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Aquilonastra rowleyi (O'Loughlin & Rowe, 2006) AND *Aquilonastra samyni* (O'Loughlin & Rowe, 2006) (Asteroidea:Valvatida:Asterinidae), NEW ADDITION TO THE ASTEROID FAUNA OF MAKRAN COAST, PAKISTAN

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Abstract
This study is providing the knowledge of new asteroid fauna *Aquilonastra rowleyi* (O'Loughlin & Rowe, 2006) and *Aquilonastra samyni* (O'Loughlin & Rowe, 2006) from Pakistan, Jiwani, Makran coast (Northern Arabian Sea). Previously comprising only 4 species of *Aquilonastra* genus, had been documented from Pakistan. This study provides detailed morphological and taxonomic insights into these species. The morphological and taxonomic characteristics of *A. rowleyi* and *A. samyni*, contributing considerably to the knowledge of asteroid fauna along the coast of Pakistan.

Keywords: Asteroidea, *Aquilonastra*, faunal diversity, Makran Coast, new addition

Introduction
Sea stars belong to the class Asteroidea (phylum Echinodermata), play a fundamental ecological role in marine ecosystems and exhibit remarkable diversity in marine ecosystems across the worldwide. The Asteroidea is one of the mainly varied and familiar classes within the Echinodermata, comprising over 1,800 species that inhabit all major ocean basins, as well as the Atlantic, Indian, Pacific, Arctic, and Southern Oceans, and width a broad range of depths from intertidal zones about 6,000 meters in the abyssal zone (Mah, 2025). *Aquilonastra* O'Loughlin in (O'Loughlin & Waters, 2004) is most diverse genus within the family

Asterinidae, characterized by generally small, flat and stellate bodies (O'Loughlin & Rowe, 2006; O'Loughlin, 2009; Mah & Blake, 2012; O'Loughlin & Bribiesca-Contreras, 2015, 2017). Aquilonastra usually occurs at shallow depths in tropical to temperate waters in the Indo-West Pacific region (O'Loughlin & Rowe, 2006). Both sexual and asexual reproductions through fissiparity have been reported in this genus (Achituv & Sher, 1991; Sterling & Shuster, 2011). Some species develop benthically in sexually reproducing forms (Komatsu et al., 1979), while others develop pelagically (Komatsu, 1975; Kano & Komatsu, 1978). Actinal gonopores indicate benthic development, abactinal gonopores indicate pelagic development, and more than five arms and multiple madreporites indicate fissiparity. These morphological characteristics vary among species based on their reproductive and developmental modes (Byrne, 2006; O'Loughlin & Rowe, 2006). Taxonomic studies on sea stars in Pakistan have been limited (Clark & Rowe, 1971; Tahera, 1992, 2007; Moazzam & Moazzam, 2020; Ghory & Tahera, 2023; Ali et al., 2025a). Only four *Aquilonastra* species have been documented in Pakistan: *Aquilonastra lorioli* (Koehler 1910), *Aquilonastra burtoni* (Grey, 1840), *Aquilonastra iranica* (Mortensen, 1940), and *Aquilonastra richmondi* (O'Loughlin & Rowe, 2006). Apart from these four species, no thorough taxonomic analysis of the intertidal Asteroidea fauna along the Pakistan coast has been carried out up to date.

In this study, we have identified two new species of the genus *Aquilonastra* from Jiwani Makran Coast Pakistan. This study presents the first comprehensive taxonomic description and habitat data for the species of *A. rowleyi* and *A. samyni* with detailed morphological and taxonomic analyses from Pakistani coastal waters.

Material and Method

Starfish samples were collected from Bandari Beach (25°03'09"N, 61°44'36"E) under the rocks using forceps, during a coastal monitoring survey of Makran coast Balochistan, Pakistan (Figure 1). Specimen underwent initial fixation in 5% formalin (v/v in seawater) for 24 hours before being transitioned to a 70% buffered ethanol solution for stabilized long-term storage and subsequent morphological analysis (Ali et al., 2025a,b).

