Journal of Tropical Biology and Conservation 12: 25–34, 2015 ISSN 1823-3902

Research Article

A New Species of *Kenyirus* (Pulmonata, Camaenidae) from Peninsular Malaysia

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Abstract
We describe a new land snail species of the family Camaenidae from the Belum-Temengor Forest Complex in the State of Perak, Peninsular Malaysia. *Kenyirus sheema*, sp. nov., is compared with its congener *Kenyirus sodhii* (Clements & Tan, 2012), which shares similar conchological characteristics such as a depressed apex, convex base, sub-triangular peristome, angulated lip periphery and partially-covered umbilicus through columellar margin dilation. The shell of the new species differs from *K. sodhii* by being more globular, having rounded whorls with a less prominent peripheral keel and a distinctly rostrate outer lip is absent.

Keywords: *Kenyirus sheema,* Camaenidae, New Species, Land Snail, Malaysia

Introduction
The family Camaenidae Pilsbry, 1895, is composed of hundreds of genera (Vaught, 1989) with disjunct groups occupying Asia, Australasia and the Americas (Wade et al., 2007; Cuezzo, 2003; Scott, 1996; Wurtz, 1955). Camaenidae is traditionally classified by the lack of dart sac and several female reproductive traits (Pilsbry, 1890, 1895, 1939). However, no consensus has been reached on the phylogeny of Camaenidae due to differing conclusions between morphological and molecular phylogenetic analyses (Scott, 1996; Cuezzo, 2003; Schileyko, 2003; Wade et al., 2006, 2007; Bouchet & Rocroi, 2005; Hugall & Stanistic, 2011). The shells of Camaenidae are morphologically variable, but are neither auriform nor plate-like (Schileyko, 2003).

In the Malay Peninsula, Camaenidae is represented by fewer than 30 species and subspecies from five genera: *Amphidromus* (Albers, 1850), *Ganesella*

Received 10 September 2014
Accepted 04 December 2014
Published 15 October 2015

(Blanford, 1863), *Chloritis* (Beck, 1837), *Trachia* (Albers, 1860) (Maassen, 2001; http:malaypeninsularsnail.lifedesk.org), and the recently described *Kenyirus* (Clements & Tan, 2012).

In this paper, we describe a new species of the camaenid genus *Kenyirus* from the hill dipterocarp forests of the Belum-Temengor Forest Complex in the state of Perak, Peninsular Malaysia. Historically, the entire malacofauna of the northern Malay Peninsula, including this forest complex has been researched by Collinge (1902), Sykes (1903) and Godwin-Austen (1909), during the Skeat Expedition, which yielded 54 species belonging to 38 genera. The most recent survey on the general malacofauna in Belum-Temengor was conducted by Davison (1995) during the Malaysian Heritage and Scientific Expedition, where 49 species from 29 genera of terrestrial and arboreal molluscs were found. However, none of the species identified from both expeditions are similar to this new taxon.

Materials and Methods

Description of *Kenyirus sheema*, a new species, is based on conchological characters. The shell morphology of the new species proposed is compared to *Kenyirus sodhii* (Clements & Tan, 2012). Measurements were taken in millimetres using a Vernier caliper. Shell height (SH) and shell diameter (SD) were measured to the nearest 0.1 mm. Shell height was measured from the apex to the lowest part of the peristome parallel to the coiling axis (Tan et al., 2011). Shell diameter was measured at the widest section perpendicular to the coiling axis (Tan et al., 2011). Number of whorls was counted with the inclusion of the protoconch (Vermeulen & Whitten, 1998). The specimen examined was deposited in the Zoological Reference Collection (ZRC), Lee Kong Chian Natural History Museum, National University of Singapore.

Systematic Description
FAMILY CAMAENIDAE, (Pilsbry, 1895)
Genus *Kenyirus* (Clements & Tan, 2012)

Type species. *Kenyirus sodhii* (Clements & Tan, 2012).

Diagnosis. The suite of traits distinguishing *Kenyirus* from confamilials in Sundaland includes the following: Shell subglobose-trochoidal, peristome sub-triangular, apex depressed. Embryonic and post-nuclear whorl with numerous microscopic pits and axial striations; post-nuclear whorls and base convex.

The last whorl slightly descending before abruptly deflecting to form a thickened and slightly reflexed lip with an angulated rostrum. Body whorl with a slight constriction aft of the lip. Aperture oblique, rhomboidal and slightly angled on the outer lip. Umbilicus partially covered by dilated columellar margin.

Remarks. There are no camaenid genera on Sundaland with morphological characteristics similar to genus *Kenyirus*. Nevertheless, the taxonomic placement of *Kenyirus* in Camaenidae and its affinity with other camaenid genera are to be regarded as provisional until anatomical and molecular materials become available (Clements & Tan, 2012).

