

WHAT IS THE COLOUR OF THE FRANCISCANA (*PONTOPORIA BLAINVILLEI*)?: A REVIEW AND A PROPOSED ASSESSMENT METHOD

MICAELA TRIMBLE^{1*} AND RICARDO PRADERI²

ABSTRACT: Colouration pattern is suggested as a potentially useful characteristic to identify populations of franciscana (*Pontoporia blainvillei*). Such information is needed for the creation of management and conservation plans for the species. The existence of geographic variation in the colour of the franciscana has been hypothesized; it is suggested that Brazilian and Uruguayan individuals are greyish, while the Argentinean are brownish. We examined individuals from Uruguay using an objective method (Villalobos and Villalobos, 1947) to determine colour patterns. We also reviewed the variation of the colour pattern of the franciscana throughout this species' distribution as noted in the published literature. In the original description of the species in 1844 and in several subsequent papers during the 19th century, the colour pattern of the franciscana was erroneously described (e.g. as black and white). Only since the 20th century have the colouration descriptions approximately matched the actual specimens observed. These descriptions can be typically divided into two basic classes: greyish and ochre/brown. However, within these two general colour groups there is great variation. Several descriptions provided by Brazilian, Uruguayan, and Argentinean authors agree with the above hypothesis. The great variation within the modern descriptions of the franciscana's colour suggests that a variety of factors must be involved; therefore, we conclude that on the basis of the literature alone, it is very difficult to decide whether differences really exist in the franciscana's colour along its distribution. According to Villalobos and Villalobos (1947), the colour pattern of Uruguayan specimens could be interpreted as 'greyish dorsally and yellowish-grey laterally'. Due to some limitations found in this technique, we propose a new method based on the RGB ("red, green, blue") system that may fulfill our expectations for an objective procedure to determine colouration patterns. This standardized method would allow for a reliable comparison of colour patterns among franciscana populations.

RESUMEN: El patrón de coloración es sugerido como un carácter potencialmente útil para identificar poblaciones de franciscana (*Pontoporia blainvillei*). Esta información es necesaria para la creación de planes de manejo y conservación de la especie. La existencia de variación geográfica en la coloración de esta especie ha sido hipotetizada; se sugiere que los ejemplares de Brasil y Uruguay son grisáceos y los de Argentina amarronados. Se examinaron ejemplares de Uruguay mediante una técnica objetiva (Villalobos y Villalobos, 1947) para determinar patrones de coloración. También se hizo una revisión de la variación del patrón de coloración de la franciscana a lo largo de su distribución, basada en la literatura publicada. Según la descripción original de la especie en 1844, y varios trabajos subsecuentes del siglo XIX, la coloración de la franciscana es errónea (e.g. blanca y negra). Recién a partir del siglo XX las descripciones comenzaron a corresponderse en cierto grado con los ejemplares observados. Estas descripciones pueden ser divididas básicamente en dos clases fundamentales: grisáceo y marrón/ocre, pero con una gran variación de tonalidades dentro de cada grupo. Varias de las descripciones hechas por autores brasileños, uruguayos y argentinos, concuerdan con la hipótesis planteada. La gran variación encontrada en las descripciones modernas del color de la franciscana, sugiere que debe haber varios factores involucrados; por lo tanto, se concluye que es muy difícil decidir, a partir de la literatura solamente, si realmente existen diferencias en la coloración de la franciscana a lo largo de su distribución. De acuerdo con Villalobos y Villalobos (1947), el patrón de coloración de los ejemplares de la costa uruguaya podría ser definido como 'grisáceo dorsalmente y gris amarillento lateralmente'. Debido a algunas limitaciones encontradas en esta técnica, se propone un nuevo método basado en el sistema RGB ("red, green, blue"), que cumpliría con las expectativas de un procedimiento objetivo para determinar patrones de coloración. Este método estandarizado permitiría realizar comparaciones confiables de los patrones de coloración entre poblaciones de franciscana.

KEYWORDS: *Pontoporia blainvillei*, franciscana, colour description, geographic variation.

Introduction

The franciscana *Pontoporia blainvillei* (Gervais and d'Orbigny, 1844a) is a small platanistoid cetacean that inhabits the waters off the Atlantic coast of Brazil, Uruguay, and Argentina. The northern and southern limits of the species' distribution are Itaúnas (18°25'S) (Espírito Santo, Brazil) and Golfo San Matías (41°10'S) (Patagonia,

Argentina) (Moreira and Siciliano, 1991³; Crespo, 2002). This endemic distribution, together with its low reproductive potential (Pinedo *et al.*, 1989) and its incidental mortality in nets of the artisanal fisheries for more than half a century along its entire range (Praderi *et al.*, 1989; UNEP/CMS, 2000), make the species the most threatened cetacean of the Southwest Atlantic Ocean (e.g. Bastida and Rodriguez, 2003; Secchi *et al.*, 2003; Siciliano *et al.*, 2005⁴).

¹ Universidad de la República, Facultad de Ciencias, Sección Etología, Cetáceos Uruguay. Iguá 4225, Montevideo C.P. 11400, Uruguay.

* Corresponding author, e-mail: micatn25@yahoo.com.ar.

² Museo Nacional de Historia Natural y Antropología (MUNHINA), Montevideo, Uruguay.

³ Moreira, L.M. de P. and Siciliano, S. (1991) *Northward extension range for Pontoporia blainvillei*. Page 48 in Abstracts, Ninth Biennial Conference on the Biology of Marine Mammals, 5-9 December, Chicago, Illinois.

