

The first Jurassic thecideide brachiopods from the Middle East: A new species of *Moorellina* from the Upper Callovian of Hamakhtesh Hagadol, southern Israel

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ABSTRACT:

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The Matmor Formation is a set of late Callovian marls and limestones exposed in the Matmor Hills, Hamakhtesh Hagadol, southern Israel. It was deposited during a regional transgression which produced patch reefs across a shallow carbonate platform in this area. The thecideide brachiopods described here were part of a diverse sclerozoan community which encrusted the calcareous surfaces of sponges and corals. These brachiopods represent a new, very small species of *Moorellina* and the only thecideide brachiopod found in the Jurassic deposits of the Middle East. A gall-like structure interpreted as the trace of the parasitic (ascothoracid?) infestation has been recorded in one specimen of *Moorellina negevensis* sp. nov.

Key words: Brachiopods; Thecideida; *Moorellina*; Parasites; Ascothoracida; Jurassic; Israel.

STRATIGRAPHY

The Matmor Formation was defined by Hirsch and Roded (1996) as a series of marls and limestone in the Matmor Hills near the center of Hamakhtesh Hagadol. (The name of this Jurassic interval is debated; some refer to it as the Be'er Sheva Formation; see Wilson *et al.* 2010, for discussion). It is exposed only within this *makhtesh*, which is an erosional feature formed from a breached anticline. The Matmor is correlated through ostracodes and foraminiferans with the upper Hermon Formation exposed at Majdal Shams in the Golan as well as with the top of the Zohar Formation in the Sinai (Hirsch and Roded 1996). Ammonites show that the lower Matmor Formation

(Goldberg 1963 subunits 43–52, about 30 meters) is in the late Callovian *athleta* Zone, and the upper portion (subunits 53–74) is in the late Callovian *lamberti* Zone (Hirsch and Roded 1996). The brachiopods described here are from a coral-rich horizon 33 meters above the base of the formation (subunits 53–54) and thus in the lower *lamberti* Zone.

The sediments of the Matmor Formation were deposited during a transgression across the Arabian Plate at equatorial latitudes (Hirsch *et al.* 1998; Sharland *et al.* 2004; Haq and Al-Qhatani 2005). This transgression covered most of the Arabian Platform with marly carbonates and patch reefs of corals and calcareous sponges. The top of the Matmor Formation is an unconformity topped by coarse terrestrial sandstones and



Text-fig. 1. Location of Hamakhtesh Hagadol in the Negev Desert of southern Israel

laterites of the Lower Cretaceous (Aptian) Hatira Formation (Levy and Weissbrod 1993).

LOCATION

The specimens for this study were collected from Goldberg (1963) subunits 53 and 54 (which cannot be distinguished from each other at this locality) of the Matmor Formation in Hamakhtesh Hagadol, Israel, approximately 33 meters from the base. This location is in the Matmor Hills at N30.93374° latitude and E34.97533° longitude (Text-fig. 1) which is the same site as that for the sclerozoan study of Wilson *et al.* (2008). It is designated C/W-226 in The College of Wooster locality database.

METHODS AND MATERIALS

All the brachiopod specimens were collected from the Matmor Formation as it was measured and described during field seasons from 2003 to 2009 in Hamakhtesh Hagadol. The loose valves were collected by screening sediment between coral heads. The attached specimens are cemented to recrystallized scleractinian corals and calcareous sponges.

THE MATMOR CORAL AND SPONGE REEF COMMUNITY

This coral and sponge reef community that included these brachiopods is described by Wilson *et al.* (2008). The most common fossils in the community are large (up to 20 cm in diameter) platters of the microsolenid coral *Microsolena* aff. *M. sadeki*. The upper surfaces of these coralla are often slightly concave with raised edges, indicating that they were “microatolls” (Kobluk and Noor 1990) formed in very shallow water just below the low-tide mark. The next most common fossils are calcified axinellid demosponges (*sensu* Wood 1987 p. 72; sometimes called “stromatoporoids”) which are pillars, platters and mounds up to 15 cm in diameter. The most abundant of these sponges are the milleporellid *Dehornella harrarensis* and the actinostromarid *Actostroma damesini*. These corals and sponges form the framework of the Matmor Formation patch reefs, which would be termed “stromatoporoid-rich” reefs by Leinfelder *et al.* (2005, p. 287). These Matmor reefs were briefly described in Wood (1999) as forming in a shallow shoal environment with frequent wave disturbances.

The corals and sponges at this location were encrusted by a variety of sclerozoans besides the thecideides described here. The other encrusters include four species of serpulids, one species of sabellid, small attached corals and sponges, rare plicatulid bivalves, and rare sheet-like cyclostome bryozoans. The distribution patterns of these sclerozoans on the corals and sponges are described in detail by Wilson *et al.* (2008).

Diverse organisms lived between the coral and sponge skeletons. These include common rhynchonellid and terebratulid brachiopods, abundant regular echinoids of three families, common small oysters, rare millericrinid crinoids, and gastropods preserved as unidentifiable internal molds.

The deposition rates of marl sediments in the Matmor Formation were probably high because the corals and sponges are often found in cone or mushroom shapes, suggesting that they grew upwards to pace sed-

iment accumulation below (Wilson *et al.* 2008). The brachiopods described in this paper thus lived in an environment much like that of a modern coral reef lagoon growing off an equatorial continental margin which is shedding silts and clays. A modern analogue would be the coral patch reefs of the Red Sea.

