

First records of snail-killing flies (Diptera: Sciomyzidae) from Singapore with notes on morphology and DNA sequencing

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Abstract. The collection of the National University of Singapore as well as material collected in 2018 were checked for Sciomyzidae, resulting in the uncovering of two species previously unknown to Singapore: *Sepedon senex* Wiedemann, 1830, and *Sepedon plumbella* Wiedemann, 1830. These records are the first observations of the family Sciomyzidae in Singapore.

Key words. Oriental, snail-killing flies, *Sepedon*, distribution, barcodes

Recommended citation. Mortelmans J, Maimon H, Lee L & Ang Y (2022) First records of snail-killing flies (Diptera: Sciomyzidae) from Singapore with notes on morphology and DNA sequencing. Nature in Singapore, 15: e2022014. DOI: 10.26107/NIS-2022-0014

INTRODUCTION

Snail-killing flies (Diptera: Sciomyzidae) are amongst the more ecologically well-known families of flies in the world. The fact that their larvae prey on gastropods makes them interesting study organisms in applied ecology, as biocontrol agents, as well as in fundamental ecology, in studies on the evolution of larval feeding behaviour. For nearly half of all known species, extensive research has revealed their life cycles, immature stages and host preference (Knutson & Vala, 2011; Murphy et al., 2012). All species of Sciomyzidae, with only a few exceptions, are known to have malacophagous larvae feeding on several families of land and aquatic snails.

Sciomyzidae from the Oriental region are scarcely known, and there are hitherto no known records from Singapore (Knutson & Ghorpadé, 2004). The complete Oriental region is poorly surveyed, and most collections only hold specimens from expeditions in the beginning of the 1900s. Recently, we found a number of specimens in the Zoological Reference Collection of the Lee Kong Chian Natural History Museum, National University of Singapore (ZRC), that were collected from Singapore since the 1960s. This article thus serves as the first overview of the sciomyzid fauna in Singapore, and provides an easily accessible visual identification tool to distinguish the presently recorded species.

MATERIAL & METHODS

Thirteen specimens of Sciomyzidae were found in the ZRC Entomology collections. They were then imaged in high resolution through different depths of field using the Dun Inc. Passport II Imaging System (Canon Mk II, MPE 65mm lens), focus-stacked into fully focused images using Zerene Stacker 1.04 (© Zerene Systems LLC), and digitally cleaned up and plated using Adobe Photoshop CS6. Based on these images, the specimens were identified to species based on the key in Vikhrev & Yanbulat (2019). Subsequently, further field expeditions by the last author yielded an additional Singaporean specimen to sequence for COI barcode. DNA from this specimen was extracted using HotSHOT extraction (Truett et al., 2000); a 313-bp fragment of cytochrome oxidase I (COI) was amplified using forward and reverse primers (mlCOIintF: 5'-GGWACWGGWTGAACWGTWTAYCCYCC-3' [Leray et al., 2013] and modified jgHCO2198: 5'-TANACYTCNGGRTGNCCRAARAAYCA-3' [Geller et al., 2013]), and sequenced using MinION™ (Oxford Nanopore Technologies, Oxford, UK). The barcode was then uploaded onto GenBank. Finally, an online taxon search on observational platform www.inaturalist.org was made to gain additional observations.

RESULTS

The ZRC Entomology collection holds two species of Sciomyzidae, *Sepedon senex* Wiedemann, 1830, and *Sepedon plumbella* Wiedemann, 1830. Recent field expeditions yielded only *Sepedon plumbella*—one specimen (ZRC_ENT00021053) was sequenced for a 312-bp COI barcode and uploaded onto GenBank (MZ434877).

On www.inaturalist.org, one specimen, a male photographed in Springleaf Nature Park (Singapore), was identified as *Sepedon plumbella*; no observations of *Sepedon senex* were found. Thirteen specimens were imaged in high resolution for this study. Four specimen images are included in this paper to illustrate the adult male and female life stages of both species (Figs. 1–4), while the other images are all uploaded on the Biodiversity of Singapore portal, a digital reference collection that aims to represent the flora and fauna of Singapore (<https://singapore.biodiversity.online/taxon/A-Arth-Hexa-Dipt-Sciomyzidae-Sepedon/>). Associated information for all examined material is shown in Table 1.

Table 1. List of Sciomyzidae specimens in the Zoological Reference Collection of the Lee Kong Chian Natural History Museum (ZRC) as of 2021, with associated collection information. All specimens are dry-pinned.

