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ORIGINAL ARTICLE

Bryozoa from the Surmaq Formation (Permian) of the Hambast Mountains, south of Abadeh, central Iran

Andrej Ernst · Baba Senowbari-Daryan · Koorosh Rashidi

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Abstract The Permian bryozoan fauna of the Surmaq Formation exposed in a section near Kuh-e Hambast (Hambast Mountains, central Iran) includes ten species. Four species (*Fistulipora sawatai* Sakagami 1999, *Fistulipora takauchiensis* Sakagami 1961, *Fistulipora monticulosa* Nikiforova 1933, and *Eridopora parasitica*, Waagen and Wentzel 1886) indicate a Middle Permian (Murgabian) age of the formation. Six additional taxa, three cystoporates *Fistulipora* sp. 1, *Fistulipora* sp. 2, and Fistuliporidae gen. et sp. indet., as well as three trepostomes *Dyscritella* sp., Trepostomata gen. et sp. indet. 1 and Trepostomata gen. et sp. indet. 2 could not be identified at the genus and species level. The investigated fauna refers to the Middle Permian of Thailand, Pakistan, Indonesia, and Japan.

Keywords Bryozoa · Cystoporata · Trepostomata · Taxonomy · Palaeobiogeography · Permian · Surmaq Formation · Hambast Mountains · Iran

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Introduction

Bryozoans are usually abundant in Permian sediments of Iran. However, their diversity as well as their stratigraphic and palaeobiogeographic importance have not been thoroughly investigated. Few publications have been made on Iranian Permian bryozoans in the last century. Fantini Sestini (1965) described three species from the Permian Ruteh Limestone of the Elborz Mountains (northern Iran). Later, Sakagami (1980) described 15 species from the Permian of central Iran (Abadeh region). This fauna displayed a close relation to the Dzhulfian (= Changhsingian) stage, as well as connections to the Permian of Pamir, Russian platform, Salt Range, Kashmir, South China, and Timor.

Four bryozoan faunas from the Permian Jamal Formation of central and northeast Iran are described in a recent series of publications: (1) Thirty-one bryozoan species were identified from the Permian Jamal Formation exposed in the Lakaftari area, south of the town of Bagher-Abad, northeast of Esfahan (central Iran) (Ernst et al. 2006a). This fauna is regarded as Middle Permian (Murgabian) in age, and shows palaeobiogeographic connections to Australia, Indonesia, Thailand, and Transcaucasia; (2) Six bryozoan species were described from the Permian Jamal Formation, of Kuh-e Bagh-e Vang (Shotori Mountains, northeast Iran) (Ernst et al. 2006b). This association indicates a Lower Permian age and shows palaeogeographic connections with bryozoan faunas known from Australia and Urals Mountains; (3) Nine bryozoan species were described from the Permian Jamal Formation outcropped near the village of Chiruk, Shotori Mountains, northeast Iran (Ernst et al. 2008). The bryozoan *Filiramoporina* sp. from the last faunal association shows relations to the Lower Permian of Kansas, North America. Other species are known from the Permian of Afghanistan, Indonesia, Russian Plate, and the

Far East; (4) Seven bryozoan species were described from the Jamal Formation exposed near Deh-e Mohammad, Shotori Mountains (northeast Iran) displaying palaeobiogeographic connections to the Lower Permian of Pamir (Tajikistan), Indonesia, Thailand, and Kansas (North America) (Ernst et al. 2009).

The present paper is a further contribution to the knowledge of the Permian bryozoans of Iran. The investigation is based on material collected from a section of the Surmaq Formation exposed near the Kuh-e Hambast (Hambast Mountains, south of the town of Abadeh, central Iran) (Fig. 1a, b). The described bryozoan fauna of the Surmaq Formation from Kuh-e Hambast includes ten species: seven cystoporates and three trepostomates:

Fistulipora sawatai Sakagami 1999
Fistulipora takauchiensis Sakagami 1961
Fistulipora monticulosa Nikiforova 1933
Fistulipora sp. 1
Fistulipora sp. 2
Eridopora parasitica (Waagen and Wentzel 1886)
Fistuliporidae gen. et sp. indet.
Dyscritella sp.
Trepostomata gen. et sp. indet. 1
Trepostomata gen. et sp. indet. 2

Beside these, unidentifiable fragments of fenestrates were found in thin sections (*Spinofenestella* sp., *Minilya* sp., *Penniretepora* sp.).

The described fauna can be correlated with the Middle Permian of Thailand, Pakistan, Tibet, Indonesia, and Japan, and indicates the Middle Permian (Murgabian) age of the Surmaq Formation from Kuh-e Hambast. *Fistulipora sawatai* Sakagami 1999 is known from the ?Guadalupian of Thailand. *Fistulipora takauchiensis* Sakagami 1961 was originally described from the Takauchi Limestone

