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Five new species and one new genus of recent miliolid foraminifera from Raja Ampat (West Papua, Indonesia)

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Raja Ampat is an archipelago with about 1500 small islands located northwest off the Bird's Head Peninsula of Indonesia's West Papua Province. It is part of the Coral Triangle, a region recognized as the epicenter of tropical marine biodiversity. In the course of a large-scale survey on shallow benthic foraminifera we have discovered one new genus and five new species of recent miliolid benthic foraminifera from the highly diverse reefal and nearshore environments. The new fischerinid genus *Planispirinoides* is characterized by its planispiral coiling and the presence of a simple tooth, what differentiates it from *Planispirinella* Wiesner. The other four new species described herein belong to the genera of *Miliolinella* Wiesner, *Triloculina* d'Orbigny and *Siphonaperta* Vella. All new species are comparatively rare and occur sporadically in the sample material. Detailed morphological descriptions, Scanning Electron Microscopy pictures of complete and dissected specimens as well as micro-computed tomography images are provided.

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Abstract

Raja Ampat is an archipelago with about 1500 small islands located northwest off the Bird's Head Peninsula of Indonesia's West Papua Province. It is part of the Coral Triangle, a region recognized as the epicenter of tropical marine biodiversity. In the course of a large-scale survey on shallow benthic foraminifera we have discovered one new genus and five new species of recent miliolid benthic foraminifera from the highly diverse reefal and nearshore environments. The new fischerinid genus *Planispirinoides* is characterized by its planispiral coiling and the presence of a simple tooth, what differentiates it from *Planispirinella* Wiesner. The other four new species described herein belong to the genera of *Miliolinella* Wiesner, *Triloculina* d'Orbigny and *Siphonaperta* Vella. All new species are comparatively rare and occur sporadically in the sample material. Detailed morphological descriptions, Scanning Electron Microscopy pictures of complete and dissected specimens as well as micro-computed tomography images are provided.

Introduction

The Raja Ampat Archipelago (West Papua, Indonesia) at northwestern New Guineas Bird's Head Peninsula (Fig. 1B) is one of the most species rich marine environments (Erdmann & Pet, 2002; McKenna, Allen & Suryadi, 2002), situated in the Indo-Pacific's epicenter of biodiversity, commonly referred to as the Coral Triangle (Hoeksema, 2007). The Coral Triangle encompasses a large part of the tropical marine waters of Indonesia, the Philippines, Malaysia, the Solomon Islands, Papua New Guinea and Timor-Leste (Fig. 1A). It includes ecoregions that are each home to at least 500 species of hermatypic corals and also show extraordinary diversity among coral associated species (Veron, 1995; Veron *et al.*, 2009; Roberts *et al.*, 2002; Bellwood & Hughes, 2001; Tittensor *et al.*, 2010). The region is recognized as a "species factory" and functions as the most significant net exporter of biodiversity for adjacent reef regions (Briggs & Bowen, 2013; Ekman, 1953).

Comprehensive studies on benthic foraminifera from the central Indo-Pacific region startet with marine scientific expeditions in the late 1800s with the report on the Challenger Foraminifera by Brady (1884), and the work of Millett (1898-1904) from the Malay Archipelago. In the 20th century, systematic surveys were conducted around the Philippines (Cushman, 1921; Graham & Militante, 1959), in the Papuan Lagoon near Port Moresby, Papua New Guinea (Haig, 1988a; Haig, 1988b; Haig, 1993), in the Timor Sea and Sahul Shelf (Loeblich & Tappan, 1994), in Madang, eastern Papua New Guinea (Langer, 1992; Langer & Lipps, 2003) and more recently in the Ningaloo Reef area at Australia's northwest coast (Parker, 2009), at Chuuk Island of the Caroline reefs (Makled & Langer, 2011) and around New Caledonia (Debenay, 2012). Recent environmental and biogeographic studies on larger benthic foraminifera in the tropical waters of the central Indo-Pacific were conducted by Langer and Hottinger (2000), Renema (2003; 2005; 2006; 2010), Renema & Troelstra (2001), Hohenegger (2004; 2005; 2011), Weinmann *et al.* (2013), and Prazeres, Uthicke & Pandolfini (2016).

To date, however, large-scale systematic studies on benthic foraminifera from Raja Ampat are lacking. The archipelago consists of the four main islands Waigeo, Batana, Salawati, and Misool, and hundreds of small satellite islets, which are largely uninhabited. Due to its remote location and difficult access conditions the coral reefs of the region remained relatively unexplored and pristine, but increasing exposure to exploitation have required the establishment of several Marine Protected Areas (Agostini et al., 2012). The first and to date only report on benthic foraminifera from Raja Ampat is that of Hofker (1927; 1930), who examined the material taken by the Siboga Expedition (1899-1900), that included five

samples from Raja Ampat. He documented nine species of benthic foraminifera from Raja Ampat, eight rotalid taxa and the miliolid symbiont bearing species *Peneroplis pertusus* (Forskål).

Smaller miliolid benthic foraminifera are typical dwellers in surface sediments of shallow water reefal and lagoonal habitats. By studying on the highly diverse assemblages of benthic foraminifera from Raja Ampat, taken from different locations around the islands (Fig. 1C), we recorded a total of 455 species among them 249 miliolid species, of which five are described here as new. Four species belong to the widely distributed miliolid genera of *Miliolinella* Wiesner, *Triloculina* d'Orbigny and *Siphonaperta* Vella. As the morphological properties of the fifth species of the miliolids differentiate it from any of previously known genera we designate and describe it as the new genus *Planispirinoides*.

Material and Methods

This study was conducted with 30 samples from the Raja Ampat Archipelago (New Guinea, Indonesia) from around the islands of Waigeo, Batana, Kawe, Fam and adjacent small islets in an area that covers about 2.500km² (Fig. 1C). The archipelago is located in the central Indo-Pacific warmpool with an average annual sea surface temperature of 29°C (Mangubhai *et al.*, 2012). Raja Ampat is further situated in the passage way of the Indonesian Throughflow, a major ocean current that leads water masses from the western Pacific to the eastern Indian Ocean, and affects the reefal habitats. Studies have shown that the reef fauna of Raja Ampat is strongly current dependent (DeVantier, Turak & Allen, 2009; Turak, 2003).

