The sexual dimorphism in cranial features of the *Stenella coeruleoalba* (Cetacea, Delphinidae): a case study of an italian sample

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Abstract. Cranial measurement of *Stenella coeruleoalba* were analyzed for contributing to knowledge on the sexual dimorphism in skull of Italian striped dolphins. Were investigated 65 specimens (36 males, 19 females and 10 unsexed) sub-adults and adults for studying 37 cranial parameters identifying the greatest parietal width as sexual dimorphic characteristic.

Keywords: sexual dimorphism, skull parameters, Italian striped dolphin population, linear cranial measurements.

INTRODUCTION

The causes and the significances of sexual dimorphism may be various, from sexual selection to differential niche utilization between sexes, to environmental and predation pressure (Bergmann, 1965; Selander, 1966; Andersson, 1994). Studies about sexual dimorphism in marine mammals are more interesting to increase the knowledges about them; in effect cetaceans, as the other mammals, may present different degree of the sexual size dimorphism or the secondary sexual features especially due to local adaptations (Gautier-Hion, 1975; Lowther, 1975; Ralls, 1977). In the striped dolphin *Stenella coeruleoalba* (Meyen 1833) external morphology or coloration show no evident sex differences (Carlini et al., 2014) and, after stranding, sex determination is very difficult or impossible without genital organs which decompose very quickly (Cagnolaro, 1993). Therefore, the collections own several osteological finds unsexed, cannot be used in the studies on biology and on population dynamic (Centro Studi Cetacei, 1986-2005).

The striped dolphin represent the most abundant marine mammal in the Mediterranean Sea (Cagnolaro, 1993; Di Natale, 1983; Fortuna et al., 2007; Magnaghi & Podestà, 1987) and in other waters around the world (Sampson, 1970; Hubbs et al., 1973; Perrin, 1975; Isaksen & Syvertsen, 2002; Kumaran, 2003), commonly inhabiting inshore and offshore environments with a large swimming skills (Notarbartolo di Sciara et al., 1993; Wurtz & Marrale, 1993 Forcada et al., 1994; Frantzis et al. 2003, Gannier, 2005). Thus, it is the most abundant in Italian Naturalistic collections by stranding (Centro Studi Cetacei, 1986-2005). The morphological and genetic studies suggest the existence in the Mediterranean Sea of populations differentiated from Atlantic Ocean one, due to low gene flow through the Straits of Gibraltar (Calzada & Aguilar, 1995; Gaspari et al. 2007; Loy et al., 2011). Although the abundance of striped dolphin species worldwide, lately the Mediterranean populations decreased for the various environmental and antropic factors (Bortolotto et al., 1992; Hammond et al., 2008) and the better investigations about the recognition of the local populations and the sexual dimorphic characteristics could allow the specific measures of conservation.

The approaching to study of sexual dimorphism in Italian specimens of *S. coeruleoalba* by analysis of cranial parameters is the aim of this work; the previous results obtained could be used in further studies to individuate the sex indicators for unsexed osteological finds.

MATERIALS AND METHODS

Cranial measures were obtained on 65 skulls recovered along Italian coasts by Zoological Museums staff (Tab.1, Appendix I). All measurements were to nearest mm following the guidelines from Perrin (1975) (Tab. 2, Fig. 1).

For cranial measurements were used an anthropological compass, a standard sliding callipers and a graph transparent plexiglass plane. Following Perrin & Heyning criteria (1993), comparing the striped dolphin skull with one of other small cetaceans (Leduc et al., 1999), the skull was defined sexually mature with the complete distal fusion between the premaxillae and maxillae bones in the rostrum. Thus, the whole sample was subdivided in two age-groups: the sub-adults (31 specimens - 19 males, 7 females, 5 unsexed) and the adults (34 specimens - 17 males, 12 females, 5 unsexed).

The mean and standard deviation (SD) calculations were estimated for sub-adults and adults of each sex; data were submitted to the Principal Components Analysis (PCA) that identified which variables can be grouped (i.e. determined by common factors). The correlation matrix calculated from data analyzed was submitted to VARIMAX rotation, to simplify identification of first, second and third PCs. For each factor were calculated eigenvalue and variance explained. PCA considered factors with eigenvalue greater than 1; eigenvalues following the first were extracted with a lower variance explained (Fowler & Cohen 2010). Subsequently, the comparison of averages obtained from the male and the female measurements (sub-adults and adults) was performed with the t-Student test (using pooled variance) with Bonferroni correction. t-Student analysis was conducted on male and female individuals, whereas unsexed individuals, i.e. 10 samples and 370 measurements (15,4%), and not avail-

Tab. 1 – List of specimens from various Italian collections.

