

New asterinid species from Africa and Australia (Echinodermata: Asteroidea: Asterinidae)

P. MARK O'LOUGHLIN

Marine Science Department, Museum Victoria, GPO Box 666, Melbourne 3001, Victoria, Australia (pmo@bigpond.net.au)

Abstract

O'Loughlin, P.M. 2009. New asterinid species from Africa and Australia (Echinodermata: Asteroidea: Asterinidae). *Memoirs of Museum Victoria* 66: 203–213.

Three new species are described: *Aquilonastra shirleyae* sp. nov. from central Western Australia; *Asterina hoensonae* sp. nov. from southern Africa; *Callopatiria cabrinovici* sp. nov. from central east Africa. The variety *Disasterina leptalacantha* var *africana* Mortensen is *Tegulaster leptalacantha* (H.L. Clark). *Asterina gracilis* H.L. Clark is reviewed systematically.

Keywords

Australia, Africa, Echinodermata, Asteroidea, Asterinidae, *Aquilonastra*, *Asterina*, *Callopatiria*, *Parvulastra*, *Tegulaster*, new species, generic reassignment

Introduction

This paper continues a series on family Asterinidae. Genus *Meridiastra* O'Loughlin, 2002 was erected to accommodate some southern Australian and Pacific species that had been assigned to *Asterina* Nardo, 1834. O'Loughlin et al. (2002) reviewed species *Patiriella regularis* (Verrill, 1867) using morphological and molecular data, and a new species of *Patiriella* Verrill, 1913 was described for New Zealand. O'Loughlin et al. (2003) reviewed genus *Patiriella* Verrill, 1913 using morphological and molecular data, and three new species were described for southern Australia. O'Loughlin and Waters (2004) revised genera of Asterinidae based on morphological systematics and a molecular phylogeny, and four new genera were erected with O'Loughlin as author. O'Loughlin and Rowe (2005) erected a new genus for the Indo-West Pacific region, and described five new species. Most recently O'Loughlin and Rowe (2006) undertook a morphological systematic revision of genus *Aquilonastra* O'Loughlin, 2004, and described 13 new species. In O'Loughlin and Waters (2004) and O'Loughlin and Rowe (2006) genera *Aquilonastra* O'Loughlin, *Asterina* Nardo, *Callopatiria* Verrill, 1913, *Parvulastra* O'Loughlin, 2004 and *Tegulaster* Livingston, 1933 were discussed in detail, and are the subjects of systematic work here.

This work is based on a continuing study of loan material from the Australian Museum (Sydney; AM with registration prefix J), Muséum National d'Histoire Naturelle (Paris; MNHN with registration prefix EcAs), Museum of the Republic of Central Africa (Brussels; MRAC), Museum Victoria (Melbourne; NMV with registration prefix F), Natural History Museum (London; NHM), South Africa Museum (Cape Town; S.A.M. with registration prefix A for asteroids) and University of Florida

(UF). Recently included in this study is a Western Australian Museum (Perth; WAM with registration prefix Z) loan of specimens from voyage SS10/05 by the RV *Southern Surveyor* for Australia's national science agency, the Commonwealth Scientific and Industrial Research Organization (CSIRO) through the Marine National Facility. New species of *Aquilonastra* O'Loughlin from Western Australia, *Asterina* Nardo from South Africa, and *Callopatiria* Verrill from east Africa are described. Type specimens of species of *Asterina* and *Disasterina* Perrier, 1875 that are held in the South Africa Museum are reviewed.

Methods

Skeletal plates were cleared for observation using commercial bleach. Terminology follows O'Loughlin and Waters (2004). Photographs for figures 1, 3a, 3c, and 4 were taken by Leon Altoff and Audrey Falconer using a Pentax K10D camera, with an Olympus 80 mm f4 macro lens with bellows for large specimens and Olympus 38 mm f2.8 macro lens with bellows for small specimens. Photographs for figures 2, 3b, 3d, and 5 were taken by Chris Rowley using a Leica MZ16 stereomicroscope, DC300 Leica digital camera, and "Auto-Montage" software. Figures were prepared by Caroline Harding.

Asterinidae Gray, 1840

Remarks. See O'Loughlin and Waters (2004).

Aquilonastra O'Loughlin, 2004

Remarks. See O'Loughlin and Waters (2004), O'Loughlin and Rowe (2006).

Aquilonastra shirleyae sp. nov.

Figure 1a–f

Material examined. Holotype: Western Australia, Point Cloates, 22°50'55" S, 113°30'39" E to 22°51'29" S, 113°30'50" E, 100 m, *Southern Surveyor*, SS10/2005 stn 135, M.P. Salotti and S. Slack-Smith, 9 Dec 2005, WAM Z37278.

Paratype: Red Bluff, 24°02'37" S, 113°01'37" E to 24°02'50" S, 113°01'44" E, 100 m, *Southern Surveyor*, SS10/2005 stn 126, M.P. Salotti and S. Slack-Smith, 8 Dec 2005, WAM Z37279 (1, denuded).

Description. Small, stellate, R = 13 mm, r = 5 mm (holotype; abnormal abactinal digitiform growth near disc), R = 8 mm, r = 4 mm (paratype; 2 rays regenerating); 5 sub-equal discrete rays, subdigitiform, interradial margin deeply incurved; rays tapering to narrow rounded distal end; rays flat actinally, high domed elevation abactinally; body integument not evident; single madreporite; not fissiparous; gonopores abactinal; glassy convexities on plates; superambulacral and superactinal plates present internally.

Abactinal: disc not discretely defined; rare proximal doubly or singly papulate carinal plates on holotype, weakly developed singly papulate carinal series on paratype, remaining upper ray plates irregular in arrangement; non-carinal plates crescentiform with single notch for papula; papular spaces small, single papula per space; 3 longitudinal series of singly papulate plates along each side of rays; rare secondary plates except in disc area; large white opaque bi-valved pedicellariae over papulae on upper sides of rays of holotype, less developed on small paratype; spinelets glassy, conical or columnar, up to about 0.15 mm long, tapered or splay-pointed distally, rugose, in splayed clusters on plates, in 3 small clusters across rare doubly papulate carinal plates, up to about 25 spinelets per plate; ends of distal abactinal interradial splayed spinelets rarely overlap ends of adjacent plate spinelets.

Margin: superomarginal plates about half size of inferomarginal plates, both in regular series; up to about 16 spinelets on both superomarginal and inferomarginal plates, thicker on inferomarginals.

Actinal: plates in longitudinal series, parallel to furrow; complete series of adradial actinal plates and spines. Actinal spines per plate: oral 8–10, suboral 7–9, ambulacral / furrow 7–8, subambulacral 7–8, proximal actinal 7–10, distal actinal, 7–10; oral spines digitiform, rugose; other actinal spines thin, glassy, rugose, pointed distally.

