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New asterinid seastars from the western Pacific Ocean (Echinodermata: Asteroidea)

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Abstract

O'Loughlin, P.M. and Bribiesca-Contreras, G. 2017. New asterinid seastars from the Pacific Ocean (Echinodermata: Asteroidea). *Memoirs of Museum Victoria* 76: 121–132.

Three new *Aquilonastra* O'Loughlin (in O'Loughlin and Waters, 2004) species are described: *Aquilonastra donia* sp. nov. for New Caledonia, lodged in the Muséum national d'Histoire naturelle in Paris; *Aquilonastra korora* sp. nov. and *Aquilonastra starmeri* sp. nov., both for Palau and lodged in the Florida Museum of Natural History.

Keywords

New Caledonia, Palau, *Aquilonastra*, new species.

Introduction

O'Loughlin and Waters (2004) provided a comprehensive revision of genera of Asterinidae based on morphological and limited molecular genetic data. Within this work they established the new genus *Aquilonastra* O'Loughlin and provided a key to Asterinidae genera. O'Loughlin and Rowe (2006) revised genus *Aquilonastra* based on morphological observations. Thirteen new species were described and a key to *Aquilonastra* species was provided. O'Loughlin (2009), O'Loughlin and Mackenzie (2013), and O'Loughlin and Bribiesca-Contreras (2015) added new species of *Aquilonastra*. O'Loughlin and Bribiesca-Contreras (2015) provided a revised key to *Aquilonastra* species. We recognise the need for further revision of Asterinidae based on comprehensive genetic data. We assign the current new species from the Pacific Ocean to *Aquilonastra* based on morphological observations only, and acknowledge some uncertainty with these assignments.

Methods

For photography purposes, the alcohol-preserved specimen was allowed to partly air-dry. Photographs were taken using a Cannon 5D Mark II camera with a Cannon 65 mm macro lens and a 100 mm lens. Series of photographs were taken and stacked using the Zerene Stacker software.

After assembling the whole-specimen montage photographs, a ray from each of the three type specimens was cut off for the purpose of observing external and internal skeletal structure. The distal end of each of these three cut-off arms was cleared briefly in bleach and then washed in water. Photographs were taken to show internal skeletal structures.

Definitions and illustrations of terms

For definitions and illustrations of terms used, such as superactinal plates, superambulacral plates, sacciform spinelets and splay-pointed spinelets, see O'Loughlin and Waters (2004).

Abbreviations

MNHN Muséum national d'Histoire naturelle.

UF Florida Museum of Natural History, University of Florida.

Asterinidae Gray, 1840

Synonymy. See Clark and Downey, 1992.

Diagnosis. See Clark and Downey, 1992.

Remarks. For a recent revision of Asterinidae, see O'Loughlin and Waters (2004). For the addition of genus *Ailsastra*, see O'Loughlin and Rowe (2005).

Aquilonastra O'Loughlin, 2004 (in O'Loughlin and Waters, 2004)

Aquilonastra O'Loughlin, in O'Loughlin and Waters, 2004: 5 (key to genus), 13–15, tables 1, 2.—O'Loughlin and Rowe, 2005: 181.—Saba and Fujita, 2006: 270.—Byrne, 2006: 244, 245, 248, 250, 251.—O'Loughlin and Rowe, 2006: 257–287 (key to species).—O'Loughlin, 2009: 204, fig. 1.—O'Loughlin and Mackenzie, 2013: 177–180, figs 1, 2.—O'Loughlin and Bribiesca-Contreras, 2015: 33–46, figs 1–8 (revised key to species).

Diagnosis (from O'Loughlin and Bribiesca-Contreras, 2015). Rays 5, or 5–8 in fissiparous species; inter-radial margin deeply

incurved, form stellate; rays discrete, broad at base, tapering, rounded distally; flat actinally, convex abactinally; abactinal plates in longitudinal series, not perpendicular to margin; papulate areas extensive; papulae predominantly single, large, in longitudinal series along sides of rays; abactinal plates with glassy convexities; abactinal spinelets and actinal spines predominantly fine, glassy, conical or sacciform or splay-pointed sacciform, in bands or tufts, numerous (10–40 per plate); actinal plates in longitudinal, sometimes oblique, series; superambulacral plates present for all of ray, sometimes for part of ray or absent in paedomorphic species; superactinal plates present.

