



**A new pseudolepidinid foraminifer,
Hanovolepidina browni gen. nov. sp. nov.,
from the middle Eocene (mid-Lutetian) of Jamaica
and its significance**

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Abstract: The new larger benthic foraminifer, *Hanovolepidina browni* gen. nov. sp. nov., is described from the Chapelton Formation (mid-Lutetian, middle Eocene, ABZ7) of Jamaica. The genus shows the characteristic transition from a single to double equatorial layer about mid-way across the radius as seen in axial sections that characterises the family Pseudolepidinidae. Equatorial sections show the embryo followed by 4 or 5 spiral rotaliid chambers with the last chamber giving rise to a primary spiral and secondary (counter-) spiral of equatorial chambers. The presence of a long rotaliid stage suggests a more primitive form than *Pseudolepidina*, and *Hanovolepidina* gen. nov. differs also from the latter in lacking the extra principal accessory chamber seen in axial section. *Hanovolepidina* gen. nov. is provisionally suggested as an ancestor of the late Eocene *Triplalepidina*. The new discovery demonstrates a greater diversity of the family Pseudolepidinidae in the Caribbean than previously recorded, although occurrences of this family are very restricted stratigraphically suggesting that it may appear in the region due to migration events.

Keywords:

- Pseudolepidinidae;
- Larger Benthic Foraminifera;
- Lutetian (Middle Eocene);
- Yellow Limestone Group;
- Jamaica

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Résumé : Un foraminifère pseudolepidinidé nouveau, *Hanovolepidina browni* gen. nov. sp. nov., de l'Éocène moyen (Lutétien moyen) de Jamaïque et sa signification.- Un nouveau grand foraminifère benthique, *Hanovolepidina browni* gen. nov. sp. nov., est décrit dans la Formation Chapelton (Lutétien moyen, Éocène moyen, ABZ7) de Jamaïque. Le genre présente la transition caractéristique d'une couche équatoriale simple à double à mi-distance environ du rayon observable en sections axiales, un critère qui définit la famille Pseudolepidinidae. Les sections équatoriales montrent un embryon suivi de 4 ou 5 chambres spirales rotaliides avec la dernière chambre donnant naissance à une spirale primaire et une (contre-) spirale secondaire de chambres équatoriales. La présence d'une longue phase rotaliide suggère une forme plus primitive que *Pseudolepidina*, tandis que *Hanovolepidina* gen. nov. diffère également de ce dernier par l'absence de chambre accessoire principale supplémentaire visible en section axiale. *Hanovolepidina* gen. nov. est considéré provisoirement comme un ancêtre du genre fini-éocène *Triplalepidina*. Bien que les occurrences de la famille Pseudolepidinidae soient très restreintes stratigraphiquement, cette nouvelle découverte dans les Caraïbes illustre une diversité plus grande que celle précédemment enregistrée, suggérant ainsi qu'elle a pu apparaître dans la région à la faveur d'événements migratoires.

Mots-clefs :

- Pseudolepidinidae ;
- Grand Foraminifère Benthique ;
- Lutétien (Éocène moyen) ;
- Groupe du Calcaire jaune ;
- Jamaïque

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1. Introduction

The Eocene foraminiferid family Pseudolepidinidae MITCHELL, E. ROBINSON & ÖZCAN *in* MITCHELL *et al.*, 2022, contains two previously described genera, *Pseudolepidina* BARKER & GRIMSDALE, 1937, and *Triplalepidina* VAUGHAN & COLE, 1938. The family is restricted to the Americas, where there are only sporadic occurrences (BARKER & GRIMSDALE, 1937; VAUGHAN & COLE, 1938; ADAMS, 1987; MITCHELL *et al.*, 2022). The family contains orbitoidiform foraminifers that are distinguished by the development of a double row of equatorial chamberlets in conjunction with well-developed tiers of lateral chamberlets. In the previously earliest known form *Pseudolepidina*, from the mid-Lutetian, two Principal Accessory Chambers (PACs) are already developed (together with a possible third PAC that is seen in axial section). PACs only develop within the two subfamilies (Orbitoininae MITCHELL, E. ROBINSON & ÖZCAN *in* MITCHELL *et al.*, 2022, and Lepidocyclininae SCHEFFEN, 1932) of the Lepidocyclinidae SCHEFFEN, 1932, in the late Lutetian (MITCHELL *et al.*, 2022), implying that the Pseudolepidinidae are a separate radiation. In this paper the new genus *Hanovolepidina* is described from the middle Eocene of central and western Jamaica and its significance for understanding the evolution of Pseudolepidinidae is discussed.

2. Stratigraphy

Eocene rocks are widely distributed across Jamaica where they form parts of the Wag Water and Richmond formations and the Yellow Limestone and White Limestone groups (ZANS *et al.*, 1963; ROBINSON, 1994; ROBINSON & MITCHELL, 1999; MITCHELL, 2004, 2013a, 2013b, 2016, 2021; MITCHELL *et al.*, 2022). The material described herein comes from two localities: the Yellow Limestone below Swanswick House, parish of Trelawny, and the Chapelton Formation, south of the Cretaceous Green Island Inlier, in the parish of Hanover (Fig. 1).

A single specimen of *Hanovolepidina browni* sp. nov., previously figured as *Pseudolepidina trimera* BARKER & GRIMSDALE by MITCHELL *et al.* (2022, Fig. 54.6), was collected from the roadway to Swanswick House (Fig. 2). The specimen came from sample WL3275A (GPS coordinates: 18°24'58.9"N 77°31'54.9"W) which was collected from a soil sample weathering out of a yellow-brown limestone in the lower part of the roadway (Fig. 2). MITCHELL *et al.* (2022) showed that this was a limestone level developed within the Preston Hill Formation (Yellow Limestone Group). In this locality *Hanovolepidina* gen. nov. is associated with a foraminiferal assemblage including: *Operculinoides jennyi* BARKER, *Nummulites guayabalensis* BARKER, *Helicostegina gyralis* BARKER & GRIMSDALE, *Pseudolepidina trimera*, *Linderina floridana* COLE and *Caudriella* sp., and can be assigned to ABZ7 (mid-Lutetian) (MITCHELL *et al.*, 2022; ÖZCAN *et al.*, 2022).

