found along the coast of Liguria (Cagnolaro et al., 1986), five specimens recovered along the coast of Tuscany (Centro Studi Cetacei, 1986-2005), and 24 specimens recovered along the coast of Latium (Carlini, 1990).

Each freshly dead dolphin was measured following the standard guidelines from Norris (1961) and Cagnolaro et al. (1983). The guidelines describe a set of 28 line measures without replicates (Table 1 & Figure 2).

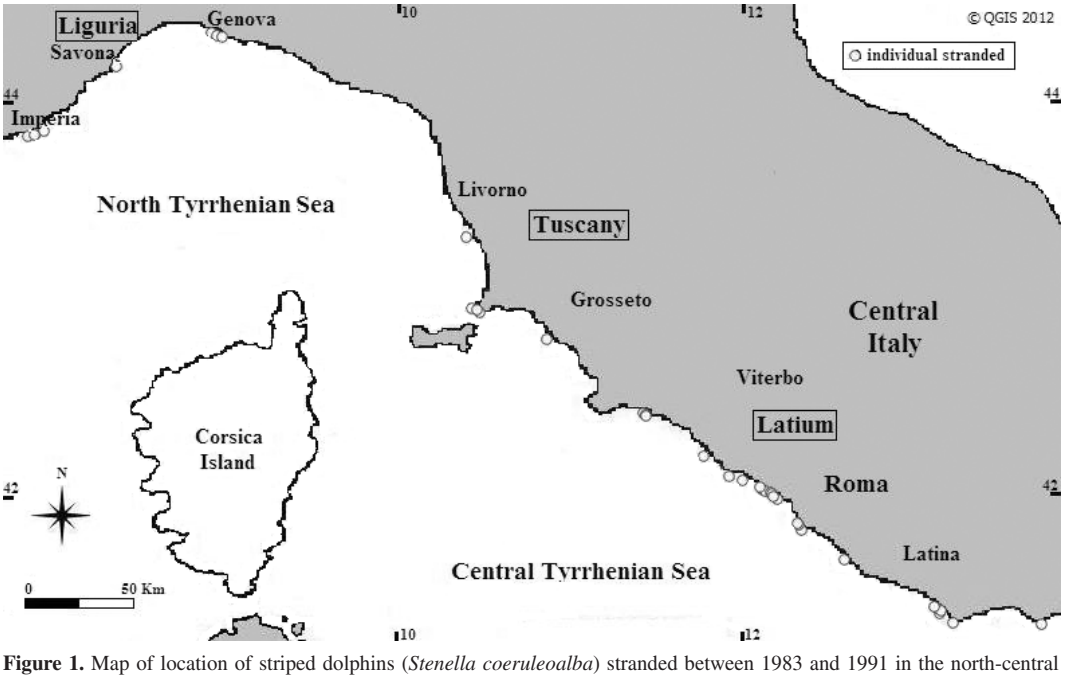

Figure 1. Map of location of striped dolphins (*Stenella coeruleoalba*) stranded between 1983 and 1991 in the north-central Tyrrhenian Sea (39° 31' 22" N, 13° 21' 12" E), Italy; the Tyrrhenian Sea is located between the Italian peninsula and the Corsica and Sardinia Islands (Sardinia Island, not shown in the figure, is located under Corsica Island), with a maximum depth of nearly 4,000 m in the south where there is a fault line that divides Italy from Africa, with mountains and active volcano submarines.

Sex recognition was performed only by examination of the mid-ventral body and genital organs (i.e., the penis may be protruded in males after death), although body and genital decomposition, which rapidly occur after stranding, make sex recognition particularly difficult (Cagnolaro et al.,

