

## TERRESTRIAL SNAILS AND SLUGS (MOLLUSCA: GASTROPODA) OF PULAU TEKONG, SINGAPORE

Siong Kiat Tan\*, Kelvin K. P. Lim and Marcus A. H. Chua

Lee Kong Chian Natural History Museum, National University of Singapore

2 Conservatory Drive, Singapore 117377, Republic of Singapore

(\*Corresponding author: [dbstsk@nus.edu.sg](mailto:dbstsk@nus.edu.sg))

**ABSTRACT.** — During recent wildlife surveys on Pulau Tekong, Singapore, opportunities were taken to document the terrestrial malacofauna diversity, which is hitherto unknown. Eleven species were consequently recorded, namely *Semperula* cf. *maculata*, *Semperula* cf. *variegatula*, *Achatina fulica*, *Subulina octona*, *Paropeas achatinaceum*, *Hemiplecta humphreysiana*, *Sarika resplendens*, *Parmarion martensi*, *Quantula striata*, *Bradybaena similis* and *Amphidromus atricallosus temasek*, from the families Veronicellidae, Achatinidae, Subulinidae, Ariophantidae, Dyakiidae, Bradybaenidae and Camaenidae. The records, and photographic evidence, of the terrestrial molluscs occurring on the island are provided in this short note. Notably, *Paropeas achatinaceum* is rediscovered in Singapore after more than a century, and the discovery of sympatrically occurring yellow- and white-shelled forms of *Amphidromus atricallosus temasek* is reported for the first time.

**KEY WORDS.** — Pulau Tekong, Singapore, mollusc, land snail, land slug

### INTRODUCTION

Pulau Tekong is an island situated off northeastern Singapore Island, in the Johor Straits, at the mouth of the Johor River. The island has an area of about 2,400 hectares (National Environment Agency, 2010) and was Singapore's largest island until the creation of Jurong Island (Chou, 2011). It has been inhabited as early as the mid-19<sup>th</sup> century and once had a population of about 5,000 living in more than a dozen villages (Chen & Lee, 2012). The island is now used exclusively by the Singapore Armed Forces for military purposes and access to the public is restricted.

Sizable natural habitats still exist on Pulau Tekong as it was spared from the past few decades of rapid urbanisation and other development that affected Singapore Island. Wildlife surveys conducted in recent years have revealed Pulau Tekong to be a refuge for many threatened and endangered animals of Singapore such as the leopard cat (*Prionailurus bengalensis*), Malayan porcupine (*Hystrix brachyuran*), and Sunda pangolin (*Manis javanicus*) (Chang, 2006). To date, many mammals, birds, reptiles, and amphibians have been recorded from the island (e.g., Wang & Hails, 2007; Baker & Lim, 2008), but the invertebrate fauna remains largely unknown.

Recent wildlife surveys provided opportunities for us to document the terrestrial molluscan fauna diversity on Pulau Tekong, albeit anecdotally, and provided an interesting first glimpse of the land snail and slug diversity on the island. The 11 species recorded on the surveys are herein reported, with photographic evidence, in this article.

### RECORDS AND OBSERVATIONS

Family Veronicellidae

*Semperula* cf. *maculata* (Templeton, 1858), Fig. 1

This is apparently one of the more common slugs on Pulau Tekong. Foraging individuals were commonly sighted, especially at the reclaimed land at the southern part of the island. A small individual was also found on a camera trap set in a cultivated area at the eastern part of the island.

*Semperula* cf. *variegatula* (Simroth, 1918), Fig. 2

Only two examples of this species were seen. One observed feeding on faecal matter of a leopard cat (*Prionailurus bengalensis*) in a cultivated area at the eastern part of the island, the other an individual being attacked by ants on the floor of a building.



Fig. 1. *Semperula* cf. *maculata*. Total length c. 5 cm. (Photograph by: Kelvin K. P. Lim).  
 Fig. 2. *Semperula* cf. *variegatula*. Total length c. 2.5 cm. (Photograph by: S. K. Tan).