⁴ Siciliano, S., Di Benedetto, A.P.M., Pacheco de Souza, S., Moreno, I.B., Ott, P.H., Tavarez, M., Danilewicz, D., Secchi, E.R., Hassel, L.B. and Alves, V.C. (2005) *O plano de ação para a toninha (Pontoporia blainvillei): esforço de conservação para salvar o cetáceo mais ameaçado do Atlântico Sul Ocidental*. Page 27 in Abstracts, III Jornadas de Conservación y Uso Sustentable de la Fauna Marina, 14-17 September, Montevideo, Uruguay.

Previous research based on morphological (Pinedo, 1991; Higa *et al.*, 2002; Ramos *et al.*, 2002) and genetic data (Secchi *et al.*, 1998; Lázaro *et al.*, 2004) have suggested the existence of at least two clearly defined stocks of franciscana, one to the north of Santa Catarina (~29°S), Brazil and the other to the south. Furthermore, a phylogeographic analysis by Secchi *et al.* (2003) (combining mtDNA data, morphometrics, and life-history parameters) provided evidence for separating the species into four management stocks: two inhabiting coastal waters of Brazil, the third occurring in Rio Grande do Sul state (southern Brazil) and Uruguay, and the fourth in coastal Argentinean waters. Identifying stocks is critical for the creation and implementation of conservation and management plans, which should be applied along the entire distribution of a species.

Colouration pattern was suggested by H.P. Castello and R. Praderi (*e.g.* see Pinedo, 1997) as a characteristic potentially useful for identifying populations of franciscanas.

Since its original description in 1844, the colouration pattern of the franciscana has been examined by regional and international authors in a variety of books, papers and abstracts of scientific congresses. In several cases, it has been suggested that there exists geographic variation in the colour of the franciscana, postulating that the Brazilian and Uruguayan individuals are greyish whereas the Argentinean are brownish.

The goal of this study was to review the variation of colour patterns of the franciscana along the species distribution based on the published literature, and to determine the colour pattern of Uruguayan individuals using an objective method. We emphasize the importance of standardizing an objective method for comparison among individuals from different areas in order to investigate geographic variation in the colour patterns of franciscanas.

Material and Methods

We conducted an extensive bibliographic review of descriptions of the franciscana's colour pattern; a summary of the most important described features is presented here. Secondly, a chromatic analysis of 13 examined individuals from Uruguay using an objective method to determine colour patterns is presented.

The 13 specimens (see Table 1) were obtained as fishery bycatch; they were not dead for more than 5 hrs. In order to avoid damage to the skin, and therefore, possible mistakes in determining exact colour, the specimens were left on the boat deck covered with wet rags soaked in salt water. They were removed cautiously from the boat so as to avoid bruises.

Chromatic analyses were performed in six different regions (see Figure 1):

1. Dorsal surface of the rostrum at the base.
2. Back above the flippers.
3. Centre of the dorsal side of the flippers.
4. Dorsal surface of the body (just anterior of the dorsal fin).
5. Flanks at mid-body.
6. Flanks of the tailstock.

The chromatic analyses were conducted using the Atlas de los Colores of Villalobos and Villalobos (1947), which has been employed in several biological researches (*e.g.* Davis, 1957; Van Deusen, 1969; Raposo *et al.*, 1998; Lahti and Lahti, 2002; Bordignon and França, 2004; Barp *et al.*, 2006; Camargo *et al.*, 2006). It represents one of the most ambitious efforts to date at developing a colour atlas as it contains nominally 7279 samples on 38 plates, each conveniently perforated so that direct comparison with materials is possible (Brown *et al.*, 2006).

Table 1. Uruguayan specimens employed in the chromatic analysis.

NUMBER	LOCALITY	DATE	SEX	TOTAL LENGTH (cm)
LC 06	La Coronilla	21.12.1992	♀	123
LC 09	La Coronilla	21.12.1992	♂	100
PD 02	Punta del Diablo	19.12.1992	♀	126
PD 06	Punta del Diablo	05.03.1993	♀	114
RP 712	Punta del Diablo	22.12.1992	♂	126
RP 722	Punta del Diablo	29.12.1992	♂	107
RP 723	Punta del Diablo	29.12.1992	♂	102
RP 725	Punta del Diablo	29.12.1992	♀	114
RP 820	Punta del Diablo	02.10.1998	♂	142
RP 821	Punta del Diablo	06.10.1998	♀	127
RP 822	Punta del Diablo	12.11.1998	♀	152
RP 832	Punta del Diablo	31.10.1998	♂	110
RP 833	Punta del Diablo	10.11.1998	♂	109

