



## ***Crikey steveirwini* gen. et sp. nov. from montane habitats in the Wet Tropics of northeastern Queensland, Australia (Gastropoda: Eupulmonata: Camaenidae)**

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### **Abstract**

*Crikey steveirwini* **gen. et sp. nov.** is described from montane habitats in the Wet Tropics of northeastern Queensland, Australia. This species is unique among the eastern Australian arboreal camaenids in both distribution (confined to montane refugia), and genital morphology (lacking a penial verge). An assessment of the phylogenetic position of *C. steveirwini* is made based on a combination of morphological features (shell and anatomy) and available molecular data. The biogeographic implications for the Australian camaenid radiation of this altitudinally restricted species are briefly discussed.

**Key words:** Camaenoidea, arboreal snails, taxonomy, phylogeny, biogeography

### **Introduction**

The Camaenidae is a diverse family of land snails inhabiting many parts of the Australian continent. The vast majority are ground-dwelling species but there are a small number (11 species and one subspecies) that have assumed arboreal lifestyles. All but one of these species occur along the east coast. The arboreal species have a patchy distribution in the eastern coastal rainforests and range from Booti Booti National Park, c. 7 km south of Forster, central New South Wales north to Mua, an island in the Torres Strait, far northern Queensland. However, they are absent from the central Queensland rainforests (Smith 1992). Greatest diversity in arboreal camaenids occurs in the Wet Tropics which is an area between Townsville and Cooktown characterised by high rainfall, rainforest and high mountains whose summits are regularly enshrouded by clouds.

These species are characterised by medium- to high-spired, trochoidal shells that are uncharacteristically brightly coloured when compared to the more numerous drab-coloured, ground-dwelling relatives. Iredale (1938) grouped these arboreal Australian species into his somewhat controversial and artificial family Papuinidae (based on *Papuina* von Martens in Albers 1860 from the New Guinean region). Later he also included the many arboreal species from Papua New Guinea (Iredale 1941). This taxon was later downgraded to rank of subfamily by Clench and Turner (1962) pending further revisionary studies. More recently, Solem (1992) considered all the east coast camaenids to be members of the single subfamily Camaeninae, which entered Australia from land masses to the north during the Miocene at a time when xerification of the continent was beginning. This wave of immigration established the family in Australia.

*Crikey steveirwini* **gen. et sp. nov.** is a relatively recent discovery on the summits of the high mountains of the Wet Tropics, having been first collected in 1989. In the context of Wet Tropics land snails this is a rare species and only two live specimens have been collected, one being sub-adult. Most specimens hitherto collected have been taken from the ground as empty shells. Significantly all shells, except for the holotype, show some degree of mechanical damage which may be due to predation. One live specimen has been collected from low shrubs indicating that the species is arboreal.

*Crikey steveirwini* is unusual in the context of the Camaenidae in that it is restricted to montane refugia in

the Wet Tropics. This pattern is shared with only a handful of other members of the Camaenidae, which is considered to be a comparatively recent (in geological time) addition to the Australian land snail fauna. The Wet Tropics bioregion is more commonly renowned for the altitudinally restricted, temperate-related snail faunas of Gondwanan origin e.g. charopids (Stanisic 1987; 1993a,b; Stanisic *et al.* 1994).

This atypical geographical distribution and the presence of some unusual morphological characters combined with the results from a recently completed molecular-based, phylogenetic study of the camaenids (Hugall & Stanisic, in press), provide the opportunity to assess the phylogenetic position of *C. steveirwini* and to briefly comment on the origins of the Australian arboreal camaenids.

All material studied resides in the Queensland Museum, Brisbane (QMMO).

## Taxonomy

### Order Eupulmonata

### Superfamily Camaenoidea

### Family Camaenidae

#### *Crikey* gen. nov.

**Type species.** *Crikey steveirwini* sp. nov.

**Etymology.** The world famous ‘catch-cry’ of the ‘Crocodile Hunter’, Steve Irwin.

**Diagnosis.** Shell turbinate with an elevated spire and rounded whorls; sculpture of numerous strong spiral striae crossed by very weak, axial growth ridges; aperture lunately ovate, lip only weakly thickened; imperforate. Penis without a verge.