Collection	Male	Female	Unsexed	Total
Zoological Museum of Genoa	7	4	-	11
Natural History Museum of Milan	6	2	3	11
La Specola Zoological Museum of Florence	3	3	2	8
Natural History Museum of Livorno	3	1	2	6
Fisiocritici Academy of Siena	2	-	3	5
Zoological Museum of Rome	8	5	-	13
Calimera Museum of Lecce	7	4	-	11
Total	**36**	**19**	**10**	**65**

Tab. 2 – Cranial osteometric parameters (Perrin 1975) as per Figure 1.

1	Condylobasal length	20	Smaller diameter of left temporal fossa
2	Rostral length	21	Premaxillae length of over the maxillae
3	Rostral width at the base	22	Nasal bone to occipital crest
4	Rostral width 60 mm anterior to base	23	Length of left orbital bone
5	Rostral width at midlength	24	Length of left lacrimal bone
6	Premaxillae width at midlenght	25	Greatest width of internal nares
7	Rostral width at ¾ length	26	Greatest length of left pterygoid
8	Tip of rostrum to external nares	27	Greatest length of left timpanic bulla
9	Tip of rostrum to internal nares	28	Greatest length of periotic left
10	Greatest preorbital width	29	Length of upper left row
11	Greatest postorbital width	30	Number of teeth (upper left)
12	Smaller supraorbital width	31	Number of teeth (upper right)
13	Greatest width of external nares	32	Number of teeth (lower left)
14	Greatest squamous width	33	Number of teeth (lower right)
15	Greatest premaxillary width	34	Length of lower left row
16	Greatest parietal width	35	Greatest length of left ramus
17	Greatest length of left temporal fossa	36	Greatest height of left ramus
18	Greatest width of left temporal fossa	37	Length of left mandibular fossa
19	Greatest diameter of left temporal fossa		

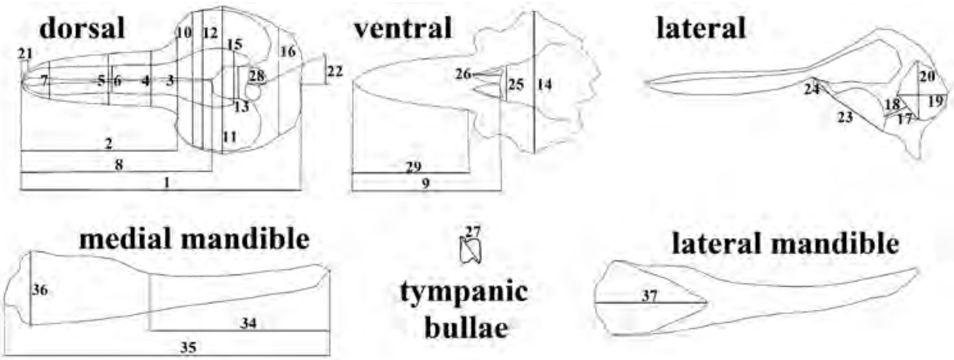

Fig. 1 – Cranial parameters (Perrin, 1975) as defined in Table 2. Projections: dorsal, ventral, lateral, medial mandible, tympanic bulla, lateral mandible.

able measures, i.e. 95 measurements (3,9%), were excluded from the statistical analysis. The linear regression test was used to identify which parameters were not correlated with CBL revealing differences attributable to sexual dimorphism (variances homogeneity). The differences may be considered significant for p-value < 0,05 (α < 5%). Finally, the sexual differences during the growth in both sexes (using only sexed specimens) were analysed comparig the trends of male and female regression lines in the scatterplot Total Body Lenght (TBL) vs Condilo-Basal Length (CBL). The statistical analysis were performed with the software package STATISTICA.10 (StatSoft Inc.1984-2011).

RESULTS

Was measured 27 sub-adults and 28 adults striped dolphins, obtaining 1271 measures for males and 671 measures for females, used to calculate means and SD in both sexes for each cranial parameter (Tab. 3).

Tab. 3 – Cranial parameters measurements [mean ± SD (cm), SE (*n*)] in *S. coeruleoalba*.

