



Afrocucumis africana (Semper, 1867) (Holothuroidea: Dendrochirotida: Cladolabidae), new addition to the holothuroid fauna of Pakistan

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Abstract

Two dendrochirotid holothuroids, here identified as *Afrocucumis africana*, were collected from Gariyan Beach, Jiwani Makran Coast, Balochistan, for morphological and taxonomic study. This species is a new record of a dendrochirotid holothuroid from the Pakistani coastal waters. Identification was confirmed through morphology and microscopic observations of the ossicles. Identified specimens are deposited in Marine Reference Collection and Resource Centre, University of Karachi.

Key words: new record, Pakistan coastal waters, northern Arabian Sea

Introduction

Members of the order Dendrochirotida are characterized by elongated, often barrel-shaped bodies, a leathery skin and tentacles usually richly branched, but occasionally digitate (Pawson *et al.*, 2010). Currently, the order includes about 14 extant families and one extinct family, according to Smirnov (2012), whose system is here used, viz. Cladolabidae Heding & Panning, 1954, Psolidae Burmeister, 1837; Rhopalodinidae Theel, 1886; Cucumariidae Ludwig, 1894; Phylloporidae Östergren, 1907; Ypsilothuriidae Heding, 1942. Sclerodactylidae Panning, 1949; Paracucumidae Pawson & Fell, 1965; Sclerothyonidae Thandar, 1989; Vaneyellidae Pawson & Fell, 1965; Placothuriidae Pawson & Fell 1965; Heterothyonidae Pawson, 1970; Thyonidiidae Heding & Panning, 1954, Cucumellidae Thandar & Arumugam, 2011 and the extinct family Monilipsolidae Smith & Gallemí, 1991.

The species *Afrocucumis africana* (Semper, 1867) belongs in the family Cladolabidae Heding & Panning, 1954, elevated from Cladolabinae by Smirnov (2012). Members of this family normally inhabit shallow tropical-subtropical Indo-West Pacific waters, especially in the intertidal zone, often living in rock crevices even in the supra-littoral zone (Chao, 2018). Members of the family Cladolabidae are characterised by a low, often non-tubular calcareous ring with undivided radial and interradial plates, the former bearing usually short, divided or undivided radial processes. *Afrocucumis africana* is one of the most common dendrochirotid sea cucumbers observed in shallow tropical-subtropical coastal waters (Teo *et al.*, 2010) of the Indo-West Pacific region, extending from India, southeast Asia, China, Japan, Taiwan, Australia and the Pacific Islands to the east coast of Africa.

The classification, here used, follows that of Smirnov (2012) rather than that of Pawson & Fell (1965), which has always been more widely used but presents several inconsistencies, now ironed out by Smirnov (2012) who provided a new classification based on the distribution of tube feet, number of tentacles, morphology of the calcareous ring and the ossicles of the body wall, by elevating some subfamilies of Panning (1949), Heding & Panning (1954) and Thandar (1989) to full family rank. However, WoRMS (accessed 02/08/2023) gives Smirnov's classification as an alternative representation. Smirnov's (2012) system was used by Thandar (2018, 2021), Thandar & Arumugam (2022) and Thandar (2022), the latter in his extensive monograph of the holothuroid fauna of southern Africa.

The following papers provide a good taxonomic, habitat and biodiversity notes on this species and all were consulted to establish correctness of identification, for noting intra-specific differences and presenting reliable description and/or diagnosis of the species. Illustrated taxonomic characters are found in Clark & Rowe (1971); Rowe & Doty (1977); Thandar (1989, 2022); Massin (1996), Liao (1997); Marsh & Morrison (2004); Samyn *et al.* (2006); Teo *et al.*, (2010); Chao (2012); and Ong *et al.* (2016).

Previously only two species of the former family Sclerodactylidae, viz. *Ohshimella ehrenbergii* (Selenka, 1868) and *Cladolabes aciculus* (Semper, 1867) were reported from Pakistani coastal waters (Clark & Rowe 1971; Ahmed *et al.* 2016). The former is currently retained in the Phyllophoridae and the latter now transferred to Cladolabidae. This paper describes a second cladolabid record from the coastal waters of Pakistan.

Materials and methods

Two specimens of *A. africana* were collected from the intertidal zone at Gariyan Beach (25°01'57"N, 61°46'38"E), Makran coast, Balochistan, on 2nd December 2021 at low tide (0.05m; 2:30 pm) (Figure 1) by Dr. Qadeer Mohammad Ali, Iqra Shaikh and Ateeqa Baloch. Photographs of the specimens were taken in their natural habitat. The specimens were initially preserved in 5% formaldehyde solution for 24hrs for fixing and later transferred to 70% ethanol for permanent preservation and taxonomic study.