Table 1. External measurements (Cagnolaro et al., 1983) as per Figure 2

Parameter	External measurements
1	Total length*
2	Tip of upper jaw to cranial insertion of flipper*
3	Beak to angle of mouth*
4	Snout to eye*
5	Snout to ear*
6	Length of beak
7	Snout to jaw
8	Snout to blowhole
9	Snout to anterior insertion of dorsal fin*
10	Dorsal fin to interlobar tail sinus
11	Centre of anus to interlobar tail sinus*
12	Genital slit to notch between flukes*
13	Umbilicus to interlobar tail sinus*
14	Genital slit to anus centre*
15	Body height at the margin of the eye
16	Body height at insertion of pectoral fin
17	Body height at the dorsal fin
18	Body height at the tail fin
19	Length of dorsal fin base
20	Height of dorsal fin
21	Length of caudal fin
22	Thickness of caudal fin
23	Pectoral fin width (maximum)
24	Pectoral fin length (anterior insertion)
25	Pectoral fin length (posterior insertion)
26	Blowhole length (maximum)
27	Umbilicus to genital slit*
28	Eye diameter

*Distances taken in straight line parallel to body axis

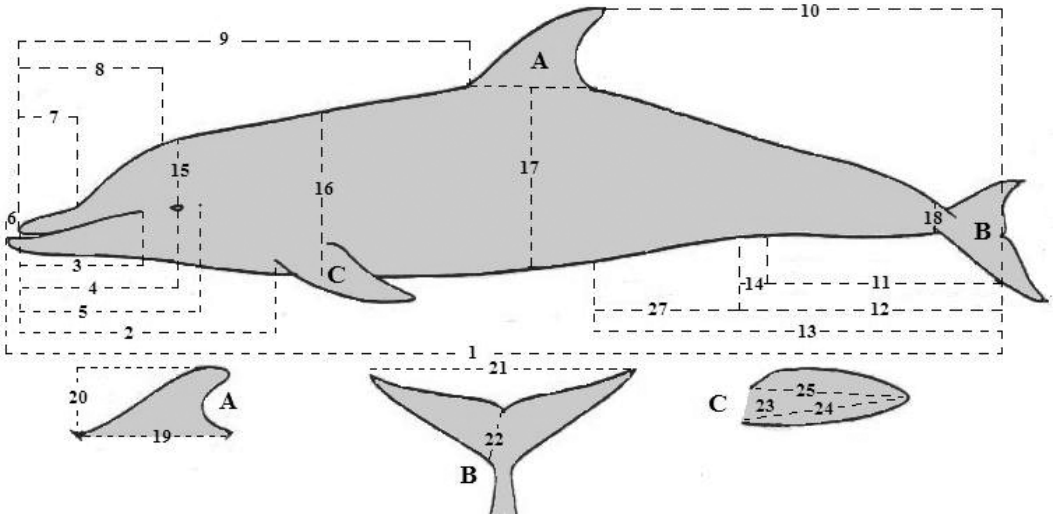

Figure 2. Body measurements taken from the striped dolphin specimens (Cagnolaro et al., 1983) as defined in Table 1

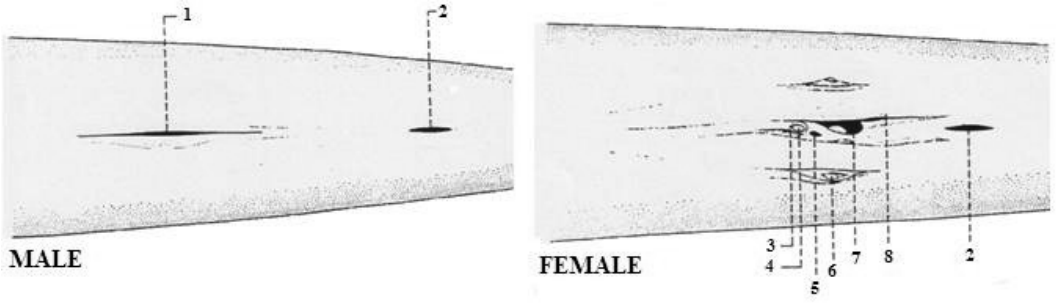

Figure 3. Male and female genital organs (Cagnolaro et al., 1983): (1) genital slit, (2) anus, (3) labia minora, (4) clitoris, (5) external urethral orifice, (6) nipples, (7) vaginal opening, and (8) labia majora

1983). Also, sex can be determined by measuring the distance between the genital and anal openings (Figure 3). Thus, the distance between genital slit and anus centre is a reliable biometric parameter for sex recognition.

In the current study, sex determination was possible for 34 of the 37 specimens (19 males and 15 females). Three of the 37 specimens were found in an advanced state of decomposition; thus, it was not possible to determine their sex.

