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Authors: Zágoršek, Kamil, and Gordon, Dennis P.

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Late Tortonian bryozoans from Mut Basin, Central Anatolian Plateau, southern Turkey

KAMIL ZÁGORŠEK and DENNIS P. GORDON

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Sixteen bryozoan species have been identified in the Başyayla section, Mut Basin, southern Turkey. Five of these species are described here, including two new to science representing new genera: *Basyaylella elsae* gen. et sp. nov. and *Ostrovskia triforamina* gen. et sp. nov. The other three described species (*Exidmonea* sp., *Biflustra savartii*, and *Margaretta* sp.) show unusual features that have not been reported previously. Based on bryozoan data, the Başyayla sequence represents a tropical to subtropical, normal marine environment, with seafloor composed of fine sedimentary particles in a low-energy setting.

Key words: Bryozoa, Cheilostomata, *Basyaylella*, *Ostrovskia*, Tortonian, Eocene, Miocene, Mut Basin, Turkey.

Kamil Zágoršek [kamil_zagorsek@nm.cz], Department of Paleontology, National Museum, Vaclavské nam. 68, CZ-115 79 Prague 1, Czech Republic;
Dennis P. Gordon [d.gordon@niwa.co.nz], National Institute of Water & Atmospheric Research, Private Bag 14901, Kilbirnie, Wellington, New Zealand.

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Introduction

The Central Anatolian Plateau (CAP) formed as a consequence of a long and complex deformational history, mainly owing to the convergence between the Arabian and Eurasian plates. Pontide and Taurides orogenic belts bounded the northern and southern margins of the CAP. An intramontane extension, initiated throughout the Taurides during the Late Eocene–Early Miocene, produced tectonically controlled sedimentary basins including, among others, the Mut-Ermenek Basin on the southern margin of the CAP (Aksu et al. 1992; Görür 1992). The epicontinental Mut-Ermenek Basin was predominantly filled by marine sedimentary sequences of Oligocene–Early Miocene age, corresponding to the Burdigalian–Serravallian TB2 supercycle of Haq et al. (1988).

The marine deposits are mainly marls with intercalations of carbonates, laterally transitioning to carbonate ramp deposits such as bryomol, foramol and/or rhodalgal limestone (Mandic et al. 2004; Eriş et al. 2005; Şafak et al. 2005; Janson et al. 2010). The deposits are usually undeformed and subhorizontal throughout the Mut-Ermenek Basin. In the Başyayla area, the uppermost part of the Miocene marine succession of the Mut-Ermenek Basin covered Mesozoic rocks. The maximum thickness of these undeformed Miocene marine sediments is about 2000 m (Cosentino et al. 2010).

The Başyayla section is situated close to the town of Başyayla and shows about 40 m of offshore marls with about 20 m of sediments transitional to the shallow-water limestone at the northern margin of the Mut-Ermenek Basin.

Recent studies have given a Late Tortonian age, based on the ostracods *Semicytherura velata* and *Cytherella vulgata* (Gliozzi et al. 2010) and the foraminiferan *Globigerinoides extremus*–*Globorotalia suterae* Interval Subzone (MMi 12a) that ranges from 8.35 to 7.81 Ma (Cosentino et al. 2010).

Paleontological analyses were performed on 25 samples, spaced more or less regularly every 50 cm along the clayey-marly sediments cropping out in the two studied Başyayla successions (GPS 36°46’1.084” N, 32°40’55.309” E), ranging from 1781 m a.s.l. at the base to 1839 m a.s.l. at the top (Gliozzi et al. 2010). Bryozoans were found in 22 samples. Altogether 16 species have been identified. Volumetrically the commonest species are free-living bryozoans of the genus *Reussirella*, occurring in 17 samples. Free-living colonies of *Cupuladria* are also very abundant, as are erect-rigid branches of *Basyayella* gen. nov. and nodes of erect-flexible *Nellia*, occurring in seven to eight samples.

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Table 1: List of all determined taxa with their occurrences within the Başyayla section.

Taxa/samples BAS	1	2	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Biflustra savartii			1				1	1							1						1	
Cellaria cf. *fistulosa*	1		1		1	1		1				1				1						
Crisia haueri	1												1			1			1	1		1
Cupuladria sp.			1	1	1					1				1		1	1					1
Exidmonea sp.		1																				1
Basyaylella elsae sp. nov.	1	1	1		1	1				1				1	1			1				
Idmidronea sp.	1	1																				1
Lunulites cf. *androsaces*					1							1										
Margaretta sp.		1	1		1	1	1	1		1		1	1					1				
Nellia cf. *tenella*												1	1	1	1	1		1	1	1		
Pleuronea pertusa																						1
Reteporella sp.			1		1						1										1	
Reussirella haidingeri	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1			1	
Ostrovskia triforamina sp. nov.		1	1																			
Schizostomella grinzingensis			1					1				1			1						1	
Steginoporella montenati																					1	
Number of species	5	6	9	2	7	3	3	5	1	4	2	6	4	4	5	5	2	4	2	2	5	5

Remarkably, two new monotypic genera of Cheilostomata are recognised in the samples, both incertae sedis and unrelated. One genus is superficially similar to the North American genus *Enoplostomella* (putatively Stomachetosellidae) and the opportunity is taken here to comment on the status of this genus. The other genus is a probable member of the superfamily Schizoporelloidea but has distinctive morphological features that confound exact taxonomic placement. We discuss these new and little-known taxa and the novel morphological features.

We present evidence, based on taxonomic composition and colonial morphology, that the paleoclimate was tropical to subtropical, and that the paleoenvironment was that of a well-consolidated seafloor, with the presence of small particles and low water energy in a fully marine setting.

Institutional abbreviations.—PM2, Natural History collection, National Museum, Prague, Czech Republic; T, foreign Tertiary collection within PM2.

Other abbreviations.—CAP, Central Anatolian Plateau; TB2, Haq et al. (1988) supercycle; TEM, transmission electron microscope.

Material and methods

All material came from the collection of Elsa Gliozzi (Università degli Studi, Roma, Italy), who collected it in the field and kindly presented the collection to the first author for study. The material was washed and sieved, then sorted under a binocular microscope. Well preserved and/or ovicellate examples of each species were cleaned ultrasonically and studied using a low-vacuum LV Hitachi S-3700N SEM at the National Museum, Prague, Czech Republic. This instrument allowed backscattered electron images to be obtained of uncoated specimens temporarily mounted to stubs using adhesive carbon tabs, or affixed to stage mounts with carbon plastic.

Systematic paleontology

All of the bryozoans found in the Başyayla section taxa are listed in Table 1. New taxa and material with notable morphological features are described or commented on below.

Phylum Bryozoa Ehrenberg, 1831

Order Cyclostomata Busk, 1852

Suborder Tubuliporina Milne Edwards, 1838

Family Tubuliporidae Johnston, 1838

Genus *Exidmonea* David, Mongereau, and Pouyet, 1972

Type species: *Exidmonea atlantica* David, Mongereau, and Pouyet, 1972 (see Johnston 1847 and also Braga and Barbin 1988; Taylor and Voigt 1993; Florence et al. 2007); Miocene of Paris Basin.

