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# *Leptychaster kerguelenensis* (Echinodermata: Asteroidea) from Southwest Atlantic: Redescription and geographic distribution

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## Abstract

The only two specimens of *Leptychaster* spp. reported from Southwest Atlantic, were determined as *L. kerguelenensis mendosus* by Fisher (1940). Twelve specimens of *Leptychaster kerguelenensis* from Argentine continental shelf collected by the R/V *Shinkai Maru*, and two specimens from Kerguelen Islands collected by B.A.N.Z.A.R.E., were used to redescribe the species. All the material is deposited at the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia". All Atlantic specimens agree with the description of *Leptychaster kerguelenensis* and no morphological differences were found with specimens from Kerguelen Islands. From the present study, no subspecies are recognized within *L. kerguelenensis and L. mendosus* is a junior synonym of the former.

**Key words:** Astropectinidae, Subantarctic, Patagonian shelf, Kerguelen Islands, *Leptychaster mendosus*

## Introduction

The genus *Leptychaster* (Astropectinidae) was proposed by Smith (1876) to include his new species *L. kerguelenensis* from the Kerguelen Islands (49º 15´S, 69º 10´ E). This genus differs from the others of the family Astropectinidae by inferomarginal plates making a broad border to the body, each plate raised abruptly to form wide, sharply defined intermarginal fasioles lined with fine spinules, and the rised areas armed with short spines (Clark & Downey 1992).

Smith (1879) proposed the name *Leptoptychaster* to correct, *Leptychaster* however, Fisher (1911) made clear that this change was not justified and retained the original spelling.

Koehler (1923) described a specimen of *Leptoptychaster mendosus* from near Isla de los Estados Island, reporting the different body form and shorter arms, to distinguish it from *L. keguelenensis*.

Fisher (1940), studied a second specimen of *L. mendosus* collected south of the Malvinas (Falkland) Islands and noted the similarity with *L. kerguelenensis*. He agreed that *L. mendosus* had arms with a slightly different shape, (they were broader and sharper) with a less arched interradius, than *L. kerguelenensis*. Fisher (1940) found few differences between the abactinal and marginal plates and proposed that *L. mendosus* was actually a subspecies of *L. kerguelenensis*: *Leptychaster kerguelenensis mendosus*.

Clark & Downey (1992) questioned the presence of true *Leptychaster* as part of their review of the Atlantic Asteroidea. The two known specimens of *L. kerguelenensis mendosus* were poorly preserved and there were no other reports of this subspecies from the Argentine coast. Bastida *et al.* (1992) listed *Leptychaster kerguelensis* (sic) as a member of the benthic community of the Argentine continental shelf.

The objectives of the present study were to redescribe *Leptychaster kerguelenensis* from the Argentine coast, providing a complete description of the external morphology, and to undertake a comparative study of specimens from off South American waters and those from Kerguelen and Marion islands.

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## Material and methods

*Leptychaster* specimens used for the present study are deposited at the Invertebrate National Collection, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" (MACN-In) (Table 1). Twelve specimens of *Leptychaster kerguelenensis* were collected by the Japanese fisheries research vessel "Shinkai Maru" from the continental Argentine shelf during 10–Apr–1978 and 12–Apr–1979, with the main goal of evaluating the actual fishing and latent exploitable demersal species for the Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP) (Bastida & Urien1981). In addition, the MACN-In collection house 2 specimens of *Leptychaster kerguelenensis* from Kerguelen Islands collected by the British, Australian and New Zealand Antarctic Research Expedition (B.A.N.Z.A.R.E.), and obtained by exchange with The Natural History Museum in London.

**TABLE 1.** Collecting sites of *Leptychaster kerguelenensis* material deposited in the National Collection of Invertebrates of the Argentine Museum of Natural Sciences “Bernardino Rivadavia" (MACN-In) and specimens previously published of this genus from the Argentinian continental shelf. (geographic coordinates for the trawls of "Shinkai Maru" correspond to average values). B.A.N.Z.A.R.E.: British, Australian and New Zealand Antarctic Research Expedition. E.A.S.: Expédition Antarctique Suèdoise. *: Near Head of Bras Bossière, Kerguelen.

| MACN-In | Campaign | Station | Date | Lat. | Long. | Depht | Ind. |
|---|---|---|---|---|---|---|---|
| 37920 | B.A.N.Z.A.R.E. | 7 | 20/11/1929 | * | * | 4 m | 1 |
| 31184 | B.A.N.Z.A.R.E. | 49 | 10/02/1930 | 49º 30.0' S | 69° 48.0' E | 2–20 m | 1 |
| 29724 | Shinkai Maru IV | 71 | 28/07/1978 | 48° 29.4' S | 62° 30.2' W | 141–142 m | 7 |
| 29723 | Shinkai Maru V | 79 | 09/09/1978 | 49° 29.6' S | 62° 29.6' W | 152–153 m | 2 |
| 37921 | Shinkai Maru V | Ad.3 | 05/09/1978 | 49° 27.5' S | 63° 30.0' W | 140 m | 1 |
| 37923 | Shinkai Maru XI | 71 | 23/02/1979 | 48° 58.0' S | 62° 34.0' W | 140 m | 1 |
| 37922 | Shinkai Maru XI | 88 | 03/03/1979 | 50° 25.0' S | 66° 39.5 W | 98–100 m | 1 |
| Koehler, 1923 | E.A.S. | 3 | 06/01/1912 | 54° 43.0' S | 64° 08.0' W | 86 m | 1 |
| Fisher, 1940 | William Scoresby | 86 | 1930–1932 | 53° 53.0' S | 60° 34.5' W | 147–151 m | 1 |