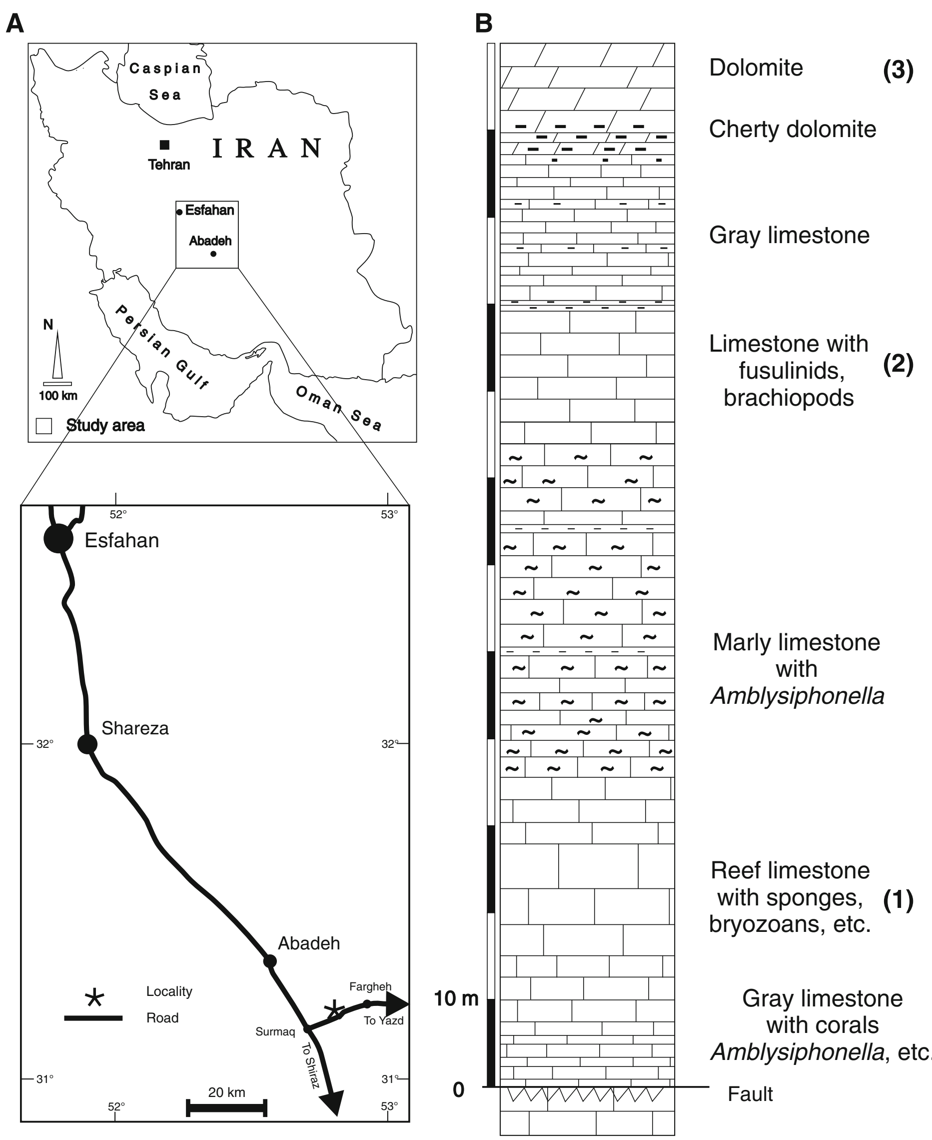


Fig. 1 **a** Geographic position of the studied locality, south of the town of Abadeh, marked with an *asterisk*. **b** Lithological column of the sampled section showing thick-bedded carbonate units (1–3). The described bryozoan fauna comes from the unit 1

(*Lepidolina-Yabeina* zone, Middle Permian, Upper Guadalupian of Japan). *Fistulipora monticulosa* Nikiforova 1933 is known from Gnishik Horizon (Middle Permian, Murgabian) of Transcaucasia, Middle Permian of central Turkey, Jamal Formation (Middle Permian, Murgabian) of Lakaftari area in central Iran as well as Upper Permian (*Araxopora araxensis*-Horizon) of Abadeh area in central Iran. *Eridopora parasitica* (Waagen and Wentzel 1886) was reported from the Permian of Indonesia and Thailand, Lower Permian (Artinskian) of Caucasus, Middle Permian of Oman, Lower and Middle Permian of Xizang (Tibet), and the Upper Permian; Pakistan (Salt Range).

Geological setting and geographic position of studied area

The study area lies northwest of the Kuh-e Hambast in the Hambast Mountains, about 20 km southeast of the town of Abadeh (Fig. 1). The Hambast Mountains belong to the so-called Sanandaj-Sirjan structural belt (Stöcklin 1968), a tectonic zone of almost 1,500 km, running NW–SE, more or less parallel to the Zagros belt to the southwest. The Sanandaj-Sirjan zone belongs to the southwest part of the central Iranian plate. It differs from the other part of the Iranian plate in its structural geology, and corresponds to the Zagros belt. The Sanandaj-Sirjan belt is bound by the Zagros belt in the southwest, by the "Main Zagros fault", and by the central Iranian plate in the northeast by different geological structures, generally NW–SE-trending small basins containing Upper Cenozoic deposits. Lithologically, the occurrence of abundant metamorphic rocks of the Sanandaj-Sirjan zone differentiates this zone from the other central Iranian plates and from the neighboring Zagros belt.

The stratigraphic subdivision of Permian sediments of Hambast Mountains was proposed by Taraz (1969, 1974), who recognized seven stratigraphical units. Based on foraminiferal investigations, the "Iranian-Japanese Research Group" (1981) introduced the name Surmaq Formation (after the nearest small town to the mountains) for units 1–3, Abadeh Formation for units 4–5, and finally the Hambast Formation for units 6–7 of Taraz. Kobayashi and Ishii (2003) restudied the foraminifera of the region, based on several sections. Apparently, the section N-R of the latter authors corresponds to or is very close to our section from where the bryozoans, described in this paper, were collected. According to their stratigraphy, our sampled section corresponds to the Surmaq Formation (unit 1 of Taraz) and indicates a Middle Permian (Murgabian) age for the fossils in our collection.

The studied section is about 120 m thick and starts with sandy limestones at its base. Three thick-bedded carbonate units (1–3) are distinct in the section (Fig. 1b). The first one is about 28 m thick, and represents reefs or reefal limestones. Hypercalcified sponges, *Tubiphytes* and *Tubiphytes*-like organisms, bryozoans, and corals are the most abundant reef-building organisms. The sponge fauna of the Hambast Formation was described by Senowbari-Daryan et al. (2007). The described bryozoan fauna comes from the same unit. The second thick-bedded limestone unit (2) is about 15 m thick and contains abundant brachiopods. The thick-bedded carbonate unit (3) is represented by dolomites at the top of the section.

Materials and methods

Bryozoans were investigated in thin sections using a transmitted light microscope. Statistics were summarized with arithmetic mean, sample standard deviation, coefficient of variation, and minimum and maximum value. The studied material includes 20 large thin sections and is deposited in the collections of the Palaeoenvironment Research Division, University of Erlangen-Nuremberg (under the label "Senowbari-Daryan, Perm Hambast, thin sections "Ham-…", "PCH-" and "PA-…")".

Systematic palaeontology

Phylum: **Bryozoa** Ehrenberg 1831
Class: **Stenolaemata** Borg 1926
Order: **Cystoporata** Astrova 1964
Family: **Fistuliporidae** Ulrich 1882
Genus: ***Fistulipora*** M'Coy 1849