Repository of specimens

The material is housed in the Polish Academy of Sciences Museum of the Earth in Warsaw, Warsaw, Poland, under catalogue numbers: MZ VIII Bra 1679-1691 and the Department of Geology of the College of Wooster, Wooster, Ohio, USA, under catalogue number: C/W-226.

SYSTEMATIC DESCRIPTION

The classification used follows the fifth volume of the revised *Treatise on Invertebrate Paleontology, part H Brachiopoda* (Baker 2006).

Order Thecideida Elliott, 1958
 Superfamily Thecideoidea Gray, 1840
 Family Thecidellinidae Elliott, 1958
 Subfamily Moorellininae Pajaud, 1966

Genus *Moorellina* Elliott, 1953

TYPE SPECIES: *Moorellina duplicata* (Moore, 1854).

Moorellina negevensis sp. nov.

(Pl. 1, Figs 1–2; Pl. 2, Fig. 1; Pl. 3, Fig. 1; Pl. 4, Figs 1–4; Pl. 5, Figs 1–8)

HOLOTYPE: The specimen (MZ VIII Bra–1684) illustrated in Pl. 3, Fig. 1.

PARATYPES: Six specimens: three dorsal valves – MZ VIII Bra–1685 (Pl. 1, Fig. 1), MZ VIII Bra–1686 (Pl. 1, Fig. 2), MZ VIII Bra–1687 (Pl. 2, Fig. 1) and three complete shells – MZ VIII Bra–1688 (Pl. 4, Fig. 1), MZ VIII Bra–1689 (Pl. 4, Fig. 2), MZ VIII Bra–1690 (Pl. 4, Fig. 3).

TYPE LOCALITY: Matmor Hills in Hamakhtesh Hagadol, southern Israel.

TYPE HORIZON: Upper Callovian, Lamberti Zone.

DERIVATION OF NAME: After the Negev Desert, where the type locality is located.

DIAGNOSIS: A species of *Moorellina* up to about 2.2 mm in length, 2.1 mm width and 1.5 mm thick; shell subtriangular to subcircular in outline; shell surface smooth, endopunctate, with distinct growth lines; attachment scar relatively large, triangular in outline; pseudodeltidium very poorly visible, flush with surface of ventral interarea; ventral valve interior with distinct median ridge, elongate-triangular sessile hemispondylium and small hinge teeth; cardinal process large; median septum with lateral ridges arranged in typical moorellinid Y-shaped configuration; intrabrachial depressions relatively small; subperipheral rim usually ornamented by three rows of strong tubercles; fibrous secondary shell layer continuous in both valves.

MATERIAL: 35 specimens, including 14 complete shells, 4 dorsal valves and 17 ventral valves.

DESCRIPTION:

External morphology: The shell is small and subtriangular to subcircular in outline (Pl. 4, Figs 1–2, 3a, 4a). The shell surface is smooth, endopunctate, with distinct growth lines (Pl. 4, Figs 1–2, 3a). The attachment scar is large, triangular in outline and the free ventral valve is relatively high (Pl. 4, Figs 3–4). The cardinal margin is straight, long and varies between 0,62–0,66 of the shell width (Pl. 4, Figs 1–2). The ventral interarea is flat, with very poorly visible pseudodeltidium (Pl. 4, Figs 1–2).