Diagnosis.—Colony erect, rarely bifurcating. Branches rod-like, oval to triangular in transverse section. Autozooecial apertures arranged in parallel fascicles. Gonozooecia situated on the frontal side, globular with an ooeciopore smaller than an autozooecial aperture. No kenozooecia on the dorsal side.

Exidmonea sp.

Fig. 1A.

Material.—One fragment (PM2-T 1124) of a large bifurcating colony with the gonozooecium extending across ten autozooecial fascicles.

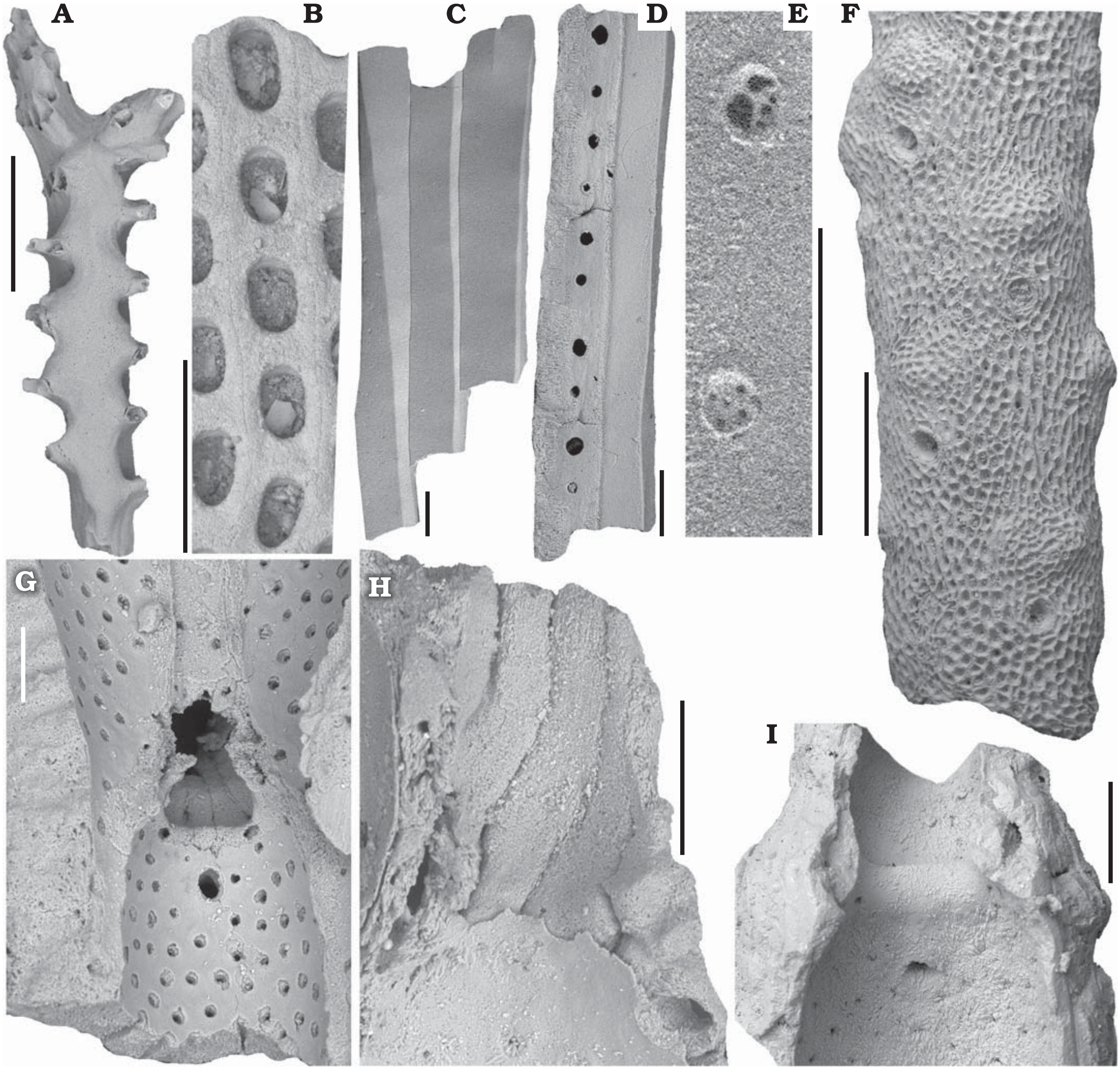


Fig. 1. Late Tortonian bryozoans from the Başyayla section. **A**. *Exidmonea* sp. (PM2-T1124) with very extended frontal gonozooecium from sample BAS 2. **B**–**E**. *Biflustra savartii* auctt. **B**. PM2-T1127, frontal view of colony, sample BAS 8. **C**. PM2-T1126, abfrontal view showing three rows of autozooecia with characteristic angled appearance, sample BAS 8. **D**. PM2-T1125, lateral view of the three autozooecia showing regularly distributed lateral communication pores, sample BAS 4. **E**. PM2-T1129, detail of lateral communication pores showing multiporous septula, sample BAS 4. **F**–**H**. *Margaretta* sp. **F**. PM2-T1130, external view showing concealed ovicells (visible as bulges in frontal shield), sample BAS 8. **G**. PM2-T1131, internal view showing peristomial chamber, with an ascopore situated in the midline of the frontal shield, sample BAS 11. **H**. PM2-T1132, detail of the aperture of a colony showing linear structures in the peristomial wall, sample BAS 7. **I**. *Margaretta cereoides* (Ellis and Solander, 1786) (PM2-P1939) from section Hlohovec (Moravia) showing the smooth interior surface of the peristome. Scale bars A, B, F, 1 mm; C–E, G–I, 100 µm.

Remarks.—The Turkish specimen very much resembles *Exidmonea atlantica* David, Mongereau, and Pouyet (1972) as illustrated by Zágoršek (2010a) from Moravia. However, the size and shape of the gonozooecium is much smaller in the Moravian material (extending only across five autozooecial fascicles). The size and shape of the gonozooecium is very similar to the specimen described by Hayward and McKinney (2002: fig. 49H) as *Exidmonea triforis* (Heller, 1867) from Rovinj in the Adriatic Sea, which was never reported from fossil sequences. The gonozooecium is unusually large for any fossil known species. Because only one specimen has been found, the exact determination remains uncertain.

Order Cheilostomata Busk, 1852

Suborder Malacostegina Levinsen, 1902

Superfamily Membraniporoidea Busk, 1852

Family Membraniporidae Busk, 1852

Genus *Biflustra* d'Orbigny, 1852

Type species: *Flustra ramosa* d'Orbigny, 1852; Recent, Manila Bay Philippines. For details see Tilbrook (2006).

Diagnosis.—Embedded from Tilbrook (2006): Colony encrusting or erect, foliaceous, or vincularian from an encrusting base. Autozooecia with well-developed cryptocyst and no spines. Opesia usually very large. Gymnocyst not developed. Ovicell unknown. Avicularia lacking.

Biflustra savartii auctt.

Fig. 1B–E.

1974 *Biflustra savartii* (Audouin, 1826); David and Pouyet 1974: 99.
1988 *Biflustra savartii* (Audouin, 1826); Moissette 1988: 73, pl. 11, fig. 6.