Fistulipora sawatai Sakagami 1999
Figure 2a–e; Table 1

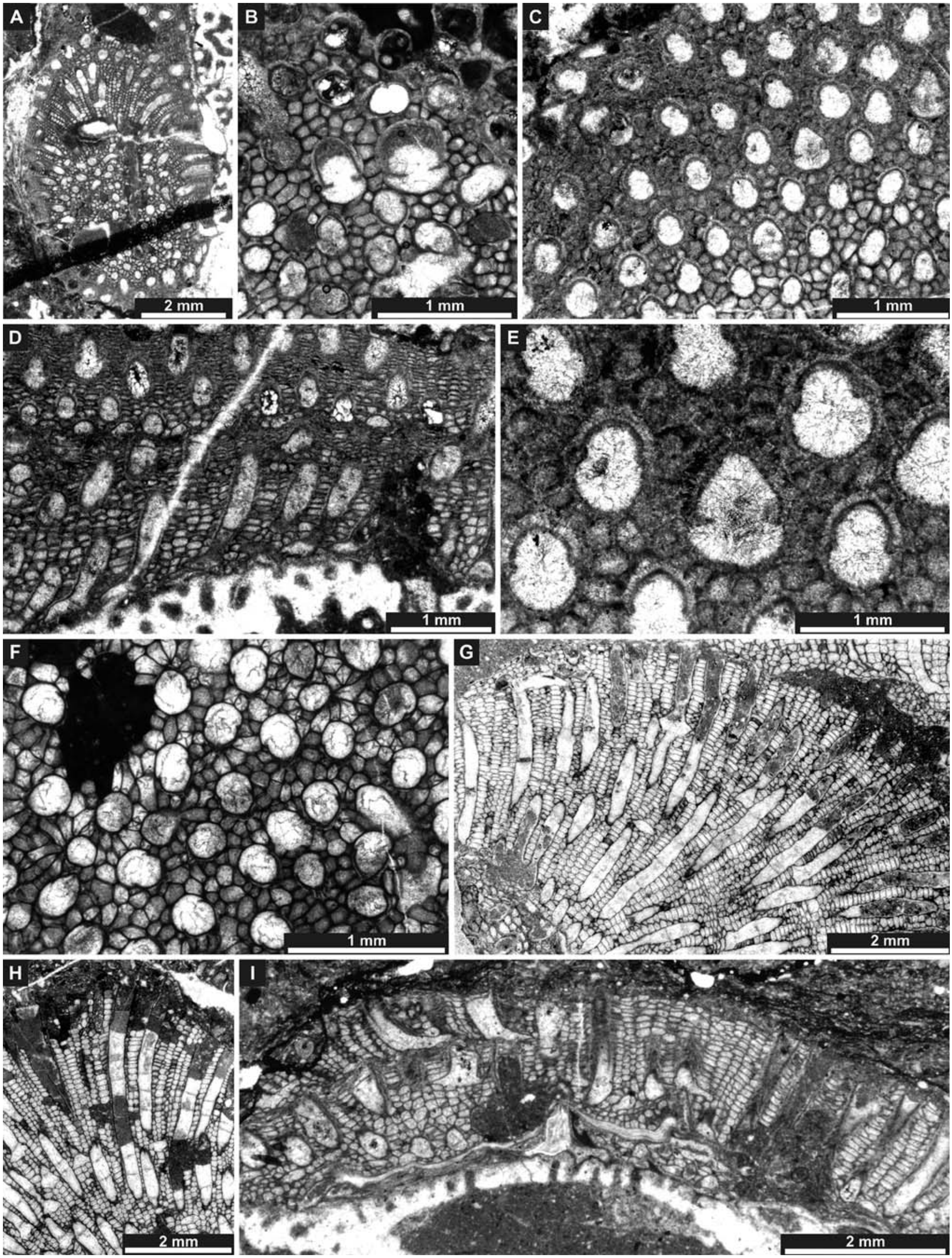
1999 *Fistulipora sawatai* Sakagami: 83–84, pl. 19, Figs. 1–3

Material

Five colonies Ham10, PA/0/1, PA/0/2, PA/4, and PA/22.

Description

Encrusting and ramose colonies. Encrusting colonies 0.48–1.95 mm in thickness. Secondary overgrowth common. Branches 4.7–5.0 mm in diameter. Autozooecial apertures rounded to oval, spaced 3.5–4.5 in 2 mm on the colony surface in growth direction, separated usually by 1–2 rows of vesicles. Lunaria are prominent, with ends projecting deeply into the autozooecial chamber. Basal diaphragms are rare to absent. Vesicles polygonal in cross section, having rounded roofs in longitudinal section, spaced 15–20 in 1-mm colony thickness. The outer granular skeleton is well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◀ **Fig. 2** **a–e** *Fistulipora sawatai* Sakagami 1999. **a** Oblique section through a branched colony. **b** Tangential section showing autozooecial and megazooecial apertures. **c** Tangential section showing autozooecial and megazooecial apertures. **d** Longitudinal section showing secondary overgrowth, autozooecial chambers, and vesicles. **e** Tangential section showing autozooecial and megazooecial apertures. **f–h** *Fistulipora takauchiensis* Sakagami 1961. **f** Tangential section showing autozooecial apertures. **g, h** Longitudinal section of a massive colony. **i** *Fistulipora* sp. 1, longitudinal section showing secondary overgrowth, autozooecial chambers, and vesicles

developed. Megazooecia are large, and appear randomly throughout the colony, and have large triangular or horseshoe-shaped lunaria.

Comparison

The present species is similar to *Fistulipora sawatai* Sakagami 1999 from the Middle Permian (? Guadalupian) of Thailand in the kind of lunaria and presence megazooecia. *Fistulipora zhejiangensis* Lu 1986 from the Lengwu Member of the Maokou Stage (? Upper Permian) of central Hunan—Western Zhejiang (China) is similar to the present species in presence of characteristic megazooecia. However, megazooecia in *F. zhejiangensis* are larger than those in the present species (0.55–0.75 vs. 0.30–0.43 mm). Furthermore, *F. zhejiangensis* differs from the present material in the presence of abundant autozooecial diaphragms.

Occurrence

Surmaq Formation, Middle Permian (Murgabian); Hambast Mountains, south of Abadeh, central Iran. Middle Permian (? Murgabian); Khao Hin Kling area, north-central Thailand.

Fistulipora takauchiensis Sakagami 1961
Figure 2f–h; Table 2

1961 *Fistulipora takauchiensis* Sakagami: 17–18, pl. 3, figs. 1–2, pl. 4, figs. 1–5

Material

Three colonies Ham4, PA/15, and PA.

Description

Massive colonies, 10–12 mm in diameter. Autozooecia are long, and radiate from the center of the colony. Autozooecial apertures are rounded to oval, and spaced 4–5 in 2 mm on the colony surface in the growth direction, usually separated by 1–3 rows of vesicles. Lunaria are large, with ends projecting deeply into the autozooecial chamber. Basal diaphragms are common to abundant, planar, thin, 4–7 spaced in 1 mm of autozooecial length. Vesicles are large, polygonal in cross section, having rounded roofs in longitudinal section, 10–18 spaced in 1-mm colony thickness. The outer granular skeleton is weakly developed.

