

## Recent brachiopods from the Persian Gulf and their biogeographical significance

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**SUMMARY:** Two brachiopod species *Discradisca indica* (Dall, 1920) and *Argyrotheca jacksoni* Cooper, 1973, together with *Lingula* sp., have been identified from the Persian Gulf. These species, added to the two species *Terebratulina retusa* (Linnaeus, 1758) and *Megerlia truncata* (Linnaeus, 1767) previously identified by Jackson (1921), and *Lingula anatina* Lamarck, 1819 by Emig (1988) bring the total to 5 species for the region. The genera *Discradisca* and *Argyrotheca* are recorded for the first time from the Persian Gulf. This fauna shows biogeographical affinities to the Indian Ocean and the Mediterranean faunas. The disjunct geographical distribution of *Discradisca* suggests this genus is a relict of an ancient Tethyan fauna.

**Keywords:** Brachiopoda, *Lingula*, *Discradisca*, *Argyrotheca*, biogeography, Persian Gulf, Indian Ocean.

**RESUMEN:** BRAQUIÓPODOS RECIENTES DEL GOLFO PÉRSICO Y SU SIGNIFICACIÓN GEOGRÁFICA. – Se identificaron dos especies de braquiópodos, *Discradisca indica* (Dall, 1920) y *Argyrotheca jacksoni* Cooper, 1973, junto con *Lingula* sp., en material procedente del Golfo Pérsico. Estas especies, junto con las previamente identificadas por Jackson en 1921, *Terebratulina retusa* (Linnaeus, 1758) y *Megerlia truncata* (Linnaeus, 1767), y por Emig (1988), *Lingula anatina* Lamarck, 1819, elevan a cinco el total de especies reconocidas en la región. Los géneros *Discradisca* y *Argyrotheca* se dan a conocer por vez primera en el Golfo Pérsico. Las especies estudiadas muestran una relación biogeográfica con las presentes en el océano Índico y en el mar Mediterráneo. La distribución geográfica disjunta observada del género *Discradisca*, sugiere que se trata de un género que, presente en el antiguo Tetis, ha logrado sobrevivir sólo en determinados refugios mientras que se ha extinguido en los demás.

**Palabras clave:** Brachiopoda, *Lingula*, *Discradisca*, *Argyrotheca*, biogeografía, golfo Pérsico, océano Índico.

### INTRODUCTION

Recent brachiopods had not been recorded from the Persian (Arabian) Gulf until 1921, when J. Wilfrid Jackson described two species from four dead shells collected by F.W. Townsend from Dabai (Dubai) on the west side of the Ruus el Jibál peninsula, northwest coast of Oman, depth unknown. The approximate position of this locality, which now lies

in the United Arab Emirates, is shown in Figure 1. One specimen he identified as *Terebratulina caput-serpentis* (now *retusa*) var. *abbreviata* Jackson and the other three as *Mühlfeldtia* (now *Megerlia*) *truncata* var. *paucistriata* Jackson. On the basis of these specimens Jackson equated the Persian Gulf specimens with the typical Lusitanian forms *Terebratulina retusa* (Linnaeus) and *Megerlia truncata* (Linnaeus) from the Atlantic and Mediterranean and cit-

ed them as additional evidence of a past connection between the Atlantic and Indian oceans by way of the Mediterranean. Unfortunately, none of the four specimens were figured by Jackson, although his descriptions of the two species are fairly detailed. The three *Megerlia* specimens (2 complete, one dorsal valve) are in the Natural History Museum, London but we were unable to examine them, while the specimen of *Terebratulina* is not in either the Natural History Museum or the Manchester Museum, where Jackson was based (S.L. Long, pers. comm.; R. Smith, pers. comm.) and is presumed to be missing.

The species *Lingula anatina* Lamarck was mentioned by Emig (1988) from a depth of 6–16 m in the Persian Gulf but without any details of the exact locality. Undetermined *Lingula* was also found at several stations in the Khor al Bazm and Gulf of Salwa (Hughes Clarke and Keij, 1973). From the nearby Gulf of Oman an immature individual of *Lingula* was reported by Muir-Wood (1959).

