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***Pallidelix simonhudsoni* sp. nov.: a new land snail from the central highlands of inland southern Queensland, Australia (Gastropoda: Eupulmonata: Camaenidae)**

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ABSTRACT

Pallidelix simonhudsoni sp. nov. is described from vine thicket habitats on Carnarvon Station in the highlands of south central Queensland. The species is part of a much larger radiation of species of the camaenid genus *Pallidelix* Iredale, 1933 centred around the sandstone belt of inland central Queensland. *P. simonhudsoni* sp. nov. is distinguished by aspects of both shell sculpture and reproductive anatomy. The new species is hitherto only known from immediate environs of the type locality Carnarvon Station. The conservation status of the species is discussed within relation to: (1) its occurrence on a nature conservancy dedicated to biodiversity protection; (2) the endangered status of the species' primary habitat; and, (3) current land management practices on Carnarvon Station. □ *Pallidelix simonhudsoni* sp. nov., Eupulmonata, Camaenidae, systematics, new species, Queensland, Australia.

The Camaenidae is a family of land snails that is particularly diverse in the rainforests of eastern Queensland (Stanisic *et al.* 2010). Long recognised as a late Miocene invader from land masses to Australia's north (Bishop 1981; Solem 1992, 1997), the family has managed to radiate extensively in many areas of Australia. In eastern Australia camaenids are prominent snails in both the wetter humid coastal rainforests and the drier subcoastal and inland rainforests. Semi-evergreen vine thicket is a unique and widespread structural form of dry rainforest (Webb & Tracey 1981; Fensham 1996). Relatively few camaenids have made the transition to much drier eucalypt forests and woodland in eastern Australia. A mega-clade of semi-arid to arid-adapted, medium-sized

to large camaenids inhabiting inland parts of Queensland, coastal and inland New South Wales and the arid areas of South Australia and the Red Centre was identified by Hugall & Stanisic (2011, Clade 3). The Queensland endemic *Pallidelix* Iredale, 1933 (type *P. greenhilli*) is one of these Clade 3 genera with species centred in semi-arid inland southern and central Queensland in the Brigalow Lands bioregion.

Pallidelix currently includes three species: one from the semi-evergreen vine thickets of the central ranges (Expedition, Bigge & Carnarvon Ranges) [*P. greenhilli* (Cox 1866)], a second from south of the Great Dividing Range in the brigalow scrubs of the Dalby-Miles area of southern Queensland [*P. chinchilla* Stanisic,

2010] and a third from eucalypt woodland communities in southeastern Queensland [*P. bennetti* (Brazier 1872)] (see Stanisic *et al.* 2010). These species were collectively included in the genus on the basis of similarity of shell sculpture (coarse pustules and oblique to zigzag periostracal ridges) subject to future revision.

A new addition to this broad species inventory (*P. simonhudsoni* sp. nov.) was discovered on a recent Bush Blitz expedition to Carnarvon Station (a nature conservancy) situated on the western fringes of the central Queensland sandstone belt (see explanatory note in 'Acknowledgements'). Vegetation communities on Carnarvon Station although varied are dominated by native grasslands, brigalow, eucalypt woodland and a series of scattered semi-evergreen vine thickets in the sheltered gullies and on the surrounding hillsides. *P. simonhudsoni* sp. nov. lives primarily in semi-evergreen vine thickets. Less frequently it was also found to occur in adjacent woodland communities probably as result of 'leakage' from the thickets during periods of rain.

Although a taxonomic revision of *Pallidelix* is seen as overdue, this task will necessitate additional fieldwork to obtain specimens for molecular studies. In the meantime, the formal description of *P. simonhudsoni* sp. nov. is deemed necessary from a conservation perspective and the likely flow-on effects this action could achieve for terrestrial invertebrate communities on Carnarvon Station.

MATERIALS AND METHODS

Material used in this study is held in the collections of the Queensland Museum (QMMO). Studies of shell characters were carried out on specimens in the museum's dry collection (RC) and anatomical studies were based on ethanol preserved samples (SC). Measurements of shell characters (height, diameter) were made using callipers with a precision of 0.01 mm. Whorl counts were made to the nearest 1/8 whorl. Three representatives of the species from the type locality (Carnarvon Station) were dissected and studied using a WILD M5 stereo microscope with drawing

apparatus in order to confirm stability of reproductive structures.

SYSTEMATICS

Infraorder EUPULMONATA

Superfamily HELICOIDEA

Family CAMAENIDAE

Genus *Pallidelix* Iredale, 1933

Type species. *Helix greenhilli* Cox, 1866-by original designation.