Table 1 Measurements of *Fistulipora sawatai* Sakagami 1999

	N	*X*	SD	CV	MIN	MAX
Autozooecial aperture width (mm)	43	0.27	0.05	16.89	0.20	0.40
Lunarium width (mm)	42	0.18	0.02	13.51	0.11	0.24
Lunarium length (mm)	42	0.14	0.02	17.96	0.08	0.19
Autozooecial aperture spacing (mm)	20	0.45	0.05	11.64	0.36	0.56
Vesicle diameter (mm)	30	0.09	0.02	22.26	0.05	0.13
Lunarium thickness (mm)	20	0.07	0.01	14.44	0.05	0.08
Megazooecial aperture width (mm)	10	0.37	0.04	11.86	0.30	0.43
Megazooecial lunarium width (mm)	10	0.29	0.06	22.26	0.17	0.40
Megazooecial lunarium length (mm)	10	0.21	0.06	30.93	0.12	0.28
Megazooecial lunarium thickness (mm)	7	0.10	0.03	27.18	0.06	0.12

N Number of measurements; *X* Mean; *SD* Standard deviation; *CV* Coefficient of variation; *MIN* Minimal value; *MAX* Maximal value

Table 2 Measurements of *Fistulipora takauchiensis* Sakagami 1961. Abbreviations as in Table 1

	N	*X*	SD	CV	MIN	MAX
Autozooecial aperture width (mm)	27	0.25	0.04	14.24	0.19	0.35
Lunarium width (mm)	27	0.19	0.04	19.40	0.12	0.25
Lunarium length (mm)	27	0.15	0.03	20.27	0.10	0.22
Autozooecial aperture spacing (mm)	27	0.48	0.06	12.11	0.42	0.66
Vesicle diameter (mm)	30	0.09	0.02	21.12	0.05	0.13
Lunarium thickness (mm)	16	0.07	0.02	28.13	0.05	0.12

Comparison

Fistulipora takauchiensis Sakagami 1961 is similar to *F. crescens* Crockford 1944 from the Noonkanbah Series (Lower Permian) of Western Australia. However, it differs from *F. crescens* in having smaller autozooecia (0.19–0.35 vs. 0.29–0.43 mm in *F. crescens*).

Occurrence

Surmaq Formation, Middle Permian (Murgabian); Hambast Mountains, south of Abadeh, central Iran. Takauchi Limestone (*Lepidolina-Yabeina* zone), Middle Permian (Midian); Japan.

Fistulipora monticulosa Nikiforova 1933
Figure 3e–h; Table 3

1933 *Fistulipora monticulosa* Nikiforova: 10, pl. 1, figs. 9–15, text-figs. 3, 4
1970 *Fistulipora monticulosa* Nikiforova 1933—Morozova: 61–62, pl. 1, fig. 2
1976 *Fistulipora* sp. cf. *F. monticulosa* Sakagami: 400, pl. 42, figs. 3, 4
1980 *Fistulipora pseudomonticulosa* Sakagami: 272, pl. 31, figs. 4–6
2006a *Fistulipora monticulosa* Nikiforova 1933—Ernst, Senowbari-Daryan and Hamedani: 546–547, figs. 2a, b, d, e, g

Material

Single colony PCH28.

Description

Encrusting colonies 0.93 mm in thickness. Autozooecial apertures are rounded to oval, spaced 3.8–4.5 in 2 mm on the colony surface in growth direction, and are usually separated by a single row of vesicles. Lunaria distinct, horseshoe-shaped to slightly triangular. Basal diaphragms are absent. Vesicles polygonal in cross section, moderately large, flat, and have rounded roofs in longitudinal section, spaced 9–10 in 1-mm colony thickness. Outer granular skeleton is well developed.

Comparison

Fistulipora monticulosa is similar to *F. timorensis* Bassler 1929, which is widely distributed in Permian rocks of Asia (Indonesia, Thailand, Primorye, Iran). *F. timorensis* has larger apertures (aperture width 0.35 vs. 0.30 mm at average in *F. monticulosa*).

Fig. 3 **a** *Fistulipora* sp. 1, tangential section showing autozooecial apertures. **b–d** *Fistulipora* sp. 2. **b** Oblique section through a branched colony. **c** Longitudinal section through a branched colony. **d** Tangential section showing autozooecial apertures. **e–j**, **h** *Fistulipora monticulosa* Nikiforova 1933. **e** Longitudinal section showing autozooecial chambers and vesicles, **f** tangential section showing autozooecial apertures, **h** autozooecial aperture. **g** *Eridopora parasitica* (Waagen and Wentzel 1886), tangential section showing autozooecial apertures ▶

Occurrence

Gnishik Horizon, Middle Permian (Murgabian); Transcaucasia (Nakhichevan). Middle Permian; Sainbeyli, Central Turkey. Upper Permian (*Araxopora araxensis*-Horizon); Abadeh, central Iran. Jamal Formation, Middle Permian (Murgabian); Lakaftari, central Iran. Surmaq Formation, Middle Permian (Murgabian); Hambast Mountains, south of Abadeh, central Iran.

Fistulipora sp. 1
Figures 2i, 3a; Table 4

Material

Single colony Ham6.

Description

Encrusting colony 0.24–0.29 mm in thickness. Secondary overgrowth common. Autozooecial apertures rounded to oval, spaced 4.3–4.4 in 2 mm on the colony surface in growth direction, usually separated by 1–3 rows of vesicles. Lunaria distinct, horseshoe-shaped. Basal diaphragms are absent. Vesicles are polygonal in cross section, flat, and have rounded roofs in longitudinal section, and are spaced 15–17 in 1-mm colony thickness. Outer granular skeleton is well developed.

Comparison

Fistulipora sp. 1 is similar to *F. rutogensis* Xia, 1991 from the Chainaha Formation (Middle Permian) of Rutog County, China. The present species differs from *F. rutogensis* in having weakly developed lunaria and smaller autozooecia (autozooecial apertures width 0.20–0.26 vs. 0.24–0.30 mm in *F. rutogensis*).

Occurrence

Surmaq Formation, Middle Permian (Murgabian); Hambast Mountains, south of Abadeh, central Iran.