Morphological and taxonomic studies were conducted under dissecting and compound microscopes. For taxonomic studies, ossicles were removed from the dorsal and ventral body wall, tube feet, tentacles and introvert. The excised organs were placed on microscope slides to which a few drops of commercial/household bleach were added and the slides were then examined after about 30 min (Hickman, 1998). A drop of liquid (with ossicles) was spread on another glass slide, covered with water and cover slip and examined under the compound microscope. Photographs of the ossicles were taken, using a digital camera (FujiFilm 16MP) in order to illustrate the ossicles for confirmation of identification.

Results and discussion

Order Dendrochirotida Grube, A.E., 1840

Family Cladolabidae Heding and Panning, 1954

Genus; *Afrocucumis* Deichmann, 1944

Afrocucumis africana (Semper, 1867)

(Figures 2 & 3)

Cucumaria africana Semper, 1867: 53, 270, pl. 15, fig. 16; Théel, 1886: 108; Ludwig, 1887: 1236.

Pseudocucumis africana Ludwig, 1888: 815; Lampert, 1896: 61; Sluiter, 1901:107; Mitsukuri, 1912: 257, text-fig. 52, pl. 8, fig. 66; H.L. Clark, 1923: 417.

Phyllophorus transvectus Sluiter, 1914: 19, fig. 7a, b.

?*Orcula cucumiformis* Semper, 1867: 244, 274, pl. 40, figs. 8,9.

Cucumaria assimilis Bell, 1886: 27; Ludwig, 1899: 561.

Pseudo cucumistheeli Ludwig, 1887: 1236, . pl. 15, figs. 12–16.

Discucumaria africana H.L. Clark, 1946: 404.

Afrocucumis africana Deichmann, 1944: 736; 1948: 358; Heding and Panning, 1954: 109, text fig. 39; Clark and Rowe, 1971: 182 (dist.), text fig. 95g, pl. 30, fig. 3; Rowe and Doty, 1977: 226, fig. 2a.

Thandar, 1989: 298, text fig. 5, 9d; 2022: 69. Fig. 15; Kerr, 1994: 171; Marsh, 1994: 11; Rowe & Gates, 1995: 321;

Massin, 1996: 39, text fig. 27, A–E; Liao, 1997: 179, text fig. 104, a–b; Massin, 1999: 96, text fig. 79, 113c; Samyn &

Vanden Berghe: 2000, 5, 18, 32; Samyn, 2003: 180, 194, text fig. 1A–C, 51A; Teo, 2010: 65, text figs. 1–4; Purwati &

Wirawati, 2012: 244, fig. 10, 11 A–E; Ong, 2016: 297, text figs. 4A, 22.

?*Afrocucumis stracki* Massin, 1996: 40, plate 28, figs. A–J.

Diagnosis (after Semper 1867, Thandar 2022, amended herein). A small species of *Afrocucumis*, reaching a length

of just over 40 mm; colour in life reddish-violet, dull brown in alcohol. Tentacles in 2(?) circles. Posterior radial processes of calcareous ring short, broken into three pieces. Ossicles in the form of thick, discoidal, lenticular plates with tiny, often occluded, holes and pyramidal knobs or low spines on surface. Sometimes with rosette-like miliary granules in body wall and/or tube feet.

Remarks. The above diagnosis is taken from Semper (1867) and Thandar (2022) with slight amendment to include the sometimes presence of rosette-shaped granules in the body wall and/or tube feet. Both authors mention a single polian vesicle and stone canal, in contrast to Heding & Panning (1954) who state that there are numerous polian vesicles and stone canals. Whether these are intraspecific or geographic variations is unknown as the holotype came from Querimba, while Thandar's (1990, 2022) specimens came from the east coast of southern Africa and those Heding & Panning (1954) from Bowen, Australia. *Orcula cucumiformis* Semper, 1867 from Zanzibar was synonymized with *A. africana* by Heding & Panning (1954) while Massin's (1996) *A. stracki* from Ambon, Indonesia, is here also synonymized with *A. africana*, both with a query. In view of this and the number of synonyms this species needs to be thoroughly re-examined based on materials from different parts of the world.

Material examined. Gariyan Beach, Jiwani Makran Coast, Balochistan, Pakistan. (25°01'57"N, 61°46'38"E), collectors Dr. Qadeer Mohammad Ali, Iqra Shaikh and Ateeqa Baloch, 2nd December 2021, 2 specimens, intertidal zone, shallow water (cat no. MRCC-Holo 25).

Description. Length and weight of preserved specimens 35 mm x 2 g and 40 mm x 2.3 g. Live coloration dark purplish-black; preserved specimens turn black within 24 hrs. Body wall leathery, cylindrical, slightly rough to the touch; body tapering a little at each end. Mouth and anus terminal. Body wall thick (ca. 2.0 mm). Mouth surrounded by two circles of tentacles, an outer ring of 15 very bushy tentacles and an inner ring of 5 small tentacles. Anal teeth absent. Podia long, large, arranged in two rows along each radius. Calcareous ring elongated; interradial plates pointed or tapering anteriorly; radial plates sub-rectangular, enlarged basally; radial processes of calcareous ring fragmented into three pieces. Single free stone canal (5 mm long); madreporite (1.3 mm), slightly wider and clearly distinguishable from stone canal (Figure 3F). Gonad yellowish, immature, tubules unbranched, in two tufts.