This report describes and illustrates some of the recently-discovered Persian Gulf specimens, from sediment samples kept in the Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt, and from Eberhard Gischler's collection (Institut für Geowis-

senschaften, J. W. Goethe-Universität, Frankfurt), collected during expeditions over the last few years.

## MATERIAL AND METHODS

Part of the investigated material comes from 6 shell-grit samples (PG95-38-42, 44) collected by M. Apel, U. Zajonz and A. Plaga around the Karan and Jana islands (Fig. 1) during a German expedition in May 1995, and kept in the Molluscan section of the Senckenberg Museum, Frankfurt. Brachiopods belonging to *Lingula*, *Discradisca* and *Argyrotheca* were sorted by one of us (MAB) during a visit to the Museum in autumn 2005. All these specimens are dead empty shells.

Most of the specimens of *Discradisca indica* come from a sediment sample (K119) from southern Kuwait (Fig. 1) collected by E. Gischler, using a Lenz-type sampler operated from a small boat (see also Gischler and Lomando, 2005). All occurred in living position with soft parts preserved, and were attached to oyster shells.

The investigated specimens are housed in the Senckenberg Museum, Frankfurt (SMF) and at the Institute of Paleobiology, Warszawa (ZPAL Bp.)

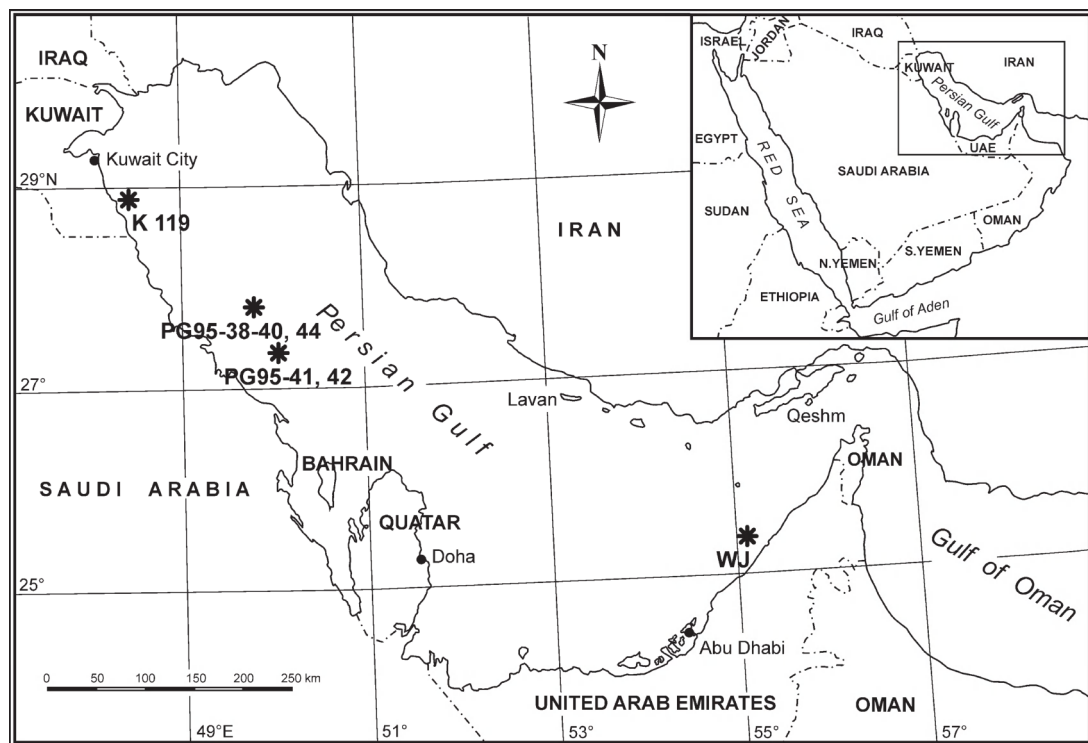


FIG. 1. – Map of the Persian Gulf, showing the location of the samples where brachiopods were found; WJ – approximate position of Jackson's collecting locality.