Remarks. We have not further revised the morphological diagnosis of genus *Aquilonastra* to accord with variations observed here, such as a shallow incurved junction of rays in two of the species below and the absence of superambulacral plates in one of the species below. We anticipate a necessary extensive revision when adequate genetic data become available.

***Aquilonastra donia* sp. nov.**

Zoobank LSID. <http://zoobank.org/urn:lsid:zoobank.org:act:41D2993-A090-4D51-A8B9-C15A29B271B3>

Figures 1, 2, 3a–d.

Material examined. Holotype. New Caledonia, Yaté reef flat, coll. Gaillande, July 1970, MNHN-IE-2014-641 (original registration MNHN EcAs11855) (dry; many spinelets and pedicellariae lost with handling over time).

Description. Asterinid seastar, five sub-equal rays, rays wide basally, bluntly rounded distally, $R = 22$ mm, $r = 15$ mm, rays merge at bases, inter-radial junction of rays shallow in-curved, central rays elevated and rounded abactinally, distinct broad inter-radial low non-papulate apron marginally, rays flat actinally, margin acute. No abactinal or actinal gonopores detected. Single madreporite. Not fissiparous. Superomarginal and inferomarginal plates sub-equal, superomarginal plates in discrete series, slightly larger than adjacent distal abactinal plates, inferomarginal plates projecting outwards. Broad low marginal apron up to 7 plates across longitudinally, supported by internal superactinal plates; superambulacral plates present, small. Glassy convexities on cleared abactinal and actinal plates.

Abactinal: disc discrete, small, demarcated irregularly by 5 wide doubly papulate radial plates and 5 smaller inter-radial plates; single conspicuous madreporite, above junction of bases of two rays; pedicellariae present inter-radially, proximally and distally, conspicuous, frequently longer than adjacent spinelets, each comprising two stout, in-curved pointed conical teeth, present on proximal edges of inter-radial plates over concave indentation for papula; abactinal plates imbricate, indented proximally for single papula; no regular carinal series of plates, but a few doubly papulate carinal plates along some proximal upper rays; few small secondary plates on disc, rays and marginal apron; abactinal papular plates in about 7 longitudinal series down each side of each ray, plates with elevated rounded proximal edge, about 20 papular plates in uppermost series, 1–2 in lowest series; distal inter-radial plates on apron in longitudinal series parallel to the rays and oblique curved series from the ray to the margin.

Abactinal spinelets readily lost: up to at least 20 digitiform spinelets over crown of proximal plates, not in tufts, distal spinelets slender conical to subsacciform; up to about 5 slender conical spinelets per superomarginal plate.

Actinal: inter-radial plates in longitudinal series parallel to the ambulacrum and oblique transverse series from the ambulacrum to the margin. Actinal spines per plate: oral 6, long digitiform to conical proximally, to short distally; sub-oral about 5, long conical proximally to short distally; furrow 4–5 long conical; subambulacral 4–5 long conical; actinal 2–3, mostly 2, long conical; inferomarginal up to about 16, thick digitiform actinally to thin conical subsacciform abactinally.

Distribution. New Caledonia, reef flat.

Etymology. Original collection record is New Hebrides, now New Caledonia, and named for the *donia* ending to Caledonia.