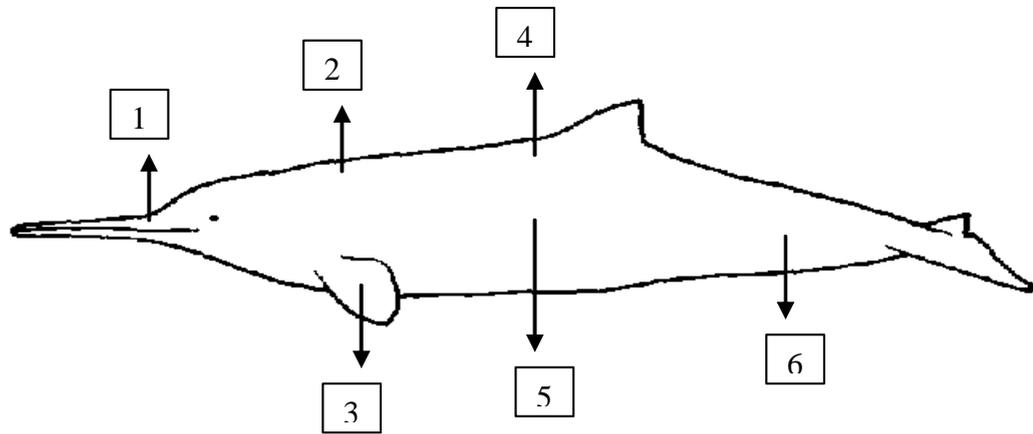


Figure 1. The six regions in which the chromatic analyses were performed (1: Dorsal surface of the rostrum at the base, 2: Back above the flippers, 3: Centre of the dorsal side of the flippers, 4: Dorsal surface of the body (just anterior of the dorsal fin), 5: Flanks at mid-body, 6: Flanks of the tailstock). The chromatic analyses consisted in placing the colour charts of Villalobos and Villalobos (1947) over the animal skin or a colour picture of it.

Therefore, the chromatic analyses consisted in placing the colour plates of Villalobos and Villalobos (1947) over the animal skin or a colour picture of it. Each colour plate has a code that allows for objective identification. When analysing each region for each specimen, several colour plates were used until the one that matched the colour of the skin was found. By doing so, the six regions for every specimen were assigned a code. After evaluating the 13 specimens, the final value assigned to each region of the body was the one corresponding to the colour which occurred with the greatest frequency.

Results

Historical Review of Franciscana Colouration

The franciscana was first described by Paul Gervais and Alcide d'Orbigny (1844a) based on an individual from the surroundings of Montevideo and sent to the Museum of Paris by M. de Fremenville (Publication date: 15 May 1844, see Mones and Philippi, 1992). However, it is commonly and erroneously believed that the species was described in Gervais and d'Orbigny (1844b) (e.g. Pinedo *et al.*, 1989; Higa *et al.*, 2002). The reason for the confusion lies in the fact that the publication date of Gervais and d'Orbigny (1844b) (27 April 1844), corresponds to the date of the session of the Société Philomatique but not to the date of its actual publication (see Mones and Philippi, 1992).

The colour pattern of the franciscana in its original description and in several subsequent papers in the 19th century was erroneously described as black and white (Gervais and d'Orbigny, 1844a,b; Gray, 1846; d'Orbigny, 1847; Burmeister, 1869), ashy and white (Gray, 1846), dun and white (Burmeister, 1867), and blackish, grey and brownish (Malm, 1871). (For details see Appendix 1).

The holotype of the franciscana, which is at the Muséum National d'Histoire Naturelle (Paris), consists only of the

skull, but no skin. This may explain why the first descriptions of the colouration pattern of this species were erroneous. According to these descriptions, the beak and anterior part of the head at the melon level were perceived as white. From the blowhole, all along the back -including the dorsal fin- and flanks, to the end of the caudal fin, there was supposed to be a brownish black streak. In addition, the flippers and belly were, again, according to those first descriptions, yellowish white.

Only since the 20th century have the colouration descriptions of the franciscana approximately matched the actual specimens observed (described below). However, some authors still describe the franciscana as being black and white:

- ▶ 'Dorsalmente es de color negro, y blanco en el vientre' [It is black dorsally and white on the belly], Carcelles (1948).
- ▶ 'A few older individuals become so pale and bleached that they are known in the estuary as white ghosts', Watson (1981).
- ▶ 'Podem ocorrer animais totalmente brancos, daí chamados de fantasmas brancos' [Entirely white animals may occur, therefore being called white ghosts], Bittencourt (1984).
- ▶ 'Some animals -known to fishermen as white ghosts and observed in the La Plata River estuary- are nearly all white', Minasian *et al.* (1984).
- ▶ 'Its body colour may lighten during winter and with age; some older animals are predominantly white', Carwardine (1995).

The modern descriptions of the colour of the franciscana fall into two basic classes, greyish and ochre/brown. However, within these two general groups there is great variation. Table 2 shows this variation and lists the sources where such descriptions were found, giving detail of the geographical precedence of the samples (*i.e.* Brazil, Uruguay or Argentina).

This classification, together with the geographical location of the samples, enabled us to examine geographic differences in the specimens off the coasts of Brazil, Uruguay and Argentina.

Of the total of 41 descriptions found, 34 were written in the 20th and 21st centuries. Of these, six were from Brazil,

six from Uruguay and 10 from Argentina. Several descriptions made by these authors agreed with the hypothesis: three Brazilian authors (Carvalho, 1961; Lodi *et al.*, 1987; Flores *et al.*, 2000) and five Uruguayan researchers (Vaz-Ferreira, 1970; Praderi, 1975; Little *et al.*, 1992⁵; Del Pino, 1993; González, R.B., 1993)

Table 2. Classification of the franciscana's colour in the literature.