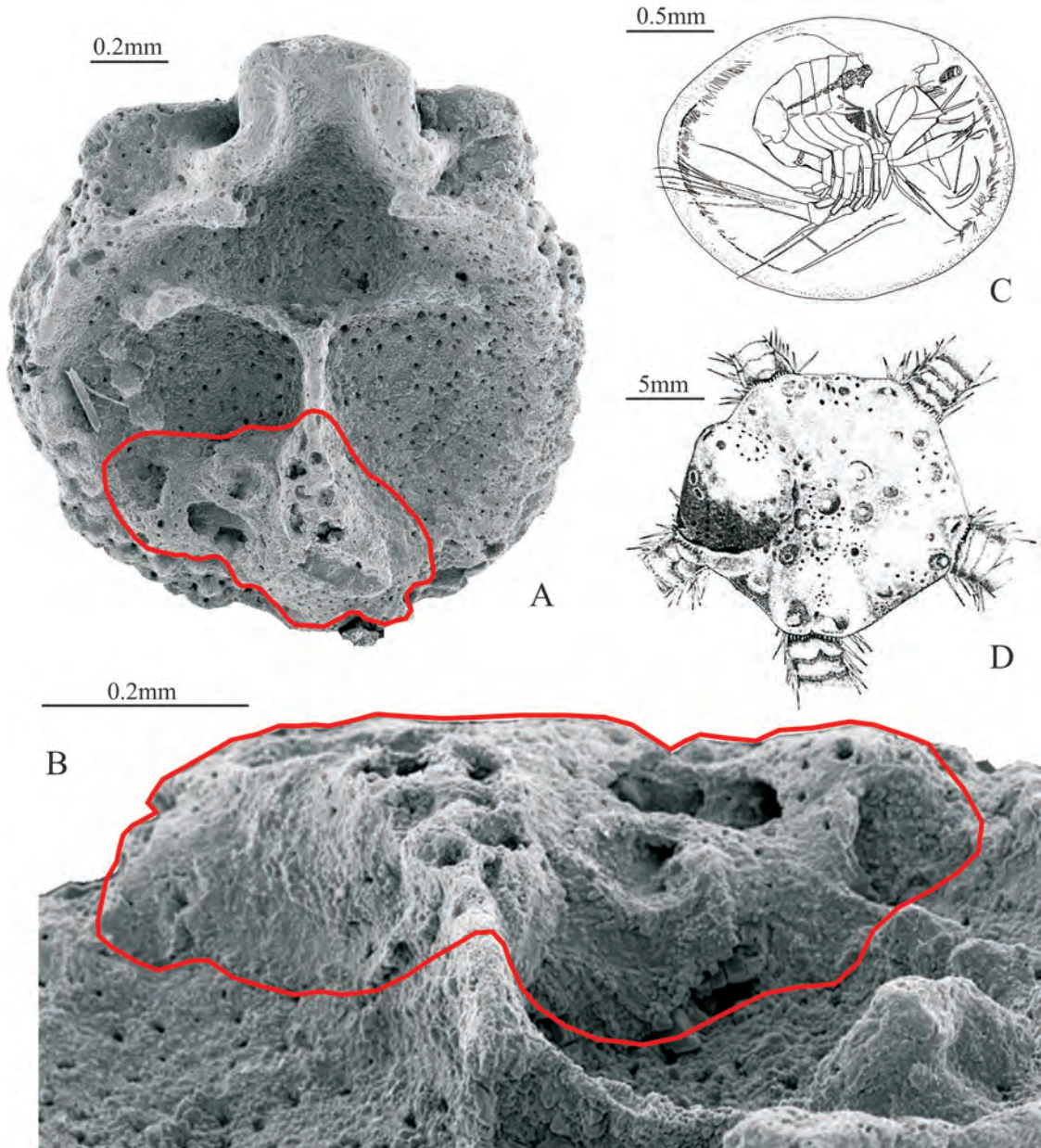
Internal morphology:

Ventral valve: The median ridge is distinctly marked and reaches $\frac{1}{2}$ to $\frac{2}{3}$ of the length of the valve interior. The hinge teeth are small and not widely separated. The sessile hemispondylium is well visible in the posterior part of the ridge.

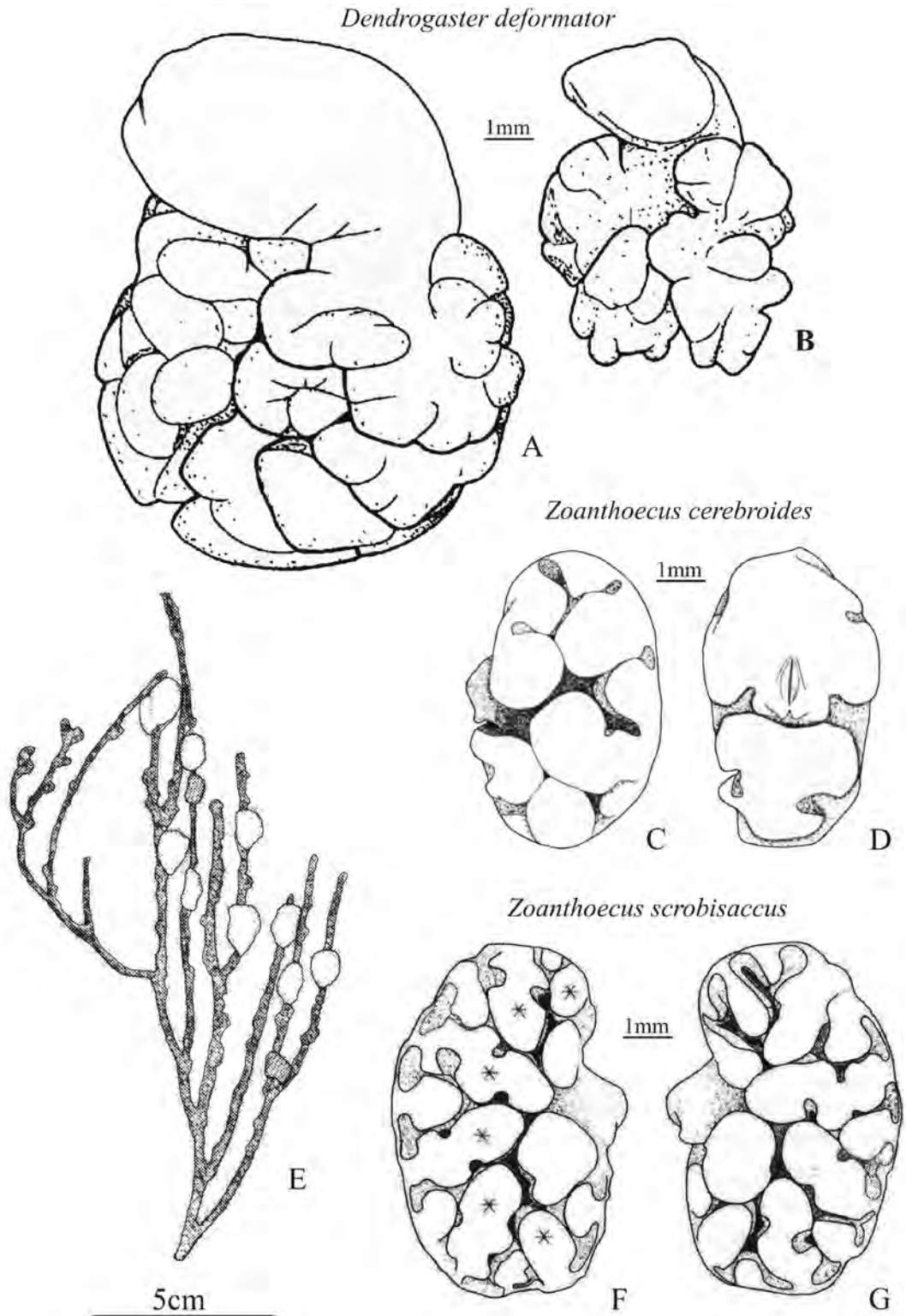
Dorsal valve: The cardinal process is large and protruding well beyond the cardinal margin (Pl. 1, Figs 1–2; Pl. 2, Fig. 1; Pl. 3, Fig. 1). The dental sockets are small, oval and lie close to the base of the cardinal process (Pl. 1, Fig. 1c, 2b; Pl. 2, Fig. 1e; Pl. 3, Fig. 1c). The lateral adductor muscle scars are poorly visible and form two subtriangular imprints between the base of the cardinal process and the base of the bridge (Pl. 1, Fig. 1b–c, 2b; Pl. 2, Fig. 1b, 1e; Pl. 3, Fig. 1c). The transversarium (bridge) is straight and strong (Pl. 1, Fig. 1; Pl. 2, Fig. 1a–b, 1e). The bridge edge denticulation is very poorly marked. The outer surface of the subperipheral rim is wide and usually ornamented by three rows of strong tubercles. (Pl. 3, Fig. 1a–c). The median septum reaches up to $\frac{2}{3}$ of the valve interior and is arranged, with the lateral ridges, in Y-