No.	Species	Specimen voucher code	Locality	Collection date	Collector
1	<i>Sepedon senex</i>	ZRC_BDP0041735	Cluny Road (Garden)	April 1967	n.a.
2	<i>Sepedon senex</i>	ZRC_BDP0041736	Cluny Road (Garden)	April 1967	n.a.
3	<i>Sepedon senex</i>	ZRC_BDP0041738	MacRitchie	19 January 1975	Eleanor Chin
4	<i>Sepedon senex</i>	ZRC_BDP0041746	Cluny Road (Garden)	April 1967	n.a.
5	<i>Sepedon plumbella</i>	ZRC_ENT00021053	Kent Ridge Park (Dragonfly Pond)	17 March 2018	Yuchen Ang
6	<i>Sepedon plumbella</i>	ZRC_BDP0041737	Jurong (Mangrove)	15 April 1976	D. H. Murphy
7	<i>Sepedon plumbella</i>	ZRC_BDP0041739	Kranji (“14/5-2”)	1975	D. H. Murphy
8	<i>Sepedon plumbella</i>	ZRC_BDP0041740	Mandai (Forest)	29 July 2013	M. K. Tan & H. Yeo
9	<i>Sepedon plumbella</i>	ZRC_BDP0041747	Kranji (“14/5-2”)	1975	D. H. Murphy
10	<i>Sepedon plumbella</i>	ZRC_BDP0041750	Kranji (“14/5-2”)	1975	D. H. Murphy
11	<i>Sepedon plumbella</i>	ZRC_BDP0041752	Kent Ridge Park	10 July 2013	Loh Ge Yi
12	<i>Sepedon plumbella</i>	ZRC_BDP0041753	Kranji (“14/5-2”)	1975	D. H. Murphy
13	<i>Sepedon plumbella</i>	ZRC_BDP0041755	Kranji (“14/5-2”)	1975	D. H. Murphy
14	<i>Sepedon plumbella</i>	ZRC_BDP0041756	Kranji (“14/5-2”)	1975	D. H. Murphy



Fig. 1. *Sepedon senex* female (specimen ZRC_BDP0041735), lateral view. (Photograph by: Maimon Hussin).



Fig. 2. *Sepedon senex* male (specimen ZRC_BDP0041738), lateral view. (Photograph by: Maimon Hussin).




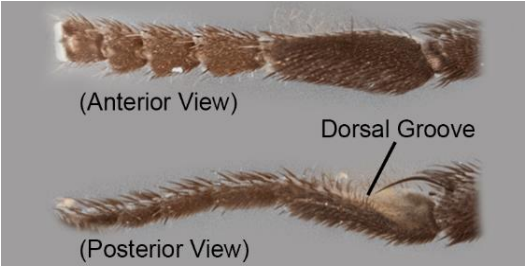
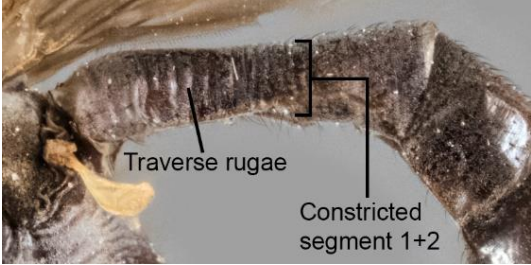
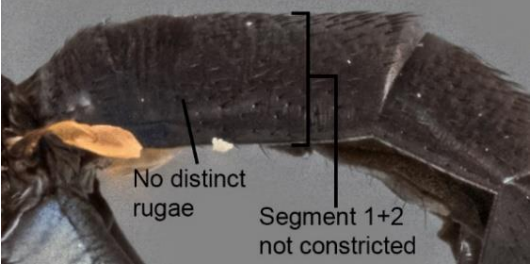
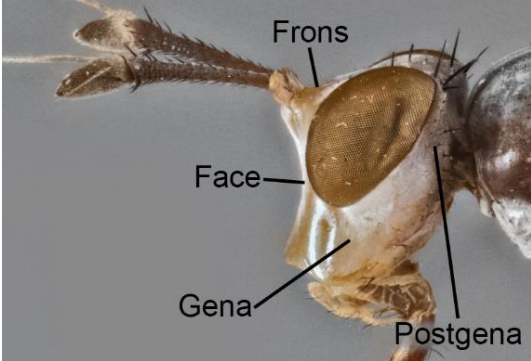
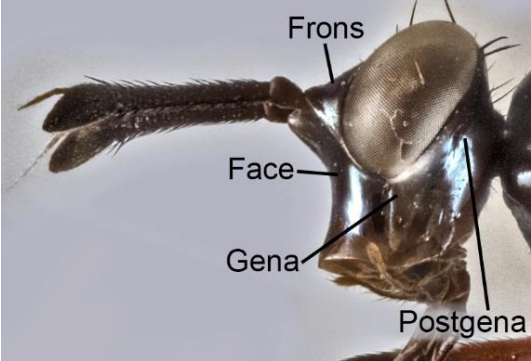
Fig. 3. *Sepedon plumbella* female (specimen ZRC_BDP0041737), lateral view. (Photograph by: Maimon Hussin).



Fig. 4. *Sepedon plumbella* male (specimen ZRC_BDP0041756), lateral view. (Photograph by: Maimon Hussin).

Thus far, evidence indicates that there are only two species of Sciomyzidae to be found in Singapore: *Sepedon senex* (Figs. 1, 2) and *Sepedon plumbella* (Figs. 3, 4). Adults are easily recognised by their elongate body shape, distinct porrect (front-pointing) long antennae, extended gena and fuscous wings; they are very habitat-specific, and are usually spotted facing downwards on grassy stems around freshwater areas (usually ponds, marshes) where smaller freshwater gastropods can be found (Mortelmans, pers. obs.). We here provide a short image-based list of the easily accessible characters that distinguish the two species (Table 2).