GREYISH	
Ceniza azulado a ceniza claro [Blue ash to light ash].	
Grisáceo dorsalmente a gris amarillenta ventralmente [Greyish dorsally to yellowish grey ventrally].	
Medium grey on back and sides, paler underneath.	
Gris en parte dorsal, aclarándose hacia ventral [Grey dorsally, lightening towards the belly].	
Grey dorsally and paler ventrally.	
Cinza claro, tornando-se mais claro no flanco com tons rosados inclusive no ventre [Light ash, turning lighter on the flank with pink shades as in the belly].	
Basically grey overall, with a lighter ventral colouration.	
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OCHRE-BROWN	
Marrón-ocre [Ochre-brown].	
Pardosácea ('borravino') [Pinky dun].	
Amarronada [Brownish].	
Pardo claro en el dorso, más claro en el vientre [Light dun dorsally, lighter ventrally].	
Buffy ochre brown grading to mustard brown on the belly.	
Greyish brown above, with lighter underparts.	
Brownish to dark grey above and lighter on flanks and belly.	
Pale brown above fading to light brown below.	
Amarillo un poco gris [A little grey yellow].	
Ocre amarillo aclarándose a mostaza pálido en el vientre [Yellow ochre fading to pale mustard on the belly].	
Marrón ocre, claro ventralmente [Ochre brown, light ventrally].	
Pardo claro, entre amarillo y gris, más oscuro en el dorso [Light dun, between yellow and grey, darker dorsally].	
Pardo amarillenta [Yellowish dun].	
Individuals in the southern parts of the species' range are said to appear more brown than grey.	
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BLACK AND WHITE	
Almost entirely white, with a black streak on its back.	
White, with a black dorsal streak.	
Con lomo negro, barriga blanca y una faja longitudinal blanca en cada lado [With black back, white belly and a white longitudinal streak on each side].	
Negro dorsalmente, blanco en el vientre [Black dorsally, white ventrally].	
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WHITE	
Some animals are nearly all white.	
Entirely white animals ("white ghosts") may occur.	
Some older animals are predominantly white.	
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Obs.: Authors within each group are presented in a chronological order, and Brazilian, Uruguayan and Argentinean ones are indicated with a "B", "U" and "A", respectively.	

⁵ Little, V., Gorga, J. and Rondini, G. (1992) *Mortalidad incidental de Pontoporia blainvillei en las pesquerías artesanales de La Paloma, Cabo Polonio, Punta del Diablo y La Coronilla*. Instituto Superior San Fernando de Maldonado, Maldonado. (Unpublished).

described the franciscana as greyish, whereas eight Argentinean authors (Lahille, 1903; Cabrera and Yepes, 1940; Carcelles, 1948; Lichter and Hooper, 1984; Junín and Castello, 1994⁶; Crespo, 2002; Parera, 2002; Bastida and Rodríguez, 2003) stated the franciscana was ochre/brown.

Interestingly, among all the descriptions we found, one (Reeves *et al.*, 2002) points out the possibility of geographic variation in the colour of this species: 'Franciscanas are basically gray overall, with a lighter ventral coloration. Individuals in the southern parts of the species' range are said to appear more brown than gray.' Nevertheless, this comment must be taken cautiously as it comes from a field guide and we do not know the evidence on which it was based.

Chromatic Analysis

The chromatic analysis of dolphins collected in Uruguay using Villalobos and Villalobos (1947) indicated that the colour pattern of the franciscana is better described as:

1. OOS154°
2. UUV148°
3. MR142°
4. UV103°
5. MR122°
6. Y199°

By looking at the colour of the plates to which these codes correspond, the colouration pattern of the Uruguayan specimens could be interpreted as 'greyish dorsally and yellowish grey laterally'.

Discussion

Historical Review of Franciscana Colouration

One possible explanation for the various mistakes and misperceptions in the first descriptions of the franciscana's colour is that at the time those descriptions were written, it was the practice to preserve not just the skull and skeleton of the animal, but also its skin. In order to do this, the skin of the animal was covered in salt, and then folded. The skin was then placed in a wooden barrel. The part of the skin where the fold occurred would lose its original pigmentation, and the colouration pattern could no longer be considered authentic.

The great variation within the modern descriptions of the franciscana's colour suggests that a variety of factors must be involved. One of the most important is subjectivity, with different people defining colours under the same conditions differently. Observations even by

experienced observers always contain some element of subjectivity. Another matter to consider is that within hours after death, the contrast between lightly and heavily pigmented areas is lost in the overall darkening process which accompanies postmortem change (Mitchell, 1970), and only in a few descriptions are there details of the condition of the animals when they were described. The lack of such information makes an accurate comparison impossible. When the animal is seen in its natural habitat, the colour which each observer uses to describe it also depends on several factors, such as the relative position of the sun, the sea conditions, etc. According to Mitchell (1970), in-water observations are necessary in determining the adaptive importance of coloration, but these observations must not be assumed to provide a reliable guide to the relative intensity of the true pigmentation patterns. As he concludes, unless an animal is captured and quickly photographed, observations on its pigmentation pattern are in many ways suspect. In addition, if ontogenetic and seasonal colouration changes do occur (as suggested by Carwardine, 1995) two more factors would affect comparisons.

Therefore, on the basis of the literature alone, it is very difficult to conclude whether differences really exist in the franciscana's colour along its distribution. However, the several descriptions which agreed with the specimens off the coasts of Brazil and Uruguay being greyish and those off Argentina being brownish, suggest that the hypothesis might be true, although further studies are needed.

Some authors have pointed out that the franciscana exhibits cryptic colouration, being similar to the colour of the turbid waters of much of its range (*e.g.* Bordino *et al.*, 1999; Secchi *et al.*, 2001; Crespo *et al.*, 2002). This could mean an adaptation to its particular environment, so if the franciscanas from Argentina are brownish, a possible explanation could be the presence of more suspended material in the waters from the continent.

Despite the great variation in the most recent descriptions, most authors agreed that the franciscana's ventral colouration is lighter than the flanks and back. This colouration pattern called countershaded was first described for cetaceans by Yablokov (1963). He proposed that countershading served to help camouflage the animal against predators. When viewed from above the darker dorsal surface blends in with the water; from below the lighter ventral surface matches the light coming from the sky, making the animal harder to see. Other adaptive function that could be associated with this pattern is that the higher concentration of melanin in the back can protect the skin from harmful UV rays.