Ossicles. The large lenticular plates with pyramidal knobs/spines, described by all authors for this species, were not observed perhaps due to the juvenility of the specimens or they were affected by formaldehyde after first preservation. Such ossicles are stated to measure 246–324 µm across. However, their supposed precursors, found in our material, measured only 150–200 µm in diameter (Figure 2A and 3C & D) but are here suspected to develop into the characteristic large lenticular plates. Introvert ossicles (Figure 2B and 3E) appear as elongated straight or curved rods with 1–4 holes at each end. Tube feet deposits appear as straight or slightly curved rods (165–195 µm long) (Figure 2F, 3C), multilocular at their ends but with one or more lateral projections). Tentacle ossicles (Figure 2G, 3D), comprise straight rods, 155–285 µm long, also perforated at their extremities.

Distribution. *Afrocucumis africana* is among the most common dendrochiotid holothuroids in the shallow tropical-sub tropical waters of the Indo-West Pacific region but can reach a depth of 200 according to Rowe & Gates (1995). Its distribution is well documented by Clark & Rowe (1971) and Massin (1996). Rowe & Doty (1977) reported it from (Guam, Micronesia); Rowe & Gates from various localities in Australia; Marsh & Morrison (2004) from Western Australia; Samyn *et al.* (2006) from East Africa; Liao (1997) from China; Massin (1999) from south-west Sulawesi, Indonesia, and Thandar (1989, 2022) from southern Africa. The synonymy given above indicates there are many other records.

Habitat. The specimens were taken from the intertidal zone, from under rock crevices but hardly attached to rocks.

Remarks. We compared our specimen with those diagnosed and illustrated by Thandar (1989, 2022), Massin (1996) and Samyn *et al.*, (2006). Massin (1996) described the morphological features and taxonomic characters of *A. africana* as uniform grey-black; body wall with large (246–324 µm) lenticular, perforated plates covered with prominent pyramidal teeth. We suspect such plates are derived from small knobbed perforated plates which we illustrate in Figure 2C. According to Massin (1996) the tube feet are strengthened by straight rods perforated at their extremities (see Figure 2F). The tentacles are provided with straight rods, 155–285 µm long, also perforated at their extremities (Figure 2G). Thandar (1989) described his specimen as reddish-violet in life and dull brown in alcohol, the radial processes of the calcareous ring are broken into three segments, but one of the ventral radial plate in juvenile was fragmented transversely into two pieces, “probably an artifact or an abnormal development”. Smooth,

