

AQUATIC COLEOPTERA OF SINGAPORE: SPECIES RICHNESS, ECOLOGY AND CONSERVATION

Lars Hendrich

Mörchinger Strasse 115 A, D-14169 Berlin, Germany
Email: hendrich1@aol.com

Michael Balke

Zoologische Staatssammlung München, Münchhausenstrasse 21, D-81247 München, Germany
Present address: The Natural History Museum, Cromwell Road, London SW7 5BD, England
Email: michael_balke@yahoo.de

Chang Man Yang

Raffles Museum of Biodiversity Research,
Department of Biological Sciences, National University of Singapore, Kent Ridge, Singapore 119260
Email: dbsycm@nus.edu.sg

In memoriam: Michael Hansen

ABSTRACT. – The present paper is the first comprehensive review of the aquatic Coleoptera, or water beetles, of Singapore. A total of 93 species are reported here. They are: Noteridae (9), Gyrinidae (9), Dytiscidae (35), Spercheidae (1), Hydrophilidae (30), Hydraenidae (3), Limnichidae (3), Curculionidae (2), and Chrysomelidae (1). The water beetle fauna of Singapore is mainly Oriental with a high percentage of Sundaic faunal elements. Thirty species (32%) are first recorded for Singapore. However, eight species are believed to be locally extinct, and 27 species (29%) are listed as threatened. The main causes of species becoming endangered are deforestation and change of ground water level in the vicinity of springs; as well as waste water pollution and infill. The water beetle communities of the main habitat types are briefly outlined. For each species all literature references are cited, and the distribution and ecology are described. A brief account on the conservation status and future prospects of Singapore's aquatic beetle fauna is given. The dytiscid species *Copelatus andamanicus* Régimbart, 1899, is here suggested to be a junior subjective synonym of *C. oblitus* Sharp, 1882.

KEY WORDS. – Aquatic Coleoptera, Singapore, biodiversity, taxonomy, ecology, conservation.

INTRODUCTION

Water beetles are an important and speciose animal group in Indo-Malayan freshwaters (Fernando, 1961, 1964; Balke, 1999; Balke & Hendrich, 1999; Balke et al., 1997a, b; Hendrich, 1995; Ng, 1991). They inhabit virtually every kind of fresh and brackish water habitat, from the smallest waterholes up to large lakes, from irrigation ditches and paddy fields to streams. Some are carnivorous, others prey on algae. Some are rather small (length < 2 mm) while others are larger (> 20 mm) and have even been utilised by man as toys (Pemberton, 1990) or food (Chen et al., 1998; Gressitt & Hornabrook, 1977; Hill et al., 1982). Due to their diversity in terms of species numbers, variation in size and niches inhabited (or formed), they represent a promising group for environmental impact assessments (EIAs), conservation assessments and biodiversity studies (Balke et al., 1999).

Collecting of water beetles from Singapore began as early as in the 1870's. Some of the specimens collected then eventually became types, e.g., *Copelatus minutissimus* Balfour-Browne, 1939 (Balke et al., 1999), which is now a highly threatened species in Singapore. Brancucci (1986) described *Lacconectes corayi*, based on the collection made by H.N. Ridley in the last century. This species is no longer found in Singapore. The holotypes of *Hydrovatus stridulus* Biström, 1996, and the very rare *Hydrovatus pisiformis* Biström, 1996, were collected by Saunders in the 1920's. Work on the water beetles of Singapore is sporadic. Yang (1992) listed 28 species of aquatic beetles from the Lower Peirce forest and Balke et al. (1999) summarized a total of 38 species of aquatic beetles from the nature reserves of Bukit Timah and the Central Catchment Area.

Water beetles are not a natural group. Rather, beetles have invaded the aquatic environment several times independently.

Here, we deal with the following groups of water beetles according to the ecological classification of Jäch (1998):

True Water Beetles: Adults are aquatic during most part of their life while larvae are aquatic or terrestrial. There are representatives of True Water Beetles in the following families of beetles that occur in Singapore: Noteridae, Dytiscidae, Gyrinidae, Spercheidae, Hydrophilidae, Hydraenidae.

Phytophilous Water Beetles: There are representatives of such beetles in the families Curculionidae and Chrysomelidae. They live in and/or on aquatic plants.

Shore Beetles: Species of Limmichidae are usually found along the shores of aquatic habitats. There are also species known to be intertidal in coral reefs (see Jäch, 1998).

Here, we present a checklist and a guideline for the study of the aquatic beetles of Singapore. First, we hope that this work will be of use to authorities concerned with planning and implementation of conservation measures to preserve our natural heritage. Second, we hope this study will inspire students to gather more data and eventually look at the biology of Singapore water beetles which remain very little known in many cases. Third, we are enthusiastic that this compilation once more proves that Singapore still has a great biological diversity to offer and to be explored.

THE STUDY AREA

Singapore spreads across an area of some 648 km² (Fig. 1). Situated at the southern end of Peninsular Malaysia, the 570 km² main island holds most of the remaining and diverse freshwater habitats. Geologically and biologically the area under study is part of Peninsular Malaysia. Singapore's climate reflects its maritime position close to the equator, where diurnal processes are the main determinants of weather, coupled with the seasonal cycle of monsoons. The annual rainfall, around 2000 mm, is fairly uniformly distributed throughout the year, although it tends to be greater during the northeast monsoon. Water temperatures (mean 28°C), like air temperatures, are generally fairly stable over the year, with only slight diurnal changes. However, open bodies of standing

water exposed to the sun generally show greater daily variations in temperature (Johnson, 1968, 1973; Munro, 1990) than shaded ones do.

The depths of the waters vary but nowhere does very deep water occur. Except during the monsoons all flowing waters rarely exceed two metres in depth. The completely freshwater reservoirs like Seletar, MacRitchie and Peirce have depths of about 5 - 10 m. Oxygen levels in general are high, exceeding 50% in cool forest areas with flowing water. In areas with dense submerged or aquatic vegetation, oxygen saturation may even exceed 150% under strong sunlight because of photosynthesis. At night however, the oxygen levels in these areas become severely depleted due to plant respiration, sometimes falling below 10% saturation. Extreme habitats in the Catchment Areas of Singapore are not uncommon, like the waters of a fresh water swamp forest, where the water gets so peaty (laden with tannins and humic acids) that it becomes brownish and highly acidic (pH 5.0 or less) - a condition referred to as blackwater (Johnson, 1973; Ng, 1991).

Singapore was completely covered with lowland rainforest, freshwater swamps and mangroves in the past. Only remnant parts of these primary landforms still exist in the nature reserves or proposed nature reserves: Bukit Timah (75 ha), Pandan (219 ha), Kranji (20 ha) and the Central Catchment Area (1,622 ha), including Nee Soon Swamp Forest, Seletar, Upper Peirce, Lower Peirce and MacRitchie Reservoirs (Briffet, 1990). Because of the small size of Singapore island, running water usually exists as short, shallow and slow-flowing streams. The low topography of the island also restricts the range of habitats. There are only temporary rapidly-flowing torrents and springs, whilst brackish estuarine waters often may extend up a large portion of each stream's total length (Munro, 1990).

Our study area includes the habitats of both the open-country fresh waters and forest fresh waters of Singapore as recognised by Johnson (1973) and Ng (1991, 1994):

1. Open-country fresh waters. – The water is generally eutrophic with suspended silt, soil particles and phytoplankton. It is almost neutral to slightly acidic or alkaline (pH 6 - 8); and moderately hard (i.e. with some dissolved salts like calcium and bicarbonates).

Artificial ponds and lakes in public parks, gardens and woodlands: The bigger and permanent ponds or lakes of Kent Ridge Park and Botanical Gardens are covered with *Nymphaea* sp. The smaller ones are more temporary and covered with *Pistia stratiotes* and *Salvinia molesta*, and partially shaded by bamboo plants. The pond of Bukit Batok Nature Park is partially shaded by trees, and some parts covered with large stands of *Nelumbo* sp. and mats of floating grass. The pond (Little Guilin) of Bukit Batok Town Park is exposed and partially covered with mats of floating grass. The eutrophic Jurong Lake with its polluted lakeshore, is partly shaded by trees, mats of floating grass and *Ipomoea aquatica*. The muddy ponds of Sungai Buloh Nature Park



Fig. 1: Map of Singapore, showing locations of sampling sites.

are partly shaded by second growth mangrove vegetation and also *Sagittaria* sp., *Limnocharis* sp., *Wolffia* sp. and *Lemna* sp.

Permanent and temporary ponds on waste sites and second growth vegetation: Two ponds in Lorong Banir (next to Nee Soon Swamp Forest) are shaded by second growth vegetation and old coconut plantations, mats of floating grass, *Utricularia* sp. and *Hydrilla verticillata*.