⁶ Junín, M. and Castello, H.P. (1994) *Avistajes de Franciscana Pontoporia blainvillei en la Costa de La Provincia de Buenos Aires, Argentina*. Documento de trabajo presentado durante '2º Encontro de Trabalho sobre a Coordenação de Pesquisa em Conservação da Franciscana', 22-23 October, Florianópolis, SC. (Unpublished).

Chromatic Analysis

Although we have used an objective method to determine the colouration pattern of Uruguayan individuals, there are two points that make the use of Villalobos and Villalobos (1947) disadvantageous for standardization: 1) the Atlas may not be available in many regions of the distribution of the species, and 2) the only edition that exists is over 60 years old, so samples may have degraded to some degree (Brown *et al.*, 2006).

Thus, it is important to mention a recently proposed objective technique which is based on a well established and widely used system for colour description, the RGB, or "red, green, blue" system (Aguiar, 2005). This procedure allows leads to accurate colour descriptions without the need of a colour atlas, to check a continuous range of colours, and to refer to the exact colour textually in such way that it can be quickly reproduced and visualized by anyone with access to a personal computer. It consists of breaking the intensity of each root color into even values from 0–255. This gives a total of 16777216 colours, referred in computer jargon as "millions of colours," "True Colour," or "24-bit colour". One of the methods proposed consists of the following steps: (1) photograph the specimen or the specific area of interest, (2) import the picture into an illustration software (*e.g.* CorelDRAW, Adobe Photoshop), and (3) sample the colour from the picture, using a picking tool (Aguiar, 2005). The most important advantages of this procedure are (1) stability, (2) reproducibility, (3) objectiveness, (4) prompt visualization, and (5) null influence of surrounding colours in changing the perception of the displayed colour on a computer screen (Aguiar, 2005).

This new method should be standardized to compare the colouration pattern of the franciscana among different regions, and to test the hypothesis that there is geographic variation in this character.

Final Considerations

Although we have used Villalobos and Villalobos (1947) as an objective method to determine colouration patterns, we realized that it presents some limitations that does not allow us to recommend its standardization. Nevertheless, we encountered a recently proposed technique based on the RGB system that may fulfill our expectations for an objective procedure to determine colouration patterns (Aguiar, 2005).

Chromatic analyses of franciscanas along their entire range should be conducted using this new method in order to investigate geographic variation in the colouration patterns. The existence of sex, ontogenetic and seasonal colouration changes should also be examined.

A factor that should always be kept in mind is time of death, as the lack of this information can render the description inaccurate. Following the cautions presented by Mitchell (1970), only photographs of live or recently killed specimens (less than 4 hours) should be analyzed.

Another objective method, although much more laborious, to test the hypothesis of geographic variation in franciscana colouration patterns consists of a histological study of fresh skin samples from its entire distribution. Since the melanocytes (cells located in the germinative layer of the cetacean epidermis (Geraci *et al.*, 1986)) are those that determine skin colour, that research could determine the depth of melanocytes within the epidermis, and the proportion of these cells to epithelial cells, as well as the distribution of the pigment within the melanocytes, and even the diameter of granules, as all these factors affect skin colour.

We emphasize that an objective procedure is essential to minimize the subjectivity in accurately assessing colouration patterns, especially when this character is compared among populations. However, due to the frequently problem of not knowing time from death or this being longer than 4 hours, it may be very difficult if not impossible to separate franciscana populations based on this character. Fortunately other approaches including morphological and molecular analyses have been used successfully for determining stock units (*e.g.* Pinedo, 1991; Secchi *et al.*, 1998; Higa *et al.*, 2002; Ramos *et al.*, 2002; Secchi *et al.*, 2003; Lázaro *et al.*, 2004).

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References

- AGUIAR, A.P. (2005) An accurate procedure to describe colors in taxonomic works, with an example from Ichneumonidae (Hymenoptera). *Zootaxa* 1008: 31–38.
- BARP, E.A., SOARES, G.L.G., GOSMANN, G., MACHADO, A.M., VECCHI, C. AND MOREIRA, G.R.P. (2006) Phenotypic plasticity in *Passiflora suberosa* L. (Passifloraceae): induction and reversion of two morphs by variation in light intensity. *Brazilian Journal of Biology* 66(33): 853–862.
- BASTIDA, R. AND RODRÍGUEZ, D. (2003) *Mamíferos marinos de Patagonia y Antártida*. Vazquez Mazzini Editores, Argentina.
- BITTENCOURT, M.L. (1984) Contribuições para a identificação dos cetáceos ocorrentes na costa e águas interiores do Brasil. *Arquivo Biología Tecnología* 27(4): 529–547.