Colour. Live (photo of paratype): abactinal pale mottled with white, pale brown, pale orange; actinal white.

Preserved: white.

Distribution. Western Australia, Point Cloates, Red Bluff, continental shelf, 22–24° S, 113° E, 100 m.

Etymology. Named for Shirley Slack-Smith of the Western Australian Museum, with appreciation of her role in collecting these specimens, and in recognition of four decades of dedicated contribution to Australian marine mollusc research.

Remarks. The new species has the diagnostic characters of genus *Aquilonastra* O'Loughlin as detailed in the emended diagnosis by O'Loughlin and Rowe (2006): discrete rays,

interradial margin deeply incurved, stellate; high domed abactinally, flat actinally; abactinal plates predominantly irregular in arrangement on upper rays; longitudinal series along sides of rays, not perpendicular to margin; predominantly single papular notch per plate; predominantly single papula per papular space; numerous elongate glassy spinelets on each abactinal plate; superomarginal and inferomarginal plates in regular series; suboral spines present; adradial actinal spines in complete series; superambulacral and superactinal plates present internally.

A key to the 24 species of *Aquilonastra* is provided by O'Loughlin and Rowe (2006). *Aquilonastra shirleyae* sp. nov. is close diagnostically to *Aquilonastra rowleyi* O'Loughlin and Rowe, 2006 (Sodwana Bay, SE Africa) and *Aquilonastra watersi* O'Loughlin and Rowe, 2006 (Arabian and Red Seas, and western Indian Ocean). *Aquilonastra shirleyae* is distinguished from *Aquilonastra rowleyi* (details in brackets) by: size (up to R = 23 mm); subdigitiform rays (rays short, wide at base; fig. 6i in O'Loughlin and Rowe, 2006); pedicellariae squat (elongate; fig. 10c in O'Loughlin and Rowe, 2006); disc not discretely defined (disc clearly bordered; fig. 10b in O'Loughlin and Rowe, 2006); superomarginal plates half size of inferomarginals (subequal); actinal interradial spines 7–10 (3–4).

Aquilonastra shirleyae is distinguished from *Aquilonastra watersi* (details in bracket) by: size (up to R = 19 mm); rays that are thinner, with narrower base (rays short with wide base; figs. 3j, 10e in O'Loughlin and Rowe, 2006); few singly and doubly papulate carinal plates (up to 10 doubly papulate); up to about 25 abactinal spinelets per plate (up to about 20); pedicellariae conspicuous (inconspicuous; fig. 6l in O'Loughlin and Rowe, 2006); up to about 16 superomarginal spinelets per plate (up to about 7); up to 10 actinal spines per plate (up to 8); mottled very pale white, pale brown, pale orange (mottled pale brown, red-brown, grey-brown, blue-grey; off-white; fig. 3j in O'Loughlin and Rowe, 2006).

O'Loughlin and Rowe (2006) reported most *Aquilonastra* species from the shallow sub-littoral to about 50 m. *A. batheri* (from Japan) was reported to 92 m, and *A. cepheus* (from southern China to northern Australia) to 70 m. *A. rosea* (SW Australia) was reported to 110 m, the only occurrence deeper than *A. shirleyae*.

Asterina gracilispina H.L. Clark, 1923

Figure 2a–d

Asterina gracilispina H.L. Clark, 1923: 286–287, pl. 16 figs. 3–4.—A.M. Clark, 1974: 437 (part).—A.M. Clark and Courtman-Stock, 1976: 77 (part).

Material examined. Holotype (dry): South Africa, East London, SW of Cove Rock, 40 m, S.A.M. A6421.

Description. Small, subpentagonal, R = 6 mm, r = 4 mm; rays 5, discrete, wide at base, short, rounded distally; low convex abactinally, flat actinally, sides not steep, margin acute; body integument not evident; single inconspicuous madreporite; not fissiparous; gonopores not seen; glassy convexities on plates; presence or absence of superambulacral and superactinal plates

