

## *Whittenia*, a new genus of land snails from Perak, Peninsular Malaysia (Gastropoda: Diplommatinidae)

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**Abstract.** This paper proposes a new genus, *Whittenia*, for a group of irregularly coiled land snail species hitherto placed in the genus *Opisthostoma*. *Whittenia* differs from congeners in Diplommatinidae based on both molecular phylogeny and shell morphology. We reassign two previously described species (*Opisthostoma vermiculum* and *O. gittenbergeri*) to *Whittenia*. Both species are endemic to the limestone karsts of Kinta Valley in Perak, Peninsular Malaysia.

**Key words.** Diplommatinidae, land snails, karst ecosystem, endemic, Kinta Valley

### INTRODUCTION

In Peninsular Malaysia, taxonomic revisions of land snails have focused on micro land snails (< 5 mm) from limestone karsts (Laidlaw, 1949; van Benthem Jutting, 1952, 1961; Liew et al., 2014). To date, the best studied land snail family in Peninsular Malaysia is arguably Diplommatinidae, which consists of four genera: *Diplommatina* W.H. Benson, 1849, *Plectostoma* H. Adam, 1865, *Opisthostoma* W.T. Blanford & H.F. Blanford, 1860, and *Arinia* H. Adams & A. Adams, 1856.

Locally and regionally, Diplommatinidae is also one of the most diverse land snail families (Webster et al., 2012). For example, recent surveys of 13 limestone hills in Kinta Valley, Perak, showed that *Opisthostoma* is the most diverse genus (Foon et al., 2017; Phung et al., 2018). Of the 11 known *Opisthostoma* species, two possess shell forms atypical for *Opisthostoma*: *O. vermiculum* Clements & Vermeulen in Clements et al., 2018, *O. gittenbergeri* Vermeulen & Clements, 2008, and divergent forms of the two species (see Foon et al., 2017: *O. cf. vermiculum* and *O. cf. gittenbergeri*) (Fig. 1).

Originally, *Opisthostoma vermiculum* was placed in the genus *Opisthostoma* based on the presence of an internal constriction and more than two coilings (Clements et al., 2008). However, a recent molecular phylogenetic study of the *Plectostoma*, *Opisthostoma*, and *Arinia* by Liew et al. (2014) showed that *O. vermiculum* is unrelated to the other species in the genus (Fig. 2).

We propose a new genus, *Whittenia*, for the group of irregularly coiled land snail species hitherto placed in the genus *Opisthostoma*. We justify this using more specimens from recent malacological surveys and a newly established molecular phylogeny for Diplommatinidae in Peninsular Malaysia.

### MATERIAL AND METHODS

Type material of *Whittenia vermicula* and *W. gittenbergeri*, is illustrated in Clements et al. (2008) and Vermeulen & Clements (2008). Specimens collected by Foon have been illustrated in Foon et al. (2017). We reproduce the latter.

Aperture height and width were measured at the widest section of the aperture with the aperture aligned to image plane, irrespective of the shell coiling axis. The number of whorls in the regular coiling part of the shell, including the protoconch together with top whorls, and whorls before the tuba, was counted. All measurements were measured to the nearest 0.1 mm. Specimens were deposited in the following collections: BOR, BORNEENSIS collection, Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, Kota Kinabalu, Malaysia (BOR/MOL); RMNH, Naturalis Biodiversity Center (formerly Rijksmuseum van Natuurlijke Historie), Leiden, the Netherlands; ZRC, Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore.