The samples were collected by snorkeling and SCUBA diving in September 2011 by MRL. Sampling was mainly carried out in fore-reef zones in current-exposed and sheltered depositional environments, in fringing reef and patch reef environments, and also in shallow sand shoals and sand banks with sparse coral cover (Tbl. 1). The sediment is predominantly carbonaceous (~90%) and includes fine-grained sediments as well as coarse reef rubble. All samples were washed over a 63µm sieve and dried at 50°C in an oven overnight. Foraminifera were picked from each sample and the best preserved specimens were imaged using a Tescan VEGA MV2300 Scanning Electron Microscope (SEM) at the Steinmann Institute of the University of Bonn. Digital plates were assembled using Adobe Photoshop CS6. Micro-computer tomography (CT) scan imaging was conducted using a phoenix v|tome|x s computer tomograph at the Steinmann Institute and visualization of the datasets was done with Avizo 7.1.0. The new species and the new genus are described in detail using the supra-generic classification of Loeblich & Tappan (1987).

Repository of the Material: The holotypes and topotypic paratypes of the new species are deposited in the micropaleontology collection of the Steinmann Institute of Paleontology at the University of Bonn, Germany (MaLaPNG 2011-10, MaLaPNG 2011-11, MaLaPNG 2011-12, MaLaPNG 2011-13, MaLaPNG 2011-14).

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Systematic descriptions

Subclass Miliolana Saidova 1981
Order Miliolida Delage & Hérouard 1896
Suborder Miliolina Delage & Hérouard 1896
Superfamily Nubeculariacea T.R. Jones 1875
Family Fischerinidae Millett 1898
Subfamily Fischerininae Millett 1898

Genus ***Planispirinoides*** Förderer and Langer **n. gen.**

Description. Test small, broadly circular in outline, discoidal and slightly biconvex. Periphery with a weakly developed subrounded keel that encircles the entire test margin. Wall thick, calcareous, porcelaneous, imperforate. Coiling involute, throughout planispirally enrolled with 2.5 to 3.5 tubular chambers per whorl, each whorl slightly offset to the proceeding coil with a tendency to become sigmoiline (axial section as seen in CT scan, Fig. 2H). Lateral wall extensions of the ultimate chambers entirely covering the earliest chambers and tend to overlap the umbilical region in each whorl. Sutures oblique, thin and irregular. Aperture terminal, triangular in juvenile specimens, high and subtriangular in adult specimens, tapering apical, on the base connected with the peripheral margin of the proceeding chamber and provided with a very small and thin tooth. In juvenile specimens the tooth appears just like a little knob or slightly raised spine.

Type species. *Planispirinoides occultus* n. sp.

Remarks. *Planispirinoides* n. gen. resembles *Planispirinella* Wiesner 1931 in having a discoidal shape, a high aperture and a planispiral chamber arrangement, but differs from *Planispirinella* by the presence of a tooth and the more biconvex test shape in apical view. The apertural features and the mode of coiling of *Planispirinoides* gen. nov. further distinguishes it from *Nummoloculina* Steinmann 1881, which has an apertural flap and an early quinqueloculine coiling.

Planispirinoides occultus Förderer and Langer **n. sp.**
Figure 2A-K

Etymology. From the Latin “occultare” meaning for “hiding”.

Material. 28 specimens from nine samples (MR18, MI05, MI06, MS03, MS04, MG, M21, U16, Y24), recent.

Holotype. The specimen illustrated here as Fig. 2C, D (sample MS03; MaLaPNG 2011-10).

Paratype. The specimen illustrated here as Fig. 2A, B (sample MS03; MaLaPNG 2011-10).

Type locality. The holotype and the paratype are from sample station MS03 (16m), a sand channel between Arborek Island and Pulau Mansuar; Raja Ampat, New Guinea (Indonesia).

Diagnosis. A small species of *Planispirinoides* gen. nov. with a discoidal biconvex test shape, a keeled periphery, a wrinkled surface ornamentation and a triangular aperture provided with a small tooth.

Dimensions. Maxium test height of the holotype 0.39mm.

Occurence. *Planispirinoides occultus* n. sp. is widely distributed in the Raja Ampat area in fine to coarse coral rubble samples from a depth range from 14 to 45 meters.

Description. Test porcelaneous and imperforate. Almost circular in lateral view, lenticular and biconvex in apertural view with a subrounded keel and weakly inflated chambers. Coiling planispiral and involute. Two and a half to 3.5 chambers visible from the exterior. Lateral wall extensions of the ultimate chambers entirely covering the earliest chambers and tend to overlap the umbilical region; the final chamber covers approximately half of the test surface. Sutures oblique, thin, irregular and recurved near the periphery. Test surface ornamented with fine irregular striae that are mostly oriented parallel, straight to slightly curved backwards, towards the outer margins of the chambers. Central part of the test more weakly ornamented. Outer wall layer constructed of longitudinal parallel aligned needle-shape crystals, oriented perpendicular to direction of ornamentation. The color of the test is white under the light microscope. Apertural face not ornamented. Aperture triangular in juvenile specimens, high and subtriangular in adult specimens, tapering apical, on the base connected with the peripheral margin to the preceding chamber and provided with a peripheral rim. Aperture provided with a very small and thin tooth, with the flat side oriented in lateral direction.

Remarks. *Planispirinoides occultus* n. sp. differs from *Planispirinella involuta* Collins (1958, p. 374, pl. 4, figs 2a, b) by its more lenticular biconvex shape in horizontal section, the subtriangular shape of the aperture, the presence of a small tooth, and the striate surface ornamentation.

Superfamily Milioloidea Ehrenberg 1839
Family Haueriniidae Schwager 1876
Subfamily Hauerininae Schwager 1876

Genus *Miliolinella* Wiesner 1931

Miliolinella moia Förderer and Langer **n. sp.**
Figure 3A-F

Etymology. The new species is named after the indigeneous Moi people from Malaumkarta, a Papuan tribe from the north coast near Sorong.

Material. 11 specimens from six samples (B14, B15, E23, MR17, N18, U16), recent.

Holotype. The specimen illustrated here as Fig. 3A-C (sample B14; MaLaPNG 2011-11).

Paratype. The specimen illustrated here as Fig. 3D-F (sample B14; MaLaPNG 2011-11).

Type locality. The holotype and the paratype are from sample station B14 (41m), Bag Island, east of Pulau Uranie; Raja Ampat, New Guinea (Indonesia).

Diagnosis. A slightly enlongated, medium-sized species of *Miliolinella* Wiesner 1931 with a compressed, angular and slightly slanted outline, a smooth and shiny wall, and a high subcircular opening.

Dimensions. Maxium test height of the holotype 0.56mm.

Occurence. This species is widely distributed in the Raja Ampat area in fine to coarse coral rubble samples and occurs at depths between 12 and 45 meters.

Description. Test porcelaneous and imperforate, ovate in outline and slightly higher than broad. Test weakly compressed and flattened, subtriangular in apertural view. Chamber arrangement quinqueloculine with five chambers visible from the exterior. In juvenile specimens usually only three chambers are visible. Periphery rounded to subrounded, chambers slightly inflated with blunt angles. Sutures curved, distinct and depressed. Chambers tend to be off-centered, giving them a slanted appearance. Test wall smooth, translucent to opaque and glossy under the light microscope. Aboral end inflated, rounded and produced. Aperture terminal, a *Miliolinella*-type large subcircular opening with a distinct peristomal rim and provided with a semicircular, slightly excavated flap, that covers more than half of the opening.