Diagnosis. Shell large, yellowish brown, helicoid with an elevated spire and rounded whorls; teleoconch sculpture of closely spaced pustules that occasionally coalesce into micro-ridgelets and an overlying pattern of oblique to zigzag periostracal ridges; aperture roundly lunate, lip white, expanded and reflected; umbilicus narrowly open, reduced to a chink. Penis with a sheath, internally with smooth, thick longitudinal pilasters and a smooth papillate verge with a terminal pore; epiphallus thick, muscular; epiphallallic flagellum present.

Pallidelix simonhudsoni sp. nov. (Figs 1-4)

Etymology. Named for Simon Hudson, ecologist, colleague and environmental consultant.

Material examined. (All Carnarvon Station, south central Queensland).

Holotype. QMMO80282, Fig Tree Spring, (24° 47.813'S, 147° 41.593'E), semi-evergreen vine thicket on basalt scree, under rocks, 10.x.2014, coll. J. Stanisic. Height of shell 28.02 mm, diameter 31.89 mm, H/D = 0.88.

Paratypes. QMMO80231, same data as holotype; QMMO80124, 2SC/9RC, rocky knoll NW homestead (24° 46.007'S, 147° 43.533'E), Ironbark woodland/rocky scree, under rocks/in litter, 9.x.2014, J. Stanisic; QMMO80227, 5RC, rocky knoll NW homestead (24° 46.007'S, 147° 43.533'E), Ironbark woodland/rocky scree, under rocks/in litter, 10.x.2014, J. Stanisic; QMMO80247, 2SC/6RC, hillock N homestead, (24° 48.627'S, 147° 45.135'E), vine thicket/basalt scree, under rocks/in litter, 11.x.2014, J. Stanisic; QMMO80250, 15RC, homestead flats, (24° 48.423'S, 147° 45.149'E), grassy woodland, on ground,

Pallidelix simonhudsoni sp. nov.



FIG. 1. *Pallidelix simonhudsoni* sp. nov. Shell views, holotype QMMO80261, Carnarvon Station. A, apertural; B, dorsal; C, ventral. Scale bars = 20 mm.

TABLE 1. Shell measurements for *Pallidelix simonhudsoni* sp. nov. [Range and mean].

	Number	Height (mm)	Diameter (mm)	H/D ratio	Whorls
<i>P. simonhudsoni</i> sp. nov. QMMO80231	5	23.50-25.88 Mean 24.69	26.53-29.63 Mean 28.41	0.82-0.90 Mean 0.88	5 5/8-6 1/2 Mean 5 5/8
<i>P. simonhudsoni</i> sp. nov. QMMO80227	4	24.79-27.53 Mean 25.89	24.34-31.17 Mean 29.78	0.84-0.88 Mean 0.87	5 5/8-5 3/4 Mean 5 5/8
<i>P. simonhudsoni</i> sp. nov. QMMO80124	4	23.38-26.14 Mean 24.23	25.57-29.59 Mean 28.24	0.83-0.92 Mean 0.86	5 3/8-5 1/2 Mean 5 1/2
<i>P. simonhudsoni</i> sp. nov. QMMO80247	4	23.33-26.13 Mean 24.43	27.17-29.57 Mean 28.27	0.84-0.88 Mean 0.86	5 1/2-5 3/4 Mean 5 5/8
<i>P. simonhudsoni</i> sp. nov. QMMO80250	15	23.47-28.30 Mean 22.88	24.87-31.15 Mean 27.75	0.81-0.93 Mean 0.88	5 3/8-5 3/4 Mean 5 5/8
<i>P. simonhudsoni</i> sp. nov. QMMO80261	4	22.79-24.32 Mean 23.63	26.55-28.82 Mean 27.94	0.82-0.87 Mean 0.85	5 1/4-5 3/4 Mean 5 1/2

12.x.2014, J. Stanisc; QMMO80261, 4RC, vine thicket N homestead, (24° 47.935'S, 147° 45.284'E), vine thicket/basalt scree, under rocks/in litter, 13.x.2014, J. Stanisc, K. & C. Wilson.

Other material. QMMO80219, 80220, 80258, 80271, 80274, 80275, 80280.

Diagnosis. Shell large, dark to yellowish brown, occasionally with a thin reddish brown subsutural band, helicoid with an elevated spire and rounded whorls; teleoconch sculpture of relatively fine, closely spaced pustules that occasionally coalesce into micro-ridgelets and scattered oblique to zigzag periostracal ridges. Penis long, thin with sheath; internally with smooth, thick longitudinal pilasters in the upper

part of the penial chamber becoming thinner and corrugated toward the atrium; epiphallus long with very thick, muscular ascending arm partially folded within sheath and a thinner descending arm; penial verge smooth, papillate with a terminal pore; epiphallic flagellum present.