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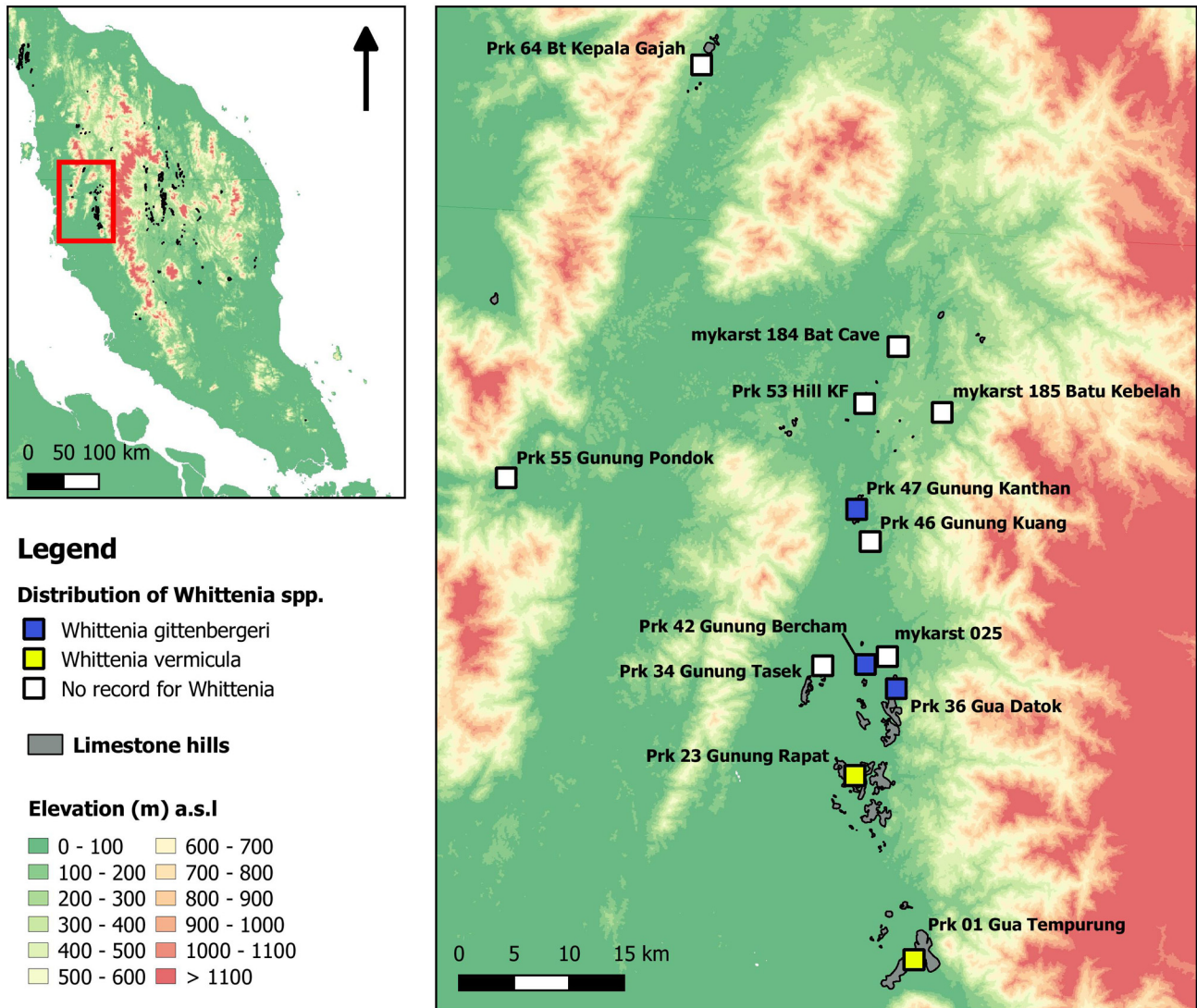


Fig. 1. The distribution of species of *Whittenia* in Kinta Valley, Perak. Peninsular Malaysia. The square symbols indicate the hills sampled systematically in Foon et al. (2017) and Phung et al. (2018). The limestone hills' naming follows Liew et al. (2016).

## SYSTEMATICS

### Family Diplommatinidae Pfeiffer, 1856

#### *Whittenia*, new genus

**Type species.** *Opisthostoma vermiculum* Clements & Vermeulen, in Clements et al., 2008.

**Diagnosis.** Species of *Whittenia* bear some resemblance with *Arinia* and *Opisthostoma*. They differ by the outer whorl around the discoid apex, which is raised above the level of the apex. The periostome is similar to that of *Opisthostoma* but its whorl diameter size increases more gradually, similar to *Arinia* species. *Whittenia* is distinguished from *Opisthostoma* and *Arinia* by its outer whorl around the discoid apex raised above the level of the apex.