Remarks. *Miliolinella moia* n. sp. differs from *Miliolinella pilasensis* McCulloch 1977 (p. 566, pl. 238, fig. 16 and Loeblich & Tappan 1994, p. 57, pl. 99, figs 1-9) in its angular and more compressed outline, and the large subcircular opening. Millet (1898) depicted a species of *Miliolina valvularis* (Reuss) from the Malay Archipelago (p. 11, fig. 5a-c) that shows a high degree of similarity to *Miliolinella moia* n. sp., but his specimen has a more rounded periphery. The original description of *Triloculina valvularis* by Reuss (1851, p. 85, pl. 7, fig. 56) shows a specimen with a broadly rounded periphery and inflated chambers without angles. *Miliolinella* sp. 2 figured in Parker 2009 from Ningaloo Reef, Australia (p. 128, figs 92a-i, 93a-j, 94a-k) differs from *Miliolinella moia* n. sp. by the low apertural opening and the broadly rounded and more inflated chambers.

Miliolinella undina Förderer and Langer **n. sp.**
Figure 4A-I

1988a *Miliolinella* sp. B – Haig, Papuan Lagoon, Port Moresby, p. 224, pl. 2, figs 23, 24.
1992 *Miliolinella* sp. – Hatta & Ujiié, Ryukyu Islands, p. 72, pl. 10, fig. 6.
?2012 *Miliolinella* cf. *M. semicostata* (Wiesner) – Debenay, New Caledonia, p. 110, 275.

Etymology. After the undulate ornamentation of the test. From the Latin “unda” meaning wave and mythological “Undine” meaning water spirit.

Material. Three specimens from three samples (MR18, N18, U16), recent.

Holotype. The specimen illustrated here as Fig. 4A-C (sample MR18; MaLaPNG 2011-12).

Paratypes. The specimens illustrated here as Fig. 4D-F (sample N18) and Fig. 4G-I (sample U16; MaLaPNG 2011-12).

Type locality. The holotype is from sample station MR18 (18m), east of Kawe Island. The paratypes are from sample stations N18 (30m), south-west coast of Pulau Wayag, and U16 (45m), between Pulau Uranie and Bag Island; Raja Ampat, New Guinea (Indonesia).

Diagnosis. A small quinqueloculine species of *Miliolinella* Wiesner with inflated chambers, a rounded outline and an undulate surface ornamentation.

Description. Test porcelaneous and imperforate, small, ratio of height and width variable but usually slightly higher than broad. Periphery rounded and chambers slightly inflated. Chamber arrangement quinqueloculine, with five cambers visible from the exterior; somewhat erratic in the adult stage. Aboral end rounded, not produced and flush with the surface. Wall smoothly finished, matte, translucent under the light microscope. Sutures curved and depressed. Test surface ornamented with numerous irregular, predominantly longitudinal, somehow honeycombed reticulate to undulate low anastomosing costae that are covering large parts of the test. Ornamentation most pronounced in adult specimens. Outer-wall layer constructed of needle-shaped crystals that are primarily aligned in longitudinal direction. Aperture terminal, a large semicircular *Miliolinella*-type opening, provided with a thickened peristomal rim and a broad, slightly excavated basal flap.

Dimensions. Maxium test height of the holotype 0.15mm.

Occurence. *Miliolinella undina* n. sp. is present with one specimen in each of three highly diverse, miliolid-rich, fine coral rubble samples from a depth range between 18 to 45 meters.

Remarks. Specimens of *Miliolinella undina* n. sp. have been previously documented by Haig 1988a as *Miliolinella* sp. B from the Papuan Lagoon, Port Moresby and by Hatta & Ujiié 1992 as *Miliolinella sp.* from the Ryukyus. Hatta & Ujiié mentioned the species to occur rarely in their assemblages. *Miliolinella* cf. *M. semicostata* (Wiesner) depicted by Debenay from New Caledonia (2012, p. 110, 275) may also belong to *Miliolinella undina* n. sp., but shows a less undulated test ornamentation. The shape, apertural features, and the ornamentation are more similar to our juvenile forms (Fig. 4A-C) than to *Miliolinella semicostata* (Wiesner 1923) from the Mediterranean Sea (see Cimerman & Langer 1991, p. 42, pl. 38, figs 10-15). *Miliolinella semicostata* has less inflated chambers and the ornamentation is not reticulate but longitudinally striate and restricted to the angles. *Miliolinella undina* n.sp. also resembles *Miliolinella* sp. 4 depicted by Parker from the Ningaloo Reef in Western Australia (2009, p. 136, fig. 97a-h), but his specimen has a less undulated and more striate alignment of costae. The new species also resembles *Miliolinella flintiana* (Cushman) (1932, p. 55, pl. 12: 4a-c) in size, test shape, chamber arrangement and apertural features. However it differs in its surface ornamentation, that is distinctly longitudinal costate in *Miliolinella flintiana* and undulate and more irregular in *Miliolinella undina* n.sp.. *Miliolinella flintiana* also occurs in our assemblages.

Genus *Triloculina* d'Orbigny 1826

Triloculina kaweensis Förderer and Langer **n. sp.**
Figure 5A-H

2009 Triloculina? sp. 2 – Parker, Ningaloo Reef, p. 372, fig. 271f-j.

Etymology. This species is named in honor of the indigeneous people of West Papua after the Kawe tribe, that owns and protects a highly diverse Marine Protected Area of Raja Ampat.

Material. 12 specimens from seven samples (B15, FW, M05, MS04, N18, U16, Y25), recent.

Holotype. The specimen illustrated here as Fig. 5A-C (sample FW; MaLaPNG 2011-13).

Paratype. The specimen illustrated here as Fig. 5E-G (sample FW; MaLaPNG 2011-13).

Type locality. The holotype and the paratype are from sample station FW (49m), south-east Penemu, Fam Islands; Raja Ampat, New Guinea (Indonesia).

Diagnosis. A medium-sized species of *Triloculina* d'Orbigny with a slightly elevated *"Lachlanella"*-type aperture, rounded periphery, blunt angles and a roughly textured wall.

Dimensions. Maxium test height of the holotype 0.4mm.

Occurence. This species is widely distributed in our sampling area in fine to coarse coral rubble samples covering a depth range from 14 to 49 meters.