Infrequent specimens of *Hanovolepidina browni* sp. nov. are also found in the Chapelton Formation (sample WL4538; GPS coordinates: 18°22'17.5"N 78°16'59.3"W) on a trail NW from the road between Winchester and Phoenix Town, on the edge of the Green Island Cretaceous Inlier in the parish of Hanover (Fig. 3). Although abundant foraminifers occur at this locality, the only other species occurring with *Hanovolepidina browni* MITCHELL sp. nov. are abundant specimens of *O. jennyi* (Fig. 4.1) that represent more than 99% of the fauna, and a single specimen of *Planorbotoinella ecuadorensis* HOFKER (Fig. 4.2). This sample is also assigned to ABZ7 largely due to the presence of *Operculinoides jennyi* and *P. ecuadorensis* (MITCHELL *et al.*, 2022). Further south in the Chapelton Formation north of Phoenix Town, specimens of *Yaberinella* cf. *hottingeri* ROBINSON are common suggesting ABZ9-10 (late Lutetian). No calcareous nannofossil data is available for these samples.

3. Systematic palaeontology

Bulk samples of rock were collected in the field. The samples were disaggregated by washing in water through a 0.5 mm sieve. Larger Benthic Foraminifers (LBF) were then picked from the residues and stored in glass tubes. Specimens were sorted into morphotypes and thin sections were prepared to show orientated (equatorial and axial) sections that show taxonomically significant features. Thin sections were prepared by grinding using 600-grade carborundum grit on a glass plate, with specimens secured to a glass slide using thermoplastic cement to allow specimens to be orientated, and re-orientated after heating, during sample preparation. The resulting sections were numbered with the sample number and a specimen number (e.g., WL4538-6); specimens are stored in the collections of the University of the West Indies Geological Museum (UWIGM), the national repository for geological samples in Jamaica. Specimens were photographed using a Hayear 4K HDMI Microscope Camera (for 3D specimens) and an AmScope T490B-10MA Digital Compound Trinocular Microscope (for thin sections).

The classification for the larger benthic foraminifers described here follows LOEBLICH & TAPPAN (1988) as amended by MITCHELL *et al.* (2022). For details of taxonomic terms see HOTTINGER (2006) and MITCHELL *et al.* (2022). Material is preserved in the University of the West Indies Geology Museum (the Jamaican repository of geological specimens).



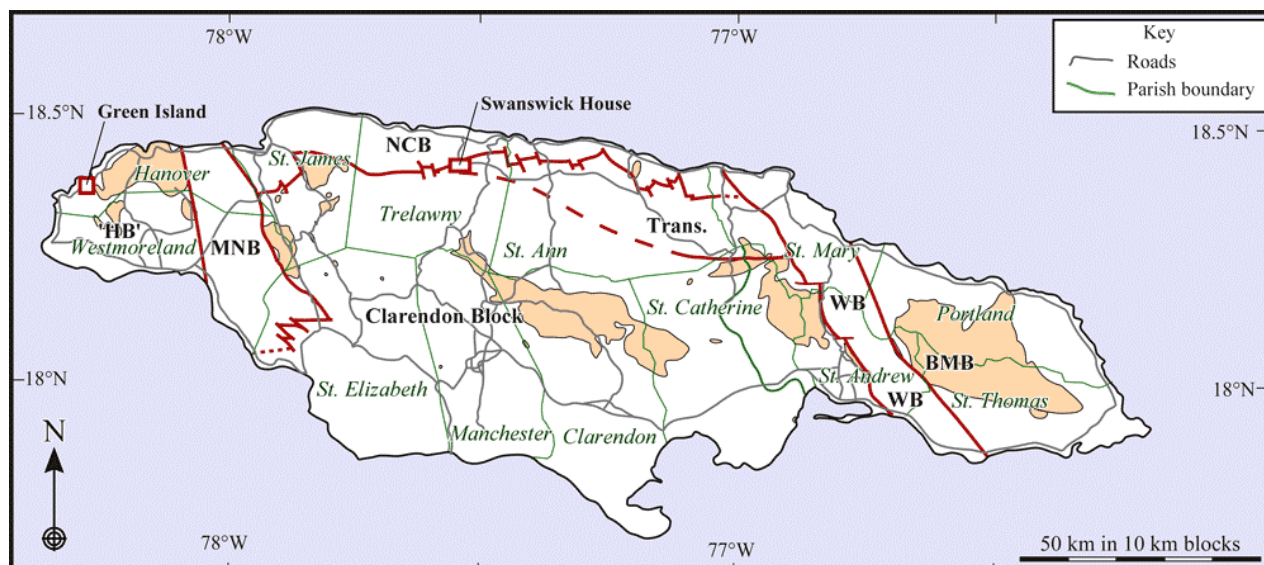


Figure 1: Geographical map of Jamaica showing parishes, Cretaceous inliers (pale orange), main Cenozoic blocks (HB, Hanover, BMB, Blue Mountains) and belts (MNB, Montpelier - New Market, NCB, North Coast, WB, Wag Water) and location of maps where *Hanovolepidina* gen. nov. has been collected.

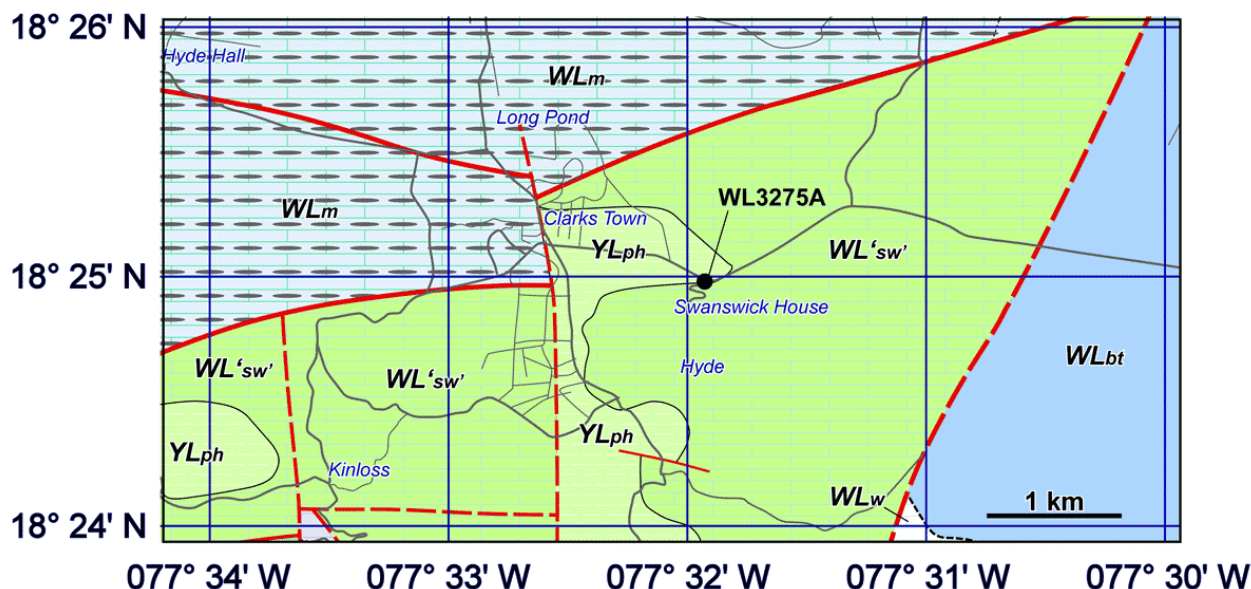


Figure 2: Geology of the area around Swanswick House (based on unpublished map by SFM) in Trelawny, Jamaica, showing location of sample WL3275A from which a specimen of *Hanovolepidina browni* sp. nov. has been collected. YLph, Preston Hill Formation (marlstones); WLm, Montpelier Formation (deep water chalks); WL'sw', Swanswick Formation *sensu stricto*; WLw, Walderston Formation; WLbt, Browns Town Formation. Alluvium omitted for clarity.