The specimens were measured using a ruler and photographed using a camera (Fujifilm 16MP). For species-level identification, the samples were examined under a stereo-zoom microscope (Wild 181300, Switzerland) at a magnification of 10x50. Illustrations were made using a drawing tube (camera lucida). The specimens were identified up to the species level using literature and taxonomic keys (Clark & Rowe, 1971; O'Loughlin & Rowe, 2006).

Samples were cataloged. *Aquilonastra rowleyi* (O'Loughlin & Rowe, 2006) (Cat. no. MRC&RC-UOK-ECHI-86), and *Aquilonastra samyni* (O'Loughlin & Rowe, 2006) (Cat. no. MRC&RC-UOK-ECHI-87) placed in the Marine Reference Collection and Resource Centre repository at the University of Karachi, Pakistan.

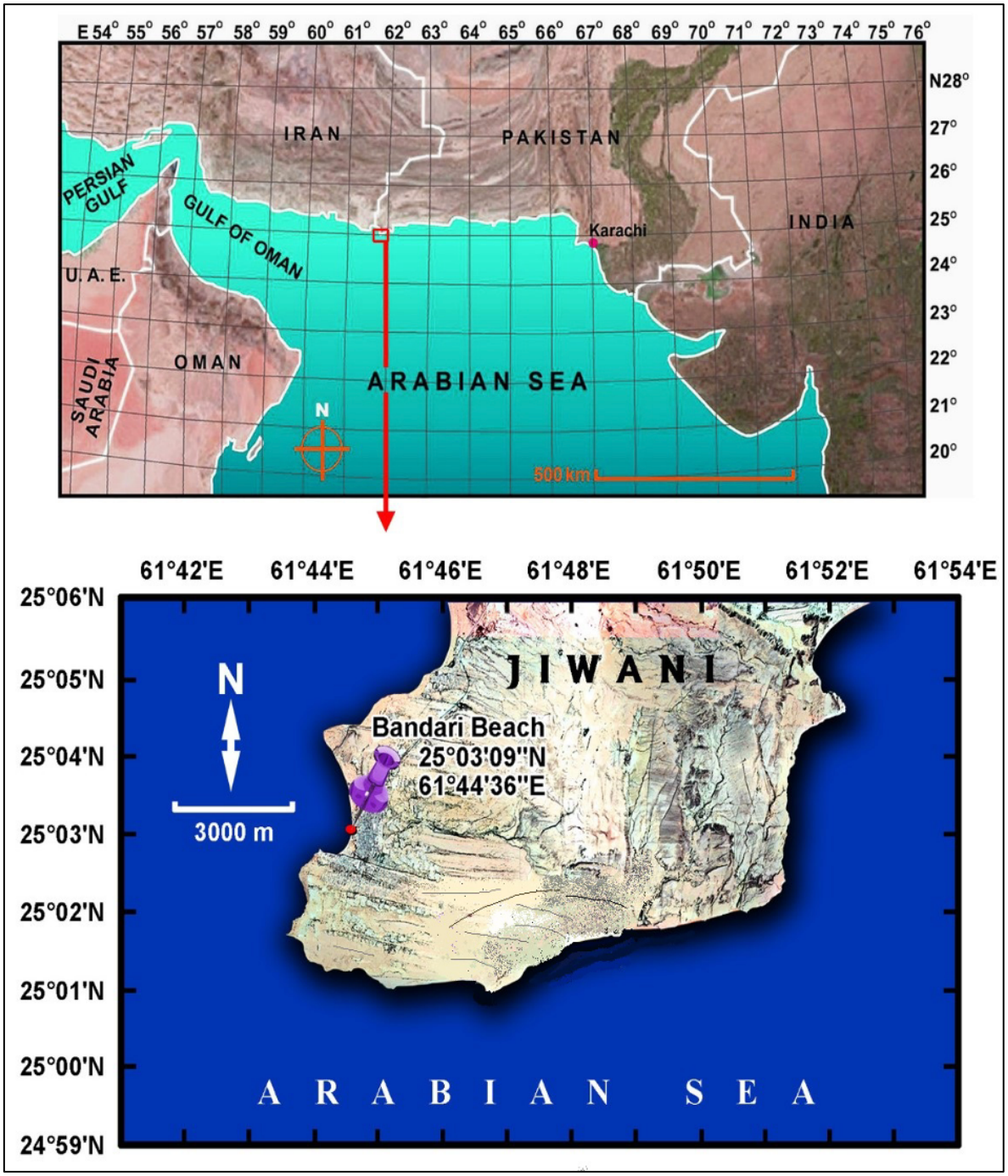

Figure 1. Bandari Beach, Jiwni Makran coast. (Map developed by Abrar Ali, Marine Reference Collection and Resource Centre, University of Karachi).