Measurements were taken with a flexible ruler that allowed working with preserved specimens. Minor radius, r (distance between the mouth and interradial angle); major radius, R (distance between mouth and tip of arm); width of arm at base, B (distance between two contiguous interradial angles); and width in middle of arm, b (in all complete arms) were measured. Averages of all available measurements, according to the state of conservation of specimens, were obtained.

Measurement and counts of the actinal, superomarginal, inferomarginal, adambulacral, and abactinal plates and spines were obtained from middle third of arms using a stereoscopic microscope provided with a micrometric eypiece. Additional data were obtained from literature when values were reported by the authors (Sladen 1889, Bell 1908, Koehler 1910, 1917 and Bernasconi 1971). Moreover and in spite of limitations, some measured were taken from illustrations in Sladen (1889), and from photographs in Koehler (1923), Fisher (1940), and Bernasconi (1971).

Linear regression between minor (r) and major radii (R), taking r as the independent variable, was studied in order to check if arm length from the Southwest Atlantic specimens differed from the Kerguelen and Marion Islands specimens. Analysis of covariance (ANCOVA) was used to compare both regressions taking also r as the independent variable. We performed the same procedure to compare the width of the arms, b (main character highlighted by Koehler (1923) to differentiate *L. mendosus* to *L. kerguelenensis*).

## Results

Table 2 summarizes the studied external morphological characters of specimens from Southwest Atlantic and, Kerguelen and Marion islands. For all the studied characters, graphics corresponding to measures and counts of structures yielded figures whose ranges overlapped for specimens from both regions.

**TABLE 2.** Comparison of external morphological characters of *Leptychaster* specimens housed at Museo Argentino de Ciencias Naturales from South Indian and Southwestern Atlantic oceans, and the original descriptions of *L. kerguelenensis* and *L. mendosus*. Mean and standard deviation of the data were calculated for R, r, B and b parameters. Modal values and range number of plates and spines (in parentheses) are indicated.

| Character | *L. kerguelenensis* type | B.A.N.Z.A.R.E. specimens | *L. mendosus* type | "Shinkai Maru" specimens |
|---|---|---|---|---|
| Major radius (R) | 38.0 | 30.1 ± 0.2 | 40.0 | 29.8 ± 13.4 |
| Minor radius (r) | 11.5 | 8.6 | 11.0 | 8.3 ± 3.1 |
| Arm base width (B) | 13.0 | 10.7 ± 1.8 | 11.0 | 9.1 ± 3.5 |
| Arm middle width (b) | | 6.1 ± 2.1 | 8.5 | 5.4 ± 2.2 |
| Abactinal plates (center of the disc and arms) | Pedunculate fascicles of short thick spines | Smaller than those near superomarginals plates, with 20 (16–24) spines | Small enclosed paxilli arranged in oblique transverse rows, each row with 7–8 paxillae | Smaller than those near superomarginals plates, with 18 (15–22) spines |
| Abactinal plates (close to superomarginals) | Pedunculate fascicles of short thick spines | Paxillae with 32 (31–33) spines in one specimen and 18 (15–25) in the others | Paxilli somewhat larger than in the center of the disc | Paxillae with 26 (21–30) spines |
| Madreporite | Fairly large, suboral, marginal, covered fascicles | Marginal and obscured by paxilliform plates | Hidden by paxillae | Marginal and obscured by paxilliform plates |
| Superomarginal plates | Not reported | Paxillae with 30 (29–32) spines in one specimen and 24 (20–29) in the other | Inconspicuous and paxillliforms, formed by a crown of spines, covered by a clear coat and length ranging among 0.25 to 0.3 mm | Paxillae with 25 spines (23–26) |
| Inferomarginal plates | Transverse, narrow, laminar and ordered plates | Tall and short (from 1.2–1.7 tall and from 0.3–0.5 wide) carry 45 (43–52) spines. Slope of prominent metapaxillar ridge carry small, thin and delicate hairlike spinules | 50 plates well developed that correspond exactly with superomarginals plates. Tall and short covered by 3–4 spine series and others very small spinelets cross is between the neighboring plates | Tall and short (from 1.2–1.7 tall and from 0.3–0.5) carry 51 (46–61) spines. Slope of prominent metapaxillar ridge carry small, thin and delicate hairlike spinules |
| Actinal plates | 2, 3, 4 series of small fascicles | Only one row of actinal plates is present between furrow and margin in the most part of the arm. Small triangular actinal area with 14 plates carry 21 (20–22) spines | Paxilliform forming transverse series of three plates each, with spines longer than inferomarginals plates (1 mm) | Only one row of actinal plates is present between furrow and margin in the most part of the arm. Small triangular actinal area with 17 plates (16–21) carry 12–14 spines |
| Adambulacral plates | With thin spines | Contiguous and separate by ligamentous bands, with 6–7 large spines arranged in pairs that increase in size to the ambulacral furrow | Rectangular with 7 spines each, 3 of the same size, then another 2 and finally another 2 | Contiguous and separate by ligamentous bands, with 6–10 large spines arranged in pairs that increase in size to the ambulacral furrow |
| Oral plates | Not reported | Oral plates elongate, 6 oral spines in each oral plate and 10–12 suboral spines (the oral ones are longer than the suboral) | Each plate with 4–5 spines irregularly arranged | Oral plates elongate, 7–9 oral spines in each oral plate and 15–20 suboral spines (the oral ones are longer than the suboral) |