#### Family Achatinidae

##### *Achatina fulica* Bowdich, 1822, Fig. 3

Live animals and empty shells of this species were observed in many parts of Pulau Tekong and it is presumed to be widespread and common. This species is especially common at the reclaimed land at the southern part of the island, although usually hidden from sight amongst plants at the sides of the dirt tracks. It is known to thrive in disturbed human-modified habitats and is not usually common in undisturbed forests (Tan et al., 2012). Originally native to Africa, its occurrence in Singapore was first reported in the early 1920s (Jarrett, 1923). It is presently the largest land snail species in Singapore, occasionally attaining more than 130 mm in shell length (pers. obs.).

#### Family Subulinidae

##### *Subulina octona* (Bruguière, 1789), Fig. 4

Only a single example of this species was found under leaf litter at a forest edge adjacent to a road at Selabin, but it is presumed to be more common and widespread on the island. More examples were probably not observed only because little effort was made to sample the soil and leaf litter thoroughly during the surveys. This tropical cosmopolitan species has been recorded in the Malay Archipelago since the late 1800s (van Benthem Jutting, 1952).

##### *Paropeas achatinaceum* (Pfeiffer, 1846), Fig. 5

Several specimens of this smallish species, averaging about 10 mm in shell length, were found in a small damp mossy concrete drain on the eastern end of the island. The observation of this species on the island is noteworthy and may be regarded as a rediscovery of the species in Singapore. Specimens collected more than a century ago from Singapore (H. N. Ridley collection; NHMUK 1896.9.3.33–37) are present in the Natural History Museum, London (see Naggs, 1994), but this species appears to be rare and has not been collected or mentioned by latter workers (e.g., Lim, 1969; Ho, 1995; Tan et al., 2012). However, it is not ascertained if the species is native to Singapore. Owing in part to human activities, this species occurs in the Mascarene Islands, Southeast Asia, Borneo, and has also been introduced to the Hawaiian Islands (van Benthem Jutting, 1952; Cowie, 1997; Vermeulen & Whitten, 1998).



Fig. 3. *Achatina fulica*. Shell length c. 8 cm. (Photograph by: Kelvin K. P. Lim).  
 Fig. 4. *Subulina octona*. Shell length: c. 1.5 cm. (Photograph by: Marcus A. H. Chua).  
 Fig. 5. *Paropeas achatinaceum*. Shell length c. 1 cm. (Photograph by: S. K. Tan).

## Family Ariophantidae

***Hemiplecta humphreysiana*** (Lea, 1840), Fig. 6

This large, native species appears to be rather common and widespread on Pulau Tekong. Most encounters were in the forests and swampy areas, at the northern and central parts of the island. The species is quite widely distributed from Thailand, Malaysia, Singapore to Borneo, and other parts of Indonesia (van Benthem Jutting, 1950), but the taxon is however a species-complex with several distinct forms known. Interestingly, even the population on Pulau Tekong is slightly different in colouration compared to those on Singapore Island despite the close proximity.

***Sarika resplendens*** (Philippi, 1846), Fig. 7

As observed for the species on Singapore Island, this species appears to be more common in modified habitats and is very common with more than two dozen individuals sighted in about half an hour's search at the reclaimed land at the southern part of the island. This species has a varied diet and is known to feed on fresh and rotting vegetable matter as well as scavenging on carrion. A small group was observed scavenging on the remains of a dead frog on one occasion (Tan et al., 2015).

***Parmarion martensi*** Simroth, 1893, Fig. 8

Apparently one of the more common slugs, this species was sighted several times in a few locations around the island. A larger congeneric species *Parmarion pupillaris*, which cannot be reliably distinguished from *Parmarion martensi* by external features, has also been recorded from Singapore (Lim, 1969; Ho, 1995). It is thus possible that more than one species may be present. Most of the specimens encountered were about 50 mm long which, according to van Benthem Jutting (1950), is the normal adult size for *Parmarion martensi*.

## Family Dyakiidae

***Quantula striata*** (Gray, 1834), Fig. 9

This commonly seen native snail in Singapore is equally common in forests and in modified habitats. Its shell colour is known to be variable (Tan et al., 2012), but shells of all specimens seen on Pulau Tekong appear to be invariably dark reddish brown. Bioluminescence in this species was first discovered in Singapore by Haneda (1946), and it remains the only bioluminescent terrestrial snail known to date.