shaped configuration (Pl. 1, Fig. 1a, 2a; Pl. 2, Fig. 1a-d; Pl. 3, Fig. 1a, 1c). The intrabrachial depressions are relatively small and ringed in the antero-lateral part by the broken canopy skeletal supports (Pl. 1, Fig. 1a, 2a; Pl. 2, Fig. 1a-b; Pl. 3, Fig. 1a, 1c). The complete canopies of the brachial lobes are not preserved in the present material. The lophophoral impressions are poorly visible as shallow grooves running along the inner margin of the subperipheral rim (Pl. 2, Fig. 1a-b; Pl. 3, Fig. 1a, 1c).

Microstructure: The shell is endopunctate (Pl. 5, Figs 1-3, 5, 7) and the diameter of particular endopunctae varies between 11 and 21 μm on the inner surface and between 11 and 19 μm on the outer. The fibrous secondary shell layer is continuous in both valves (Pl. 5, Figs 5, 7), as in the other species of *Moorellina* (see Baker 1970, 1990, 1991, 2006). The fine-grained primary layer is thicker and relatively better preserved in the ventral valves, than in the dorsal valves (Pl. 5, Figs 5-8).



Text-fig. 2. Parasitic (ascothoracid?) infestation in the dorsal valve interior of *Moorellina negevensis* sp. nov.; A – interior of the dorsal valve of *Moorellina negevensis* sp. nov., with parasitic (ascothoracid?) infestation marked in red; B – enlargement of parasitic infestation, posterior-lateral view; C – *Synagoga paucisetosa* Grygier, 1990, a recent ascothoracid parasite (redrawn from Grygier 1990, slightly modified); D – recent ophiuroid *Ophiocten sericeum* (Forbes, 1852) with the genital bursae infested by *Ascothorax ophioctenis* Djakonov, 1914 (redrawn from Wagin 1946, slightly modified)



Text-fig. 3. Recent examples of ascothoracid crustacean parasites (redrawn from Grygier 1985a and Grygier 1990; slightly modified); A-B – *Dendrogaster deformatior* Grygier, 1990, a parasite of the brisingid starfish *Novodinia*, lateral view of habitus; C-D – *Zoanthoeus cerebroides* Grygier, 1985, a parasite of the gorgonian coral *Gerardia*, lateral and posterior views of carapace; F-G – *Zoanthoeus scrobisaccus* Grygier, 1990, a parasite of the gorgonian coral *Epizoanthus*, left and right sides of carapace; E – twelve specimens of *Zoanthoeus scrobisaccus* Grygier, 1990 *in situ* in galls on *Epizoanthus fatuus* Schulze, 1860

Remarks: *Moorellina negevensis* sp. nov. shows the greatest resemblance to the Aalenian-Bajocian species *Moorellina duplicata* (Moore, 1854), especially in the construction of the brachidium (see Davidson 1874–1882; Pajaud 1966, 1970; Baker 2006). However, adult specimens of *Moorellina negevensis* sp. nov. are nearly two times smaller than adults of *Moorellina duplicata* (Moore, 1854). The sizes of *Moorellina negevensis* sp. nov. are most comparable with the Toarcian slightly larger species – *Moorellina parca* (Rau, 1905), but the shell shape of these two species and the length/wide ratios of the dorsal valves are different (see Pajaud 1963, 1970). The complete canopies of the brachial lobes are not preserved in *Moorellina negevensis* sp. nov. However, an analysis of the broken canopy skeletal supports shows that the canopies of this species were rather rudimentary as in *Moorellina dubia* (d'Orbigny, 1847) than more complete as in *Moorellina granulosa* (Moore, 1854); see Pajaud (1970) and Baker (1991) for further discussion.