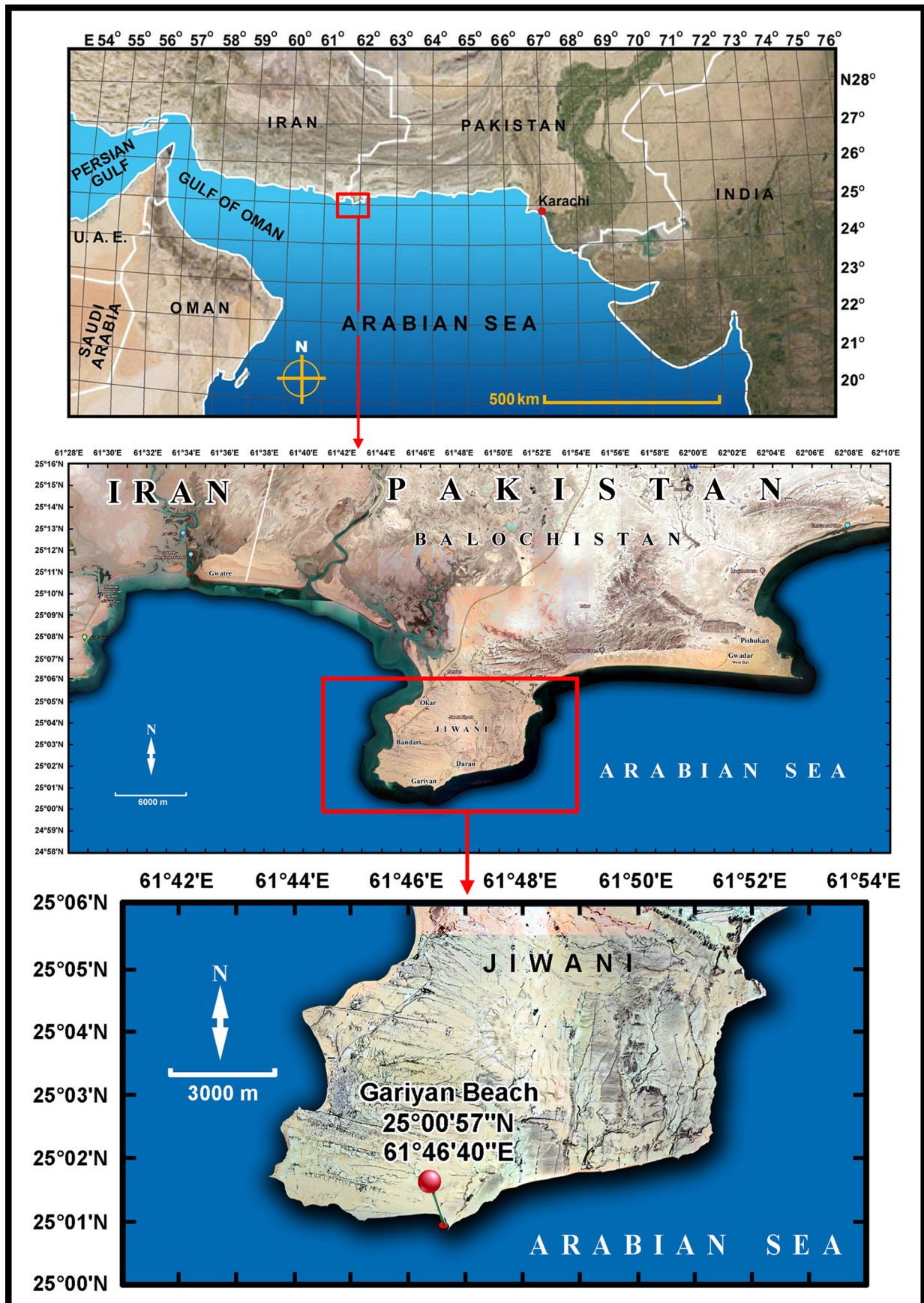


FIGURE 1. Map showing location of Gariyan (map developed by Abrar Ali, Marine Reference Collection and Resource Centre, University of Karachi)