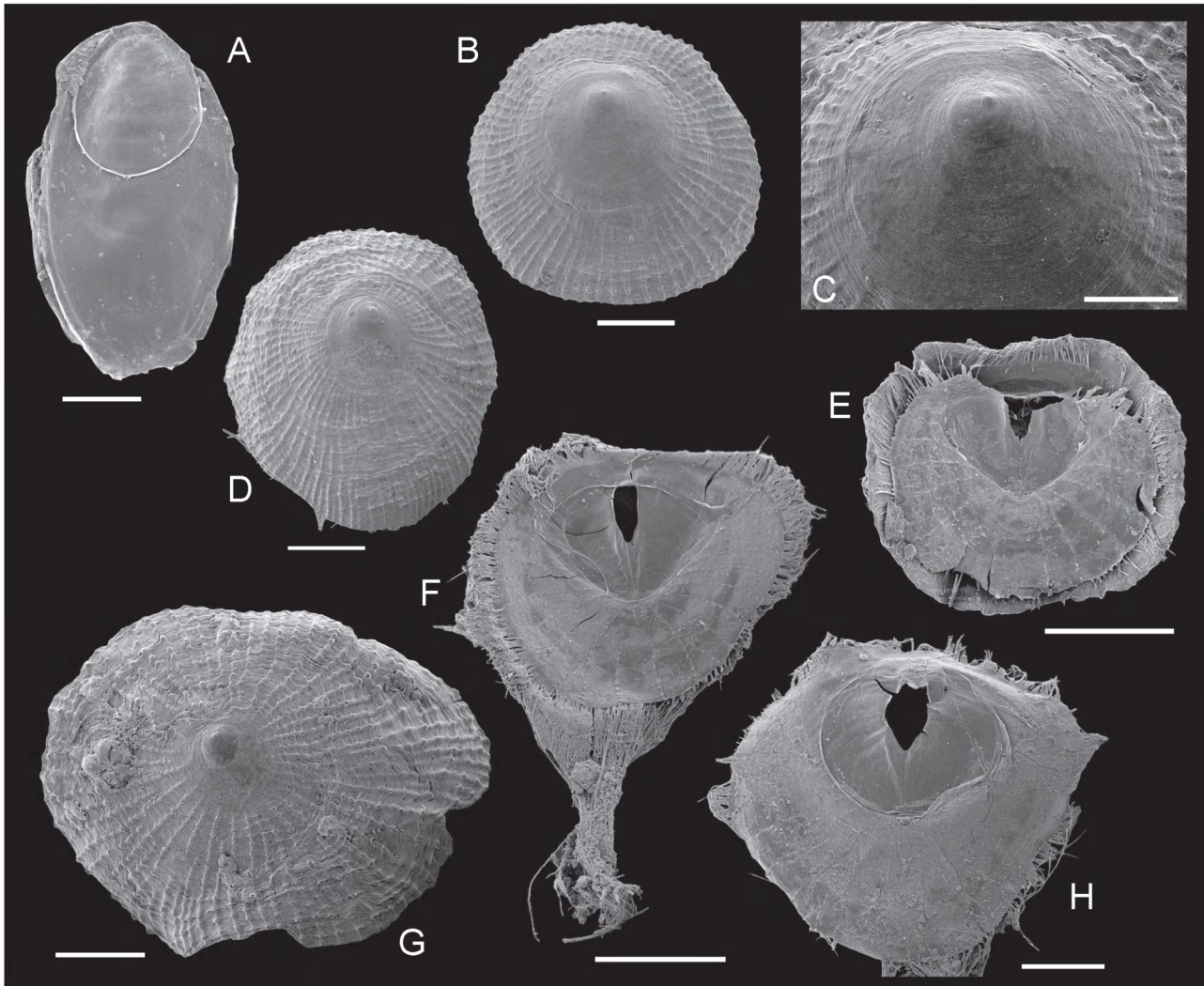


FIG. 2. – A, *Lingula* sp., damaged valve from Persian Gulf, Jana Island, sample PG95-42, 16 m, SMF 869 01; B-H, *Discradisca indica* (Dall, 1920); B, C, exterior view of dorsal valve and enlargement (C) of the apex, sample K119, 27.5 m, ZPAL Bp.61/1; D, dorsal view of complete specimen, sample K119, 27.5 m, ZPAL Bp.61/2; E, F, ventral views of complete specimens showing large subcircular peduncular area, sample K119, 27.5 m, ZPAL Bp.61/3-4; G, exterior view of dorsal valve, Karan Island, sample PG95-40, 12 m, SMF 869 02; H, exterior view of ventral valve, sample K119, 27.5 m, ZPAL Bp.61/5. All SEM. Scale bars: A, C, 500 µm; B, D, E, G, H, 1 mm; F, 2 mm.