Referred material.—Altogether eight specimens were studied (four of them illustrated PM2-T1125 to PM2-T1127 and PM2-T1129), mainly with smooth dorsal walls and well-preserved lateral communication pores.

Remarks.—This species is frequently listed under the genus *Biflustra*, however the type species of *Biflustra* (Recent *Biflustra ramosa* d'Orbigny, 1852 from the Philippines) is known only from a single specimen that lacks the ancestrular region. Therefore it is not known if the ancestrula is twinned or single. The type species of *Acanthodesia* is *Flustra savartii* and Taylor and Foster (1998) prefer to retain this genus pending description of the ancestrula of *B. ramosa*.

The frontal features of studied specimens are identical with those described by Zágoršek (2010a) from the Moravian Miocene (Fig. 1B) as *Biflustra savartii*. The abfrontal side of the zooids is very smooth, giving evidence that the colony was originally bilamellar and the two layers have separated (Fig. 1C). Lateral walls are perforated by well-preserved uniporous and multiporous mural septula (communication pore areas), lacking in Moravian material (Fig. 1D, E). The precise taxonomic status of the species *Flustra savartii* Audouin (1826) and the various forms attributed to it have yet to be resolved, although Taylor and Foster (1998) figured a putative specimen of *Flustra savartii* from the type area of the Red Sea. For this reason our specimens are referred to as *A. savarti* auctt.

Stratigraphic and geographic range.—Miocene to Recent, cosmopolitan.

Suborder Ascophora Levinsen, 1909

Incertae sedis

Genus *Basyaylella* nov.

Type species: *Basyaylella elsae* sp. nov.; see below.

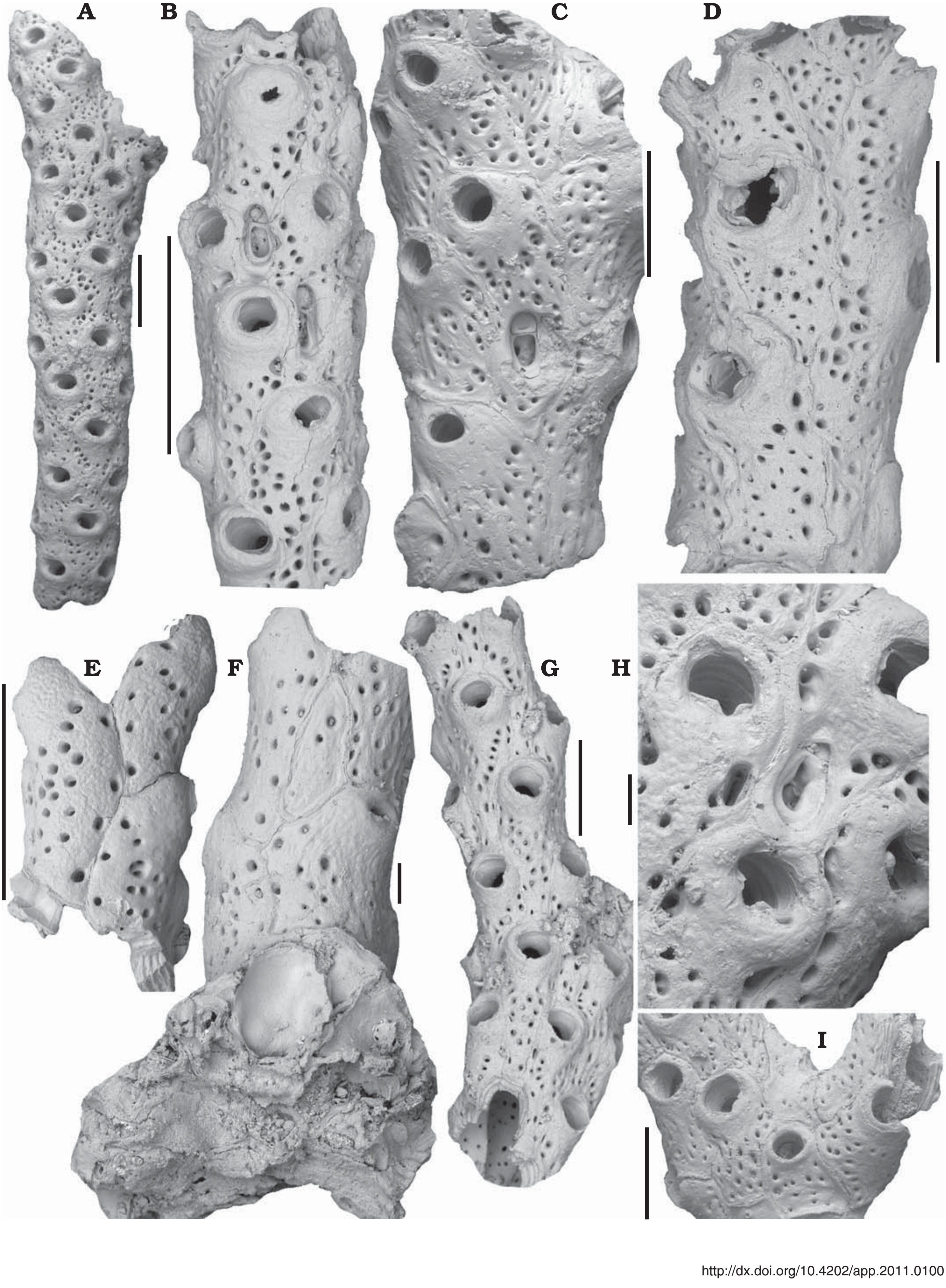
Etymology: Alluding to the name of the Başyayla section.

Diagnosis.—Colony erect, rigid, branches with circular cross sections. Up to five rows of autozooecia around branch, abfrontal side without orifices, formed by dorsal sides of marginal rows of autozooecia. Autozooecia with areolar pores, frontal pseudopores and central nonporous area on frontal shield as viewed from exterior. Orifices circular with thick, wide but short peristome. Primary orifice without sinus, secondary orifice may have a pseudosinus. Avicularia adventitious, situated on proximal part of autozooecia, on frontal as well on abfrontal side of colony. Ovicell globular with perforated entooecium, deeply immersed in distal autozooecium, but not frontally pronounced. Kenozooecia present.