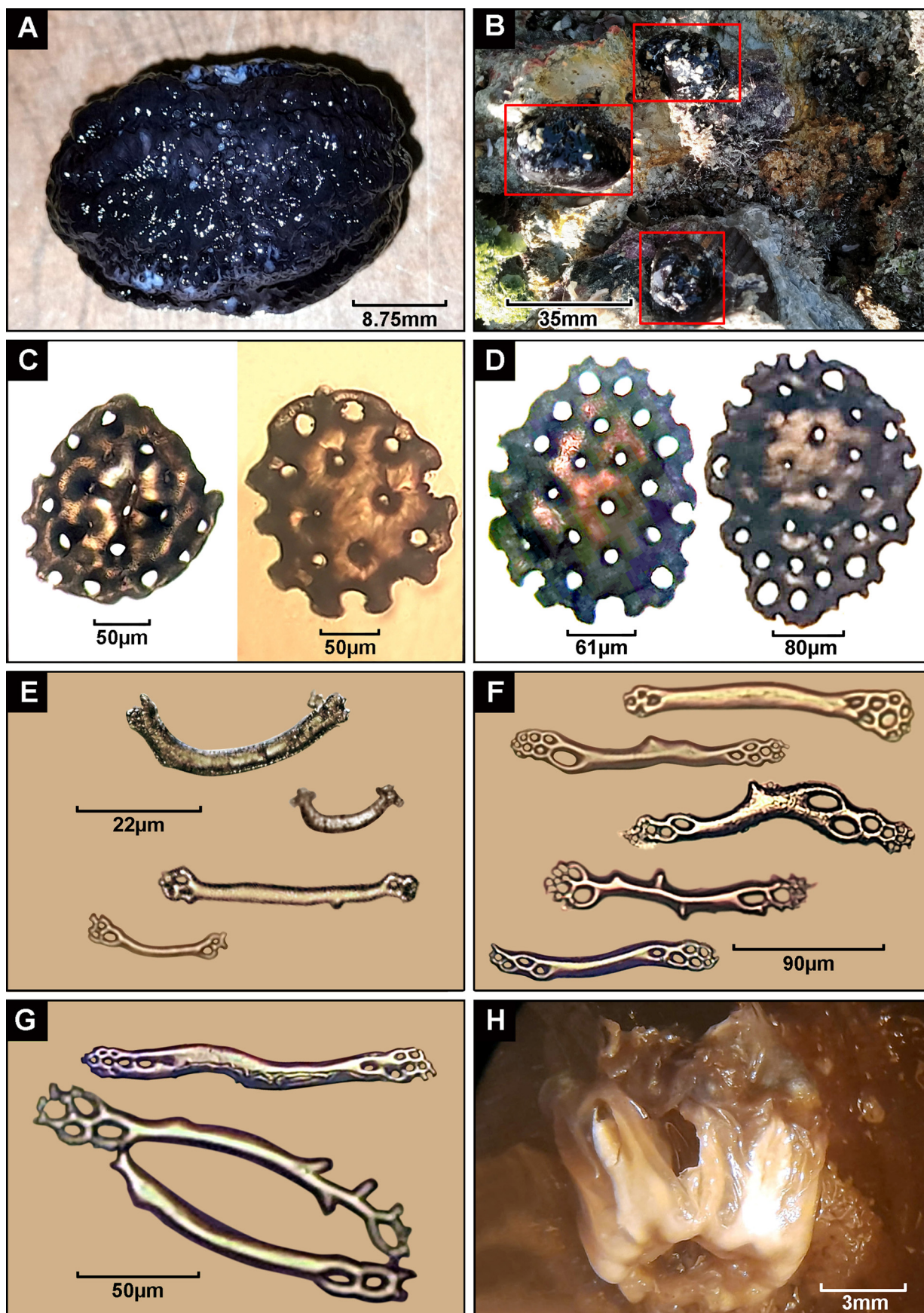


FIGURE 2. *Afrocucumis africana* (Semper, 1867) A. preserved specimen (Cat no.MRCC-Holo 25), B. live specimen, C. developing body wall plates, D. lenticular plates, E. introvert rods, F. tube feet rods, G. tentacle rods H. calcareous ring with the posterior radial processes tucked beneath the radial plates.

