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A new genus and three new species of Pinwheel Snails from Queensland and New South Wales (Gastropoda: Eupulmonata: Charopidae)

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ABSTRACT

A new genus and three new species of Charopidae (Pinwheel Snails) from differing habitats in Queensland and New South Wales are described: *Bindiropa irwiniae* gen. et sp. nov. from the Carnarvon Gorge Section of Carnarvon National Park, south-central Queensland; *Stanisicaropa covidurnus* sp. nov. from St Bees Island, mid-eastern Queensland; and *Gyrocochlea occidentalis* sp. nov. from the western Border Ranges, south-eastern Queensland and north-eastern New South Wales. An additional putative *Gyrocochlea* species from the Richmond Range, north-eastern New South Wales, represented by a single damaged shell, is figured but not described.

□ *Mollusca, Eupulmonata, Charopidae, Queensland, New South Wales, new genus, new species.*

Pinwheel Snails (Charopidae) are extremely diverse in the humid, wet rainforests and coastal vine thickets of eastern Australia. The family is considered to be a Gondwanan origin that has survived the vagaries of climate induced rainforest fragmentation since the Miocene. The vast majority of species now mainly live in moist humid rainforest and smaller isolated mesic refugia on mountain tops and in sheltered gullies. More recently, semi-evergreen vine thickets (dry rainforests) in the semi-arid Brigalow Lands bioregion have entered the spotlight of favoured habitats for these tiny snails (Stanisic 2020). In stark contrast, relatively few charopids have made the transition to the drier eucalypt forests an eastern Australia.

This publication describes three new species of pinwheel snail from differing forest habitats in southern, central and mid-eastern

Queensland and north-eastern New South Wales. These are variously assigned to *Bindiropa* gen. nov., *Stanisicaropa* Holcroft, 2018 and *Gyrocochlea* Hedley, 1924. An additional putative *Gyrocochlea* species from the Richmond Range, north-eastern New South Wales, represented by a single damaged shell, is figured but not formally described.

Abbreviations. *General.* alt, altitude; Ck, Creek; cnvf, complex notophyll vine forest; MEQ, mid-eastern Queensland; NP, National Park; NSW, New South Wales; NE NSW, north-eastern New South Wales; NP, National Park; nvf, notophyll vine forest; R, River; Ra, Range; SCQ, south-central Queensland; SEM, scanning electron microscopy; SEQ, south-eastern Queensland; sevt, semi-evergreen vine thicket; SF, State Forest; Stn, Station.

Material. A, adult; D/U, diameter/umbilical width; H/D, height/diameter; RC, dry specimen; SA, subadult; SC, spirit specimen.

MATERIALS AND METHODS

This study, with a single exception, is based on material housed in the Queensland Museum's land snail collections. Apart from several lots of preserved snails the study material is comprised chiefly of dead shells covering a range of age classes (mostly juvenile and sub-adult) recovered from leaf litter sorting. Investigations of shell characters are confined, with one exception, to specimens with greater than four whorls which designates an adult snail. Characters scored include shell diameter and height, protoconch whorl numbers and diameter, adult whorl count, rib count on the first whorl and umbilical width. Whorl counts were made to the nearest 1/8 whorl following Solem (1983). Use of the term nautiliform as applied to charopids alludes to a biconcave shell resembling that of a marine nautilus. Specimens were studied using a WILD M5 stereo microscope. High resolution images of shells were obtained using a Visionary Digital BK-Plus lab system camera set-up located in the Queensland Museum's Digital Imaging Unit (QMDIU). Shell sculpture was investigated and photographed using a TM-1000 Tabletop Scanning Electron Microscope (SEM) located in the Queensland Museum.

SYSTEMATICS

Class GASTROPODA

Order EUPULMONATA

Superfamily PUNCTOIDEA

Family CHAROPIDAE

Bindiropa gen. nov.

Type species. *Bindiropa irwinae* sp. nov.- herein designated.

Etymology. A combination of Bindi and a contraction of *Charopa*.

Diagnosis. Shell tiny, brown, discoidal and nautiliform with a depressed spire, whorls rounded, sutures impressed; protoconch pitted cancellate consisting of 19-21 low, broad spiral cords and thin sinuate radial ridges becoming more prominent toward the protoconch-teleoconch border; teleoconch sculpture of numerous, crowded, bladed radial ribs, microsculpture of fine radial threads and numerous low spiral cords forming round beads at their intersection; umbilicus wide V-shaped.

Remarks. *Bindiropa* gen. nov. differs most notably from other charopid genera hitherto diagnosed from the brigalow lands of SCQ by having a markedly depressed spire. The protoconch sculpture most closely resembles that of *Platyumbiropa* Stanisic, 2020 but differs by the combination of having a greater number of spiral cords and a greater proliferation of radial ridges.

Bindiropa irwinae sp. nov. (Fig. 1A-F)

Etymology. Named for Bindi Irwin, Wildlife Warrior and daughter of Terri and the late Steve Irwin.

Preferred common name. Bindi Irwin's Pinwheel Snail.