Remarks.—The frontal shield of *Basyaylella* is perhaps mixed (umbonuloid and lepralioid), and therefore the family and even the superfamily relationships are uncertain. However, it may have affinities with some genera traditionally classified in the Stomachetosellidae. This family is itself somewhat heterogeneous and badly needs revising, and the type species of *Stomachetosella* is an Oligocene fossil, but let us consider the potential candidate genera, each based on its type species:

- *Stomachetosella crassicollis* Canu and Bassler, 1917, Early Oligocene, Mississippi, has erect bilamellar/flabellate fronds to subvincularian stems in which the zooids, opening on all sides, have a regularly perforated, pseudoporous lepralioid frontal shield. The orifice has a tapering rounded poster and condyles appear to be lacking. Ovicells are hyperstomial and porous, somewhat like the frontal shield, and there are no avicularia.
- *Enoplostomella defixa* Canu and Bassler, 1917, Late Eocene–Early Oligocene, Alabama, has erect cylindrical stems with zooids opening all around. The frontal shield in frontal view appears more or less evenly pseudoporous. The orifice develops a thickened peristomial rim in which an avicularium is set on one side of the sinus. Ovicells are conspicuous, hyperstomial, and evenly porous, and a well-developed adventitious avicularium is set in the peristomial rim on one side of the orifice.
- *Metrocrypta bucculenta* Canu and Bassler, 1917, Late Eocene, North Carolina, has dichotomously branching cylindrical stems with zooids opening all around. Zooids are more or less evenly pseudoporous and, with secondary calcification, the interzooidal boundaries become indis-

Fig. 2. Exterior view of an ascophoran bryozoan *Basyaylella elsae* gen. et sp. nov. from the Miocene of Turkey. **A**. PM2-T1218, paratype showing a general view of the colony. **B**. PM2-T1217, holotype showing secondary orifices and avicularia on the autozooecial frontal shield. **C**. PM2-T1219, abfrontal view showing avicularium with obvious pivot bar. **D**. PM2-T1220, frontal view showing autozooecia with peristomial sinus. **E**. PM2-T1221, abfrontal side of a colony fragment. **F**. PM2-T1222, basal part of a colony with the attachment point and an elongated kenozooecial surface on the abfrontal side. **G**. PM2-T1223, frontal view of less-calcified colony showing distribution of marginal areolar pores. **H**. PM2-T1224, detail of autozooecial secondary orifices with pseudosinuses and small heterozooecia. **I**. PM2-T1225, a branch fragment showing kenozooecia in the area of the bifurcation. All specimens from sample BAS 4. Scale bars A–E, G, I, 1 mm; F, H, 100 µm. →



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tinct. Primary orifices are deeply concealed and described as "orbicular", i.e., lacking a sinus; secondary (peristomial) orifices are more or less round and raised above the zooidal surface. Small adventitious avicularia are lacking but Canu and Bassler (1917) described a very large laterofrontal avicularium suborally that occupies much of the frontal wall. Definite ovicells have not been identified but rare large, round broken chambers distal to some orifices could be ovicell chambers, in which case they would be described as hyperstomial and prominent in life.

- *Ochetosella jacksonica* Canu and Bassler, 1917, Middle Eocene, Alabama, to Late Eocene, Mississipi and southeastern USA, likewise has cylindrical branching stems but the frontal shield is non-pseudoporous, with only marginal areolar pores. Interzooidal boundaries are raised in young zooids but become indistinct in older zooids. There is a large laterofrontal avicularium suborally in some zooids. Ovicells are subglobular, smooth-surfaced and recumbent.
- *Metradolium dissimile* Canu and Bassler, 1917, Late Eocene, southeastern USA, has flattened bifurcating branches with parallel sides and zooids opening all around. The frontal shield is convex and evenly pseudoporous with indistinct zooidal boundaries. The primary orifice is deeply concealed and suborbicular; the secondary orifice tends to be wider than long and is rounded without a projecting peristomial rim. Adventitious oval avicularia may occur just proximal of the corners of the peristomial orifice, single or paired, with one typically larger than the other. The ovicell is concealed and opens into the peristome; it is visible externally as a bulge.

Of the above genera, *Ochetosella* can be quickly ruled out. Although some individual zooids in *Basyaylella* gen. nov. can resemble zooids of *Ochetosella* (see the distalmost zooids in Fig. 2G), the species has a mostly frontally porous shield, which is not the case in *Ochetosella*. In the type species of the other four genera zooids open on all faces of the stems and the frontal shields are externally evenly pseudoporous. In details of form and placement of avicularia and ovicells, these three genera do not appear close enough to our new species to include it in the scope of their characters. On the other hand, what is known about the characters of two of the species ascribed by Canu and Bassler (1917) to *Enoplostomella* invites comparison with this genus. *Enoplostomella vallata* and *E. magniporosa* have dichotomously branching stems with distinct frontal and abfrontal faces, with 3–4 longitudinal rows of zooids opening mostly frontally and two longitudinal rows of dorsal zooidal walls appearing abfrontally. The dorsal side is relatively coarsely perforated and the interzooidal boundary between the two longitudinal rows of zooids forms a distinctively sinuous line down the middle. In this regard, plate 89, fig. 18 of Canu and Bassler (1917) showing the abfrontal side of *E. magniporosa* greatly resembles the arrangement in our Fig. 2E. Canu and Bassler (1917) presented no illustrations of the zooidal interiors in *E. vallata* and *E. magniporosa* and there is thus no evidence that either of these species has a mixed frontal shield. Our species also lacks a peristomial avicularium, whereas it has relatively large interzooidal avicularia, lacking in *E. vallata* and *E. magniporosa*. On the other hand, ovicells in the latter two species are concealed by secondary calcification (except distally in young zooids in *E. magniporosa*), just as in our species. The "apertura", i.e., the primary orifice, in *E. vallata* is described as "semilunar with a straight proximal border" in *E. vallata* and suborbicular in *E. magniporosa*; in our species the primary orifice lacks a sinus.

On balance, we conclude that our species differs significantly from the type species of *Enoplostomella* to warrant a new genus. On the other hand, it appears highly likely that *E. vallata* and *E. magniporosa* are not congeneric with *Enoplostomella*. We cannot say, without detailed examination of these species, if they may be included in *Basyaylella*.

Geographic and stratygraphic range.—Late Tortonian, Başyayla section

Basyaylella elsae sp. nov.

Figs. 2, 3.

Etymology: In honour of Professor Elsa Gliozzi, who provided us with the samples and who has been studying the Başyayla section in detail for many years.

Type material: Holotype: PM2-T1217 (Fig. 2B), sample BAS 4. Paratypes: PM2-T1218 to T1229, 12 specimens, samples BAS 4, 6, 7, and 19 (Figs. 2, 3).

Type locality: Başyayla section, Turkey.

Type horizon: Upper Tortonian, Miocene.

Referred material.—22 additional colonies (two of them illustrated (Fig. 3B, F) PM2-T1159 and PM2-T1160) were studied from samples BAS 7, 13, 14, and 19 under the SEM, but not included into the type collection.

Diagnosis.—As for the genus.

Description.—Colony erect, rigid, branches bifurcating (Fig. 2A) with autozooecia opening on three sides. Branch cross section circular, no median lamella developed. Attachment point wide, rigid (Fig. 2F). Frontal part of branch with up to five rows of autozooecia (Fig. 2A, B), abfrontal side with sinuous, slightly zigzag pattern of attachment of lateral walls (Fig. 2C–E).

In external view, autozooecia elongated, separated by narrow furrows. Frontal shield of less-calcified autozooecia apparently with areolar pores only (Fig. 2G) and large central nonporous area. Later, the nonporous area becomes reduced, with the rest of frontal wall strongly perforated. (Fig. 2B–D, I). Primary orifice circular, semi-oval, with thick, wide but short peristome (Fig. 2B). A few secondary orifices develop a pseudosinus, perhaps during intramural budding, similar that those described by Berning (2008) (Fig. 2B, D, H).

