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Thirteen new charopid land snails from mid-eastern Queensland rainforests (Gastropoda: Eupulmonata: Charopidae)

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ABSTRACT

Thirteen new species of charopid land snail are described from mid-eastern Queensland rainforests. These are assigned to four newly diagnosed genera: *Hirsutaropa sarina* gen. et sp. nov., *Burwellia staceythomsonae* gen. et sp. nov., *Albiropa microscopica* gen. et sp. nov., *Eungellaropa crediton* gen. et sp. nov. and six existing genera: *Lenwebbia marissae* sp. nov., *Omphaloropa subvaricosa* sp. nov., *Amfractaropa southpercyensis* sp. nov., *Comularopa wendyae* sp. nov., *Isolderopa gloucester* sp. nov., *Tristanoropa southmolle* sp. nov., *Tristanoropa summerae* sp. nov., *Tristanoropa jaxut* sp. nov. and *Tristanoropa hazelwood* sp. nov. An additional six species are recognised formally but not formally described due to poor quality material. New distribution data is presented for *Setomedea janae* Stanisic, 1990, *Discocharopa aperta* (Möllendorff, 1888) and *Sinployea intensa* Iredale, 1941. The latter two represent new records for mid-eastern Queensland. A short discussion on the potential implications of the expanded MEQ charopid fauna for east coast biogeography is presented.

□ *Gastropoda, Eupulmonata, Charopidae, new genera, new species, mid-eastern Queensland.*

Until recently, knowledge of the charopid fauna of the extensive mid-eastern Queensland (MEQ) rainforests was limited to relatively few species. This was somewhat surprising considering that the family is the most speciose and numerically dominant group of land snails in other eastern Australian rainforests (Stanisic unpublished). Additions to the charopid fauna of MEQ has been incremental: Forbes (1851) the first to describe a single species; Hedley (1912) added a species; Iredale (1937) listed two species; Stanisic (1990) added one additional species; Smith (1992)'s catalogue of Australian

non-marine Mollusca listed three species; and Stanisic *et al.* (2010) featured 11 species of which eight were new. However, it was not until Holcroft (2018b) investigated the entire MEQ charopid holdings of the Queensland (QM) and Australian (AM) museums that the family's true diversity in these rainforests was uncovered. In doing so, the number of known species in MEQ was expanded from 11 to a possible 43, and most are new to science. The majority of species were from the mainland rainforests between Sarina and Proserpine, MEQ but several species were collected from

MEQ but several species were collected from off-lying islands which in fairly recent times (approximately 15 000 ybp) were connected to the mainland. Many of the putative new species (14) have been formally described in two systematic papers which also revised existing species (Holcroft 2018c, d).

In this paper we describe an additional thirteen species of MEQ Charopidae recorded by Holcroft (2018b) including some which were concealed among 'material examined' lists of more broadly defined species in that study. These new species are allocated to four newly diagnosed and six existing genera. We also present additional distribution data for three previously described species occurring in the region: *Setomedeia janae* Stanisic, 1990, *Discocharopa aperta* (Möllendorff, 1888) and *Sinployea intensa* (Iredale, 1941). The latter two are new records for MEQ.

A further six species are identified as putatively new from material listed in Holcroft (2018b) but are not formally described at this time because of poor quality material or material damaged during specimen preparation and handling. These damaged shells and fragments are documented and illustrated with brief accompanying remarks, not only to complete the species inventory, but more so to encourage and direct future investigations.

MATERIALS AND METHODS

The study is based on material revised in Holcroft (2018b). Individual specimens are identified by their registration number and respective institutional prefix (QMMO, Queensland Museum; AMSC, Australian Museum). Species not formally described are denoted by a family descriptor and alphanumeric codon that is used in both the QM's and AM's land snail databases to denote undescribed land snail species, e.g. Charopid MQ 43. Investigations of shell characters were carried out on specimens in the museums' dry collections (denoted as RC) by Holcroft and are presented in detail in Holcroft (2018b). Spirit specimens are denoted SC. Characters scored included shell height and diameter, whorl

count, rib count on the first whorl and umbilical width. Whorl counts were made to the nearest 1/8 whorl using the methodology of Solem (1983). Specimens were studied using a WILD M5 stereo microscope and shell photographs were taken using a NIKON 4200 Coolpix camera with microscope attachment. High resolution images of shells (260-600MB) were obtained using a Visionary Digital BK-Plus lab system camera set-up located in the Queensland Museum's Digital Imaging Unit. Shell sculpture was investigated and photographed using a TM-1000 Tabletop Scanning Electron Microscope at the Queensland Museum.

Shells were cleaned in an ultrasonic cleaner and not by chemical means in order to prevent the removal of the periostracum which shows many of the shell's sculptural elements. Shells used in the study were mostly recovered from leaf litter and occasionally were extremely fragile. In some cases the cleaning process and subsequent handling led to shell damage, some severe with only an illustration as evidence of the shell's morphology and its existence in MEQ.

Abbreviations used: General: SEM, scanning electron microscopy; SC, spirit collection; RC, dry collection.

Institutions: AM, Australian Museum, Sydney; QM, Queensland Museum, Brisbane.

Habitat Data: alt, altitude; Ck, Creek; CMC, Central Mackay Coast; cnvf, complex notophyll vine forest; Hts, Heights; I., Island; Mts, Mountains; nvf, notophyll vine forest; R, River; Ra, Range; sevt, semi-evergreen vine thicket; MEQ, Mid-eastern Queensland; NP, National Park; NSW, New South Wales; NENSW, North-eastern New South Wales; NEQ, North-eastern Queensland; SEQ, South-eastern Queensland; SF, State Forest; WT, Wet Tropics.

Generic differentiation and species delimitation

Holcroft (2018a) established a framework for using protoconch sculpture as a means of recognising putative genera in the absence of soft

parts for the study of reproductive structures and DNA analyses. Through the examination of the protoconch sculptures of 186 eastern Australian charopids (described and undescribed) by scanning electron microscopy her study concluded that this embryonic shell feature could provide a more reliable generic signature for members of the family than earlier *ad hoc* attempts had done (e.g., Iredale 1933, 1937, 1941a, b). This conclusion largely reflected the results of the most recent and only molecular-based study of eastern Australian charopids which showed a strong connection between protoconch sculptural pattern and DNA-based generic-level clades (Shea *et al.* 2012).

Thus new genera are diagnosed herein primarily on protoconch sculpture that is considered to be distinctive and differs from the sculptural patterns documented in previous studies (Stanisic 1990, Hyman & Stanisic 2005, Shea *et al.* 2012, Stanisic 2016, Holcroft 2018c, d). General shell features such as teleoconch sculpture and coiling pattern may also be important secondary considerations in generic determinations. New species are diagnosed on the basis of protoconch sculpture combined primarily with coiling pattern, shell shape and teleoconch sculpture.

SYSTEMATICS

Lenwebbia Stanisic, 1990

Lenwebbia Stanisic, 1990: 52; Smith, 1992: 192; Stanisic *et al.*, 2010: 256.

Type species. *Lenwebbia protoscrobiculata* Stanisic, 1990-by original designation.

Diagnosis. Shell tiny, depressedly turbinata with a moderately raised, domed spire; whorls sub-angulate to rounded, sutures impressed; protoconch sculpture malleate, teleoconch with or without spiral grooves and fine thread-like radial ribs; umbilicus tiny, U-shaped. Colour yellowy-brown with darker grey spire.

Remarks. *Lenwebbia* Stanisic, 1990 differs from other east coast charopid genera primarily by a combination of malleate protoconch sculpture and reduced teleoconch sculpture. A malleate protoconch is highly unusual in

eastern Australian charopids and thus far seen elsewhere only in *Letomola* Iredale, 1941 from limestone outcrops in the Macleay Valley, NENSW (Hyman & Stanisic 2005).

Lenwebbia marissae sp.nov.

(Figs. 1A, B; 2A, B)

Etymology. Named for Marissa McNamara, Biodiversity Collection Manager, Queensland Museum.

Preferred **Common name.** Marissa's Pinwheel Snail.

Material examined. All MEQ. Holotype. QMMO77441, RC, Mt Dryander, 20° 15' S, 148° 33' E, 700 m, coll. QM party, 21.xi.1992. Height of shell 2.79 mm, diameter 4.43 mm, umbilical width 0.25 mm, H/D 0.63, D/U 18.00, number of whorls 4.500.

Paratype. QMMO85335, 1 subadult RC, Brandy Creek NP, rainforest, 20° 21' S, 148° 43' E, Litter, under logs, coll. J. Stanisic, L. Holcroft, 14.xi.2016.

Other material. AMSC154893, 1 subadult RC, Mt Dryander, 20° 15' S, 148° 32' E, 120m, coll. J. Burch, W. Ponder, P. Colman, 3.v.1975.

Diagnosis. Shell tiny, depressedly turbinata with a moderately raised domed spire; protoconch sculpture malleate, teleoconch sculpture of complex curved, irregularly spaced radial thickenings each comprised of several thin radial threads and spiral grooves; umbilicus tiny U-shaped.

Description. Shell tiny, yellow-brown, depressedly turbinata with a moderately raised domed spire; whorls 4.5 rounded, sutures impressed; diameter of shell 4.43 mm, height 2.79 mm, H/D 0.63. Protoconch sculpture malleate with scattered dimples, no spiral cords or radial ribs, diameter 660 µm; teleoconch sculpture of spiral grooves (Fig. 2A) and complex curved, irregularly spaced radial thickenings each comprised of several thin radial threads (Fig. 2B); umbilicus tiny, U-shaped, diameter 0.25 mm, D/U 18.0. Based on 1 measured adult specimen (QMMO77441).

Distribution and habitat. Brandy Creek and Mt Dryander, MEQ; in rainforest found under logs in litter.

Remarks. *Lenwebbia marissae* sp. nov. is similar to both *L. protoscrobiculata* Stanisic, 1990 from the Kalpowar SF, SEQ and *L. paluma* Stanisic,

1993 from the Paluma Range, NEQ in general shell shape and size. However, *L. marissae* lacks the prominent spiral grooves evident on the teleoconch of *L. protoscribiculata* and has reduced teleoconch sculpture more like that of *L. paluma* (see Stanistic 1993). Habitat preference for the drier araucarian rainforests of the Whitsunday bioprovince is similar to that of its congeners. Both *L. protoscribiculata* and *L. paluma* live under bark of standing and fallen trees whereas *L. marissae* has only been found as dead shells in leaf litter. Hence lifestyle remains unknown. With the discovery of *L. marissae* in MEQ, *Lenwebbia* now spans a distribution range from SEQ, through MEQ to NEQ similar to that seen in *Setomedea* Iredale, 1941 (Stanistic 1990).

***Hirsutaropa* gen. nov.**

Type species. *Hirsutaropa sarina* sp. nov.

Etymology. From the Latin *hirsutus* = hairy, referring to the periostracal hair-like setae; and a contraction of *Charopa*.

Diagnosis. Shell tiny, flammulated, turbinata with an elevated spire and evenly coiled whorls; protoconch sculpture radial consisting of closely spaced, thin, slightly curved radial ribs, teleoconch sculpture of curved, widely spaced radial ribs and prominent thick spiral cords with a microsculpture comprised of crowded microradial threads; several spiral rows of widely spaced, stout, elongate setae located on the radial ribs; umbilicus narrowly open, U-shaped.

Remarks. *Hirsutaropa* gen. nov. differs from the hirsute *Setomedea* Iredale, 1941 by the combination of radial rather than spiral protoconch, depressedly turbinata rather than discoidal shell and sparse stout setae in contrast to the fine, crowded setae of the latter. The hirsute *Setoturbinata* Stanistic, 2010 from the Wet Tropics, NEQ is smaller, but differs by the combination of depressed conical spire, spiral protoconch, teleoconch with widely spaced, raised thin spiral cords and more scattered setae.

***Hirsutaropa sarina* sp. nov.**
(Figs 1C, D; 2C, D)

Etymology. For the township of Sarina.

Preferred Common name. Sarina Hairy Pinwheel Snail.

Material examined. Holotype. QMMO77399, RC, Sarina, SW at Upper East Funnel Ck, MEQ, 21° 34' S, 149° 12' E, 200m, coll. QM party, 16.xi.1992. Height of shell 2.3 mm, diameter 3.69 mm, umbilical width 0.82 mm, D/U 4.50, H/D 0.62, whorls 4.0.

Diagnosis. As for genus.

Description. Shell tiny, brown with darker radial streaks (flammulations), turbinata with an elevated spire and 4 evenly coiled whorls, sutures moderately impressed; diameter of shell 3.69 mm, height 2.3 mm, H/D 0.62. Protoconch damaged and only last quarter visible, radial with sculpture of closely spaced, thin, slightly curved radial ribs (Fig. 2C); teleoconch sculpture of curved, widely spaced radial ribs and prominent spiral cords with a microsculpture comprised of crowded microradial threads (Fig. 2D); several spiral rows of widely spaced, stout, elongate setae located along the major radial ribs; aperture ovately lunate; umbilicus narrow U-shaped, diameter 0.82 mm, D/U 4.50.

Distribution and habitat. Known only from the type locality at Upper East Funnel Creek, MEQ; in rainforest found in litter.

Remarks. *Hirsutaropa sarina* sp. nov. is known only from the holotype specimen but is readily distinguishable from other MEQ charopids by the combination of turbinata, flammulated shell with radial protoconch, narrow umbilicus and scattered, stout elongate setae on the teleoconch. In contrast the superficially similar *Setomedea janae* Stanistic, 1990 has a flammulated, discoidal shell with spiral protoconch, wide umbilicus and relatively crowded, short and fine periostracal setae. Although the protoconch of the *H. hirsuta* holotype is damaged the last quarter is intact and shows a sculpture of curved radial ribs without any spiral elements (Fig. 2C).

Setomedeia Iredale, 1941

Setomedeia Iredale, 1933: 53; 1937: 329-nomina nuda.

Setomedeia Iredale, 1941: 267-valid description (Stanisic, 1990: 57); Stanisic *et al.*, 2010: 242.

Type species. *Suteria seticosata* Hedley, 1924-by original designation.

Diagnosis. Shell tiny, creamy yellow with reddish zigzag flammulations, discoidal with a low to flat spire; whorls rounded, sutures impressed; protoconch superior spiral with weak to strong squiggly spiral cords and weaker radial ribs, teleoconch with regularly spaced, curved radial ribs and with or without short crowded setae, microsculpture of microradial threads and low microspirals; umbilicus narrow V-shaped to wide U-shaped.

Remarks. The original introduction (Iredale 1933) and subsequent citation (Iredale 1937) were considered invalid by Stanisic (1990). The following are new records for *Setomedeia* Iredale, 1941 in MEQ and additional to those given in Stanisic (1990).

***Setomedeia janae* Stanisic, 1990**
(Figs 1E, F; 2E, F)

Setomedeia janae Stanisic, 1990: 69; Smith, 1992: 205; Stanisic *et al.* 2010: 242.

Type locality. Mt Dryander, MEQ.

Common name. Jan's Pinwheel Snail.

