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ARTICLE

Morphologic analysis and Neotype designation of the Raspthorn sandskate, *Psammobatis scobina*, from its type locality

Análisis morfológico y designación de Neotipo de la Raya pequén, *Psammobatis scobina*, desde su localidad tipo

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Resumen.- El género *Psammobatis* es endémico de América del Sur, y tres de sus especies son simpátricas a lo largo de la costa chilena. Su similitud morfológica junto con la ausencia de material tipo han hecho que la identificación taxonómica de *Psammobatis scobina* sea especialmente compleja. El objetivo de este trabajo fue proporcionar la identificación y comparación objetiva de *P. scobina*, a través de una nueva caracterización morfológica, incorporando rasgos morfométricos y merísticos para ambos sexos y designando un Neotipo. Los datos morfométricos y merísticos se presentan por separado para el Neotipo, machos y hembras, con el fin de determinar la variabilidad entre los sexos. Aunque hay superposición entre algunos rasgos morfométricos de machos y hembras, también hay algunos que difieren sexualmente entre especímenes de tamaños similares, como ancho del disco, longitud del lóbulo posterior de la aleta pélvica, longitud preoral, distancia entre las quintas hendiduras branquiales y distancia desde la cloaca hasta la segunda aleta dorsal. Adicionalmente, con el análisis de componentes principales (ACP) y el análisis de conglomerados fue posible identificar el dimorfismo sexual en los especímenes, siendo las variables más influyentes, las relacionadas con la longitud de la cola. Hay varios problemas sin resolver en relación con la taxonomía de este intrincado género, especialmente en *P. scobina* y *P. normani*, simpátricas en el Pacífico sudoriental. Además del análisis de las estructuras esqueléticas y de las cápsulas de huevos, sigue siendo necesario un análisis morfométrico comparativo integrado, basado en una metodología estandarizada reciente con la inclusión de datos morfológicos y moleculares. La designación de un Neotipo para fines comparativos objetivos, permitirá en el futuro tal estudio.

Palabras clave: Rayas de rostro blando, *Psammobatis scobina*, neotipo, morfometría, dimorfismo sexual

Abstract.- The genus *Psammobatis* is endemic to South America, and three of its species are sympatric along the Chilean coast. Its morphological similarity along with the absence of type material have given evidence that the taxonomic identification of *Psammobatis scobina* is especially complex. The aim of this work was to allow for objective identification and comparisons of *P. scobina*, providing a new morphological characterization, incorporating both morphometric and meristic features for both sexes, and designating a Neotype. Morphometric and meristic data are presented separately for the Neotype, and for males and females to determine variability between sexes. Although there is overlap between some morphometric features of males and females, there are also some morphometric measures that differed between sexes among specimens of similar sizes, such as disc width, length of posterior pelvic lobe, preoral length, distance between fifth gill slits and distance from cloaca to second dorsal fin. Additionally, with the Principal Component Analysis (PCA) and Cluster analyses it was possible to identify sexual dimorphism in the specimens, with the most influential variables related to tail length. There are several unresolved issues regarding the taxonomy of this problematic genus, especially those regarding *P. scobina* and *P. normani*, which are sympatric in the southeastern Pacific. In addition to the analysis of skeletal structures and egg cases, an integrative comparative morphometric analysis, based on a recent standardized methodology with the inclusion of both morphological and molecular data, is still needed. The designation of a Neotype for objective comparative purposes, will allow such future study.

Key words: Softnosed skates, *Psammobatis scobina*, neotype, morphometry, sexual dimorphism

INTRODUCTION

The genus *Psammobatis* Günther, 1870 (Rajiformes, Arhynchobatidae) constitutes a group of small to medium size skates, endemic to South America (McEachran 1983, Last *et al.* 2016). The morphological similarity within members of the genus has made the taxonomic identification within this group of rays especially complex (de Carvalho & de Figueiredo 1994). McEachran (1983) conducted the last comprehensive revision of the genus validating eight nominal species. This author, based on skeletal and morphometric analyses, recognized the four previously described species [*i.e.*, *P. scobina* (Philippi, 1857), *P. rudis* Günther, 1870, *P. rutrum* Jordan, 1890, and *P. bergi* Marini, 1932], and additionally described four new species (*i.e.*, *P. glansdissimilis* McEachran, 1983, *P. lentiginosa* McEachran, 1983, *P. normani* McEachran, 1983, and *P. parvacauda* McEachran, 1983). Subsequently, de Carvalho & de Figueiredo (1994) resurrected *P. extenta* (Garman, 1913) and synonymized *P. glansdissimilis* with the former. Recently, Mabragaña *et al.* (2020), based on skeletal anatomy and morphometric analyses, synonymized *P. parvacauda* with *P. normani*. Currently, the genus comprises seven valid species (Fricke *et al.* 2020, Mabragaña *et al.* 2020), for which, with the exception of *P. scobina*, there is general consensus regarding their distribution. There are two amphioceanic species (*P. rudis* and *P. normani*), both occurring in the Southwest Atlantic Ocean (SWA) and the Southeast Pacific Ocean (SEP), four species exclusively distributed in the SWA (*P. bergi*, *P. extenta*, *P. lentiginosa* and *P. rutrum*) and one species exclusively found in the SEP but with questioned records in the SWA (*P. scobina*) (McEachran 1983, Pequeño & Lamilla 1985, 1993; Mabragaña 2007, Last *et al.* 2016, Weigmann 2016, Mabragaña *et al.* 2020).

The Raspthorn sandskate, *P. scobina*, was briefly described by Philippi (1857) based on a single specimen from off Valparaíso (Central Chile) and after four decades the same author provided some additional morphological details for the species, presumably from the same specimen (Philippi 1892). As stated by Philippi (1857), the specimen was kept in the National Museum of Natural History of Chile (MNHNCL). According to the International Code of Zoological Nomenclature, this specimen should be considered as the holotype of *P. scobina* by monotypy (article 73.1.2. 73.1.2.). However, the whereabouts of this type specimen are unknown [Fricke *et al.* 2020, Cornejo (pers. comm.)[1]]. In fact, it is surprising that the holotype of *P. scobina* was not included by McEachran (1983), in his major revision of the genus, since he examined the type specimens of all the other species of *Psammobatis*. In his taxonomic revision of *Psammobatis*, McEachran (1983) made a complete redescription of *P. scobina*, providing diagnostic features to identify this species among its congeners. In spite of separately analyzing males and females, he only provided average data for external measurements of the species (McEachran 1983). Subsequently, Pequeño & Lamilla (1985) furnished morphometric data on four females and two males of *P. scobina* from Chilean waters, and Lloris & Rucabado (1991) provided data on morphometrics for a single male collected in waters of the Beagle Channel. However, comparisons are difficult to make from the morphometric data obtained in these studies, because measurements performed were not clearly explained. This has been a common issue in the taxonomy of skates, and thus Last *et al.* (2008) proposed a standardized method to measure batoids for consistency among taxonomic studies.

There are some discrepancies regarding the distribution of the Raspthorn sandskate. According to the thorough revision made by McEachran (1983) which included 159 specimens from the entire known range of the genus (from Brazil to Chile), *P. scobina* is distributed exclusively in the SEP, in Chilean waters. Lloris & Rucabado (1991) reported a male specimen of *P. scobina* in the Beagle Channel, but Mabragaña (2007) questioned this record, because the description made for this specimen was consistent to that of *P. normani* and no clasper analyses were performed to validate the identification. The Raspthorn sandskate was also cited in a species list for Uruguayan waters (Nión *et al.* 2016), around the Malvinas/Falkland Islands (Agnew *et al.* 2000) and Last *et al.* (2016), mentioned its presence in the SEP (Chile), and possibly off Patagonia. However, except for Lloris & Rucabado (1991), no data on the specimens of *P. scobina* reported in SWA are available. In agreement with McEachran (1983), Mabragaña (2007) questioned the presence of *P. scobina* in Patagonian waters. The latter author examined hundreds of specimens of *Psammobatis* from Patagonia, and clasper morphology of males was consistent only with that of *P. rudis* or *P. normani*. It is important to highlight that species from this genus are conspicuous and abundant in the Patagonian shelf (Cousseau *et al.* 2007). The similarities in external morphology of within *Psammobatis*, and the lack of type specimens of *P. scobina*, have probably contributed to inaccurate species identification.

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Taking into account *P. scobina* is part of the bycatch of different fisheries along the Chilean coast (Acuña & Villarroel 2002, Acuña *et al*. 2005, Concha *et al*. 2009), the questioning of SWA records, and, despite the fact that this species has been recently classified as 'Least Concern' at the International Union of Conservation of Nature's Red List (Dulvy *et al.* 2020), for more studies in order to inform fisheries managers about its distribution, biology, and trends in abundance of its populations, are still needed. An accurate identification of this species should be the first step to ensure the reliability of newly collected data, especially when sympatric with *P. normani* and *P. rudis*. Moreover, sexual dimorphism and intraspecific variability has been reported in other batoids with broad distribution ranges (Leible 1988, Braccini & Chiaramonte 2002, Mabragaña 2007), and thus also needs to be studied in *P. scobina*.

Therefore, the aim of this work was to contribute to both the objective identification and comparisons of *P. scobina*, providing a new morphological characterization, incorporating both morphometric and meristic features for both sexes, and designating a Neotype. Furthermore, considering the fact that type material is lost from its collection, and issues regarding taxonomic identification of this species are in place, a newly collected specimen from near the type locality off Chile is designated as a Neotype.