Remarks. The long abactinal pedicellariae, with 2 conical pointed and curved valves that are frequently longer than adjacent spinelets, and actinal inter-radial plates with predominantly 2 spines, are distinguishing feature of *Aquilonastra donia* sp. nov. Other *Aquilonastra* species with prominent pedicellariae with differentiated valves (teeth) are distinguished by: *Aquilonastra anomala* (H.L. Clark, 1921) is fissiparous with multiple madreporites; *Aquilonastra batheri* (Goto, 1914) has tufts of splayed abactinal spinelets, and up to 12 actinal inter-radial spines; *Aquilonastra corallicola* (Marsh, 1977) is fissiparous and has two different forms of spinelets on the paxilliform upper ray plates; *Aquilonastra coronata* (Martens, 1866) has irregularly distributed high paxilliform abactinal plates with two different forms of spinelets; *Aquilonastra iranica* (Mortensen, 1940) has up to 5 doubly papulate proximal carinal plates and the spinelets on proximal abactinal plates are in small groups; *Aquilonastra richmondi* O'Loughlin and Rowe, 2006 has spinelets of two forms on abactinal plates; *Aquilonastra rowleyi* O'Loughlin and Rowe, 2006 has a disc that is delineated by a dense band of spinelets on wide radial plates, each plate with about 100 long thin pencil-like glassy spinelets; *Aquilonastra shirleyae* O'Loughlin, 2009 has spinelets in splayed clusters and up to 10 actinal inter-radial spines per plate; *Aquilonastra watersi* O'Loughlin and Rowe, 2006 has abactinal spinelets in clusters.

***Aquilonastra korora* sp. nov.**

Zoobank LSID. <http://zoobank.org/urn:lsid:zoobank.org:act:765787CA-CF22-4FF5-8637-497D9E9FA85D>

Figures 4, 5, 6a–d.

Material examined. Holotype. Palau, Koror, Mutremdiu reef, rock, 30 m, coll. J. Starmer, 19 Aug 1995, code BEL–276, UF 2437 (fixed in formalin, dry; many spinelets and pedicellariae lost with handling over time).

Description. Asterinid seastar, five sub-equal rays nearly digitiform, rays wide basally, narrowly rounded to pointed distally, $R = 25$ mm, $r = 10$ mm, rays merge at bases, inter-radial junction of rays deeply in-curved, central rays elevated and rounded abactinally, weakly evident low sloping distal abactinal margin, no distinct apron; rays flat actinally, margin acute. Abactinal gonopores detected. Single madreporite. Not



Figure 1. Montage photograph of the holotype of *Aquilonastra donia* sp. nov. (MNHN-IE-2014-641). Abactinal view showing five sub-equal rays, distinct low marginal apron, absence of carinal series of plates, presence of rare doubly papulate carinal plates, and single large madreporite. The abactinal plates have become denuded of most spinelets over time.



Figure 2. Montage photograph of the holotype of *Aquilonastra donia* sp. nov. (MNHN-IE-2014-641). Actinal view showing five sub-equal rays, spination, longitudinal and oblique-transverse series of actinal plates.