The entire sample size was divided into three body size subgroups for each sex. The newborn group was comprised of one female with a body length of < 100 cm (Kasuya, 1972; Miyazaki, 1977; Aguilar, 1991); the juvenile group had nine males and six females, with lengths ranging from 101 to 190 cm; and the adult group was composed of 10 males and eight females, with lengths greater than 191 cm (Perrin & Reilly, 1984; Calzada et al., 1996). Averages and standard deviations (SD) were calculated separately for juvenile and adult individuals of each sex, and newborn and unsexed specimens—that is, four samples/77 measurements (29.7%) as well as unavailable measures (i.e., 113 measurements, 10.9%), which were excluded from statistical analysis.

A comparison of male and female averages using the Student *t*-test (using pooled variance) was meant to identify if differences were due to chance or sexual dimorphism. The *t*-test was based on variance homogeneity (i.e., homoscedasticity) within the observed groups (males and females); significant differences were considered for p values < 0.05 ($\alpha < 5\%$). The Student *t*-test (parametric test) was conducted separately for juvenile and adult individuals to verify the presence in both groups of parameters having statistically important differences. A Bonferroni adjustment for multiple tests was also applied.

The trend of each external morphological parameter vs the total body length (parameter 1) was analyzed in adult specimens with Spearman's correlation analysis (non-parametric test) in order to identify those morphometric measurements that did not vary uniformly with total body length, indicating sexual dimorphism. Non-parametric tests validated results obtained by parametric tests. Spearman's test identifies those biometric parameters that have no linear correlation with the body's length, indicating differences between individuals of both sexes. Therefore, the test results of Spearman's test were not reported in the present work. A stepwise discriminant analysis (multivariate test) was performed to compare variables discriminating sex groups. Discrimination was measured by Wilks' λ test, with values ranging from 1 to 0 (lower values indicate greater differences between groups). Discriminant analysis was initially conducted on all 28 parameters of external morphology. Statistical analyses were performed with the *Statistica 10* software package (StatSoft Inc., 1984-2011).

Results

Measurements of 37 striped dolphin (19 males, 15 females, and 3 unsexed) from the north-central Tyrrhenian Sea were analyzed (Table 2). Values for adults of both sexes indicated no significant differences; for some parameters, female averages were slightly larger than those of males, including size range. Important differences can be seen in parameter 14 (i.e., genital slit to anus centre), which was longer in males, and parameter 27, which was greater in females (Table 2). Similarly, averages of juveniles of both sexes demonstrated no significant differences, except for parameters 14 and 27 (Table 2). In the sample, females reached longer total body length and size range (202.3 cm, 115 to 231.0 cm) than males (199.0 cm, 101.0 to 210.0 cm).

The existence of significant differences linked to sexual dimorphism rather than chance variability was examined using the Student *t*-test (Table 3), which was performed on both adult (with and without Bonferroni adjustment) and

Table 2. External measurements 1 to 28 as cited in Table 1 and Figure 2 (mean ± SD [*n*]) in *S. coeruleoalba*