**Comparative remarks.** Anatomically the lack of a penial verge (a structure that directs the sperm or sperm packet during mating) and penial flagellum (a structure usually involved in spermatophore formation) separates *Crikey* from the other Australian arboreal camaenid genera which all have a well developed, sculptured verge and short to long epiphallic flagellum (Clench and Turner 1966; Scott 1998; Stanisic unpublished). The absence of a penial verge is apparently rare in the Australian camaenids generally and is elsewhere seen in non-arboreal east coast genera such as *Hadra* Albers, 1860, *Spurlingia* Iredale, 1933 and *Jacksonena* Iredale, 1937 [from the Wet Tropics, Cape York and Einasleigh Uplands bioregions] (Solem 1979; Stanisic unpublished).

#### *Crikey steveirwini* sp. nov.

(Fig. 1)

**Etymology.** In memory of the late Steve Irwin, wildlife warrior, environmental educator and Queensland Museum medallist.

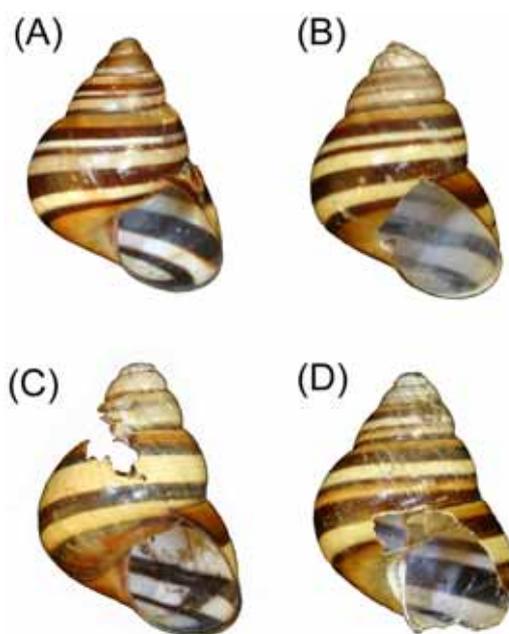
**Diagnosis.** Shell moderately large with an elevated spire and rounded whorls; light creamy yellow base colour with darker brown suffusions and bands; sculpture of numerous strongly incised spiral striae crossed by weak axial growth ridges; lip barely thickened and weakly reflected; imperforate. Penis without a verge; epiphallus entering penis through an apical pore surrounded by a muscular collar; epiphallic flagellum absent.

**Material examined.** (All north-east Queensland.) **Holotype.** QMMO 78184, Mount Spurgeon, 7 km north, 16°22'S, 145°13'E, 1250 m G.B. Monteith, H. Janetzki, L. Roberts, 19.x.1991 (Fig. 1A).

**Paratypes.** QMMO 34222, 1 subadult, same data as holotype; QMMO 27117, 1 adult, Lambs Head, 10 km west of Edmonton, 17°01'S, 145°39'E, 1200 m, rainforest, G. B. & S. R. Monteith, 8.i.1990 (Fig. 1C);

QMMO 27118, 1 adult, Mount Lewis Road, 30 km from highway, 16°30'S, 145°16'E, 1200 m, rainforest, ANZSES Expedition, 14.i.1990; QMMO 20911, 1 adult, Mount Lewis Road, Old Barracks Area, 16°35'S, 145°16'E, 1000 m, K. McDonald, G. Baines, 16.iii.1989 (Fig. 1B).

**Other material.** QMMO 34221, 1 subadult, Stewart Creek, c.4 km north-north-east Mount Spurgeon, 16°24'S, 145°13'E, 1300 m, G.B. Monteith, H. Janetzki, L. Roberts, 16.x.1991; QMMO 57999, 1 subadult, Mount Lewis, summit, 16°35'S, 145°17'E, P. Hasenpusch, 28.xii.1995; QMMO 69655, 1 subadult, Mossman, c.14 km west-south-west on Main Coast Range, 16°30'S, 145°16'E, rainforest, R. Crookshanks, 19.v.2001 (Fig. 1D); QMMO 70536, 1 adult (dissected) & 1 subadult, Mossman, c.14 km west-south-west on Main Coast Range, 16°30'S, 145°16'E, rainforest, among shrubs, R. Crookshanks, L. Free, 3.ii.2002.



**FIGURE 1.** *Crikey steveirwini* gen. et sp. nov. showing variation in banding pattern. **A.** Holotype, QMMO 78184, height = 14.61mm. **B.** Paratype, QMMO 20911, Mt Lewis, height = 14.77 mm. **C.** Paratype, QMMO 27117, Lambs Head, height = 16.59 mm. **D.** QMMO 69655, Main Coast Range, height = 13.63 (subadult).