Material examined. All MEQ. QMMO35546, Mt Dryander, lower slopes, via Gregory, NE Proserpine, 20° 17' S, 148° 35' 30" E, coll. J. Stanisic, D. Potter, 16.v.1990; QMMO35620, Mt Macartney slopes, Cathu Forest Dve, SW Proserpine, 20° 20' S, 148° 33' E, 18.v.1990; QMMO35632, Mt Macartney slopes, Cathu Forest Dve, SW Proserpine, 20° 20' S, 148° 33' E, 900 m, coll. J. Stanisic, D. Potter, 18.v.1990; QMMO36092, Mt Dalrymple, lower slopes, Eungella, 21° 04' S, 148° 35' E, coll. J. Stanisic, D. Potter, N. Potter, 21.v.1990; QMMO77233, Sarina, SW at Blue Mts, c.0.6k SE, 21° 36' S, 148° 58' E, 930 m, coll. G. Monteith, 23.iii.2000; QMMO77236, Sarina, SW at Blue Mts, c.0.6k SE, 21° 36' S, 148° 58' E, 930 m, coll. G. Monteith, 23.iii.2000; QMMO77322, Sarina, SW at Blue Mts, c.0.6 km SE, pitfall trap, 21° 36' S, 148° 58' E, 930 m, coll. G. Monteith, D. Cook, 30.v.2000; QMMO77326, Sarina, SW at Blue Mts, c.0.6k SE, 21° 36' S, 148° 58' E, 950 m, coll. G. Monteith, 31.v.2000; QMMO77328, Sarina, SW at Blue Mts, c.0.6k SE, 21° 36' S, 148° 58' E, 900 m, coll. QM party, 31.v.2000;

QMMO77432, Eungella NP, at Upper Cattle Ck, 21° 02' S, 148° 36' E, 900 m, coll. QM party, 17.xi.1992; QMMO77466, Proserpine, S at Mt Macartney, 20° 50' S, 148° 34' E, 900 m, coll. QM party, 19.xi.1992; QMMO85175, Eungella NP, Mt Henry, rainforest, 21.026° S, 148.627° E, 1200 m site 2, under logs, 1164 m, coll. J. Stanisic, 14.xi.2013.

Description. Shell small (mean diameter 3.64 mm), pale yellow with reddish flammulations, discoidal with a flat spire and rounded whorls. Protoconch spiral, sculptured with squiggly spiral cords over weak radial undulations, teleoconch with prominent radial ribs and with a dense covering of moderately long periostracal setae; umbilicus open U-shaped.

Remarks. *Setomedeia janae* Stanisic, 1990 is the sole representative of the genus in MEQ. *Setomedeia janae* is distinguished by the flammulated, discoidal shell with dense covering of periostracal setae and differs from *Hirsutiaropa sarina* sp. nov. which has a flammulated, turbinated shell with sparsely scattered setae. Additional species of *Setomedeia* occur in SEQ and NEQ (Stanisic 1990, Stanisic *et al.* 2010), some without setae.

***Burwellia* gen. nov.**

Type species. *Burwellia staceythomsonae* sp. nov.

Etymology. For Chris Burwell, Senior Entomologist, Queensland Museum.

Diagnosis. Shell minute, white, discoidal with a flat spire; protoconch superior radial consisting of closely spaced, bold and weakly curved radial ribs and numerous, crowded, thin spiral cords that rise over the radials forming elongate beads on the apex of the radial; teleoconch with crowded, bold radial ribs and numerous, crowded, weak microradial threads and prominent microspirals that form a bead at their intersection; umbilicus pinhole, narrowly open, U-shaped.

Remarks. *Burwellia* gen. nov. is readily distinguished from other MEQ charopid genera by its minute, white discoidal shell with superior radial protoconch sculpture

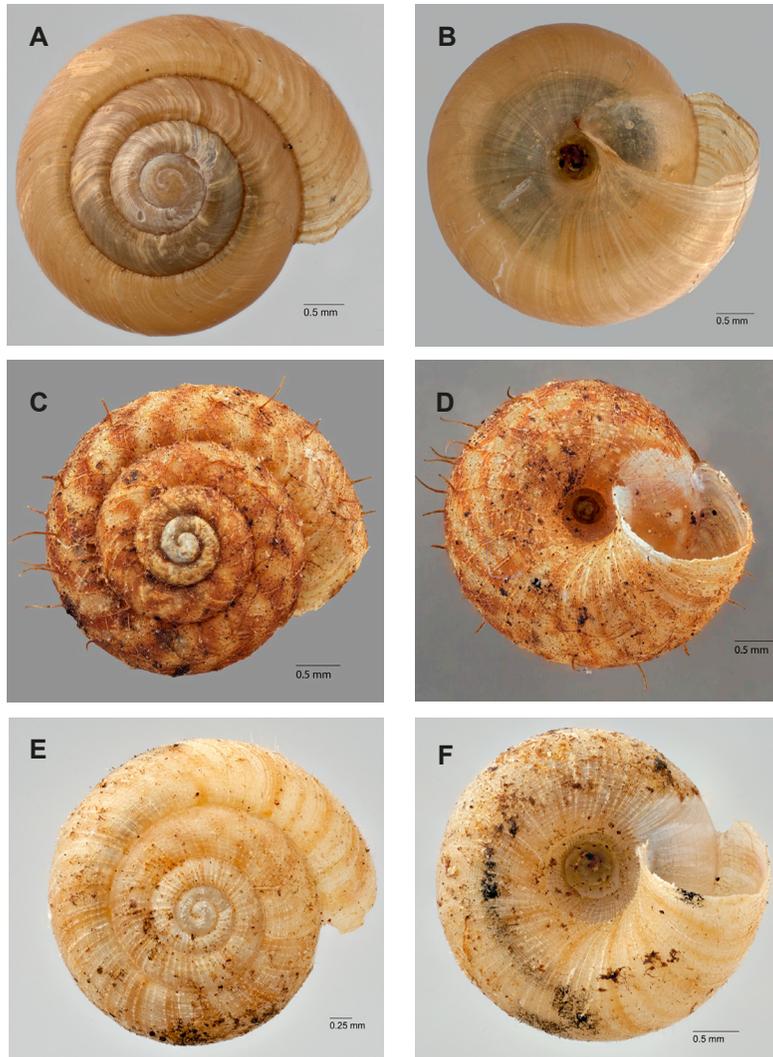


FIG. 1. **A-B**, *Lenwebbia marissae* sp. nov., QMMO77441, holotype, Mt Dryander, MEQ. A, apical view; B, umbilical view. **C-D**, *Hirsutaropa sarina* gen. et sp. nov., QMMO77399, holotype, Funnel Creek, MEQ; C, apical view; D, umbilical view. **E-F**, *Setomedea janae*, QMMO36092, Mt Dalrymple, MEQ; E, apical view; F, umbilical view. Images A-F: Geoff Thompson, QM. Scale lines as marked.

consisting of bold radial ribs and thin spiral cords, teleoconch with widely spaced, bold radial ribs and very narrow umbilicus. The general shell facies consisting of prominent bold ribbing on both protoconch and teleoconch is more like that seen in genera from limestone outcrops rather than rainforest (see Hyman & Stanisic 2005).

Burwellia staceythomsonae sp. nov.

(Fig. 3A-D)

Etymology. Named for Stacey Thomson, presenter on the popular television program *Totally Wild* and former national parks ranger.

Preferred Common name. Ranger Stacey's Pinwheel Snail.

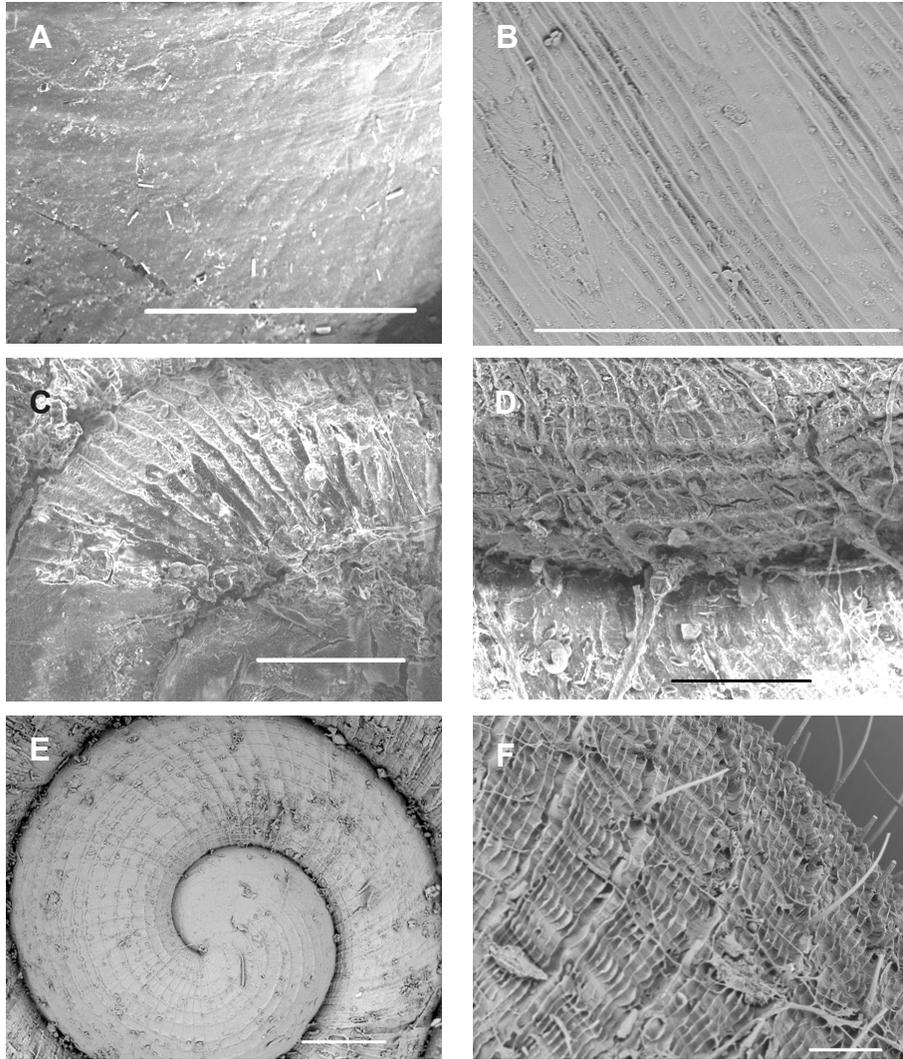


FIG. 2. **A-B**, *Lenwebbia marissae* sp. nov., QMMO77441, holotype, Mt Dryander, MEQ. Teleoconch sculpture showing vague spiral grooves (A) and complex radial ribs (B); **C-D**, *Hirsutaropa sarina* gen. et sp. nov., QMMO77399, holotype, Funnel Creek, MEQ. C, protoconch showing radial ribs; D, teleoconch showing long setae attached to major radial ribs and thick spiral cords; **E-F**, *Setomedea janae*, QMMO36092, Mt Dalrymple, MEQ. E, protoconch with spiral cords; F, teleoconch sculpture showing fine setae. Scale bars = 100 μ .

Material examined. Holotype. QMMO85089, RC, Eungella NP, Mt Dalrymple track, rainforest, MEQ, 21.026°S, 148.627°E, 1200 m site 3, litter, 1144 m, coll. A. Nakamura, E. Leach, 2-12.iv.2014. Height of shell 0.82 mm, diameter 1.48 mm, width of umbilicus 0.25 mm, D/U 6.00, H/D 0.56, whorls 4.0.

Diagnosis. As for genus.

Description. Shell minute, white, discoidal with a flat spire; whorls 4 evenly coiled, sutures moderately impressed; diameter of shell 1.48 mm, height 0.82 mm, H/D 0.56. Protoconch superior radial, diameter 250 μ m, sculptured with prominent, bold and widely spaced radial ribs which increase in frequency the closer to the protoconch-teleoconch boundary

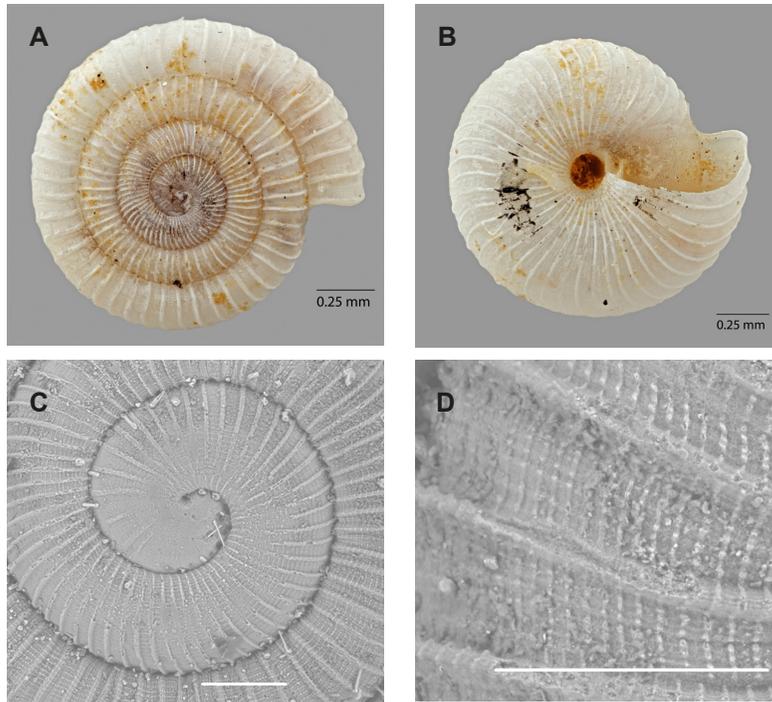


FIG. 3. *Burwellia staceythomsonae* gen. et sp. nov., QMMO85089, holotype, Mt Dalrymple, MEQ. **A**, apical view; **B**, umbilical view; **C**, bold radial ribs on protoconch; **D**, teleconch sculpture showing bold radial ribs and beaded microsculpture. A-B: scale lines as marked; C-D: scale bars = 100µm. Images A-B: Geoff Thompson, QM.

and numerous thin, spiral cords rising over the radial ribs where they form an elongate bead; teleconch with bold, rounded radial ribs, 47 on the first whorl; microsculpture of numerous, crowded weak microradial threads and prominent microspiral cords that cross the microradials and form a bead at their intersection; aperture ovately lunate; umbilicus pinhole, narrow U-shaped, diameter 0.25 mm, D/U 6.00. Based on 1 measured adult specimen (QMMO85089).

Distribution and habitat. Eungella NP, MEQ; in moist humid rainforest, found in litter.

Remarks. *Burwellia staceythomsonae* sp. nov. is unique among MEQ charopids in being the only one with a superior radial protoconch sculpture consisting of very broad, straight-sided, widely spaced radial ribs (Fig. 3C). The radially ribbed, white shell with tiny pinhole umbilicus and

large D/U ratio readily separate this species from the many MEQ charopid species of similar shell dimensions. No comparable charopid species has been encountered among the many MEQ charopid specimens thus far examined and the shell morphology is unusual for a high altitude rainforest specialist. *B. staceythomsonae* has all the attributes of a rainforest relict but at this time is known only from a single shell specimen from the higher reaches of Mt Dalrymple (alt. 1144 m). Additional collecting for live material in all the higher elevations of Eungella NP is needed to determine the full extent of its distribution and affinities.

Albiropa gen. nov.

Type species. *Albiropa microscopica* sp. nov.

Etymology. From the Latin *albus* = white, referring to the white shell; and a contraction of *Charopa*.