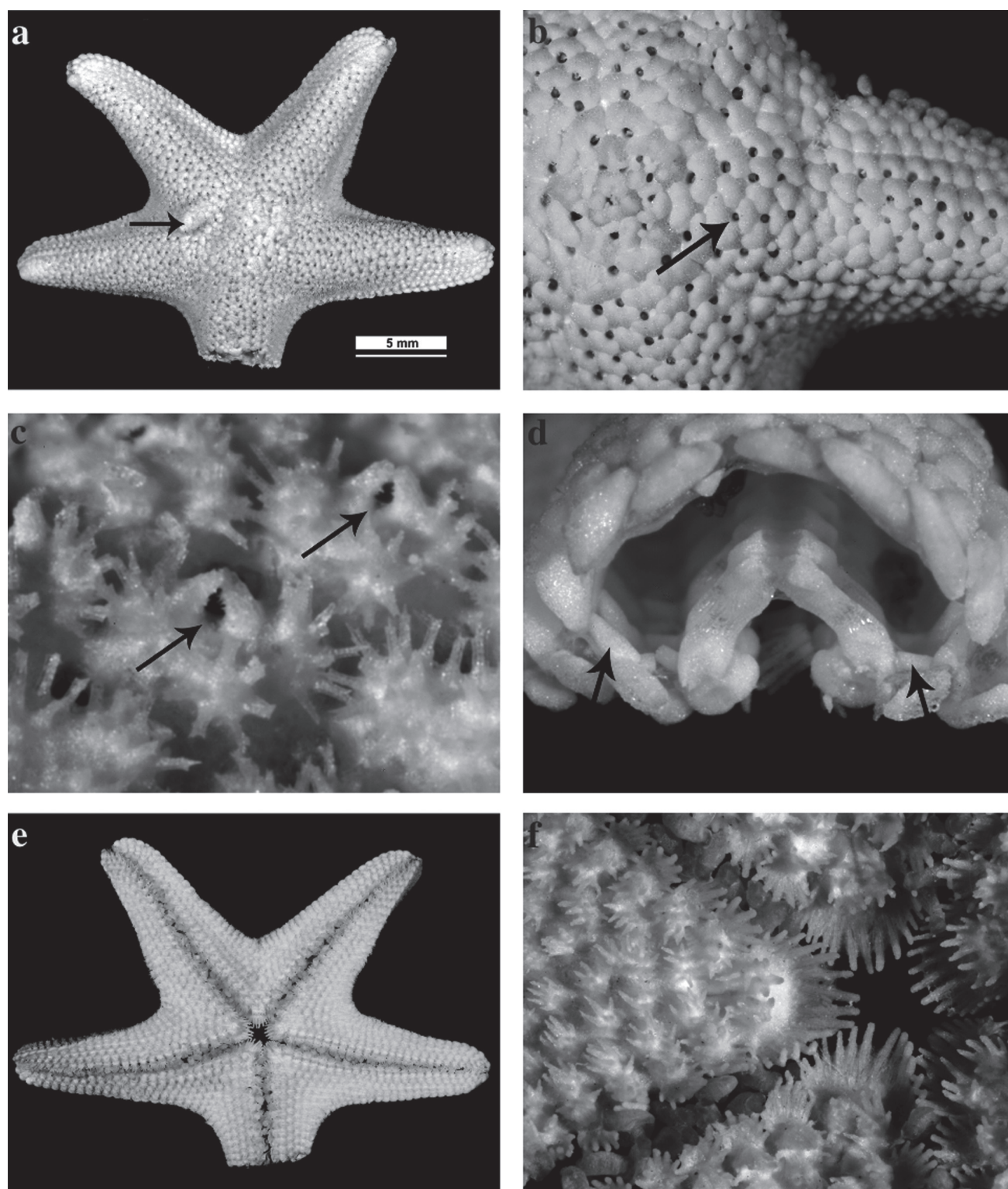


Figure 1. *Aquilonastra shirleyae* sp. nov. (photos by L. Altoff and A. Falconer). Holotype, WAM Z37278 (R = 13 mm; all except b); paratype WAM Z37279 (R = 8 mm; cleared; b only). a, abactinal surface (one ray dissected off; abnormal digitiform growth arrowed). b, disc not discretely defined; few proximal carinal plates with single papula arrowed. c, abactinal pedicellariae (arrowed) and spinelets on upper side of ray. d, section through cleared ray showing superambulacral plates (right arrow) and superactinal plates (left arrow). e, actinal surface with actinal plates in longitudinal series. f, oral, suboral, furrow, subambulacral and proximal actinal spines.

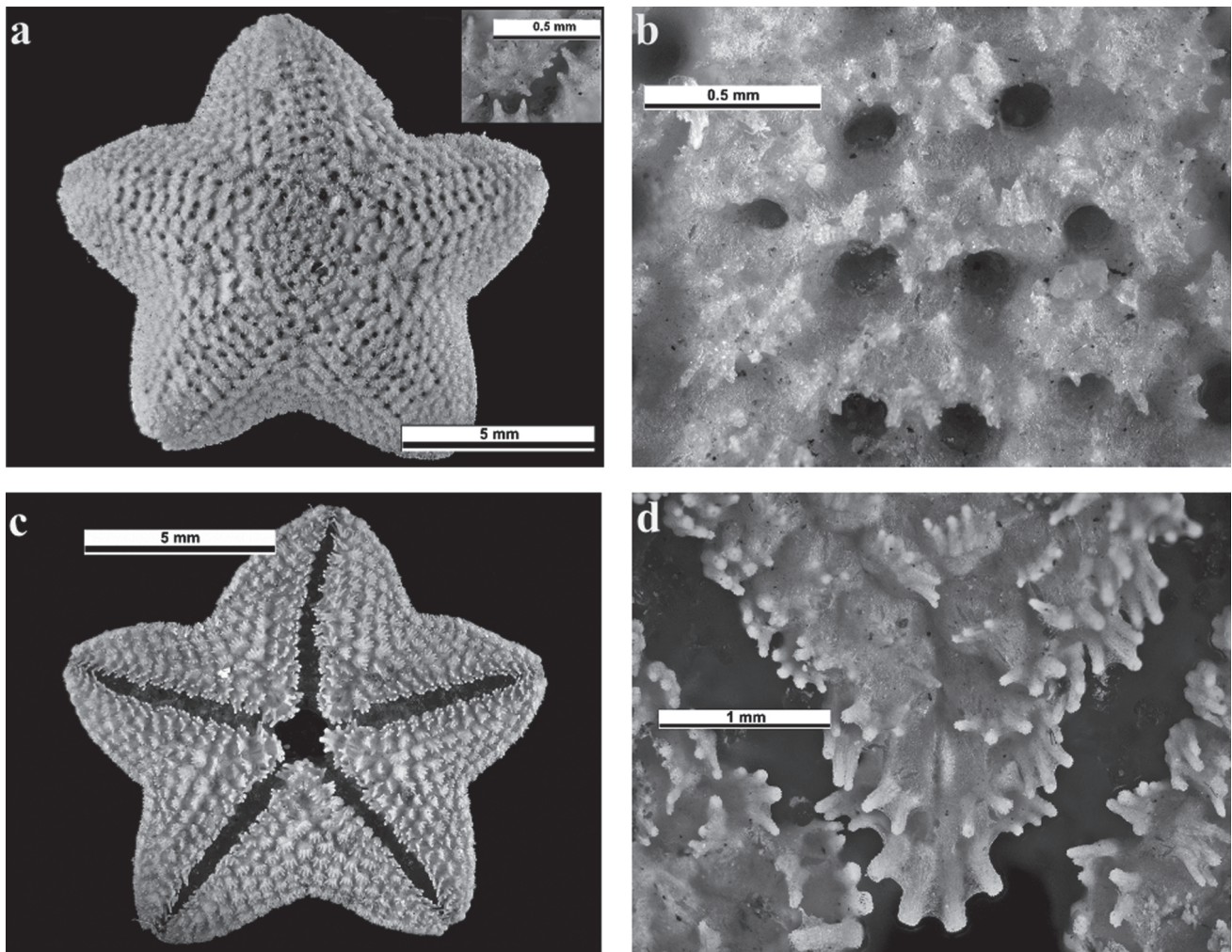


Figure 2. *Asterina gracilispina* H.L. Clark, 1923 (photos by C. Rowley). Holotype, S.A.M. A22559 (R = 6 mm). a, abactinal surface, insert showing spinelets. b, carinal series of doubly papulate plates and spinelets. c, actinal surface with actinal plates in longitudinal series. d, oral, suboral, furrow, subambulacral and proximal actinal spines.

unknown (small type specimen not dissected); glassy convexities on plates.

Abactinal: disc not distinctly bordered; plates imbricate, projecting proximal edge frequently tabular, plates not notched, slight proximal indentation for papula sometimes present, papulae emerge from under projecting proximal raised edge of plates; doubly papulate carinal series of plates along most of upper ray, rare secondary plates; papulae large, single per papular space, rarely 2; 8 longitudinal series of papulae across mid ray; small subsacciform to conical, pointed glassy spinelets, up to about 0.15 mm long, spread over plates, up to 20 per plate.

