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A Potential Morphotype of Common Dolphin (*Delphinus* spp.) on the Northeast Coast of Venezuela

Maria Alejandra Esteves[1] and Lenin E. Oviedo[1, 2, 3]

[1]*Proyecto Delphinus, Isla de Margarita, Nueva Esparta, Venezuela 6010*
[2]*Biotrópica: Centro de Investigación y Conservación de la Biodiversidad Tropical, Caracas, Venezuela 1001*
[3]*Maestría de Ciencias Marinas y Costeras, Universidad Nacional, Heredia, Costa Rica, Apto 86-3000*

Abstract

Records of the common dolphin on the northeast coast of Venezuela have been widely documented. The complex topography and bathymetry of this area and the enhanced productivity due to upwelling processes promote the occurrence of common dolphin populations. It has not been clear, however, whether the species involved is *Delphinus delphis* or *D. capensis*. The aim of this contribution is to review taxonomically *Delphinus* spp. from the northeast coast of the country through skull morphometric analysis. A sample of 30 skulls comprised of specimens collected in Nueva Esparta State (n = 28) and Sucre State (n = 2) in Venezuela were analyzed using the morphometric parameters rostrum length (RL) and zygomatic width (ZW), including the ratio of the measurements RL/ZW. Only skulls identified as mature individuals (n = 16) were included in the analysis. The data were compared with published records of South Atlantic dolphins from Brazil and West Africa. Rostral length showed significant differences within the Venezuelan sample ($p < 0.05$) and between the dolphins from Brazil and West Africa. Zygomatic width also showed clear differences (Venezuela to Brazil, $p < 0.05$; Venezuela to West Africa, $p < 0.05$). In contrast, no differences were found for the RL/ZW ratio (Venezuela to Brazil, $p = 0.21$; Venezuela to West Africa, $p = 0.33$). Observations in the study area during sightings of common dolphins noted small females with calves. These observations suggested the occurrence of a small morphotype of common dolphin on the northeast coast of Venezuela, a semi-closed basin. Habitat conditions in this kind of ecosystem could lead to morphologic differences between smaller coastal forms and larger off-shore forms, an effect that could be related to feeding ecology.

Key Words: *Delphinus* spp., skull morphometric analysis, northeast coast of Venezuela, Brazil, West Africa, morphotype

Introduction

Skull morphology has been a crucial means of identifying cetacean species. It is in the skull where cetacean species have developed extraordinary modifications of bones and structures that make them unique among mammals (Barnes, 1990). Perrin (1990) used skull morphology in the identification of several subspecies of spinner dolphin (*Stenella longirostris*): *S. l. longirostris*, *S. l. orientalis*, and *S. l. centroamericana*. Heyning & Perrin (1994) and Rosel et al. (1994) established the differentiation of *Delphinus delphis* and *D. capensis* into separate species, with substantial differences between sexes in both species. Recent studies of the taxonomic status of common dolphin populations are restricted to local areas (Murphy et al., 2006). Due to their cosmopolitan distribution and geographical variability, common dolphins (*Delphinus* spp.) are in need of worldwide systematic review (Evans, 1994).

Common dolphins are the most common odontocete occurring on the northeast coast of Venezuela. They have traditionally been classified as *D. delphis*. Records of this species have been associated with oceanographic features such as upwelling in the northeast coast basin (Acevedo, 2001; Quevedo, 2004; Rangel et al., 2005). The only taxonomic review (Bolaños, 1995) analyzed differences with other delphinid species in scientific collections, but did not examine intraspecific variation using the characters suggested by Heyning & Perrin (1994). This contribution aims to review the common dolphin (*Delphinus*) occurring on the northeast coast of Venezuela through skull morphometric analysis.

Materials and Methods

The Sample of Skulls

The sample of 24 *Delphinus* skulls was collected from strandings at Margarita Island, Cubagua Island, and Araya Peninsula on the mainland. The diagnostic criterion to classify them as *Delphinus*

was the presence of longitudinal palatine grooves (Heyning & Perrin, 1994). Sex and total body length are unknown for many of the specimens; therefore, sexual dimorphism could not be documented.