Diagnosis. Shell minute, white, discoidal with rounded whorls; protoconch sculpture radial comprising densely crowded, curved radial ribs and short, interrupted spiral wrinkles, teleoconch with very crowded, bladed radial ribs, microsculpture of prominent simple microradial threads overlaying numerous, low microspirals forming elongate beads at their intersection; umbilicus wide saucer-shaped.

Remarks. Differs from the very similar *Discocharopa* Iredale, 1913 by having more crowded radial ribs on the protoconch (compare Figs. 4C and 4G), spiral cords on the teleoconch and a smaller cup-shaped rather than wide saucer-shaped umbilicus.

Albiropa microscopica sp. nov.
(Fig. 4A-D)

Etymology. Referring to the minute size of the species.

Preferred Common name. Microscopic Pinwheel Snail.

Material examined. All MEQ. Holotype. QMMO86563, RC, Diamond Cliffs, Homevale NP, 21°22'59" S, 148°34'21" E, coll. QM Party, 14.x.2005. Height of shell 0.66 mm, diameter 1.15 mm, width of umbilicus 0.41 mm, D/U 2.80, H/D 0.50, whorls 3.250.

Paratypes. QMMO85314, 4 partly broken adult and subadult shells RC, same data as holotype.

Other material. QMMO85313, 1 damaged adult RC, Calen - Mt Charlton Rd, c.17.5 km W Calen, 21°00'S, 148°42' E, coll. J. Stanisic, 6.vii.1982; QMMO85091, 1 damaged adult RC, Eungella NP, Finch Hatton Gorge, 21°03'39.6" S, 148°38'16.8" E, 766 m, coll. C. Burwell, C. Gely, 18.iii.2014.

Diagnosis. As for genus.

Description. Shell minute, white, discoidal with a flat spire; whorls 4 multicoiled; sutures moderately impressed; diameter of shell 1.07-1.31 mm (mean 1.20 mm), height 0.57-0.74 mm (mean 0.66 mm), H/D 0.50-0.62 (mean 0.55); protoconch flat, diameter 330 µm, sculpture radial with extremely crowded, curved radial ribs and spiral periostracal wrinkles; teleoconch with bladed crowded radial ribs, 69-100 (mean 88) on the first whorl; microsculpture of prominent, simple microradial threads overlaying numerous, low microspirals forming elongate beads at their intersection;

aperture ovately lunate; umbilicus wide saucer-shaped, diameter 0.41-0.49 mm (mean 0.44 mm), D/U 2.17- 3.20 (mean 2.73). Based on 5 measured adult specimens (QMMO85313 [1], QMMO85314 [4]).

Distribution and habitat. Mt Charlton, Finch Hatton Gorge and Diamond Cliffs, MEQ; in rainforest living in litter.

Remarks. *Albiropa microscopica* sp. nov. is a tiny white species which is easily confused with *Discocharopa aperta* (Möllendorff, 1888) which also has a minute white shell, radial protoconch sculpture and a similar number of radial ribs on the teleoconch. However a key distinguishing feature is in the teleoconch sculpture. *Albiropa microscopica* has a radially ribbed teleoconch with simple interstitial microradial riblets and low, broad microspirals which form elongate beads when they intersect with the microradial riblets (Fig. 4D). *Discocharopa aperta* has a similar radial teleoconch but the interstitial microradial riblets have serrate apices and there is no microspiral sculpture (Fig. 4H). Furthermore the protoconch of *A. microscopica* is smaller at 330 µm as compared to 410 µm in *D. aperta* and the radial ribbing is more crowded. This species appears to inhabit the slightly wetter rainforest environments of MEQ as opposed to *D. aperta* which prefers drier araucarian rainforest and dry vine thickets.

Discocharopa Iredale, 1913

Discocharopa Iredale, 1913; Iredale 1937 (in part); Stanisic, 1992; Smith, 1992 (in part); Stanisic *et al.* 2010 (in part).

Type species. *Charopa* (*Discocharopa*) *exquisita* Iredale, 1913-by original designation.

Diagnosis. (amended from Stanisic 2010). Shell minute, white, discoidal with a flat spire; whorls rounded, suture weakly impressed; protoconch radial comprising slightly curved, crowded radial ribs and interrupted spiral wrinkles, teleoconch with curved and crowded radial ribs and microsculpture of thin serrated microradial threads; umbilicus wide cup to wide saucer-shaped.

Remarks. The lack of spiral sculpture on the teleoconch readily distinguishes *Discocharopa* from *Albiropa* gen. nov. Staniscic (1990) included several additional species in *Discocharopa* for convenience while acknowledging that the genus as defined therein was most likely polyphyletic. Following examination of these species by SEM it would appear that *Discocharopa* is most likely monotypic and that the additional species belong elsewhere. The following represent the first formally documented records of the genus in MEQ.

***Discocharopa aperta* (Möllendorff, 1888)**
(Fig. 4E-H)

Patula aperta Möllendorff, 1888 (Philippines).
Endodonta (Charopa) planorbulina Tate, 1896 (Central Australia).
Endodonta concinna Hedley, 1901 (Bundaberg, Qld).
Charopa (Discocharopa) exquisita Iredale, 1913 (Kermadec Island).
Discocharopa concinna (Hedley). Iredale, 1937: 325.
Discocharopa aperta (Möllendorff). Solem, 1957 (New Hebrides); Staniscic, 1990: 143 (Eastern Australia); Staniscic *et al.*, 2010: 216 (Eastern Australia).

Type locality. Montalban, Luzon, Philippines.

Common name. Miniscale White Pinwheel Snail.

Material examined. All MEQ. QMMO13098, Endeavour Ck, c.17.5 km W Calen, 21°00' S, 148°42' E, 900 m, coll. J. Staniscic, D. Potter, N. Potter, 18.v.1990; QMMO50882, Eungella NP, Rocky Ck, 20°54' S, 148°36' E, coll. G. Annabell, 12.v.1988; QMMO73832, Long I, NE Side on Whitsunday Circuit, 20°19'44" S, 148°51'27" E, J. Staniscic, D. Potter, 15.vi.1987; QMMO77074, Mackay, WSW at Diamond Cliffs, Homevale NP, 21°22'59" S, 148°34'21" E, coll. J. Staniscic, D. Potter, N. Potter, 17.v.1990; AMSC152150, Brandy Creek SF, E of Proserpine, 20°21' S, 148°43' E, 120 m, cnvf, litter, coll. J. Burch, W. Ponder, 2.v.1975

Description. Shell minute (mean diameter 1.31 mm), white with evenly coiled, rounded whorls and impressed sutures. Protoconch radial sculptured with curved and crowded radial ribs and scattered short spiral wrinkles, teleoconch with prominent crowded curved radial ribs, microsculpture of serrated microradial threads, 3-5 between each major rib; umbilicus wide, saucer-shaped.

Remarks. *Discocharopa aperta* is an extremely widespread and well known species (as seen in the synonymy above), occurring in the drier

forests and vine thickets of tropical and subtropical Australia and many areas extralimital to the continent (see Solem 1983). The species' discovery in MEQ was not unexpected given the presence of drier rainforest in the region and this is the first opportunity to formally document its presence in the bioregion. *D. aperta* differs from *Albiropa microscopica* sp. nov. by the lack of spiral sculpture on the teleoconch and in having serrated rather than simple microradial threads (Fig. 4H). In general appearance the teleoconch sculpture of *D. aperta* is coarser than that of *A. microscopica*.

***Omphaloropa* Staniscic, 1990**

Omphaloropa Staniscic, 1990: 198; Smith 1992: 196; Staniscic *et al.* 2010: 252.

Type species. *Omphaloropa varicosa* Staniscic, 1990-by original designation.

Diagnosis. Shell tiny, subdiscoidal with an elevated, domed and rounded whorls. Protoconch spiral consisting of low, broad, widely spaced spiral cords, teleoconch sculpture of very widely spaced, bold radial ribs, microsculpture of low microradial threads that are continuous on the major ribs and low, crowded, prominent spiral cords that form beads at the intersection with the microradial threads; umbilicus wide, cup-shaped.

***Omphaloropa subvaricosa* sp. nov.**
(Fig. 5A-D)

Etymology. Alluding to its close similarity to the genotype.

Preferred Common name. Wide-ribbed Pinwheel Snail.

Material examined. All MEQ. Holotype. QMMO86564, RC, Hatfields Gap, Koumala-Bolingbroke Rd, vine forest, 21°33' S, 149°11' E, under logs, coll. J. Staniscic, L. Holcroft, 19.xi.2016. Height of shell 1.48 mm, diameter 2.87 mm, width of umbilicus 1.07 mm, D/U 2.54, H/D 0.58, whorls 4.625.

Paratypes. QMMO85346, 2 subadult RC, same data as holotype; QMMO85341, 1RC, Cherry Tree Ck, 1.2 km of Pinnacle Station Rd, 21°12' S, 148°42' E, under rocks and logs, vine forest, coll. J. Staniscic, L. Holcroft, 17.xi.2016.

Diagnosis. Shell tiny, subdiscoidal with an elevated domed spire; protoconch spiral comprising widely spaced, broad spiral cords,

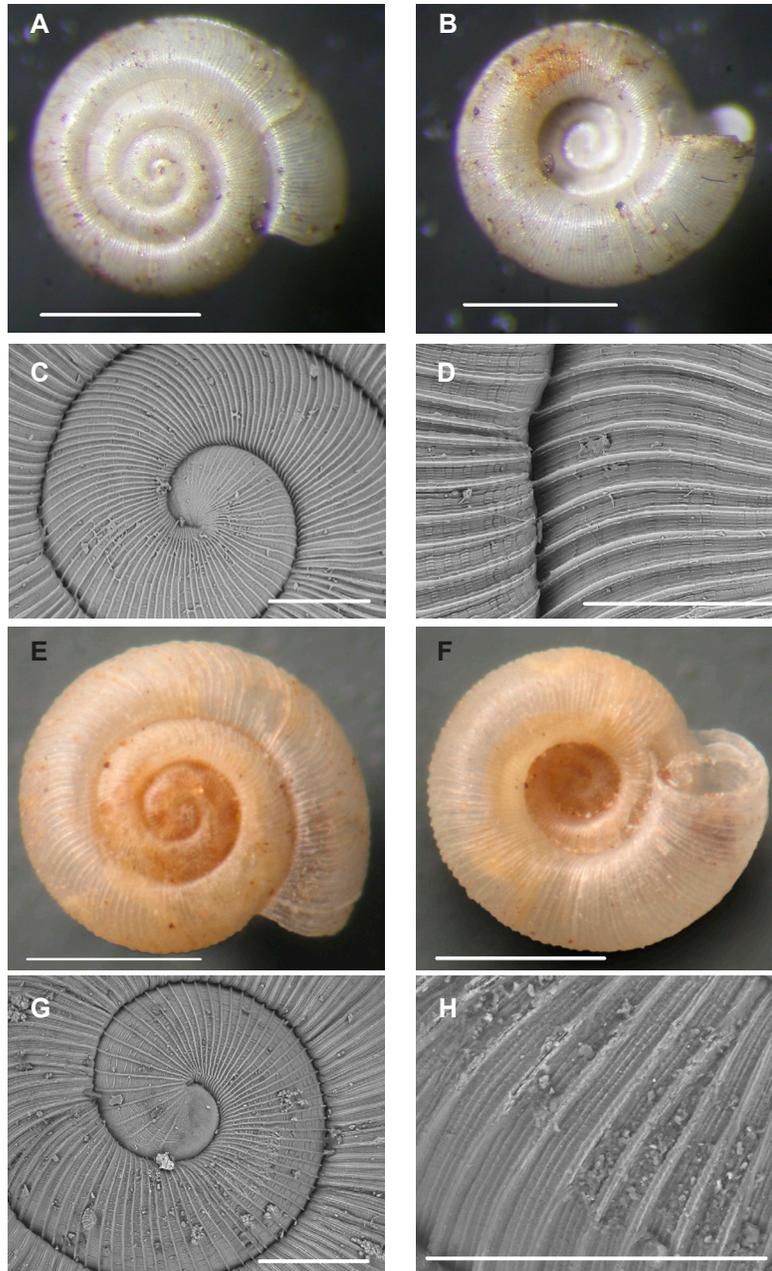


FIG. 4. **A-D**, *Albiropa microscopica* gen. et sp. nov., Diamond Cliffs, MEQ. A-B, QMMO85314, paratype. A, apical view. B, umbilical view. **C-D**, QMMO86563, holotype. C, protoconch showing crowded radial ribs and continuous spiral cords; D, teleoconch showing broad spiral cords and elongate beading. **E-H**, *Discocharopa aperta*, E-F, QMMO17312, Mt Etna, SEQ. E, apical view; F, umbilical view. G, AMSC152150, Brandy Creek, Conway NP, MEQ. Protoconch showing radial ribs and interrupted spiral wrinkles. H. QMMO50882, Rocky Creek, Eungella NP, MEQ. Teleoconch showing serrated microradial ribs. A-B, E-F: scale lines = 0.5 mm; C-D, G-H: scale bars = 100 μ m.

teleoconch with widely spaced, bladed radial ribs, mean 22 on the first whorl; microsculpture of raised microradial threads continuous on the major ribs and low, crowded, prominent spiral cords; umbilicus wide saucer-shaped.

Description. Shell tiny, golden-brown, sub-discoidal, with an elevated domed spire; whorls rounded 4.375-4.675, sutures strongly impressed; diameter of shell 2.54-2.70 mm (mean 2.70 mm), height 1.39-1.50 mm (mean 1.56 mm), H/D 0.51-0.58 (mean 0.55). Protoconch flat of 1.5 whorls, diameter 570 μ m, sculpture spiral with widely spaced, broad spiral cords, teleoconch with widely spaced, bladed radial ribs, 17-25 (mean 22) on the first whorl; microsculpture of raised microradial threads continuous on the major ribs and low, crowded, prominent spiral cords that form beads at the intersection with the microradial threads; aperture ovately lunate with margins approximating; umbilicus wide saucer-shaped, diameter 0.98-1.07 (mean 1.05 mm), D/U 2.54-2.69 (mean 2.59). Based on 4 measured adult specimens (QMMO85346 [3], QMMO85341 [1]).

Distribution and habitat. Thus far only known from Cherry Tree Creek (Crediton SF) and Hatfield's Gap, MEQ; in dry rainforest living under rocks and logs.

Remarks. *Omphaloropa subvaricosa* sp. nov. represents the first record of the genus in MEQ. A single species *O. varicosa* Stanisic, 1990 was previously recorded from SEQ (Stanisic 1990). *Omphaloropa subvaricosa* differs from its southern congener in having a larger, monochrome golden-brown shell characterised by larger diameter whorls, regularly spaced radial ribs on the teleoconch, a more elevated spire and smaller umbilicus. *O. varicosa* has a smaller, flammulated shell with more closely spaced radial ribs on the teleoconch that become very crowded and irregular on the last quarter of the body whorl. The apparent disjunct distribution of *O. subvaricosa* in the geographically distant rainforests of Cherry Tree Creek in the Crediton SF, Clarke Range and those of Hatfields Gap on the eastern escarpment of the Clarke Range may simply reflect an artefact of collecting with the gap

liable to be filled with additional fieldwork. Alternatively, the distribution may represent a species that has survived continental aridification but has been restricted in range as broadacre rainforests gave rise to smaller isolated patches of dry vine forest.