	Male			Female		
	101 to 190 cm juveniles	> 191 cm adults	Size range male	101 to 190 cm juveniles	> 191 cm adults	Size range female
	mean ± SD (*n*)	mean ± SD (*n*)		mean ± SD (*n*)	mean ± SD (*n*)	
1	153.0 ± 30.4(*9*)	199.0 ± 5.2 (*10*)	101.0-210.0	169.3 ± 27.6 (*6*)	202.3 ± 13.7 (*8*)	115.0-231.0
2	38.7 ± 7.1 (9)	44.4 ± 2.2 (*10*)	25.0-47.0	41.1 ± 5.2 (*6*)	46.9 ± 4.1 (*8*)	31.0-55.0
3	22.8 ± 4.7 (*9*)	26.6 ± 1.4 (*10*)	14.5-29.0	24.4 ± 3.2 (*6*)	26.9 ± 2.2 (*8*)	19.0-30.0
4	26.5 ± 5.3 (*9*)	30.8 ± 1.1 (*10*)	17.0-32.0	28.7 ± 3.8 (*6*)	30.7 ± 2.1 (*8*)	22.0-34.0
5	32.4 ± 7.0 (*8*)	39.0 ± 5.0 (*5*)	20.5-47.5	33.4 ± 4.7 (*5*)	36.7 ± 2.7 (*7*)	26.0-41.3
6	9.1 ± 2.4 (*9*)	11.1 ± 0.6 (*9*)	5.0-12.5	10.6 ± 2.5 (*6*)	12.1 ± 0.9 (*8*)	3.0-13.0
7	0.5 ± 0.1 (*3*)	1.0 ± 0.7 (*7*)	0.3-2.3	0.2 ± 0.1 (*2*)	1.4 ± 1.7 (3)	0.1-3.3
8	25.2 ± 5.7 (*9*)	31.2 ± 2.2 (*10*)	15.0-34.0	28.7 ± 6.8 (*6*)	30.3 ± 2.4 (*8*)	19.0-40.0
9	69.5 ± 13.0 (*9*)	88.1 ± 6.7 (*9*) 8	46.5-90.0	78.8 ± 13.2 (*6*)	90.1 ± 4.4 (*8*)	53.0-96.0
10	61.3 ± 13.3 (*9*)	85.4 ± 6.2 (*10*)	40.0-85.0	68.8 ± 12.8 (*6*)	87.2 ± 13.5 (*8*)	46.0-117.0
11	45.8 ± 10.6 (*9*)	60.4 ± 3.8 (*8*)	28.0-62.0	48.2 ± 7.3 (*6*)	59.5 ± 4.4 (*8*)	34.0-68.0
12	56.0 ± 13.3 (*9*) 7	73.7 ± 6.4 (*10*)	33.5-75.0	54.3 ± 8.9 (*6*)	66.8 ± 3.7 (*6*)	37.0-72.8
13	82.1 ± 19.4 (*8*)	108.6 ± 6.7 (*8*)	49.0-101.0	85.2 ± 16.5 (*6*)	107.1 ± 5.7 (*6*)	56.0-115.0
14	10.2 ± 3.2 (*9*)	13.4 ± 3.4 (*6*)	3.5-13.0	6.2 ± 1.8 (*6*)	7.1 ± 2.1 (*6*)	3.5-9.5
15	20.1 ± 3.1 (*9*)	23.2 ± 5.4 (*9*)	10.0-24.0	21.0 ± 3.3 (*6*)	23.9 ± 5.0 (*8*)	15.0-35.0
16	23.3 ± 6.7 (*9*)	31.4 ± 5.8 (*8*)	9.0-30.0	25.8 ± 5.5 (*6*)	31.1 ± 2.0 (*7*)	16.0-33.0
17	25.9 ± 5.0 (*8*)	37.5 ± 3.3 (*8*)	16.5-34.0	29.0 ± 7.6 (*6*)	36.3 ± 8.3 (*7*)	16.5-54.0
18	7.4 ± 1.3 (*9*)	8.8 ± 1.9 (*9*)	4.5-11.0	8.6 ± 0.9 (*6*)	9.4 ± 0.6 (*8*)	7.0-10.0
19	21.5 ± 5.2 (*8*)	28.1 ± 3.1 (*10*)	15.0-27.0	23.7 ± 4.5 (*6*)	28.2 ± 2.3 (*8*)	16.0-32.0
20	14.5 ± 3.0 (*9*)	18.5 ± 2.4 (*9*)	10.0-18.5	14.4 ± 2.5 (*5*)	16.1 ± 2.4 (*8*)	10.0-18.0
21	35.5 ± 8.1 (*9*)	46.1 ± 6.8 (*10*)	24.5-45.0	40.7 ± 9.5 (*5*)	46.5 ± 4.1 (*6*)	24.5-53.0
22	10.2 ± 2.1 (*9*)	12.8 ± 1.4 (*8*)	7.0-16.5	12.7 ± 2.6 (*6*)	12.8 ± 0.8 (*7*)	8.5-16.5
23	6.8 ± 2.9 (*9*)	9.6 ± 0.6 (*8*)	2.0-13.0	8.7 ± 1.2 (*6*)	10.2 ± 1.2 (*8*)	6.5-13.0
24	24.6 ± 4.6 (*9*)	27.5 ± 4.1 (*9*)	17.0-29.5	26.1 ± 4.3 (*6*)	29.4 ± 2.6 (*8*)	18.5-33.5
25	17.6 ± 3.1 (*9*)	21.1 ± 2.1 (*8*)	13.0-22.5	18.1 ± 2.6 (*6*)	20.6 ± 1.8 (*8*)	13.0-22.5
26	1.2 ± 0.5 (*7*)	1.7 ± 0.6 (*9*)	0.4-3.0	1.8 ± 0.6 (*6*)	1.6 ± 1.0 (*7*)	0.6-3.0
27	25.7 ± 6.4 (*8*) 2.	35.6 ± 4.8 (*7*)	15.0-45.0	33.5 ± 7.6 (*6*)	42.7 ± 4.5 (*5*)	19.0-48.0
28	2.1 ± 0.7 (*8*)	1.7 ± 0.5 (*7*)	0.5-3.0	2.0 ± 0.2 (*6*)	2.3 ± 0.6 (*8*)	1.5-3.0