Superfamily Asterigerinoidea ORBIGNY, 1839

Family Pseudolepidinidae MITCHELL,

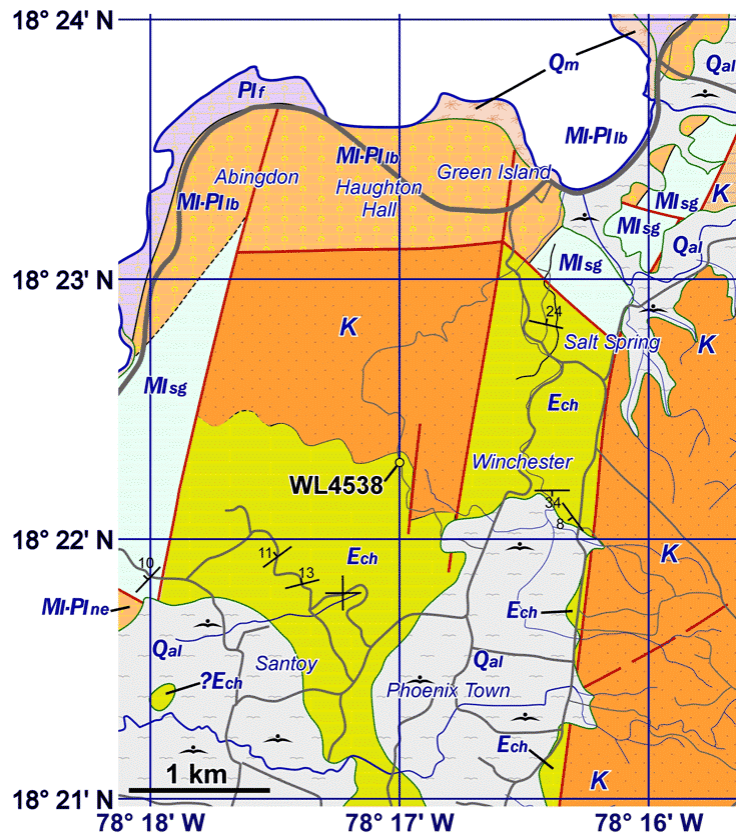
E. ROBINSON & ÖZCAN *in* MITCHELL *et al.*, 2022

Genus *Hanovolepidina* gen. nov.

Type species. *Hanovolepidina browni* sp. nov. from the Chapelton Formation (Lutetian) south of the Cretaceous Green Island Inlier, parish of Hanover, Jamaica.

Diagnosis. Test lenticular, with scattered piles (pustules) on the surface. Equatorial sections of megalospheric specimens show a bilocular embryo with a short spire (4 to 5 chambers, excluding the embryonic chambers),

with the last chamber (R) having a retrovert aperture. A spiral and counter spiral of chambers develop from the R-chamber and terminate in a closing chamber. Equatorial chamberlets are developed from the spiral and counter spiral that develop from the R-chamber. Axial sections show that the equatorial layer is initially composed of a single layer of chamberlets, but at a short distance from the embryo it develops into a double layer of equatorial chamberlets that extends to the margin of the test. Axial sections show that most specimens have only a few lateral chambers, but one specimen has much better developed lateral chambers in multiple tiers.



◀ **Figure 3:** Geology (based on unpublished map by SFM) of the area around Green Island in the parish of Hanover, Jamaica, showing the location of sample WL4538 in the Chapelton Formation that has yielded *Hanovolepidina browni* sp. nov. **K**, Cretaceous rocks in Green Island and Lucea inliers; **Ech**, Chapelton Formation (Yellow Limestone Group); **Mi sg**, Spring Garden Formation of the White Limestone Group; **MI-PI**, various units in the Miocene-Pleistocene Coastal Group; **Mif**, Falmouth Formation; **Qal**, alluvium; **Qm**, mangroves.

Microspheric specimens are only marginally larger than megalospheric specimens and, in general, it is not possible to separate them unless they are sectioned. The single equatorial section of a microspheric specimen has a very small proloculus (which is not clearly visible) succeeded by about $2\frac{1}{2}$ whorls of rotaliid chambers), after which orbitoidal equatorial chamberlets are produced. A single axial section shows a largely lamellar wall structure containing scattered, vacuole-like lateral chamberlets, similar to most of the axial sections of megalospheric specimens.

Origin of name. From the parish of Hanover, Jamaica, where the largest population of specimens has been collected. Gender feminine. This represents the type locality.

Discussion. In equatorial section, *Hanovolepidina* resembles many early members of the Lepidocyclinidae and the Pseudolepidinidae. It is distinguished from all early lepidocyclinids (e.g., *Eulinderina* BARKER & GRIMSDALE, *Eolepidina* TAN and *Planorbitoinella* MITCHELL) in possessing a double equatorial layer that begins about half way through the test in axial section. *Hanovolepidina* gen. nov. is distinguished from *Pseudolepidina* by its possession of a short spire of chambers following the embryonic chambers; in contrast *Pseudolepidina* has two PACs, together with the additional 'PAC' which is seen in axial sections. This additional 'PAC' is absent in *Hanovolepidina* gen. nov. *Triplalepidina* differs in possessing two PACs and a bilaterally symmetrical embryo, as well as having a compact layer of shell material