Margin: superomarginal plates longitudinally elongate, in regular series, up to about 14 spinelets spread over each plate, subequal with abactinal and inferomarginal spinelets, projecting inferomarginal plates with up to about 20 spinelets.

Actinal: interradial plates in longitudinal series, not predominantly oblique; complete series of adradial actinal plates and spines. Actinal spines per plate: oral 5 (2 long proximal; gap to 3 short distally, increasing in length to distalmost longest of 3); suboral 2 (webbed, long); furrow 4–3; subambulacral 4–3; adradial actinal 3–5; actinal interradial up to 7 mid ray, webbed transverse series, frequently 5–6; spines subsacciform to conical.

Distribution. South Africa, East London, 40 m.

Remarks. For O'Loughlin and Waters (2004) I used a specimen from Cape Agulhas, registered to the Natural History Museum in London as *Asterina gracilispina* (NHM 1975.10.29.47), as evidence for remarks on *A. gracilispina*. The subsequent availability of the holotype of *A. gracilispina* for examination in this work has made it possible for me to recognize that the

Cape Agulhas specimen is not conspecific. The Cape Agulhas specimen is similar in form, but is distinguished ($R = 12$ mm) by: disc distinctly bordered; conspicuous madreporite; short, blunt, digitiform to subgranular abactinal spinelets; 9 oral spines in series tapering evenly from long to very short, spines slightly swollen distally; up to 3 actinal spines mid ray. This specimen is described below as a new species.

Mortensen (1933) referred “with considerable doubt” a specimen ($R = 10$ mm) in the South Africa Museum from False Bay (26 m) to *A. gracilispina*. His grounds for doubt were: dorsal spinelets blunt; distinct madreporite; 2–3 stout actinal interradial spines. These characters are consistent with those of the Cape Agulhas specimen, described below as a new species of *Asterina*.

A.M. Clark (1974) reported on six specimens from South Africa determined as *A. gracilispina*, but her notes indicate to me that there were two species. Most of the specimens were in poor condition, but details of spine number for the Mossel Bay specimen ($R = 6$ mm) are compatible with the holotype of *A. gracilispina*. Notes that the Algoa Bay specimen ($R = 10$ mm) had 3–5 actinal spines per plate and an inconspicuous madreporite indicate that it is also probably *A. gracilispina*. But notes of 9 oral spines and only 2–3 actinal spines for the Cape Agulhas specimen ($R = 12$ mm; registered to the NHM) confirm the observations discussed above that it is not conspecific with *A. gracilispina* and it is the type for the new species referred to above and described below.

H.L. Clark (1923) was uncertain about generic assignment for this species, and chose *Asterina*. Currently there is inadequate data to confirm or reassign. However, the atypical arrangement and form of the oral spines is similar to that in *Parvulastra* O’Loughlin, 2004. If superambulacral and superactinal plates are present, then the species would be more appropriately assigned to *Parvulastra*.

Asterina hoensonae sp. nov.

Figure 3a–d

Asterina gracilispina.—Mortensen, 1933: 255–256 (non *A. gracilispina*).—O’Loughlin and Waters, 2004: 11, 15–16 (non *A. gracilispina*).—A.M. Clark, 1974: 437 (part non *A. gracilispina*).—A.M. Clark and Courtman-Stock, 1976: 77 (part non *A. gracilispina*).

Material examined. Holotype (in alcohol; part dissected): South Africa, Cape Agulhas, 34°S, 20°E, C. Griffiths (University of Cape Town), NHM 1975.10.29.47.

Description. Small, subpentagonal, $R = 12$ mm, $r = 9$ mm; rays 5, discrete, wide at base, short, rounded distally; body integument not evident; low convex abactinally, sides not steep, margin acute, single conspicuous madreporite; gonopores not detected; absence of pedicellariae; absence of superambulacral and superactinal plates; margin supported by internal contiguous projections of abactinal and actinal plates; glassy convexities on plates.

Abactinal: plates imbricate, surface flat, not broken by raised edges of plates, plates not notched, shallow concave proximal indentations for papulae; doubly papulate carinal series of plates along upper ray; papular spaces large, 0–2

secondary plates per space, 0–3 large papulae per space, 10 longitudinal series of papulae across mid ray; disc distinctly bordered; spinelets digitiform to subgranuliform, short, blunt, up to about 0.15 mm long, cover projecting abactinal plates, up to 16 spinelets per plate.

Margin: superomarginal and inferomarginal plates longitudinally elongate, in regular series, up to about 11 slightly conical subgranuliform spinelets spread over each superomarginal plate, subequal with inferomarginal spinelets, projecting inferomarginal plates with up to about 16 spinelets.

Actinal: interradial plates in variably longitudinal and oblique series; complete series of adradial actinal plates and spines. Actinal spines per plate: oral 9 (series tapering uniformly from tall proximally to short distally, tallest spines slightly swollen distally, smallest pointed distally); suboral 3; furrow 6; subambulacral 4; adradial actinal 2–3; actinal interradial 2–3 mid ray, 3–5 distally; spines digitiform, webbed.

Distribution. South Africa, Cape Agulhas (E of Cape Town).

Etymology. Named in appreciation of the contribution to this work by Elizabeth Hoenson of the South Africa Museum, who went to considerable lengths to make available essential loans for this work.

Remarks. The new species has the diagnostic characters of genus *Asterina* Nardo as detailed in the emended diagnosis by O’Loughlin and Rowe (2006): 5 discrete rays; not fissiparous; disc distinctly bordered; carinal series of doubly papulate plates; extensive papulate areas, numerous papulae and secondary plates; abactinal spinelets digitiform to subgranuliform; predominantly 2–3 digitiform actinal spines per plate; lacking superambulacral and superactinal plates; margin supported internally by contiguous projections of abactinal and actinal plates.

Some characters distinguishing *Asterina hoensonae* sp. nov. from *Asterina gracilispina* are listed under *A. gracilispina* above. *Asterina hoensonae* is distinguished from most of the remaining species of *Asterina* (*A. gibbosa*, *A. ocellifera*, *A. pancerii*, *A. phylactica* and *A. stellifera*) by lacking pedicellariae; and from *A. fimbriata* by having a distinctly bordered disc.

I discuss this specimen under *Asterina gracilispina* above. It is the specimen I wrongly accepted as being *Asterina gracilispina* in O’Loughlin and Waters (2004). Another specimen (False Bay, 26 m; $R = 10$ mm) in the South Africa Museum, referred “with considerable doubt” to *A. gracilispina* by Mortensen (1933), is probably *A. hoensonae* (see above). Specimens from Algoa Bay and Mossel Bay referred to *A. gracilispina* by A.M. Clark (1974) and A.M. Clark and Courtman-Stock (1976) are probably *A. hoensonae* (see above).