MATERIALS AND METHODS

In total, 35 specimens (20 males and 15 females) of *Psammobatis scobina*, ranging from 33.9 cm to 50.8 cm in total length (TL), were examined. Twenty five of them were obtained from the Ichthyological Collection of the Chilean Museum of Natural History of Santiago, Chile (MNHNCL) and the remaining 10 were collected from Valparaíso Bay (33°0’36.91’’S; 71°33’25.99’’W). Captures were made with gillnets set at about 40 m in depth. Specimens were examined when fresh or kept frozen for further examination in the Laboratory or at the Museum. A mature male from the bay of Valparaíso was designed as Neotype and deposited at the National Museum of Natural History of Santiago (MNHNCL ICT 7624, 41.7 cm TL). The geographic location of each examined specimen is summarized in Table 1 and shown in Figure 1.

Table 1. Neotype and voucher specimens of *Psammobatis scobina*, examined for morphological analysis, with their respective, geographic location, number of specimens (n), sex, accession number, and type status. Multiple specimens with a single common accession number corresponded to lots containing individuals of the same sex and locality / Neotipo y ejemplares de *Psammobatis scobina* examinados para los análisis morfológicos, con su respectiva, ubicación geográfica, número de especímenes (n), sexo, número de acceso y estado de tipo. Especímenes múltiples con el mismo número de acceso corresponden a lotes con individuos del mismo sexo y localidad

Location	n	Sex	Accession number	Type status
51°00′06″S; 75°44′02″W	4	Female	MNHNCL ICT 6930	Voucher
47°30′S; 75°52′W	1	Male	MNHNCL ICT 7551	Voucher
47°30′S; 75°52′W	1	Female	MNHNCL ICT 7551	Voucher
40°36′02″S; 72°53′W	1	Female	MNHNCL ICT 7552	Voucher
42°46′03″S; 74°42′09″W	1	Male	MNHNCL ICT 7553	Voucher
46°03′S; 75°21′W	1	Male	MNHNCL ICT 7554	Voucher
42°18′06″S; 74°39′02″W	1	Male	MNHNCL ICT 7555	Voucher
48°08′S; 74°54′W	1	Female	MNHNCL ICT 7556	Voucher
43°53′06″S; 74°35′08″W	2	Female	MNHNCL ICT 7557	Voucher
44°09′07″S; 74°47′09″W	1	Female	MNHNCL ICT 7558	Voucher
46°03′05″S; 75°21′05″W	1	Male	MNHNCL ICT 7561	Voucher
46°02′02″S; 75°23′W	1	Male	MNHNCL ICT 7562	Voucher
43°32′S-74°30′W	1	Female	MNHNCL ICT 7563	Voucher
41°41′04″S; 74°10′05″W	1	Male	MNHNCL ICT 7564	Voucher
42°46′03″S; 74°54′09″W	1	Female	MNHNCL ICT 7565	Voucher
33°00′S; 71°33′W	1	Male	MNHNCL ICT 7566	Voucher
33°00′S; 71°33′W	1	Male	MNHNCL ICT 7624	Neotype
46°03′05″S; 75°21′05″W	2	Male	-	Voucher
40°00′-47°30′S; 73°56′-75°21′W	1	Male	-	Voucher
40°00′-47°30′S; 73°56′-75°21′W	3	Female	-	Voucher
33°00′S; 71°33′W	8	Male	-	Voucher

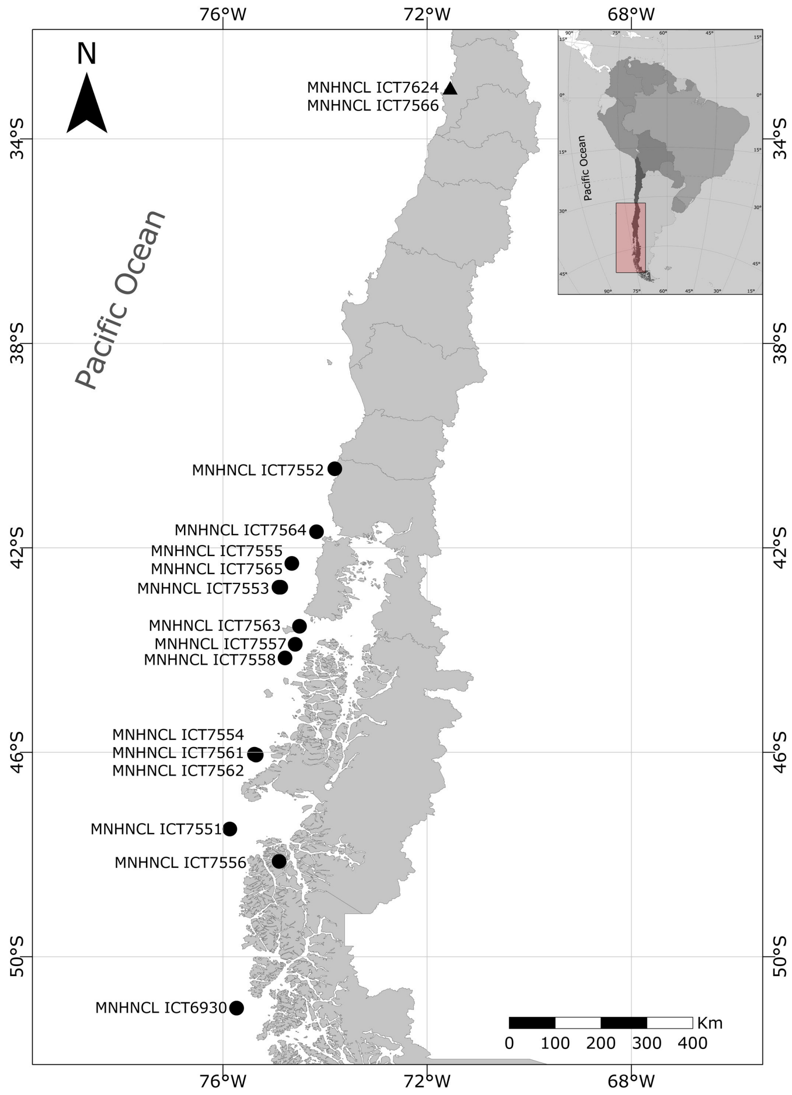

Figure 1. Sampling locations of examined specimens of *Psammobatis scobina*. Black triangle indicates the origin of Neotype, and black points indicate specific origin of each specimen / Lugares de muestreo de los especímenes examinados de *Psammobatis scobina*. El triángulo negro indica el origen del Neotipo, y los puntos negros indican el origen específico de cada espécimen

MORPHOLOGICAL METHODS

All specimens were measured and photographed. Retained specimens were fixed in a solution of formalin (4%), and subsequently preserved in ethanol (70%). A total of 68 measurements were included based on Last *et al.* (2008) and Fuentes (2018) (Table 2). Claspers were cleaned manually with a scalpel. Meristic data (26 in total), corresponded to spinulation, number of teeth, tooth rows, and tooth series, were also recorded for each specimen (Table 3). In addition, radiographs (37 kV; 40 MAs) were used to count vertebrae and radials of the left pectoral and pelvic fin from two voucher specimens (ICT 7555, adult male and ICT 7563, adult female). Furthermore, 25 measurements from McEachran (1983) were included for a Principal Components Analysis (PCA) based on %DW with a variance-covariance matrix, using PAST software (Table 4). Sexual dimorphism was tested with a non-parametric multivariate analysis (ANOSIM: analysis of similarities and Cluster), using PRIMER software. Morphometric data were compared with those obtained by McEachran (1983). Meristics between males and females were tested with a Mann-Whitney U Test.

Table 2. Morphometrics for Neotype, and male and female voucher specimens of *Psammobatis scobina*. Neotype measurements, mean, range and standard deviation (SD) are expressed in percentage of total length (TL) and disc width (DW). Total length is expressed in cm in both percentages, and also disc width in DW / Datos morfométricos de Neotipo, y ejemplares machos y hembras de *Psammobatis scobina*. Medidas de Neotipo, promedio, rango y desviación estándar (SD) expresadas en porcentajes de longitud total (TL) y de ancho de disco (DW). Longitud total expresada en cm en los dos porcentajes, y también el ancho del disco en DW