**Description.** Shell minute, thin, white or pale yellowish. Apex not or hardly oblique with respect to the top whorls; top whorls coiled around protoconch for  $2\frac{1}{3}$ – $2\frac{3}{4}$  whorls,

with the next whorl raised above level of apex (Fig. 3), then passing into body whorls without or with a completely detached whorl section; body whorls  $2\frac{1}{8}$ – $2\frac{2}{8}$ , coiled to form an approximately cylindrical body, never attached to top whorl, or body whorl uncoiled at end of top whorls, then returns to reattach to the top whorls, the last whorl and the tuba, before gradually turning downwards, always forming a complete whorl with wide open to closed umbilicus. Tuba detached, coiling downwards with the angle between the last portion of the whorl before peristome and the horizontal penultimate whorl approximately  $35$ – $70^\circ$ . Constriction slight, with an inconspicuous transverse lamella. Spire with numerous straight, fine radial ribs, on the top whorls densely placed, 4–5 ribs/0.1 mm, somewhat more spaced elsewhere, with 3–4 and 2–4 ribs/0.1 mm on the body whorls and the tuba respectively. Peristome double, inner peristome slightly protruding from the outer or not, outer peristome reflected. Plane of aperture turned  $45$ – $80^\circ$  downwards with respect to the penultimate whorl when the shell is observed laterally and with the penultimate whorl horizontal.