Sinployea Solem, 1983

Sinployea Solem, 1983: 81; Stanisic, 1990: 205; Smith, 1992: 205; Stanisic *et al.*, 2010: 248.

Type species. *Sinployea peasei* Solem, 1983-by original designation.

Diagnosis. Shell tiny, cinnamon brown, discoidal with a low to flat spire; whorls rounded, sutures deeply impressed; protoconch spiral comprising low, flattened widely spaced spiral cords, teleoconch sculpture of crowded, curved radial ribs, microsculpture of microradial threads and low spiral cords; umbilicus wide V-shaped.

Remarks. Stanisic (1990) introduced the chiefly Pacific Basin *Sinployea* Solem, 1983 to the Australian region for the first time for *Cralopa intensa* Iredale, 1941 from Byron Bay, NE NSW and extended the range of the species to near Gladstone, SEQ. Subsequently Stanisic (in Stanisic *et al.* 2010) also added *Endodonta* (*Charopa*) *intermedia* Odhner, 1917 from the Wet Tropics, NEQ to the genus. The following records of *S. intensa* represent the first records of the genus in MEQ.

Sinployea intensa (Iredale, 1941) (Figs 6A, B; 7A, B)

Cralopa intensa Iredale, 1941a: 269.

Sinployea intensa (Iredale). Stanisic, 1990: 206; Stanisic *et al.*, 2010: 248.

Type locality. Byron Bay, NENSW.

Common name. Southern Cinnamon Pinwheel Snail.

Material examined. All MEQ. QMMO11733, c. 19k N. of Proserpine, beside Gregory R., 20°17' S, 148°35' E, J. Stanisic, 6.vii.1982; QMMO13084, Bells Gap, Sarina Ra, c.15 km S Sarina, 21°31' S, 149°07' E, J. Stanisic, 7.vii.1982; QMMO13454, Eungella NP, Broken R, 21°10' S, 148°30' E, J. Stanisic, 5.vii.1982; QMMO13475, c. 36.7k N. of Mackay, on Mackay-Seaforth Rd., 21°00' S, 148°52' E, J. Stanisic, 3.vii.1982; QMMO35808, Endeavour Ck, Upper Reaches, Clarke Ra, W of Mackay, 21°15'30" S, 148°37'30" E, coll. J. Stanisic, D. Potter, 20.v.1990; QMMO59644, Eungella NP, Dalrymple

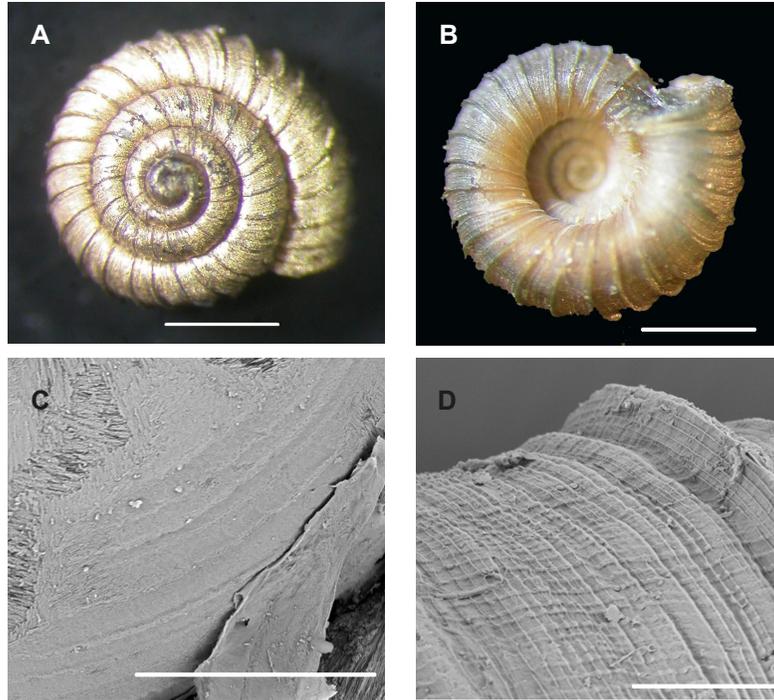


FIG. 5. *Omphaloropa subvaricosa* sp. nov., QMMO86564, holotype, Hatfields Gap, MEQ. **A**, apical view; **B**, umbilical view; **C**, protoconch showing low, widely spaced spiral cords; **D**, teleoconch showing microsculpture. A-B: scale lines = 1 mm; C-D: scale bars = 100 μ m.

Heights, 21°2' S, 148°36' E, 1000 m, coll. M.J. Bishop, xi.1976; QMMO35621, Mt Macartney, slopes, Cathu Forest Drive, SW Proserpine, 20°50' S, 148°33' E, 800 m, coll. J. Stanisic, D. Potter, N. Potter, 18.v.1990.

Description. Shell tiny (mean diameter 2.66 mm), brown, discoidal with low to flat spire and relatively few rounded whorls, sutures deeply impressed; protoconch spiral, sculptured with 10-12 low, flattened, widely spaced spiral cords, teleoconch sculpture of crowded, curved radial ribs, microsculpture of microradial threads and low, broad spiral cords; umbilicus wide, V-shaped.

Remarks. *Sinployea intensa* is characterised by a spiral protoconch in which the spiral cords are relatively widely spaced and flattened (Fig. 7A). The MEQ specimens cited above are the first record of the species from the region and correspond with the southern specimens in most details except size. The MEQ specimens are larger in both mean diameter (2.46 mm cf.

2.30 mm) and mean height (1.39 mm cf. 1.13 mm) but there is not enough evidence from general shell features of the available material to identify the MEQ specimens as a new species of *Sinployea* at this stage.

Comularopa Holcroft, 2018

Comularopa Holcroft, 2018c: 16.

Type species. *Comularopa georginae* Holcroft, 2018c-by original designation.

Diagnosis. Shell tiny, brown, nautilus-like with evenly coiled whorls and a slightly sunken spire; sutures strongly impressed; protoconch sculpture spiral with 11-14 thin, moderately spaced spiral cords, teleoconch with very crowded radial ribs, umbilicus moderately wide, V-shaped.

Remarks. *Comularopa* is differentiated from *Eungellaropa* gen. nov. primarily by the number of apical spiral cords (10-14 in *Comularopa* compared with 7-8 in *Eungellaropa*). Another

characteristic feature of *Comularopa* are the strongly impressed, almost furrowed sutures. *Sinployea intensa* also has a similar number of apical cords but these are broadly flattened compared with the crisp, raised spiral cords of *Comularopa*.

***Comularopa wendyae* sp. nov.**
(Figs 6C, D; 7C, D)

Etymology. Named for Wendy Dick, sister of one of the authors (LH).

Preferred **Common name.** Wendy's Pinwheel Snail.

Material examined. Holotype. AMSC340763, RC, Eungella Range, 50 miles W of Mackay, MEQ, 21° 04' S, 148° 36' E, coll. L. Price, ix.1957. Height of shell 1.48 mm, diameter 2.87 mm, width of umbilicus 0.98 mm, D/U 2.92, H/D 0.51, whorls 4.000.

Diagnosis. Shell tiny, brown, nautiliform with evenly coiled whorls and a slightly sunken spire; sutures strongly impressed; protoconch spiral comprising 11-14 thin, evenly spaced spiral cords; teleoconch with crowded radial ribs, 76 on the first whorl; umbilicus moderately wide, V-shaped.

Description. Shell tiny, brown, nautiliform, whorls slightly shouldered above and rounded below the periphery with a sunken spire, whorls 4, sutures strongly impressed; diameter of shell 2.87, height 1.48 mm, H/D 0.51; protoconch flat, 1.5 whorls, diameter 570 µm, spiral with 11-12 thin widely and evenly spaced spiral cords; teleoconch with crowded radial ribs, 76 on the first whorl; microsculpture of prominent microradial threads and low microspiral cords that buttress the microradial threads and form small beads at their intersection; aperture ovately lunate; umbilicus wide V-shaped, diameter 0.98 mm, D/U 2.92. Based on 1 measured specimen (AMSC340763).

Distribution and habitat. Clarke Range (=Eungella Range), west of Mackay, MEQ; presumably in rainforest under logs.

Remarks. *Comularopa wendyae* sp. nov. is distinguished from all other MEQ nautiliform charopids hitherto recorded by the combination of tiny shell with evenly coiled whorls, strongly impressed sutures (Fig. 6C) and protoconch

sculpture of 11-12 widely spaced spiral cords (Fig. 7C). *C.wendyae* differs from *C. georginae* by having a larger shell with fewer radial ribs on the teleoconch (76 in the former compared with 132 in the latter). In general shell features *C. wendyae* resembles both *Eungellaropa crediton* sp. nov. and *Sinployea intensa*. *E. crediton* has fewer apical spiral cords, rounded whorls and an elevated spire. *S. intensa* has a similar number of apical cords but these are flattened and broad. Holcroft (2018b) listed this specimen of *S. wendyae* among a number of specimens identified as *S. intensa*.

***Eungellaropa* gen. nov.**

Type species. *Eungellaropa crediton* sp. nov.

Etymology. For the township of Eungella; and a contraction of Charopa.

Diagnosis. Shell tiny, creamy beige to brown, discoidal with evenly coiled, rounded whorls and a slightly raised spire; protoconch spiral with 7-9 thin, high spiral cords; teleoconch with crowded radial ribs, microsculpture of prominent microradial threads and numerous, low microspiral cords forming small beads at their intersection; umbilicus moderately wide, V-shaped.

Remarks. *Eungellaropa* gen. nov. differs from *Comularopa* which also has a spiral protoconch by having a larger shell with fewer, more widely spaced spiral cords on the protoconch (7-8 in *Eungellaropa* compared with 10-14 in *Comularopa*). *Eungellaropa* has rounded whorls with a slightly raised spire in contrast to a shell with shouldered whorls and depressed spire in *Comularopa*. The difference in apical whorl numbers is the primary character for generic separation but the coiling pattern and general shell shape also distinguish *Eungellaropa* from *Comularopa*.

***Eungellaropa crediton* sp. nov.**
(Figs 6E, F; 7E, F)

Etymology. For the locality of Crediton.

Preferred **Common name.** Eungella Pinwheel Snail.

Material examined. All MEQ. Holotype. QMMO85086, RC, Eungella NP, off Eungella Dam Rd, rainforest,

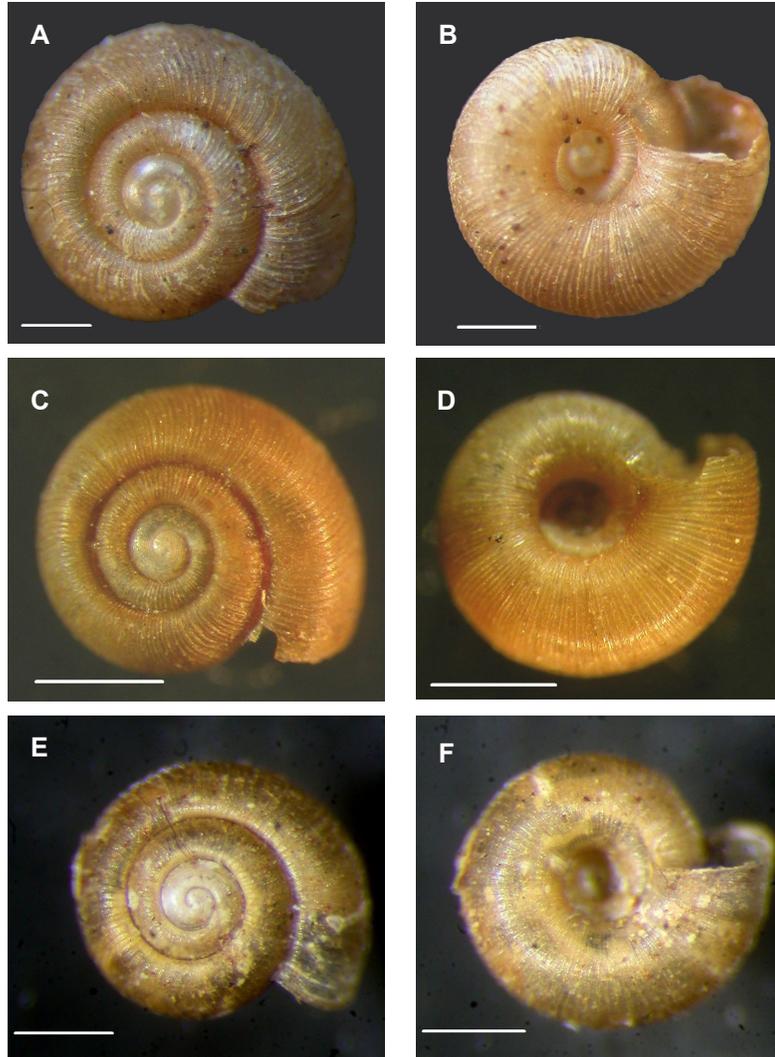


FIG. 6. A-B, *Sinployea intensa*, AMSC63769, Byron Bay, NENSW. **A**, apical view; **B**, umbilical view. C-D, *Comularopa wendyae* sp. nov. AMSC340763, holotype, Eungella Range, MEQ. **C**, apical view; **D**, umbilical view. E-F, *Eungellaropa crediton* gen. et sp. nov., QMMO85086, holotype, Eungella Dam Rd, MEQ. **E**, apical view; **F**, umbilical view. A-B, E-F: scale lines = 0.5 mm; C-D: scale lines = 1 mm.

21.143°S, 148.497°E, 800 m site 2 (rep 1), litter, 766 m, coll. C.Burwell, C.Gely, 18.iii.2014. Height of shell 0.82 mm, diameter 1.56 mm, width of umbilicus 0.49 mm, D/U 3.17, H/D 0.53, whorls 3.375.

Paratypes. QMMO9724, 5 subadults RC, Crediton Ck, Eungella NP, 21°11' S, 148°32' E, 850 m, coll. M. Bishop, xi.1976.

Other material. QMMO59647, 3 juvenile RC, Diggings Rd, Eungella NP, 21°9' S, 148°29' E, coll. J. Stanisc, 8.vii.1982; QMMO85096, 1 juvenile RC, Eungella NP, Finch Hatton Gorge, rainforest, 21.062°S, 148.636°E, 400 m site 1 (rep 2), litter, 371 m, coll. C.Burwell, 16.iii.2014.

Diagnosis. As for genus.