between the two equatorial layers of chamberlets. COLE (1963) followed GRIMSDALE (1959) in synonymising *Triplalepidina* with *Lepidocyclina*, and *T. veracruziana* VAUGHAN & COLE with *L. pustulosa* DOUVILLÉ. COLE (1963) used the stolon structure visible in the equatorial layers of *L. ocalana* (CUSHMAN) and *L. gubernacula* COLE to justify this. *L. ocalana* has multiple stolons (two or three are indicated) between equatorial chamberlets in axial sections, whereas *L. gubernacula* shows as many as four to six stolons, and in axial sections the equatorial layer flares towards the test margin and develops several to multiple layers of equatorial chamberlets close to the margin of the test. Thus COLE (1963) considered that *Triplalepidina* was a junior synonym of *Lepidocyclina*. However, *Triplalepidina*, *Hanovolepidina* gen. nov. and *Pseudolepidina* all develop a double layer of equatorial chamberlets in the middle of the test, whereas in *L. gubernacula* multiple equatorial chamberlets develop only close to the test margin and no extended interval showing a double layer of equatorial chamberlets is present. The arrangement of equatorial chamberlets seen in *L. gubernacula* could be generated by the multiple stolons seen in *L. ocalana* giving rise to additional layers of equatorial chamberlets towards the test margin. However, there is clearly no phylogenetic connection between *Pseudolepidina* and *Hanovolepidina* gen. nov. (both are mid-Lutetian) and *L. ocalana* and *L. gubernacula* (Bartonian-Priabonian and Priabonian, respectively) and these two groups form separate radiations that are best placed in separate families (MITCHELL *et al.*, 2022).

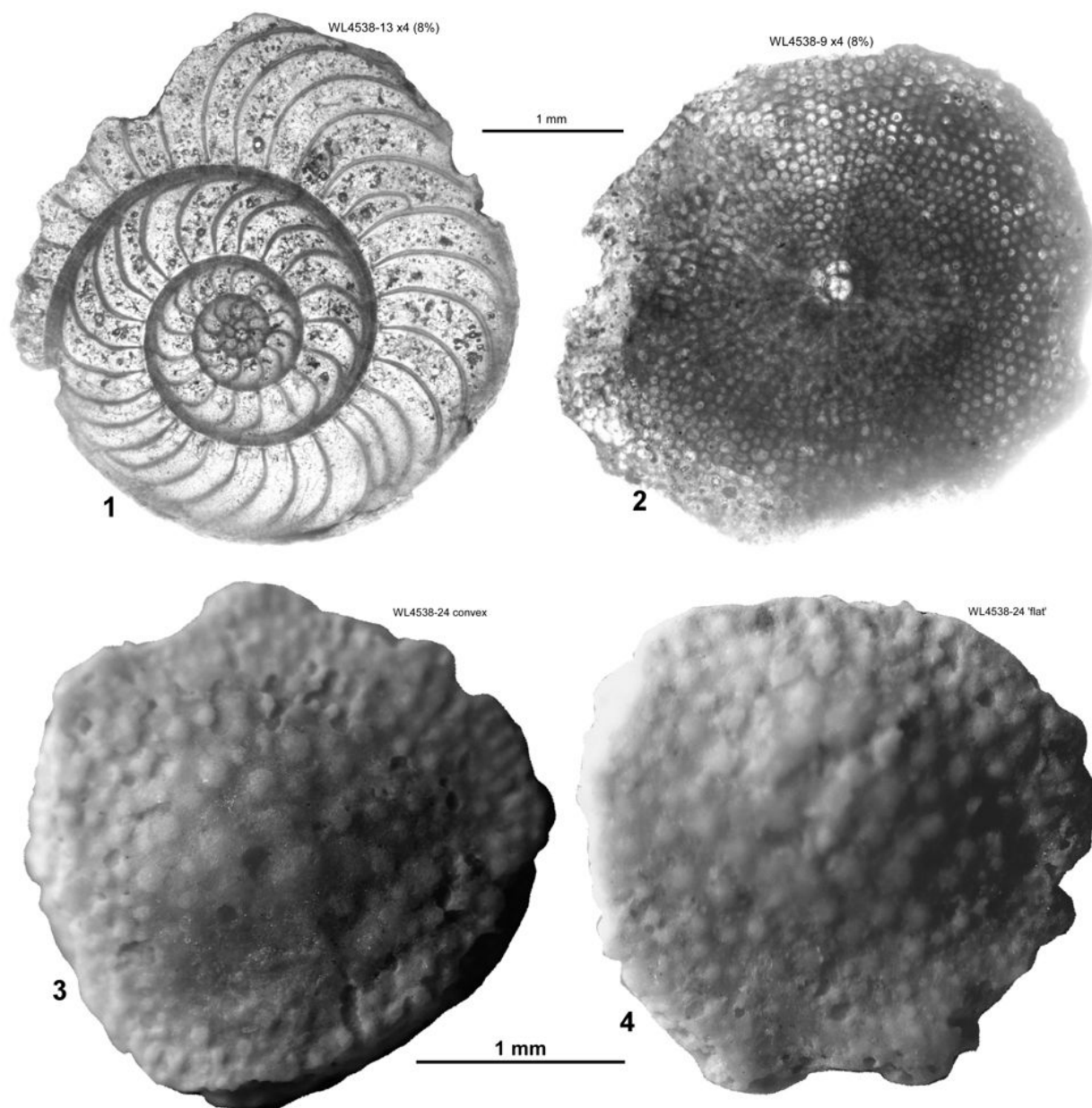


Figure 4: Foraminifers from sample WL4538, Chapelton Formation, south of the Green Island Inlier, parish of Hanover, Jamaica. **1** (UWIGM.WL4538-13), *Operculinoides jennyi* BARKER. **2** (UWIGM.WL4538-9), *Planorbitoinella ecuadorensis* (HOFKER). **3-4** (UWIGM.WL4538-24), *Hanovolepidina browni* sp. nov., holotype, external views: **3**, view of pustules on 'convex' side, **4**, view of pustules on 'flat' side. This assemblage (*O. jennyi* and *P. ecuadorensis*) indicates ABZ7 (mid-Lutetian: MITCHELL *et al.*, 2022).

The morphology of *Triplalepidina* mirrors that of *Hanovolepidina* gen. nov. other than having an isolepidine embryo and it seems best to derive *Triplalepidina* from *Hanovolepidina* since both forms lack the additional 'PAC' seen in *Pseudolepidina*.

***Hanovolepidina browni* MITCHELL sp. nov.**

(Figs. 4.3-4, 5.1-6, 6.1-6, 7.1-4, 8.1-2, 9.1-3)

2022 *Pseudolepidina trimera* BARKER & GRIMSDALE; MITCHELL *et al.*, p. 478-484, Fig. 54.6 only.

Type material. Twenty specimens: holotype (UWIGM.WL.4538-24) and paratypes (UWIGM.WL 4538-5, UWIGM.WL4538-6, UWIGM.WL4538-7,

UWIGM.WL4538-8, UWIGM.WL4538-10, UWIGM.WL4538-11); all from the Chapelton Formation (sample WL4538; GPS coordinates: 18°22'17.5"N 78°16'59.3"W), south of the Cretaceous Green Island Inlier, parish of Hanover, Jamaica.