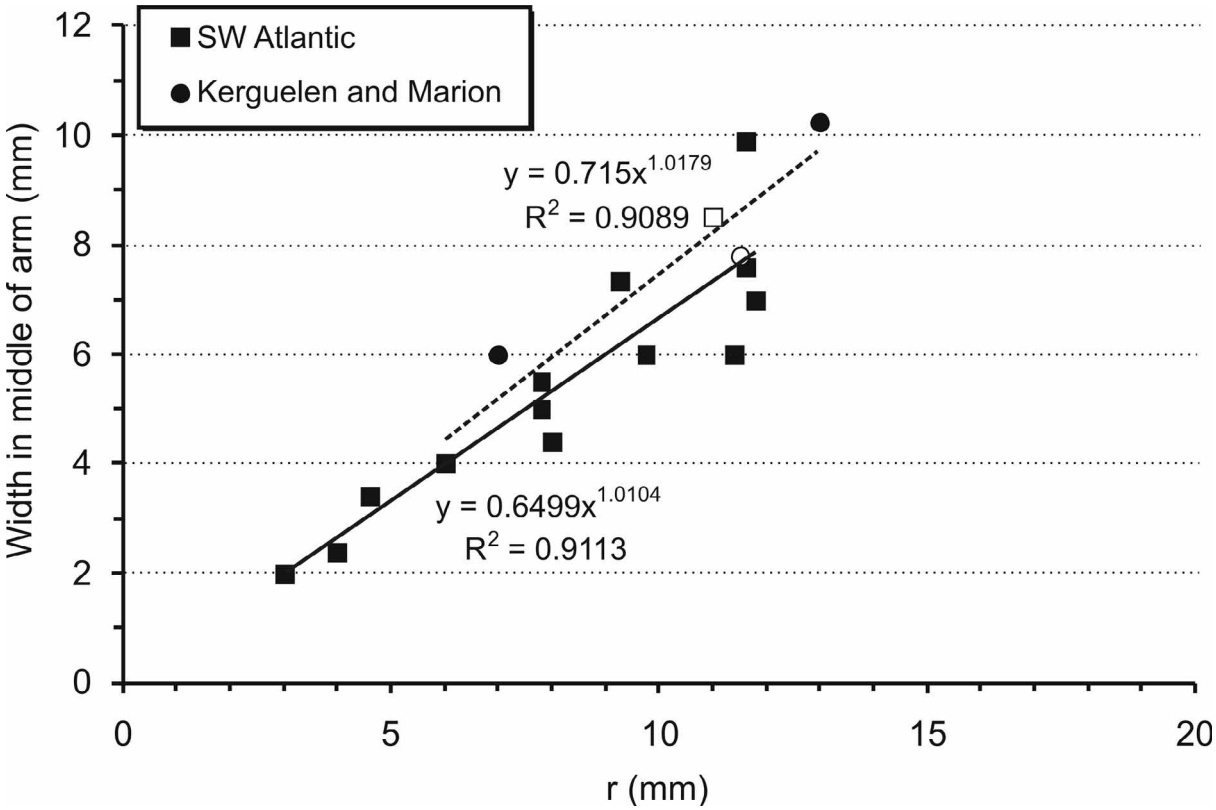


**FIGURE 1.** Relationship between arm length (R) and disk radious (r). Empty square: *Leptychaster kerguelenensis* type. Empty circle: *L. mendosus* type. Dotted line: regression line fitted to SW Atlantic specimens. Straight line: regression line fitted to Kerguelen and Marion islands specimens.