Adventitious (interzooidal?) avicularia situated on frontal (Fig. 2B) and abfrontal sides (Fig. 2C) of branch, occupying proximal part of autozooecial frontal wall (Fig. 2B, H). Pivot bar well developed, rounded rostrum palate tapering proximally (Fig. 2B, C). Ovicells not observed on branch exteri-

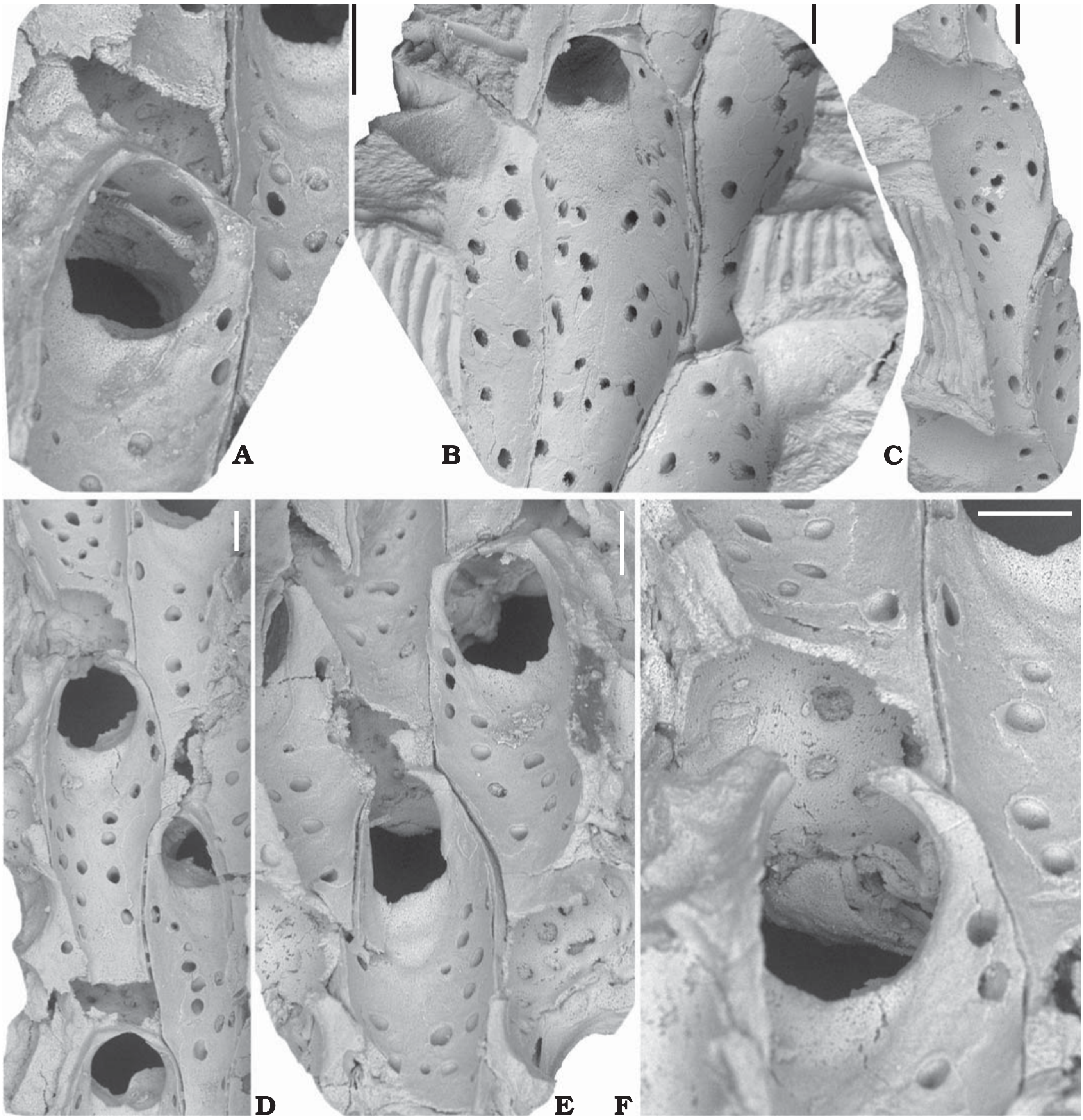

Fig. 3. Interior view of an ascophoran bryozoan *Basyaylella elsae* gen. et sp. nov. from the Miocene of Turkey. **A**. PM2-T126, detail showing part of a concealed ovicell chamber (broken) and the reduced umbonuloid part of the frontal shield. **B**. PM2-T1159, autozooecial profiles with clearly observable umbonuloid part of the frontal shield, smooth peristome, large pseudopores and laminations in frontal shield. **C**. PM2-T1227, detail of a laterally broken specimen with well pronounced laminations in frontal shield and a smooth peristome. **D**. PM2-T1228, interior view showing broken, concealed ovicellular chambers, deeply immersed in distal autozooecia. **E**. PM2-T1229a, similar view to D and also showing the umbonuloid part of the frontal shield. **F**. PM2-T1160, detail of ovicell interior with entooecial perforations. A, C, D, E sample BAS 4; B, F sample BAS 7. Scale bars 100 µm.

ors. Kenozooecia often present in branch bifurcations (Fig. 2I) or on abfrontal side (Fig. 2F).

In internal views autozooecia clearly separated by furrows with mixed (umbonuloid and lepralioid) frontal shield. The umbonuloid part elongated semicircular, small with characteristic microstructure (Fig. 3B, E) and ring scar (Fig. 3A, B, D–F). The lepralioid part perforated by very large pores (Fig. 3B–F). Marginal areolar pores visible only near orifice (Fig.

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3B, F). Primary orifice circular with slightly straight proximal margin (Fig. 3A, D) and sometimes with median ridge (Fig. 3B, E). Peristome long, smooth (Fig. 3B, C). Parallel longitudinal furrows evident in sides of separated adjacent frontal shields (Fig. 3B, C). Internal walls thin (Fig. 3E).

Ovicells deeply immersed in distal autozooecia (Fig. 3A, D–F), not pronounced on external surface; ovicells globular (Fig. 3F), visible only when zooids are fractured and viewed from interior (Fig. 3E); entooecium perforated by pores of same size as frontal pseudopores (Fig. 3A, F), ectooecium not observable. A narrow wall developed between autozooecial orifice and ovicell chamber (Fig. 3A, F).

Measurements.—Given in µm, average value in brackets:

- width of colony branch: 519–886 (682) in bifurcation up to 1270
- width of autozooecium (external): 218–399 (310)
- length of autozooecium (external): 503–914 (744)
- width of autozooecium (internal): 170–209 (191)
- length of autozooecium (internal): 633–778 (678)
- width of avicularium: 101–124 (116)
- length of avicularium: 238–319 (267)
- width of kenozooecium: 150–252 (201)
- length of kenozooecium: 160–378 (269)
- diameter of orifice (external): 122–167 (150)
- diameter of orifice (internal): 99–133 (117)
- diameter of pseudopores (external): 29–41 (36)
- diameter of pores (internal): 21–28 (23)
- diameter of peristome in section: 160–167 (164)
- width of ovicell (internal): 151–164 (147)
- width of umbonuloid shield: 87–139 (113)
- length of umbonuloid shield: 109–170 (139)

Remarks.—As noted above, there are some similarities with two North American species attributed to *Enoplostomella* but which are unlikely to belong to that genus.