	MALE			FEMALE		
	Sub-adults mean ± SD (*n*)	**Adults mean ± SD (*n*)**	**Size range**	**Sub-adults mean ± SD (*n*)**	**Adults mean ± SD (*n*)**	**Size range**
TBL	165,3±17,3 (16)	194,9±7,9 (15)	130,0-210,0	171,7±19,2 (8)	203,9±19,1 (10)	143,0-240,0
1	38,2±3,7 (18)	40,3±1,3 (17)	27,2-42,4	39,2±2,1 (8)	40,8±2,2 (11)	36,2-44,4
2	20,8±2,3 (18)	22,5±2,2 (17)	13,8-24,0	22,0±1,4 (8)	22,8±2,4 (11)	20,4-27,6
3	9,4±2,2 (19)	10,1±0,7 (17)	6,0-11,4	9,6±1,1 (8)	10,2±0,8 (11)	7,9-11,4
4	6,2±0,9 (19)	7,0±0,5 (17)	3,8-7,8	6,6±0,8 (8)	6,8±0,6 (11)	5,3-7,8
5	5,3±0,7 (18)	6,1±0,5 (17)	3,4-7,1	5,7±0,6 (8)	5,8±0,5 (11)	4,7-6,0
6	2,6±0,3 (18)	2,9±0,3 (17)	1,7-3,8	2,7±0,4 (8)	2,9±0,3 (11)	2,2-3,5
7	4,4±0,8 (18)	5,0±0,5 (16)	2,4-5,8	4,7±0,6 (8)	4,6±0,5 (11)	3,9-5,4
8	24,4±2,7 (18)	26,1±1,7 (17)	16,5-28,8	25,4±1,7 (8)	26,1±2,4 (11)	23,3-30,4
9	23,9±2,5 (16)	25,0±1,3 (15)	16,6-27,0	25,4±1,8 (8)	24,6±1,6 (11)	22,3-27,2
10	16,6±1,8 (19)	18,3±1,1 (17)	14,0-19,8	17,2±1,2 (8)	18,4±1,0 (10)	15,3-19,9
11	18,3±1,9 (19)	20,6±1,1 (17)	12,8-22,5	18,3±2,2 (8)	19,9±1,1 (11)	15,3-22,0
12	16,8±1,9 (19)	18,2±1,1 (17)	11,3-19,9	16,8±0,9 (8)	17,8±1,0 (11)	15,6-19,6
13	4,3±0,4 (19)	4,6±0,3 (17)	3,1-5,2	4,4±0,5 (8)	4,6±0,3 (11)	3,8-5,2
14	16,7±2,0 (18)	19,1±0,8 (17)	11,5-20,2	15,5±6,4 (8)	19,1±0,9 (11)	15,7-20,4
15	7,4±0,8 (19)	8,1±0,4 (17)	5,0-8,8	7,6±0,7 (8)	8,0±0,3 (11)	6,4-8,7
16	15,3±1,2 (19)	16,3±0,8 (17)	12,2-17,7	15,9±0,9 (8)	14,9±3,0 (11)	14,5-17,4
17	6,2±0,7 (19)	6,6±0,5 (17)	4,8-7,2	6,2±1,4 (8)	6,7±0,4 (11)	3,0-7,5
18	4,8±0,6 (18)	5,2±0,3 (17)	3,4-5,6	4,9±0,7 (8)	5,0±0,4 (11)	3,7-5,9
19	4,4±4,0 (19)	3,6±0,2 (17)	2,6-3,9	3,5±0,3 (7)	3,7±0,2 (11)	3,2-4,1
20	2,6±0,6 (19)	3,0±0,3 (17)	1,1 -3,5	2,8±0,3 (7)	3,1±0,2 (10)	2,4-3,4
21	1,9±0,5 (18)	1,8±0,4 (16)	0,9-2,6	2,1±0,7 (7)	1,8±0,5 (11)	0,8-2,7
22	2,6±0,5 (19)	2,8±0,5 (17)	1,7-4,0	2,2±0,5 (7)	2,8±0,8 (11)	1,4-5,0
23	4,9±0,4 (19)	5,1±0,2 (17)	3,9-5,7	4,8±0,2 (8)	5,0±0,3 (11)	4,5-5,4
24	4,6±0,7 (19)	5,1±0,4 (17)	3,4-5,7	4,9±0,4 (8)	5,1±0,4 (11)	4,1-5,7
25	5,2±0,6 (18)	5,5±0,4 (17)	3,8-6,4	5,4±0,3 (8)	5,7±0,8 (11)	4,9-7,6
26	7,2±1,5 (18)	8,0±1,3 (14)	4,3-10,5	7,4±0,8 (8)	6,9±1,5 (9)	6,3-8,0
27	3,1±0,2 (16)	3,2±0,2 (14)	2,9-3,6	3,3±0,1 (8)	3,1±0,1 (9)	3,1-3,3
28	2,9±0,3 (16)	2,8±0,2 (14)	2,0-3,1	3,0±0,1 (8)	4,4±4,6 (10)	2,7-17,5
29	18,5±2,3 (18)	19,8±1,1 (16)	11,8-21,5	19,2±1,5 (7)	22,1±5,0 (10)	16,6-36,0
30	41,4±4,2 (13)	39,3±4,6 (15)	33,0-47,0	40,2±2,8 (6)	40,7±3,6 (8)	38,0-45,0
31	40,8±5,5 (13)	39,7±5,1 (16)	27,0-47,0	39,3±3,0 (6)	40,6±3,8 (8)	37,0-45,0
32	40,6±3,9 (15)	40,0±3,0 (16)	32,0-45,0	38,7±2,9 (6)	39,6±2,8 (8)	35,0-43,0
33	40,6±4,4 (15)	39,4±3,5 (16)	30,0-44,0	38,7±2,5 (6)	37,8±8,1 (8)	36,0-46,0
34	19,7±4,2 (18)	19,9±1,0 (17)	14,1-35,2	20,6±5,4 (8)	21,7±4,4 (11)	16,0-34,1
35	32,4±3,2 (18)	34,3±1,5 (17)	20,2-36,7	31,3±5,1 (8)	32,7±8,9 (11)	19,7-38,7
36	6,0±0,7 (19)	6,7±0,2 (17)	3,8-12,8	6,3±0,5 (8)	7,0±1,5 (11)	5,5-11,5
37	11,1±0,8 (18)	11,8±0,6 (17)	9,4-12,8	11,2±0,5 (8)	12,0±0,6 (10)	10,3-12,8