Results and Discussion

***Aquilonastra rowleyi* (O'Loughlin & Rowe, 2006)**
Phylum Echinodermata
Class : Asteroidea
Order : Valvatida (Perrier, 1884)
Family : Asterinidea (Gray, 1840)
Genus : *Aquilonastra* O'Loughlin & Waters, 2004

Diagnosis (from O'Loughlin & Rowe, 2006, amended herein):
Non-fissiparous *Aquilonastra* species; rays 5, not discrete or elongate, wide basally, narrowly to broadly rounded distally, R = 23 mm, r = 14 mm; form shallow concave inter radially; pedicellariae present in proximal interradii, 2 valves differentiated with inner teeth, taller than adjacent spinelets; abactinal gonopores.
Material examined Catalogue no:(MRC&RC-UOK-ECHI-86):
Bandari Beach, Jiwani, Makran Coast, Balochistan (25°03'09"N, 61°44'36"E), during low tide (-0.06m; 3:39 pm), 02-12- 2021; (-0.01m, 4:46 pm) 17- 21, 2024.
Detailed Morphological Description of *Aquilonastra rowleyi* (O'Loughlin & Rowe, 2006)
Dimensions and Coloration:
The specimen is 23/14 mm (R/r) in length and 0.2 g weighs. Its coloration is not fixed specimen is spotted with grey-brown, green-brown, yellow-brown, and red brown.
Abactinal Surface:
The abactinal carinal series of plates absent (Figures 2A and 3A); secondary plates many on irregular upper ray; disc incessant bent thick group of spinelets on 5 wide radial plates, 5 small inter radial plates; spinelets flat, elongate, thin, pencil-like; up to about 30 spinelets in short semi-circular form group transversely projecting boundary of each plate on proximal ray; uneven rough surface more than flat convexities on plates (Figures 2D and 3D).
Marginal Plates:
The superomarginal plates with up to 8 pencil-like spinelets; inferomarginal plates with up to 16 spinelets. Actinally flat (Figures 2B and 3B).
Actinal Spination:
Spines per actinal plate: oral 10 long and thin (Figure 2E); suboral 5 long, 5 short (Figure 2E); furrow 5 (Figure 2F); actinal inter radial 5, mostly 4 (Figure 2G); inter radial spines flat and long.
Distribution:
East African coast: KwaZulu-Natal, Sodwana Bay (O'Loughlin & Rowe,, 2006).
Habitat:
The specimen was taken from the intertidal rocky cum sandy shoreattached with rock.
Remarks:
We compared our specimens with those described by O'Loughlin & Rowe, (2006). The coloration of our specimen was not similar with described by O'Loughlin & Rowe,, (2006). The shape of our specimen is somehow similar with O'Loughlin & Rowe,, (2006) but actinal spines of furrow are different in number O'Loughlin & Rowe, (2006) described 7 furrow spines while the specimen has 5 furrow spines, other actinal spines are same in number as well as in same in shape.