Specimen total number is 37.

juvenile (with Bonferroni adjustment) groups, with the aim of identifying the presence of significant averages in mature and immature individuals.

In addition to averages obtained for parameter 14 (which is a sexually distinctive character in juvenile and adult delphinids), averages obtained for parameters 12 (i.e., genital slit to interlobar tail sinus), 27, and 28 (i.e., eye diameter) were statistically significant for adults (Table 3). Parameter 26 (i.e., blowhole length) was also significantly different for juveniles but not for adults (Table 3). The averages obtained for parameters 12 and 28 were not significant for juveniles (Table 3). Differences between the sexes are visible with the attainment of sexual maturity: parameter 20 (i.e., height of dorsal fin) was significantly different for adults (without the Bonferroni adjustment) but not in juveniles.

Discriminant analysis was initially performed on all 28 parameters of external morphometry with Wilks' $\lambda = 0.08$ (p value < 0.001). The discriminant function indicates parameters 14, 21, and 27 as those discriminating the sexes. Variables 14 and 27, also identified by previous tests, have Wilks' $\lambda = 0.20$ ($p < 0.001$); variable 21 (length of caudal fin) has no significant mean for the *t*-test but is highly discriminatory following discriminant analysis (Wilks' $\lambda = 0.22$; $p < 0.001$). Such analysis also suggests that once excluded, variables 14, 21, and 27 and parameters 12 and 28 become important criteria for sex differentiation. Parameter 20, significant only for adults in the *t*-test (without Bonferroni adjustment) becomes a discriminatory element as well.

Discriminant analysis confirmed the results obtained through the *t*-test and Spearman's correlation analysis. Precisely, parameters 14 and 27 are identified as dimorphics; they do not increase together with the total body length but form two distinguishable groups, one for each sex.

A scatterplot of parameter 14 vs parameter 1 (Figure 4) shows a significant distinction between

Table 3. Results of *t*-test with and without Bonferroni adjustment in juvenile and adult individuals