Material examined. Holotype. QMMO86199, RC, Carnarvon NP, Carnarvon Gorge Section, at the Rock Pool, SCQ, 25° 04' 06" S, 148° 14' 52" E, eucalypt woodland with palms and figs, in soil under logs and among rocks, coll. C. Eddie, 3.x.2020. Height of shell 2.05 mm, diameter 3.90 mm, width of umbilicus 1.30 mm, D/U 3.00, H/D 0.53, whorls 4.250.

Paratypes. QMMO86830, 1A RC, Carnarvon NP, beginning of Carnarvon Gorge track, SCQ, 25° 03' 25" S, 148° 13' 30" E, woodland with palms and tree ferns, under logs and rocks, coll. J. Stanisic, D. Potter, C. Eddie, 20.ix.1995; QMMO87259, 2A, 4SA RC, Carnarvon Gorge at Carnarvon Ck downstream of the Rock Pool, SCQ 25° 04' 09" S, 148° 15' 17" E, riparian thicket/figs/ferns, in leaf litter, alt. 384m, coll. C. Eddie, 3.x.2020.

Other material. QMMO87257, 2SA RC, same data as holotype; QMMO56634, 1 damaged SA, RC, Carnarvon NP, Carnarvon Gorge at Hellhole Gorge, SCQ, 25° 03' 35" S, 148° 12' 35" E, rainforest, under logs, coll. J. Stanisic, D. Potter, C. Eddie, 20.ix.1995; QMMO56640, 1 damaged SA RC, same data as

paratype; QMMO87261, 1I SA RC, Carnarvon NP, Carnarvon Gorge section, un-named gully E of Boolimba Bluff, SCQ, 25° 03' 26" S, 148° 14' 46" E, eucalypt woodland/figs/ferns on rocky outcrop, in leaf litter, alt. 432 m, coll. C. Eddie, 14.ix.2020; QMMO87260, 4SA RC, Carnarvon NP, Carnarvon Gorge Section between nature Trail and Rock Pool, SCQ, 25° 03' 56" S, 148° 14' 50" E, eucalypt woodland/figs/palms, in soil under and among rocks, alt. 411 m, coll. C. Eddie, 1.xi.2020; QMMO87258, 1SA RC, Carnarvon NP, Carnarvon Gorge Section, Wagooroo Ck, SCQ, 25° 02' 47" S, 148° 13' 44" E, microphyll vine forest/palms/figs on hill slope in gorge, in leaf litter, alt. 509 m, coll. C. Eddie, 14.ix.2020.

Diagnosis. As for genus.

Description. Shell tiny, light-brown to brown, discoidal, nautiliform with a sunken spire; whorls 4.25-4.50, rounded, sutures impressed; diameter 3.55-4.81 mm (mean 4.42 mm), height 2.05-2.34 mm (mean 2.24 mm), H/D 0.49-0.53 (mean 0.51); protoconch pitted cancellate, of 1.50 whorls, diameter 610 µm, sculptured with 19-21 low, broad spiral cords and sinuate radial ridges becoming more prominent toward the protoconch-teleoconch border; teleoconch sculpture of numerous, thick, crowded, bladed radial ribs (65 on the first whorl), microsculpture of fine radial threads and numerous low spiral cords forming rounded beads at their intersection; aperture ovately lunate; umbilicus wide V-shaped, diameter 1.30-1.31 mm (mean 1.31 mm), D/U 3.00-3.67 (mean 3.38). Based on 3 measured specimens (QMMO87199, QMMO87259 [2]).

Distribution and habitat. Known only from Carnarvon National Park, SCQ; living under rocks and logs in eucalypt woodland studded with cabbage palms (*Livistona nitida*), figs (*Ficus opposita*) and tree ferns (*Cyathea cooperi*). (Fig. 3A)

Remarks. The markedly depressed spire of *Bindiropa irwiniae* sp. nov. is a feature commonly seen in the nautiliform charopids of the wetter coastal and near coastal rainforests of eastern Australia (Stanisic 2010 *et al.*, Shea *et al.* 2012). Nautiliform charopids described from Carnarvon NP, SCQ and the surrounding brigalow lands to date have at most, a slightly sunken to flat spire with notably different

protoconch sculpture (see Stanisic 2020). The majority of material studied consists of litter-derived and damaged juvenile or sub-adult specimens, thus highlighting once again the difficulty in collecting live adult specimens of these tiny snails.

Stanisicaropa Holcroft, 2018

Stanisicaropa Holcroft, 2018: 6.

Type species. *Gyrocochlea chambersae* Stanisic, 2010 - by original designation

Diagnosis. Shell tiny, brown with darker streaks, discoidal and nautiliform with a depressed spire, whorls rounded, sutures impressed; protoconch pitted cancellate, pits formed by intersecting broad spiral cords and broad, low radial ridges of equal height; teleoconch sculpture of numerous, crowded, bladed radial ribs, microsculpture of fine radial threads continuous on the major ribs; umbilicus wide V to cup-shaped.