Open drainage and monsoon canals in different places of the city, usually without any aquatic vegetation, generally exposed and polluted.

2. Forest fresh waters. – The water in undisturbed forest areas is generally oligotrophic, relatively clear, acidic to highly acidic (pH 4 - 6) and very soft (i. e. with almost no dissolved salts).

Freshwater Swamp Forest (Nee Soon Swamp Forest and some swampy areas in the Central Catchment Area): These include shaded ponds, ditches and small temporary puddles rich in rotten leaves and emerged plants (e.g., mats of floating grass, *Eleocharis* sp., *Brachiaria* sp., *Eriocolon* sp.). A moderate-flow stream passes by the Nee Soon Swamp and floods the forest floor during rainy seasons.

Reservoirs and their wetland perimeter areas (all reservoirs, ponds, ditches in the Central Catchment Area): These places are partly shaded and are rich in rotten leaves and emerged plants (e.g., mats of floating grass, *Eleocharis* sp., *Brachiaria* sp., *Eriocolon* sp.).

Forested springs and streams of Nature Reserves: The small, shallow streams of Bukit Timah's more or less primary forest are shaded, with or without any aquatic vegetation (studied: Taban Valley). The bottom consists of sand and a thin layer of rotten leaves in places. The upper streams in the Central Water Catchment Area are shaded, muddy or sandy, quickly becoming broader, partially open and are slowly flowing into the reservoirs.

MATERIALS AND METHODS

The survey area of this study includes the major habitat types in Singapore (Figs. 1, 5-14) carried out between 1992-1999. The sites of particular interest according to our field experience were sampled most intensively. Interesting sites were revisited for initial observations on population dynamics and habitat succession. The freshwater habitats sampled in this study can be divided into two basic types, lotic (running water) and lentic (stagnant water). This division is not always apparent as both habitat types often merge into each other especially after heavy rainfalls.

Most of the specimens were collected using different kinds of aquatic dip nets and kitchen strainers. Diameters of meshes varied from 500 to 1000 μm . Leaf litter and vegetation were swept heavily; the material obtained was then placed on a

white nylon sheet. Specimens were sorted with a pair of forceps and/or an aspirator. Specimens of Hydrophilidae and Hydraenidae were frequently collected by washing leaf litter and grass mats at the edge of a water body. These beetles, which usually cling to the substrate, are thus released from the substrate and float on the water surface, where they can then easily be picked up with a pair of forceps. Beetles from springs and small streams (genera *Microdytes*, *Lacconectus*, *Paracymus* and *Hydraena*) were sometimes directly collected from the very shallow water with an aspirator or a pair of forceps. Some specimens were obtained by operating Black light trap, Heath Robinson Mercury light traps (H.R. light trap), and a flight interception trap (FIT). All specimens were either preserved in 75% alcohol or pinned dry.

A total of 2142 specimens were examined in this study and they have been deposited in the following institutions and private collections: BMNH - The Natural History Museum, London (formerly British Museum of Natural History), United Kingdom; CBH - Collections of Dr Michael Balke and Dr Lars Hendrich, Berlin, Germany; CFH - Collection of Dr Franz Hebauer, Deggendorf, Germany; CGW - Collection of Prof Dr Günther Wewalka, Vienna, Germany; CHF - Collection of Dr Hans Fery, Berlin, Germany; CPM - Collection of Paolo Mazzoldi, Brescia, Italy; DEI - Deutsches Entomologisches Institut, Eberswalde, Germany; IRSNB - Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium; MNHN - Muséum National d'Histoire Naturelle, Paris, France; NMW - Naturhistorisches Museum Wien, Vienna, Austria; NMKL - National Museum, Damansara Road, Kuala Lumpur, Malaysia; RINSB - Royal Institute of Natural Sciences of Belgium, Brussels, Belgium; TDMB - Természettudományi Múzeum, Budapest, Hungary; USNM - U.S. National Museum of Natural History, Washington D.C., United States of America; ZRC - Zoological Reference Collection of the Raffles Museum of Biodiversity Research, National University of Singapore, Singapore.

Besides the important works by Jäch & Ji (1995, 1998) and Dudgeon (1999), the following publications have been used for the study of Singaporean water beetles:

I. Family Noteridae (Burrowing Water Beetles) (Figs. 3, 25). The last comprehensive work on Indo-Malayan Noteridae by Régimbart (1899) is still an important source for the study. Species of the *Canthydrus flavus*-group were revised by Wewalka (1992). Some specimens were also compared with already identified museum material.

II. Family Dytiscidae (Predaceous Diving Beetles) (Figs. 2, 15-24). The publications by Régimbart (1899), Balfour-Browne (1939a) and Gschwendtner (1931) are still very useful and important references for the identification of many genera and species of the family. Recent revisions are available for *Laccophilus* (Brancucci, 1983), *Lacconectus* (Brancucci, 1986), *Hyphydrus* (Biström, 1982), *Hydaticus* in part (Wewalka, 1975, 1979), *Hydrovatus* (Biström, 1996), *Neptosternus* (Hendrich & Balke, 1997) and *Microdytes* (Wewalka, 1997).

III. Family Gyrinidae (Whirligig Beetles) (Fig. 3). Except

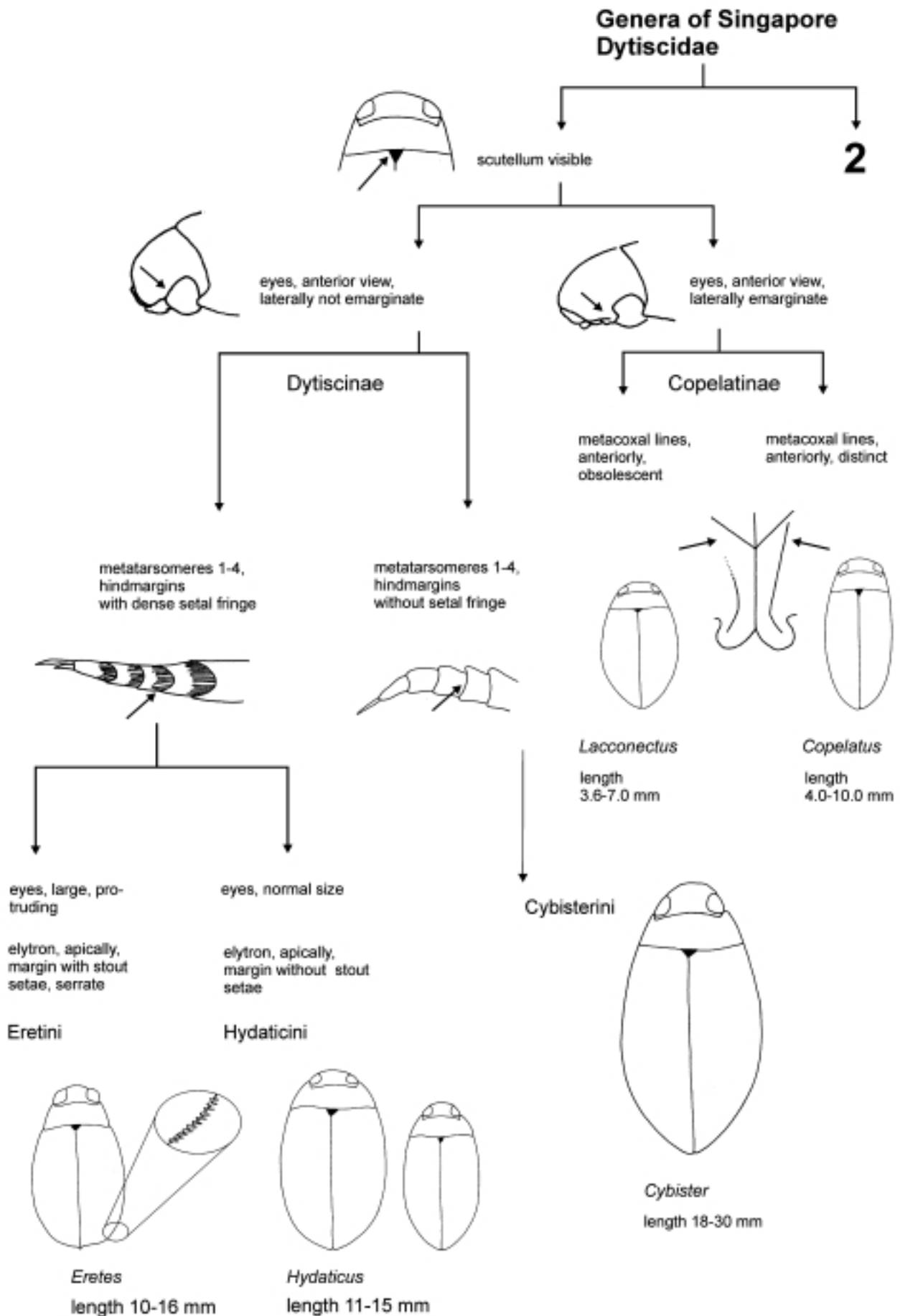


Fig. 2: Key to genera of Dytiscidae of Singapore.