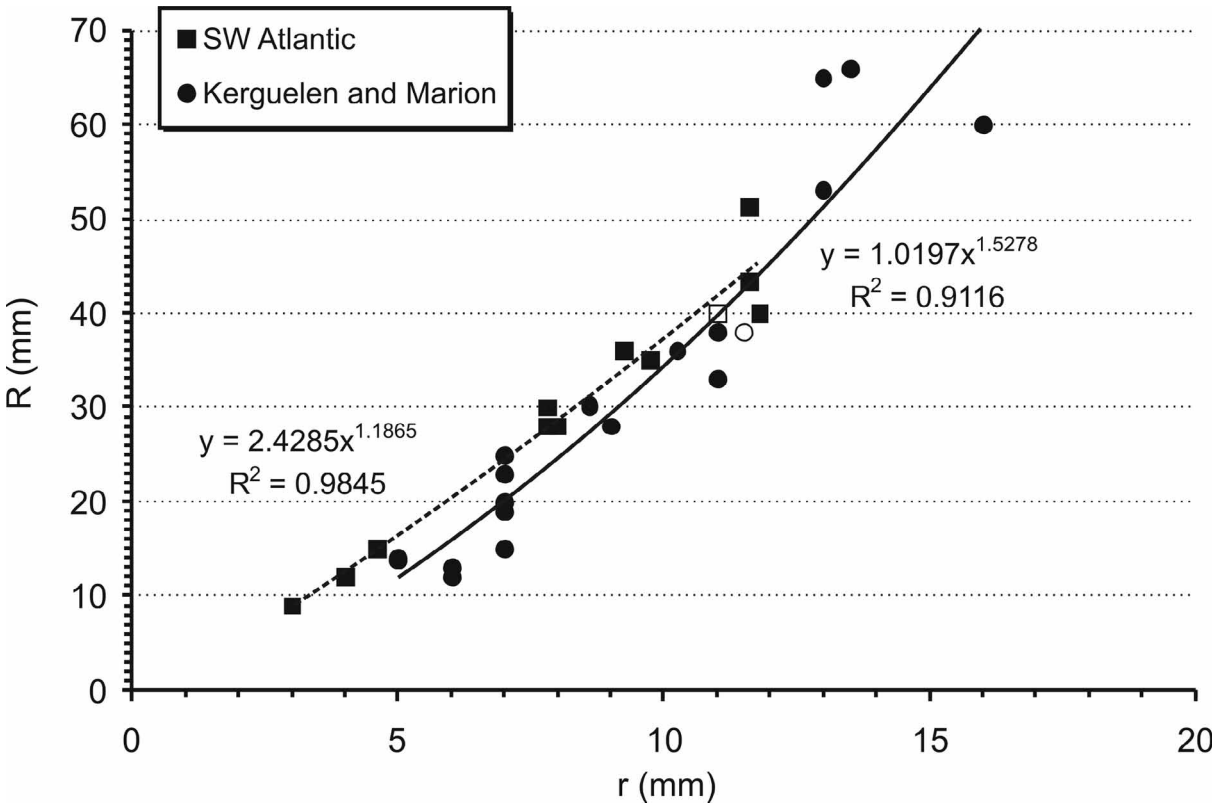


**FIGURE 2.** Relationship between arm width at half of it (b) and disk radious (r). Empty square: *Leptychaster kerguelenensis* type. Empty circle: *L. mendosus* type. Dotted line: regression line fitted to SW Atlantic specimens. Straight line: regression line fitted to Kerguelen and Marion islands specimens.

The R/r relationship showed an exponential form in specimens from both regions, indicating an allometric growth of the arms with respect to the disk or star's body. The values ranged between 2.0 and 5.0 for specimens from Kerguelen and Marion islands, and between 3.0 and 4.4 for specimens from Southwest Atlantic (Table 2 and Fig. 1). However, the analysis of covariance of R as a function of r, between the studied regions, showed no statistically significant differences ($p = 0.078$).

The differences in relative width of the arm in specimens from both regions resulted no statistically significant ($p = 0.728$). The exponents of the equations, very close to unity, indicate that growth of the width of the arms is proportional or isometric with respect to size (Fig. 2).

**TABLE 3.** Mean values of measurements of specimens at MACN-In collection and from literature data. r: minor radius; R: major radius; B: width of the arm at the base of the disc, b: width of the arm in the middle of it. All dimensions are in millimeters.