Remarks. *Stanisicaropa* Holcroft, 2018 was introduced for *S. chambersae* (Stanisic, 2010), a species of charopid with a pitted cancellate protoconch endemic to the rainforests of the Clarke Range, MEQ. The St Bees Island species has an almost identical protoconch while the unusual brown shell with darker brown radial streaks and wide umbilicus are other features shared with the Clarke Range species. These similarities in shell characters are considered to place the species close to *S. chambersae*.

Stanisicaropa covidurnus sp. nov.

(Fig. 2A-D)

Etymology. A combination of covid, derived from the name of the coronavirus, and the Latin *urnus* = time; alluding to an unusual time in human history when COVID-19 coronavirus caused a deadly pandemic and major disruption worldwide.

Preferred common name. Covid-19 Pinwheel Snail.

Material examined. Holotype. QMMO86845, RC, St Bees Island, MEQ, 20.9147° S, 149.4290° E, open eucalypt forest, in litter, coll. A. Melzer, C. Foelz, A. McDougall, 19.v.2019. Height of shell 3.12 mm, diameter 6.07 mm, width of umbilicus 1.65 mm, D/U 3.68, H/D 0.51, whorls 4.500.

Paratypes. QMMO86844, 1A/4SA 5RC, same data as holotype; QMMO86890, 3A/5SA RC, St Bees Island, MEQ, 20.9253° S, 149.4320° E, eucalypt forest,

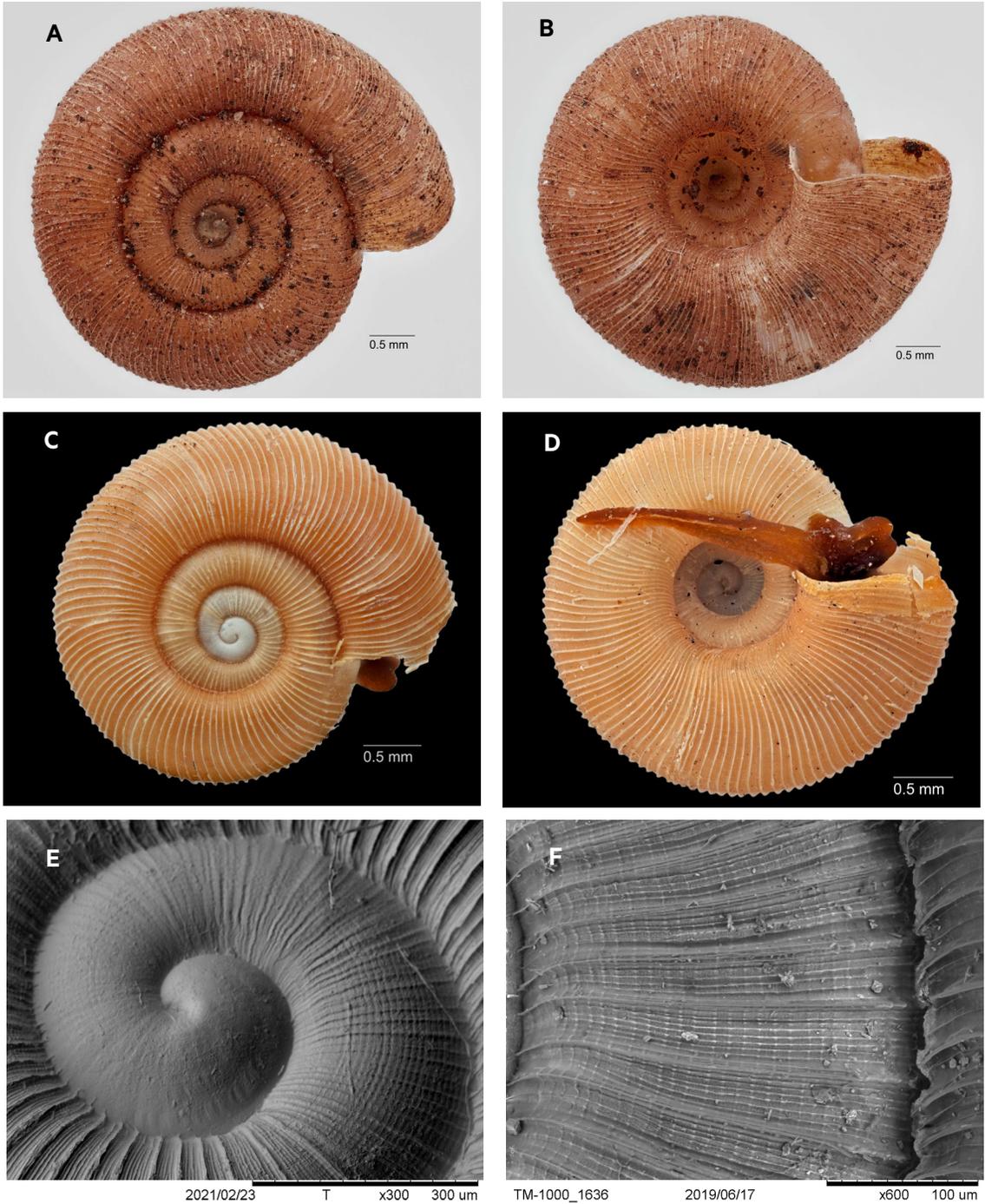


FIG. 1. *Bindiropa irwinae* sp. nov., A-B, QMMO87199, holotype; C-D, QMMO86830, paratype; E, QMMO87261, protoconch sculpture; F, QMMO56634, teleoconch sculpture.