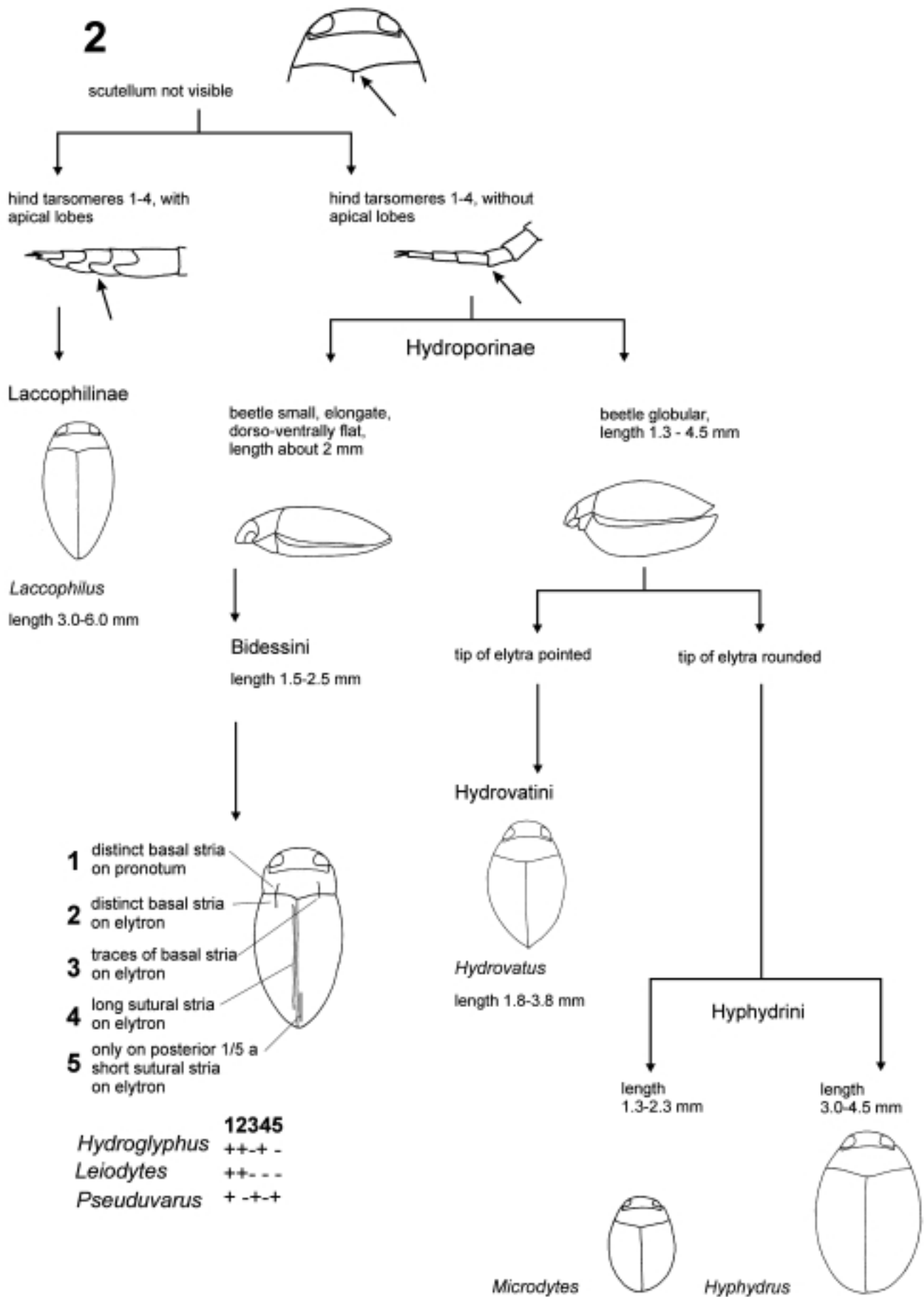


Fig. 2: (Continued).

for *Spinosodineutes* Brinck, 1981, no other recent revision on Asian Gyrinidae is available. Many original descriptions were published by Ochs (e.g., 1927a, b, 1928, 1929, 1931, 1953) and Peschet (1923a, b). A revision of the Southeast Asian *Orectochilus* is in preparation (Mazzoldi, in litt.).

IV. Family Spercheidae (Filterfeeding Water Scavenger Beetles) (Fig. 26). A taxonomic revision of this small family (17 species worldwide) was published by Hebauer (1997).

V. Family Hydrophilidae (Water Scavenger Beetles) (Figs. 4, 27-30). Taxonomy and classification mainly follows Hansen (1991, 1999), Zaitzev (1909), Knisch (1924a), d'Orchymont (e.g., 1923a, b, 1925a, b, 1932, 1936), Wooldridge (1975, 1977), Hebauer (1992, 1995a, b) and Schödl (1993) were consulted.

VI. Family Hydraenidae (Minute Moss Beetles). Southeast Asian species of this family are poorly known. Thus far, it is not possible to identify the Singapore species (M. A. Jäch, pers. comm.). Many new species are expected.

VII. Family Limnichidae (Minute Marshloving Beetles). According to Wooldridge (in litt.), Southeast Asian species of this family are poorly known. The literature (Wooldridge, 1990) lists three species from Singapore, which are cited here.

VIII. Family Chrysomelidae (Leaf Beetles). These are compared with identified museum material and private collections. There is no recent literature for Southeast Asian *Donacia*.

IX. Family Curculionidae (Weevils). These are compared with identified museum material and private collections. A revision of the Southeast Asian species of the genus *Bagous* is in preparation (O'Brien, in litt.).

Due to insufficient literature, specimens of the semi-aquatic families Heteroceridae and Scirtidae, found in Singapore, are not included in the present study. Other papers dealing with the water beetle fauna of Peninsular Malaysia are listed in the reference section.

The checklist of the water beetles recorded from Singapore is presented in systematic order, except for genera and species that are in alphabetical order. Taxonomy and nomenclature follow the papers mentioned above. "**Singapore!**" indicates new records of species from Singapore.

KEY TO THE FAMILIES OF SINGAPORE AQUATIC COLEOPTERA

(True and Phytophilous Water Beetles, adults only)

1. Head prolonged into a beak Curculionidae
- Head not prolonged into a beak 2
2. Middle and hind legs much shorter than forelegs, broad and paddlelike. Eyes completely divided into a dorsal and a ventral eye. Gyrinidae
- Middle and hind legs not remarkably shorter than forelegs. Eyes usually not divided. If divided, then body of beetle strongly arched in lateral view (only genus *Amphiops*) 3
3. Hind tarsi 4-segmented, third segment bilobed (genus *Donacia*) Chrysomelidae
- Hind tarsi 5-segmented, third segment not bilobed 4
4. Antennae club-shaped 5
- Antennae not club-shaped 7

5. Small, elongated beetles, length < 2.5 mm. Body in lateral view appearing rather flat. Abdomen with 6 or 7 ventrites Hydraenidae: Genus *Hydraena*
- Beetle usually larger than 2.5 mm, body oval. In lateral view usually at least dorsally more or less convex or arched. Abdomen with 5 ventrites, or with 5th ventrite short and emarginate so that an invaginated segment becomes visible, producing the impression of presence of a sixth ventrite (only *Berosus*) 6
6. Beetle with dorsal tubercles. Anterior margin of head (i.e. anterior margin of clypeus) distinctly emarginate with anterior corners upturned; labrum strongly deflected (not seen from above) Spercheidae
- Beetle without dorsal tubercles. Anterior margin of clypeus rarely emarginate, with anterior corners never upturned; labrum usually visible from above, rarely strongly deflected Hydrophilidae
7. Metacoxa elevated Noteridae
- Metacoxa not elevated Dytiscidae

SYSTEMATICS AND TAXONOMY

TRUE WATER BEETLES

FAMILY NOTERIDAE

The Noteridae are a rather small family with about 270 described species. They are widely distributed throughout the warmer parts of the world. Around 23 species are reported from Southeast Asia (Vazirani, 1977). Noterids usually inhabit the margins of more permanent, plant-rich and shallow ponds, swamps and ditches. Larvae of some European species obtain oxygen by tapping plants with the aid of the spiracle-bearing siphon at the end of the abdomen. Little is known of the feeding habits, but it is generally thought that noterid larvae and adults are carnivorous. Known pupae inhabit air-filled cocoons attached to the roots of aquatic plants (Holmen, 1987; Lawrence & Britton, 1991).