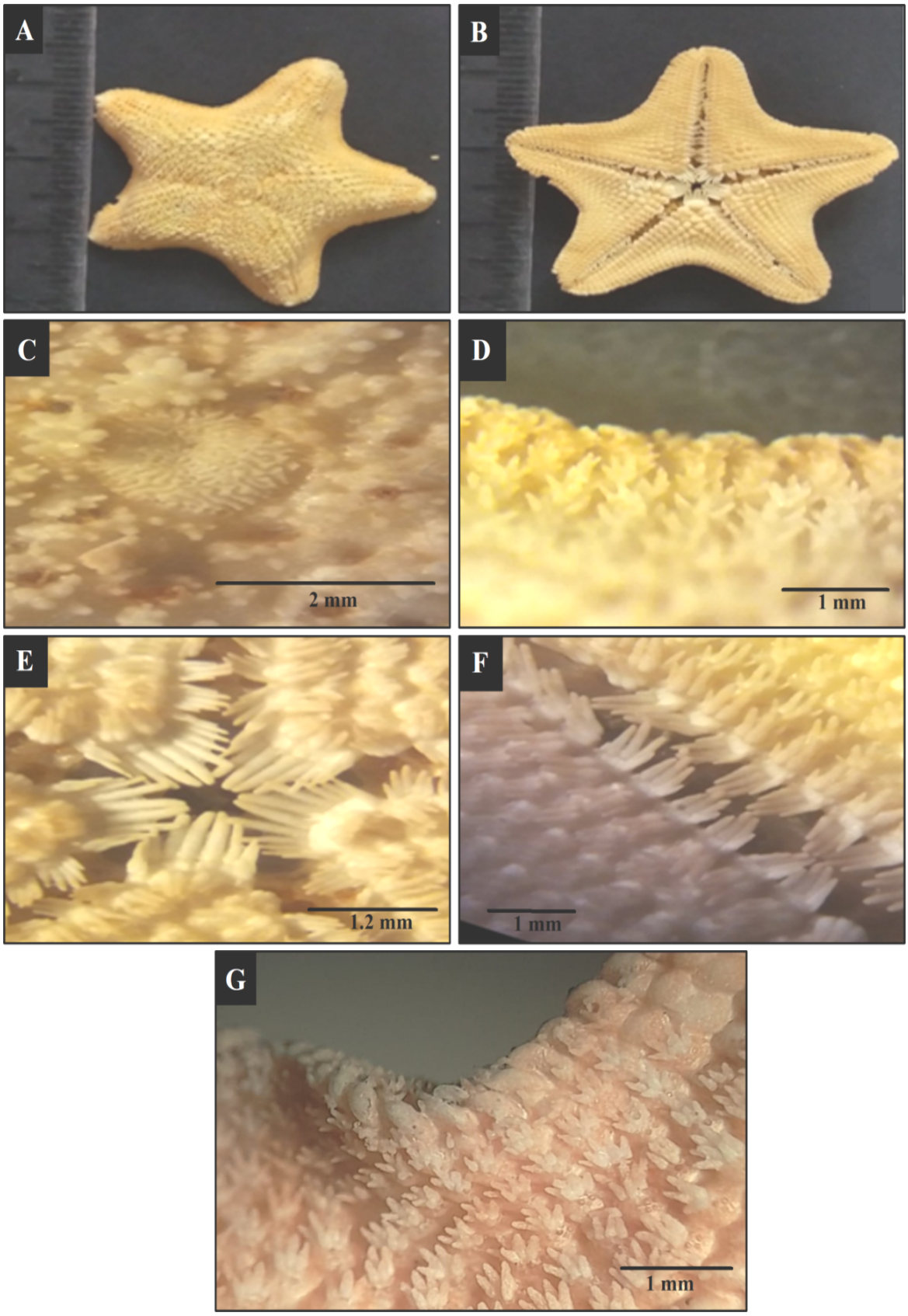

Figure 2. *Aquilonastra rowleyi* (O'Loughlin & Rowe, 2006): A. abactinal view; B. actinal view; C. madreporite; D. abactinal plates; E. Oral and sub oral spines; F. furrow spines; G. actinal, inferomarginal plate and spines.