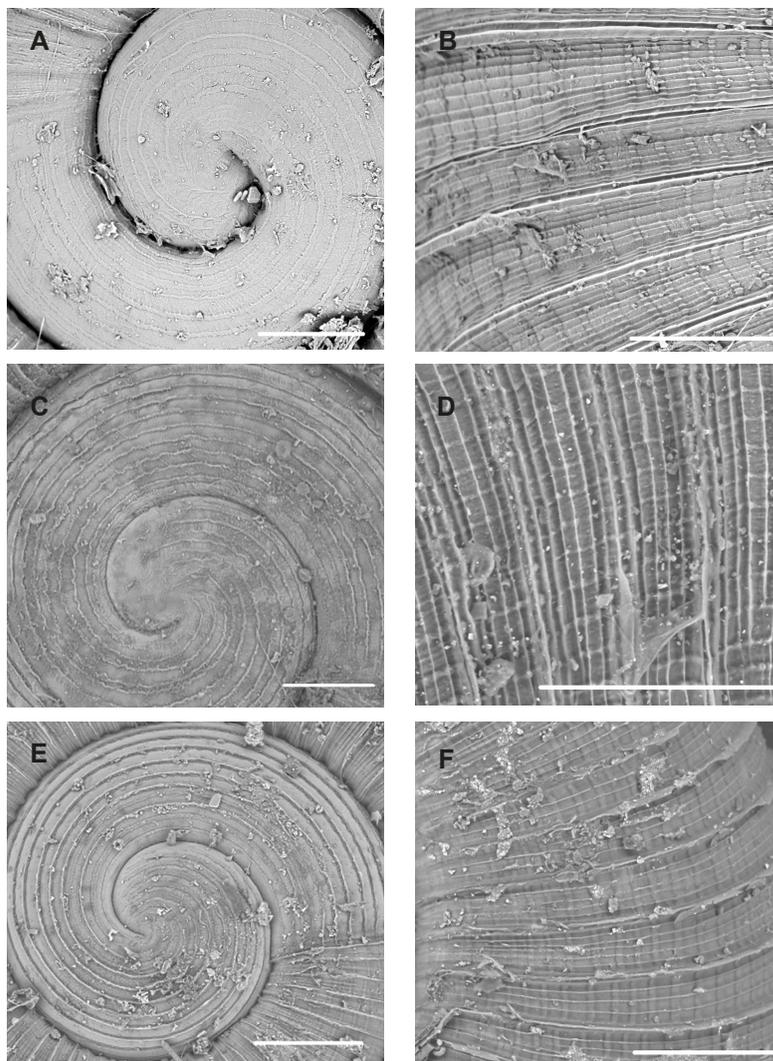


FIG. 7. A-B, *Sinployea intensa*, QMMO13475, Mackay-Seaforth Road, MEQ. A, protoconch showing flattened spiral cords; B, teleoconch showing broad spiral cords and elongate beading. C-D, *Comularopa wendyae* sp. nov. AMSC340763, holotype, Eungella Range, MEQ. C, protoconch showing slightly wavy spiral cords; D, teleoconch showing narrow spiral cords buttressing microradial threads and associated beading. E-F, *Eungellaropa crediton* gen. et sp. nov. QMMO59647, Diggings Rd, Eungella, MEQ. E, protoconch showing well-spaced, high spiral cords; F, teleoconch showing bladed major ribs and microsculpture with low, broad spiral cords. Scale bars = 100 μ m.

Description. Shell tiny, golden-brown, discoidal, with rounded whorls and a slightly evert spire, whorls 3.0-3.375, sutures moderately impressed; diameter of shell 1.48-1.56 mm (mean 1.43 mm), height 0.82 mm, H/D 0.53-0.56 (mean 0.54).

Protoconch flat, 1.5 whorls, diameter 410 μ m, sculpture spiral with 7-8 thin, high spiral cords; teleoconch with crowded radial ribs, 54-64 (mean 59) on the first whorl; microsculpture of prominent microradial threads over numerous,

low microspiral cords forming small beads at their intersection; aperture ovately lunate; umbilicus wide V-shaped, diameter 0.49–0.57 mm (mean 0.53 mm), D/U 2.57–3.17 (mean 2.87). Based on 2 measured specimens (QMMO85086, QMMO9724).

Distribution and habitat. Eungella NP (Crediton, Finch Hatton Gorge, Diggings Rd), MEQ; in moist humid rainforest living under logs.

Remarks. *Eungellaropa crediton* sp. nov. can be distinguished from the sympatric *Comularopa georginae* by having a smaller, golden-brown shell with rounded rather than shouldered whorls, a slightly raised spire (depressed in the latter), fewer more widely spaced spiral cords (Fig. 7E) and more widely spaced teleoconch ribbing. Shell diameter, height and umbilical width are much smaller than that of *C. georginae* which has a nautiloid shell with a much wider almost U-shaped umbilicus.

Amfractaropa Holcroft, 2018

Amfractaropa Holcroft, 2018c: 15.

Type species. *Amfractaropa bretti* Holcroft, 2018c-by original designation.

Diagnosis. Shell tiny, discoidal, nautiliform with a slightly sunken spire; protoconch spiral, of 1.75 whorls with broad spiral cords initially and broad radial ridges only appearing after 1.25 whorls; teleoconch with very crowded radial ribs, umbilicus wide, V to U-shaped.

Amfractaropa southpercyensis sp. nov. (Fig. 8A–D)

Etymology. Named for South Percy Island.

Preferred Common name. South Percy Pinwheel Snail.

Material examined. Holotype. QMMO77210, South Percy I., lagoon area, SEQ, 21°46'S, 150°20'E, eucalypt forest, coll. D. Cook, H. Janetzki, 26.xi.1992. Diameter 4.18 mm, height 2.21 mm, with of umbilicus 0.57 mm, H/D 0.53, D/U 3.64, number of whorls 4.375.

Diagnosis. Shell tiny, brown, discoidal, nautiliform with a slightly sunken spire; protoconch spiral comprising low spiral cords initially giving rise to bold radial ribs on the last quarter of the protoconch; teleoconch with crowded radial ribs, 64 on the first whorl; umbilicus wide U-shaped.

Description. Shell tiny, brown, discoidal, nautiliform with a slightly sunken spire; whorls 4.375, sutures moderately impressed; diameter of shell 4.18 mm, height 2.21 mm, H/D 0.53. Protoconch flat of 1.75 whorls, sculpture spiral with low spiral cords initially giving rise to bold radial ribs toward the protoconch-teleoconch boundary; teleoconch with crowded radial ribs, 64 on the first whorl; microsculpture of microradial threads and very low spiral cords buttressing against the radial threads and forming a small bead at their intersection; aperture ovately lunate; umbilicus wide U-shaped, diameter 0.57 mm, D/U 3.64. Based on 1 adult specimen (QMMO77210).

Distribution and habitat. Known only from South Percy Island, MEQ; living in eucalypt woodland presumably under logs and rocks.

Remarks. *Amfractaropa southpercyensis* sp. nov. is placed in *Amfractaropa* on the basis of protoconch sculpture consisting of early spiral cords followed by dominant radial ribs only on the last quarter of the longer than normal protoconch (Fig. 8D). *Amfractaropa southpercyensis* differs from the type of the genus, *A. bretti* Holcroft, 2018 by being larger and having fewer radial ribs on the teleoconch. *Amfractaropa southpercyensis* is broadly similar to *Whitcochlea iuloidea* (Forbes, 1851) in having a large, brown shell with similar shell height, umbilical width and apertural height. However it can be readily distinguished from *W. iuloidea* by the combination of protoconch sculpture featuring spiral cords initially and dominant radials on the latter third of the protoconch (= bimodal *sensu* Hyman & Stanisic, 2005: 292) compared with a singular pattern of dominant crowded spirals cords over low radials ribs in *W. iuloidea*. *Amfractaropa southpercyensis* also has much denser radial ribbing on the teleoconch (mean 51 ribs on the third quarter of body whorl as opposed to an average of 25 on the third quarter of the body whorl of *W. iuloidea*). *Amfractaropa southpercyensis* represents the only charopid thus far recorded from the Northumberland Group of islands.

A 'bimodal' protoconch is also present in the southern *Diphyoropa* Hyman & Stanisic,

2005 and was originally documented in the Sydney Basin *D. saturni* (Cox, 1868) by Hyman & Stanisic (2005). However, *Amfractaropa* differs from *Diphyoropa* in the structure and abundance of the spiral cords which are more numerous, less bold and more evenly spaced in the former than those of *Diphyoropa*. Bimodal protoconch sculpture is also a feature of many putative undescribed species from SEQ (Stanisic unpub.). Whether these belong in the current genus and thus extending its distribution significantly or to *Diphyoropa* is open to future investigation.

Isolderopa Stanisic, 2010

Isolderopa Stanisic, 2010 in Stanisic *et al.*, 2010: 260; Holcroft 2018d: 94.

Type species. *Isolderopa iangallowayi* Stanisic, 2010-by original designation.

Diagnosis. Shell minute to tiny, golden-brown to brown, with a depressed to very depressed, rarely flat spire, whorls numerous and very tightly coiled; protoconch sculpture finely cancellate consisting of 12-17 scalloped, fine, crisp, crowded spiral cords and widely spaced, strong radial ribs; teleoconch sculpture of densely crowded radial ribs, microsculpture of microradial threads and low spiral cords; apertural barriers usually present, umbilicus wide V-shaped to wide cup-shaped.

Remarks. The combination of a strongly sunken spire with more prominent apical spiral cords, numerous tightly coiled whorls and apertural barriers separate *Isolderopa* from *Tristanoropa* gen. nov. The species described below has a flat spire but in all other respects conforms to the *Isolderopa* plan.

Isolderopa gloucester sp. nov. (Fig. 8E-F)

Etymology. For Gloucester Island, MEQ.

Preferred Common name. Gloucester Island Pinwheel Snail.

Material examined. Holotype. QMMO71737, RC, Gloucester I., E of Bowen, MEQ, sev't, 20°00'44" S, 148°27'03" E, in litter, coll. J. Stanisic, G. Ingram, 1.x.2002. Height of shell 0.82 mm, diameter 1.39 mm,

width of umbilicus 0.57 mm, D/U 2.43, H/D 0.59, whorls 4.125.

Diagnosis. Shell minute, discoidal with numerous tightly coiled whorls and a flat to slightly raised spire; protoconch finely cancellate sculptured with scalloped, crowded spiral cords and low radial ribs forming a web-like pattern; teleoconch with numerous, extremely crowded radial ribs; three vertical palatal barriers present in aperture; umbilicus wide, cup-shaped.

Description. Shell minute, golden brown, discoidal, with a flat to slightly raised spire; whorls 4.125, sutures moderately impressed; diameter of shell 1.39 mm, height 0.82 mm; H/D 0.59, protoconch diameter 410 µm. Protoconch of 1.5 whorls, finely cancellate comprising thin, numerous scalloped spiral cords and low radial ribs forming a web-like pattern; teleoconch with extremely crowded radial ribs, 121 on the first whorl; microsculpture of microradial threads and numerous, low, prominent microspiral cords rising over the microradials forming a short bead at their intersection; aperture ovately lunate with three vertical palatal barriers and three basal barriers; umbilicus open, wide cup-shaped, diameter 0.59, D/U 2.43. Based on 1 measured adult specimen (QMMO71737).

Distribution and habitat. Gloucester I., MEQ; in vine thicket, found in litter.

Remarks. *Isolderopa gloucester* sp. nov. is distinguished from most of its congeners by the combination of flat to slightly raised spire (Fig. 8E) and extremely crowded radial ribs on the teleoconch and in having four palatal and four basal barriers (Fig. 8F). *Isolderopa gloucester* most closely resembles *I. whitsunday* Holcroft, 2018 in having very crowded radial ribs on the teleoconch (mean 118 on first whorl) and similarly configured apertural barriers but the former has a depressed rather than flat spire and more numerous barriers (five vertical and five basal).

Tristanoropa Holcroft, 2018

Tristanoropa Holcroft, 2018d: 98.

Type species. *Tristanoropa hughesae* Holcroft, 2018d-by original designation.

Thirteen new charopid land snails

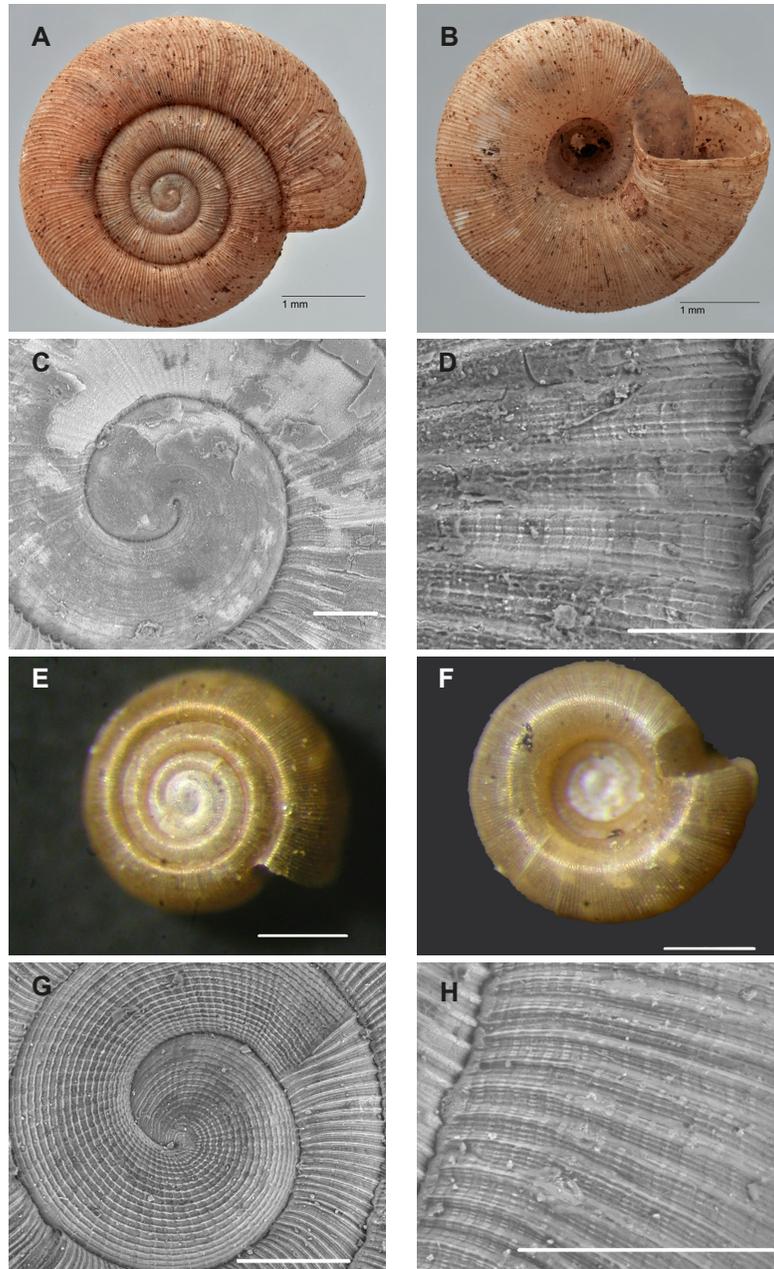


FIG. 8. **A-D**, *Amfractaropa southpercyensis* sp. nov., QMMO77210, holotype, South Percy Island, MEQ. A, apical view; B, umbilical view; C, protoconch showing bimodal sculpture; D, teleoconch showing beaded microsculpture. **E-H**, *Isolderopa gloucester* sp. nov., QMMO71737, holotype, Gloucester I., MEQ. E, apical view; F, umbilical view with apertural barriers visible through base of shell. G, protoconch showing finely cancellate sculpture; H, teleoconch showing broad spiral cords and elongate beading. A-B: scale lines as marked; E-F: scale lines = 0.5 mm; C-D, G-H: scale bars = 100µm. Images A-B: Geoff Thompson, QM.

Diagnosis. Shell tiny, brown, discoidal, multi-whorled with a flat to slightly raised spire, whorls numerous (> 4.5) and tightly coiled; sutures impressed; protoconch finely cancellate with 17-19 scalloped spiral cords and prominent radial ribs, teleoconch with crowded radial ribs. Apertural barriers may be present. Umbilicus wide V-shaped.