**Description.** Shell: Shell thin, turbanate with an elevated spire, with 4  $\frac{7}{8}$  (holotype) evenly rounded whorls, the last descending more rapidly in front; apex and spire strongly elevated, sutures moderately impressed; protoconch approximately 1  $\frac{1}{2}$  whorls with sculpture of crowded, slightly curved, fine radial growth ridges; teleoconch whorls with moderately crowded, strongly incised spiral striae crossed by weak axial growth ridges. Aperture lunately ovate; lip slightly thickened and weakly reflected. Umbilicus absent. Colour light creamy-yellow with dark chocolate-brown spiral bands of various widths and a lighter brown spiral band subsuturally; base with a light-brown suffusion, lip dark chocolate-brown. Measurements, based on 3 (including 2 damaged) adults (QMMO 20911, QMMO 27117, QMMO 78184 = holotype):

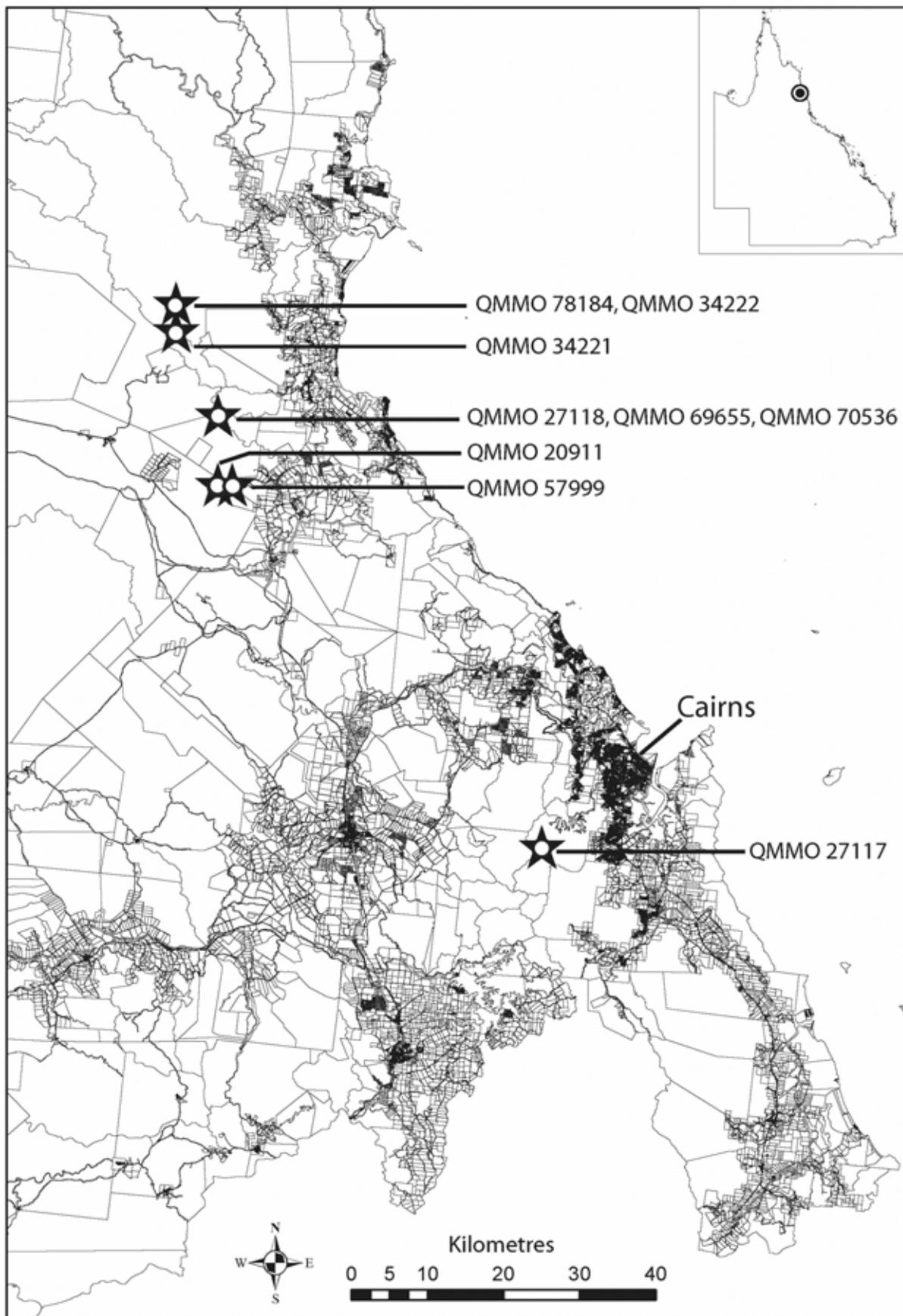
height 14.61–16.59 mm (holotype 14.61 mm; mean 15.32 mm)

diameter 11.24–12.26 mm (holotype 12.26 mm; mean 11.60 mm)