Canthydrus flavus (Motschulsky, 1855)

Hydrocanthus flavus Motschulsky, 1855: 83 (part).

Canthydrus fulvescens Régimbart, 1889: 149.

Canthydrus flavus (Motschulsky) - Yano et al., 1983a: 16; Wewalka, 1992: 804, and references therein.

Material examined. – 5 specimens – **Central catchment area** - 1 ex., Nee Soon Swamp Forest, Transect "G", 17 Jun.1992, NS 22, coll. K. L. Yeo (ZRC). **Other areas** - 4 ex., Lorong Banir stream, 10 Jun.1994, NS 157 E, coll. K. C. Queck et al. (ZRC).

Distribution. – China, Indonesia [Sumatra, Java], Myanmar, Thailand, Taiwan, Vietnam (Wewalka, 1992). **Singapore!**

Ecology. – *Canthydrus flavus* inhabits shallow, muddy waters of open or semi-shaded swamps, the edge of permanent artificial water bodies such as paddy fields (Yano et al., 1983a), and slow-flowing irrigation ditches. The habitat must be rich in rotten leaves and submerged plants. The species is also attracted to light.

**Genera of Singapore
Gyrinidae
and Noteridae**

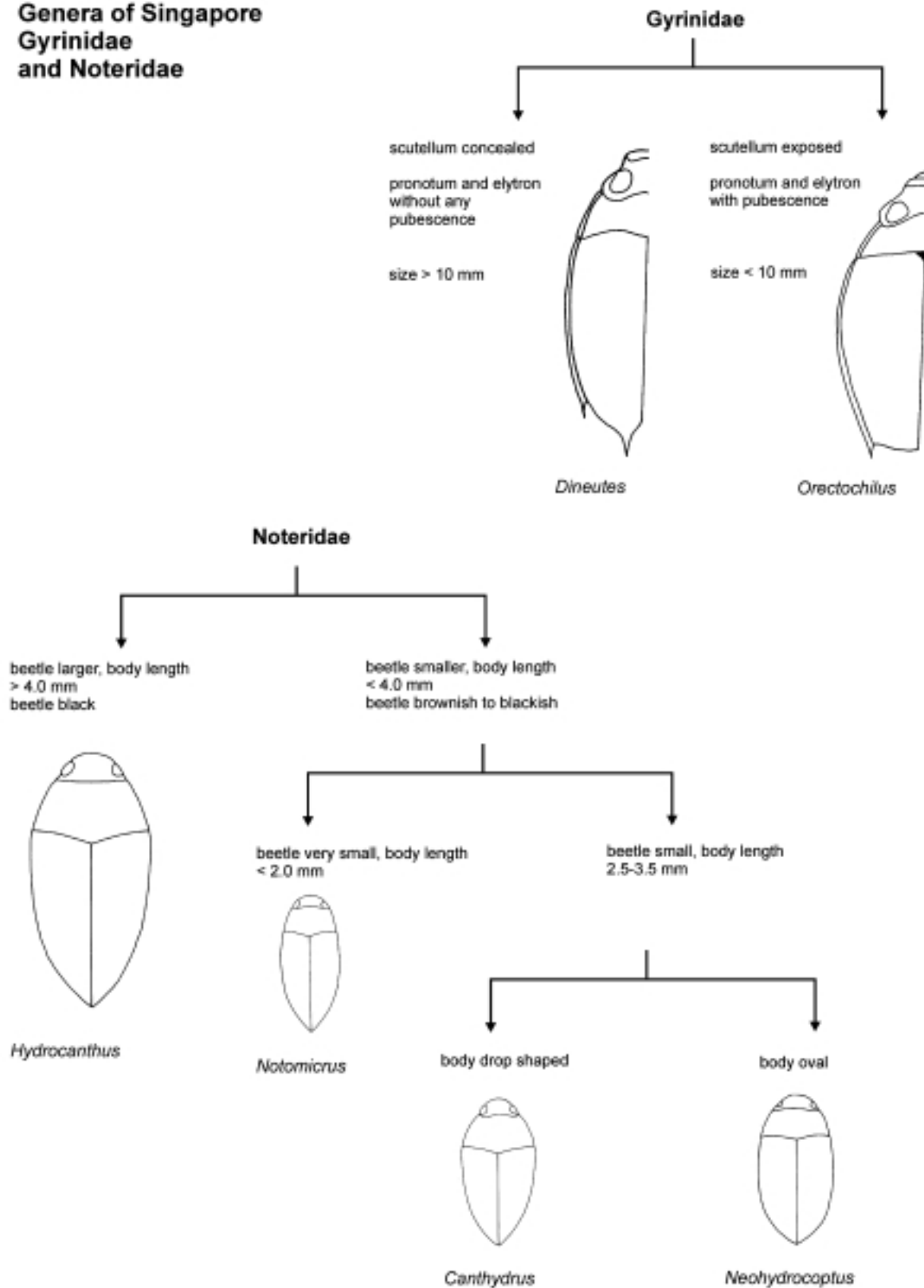


Fig. 3: Key to Noteridae and Gyrinidae of Singapore.

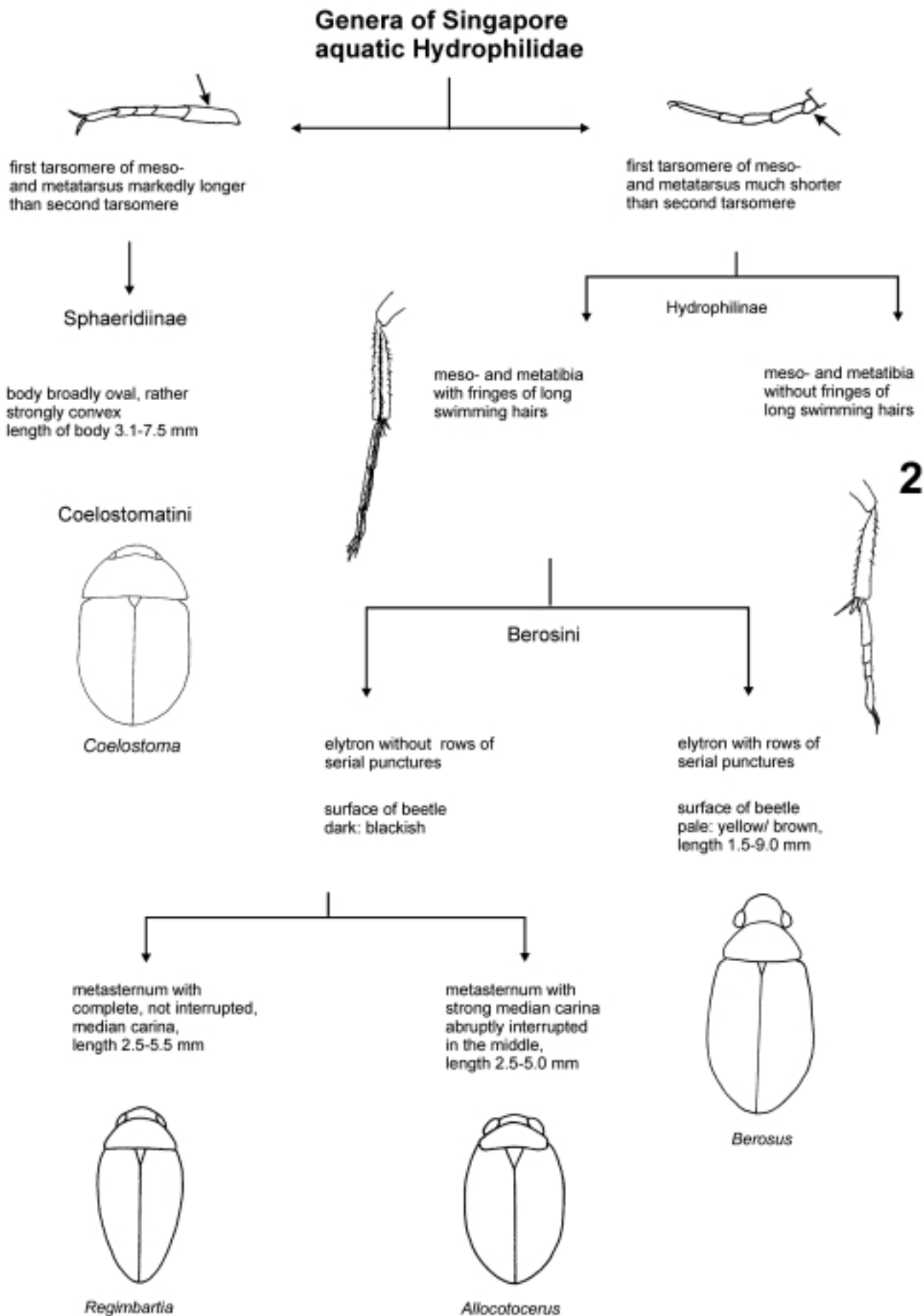


Fig. 4: Key to genera of Hydrophilidae of Singapore.

