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Diversity of genus *Phromachocrinus* Carpenter, 1879 of the National Invertebrates collection, *Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"*

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Abstract: Professor Irene Bernasconi was a pioneer in Antarctic crinoid research in Argentina, with her work on *Promachocrinus kerguelensis* published in 1932. This study review *Promachocrinus* material housed in the collection of the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" (MACN-In), including specimens collected by Carcelles in 1929. Through an analysis of new samples from Antarctic expeditions and a review of historical material, three species within the genus were identified: *P. kerguelensis*, *P. fragarius*, and *P. joubini*. These studies update the understanding of genus diversity, previously considered a single circum-Antarctic species, and underscore the importance of integrating molecular and morphological methods for identifying cryptic species. This advancement emphasizes the need to reassess historical biodiversity records and highlights the significance of pioneering researchers such as Bernasconi.

Key words: Bernasconi, crinoids, Antarctic, lots, cryptic species

Resumen: Diversidad del género *Phromachocrinus* Carpenter, 1879 de la Colección Nacional de Invertebrados, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia". La Profesora Irene Bernasconi fue pionera en la investigación de crinoideos antárticos en Argentina, con su trabajo publicado en 1932 sobre *Promachocrinus kerguelensis*. Este estudio se centra en la revisión y actualización del material de *Promachocrinus* de la colección de invertebrados del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" (MACN-In), que incluye especímenes recolectados por Carcelles en 1929. A través de un análisis de muestras actuales de campañas antárticas y la revisión de material histórico, se identificaron tres especies dentro del género: *P. kerguelensis*, *P. fragarius* y *P. joubini*. Estos estudio actualizan el conocimiento sobre la diversidad del género, previamente considerado como una sola especie circunantártica, y destaca la importancia de la combinación de métodos moleculares y morfológicos en la identificación de especies cripticas. Este avance refuerza la necesidad de reevaluar los registros históricos de biodiversidad y subraya la relevancia de las contribuciones de investigadores pioneros como Bernasconi.

Palabras clave: Bernasconi, crinoideo, Antarctic, lotes, especies crípticas

INTRODUCTION

Professor Irene Bernasconi pioneered crinoid research in Argentina, dedicating her work to the *Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"* (MACN). Bernasconi (1934) published an article on echinoderms from the Argentine seas, where she mentioned the Antarctic crinoid *Promachocrinus kerguelensis*. However, it was in 1932 that she published her first and only study focused on this crinoid from South Georgia. The material was collected by A. Carcelles in 1929 and deposited in the MACN Invertebrate collection (MACN-In 18707, MACN-In 18708).

The genus *Promachocrinus* was established by Carpenter (1879), with *P. kerguelensis* as type species, collected during the Challenger expedition (1872–1876). For many years, it was considered a single circum-Antarctic species. However, through molecular and morphological analyses, McLaughlin *et al.* (2023) have revealed a more complex scenario, that corroborates the existence of multiple cryptic species within the genus (Wilson *et al.*, 2007; Hemery *et al.*, 2012; 2013; Eléaume *et al.*, 2014), identifying eight dis-

tinct species. In light of this, the present study provides a review of the genus *Promachocrinus* in the MACN-In, encompassing the material studied by Bernasconi and new material from Antarctic expeditions.

MATERIAL AND METHODS

We studied samples of *Phromachocrinus* Carpenter, 1879 from the Invertebrate Collection of the *Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"* (MACN-In) and samples collected during the Antarctic Summer Campaigns (CAV), from 67 to 454 meters depth. The campaigns took place around the Antarctic Peninsula, South Shetland Islands, and South Orkney Islands. Based on diagnostic characters, species descriptions and following the work of McLaughlin *et al*. (2023), the material was identified, and added to the MACN collection. For the specimens already identified as *P. kerguelensis*, we apply the same protocol, in order to revise their identity. A table was provided with each catalog number, coordinates or geographic areas, depth, and specimen identification (Table 1). The location of each specimen was represented on a map (Fig. 1). Maps were created using QGIS v3.8 Zanzibar software.

RESULTS

Promachocrinus kerguelensis Carpenter, 1879

Catalog numbers: MACN-In 18707, MACN-In 18708, MACN-In 27711, MACN-In 35320, MACN-In 44588, MACN-In 44589, MACN-In 44590, MACN-In 44597, MACN-In 44603 (Fig. 1).
Diagnosis (after McLaughlin *et al.,* 2023): Radials 10. Arms 20, with dark pigmented spots, 1–2 mm in diameter scattered along arms, sometimes lacking. Centrodorsal rounded to rounded conical. Cirral sockets rounded, extend to ~1 mm from aboral pole. Cirri up to 4 cm long with 40 cirrals. Proximal and distal three cirrals have length half that of width, other cirrals often reasonably uniform, usually only as long as wide, sometimes two or three times the width; penultimate cirral with small opposing spine, terminal claw tends to be hooked.
Distribution: Antarctica, recorded in the Antarctic Peninsula, Scotia Arc, Ross Sea, Weddell Sea, and Davis Sea.
Depth: 103–926 m
Remarks: The specimens MACN-In 18707 and MACN-In 18708, studied by Irene Bernasconi (1932), were re-examined and their identification was confirmed.