	Measurements	TL									DW								
		Males					Females				Males					Females			
		Neotype	Mean	Min	Max	SD	Mean	Min	Max	SD	Neotype	Mean	Min	Max	SD	Mean	Min	Max	SD
1	Total length	41.70	44.17	38.50	50.80	3.85	39.35	33.90	45.60	3.69	41.70	44.17	38.50	50.80	3.85	39.35	33.90	45.60	3.69
2	Disc width	62.35	62.71	58.59	66.74	2.32	59.01	56.00	61.89	1.73	26.00	27.69	24.80	32.50	2.60	23.24	19.00	27.20	2.52
3	Disc length (direct)	52.04	52.77	47.30	56.36	2.01	51.87	49.56	53.72	1.08	83.46	84.21	75.08	89.60	3.11	87.95	83.41	94.45	2.60
4	Snout to maximum disc width	28.06	28.59	25.97	35.10	2.06	28.53	25.70	35.61	2.52	45.00	45.64	39.62	54.09	3.50	48.37	43.82	60.24	4.19
5	Trunk length	28.87	28.47	24.86	30.28	1.15	29.19	28.25	30.53	0.68	46.31	45.48	38.28	50.97	2.80	49.50	46.74	51.15	1.44
6	Snout length (pre-orbital direct)	11.65	10.94	8.16	13.26	1.34	11.01	8.87	12.70	1.16	18.69	17.44	13.09	21.44	1.97	18.68	15.03	21.43	2.12
7	Snout to spiracle	17.65	17.28	15.60	18.46	0.81	17.34	15.27	18.71	0.85	28.31	27.56	25.20	29.84	1.11	29.42	24.67	32.31	1.83
8	Head length (dorsal)	19.33	19.25	17.52	21.20	0.89	19.15	17.47	20.74	0.99	31.00	30.72	28.02	34.93	1.66	32.48	29.78	35.01	1.76
9	Orbit diameter	4.75	4.26	3.34	5.12	0.51	4.68	3.30	5.54	0.59	7.62	6.81	5.28	8.74	0.95	7.94	5.62	9.90	1.04
10	Orbit and spiracle length	6.86	6.56	5.90	7.33	0.37	6.15	4.90	7.07	0.52	11.00	10.48	9.27	12.51	0.84	10.44	8.35	12.00	0.92
11	Spiracle length	3.74	3.27	2.60	4.24	0.43	2.99	2.43	3.46	0.34	6.00	5.21	4.16	6.54	0.60	5.07	4.31	5.82	0.52
12	Distance between orbits	4.44	4.69	3.96	5.40	0.43	4.36	3.88	5.24	0.39	7.12	7.48	6.50	8.84	0.62	7.39	6.42	8.64	0.67
13	Distance between spiracles	6.50	6.94	6.50	7.35	0.24	6.95	6.52	7.66	0.30	10.42	11.08	10.35	12.39	0.61	11.78	10.68	12.38	0.45
14	Snout to cloaca (beginning)	43.17	44.66	42.33	48.28	1.46	44.11	42.62	46.45	1.03	69.23	71.29	65.23	75.60	2.63	74.80	71.33	80.24	2.32
15	Snout to cloaca (middle)	44.12	45.38	42.95	48.97	1.34	44.92	43.33	47.04	1.04	70.77	72.42	67.38	76.80	2.48	76.16	73.14	81.25	2.22
16	Snout to cloaca (first hemal spine)	45.08	46.64	44.92	49.89	1.05	46.92	45.45	49.20	1.08	72.31	74.46	69.23	78.86	2.57	79.56	75.83	84.98	2.57
17	Cloaca to first dorsal-fin origin	42.45	40.04	35.35	44.66	2.28	40.08	35.88	43.33	2.10	68.08	63.95	54.47	71.68	4.54	68.01	61.57	75.47	4.60
18	Cloaca to second dorsal-fin origin	43.65	45.95	41.16	51.42	2.25	46.37	43.68	49.01	1.91	70.00	73.38	63.42	82.52	4.55	78.67	72.00	86.71	4.59
19	Cloaca to caudal-fin origin	48.44	51.41	47.98	54.25	1.89	51.37	47.37	55.12	2.30	77.69	82.10	73.93	87.78	4.28	87.16	80.22	98.42	5.41
20	Ventral snout length (preoral)	10.10	10.36	8.95	11.58	0.65	11.34	9.32	12.51	0.78	16.19	16.52	14.36	19.08	1.09	19.24	15.06	20.94	1.49
21	Ventral snout length (middle jaw)	10.86	11.37	9.86	12.89	0.80	12.14	10.22	13.29	0.73	17.42	18.13	15.91	21.23	1.24	20.60	16.51	22.48	1.43
22	Pre-nasal length	8.82	8.69	7.90	9.85	0.49	8.72	8.02	9.30	0.44	14.15	13.87	11.84	15.82	0.94	14.79	13.30	16.17	0.90
23	Ventral head length (to fifth gill)	28.15	28.07	25.38	30.71	1.61	26.40	24.89	27.76	0.85	45.15	44.78	40.01	48.58	2.37	44.76	41.05	48.03	1.60
24	Mouth width	6.98	6.70	4.25	8.96	1.57	4.82	4.14	5.84	0.59	11.19	10.65	7.22	14.03	2.35	8.17	6.97	9.95	0.95
25	Mouth width (max)	8.90	11.19	8.67	12.89	1.08	10.82	9.75	11.65	0.51	14.27	17.87	14.27	21.46	1.81	18.34	16.56	20.16	0.99
26	Distance between nostrils	7.53	7.50	6.06	9.36	0.77	7.74	6.10	9.20	1.17	12.08	11.99	9.54	15.03	1.40	13.12	9.86	15.63	1.95
27	Nasal curtain length	4.72	4.70	4.23	5.27	0.31	4.35	3.80	4.94	0.35	7.58	7.50	6.61	8.60	0.55	7.37	6.40	8.42	0.61
28	Nasal curtain (total width)	8.90	8.59	6.48	9.39	0.69	8.15	7.21	9.28	0.56	14.27	13.69	11.07	14.92	0.84	13.81	11.81	15.73	0.93
29	Nasal curtain (min. width)	3.62	4.39	3.38	5.59	0.53	4.51	3.29	4.93	0.42	5.81	7.02	5.07	8.83	0.93	7.65	5.86	8.50	0.67
30	Nasal curtain (lobe width)	2.81	2.75	2.04	3.38	0.33	2.65	2.28	3.02	0.20	4.50	4.39	3.36	5.21	0.48	4.49	3.89	5.23	0.33
31	Nasal curtain (bottom width)	3.65	3.74	3.09	4.32	0.33	3.59	2.97	4.36	0.38	5.85	5.97	5.19	6.82	0.51	6.08	5.29	7.18	0.57
32	Width of first gill slits	3.07	2.34	1.62	3.07	0.43	1.99	1.62	2.46	0.25	4.92	3.74	2.76	4.92	0.66	3.37	2.77	4.02	0.39
33	Width of third gill slits	3.14	2.52	1.85	3.37	0.51	1.94	1.35	2.34	0.26	5.04	4.01	3.11	5.32	0.78	3.29	2.40	3.99	0.41
34	Width of fifth gill slits	2.11	1.70	1.04	2.73	0.51	1.31	0.96	1.59	0.17	3.38	2.71	1.78	4.20	0.78	2.22	1.58	2.72	0.30
35	Distance between first gill slits	17.77	16.92	14.69	20.10	1.52	15.95	15.06	17.16	0.70	28.50	26.98	23.43	30.96	2.10	27.04	25.90	28.78	0.91
36	Distance between fifth gill slits	7.29	8.00	7.20	8.68	0.42	8.84	8.41	9.27	0.27	11.69	12.76	11.36	13.98	0.72	15.02	14.27	15.81	0.40
37	Length of anterior pelvic lobe	13.69	12.80	11.51	15.25	1.18	12.09	10.25	13.46	0.93	21.96	20.45	17.46	25.68	2.14	20.50	17.43	23.06	1.61
38	Length of posterior pelvic lobe	21.92	20.77	19.14	23.19	1.18	20.10	19.07	21.65	0.79	35.15	33.15	30.72	36.44	1.78	34.09	32.12	37.39	1.72
39	Caudal region (pectoral fin)	43.65	52.95	43.65	61.47	5.46	49.63	39.14	60.54	5.90	70.00	84.63	70.00	102.8	10.1	84.21	66.22	108.1	10.7
40	Caudal region (cloaca center)	53.48	54.71	52.53	56.86	1.23	54.51	52.14	56.90	1.40	85.77	87.36	79.79	93.98	3.88	92.48	86.19	101.0	4.23
41	Pelvic base width	13.86	15.70	12.86	18.55	1.32	17.63	16.20	19.35	1.13	22.23	25.05	20.32	28.12	2.08	29.87	27.92	32.97	1.53
42	Tail length (cloaca to caudal–fin tip)	51.80	52.28	50.00	55.58	1.23	51.66	50.32	53.85	1.09	83.08	83.48	77.04	88.40	3.42	87.64	82.35	95.80	3.77
43	Caudal length at D1 (pelvic insertion)	27.61	29.88	25.58	34.15	2.42	31.16	29.18	33.48	1.20	44.28	47.74	41.40	58.29	4.64	52.86	47.81	57.05	2.89
44	Caudal length at D2 (pelvic insertion)	33.45	35.85	32.73	39.68	2.18	37.00	34.92	38.63	1.05	53.65	57.26	50.43	67.34	4.46	62.78	57.20	68.99	3.31

D1: first dorsal-fin, D2: second dorsal-fin, TL: total length, DW: disc width, SD: standard deviation