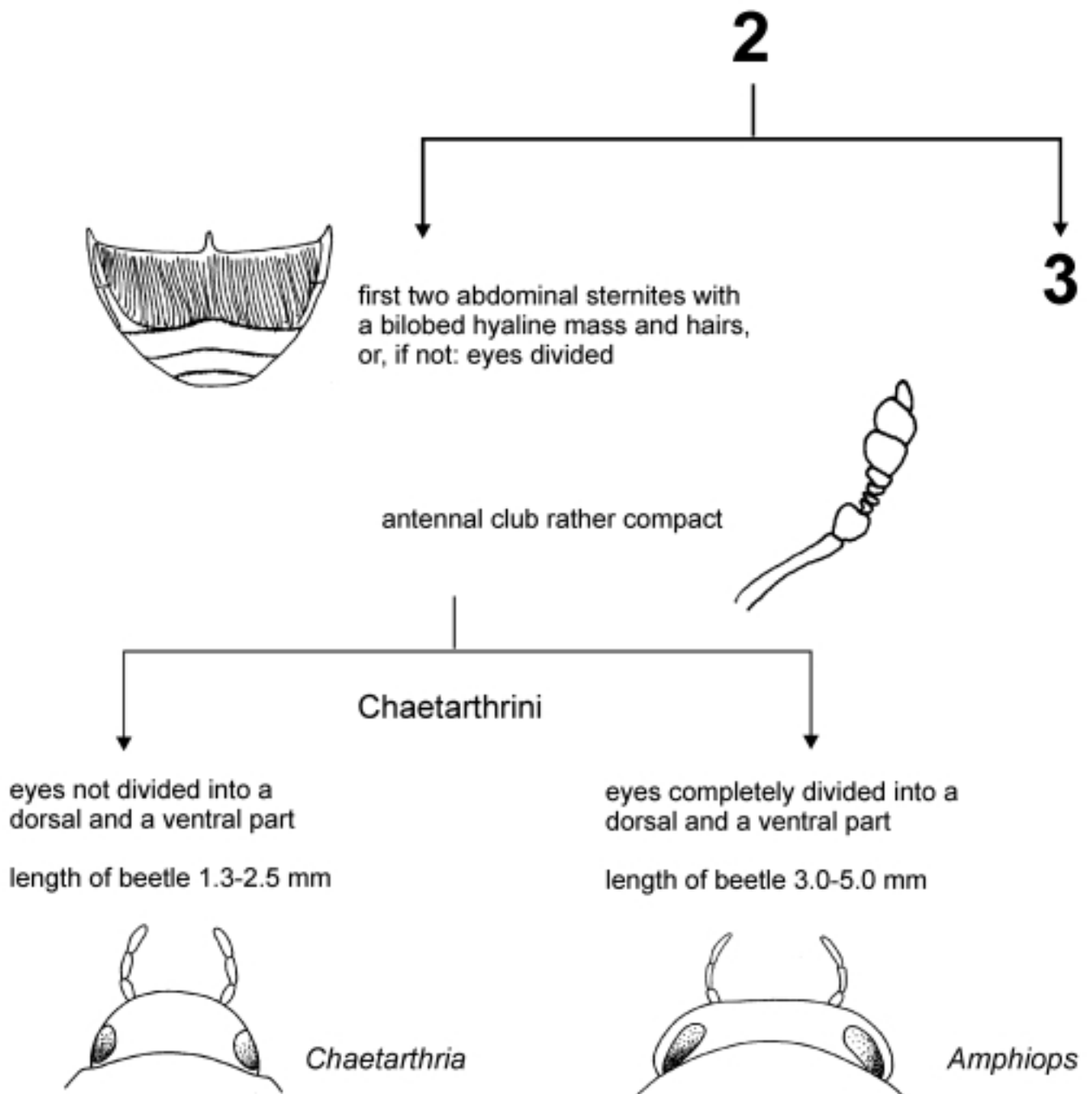


Fig. 4: (Continued) for 2nd.

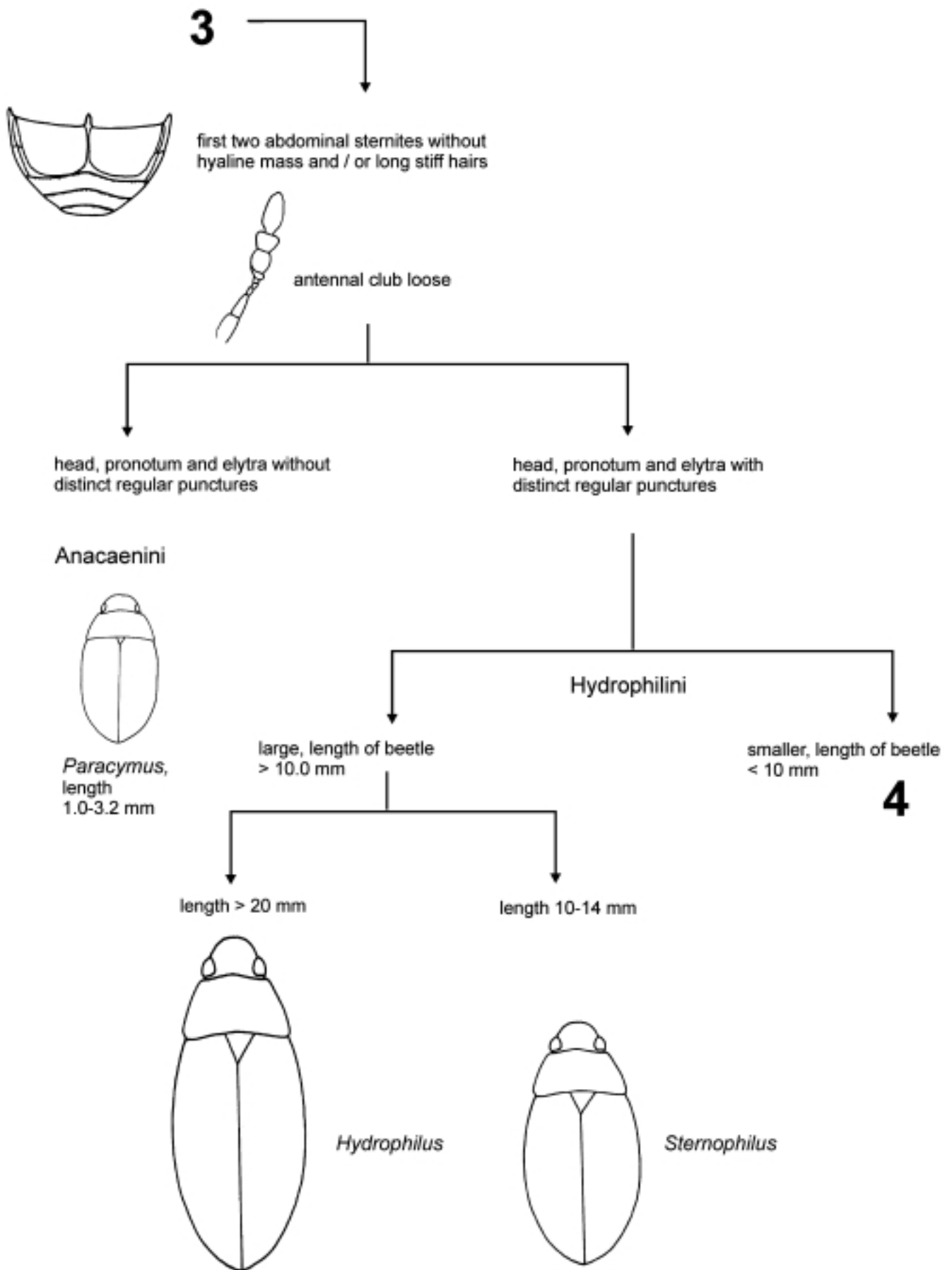


Fig. 4: (Continued) for 3rd.