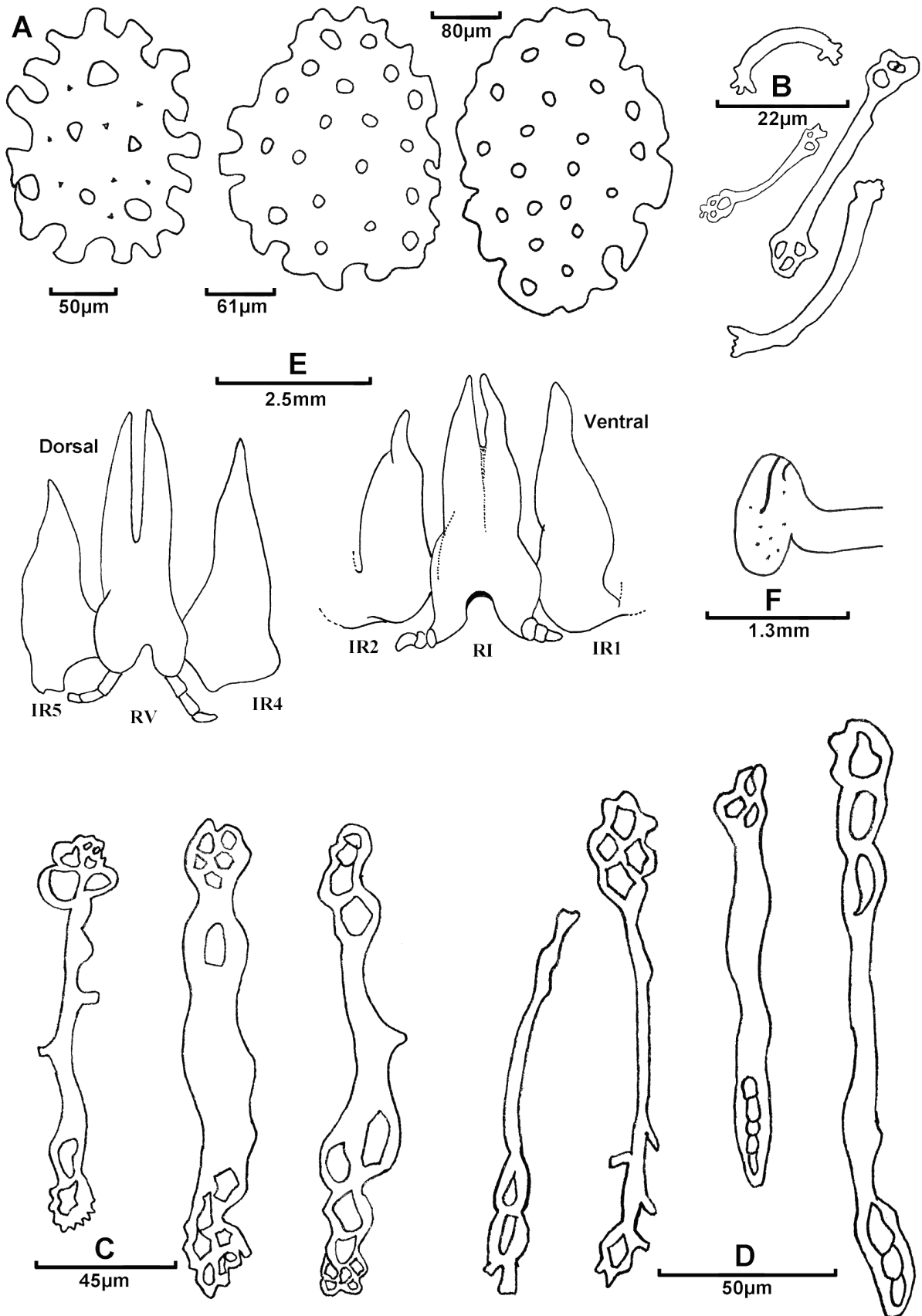


FIGURE 3. *Afrocumis africana* (Semper, 1867) (Cat no.MRCC-Holo 25). A. body wall plates; B. introvert; C. tube feet rods; D. tentacle rods; E. part of calcareous ring—labelled according to Ludwig’s 1888-1889 system (IR—interradial plate, R—radial plate); F. madreporic body.

simple, multilocular plates, common in the smaller individual (17 mm), are perhaps precursors of the large lenticular plates (144 μm –213 μm) of adults. Samyn *et al.* (2006) described their specimen as dark brown to nearly black, with darker podia and the typical body wall ossicles, which were large plates with diameter ranging from (100 to 290 μm) and appeared to be thick, nodular, convex, perforated, lens-like deposits; the podial deposits appear as small, multi-perforated plates and rods with terminal perforations; tentacles rods are perforated at the ends.

In our specimens the large lenticular plates with pyramidal knobs, mentioned by other workers, were not observed but the other plates are similar to those illustrated by Massin (1996) and others. The rods of the tube feet of our specimens are perforated at the ends and appear similar to those illustrated by Thandar (1989), Massin (1996) and Samyn *et al.* (2006). Tentacle rods are also perforated at the ends and are similar to those illustrated by Thandar (1989) and Massin (1996). The differences between our materials and that described by other workers are perhaps age-related or geographic or intraspecific variation. Interestingly Massin (1996) describes a similar species which he called *Afrocucumis stracki*, from Indonesia, differing from *A. africana* in the presence of miliary granules (which, in his illustration, appear as mulberry-like rosettes) in the tube feet; rods that are multilocular at the ends, and posterior radial processes undivided, perhaps indicating some speciation in the Indonesian region. However, on closer look we see that such granules have also been described in the tube feet of *Orcula cucumiformis* by Semper himself, long regarded as a synonym of *Afrocucumis africana*. Whether these species are separate or not can only be determined if Semper's *A. africana* from Querimba and *O. cucumiformis* from Australia, are re-examined. Hence, both these species are here indicated with a query (?) under the synonymy of *A. africana*.

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References

- Ahmed, Q., Ali, Q.M. & Conand, C. (2016) New additions to the holothurian fauna of Pakistan: *Holothuria verrucosa*, *Holothuria cinerascens* and *Ohshimella ehrenbergii*, *SPC Beche-de-mer Information Bulletin*, 36, 20–23.
- Bell, F.J. (1886) On the Holothurians of the Mergui Archipelago collected for the Trustees of the Indian Museum, Calcutta, by Dr. John Anderson, Superintendent of the Museum. *Zoological Journal of the Linnean Society*, 21 (126), 25–28.
<https://doi.org/10.1111/j.1096-3642.1886.tb00968.x>
- Burmeister, H. (1837) *Handbuch der Naturgeschichte. Zum Gebrauch bei Vorlesungen. Zweite Abtheilung: Zoologie*. Verlag von Theod. Chr. Friedr. Enslin, Berlin, xii + 858 pp. [Zoology pp. 369–858]
<https://doi.org/10.5962/bhl.title.100177>
- Chao, S. & Wu, S. (2012) Holothurians (Echinodermata: Holothuroidea) from the intertidal zone of Houbihu, southern Taiwan. *Collection and Research*, 25, 31–39.
- Chao, S.M. (2018) The assemblage of shallow-water holothurians (Echinodermata: Holothuroidea) from Hsiao Liouciou Island off southwestern Taiwan. *Collection and Research*, 31, 91–99.
- Clark, H.L. (1923) The echinoderm fauna of South Africa. *Annals of the South African Museum*, 13, 221–435.
- Clark, A.M. & Rowe, F.W.E. (1971) *Monograph of shallow-water Indo-West Pacific echinoderms. Trust British Museum (Natural History) Publication No. 690*. British Museum (Natural History), London, 238 pp.
- Deichmann, E. (1944) *Urodemas bifurcatum*, a new holothurian from South Africa, with a revision of the genus *Urodemas* Selenka. *Annals and Magazine of Natural History*, Series 11, 11 (83), 731–737.
<https://doi.org/10.1080/00222934408527470>
- Deichmann, E. (1948) The holothurian fauna of South Africa. *Annals of the Natal Museum* 11 (2), 325–376.
- Heding, S.G. (1942) *Holothurioidea. Part II. Aspidochirota—Elasipoda—Dendrochirota*. In: *The Danish Ingolf expedition 1895–1896. 4 (13)*. Hagerup, Copenhagen, pp. 3–39, 2 pls.
- Heding, S.G. & Panning, A. (1954) Phyllophoridae. Eine Bearbeitung der polytentaculaten dendrochiroten Holothurien des Zoologischen Museums in Kopenhagen. *Spolia Zoologica Musei Hauniensis*, 13, 7–209.
- Hickman, W.S. (1998) Washing theory and practice. *Review of progress in coloration and Related Topics*, 28 (1), 39–60.
<https://doi.org/10.1111/j.1478-4408.1998.tb00118.x>