Parasitic infestation: A pathologically changed area has been observed in the interior of the dorsal valve of one specimen (Text-fig. 2; Pl. 1, Fig. 2). This is a gall-like structure about 0.84 mm long and 0.56 mm wide, localized in the anterior part of the valve – mostly in the left brachial cavity and median septum (Text-fig. 2). The gall is built of the same shell material as the bottom of the dorsal valve (Pl. 1, Fig. 2c), which shows that the host reacted against infestation by encystation of the parasite. The shape and form of this structure resemble, in some aspects, galls of recent ascothoracid parasites (Text-figs 2–3; Grygier 1984, 1985a, 1985b, 1990; Jangoux 1987). All recent Ascothoracida are marine parasites of various echinoderm and cnidarians hosts and occur from the intertidal to the deep sea, up to 5000 m (Grygier and Høeg 2005). They have been found both as endoparasites in the coelomic cavity of asteroids and echinoids (Madsen and Wolff 1965; Grygier 1985b, 1990; Jangoux 1987; Kolbasov *et al.* 2008) and as ectoparasites on anthozoans, crinoids and ophiuroids (Wagin 1946; Grygier 1984, 1985a, 1990; Jangoux 1987). The case of an infested brachiopod is especially interesting in this light.

The major problem with an “ascothoracidan” interpretation of this gall-like structure is that no ascothoracidans are known as fossils (Grygier and Høeg 2005). However, several trace fossils such as excavations and galls dating back to the Cretaceous on echinoderm and anthozoan hosts have been attributed to the Ascothoracida (Madsen and Wolff 1965; Grygier and Høeg 2005). So far no trace fossils produced by ascothoracidans have been reported from the Jurassic (Grygier and Høeg 2005; Radwańska and Radwański 2005). If our interpretation is correct than the history of these creatures should be extended to the Middle Jurassic.

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PLATE 1

Moorellina negevensis sp. nov., Upper Callovian, Lamberti Zone, Matmor Hills, Hamakhtesh Hagadol

- 1 – Paratype (MZ VIII Bra-1685), juvenile dorsal valve: 1a – general view of the valve interior, 1b – oblique view showing brachial cavities and cardinalia, 1c – posterior view, cardinalia.
- 2 – Paratype (MZ VIII Bra-1686), adult dorsal valve with the left brachial cavity changed by parasitic (ascothoracid?) infestation, 2a – general view of the valve interior, 2b – oblique view showing brachial cavities and cardinalia, 2c – magnification of the valve area infested by parasite.