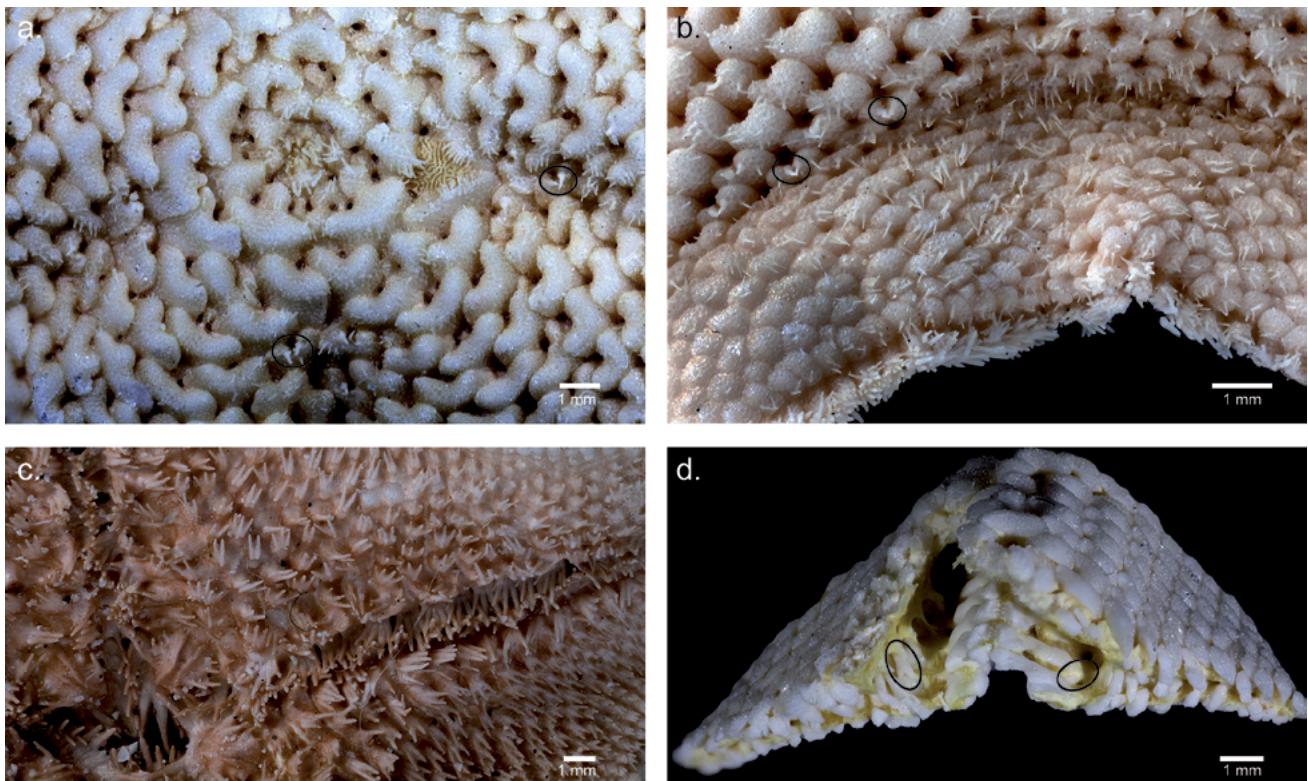


Figure 3. Montage photographs of the holotype of *Aquilonastra donia* sp. nov. (MNHN-IE-2014-641): a, abactinal view of disc, single large madreporite, some remaining digitiform spinelets, and pedicellariae (highlighted); b, abactinal details of distal interradius showing pedicellariae (highlighted), and conical to sub-sacciform spinelets on apron; c, actinal view showing oral, suboral, furrow and inter-radial spines; d, transverse section of a ray with superactinal (highlighted left) and superambulacral plates (highlighted right).

fissiparous. Fairly irregular series of supermarginal plates, subequal with adjacent abactinal and inferomarginal plates, inferomarginal plates project narrowly outwards. Narrow sloping margin up to about 5 plates across longitudinally, supported by some internal superactinal plates, distal marginal abactinal and actinal plates contiguous internally; superambulacral plates absent with tissue strengthening only of junction internally between ambulacral and actinal plates. Glassy convexities on cleared abactinal and actinal plates.

Abactinal: disc discrete, small, demarcated irregularly by 5 bean-shaped non-papulate radial plates and 5 slightly smaller inter-radial plates, disc plates papulate, distal abactinal plates on rays not papulate; single conspicuous madreporite, above junction of bases of two rays; pedicellariae present interradially, proximally, low, not conspicuous, each comprising two short thick blunt teeth, present on proximal edges of inter-radial plates over concave indentations for papulae; abactinal plates imbricate, indented proximally for predominantly 1 rarely 2 papulae; no regular carinal series of plates, rare doubly papulate carinal plates present; rare small secondary plates on disc and proximal upper rays; abactinal plates in about 3 longitudinal series down each side of each ray, plates with elevated rounded proximal edge, up to about 20 papular plates in uppermost series, about 10 in mid-series, about 4–7 in lowest

series; distal inter-radial plates in longitudinal and irregularly distributed oblique series. Abactinal spinelets readily lost; abactinal spinelets finely sacciform with needle-like long taper, up to at about 16 spinelets across proximal raised edge of proximal plates, not in tufts, distal spinelets slender conical to subsacciform; up to about 2–3 small fine sacciform acicular spinelets on crowns of supermarginal plates.

Actinal: inter-radial plates in longitudinal series parallel to the ambulacrum, distal inter-radials irregular in distribution. Actinal spines per plate: oral up to 9, long conical proximally, to short distally; suboral up to 6, 3 long conical proximally, 2–3 shorter on each side of plate distally; furrow 5–6 conical subsacciform, 2 long apically, 1–2 short laterally on each side of plate; subambulacral up to 8, 2 long subsacciform conical apically, 3 short conical on each side of plate; actinal predominantly 2, subsacciform conical; inferomarginal predominantly about 5 sacciform.