Fistulipora sp. 2
Figure 3b–d; Table 5

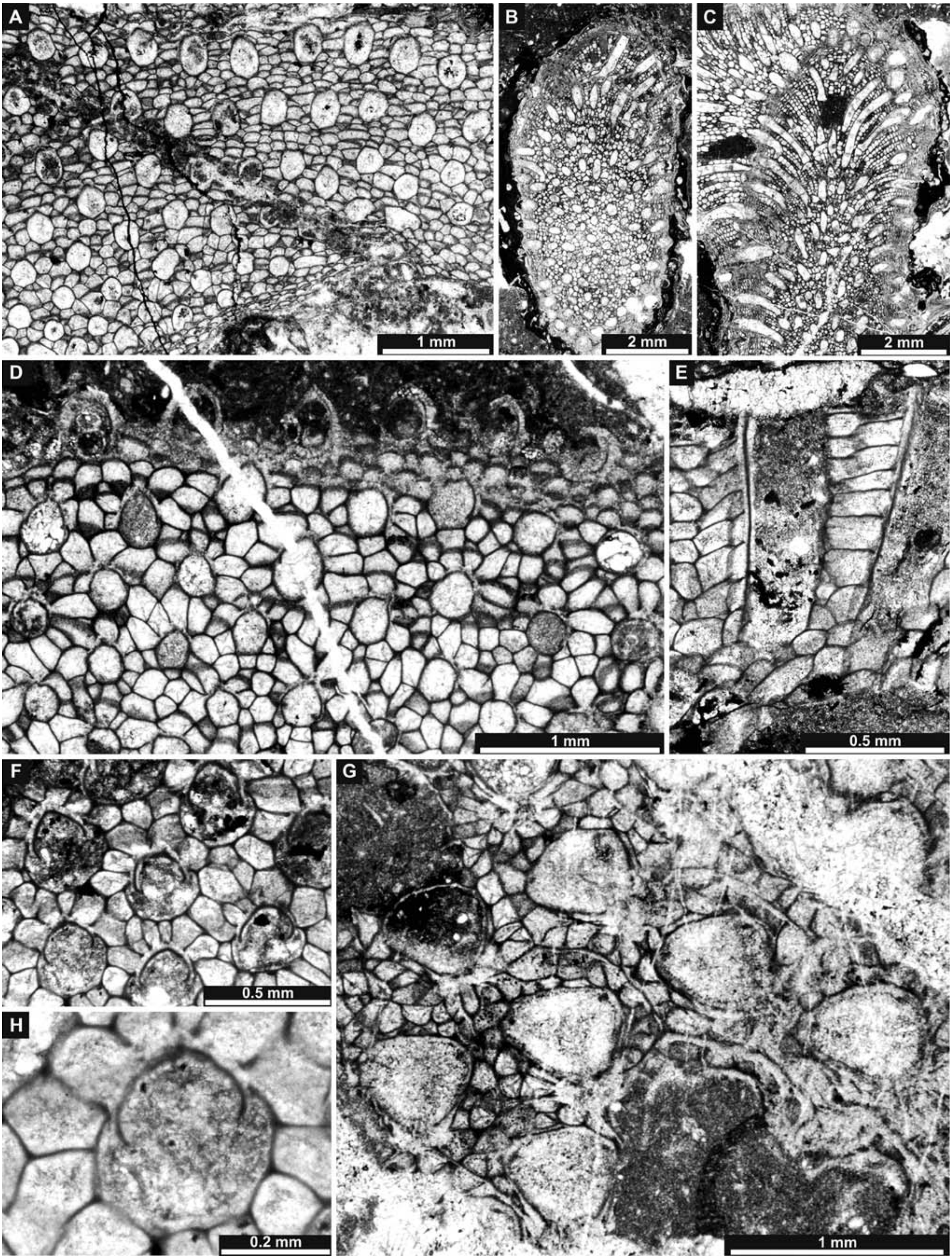
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Table 3 Measurements of the species *Fistulipora monticulosa* Nikiforova 1933. Abbreviations as in Table 1

	N	*X*	SD	CV	MIN	MAX
Autozooecial aperture width (mm)	20	0.30	0.03	10.91	0.24	0.36
Lunarium width (mm)	20	0.17	0.02	11.75	0.13	0.20
Lunarium length (mm)	20	0.14	0.02	13.46	0.11	0.17
Autozooecial aperture spacing (mm)	20	0.48	0.05	10.70	0.40	0.60
Vesicle diameter (mm)	20	0.10	0.03	24.20	0.06	0.14

Table 4 Measurements of *Fistulipora* sp. 1

	N	X	SD	CV	MIN	MAX
Autozooecial aperture width (mm)	14	0.23	0.02	6.62	0.20	0.26
Lunarium width (mm)	5	0.17	0.03	15.72	0.13	0.20
Lunarium length (mm)	3	0.12	0.03	27.94	0.08	0.14
Autozooecial aperture spacing (mm)	10	0.47	0.05	11.39	0.39	0.60
Vesicle diameter (mm)	10	0.12	0.02	18.45	0.08	0.16

Abbreviations as in Table 1

Table 5 Measurements of *Fistulipora* sp. 2

	N	*X*	SD	CV	MIN	MAX
Autozooecial aperture width (mm)	15	0.22	0.03	14.38	0.17	0.28
Lunarium width (mm)	15	0.15	0.02	13.57	0.13	0.20
Lunarium length (mm)	15	0.12	0.02	16.33	0.08	0.17
Autozooecial aperture spacing (mm)	10	0.47	0.04	9.08	0.42	0.52
Vesicle diameter (mm)	20	0.08	0.01	18.51	0.06	0.11

Material

Three colonies PA/27/(1–3).

Description

Branched colonies, 3.9–4.8 mm in diameter, with 2.9–3.0-mm-wide endoozones and 0.5–0.9-mm-wide exozones. Autozooecial apertures are rounded to oval, spaced 3.5–4.5 in 2 mm on the colony surface in growth direction, usually separated by 1–2 rows of vesicles. Lunaria distinct, horseshoe-shaped. Basal diaphragms are rare to absent. Vesicles are polygonal in cross section and have rounded roofs in the longitudinal section, spaced 10–15 in 1-mm colony thickness. Outer granular skeleton is well developed.

Fig. 4 **a–c** *Eridopora parasitica* (Waagen and Wentzel 1886). **a** Tangential section showing autozooecial apertures, **b** longitudinal section, **c** tangential section showing autozooecial aperture with a lunarium and lunarial nodes. **d–h** Fistuliporidae gen. et sp. indet. **d** Tangential section, **e** longitudinal section of a branched colony, **f** oblique section through a branched colony, **g** central part of the branch displaying hemiphragms (*arrows*) in autozooecial apertures, **h** tangential section. **i, j** *Dyscritella* sp. **i** Longitudinal section of an encrusting colony, **j** cross section of an encrusting colony ▶

Comparison

Fistulipora sp. 2 is similar to *F. maanensis* Yang 1956 from the Changhsing Formation (Upper Permian) of Hupeh, China. The latter species has thicker colonies (branch diameter 15.0 vs. 2.9–3.0 mm in present species) and larger apertures (autozooecial aperture width 0.26–0.30 vs. 0.17–0.28 mm in the present species).