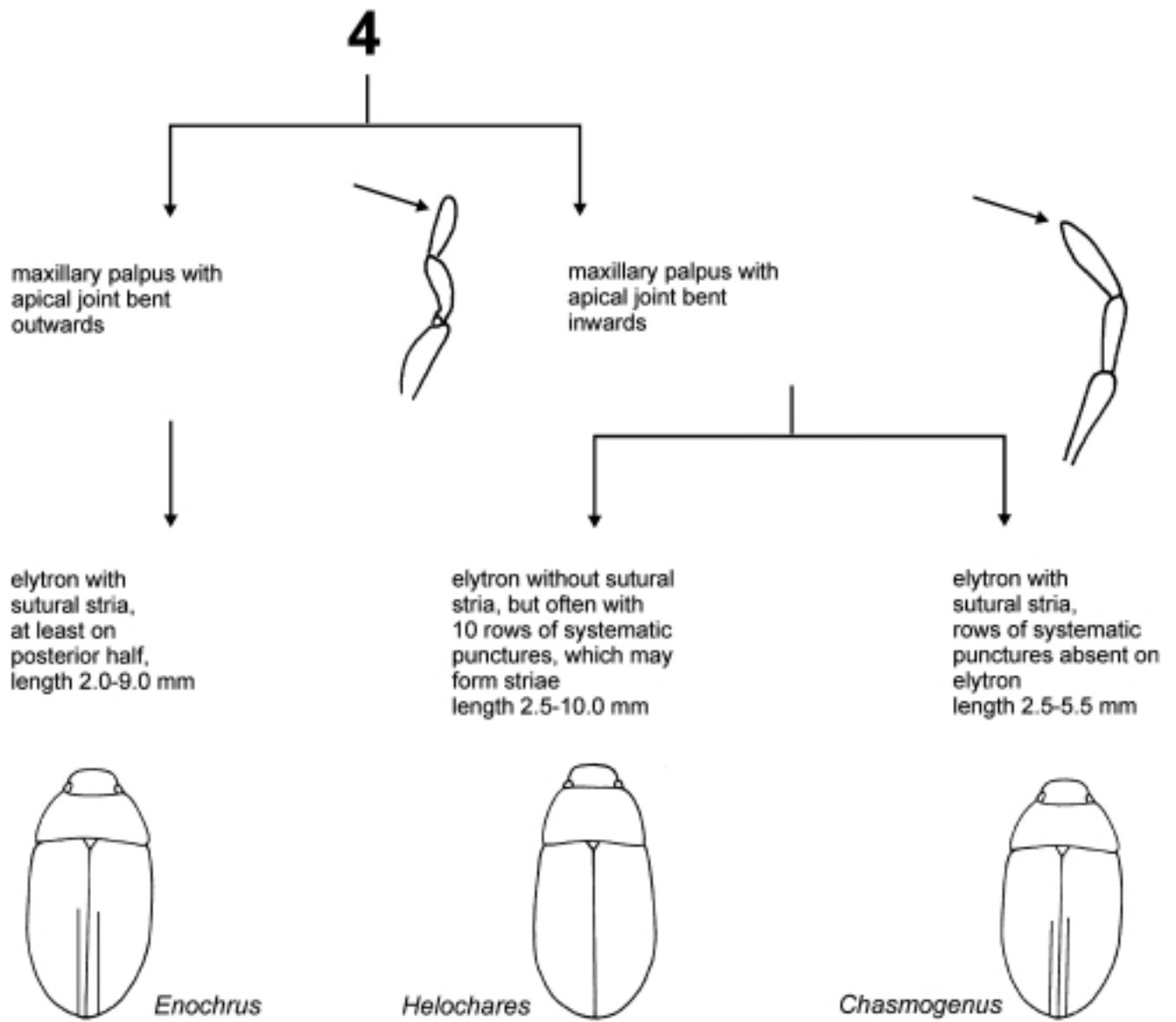


Fig. 4: (Continued) for 4th.

Canthydrus morsbachi (Wehncke, 1876)

Hydrocanthus morsbachi Wehncke, 1876: 222.

Canthydrus morsbachi (Wehncke) - Sharp, 1882: 276; Régimbart, 1899: 247; Zimmermann, 1920: 12, 1928: 2; Vazirani, 1968: 232; 1977: 7; Yano et al., 1983a: 16.

Material examined. – 165 specimens – **Central catchment area** - 1 ex., SICC, Sime Rd., MacRitchie Forest, plot 22, 7 May.1993, NS 72, coll. T.W. Koh et al. (ZRC). **Sungai Buloh** - 3 ex., 15 Nov.1990, coll. C. M. Yang & K. L. Yeo (ZRC); 6 ex., shallow pool no. 3, 4 Dec.1990, coll. C. M. Yang & K. L. Yeo (ZRC); 4 ex., pond, 34e, 16 Jan.1991, coll. C. M. Yang et al. (ZRC); 6 ex., 10 Apr.1991, 34b, coll. C. M. Yang (ZRC); 43 ex., fish pond, H.R. light trap, 10 Jul.1992, y 804, coll. K. Lim (ZRC); 78 ex., fish pond, 5 Dec.1996, coll. L. Hendrich (CBH, ZRC). **Other areas** - 1 ex., Pasir Ris Mangrove, at light, 14 Nov.1989, coll. Y.H. Koo & K. Lim (ZRC); 16 ex., Fish pond near Kranji, Turut Track off New Tiew Road, 10 Oct.1990, coll. C. M. Yang et al. (ZRC); 2 ex., Neo Tiew Road, Turat track, 27 Nov.1990, ZRC.6., coll. K. L. Yeo (ZRC); 2 ex., Lorong Banir, pond 1, 16 Jun.1995, NS 190, coll. C. M. Yang & H. K. Lua (ZRC); 3 ex., pond 1, 28 Apr.1997, coll. M. Balke & L. Hendrich (CBH).

Distribution. – Cambodia, India, Indonesia [Sumatra], Myanmar, Singapore, Vietnam. An African [Congo] report needs to be confirmed (Vazirani, 1977).

Ecology. – An inhabitant of shallow, muddy water of open or semi-shaded, more permanent swamps and artificial ponds (e.g., fish ponds and paddy fields)(see Yano et al., 1983a). The habitat must be rich in rotten leaves and submerged plants. The species also occurs in brackish waters of coastal and mangrove swamps (e.g., Sungai Buloh Nature Park and Pasir Ris Mangrove).

Canthydrus cf. proximus Sharp, 1882

Canthydrus proximus Sharp, 1882: 278; Régimbart, 1899: 250; Zimmermann, 1920: 13; Vazirani, 1977: 7.

Canthydrus sp. - Yang, 1991: 93.

Material examined. – 27 specimens – **Central catchment area** - 1 ex., Nee Soon Swamp Forest, Range II, open space, 28 May.1992, NS 16a, coll. K. L. Yeo (ZRC); 3 ex., Nee Soon Swamp Forest, Transect “G”, 17 Jun.1992, NS 22, coll. K. L. Yeo et al. (ZRC). **Sungai Buloh** - 21 ex., pond Lim Chu Kang, 16 Jan.1991, 34a, coll. C. M. Yang (ZRC); 1 ex., Sungai Buloh, 5 Dec.1996, coll. L. Hendrich (ZRC). **Other areas** - 1 ex., Lorong Banir, pond 2, 16 Jun.1995, NS 192, coll. H. K. Lua & C. M. Yang (ZRC).

Ecology. – See *Canthydrus morsbachi*.

Remarks. – Our identification remains tentative as suitable literature is not available and we have not seen any type material yet. The specimens were compared with identified beetles deposited in the collections of DEI and CBH. *Canthydrus proximus* has been recorded from Thailand, Vietnam, and Malaysia (Vazirani, 1977). Chinese reports were not verified (Nilsson, 1995).

Canthydrus ritsemae (Régimbart, 1880)

Hydrocanthus ritsemae Régimbart, 1880: 213.

Canthydrus javanus Wehncke, 1883: 149.

Canthydrus pseudoflavus Rocchi, 1986: 31.

Canthydrus ritsemae (Régimbart, 1880) - Wewalka, 1992: 806, and references therein.

Material known. – Number ? – “Singapore”, coll. C. J. Saunders (BMNH) (Wewalka, 1992). Specimens not seen.

Distribution. – China, India, Indonesia [Kalimantan, Java, Sumatra], Malaysia, Myanmar, Nepal, Singapore, Thailand, Vietnam (Nilsson, 1995; Wewalka, 1992).

Ecology. – In other countries of Southeast Asia *C. ritsemae* inhabits shallow water of open or semi-shaded swamps; at the edge of artificial ponds (e.g., fish ponds or paddy fields); and in slowly flowing ditches and streams. The species is also attracted to light.

Hydrocanthus indicus Wehncke, 1876

(Fig. 25)

Hydrocanthus indicus Wehncke, 1876: 223; Sharp, 1882: 279; Régimbart, 1889: 151; Zimmermann 1919a: 118; 1920: 15; 1928: 4; Satô, 1972: 144; Vazirani, 1977: 4; Balke et al., 1999: 325.

Material examined. – 1 specimen – **Central catchment area** - 1 ex., MacRitchie Reservoir Park, close to Sime Road, 24 Apr.1997, coll. M. Balke & L. Hendrich (ZRC).