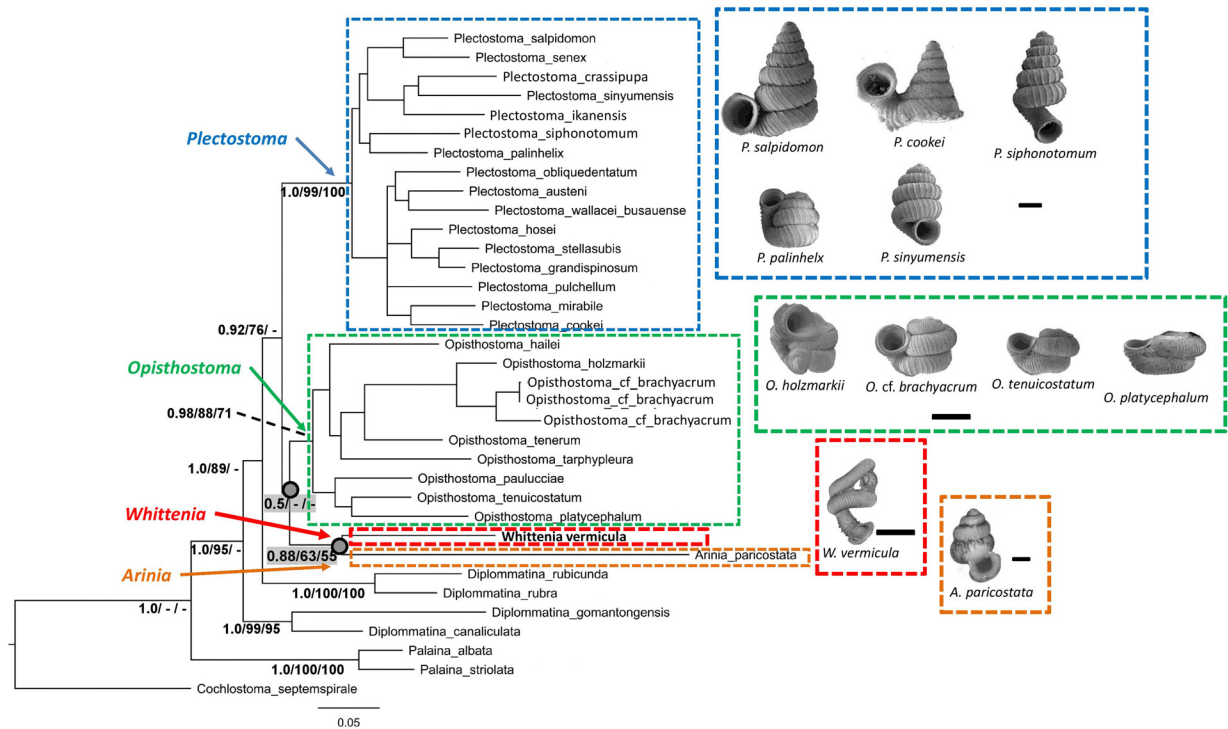


Fig. 2. The phylogeny of Diplomatinae genera in Peninsular Malaysia with *Cochlostoma septemspirale* as outgroup adapted from Liew et al. (2014) (CC BY 4.0). Bayesian inference 50% majority-rule consensus trees based on the concatenated dataset consisting of parts of 28S, 18S, COI, and 16S. Bayesian posterior probabilities (PP), percent bootstrap support after 1000 maximum likelihood replicates (MLBS), and percent bootstrap support after 1000 maximum parsimony replicates (MPBS) are shown for the major clades. The shell forms are shown for representative taxa. Scale bar: 0.5 mm.

**Dimensions.** Height 1.25–1.4 mm. Width 0.6–1.1 mm.

**Molecular phylogeny.** Liew et al. (2014) found that *W. vermicula* is not a sister taxon to *Opisthostoma*, rather it is more closely related to *Arinia* but with poor support value (PP < 0.9; MPBS & MLBS < 0.7).

**Etymology.** Named after the late Dr. Tony Whitten, for his significant contributions to the conservation of land snails and limestone karsts in Southeast Asia. He will be especially remembered for his tireless efforts to engage with the cement industry to protect limestone karsts in the Kinta Valley. Gender feminine.

**Remarks.** A standardised orientation of the shell is very important for quantitative and qualitative description of the shell characters. However, this cannot be used for this genus due to the irregularity of the shell coiling. After examining all *Whittenia* specimens, the part of the shell that can serve as a guideline to position of the shell is the penultimate whorl and the position of the aperture. For a standardised orientation we rotate the shell until the axis of the penultimate whorl is vertical. We rotate the shell around this axis until (the shell is observed from aside) the aperture passes in front of the axis of the penultimate whorl. This is the right lateral view of the shell (see Fig. 3). A further anticlockwise 90° turn gives the frontal view of the shell.

Each species exhibits conspicuous variability in shell shape. This is mainly due to the position of the top whorls, which is determined by the number of whorls before the transition to the lower part of the shell, in combination with the amount of torsion in the transition (Fig. 3; see also Liew & Schilthuizen, 2016). The top whorls and the last whorl together with tuba are rather consistent in shape within each of the two species.

***Whittenia vermicula* (Clements & Vermeulen, in Clements et al., 2008)**

*Opisthostoma vermiculum* Clements & Vermeulen, 2008 (type locality: Peninsular Malaysia, Perak, Gunung Rapat a.k.a. Prk 23 G. Rapat, 4°30'N 101°07'E).

*Opisthostoma vermiculum* – Foon et al., 2017: 38.

*Opisthostoma cf. vermiculum* – Foon et al., 2017: 32.

**Material examined.** ZRC.MOL.002824, Prk 23 G. Rapat, coll. R. Clements, 16 July 2005; ZRC.MOL.002825, Prk 23 G. Rapat, coll. R. Clements, 16 July 2005; ZRC.MOL.002826, Prk 23 G. Rapat, coll. R. Clements, 16 July 2005; BOR/MOL 10214, Prk 23 G. Rapat, coll. R. Clements, 16 July 2005; BOR/MOL 10242, Prk 23 G. Rapat, coll. R. Clements, 16 July 2005; BOR/MOL 10267, Prk 23 G. Rapat, coll. R. Clements, 16 July 2005; BOR/MOL 11400, Prk 01 G. Tempurung, coll. J.K. Foon, 27 August 2016. The limestone hills' naming follows Liew et al. (2016).