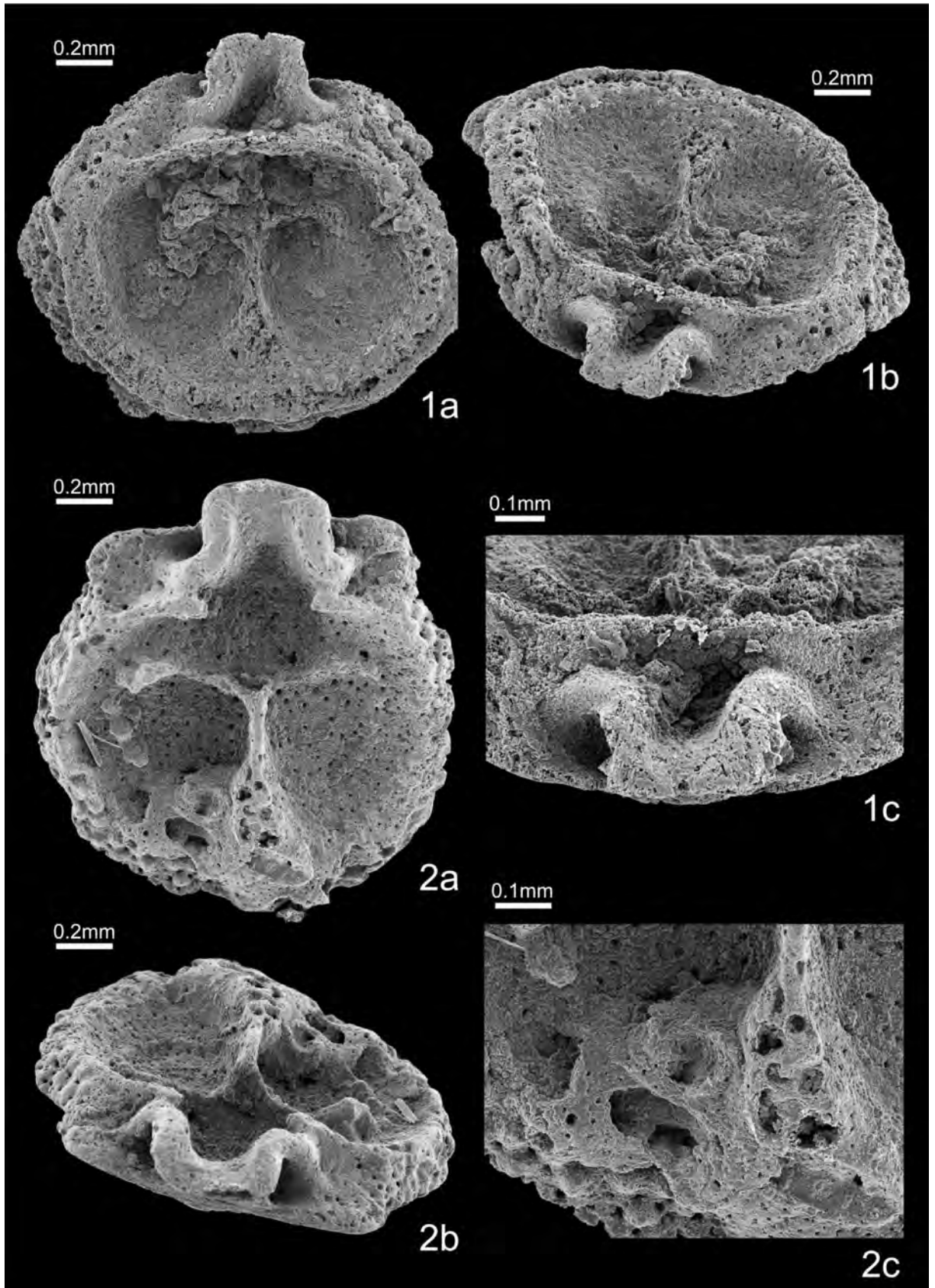


PLATE 2

Moorellina negevensis sp. nov., Upper Callovian, Lamberti Zone, Matmor Hills, Hamakhtesh Hagadol

- 1** – Paratype (MZ VIII Bra-1687), adult dorsal valve: 1a – general view of the valve interior, 1b – oblique view showing brachial cavities and cardinalia, 1c – right brachial cavity and Y-shaped configuration of the median septum and the lateral ridges, white arrow shows enlarged fragment, 1d – enlarged area of the top of the median septum and the beginning of the lateral ridges, 1e – posterior view, cardinalia.