Description. Test porcelaneous and imperforate, about one and a half times longer than broad. Broadly triangular in apterural view, ovate in outline. Chamber arrangement triloculine, periphery rounded to subrounded, chambers inflated with blunt angles. Sutures distinct and depressed. Surface ornamented with elongated, irregular longitudinal arranged indentations covering the entire test surface, giving the appearance of a matte and roughly textured wall under the light microscope. Outer wall layer consisting of longitudinally aligned plate shaped chrystals. Aboral end rounded and slightly produced, oral end produced and connected with the peripheral margin of the preceeding chamber. Aperture terminal, *"Lachlanella"*-type with a long slender tooth that becomes thickened at the tip.

Remarks. The species *Triloculina*? sp. 2 reported by Parker 2009 from Western Australia differs from *Triloculina kaweensis* n. sp. in its less triangular shape and less elongated outline. We consider Parker's specimen a juvenile individuel of *Triloculina kaweensis* n. sp.. The aperture of Parker's specimen is not intact but resembles very well the apertural features of *Triloculina kaweensis* n. sp.. The outer wall layer appears identical (Fig. 5H). Parker mentioned the species to be possibly cryptoquinqueloculine. The horizontal section of one of *Triloculina kaweensis* n. sp. shows the triloculine chamber arrangement (Fig. 5D). *Triloculina* sp. 1, reported by Debenay 2012 from New Caledonia (p. 139, 278) is very similar in shape and surface ornamentation to *Triloculina kaweensis* n. sp., but has significantly more acute angles and a Y-shaped tooth. *Triloculina kaweensis* n. sp. further differs from *Triloculina linneiana* d'Orbigny depicted by Baccaert 1987 from the Great Barrier Reef (p. 128, pl. 57, figs 3, 4) in the less striate ornamentation and more acute angles.

Subfamily Siphonapertinae Saidova 1975

Genus *Siphonaperta* Vella 1957
Siphonaperta hallocki Förderer and Langer **n. sp.**
Figure 6A-F

?1988a *Quinqueloculina* sp. C – Haig, Papuan Lagoon, Port Moresby, p. 234, pl. 9, figs 7-10.
?2009 *Quinqueloculina* sp. 4 – Parker, Ningaloo Reef, p. 297, fig. 214a-e.

Etymology. In honor of Pamela Hallock Muller for her extensive work on tropical foraminifera.

Material. Four specimens from three (MS03, N18, W07) samples, recent.

Holotype. The specimen illustrated here as Fig. 6A-C (sample MS03; MaLaPNG 2011-14).

Paratype. The specimen illustrated here as Fig. 6D-F (sample N18; MaLaPNG 2011-14).

Type locality. The holotype is from sample station MS03 (18m), a sand channel between Arborek Island and Pulau Mansuar. The paratype is from sample station N18 (30m), south-west coast of Pulau Wayag; Raja Ampat, New Guinea (Indonesia).

Diagnosis. A medium-sized species of *Siphonaperta* Vella with a finely agglutinated wall, carinate shoulders, a short neck and a circular aperture with a small bifid tooth.

Description. Test porcelaneous and imperforate, medium-sized, about two times longer than broad, ovate in outline, subquadrangular in apertural view. Outer layer of the calcareous test wall covered with finely agglutinated mostly biogenic grains. Agglutinated grains are particularly frequent along the sutures. Periphery carinate to subacute. Chamber arrangement quinqueloculine with five chambers visible from the exterior. Sutures slightly curved, incised and depressed. Chambers weakly inflated and angular in section, with weakly developed longitudinal striae (in well preserved specimens). Aboral end rounded and produced; oral end becoming more slender and leading into a short produced neck. Aperture terminal, a wide circular opening with a short T-shaped, bifid tooth, that reaches more than one third of the apertural diameter. Apertural opening surrounded by a slightly thickened peristomal rim.

Dimensions. Maxium test height of the holotype 0.54mm.

Occurence. *Siphonaperta hallocki* n. sp. occurs sporadically in fine to coarse coral rubble samples from a depth range between 16 and 30 meters.

Remarks. A very similar species has been previously documented by Haig 1988a and was tentatively identified as *Quinqueloculina* sp. C from the Papuan Lagoon, Port Moresby. It resembles very well in shape, wall texture and apertural features our specimens from Raja Ampat. However, it is uncertain if the species depicted by Haig is also agglutinated. *Quinqueloculina* sp. 4 documented by Parker 2009 from the Ningaloo Reef appears very similar to *Siphonaperta hallocki* n. sp. but differs in its more elongated shape, more rounded and inflated chambers and the cryptoquinqueloculine coiling. In addition, Parker describes the wall as roughly textured with some agglutinated grains. *Quinqueloculina tropicalis* Cushman from Samoa (1924, p. 63, pl. 23, figs 9, 10) differs from our new species by its more compressed shape and more elongated broadly rounded chambers without any angles or costae. *Quinqueloculina polygona* d'Orbigny (1839, p. 198, pl. 12, figs 21-23) differs from *Siphonaperta hallocki* n. sp. in its smooth and shiny surface, the pronounced carinae and the less inflated chambers. Langer *et al.* 2013 depicted a specimen of *Quinqueloculina polygona* d'Orbigny from Bazaruto (Langer *et al.*, 2013, p. 163, fig. 5: 14) that resembles our new species in size, shape und apertural features. However, it is

unlikely that this species from Bazaruto belongs to *Siphonaperta hallocki* n. sp., as its outer wall layer is not agglutinated.