The type of substrate colonized by *Basyaylella elsae* sp. nov. has not been observed.

Family Margarettidae Harmer, 1957

Genus *Margaretta* Gray, 1843

Type species: *Cellaria barbata* Lamarck, 1816; Recent; Australia and New Zealand.

Diagnosis.—Colony erect, articulated. Autozooecia elongate with perforated frontal wall and well-defined ascopore. Oral spines and avicularia not developed. Ovicell peristomial.

Stratigraphic and geographic range.—Palaeogene to Recent, cosmopolitan.

Margaretta sp.

Fig. 1F–J.

Referred material.—Altogether eight specimens were studied (three of them illustrated (Fig. 1F–H) PM2-T1130 to PM2-T1132), mainly with highly developed secondary calcification.

Description.—Colony columnar with branches of circular cross-section (Fig. 1F). Autozooecia arranged in 4–8 longitudinal rows, of indistinct shape owing to densely perforated slightly convex frontal wall (Fig. 1F). Secondary orifice circular to oval, no external peristome observed. Ascopore not observable from exterior. Ovicell deeply immersed, peristomial (Fig. 1F). Interior view shows regular small frontal pores (Fig. 1G) and median, circular, slightly larger ascopore (Fig. 1G); peristome consisting of 5–8 longitudinal bands separated by narrow, but distinct furrows (Fig. 1G, H). Ovicell not observed in interior view.

Remarks.—*Margaretta cereoides* (Ellis and Solander, 1786) as described from the Miocene of Moravia by Zágoršek (2010b: 154, pl. 109: 1–4) does not have furrows in the peristomial wall fabric (visible in our Fig. 1J), which may be considered a species-specific feature. However, a revision of the Margarettidae would be needed for a definite conclusion.

Family Incertae sedis

Genus *Ostrovskia* nov.

Type species: *Ostrovskia triforamina* sp. nov., see below.

Etymology: For Dr Andrei N. Ostrovsky, in recognition of his illuminating studies on cheilostome reproductive structures.

Diagnosis.—Colony erect, rigid, narrowly bilamellar, branches circular to oval in cross section. Frontal shield evenly pseudoporous with indistinguishable areolar pores. Primary orifice concealed within peristomial shaft; anter semicircular, poster a little wider, small condyles, proximal rim straight or gently convex, no sinus. Peristomial (secondary) orifice circular, surrounded entirely by broad rim, in the inner proximal margin of which is tiny opening of heterozooecium that originates internally from a pair of areolar septula. No frontal avicularia. Ovicell concealed, opening into peristome above primary orifice; entooecium perforated by relatively large pores.

Remarks.—The family and even the superfamily are uncertain. The most distinctive feature of the genus is a triangular heterozooecium that lies against the proximal wall of the deep peristomial shaft. The apex of the heterozooecium is a tiny opening that, in the best-preserved specimens, appears as a small circular foramen, but it is often damaged and, in frontal view, the broken edge can appear as a denticulate structure. Internally, the chamber of the heterozooecium broadens to form a flattened triangular shape, with its tubular proximal corners originating from a pair of areolar septular pores. In this regard, the topology of the structure is reminiscent of the median suboral or intraoral avicularium of a smittinid; however, the ovicell is deeply concealed by cryptocystal secondary calcification, which is atypical of smittinids.

As Zágoršek (2010b: 155) has remarked when describing this species as *Phoceana tubulifera* (Reuss, 1847), the type species of *Ostrovskia* resembles *Smittina cervicornis* (Pallas, 1766) in general appearance, but only when the peristome is not produced. In specimens in which a peristome is present, a general similarity to *Phoceana* Jullien in Jullien and Calvet, 1903 has led to previous inclusion in that genus, beginning with David and Pouyet (1974). It is doubtful if this connec-