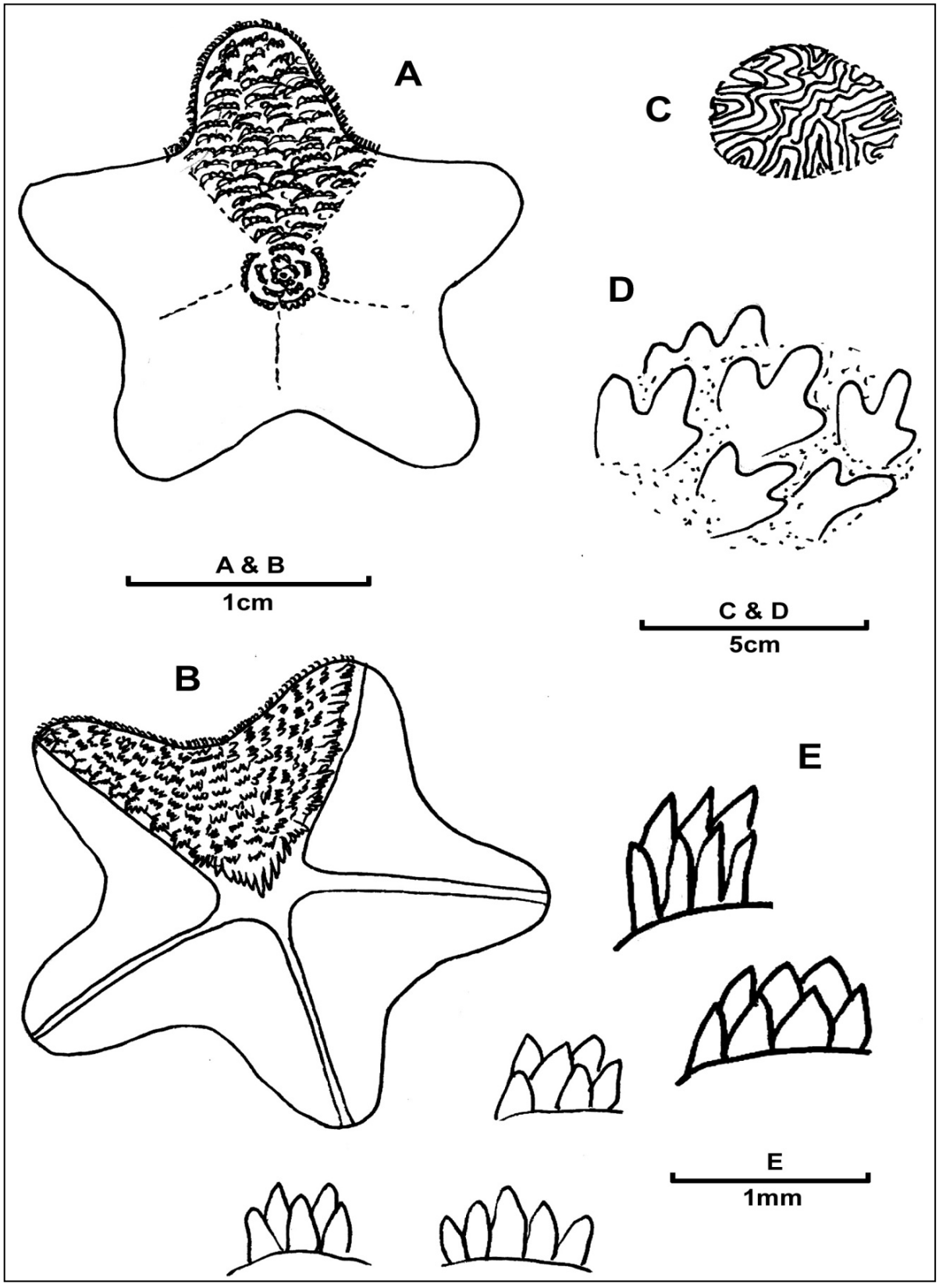

Figure 3. *Aquilonastra rowleyi* (O'Loughlin & Rowe, 2006): A. abactinal view; B. actinal view; C. madreporite D. abactinal plates; E. actinal spines.

***Aquilonastra samyni* (O'Loughlin & Rowe, 2006)**

Phylum : Echinodermata
Class : Asteroidea
Order : Valvatida (Perrier, 1884)
Family : Asterinidea (Gray, 1840)
Genus : *Aquilonastra* (O'Loughlin & Waters, 2004)

Diagnosis (from O'Loughlin & Rowe, 2006, amended herein):
Non-fissiparous *Aquilonastra* species; rays predominantly 5, rarely 6, narrow basally, slight taper, rounded distally, subdigitiform, up to R = 45 mm, r = 11 mm; single conspicuous madreporite, 2 rare, 3 very rare; gonopores abactinal.