Promachocrinus fragarius McLaughlin, Wilson & Rouse, 2023

Catalog numbers: MACN-In 26884, MACN-In 35320/1, MACN-In 35321, MACN-In 35322/1, MACN-In 35324, MACN-In 35325/1, MACN-In 44595, MACN-In 44598, MACN-In 44599, MACN-In 44600, MACN-In 445602 (Fig. 1).
Diagnosis (after McLaughlin *et al.,* 2023): Radials 10. Arms 20. Centrodorsal shape rounded–conical, slightly increases in width before curving back to rounded tip, strawberry-like. Cirral sockets mostly in columns, taller than wide, covering centrodorsal to aboral pole, occasionally aboral pole tip bare. Pinnules may have pigmentation, purplish, extending to corresponding brachials. Cirri pigmentation paler if present.
Distribution: Antarctica, western Antarctic Peninsula, Scotia Arc, Amundsen Sea, Ross Sea, Davis Sea, and Weddell Sea.
Depth: 65–1170 m.

Promachocrinus joubini Vaney, 1910

Catalog numbers: MACN-In 44593, MACN-In 44594, MACN-In 44596, MACN-In 44601 (Fig. 1).
Diagnosis (after McLaughlin *et al.,* 2023): Radials 10. Arms 20. Arms extend from the body nearly horizontally. Centrodorsal 5.4 mm long, 7.4 mm wide; semispherical. Cirral sockets, in three rows, diameter 0.8–1.3 mm; aboral pole lacks cirral sockets. Cirri not present, though drawn for description, proximal segments wider than long, fourth segment as wide as long, and most after that are 1.5 times longer than wide, with distal cirral pointed. Oral disc region 24.7 mm wide. Radial ossicle 1.2 mm long; axil 3.6 mm long. First syzygy occurs at Br3+4, 2.4 mm wide; second syzygy at Br9+10. IBr1+2 protrudes slightly, unlike IIBr1+2.
Distribution: Antarctica, western Antarctic Peninsula, Scotia Arc, Amundsen Sea, Ross Sea, Davis Sea, and Weddell Sea.
Depth: 110–1157 m.

DISCUSSION AND CONCLUSION

The revision of *Promachocrinus* specimens from the Invertebrate Collection of the *Museo Argentino de Ciencias Naturales "Bernardino*