Description. Shell large, dark to yellowish brown, helicoid with an elevated spire, whorls 5¼-5⅞ (mean 5⅝) evenly rounded, the last descending in front; apex and spire strongly elevated. Height of shell 22.79-28.30 mm (mean 24.29 mm), diameter of shell 24.87-31.17 mm (mean 28.40 mm), H/D = 0.85-0.88 (mean 0.87). Protoconch of 1¾ whorls sculptured with

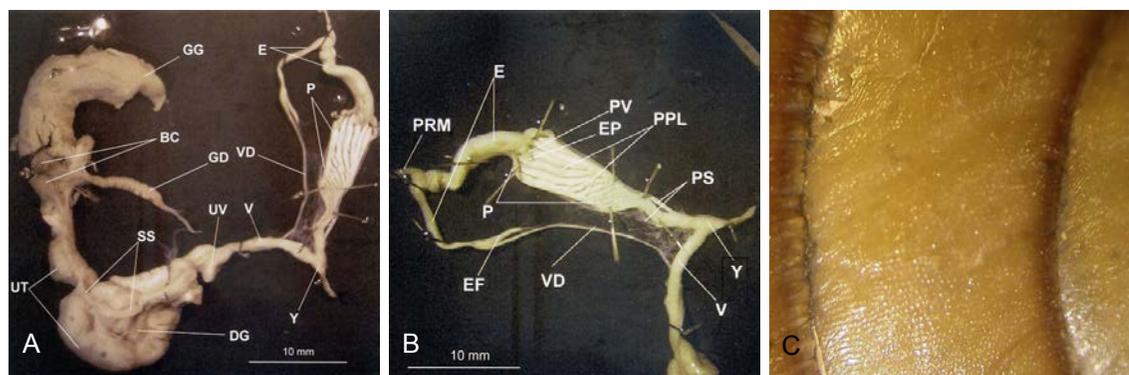


FIG. 2. *Pallidelix simonhudsoni* sp. nov. QMMO80124, paratype. A, Genital system; B, Penial complex; C, Close-up of shell whorls showing periostracal sculpture. Abbreviations used: BC, bursa copulatrix; DG, prostate; E, epiphallus; EF, epiphallic flagellum; EP, epiphallic pore; GD, hermaphroditic duct; GG, albumen gland; P, penis; PPL, penial pilasters; PRM, penial retractor muscle; PS, penial sheath; PV, penial verge; SS, bursa stalk; UT, uterus; UV, free oviduct; V, vagina; VD, vas deferens; Y, atrium. Scale bars as marked.

weak, low radial ridges that are often worn in adult specimens, teleoconch with a pattern of fine crowded pustules that occasionally coalesce into micro-ridgelets, and scattered oblique to zigzag periostracal ridges that become more prominent on the penultimate and body whorls. Aperture roundly lunate, lip expanded and strongly reflected, white. Umbilicus narrowly open, reduced to a chink. Animal orange grey with dark grey eyestalks. (Figs.1A-C, 2C, 3).

Genitalia. Penis (P) long, tapered with slightly expanded apical bulb; thin sheath (PS) present; internally with a papillate verge (PV), walls of penial chamber with fleshy longitudinal pilasters (PPL) apically becoming corrugated basally and thinner descending into the atrium. Epiphallus (E) with relatively long, thick muscular ascending arm enveloped and partially folded within penial sheath, descending arm thin, relatively short; epiphallus entering penis through a simple pore (EP) situated terminally on verge. Penial retractor muscle (PRM) inserted at the junction of the two arms of the epiphallus. Vas deferens (VD) thin, attached to penial sheath with connective tissue; a short, thin epiphallic flagellum (EF) present, situated at epiphallus-vas deferens junction, tightly bound to vas deferens. Vagina (V) short, less than half length of penis, internally with several longitudinal pilasters. Atrium (Y) simple. Free oviduct (UV) shorter than vagina; bursa copulatrix (BC)

simple with a slender stalk (SS), situated at the base of the albumen gland (GG); prostate (DG), uterus (UT) and hermaphroditic duct (GD) without unusual features (Fig 2A, B).

Habitat and ecology. Semi-evergreen vine thicket and adjacent eucalypt woodland on Carnarvon Station. Additional collecting may extend the range south into other parts of the Chesterton Range. To the north-west the vine thickets of the Ka Ka Mundi Section, Carnarvon NP is home to a different and yet to be described species of *Pallidelix* (Stanisic, unpublished); it is unlikely to occur to the south and west due to the absence of suitable habitat. The species lives under rocks and woody debris.