- BORDIGNON, M.O. AND FRANÇA, A.O. (2004) Variações na coloração da pelagem do morcego-pescador *Noctilio leporinus* (L., 1758) (Mammalia, Chiroptera). *Revista Brasileira de Zootecias* 6(2): 181-189.
- BORDINO, P., THOMPSON, G. AND INÍGUEZ, M. (1999) Ecology and behaviour of the franciscana (*Pontoporia blainvillei*) in Bahía Anegada, Argentina. *Journal of Cetacean Research and Management* 2: 213-222.
- BROWN, M., KUEHNI, R.G. AND HINKS, D. (2006) The Villalobos Colour Atlas: An Analysis. *COLOR research and application* 31(2): 109-116.
- BURMEISTER, G. (1867) Sobre (*Pontoporia blainvillei*). Actas de la Sociedad Paleontológica de Buenos Aires in *Anales del Museo Público de Buenos Aires* 1(4): xix-xxii. 9-22.
- BURMEISTER, G. (1869) Descripción de cuatro especies de delfinides de la costa Argentina del Océano Atlántico. *Anales del Museo Público de Buenos Aires* 1(6): 367-445.
- CABRERA, A. AND YEPES, J. (1940) *Mamíferos Sudamericanos: Vida, Costumbres y Descripción*. Compañía Argentina de Editores (Historia Natural Ediar), Tucumán, Argentina.
- CAMARGO, C.R., COLARES, E. AND CASTRUCCL, A.M.L. (2006) Seasonal pelage color change: news based on a South American rodent. *Anais da Academia Brasileira de Ciências* 78(1): 77-86.
- CARCELLES, A. (1948) Los cetáceos en las aguas Argentinas. *Museo Argentino de Ciencias Naturales de Buenos Aires* 238 (Publicación Extra): 1-10.
- CARVALHO, C.T. DE (1961) *Stenodelphis blainvillei* na costa meridional do Brasil, com notas osteológicas (Cetacea, Platanistidae). *Revista Brasileira de Biologia* 21: 443-454.
- CARWARDINE, M. (1995) *Eyewitness Handbooks: Whales, Dolphins and Porpoises. The Visual Guide to all the World's Cetaceans*. Dorling Kindersley Ltd., London, United Kingdom.
- CRESPO, E.A. (2002) Franciscana - *Pontoporia blainvillei*. Pages 482-487 in Perrin, W.F., Würsig, B. and Thewissen, J.G.M. (Eds) *Encyclopedia of Marine Mammals*. Academic Press, San Diego, CA, USA.
- CRESPO, E.A., SECCHI, E.R., DALLA ROSA, L., KINAS, P.G., DANILEWICZ, D. AND BORDINO, P. (2002) Report of the working group on abundance estimates. *Latin American Journal of Aquatic Mammals* 1: 65-66.
- DAVIS, J.A. (1957) A New Shrew (Sorex) from Florida. *American Museum Notivates* 1844: 1-9.
- DEL PINO, C.A. (1993) *Guía para identificación de los mamíferos del Uruguay*. Aportes a la Educación Nacional 4, Ministerio de Educación y Cultura, Montevideo, Uruguay.
- D'ORBIGNY, A. (1847) *Voyage dans l'Amérique Meridionale (le Brasil, la République Orientale de l'Uruguay, la République Argentine, la Patagonie, la République du Chili, la République de Bolivie, la République du Perou, exécuté pendant les années 1826, 1827, 1828, 1829, 1830, 1831, 1832, et 1833)* 4(2): 1-32; 9 (Atlas), pls. 3-23.
- ELLIS, R. (1989) *Dolphins and Porpoises*. Alfred A. Knopf, New York, NY, USA.
- EVANS, P.G.H. (1987) *The Natural History of Whales and Dolphins*. Facts on File, New York, NY, USA.
- FLORES, P.A.C., SOUSA-LIMA, R.S. AND SIQUEIRA, G.S. (2000) Avistagens de Franciscana (*Pontoporia blainvillei*) na Baía Norte, Santa Catarina, Sul do Brasil. Pages 71-74 in *Report of the Third Workshop for Coordinated Research and Conservation of the franciscana Dolphin (Pontoporia blainvillei) in the Southwestern Atlantic*. (UNEP/CMS), Bonn, Germany.
- GERACI, J.R., ST. AUBIN, D.J. AND HICKS, B.D. (1986) The epidermis of odontocetes: a view from within. Pages 3-21 in Bryden, M.M. and Harrison, R. (Eds) *Research on Dolphins*. Oxford University Press, New York, NY, USA.
- GERVAIS, P. AND D'ORBIGNY, A. (1844a) Mammalogie. *L'Institut* 12(542): 170.
- GERVAIS, P. AND D'ORBIGNY, A. (1844b) M. Paul Gervais, au nom de M. Alcide d'Orbigny et au sien, met sous les yeux de la Société trois planches représentant des dauphines observés par ce dernier pendant son voyage dans l'Amérique méridionale. *Bulletin de la Société Philomatique de Paris* 1844: 38-39.
- GONZÁLEZ, E.M. (2001) *Guía de Campo de los Mamíferos de Uruguay. Introducción al Estudio de los Mamíferos*. Vida Silvestre, Montevideo, Uruguay.
- GONZÁLEZ, R.B. (1993) *La vida al borde del mar*. Editorial Fin de Siglo, Montevideo.
- GRAY, J.E. (1846) On the cetaceous animals. Pages 13-53 in J. RICHARDSON, J. AND GRAY, J.E. (Eds) *The Zoology of the Voyage of H.M.S. Erebus and Terror, Under the Command of Captain Sir James Clark Ross, R.N., F.R.S. During the Years 1839 to 1843 by Authority of the Lords Commissioners of the Admiralty, Volume 7: Mammalia, Birds*. E. W. Janson, London, United Kingdom.
- GRAY, J.E. (1871) *Supplement to the Catalogue of Seals and Whales in the British Museum*. British Museum of Natural History, London, United Kingdom.
- HARRISON, R. AND BRYDEN, M.M. (Eds) (1990) *Whales, Dolphins and Porpoises*. Merehurst Limited, London, United Kingdom.
- HIGA, A., HINGST-ZAHER, E. AND VIVO, M. DE. (2002) Size and shape variability in the skull of *Pontoporia blainvillei* (Cetacea: Pontoporiidae) from the Brazilian coast. *Latin American Journal of Aquatic Mammals* 1: 145-152.
- HOYT, E. (1984) *The Whale Watchers Handbook*. Madison Press Lt. & Hoyt, Ontario, Canada.
- JEFFERSON, T.A., LEATHERWOOD, S. AND WEBBER, M.A. (1993) *Marine Mammals of the World*. FAO, Rome, Italy.
- LAHILLE, F. (1903) Las ballenas de nuestros mares. *Boletín del Centro Naval de Buenos Aires* 21(239): 361-387.
- LAHTI, D.C. AND LAHTI, A.R. (2002) How precise is egg discrimination in weaverbirds? *Animal Behaviour* 63: 1135-1142.
- LÁZARO, M., LESSA, E.P. AND HAMILTON, H. (2004) Geographic genetic structure in the franciscana dolphin (*Pontoporia blainvillei*). *Marine Mammal Science* 20 (2): 201-214.
- LEATHERWOOD, S. AND REEVES, R.R. (1983) *The Sierra Club Handbook of Whales and Dolphins*. Sierra Club Books, San Francisco, CA, USA.
- LICHTER, A. AND HOOPER, A. (1984) *Guía para el Reconocimiento de los Cetáceos del Mar Argentino*. Fundación Vida Silvestre Argentina, Buenos Aires, Argentina.
- LICHTER, A. (1992) *Huellas en la Arena, Sombras en el Mar*. Ediciones Terra Nova, Buenos Aires, Argentina.