Occurrence

Surmaq Formation, Middle Permian (Murgabian); Hambast Mountains, south of Abadeh, central Iran.

Genus: ***Eridopora*** Ulrich 1882

Eridopora parasitica (Waagen and Wentzel 1886)
(=*E. major* Bassler 1929)
Figures 3g, 4a–c; Table 6

1886 *Fistulipora parasitica* Waagen and Wentzel: 923, pl. 45, fig. 6, pl. 105, figs. 1–4
1929 *Eridopora major* Bassler: 52, pl. 225 (1), figs. 1–4
1975 *Eridopora major* Bassler 1929—Gorjunova: 45–46, pl. 3, fig. 1
1980 *Eridopora* cf. *parasitica* (Waagen and Wentzel 1886)—Sakagami: 273, pl. 31, figs. 7–9
1986 *Eridopora parasitica* (Waagen and Wentzel 1886)—Xia: 232, pl. 132, figs. 8–9, pl. 15, figs. 5, 7
1988 *Eridopora major* Bassler 1929—Sakagami *in* Yanagida: pl. 12, fig. 4, pl. 14, fig. 1
1988 *Eridopora*? sp. indet.—Sakagami *in* Yanagida: pl. 15, figs. 1–2
1991 *Eridopora major* Bassler 1929—Xia: 189, pl. 7, figs. 8–9
1999 *Eridopora parasitica* (Waagen and Wentzel 1886)—Sakagami: 84, pl. 19, figs. 4–6
1997 *Eridopora parasitica* (Waagen and Wentzel 1886)—Sakagami and Pillevuit: 206, figs. 2–3
2000 *Eridopora parasitica* (Waagen and Wentzel 1886)—Sakagami: 146–147, figs. 4.1–2

Material

Six colonies PA/30, PA/7/2, PA/32/2, PA/32/3, PA/32/5, and Ham7.

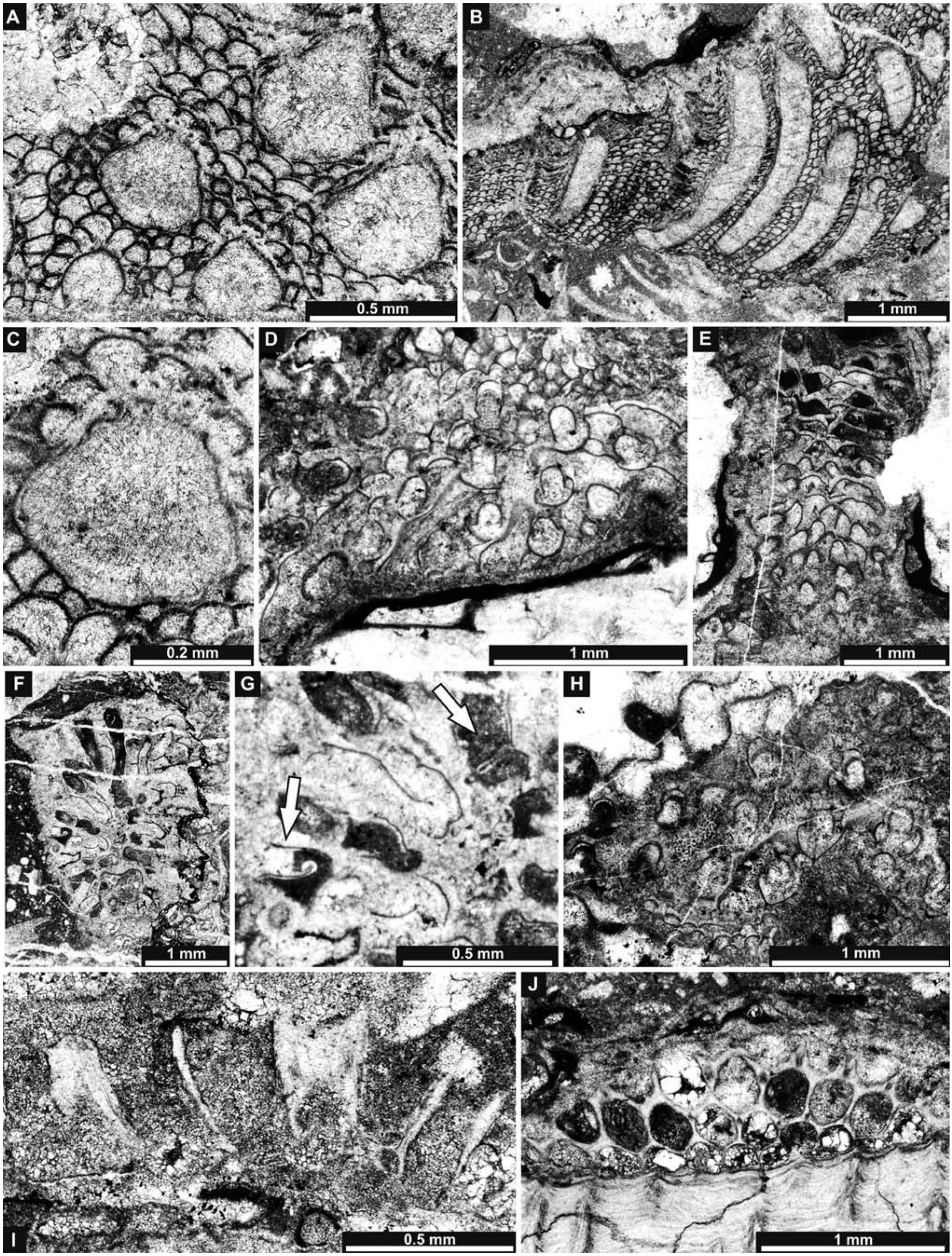
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Table 6 Measurements of *Eridopora parasitica* (Waagen and Wentzel 1886)

	N	*X*	SD	CV	MIN	MAX
Colony thickness (mm)	9	1.62	0.93	57.43	0.80	3.60
Autozooecial aperture width (mm)	20	0.37	0.05	12.51	0.30	0.48
Lunarium width (mm)	10	0.29	0.03	8.54	0.24	0.32
Lunarium length (mm)	10	0.18	0.04	20.95	0.14	0.24
Autozooecial aperture spacing (mm)	10	0.56	0.06	11.22	0.48	0.68
Vesicle diameter (mm)	10	0.09	0.03	29.03	0.06	0.14

Abbreviations as in Table 1

Description

Encrusting colonies, 0.8–3.6 mm thick. Autozooecial apertures are rounded to oval, with well-developed triangular lunaria, spaced 2–4 in 2 mm at the colony surface. Lunaria large, prominent, 0.20 mm thick in their middle part, and contain 6–7 nodes. Autozooecial diaphragms are abundant, 7–12 spaced in 1 mm of autozooecial length, planar, thin. Vesicles are small, angular, separating autozooecia usually in 2 rows, spaced 12–16 in 1 mm of autozooecial length. Distinct polygons developed by keels on the colony surface, enclosing apertures.