Origin of name. After Charles Barrington BROWN who produced the first map of the parish of Hanover in 1867 (SAWKINS, 1869).

Diagnosis. As for the genus.



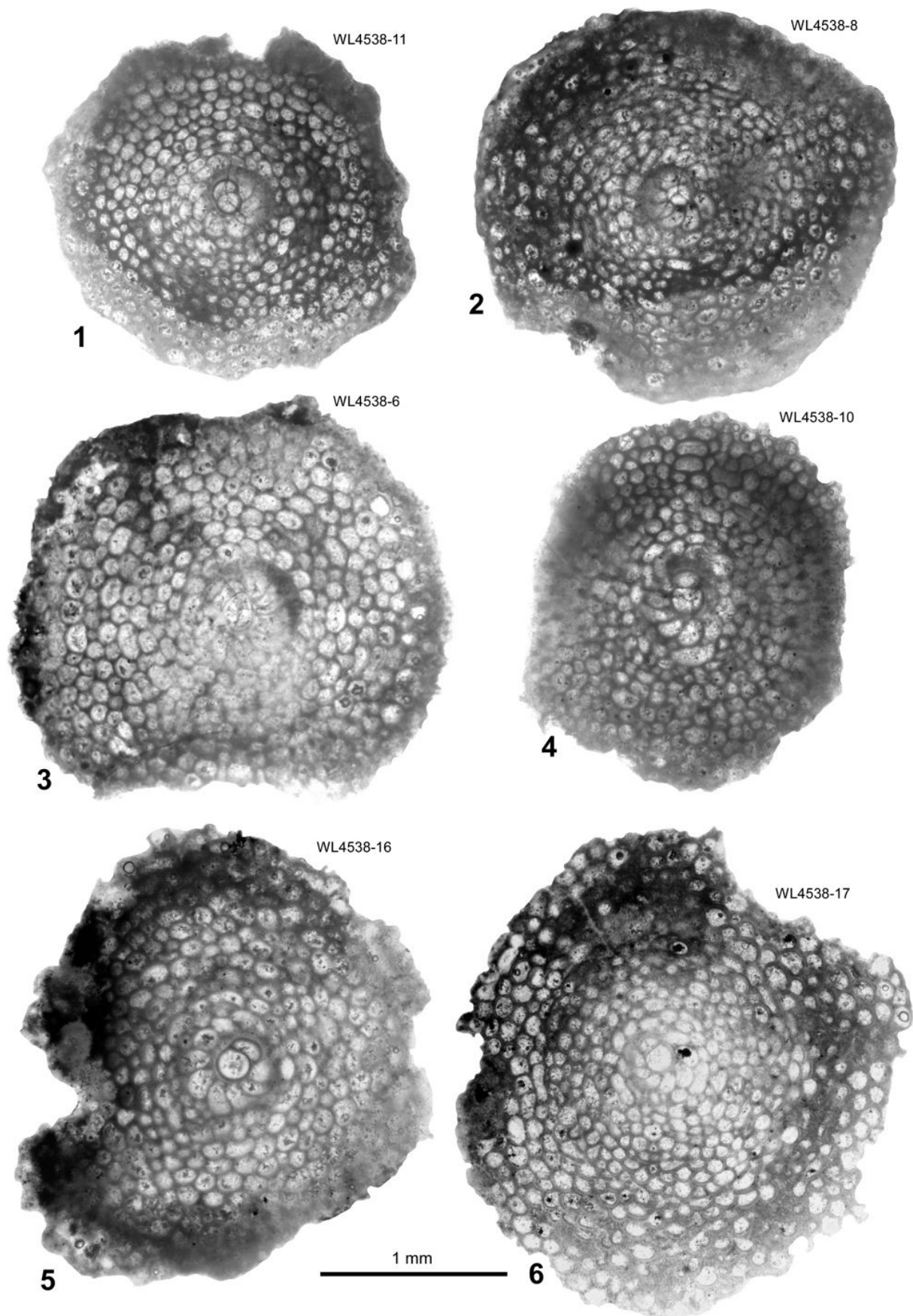


Figure 5: *Hanovolepidina browni* sp. nov., megalospheric specimens in equatorial section, from the Chapelton Formation (ABZ7, mid-Lutetian), south of the Green Island Inlier, parish of Hanover, Jamaica: **1** (UWIGM.WL4538-11, paratype); **2** (UWIGM.WL4538-8, paratype); **3** (UWIGM.WL4538-6, paratype); **4** (UWIGM.WL4538-10, paratype); **5** (UWIGM.WL4538-16, paratype); **6** (UWIGM.WL4538-17, paratype).