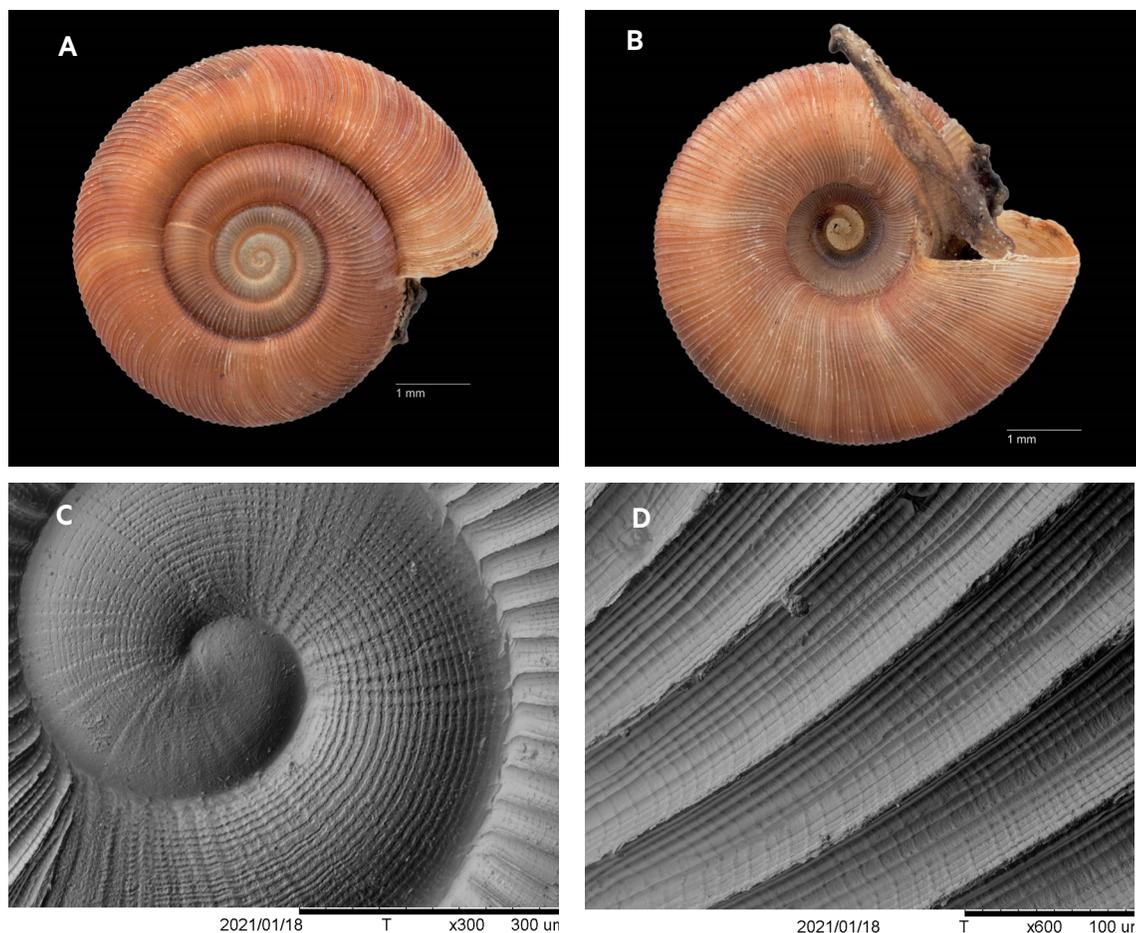


FIG. 2. *Stanisicaropa covidurnus* sp. nov. A-B, QMMO86845, holotype; C, QMMO86890, protoconch sculpture; D, QMMO86890, teleoconch sculpture.

in litter, coll. W. Houston, A. Melzer, 1.vii.2017; QMMO86889, St Bees Island, MEQ, 1A/3SA RC, 20.9147° S, 149.4290° E, eucalypt forest, in litter, coll. W. Houston, A. Melzer, 1.v.2018.

Other material. (All St Bees Island, MEQ). QMMO87253, 5SA RC, 20.9523° S, 149.4320° E, rainforest with eucalypt emergents, in litter, coll. A. Melzer, C. Foelz, A. McDougall, 1.v.2019; QMMO86891, 1A/1SA RC, 20.9246° S, 149.4321° E, *Lantana* shrubland, in litter, coll. W. Houston, A. Melzer, 1.vii.2017

Diagnosis. Shell tiny, brown with darker brown radial streaks, discoidal, nautiliform with a depressed spire, whorls rounded, sutures impressed; protoconch pitted cancellate, pits formed by intersecting broad 23-25 spiral

cords and broad, low radial ridges (mean 51 on first whorl) of equal height; teleoconch sculpture of numerous, crowded, bladed radial ribs, microsculpture of fine radial threads continuous on the major ribs; umbilicus wide V to cup-shaped.