H/D ratio 1.19–1.47 (holotype 1.19 mm; mean 1.32 mm)

Genital anatomy: Penis without a verge; epiphallus entering penis through an apical pore surrounded by a muscular collar; longitudinal pilasters in the lower chamber; epiphallic flagellum absent (genitalia not figured due to destruction of material during dissection). Otherwise typical of the family Camaenidae. Based on one dissected adult specimen (QMMO 70536).

**Distribution and habitat.** Wet Tropics (Main Coast Range, Lamb Range and Spurgeon Uplands), north-east Queensland at altitudes mainly above 1000 m (Fig. 2); living in rainforest and presumed arboreal though hitherto only collected from the forest floor and among low shrubs.



**FIGURE 2.** Distribution map showing the location of all known records of *C. stevirwini* in north-east Queensland (inset shows regional location).

**Remarks.** *Crikey steveirwini* differs from all other Australian arboreal camaenids by the combination of rounded body whorl, strongly elevated spire, relatively simple, weakly reflected lip and lack of a penial verge and epiphallallic flagellum. Other arboreal camaenids occurring in the Wet Tropics comprise *Rhynchotrochus macgillivrayi* (Forbes, 1851), *Noctepuna mayana* (Hedley, 1899), *Noctepuna cerea* (Hedley, 1894) and *Meliobba shafferyi* Iredale, 1940. These species have angulate to strongly carinate body whorls, usually more complex apertural lips and often larger, more robust shells. The most conchologically similar arboreal camaenid is the south-east Queensland *Posorites fucata* (Pfeiffer, 1853), which also has a creamy-white shell with several brown to black spiral bands and sculpture of incised spiral striae.

The only adult specimen available for dissection was poorly preserved making interpretation of reproductive structures difficult. However, teasing apart structures, while destructive, revealed sufficient detail to enable a description of the genitalia. Anatomically, *C. steveirwini* differs from the other arboreal camaenids found in the Wet Tropics and elsewhere along the east coast by the absence of a penial verge and epiphallallic flagellum. Entry of the epiphallus to the penis is through a simple pore surrounded by a muscular collar. All other papuinids thus far dissected by the author have a conical verge (Stanisic, unpublished).

Conchologically *C. steveirwini* also bears some vague similarity to the introduced and unrelated, arboreal cerastid *Rhachistia histrio* (Pfeiffer, 1855). But apart from the gross similarity in overall shell shape, *R. histrio* differs in having a white shell with interrupted dark brown bands and suffusions, and a simple lip that is not thickened or reflected. In northeastern Queensland *R. histrio* is found in the vine thickets of the Forty Mile Scrub and the Kinrara lava flow, south of Mount Garnet, inland north-east Queensland and thus far has not been recorded from the more easterly rainforests of the Wet Tropics.

## Discussion

**Phylogeny.** Molecular studies completed to date (Hugall & Stanisic in press) indicate that *C. steveirwini* has affinities with the arboreal *R. macgillivrayi* and *P. bidwilli*, which together with the former form a sister clade to *Austrochloritis*, a group of ground-dwelling camaenids. *Rhynchotrochus macgillivrayi* is endemic to the Wet Tropics and inhabits lowland to upland rainforests (usually up to 800 m). It is considered to be congeneric with a number of Melanesian and New Guinean species which it closely resembles in both anatomical and conchological features (Clench & Turner 1966). *Papuexul bidwilli* belongs to a monotypic genus and inhabits drier, lowland hoop-pine scrubs in south-east Queensland and northern New South Wales. Conchological similarity within the three species is limited to the sculpture of incised spiral lines and offers little in the way of conclusive evidence on the relationships of *Rhynchotrochus*, *Papuexul* and *Crikey* other than that which is broadly inferred by the molecular studies. However, the lack of a penial verge and epiphallallic flagellum are major differences from the remainder of species within the *Austrochloritis-Rhynchotrochus-Papuexul* lineage. This suggests that these are derived character states within *Crikey* and as such, represent a generic-level difference within this diverse clade.