Material examined:
Catalogue no:(MRC&RC-UOK-ECHI-87): Bandari Beach, Jiwani, Makran Coast, Balochistan (25°03'09"N, 61°44'36"E), during low tide (-0.06m; 3:39 pm), on 02-12- 2021; (-0.01m, 4:46 pm) 17- 21, 2024.

Detailed Morphological Description of *Aquilonastra samyni* (O'Loughlin & Rowe, 2006)

Dimensions and Coloration:
The specimen is 45/11 mm (R/r) in length and 0.2 g weighs. Its color is brown with bright red spots, rays' spotty violet.

Abactinal Surface:
The abactinal plateshave 30 irregularly arranged spinelets per plates, some spinelets are arranged in cluster form (Figures 4B and 5A). Abactinal spines small, thick and short some pointed and some in columnar shape (Figures 4G and 5D).

Marginal Plates:
The inferomarginal plates are larger than superomarginal plates, with approximately 24 larger spinelets per plate and superomarginals with approximately 12 spinelets per plate (Figure 4F).

Actinal Spination:
Spines per actinal plate: oral 8 (Figure 4D), suboral 6 (Figure 4D), furrow 7 (Figure 4E), actinal inter radial 14, actinal inter radial spines thick and short ingenuously pointed.

Distribution:
Oman (Masirah I.); Madagascar; La Réunion I.; E South Africa (Sodwana Bay) (O'Loughlin & Rowe, 2006), Persian Gulf (Pourvali, 2013).

Habitat:
The specimen was taken from the intertidal rocky cum sandy shore under the rock.

Remarks:
We compared our specimens with those described by O'Loughlin and Rowe (2006) and Pourvali (2013). The coloration of our specimen is somehow similar with described by O'Loughlin and Rowe (2006) and Pourvali (2013) had not described color of the specimen. The shape of our specimen is similar with both O'Loughlin and Rowe (2006) and Pourvali (2013) rays 5 slight tapers, rounded distally. Abactinal spines are similar in shape as O'Loughlin and Rowe (2006) spines small, short, thick, conical to columnar, sometimes splay-pointed, actinal spines are same as observed by O'Loughlin and Rowe (2006) and Pourvali (2013) oral 8, sub oral 6, furrow 7, sub ambulacral 8, actinal inter radial 14.