Description. Shell tiny, light-brown to brown with darker streaks, discoidal, nautiliform with a sunken spire; whorls 4.375-4.500, rounded, sutures impressed; diameter 5.40-6.23 mm (mean 5.85 mm), height 2.95-3.28 mm (mean 3.03 mm), H/D 0.47-0.55 (mean 0.53); protoconch pitted cancellate, of 1.50 whorls, diameter 670-1100 µm (mean 840 µm), sculptured with 23-

25 low, broad spiral cords and numerous low radial ridges of equal height producing a pitted appearance; teleoconch sculpture of numerous, thick, crowded, protractively sinuate, bladed radial ribs 43-56 (mean 51) on the first whorl; microsculpture of fine radial threads and numerous low spiral cords forming rounded beads at their intersection, rolling over the major ribs; aperture ovately lunate; umbilicus wide V-shaped, diameter 1.49-1.77 mm (mean 1.60 mm), D/U 3.44-4.02 (mean 3.66). Based on 6 measured specimens (QMMO86845, QMMO86844, QMMO86889, QMMO86890 [3]).

Distribution and habitat. Eucalypt forest and rainforest with eucalypt emergents; all material is litter-derived and presumably this species lives under strewn forest debris such as logs and rocks. (Fig. 3B).

Remarks. *Stanisicaropa covidurnus* sp. nov. is only known from St Bees Island, MEQ. No records of the species have thus far been recorded from nearby Keswick Island. The protoconch configuration differs significantly from those of *Whitcochlea* Holcroft 2018 (superior spiral), *Xenoropa* Holcroft, 2018 (superior radial) and *Amfractaropa* Holcroft, 2018 (spiral) which all have species on various Whitsunday islands (Holcroft 2018b). From a biogeographic perspective the assignment of

the new species to *Stanisicaropa* infers a past connection between this island locality and the nearby mainland uplands. In contrast to the rainforest environments inhabited by *S. chambersae*, *S. covidurnus* appears to occupy drier eucalypt dominated forest.

Gyrocochlea Hedley, 1924

Gyrocochlea Hedley, 1924: 218 (in part); Iredale, 1937: 322 (in part); Iredale, 1941: 267 (in part); Stanisic, 1990: 77 (in part); Smith, 1992: 190 (in part); Stanisic 2010 (in Stanisic *et al.*, 2010): 196 (in part); Shea *et al.*, 2012: 85.

Type species. *Helix vinitincta* Cox, 1868 - by original designation.

Diagnosis. Shell tiny to small, reddish-brown to yellowish-brown, discoidal, nautiliform, strongly biconcave with a deeply depressed spire, protoconch beaded cancellate with crowded, thin spiral lirae and thin radial threads forming tiny beads at their intersection, teleoconch sculpture of widely spaced to crowded, sinuate radial ribs; umbilicus wide to very wide U-shaped.

Remarks. Hedley (1924) introduced *Gyrocochlea* for 11 species of nautiliform pinwheel snail from eastern Australia. Subsequently, authors have invariably referred many east coast nautiliform charopids to *Gyrocochlea sensu lato* based on shell form alone (Iredale 1937, Stanisic *et al.* 2010). Shea *et al.* (2012) restricted *Gyrocochlea* to include only three of these species (*vinitincta*,



FIG. 3. Charopid habitats. **A**, Carnarvon Gorge, Carnarvon NP, SCQ; **B**, St Bees Island, MEQ. (Images: A, C. Eddie; B, A. Melzer)

convoluta, *paucilamellata*) living in the Border Ranges of Qld/NSW on the basis of the beaded cancellate protoconch and DNA analyses.

The new species described below is assigned to *Gyrocochlea* s.s. on the basis of the beaded cancellate protoconch sculpture. An additional putative species, yet to be described, is also identified from damaged material.

***Gyrocochlea occidentalis* sp. nov.**
(Fig. 4A-D)

Etymology. From the Latin *occidentalis* = western, referring to the distribution of this *Gyrocochlea* species in the western part of the Border Ranges of Qld/NSW.

Preferred common name. Cunningham's Gap Pinwheel Snail.

Material examined. Holotype. QMMO87255, RC, track to Mt Mitchell on south side of the Cunningham Highway, Cunningham's Gap, SEQ, 28° 03' 08" S, 152° 24' 04" E, rainforest, under logs and bark, coll. C. Eddie, 20.x11.1989. Height of shell 2.46 mm, diameter 4.26 mm, width of umbilicus 1.39 mm, D/U 3.07, H/D 0.58, whorls 4.250.

Paratype. QMMO27120, RC, same data as holotype.