Callopatiria cabrinovici sp. nov.

Figure 4a–f

Material examined. Holotype: East Africa, Zanzibar, M. Angel, NHM 1965.6.1.743 (dry).

Paratypes: type series, NHM 1965.6.1.744 (1); East Africa, Zanzibar, Mazizini, rocky outcrop, M.D. Richmond, 1993, NHM 2004.2833 (1, dry); Zanzibar, C. Crossland, NHM 1903.4.2.61–62 (2);

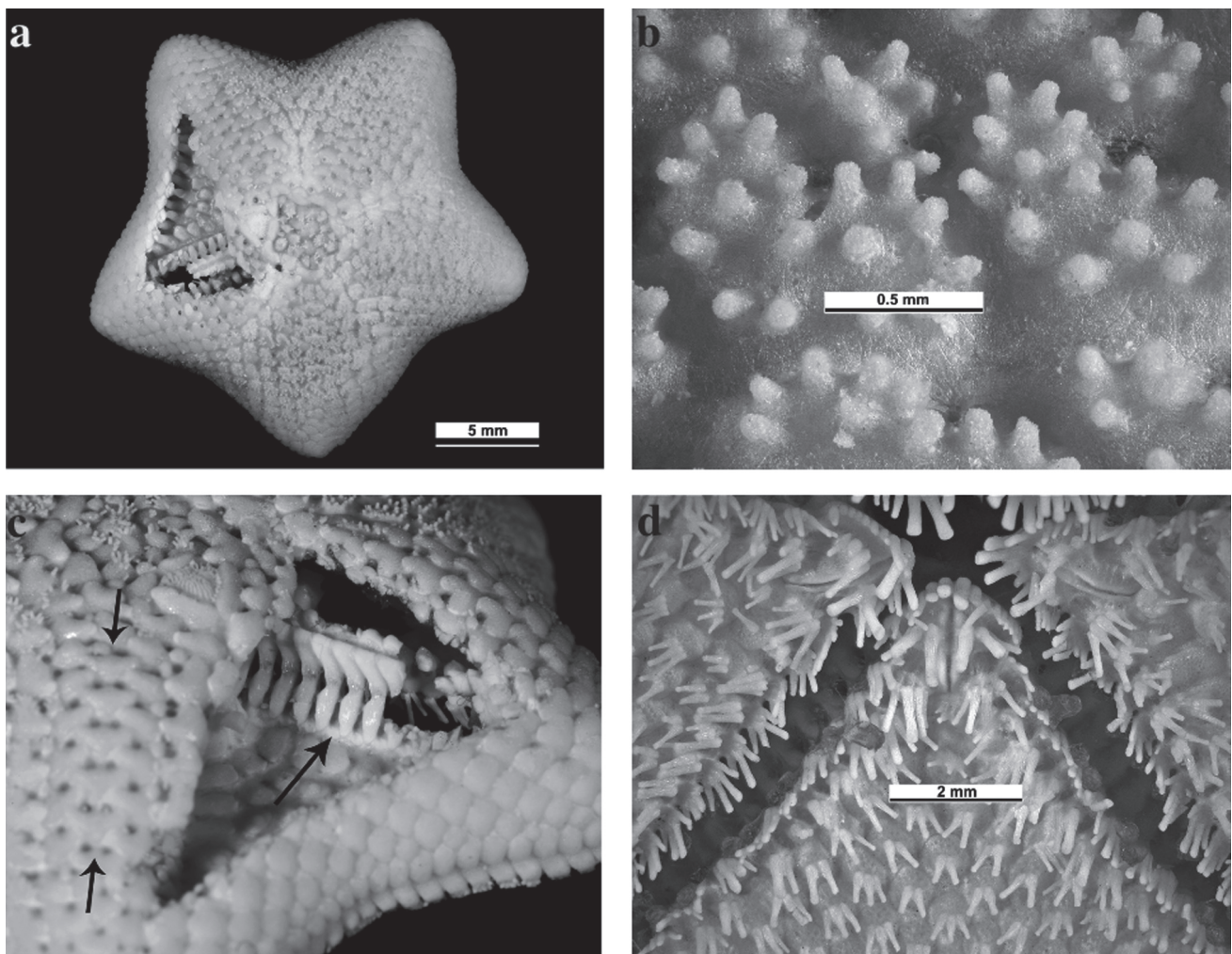


Figure 3. *Asterina hoensonae* sp. nov. (photos a, c by L. Altoff and A. Falconer; b, d by C. Rowley). Holotype, NHM 1975.10.29.47 (R = 12 mm). a, abactinal surface with section of abactinal plates removed. b, abactinal subdigitiform to subgranuliform spinelets. c, abactinal view (plates cleared, section of plates removed), showing doubly papulate carinal series of plates (left arrows) and absence of superambulacral plates (right arrow). d, oral, suboral, furrow, subambulacral and proximal actinal spines.

Kenya, Watamu, Ras Ngomeni, W.F. Humphreys, 1 Apr 1969, NHM 1979.2.5.147 (1); Watamu, rock platform, sub-littoral, W.F. Humphreys, 9 Sep 1969, NHM 1979.2.5.146 (2).

Other material. *Callopatiria cabrinovici* sp. nov. Kenya, Shimoni, J.D. Taylor, NHM 1973.10.4.48 (1); Zanzibar, Dr Kirk, NHM 68.3.6.13 (1); N Oman, Khesab Bay, coral reef, P. Cornelius, 30 Dec 1971, NHM 1972.4.10.57 (1).

Callopatiria granifera (Gray, 1847). South Africa, Western Cape Province, NMV F98049 (1, donation to NMV by A. Thandar).

Description. Rays 5, discrete, subdigitiform, narrow base, tapering to point or narrowly rounded end, broadly flat actinally, acute angular margin, sides steep, close to perpendicular, high convex abactinally; size large, rays unequal, up to R = 27–35 mm; integument evident; conspicuous single madreporite, not fissiparous; lacking pedicellariae; complete series of internal

superambulacral plates; interradial margin supported by numerous internal superactinal plates; superambulacral and superactinal plates contiguous on actinal internal surface for most of ray length; inner resinous brown lining to ray; gonopores not observed.