Remarks. *Tristanoropa* Holcroft, 2018 was introduced for mainland species with 4.5 or more tightly coiled whorls, wide U-shaped umbilicus, flat to slightly raised spire and a finely cancellate protoconch consisting of scalloped spiral cords and prominent radial ribbing in a web-like arrangement. The four species described below conform to this pattern in all respects and hence are assigned to *Tristanoropa* pending further study.

Tristanoropa southmolle sp. nov.
(Fig. 9A-D)

Etymology. For South Molle Island, MEQ.

Preferred Common name. South Molle Pinwheel Snail.

Material examined. Holotype. QMMO6347, South Molle I, Molle Channel, MEQ, 20°16' S, 148°50' E, coll. M. Bishop, xii.1976. Height of shell 0.66 mm, diameter 1.15 mm, width of umbilicus 0.41 mm, D/U 2.80, H/D 0.57, whorls 4.0.

Diagnosis. Shell minute, light brown, discoidal, multi-whorled with a flat spire, whorls numerous and tightly coiled; sutures impressed; protoconch finely cancellate with 17-19 scalloped spiral cords, protoconch length 1.500-1.625 whorls; teleoconch bladed with crowded radial ribs (mean 136 ribs on the first whorl); umbilicus wide V-shaped.

Description. Shell minute, light brown, discoidal with a flat spire; whorls 4.0, tightly coiled, sutures impressed; diameter of shell 1.15 mm, height 0.66 mm, H/D 0.57. Protoconch finely cancellate, flat, 1.5 whorls sculptured with scalloped, crowded spiral cords and radial ribs forming a web-like pattern; teleoconch sculpture of bladed, very crowded radial ribs 142 on the first whorl, microsculpture of microradial threads and low, broad spiral cords forming elongate beads at their intersection; a large

parietal barrier recessed about ¼ whorl back from the aperture; umbilicus wide, V-shaped, diameter 0.41 mm, D/U 2.80. Based on 1 measured adult specimens (QMMO6347).

Distribution and habitat. South Molle Island, MEQ; presumably in araucarian rainforest living in litter.

Remarks. *Tristanoropa southmolle* sp.nov. has a similar shell morphology and coiling pattern to *T. hughesae* and *T. conwayensis* Holcroft, 2018 but has a protoconch with radial rib spacing of about 5 µm as compared to the 10 µm in the previously assigned species. However, the scalloped cancellate protoconch pattern (Fig. 9C) is entirely comparable with that of *T. hughesae* and *T. conwayensis*. Hence, the species is placed in *Tristanoropa* pending further study. *T. southmolle* is distinguished from *T. conwayensis* from the Conway Range on the adjacent mainland by having a smaller shell diameter, a larger H/D ratio, much more crowded teleoconch ribbing and in possessing a parietal barrier.

Tristanoropa jaxut sp. nov.
(Figs 10A, B; 11A, B)

Etymology. Named for the Jaxut State Forest, MEQ.

Preferred Common name. Jaxut Pinwheel Snail.

Material examined. Holotype. QMMO86632, Jaxut SF, via Proserpine, MEQ, 20°48' S, 148°31' E, litter, coll. G. Annabell, 20.iv.1989. Height of shell 1.15 mm, diameter 2.30 mm, width of umbilicus 0.82 mm, D/U 2.80, H/D 0.50, whorls 5.250.

Paratypes. 13RC, QMMO85129, same data as holotype.

Diagnosis. Shell tiny, light brown, discoidal with a slightly raised spire and tightly coiled whorls; protoconch finely cancellate sculptured with scalloped, crowded spiral cords and radial ribs forming a web-like pattern; teleoconch with moderately crowded radial ribs (68 on the first whorl); umbilicus wide V-shaped.

Description. Shell tiny, light brown, discoidal with a slightly raised spire; whorls 4.125-5.250, tightly coiled, sutures impressed; diameter of shell 2.30-2.38 mm (mean 2.34 mm), height 1.15-1.31 mm (mean 1.23 mm), H/D 0.50-0.55 (mean 0.53). Protoconch finely cancellate, 1.5 whorls with

a diameter of 410 μm , sculptured with scalloped, crowded spiral cords and radial ribs forming a web-like pattern; teleoconch sculpture of bladed, moderately crowded radial ribs, 68 on the first whorl, microsculpture of microradial threads and low, vague microspiral cords; umbilicus wide, V-shaped, diameter 0.82 mm, D/U 2.80-2.90 (mean 2.85). Based on 2 measured adult specimens (QMMO86632, QMMO85129).

Distribution and habitat. Jaxut State Forest, SW of Proserpine, MEQ; vine forest found in litter.

Remarks. *Tristanoropa jaxut* sp. nov. resembles *T. summerae* sp. nov. but has a larger shell with wider umbilicus and more widely spaced radial ribs on the teleoconch. Presently known only from the Jaxut State Forest, MEQ.

Tristanoropa summerae sp. nov.
(Figs 10C, D; 11C, D)

Etymology. Named for the grand-daughter of one of the authors (JS).

Preferred Common name. Summer's Pinwheel Snail.

Material examined. Holotype. QMMO86634, St Helens Beach, at northern end, NE Mackay, MEQ, 20° 49' 34" S, 148° 50' 13" E, litter, coll. G. Annabell, 21.iv.1984. Height of shell 1.23 mm, diameter 2.05 mm, width of umbilicus 0.82 mm, D/U 2.50, H/D 0.60, whorls 5.625.

Paratypes. QMMO85135, 5RC, same data as holotype.

Other **Material examined.** QMMO85134, 1RC, St Helens Beach, at northern end, NE Mackay, MEQ, 20° 49' 34" S, 148° 50' 13" E, litter, coll. G. Annabell, 21.iv.1984; QMMO85144, 3RC, Cathu State Forest near O'Connell River, MEQ, 20° 49' S, 148° 36' E, litter, coll. G. Annabell, 10.iv.1982.

Diagnosis. Shell tiny, light brown, discoidal with a slightly raised spire and tightly coiled whorls; protoconch finely cancellate sculptured with scalloped, crowded spiral cords and radial ribs forming a web-like pattern; teleoconch with numerous, crowded radial ribs (mean 105 ribs on the first whorl) and vague microspiral cords; umbilicus wide V-shaped.

Description. Shell tiny, light brown, discoidal with a slightly raised spire; whorls 4.875-5.625, tightly coiled, sutures impressed; diameter of shell 1.80-2.05 mm (mean 1.91 mm), height

0.98-1.23 mm (mean 1.09 mm), H/D 0.55-0.60 (mean 0.57). Protoconch finely cancellate, 1.5 whorls with a diameter of 410 μm , sculptured with scalloped, crowded spiral cords and radial ribs forming a web-like pattern; teleoconch sculpture of bladed, very crowded radial ribs 104-105 (mean 105) on the first whorl, microsculpture of microradial threads and vague microspiral cords; umbilicus wide, V-shaped, diameter 0.66-0.82 mm (mean 0.71 mm), D/U 2.50-2.88 (mean 2.72). Based on 3 measured adult specimens (QMMO85134, QMMO85135, QMMO85144).

Distribution and habitat. St Helens Beach and Cathu State Forest, MEQ; in vine forest living under logs.

Remarks. *Tristanoropa summerae* sp. nov. differs from *T. hughesae* in having a slightly more elevated spire, less dense radial ribbing and barely visible microspiral cords on the teleoconch (Fig. 11D). In having a slightly raised spire *T. summerae* resembles *T. jaxut* sp. nov. but has a smaller shell, finer teleoconch sculpture and smaller umbilicus.

Tristanoropa hazelwood sp. nov.
(Figs 10E, F; 11E, F)

Etymology. Named for Hazelwood Creek Gorge, MEQ.

Preferred Common name. Hazelwood Pinwheel Snail.

Material examined. Holotype. QMMO85342, Hazelwood Creek, Lizzie Creek Rd, via Eungella Dam at pipeline crossing, MEQ, 21° 10' S, 148° 22' E, sevt, on banks under rocks, coll. J. Stanicic, L. Holcroft, 18.xi.2016. Height of shell 1.48 mm, diameter 2.87 mm, width of umbilicus 1.07 mm, D/U 2.54, H/D 0.58, whorls 4.625.

Diagnosis. Shell tiny, discoidal with numerous tightly coiled whorls; protoconch finely cancellate sculptured with scalloped, crowded spiral cords and radial ribs forming a web-like pattern; teleoconch with numerous, moderately crowded radial ribs (49 on the first whorl); umbilicus wide, V-shaped.

Description. Shell tiny, brown, discoidal, multiwhorled with a flat spire; whorls 5, sutures moderately impressed; diameter of shell 2.21 mm, height 1.23 mm; H/D 0.56. Protoconch of

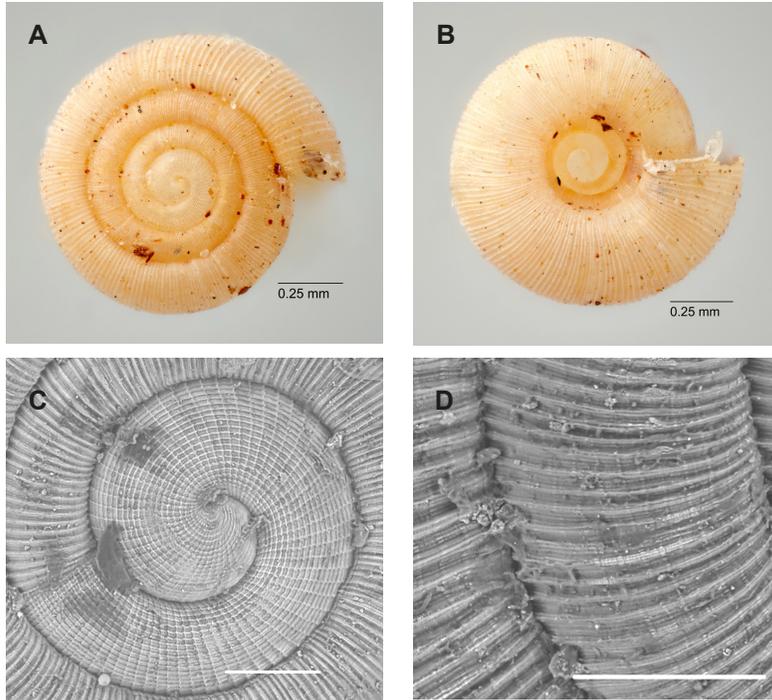


FIG. 9. *Tristanoropa southmolle* sp. nov., QMMO6347, holotype, South Molle I., MEQ. **A**, apical view; **B**, umbilical view; **C**, protoconch showing finely cancellate sculpture; **D**, teleoconch showing broad spiral cords and elongate beading. A-B: scale lines as marked; C-D: scale bars = 100µm. Images A-B: Geoff Thompson, QM.

1.625 whorls, diameter 410 µm, sculpture finely cancellate with thin, numerous spiral cords and radial ribs in a web-like pattern; teleoconch with moderately crowded radial ribs, 49 on the first whorl; microsculpture of microradial threads and numerous, low, prominent microspiral cords rising over the microradials forming a short bead at their intersection; aperture ovately lunate; umbilicus wide, V-shaped, diameter 0.82, D/U 2.70. Based on 1 measured adult specimen (QMMO85342).

Distribution and habitat. Hazelwood Creek gorge, Eungella Dam environs, MEQ; in vine thicket, found in litter under rocks.

Remarks. *Tristanoropa hazelwood* sp. nov. from Hazelwood Creek Gorge shares a multi-whorled coiling pattern similar, scalloped finely cancellate web-like protoconch and open V-shaped umbilicus with other *Tristanoropa* species but can be separated from its congeners by the

larger sized shell and having a much smaller number of ribs on the teleoconch.

PUTATIVE MEQ CHAROPID SPECIES NOT DESCRIBED AT THIS TIME

The following putative species are represented by juvenile or damaged shells and fragments that cannot be designated as holotypes for description. They have been identified as new species by their distinctive shell morphology which separates them from other MEQ charopids thus far described. Several probably represent new genera. These species will represent significant future additions to the charopid fauna of MEQ once formally described.

Comularopa Holcroft, 2018

Type species. *Comularopa georginae* Holcroft, 2018c-by original designation.

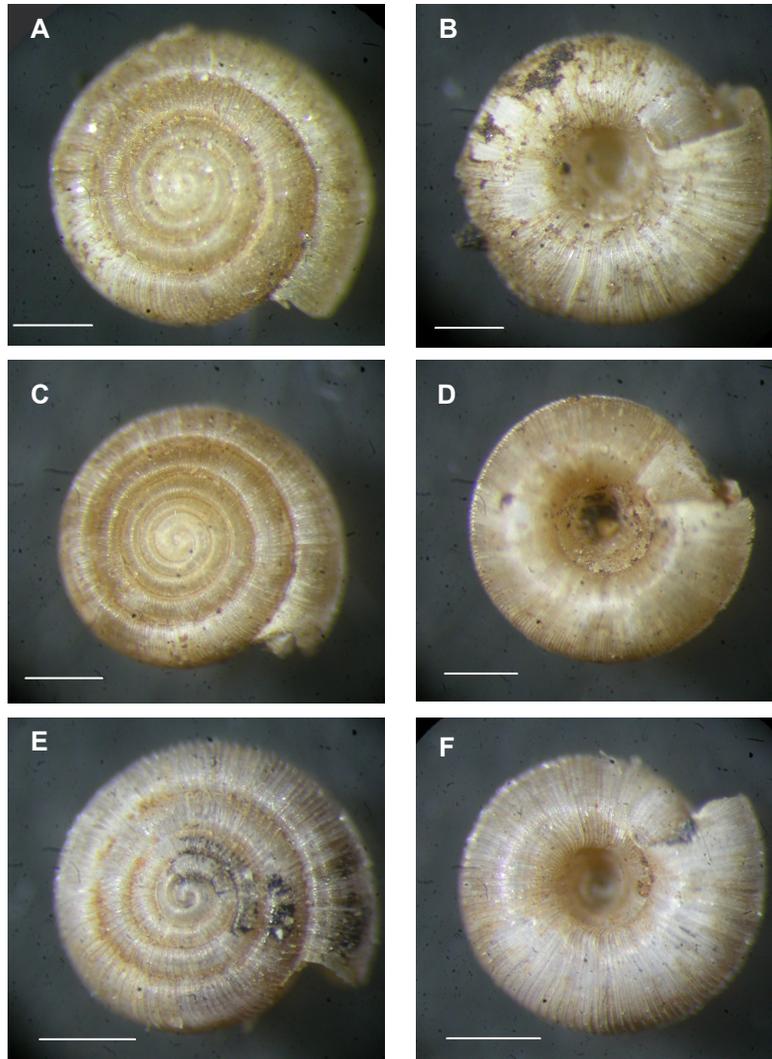


FIG. 10. A-B, *Tristanoropa jaxut* sp. nov., QMMO86632, holotype, Jaxut SF, MEQ. **A**, apical view; **B**, umbilical view. C-D, *Tristanoropa summaerae* sp. nov., QMMO86634, holotype, St Helen's Beach, MEQ. **C**, apical view; **D**, umbilical view. E-F, *Tristanoropa hazelwood* sp. nov., QMMO85342, holotype, Hazelwood Ck, MEQ. **E**, apical view; **F**, umbilical view. Scale lines = 0.5 mm.