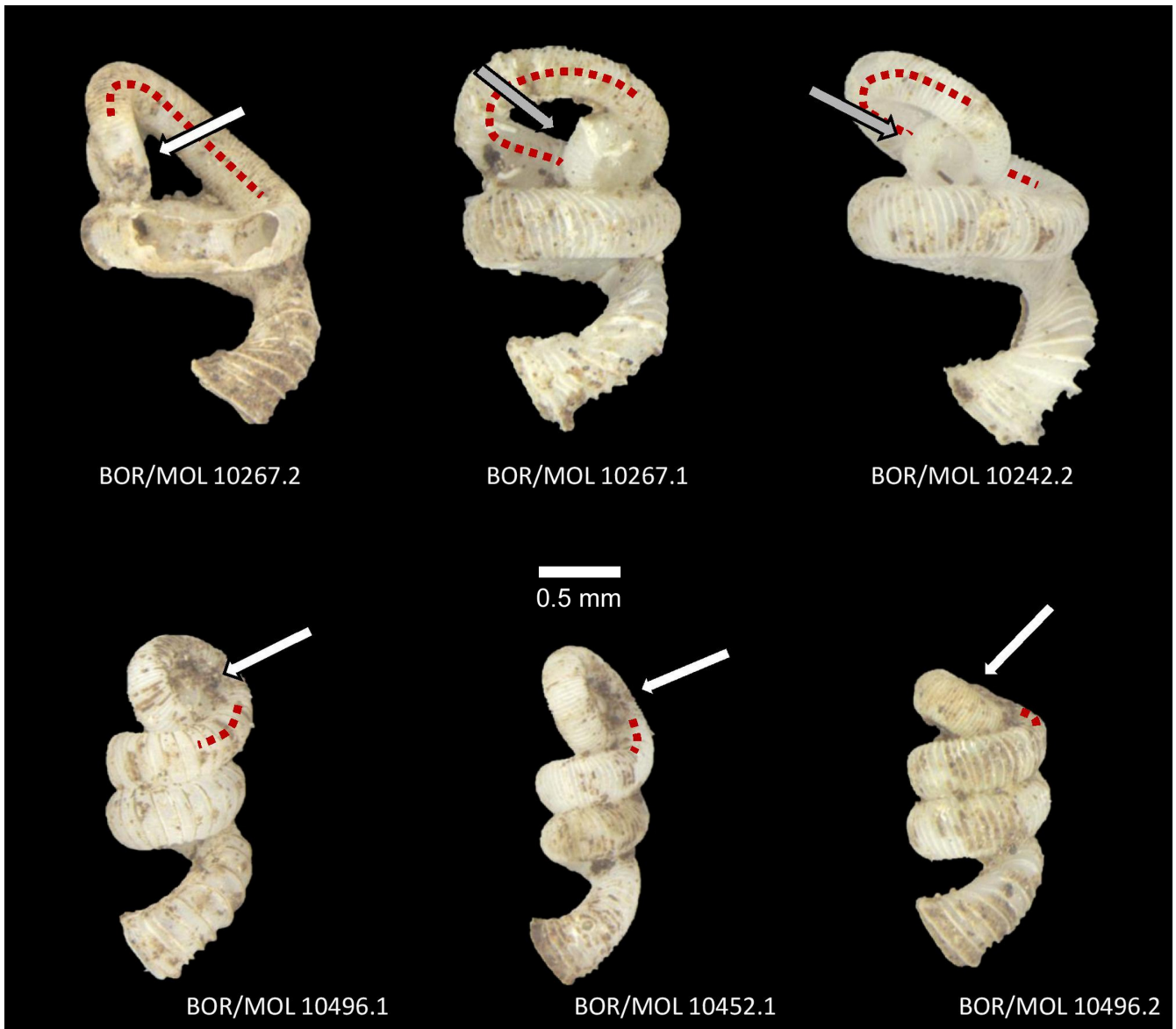


Fig. 3. Selected shell form in species of *Whittenia* in lateral view. Top row: *W. vermicula*. Bottom row: *W. gittenbergeri*. White arrows indicate the position of shell apex; grey arrows indicate the position of shell apex if it is not visible. The part of the shell whorls marked with dashed line is the outer whorl raised above the level of apex of top whorls.

**Distribution.** Known from Gunung Rapat and Gunung Tempurung (Clements et al., 2008; Foon et al., 2017). It is likely to occur on nearby limestone hills that have not been surveyed.