Other material. QMMO28452, 4SA SC/2SA RC, slopes of Mt Mitchell, Cunningham's Gap, SEQ, 28° 03' S, 152° 24' E, cnvf, under logs, coll. J. Stanistic, J. Chaseling, 18.i.1990; QMMO16897, 1SC dissected, Hall's Plain, east of Emu Vale, 28° 15' S, 152° 22' E, SEQ, cnvf, under logs, coll. J. Stanistic, J. Chaseling, 04.v.1986; QMMO16478, 1SC dissected, C. 1km east of Carr's Lookout, Koreelah SF, SEQ, 28° 21' S, 152° 24' E, nvf, under logs, coll. J. Stanistic, J. Chaseling, 03.v.1986; QMMO12682, 1SA RC, Cunningham's Gap NP, near monument, SEQ, 28° 04' S, 152° 24' E, alt. 755 m, nvf/ferns, coll. J Stanistic, D Potter, W Ponder, O Griffiths, 07.xii.1981: QMMO16899, 1SA RC, Tooloom Scrub, Beaury SF, NE NSW, 28° 29' S, 152° 24' E, nvf, under logs, coll. J. Stanistic, J. Chaseling, 04.v.1986; QMMO11137, 2 damaged SA RC, top of Condamine River valley on slopes of Wilson's Peak, along Croftby Rd, SEQ, 28° 16' S, 152° 28' E, rainforest/hoop pine, litter, coll. J Stanistic, D Potter, W Ponder, O Griffiths, iii.1981.

Diagnosis. Shell tiny, protoconch beaded cancellate, diameter 590 µm, sculptured with 35-40 thin spiral lirae and numerous low radial threads forming tiny beads at their intersection; teleoconch with widely spaced, sinuate, bold, strongly bladed radial ribs, 22 on the first whorl, umbilicus wide V-shaped.

Description. Shell tiny, yellowish-brown, discoidal, nautiliform with a deeply sunken spire; whorls 4.125-4.500, rounded, sutures impressed; diameter 4.10-4.26 mm (mean 4.18 mm), height 2.30-2.46 mm (mean 2.38 mm), H/D 0.56-0.58 (mean 0.57); protoconch beaded cancellate, of 1.625-1.750 whorls, diameter 590 µm, sculptured with 35-40 thin spiral lirae and numerous low radial threads forming tiny beads at their intersection; teleoconch sculpture of widely spaced, sinuate, bold and strongly bladed radial ribs, 22 on the first whorl, microsculpture of fine radial threads, 10-12 between the major ribs, and numerous low spiral cords forming tiny rounded beads at their intersection, rolling over the major ribs; aperture ovately lunate; umbilicus wide V-shaped, diameter 1.23-1.39 mm (mean 1.31 mm), D/U 3.07-3.33 (mean 3.20). Based on 2 measured specimens (QMMO27120, QMMO87255).

Distribution and habitat. Western parts of the Qld/NSW Border Ranges; in moist rainforest living under logs.

Remarks. *Gyrocochlea occidentalis* sp. nov. differs from the other three species in the genus by the smaller shell, wider spacing of the teleoconch ribs and more deeply sunken spire. *G. occidentalis*, like the three species included in *Gyrocochlea* s.s. by Shea *et al.* (2012), is an obligate rainforest dweller.

***Gyrocochlea* probable new species 'Richmond Range' (Fig.5)**

Material. QMMO10970, 1 damaged slightly subadult shell, c.1.7km along McIntosh's Road, near Back Creek, east side of Richmond Range, NE NSW, 28° 24' 35" S, 152° 43' 30" E, rainforest with eucalypt emergents, litter, coll. J Stanistic, D Potter, W Ponder, O Griffiths, 15 iii.1981. Shell diameter 5.71 mm.

Remarks. The single damaged specimen from the Richmond Range represents an additional species of *Gyrocochlea* s.s. The combination of discoidal nautiliform shell with deeply concave spire, beaded cancellate protoconch, teleoconch sculpture of bold, strongly sinuate ribs and wide cup-shaped umbilicus are diagnostic features that place the species in *Gyrocochlea*.

The specimen differs most notably from the geographically proximate *G. occidentalis* sp. nov. in having a larger shell (diameter 5.71 mm) with more crowded teleoconch ribbing. Unfortunately, the specimen is too damaged to qualify as type material and formal description of the species will have to await the collection of intact adult material.

DISCUSSION

This study represents another small step in the ongoing task of documenting the mega-diverse pinwheel snail fauna of eastern

Australia. Following a recent publication describing 15 new species of pinwheel snails from the brigalow lands of SCQ (Stanisic 2020), a further three species (including a new genus) from various Queensland and New South Wales localities, are described as new.