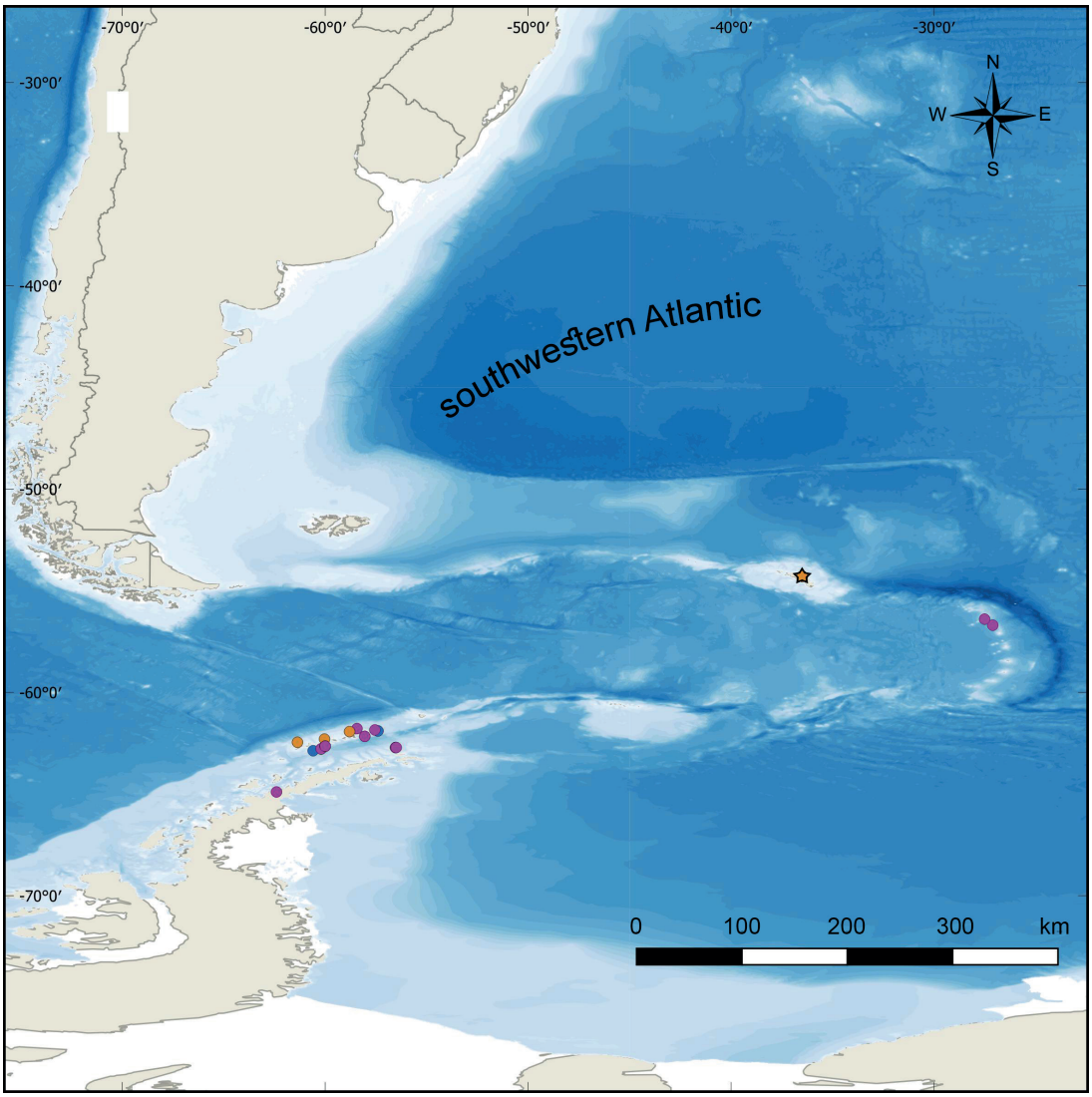

Fig. 1. Map showing the distribution of the lots of Promachocrinus: P. kerguelensis (orange), P. fragarius (purple) and P. joubii (blue). Lots of P. kerguelensis that worked Bernasconi and published in 1932 (star, MACN-In 18707, MACN-In 18708).

Rivadavia" (MACN-In) expands and updates the material deposited for the class. This study builds upon the pioneering work done in Argentina by Professor Irene Bernasconi, who reviewed Antarctic crinoid *Promachocrinus kerguelensis* Carpenter, 1879. Her work was constrained by the limited taxonomic tools available at the time. By revisiting the historical material and incorporating new samples from recent Antarctic expeditions, this research extends our understanding of the genus within the collection. After this study, three species were identified within the MACN-In collection, including *P. kerguelensis*, *P. fragarius* McLaughlin, Wilson & Rouse, 2023 and *P. joubini* Vaney, 1910 , each characterized by unique morphological features and broad bathymetric ranges.

The genus *Promachocrinus* was comprised for one specie (Eléaume *et al.*, 2014; McLaughlin *et al.*, 2023), with two synonyms: *Promachocrinus vanhoeffenianus* Minckert, 1905, and *P. joubini* Vaney, 1910 (Clark, 1915; Mortensen, 1918; John, 1938; Clark & Clark, 1967). Currently, the genus is divided into 8 species that have, 5

radials and 10 arms, such as *P. mawsoni* (Clark, 1937) and *P. wattsorum* McLaughlin, Wilson & Rouse, 2023, or 10 radials and 20 arms, such as *P. kerguelensis*, *P. vanhoeffenianus*, *P. fragarius*, *P. unruhi* McLaughlin, Wilson & Rouse, 2023, *P. uskglass* McLaughlin, Wilson & Rouse, 2023, and *P. joubini*. The genus *Promachocrinus* is endemic to the Southern Ocean, and the specimens analyzed herein, match with the distribution records of McLaughlin *et al.* (2023).

The discovery of these cryptic species necessitates a reevaluation of historical biodiversity records and re-examining collections, using modern analytical tools. What was once perceived as populations of a single species is now recognized as distinct evolutionary lineages (Eléaume *et al.*, 2014). There is evidence of cryptic biodiversity in Antarctica across various taxa (Heimeier *et al.,* 2010; Baird *et al.,* 2011; Brasier *et al.,* 2016; Soler-Membrives *et al.,* 2017; González-Wevar *et al.,* 2019; Jossart *et al.,* 2019; Maroni *et al.,* 2022). This has significant implications for our understanding of Antarctic biodiversity and the evolutionary processes shaping life in these extreme environments. Additionally, the identification of these species raises important questions regarding potential barriers to gene flow and the role of glacial refuge in promoting speciation. The integration of molecular data with traditional morphological approaches has profoundly transformed our understanding of the genus *Promachocrinus*, revealing a previously unrecognized level of diversity. As Antarctic research continues to advance, it is essential to acknowledge the foundational contributions of early researchers, such as Irene Bernasconi, whose work laid the groundwork for these recent discoveries.