The inference from molecular data on all the Australian papuinids is one of a long period of dispersal and isolation, and a complex history of environmental sifting. They show diverse origins and considerable phylogenetic diversity (Hugall & Stanisic in press).

The few Melanesian and New Guinean ‘pauinids’ that were included in the molecular study (*Rhynchotrochus woodlarkianus*, *Megalacron* spp.) were shown to be only distantly related to the Australian papuinids. This implies that *Rhynchotrochus* is polyphyletic, however, data on the type of the genus [*R. taylorianus* (Adams & Reeve, 1850)] is needed before the taxonomic position of *R. macgillivrayi* can be clarified.

**Biogeography.** The land snail fauna of the Wet Tropics is characterised by a significant number of species from a range of families that are restricted to montane refugia (above 900 m) (Stanisic *et al.* 1994). The majority of these belong to the Gondwanan Charopidae, a group that is mega-diverse in the temperate areas of southeastern Australia (Smith 1992). It is presumed that these species became restricted to the cooler, wetter

uplands in the north as mesic communities receded to montane refugia in response to Australia's movement into lower and more tropical latitudes (Stanisic 1987, 1990, 1993a, 1993b).

In contrast the documented records of altitudinally restricted, tropical-adapted camaenids in montane refugia are comparatively rare. *Monteithosites helicostracum* Stanisic, 1996 from the Hann Tableland (a northern outlier of the Wet Tropics) is one such species while there is a small number of undescribed camaenids in the Wet Tropics proper that also show this peculiar distribution pattern (Stanisic *et al.* 1994). The large ground-dwelling camaenid, *Gnarosophia bellendenkerensis* (Brazier, 1875) displays a broader, equally uncommon pattern of altitudinal restriction in the Wet Tropics. This species occurs in the uplands and highlands above approximately 400 m (Stanisic 2000), a trait shared with a small number of other species from a range of land snail families (Stanisic *et al.* 1994). In all these cases the presumption is also one of upland restriction caused by climatically induced regression of mesic communities to higher altitudes.

The camaenids are considered to have entered Australia during the Miocene from land masses to Australia's tropical north and would have had a long history of existence in tropical monsoonal conditions. As a result they would have been pre-adapted for life in the alternating wet warm conditions that prevailed in Australia's north through the early part of the Miocene. Elsewhere in Queensland, the Camaeninae managed to successfully colonise and radiate prodigiously in the warm, drier Brigalow Lands and Einasleigh Uplands. Members of the Camaeninae have also managed to penetrate the Red Centre (Solem 1992). Hence, the presence of altitudinally restricted camaenids in the cooler montane refugia of the Wet Tropics is intriguing.

Beginning in the middle and late Miocene, conditions became cooler and drier and there was a gradual restriction of rainforests to wet refugia in the east (Galloway & Kemp 1981). This cooling continued into the Pliocene and Pleistocene and gradually resulted in a north-south attenuation of warm, mesic communities (mesotherm) along the east coast with the development of temperate communities (microtherm) in the south. The general distribution of east coast camaenids reflects this north-south attenuation of mesothermal communities, which suggests that climate played a major role in limiting spread along a cooling east coast rather than the snails' dispersal ability. The presence of a species of the widespread *Austrochloritis* group (south-east Queensland to south-east Victoria) in the temperate forests of Wilsons Promontory, Victoria (the mainland's most southerly point) shows that camaenids were physically able to disperse the length of the east coast (Stanisic unpublished). *Papuexul bidwilli* is the southernmost-occurring arboreal camaenid (mideastern New South Wales).

During the glacial phases of the Quaternary the northern rainforests would have further retreated to very small mountain-top refugia (Kershaw 1981). Most probably *C. steveirwini* became restricted to montane refugia during one of these glacial episodes. The present distribution of *C. steveirwini* on the peaks of geographically isolated rainforest blocks [Lamb Uplands and Spurgeon Uplands] infers fragmentation of a more extensive range in the recent geological past. The species' current distribution spans the Black Mountain Corridor, which is considered to be a major biogeographic barrier. Rainforest was absent from this corridor until about 8000 years ago (Joseph *et al.* 1995). Whether the upland restriction and isolation of the populations of *C. steveirwini* dates from this period or from some earlier period remains debatable. A more explicit chronology of events may emerge when additional studies on some of the many other altitudinally restricted land snails in the Wet Tropics have been completed.

Notwithstanding the many unresolved issues regarding its origins and relationships, *C. steveirwini* is a distinctive Australian land snail befitting the commemoration of a unique Australian identity.

## Acknowledgements

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