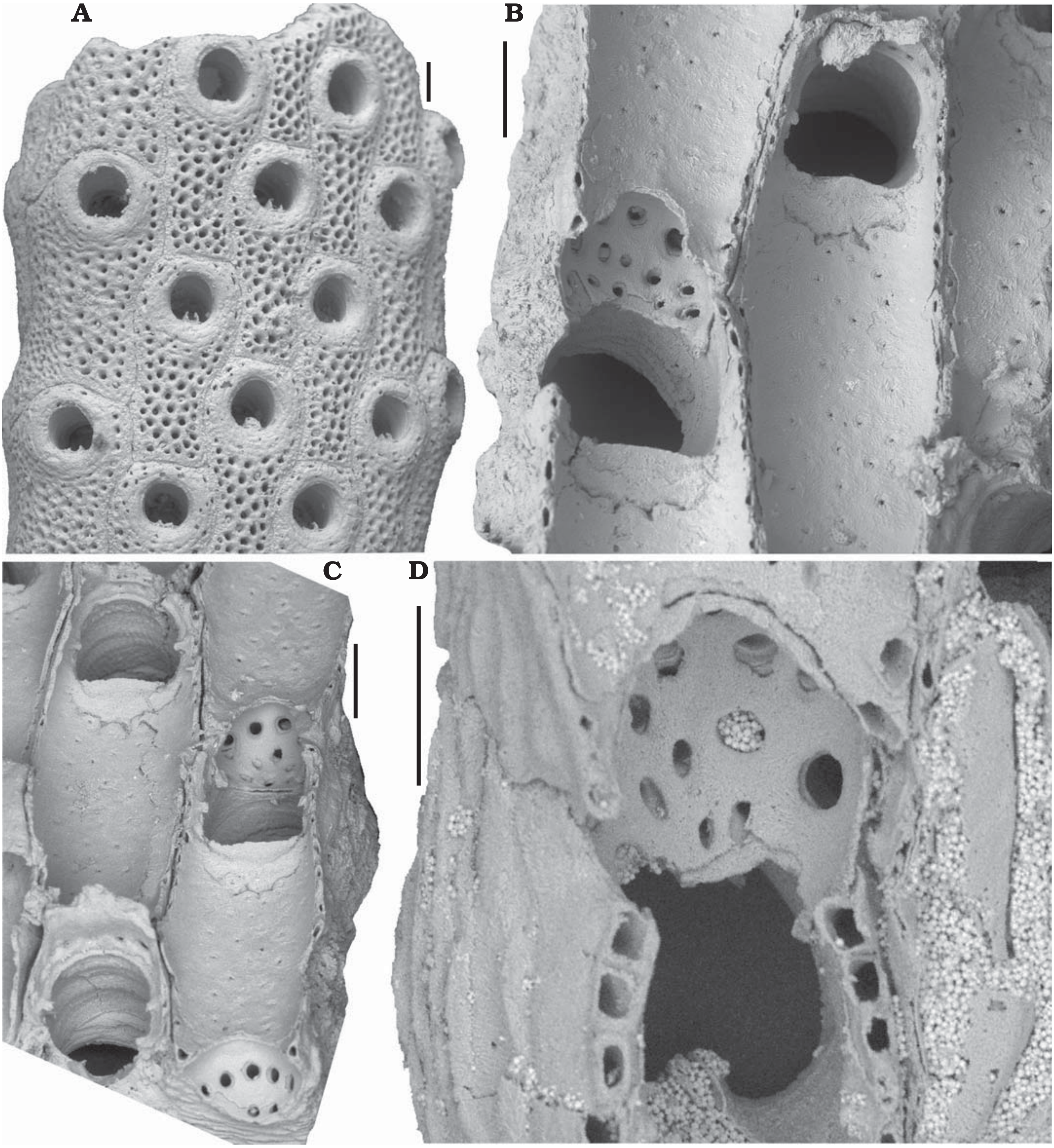

Fig. 4. Exterior and interior view of an ascophoran bryozoan *Ostrovskia triforamina* gen. et sp. nov. from the Miocene of Turkey. **A**. PM2-T1245, holotype, exterior view showing arrangement of autozooecia and the broken tips of intra-peristomial heterozooecia visible on the proximal margin of the orifice, appearing as denticles. **B**. PM2-T1246, interior view showing immersed ovicell, marginal areolar-septular pore canals in section, perforation of frontal wall and small condyles on the sides of the orifice. **C**. PM2-T1247, detail of autozooecia showing ovicells with perforated endooecium and a small suboral area of imperforate frontal shield. **D**. PM2-T1134, detail of ovicell with entooecial perforations and, proximolateral to it on both sides, broken areolar-septular pore canals. All specimens from sample BAS 4. Scale bars A, 1 mm; B–D, 100 µm.

tion is valid, however. In the type species of *Phoceana*, *P. columnaris* Jullien, in Jullien and Calvet, 1903, the frontal shield is non-pseudoporous. Very little is known about *P. columnaris*, however, and neither avicularia nor ovicells

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were described. *Phoceana acadiana* Lagaaij, 1963, however, appears to be conspecific with *P. columnaris* (Lagaaij [1963] was able to examine a specimen of *P. columnaris* from the Mediterranean) and it has a primarily non-pseudoporous frontal shield "with irregular patches of white tremocyst"; this description suggests that the frontal pores in this species may be derived from lateral areolar pores in secondary calcification. It also has ovicells "lodged in the acute angle between the peristome and the outer wall of the zoarial branch" but Lagaaij (1963) did not illustrate these. Largely on the basis of the frontal shield, we conclude that *P. tubulifera* does not belong to *Phoceana*.

One of the specimens illustrated by Zágoršek (2010b: pl. 114: 1) has an ovicell. This is in a zooecium near the distal end of a neanic branch in which secondary calcification is not so thick. Hence it is likely that newly formed zooids have a relatively long peristome and ovicells are still visible as a bulge in the wall, but, as secondary calcification increases, it rises to the level of the peristomial opening and the ovicells becomes deeply concealed. The neanic ovicell is nevertheless covered by a cryptocystal layer that resembles the pseudoporous frontal shield, hence it is "schizoporelloid" rather than "smittinoid". For this reason, assigning *Ostrovskia* to a particular family is difficult. Overall, we conclude that the superfamily is Schizoporelloidea sensu lato, but cannot suggest a family.

Ostrovskia triforamina sp. nov.

Figs. 4, 5.

?1847 *Eschara tubulifera* Reuss, 1847: 67, pl. 8: 19.

2010b *Phoceana tubulifera* (Reuss, 1847); Zágoršek 2010b: 155, pl. 114: 1–5.

Etymology: Alluding to the three hollow apices of the triangular heterozooecium that lies against the proximal wall of the deep peristomial shaft. The frontal apex is the opening of the heterozooecium; the two basolateral apices connect with an areolar septular pore either side of the primary orifice.

Type material: Holotype: PM2-T 1245 (Fig. 4A), sample BAS 4. Paratypes: PM2-T 1246 and T 1247 (Figs. 4, 5), two specimens, samples BAS 4.

Type locality: Başyayla section, Turkey.

Type horizon: Upper Tortonian, Miocene.

Referred material.—Eight specimens, five of which having ovicells (PM2-T 1134, PM2-T 1155 to PM2-T 1158).

Diagnosis.—As for the genus.

Description.—Colony erect, rigid, narrowly bilamellar with up to 10 longitudinal autozooecial series, circular to oval in cross section. Frontal shield evenly pseudoporous; marginal areolar pores of same diameter as pseudopores. Primary orifice at bottom of deep peristomial shaft; no sinus, the broad poster a little wide than the anter and one third its length, with a pair of condyles marking the boundary between them; proximal apertural rim straight or gently convex. Secondary orifice circular, surrounded entirely by broad, peristomial rim that is not markedly projecting, in the inner proximal margin of which is the tiny opening of a heterozooecium; chamber of heterozooecium triangular, with its apex at the peristomial rim and broadening as it descends so that at the level of the primary aperture it occupies the full internal width of the zooecium, its basolateral corners tubular, originating from an areolar septulum on each side. No frontal avicularia. Ovicell deeply concealed, opening into peristome above primary aperture; endooecium perforated by relatively large pores.

Measurements.—Given in μm, average value in brackets:

- width of colony branch: up to 1920
- width of autozooecium (external): 311–666 (469)
- length of autozooecium (external): 931–1380 (1029)
- width of autozooecium (internal): 284–407 (335)
- length of autozooecium (internal): 767–1160 (952)
- maximal width of heterozooecium (measured from internal side): 122–246 (171)
- minimal width of heterozooecium (measured from external side): 45–71 (57)
- diameter of orifice (external): 185–244 (215)
- diameter of orifice (internal): 156–318 (217)
- diameter of frontal pores (external): 20–37 (26)
- diameter of frontal pores (internal): 6–14 (9)
- diameter of peristome in section: 195–216 (208)
- width of ovicell (internal): 191–266 (232)
- diameter of ovicell pores (internal): 23–43 (29)
- diameter of areolar pores (measured from internal side): 18–27 (23)
- thickness of frontal wall in section: 208–356 (258)

Remarks.—In external view, our colonies show all of the features seen in the specimens attributed by Zágoršek (2010b) to Reuss's (1847) species *Eschara tubulifera*, including the characteristic median convexity inside the apertures. Reuss's (1847) type material differs, however, in having much longer peristomes and ovicells appear to be lacking. Study of the shield interior in the type material has not been possible owing to its type status and the Moravian material is too fragile because of its state of preservation. Accordingly, the attribution to *E. tubulifera* Reuss, 1847 is uncertain.

The intra-peristomial heteromorphic zooid is a striking feature, and the question arises as to its possible function. Its location suggests two possibilities—an avicularium, a glandular chamber, or both. The frontally visible apex of the heteromorph is a small intra-oral (not suboral) foramen. In this regard it is reminiscent of the suboral (sometimes intra-oral) avicularia that are seen in smittinids. These typically have a cross-bar, which has not been seen in our material of *O. triforamina* (the heteromorph appears damaged in our specimens). In smittinids, however, regardless of the position of the aperture of the suboral avicularium, its chamber is also suboral and rests upon the frontal shield. In *Smittin*a and *Smittoidea* it is median in position and originates from an areolar septular pore on either side. In *Hemismittoidea* it is slightly larger and off-centre and originates from a single marginal pore.