## SYSTEMATICS

Class LINGULATA Gorjansky and Popov, 1985  
 Order LINGULIDA Waagen, 1885  
 Superfamily LINGULOIDEA Menke, 1828  
 Family LINGULIDAE Menke, 1828  
 Genus *Lingula* Bruguière, 1797

*Lingula* sp.  
 (Fig. 2A)

*Material examined:* Persian Gulf, Jana Island, sample PG95-42, 27°22.4'N 49°54'E, 16 m, one juvenile complete specimen.

*Remarks.* The material of only one immature specimen, 2.4 mm long and 1.4 mm wide, prevents any specific determination. However, this specimen

belongs most probably to *Lingula anatina* already reported from the Persian Gulf (Emig, 1988). The specimens of *Lingula* collected in restricted environments in the Khor al Bazm and Gulf of Salwa by Hughes Clarke and Keij (1973) live in muddy molluscan sand at depths of 4-16 m where salinities vary between 56-60.

Superfamily DISCINOIDEA Gray, 1840  
 Family DISCINIDAE Gray, 1840  
 Genus *Discradisca* Stenzel, 1964

*Discradisca indica* (Dall, 1920)  
 (Fig. 2B-H)

*Discradisca indica* Dall, 1920: 279. Cooper, 1973: 5, pl. 1, figs.18-25.



*Discinisca keiensis* Jackson and Stiasny, 1937: 7-8, pl. 1, figs. 13-16.

**Material examined:** Persian Gulf, Karan Island, 27°43'N 49°48.8'E: sample PG95-40, 12 m, one dorsal valve; sample PG95-44, 11 m, fragment of dorsal valve. Jana Island, 27°22.4'N 49°54'E: sample PG95-41, 5-10 m, one dorsal valve. Kuwait, sample K119, 28°57.04'N 48°22.87'E, 27.5 m, 15 complete specimens attached to oyster shells.

| <i>Dimensions (in mm)</i> |        |       |
|---------------------------|--------|-------|
| Sample                    | Length | Width |
| PG95-40                   | 4.1    | 5.0   |
| PG95-41                   | 4.0    | 4.6   |
| K119                      | 4.2    | 3.8   |
| K119                      | 3.4    | 3.8   |
| K119                      | 2.3    | 2.1   |

**Description.** Shell small (maximum length 4.1 mm) subcircular in outline, with margins often irregular. Dorsal valve conical in profile with smooth apex, situated posteriorly, and ornamented by fine radial costae and numerous concentric growth lines. Ventral valve concave medially and slightly convex marginally. Pedicle region subcircular to heart-shaped without ornamentation. Rest of ventral valve ornamented by widely spaced, straight radial costellae. Dorsal valve overlapping ventral valve. Setae short in posterior and lateral regions but can be very long in anterior part (Fig. 2F).

**Remarks.** The name *Discradisca* was proposed by Stenzel (1964) as a subgenus of *Discinisca* to distinguish those species having radial costae on the dorsal valve from those lacking costae. Later Cooper (1977) elevated *Discradisca* to generic rank. In the modern diagnosis *Discradisca* is described as "similar to *Discinisca* but with wide, transversely suboval pedicle track..." (Holmer and Popov, 2000). The following species: *D. antillarum* (d'Orbigny, 1845), *D. cumingi* (Broderip, 1833), *D. strigata* (Broderip, 1834), *D. stella* (Gould, 1862), *D. sparselineata* (Dall, 1920) and *D. indica* were transferred to *Discradisca* (see Emig 1997; and <http://paleopolis.rediris.es/BrachNet/CLASS/DISCINIDAE/Discradisca.html>). *D. indica* was originally described from off Bombay and Ceylon by Dall (1920) and some of his types were figured by Cooper (1973).