Table 2. Continue / Continuación

	Measurements	TL									DW								
		Males					Females				Males					Females			
		Neotype	Mean	Min	Max	SD	Mean	Min	Max	SD	Neotype	Mean	Min	Max	SD	Mean	Min	Max	SD
45	Tail at insertion of pelvic fins (width)	4.41	4.58	3.57	5.52	0.52	4.82	3.75	5.66	0.53	7.08	7.32	5.35	9.21	0.97	8.17	6.15	9.60	0.94
46	Tail at distal margin of pelvic fins (width)	3.96	3.80	2.99	4.59	0.48	4.28	3.12	4.86	0.47	6.35	6.07	4.50	7.84	0.85	7.26	5.11	8.39	0.86
47	Tail at insertion of pelvic fins (height)	2.78	2.63	2.17	3.09	0.24	2.67	2.28	3.10	0.23	4.46	4.21	3.26	5.28	0.47	4.54	3.74	5.54	0.42
48	Tail at distal margin of pelvic fins (height)	1.94	2.14	1.58	2.67	0.27	2.23	1.83	2.58	0.18	3.12	3.42	2.50	4.39	0.47	3.78	3.00	4.61	0.37
49	Tail at mid-length (width)	2.52	2.22	1.85	2.94	0.26	2.44	2.12	2.88	0.24	4.04	3.55	2.98	4.84	0.49	4.14	3.63	4.86	0.43
50	Tail at mid-length (height)	1.46	1.45	1.18	1.71	0.16	1.39	1.19	1.82	0.19	2.35	2.31	1.90	2.81	0.27	2.35	2.03	3.25	0.34
51	Tail at D1 origin (width)	1.70	1.49	1.16	1.98	0.21	1.60	1.35	1.99	0.21	2.73	2.39	1.86	3.27	0.34	2.72	2.28	3.55	0.38
52	Tail at D1 origin (height)	1.34	1.18	1.02	1.45	0.15	1.00	0.89	1.18	0.09	2.15	1.89	1.62	2.24	0.22	1.70	1.46	2.07	0.16
53	Tail at D2 origin (width)	1.58	1.12	0.84	1.58	0.20	1.24	1.00	1.52	0.19	2.54	1.79	1.27	2.54	0.32	2.11	1.71	2.64	0.35
54	Tail at D2 origin (height)	0.94	0.90	0.58	1.14	0.14	0.79	0.50	0.95	0.11	1.50	1.44	0.96	1.79	0.22	1.34	0.81	1.63	0.19
55	Tail at caudal origin (width)	0.50	0.49	0.29	0.72	0.11	0.49	0.23	0.67	0.14	0.81	0.78	0.46	1.19	0.18	0.84	0.38	1.16	0.26
56	Tail at caudal origin (height)	0.50	0.43	0.26	0.63	0.10	0.34	0.16	0.44	0.08	0.81	0.68	0.42	0.99	0.16	0.57	0.26	0.78	0.14
57	D1+D2 base length	11.29	11.58	8.94	13.21	1.13	11.24	10.07	12.60	0.77	18.12	18.50	14.35	21.85	1.94	19.07	16.98	21.97	1.59
58	D1 base length	4.94	5.81	4.63	6.69	0.51	5.78	4.56	6.80	0.58	7.92	9.27	7.43	10.67	0.75	9.81	7.75	11.74	1.09
59	D2 base length	4.82	5.42	2.99	6.66	1.00	5.18	4.22	5.96	0.51	7.73	8.65	4.80	11.11	1.60	8.78	6.88	10.16	0.88
60	Caudal-fin length	2.30	2.32	1.01	3.44	0.57	1.74	0.41	2.92	0.71	3.69	3.71	1.51	5.52	0.91	2.95	0.69	4.97	1.21
61	D1 height	3.72	3.13	1.56	4.14	0.77	2.41	1.67	3.28	0.45	5.96	4.99	2.51	6.84	1.20	4.07	2.84	5.37	0.71
62	D2 height	3.98	2.99	1.23	4.34	0.92	2.21	1.55	3.05	0.35	6.38	4.77	1.85	6.68	1.42	3.74	2.78	5.00	0.56
63	Caudal-fin height	1.03	0.87	0.40	1.36	0.28	0.72	0.27	1.23	0.23	1.65	1.40	0.60	2.10	0.44	1.22	0.48	2.09	0.39
64	D1 origin to caudal-fin tip	14.58	14.00	9.86	15.88	1.59	13.43	10.98	14.99	1.02	23.38	22.33	16.24	25.90	2.52	22.80	18.63	26.12	2.03
65	D2 origin to caudal-fin tip	8.75	7.99	4.99	9.67	1.36	7.34	5.76	8.52	0.88	14.04	12.74	8.52	15.44	2.19	12.45	9.77	14.53	1.61
66	Interdorsal distance	0.98	1.08	0.50	2.00	0.56	0.84	0.49	1.19	0.49	1.58	1.71	0.84	3.31	0.91	1.44	0.85	2.02	0.83
67	Clasper (post-cloacal length)	24.58	24.23	18.06	27.75	2.11	NA	NA	NA	NA	39.42	38.68	28.55	45.88	3.42	NA	NA	NA	NA
68	Cloaca to pelvic-clasper insertion	5.85	6.33	5.22	7.03	0.38	NA	NA	NA	NA	9.38	10.11	8.04	11.05	0.73	NA	NA	NA	NA

D1: first dorsal-fin, D2: second dorsal-fin, TL: total length, DW: disc width, SD: standard deviation, NA: Not applicable

Table 3. Meristic data for Neotype, and male and female voucher specimens of *Psammobatis scobina*, and Mann-Whitney U Test by sex. Values in bold are significant at *P* < 0.05 / Datos merísticos de Neotipo y ejemplares machos y hembras de *Psammobatis scobina*, y Prueba U de Mann-Whitney por sexo. Los valores en negrita son significativos a *P* < 0,05

	Measurements	Males					Females				U	Z	*P*-level
		Neotype	Mean	Min	Max	SD	Mean	Min	Max	SD			
1	Teeth rows (upper jaw)	41	41	40	42	1	41	38	43	1	148.5000	-0.05000	0.960122
2	Teeth rows (lower jaw)	39	39	38	40	1	39	36	40	1	135.0000	-0.50000	0.617075
3	Teeth series (upper jaw)	7	7	6	8	1	6	6	7	1	100.5000	-1.65000	0.098944
4	Teeth series (lower jaw)	7	7	6	8	0	7	6	7	0	117.5000	-1.08333	0.278661
5	Orbital thorns (right)	6	7	4	10	2	6	2	8	2	134.5000	-0.51667	0.605389
	a) Pre-orbit thorns	2	2	1	3	1	1	1	2	1	**75.0000**	**-2.50000**	**0.012420**
	b) Mid-orbit thorns	2	2	1	4	1	3	1	5	1	96.0000	1.25269	0.210320
	c) Post-orbit thorns	1	1	1	3	1	1	1	2	1	139.5000	0.10405	0.917127
	d) Espiracular thorns	1	1	1	2	0	1	1	1	0	123.5000	-0.23948	0.810730
6	Orbital thorns (left)	5	7	2	9	2	5	2	10	2	**77.5000**	**-2.41667**	**0.015664**
	a) Pre-orbit thorns	1	2	1	3	1	1	1	3	1	**58.5000**	**-2.85191**	**0.004346**
	b) Mid-orbit thorns	2	2	0	4	1	2	1	4	1	126.0000	-0.14738	0.882836
	c) Post-orbit thorns	1	1	0	3	1	1	1	2	1	138.0000	-0.06999	0.944205
	d) Espiracular thorns	1	1	1	2	0	1	1	1	0	117.0000	-0.47897	0.631961
7	Nucal thorns	6	5	3	6	1	4	3	7	1	108.5000	-1.38333	0.166564
8	Scapular thorns (right)	2	2	1	4	1	2	1	3	1	121.0000	0.43711	0.662031
9	Scapular thorns (left)	1	2	1	5	1	2	1	3	1	103.0000	1.09278	0.274492
10	Dorsolateral thorns (right)	19	18	5	34	7	19	2	36	9	145.0000	-0.16667	0.867632
11	Dorsolateral thorns (left)	21	18	3	32	8	20	6	38	10	141.5000	0.28333	0.776922
12	Caudolateral thorns (right)	35	32	17	52	10	38	20	53	9	99.0000	1.70000	0.089132
13	Caudocentral thorns	42	38	25	57	7	37	24	50	8	137.0000	-0.43333	0.664773
14	Caudolateral thorns (left)	32	31	18	50	9	35	20	53	8	96.0000	1.80000	0.071862
15	Alar thorns (right)	188	79	23	188	38	NA	NA	NA	NA	NA	NA	NA
16	Alar thorns (left)	187	78	26	187	36	NA	NA	NA	NA	NA	NA	NA
17	Posterior pectoral fin thorns (right)	41	NA	NA	NA	NA	15	6	27	8	NA	NA	NA
18	Posterior pectoral fin thorns (left)	39	NA	NA	NA	NA	13	5	21	7	NA	NA	NA

NA: Not applicable

Table 4. Variable loads for the first three principal component axes in the principal component analysis for morphometric measurements of specimens. The highest loadings are indicated in bold / Cargas variables para los tres primeros ejes de componentes principales en el análisis de componentes principales para mediciones morfométricas de los ejemplares. Las cargas más altas se indican en negrita

Morphometric measurements	Principal Component Analysis		
	PC1	PC2	PC3
Disc length (direct)	0.27	0.39	0.02
Snout to maximum disc width	0.19	**0.45**	**-0.71**
Snout length (pre-orbital direct)	0.04	0.30	0.16
Orbit diameter	0.09	-0.07	-0.05
Orbit and spiracle length	0.04	-0.04	-0.05
Spiracle length	-0.02	0.05	-0.01
Distance between orbits	-0.01	0.05	0.02
Distance between spiracles	0.06	-0.03	-0.01
Snout to cloaca (first hemal spine)	0.34	0.21	0.02
Cloaca to caudal-fin origin	**0.55**	-0.31	0.02
Ventral snout length (preoral)	0.16	0.16	0.02
Pre-nasal length	0.07	0.05	-0.07
Mouth width	-0.15	0.22	0.24
Distance between nostrils	0.07	0.09	-0.22
Nasal curtain length	0.01	0.02	0.01
Width of first gill slits	-0.03	0.07	0.04
Width of third gill slits	-0.05	0.06	0.07
Width of fifth gill slits	-0.03	0.08	0.08
Distance between first gill slits	-0.01	0.22	0.12
Distance between fifth gill slits	0.11	0.04	-0.06
Length of anterior pelvic lobe	0.04	0.17	0.11
Length of posterior pelvic lobe	0.05	0.35	0.39
Tail length (cloaca to caudal–fin tip)	**0.40**	0.08	**0.41**
Caudal length at D1 (pelvic axil)	**0.46**	-0.31	0.00
Tail at axil of pelvic fins (width)	0.08	-0.05	-0.06

D1: first dorsal-fin

RESULTS

Family Arhynchobatidae

Psammobatis Günther, 1870

Type species: *Psammobatis rudis* Günther, 1870

Synonyms: *Malacorhina* Garman, 1877.