## Family Bradybaenidae

***Bradybaena similaris*** (Rang, 1831), Fig. 10

Only a few live individuals were found at Salabin, while one live snail and several empty shells were seen amongst vegetation in the reclaimed land. It is commonly found in both forests and urban areas on Singapore Island (Tan et al., 2012), hence is probably more common than our observations suggest. This species is an agricultural pest that has been introduced to the tropics and subtropics worldwide (Abbott, 1989; Cowie, 1997), and is believed to an introduced species in Singapore (Tan et al., 2012).

## Family Camaenidae

***Amphidromus atricallosus temasek*** Tan, Chan & Panha, 2011, Fig. 11

This local subspecies was sighted, mostly on tree trunks and on leaves, at several locations around the northern half of the island. Based on our observations, it is not rare, and the highest population density of this arboreal snail seems to occur around the Salabin area. This subspecies is known to be enantiomorphic in the coiling of their shells, but not a single sinistral specimen was observed by us on Pulau Tekong (but see Lok & Tan, 2008). Curiously, the Pulau Tekong population comprises animals that bear shells that are either yellow or white, a phenomenon that has not been previously reported for the local subspecies (Tan et al., 2011). A recently discovered population on Pulau Ubin appears to comprise of animals with only white shells (Tan & Xu, 2013).

## DISCUSSION

No exhaustive surveys for molluscs were made and the majority of our observations were of foraging animals encountered rather opportunistically during the nocturnal wildlife surveys. It is thus very likely that some species remain undiscovered, and the true extent of terrestrial mollusc diversity on the island may only be fully appreciated by future surveys focusing on the malacofauna.



Fig. 6. *Hemiplecta humphreysiana*. Shell length c. 5 cm. (Photograph by: Kelvin K. P. Lim).



Fig. 7. *Sarika resplendens*. Shell length c. 2 cm. (Photograph by: Kelvin K. P. Lim).



Fig. 8. *Parmarion martensi*. Total length c. 5 cm. (Photograph by: Kelvin K. P. Lim).



Fig. 9. *Quantula striata*. Shell length c. 2.5 cm. (Photograph by: S. K. Tan).



Fig. 10. *Bradybaena similaris*. Shell length c. 1.5 cm. (Photograph by: S. K. Tan).



Fig. 11. *Amphidromus atricallosus temasek* (subadult). Shell length c. 3.5 cm. (Photograph by: Kelvin K. P. Lim).

Incidentally, most of the taxa regarded as native by Tan et al (2012) are generally conspicuously absent in urban settings and cultivated areas Pulau Tekong. Our observations also seem to suggest that many species are unevenly distributed or restricted to certain parts of the island. It is however unclear if this is due to inadequate sampling or the fact that large areas have been extensively cultivated for agriculture in the past (see Chen & Lee, 2012).

At least three veronicellid and five ariophantid slugs have been recorded from Singapore (Tan & Woo, 2010 and references therein), including *Semperula carusi* (Simroth, 1893), a species described from Singapore. However many slug species are very similar in external morphology and reliable identification of these taxa usually requires anatomical examination (van Benthem Jutting, 1952; see also Gomes & Thomé, 2002). Available references and comparative material in the Zoological Reference Collection of the Lee Kong Chian Natural History Museum, National University of Singapore are at present inadequate to enable confident determination of the slug species encountered, hence the slug identifications in this article are provisional.

On Singapore Island, the sympatrically occurring *Amphidromus atricallosus temasek* and *Hemiplecta humphreysiana* are restricted to relatively undisturbed forests around the Central Catchment Nature Reserve, and the Western Catchment Area (Chua & Tan, 2015; Tan & Chua, 2015). It is thus heartening to record these species, which are vulnerable to habitat loss in Singapore, on Pulau Tekong, and apparently in good numbers. However it should also be noted that native terrestrial gastropod diversity in the forests on Pulau Tekong is lower compared to the better quality forests of Singapore Island because many other forest dwelling species (e.g., *Cyclophorus perdix aquila*, *Dyakia kintana*, *Geotrochus lychnia*, *Videna bicolor*) were not recorded, or at least not yet. Therefore although the island may serve as a refuge for certain imperilled or vulnerable terrestrial mollusc species, its importance for the conservation of native mollusc species would require further study to ascertain.