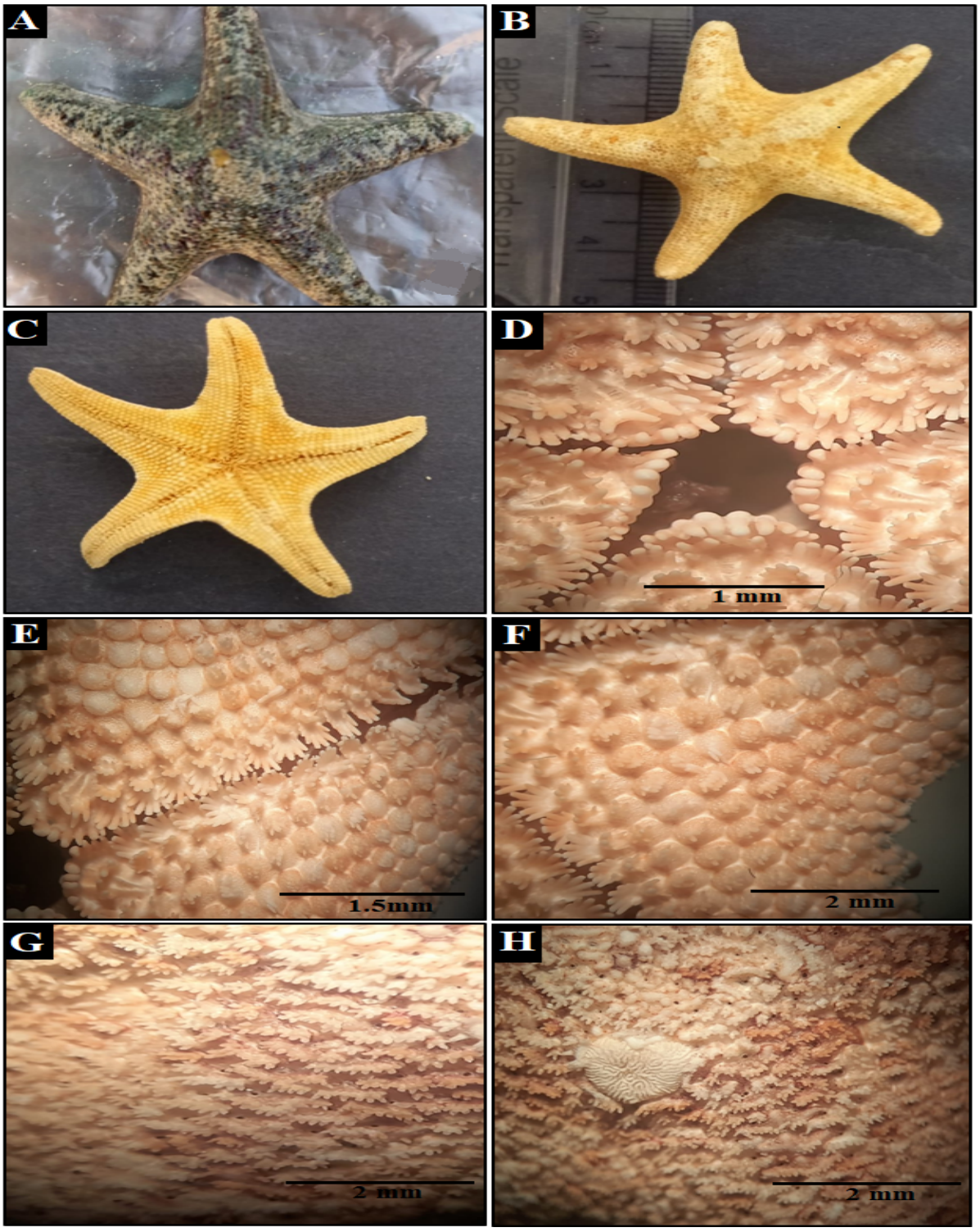

Figure 4. *Aquilonastra samyni* (O'Loughlin & Rowe, 2006): A. live specimen; B. abactinal view; C. actinal view; D. Oral and sub oral spines; E. furrow spines; F. actinal, inferomarginal plate and spines; G. abactinal plates; H. madreporite.