Psammobatis scobina (Philippi, 1857)

Raspthorn sandskate, Raya pequén

Type locality: Valparaíso. (Figs. 2-5, Tables 1-3)

Synonyms: *Raja scobina* Philippi, 1857, *Uraptera scobina* Dumeril, 1865; *Raja* (*Malacorhina*) *mira* Garman, 1877; *Raja philippii* Delfin, 1902.

Neotype. Mature male MNHNCL ICT 7624, 41.6 cm TL, collected with a gillnet in Valparaíso Bay, central Chile, southeastern Pacific Ocean (33°0’36.91’’S; 71°33’25.99’’W; approx. 40 m) on November 8th, 2016 by Pamela Fuentes (Figs. 2A-B and 4C).

DESCRIPTION OF NEOTYPE AND EXAMINED VOUCHER SPECIMENS

Morphometric (as %TL and %DW) and meristic data (Table 2, Table 3, respectively) are presented separately for the Neotype, males and females. Even though there is overlap in all morphometric measurements between males and females (Table 2), some measurements differed between sexes among specimens of similar sizes (Fig. 6). In the following description, values are presented as follows: Neotype measurements followed by [mean (range)] of all voucher specimens; males and females will be showed separately only when there is a dimorphic character.

A relatively small softnose skate. Dorsal surface brownish, with multiple dark brownish small spots; ventral surface white, in fresh specimens’ edge of disc brown (Figs. 2 and 3). Disc three-lobed in mature males (Fig. 2), more rounded in juveniles and females (Fig. 3), 1.2 [1.2 (1.1-1.3)] times as broad as long, being wider in males than females at similar sizes (Fig. 6A), disc width 3.5 [3.7 (3.2-4.3)] times distance between first gill slits. Anterior margin of disc more undulated in adult males than in adult females, convex anterior to orbits, concave posterior to spiracles (Figs. 2 and 3); pectoral fins rounded at laterals. Head rounded; snout short and flexible, tip of snout with fleshy process, lacking rostral node, rostral appendix and rostral shaft, area flanking slightly translucent, more visible in fresh than fixed specimens (Fig. 4); pre-orbital snout length, 2.5 [2.5 (1.7-3.6)] times orbit length, 2.6 [2.4 (1.7-3.0)] times distance between orbits, 1.7 [1.7 (1.2-2.4)] times orbital and spiracle length, 1.2 [1.0 (0.8-1.2)] times pre-oral snout length; orbital and spiracle length 1.8 [2.1 (1.6-2.7)] times spiracle length; snout to spiracle length 4.7 [5.6 (4.4-7.1)] times spiracle length; orbit small compared to TL (Figs. 2A, 3A, 4A-B), length 1.1 [1.0 (0.7-1.4)] times distance between orbits, and 1.3 [1.4 (0.9-1.9)] times spiracle length; distance between orbits 0.7 [0.7 (0.5-0.8)] times distance between spiracles; spiracle oval, small (Figs. 2A, 3A, 4A-B), length 0.6 [0.5 (0.4-0.6)] times distance between spiracles. Prenasal length 1.2 [1.0 (0.9-1.2)] distance between fifth gill slits; preoral snout length 1.3 [1.4 (1.1-2.0)] times distance between nostrils. Preoral length is larger in females than males for similar size (Fig. 6C). Nostrils semi-circular; anterior nasal flaps expanded, overlapping nostril (Fig. 4C-D); posterior lobes of nostrils forming well developed nasal curtain, produced slightly postero-laterally, slightly concave external margins, with fringed posterior margins, shorter in females (Fig. 4D) than in males (Fig. 4C), reaching lower jaw in males and upper jaw in females; mouth weakly arched with numerous rows of small teeth (Fig. 4C-D), mouth width 0.8 [0.7 (0.5-1.0)] times nasal curtain; distance between first gill slits 2.4 [2.2 (1.8-2.8)] times distance between nostrils, 2.4 [2.0 (1.7-2.4)] times distance between fifth gill slits, and 2.5 [2.9 (2.0-3.9)] times mouth width; distance between fifth gill slits 1.0 [1.1 (0.9-1.4)] times distance between nostrils, and 1.0 [1.5 (0.9-2.2)] times mouth width. The distance between

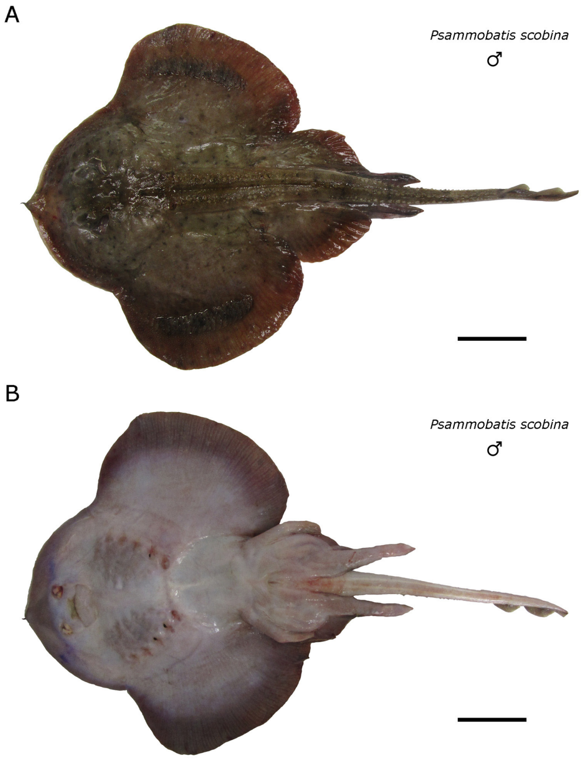

Figure 2. *Psammobatis scobina*. Adult male, Neotype (MNHNCL ICT 7624). A) Dorsal view, B) Ventral view. Scale bar: 5 cm. Photos by P. Fuentes-Fuentes / *Psammobatis scobina*. Macho adulto, Neotipo (MNHNCL ICT 7624). A) Vista dorsal, B) Vista ventral. Barra de escala: 5 cm. Fotos de P. Fuentes-Fuentes

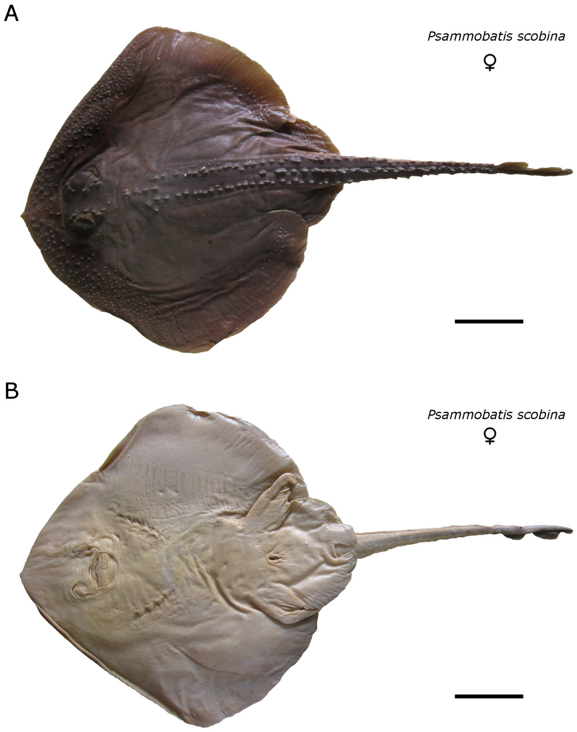

Figure 3. *Psammobatis scobina*. Adult female, voucher (MNHNCL ICT 7558). A) Dorsal view, B) Ventral view. Scale bar: 5 cm. Photos by P. Fuentes-Fuentes / *Psammobatis scobina*. Hembra adulta, ejemplar (MNHNCL ICT 7558). A) Vista dorsal, B) Vista ventral. Barra de escala: 5 cm. Fotos de P. Fuentes-Fuentes

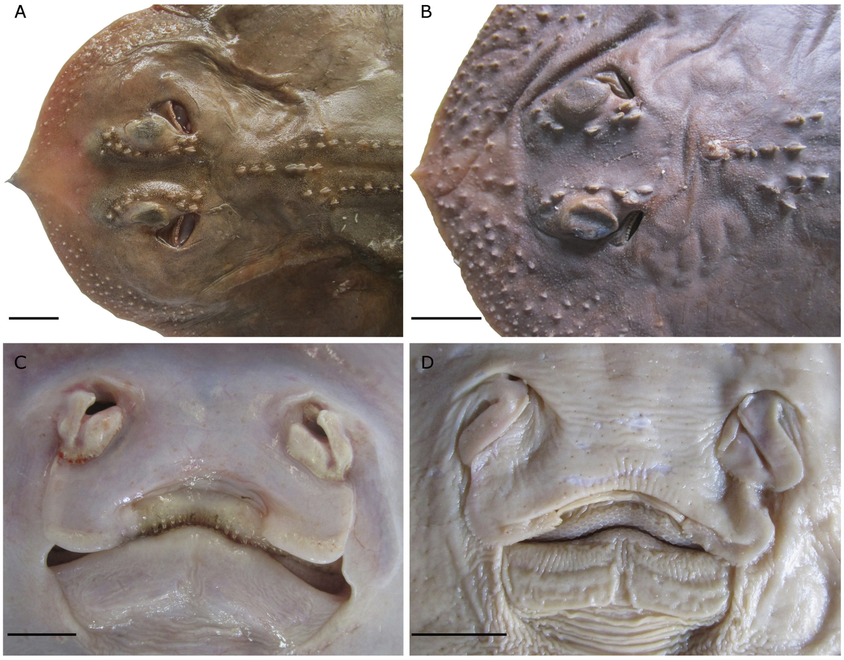

Figure 4. Adult specimens of *Psammobatis scobina*. A) Dorsal view of head of male voucher (Ray 4), B) Dorsal view of head of female voucher (MNHNCL ICT 7558), C) Ventral view of oronasal area of male Neotype (MNHNCL ICT 7624), D) Ventral view of oronasal area of female voucher (MNHNCL ICT 7558). Scale bar: A-B= 2 cm and C-D= 1 cm. Photos by P. Fuentes-Fuentes / Ejemplares adultos de *Psammobatis scobina*. A) Vista dorsal de la cabeza del ejemplar macho (Raya 4), B) Vista dorsal de la cabeza del ejemplar hembra (MNHNCL ICT 7558), C) Vista ventral del área oronasal del Neotipo macho (MNHNCL ICT 7624), D) Vista ventral del área oronasal del ejemplar hembra (MNHNCL ICT 7558). Barra de escala: A-B= 2 cm y C-D= 1 cm. Fotos de P. Fuentes-Fuentes