| Locality | Specimen | r | R | B | b |
|---|---|---|---|---|---|
| Kerguelen | MACN-In 31184 | 8.6 | 30.3 | 9.4 | 4.6 |
| Kerguelen | MACN-In 37920 | 8.6 | 30.0 | 12.0 | 7.6 |
| SW Atlantic | MACN-In 29723 | 9.3 | 36.0 | 11.0 | 7.3 |
| SW Atlantic | MACN-In 29723 | 4.6 | 15.0 | 5.4 | 3.4 |
| SW Atlantic | MACN-In 29723 | 3.0 | 9.0 | 4.0 | 2.0 |
| SW Atlantic | MACN-In 37922 | 7.8 | 30.0 | 7.4 | 5.0 |
| SW Atlantic | MACN-In 37923 | 8.0 | 28.0 | 7.6 | 4.4 |
| SW Atlantic | MACN-In 37921 | 11.6 | 51.2 | 14.4 | 9.9 |
| SW Atlantic | MACN-In 29724 | 11.6 | 43.4 | 12.6 | 7.6 |
| SW Atlantic | MACN-In 29724 | 11.4 |  | 12.8 | 6.0 |
| SW Atlantic | MACN-In 29724 | 9.0 | 35.0 | 10.0 | 6.0 |
| SW Atlantic | MACN-In 29724 | 6.0 |  | 6.6 | 4.0 |
| SW Atlantic | MACN-In 29724 | 4.0 | 12.0 | 4.0 | 2.4 |
| SW Atlantic | MACN-In 29724 | 11.8 | 40.0 | 13.0 | 7.0 |
| SW Atlantic | MACN-In 29724 | 7.8 | 28.0 | 9.4 | 5.5 |
| SW Atlantic | Koehler, 1923 | 11.0 | 40.0 | 11.0 | 8.5 |
| Kerguelen | Smith, 1876 | 11.5 | 38.0 | 13.0 |  |
| Marion | Sladen, 1889 | 16.0 | 60.0 | 16.0 |  |
| Marion | Sladen, 1889 | 11.0 | 38.0 | 11.0 |  |
| Marion | Sladen, 1889 | 5.0 | 13.8 |  |  |
| Kerguelen | Sladen, 1889 | 13.5 | 66.0 | 15.0 | 7.8 |
| Kerguelen | Sladen, 1889 | 10.2 | 36.0 | 8.5 |  |
| Kerguelen | Sladen, 1889 | 11.0 | 33.0 |  |  |
| Kerguelen | Koehler, 1917 | 13.0 | 65.0 | 18.0 | 10.3 |
| Kerguelen | Koehler, 1917 | 9.0 | 28.0 |  |  |
| Kerguelen | Koehler, 1917 | 7.0 | 25.0 | 10.5 | 6.0 |
| Kerguelen | Koehler, 1917 | 7.0 | 20.0 |  |  |
| Kerguelen | Koehler, 1917 | 7.0 | 19.0 |  |  |
| Kerguelen | Koehler, 1917 | 7.0 | 15.0 |  |  |
| Kerguelen | Koehler, 1917 | 6.0 | 12.0 |  |  |
| Kerguelen | Koehler, 1917 | 6.0 | 13.0 | 9.3 | 4.0 |
| Kerguelen | Fisher, 1940 | 13.0 | 53.0 | 15.5 |  |
| Kerguelen | Fisher, 1940 | 7.0 | 23.0 |  |  |
| Marion | Bernasconi, 1971 | 5.0 | 14.0 |  |  |

## Systematic description

### *Leptychaster kerguelenensis* Smith 1876

Figures 3 and 4

*Leptychaster kerguelenensis* Smith 1876, p. 110
*Leptoptychaster kerguelenensis*: Smith 1879, p. 278, pl. 17, fig. 2
*Leptoptychaster kerguelensis*: Koehler 1917, p. 52, pl. 6, figs. 1, 2, 7, 12
*Leptoptychaster mendosus* Koehler 1923, p. 98, pl. 12, figs. 3–5
*Leptychaster kerguelenensis mendosus*: Fisher 1940, p. 84.

Compressed disc; rays five (R:r from 2.0–5.0); width of arms do not decreases along them but it do rapidly at distal end, ending as blunt point; madreporite obscured by abactinal paxillae (Fig.3).