Table 2. List of differences between *Sepedon senex* and *Sepedon plumbella* in Singapore. (Photographs by: Maimon Hussin).

Character	Key diagnostic differences	
	<i>Sepedon senex</i>	<i>Sepedon plumbella</i>
Fore basitarsus (male only)	 <p>(Anterior View) (Posterior View)</p> <p>Normal, unmodified (note that in posterior view the latter tarsal segments are slightly pivoted towards dorsal view).</p>	 <p>(Anterior View) (Posterior View)</p> <p>Modified with a dorsal groove.</p>
Abdominal segments 1+2	 <p>Traverse rugae Constricted segment 1+2</p> <p>Constricted laterally at basal 1/3, terga transversely rugulose.</p>	 <p>No distinct rugae Segment 1+2 not constricted</p> <p>Abdominal segments 1+2 not constricted laterally, terga not transversely rugulose.</p>
Head colour	 <p>Frons Face Gena Postgena</p> <p>Overall light-coloured: frons, face and gena yellow, postgena dusty-cream or white.</p>	 <p>Frons Face Gena Postgena</p> <p>Overall dark-coloured: frons, face, gena and postgena shiny dark-brown to black.</p>

DISCUSSION

While *Sepedon senex* and *Sepedon plumbella* are common, widespread and well-known species in the Oriental realm, these records are in fact of significance as they represent the first records of Sciomyzidae in Singapore. *Sepedon senex* is known from India to southern China, and south to Java (Indonesia); *Sepedon plumbella* is known from India to southern China, and south to eastern Australia (Knutson, 1977). Experimental laboratory studies on the feeding habits and other life-history aspects have been done on both *Sepedon plumbella* and *Sepedon senex* (Bhuangprakone & Areekul, 1973), making them well-researched species.

Sepedon plumbella is a very variable species when considered regionally; pigmentation of the body, legs, face and wings is considerable, and there is variation in the extent of extremities of aedeagus, and slight variation in the front basitarsus of the male (Mortelmans, pers. obs.). Nevertheless, there is consensus about the validity of the species and its currently known synonyms, *Sepedon javanensis* Robineau-Desvoidy, *Sepedon javana* Macquart, *Sepedon fuscineris* Brunetti and *Sepedon sanguinipes* Brunetti (Knutson, 1977).

ACKNOWLEDGEMENTS

The authors would like to thank Marcus Ng for photographing and uploading his record of *Sepedon plumbella* onto iNaturalist, and for providing more information on the locality.

LITERATURE CITED

- Bhuangprakone S & Areekul S (1973) Biology and food habits of the snail-killing fly, *Sepedon plumbella* Wiedemann (Sciomyzidae: Diptera). Southeast Asian Journal of Tropical Medical Public Health, 4: 387–394.
- Geller J, Meyer C, Parker M & Hawk H (2013) Redesign of PCR primers for mitochondrial cytochrome c oxidase subunit I for marine invertebrates and application in all-taxa biotic surveys. Molecular Ecology Resources, 13: 851–861.
- Knutson LV (1977) Superfamily Sciomyzoidea, family Sciomyzidae. In: Delfinado MD & Hardy DE (eds.) A Catalog of the Diptera of the Oriental Region. Vol. 3, Suborder Cyclorrhapha. University Press of Hawaii, Honolulu, pp. 168–172.
- Knutson LV & Ghorpadé K (2004) Insecta: Diptera, Sciomyzidae. In: Yule CM & Yong HS (eds.) Freshwater Invertebrates of the Malaysian Region. Academy of Sciences Malaysia, Kuala Lumpur, pp. 832–845.
- Knutson LV & Vala J-C (2011) Biology of Snail-Killing Sciomyzidae Flies. Cambridge University Press, Cambridge, 506 pp.
- Leray M, Yang JY, Meyer CP, Mills SC, Agudelo N, Ranwez V, Boehm JT & Machida RJ (2013) A new versatile primer set targeting a short fragment of the mitochondrial COI region for metabarcoding metazoan diversity: Application for characterizing coral reef fish gut contents. Frontiers in Zoology, 10: 34.
- Murphy WL, Knutson LV, Chapman EG, McDonnell RJ, Williams CD, Foote BA & Vala J-C (2012) Key aspects of the biology of snail-killing flies. Annual Review of Entomology, 57: 425–447.
- Truett GE, Heeger P, Mynatt RL, Truett AA, Walker JA & Warman ML (2000) Preparations of PCR-quality mouse genomic DNA with hot sodium hydroxide and Tris (hotSHOT). Biotechniques, 29: 52–54.
- Vikhrev N & Yanbulat M (2019) *Sepedon* Latreille, 1804 (Diptera, Sciomyzidae): Review of Asian fauna and notes on taxonomy of Asian and Nearctic species. Dipteron, 35: 42–63. DOI: 10.5281/zenodo.3252595