Comparative remarks. *Pallidelix simonhudsoni* sp. nov. is similar to the type of the genus, *P. greenhilli* (Cox 1866) which is only definitively known from three shells: a syntype (registration number AMSC.5767, see Fig. 4) and one other specimen (AMSC.101192) which may also be considered a syntype, from the original Cox collections in the Australian Museum; and a further syntype in the National Museum of Wales (NMWZ1955.158.880). In the absence of definitive live material referable to the type, *P. simonhudsoni* sp. nov. can be distinguished from *P. greenhilli* by a combination of shell features here considered to indicate specific level separation. The shell of *P. simonhudsoni*



FIG. 3. *Pallidelix simonhudsoni* sp. nov. Live snail from Carnarvon Station.

sp. nov. has a more elevated spire than that of *P. greenhilli* (Fig. 4). But more significantly, *P. simonhudsoni* sp. nov. has a shell sculpture of very fine pustules with scattered oblique to zigzag periostracal ridges. In contrast, the shell of *P. greenhilli* has coarser pustules and very dominant oblique to zigzag periostracal ridges. In addition, the area around the umbilicus of *P. greenhilli* is slightly more excavate than that of *P. simonhudsoni* sp. nov.

The type locality of *P. greenhilli* was given by Cox (1866) as the 'Upper Dawson River' which is a large area extending from Taroom to the Carnarvon Ranges, Queensland. This range includes several apparent *Pallidelix* morphospecies. A key task of any revision will be to associate the specimens in the Australian and Welsh Museums with material from within this geographic range to enable accurate anatomical comparisons to be made. However, preliminary dissections show that *P. simonhudsoni* sp. nov. differs in aspects of the penial anatomy (comparatively narrower, elongate penis with a longer basal section) from all *Pallidelix* material hitherto examined from the 'Upper Dawson River' including specimens from both the Carnarvon Ranges and Taroom (Stanisic, unpublished).

DISCUSSION

Pallidelix is currently broadly defined and includes three species from southeastern and



FIG. 4. *Pallidelix simonhudsoni* sp. nov. holotype QMMO80261 (left) and *P. greenhilli* (Cox (1866) syntype AMSC.5767 (right) showing relative spire elevations.

south central Queensland. Unpublished results of the author indicate that the genus as currently defined (Stanisic *et al.* 2010) is polyphyletic. The two southern species (*P. chinchilla* and *P. bennetti*) included by Stanisic *et al.* (2010) will be shown to belong elsewhere when a formal revision of the genus is completed. *Pallidelix* s.s. is essentially centred on the ranges of the sandstone belt in south central Queensland. Extensive material in the Queensland Museum shows that *Pallidelix* has a wide range in the central Queensland area that extends from Taroom and the Expedition Range in the east, through the Carnarvon Ranges to the Ka Ka Mundi Section of the Carnarvon NP in the west and north to the Drummond Range, west of Emerald. Preliminary dissection of this central Queensland material, all previously provisionally identified as *P. greenhilli*, has revealed the presence of several undescribed species within this broad geographic range. *P. simonhudsoni* sp. nov. is an integral part of this radiation chiefly living in the vine thickets of Carnarvon Station.

CONCLUSIONS

The semi-evergreen vine thickets of Carnarvon Station are currently unmapped and largely unrecognised as particularly significant hubs of invertebrate biodiversity. For the station's land snails (20 native species recorded thus far), which have been found to largely inhabit only the vine thickets (17 species), these dry rainforests

are pivotal to their long-term survival and to the survival of a suite of other lesser known invertebrates (slaters, spiders, millipedes etc). In the short term the description of *P. simonhudsoni* sp. nov. hopefully will highlight the importance of the vine thicket communities as important refugia for invertebrates. In the longer term it is hoped that this recognition will lead to a mapping of all the vine thicket patches on the property so that the station's management practices (particularly the use of fire) can be more sympathetically applied to their conservation. Semi-evergreen vine thicket as a community is a scattered archipelago occurring in small, isolated patches in semi-arid inland and monsoonal eastern and northern Australia. In Queensland the community has suffered greatly from largely unnecessary land clearing in the past and will require specific conservation measures if it is to be secured for the long-term (Fensham 1996).

Semi-evergreen vine thickets are now listed as an endangered ecological community under the Commonwealth's Environment Protection and Biodiversity Conservation Act 1999. Careful management of the Carnarvon Station vine thickets has the potential to permanently secure a small subset of this community and with them a unique suite of invertebrates.

On a no less significant scale, this study adds another species to the ever-increasing list of Australia's unique but largely unknown invertebrate fauna.

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[Note. Bush Blitz is a bio-discovery program co-funded by the Australian Commonwealth Government and BHP-Billiton and also involving Earthwatch Australia which seeks to document Australia's biodiversity. Carnarvon Station is a 56,000 ha. nature conservancy (a nature reserve outside the national reserve system) owned and managed by Bush Heritage which is a non-profit organisation acquiring land specifically for biodiversity conservation].

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