Comparison

Eridopora parasitica (Waagen and Wentzel 1886) differs from *E. oculata* Bassler 1929 in possessing larger apertures and thicker colonies (apertures width 0.37 vs. 0.28 mm on average in *E. oculata*).

Occurrence

Permian; Timor, Indonesia. Permian; Thailand. Lower Permian (Artinskian); Caucasus. Middle Permian; Oman. Upper Xarla Formation, Lower Permian; Xainza, northern Xizang (Tibet). Chainaha Formation, Middle Permian; north-western Xizang (Tibet). Middle Permian (Murgabian); Irian Jaya, Indonesia. Surmaq Formation, Middle Permian (Murgabian); Hambast Mountains, south of Abadeh, central Iran. Upper Permian; Pakistan (Salt Range).

Fistuliporidae gen. et sp. indet.
Figure 4d–h; Table 7

Material

Three colonies Ham7, Ham9, and PA/4.

Table 7 Measurements of Fistuliporidae gen. et sp. indet

	N	*X*	SD	CV	MIN	MAX
Autozooecial aperture width (mm)	8	0.25	0.02	6.84	0.22	0.28
Lunarium width (mm)	8	0.12	0.02	16.18	0.11	0.17
Lunarium length (mm)	8	0.11	0.02	13.24	0.10	0.14

Abbreviations as in Table 1

Description

Small encrusting, globular, and apparently branched colonies. Autozooecia growing from a median axis in branched colonies (Fig. 4e–f). Autozooecial apertures are rounded to rhombic. Lunaria well developed, horseshoe-shaped. Vesicles are low, with rounded flats, are locally abundant, but locally absent or few. Long curved hemiphragms in autozooecia.

Comparison

The present species has general features of *Fistulipora*, but differs from it by sparse vesicles and the presence of curved hemiphragms.

Occurrence

Surmaq Formation, Middle Permian (Murgabian); Hambast Mountains, south of Abadeh, central Iran.

Order: **Trepostomata** Ulrich 1882
Suborder: **Amplexoporina** Astrova 1965
Family: **Dyscritellidae** Dunaeva and Morozova 1967
Genus: ***Dyscritella*** Girty 1911

Dyscritella sp.
Figures 4i, j, 5a; Table 8

Material

Two colonies Ham9 and PA/4.

Description

Encrusting colony, 0.36–0.50 mm thick. Endozones short. Autozooecia growing from epitheca, inclined in endozone,

Fig. 5 **a** *Dyscritella* sp., tangential section. **b–d** Trepostomata gen. et sp. indet. 1. **b** Longitudinal section displaying walls with tubules (*arrow*), **c** longitudinal section displaying hemiphragms (*arrows*), **d** tangential section displaying tubules in autozooecial walls (*arrows*). **e–h** Trepostomata gen. et sp. indet. 2. **e** Longitudinal section, showing mesozooecia and autozooecium, **f** longitudinal section showing autozooecia, mesozooecia, acanthostyles and secondary overgrowth, **g** fragment of a massive colony, **h** tangential section, showing autozooecial apertures, acanthostyles and mesozooecia ▶

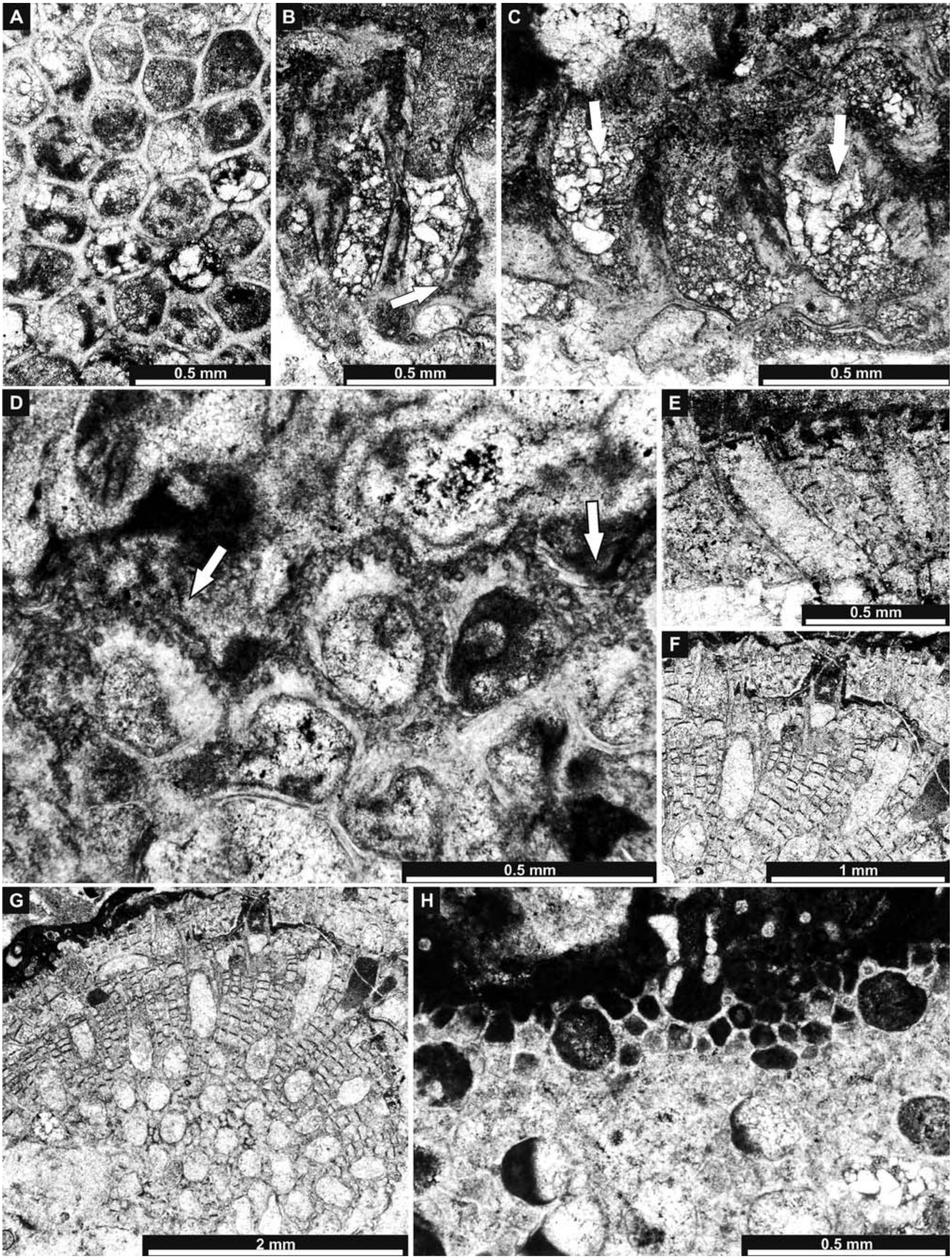
A
B
C
D
E
F
G
H
0.5 mm
0.5 mm
0.5 mm
0.5 mm
0.5 mm
1 mm
2 mm
0.5 mm