#### ACKNOWLEDGEMENTS

This compilation was made during a study of the ecology of leopard cats in Singapore by Marcus Chua, and funded by the Wildlife Reserve Singapore Conservation Grant. The authors would like to acknowledge the Ministry of Defence and the National Parks Board (permit no. NP/RP10-086) for permission to conduct field surveys on Pulau Tekong.

#### LITERATURE CITED

- Abbott, R. T., 1989. *Compendium of Landshells*. American Malacologists, Inc., Melbourne, Florida. viii + 240 pp.
- Baker, N. & K. K. P. Lim, 2008. *Wild Animals of Singapore: A Photographic Guide to Mammals, Reptiles, Amphibians and Freshwater Fishes*. Draco Publishing and Distribution Pte. Ltd. and Nature Society (Singapore), Singapore. 180 pp.
- Bowdich, T. E., 1822. *Elements of Conchology, including the Fossil Genera and the Animals. Part I. Univalves*. [no publisher given; printed by J. Smith, sold by Treuttel & Würtz, London], Paris. xiii + 14–75 + [7] + [37] pp., 19 pls.
- Bruguère, J.-G., 1789. *Encyclopédie Méthodique. Histoire Naturelle des Vers*. Panckoucke, Paris, **1**(1): [i]–xviii + 1–344 pp.
- Chang, A.-L., 2006. Tekong's treasures. *The Straits Times*, 25 Apr. 2006, P. H9.
- Chen, P. S. & L. S. Lee, 2012. *A Retrospect on the Dust-laden History: The Past and Present of Tekong Island in Singapore*. World Scientific Publishing Co. Pte. Ltd., Singapore. xiv + 121 pp.
- Chua, M. A. H. & S. K. Tan, 2015. Tree snail *Amphidromus atricallosus temasek* in Western Catchment Area. *Singapore Biodiversity Records*, **2015**: 9.
- Cowie, R. H., 1997. Catalog and bibliography of the nonindigenous nonmarine snails and slugs of the Hawaiian Islands. *Bishop Museum Occasional Papers*, **50**: 1–66.
- Gomes, S. R. & J. W. Thomé, 2004. Diversity and distribution of the Veronicellidae (Gastropoda: Soleolifera) in the Oriental and Australian biogeographical regions. *Memoirs of the Queensland Museum*, **49**: 589–601.
- Gray, J. E., 1834. Characters of a new genus of Mollusca (*Nanina*). *Proceedings of the Zoological Society of London*, **1834**: 58–59.
- Haneda, Y., 1946. A luminous snail, *Dyakia striata*, in Malaya. *Seibutsu*, **1**(5–6): 294–298. [In Japanese]
- Ho, W. H., 1995. A review of the land-snail fauna of Singapore. *Raffles Bulletin of Zoology*, **43**: 91–113.
- Jarrett, V. H. C., 1923. The occurrence of the snail *Achatina fulica* in Malaya. *The Singapore Naturalist*, **2**: 73–76.
- Lea, I., 1840. Descriptions of new fresh water and land shells. *Proceedings of the American Philosophical Society*, **1**(13): 284–289.
- Lim, R. K. Y., 1969. *The Terrestrial Molluscs of Singapore*. Unpublished Thesis. Department of Zoology, University of Singapore. vi + 241 pp.
- Lok, A. F. S. L. & S. K. Tan, 2008. A review of the Singapore status of the green tree snail, *Amphidromus atricallosus perakensis* Fulton, 1901 and its biology. *Nature in Singapore*, **1**: 225–230.
- Naggs, F., 1994. The reproductive anatomy of *Paropeas achatinaceum* and a new concept of *Paropeas* (Pulmonata: Achatinoidea: Subulinidae). *Journal of Molluscan Studies*, **60**: 175–191.
- National Environment Agency, 2010. *Singapore's Second National Communication: Under the United Nations Framework Convention on Climate Change*. National Environment Agency, Singapore. 76 pp.
- Pfeiffer, L., 1846. *Symbolae ad Historiam Heliceorum. Sectio tertia*. T. Fischer, Cassel. 100 pp.
- Philippi, R. A., 1846. Vier neue konchylienarten. *Zeitschrift für Malakozoologie*, **3**: 191–192.
- Rang, S., 1831. Description des coquilles terrestres recueillies pendant un voyage à la côte occidentale d'Afrique, et au Brésil. *Annales des Sciences Naturelles*, **24**(93): 5–60, Pls. 1–3.
- Simroth, H., 1893. Ueber einige Parmarion-Arten. In: Weber, M., *Zoologische Ergebnisse einer Reise in Niederländisch Ost-Indien. Dritter Band*. E. J. Brill, Leiden. Pp. 100–110, pls. VII–VIII.
- Simroth, H., 1918. Über einige Nacktschnecken vom Malayischen Archipel von Lombok an ostwärts bis zu den Gesellschafts-Inseln. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, **35**(3): 259–306, pls. XVIII–XX.
- Tan, S. K., S. Y. Chan & G. R. Clements, 2012. *A Guide to Snails and other Non-marine Molluscs of Singapore*. Science Centre, Singapore. 176 pp.