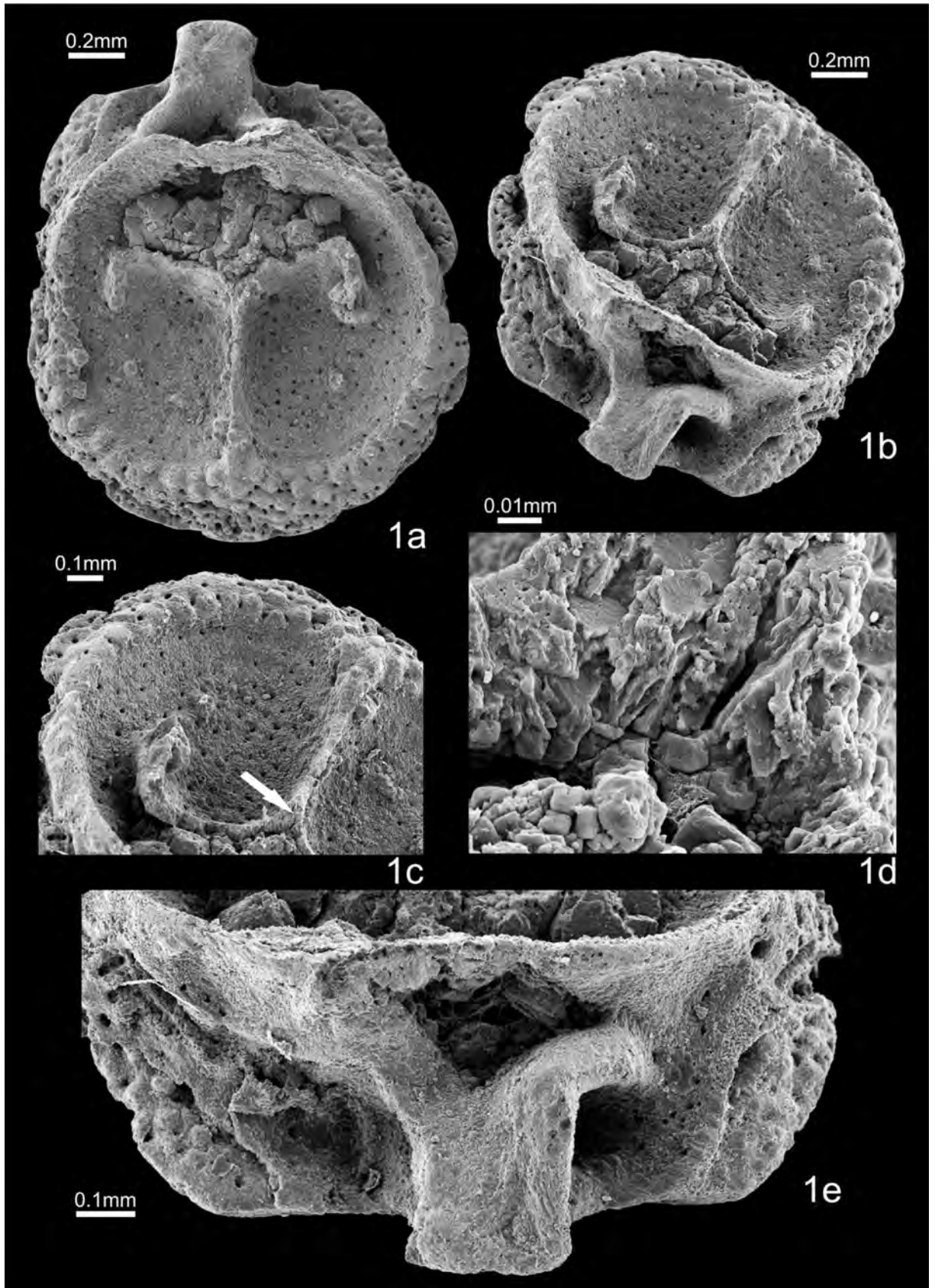


PLATE 3

Moorellina negevensis sp. nov., Upper Callovian, Lamberti Zone, Matmor Hills, Hamakhtesh Hagadol

- 1** – Holotype (MZ VIII Bra-1684), adult dorsal valve: 1a – general view of the valve interior, 1b – enlarged tubercles from the left anterolateral margin, 1c – oblique view showing brachial cavities and cardinalia.

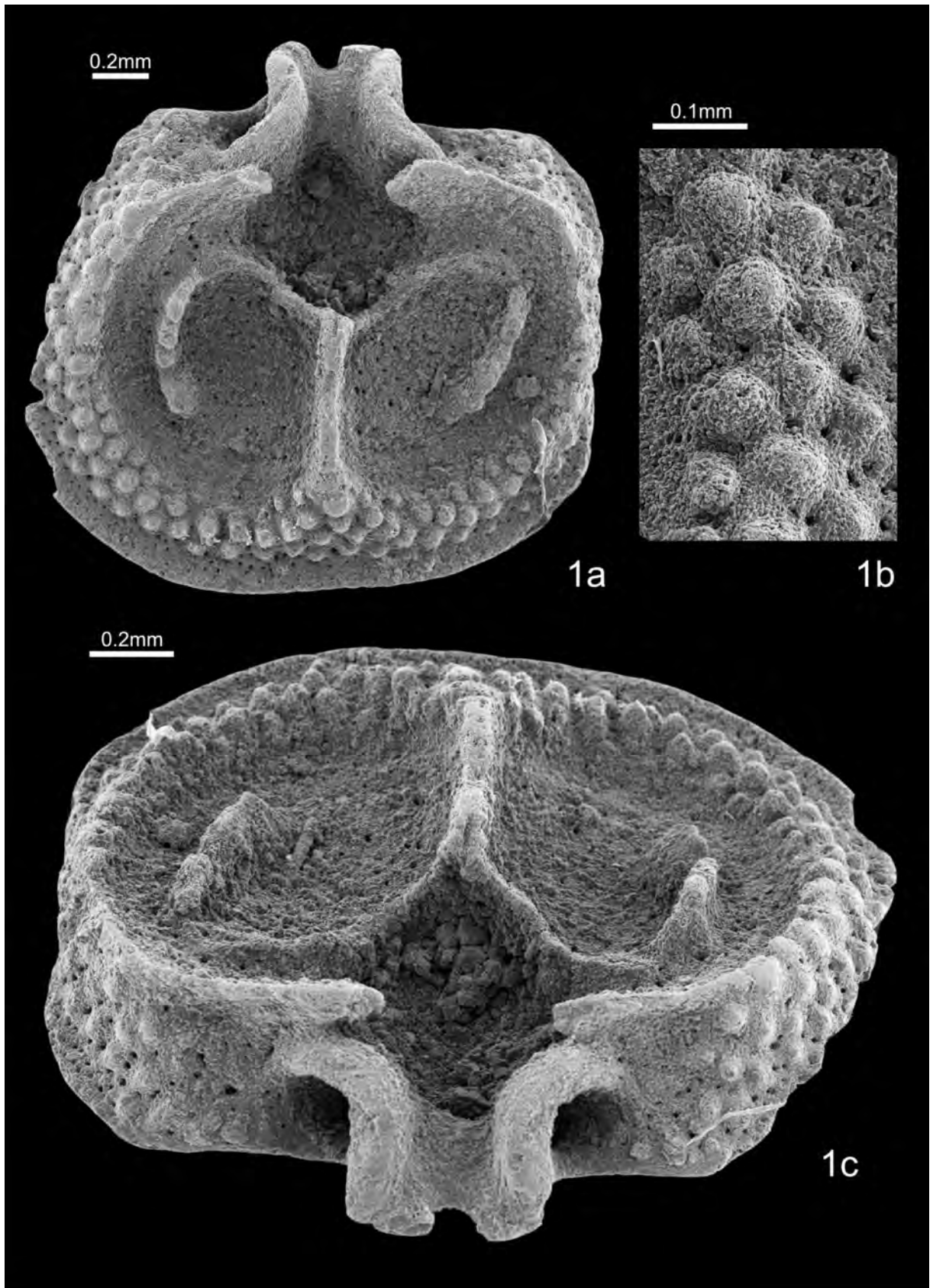


PLATE 4

Moorellina negevensis sp. nov., Upper Callovian, Lamberti Zone, Matmor Hills, Hamakhtesh Hagadol

- 1 – Paratype (MZ VIII Bra-1688), complete adult specimen, dorsal view.
- 2 – Paratype (MZ VIII Bra-1689), complete adult specimen, dorsal view.
- 3 – Paratype (MZ VIII Bra-1690), complete adult specimen: 3a – ventral view, 3b – attachment scar area.
- 4 – (MZ VIII Bra-1691), complete adult specimen: 4a – ventral view, 4b – anteroventral view.