An additional six skulls were measured from scientific collections of the following institutions: Museo Marino de Margarita, Museo de Biología Universidad Central de Venezuela, and Museo Estación Biológica Rancho Grande. The location of all of the specimens examined is provided in the Appendix. The adult series included 16 skulls. As mentioned above, unknown sex and total body length preclude more accurate arguments for the selection of adult specimens; therefore, a subjective criterion supported by the lesser degree of variation between skulls in the sample was used: a minimum cut-off in condylobasal length (> 394 mm) and fusion of cranial bones (Van Waerebeek, 1997; De Oliveira Santos et al., 2002), particularly of the proximal posterior suture of the maxillary with the frontal.

Skull Characters

Skull measurements were taken as in Perrin (1975). Those of particular value in *Delphinus* taxonomic distinction are rostral length (RL), zygomatic width (ZW), maxillary tooth count, and mandibular tooth count (per row). Measurements were taken with a 600-mm ruler and 150-mm Vernier calipers with a precision of 0.01. Measurements of greater than 10 mm were taken to the nearest millimeter, while those below 10 mm were taken to the nearest 0.1 mm (Jefferson & Van Waerebeek, 2004). To avoid significant bias related with inter-observer differences, all measurements were taken by one of the authors (MAE).

Southern Atlantic Skulls

Published data for *D. capensis* in the southern Atlantic basin from Brazil (De Oliveira Santos et al., 2002) and West Africa (Van Waerebeek, 1997) were compared with the sample of *Delphinus* from Venezuela in order to examine differences between geographical series. The measurements for RL, ZW, and tooth counts were tested for normality using the Shapiro Wilk test. Due to the small size in the sample, however, significant differences were analyzed through the two-tailed Mann Whitney U-test (*Analyse-It*, Version 1.7).

Results

The metric characters assessed in this investigation are presented in Table 1 and compared with those from the southern Atlantic samples in Table 2.

Rostral Length

Geographical variation is supported by the significant differences found between common dolphins occurring on the northeast coast of Venezuela (242 to 288 mm) and those in Brazil (284 to 342 mm, Mann Whitney, U = 254, $p < 0.0001$) and West Africa (287 to 311 mm, Mann Whitney, U = 237.5, $p < 0.0001$). The values for the Venezuelan dolphins are closer to the minimum values of the southern Atlantic samples (Table 2) than to their respective maximum.

Table 1. Cranial morphometric parameters assessed in the adult series analyses of *Delphinus* spp. from the northeast coast of Venezuela

Specimen no.	Condylobasal length (mm)	Rostral length (mm)	Zygomatic width (mm)	Ratio RL/ZW
1	451	288	180	1.6
2	397	247	147	1.68
3	436	268	171	1.57
4	441	278	177	1.57
5	417	258	168	1.54
6	434	272	184	1.48
7	432	272	161	1.69
8	403	258	159	1.62
9	424	273	168	1.63
10	431	277	166	1.67
11	443	279	170	1.64
12	402	251	162	1.55
13	432	268	175	1.53
14	429	275	176	1.56
15	431	277	171	1.61
16	394	242	162	1.49

Table 2. Summary of cranial morphometric parameters in different geographical forms in the genus *Delphinus*

Locality	Species	Rostral length	Mean ± SD	Zygomatic width	Mean ± SD	Ratio RL / ZW	Mean ± SD	Source
Northeast coast of Venezuela	*Delphinus* spp.	242-288	267.6 ± 2.8	147-184	168.5 ± 9.1	1.48-1.68	1.6 ± .06	This study
Brazil	*Delphinus capensis*	284-342	305.3	171-198	187.6	1.51-1.77	1.63	De Oliveira Santos et al., 2002
West Africa	*Delphinus capensis*	287-311	297.6	177-193	184.6	1.54-1.68	1.61	Van Waerebeek, 1997
Northeast Pacific	*Delphinus capensis*	281-321	299.1	173-204	184.5	1.52-1.77	1.62	Heyning & Perrin, 1994
Northeast Pacific	*Delphinus delphis*	218-311	249.2	170-195	182.2	1.21-1.47	1.37	Heyning & Perrin, 1994

Zygomatic Width

Zygomatic width (Table 2) varied from 148 to 168 mm in the sample from Venezuela. De Oliveira Santos et al. (2002) recorded values particularly different (171 to 198 mm, Mann Whitney, U = 243, $p < 0.0001$); similarly, the Venezuelan sample differed from the West African sample (177 to 193 mm, Mann Whitney, U = 229, $p < 0.0001$).