Distribution. Palau, rocky reef, 30 m.

Etymology. Named *korora* for Koror, the state in Palau where the type was collected.

Remarks. A diagnostic character of genus *Aquilonastra* is the presence of superambulacral plates. *Aquilonastra korora* sp.



Figure 4. Montage photograph of the holotype of *Aquilonastra korora* sp. nov. (UF 2437). Abactinal view showing residual colouration, five sub-equal digitiform rays, absence of carinal series of plates, single large madreporite (lower arrow) and at least one conspicuous abactinal gonopore (upper arrow). The abactinal plates have become denuded of most spinelets over time.



Figure 5. Montage photograph of the holotype of *Aquilonastra korora* sp. nov. (UF 2437). Actinal view showing residual actinal colouration, five sub-equal rays, spination, longitudinal and oblique-transverse series of actinal plates with irregular distal inter-radials.

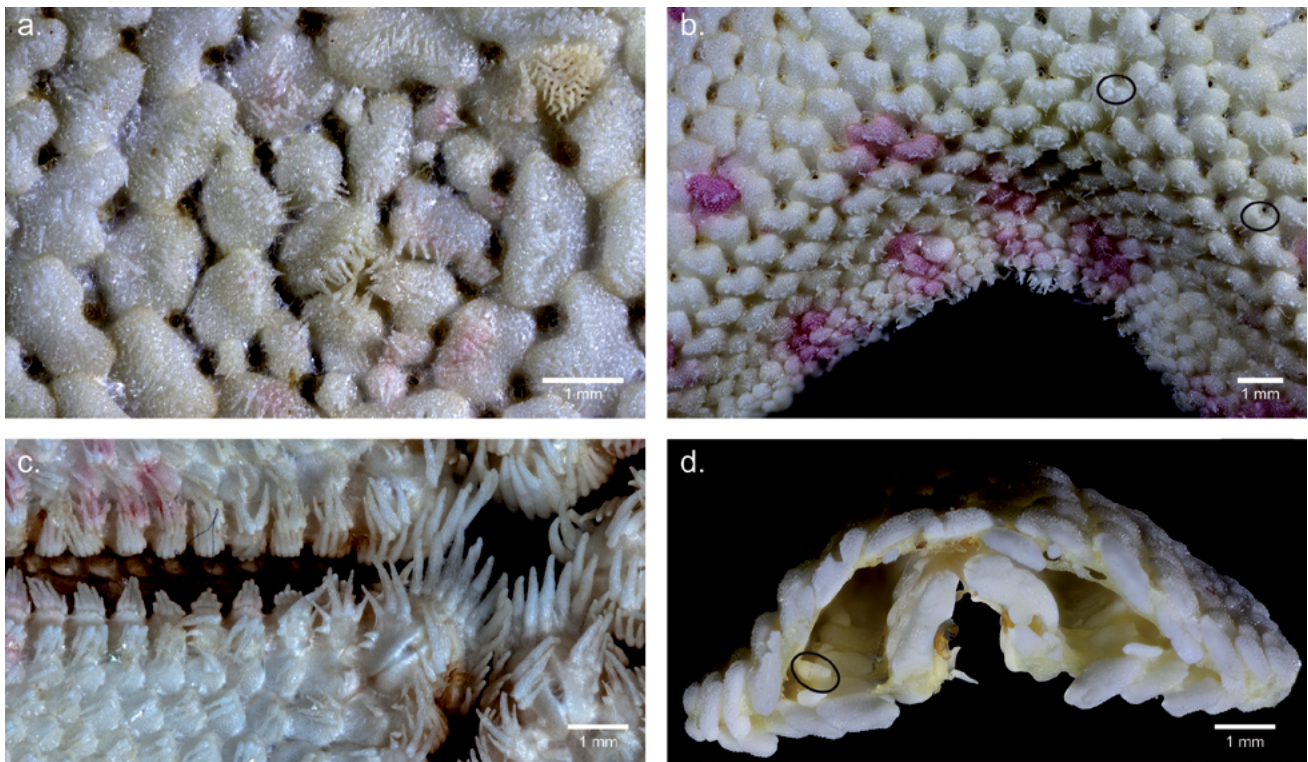


Figure 6. Montage photographs of the holotype of *Aquilonastra korora* sp. nov. (UF 2437): a, abactinal view of disc, showing disc plate arrangement, single large madreporite (top right), sacciform spinelets; b, abactinal details of distal interradius showing short blunt pedicellariae (highlighted) and residual slender conical, sub-sacciform and sacciform spinelets; c, actinal view showing oral, suboral, furrow and actinal interradial spines; d, transverse section of a ray with a superactinal plate highlighted.

nov. is thus unique among *Aquilonastra* species in lacking such plates, but the species conforms well in most ways with the diagnosis of the genus and is assigned to this genus, with reservations, as the most appropriate existing genus. The presence of low pedicellariae with two short thick blunt teeth and predominantly 2 actinal inter-radial spines per plate are distinguishing characters. There are additional characters that distinguish *Aquilonastra korora* sp. nov. from other *Aquilonastra* species that have distinctive pedicellariae: *Aquilonastra anomala* (Clark, 1921) and *Aquilonastra corallicola* (Marsh, 1977) have up to 8 rays and are fissiparous with multiple madreporites; *Aquilonastra batheri* (Goto, 1914) has tufts of splayed abactinal spinelets and up to 12 actinal inter-radial spines; *Aquilonastra coronata* (Martens, 1866) has irregularly distributed high paxilliform abactinal plates with two different forms of