The female individuals showed a TBL greater than males in both age-groups, as for other cranial parameters analyzed, even if the cranial characteristics presented values almost similar in both sexes. PCA allowed to calculate for each PCs the eigenvalue, the percentage of variance explained and cumulative. Were considered only PC1, PC2 and PC3 (sum of variance explained = 60,7%) excluding other PCs (Tab. 4).

The three PCs allowed to describe the data in a 3D space (as seen in scatterplot of Fig. 2). Some variables were grouped in two clusters: the first included parameters referring to dental profile (left and right, upper and lower hemiarch), with strong correlation with them, and the second included the most of the remaining parameters, correlated with CBL. Probably cranial parameters out of clusters, no correlated to other CBL (Tab. 5), were characterized by factors different from those that determine the growth.

The differences between the males and females means were analyzed by t-Student test in both age-groups for each cranial parameter (Tab. 6).

For sub-adult specimens in osteological parameters the t-test indicated no statistical dif-

Tab. 4 – PCA values with eigenvalues, variance explained and cumulative after VARIMAX.

Component	Eigenvalue	% of variance	Cumulative %
PC-1	16,2	42,3	4,3
PC-2	4,1	10,8	53,1
PC-3	2,9	7,5	60,7

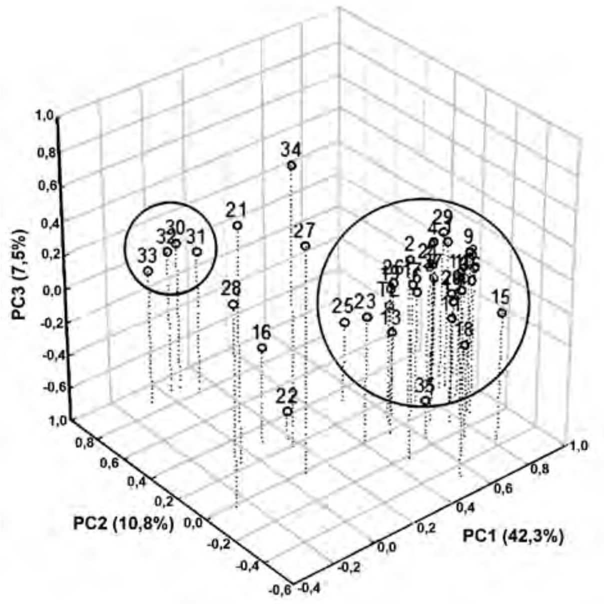

Fig. 2 – 3D scatterplot PC1 (42,3%) vs PC2 (10,8%) vs PC3 (7,5%).