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Table 1. *Promachocrinus* deposited at MACN–In. (*) The wet samples were conserved in 96° ethanol, and others in formaldehyde, then in 70° ethanol.

MACN-In	Family	Genus	Species	Locality	Depth (m)	Specs.	Conservation (*)	Id.	Observation
18707	Antedonidae	*Phromachocrinus*	*kerguelensis*	South Georgia	22	4	Dry and wet	Bernasconi	The lot is divide in a dry sample into the a box (picture of Bernasconi, 1932) and wet samples. Orcadas island cruise, 1978
18708	Antedonidae	*Phromachocrinus*	*kerguelensis*	South Georgia	28.4	3	Dry and wet, EtOH 70°	Bernasconi	Coll. Carcelles y Romero. 1929
27711	Antedonidae	*Phromachocrinus*	*kerguelensis*	South Georgia		6	Dry		Divided into boxes and bags
35320	Antedonidae	*Phromachocrinus*	*kerguelensis*	South Georgia		1	Wet		Orcadas island cruise, 1978
44588	Antedonidae	*Phromachocrinus*	*kerguelensis*	62°18' S – 60°02' W	67	1		Pertossi	E8 L6
44589	Antedonidae	*Phromachocrinus*	*kerguelensis*	62°43' S – 56°32' W	202	1		Pertossi	E22 L28
44590	Antedonidae	*Phromachocrinus*	*kerguelensis*	62°10' S – 58°3' W	105	2		Pertossi	E16 L21
44597	Antedonidae	*Phromachocrinus*	*kerguelensis*	62°27,4' S – 61°21,9' W	187	1		Pertossi	E6 L2
44603	Antedonidae	*Phromachocrinus*	*kerguelensis*	61°56' S – 58°48' W	206	1		Pertossi	E11 L11
26984	Antedonidae	*Phromachocrinus*	*fragarius*	Melchior Archipelago, Antarctic Peninsula	20-50	1	Wet	Bernasconi	Coll. Bellisio, 1966
35320–1	Antedonidae	*Phromachocrinus*	*fragarius*	South Georgia	30	3	Wet	Pertossi	Orcadas island cruise, 1978
35321	Antedonidae	*Phromachocrinus*	*fragarius*	Zavodovski Island, Scotia Arc		2	Wet	Pertossi	Orcadas island cruise, 1978
44591	Antedonidae	*Phromachocrinus*	*fragarius*	62°10' S – 58°3' W	105	2	Wet, EtOH 70°	Pertossi	E16 L20
44592	Antedonidae	*Phromachocrinus*	*fragarius*	61°54' S – 57°24' W	113	1		Pertossi	E14 L18
44595	Antedonidae	*Phromachocrinus*	*fragarius*	62°43' S – 56°32' W	202	7		Pertossi	E22 L28
44598	Antedonidae	*Phromachocrinus*	*fragarius*	62°43' S – 56°30' W	222	2		Pertossi	E22 L29
44599	Antedonidae	*Phromachocrinus*	*fragarius*	61°51' S – 57°33' W	188	3	Wet, EtOH 70°	Pertossi	E13 L15
44600	Antedonidae	*Phromachocrinus*	*fragarius*	61°47' S – 58°26' W	246	1		Pertossi	E12 L14
44602	Antedonidae	*Phromachocrinus*	*fragarius*	62°47' S – 60°12' W	454	2	Wet, EtOH 70°	Pertossi	E20 L26
35325	Antedonidae	*Phromachocrinus*	*fragarius*	South Shetland Islands		1	Wet	Pertossi	Coll. Cazzaniga. 1976
35322	Antedonidae	*Phromachocrinus*	*fragarius*	South Sandwich Islands		2	Wet	Pertossi	Coll. Aldo Toma "Hero", 1973
35324	Antedonidae	*Phromachocrinus*	*fragarius*	South Shetland Islands		3	Wet	Pertossi	Orcadas island cruise, 1978
44593	Antedonidae	*Phromachocrinus*	*joubini*	62°47' S – 60°12' W	454	2	Wet, EtOH 70°	Pertossi	E20 L26
44594	Antedonidae	*Phromachocrinus*	*joubini*	61°54' S – 57°24' W	113	1		Pertossi	E14 L18
44596	Antedonidae	*Phromachocrinus*	*joubini*	62°52,4' S – 60°35,6' W	214	1		Pertossi	E19 L25
44601	Antedonidae	*Phromachocrinus*	*joubini*	62°47' S – 60°12' W	454	9	Wet, EtOH 70°	Pertossi	E20 L26

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