- Tan, S. K., S. Y. Chan & S. Panha, 2011. A new subspecies of *Amphidromus* (*Amphidromus*) *atricallosus* from Singapore (Mollusca: Gastropoda: Camaenidae). *Raffles Bulletin of Zoology*, **59**: 39–46.
- Tan, S. K. & M. A. H. Chua, 2015. Land snail *Hemiplecta humphreysiana* in Western Catchment Area. *Singapore Biodiversity Records*, **2015**: 10.
- Tan, S. K., K. K. P. Lim & M. A. H. Chua, 2015. Land snails *Sarika resplendens* feeding on frog carcass. *Singapore Biodiversity Records*, **2015**: 15.
- Tan, S. K. & H. P. M. Woo, 2010. *A Preliminary Checklist of the Molluscs of Singapore*. Raffles Museum of Biodiversity Research, National University of Singapore, Singapore. 78 pp. [http://lkcnhm.nus.edu.sg/nus/pdf/PUBLICATION/LKCNH%20Museum%20Books/LKCNHM%20Books/preliminary\\_checklist\\_molluscs\\_singapore.pdf](http://lkcnhm.nus.edu.sg/nus/pdf/PUBLICATION/LKCNH%20Museum%20Books/LKCNHM%20Books/preliminary_checklist_molluscs_singapore.pdf). Uploaded 02 June 2010. (Accessed 6 Apr.2015).
- Tan, S. K. & W. Xu, 2013. Tree snail *Amphidromus atricallosus temasek* on Pulau Ubin. *Singapore Biodiversity Records*, **2013**: 22.
- Templeton, R., 1858. On a new species of *Vaginula* from Ceylon. *The Annals and Magazine of Natural History*, **3**: 49–50.
- van Benthem Jutting, W. S. S., 1950. Systematic studies on the non-marine Mollusca of the Indo-Australian Archipelago. II. Critical revision of the Javanese pulmonate land-snails of the families Helicarionidae, Pleurodontidae, Fruticicolidae and Streptaxidae. *Treubia*, **20**: 381–505.
- van Benthem Jutting, W. S. S., 1952. Systematic studies on the non-marine Mollusca of the Indo-Australian Archipelago. II. Critical revision of the Javanese Pulmonate land-snails of the families Ellobiidae, to Limacidae, with an appendix on the Helicarionidae. *Treubia*, **21**: 291–435.
- Vermeulen, J. J. & A. J. Whitten, 1998. *Fauna Malesiana Guide to the Land Snails of Bali*. Backhuys Publishers, Leiden. x + 164 pp.
- Wang, L. K. & C. J. Hails, 2007. An annotated checklist of the birds of Singapore. *The Raffles Bulletin of Zoology*, Supplement **15**: 1–179.