***Kenyirus sheema* sp. nov.**(Figure 1)

Holotype. 1 shell, Peninsular Malaysia, Perak, south of Royal Belum State Park, forest at Km 59 of Federal Route 4 (now known as Amanjaya Forest Reserve; gazetted on 9th May 2013), opposite Works Department temporary shelter (5°35'21.3"N, 101°29'52.8"E) (Figure 2), coll. G. R. Clements, 17th Feb. 2009 (ZRC.MOL.3073).

Shell measurements (in mm). Holotype: SH 21 × SD 24.3, whorls 4¾–5, aspect ratio 1.26

Type locality. Disturbed hill dipterocarp forest south of Royal Belum State Park, Perak, Peninsular Malaysia.

Description. Shell subglobose-trochoidal, thin but solid, dextral, body whorl with well-defined peripheral keel; spire relatively tall. Apex depressed; base (below the periphery) convex. Axial striations fine, shallow and indistinct. Last whorl slightly descending just before abruptly deflecting to form a thickened and reflexed lip; slight, but conspicuous constriction aft of the lip. Aperture oblique, rhomboidal with a slight but distinctly angled outer lip. Collumellar margin dilated and reflected over the small umbilicus. Ground colour porcellaneous white; two prominent colour spiral bands at the base, one thick maroon band along the periphery of the base and one thin inner pink satellite band. A thin brown subsutural band is present at the three earliest whorls before fading out. The shell is covered with a thin yellow-brown periostracum.

Etymology. The species is named in honour of Sheema Abdul Aziz, who led the creation of the first management plan (WWF-Malaysia, 2011) for Royal Belum State Park, north of where this species was discovered.

Remarks. *Kenyirus sheema* sp. nov. shares several diagnostic conchological characteristics to its only known congener, *Kenyirus sodhii*. Both shells have a flat apex, convex base, sub-triangular peristome and umbilicus partially covered by columellar margin dilation. *Kenyirus sheema* differs distinctly from *K. sodhii* by its globular shell, more rounded whorls, less angulated and relatively indistinct peripheral keel, and the absence of a prominent projecting rostrum when mature. The constriction aft of the lip is also more prominent in *K. sheema* than in *K. sodhii*. This is the second species described for the genus *Kenyirus*.

Discussion

The conchological traits of *Kenyirus* are unique and different from all other camaenid genera present on Sundaland (Clements & Tan, 2012). The diagnostic conchological characteristics of *Kenyirus*, especially its depression after of the lip is reminiscent of the papuinoid notch associated with members of Australasian subfamily Papuininae Iredale 1938 (Clench & Turner, 1966). This papuinin trait of *Kenyirus* is not found in any other Sundaland genera (Clements & Tan, 2012). Thus based on conchological characteristics, we regard the placement of *K. sheema* sp. nov. within this genus as most parsimonious. The characteristic similarity in the elongation and angulation of the shell lip periphery between *K. sheema* and *K. sodhii* suggests the rostrum of *Kenyirus* may be homologous, but morphologically variable. While *Kenyirus* has some papuinin features, the genus should not be implied as an extralimital taxon of the subfamily Papuininae since molecular analysis has shown papuinid conchological traits to be homoplastic in the Australasian camaenid clade (Hugall & Stanistic, 2011). Furthermore, the possibility of papuinids dispersing into Sundaland remains remote due to unfavourable biotopes limiting terrestrial mollusc dispersal between Australasia and Sundaland (Hausdorf, 2000). Thus, the similarity of papuinin traits in *Kenyirus* is most likely a case of convergent evolution rather than dispersal.

Further discovery of living individuals will likely enhance our understanding of the phylogenetic relationship between the two species and their familial assignment through anatomical and molecular methods. Regrettably, no additional individuals of the apparently rare *K. sheema* have been found since

its initial discovery. Sampling efforts are also largely hindered by the inaccessibility of the region.

The ecology and biology of *K. sheema* remain unknown. However, based on the propensity of tree-dwelling camaenids in Sundaland, *K. sheema* is postulated to be arboreal. To date, *K. sheema* has only been found in disturbed hill dipterocarp forests in the recently gazetted Amanjaya Forest Reserve near the Royal Belum State Park (Figure 2). We suspect *K. sheema* has a wider distribution across the contiguous forests of Hala-Bala Wildlife Sanctuary and