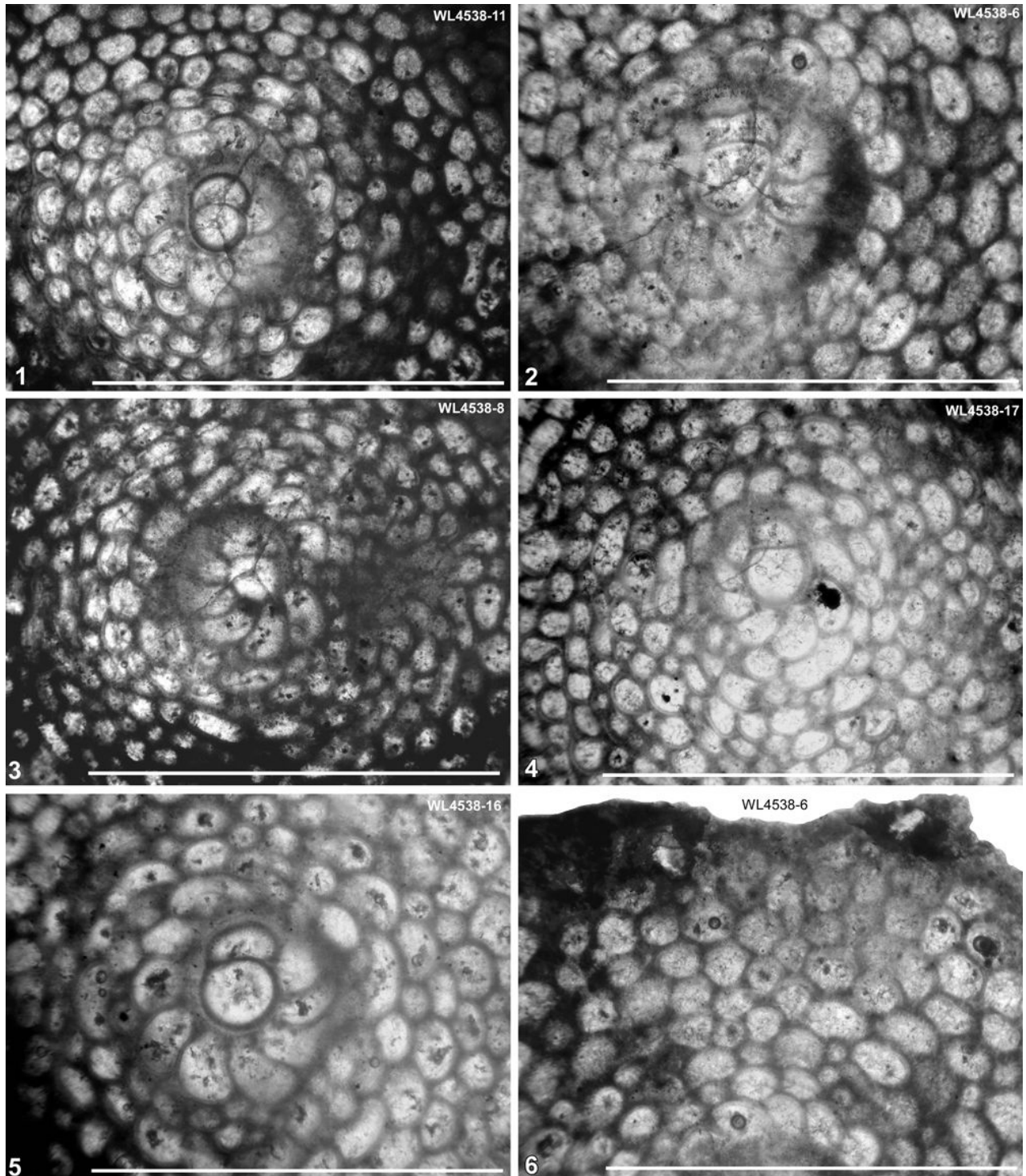


Figure 6: *Hanovolepidina browni* sp. nov. from the Chapelton Formation (ABZ7, mid-Lutetian), south of the Green Island Inlier, parish of Hanover, Jamaica. **1-5:** details of embryo and rotilid spire in equatorial sections: **1** (UWIGM.WL4538-11, paratype); **2** (UWIGM.WL4538-6, paratype); **3** (UWIGM.WL4538-8, paratype); **4** (UWIGM.WL4538-17, paratype); **5** (UWIGM.WL4538-16, paratype). **6**, detail of equatorial chamberlets in equatorial section (UWIGM.WL4538-6, paratype).

Description. Both megalospheric and microspheric specimens occur, but only two microspheric specimens have been identified by sectioning. Megalospheric and microspheric specimens look similar in external view, are of relatively similar diameters, and can only be distinguished when sectioned.

Megalospheric specimens (Figs. 4.3-4, 5.1-6, 6.1-6, 7.1-4, 8.1-2) are the same size or slightly smaller than microspheric specimens with test diameters of up to 2 mm and thicknesses of up to 1.1 mm. Orientated equatorial sections show an embryo with a broadly spherical proloculus and a hemispherical deuteroeculus. The proloculus has

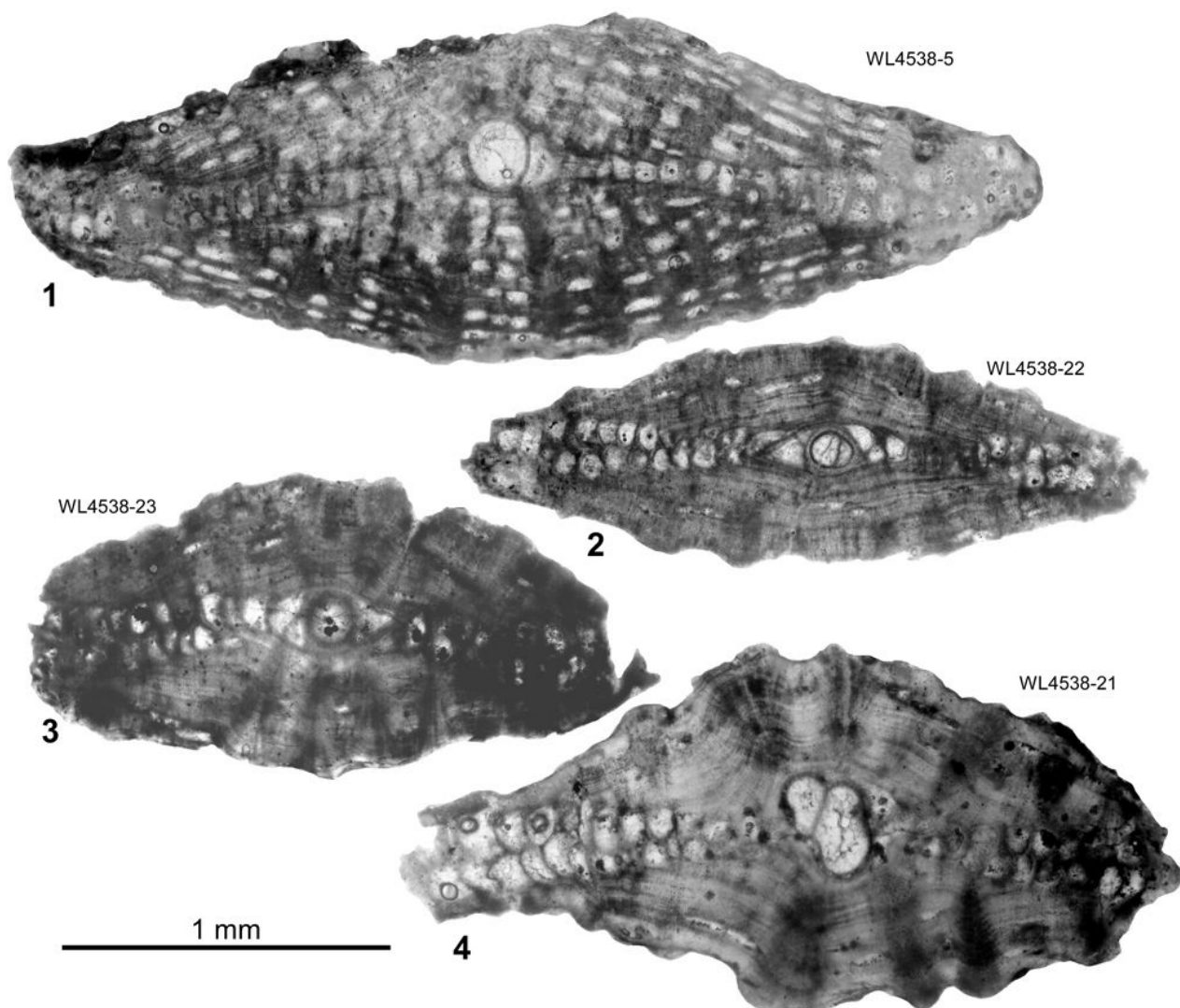


Figure 7: Axial sections of megalospheric specimens of *Hanovolepidina browni* sp. nov. **1** (UWIGM.WL4538-5), showing large numbers of lateral chamberlets. **2** (UWIGM.WL4538-22), **3** (UWIGM.WL4538-23) and **4** (UWIGM.WL4538-21) showing few vacuole-like lateral chamberlets. All from the Chapelton Formation (ABZ7, mid-Lutetian), south of the Green Island Inlier, parish of Hanover, Jamaica.