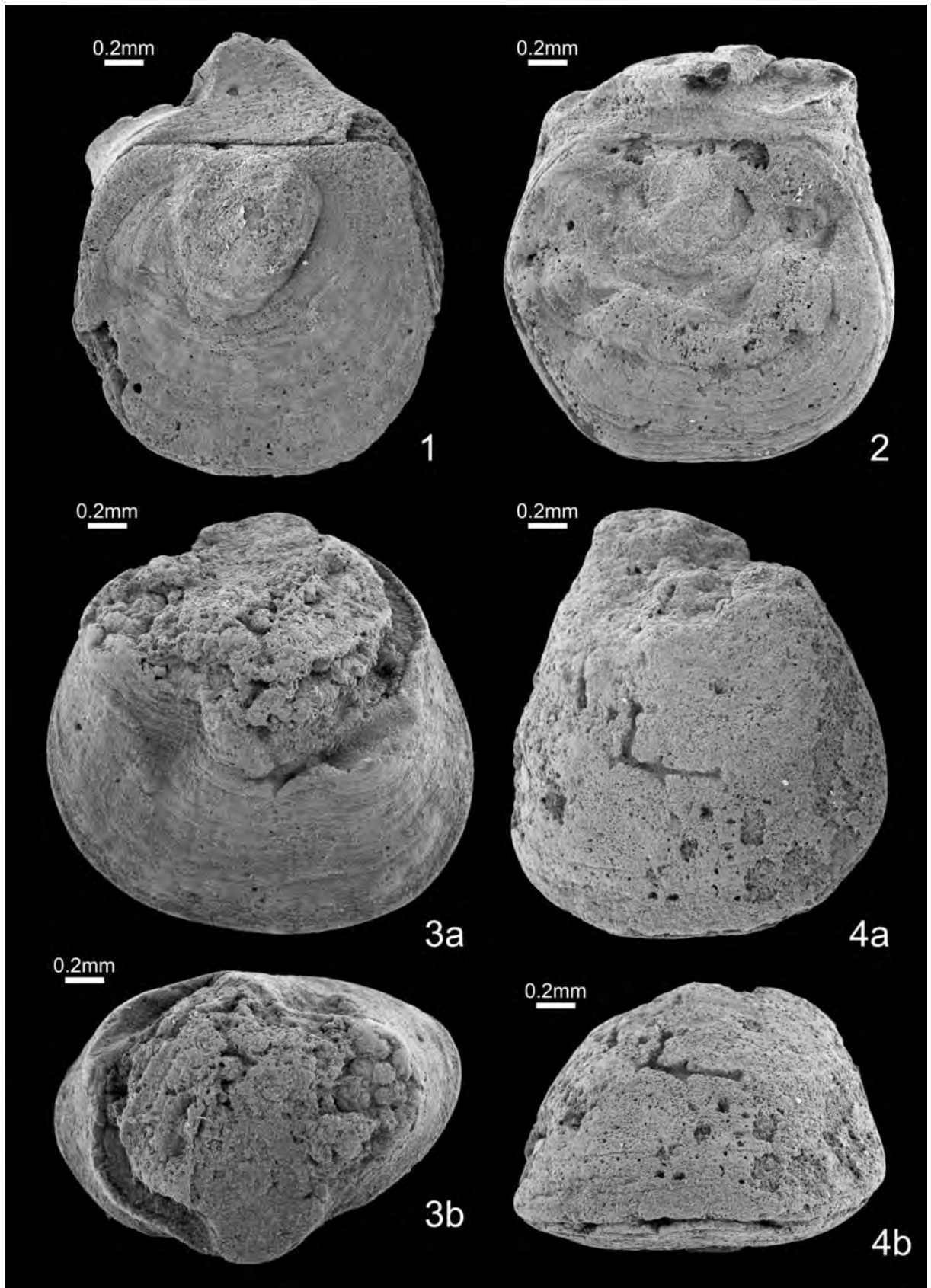


PLATE 5

The shell microstructure of *Moorellina negevensis* sp. nov., Upper Callovian, Lamberti Zone, Matmor Hills, Hamakhtesh Hagadol

- 1 – (MZ VIII Bra-1687) endopunctae in the floor of the right interbrachial cavity.
- 2 – (MZ VIII Bra-1686) endopunctae in the floor of the left interbrachial cavity.
- 3 – (MZ VIII Bra-1687) endopuncta and fibrous secondary shell layer near the base of the cardinal process.
- 4 – (MZ VIII Bra-1687) fibrous secondary shell layer of the inner side of the cardinal process.
- 5 – (MZ VIII Bra-1689) remains of the granular primary shell layer covering the fibrous secondary shell layer, dorsal valve exterior.
- 6 – (MZ VIII Bra-1688) granular primary shell layer, dorsal valve exterior.
- 7 – (MZ VIII Bra-1691) remains of the granular primary shell layer covering the fibrous secondary shell layer, ventral valve exterior.
- 8 – (MZ VIII Bra-1690) granular primary shell layer, ventral valve exterior.