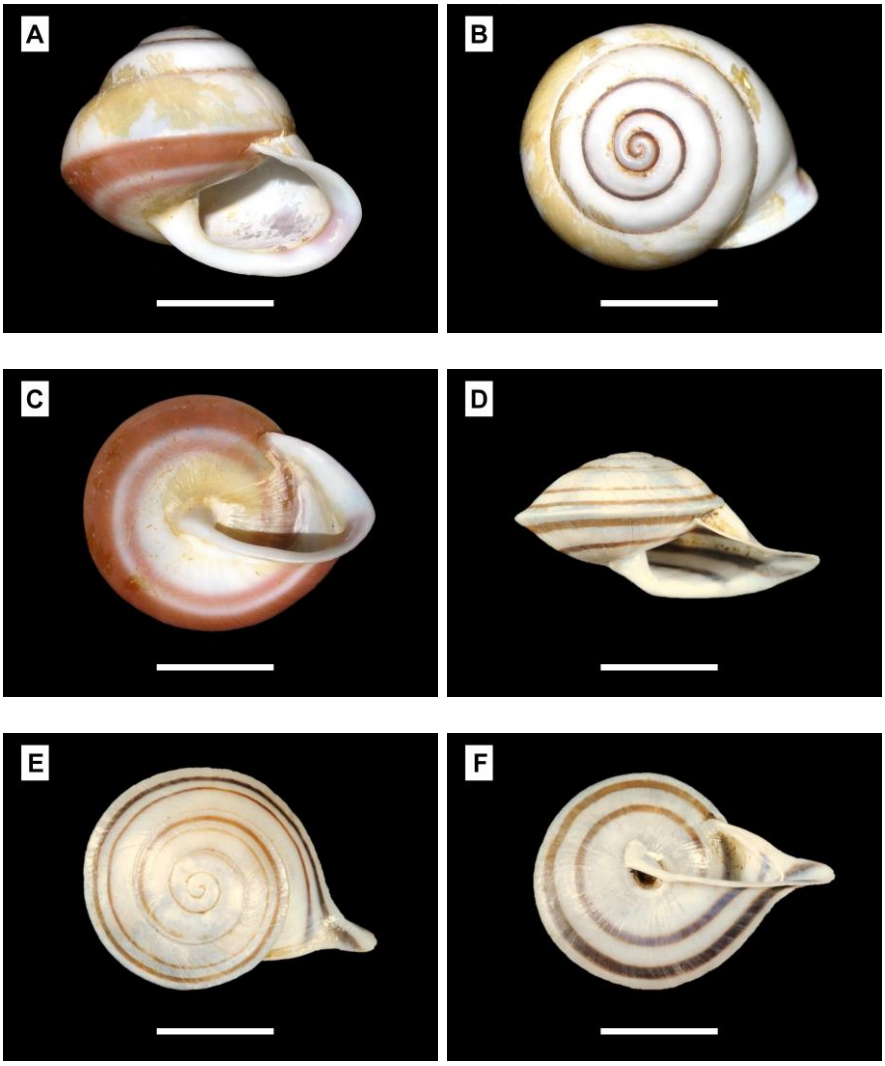

Figure 1. A-C, *Kenyirus sheema* sp. nov., Belum-Temengor Forest Complex, Perak, Peninsular Malaysia: Holotype, SH 21 × SD 24.3 (ZRC.MOL.3073). **D-F**, *Kenyirus sodhii* (Clements & Tan, 2012), Tembat Forest Reserve, Terengganu, Peninsular Malaysia: Holotype, SH 13.2 x SD 26.8 (ZRC.MOL.3072). Scale bar 10mm.