	Adult (length > 191 cm)					Juvenile (length 101-190 cm)		
	t-value with Bonferroni adjustment	*p* value	*t*-value without Bonferroni adjustment	*p* value	*df*	*t*-value with Bonferroni adjustment	*p* value	*df*
1	-0.71	0.49	-0.85	0.50	16	-1.05	0.31	13
2	-1.63	0.12	-1.04	0.31	16	-0.69	0.50	13
3	-0.31	0.76	-0.01	0.99	16	-0.71	0.49	13
4	0.10	0.92	0.19	0.85	16	-0.87	0.40	13
5	1.05	0.32	0.84	0.41	10	0.14	0.89	13
6	0.27	0.79	0.14	0.89	15	-1.16	0.26	13
7	-0.45	0.67	-1.27	0.23	8	0.91	0.37	13
8	0.83	0.42	0.01	0.99	16	-1.09	0.29	13
9	-0.73	0.48	-0.92	0.37	15	-1.34	0.20	13
10	-0.38	0.71	-0.07	0.96	16	-1.08	0.30	13
11	0.45	0.66	1.03	0.75	14	-0.48	0.64	13
12	2.38 *	0.03	3.45 **	0.01	14	0.27	0.79	13
13	0.45	0.66	1.09	0.30	12	-0.84	0.41	13
14	3.81 ***	0.00	5.57 ***	0.00	10	2.69 *	0.02	13
15	-0.24	0.82	0.32	0.75	15	-0.52	0.61	13
16	0.11	0.92	0.30	0.76	13	-0.76	0.46	13
17	0.38	0.71	0.16	0.87	13	-1.23	0.24	13
18	-0.86	0.40	1.09	0.29	15	-2.00	0.07	13
19	-0.03	0.98	0.43	0.67	16	-1.21	0.25	13
20	2.04	0.06	2.16 *	0.04	15	1.06	0.31	13
21	-0.13	0.90	0.35	0.73	14	0.23	0.82	13
22	0.00	1.00	0.24	0.81	13	-1.24	0.23	13
23	-1.20	0.25	0.93	0.36	14	-1.54	0.15	13
24	-1.08	0.30	0.78	0.44	15	-0.62	0.54	13
25	0.53	0.60	1.07	0.30	14	-0.32	0.76	13
26	0.14	0.89	1.46	0.16	14	-2.41 *	0.03	13
27	-2.27 *	0.04	-2.80	0.15	11	-2.12 *	0.05	13
28	0.16 *	0.02	1.43	0.17	14	-0.50	0.62	13

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4. Discriminant analysis results applied to the external morphology parameters in *S. coeruleoalba*

	Wilks' λ	F	*p* value	Discriminant function
All 28	0.08	8.29	< 0.001	- 3.85 (**14**) + 5.16 (**27**) - 3.04 (**21**) + 1.00
14	0.20	49.00	< 0.001	
27	0.20	48.74	< 0.001	
21	0.22	41.92	< 0.001	
All except 14	0.38	3.91	0.043	0.87 (**28**) - 0.91 (**12**) + 0.84
All except 14, 21 & 27	0.41	4.18	0.003	- 0.90 (**28**) + 0.90 (**20**) + 0.91 (**12**) - 1.88
All except 14, 21, 27 & 28	0.39	3.45	0.074	- 1.15 (**12**) + 0.99

Note: Bold numbers in parentheses refer to external morphology parameters.

two groups ($\alpha < 0.1$ %), while that of parameter 27 highlights a smaller difference which is nevertheless statistically significant ($\alpha < 5$%). Other investigations involving a greater number of specimens could further validate these results.

Discussion

Mediterranean striped dolphins from the north-central Tyrrhenian Sea are analyzed in this study. The longest lengths found were 210.0 cm for males (stranded in Piombino–Livorno in 1989)