Tab. 5 – Linear regression values for sub-adult and adult specimens.

	LINEAR REGRESSION			
	R² adj	***F***	***df***	***p***
1	0,31	22,6	50	0,00***
2	0,25	17,88	50	0,00***
3	0,08	5,8	51	0,02 *
4	0,15	10,54	51	0,00***
5	0,08	5,39	50	0,02 *
6	0,01	1,51	50	0,02 *
7	0,22	15,24	49	0,00***
8	0,24	17	50	0,00***
9	0,2	13,03	46	0,00***
10	0,05	4,03	50	0,05 *
11	0,14	9,19	51	0,00***
12	0,11	7,29	51	0,01 **
13	0,21	15,33	51	0,00***
14	0,02	21,1	51	0,13
15	0,12	8,46	51	0,00***
16	0,02	1,92	51	0,18
17	0,06	4,77	51	0,03 *
18	0,06	4,37	50	0,04 *
19	0,18	11,29	50	0,00***

	LINEAR REGRESSION			
	R² adj	***F***	***df***	***p***
20	0,14	9,1	49	0,00***
21	0	0	48	0,97
22	0	0,01	50	0,94
23	0,11	7,71	51	0,01 **
24	0,09	6,42	51	0,01 **
25	0,12	7,83	51	0,01 **
26	0,02	1,94	46	0,17
27	0,01	0,24	44	0,63
28	0,01	0,2	45	0,65
29	0,12	7,58	47	0,00***
30	0,02	0,68	38	0,41
31	0,06	3,76	39	0,06
32	0,01	1,27	41	0,27
33	0	0,01	41	0,92
34	0,02	2,28	50	0,14
35	0,01	0,7	50	0,41
36	0,05	3,81	51	0,05 *
37	0,1	6,62	48	0,01 **

p < 005 (*), *p* < 001 (**), *p* < 0001 (***)

ferences between sexes; also, for adults there were 3/37 variables showing statistical differences: parameter 5 (width of rostrum at midlength), parameter 7 (width of rostrum at ¾ length) and parameter 16 (greatest parietal width), with all parameters greater in males than females (as seen in Tab. 3). The very low statistical significance (α < 5%) was probably due to small sample size analyzed. The sexual differences in average values of TBL and CBL (Tab. 3) indicated the females longer than males in both age-classes not confirmed by t-Student test (sub-adults TBL *p*-value = 0,33; adults TBL *p*-value = 0,11; sub-adults CBL *p*-value = 0,44, adults CBL *p*-value = 0,47).

The parameters 5 and 7 were included in the cluster identified by PCA (Fig. 2) with other cranial parameters as CBL showing a strong correlation with them, while parameter 16 was included in any of the two clusters, and presented no correlation with CBL showing differences attributable to sexual dimorphism and confirming values obtained by previous statistical tests (linear regression values in Tab. 5).

Analysis of sexual dimorphism during the growth were conducted on 55 specimens, 36 males (19 sub-adults, 17 adults) and 19 females (7 sub-adults, 12 adults) testing the trend of the TBL vs CBL in both sexes and in both age-classes (Fig. 3).

The relationship between TBL vs CBL was described by a linear correlation, significant for both sexes (*p*-value=0,002), and the increase of body size corrisponded to the increase of skull size. The trends of regression lines showed in subadults a similar body size for both males and females but a different skull size, longer in females. During the growth, both males and

Tab. 6 – t-Student test (with Bonferroni correction) for sub-adult and adult specimens.