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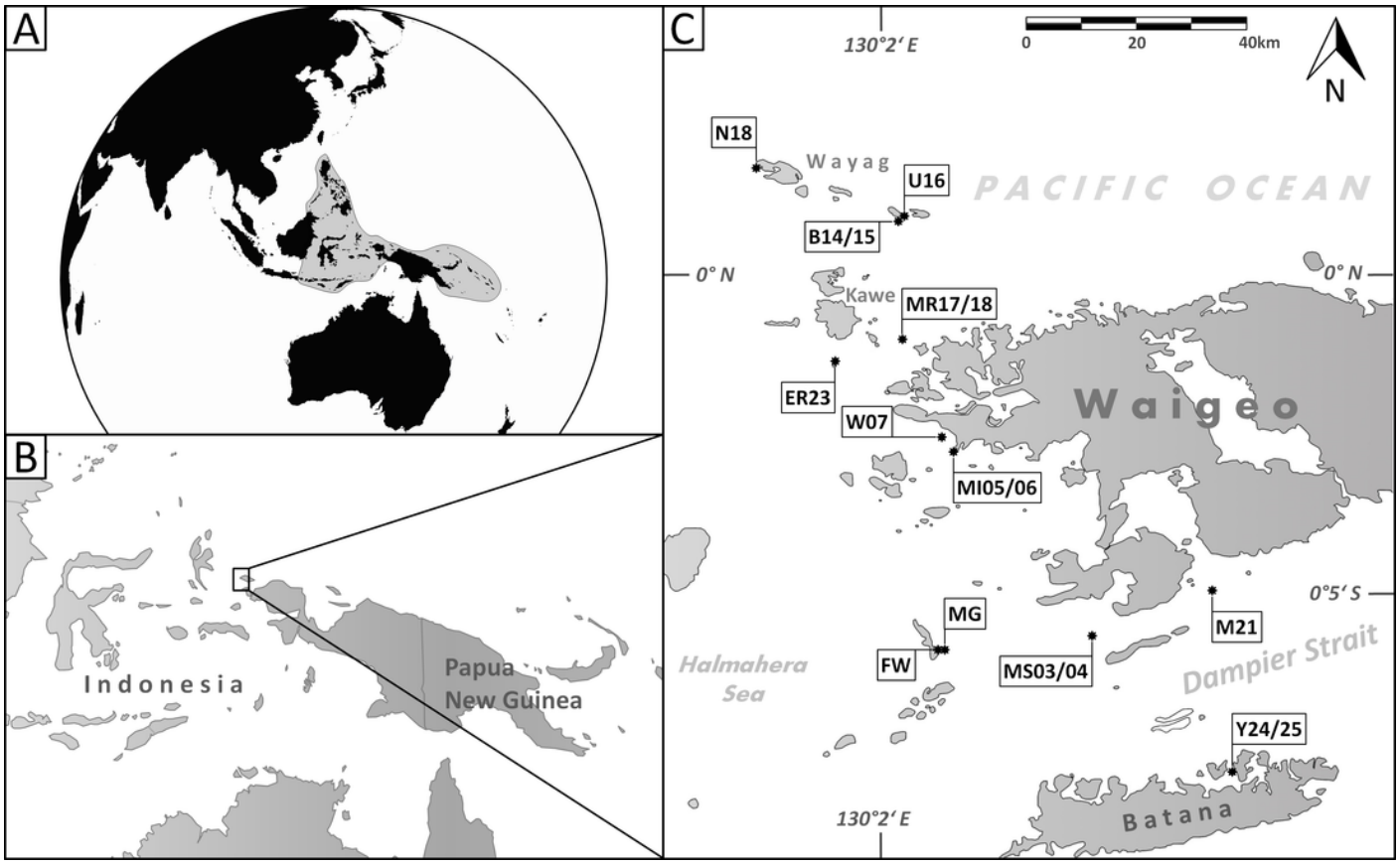
1

Location maps of the sampling area.

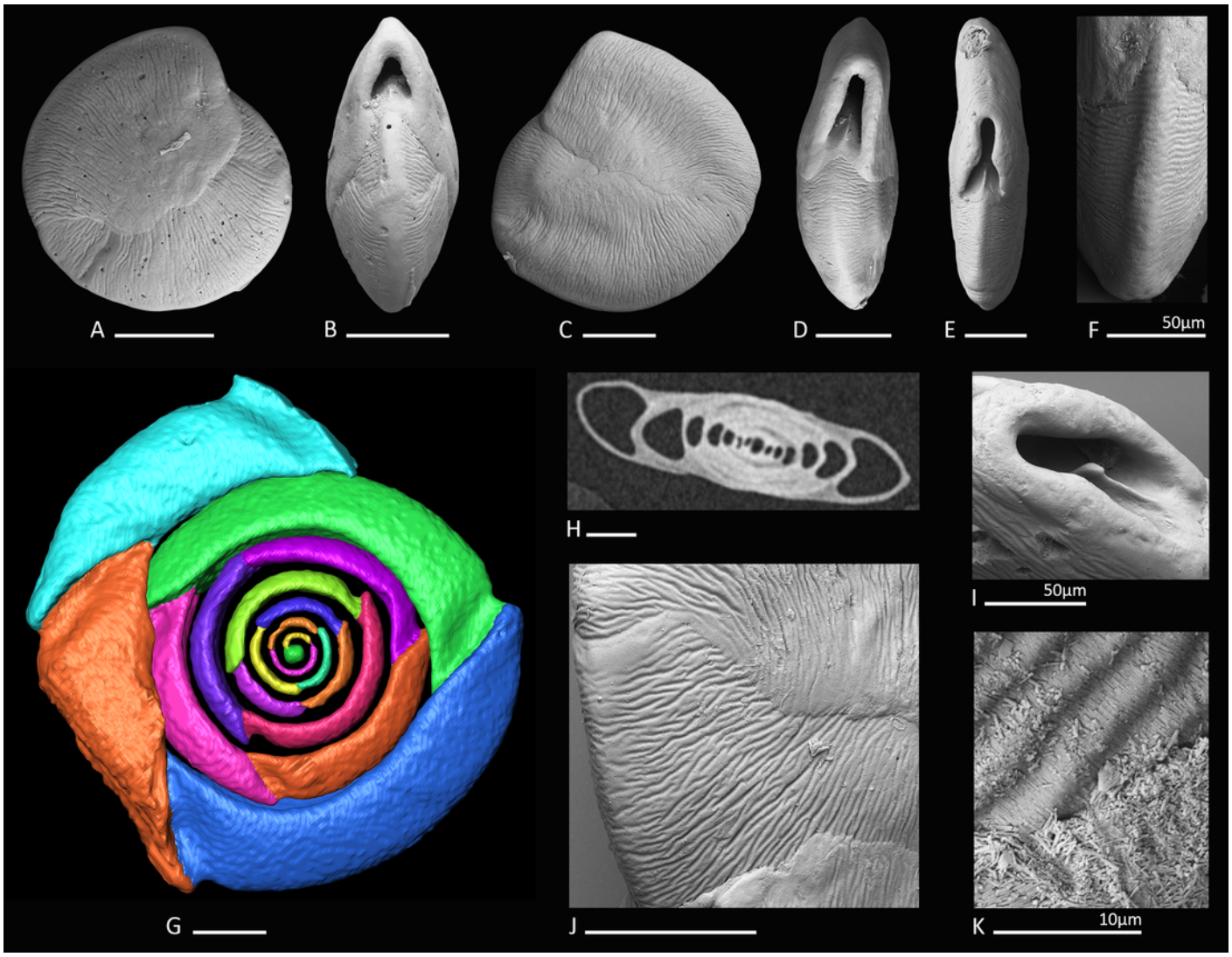
(A) Area of the Coral Triangle (shaded) in the Central Indo-Pacific; (B) location of Raja Ampat northwest of the Bird's Head Peninsula (West Papua, Indonesia); (C) location of sample stations where the species described herein occur (for details see Tbl. 1).



2

Holotype, paratype, CT scans and details of *Planispirinoides* n. gen. *occultus* n. sp.