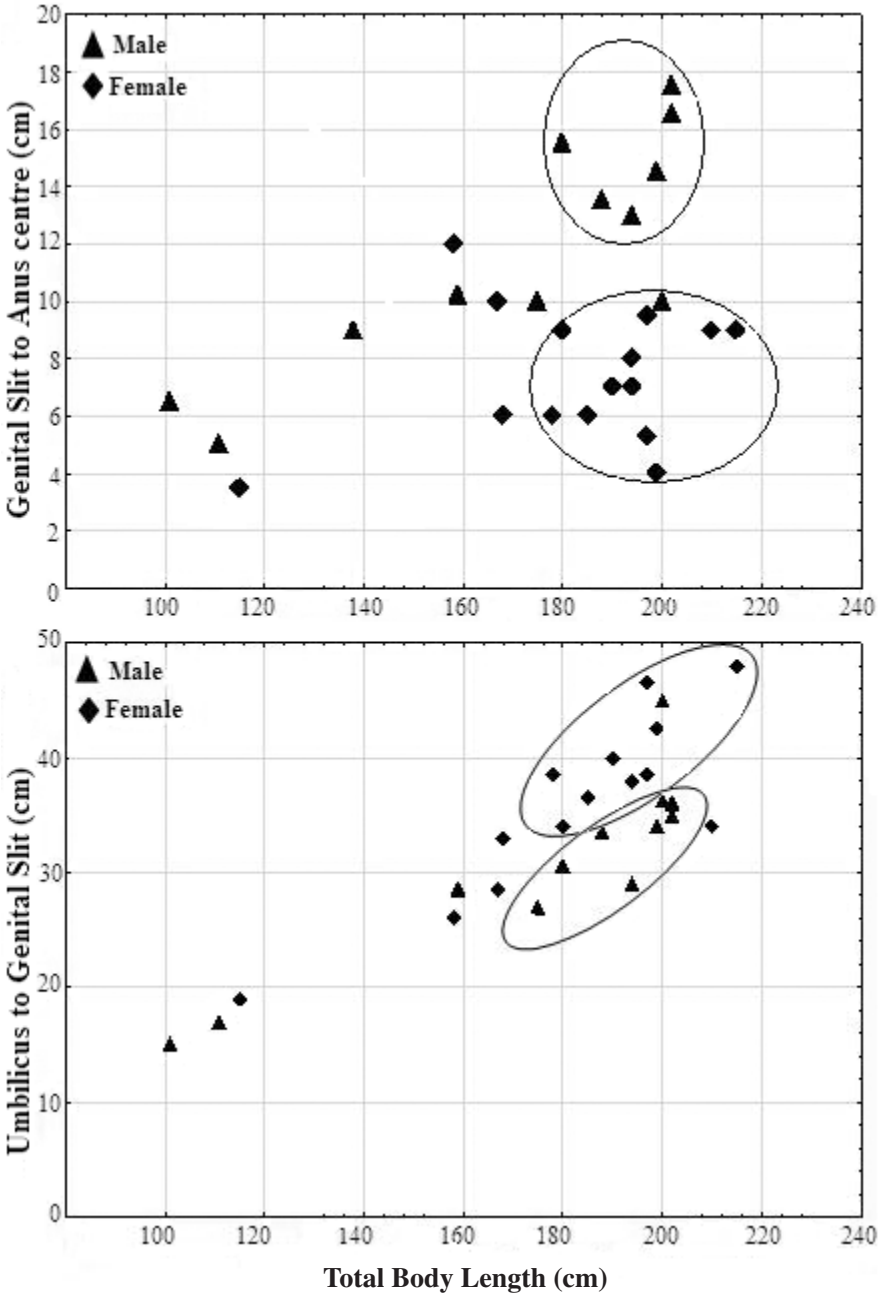

Figure 4. Scatterplot of male and female morphological differences in striped dolphins. *Top:* The distance from genital slit to anus centre increases with total body length more often in males than in females, creating a clear separation into two distinguishable groups. *Bottom:* The distance from the umbilicus to genital slit increases with total body length, but there is not a clear differentiation in the two sex groups.

and 231.0 cm for females (stranded in Sabaudia–Latina in 1989). The total length was greater in females (as also demonstrated by averages obtained: 202.3 cm for females; 199.0 cm for males). Nevertheless, parameter 1 (total body length) did not indicate statistically significant differences between sexes. The *t*-test results (p value = 0.49 in adults and 0.31 in juveniles) also

confirmed that the total length (in both juveniles and adults) did not signal sexual dimorphism in the striped dolphin. A sample of striped dolphins stranded along the Italian coasts between 1988 and 1994 was analyzed by Marsili et al. (1997). Sizes ranged from 100.0 to 220.0 cm (males) and 105.0 to 220.0 cm (females), with individuals of longer length coming from along the coast of the Adriatic Sea. Data from Marsili et al. are similar to those analyzed in this study: both investigations found female specimens longer than males and confirmed that total length does not signal sexual dimorphism. The previous results do not match those obtained by Calzada & Aguilar (1995) whose sample of striped dolphins stranded along the Spanish coasts (western Mediterranean Sea) had males with greater (by 2 cm) total body length than females. Furthermore, Rosas et al. (2002) found a male specimen of striped dolphin with total length of 244.0 cm (much longer than those of the Mediterranean) on the southeast coast of Brazil (Atlantic Ocean), while Gales (1992) obtained a total length of 237 ± 4 cm for males and 237 ± 2 cm for females in a sample of striped dolphins from Western Australia (Indian Ocean). Kasuya (1972) also found males with greater body length than females in a sample of individuals from the Pacific Ocean (with an asymptotic length of 225.3 cm for females and 236.0 cm for males). Nevertheless, in these studies as well the difference between averages obtained for both sexes was not statistically significant and did not indicate sexual dimorphism. The averages obtained by those authors indicate that individuals coming from the oceans have greater total body length than individuals coming from the Mediterranean Sea. According to Perrin (1984), small cetaceans living in oceans (offshore) have greater body size than cetaceans living in semi-enclosed and enclosed seas (inshore). Further studies on striped dolphins living in the Mediterranean could validate this hypothesis.