- Kerr, A.M. (1994) Shallow-water holothuroids (Echinodermata) of Kosrae, Eastern Caroline Islands. *Pacific Science*, 48 (2), 161–174.
- Lampert, K. (1896) Die von Dr. Stuhlmann in den Jahren 1888 und 1889 an der Ostküste Afrikas gesammelten Holothurien. *Mitteilungen aus dem Naturhistorischen Museum in Hamburg*, 13, 49–71.
- Liao, Y. (1997) *Fauna Sinica. Phylum Echinodermata. Class Holothuroidea*. Science Press, Beijing, 334 pp.
- Ludwig, H. (1887) Drei Mittheilungen über alte und neue Holothurienarten. *Sitzungsberichte der Königlich-Preussischen Akademie der Wissenschaften zu Berlin*, 2 (54), 1217–1244.
- Ludwig, H. (1888) Die von Dr. Brock im Indischen Archipel gesammelten Holothurien. *Zoologische Jahrbücher Abteilung für Systematik, Geographie und Biologie*, 3, 805–820, pl. 30.
<https://doi.org/10.5962/bhl.part.1932>
- Ludwig, H. [1889–1892 (1889)] Die Seewalzen. In: Bronn, H.G. (Ed.), *Klassen und Ordnungen des Tierreichs. I. Buch*. C.F. Winter, Leipzig, pp. 1–460, pls. I–XVII. [pp. 1–176, figs. 1–16, pls. I–VIII (1889), pp. 177–240 (1890), pls. IX–XII (1891)]
- Ludwig, H. (1894) The Holothuroidea. In: Reports on an exploration off the west coasts of Mexico, Central and South America, and off the Galapagos Islands, in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," during 1891, Lieut. Commander Z. L. Tanner, U. S. N., commanding. XII. *Memoirs of the Museum of Comparative Zoology, Harvard*, 17 (3), 1–183, 19 pls.
- Massin, C. (1996) Results of the Rumphius Biohistorical Expedition to Ambon (1990) Part. 4. The Holothuroidea (Echinodermata) collected at Ambon during the Rumphius Biohistorical Expedition. *Zoologische Verhandlungen*, 307 (1), 1–53.
- Massin, C. (1999) Reef-dwelling Holothuroidea (Echinodermata) of the Spermonde Archipelago (South-West Sulawesi, Indonesia). *Zoologische Verhandlungen*, 329, 1–144.
- Marsh, L.M. & Morrison, S.M. (2004) Echinoderms of the Dampier Archipelago, Western Australia. *Records of the Western Australian Museum*, 66, 293–342.
<https://doi.org/10.18195/issn.0313-122x.66.2004.293-342>
- Mitsukuri, K. (1912) Studies on actinopodous Holothuroidea. *Journal of the College of Science, Imperial University of Tokyo*, 29 (2), 1–284.
<https://doi.org/10.5962/bhl.title.37880>
- Ong, J.Y., Wirawati, I. & Pei-San Wong, H. (2016) Sea cucumbers (Echinodermata: Holothuroidea) collected from the Singapore Strait. *Raffles Bulletin of Zoology, Supplement* 34, 666–717.
- Östergren, H. (1907) *Zur Phylogenie und Systematik der Seewalzen*. Särtryckur Zoologiska Studier Tillägnade Professor T. Tullberg, Almquist & Wiksells Buchdruckerei-Aktiengesellschaft, Uppsala, pp. 191–215.
- Panning, A. (1949) Revision of the family Cucumariidae, Holothuroidea, Dendrochirota. *Zoologische Jahrbücher Abteilung für Systematik, Ökologie Geographie Tiere*, 78, 1–111.
- Pawson, D.L. & Barraclough-Fell, H. (1965) A revised classification of the dendrochirote holothurians. *Breviora*, 214, 1–7.
- Pawson, D.L. (1970) The Marine Fauna of New Zealand: Sea Cucumbers (Echinodermata: Holothuroidea). *Mem. New Zealand Oceanographic Institute*, 52, 1–69.
- Pawson, D.L., Pawson, D.J. & King, R.A. (2010) A taxonomic guide to the Echinodermata of the South Atlantic Bight, USA: 1. Sea cucumbers (Echinodermata: Holothuroidea). *Zootaxa*, 2449 (1), 1–48.
<https://doi.org/10.11646/zootaxa.2449.1.1>
- Purwati, P. & Wirawati, I. (2012) Sea cucumbers of Teluk Prigi, Southern Coast of Java Province. *Oldi*, 38 (2), 241–254.
- Rowe, F.W.E. & Doty, J.E. (1977) The Shallow-Water Holothurians of Guam. *Micronesica* 13 (2), 217–250.
- Rowe, F.W.E. & Gates, J. (1995) Echinodermata. In: Wells, A. (Ed.), *Zoological Catalogue of Australia*, 33, 263–337.
- Samyn, Y. (2003) Shallow-water Holothuroidea (Echinodermata) from Kenya and Pemba Island (Tanzania). *Studies in Afrotropical Zoology*, 292, 1–158.
- Samyn, Y. & Vanden Berghe, E. (2000) Annotated Checklist of the Echinoderms from the Kiunga Marine National Reserve, Kenya. Part I: Echinoidea and Holothuroidea. *Journal of East African Natural History*, 89, 1–36, pls. 1 + 2.
[https://doi.org/10.2982/0012-8317\(2000\)89\[1:ACOTEF\]2.0.CO;2](https://doi.org/10.2982/0012-8317(2000)89[1:ACOTEF]2.0.CO;2)
- Samyn, Y., Vanden Spiegel, D. & Massin, C. (2006) Taxonomie des holothuries des Comores. *Abc Taxa*, 1, i–iii.
- Semper, C. (1867–1868) *Reisen im Archipel der Philippinen. Zweiter Theil. Wissenschaftliche Resultate. Holothurien 2*. Wilhelm Engelmann, Leipzig, 285 pp., 40 pls.
<https://doi.org/10.5962/bhl.title.11687>
- Sluiter, C.P. (1914) Die von Dr. P.N. van Kampen, während seiner Fahrten mit dem Regierungsdampfer "Gier", 1906–1909, im Indischen Archipel gesammelten Holothurien. *Contributions a la faune des Indes Néerlandaises*, 1 (1), 1–28, 1 pl.
- Smith, A.B. & Gallemí, J. (1991) Middle Triassic holothurians from northern Spain. *Palaeontology*, 34 (1), 49–76, 18 figs., 5 pls.
- Smirnov, A.V. (2012) System of the class Holothuroidea. *Paleontological Journal*, 46 (8), 793–832.
<https://doi.org/10.1134/S0031030112080126>
- Théel, H. (1886) *Report on the Holothuroidea collected by H.M.S. Challenger during the Years 1873–76. Part II. Report on the Scientific Results of the Voyage of H.M.S. Challenger during the years 1873–76*, Zoology, 14 (Part 39), 1–290, pls. 1–16.
- Teo, S., Ng, C.S.L. & Suen, S.M. (2010) Notes on the sea cucumber, *Afrocucumis africana* (Semper, 1868 sic) (Holothuroidea: Dendrochirotida: Sclerodactylidae) in Singapore. *Nature in Singapore*, 3, 65–68.