Abactinal: plates thick, imbricate, angled; disc weakly delineated in larger specimens, disc boundary typically 5 transversely elongate radials each with narrow band of up to about 50 spinelets, 5 small interradials; lacking carinal series of plates; longitudinal band (“field”) of primary and secondary upper ray plates, irregular in arrangement and form, plates with shallow concave indentation for single papula, crescentiform, not sharply notched; papulate areas extensive, papular spaces large, predominantly 1 large papula per space, secondary plates numerous, frequently 1 per papular space; up

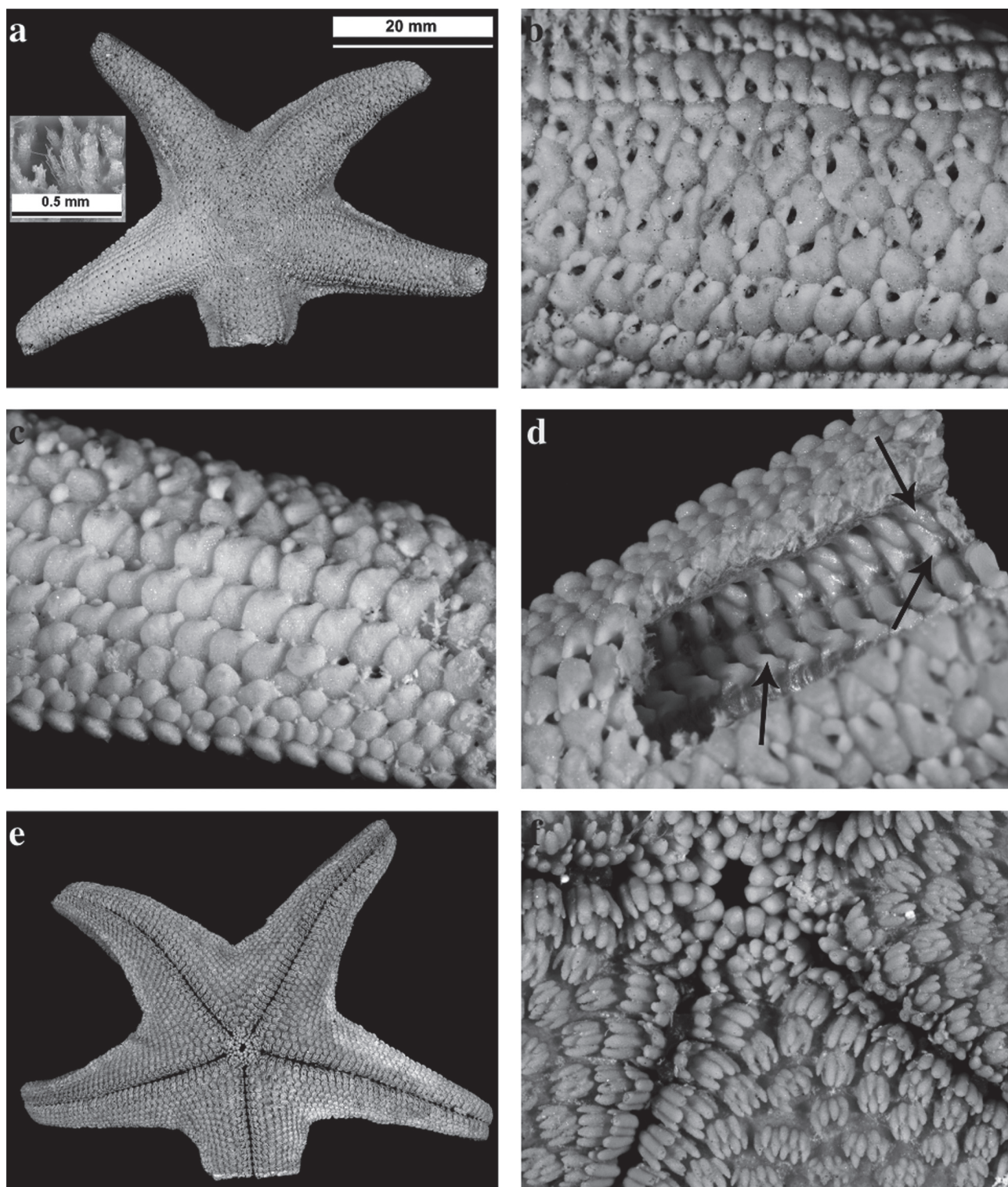


Figure 4. *Callopatiria cabrinovici* sp. nov. (photos by L. Altoff and A. Falconer). Holotype, NHM 1965.6.1.743 (R = 27–35 mm). a, abactinal view, insert showing spinelets. b, cleared proximal upper ray showing “field” of irregular singly papulate primary and few secondary plates. c, lateral view of cleared ray showing longitudinal series of plates, and superomarginal and inferomarginal series of plates. d, cleared ray with section of abactinal plates removed, showing superactinal plates (upper right arrow), superambulacral plates (lower right arrow) and ambulacral plates (left arrow). e, actinal surface showing longitudinal series of actinal plates. f, oral, suboral, furrow, subambulacral and proximal actinal spines.

to 5 longitudinal series of plates and papulae along each side of rays, frequently in transverse series also; spinelets glassy, columnar, thick to thin, splay-pointed, frequently widened terminally, some narrowed terminally; up to about 40 spinelets in narrow band 2–3 spinelets wide across projecting edge of proximal ray plates, spinelets not in discrete tufts; proximal ray spinelets up to about 0.4 mm long; distal interradius with up to about 16 splayed spinelets per plate, ends rarely overlapping those of adjacent plates; glassy convexities sometimes evident around base of plates.

Margin: superomarginal and inferomarginal plates in regular series; inferomarginals noticeably larger than superomarginals; inferomarginals project only slightly; alignment of superomarginals with inferomarginals frequently broken by presence of additional superomarginal plate; superomarginals with up to about 16 typical abactinal spinelets; inferomarginals with up to about 26 spinelets, proximally similar to superomarginal spinelets, distally stout digitiform.

Actinal: plates in longitudinal series parallel to ambulacrum; adradial actinal plates in complete series. Actinal spines per plate: oral 6, thick wedge-like proximally, slight gradation in size from proximal to distal; suboral 6–9, big gradation in size; furrow 6; subambulacral 6–8 in curved series, small at edges; adradial actinal up to about 10; interradii up to about 10 in clusters over crest of plate. Interradii spines thick digitiform and thin, opaque, rugose, bluntly rounded to pointed distally. Lacking actinal gonopores.

Distribution. East African coast, Zanzibar, Kenya, rock substrate, shallow sub-littoral; Oman, coral reef.

Etymology. Named for Andrew Cabrinovic (Natural History Museum, London), with appreciation of his gracious assistance in facilitating loans to Museum Victoria for this and previous studies.