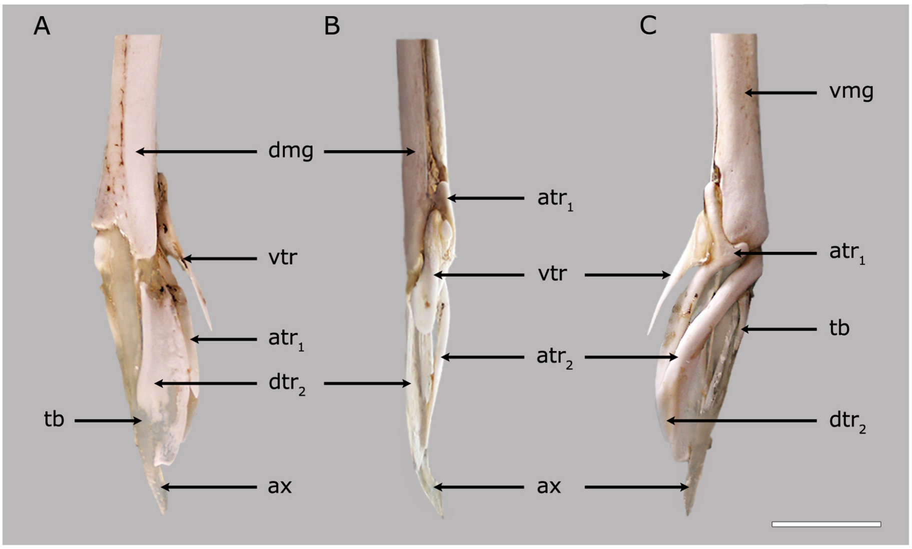

Figure 5. Clasper of *Psammobatis scobina*. A) Dorsal view, B) Lateral view, C) Ventral view. atr$_1$: accessory terminal 1, atr$_2$: accessory terminal 2, ax: axial, dmg: dorsal marginal, dtr$_1$: dorsal terminal 1, dtr$_2$: dorsal terminal 2, tb: terminal bridge, vmg: ventral marginal, vtr: ventral terminal. Scale bar: 1 cm. Photos by F. Concha / Clásper de *Psammobatis scobina*. A) Vista dorsal, B) Vista lateral, C) Vista ventral. atr$_1$: terminal accesorio 1, atr$_2$: terminal accesorio 2, ax: axial, dmg: marginal dorsal, dtr$_1$: terminal dorsal 1, dtr$_2$: terminal dorsal 2, tb: puente terminal, vmg: marginal ventral, vtr: terminal ventral. Barra de escala: 1 cm. Fotos de F. Concha

fifth gill slits is larger in females than in males for specimens of the same size (Fig. 6D); width of first gill slits is greater than width of third gill slits in males, and less in females; width of first gill slits 0.4 [0.4 (0.3-0.5)] times mouth width, 1.5 [1.5 (1.0-1.8)] times width of fifth gill slits. Pelvic fins medium sized, deeply incised to form two lobes (Figs. 2 and 3); anterior lobe relatively short, slender, bluntly pointed distally, 0.6 [0.6 (0.5-0.7)] times length of posterior lobe; posterior margin of distal pelvic lobe moderately elongate in males (Fig. 2), rounded in females (Fig. 3). Posterior pelvic fin lobe is longer in males than in females for specimens of the same size (Fig. 6B). Claspers elongate, lacking dermal denticles, with pointy tip; internal components were accessory terminal 1, accessory terminal 2, axial, dorsal marginal, dorsal terminal 2, terminal bridge, ventral marginal and ventral terminal cartilage (Figs. 2 and 5). Tail slender, moderately depressed, tapering toward tip, with narrow longitudinal folds, with two terminal dorsal fins and one caudal fin (Figs. 2 and 3), length from rear of cloaca to tail tip 1.1 [1.1 (1.0-1.2)] times distance from tip of snout to rear of cloaca (first hemal spine), narrowing posteriorly, width at pelvic fin insertion 1.6 [1.8 (1.4-2.2)] times height, 1.8 [2.0 (1.7-2.8)] times width at mid-length, 2.6 [3.1 (2.1-4.3)] times width at first dorsal fin origin, 2.8 [4.1 (2.8-6.3)] times width at the second dorsal fin origin, 8.8 [10.2 (5.9-17.8)] times width at caudal fin origin, width at distal margin of pelvic fin 2.0 [1.8 (1.3-2.3)] times height, width at mid-length 1.7 [1.6 (1.2-2.1)] times height, width at first dorsal fin origin 1.3 [1.4 (1.1-2.2)] times height, width at second dorsal fin origin 1.7 [1.4 (1.0-2.1)] times height, width at caudal fin origin 1.0 [1.3 (0.8-2.5)] times height; lateral tail fold narrow, relatively long, originating as a low membranous ridge beside or slightly posterior to pelvic insertion, extending sub-terminally to tail tip, not obviously broader at any point along its length. Distance between cloaca and second dorsal fin larger in males than in females for specimens of the same size (Fig. 6E). Dorsal fins sub-equal in size, similar in shape, elongated fins (Figs. 2 and 3); first dorsal fin long, slightly taller and more upright than second, first dorsal fin base length 1.3 [2.2 (1.3-3.6)] times height, 1.0 [1.1 (0.8-1.7)] times second dorsal fin base length, 2.1 [3.4 (1.7-11.2)] times caudal fin length, first dorsal fin height 0.9 [1.1 (0.7-1.6)] times second dorsal fin height, 3.6 [3.8 (1.9-9.3)] times caudal fin height; second dorsal fin base length 1.2 [2.1 (1.2-3.6)] times height, 2.1 [3.0 (1.2-11.2)] times caudal fin length, second dorsal fin height 3.9 [3.6 (1.7-7.8)] times caudal fin height; caudal fin small to rudimentary (Figs. 2 and 3), base length 2.2 [2.8 (0.8-7.8)] times height; inter-dorsal space moderate or absent; rear tip of first dorsal fin overlapping base of second (Figs. 2 and 3), 0.20 [0.19 (0.07-0.38)] times first dorsal fin base length, and 0.20 [0.19 (0.09-0.37)] times second dorsal fin base length.