***Comularopa* sp.**
(Fig. 12A-D)

Material examined. QMMO50890, 1 juvenile RC, Eungella NP, MEQ, 20°53' S, 148°35' E, coll. ANZSES, 25.xii.1993; QMMO85095, 1 juvenile RC, Eungella NP, Mt Dalrymple, MEQ, 21.026°S, 148.638°E, 1200 m site 4, 1225 m, rainforest, litter, coll. A. Nakamura, E. Leach, 2-12.iv.2014; QMMO86633, 1

subadult RC, Dalrymple Heights, Eungella NP, MEQ, 20° 02' S, 148° 35', nvf, coll. M. J. Bishop, xi.1976.

Remarks. The above three lots from Mt Dalrymple contain juvenile specimens with only one adult whorl. Protoconch sculpture is spiral with 10-12 raised cords present (Fig. 12B) and rib counts on the first adult whorl are approximately 120-130. Microsculpture

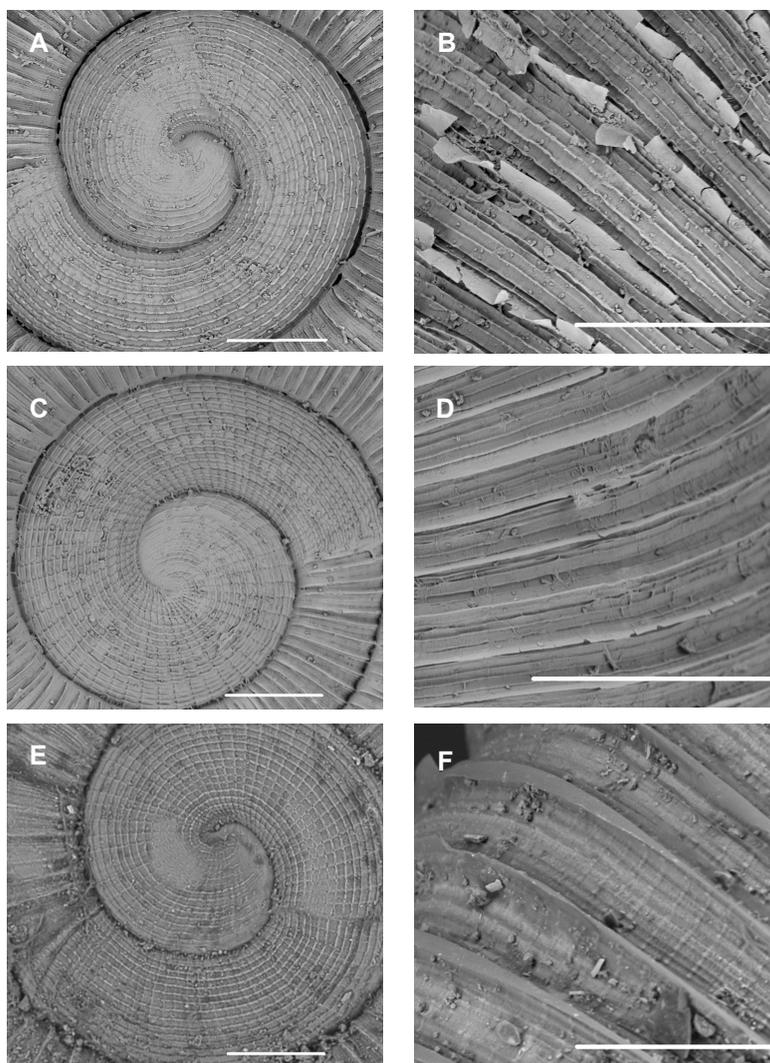


FIG. 11. A-B, *Tristaroropa jaxut* sp. nov., QMMO86632, holotype, Jaxut SF, MEQ; A, protoconch showing scalloped spiral cords; B, teleoconch showing bladed radial ribs and interstitial microradial threads. C-D, *Tristaroropa summerae* sp. nov., QMMO86634, holotype, St Helen's Beach, MEQ; C, protoconch showing finely cancellate sculpture; D, teleoconch showing bladed radial ribs and interstitial microradial threads. E-F, *Tristaroropa hazelwood* sp. nov., QMMO85342, holotype, Hazelwood Ck, MEQ. protoconch showing finely cancellate sculpture; D, teleoconch showing bladed radial ribs, low interstitial microradial threads and beading. Scale bars = 100µm.

consists of microradial threads and prominent, crowded, low microspiral cords forming buttresses and beads at their intersection. The specimens bear a close resemblance to *C. georginae* Holcroft, 2018 previously known only from the Crediton area, Eungella NP. The

one conflicting character in these specimens with those from Crediton is the intense spiral cording on the teleoconch (readily visible with an optical microscope) which is not present in *C. georginae* from Crediton. This could be local populational variation or it could indicate

a new species of *Comularopa*. Additional collecting, particularly on the higher elevations of Mt Dalrymple, is recommended in order to obtain adult specimens. Additional specimens of *C. georginae* from Crediton would also be helpful in resolving this issue.

Charopid MQ 48 (Fig. 12E-F)

Material examined. QMMO75828, 2 subadults RC, SW Sarina, c. 0.6 km SE Blue Mts, MEQ, 21°36' S, 148°58' E, coll., QM Party, 4.x.1999.

Distribution and habitat. Hitherto known only from the Blue Mountains area, MEQ; in dry rainforest found in litter.

Remarks. Charopid MQ 48 is represented by 2 subadult shells the largest of which is a damaged shell with diameter of 2.59 mm. The shell is horn-grey in colour with reddish brown flammulations, depressedly turbinate with a low spire and rounded whorls. The protoconch is sculptured with extremely crowded, broad and curved radial ridges and very low and very broad spiral cords only present towards the outer edge of the protoconch whorls, the radials and spirals fused thereby causing a pitted appearance; teleoconch sculpture consists of extremely crowded and strongly bladed radial ribs and a microsculpture of very low spiral cords, continuous on the base. The umbilicus is very narrow U-shaped almost pinhole. In general shell features the specimen bears some resemblance to species of *Ngairia* Stanistic, 1990 from NENSW and SEQ. However, the unusual protoconch sculpture has not been seen in any of the charopids described to date and would indicate allocation to a new genus. Additional adult specimens are required to affirm the identity of Charopid MQ 48.

Charopid MQ 18 (Fig. 13A, B)

Material examined. QMMO13074, 1 subadult RC (shell destroyed), Diggings Rd, Eungella NP, 21° 09' S, 148° 29' E, coll. J. Stanistic, 8.v.1982. height 1.15 mm, diameter of shell 1.64 mm, H/D 0.7, umbilical diameter 0.25 mm. D/U 6.67, number of whorls 3.125.

Distribution and habitat. Hitherto known only from Diggings Road, Eungella NP, MEQ; in rainforest found in litter.

Remarks. The specimen of Charopid MQ 18 was destroyed by ultrasonic cleaning. However the shell was examined, described and photographed prior to cleaning. The shell is cream-yellow with adhering dirt particles, subdiscoidal with 3 whorls and a low spire, the sutures are strongly impressed. Protoconch sculpture is superior radial consisting of prominent radial ribs and weak spiral cords. Teleoconch sculpture consists of very widely spaced, strongly bladed, sinuous radial ribs, 34 on the first whorl and a microsculpture consisting of numerous microradial threads and prominent, closely spaced spiral cords that rise over the microradials. The umbilicus is narrowly open, V-shaped. The general shell facies, comprising a waxy shell with dominant spiral sculpture and widely spaced radial ribs on the teleoconch, is reminiscent of some species of *Coenocharopa* Stanistic, 1990 which occur in NSW and SEQ (Stanistic 2010).

Charopid MQ 3 (Fig. 13C, D)

Material examined. QMMO50893, 1 subadult RC, Eungella NP, Urannah Ck headwaters, 20°54' S, 148°33' E, coll., ANZSES, 4.i.1994.

Distribution and habitat. Eungella NP, MEQ; in rainforest recovered from litter.

Remarks. Charopid MQ 3 is represented by one subadult shell, yellowish brown in colour, with broadly trochoidal shape and a low conical spire. The whorls are angulate and the umbilicus is narrow U-shaped. Protoconch sculpture shows traces of strongly curved radial ribs and very low spiral cords while the teleoconch sculpture is comprised of strongly curved and high-bladed radial ribs which form wing-like extensions at the whorl periphery and a microsculpture of very low, broad microspiral cords (Fig. 13D). The shell is covered with adhering dirt particles. In shell shape Charopid MQ 3 most closely resembles some of the *Coenocharopa* species from SEQ

which also include species with dirt covered shells and similar teleoconch sculpture.

Charopid MQ 34
(Fig. 13E, F)

Material examined. QMMO77454, 1 fragment RC, Mackay, WNW at Mt Blackwood, half way up south side, MEQ, 21°02'10" S, 148°57' E, 590 m, coll. QM party, 18.xi.1992.

Distribution and habitat. Known only from Mt Blackwood, MEQ; in rainforest found in litter.

Remarks. The specimen of Charopid MQ 34 comprises an extremely damaged shell with only the protoconch and a partial first whorl intact. The fragment of shell is yellowish brown, the protoconch sculpture is spiral with 7-8 high spiral cords and teleoconch sculpture consists of high, very widely spaced radial ribs. Microsculpture comprises 7-10 interstitial microradial threads that form elongate beads at their intersection with low microspiral cords. Protoconch sculpture is similar to that of *Eungellaropa* in having 7-8 widely spaced spiral cords and high, prominent and very widely spaced teleoconch ribs. However its generic status remains uncertain and additional material is needed to determine its affinities.

Mt Blackwood (altitude 639 m) is located east of the rainforests of the higher elevations of the Clarke Range (650-1200 m) and has similar vegetation to the drier araucarian forests of Mt Dryander and the Conway Range. Land snail collecting on the mountain, which has restricted access, has been sparse and there is a strong potential for finding many more charopid species on the peak. Currently this fragment represents the only known charopid specimen from the mountain.

Charopid MQ 28
(Fig. 14A-D)

Material examined. QMMO85098, 1 subadult RC, Owens Ck, Pelion SF, MEQ, 21.062°S, 148.677°E, 600 m site 7, rainforest, litter, 621 m, coll. C.Burwell, 29.iii.2014.

Distribution and habitat. Known only from Pelion SF in Finch Hatton Gorge, Eungella NP, MEQ; in rainforest recovered from litter.

Remarks. Charopid MQ 28 is represented by a biconcave subadult shell of 3.375 whorls but is immediately distinguished from other MEQ charopids by the combination of irregularly and finely beaded protoconch sculpture (Fig. 14C) and extremely fine and densely crowded radial ribs on the teleoconch (147 on the first adult whorl). The shell has a protoconch of 1.75 whorls, very deeply depressed spire and wide saucer-shaped umbilicus. Under optical microscopy, the protoconch has the appearance of frosted glass which when viewed by SEM is comprised of numerous tiny tubercles irregularly arranged in a vaguely spiral pattern. The only protoconch sculpture of the many charopids examined to date that most closely resembles the sculpture of Charopid MQ 28 is that of *Lithocouperia kalkajaka* Staniscic, 2016 from Black Mountain, near Cooktown, NEQ (Staniscic 2016). However, *L. kalkajaka* differs significantly in having a much larger shell and protoconch with the raised tubercles in more defined spiral rows. Charopid MQ 28 is considered to represent a new genus with likely congeners either in the Border Ranges, SEQ or Wet Tropics, NEQ suggesting early isolation in the CMC.

DISCUSSION

This paper concludes the trilogy of publications documenting the charopid fauna of MEQ that was begun by Holcroft (2018c, d). The first of these publications dealt with nine relatively large *Gyrocochlea*-grade species of which four previously described species were revised and three reassigned to new genera and five were described as new in newly diagnosed genera (Holcroft 2018c). The second article covered 12 very tiny species with finely cancellate sculptures of which six previously described species were redescribed and six were newly described in new and existing genera (Holcroft 2018d). With the completion of this study, the charopid fauna of MEQ stands at 37 species with an additional six considered to be putative new species but not yet formally described bringing the total to 43 species.

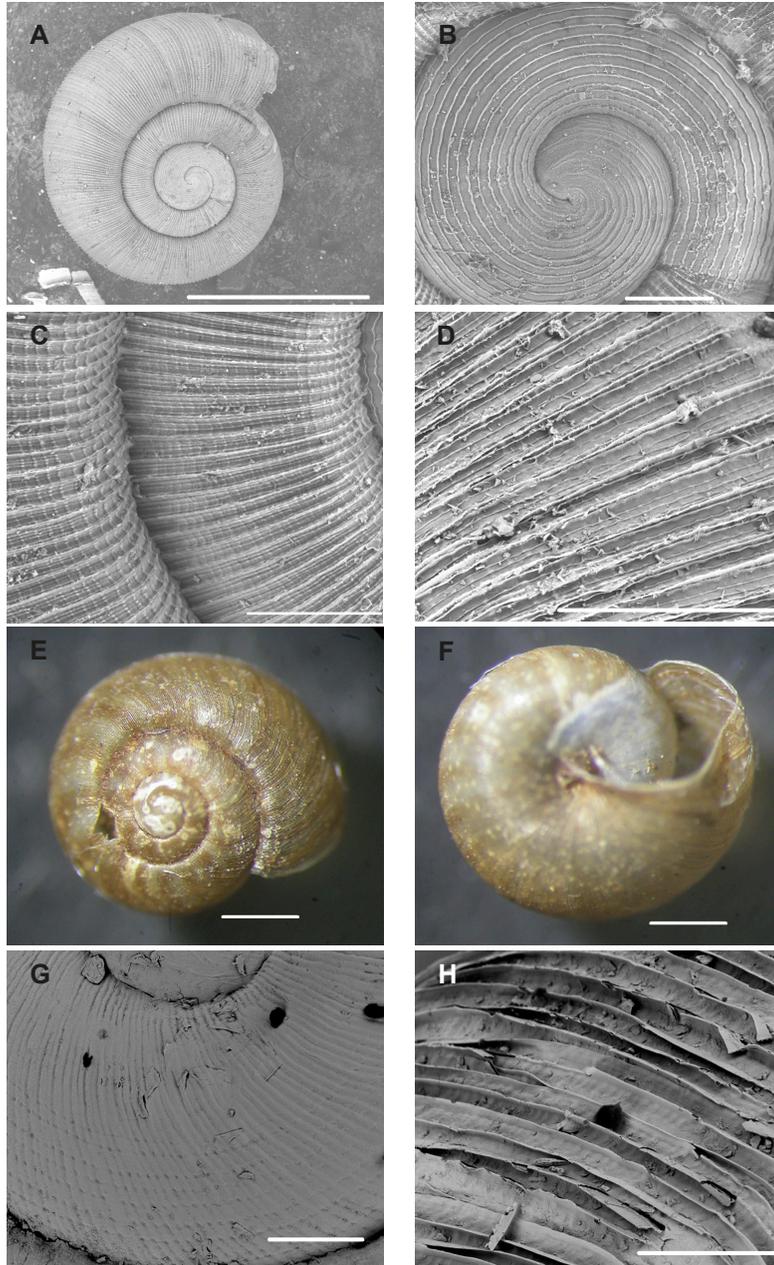


FIG. 12. A-D, *Comularopa* sp., QMMO86633, Dalrymple Hts, MEQ. A, apical view; B, protoconch showing wavy spiral cords; C-D, teleoconch sculpture. E-H, Charopid MQ48, QMMO75878, Blue Mts, MEQ; E, apical view; F, umbilical view; G, protoconch showing curved radials and pitted sculpture at outer edge; H, teleoconch showing crowded, bladed radial ribs and low, crowded microspirals. A-B, C-D, G, H: scale bars = 100µm; E-F: scale lines = 0.5 mm.