Waters (1894) was the first to document the occurrence of suboral glandular structures in a number of cheilostome species and Lutaud (1964) expanded on his list. She noted that *Smittina landsborovii* (Smittinidae) has probable glandular

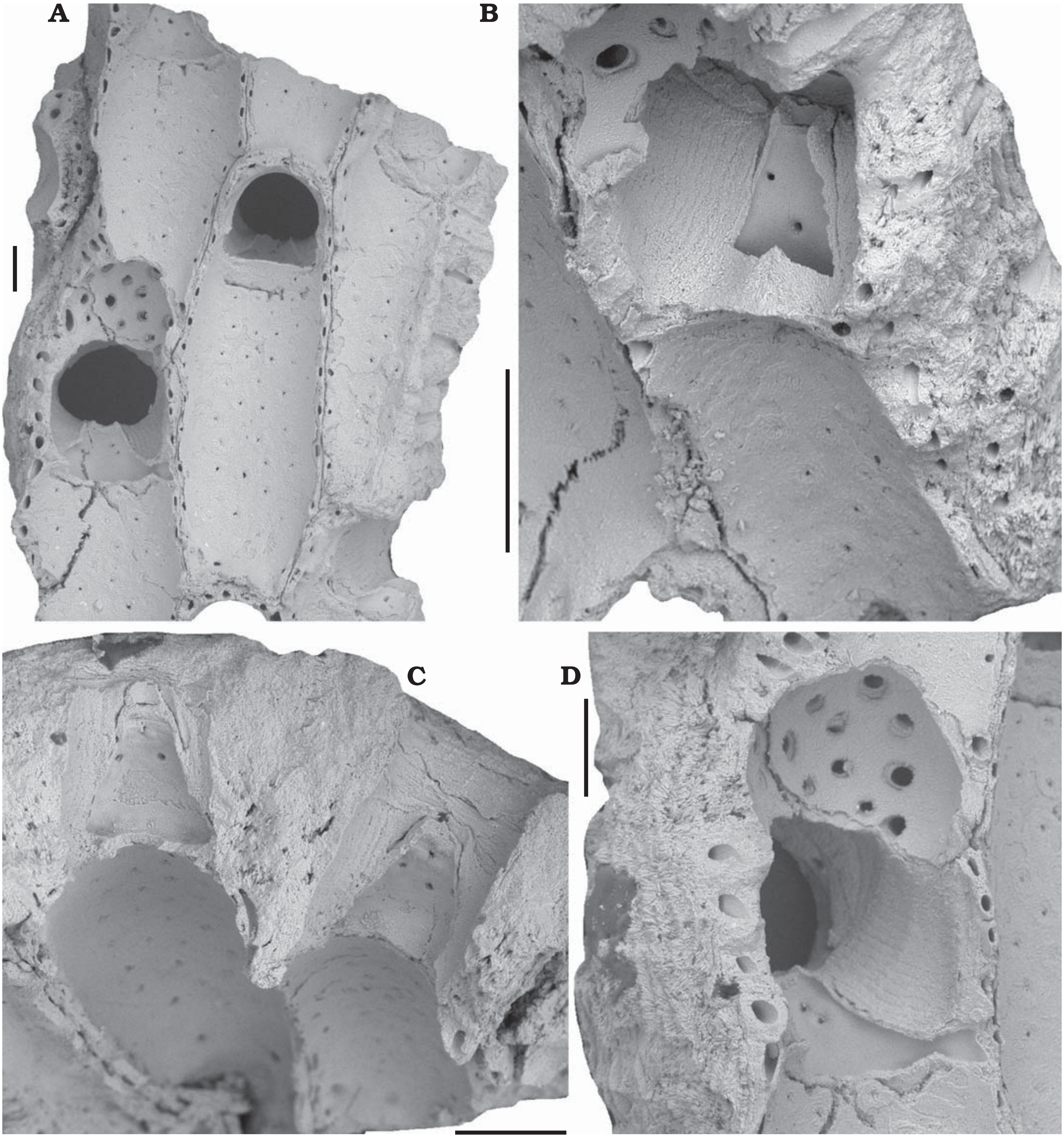

Fig. 5. Interior view of an ascophoran bryozoan *Ostrovskia triforamina* gen. et sp. nov. from the Miocene of Turkey. **A**. PM2-T1155, interior view of several zooecia showing a perforated ovicell, marginal areolar-septular pore canals in section, small pseudopores, and, in the left-hand zooecium, the interior of a triangular heterozooecium inside the peristome. **B**. PM2-T1157, proximal interior of a peristome with the fractured chamber of a triangular intraperistomial heterozooecium. **C**. PM2-T1158, detail of two broken peristomes showing triangular heterozooecium with small pores situated inside. **D**. PM2-T1156, oblique view of ovicell autozooecium showing perforation of ovicell and part of an intra-peristomial heterozooecium with one corner opening toward an interior areolar-septular pore. Scale bars 100 µm.

structures within the suboral avicularia. Taxa with larger suboral avicularian chambers (e.g., *Hippadenella margaritifera*, family incertae sedis) have more obvious such structures, and the glands can be as large as the avicularian adductor muscles. Given the relatively large internal volume of the heteromorph in *Ostrovskia triforamina*, it seems likely

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that it could have been either a heteromorph with a solely glandular function or an avicularium with small musculature and larger glands. Carter et al. (2010) have demonstrated using TEM the dual function of some cheilostome avicularia.

Conclusions

It is remarkable that, of the 16 species identified in the Başyayla section—*Basyaylella elsae* sp. nov., *Biflustra savartii*, *Cellaria* cf. *fistulosa*, *Crisia haueri*, *Cupuladria* sp., *Exidmonea* sp., *Idmidronea* sp., *Lunulites* cf. *androsaces*, *Margaretta* sp., *Nellia* cf. *tenella*, *Ostrovskia triforamina* sp. nov., *Pleuronea pertusa*, *Reteporella* sp., *Reussirella haidingeri*, *Schizostomella grinzignensis*, and *Steginoporella montenati*—two belong to two new monotypic genera. One of these, *Basyaylella* gen. nov., may possibly include two species presently known only from Paleogene of the southeastern United States that have been attributed previously to the stomachetosellid genus *Enoplostomella*. Stomachetosellidae and its constituent genera badly need revising and a more definitive conclusion is not possible here. The other new genus, *Ostrovskia*, has ovicellular characters that suggest placement in the superfamily Schizoporelloidea. Its family attribution is uncertain, but the flattened triangular chamber of a zooidal heteromorph lining the proximal surface of the deep zooidal peristome indicates that a new family could be warranted. This possibility needs further study.

Based on the bryozoan data, we interpret the Başyayla sequence as indicative of a tropical to subtropical normal marine environment, suggested by the presence of the genera *Nellia, Cupuladria*, *Schizostomella*, and *Steginoporella* (see e.g., Cook 1965, 1985; Tilbrook 2006). The presence of abundant free-living bryozoans (species of *Cupuladria* and *Reussirella*) indicates a particulate seafloor of silt or fine sand with low water energy and mobility of the sediment (Cook and Chimonides 1994; Hageman et al. 1997).

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