- Thandar, A.S. (1989) The sclerodactylid holothurians of southern Africa, with the erection of one new subfamily and two new genera (Echinodermata: Holothuroidea). *African Zoology*, 24 (4), 290–304.
<https://doi.org/10.1080/02541858.1989.11448167>
- Thandar, A.S. (2018) On some miscellaneous sea cucumbers (Echinodermata: Holothuroidea). in the collections of the South African Museum with three new species *Zootaxa*, 4532 (1), 57–85.
<https://doi.org/10.11646/zootaxa.4532.1.3>
- Thandar, A.S. (2021) Nomenclatural changes in some sea cucumbers with the erection of a new genus and description of a *Thyone* ?juvenile (?n. sp.) from the Gulf of California (Echinodermata: Holothuroidea: Dendrochirotida). *Zootaxa*, 5026 (4), 507–526.
<https://doi.org/10.11646/zootaxa.5026.4.3>
- Thandar, A. S. (2022) *A taxonomic monograph of the sea cucumbers of southern Africa (Echinodermata: Holothuroidea). Suricata* 9. South African National Biodiversity Institute. Pretoria, 352 pp.
- Thandar, A.S. & Arumugam, P. (2022) Referral of *Thyone neofusus* Deichmann, 1941, *Thyone adinopoda* (Pawson & Miller, 1981 and *Havelockiaobunca* (Lampert, 1885) to the genus *Sclerothyone* Thandar, 1990, and a replacement name for the preoccupied genus *Neothyone* Deichmann, 1941 (Echinodermata: Holothuroidea: Dendrochirotida) *Zootaxa*, 5219 (1), 065–071.
<https://doi.org/10.11646/zootaxa.5219.1.3>
- WoRMS (2023) Cladolabidae Heding& Panning, 1954. Available from: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=731921> (accessed 2 August 2023)