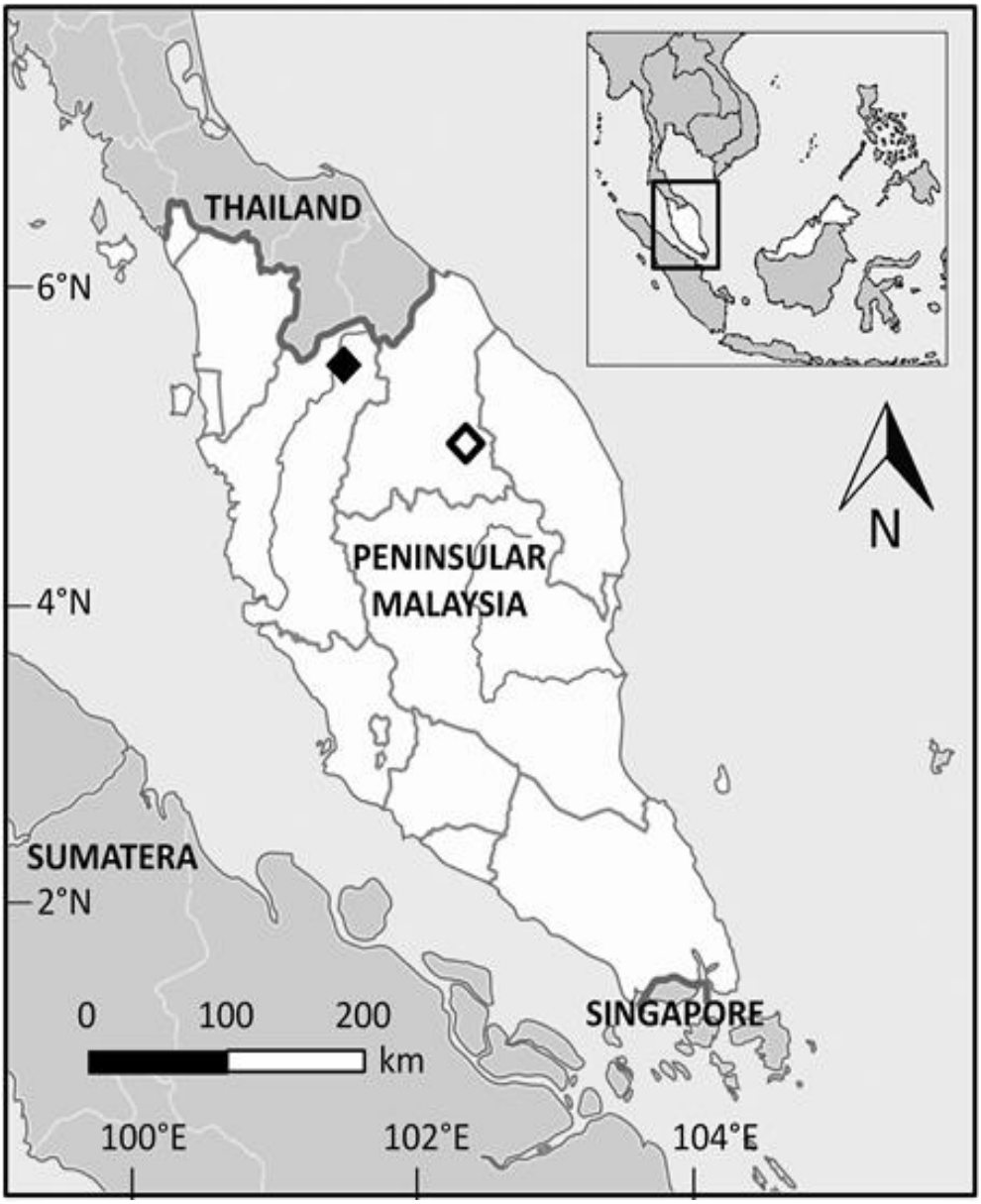

Figure 2. Map of Peninsular Malaysia, showing the type localities for *Kenyirus sheema* sp. nov. (closed diamond) and *Kenyirus sodhii* (Clements & Tan, 2012) (opened diamond). Image sourced from Hellerick (2013).

Bang Lang National Park in southern Thailand, as well as on the Temengor side of the forest complex, all of which have similar biome types (Yeap et al., 2009). Further surveys into these areas are required to obtain data on species distribution and biological characteristics.

Despite almost 200 years of malacological research, this discovery along with the recently described camaenid species *Kenyirus sodhii* (Clements & Tan, 2012), and cyclophorid species *Pearsonia tembatensis* (Mohammad Effendi bin Marzuki & Clements, 2013), suggest presence of more new land snail taxa in non-karstic rainforests of Peninsular Malaysia (Giam et al., 2011). This is not surprising because past malacological surveys in Peninsular Malaysia have concentrated heavily on limestone karsts (Maassen, 2001; Clements et al., 2008). This new discovery reflects a wider potential for further detection of new terrestrial mollusc taxa in Southeast Asia (Clements & Tan, 2012). Such findings may contribute to better understanding of regional molluscan biogeography as well as the unresolved phylogeny of Southeast Asian Camaenidae (Cuezzo, 2003; Wade et al., 2006, 2007; Hugall & Stanistic, 2011).

Acknowledgements

We would like to thank Fred Naggs (Natural History Museum, London) for confirming the novelty of this species. Thanks are also due to Thor-Seng Liew (Naturalis Biodiversity Center, Leiden) and Martyn E. Y. Low (Lee Kong Chian Natural History Museum, National University of Singapore) for their help in obtaining references used in this paper. We also thank Frank Köhler (Australian Museum, Sydney) for suggestions on improving the paper. We thank Menno Schilthuizen (Naturalis Biodiversity Center, Leiden) and an anonymous reviewer for constructive comments on the manuscript. Map image by Hellerick (2013) was sourced from Wikipedia Commons under fair use purposes for research. We also want to acknowledge the Perak Forestry Department, who collaborated with WWF-Malaysia (whom the third author and discoverer of this snail species was an employee of) to conduct wildlife surveys in the state land forest before it was gazetted as Amanjaya Forest Reserve.

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