- LODI, L., SICILIANO, S. AND CAPISTRANO, L. (1987) *Primeiro Registro de Pontoporia blainvillei (Cetacea, Platanistoidea) no litoral norte de Rio de Janeiro, Brasil*. Pages 69-70 in (FBCN) Anais da 2ª Reunião de Trabalho de Especialistas em Mamíferos Aquáticos da América do Sul, 4-8 August 1986, Rio de Janeiro, RJ, Brazil.
- MALM, A.W. (1871) Hvaldjur i Sveriges Museer, år 1869. *Kongliga Svenska Vetenskaps-Academiens nya Handlingar (Ny Följd)* 9(2): 1-104, pls. 1-6.
- MINASIAN, S.M., BALCOMB, K.G AND FOSTER, L. (1984) *The World's Whales*. Smithsonian Institution Press, Washington, DC, USA.
- MITCHELL, E. (1970) Pigmentation pattern evolution in delphinid cetaceans: an essay in adaptive coloration. *Canadian Journal of Zoology* 48: 717-740.
- MONES, A. AND PHILIPPI, M.E. (1992) Bibliografía mastozoológica anotada del Uruguay. *Anales del Museo Nacional de Historia Natural de Montevideo 2ª Serie* 8: 71-161.
- PALAZZO, J.T AND BOTH, C.C. (1988). *Guia dos Mamíferos Marinhos do Brasil*. Editora Sagra, Porto Alegre, RS, Brazil.
- PARERA, A. (2002) *Los Mamíferos de la Argentina y la Región Austral de Sudamérica*. El Ateneo, Buenos Aires, Argentina.
- PINEDO, M.C. (1991) *Development and variation of the franciscana, Pontoporia blainvillei*. PhD dissertation. University of California, Santa Cruz, CA, USA.
- PINEDO, M.C. (1997) Relatório do 2º Encontro. Pages 1-7 in PINEDO, M.C. AND BARRETO, A.S. (Eds) *Anais do 2º Encontro sobre Coordenação de Pesquisa e Manejo da Franciscana, Florianópolis, SC, 22-23 de Outubro de 1994*. Editora da Furg, Rio Grande, RS, Brazil.
- PINEDO, M.C., PRADERI, R. AND BROWNELL JR., R.L. (1989) Review of the biology and status of the franciscana, *Pontoporia blainvillei*. Pages 46-51 in PERRIN, W.F., BROWNELL JR., R.L., KAIYA, Z. AND JIANKANG, L. (Eds) *Biology and Conservation of the River Dolphins*. Occasional Papers IUCN SSC 3, Gland, Switzerland and Cambridge, United Kingdom.
- PRADERI, R. (1975) La franciscana o delfín del Río de la Plata. *Boletín del Museo Nacional de Historia Natural* 1(9): 1-5.
- PRADERI, R., PINEDO, M.C. AND CRESPO, E.A. (1989) Conservation and management of *Pontoporia blainvillei* in Uruguay, Brazil and Argentina. Pages 52-56 in PERRIN, W.F., BROWNELL JR., R.L., KAIYA, Z. AND JIANKANG, L. (Eds) *Biology and Conservation of the River Dolphins*. Occasional Papers IUCN SSC 3, Gland, Switzerland and Cambridge, United Kingdom.
- RAMOS, R.M.A., DI BENEDITTO, A.P.M., SICILIANO, S., SANTOS, M.C.O., ZERBINI, A.N., BERTOZZI, C., VICENTE, A.F.C., ZAMPIROLI, E., ALVARENGA, F.S. AND LIMA, N.R.W. (2002) Morphology of the Franciscana (*Pontoporia blainvillei*) off southeastern Brazil: sexual dimorphism, growth and geographic variation. *Latin American Journal of Aquatic Mammals* 1: 129-144.
- RAPOSO, M.A., PARRINI, R. AND NAPOLI, M. (1998) Taxonomia, Morfometria e Bioacústica do grupo específico *Hylophilus poicilotis* / *H. amaurocephalus* (Aves, Vireonidae). *Ararajuba* 6(2): 87-109.
- REEVES, R.R., STEWART, B.S., CLAPHAM, P.J. AND POWELL, J.A. (2002) *National Audubon Society Guide to Marine Mammals of the World*. Alfred A. Knopf, New York, NY, USA.
- RICE, D.W. (1984) Cetaceans. Pages 447-490 in ANDERSON, S. AND JONES JR., J.K. (Eds) *Orders and Families of Recent Mammals of the World*. John Wiley & Sons, New York, NY, USA.
- SECCHI, E.R., WANG, J.Y., MURRAY, B.W., ROCHA-CAMPOS, C.C. AND WHITE, B.N. (1998) Population differentiation in the franciscana (*Pontoporia blainvillei*) from two geographic locations in Brazil as determined from mitochondrial DNA control region sequences. *Canadian Journal of Zoology* 76: 1622-1627.
- SECCHI, E.R., OTT, P.H., CRESPO, E.A., KINAS, P.G., PEDRAZA, S.N. AND BORDINO, P. (2001) A first estimate of franciscana (*Pontoporia blainvillei*) abundance off southern Brazil. *Journal of Cetacean Research and Management* 3(1): 95-100.
- SECCHI, E.R., DANILEWICZ, D. AND OTT, P.H. (2003) Applying the phylogeographic concept to identify franciscana dolphin stocks: implications to meet management objectives. *Journal of Cetacean Research and Management* 5(1):61-68.
- UNEP/CMS. (2000) Report of the Third Workshop for Coordinated Research and Conservation of the Franciscana Dolphin (*Pontoporia blainvillei*) in the Southwestern Atlantic, 26-28 November 1997, Buenos Aires, Argentina. UNEP/CMS Secretariat, Bonn, Germany.
- VAN DEUSEN, H.M. (1969) Results of the 1958-1959 Gilliard New Britain Expedition 5. A New Species of *Pteropus* (Mammalia, Pteropodidae) from New Britain, Bismarck Archipelago. *American Museum Novitates* 2371: 1-16.
- VAN ERP, I. (1969) In quest of the La Plata dolphin. *Pacific Discovery* 22(2): 18-24.
- VAZ-FERREIRA, R. (1970) *Fauna: Conservación y Recursos*. Editorial Nuestra Tierra, Montevideo, Uruguay.
- VILLALOBOS, C. AND VILLALOBOS, J. (1947) *Atlas de los Colores*. Librería El Ateneo, Buenos Aires, Argentina.
- WATSON, L. (1981) *Sea Guide to Whales of the World*. E.P. Dutton, New York, NY, USA.
- YABLOKOV, A.V. (1963) Types of color of the Cetacea. *Byul.Morsk. Obshch. Ispytat. Pri. (Ot. Biol.)* 68(6):27-41 [In Russian].