Rostral Length/Zygomatic Width Ratio

Skulls from northeast Venezuela are notably smaller than those of their southern conspecifics (Figure 1). This could be observed in the slight overlap and almost isolation by lower values of RL and ZW in the Venezuelan sample in respect to the complete overlap of the southern Atlantic skulls. No significant differences were found for RL/ZW ratio between samples, however (see Table 2).

Tooth Count

Common dolphins in the Venezuelan sample showed a maxillary tooth count of 44 to 54 (51 ± 2.68) under the values reported for skulls from Brazil: 49 to 56 (52.6 ± 2.1). Mandibular values

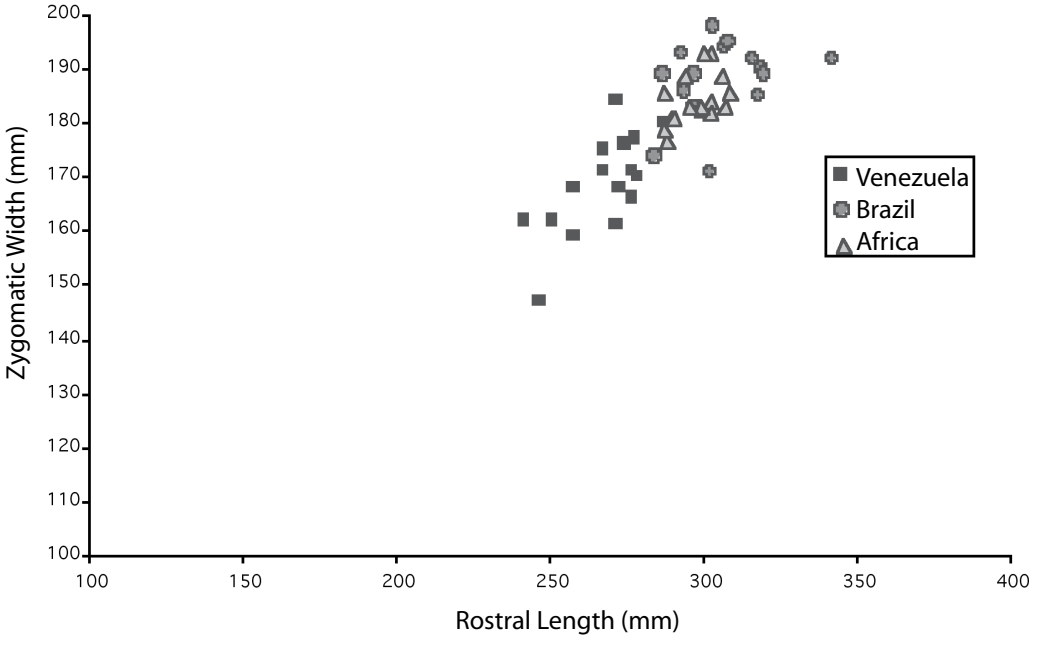

Figure 1. Scatter plot of zygomatic width and rostral length in three geographical forms of the genus *Delphinus* from the northeast coast of Venezuela (filled squares) and the southern Atlantic basin: Brazil (filled circles) and West Africa (filled triangles)

Table 3. Summary of lower and upper tooth count of *Delphinus capensis* from Brazil (De Oliveira Santos et al., 2002) and Pacific Northwest (Heyning & Perrin, 1994), *D. delphis* for the Pacific Northwest, and *Delphinus* spp. from the northeast coast of Venezuela

Locality	Species	Upper tooth count	Mean ± SD	Lower tooth count	Mean ± SD
Northeast coast of Venezuela	*Delphinus* spp.	44-54	51 ± 2.68	43-51	48 ± 1.3
Brazil	*Delphinus capensis*	49-56	52.6 ± 2.1	47-52	49.7 ± 1.6
Northeast Pacific	*Delphinus capensis*	47-59	53	47-55	51
Northeast Pacific	*Delphinus delphis*	42-54	49	41-53	49

ranged from 43 to 51 (48 ± 1.3), while the Brazil sample varied from 47 to 52 teeth (49.7 ± 1.3). Significant differences were found between the samples in both upper ($t = 2.66$; $p < 0.05$) and lower count ($t = 3.77$; $p < 0.05$) (Table 3). No comparison was possible with the West African sample since Van Waerebeek (1997) did not report tooth count averages.