Distribution. – Cambodia, Vietnam, Myanmar, Thailand, West Malaysia, Indonesia: Sumatra, Java, Kalimantan (Vazirani, 1977), Singapore (Balke et al., 1999).

Ecology. – Our single specimen was collected from leaf litter in an almost dry, shallow, muddy and shaded pond, situated in a freshwater swamp forest. In general, *Hydrocanthus* usually occur in more permanent water bodies rich in submerged vegetation and rotten leaves.

Neohydrocoptus bivittis (Motschulsky, 1859)

Hydrocoptus bivittis Motschulsky, 1859: 44; Vazirani, 1968: 224. *Hydrocoptus* (*Neohydrocoptus*) *bivittis* Motschulsky: Satô, 1972: 143; Vazirani, 1977: 2; Yano et al. 1983a: 16.

Neohydrocoptus bivittis (Motschulsky) - Nilsson et al., 1989: 313; Balke et al., 1999: 325; Hebauer et al., 1999: 337.

Material examined. – 32 specimens - **Central catchment area** - 1 ex., Nee Soon Swamp Forest, 19. Sept.1991, coll. H. K. Lua (ZRC); 4 ex., Nee Soon Swamp Forest, concrete pond, 7. Sep.1991, coll. H. K. Lua et al. (ZRC); 15 ex., Nee Soon Swamp Forest, Nature Reserve Survey, H.R. light trap 19:30-21:30, 17 Jun.1992, coll. C. M. Yang (ZRC); 1 ex., Nee Soon Swamp Forest, 6 Dec.1996, coll. L. Hendrich (CBH); 1 ex., Nee Soon Swamp Forest, 21 Apr.1997, coll. M. Balke & L. Hendrich (CBH); 3 ex., Nee Soon Swamp Forest, blacklight trap, 22 Apr.1997, coll. M. Balke & L. Hendrich (CBH, ZRC). **Sungai Buloh** - 1 ex., Sungai Buloh, 5 Dec.1996, coll. L. Hendrich (ZRC). **Other areas** - 1 ex., Kent Ridge Park Pond, 24 Aug.1993, coll. M. Balke & C. M. Yang (ZRC); 4 ex., MacRitchie Reservoir, Sime Road, ‘H’ stm. pool, 8 Apr.1997, coll. M. Balke, L. Hendrich & C. M. Yang (ZRC); 1 ex., Botanic Gardens, NIE Ecology Pond, 22 Apr.1997, coll. M. Balke & L. Hendrich (CBH).



Figs. 5-8. 5. Small artificial pond in Botanic Gardens. Almost covered with the free-floating freshwater macrophyte *Eichhornia crassipes* and *Salvinia molesta*. Habitat of the dytiscids *Hydroglyphus inconstans* and *Leiodytes nicobaricus*; 6. Former quarry pond in Bukit Batok Nature Park. Habitat of *Neohydrocoptus subvittulus*, *Hydrovatus sinister*, *H. pudicus*, *Laccophilus siamensis siamensis*, *Amphiops mater sumatrensis*, *Enochrus esuriens*, *Helochaeres minor* and *Paracymus atomus*; 7. Botanic Gardens, NIE Ecology Pond. Habitat of *Neohydrocoptus bivittis*, *Enochrus esuriens* and *Paracymus orientalis*; 8. Lorong Banir, pond 1. Habitat of *Canthydrus morsbachi*, *Hydrovatus sinister*, *Laccophilus siamensis siamensis*, *Hydaticus reductus*, *Allocotocerus muelleri*, *Helochaeres taprobanicus* and *H. lentus*.



Figs. 9-14. 9. Lorong Banir, pond 2. Fully covered with dense stands of the submerged freshwater macrophyte *Hydrilla verticillata*. Habitat of *Canthydrus morsbachi*, *Laccophilus siamensis siamensis*, *Hydaticus bipunctatus conjungens*, *Allocotocerus muelleri*, *Amphiops mater sumatrensis*, *Enochrus esuriens*, *Helochares taprobanicus*, *H. lentus*, *H. pallens* and *Coelostoma subditum*; 10. Central Catchment Area, Edge of Nee Soon Swamp Forest: The mats of floating grasses are the habitat of three *Neohydrocoptus* and eight Singaporean *Hydrovatus* species; 11. Central Catchment Area, Nee Soon Swamp Forest near former pumphouse. *Hydaticus fabricii*, *Hydrovatus sinister*, *H. stridulus*, *H. pudicus*, *Amphiops mater sumatrensis*, *Helochares lentus* and *Enochrus gaggermeieri* occur in this pond; 12. Central Catchment Area, temporary puddle on forest floor. Habitat of *Copelatus oblitus* and *C. minutissimus*; 13. Bukit Timah Nature Reserve. Taban Valley, open forest stream. The shaded springlet of this stream, a true relic site, is the habitat for the most restricted and endangered water beetles in Singapore. *Microdytes elgae*, *M. pasiricus*, *Lacconectus krikeni* and two species of the genus *Hydranea*; 14. Central Catchment Area. Shaded, slow flowing and oxygen rich artificial stream in second growth forest. Habitat of most species of the whirligig genus *Orectochilus*.



Figs. 15-17. 15. *Microdytes elgae* Hendrich, Balke & Wewalka, 1995 (Fam. Dytiscidae, 2.0 mm); 16. *Lacconectus corayi* Brancucci, 1986 (Fam. Dytiscidae, 3.7 mm); 17. *Hydaticus bipunctatus conjungens* Régimbart, 1899 (Fam. Dytiscidae, 13.4 mm).

Distribution. – China [Hainan], India, Malaysia, Myanmar, Sri Lanka, Singapore (Vazirani, 1977; Nilsson, 1995; Balke et al., 1999).

Ecology. – An inhabitant of shallow water of open or semi-shaded primary swamps, artificial ponds (e.g., fish ponds or paddy fields, Yano et al., 1983a), and slowly flowing ditches or streams. The species is also attracted by light.

***Neohydrocoptus frontalis* (Régimbart, 1899)**

Hydrocoptus frontalis Régimbart, 1899: 246; Vazirani, 1977: 3; Balke et al., 1999: 325.

Material examined. – 8 specimens - **Central catchment area** - 1 ex., Nee Soon Swamp Forest, 6 Dec.1996, coll. L. Hendrich (ZRC); 5 ex., Nee Soon Swamp Forest, 21 Apr.1997, coll. M. Balke & L. Hendrich (CBH, ZRC); 1 ex., Nee Soon Swamp Forest, 26 Apr.1997, coll. M. Balke, L. Hendrich & C. M. Yang (ZRC); 1 ex., Nee Soon Swamp Forest, light trap, 16 Jun.1992, NS 22, coll. K. L. Yeo et al. (ZRC).

Distribution. – Vietnam (Vazirani, 1977), Thailand (coll. Hendrich), Singapore (Balke et al., 1999).

Ecology. – *Neohydrocoptus frontalis* is living in shallow, muddy water of open or semi-shaded freshwater swamps. The ground must be rich in rotten leaves. Dense submerged vegetation is usually present.

***Neohydrocoptus ?subvittulus* (Motschulsky, 1859)**

Hydrocoptus subvittulus Motschulsky, 1859: 43; Wehncke, 1883: 148; Zimmermann, 1919a: 111; 1920: 11.

Hydrocoptus vittatus Sharp, 1882: 262.

Hydrocoptus subvittulus var. *vittatus*: Zimmermann, 1919a: 111.