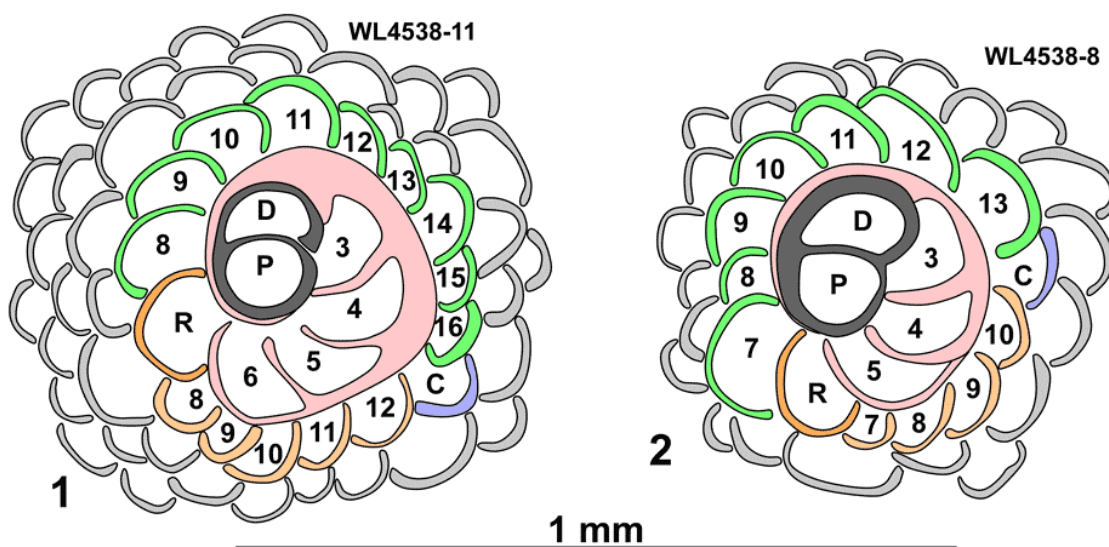


Figure 8: *Hanovolepidina browni* sp. nov. from the Chapelton Formation (ABZ7, mid-Lutetian), south of the Green Island Inlier, parish of Hanover, Jamaica. Drawings showing the development of the equatorial chamberlets. **1** (UWIGM.WL.4538-11, paratype). **2** (UWIGM.WL.4538-8, paratype). P, proloculus; D, deuterochamber; R, first chamber with a retrovert aperture giving rise to a spiral and counter-spiral; C, closing chamber.

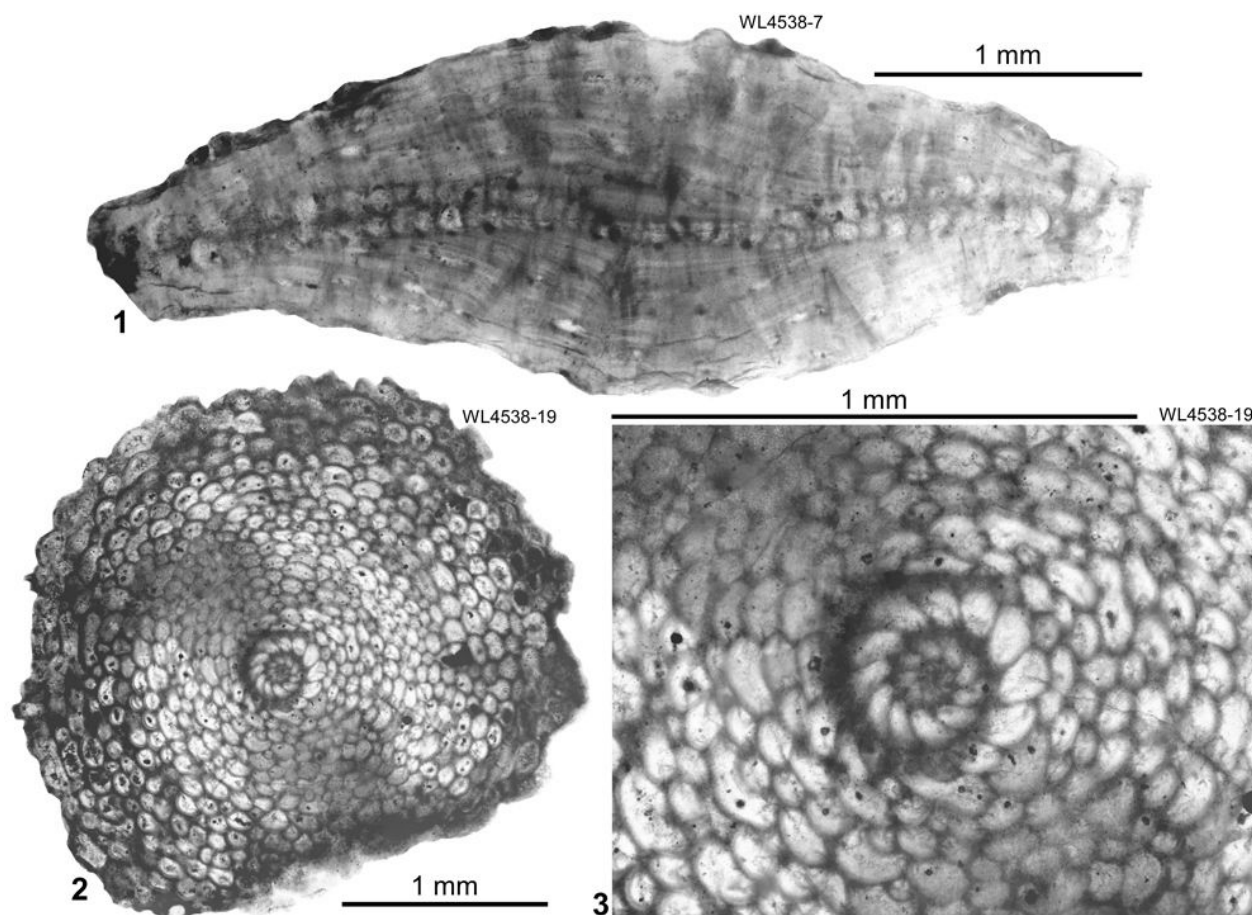


Figure 9: Microspheric specimens of *Hanovolepidina browni* sp. nov. from the Chapelton Formation (ABZ7, mid-Lutetian), south of the Green Island Inlier, parish of Hanover, Jamaica. **1** (UWIGM.WL4538-7), axial section (nearly central). **2-3** (UWIGM.WL4538-19), equatorial section.