	SUB-ADULTS			ADULTS		
	t	*df*	***p*-value**	*t*	*df*	***p*-value**
TBL	-0,99	23	0,33	-1,64	23	0,11
1	-0,78	24	0,44	-0,73	26	0,47
2	-1,36	24	0,19	-1,13	26	0,27
3	-0,2	25	0,84	-0,43	26	0,67
4	-1,32	25	0,2	1,02	26	0,31
5	-1,25	24	0,22	1,79	26	0,05 *
6	-0,53	24	0,6	0,65	26	0,52
7	-0,82	24	0,42	1,99	25	0,05 *
8	-0,92	24	0,37	-0,04	26	0,97
9	-1,58	22	0,13	0,73	23	0,47
10	-0,66	24	0,52	-0,2	26	0,84
11	0,02	25	0,98	1,66	26	0,11
12	-0,2	25	0,85	1	26	0,33
13	-0,71	25	0,48	-0,24	26	0,81
14	0,83	24	0,41	0,14	26	0,89
15	-0,49	25	0,63	0,94	26	0,36
16	-1,22	25	0,23	1,84	26	0,05 *
17	0,04	25	0,97	-0,59	26	0,56
18	-0,07	24	0,94	1,07	26	0,3
19	0,55	24	0,59	-0,74	26	0,47
20	-0,93	24	0,36	-0,18	25	0,86
21	-0,56	23	0,58	0,05	25	0,96
22	1,78	24	0,09	0,28	26	0,78
23	1,03	25	0,31	0,58	26	0,56
24	-0,97	25	0,34	0,3	26	0,77
25	-0,77	24	0,45	-0,65	26	0,52
26	-0,23	24	0,82	1,97	21	0,06
27	-1,96	22	0,06	0,87	21	0,39
28	-0,82	22	0,42	-1,24	22	0,23
29	-0,74	23	0,47	-1,81	24	0,08
30	0,64	17	0,53	-0,79	21	0,44
31	0,63	17	0,54	-0,46	22	0,65
32	1,11	19	0,28	0,29	22	0,77
33	1	19	0,33	-0,34	22	0,74
34	-0,45	24	0,66	-0,01	26	0,99
35	0,66	24	0,52	-0,49	26	0,63
36	-0,99	25	0,33	0,61	26	0,54
37	-0,33	24	0,74	-1,44	26	0,16

p < 005 (*)

females reached a similar skull size (and probably a similar cranial shape) but a different body size, longer in females (Fig. 3). The slope of regression lines indicated that males grew faster. Despite the two regression lines never crossed during the growth being parallels, differences in TBL and in CBL were not significant for t-Student test (Tab. 6).

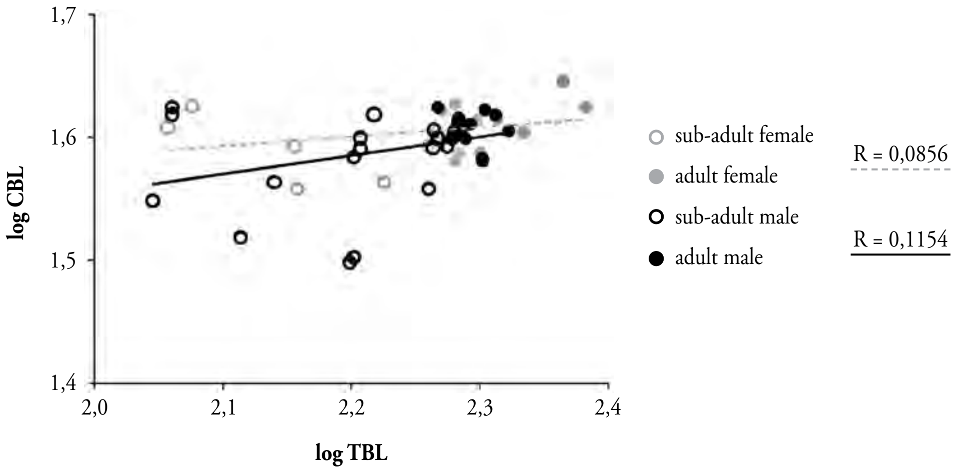

Fig. 3 – scatterplot logTBL vs logCBL in male (black point), female (gray point) specimens of striped dolphin with regression lines.

DISCUSSIONS AND CONCLUSIONS

The statistical analyses conducted to investigate sexual dimorphism in the cranial parameter of an Italian striped dolphin sample revealed that both female sub-adults (mean = 171,7 cm) and adults (mean = 203,9 cm) were longer than males (sub-adults mean = 165,3 cm; adults mean = 194,9 cm), results obtained also for female skulls, confirming a strong relationship between cranial growth and skeleton one. For Mediterranean sample, the same results were obtained by Marsili et al. (1997) with a larger body size in females, while Calzada & Aguilar (1995) in males. However, TBL and CBL in this work showed the differences between sexes not significant ($\alpha > 5\%$), as by other Authors for Mediterranean samples (Calzada et al., 1995; Marsili et al., 1997) and for samples from other seas (Gales, 1992; Kasuya, 1972; Rosas et al., 2002) not representing for striped dolphin species a sexual features.