Discussion

The differences in RL, ZW, and tooth counts between the Venezuelan sample and *D. capensis* reported from Brazil (De Oliveira Santos et al., 2002) and West Africa (Van Waerebeek, 1997) suggest geographical differentiation, with the common dolphin from Venezuela being smaller. The lack of significant differences between the geographical samples in the RL/ZW ratio could imply that *D. capensis* is indeed the species occurring in the northeast coastal basin. In another study, Natoli et al. (2006) found that *Delphinus* alpha taxonomy defined by beak length and associated morphology is not sustained by genetic data; morphotypic variation may relate more to local adaptation than separation along phylogenetic lineages.

Some researchers have already recorded *D. capensis* from the territorial waters of Venezuela (Romero et al., 2001; Molero, 2004). Such assumptions are based on overlapping of distribution ranges, however, rather than on skull descriptions or genetic studies. A single record of *D. capensis* is reported for the west coast of Venezuela (Ramirez & Gónzalez, 2004), based on the description of the skull of one individual. Naveira (1996) identified common dolphins observed in his cruises along the northeast coast basin as "*Delphinus delphis*." Acevedo (2001) and Oviedo & Silva (2005) used the denomination "*Delphinus* spp.," based on lack of taxonomic review on the genus as Mignucci-Giannoni (1998) and Roden & Mullin (2000) suggested for the common dolphin in the northern Caribbean basin.

William F. Perrin (pers. comm., 22 August 2004) considers that separation of the genus *Delphinus* into *D. delphis* and *D. capensis* is not yet entirely clear, and this is especially true for southern hemisphere waters. Intermediate forms between these two putative species have been found, suggesting the possible existence of intergradation or a super-species complex instead of two specific forms. There was a tendency of intermediate values between *D. capensis* and *D. delphis* in the Venezuelan series in RL: minimum value of 242 mm is intermediate between the minimum and maximum values for *D. delphis* in the Pacific, while the maximum value 288 mm is closer to the minimum reported for *D. capensis* (Heyning & Perrin, 1994). Zygomatic width and RL/ZW ratio followed the same trend. According to Murphy et al. (2006), north Atlantic common dolphins slightly overlap in RL/ZW ratio outlined for *D. capensis*, showing signs of being an intermediate form. Bell et al. (2002) report in their research that Australian common dolphins almost span the ranges in skull size of both species occurring in the eastern north Pacific; however, rather than the length of the rostrum, the width variables of the cranium were the more influential.

Comparison of tooth counts reported by Heyning & Perrin (1994) with the sample from the northeast coast of Venezuela showed a coincidence in maximum value (54 teeth) for the maxillary with *D. delphis*. Moreover, they are within the ranges of common dolphins from the northern Atlantic (Murphy et al., 2006) and southern Australia (Bell et al., 2002).

The morphological differences between coastal and off-shore ecotypes in several dolphin species, especially in number and size of teeth or the robustness of the lower jaw muscles, could be related with feeding ecology, specifically with the differences in size and hardness of the most common prey (Perrin, 1975). Natoli et al. (2006) agreed that selection for beak length and related characters that determine morphology in coastal

dolphin populations, may be related to prey capture in a neritic environment. Furthermore, the same authors theorized that beak length tends to be longer in dolphin species that live in relatively shallow, turbid environments—the same characteristics of the shelf ecosystem in the northeast coast of Venezuela where the common dolphin occurs.

The assumption that cetacean occurring in contiguous ocean regions or adjacent seas belong to the same population is not justified. Geographical variation in morphology and auto-ecology related with distinct marine habitats should be considered (Perrin, 1984). Therefore, this investigation supports the conclusion of Natoli et al. (2006). They suggested an independent origin of the long-beaked form in different regions, where selection for this morphotype represents adaptation to local environments and may drive a potential speciation.

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Appendix

Location of Specimens Assessed

Museo Oceanográfico Benigno Roman, EDIMAR-Fundación La Salle de Ciencias Naturales: MOBRCT0013, MOBRCT0014, MOBRCT0015.

Museo Marino de Margarita: MMMmm0001, MMMmm002

Museo de Biología Universidad Central de Venezuela: MBUCV001, MBUCV002.

Museo Estación Biológica Rancho Grande: EBRG21840, EBRG21841.

Proyecto Delphinus: PDD001

CIC-Venezuela (www.cicvenezuela.com): 20 skulls are under custody of this NGO located in Porlamar, Margarita Island. Unfortunately, there is no indication of any inclusion of these specimens into a scientific collection; therefore, no catalogue number is provided.