(A) Side view and (B) apertural view of a juvenile specimen with a nearly triangular aperture and weakly developed tooth (paratype); (C) side view and (D) apertural view (holotype); (E) apertural view of an adult specimen with a well-developed tooth and elongated aperture; (F) detail of a well-developed peripheral keel; (G) CT scan reconstruction of the chamber cavities revealing the presence of 2.5 to 3.5 chambers per whorl in an adult specimen (note that penultimate chamber is broken); (H) CT scan showing planispirally arranged chambers; (I) detail of an aperture with a very well-developed tooth; (J) detail of the striate surface ornamentation; (K) detail of the construction of the outer wall layer showing randomly arranged calcite needles in the lower part (test surface removed) and longitudinally arranged calcite needles on the outer test surface. Scale bar is 100µm (unless indicated).


A
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J
K
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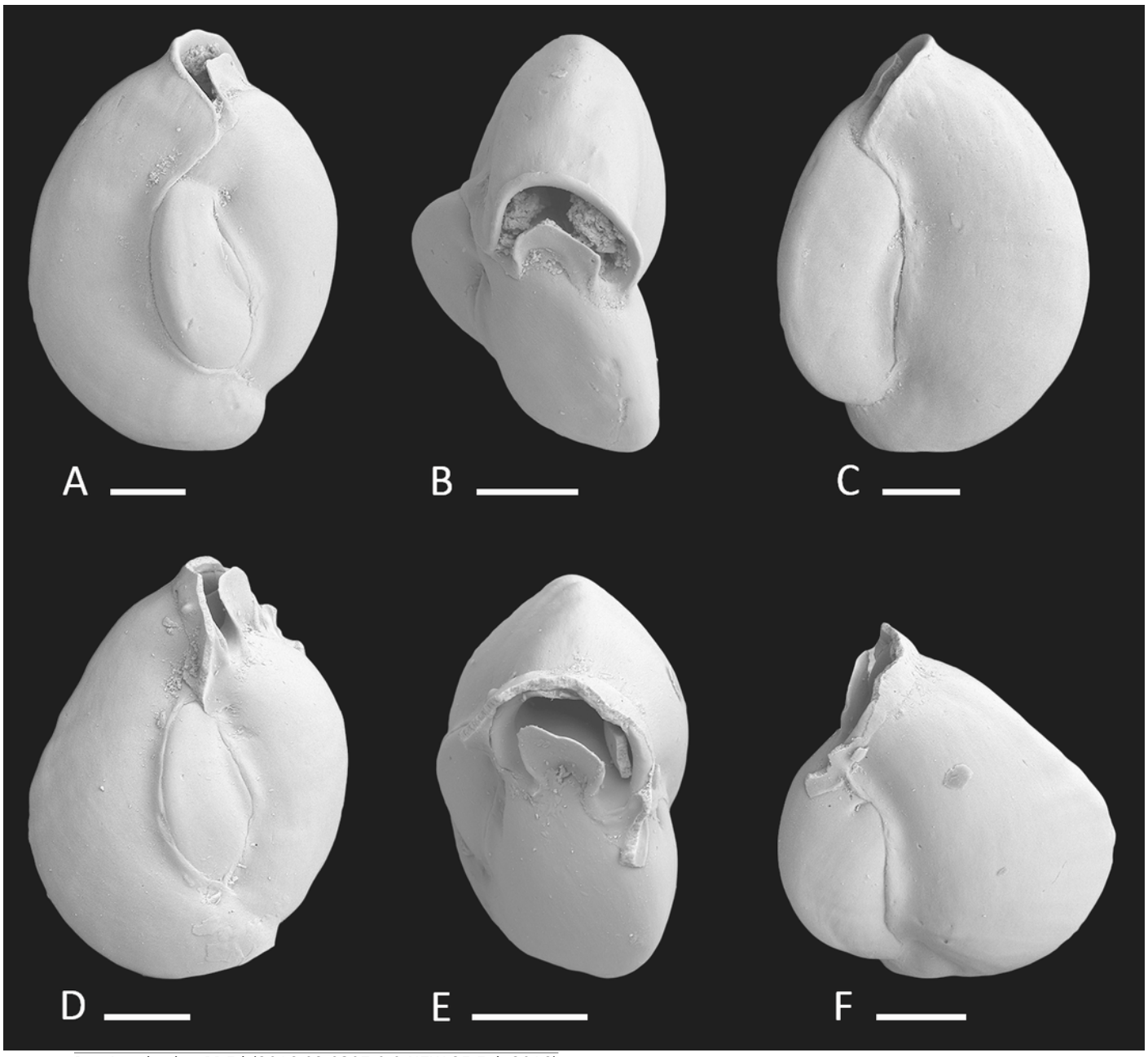
3

Holotype and paratype of *Miliolinella moia* n. sp.

(A-C) Holotype, five chambers visible from the exterior: (A) side view; (B) top view; (C) side view; (D-F) paratype, a juvenile stage with three chambers visible from the exterior: (D) side view; (E) top view; (F) side view. Scale bar is 100µm.

**Note: Auto Gamma Correction was used for the image. This only affects the reviewing manuscript. See original source image if needed for review.*