spinelets; *Aquilonastra iranica* (Mortensen, 1940) has up to 5 doubly papulate proximal carinal plates and the spinelets on proximal abactinal plates are in clusters; *Aquilonastra rowleyi* O'Loughlin and Rowe, 2006 has a disc that is delineated by a dense band of spinelets on wide radial plates, each plate with about 100 long thin pencil-like glassy spinelets; *Aquilonastra shirleyae* O'Loughlin, 2009 has spinelets in splayed clusters and up to 10 actinal inter-radial spines per plate; *Aquilonastra watersi* O'Loughlin and Rowe, 2006 has pedicellariae with differentiated valves but has

doubly papulate proximal carinal plates and abactinal spinelets in clusters. All of these species have superambulacral plates. We note that *Aquilonastra corallicola* was described for Palau.

Aquilonastra starmeri sp. nov.

Zoobank LSID. <http://zoobank.org/urn:lsid:zoobank.org:act:8B1FF925-A45F-4268-BDFE-C5F262C420D2>

Figures 7, 8, 9a–d.

Material examined. Holotype. Palau, off NE Ngeryktabe Island, rocky islets, 7° 18.26' N, 134° 27.25' E, 10 m, coll. J. Starmer, 5 Mar 2003, code BPAL-081, photo GP 954, UF 1612 (in 75% ethanol; many spinelets lost with handling over time).

Description. Asterinid seastar, five sub-equal rays, rays wide basally, bluntly rounded distally, R = 20 mm, r = 12 mm, rays merge at bases, inter-radial junction of rays with shallow incurve, central rays with high elevation and rounded abactinally, distinct broad inter-radial low non-papulate apron marginally, up to about 7 plates wide longitudinally, rays flat actinally, margin acute. Not fissiparous. No abactinal or actinal gonopores detected. No pedicellariae detected. Superomarginal plates in irregular series, slightly smaller than projecting inferomarginal plates, subequal in size with adjacent irregular apron plates. Broad low proximal marginal apron supported by internal superactinal plates, outer marginal apron supported by



Figure 7. Montage photograph of the holotype of *Aquilonastra starmeri* sp. nov. (UF 1612). Abactinal view showing five sub-equal rays, distinct marginal apron, lacking carinal series of plates, single large madreporite. The abactinal plates have become denuded of most spinelets over time.



Figure 8. Montage photograph of the holotype of *Aquilonastra starmeri* sp. nov. (UF 1612). Actinal view showing five sub-equal rays, spination, longitudinal and oblique-transverse series of actinal plates.