Remarks. The generic diagnostic characters (in O'Loughlin and Waters, 2004) of *Callopatiria* Verrill, 1913 that are shared by the new species are: 5 discrete rays; rays long, stellate form; sides of rays close to perpendicular above angular margin; rays broadly flat actinally, high convex abactinally; irregular arrangement of upper ray plates; abactinal plates crescentiform; abactinal plates covered by narrow band of numerous elongate glassy spinelets; absence of pedicellariae; secondary plates in papular spaces; inferomarginals project only slightly; numerous digitiform actinal spines per plate; presence of series of superambulacral plates; numerous superactinal plates fill the interradii angular margin of the rays, contiguous with superambulacral plates for most of ray length; interior resinous body lining.

Callopatiria cabrinovici sp. nov. differs from *C. granifera* (Gray, 1847), the type species for *Callopatiria* (distribution South Africa, from Namibia to Natal), by having: small papular spaces with predominantly single papula and secondary plate per papular space (not up to about 10); superomarginal plates smaller than inferomarginals (not subequal); actinal plates in longitudinal series (not oblique); more numerous suboral spines per plate (more than up to 6); more numerous furrow and subambulacral spines per plate (more than 4). *C.*

cabrinovici sp. nov. differs from *C. formosa* (Mortensen, 1933) (type locality False Bay, South Africa) by lacking the enlarged, rounded, distal abactinal plates that are mostly bare of spinelets; by having more numerous actinal spines (more than 3–4 furrow and subambulacral spines, more than 7 actinal interradii spines).

The specimen from Oman is in poor condition, but is judged with some uncertainty to belong to the new species. The other two specimens that are not nominated as types are small, and do not show the diagnostic characters as distinctively as the larger specimens, but they are also judged with some uncertainty to belong to the new species.

Rowe and Richmond (2004) discussed the occurrence of asterinid species from the western Indian Ocean. They recognized two undescribed species from Rodrigues, and these have subsequently been described by O'Loughlin and Rowe (2006) as *Aquilonastra conandae* and *Aquilonastra richmondi*. Reference was made by Rowe and Richmond (2004) to two specimens from Zanzibar, thought by A.M. Clark to be “possibly referable to *Paranepanthia* Fisher” (discussed fully in note 89 on pages 68–71 in Clark and Rowe 1971). Three NHM specimens that were examined in this work (see above) are from Watamu (Kenya) and had been determined as *Paranepanthia*. These specimens, and others from Kenya and Zanzibar (see above) that had been determined as *Asterina burtoni*, are referred here to the new species *Callopatiria cabrinovici*.

Tegulaster leptalacantha (H.L. Clark, 1916)

Figure 5a–f

Asterina leptalacantha H.L. Clark, 1916: 57–58, pl. 18 figs. 3–4.

Disasterina leptalacantha.—Livingstone, 1933: 6, 8–10, pl. 3 figs. 5–6, pl. 4 figs. 1, 4.—H.L. Clark, 1946: 139.—A.M. Clark and Rowe, 1971: 38–39, 67.—Rowe and Gates, 1995: 36.

Disasterina leptalacantha var. *africana* Mortensen, 1933: 259–260, pl. 12 fig. 3.—A.M. Clark and Courtman-Stock, 1976: 78.

Tegulaster leptalacantha.—O'Loughlin and Waters, 2004: 13, 35–36.

Material examined. *Disasterina leptalacantha*. Holotype: NE Australia, Queensland, Capricorn Group, Masthead I., littoral, Dec 1913, AM J3082.

Disasterina leptalacantha var. *africana*. Syntype: South Africa, Natal, off Tugela River, 366 m, S.A.M. A22559 (1).

Other material. NE Queensland, AM J6097 (1); AM J12488 (1); Indian Ocean, Mauritius I., Cape Malheureux, down to 24 m, UF 2499 (1); La Réunion I., Saint Leu, C. Conand, 22 Mar 2003, NMV F109364 (3); NMV F109367 (4); S Madagascar, Mission Decary, MNHN EcAs11856 (1); E South Africa, Sodwana Bay, 11 m, MRAC 1746 (1); 14 m, MRAC 1744 (2); Trafalgar Marine Reserve, 14 m, MRAC 1745 (1).

Description. Thick integument body cover; rays 5, discrete, medium length, wide base, tapered, blunt to narrowly rounded distally, elevated, steep sides, acute thin margin, up to R = 24.5 mm; single madreporite; abactinal gonopores; superambulacral and superactinal plates present.

Abactinal: plates predominantly bare, thick, frequently with raised domes, generally closely imbricate, rarely spaced creating non-plated areas, upper ray plates irregular in size, form, arrangement, regular longitudinal series along sides of