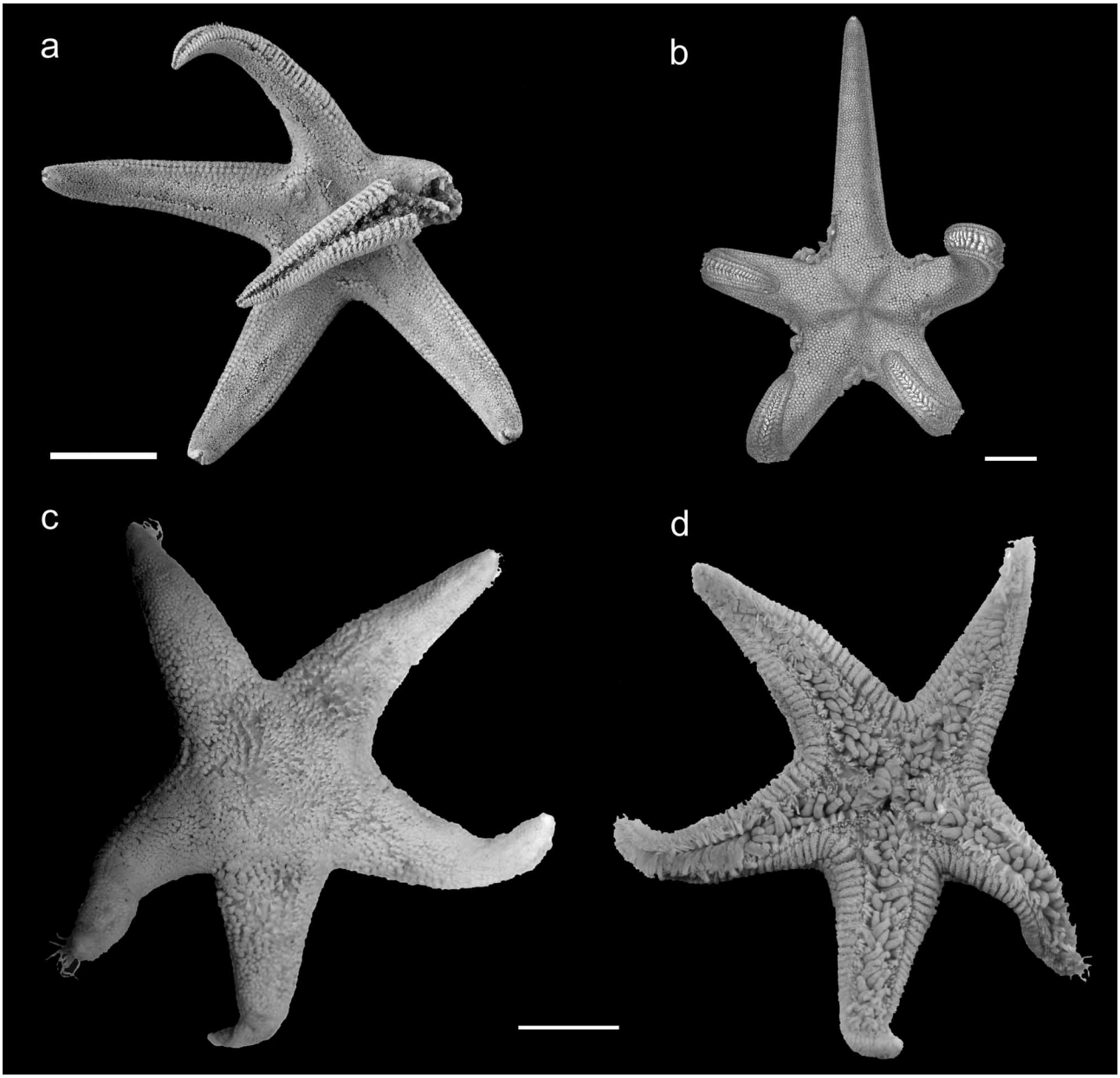


**FIGURE 3.** General view of *Leptychaster kerguelenensis*. a) MACN-In 29724 from Southwester Atlantic. b) Drawing of a Keguelen´s specimen by Sladen (1889). c) MACN-In 37920 from Kerguelen Is., aboral view. d) Idem before, oral view. Scale bars length = 1 cm.

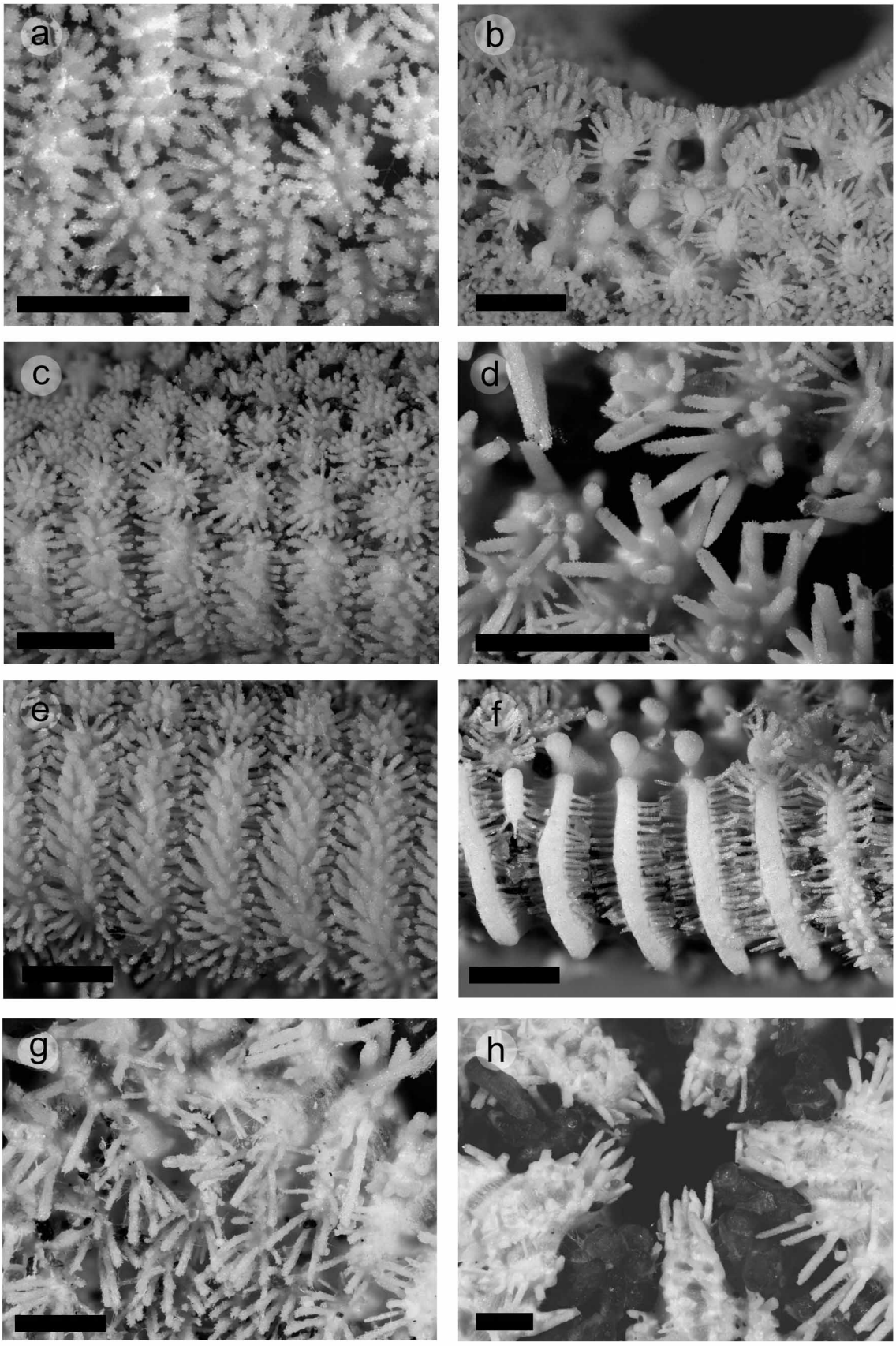


**FIGURE 4.** a) Abactinal plates top view. b) Abactinal plates lateral view. c) Superomarginal plates, second line from the bottom, just over the inferomarginal plates. d) Adambulacral plates. e) Inferomarginal plates. f) Detail of hairlike spinules on inferomarginal plates. g) Actinal plates. h) Oral plates. Scale bars = 1mm.