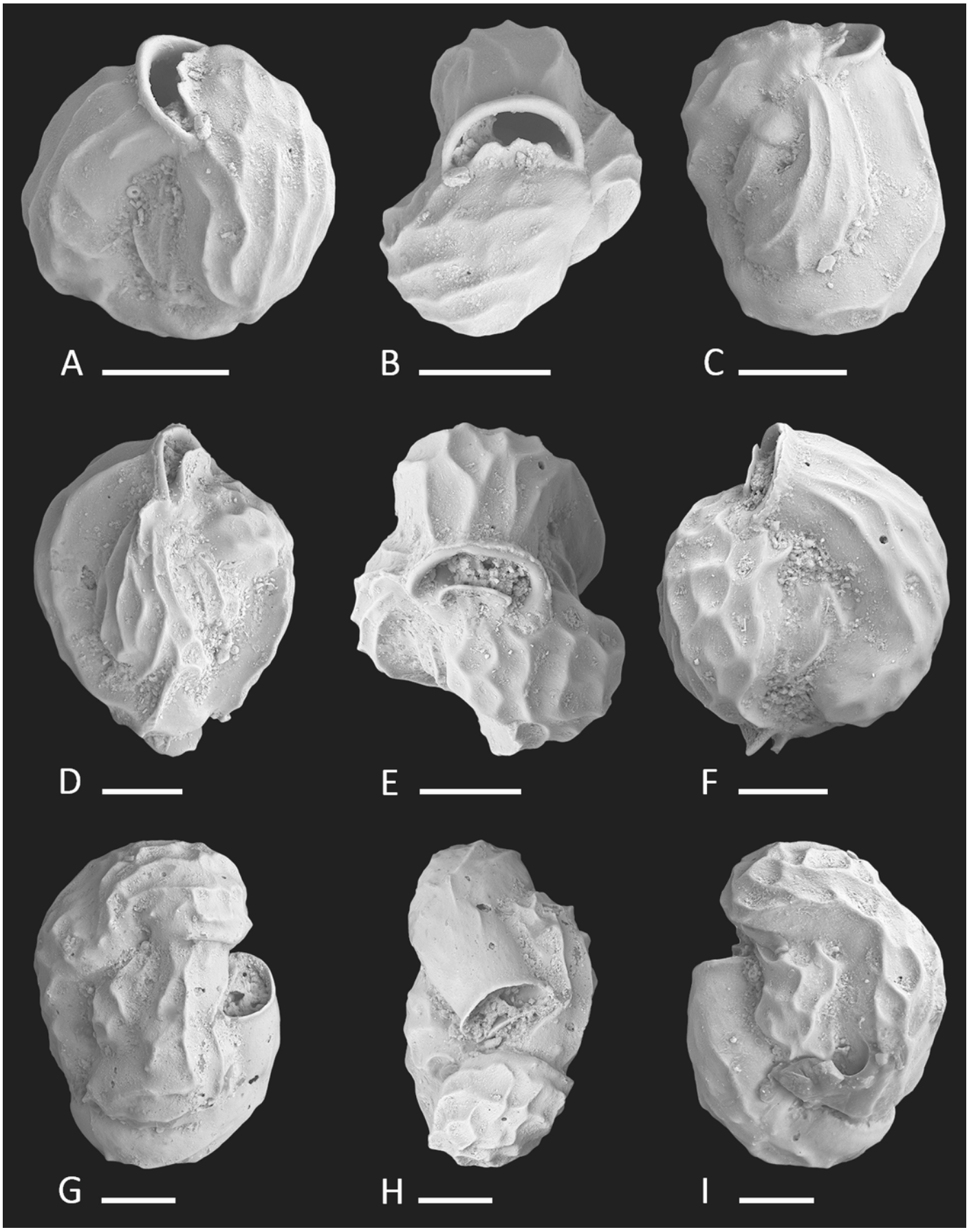


4

Holotype and paratypes of *Miliolinella undina* n. sp.

(A-C) Holotype, a juvenile specimen: (A) oblique apertural view; (B) top view; (C) side view; (D-F) an adult specimen with a broken chamber: (D) side view; (E) top view; (F) side view; (G - I) an adult specimen with an erratic growth state in the final chambers: (G) side view; (H) top view; (I) side view. Scale bar is 50µm.

**Note: Auto Gamma Correction was used for the image. This only affects the reviewing manuscript. See original source image if needed for review.*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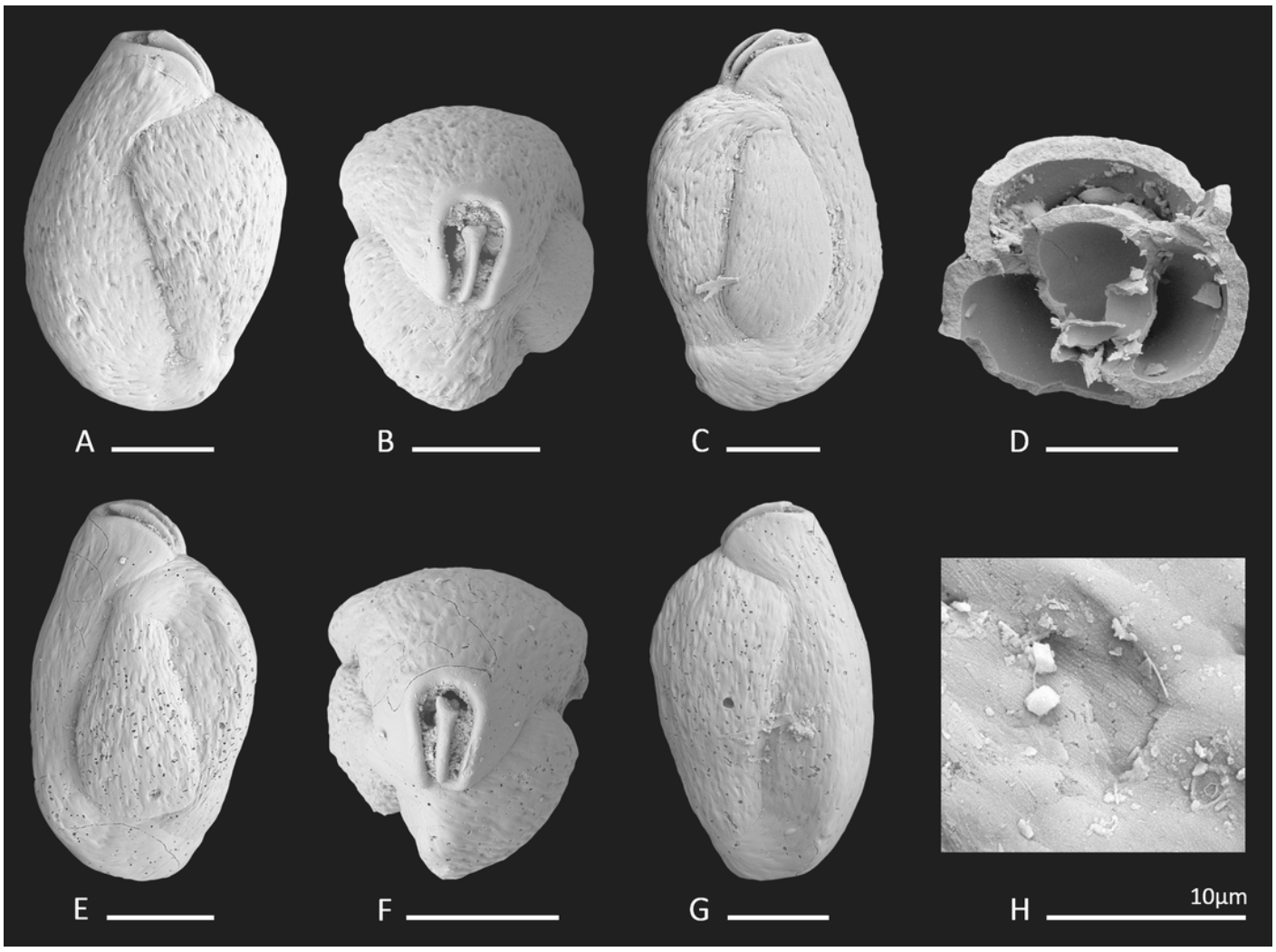
5

Holotype, paratype, cross section and detail of *Triloculina kaweensis* n. sp.