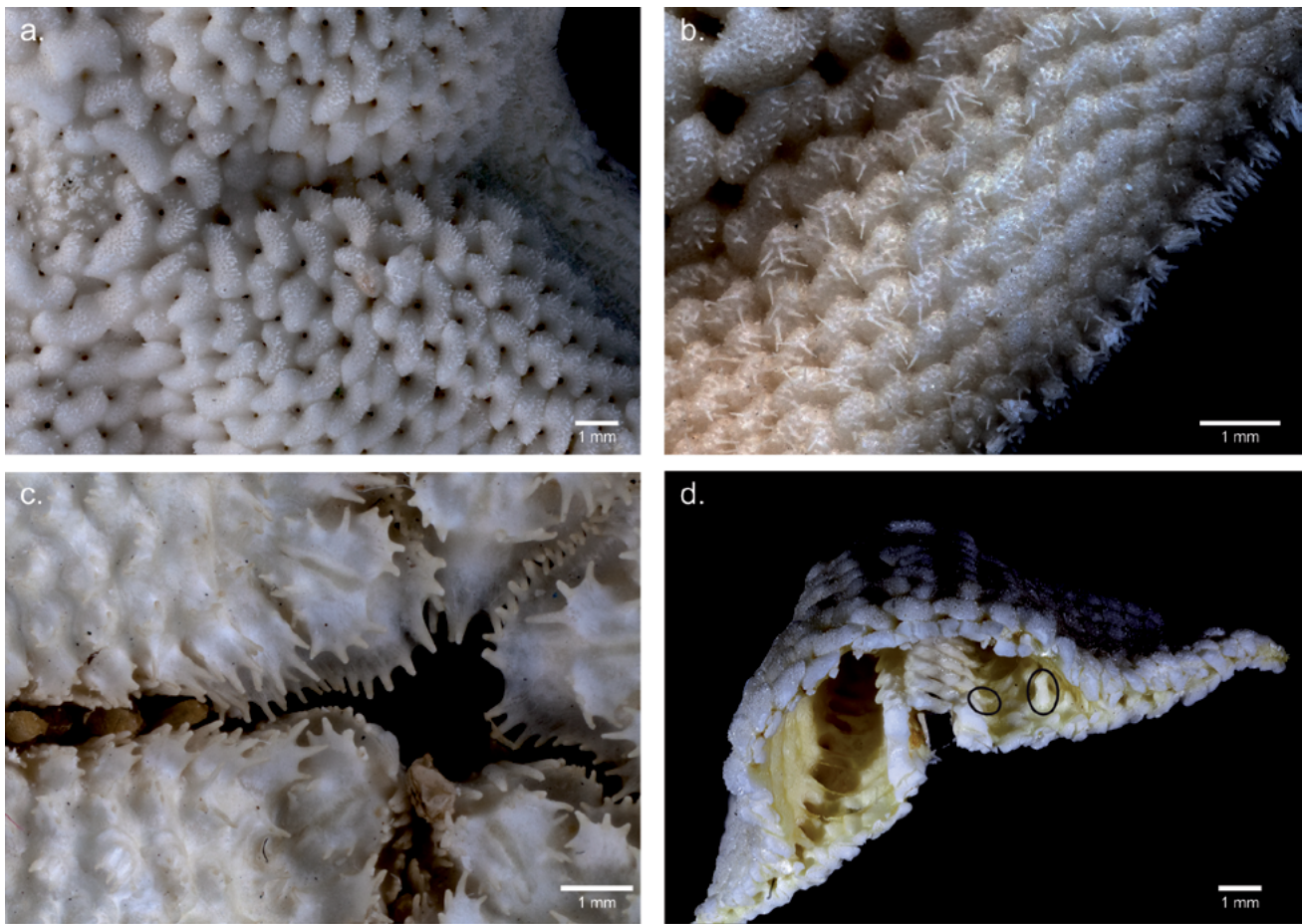


Figure 9. Montage photographs of the holotype of *Aquilonastra starmeri* sp. nov. (UF 1612): a, abactinal view of disc (left) and proximal ray plates with short conical to digitiform spinelets; b, abactinal details of distal interradius showing acicular conical to subsacciform spinelets on apron, and supero- and inferomarginal plates; c, actinal view showing oral, suboral, furrow and actinal interradial spines; d, transverse section of a ray with superambulacral plate (left) and superactinal plate (right) highlighted.

contiguous abactinal and actinal plates; some small superambulacral plates present. Glassy convexities on cleared abactinal and actinal plates.