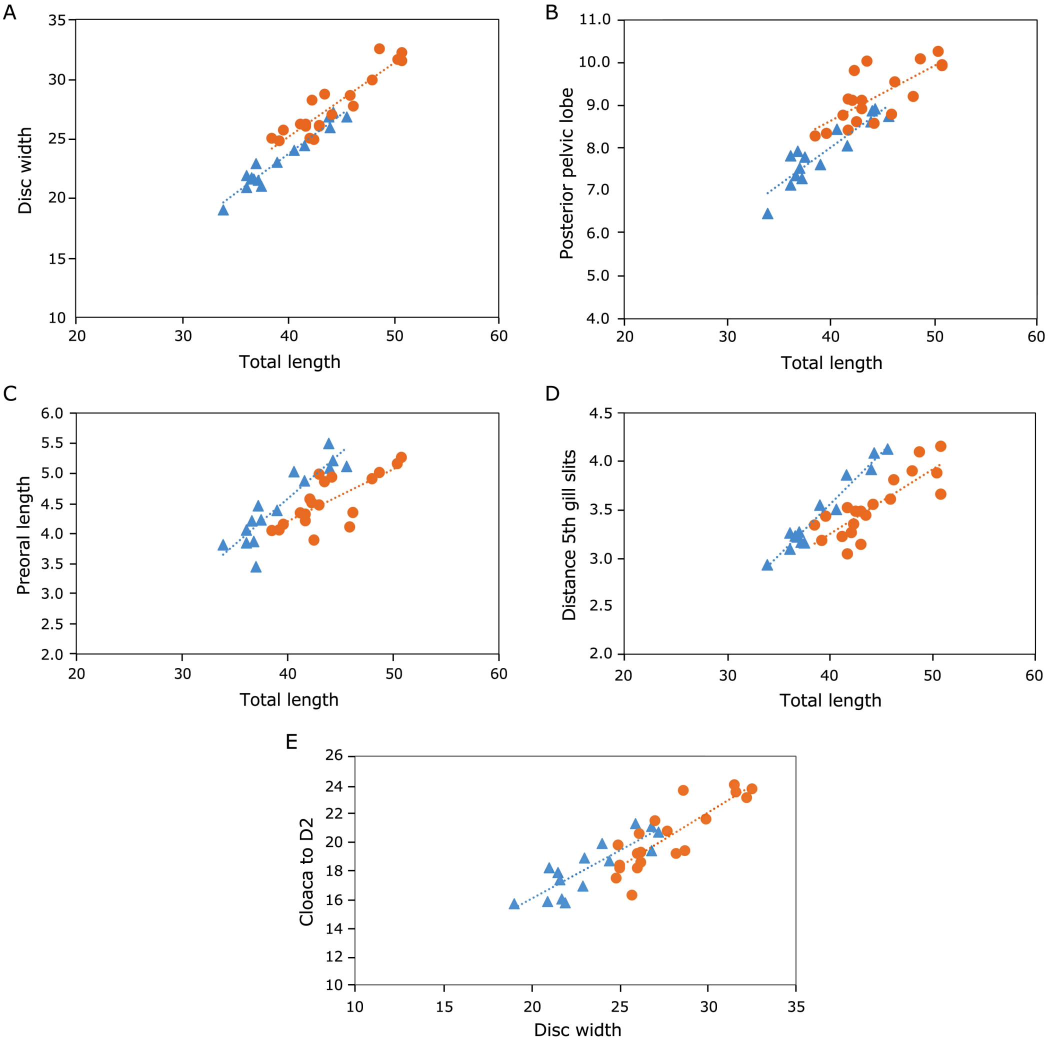

Figure 6. Direct relation between measurements of males (dots) and females (triangles) specimens of *Psammobatis scobina*. A) Total length and disc width, B) Total length and posterior pelvic lobe, C) Total length and preoral length, D) Total length and distance between fifth gill slits, E) Disc width and distance cloaca to second dorsal fin (D2). All measurements are given in cm / Relación directa entre las mediciones de machos (puntos) y hembras (triángulos) de los especímenes de *Psammobatis scobina*. A) Longitud total y ancho del disco, B) Longitud total y lóbulo posterior de la aleta pélvica, C) Longitud total y longitud preoral, D) Longitud total y distancia entre las quintas hendiduras branquiales, E) Ancho de disco y distancia de la cloaca a la segunda aleta dorsal (D2). Todas las medidas están dadas en cm

Teeth blunt in juveniles and females (Fig. 4D), pointed in mature males (Fig. 4C); teeth series parallel in males, in quincunx in females; the Mann-Whitney U Test showed no differences in the number of tooth rows (both in upper and lower jaws), and number of tooth series (both in upper and lower jaws) between males and females (Table 3). Orbital thorns similar in size in males and females, with round or oval base (Fig. 4, Table 3); alar thorns present only in males, medially-posteriorly directed, with sharp tips (Fig. 2A, Table 3); patch of thornlets on posterior angle of pectoral fin in females small in size, posteriorly directed, shorter than alar thorns (Fig. 3A, Table 3); nuchal thorns and scapular thorns relatively similar in number and size, with rounded or oval base (Fig. 4A-B; Table 3); lateral-dorsal thorns sharp, extending posteriorly, before the tail (Figs. 2A and 3A; Table 3); caudal thorns forming 3-5 rows, sharp, with oval bases, posteriorly directed, extending in linear series, beginning posteriorly to pelvic girdle, extending to first dorsal fin; lateral-caudal thorns extend to second dorsal fin (Figs. 2A and 3A; Table 3); dermal denticles on dorsal surface, covering inter-orbital and inter-spiracular spaces, and area behind spiracles, absent on pectoral fins, flanking central-caudal thorns, absent on ventral surface; forming dense patch on rostrum, forming narrow band along antero-lateral margin of disc, beginning anteriorly on snout, reaching approximately the line of spiracles (Fig. 4, Table 3). Most meristic data related to spinulation showed no differences between males and females (Table 3). However, statistical differences in the mean number of orbital thorns between sexes were observed (Table 3), having males more orbital thorns than females (Fig. 7).

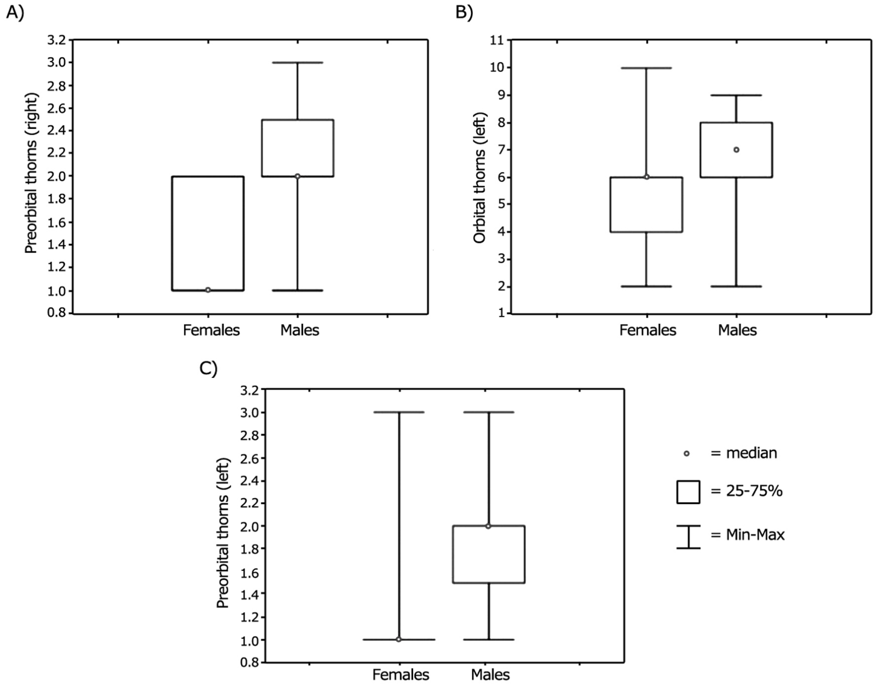

Figure 7. Box plot of meristic data of *Psammobatis scobina* by sex. A) Number of preorbital thorns (right side), B) Number of orbital thorns (left side), C) Number of preorbital thorns (left side) / Diagrama de cajas de datos merísticos de *Psammobatis scobina* por sexo. A) Número de aguijones preorbitales (lado derecho), B) Número de aguijones orbitales (lado izquierdo), C) Número de aguijones preorbitales (lado izquierdo)

In the examined male, pectoral radials 70, propterygial radials 36, mesopterygial radials 8, metapterygial radials 26; pelvic-fin radials 22; trunk vertebrae 20, pre-dorsal caudal vertebrae 64, vertebrae between origins of dorsal fins 12, total vertebrae about 96. In the examined female, pectoral radials 74, propterygial radials 38, mesopterygial radials 10, metapterygial redials 26; pelvic-fin radials 23; trunk vertebrae 20, pre-dorsal caudal vertebrae 64, vertebrae between origins of dorsal fins 12, total vertebrae about 96.

SEXUAL DIMORPHISM IN MORPHOMETRY

The PCA based on percentage DW produced 25 PCs and the first three principal components explained 76.1% of the variance of the morphometric data (50.4, 17.2, and 8.5). Correlations between variables and components >0.4 were considered for this study (Table 4). PCA allowed differentiation along the PC1 between males and females, with partial overlap (Fig. 8). Most females were located over I and IV quadrants when analyzing the three PC (Fig. 8) and showed higher loadings for the variables: Cloaca to caudal-fin origin, caudal length at D1 (pelvic insertion) and tail length (cloaca to caudal-fin tip) (Table 4). Most males were located over II and III quadrants when analyzing the three PC (Fig. 8) and showed lower loadings for the variables that characterized females. The global test of ANOSIM (R: 0.374; *P*: 0.1%) indicated statistical differences in morphometrics between males and females, this was also observed in the cluster analysis, in which most males and females were grouped in two different clusters (Fig. 9).