Jackson and Stiasny (1937) erected a new species, *Discinisca keiensis* for specimens collected at the depth of 90 m from off the Kei Islands, Indonesia. We consider the latter species and *D. indica* as synonyms. In the ornamentation of dorsal and ventral valves *D. keiensis* is consistent with *D. indica* as

indicated by Jackson and Stiasny (1937). The difference, according to them, is in the longevity of setae. In the description presented by Dall (1920) *D. indica* has short setae, and the specimens from Indonesia possess long setae. In the studied material there are specimens with both short and very long setae, so this feature cannot be used to distinguish those two species.

The investigated specimens agree well with those hitherto described (Dall, 1920; Cooper, 1973; Jackson and Stiasny, 1937), differing only in their smaller size.

#### Class RHYNCHONELLATA

Williams, Carlson, Brunton, Holmer and Popov, 1996

Superfamily MEGATHYRIDOIDEA Dall, 1870

Family MEGATHYRIDIDAE Dall, 1870

Genus *Argyrotheca* Dall, 1900

*Argyrotheca jacksoni* Cooper, 1973

(Fig. 3)

*Argyrotheca jacksoni* Cooper, 1973: 17, pl. 3, figs. 9-13.

**Material examined:** Persian Gulf, Karan Island, 27°43'N 49°48.8'E: sample PG95-38, 4-5 m, one dorsal valve; sample PG95-39, 10-12 m, 2 complete specimens, one ventral valve; sample PG95-40, 12 m, 4 complete specimens, one ventral valve, one dorsal valve; sample PG95-44, 11 m, one complete specimen, one ventral valve. Jana Island, 27°22.4'N 49°54'E: sample PG95-41, 5-10 m, 6 complete specimens, one ventral valve; sample PG95-42, 16 m, fragment of dorsal valve.

| <i>Dimensions (in mm)</i> |        |       |           |
|---------------------------|--------|-------|-----------|
| Sample                    | Length | Width | Thickness |
| PG95-39                   | 2.1    | 3.3   | 1.4       |
| PG95-39                   | 2.7    | 3.2   | 1.6       |
| PG95-40                   | 3.8    | 4.2   | 2.2       |
| PG95-41                   | 3.3    | 3.9   | 1.9       |
| PG95-41                   | 2.6    | 3.3   | 1.6       |
| PG95-44                   | 1.4    | 1.6   | 0.8       |

**Description.** Small (maximum length 3.8 mm), dorsibiconvex shell, with transversely ovate to subpentagonal outline; maximum width at hinge line or situated immediately anterior of hinge line. Shell surface of each valve ornamented by 10-12 broad, rounded ribs. Shell coarsely punctate. Anterior commissure rectimarginate. Beak with sharp, straight beak ridges; interarea well developed. Foramen large, hypothryd with narrow deltidial plates.

Ventral valve interior with short wide teeth lying parallel to hinge line. Pedicle collar well developed,