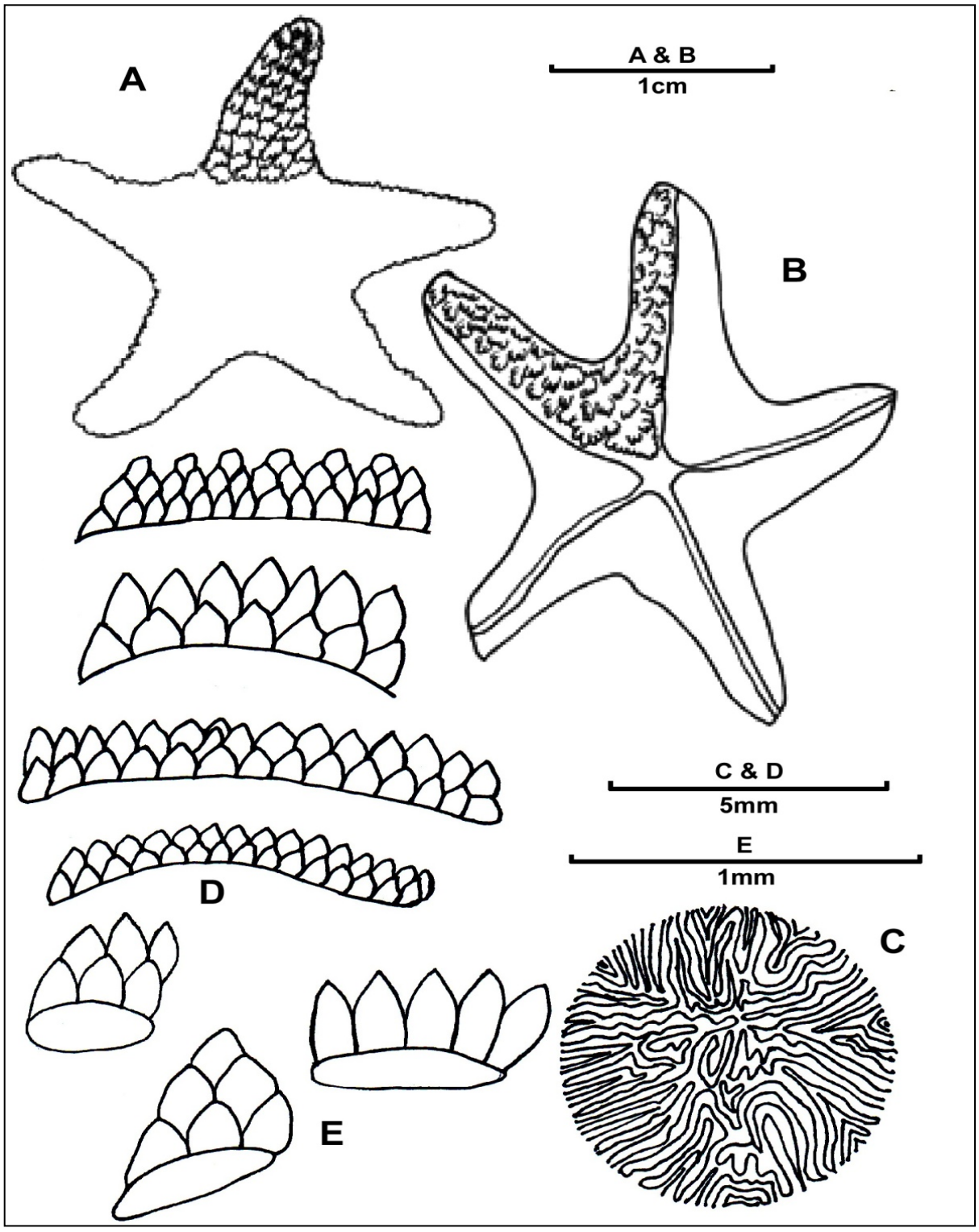

Figure 5. *Aquilonastra samyni* (O'loughlin & Rowe, 2006): a. abactinal view; b. actinal view; c. madreporite d. abactinal plates; e. actinal spines.

Conclusion

This paper presents the first comprehensive taxonomic description of *A. rowleyi* and *A. samyni* from Bandari Beach, Makran Coast. Only four species of *Aquilonastra* have been identified from Pakistan. In this study, two new records of *Aquilonastra* from the northern Arabian Sea of Pakistan are added. It provides first morphological analyses and a full taxonomical description. Research on asteroid biodiversity systematics is still ongoing and has expanded our knowledge of the development of echinoderms and past shifts in the marine environment. Even though there is a lot of stability in the taxonomy of asteroids, there are still a lot of undiscovered taxa and species that need to be described. Understanding the worldwide biodiversity evolution of asteroids will also be made easier with the use of fresh data from molecular phylogenetics and the development of global biodiversity databases.

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Ethical approval

This article does not contain any studies involving human subjects. In this article, the animal regulations are followed as per the ethical committee guidelines of The Marine Reference Collection and Resource Centre, 75270, Karachi, Pakistan; the authors observed the new records of Aquilonastra rowleyi (O'Loughlin & Rowe, 2006) and detailed taxonomy of Aquilonastra samyni (O'Loughlin & Rowe, 2006) from Jiwani Makran Coast Balochistan, Northern Arabian Sea. The Animal ethical guidelines are followed in the study for species observation, identification & experimentation.

Informed consent

Not available.

Data availability statement

No data additional to the sources cited were used for the research described in the article.

Conflicts of interest

The authors declare that there are no conflicts of interest.

Funding organizations

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Contribution of authors

Quratulan Ahmed: Taxonomic analysis, identification and corresponding to the expert for confirmation of species, writing - original draft preparation:
Qadeer Mohammad Ali: Conceptualization, sampling and data collection, paper review:
Iqra Shaikh: Writing- original draftpreparation, literature searching and illustrations:
Levent Bat: Writing - review and editing.
All authors have read and agreed to the published version of the manuscript.

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