APPENDIX 1

HISTORICAL REVIEW OF FRANCISCANA COLOURATION.

Gervais and d'Orbigny (1844a, 1844b) pointed out that this dolphin is almost entirely white, with a black streak on its back.

Gray (1846) and d'Orbigny (1847) agreed with them, because the first describes the colouration as 'white, with a black dorsal streak', and the second says: 'et il est blanc, avec une bande dorsale noire' [and it is white, with a black dorsal streak]. Gray (1846) added that, according to Desmarest, Fremenville saw a dolphin 'ashy with a white streak' on the Brazilian coast.

Burmeister (1867), referring to an individual observed near Maldonado (on the coast of the Banda Oriental) said: 'no veo en nuestro individuo nada de la faja blanca a cada lado del cuerpo' '...' 'el individuo nuestro es de color pardo en la parte dorsal y blanco en toda la parte ventral, incluyendo también las dos mandíbulas y los dos carrillos.' [I do not see in our individual anything about the white streak, ... , our individual is dun dorsally and white ventrally, including both jaws and cheeks].

Burmeister (1869) interpreted the plate of d'Orbigny as follows: 'con lomo negro, barriga blanca y una faja longitudinal blanca en cada lado' [with black back, white belly and a white longitudinal streak on each side], but according to M. de Fremenville, 'el cuerpo del animal es casi todo blanco, con una faja ancha negra en el lomo, de la frente hasta la cola' '...' 'así la aleta dorsal es negra como la grande aleta caudal, pero la pectoral de cada lado es blanco amarilla como el vientre del animal.' [the body of the animal is almost entirely white, with a black wide streak on the back, from the forehead to the tail, ... , thereby, the dorsal fin is black as the big fluke, but the flipper of each side is yellowish white as the belly of the animal].

Gray (1871) pointed out that the animal described by Gervais as *Delphinus (Stenodelphis) Blainvillii* (sic), differs from the figure of Burmeister in having the flippers elongated subfalcate, a higher dorsal fin and a broad white streak, commencing from the blower and extending down the back to near the tail. He also added: 'If this is not a figure of the animal seen at sea, which I suspect it must be, it must be a different species.' The truth is that this species has very broad spatula-like flippers, and the dorsal fin is triangular and low.

Malm (1871), in relation to a dolphin from Montevideo that had been taken to the Natural History Museum of Göteborg (Sweden), classified it as *Pontoporia tenuirostris* and notes that the body, including the flippers and tail, is blackish, but that there is a little grey region near the dorsal fin which contrasts with the rest of the body. He added that some parts are brownish, but that they probably were white, or at least whitish. After the description he concluded that this individual was not of the same species as the one observed by d'Orbigny near the Río de la Plata.

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