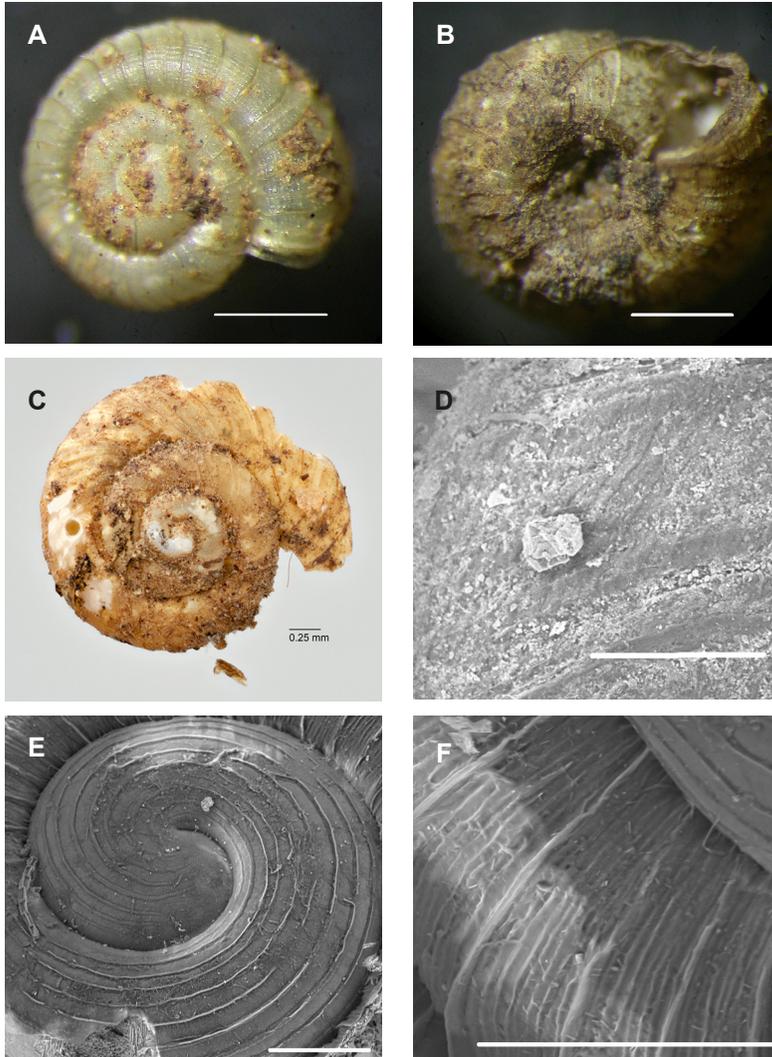
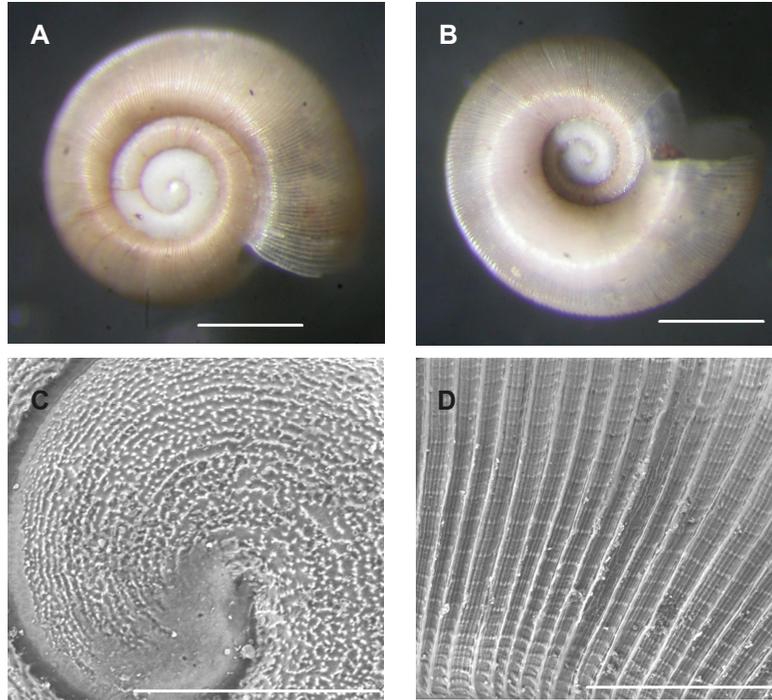


FIG. 13. A-B, Charopid MQ18, QMMO13074, Diggings Road, Eungella NP, MEQ. **A**, apical view; **B**, umbilical view. C-D, Charopid MQ3, QMMO50893, Eungella NP, MEQ; **C**, apical view; **D**, teleoconch showing low, broad spiral cords. E-F, Charopid MQ34, QMMO77454, Mt Blackwood, MEQ; **E**, protoconch showing widely spaced, high spiral cords; **F**, teleoconch sculpture of very widely spaced radial ribs and interstitial microradial threads. A-B: scale lines = 0.5 mm; C: scale line as marked; D-F: scale bars = 100µm.

Holcroft (2018c, d) dealt with mainly MEQ endemic genera and species. In contrast this study includes genera with congeners outside the Central Mackay Coast bioregion or species with more widespread distributions. Among the newly diagnosed genera in this study *Eungellaropa*, *Hirsutaropa* and *Burwellia* are identified as additional MEQ endemics.

All the charopids dealt with in the MEQ study are rainforest or dry vine thicket species and a feature of this fauna is the high number of genera represented (23) relative to species (37), many being monotypic. However, the study of the Charopidae in MEQ is only in its relative infancy despite the efforts of Holcroft (2018b). It is considered highly probable that additional



FIG, 14. A-D, Charopid MQ 28, QMMO85098, Pelion SF, Eungella NP, MEQ. **A**, apical view; **B**, umbilical view; **C**, protoconch showing vague spiral arrangement of low tubercles; **D**, teleoconch showing sculpture of very crowded radial ribs and beaded microsculpture. A-B: scale line = 0.5 mm; C-D: scale bars = 100µm.

targeted collecting, particularly of leaf litter in the key areas identified in that review, will result in the addition of more species to some of the genera.

Results to date have shown that only the 'finely cancellate' genera (*Pereduropa*, *Isolderopa* and *Tristanoropa*) have established significant radiations in the MEQ rainforests. Other genera show no such tendency.

Biogeographic implications. The relatively high generic diversity of the Charopidae in the MEQ rainforests is most likely the result of the initial period of species accumulation followed by large scale extinctions resulting from many episodes of climate-induced environmental sifting of mesic communities from mid-Miocene onwards (Kemp 1981). The gradual aridification of the continent since the late Tertiary (Miocene, Pliocene) resulting in the inexorable contraction of eastern

Australian rainforests would have had significant consequences for MEQ rainforests and their fauna. Climatic changes in the Quaternary were similar in amplitude to those experienced in the late Miocene and Pliocene but would have occurred in more rapid succession. Galloway & Kemp (1981) concluded that these changes must have placed considerable stress on montane and coastal environments and that the modern communities in these situations are recent phenomena consisting of biota that have survived in isolated refuges.

Winter's (1988) study of rainforest mammals of MEQ suggested that MEQ rainforests contracted to very small areas during this period whereby rainforest specialist mammals would not have survived. However, land snails do not require the same acreage of landscape in which to exist. Hence, throughout this period of mesic habitat reduction, the more robust of the charopid species would most likely have eked

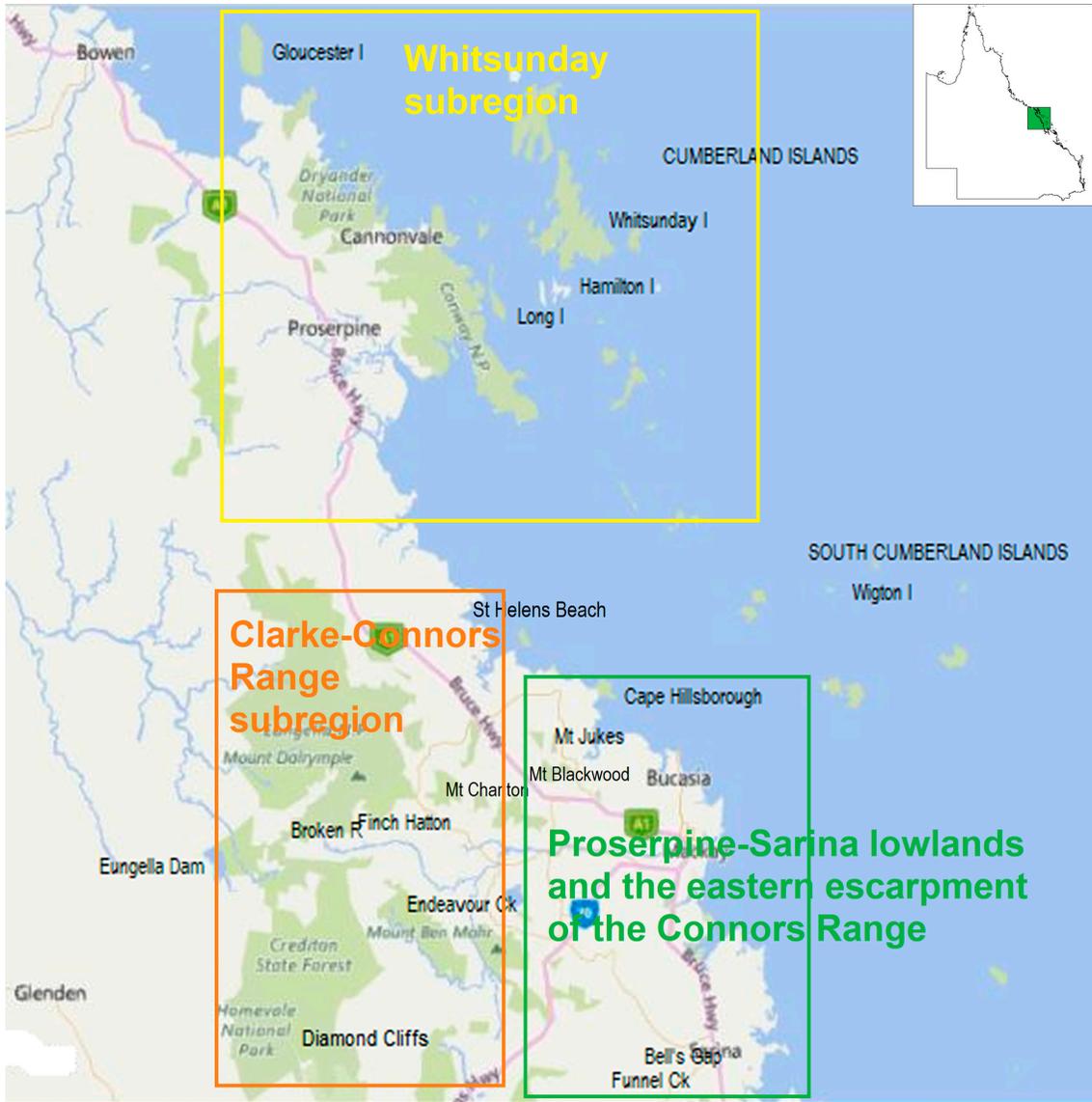


FIG. 15. Map showing major locations and collecting areas in MEQ [from Holcroft 2018d].

out an existence in arrow-head gullies, riparian habitats, small patches of drier rainforest and in scattered lithorefugia. Extinctions of less resilient species would have been widespread.

Joseph & Moritz (1993) in a study of MEQ rainforest birds provided mitochondrial evidence for the recent isolation of SEQ and

MEQ compared with the longer term isolation of NEQ rainforests from those of both SEQ and MEQ. Connections for the birds with the south would have continued through periods of climatic attrition to present day by way of smaller intervening patches of surviving drier rainforest. But it is highly unlikely that the low vagility, tiny pinwheel snails would

have recolonised MEQ rainforests from the south through this archipelago of dry vine forests once the link of continuous forest was broken. Therefore, it is logical to assume that the current charopid fauna of the Central Mackay Coast bioregion was probably molded in isolation during the many glacial episodes of the Plio-Pleistocene and 'set in stone' at the height of the last glacial.

Historical connections, with the rainforest massifs both to the south (Border Ranges) and north (Wet Tropics) probably dating to the formation of the Burdekin and St Lawrence Gaps dry corridors, are flagged by the presence of *Setomedeia janae* and *Lenwebbia marissae*. Unfortunately the support for an earlier isolation from the north versus south, as would be indicated by more affinities of the MEQ charopids with the southern taxa, is currently unavailable.

Intra-regionally the pinwheel snails provide broad evidence of persistent mesic refugia, however small, during the Plio-Pleistocene within the Clarke-Connors subregion (bioprovince) of the CMC bioregion. The monotypic genera *Burwellia*, *Eungellaropa* and *Comularopa* are endemic to higher elevations of the Clarke Range. With no known relatives outside this bioregion it can be assumed that these rainforest specialist charopid lineages either developed within refugia or as may be the case with the conchologically atypical *Burwellia staceythomsonae*, be leftover relicts of once more diverse and widespread lineages. The conchologically unusual *Hirsutaropa sarina* and Charopid MQ 48 indicate that the Blue Mountains and Funnel Creek (both riparian habitats) areas may also have been significant refugia for mesic species. The finely cancellate *Tristanoropa* has radiated extensively in the segregated patches of dry vine thicket within the CMC bioregion and may have affinities with species in similar habitat further to the south and in the Brigalow Lands bioregion to the west.

These biogeographic speculations signal the prospect of a charopid phylogeny judiciously informing our current understanding of

eastern Australian biogeography. However, a more rigorous biogeographic interpretation is contingent on a detailed study of the very large and diverse, but chiefly undescribed, charopid faunas of SEQ and NEQ currently represented and held in the collections of the Queensland Museum (Stanisic, pers. obs.).

CONCLUSIONS

Protoconch sculpture has been the basis for defining genera in this and the related studies of Holcroft (2018c, d) following on Holcroft (2018a)'s seminal investigation of eastern Australian charopid protoconchs. Holcroft's research showed that there was both a broad north-south and intra-bioregional distribution of the major protoconch sculptural configurations identified within the eastern Charopidae. The outcomes of the MEQ charopid study fully reflect this broad pattern. A high level of generic endemism within the charopids of the Central Mackay Coast bioregion is complemented by genera with more widespread connections to the north and south.

The three systematic publications emanating from the chiefly museum-based MEQ charopid study of Holcroft (2018b) have resulted in the description of 12 new genera and 24 new species from an area previously not renowned for its fauna of tiny pinwheel snails (Holcroft 2018c, d; this publication). This outcome poignantly highlights the broader taxonomic impediment facing this mega-diverse Gondwanan family in eastern Australia whereby large numbers of charopid species in museum collections await formal documentation.

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