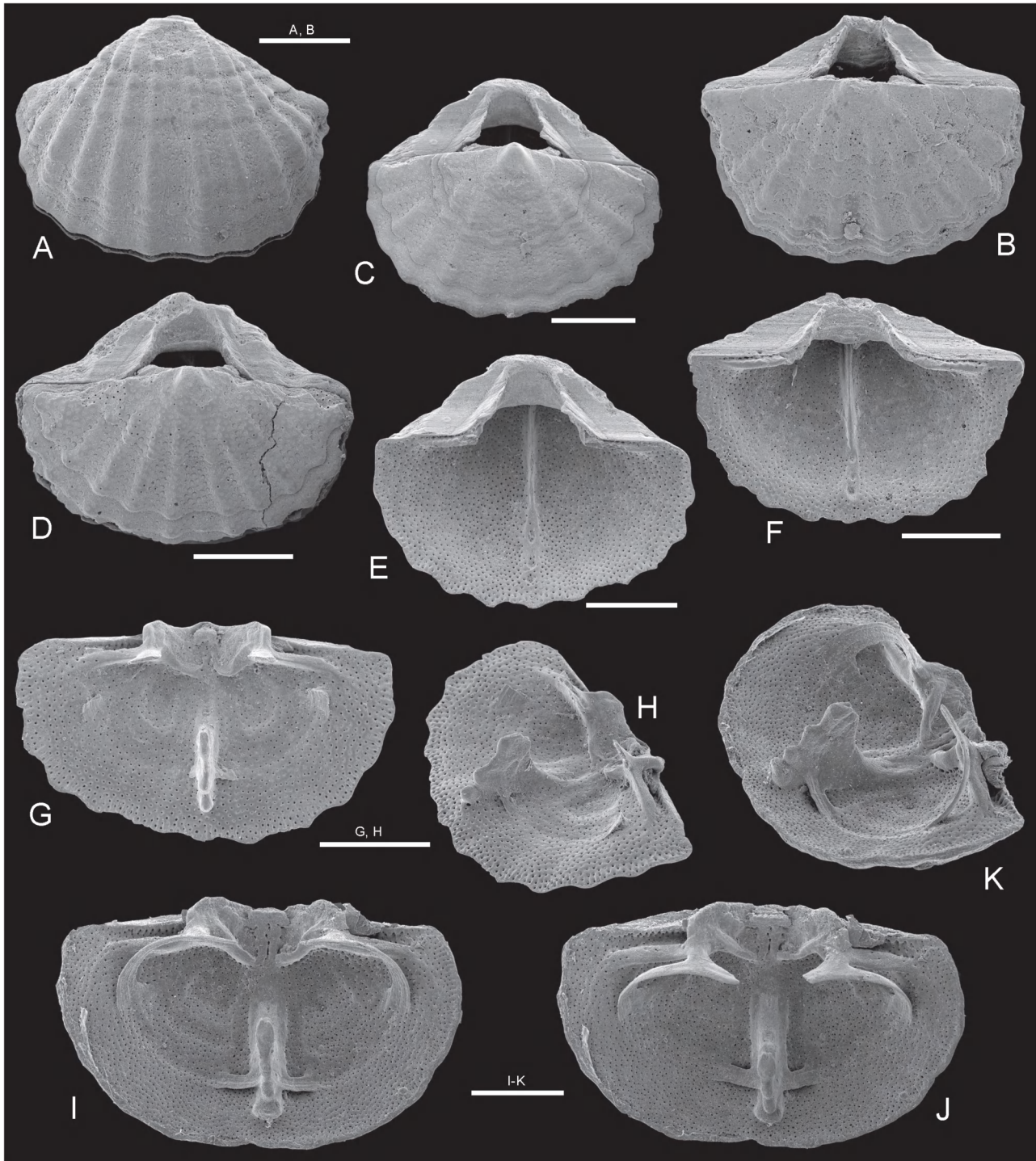


FIG. 3. — *Argyrotheca jacksoni* Cooper, 1973, Persian Gulf; A, B, ventral and dorsal views of complete specimen, Jana Island, sample PG95-41, 5-10 m, SMF 869 03; C, D, dorsal views of complete specimens, SMF 869 04-05, C, Karan Island, sample PG95-39, 10-12 m, D, Jana Island, sample PG95-41, 5-10 m; E, F, inner views of ventral valves, Karan Island, SMF 869 06-07, E, sample PG95-39, 10-12 m, F, sample PG95-44, 11 m; G-K, inner views of dorsal valves, SMF 869 08-09, G, H, inner and oblique views to show high median septum, Karan Island, sample PG95-39, 10-12 m; I-K, inner, tilted and oblique views to show short crura, massive cardinal processes and high median septum, Jana Island, sample PG95-41, 5-10 m, SMF 869. All SEM. Scale bars: 1 mm.

supported by median septum that extends to about 2/3 of the length. Anteriorly to the septum 3 shallow, ovoid depressions accommodate serrated crest of dorsal septum.

Dorsal valve interior with elongate sockets parallel to hinge line and short but high inner socket ridges. Cardinal process prominent. Crura thick, very short; crural processes massive, long directed

medianly. Descending branches extend down to unite with valve floor and emerge to join the median septum. Median septum triangular in profile, high with 3-4 serrations. Muscle scars marked as suboval depressions.

*Remarks.* This species was erected by Cooper in 1973 based on one specimen, the holotype (USNM 550432), from a shallow reef cave at Ras Muhammad, southernmost Sinai Peninsula, Red Sea. (It should be noted that Cooper's measurements (1973, p. 17) of the holotype are incorrectly inflated by a factor of about two (D. Levin, pers. comm.)). The species has since been identified from other areas in the Red Sea by Logan *et al.* (2008), particularly the Gulf of Aqaba and around Port Sudan.