**Note.** In the original description (Clements et al., 2008), vermiculum was constructed as an adjective (as shown by the etymology: “meaning wormy”) and becomes vermicula when combined with a genus name with feminine gender (here *Whittenia*), and vermiculus when combined with a genus name with masculine gender.

***Whittenia gittenbergeri* (Vermeulen & Clements, 2008)**

*Opisthostoma gittenbergeri* Vermeulen & Clements, 2008 (type locality: Peninsular Malaysia, Perak, Gunung Datok a.k.a. Prk 36 Gua Datok, 4°36'N 101°09'E).

*Opisthostoma gittenbergeri* – Foon et al., 2017: 34.

*Opisthostoma* cf. *gittenbergeri* – Foon et al., 2017: 32.

**Material examined.** RMNH 109.610, Prk 36 Gua Datok, coll. R. Clements, 17 July 2005; ZRC.MOL.002827, Prk 36 Gua Datok, coll. R. Clements, 17 July 2005; ZRC.MOL.002828, Prk 36 Gua Datok, coll. R. Clements, 17 July 2005; BOR/MOL 10452, Prk 36 Gua Datok, coll. R. Clements, 17 July 2005; BOR/MOL 10604, Prk 42 G. Bercham, coll. R. Clements, 12 July 2005; BOR/MOL 9151, Prk 47 Kanthan, coll. J.K. Foon, M.E. Marzuki, & R. Asod, 19 August 2016; BOR/MOL 12496 Prk 47 Kanthan, coll. J.K. Foon, M.E. Marzuki, & R. Asod, 19 August 2016. The limestone hills’ naming follows Liew et al. (2016).

**Distribution.** Known from Gua Datok, Gunung Bercham and Gunung Kanthan (Vermeulen & Clements, 2008; Foon et al., 2017). However, it was not found in the other three hills located between Gunung Kanthan and Gua Datok (Foon et al., 2017).

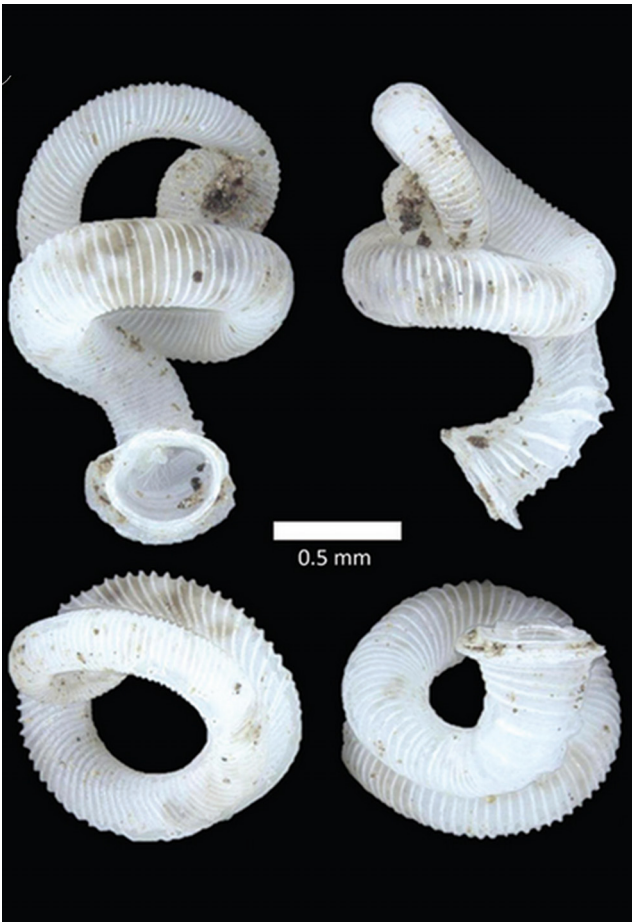


Fig. 4. *Whittenia vermicula* (BOR/MOL 10242) from Gunung Rapat, Perak. Figure from Foon et al. (2017) licensed under CC BY 4.0.



Fig. 5. *Whittenia gittenbergeri* (BOR/MOL 10452) from Gua Datok, Perak. Figure from Foon et al. (2017) licensed under CC BY 4.0.

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