a length of 88-185 μm and a width of 95-177 μm (excluding the walls). The deuterochamber has a length of 49-144 μm and a width of 68-162 μm (excluding the walls). The overall length of the embryo is 166-305 μm (including the walls). Measurements of individual specimens are given in Table 1. The embryo is followed by 4 to 5 chambers, with the last chamber having a retrovert aperture and giving rise to a second spire (Figs. 6.1-3, 7.1-2, 8.1-2). The initial spire has a rostrid-like appearance with arcuate septa, two spires of more semi-circular equatorial chambers develop from R. A thickened wall may or may not be present in the primary spire up to R. The two spires of equatorial chambers that develop from the R chamber coil around the earlier chambers and end in a closing chamber. Arcuate equatorial chamberlets develop from the primary and secondary spires giving rise to orbitoidiform growth. Equatorial chamberlets are generally arranged in short radial rows. Axial sections of megalospheric forms show that the embryo is succeeded by a single row of equatorial chambers/chamberlets (chambers and chamberlets are difficult to distinguish in axial sections). At a distance of about half way towards the margin of the test the equatorial layer becomes double, and continues as a double layer until the margin of the test. Well-developed piles are seen in axial sections. The piles

are inwardly conical and rounded on the test surface with diameters of up to a maximum of 85 μm . The development of lateral chamberlets is variable. Most axial sections show a relatively compact laminar test with irregularly developed lateral chamberlets (Fig. 7.2-4). One axial section (Fig. 7.1) shows up to eight tiers of lateral chamberlets over the centre of the test; the chamberlets are equal to or thinner than their walls and floors; semi-regular tiers of lateral chamberlets are developed in some areas, whereas in others they are more irregular.

Microspheric specimens (Fig. 9) are lenticular with a diameter of up to 4 mm and a thickness of up to 1.2 mm and carry an ornament consisting of piles similar to megalospheric specimens. A single equatorial section (Fig. 9.2-3) shows that the proloculus was small (although it cannot be definitively seen) and was succeeded by about 2½ whorls of rostrid chambers. Subsequently orbitoid growth develops. The axial section (Fig. 9.1) shows that the equatorial layer begins initially as a single layer that becomes double in the outer three-quarters of the radius of the test. The lateral areas of the test are largely composed of thick-walled, compact, laminar test material, with irregularly scattered narrow lenticular, widely-spaced lateral chamberlets.



Table 1: Measurements of embryonic chambers (μm) and R values for specimens of *Hanovolepidina browni* sp. nov. from Jamaica. Proloculus lengths (Pli) and widths (Pwi) and deuterolocus lengths (Dli) and widths (dwi) exclude walls, whereas embryo length (Ele) includes the walls (see MITCHELL, 2022, for details). R chamber includes the two chambers in the embryo.

Number	Pli	Pwi	Dli	Dwi	Ele	R
WL4538-6	185	176	72	191	305	7
WL4538-8	119	139	72	140	252	6
WL4538-10	155	177	89	155	287	7
WL4538-11	109	127	69	132	211	7
WL4538-4	126	127	79	128	255	?
WL4538-16	167	173	75	162	300	7
WL4538-20	116	141	144	135	300	6
WL4538-17	155	177	89	155	287	7
WL4538-18	88	92	49	68	166	?
Mean	136	148	82	141	263	
Stand. Dev.	31.4	30.1	26.1	34.4	47.4	
WL3275A-18	187	213	117	189	385	4?

Discussion. The development of lateral chamberlets is variable in axial sections of macro-spheric specimens of *H. browni* sp. nov., with most having relatively few chamberlets and others having larger numbers of chamberlets. The specimen with a large number of lateral chamberlets resembles the lateral chamberlets developed in *Pseudolepidina trimera* (MITCHELL *et al.*, 2022, Fig. 51.1, .3-8), but differs in lacking an additional PCA. The single axial section of a microspheric specimen of *Pseudolepidina trimera* figured by MITCHELL *et al.* (2022, Fig. 51.2) also shows relatively few lateral chamberlets; it may be that microspheric specimens of *Hanovolepidina* gen. nov. and *Pseudolepidina* are not possible to separate.

The measurements for the sizes of embryonic chambers and the embryo show a relatively wide degree of variation (Table 1). This is largely due to the presence of UWIGM.WL4538.18 which has unusually small chambers (the thin-section is poor and cannot be figured). If this specimen is ignored, there is less variation in the measurements, and this may represent a rare outlier.

4. Conclusion

The recognition of a new genus of the Pseudolepidinidae in the mid-Lutetian suggests that there were two different lineages, one including *Hanovolepidina* gen. nov. that could have evolved into *Triplalepidina*, and a second lineage including *Pseudolepidina*. In Jamaica and Mexico, specimens belonging to the family only turn up at distinct stratigraphic intervals (mid-Lutetian for *Hanovolepidina* MITCHELL gen. nov. and *Pseudolepidina*, and one sample from the ?Priabonian for *Triplalepidina*) and the appearance of these forms may represent migration events (perhaps from eastern Pacific guyots or accreted east pacific vol-

canic islands) that allowed faunal exchange, but not the establishment of long-lived evolving lineages. Only further discoveries will allow the unravelling of the history of this little known family of orbitoidiform LBF.

Contributions - Acknowledgements

SFM developed the project, collected the material from Jamaica, thin sectioned the LBF, and developed the taxonomy. The main text was prepared by SFM.

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Nomenclatural note:

Life Sciences Identifier (LSID)

<https://zoobank.org/References/da894b08-dc9a-401f-94ef-40ffafde39b8>

Genus Group

- *Hanovolepidina* MITCHELL, 2023

<https://zoobank.org/NomenclaturalActs/826F1DF9-9422-4880-97B6-11E30E5D1A0B>

Species Group

- *Hanovolepidina browni* MITCHELL, 2023

<https://zoobank.org/NomenclaturalActs/8A72F08A-D063-4607-97BF-829E316B1D64>