In size, outline and ornamentation the investigated specimens resemble *A. cuneata* (Risso, 1826), the species occurring in the Mediterranean and western Atlantic (Brunton and Curry, 1979; Logan, 1979, 1993; Logan *et al.*, 2004; Álvarez and Emig, 2005), but they differ in lacking a pink-red wash between the costae. In outline and ornamentation the specimens from the Persian Gulf also display similarities to the specimen from southern Africa described by Hiller (1994a) as *Argyrotheca* sp. which may be a young representative of *A. jacksoni*.

## DISCUSSION

Two brachiopod species *Discradisca indica* (Dall, 1920) and *Argyrotheca jacksoni* Cooper, 1973, together with *Lingula* sp., have been recognised in the material from the Persian Gulf, collected during two German expeditions. These species, added to the two species *Terebratulina retusa* (Linnaeus, 1758) and *Megerlia truncata* (Linnaeus, 1767) previously identified by Jackson (1921), and *Lingula anatina* Lamarck, 1819 by Emig (1988) bring the total to 5 species known for this region. The genera *Discradisca* and *Argyrotheca* are recorded for the first time from the Persian Gulf.

The Persian Gulf is an epicontinental sea with shallow waters (maximum depth of 100 m), a very wide temperature range (13-52°C), and high salinity (40-70) (Purser, 1973; Emig, 1988, Table 2; Gischler and Lomando, 2005). These conditions might be responsible for the low biodiversity of the brachiopod fauna when compared with brachiopods from the adjacent Indian Ocean (Muir-Wood, 1959;

Cooper, 1973, 1981a; Hiller, 1986, 1994a, b; Zezina, 1987; Logan *et al.*, 2008). Other peculiarities in the Persian Gulf organisms have been observed among molluscs; all large species of Indo-Pacific molluscs are absent (Hughes Clarke and Keij, 1973). Likewise, coral diversity in the Gulf is low as compared to the Indian Ocean, and temperature tolerant taxa predominate, including one endemic species (Veron, 1995). The western parts of the Persian Gulf have widespread areas of rock bottom which is covered by a thin layer (5-20 cm) of unconsolidated bioclastic sediment with a hard surface being exposed commonly between irregular patches of sand. The deeper Iranian parts of the basin are generally muddy (Purser, 1973).

Biogeographically this fauna shows affinities to those of the Indian Ocean and the Mediterranean. Although very rare in the investigated material *Lingula* is a widely distributed genus in the tropical and subtropical areas of the Indian Ocean (Emig, 1997) but not known in the Mediterranean. *Discradisca indica* seems to be restricted to the Indian Ocean (Cooper, 1973; Jackson and Stiasny, 1937). Moreover, neither *Discradisca* nor any discinids are known from the Mediterranean, though a discinid brachiopod was recently noted from the Red Sea (Logan *et al.*, 2008). It is worth mentioning that a related species, *D. antillarum* (d'Orbigny, 1845) occurs in the Caribbean region (Cooper, 1977). Such disjunct geographical distribution of *Discradisca* suggests that the fauna is a relict of an ancient Tethyan fauna. New findings and/or re-examination of the Tertiary material in the Mediterranean region may fill this gap.

*Argyrotheca jacksoni* has so far been noted only from the Red Sea (Cooper, 1973; Logan *et al.*, 2008) and the Persian Gulf. However, *Argyrotheca* sp. from southern Africa (Hiller, 1994a) may appear to belong to *A. jacksoni* when more material becomes available. Also, similarities of *A. jacksoni* to the Mediterranean and Atlantic form *A. cuneata* suggest affinities of those species.

Two species reported by Jackson (1921), i.e. *Terebratulina retusa* and *Megerlia truncata*, are very common in the Mediterranean and western Atlantic (Brunton and Curry, 1979; Logan, 1979, 1993; Cooper, 1981b; Logan *et al.*, 2004; Álvarez and Emig, 2005). *M. truncata* (incorrectly designated as *M. gigantea*; see also Bitner, 2007) was described from the area south of Madagascar, Indian Ocean (Cooper, 1981a).



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