Abactinal plates paxilliform, arranged irregularly, projecting proximal edges of plates lobed, reduced in size to the center of the disk and toward the midline of arms (near superomarginal plates from 2.3–2.7 mm size, carry 15–33 spines from 0.1–0.2 mm long; center of disk and arms from 1.8–2.0 mm size, carry 15–24 spines from 0.1–0.2 mm long) (Fig. 4a and b).

Superomarginal plates paxilliform, similar but larger than abactinals (from 2.9–3.2 mm size, carry 20–32 spines 0.1–0.2 mm long), and separates from inferomarginal ones by a well-defined groove (Fig. 4c). Inferomarginal plates tall, short, forming vertical edge of body; with prominent metapaxillar ridge raised transversally to the ambulacral groove (from 1.2–1.7 mm tall and from 0.3–0.5 mm wide) in middle of the ray, carry on top of the ridge 43–61 spines, 0.2–0.3 mm long, arranged irregularly (Fig. 4e). Slope of ridge carry small, thin and delicate hairlike spinules, parallel to base plate, and interlaced spinules forms fasciolar grooves between contiguous inferomarginal plates (Fig. 4f).

Small triangular actinal area with small paxilliform plates, arranged in a few rows from the mouth to distal end of arm (from 0.7–0.8 mm size, carry 12–22 spines 0.3–0.4 mm long). Only one row of actinal plates is present between furrow and margin in the most part of the arm (Fig. 4g). Adambulacral plates are widely spaced, consecutive plates being united by broad ligamentous bands. Each plate carry 6–10 spines, 2 furrow spines (from 1.3–1.4 mm long) and 4–8 subadambulacrals spines (from 0.9–1.2 mm long) (Fig. 4d). Oral plates elongate (from 2.9–3.3 mm long and 0.4–0.5 mm wide), 6–9 oral spines in each oral plate and 10–20 suboral spines (the oral ones are longer than the suboral) (Fig. 4h).

**Distribution.** Southern Indian Ocean platform (Subantarctic convergence) surrounding the Kerguelen and Marion islands, 55–182 m depth; Southwestern Atlantic platform between 48° to 55° S; from 86–152.5 m depth (Fig. 5).

**Remarks.** The above redescription is based on previous descriptions (Sladen 1889, Koehler 1923) and the study of MACN-In specimens, with sizes ranging R from 12–66 mm and r from 2–16 mm.