The *t*-test, carried out separately for juveniles and adults, highlights how the genital slit to the anus centre (parameter 14: p value = 0.02 for juveniles and 0.00 for adults) signals a significant difference between sexes. Such a result was confirmed by Spearman's correlation test and additional discriminant analysis in agreement with the conclusions of Cagnolaro et al. (1983) for striped dolphins, of Sanvincente-Añorne et al. (2004) for other species of genus *Stenella*, and those of Slijper (1966) and Harrison et al. (1972) for other small cetaceans. In fact, the distance between the genital slit and anus indicates sexual dimorphism and is greater in males than in females. The trend of parameter 14 vs parameter 1 clearly demonstrates how the distance between the genital slit and anus does not increase together with body size. Our scatterplot suggests that adults (length > 191 cm) separate into two different groups—males and females. Statistical analysis indicates parameters 12, 21, 27, and 28 as those signaling sexual dimorphism, with parameter 26 showing a significant difference (α = 5%) for juveniles. Discriminant analysis, which did not confirm these results, did indicate three main parameters able to discriminate the sexes: (1) parameter 14 (λ = 0.20), (2) parameter 27 (λ = 0.20), and (3) parameter 21 (λ = 0.22). According to Sanvincente-Añorne et al. (2004), for *S. attenuata graffmani* samples, parameter 27 (umbilicus to genital slit) is greater in females and can help identify sexes of individuals belonging to other species of dolphins.

Parameter 21 (length of caudal fin) was identified by discriminant analysis, but *t*-test and correlation analyses demonstrated how the means obtained for both sexes bear no significant difference. In fact, the difference between the averages can be noticed only for juveniles (with greater values in females). Adults have similar averages. What is more, no study has ever linked difference in the length of the tail fin to sex. Discriminant analysis has also indicated parameters 12 and 28 as dimorphic, excluding parameter 14. However, in the *t*-test, the averages obtained for parameters 12, 27, and 28 have very low (α < 5%) significance if they are compared to the average of parameter 14 (α < 0.1%). So, only a larger number of specimens could further confirm these results.

For adults, the *t*-test was done with and without Bonferroni adjustment. Results were always in agreement, except for parameter 20 (height of dorsal fin), in which case the averages obtained for males and females had significant differences (α < 5%) only without Bonferroni adjustment. Averages did not indicate difference in the juveniles, but, for adults, the male's dorsal fin is about 2 cm higher than the female's. Parameter 20 was also identified as dimorphic by discriminant analysis. In some species, the height of the dorsal fin allows a discrimination between sexes. In the killer whale (*Orcinus orca*), males have a much taller dorsal fin than females, thus allowing a rapid identification of sexes (Cagnolaro et al., 1983). Nevertheless, the data analyzed in this work do not demonstrate a significant difference between male and female averages, and a larger sample is needed in order to confirm dimorphism of this biometric parameter.

To sum up, this study confirmed that the distance between the genital slit and anus is the main sex indicator in the Mediterranean *S. coeruleoalba* from around Italy as is true for other small cetaceans studied by other authors (Slijper, 1966; Harrison et al., 1972; Cagnolaro et al., 1983; Sanvancinte-Añorne

et al., 2004). The distance between the umbilicus and anus (greater in females) proved to be another biometric parameter signaling sexual dimorphism: averages in juveniles (101 to 190 cm of length) were 25.7 cm for males and 33.5 cm for females. In adults (length > 191 cm), averages were 35.6 cm for males and 42.7 cm for females. The distance between the genital slit and caudal fin (longer in males) might be considered another important dimorphic parameter, but further studies involving larger samples are needed in order to validate these results.

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