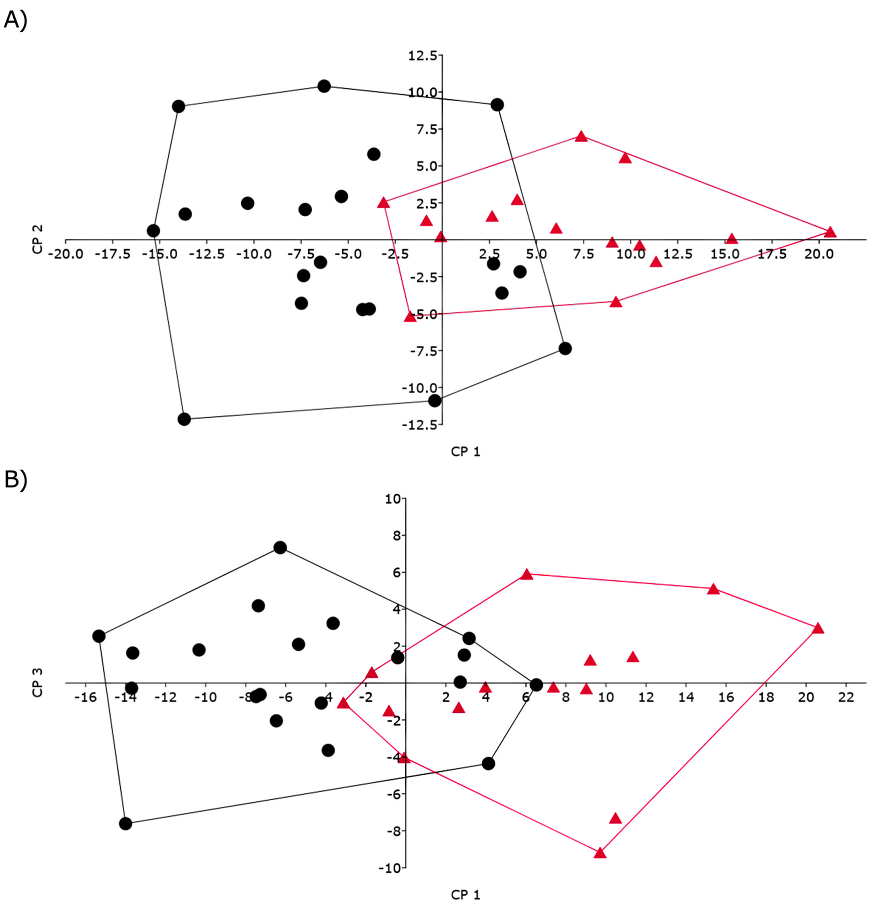

Figure 8. Principal components analyses based on morphometric data between males (dots) and females (triangles) of *Psammobatis scobina*. A) First principal component (PC1) *vs.* second principal component (PC2), B) First principal component (PC1) *vs.* third principal component (PC3) / Análisis de componentes principales basado en datos morfométricos entre machos (puntos) y hembras (triángulos) de *Psammobatis scobina*. A) Primer componente principal (PC1) *vs.* segundo componente principal (PC2), B) Primer componente principal (PC1) *vs.* tercer componente principal (PC3)

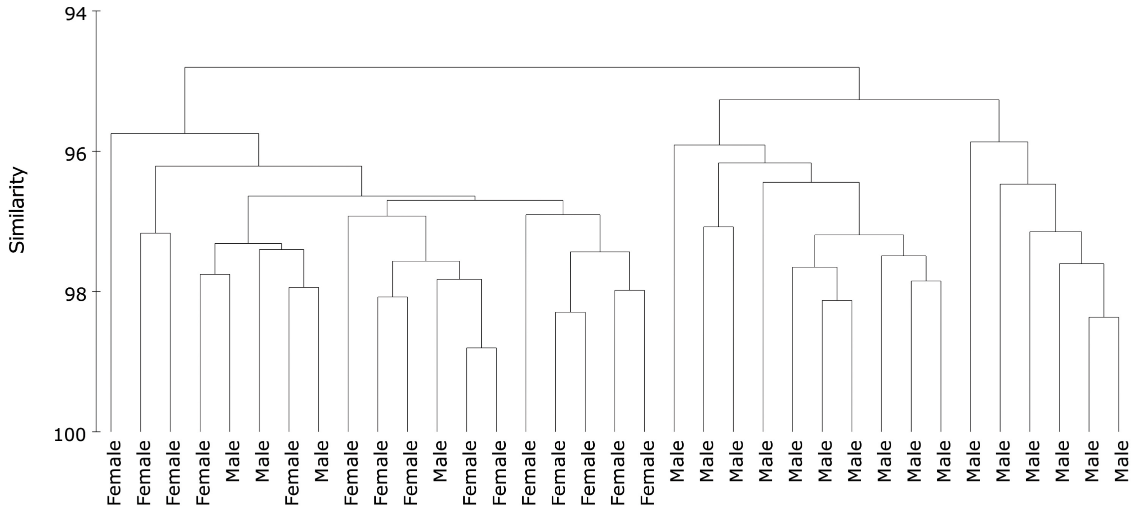

Figure 9. Cluster based on morphometric data between males and females of *Psammobatis scobina* / Agrupación basada en datos morfométricos entre machos y hembras de *Psammobatis scobina*

DISCUSSION

After almost 170 years of being erected, and due to the remarkably external morphological similarity between some of its members, identification within *Psammobatis* is still challenging for the scientific community. The lack of type specimens and the brief original description have contributed to the need of taxonomic clarification of *P. scobina*. Thus, according to Chapter 16, Article 75 of the International Code of Zoological Nomenclature (ICZN)[2], a Neotype for this species from its type locality needs to be designated. In addition, morphometric and meristic variability between males and females of *P. scobina* was assessed.

The Raspthorn sandskate, *Psammobatis scobina*, has been reported by different authors as inhabiting the SWA. These records are derived from the work of Evermann & Kendall (1907). These authors provided the first mention of *P. scobina* in the Atlantic, but stated that they could not identify their specimen as either *P. rudis* Günther, 1870 or *P. scobina* (Philippi, 1857). Therefore, they decided to use the name *P. scobina* because it was the older of the two names and because earlier authors suggested that the two species might be synonymous. Subsequently, Norman (1937) also listed *P. scobina* in Patagonian waters and cited the work of Evermann & Kendall (1907), placing *P. rudis* as a synonym of *P. scobina*, which was also followed by Menni *et al.* (1984). However, the latter work was already in press before McEachran (1983) was published. In light of McEachran's work and based on the spinulation pattern provided by Evermann & Kendall (1905), the specimens cited as *P. scobina* correspond to *P. rudis*, while those cited by Norman (1937) and Menni *et al.* (1984) correspond to *P. rudis* and *P. normani*.

After McEachran (1983), several authors continued to consider the presence of *P. scobina* in Atlantic waters (Lloris & Rucabado 1991, Pequeño & Lamilla 1993, Agnew *et al.* 2000, Nión *et al.* 2016, Last *et al.* 2016, Weigmann 2016, Dulvy *et al.* 2020). However, those reports were mostly based on previous reports and lacked images or voucher specimens, and thus, have been subsequently questioned by others (see Mabragaña 2007). Similarly, several authors did not included *P. scobina* within the skate fauna of the SWA (Cousseau *et al.* 2000, 2007, 2020; Menni & Stehmann 2000, Figueroa 2011, Arkhipkin *et al.* 2012, Bovcon *et al*. 2013, Mabragaña *et al.* 2020, Sabadin *et al.* 2020). McEachran (1983) remarked the great external similarity between *P scobina* and *P. normani*. Indeed, this had led Norman (1937) to report *P. scobina* in Patagonian waters, without questioning if specimens from SWA were different from those of SEP. Fifty years later, McEachran (1983) revealed that some specimens in Norman (1937) from the SWA waters, were in fact a new species, and described *P. normani*.

Despite their external similarity, McEachran (1983) remarked that *P. scobina* and *P. normani* can be identified by both their morphometry, and skeletal structures (clasper, neurocranium and scapulocoracoid). However, based on the intraspecific variability observed in several species of *Sympterygia* and *Psammobatis*, the utility of the scapulocoracoid as a diagnostic feature, has been questioned in these genera (Jurado *et al.* 2017, Mabragaña *et al.* 2020). Regarding these diagnostic morphometrics, our results show some differences with respect to those obtained by McEachran (1983). For instance, according to McEachran (1983), the prenasal length is less than the distance between fifth gill slits in *P. scobina*, whereas this distance is equal in *P. normani*. In this study, this feature was observed only in 7% of the examined specimens. The orbital diameter in relation to spiracular length was also pointed out by McEachran (1983) to distinguish *P. scobina* (1.1 to 1.5) from *P. normani* (1.5 to 2.2). However, we observed that this relationship could reach up to 1.9 in *P. scobina*, suggesting that this is not useful as a diagnostic feature. Additionally, differences were also observed regarding the mouth width in percent of TL reported by McEachran (1983) (*i.e.*, 8.8% of TL). In the present study, mean values for mouth width were 6.7 and 4.8% of TL, for males and females, respectively.

Even though sexual dimorphism in skates have been well documented, most of these studies has focused on the differences in tooth shape (Feduccia & Slaughter 1974, Hermann *et al.* 1994, 1995, 1996; Sáez & Lamilla 2004), size at maturity and maximum size (Walmsley-Hart *et al.* 1999, Braccini & Chiaramonte 2002, Mabragaña & Cousseau 2004, Ebert 2005), and length-weigh relationships (Mabragaña *et al.* 2002). There is little information on morphometric variability between sexes in skates (Leible 1988, Braccini & Chiaramonte 2002, Castillo-Geniz *et al.* 2007, Mabragaña 2007). In the present paper, we analyzed, for the first time, morphometric variability between sexes in *P. scobina*. Even though females and males overlapped in most proportional measurements, the PCA and cluster analyses allowed the identification of most of the specimens by sex. The most influential variables were related to tail length. This sexual differentiation was also supported by the ANOSIM test. Tail length was also one of the variables that best discriminated between sexes in *P. extenta* (Braccini & Chiaramonte 2002) and *Sympterygia acuta* (Orlando 2014). On the other hand, some of the morphometrics differed between sexes among specimens of similar sizes. Males showed widest disc and longer posterior pelvic lobe than females. The latter feature was also observed in mature males of *S. acuta* (Orlando 2014). Females showed higher preoral length, distance between 5th gill openings and tail length. The clasper examined here was slightly different to that shown by McEachran (1983). In our specimens, dorsal terminal 1 was not observed, this would indicate that a more exhaustive and integral analysis should be carried out with new tools and including more species.

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[2] <https://www.iczn.org/the-code/the-code-online/>

There are several unresolved issues regarding the taxonomy of this problematic genus. Especially when dealing with the sympatric and most similar species, *P. scobina* and *P. normani*. Even though skeletal structures (McEachran 1983) and egg cases (Concha *et al.* 2009, Mabragaña *et al.* 2011) clearly allow identification of both species, a comparative morphometric analysis, based on recent standardized methodology (Last *et al.* 2008), in addition to a molecular analysis is a pending task. In this sense, the designation of a Neotype, for comparative purposes, constitutes the first necessary step.

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