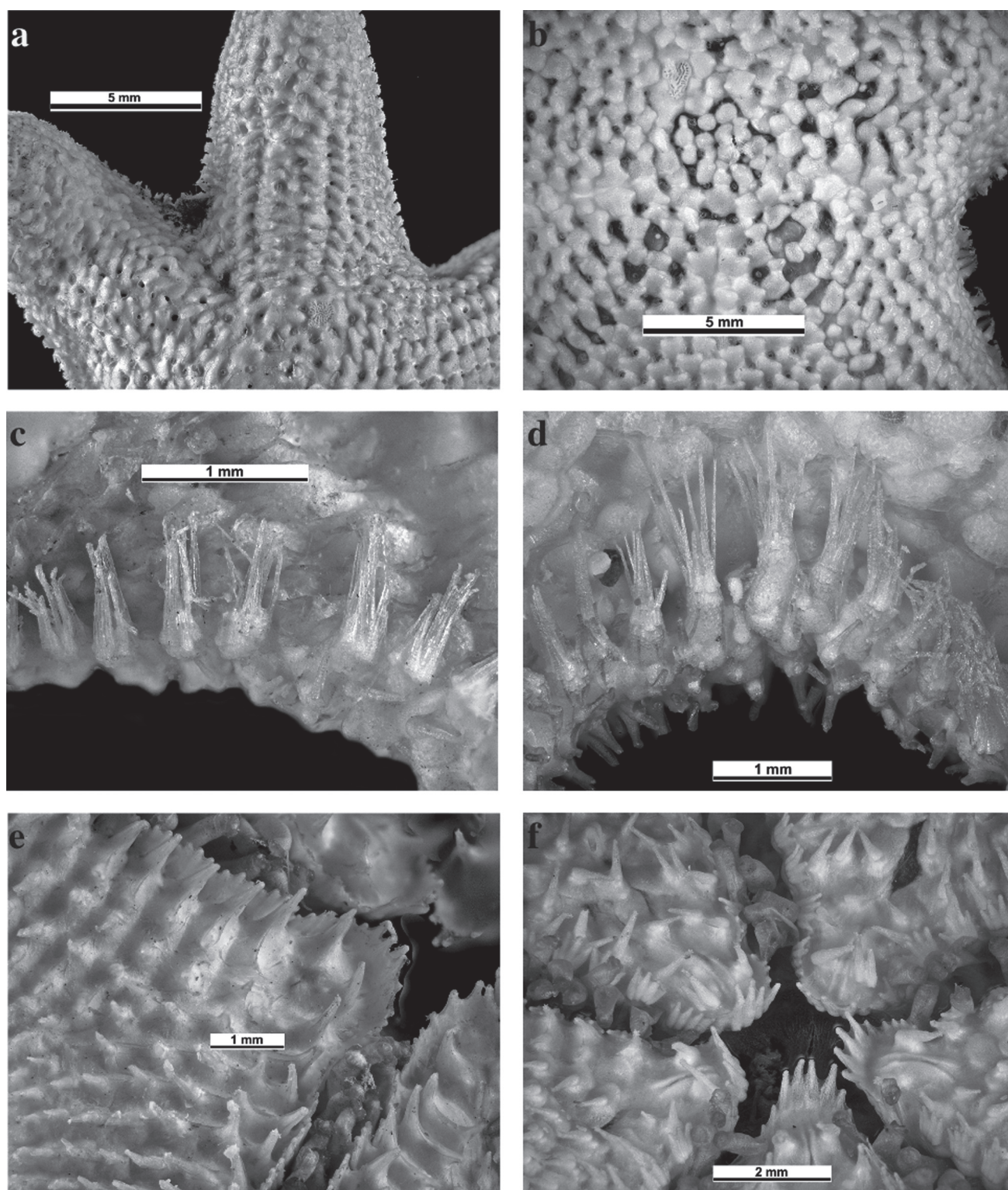


Figure 5. *Tegulaster leptalacantha* (H.L. Clark, 1916) (photos by C. Rowley). a, c, e, *Disasterina leptalacantha* var. *africana* Mortensen, 1933, syntype, S.A.M. A22559 (R = 16 mm). a, abactinal surface (not cleared). c, tufts of acicular inferomarginal spinelets. e, oral, suboral, furrow, subambulacral and proximal actinal spines. *Tegulaster leptalacantha*, b, d, f, Sodwana Bay specimens. b, disc and proximal abactinal surface (not cleared; MRAC 1746; R = 17 mm). d, tufts of acicular inferomarginal spinelets (MRAC 1744; R = 18 mm). f, oral, suboral, furrow, subambulacral and proximal actinal spines (MRAC 1746; R = 17 mm)

rays, lower ray plates indented proximally for papula; lacking distinct secondary plates; papulae large, single, irregular along upper ray, sometimes doubly papulate carinal plates mid-ray, up to 3 longitudinal series long each side of ray, up to 8 longitudinal series across mid-ray; disc variably bordered by 5 radial, 5 interradial plates; small subsacciform spinelets sometimes present perianally, on disc, around madreporite; long acicular spinelets sometimes on distal interradial; up to few small granular or subsacciform or conical spinelets on abactinal plates of small specimens (R = 5 mm); glassy convexities on plates.

Margin: superomarginal plates of variable size and regularity as series, bare except small specimens with single, small, conical glassy spinelets; inferomarginal plates project, plates sometimes with constricted waist, distal tuft of up to 10 and more glassy, long, acicular subsacciform spinelets, up to 1.5 mm long.

Actinal: interradial plates in oblique series. Actinal spines per plate: oral 8–9, strongly tapered series; suboral 1 (sometimes small additional distal one); furrow 5, short; subambulacral 1, long; adradial actinal 1; actinal interradial 1; spines long, tapering to thin, sacciform.

Distribution. NE Australia, Mauritius I., La Réunion Is., Madagascar, E South Africa, 0–366 m.

Remarks. Mortensen (1933) observed only minor morphological differences between the type and the two South Africa specimens on which he based his variety. Amongst these differences he noted that there were only five oral spines in the type, but seven in the variety. The type has eight oral spines, and eight and nine were observed on the specimen of the variety from Natal. Mortensen (1933) erected the variety “mainly for zoogeographical reasons” since the type locality for *Tegulaster leptalacantha* is Queensland (NE Australia). In O’Loughlin and Waters (2004) I determined material from Mauritius as *T. leptalacantha*, and judged that the variety was not justified. I confirm that opinion here. In O’Loughlin and Waters (2004) I reassigned *Disasterina leptalacantha* to *Tegulaster* Livingstone, 1933. I confirm the morphological grounds for the reassignment here. The diagnostic characteristics of *Tegulaster leptalacantha* are: 5 discrete, high, tapered rays; thick integument evident over body; predominantly bare abactinal plates; abactinal plates frequently with rounded domes; actinal plates in oblique series; single long sacciform spines on each actinal interradial plate; inferomarginal plates with distal dense tufts of long, glassy, acicular subsacciform spinelets; superambulacral and superactinal plates present.

Tegulaster leptalacantha is distinguished from all other species of *Tegulaster* by having a tuft of long acicular sacciform spinelets on each inferomarginal plate; and is also distinguished in particular from *T. emburyi* Livingstone, 1933 (type species for *Tegulaster*; type locality Queensland) by having single suboral and actinal interradial spines per plate, from *T. alba* (H.L. Clark, 1938) (type locality Lord Howe I.) by having abactinal gonopores, and from *T. praesignis* (Livingstone, 1933) (type locality Queensland) by having bare superomarginal plates (see O’Loughlin and Waters, 2004 for these and other distinguishing characters).

Acknowledgments

I am most grateful for the generous assistance of: Leon Altoff and Audrey Falconer (Marine Research Group of the Field Naturalists Club of Victoria, for some photography); Nadia Améziane and Marc Eleaume (MNHN, for facilitating loan material); Andrew Cabrinovic (NHM, for facilitating loan material); Chantal Conand (Emeritus Professor at La Réunion University, for donation of specimens to NMV); Caroline Harding (NMV, for preparation of figures); Karen Gowlett-Holmes (colour photo of WAM paratype live); Liz Hoenson (S.A.M., for facilitating loan material); Loiset Marsh and Mark Salotti (WAM, for facilitating loan material); Gustav Paulay (UF, for facilitating loan material); Frank Rowe (formerly of the AM, for collaboration in earlier stages of this on-going research); Chris Rowley (NMV, for montage photography); Ahmed Thandar (University of KwaZulu-Natal, for donation of a specimen to NMV and facilitating communication with the S.A.M.); Didier VandenSpiegel MRAC, for facilitating loan material). I am pleased to acknowledge the Coral Reef Research Foundation, under contract to the US National Cancer Institute contract no. N01-CM-27704, for sponsorship of fieldwork by the University of Florida that yielded specimens studied in this work. I am most appreciative of the critical review of this paper by Frank Rowe.

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