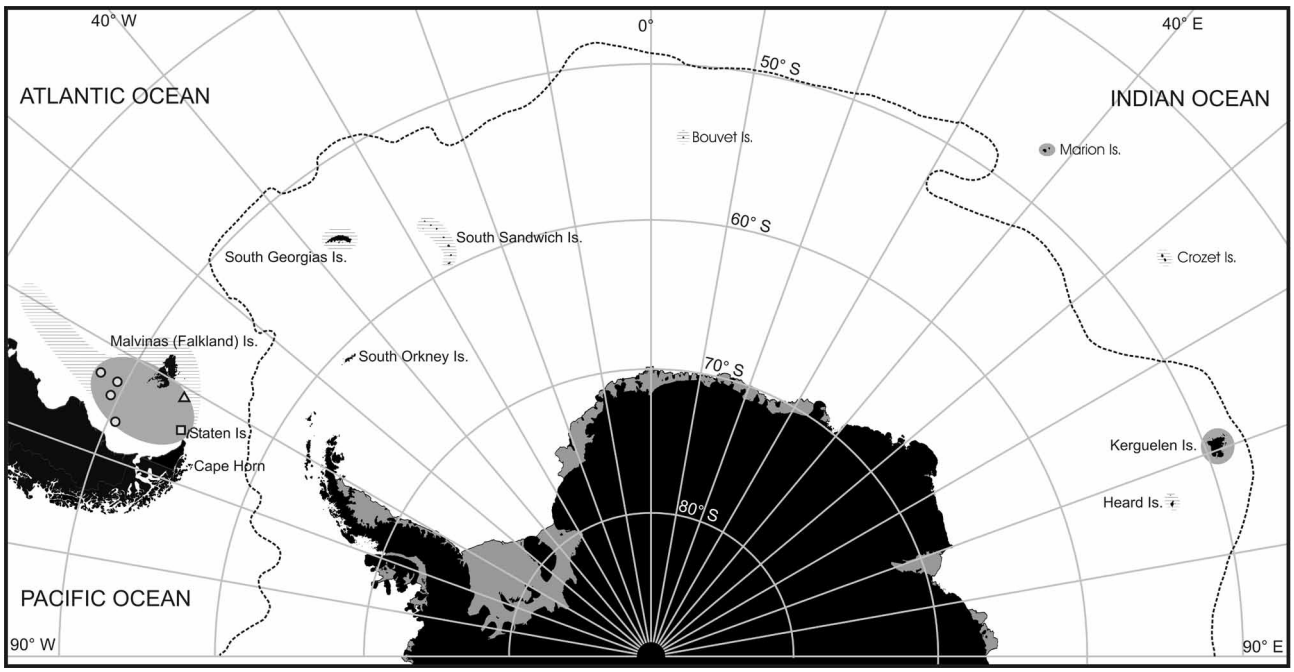


**FIGURE 5.** Known (shadow) and possible (horizontal lines) geographic distribution of *Leptychaster kerguelenensis*. Square: Type locality of *Leptychaster mendosus*. Triangle: Locality of the specimen studied by Fisher (1940). Circle: Shinkai Maru stations. Dotted line: Antarctic Convergence.

## Discussion

The analysis of external morphological characters showed a strong similarity between specimens of *L. kerguelenensis* from Southwest Atlantic and, Kerguelen and Marion islands.

Clark & Downey (1992) doubted about the occurrence of *L. kerguelenensis mendosus* in the Atlantic Ocean, however they only knew the two poorly preserved specimens from Malvinas and Isla de los Estados islands. The specimens collected by the R/V *Shinkai Maru* from the Argentine continental shelf confirm the presence of the genus *Leptychaster* in the Southwest Atlantic.

Sladen (1889) provided a detailed description of the external morphology of materials from Kerguelen and Marion islands, and all morphological characters mentioned were easily recognized in the Southwest Atlantic specimens.

Fisher (1940) compared his specimen from south of Malvinas (Falkland) Islands with those of *L. kerguelenensis* collected at the Kerguelen Islands. He reported only slight differences in shape, broader and sharper, a less arched interradius, and size of middle and lateral abactinal plates. Fisher (1940) changed *L. mendosus* to a subspecies of *L. kerguelenensis*, probably to reflect the disjunct distribution of the known specimens.

Specimens from the Kerguelen Islands showed in actinal area fewer plates and greater number of spines per plate than those observed in Southwest Atlantic ones (Table 3). Information on this character was not reported in previous descriptions by Sladen (1889) and Koehler (1923).

The genus *Leptychaster* is present in both hemispheres. Six species has been described from the Northern Hemisphere: *L. arcticus* (M. Sars 1851), *L. pacificus* Fisher 1906, *L. anomalus* Fisher 1906, *L. inermis* (Ludwig 1905), *L. propinquus* Fisher 1910, and *L. stellatus* Ziesenhenne 1942. In the Southern Hemisphere, *L. kerguelenensis* is the only species, occurring in subantarctic waters; other 4 species were reported from antarctic waters: *L. antarcticus* Sladen 1889, *L. flexuosus* Koehler 1920, *L. magnificus* (Koehler 1912), and *L. melchiorensis* Bernasconi 1969 (Mah & Danis 2011). Southern *Leptychaster* species can be determinated using the following key.

1: Inferomarginal plates similar to superomarginal ones. Triangular arms in aboral sight. . . . . *L. magnificus*
1': Inferomarginal plates much broader than superomarginal ones. Non-triangular arms in aboral sight . . . . . 2
2: Arms long (R:r > 6), narrow and flexible . . . . . *L. flexuosus*
2': Short arms (R:r < 5), non-narrow nor flexible . . . . . 3
3: Two furrow spines. Subantarctic. . . . . *L. kerguelenensis*
3': Three furrow spines. Antarctic . . . . . 4
4: Central adambulacral spine slightly curved and shorter than others two. Rectangular inferomarginal plates . . . *L. melchiorensis*
4': Three equal adambulacral spines. Rounded inferomarginal plates. . . . . *L. antarcticus*

The known geographic distribution of *L. kerguelenensis* is patchy and covers isolated and shallow areas south (Keguelen Islands) and north (Marion Islands and Argentine continental shelf) the Antarctic Convergence. It is expected that this species also inhabits other localities of circumpolar Southern Ocean which have similar oceanographic conditions (water temperature and depth) as shallow waters (< 200 m) surrounding South Georgia, South Sandwich, Bouvet, Crozet, and Heard islands. Moreover, the potential distribution of *L. kerguelenensis* on the Argentine continental shelf could extend to the entire area C defined by Bastida *et al.* (1992) on the basis of the benthic community structure determinated by multivariated analysis of 75 stations and 450 species. *L. keguelenensis* was one of the few exclusive species of area C, wich extends along the Argentine continental shelf beyond the 100 m isobath to continental slope, and it is under influence of the subantarctic Malvinas (Falkland) current (Fig. 5).

After studying the external morphology and performing statistical analysis we conclude that only one species of *Leptychaster* is present in the subantarctic area. According to the morphological approach showed here *L. mendosus* Koehler 1923 should be considered a synonym of *L. kerguelenensis* Smith 1876.

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