Abactinal: disc discrete, small, demarcated irregularly by 5 wide doubly or singly papulate radial plates and 5 smaller inter-radial plates; single conspicuous madreporite, above junction of bases of two rays. Abactinal plates imbricate, indented proximally for single papula, rarely 2; no carinal series of plates, only one doubly papulate carinal plate; small secondary plates on disc and few abactinally; abactinal plates in about 6 longitudinal series down each side of each ray, plates with elevated rounded proximal edge, about 20 papular plates in uppermost series, 1–3 in lowest series. Surface of abactinal plates covered with up to about 40 short conical to digitiform spinelets, not sacciform, not clustered, spinelets readily lost; spinelets on abactinal apron acicular, conical, subsacciform, about 6 per plate; superomarginal plates with fewer spinelets.

Actinal: inter-radial plates in longitudinal and oblique transverse series from the ambulacrum. Actinal spines per

plate: oral 11, long conical, fused basally, shorter distally; sub-oral about 8, long conical proximally to short distally; furrow 5, conical, fused basally; subambulacral 4, conical, fused basally; actinal 3–5, conical, fused basally; inferomarginal up to about 12, digitiform, short actinally.

Distribution. Palau, off NE Ngeryktabe Island, rocky islets, 10 m.

Etymology. Named for John Starmer who collected and documented the type specimen.

Remarks. *Aquilonastra starmeri* sp. nov. is distinguished from many *Aquilonastra* species by lacking pedicellariae, lacking carinal series of plates and having a non-fissiparous habit. *Aquilonastra* species that lack pedicellariae but are fissiparous are: *Aquilonastra burtoni* (Gray, 1840); *Aquilonastra cassini* O’Loughlin and Bribiesca-Contreras, 2015; *Aquilonastra chantalae* O’Loughlin and Mackenzie, 2013; *Aquilonastra colemani* O’Loughlin and Rowe, 2006; *Aquilonastra conandae* O’Loughlin and Rowe, 2006; *Aquilonastra doranae* O’Loughlin and Rowe, 2006; *Aquilonastra moosleitneri* O’Loughlin and

Rowe, 2006; *Aquilonastra yairi* O'Loughlin and Rowe, 2006. *Aquilonastra starmeri* sp. nov. has 3–5 actinal inter-radial spines per plate and is thus distinguished from those with up to eight and more: *Aquilonastra byrneae* O'Loughlin and Rowe, 2006; *Aquilonastra cepheus* (Müller and Troschel, 1834); *Aquilonastra limboonkengi* (Smith, 1927); *Aquilonastra samyni* O'Loughlin and Rowe, 2006. *Aquilonastra starmeri* sp. nov. has uniformly rounded rays abactinally and is distinguished from those with paxilliform rays: *Aquilonastra lorioli* (Koehler, 1910); *Aquilonastra minor* (Hayashi, 1974); *Aquilonastra rosea* (H.L. Clark, 1938). *Aquilonastra starmeri* sp. nov. is distinguished from the remaining species assigned to *Aquilonastra* that are not fissiparous and lack prominent pedicellariae as follows: *Aquilonastra alisonae* O'Loughlin and Bribiesca-Contreras, 2015 has splay-pointed abactinal spinelets; *Aquilonastra halseyae* O'Loughlin and Rowe, 2006 has sacciform spinelets and the primary supermarginal plates are frequently separated by smaller plates; *Aquilonastra marshae* O'Loughlin and Rowe, 2006 has some doubly papulate carinal series of plates; *Aquilonastra oharai* O'Loughlin and Rowe, 2006 has spinelets in double splayed series across the proximal edge of abactinal plates; *Aquilonastra scobinata* (Livingstone, 1933) has carinal series of singly papulate plates and long thin pencil-like sacciform splay-pointed spinelets. We note again that *Aquilonastra corallicola* was described for Palau and is fissiparous.

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