(A-C) Holotype: (A) side view, (B) top view, (C) side view; (D) cross section of a specimen showing the triloculine chamber arrangement; (E-G) Paratype: (E) side view, (F) top view, (G) side view; (H) detail of the irregular test surface. Scale bar is 100µm (unless indicated).

**Note: Auto Gamma Correction was used for the image. This only affects the reviewing manuscript. See original source image if needed for review.*

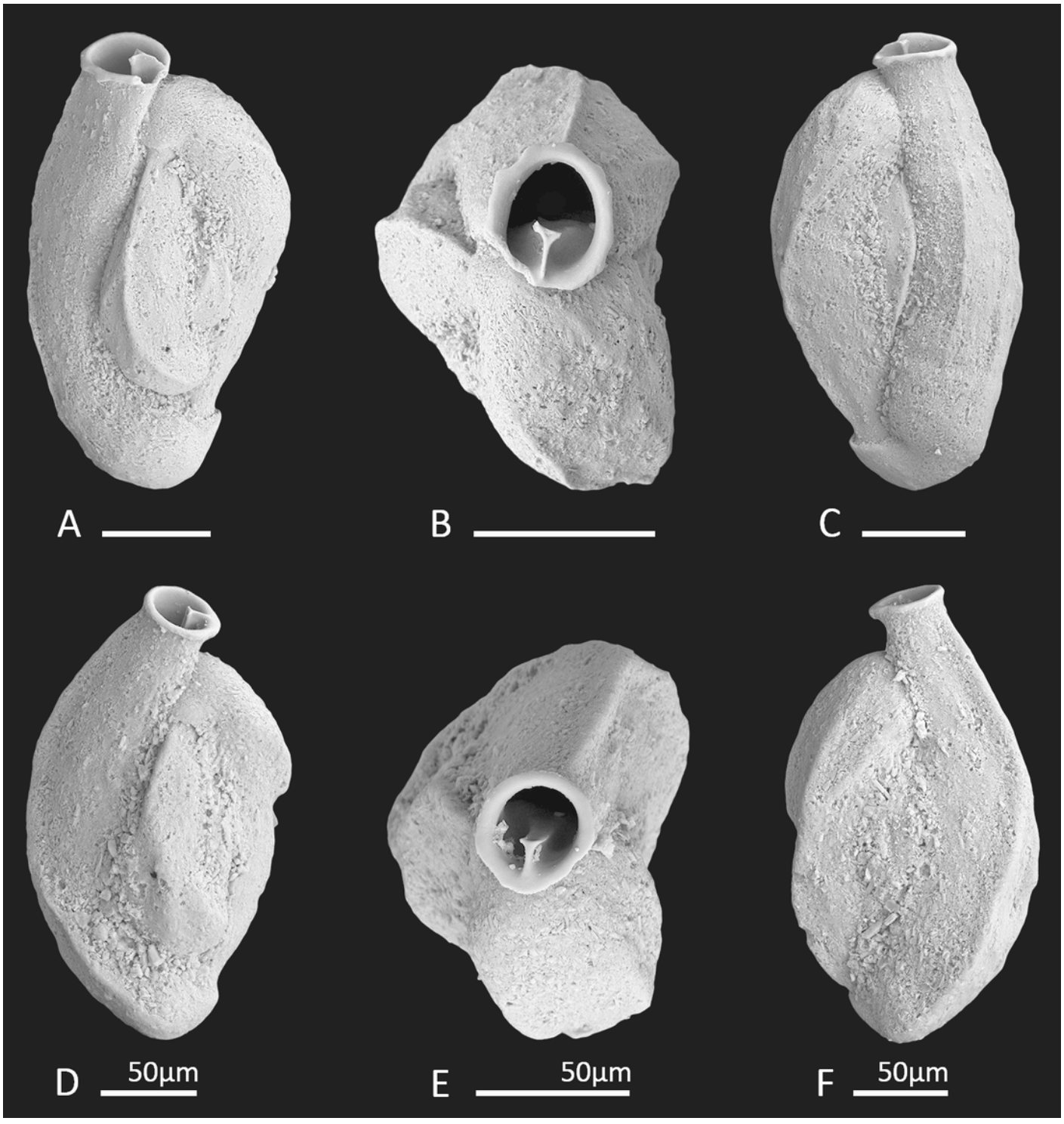


6

Holotype and paratype of *Siphonaperta hallocki* n. sp.

(A-C) Holotype: (A) side view, (B) apertural view, (C) side view; (D-F) paratype, a juvenile specimen: (D) side view; (E) apertural view; (F) side view. Scale bar is 100µm (unless indicated).

**Note: Auto Gamma Correction was used for the image. This only affects the reviewing manuscript. See original source image if needed for review.*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C
D
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E
50µm
F
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Table 1(on next page)

Collection sites

Sample site information for collection locations from Raja Ampat (Indonesia) including environmental information on reefal habitat type.

Station	Depth (m)	Latitude	Longitude	Reef- or eco-type	Reef-zone
B14	41	0° 5'22.40"N	130°13'35.29"E	Fringing reef	Fore-reef slope
B15	43	0° 5'22.40"N	130°13'35.29"E	Fringing reef	Fore-reef slope
E23	24	0°16'25.87"S	130°18'59.19"E	Fringing reef	Fore-reef slope
FW	49	0°35'19.86"S	130°17'45.54"E	Fringing reef	Fore-reef slope
M21	27	0°29'50.40"S	130°43'37.62"E	Patch reef	Fore-reef slope
MG	18	0°35'23.40"S	130°18'54.54"E	Patch reef	Platform
MI05	32	0°16'25.87"S	130°18'59.19"E	Fringing reef	Fore-reef slope
MI06	32	0°16'25.87"S	130°18'59.19"E	Fringing reef	Fore-reef slope
MR17	12	0° 5'47.58"S	130°14'9.66"E	Fringing reef	Fore-reef slope
MR18	18	0° 5'47.58"S	130°14'9.66"E	Fringing reef	Fore-reef slope
MS03	16	0°34'47.88"S	130°32'32.04"E	Sand channel, sparse coral cover	Channel
MS04	14	0°34'47.88"S	130°32'32.04"E	Sand channel, sparse coral cover	Channel
N18	30	0°10'22.74"N	130° 0'22.38"E	Fringing reef	Fore-reef slope
U16	45	0° 5'49.13"N	130°13'59.08"E	Fringing reef	Fore-reef slope
W07	24	0°15'21.72"S	130°17'32.16"E	Fringing reef	Fore-reef slope
Y24	26	0°47'8.64"S	130°45'25.62"E	Fringing reef	Fore-reef slope
Y25	26	0°47'8.64"S	130°45'25.62"E	Fringing reef	Fore-reef slope

1