Most of cranial parameters were smaller in sub-adults males, but greater in the adults ones; the differences between two means was due to the different growth rates of cranial parameters in the two sexes, with a faster rate growth in males, confirming the results by Di Meglio et al. (1996) for Mediterranean striped dolphin sample.

Dental profile was no linked to sex, showed differences not attributable to sexual dimorphism in tooth number. As seen in the multivariate analysis, the parameters indicating tooth number were grouped in a single cluster clearly separated from other parameters, because determined by unique factors. The means obtained for tooth number was from 38 to 41 teeth, in agreement with Cagnolaro et al. (1983). Furthermore, in osteological samples tooth number was determined by preparation method; when the skull was carried to Museums or Universities to be kept, it was devoid of soft tissue and teeth could easily get out of alveolus.

The unique parameter identified by PCA and confirmed by t-Student test (significant differences between sexes) and by linear regression test (growth not correlated with the body and the skull one), was number 16 - greatest parietal width. This parameter in sub-adult sample was greater in females (but not significant) while in adults was greater in males; probably, the difference between age- groups was due to different growth rates in two sexes, faster in males (Di-Meglio et al., 1996).

This cranial feature, greater in males, were found significant for sexual dimorphism also in others species of *Stenella* sp., not present in Mediterranean Sea, as in spinner dolphin *S. longirostris* (Douglas et al., 1986) and in pantropical spotted dolphin *S. attenuata* (Schnell et al., 1985) and in other genera of Delphinidae family, as in *Lagenodelphis hose* (Perrin et al., 2003). Thus, as seen in various Delphinidae, skull parietal width could be identified as a dimorphic feature.

Studies conducted on a larger size samples could validate the results obtained also for the other parameters identified in this work.

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RIASSUNTO

Il dimorfismo sessuale nelle caratteristiche craniche della specie *Stenella coeruleoalba* (Cetacea, Delphinidae): un caso studio di un campione italiano

Lo studio è stato svolto su un campione di Stenella striata *Stenella coeruleoalba* di 65 crani (36 maschi, 19 femmine e 10 indeterminati) suddivisi in due classi di età: sub-adulti (31 esemplari - 19 maschi, 7 femmine, 5 indeterminati) e adulti (34 esemplari - 17 maschi, 12 femmine, 5 indeterminati) provenienti dagli spiaggiamenti lungo le coste italiane. Lo scopo è quello di determinare l'esistenza di dimorfismo sessuale nelle caratteristiche del cranio, tali da essere utilizzati come indicatori per l'individuazione del sesso nei reperti osteologici indeterminati. Inoltre, lo studio vuole esaminare anche le differenze nel tasso di crescita dei due sessi per rilevarne eventuali differenze. Le analisi statistiche hanno permesso il calcolo della media e della deviazione standard per gli individui sub-adulti e per quelli adulti in entrambi i sessi; successivamente i dati sono stati sottoposti all'Analisi delle Componenti Principali (PCA), all'analisi della regressione lineare e al test t di Student. La PCA distribuisce i parametri principalmente in due gruppi, il primo che include i parametri dentali e il secondo che include i parametri correlati alla lunghezza totale del corpo e alla lunghezza condilo-basale del cranio. I restanti parametri sono probabilmente descritti da fattori diversi da quelli che determinano la crescita dell'animale. La comparazione tra le medie ottenute ha individuato 3 parametri che mostrano differenze significative: 5 - ampiezza del rostro a metà lunghezza, 7 - ampiezza del rostro ai ¾ di lunghezza e 16 - massima ampiezza ai parietali. Infine, la comparazione dei tassi di crescita maschile e femminile permette di stabilire la relazione tra la crescita del corpo rispetto a quella del cranio, mostrando un tasso di accrescimento maggiore nei maschi. Né la lunghezza totale del corpo, né quella condilo-basale del cranio presentano differenze significative tra sessi; l'unico parametro non incluso nei due gruppi individuati dalla PCA, che non presenta correlazione con gli altri parametri cranici e che presenta medie significative al test t di Student, è il numero 16, più grande nei maschi, mostrando una variabilità dovuta a fattori diversi dalla crescita

e perciò imputabili al dimorfismo sessuale. La massima ampiezza ai parietali rappresenta un carattere dimorfico anche in altre specie appartenenti alla famiglia dei Delphinidae.

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