Bindiropa irwinae gen. et sp. nov. is a significant addition to the charopid fauna of the Carnarvon Ranges, SCQ (Stanisic 2020). In contrast to the many charopid species restricted to vine thicket patches within the brigalow country of SCQ, *B. irwinae* inhabits a more open forest environment consisting of tall eucalypts with an understorey of tree ferns and sandpaper figs along the edges

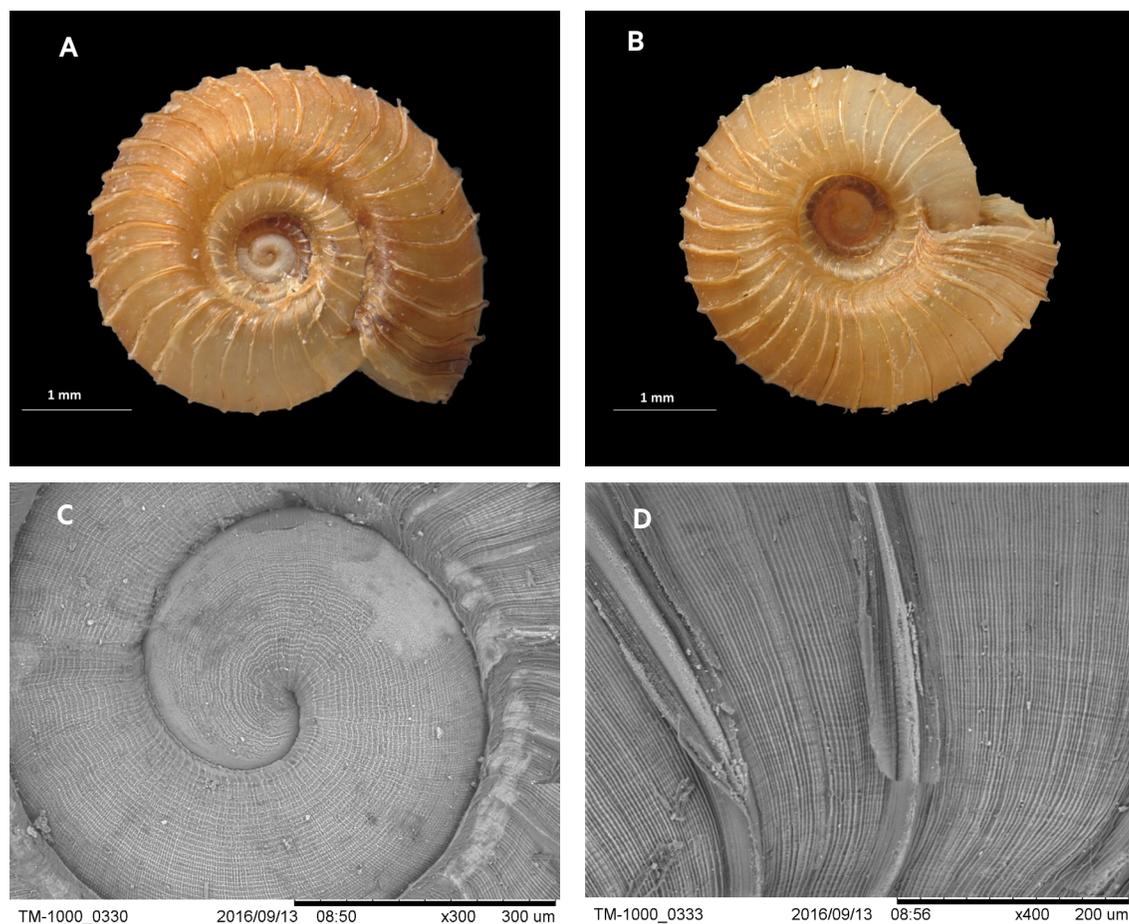


FIG. 4. *Gyrocochlea occidentalis* sp. nov. A-B, QMMO87255, holotype; C, QMMO16899, protoconch sculpture; D, QMMO16899, teleoconch sculpture.

of Carnarvon Creek. Conchologically, the species is characterised by a markedly sunken spire unlike other nautiliform charopids hitherto described from the SCQ brigalow lands that have a flat to slightly sunken spire (*Cineropa* Stanisic, 2020 and *Carnaropa* Stanisic, 2020). The general shell form of *B. irwiniae* is more common among the charopids of the rainforests and coastal vine thickets of SEQ and may imply distant relationships.

Stanisicaropa covidurnus sp. nov. from St Bees Island, MEQ is a pinwheel snail whose relationships with *S. chambersae* from the Clarke Range suggests that there were past connections between these two localities. A not too improbable scenario considering that the off-lying islands of the Whitsunday coast were connected to the mainland about 15 000-20 000 years ago. These islands would have been the rocky headlands of the old coastline and presumably supported closed forest communities that were fragmented and isolated in the post-Miocene xerification of the continent.

Gyrocochlea occidentalis sp. nov. and *Gyrocochlea* 'Richmond Range' are part of a charopid radiation that now extends along the Border Ranges from the Lamington and Roberts Plateaux, in the east to the Richmond Range, NE NSW in the west. In eastern Australia most land snail radiations, including several charopid lineages, display north-south patterns of distribution that identify major biogeographic barriers to dispersal (Lawrence Gap, Burdekin Gap dry corridors). In contrast, the current distributions of *Gyrocochlea* spp. identify the fragmentation of an ancestral population that once existed in an east-west dispersal corridor of connected closed forest.