Table 8 Measurements of *Dyscritella* sp.

	N	*X*	SD	CV	MIN	MAX
Autozooecial aperture width (mm)	20	0.19	0.04	18.83	0.13	0.24
Exilazooecia width (mm)	10	0.06	0.01	17.17	0.05	0.07
Acanthostyle diameter (mm)	9	0.04	0.01	20.74	0.04	0.06

Abbreviations as in Table 1

intersecting colony surface at right angles. Autozooecial diaphragms rare, planar. Autozooecial apertures are polygonal, 8–11 spaced in 2 mm. Autozooecial walls are 0.036–0.048 mm thick in exozone and display fine reversal U-shaped lamination. Acanthostyles are abundant, 3–5 surround each autozooecial aperture, and have narrow hyaline cores and wide laminated sheaths. Exilazooecia rare, more abundant in maculae, restricted to exozone, having polygonal apertures. Maculae consist of larger autozooecia and abundant exilazooecia.

Comparison

The present species is similar to *Dyscritella leptosa* Ernst et al. 2006a from the Middle Permian of the Lakaftari area of central Iran. However, the latter species has abundant exilazooecia and smaller autozooecial apertures (average aperture width 0.19 vs. 0.12 mm in present material).

Occurrence

Surmaq Formation, Middle Permian (Murgabian); Hambast Mountains, south of Abadeh, central Iran.

Trepostomata gen. et sp. indet. 1
Figure 5b–d; Table 9

Material

Two colonies Ham6 and Ham9.

Description

Encrusting colonies, 0.4–1.05 mm thick. Secondary overgrowths common. Autozooecial apertures are rounded to angular. Diaphragms in autozooecia are absent. Hemiphragms common, short. Exilazooecia are abundant, and have rounded to polygonal transverse section shape, and 4-5 surrounding each aperture. Acanthostyles absent. Tubules ("capillaries" of authors) in the autozooecial walls are abundant, and are aggregated in clusters along autozooecial boundaries, 0.02 mm in diameter. Autozooecial walls are indistinctly laminated, 0.012–0.025 mm thick in the endozone; regularly thickened, coarsely laminated, 0.06–0.12 mm thick in exozone.

Table 9 Measurements of Trepostomata gen. et sp. indet. 1

	N	*X*	SD	CV	MIN	MAX
Autozooecial aperture width (mm)	30	0.20	0.03	14.97	0.14	0.29

Abbreviations as in Table 1

Comparison

The present material is similar to *Stenophragmidium* Bassler 1952 in having encrusting colony and hemiphragms (Cleary and Wyse Jackson 2006). However, all species of this genus possess acanthostyles, which are absent in the present material. *Hinganella* Romantchuk, 1967 shows similar wall structure with tubules aggregated in clusters. However, this genus lacks hemiphragms.

Occurrence

Surmaq Formation, Middle Permian (Murgabian); Hambast Mountains, south of Abadeh, central Iran.

Trepostomata gen. et sp. indet. 2
Figure 5e–h; Table 10

Material

Eight colonies Ham9, PA/3/4, PA/4, PA/7/2, PA/22, and PA/27/(1–3).

Description

Massive and encrusting colonies. Colony thickness 0.60–0.75 mm. Autozooecia tubular, with rounded apertures. On average, five apertures spaced in 2 mm at colony surface. Mesozooecia abundant, large, polygonal in cross section, containing abundant closely spaced diaphragms, having straight walls, separating autozooecia in 1–3 rows. Acanthostyles abundant, 4–7 surrounding each autozooecial aperture and occurring in junctions between mesozooecia,

Table 10 Measurements of Trepostomata gen. et sp. indet. 2

	N	*X*	SD	CV	MIN	MAX
Autozooecial aperture width (mm)	15	0.16	0.02	10.30	0.14	0.19
Autozooecial aperture spacing (mm)	12	0.39	0.06	16.26	0.31	0.54
Mesozooecia diameter (mm)	10	0.06	0.01	22.19	0.04	0.08
Acanthostyle diameter (mm)	10	0.041	0.01	9.11	0.035	0.045
Acanthostyles per aperture	10	5.5	0.85	15.45	4.0	7.0

having wide laminated sheaths and distinct hyaline cores. Autozooecial walls thin, finely laminated.

Comparison

The present species is similar to *Leioclema* Ulrich 1882 in having abundant mesozooecia and acanthostyles. However, *Leioclema* has angular apertures and mainly beaded mesozooecia. *Hinaclema* Sakagami and Sugimura 1987 is also similar to the present species, but has heterozooecia without diaphragms.

Occurrence

Surmaq Formation, Middle Permian (Murgabian); Hambast Mountains, south of Abadeh, central Iran.

Discussion

Permian Bryozoa are relatively well known worldwide and therefore are often used for palaeobiogeography and stratigraphy. However, bryozoan faunas from the Permian sediments in some regions remain unstudied, despite their abundance and diversity. The progressive investigation of the Permian bryozoans from Iran uncovers new insights in the global and regional palaeobiogeography. The described bryozoan fauna of the Surmaq Formation from Kuh-e Hambast (Hambast Mountains, central Iran) can be correlated with the Middle Permian of Thailand, Tibet, Pakistan, Indonesia, and Japan. From the taxonomic point of view, this fauna is dominated by cystoporates (seven species), followed by trepostomes (three species). Besides these, fragments of three fenestrate genera are also present in studied thin sections. The majority of the described species display an encrusting colony shape (seven species), followed by two ramose and one massive species. Locally, bryozoans seem to contribute significantly to the stabilization of the reefal sediments with their encrusting colonies.

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