Taxonomic history of *Gyrocochlea* (1924-2018)

Since that initial introduction of *Gyrocochlea* Hedley, 1924 there have been a number of significant and complex taxonomic changes that have markedly altered our understanding of *Gyrocochlea*. To clarify the current restricted concept of *Gyrocochlea* and the taxonomic



FIG. 5. *Gyrocochlea* 'Richmond Range'. QMMO10970.

status of many species associated with the genus since first diagnosed, a synoptic history of these changes follows.

Hedley (1924) introduced *Gyrocochlea* for 11 species of pinwheel snail from eastern Australia (*vinitincta*, *concinna*, *conferta*, *convoluta*, *eurythma*, *impressa*, *planorbis*, *omicron*, *prava*, *recava*, *austera*, *cinnamea*, *iuloidea*, *curtisiana*, *stroudensis*). All were characterised by having a biconcave, nautiliform shell except for *Gyrocochlea stroudensis* (Cox, 1864) which Hedley noted had an exert rather than a depressed spire. Iredale (1937) in his basic faunal list of the Australian non-marine Mollusca, included 15 species in *Gyrocochlea* (*vinitincta*, *concinna*, *conferta*, *convoluta*, *eurythma*, *impressa*, *planorbis*, *omicron*, *prava*, *recava*, *austera*, *cinnamea*, *iuloidea*, *curtisiana*, *stroudensis*) but later (Iredale 1941) removed one of these (*stroudensis*) on the basis of shell morphology, to a new genus *Cralopa*. Burch (1976) in a review of Australian land snail classification included 14 species in the genus. Stanisic (1990) in a study of subtropical rainforest charopids restricted the genus to only four species (*vinitincta*, *convoluta*, *curtisiana*, *paucilamellata*, the latter newly described) on the basis of shell morphology and anatomical features. However, Stanisic (1990) expressed reservations about including *Gyrocochlea curtisiana* (Hedley, 1912) on the basis of differing protoconch sculpture (pitted cancellate) from the 'average *Gyrocochlea*

pattern' of beaded cancellate. Stanisic (1990) also reassigned three previously included species (*omicron*, *concinna*, *recava*) to newly diagnosed genera (*Nautiliropa*, *Biomphalopa*) on the basis of differing protoconch sculpture.

Smith (1992), in his non-marine catalogue, included 12 species in *Gyrocochlea*. Stanisic *et al.* (2010) in a field guide to eastern Australian land snails, provisionally allocated 34 nautiliform species to *Gyrocochlea* including 22 newly described: *appletoni*, *burleigh*, *calliope*, *canalis*, *chambersae*, *danieli*, *etna*, *fitzgeraldae*, *flammulata*, *gibraltar*, *goodnight*, *greenae*, *hawkesburyana*, *janetwaterhouseae*, *kessneri*, *multicosta*, *myora*, *notiala*, *ponderi*, *raveni*, *sonyaeleggae*, *wauchope*. In doing so the authors stated that the concept of the genus was undeniably polyphyletic but the assignments were made in an attempt to bring a largely undescribed *Gyrocochlea*-grade charopid fauna into open focus. The expectation was that the re-allocation of these species would be the subject of future revisionary studies.

In the first of these studies, Shea *et al.* (2012), utilised protoconch sculpture (beaded cancellate) and DNA analyses to restrict *Gyrocochlea* to include only three of these species (*vinitincta*, *convoluta*, *paucilamellata*) living in the Border Ranges of Qld/NSW. In the same publication six new genera (*Cumberlandica*, *Planorbacochlea*, *Comboynea*, *Macphersonia*, *Richmondaropa*, *Dictyoropa*) were introduced to accommodate nine of the species included in *Gyrocochlea* by Stanisic *et al.* (2010). These were species from mid-east and north-east NSW with variously different protoconch sculptures (*impressa*, *ponderi*, *hawkesburyana*, *planorbis*, *conferta*, *canalis*, *prava*, *conjuncta*, *eurythma*). This left another 23 species listed in the field guide, mainly from Queensland, that still needed to be reassigned based on their incompatible protoconch sculptures. Stanisic (2016), on the basis of protoconch sculpture (cancellate), reassigned one of these (*myora*) from North Stradbroke Island to a new genus *Chordaropa*.

The use of protoconch sculpture as a key character in the diagnosis of charopid genera was formalised by Holcroft (2018a). Shortly thereafter, Holcroft (2018b) revised the MEQ

Gyrocochlea-grade charopids and introduced three new genera (*Whitcochlea*, *Stanisicaropa*, *Radiolaropa*), on the basis of their differing protoconch sculptures from *Gyrocochlea* s.s., to accommodate a further three species (*iuloidea*, *chambersae*, *danieli*) included in *Gyrocochlea* by Stanisic *et al.* (2010) from the region. However, there still remain a further 19 nautiliform charopids included in *Gyrocochlea* from Queensland by Stanisic *et al.* (2010), that need to be formally re-allocated to either already existing or newly described genera. Using the protoconch sculpture as a generic marker, preliminary studies by the author have begun to address this significant but unresolved taxonomic issue.

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