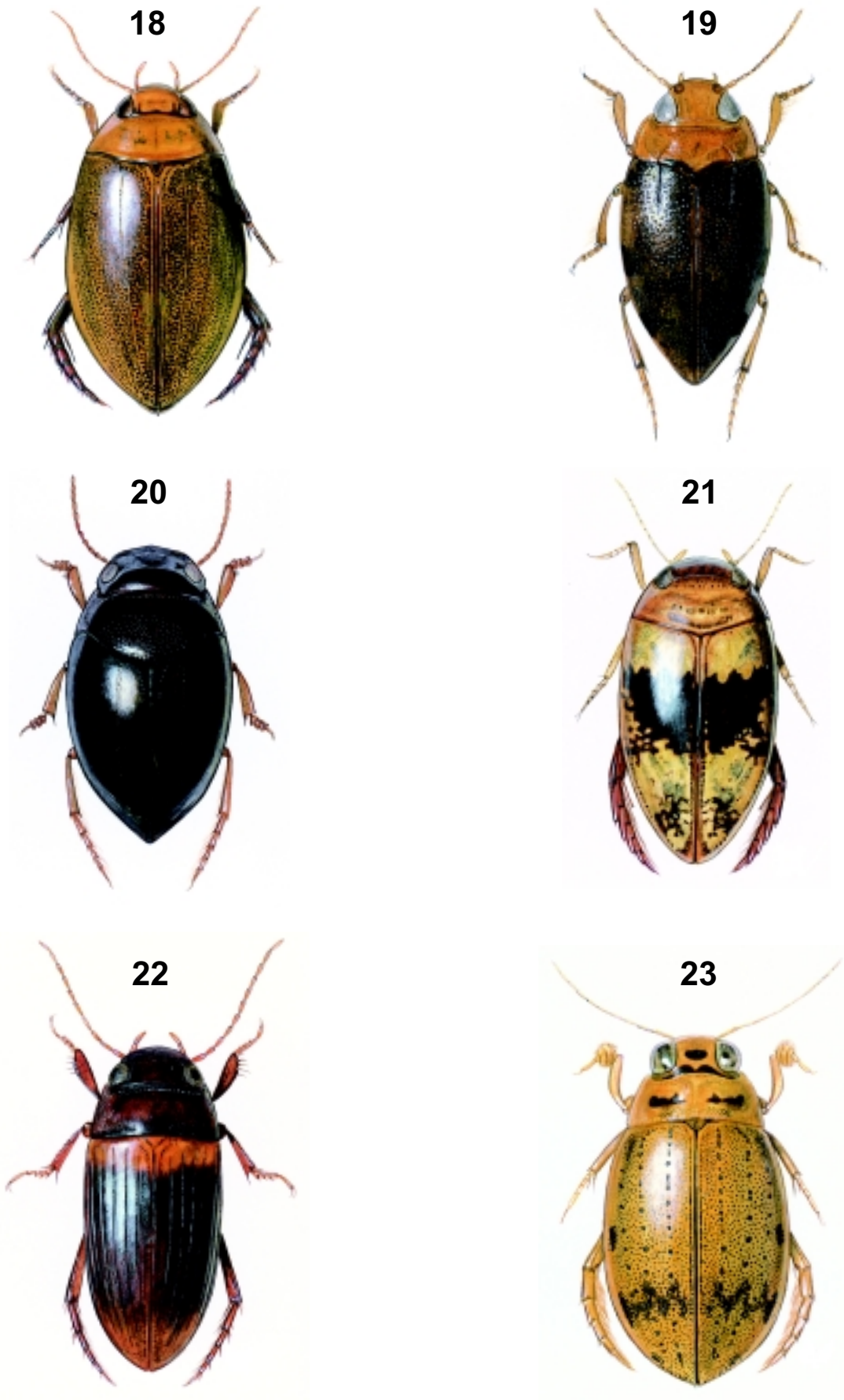
Hydrocoptus (s. str.) *subvittulus*: Satô, 1972: 144; Vazirani, 1977: 4, and references therein.

Neohydrocoptus distinctus (Wehncke, 1883) - Balke et al., 1999: 325 (misid.).

Material examined. – 22 specimens - **Central catchment area** - 2 ex., Nee Soon Swamp Forest, 6 Dec.1996, coll. L. Hendrich (CBH, ZRC); 4 ex., idem, 22 Apr.1997, blacklight trap, coll. M. Balke & L. Hendrich (CBH, ZRC); 5 ex., idem, 26 Apr.1997, M. Balke & L. Hendrich coll. (CBH, ZRC); 7 ex., idem, 21 Apr.1997, coll. M. Balke & L. Hendrich (CBH, ZRC). **Pulau Ubin** - 3 ex., pond near Kampung Bahru, 28 May.1997, coll. K. L. Yeo (ZRC). **Other areas** - 1 ex., Bukit Batok Nature Park, pond, 23 Apr.1997, coll. M. Balke & L. Hendrich (CBH).

Ecology. – *Neohydrocoptus subvittulus* living in shallow, muddy water of open or semi-shaded freshwater swamps, ponds and irrigation ditches. The habitat must be rich in rotten leaves and dense submerged vegetation. The species is also attracted by light.

Remarks. – The genus is in need of a comprehensive revision. Our determination is based on the study of identified specimens deposited in DEI. Some of the larger specimens collected at Nee Soon may belong to another species. *Neohydrocoptus subvittulus* is recorded from Vietnam, Thailand, Indonesia: Sumatra, Java (Vazirani, 1977). The



Figs. 18-23. 18. *Hydaticus fabricii* (MacLeay, 1825) (Fam. Dytiscidae, 10.5 mm); 19. *Leiodytes nicobaricus* (Redtenbacher, 1867) (Fam. Dytiscidae, 2.1 mm); 20. *Hydrovatus rufoniger rufoniger* (Clark, 1863) (Fam. Dytiscidae, 3.6 mm); 21. *Laccophilus medialis* Sharp, 1882 (Fam. Dytiscidae, 3.3 mm); 22. *Copelatus minutissimus* Balfour-Browne, 1939 (Fam. Dytiscidae, 4.1 mm); 23. *Eretes griseus* (Fabricius, 1781) (Fam. Dytiscidae, 13.5 mm).

species has not yet been recorded from Peninsular Malaysia and **Singapore!**

***Notomicrus tenellus* (Clark, 1863)**

Hydroporus tenellus Clark, 1863: 427.
Hydroporus politus MacLeay, 1871: 124.
Notomicrus laevigatus Sharp, 1882: 260.
Notomicrus punctulatus Fauvel, 1903: 245.
Notomicrus tenellus (Clark) - Balfour-Browne, 1939b: 97; Vazirani, 1977: 2; Balke et al., 1998: 73; Hebauer et al., 1999: 337.

Material known. – Number ? – «Singapore» cited in Balfour-Browne (1939b). Specimens not seen.

Distribution. – West Malaysia, Indonesia: Java, Philippines, Papua New Guinea, Salomon Islands and Australia (Vazirani, 1977); Singapore (Balfour-Browne, 1939b).

Ecology. – A lentic species which occurs in various types of habitats such as pools, ponds and swamps. The beetles generally occur in very shallow water among rotten leaves adjacent to the shoreline. Because of their small size (length < 2.0 mm) the beetles may be overlooked in the field when using a large aquatic dip net instead of a fine strainer (Balke et al., 1998).

FAMILY DYTISCIDAE

The Dytiscidae is a large family with more than 3792 described species worldwide (Nilsson, 2001). In Singapore they are found in virtually all freshwater habitats, being most common in the littoral zones of swamps, pools, lakes and ditches, but less frequently in streams and rivers, and water bodies where fish are present. Both larvae and adults are aquatic. The pupal stage is spent on land in a mud cell. Eggs are usually laid beneath the water surface attached to aquatic plants. The larva passes through three larval instars. The larval development of most Southeast Asian dytiscids is still unknown. Both larvae and adults must periodically travel to the water surface to obtain atmospheric air through their posterior spiracles. However, adults can prolong submergence by using a bubble of air under their elytra as a plastron. Both larvae and adults are carnivorous. The prey items of the smaller species (e.g., *Hydrovatus*, *Leiodytes*, *Copelatus*, *Lacconectus*) include larvae of mosquitoes, chironomids and *Daphnia*; the larger species (e.g., *Cybister*) feed on small fishes and tadpoles as well.

SUBFAMILY HYDROPORINAE

TRIBE BIDESSINI

***Hydroglyphus inconstans* (Régimbart, 1892)**

Bidessus inconstans Régimbart, 1892: 119.
Guignotus inconstans (Régimbart) - Abe, 1989: 2.
Hydroporus intermixtus Walker, 1858: 202-213; Régimbart, 1899: 227 (misident.).

Hydroglyphus inconstans (Régimbart) - Yano et al., 1983a: 17; Biström, 1988: 14; Hendrich & Balke, 1995: 33; Nilsson et al., 1995: 363; Nilsson, 2001: 123.

Material examined. – 61 specimens – **Central catchment area** - 8 ex., Nee Soon Swamp Forest, 9 May.1992, 795D, coll. K. L. Yeo et al. (ZRC). **Other areas** - 50 ex., Sembawang Senoko, grassland on eastern side of Sembawang, 10 Jan.1992, Y 777 B, coll. C. M. Yang & K. L. Yeo (ZRC); 1 ex., Lorong Banir, pond 2, 16 Jun.1995, NS 192, coll. H. K. Lua & C. M. Yang (ZRC); 1 ex., Lorong Banir, pond 1, 29 Jun.1995, NS 193, coll. H. K. Lua & C. M. Yang (ZRC); 1 ex., Singapore Science Centre, 22 Oct.1990, coll. C. M. Yang & K. L. Yeo (ZRC).

Distribution. – This widespread Oriental species occurs from India and Sri Lanka to Sumatra, Taiwan, and north to the Ryukyu Islands (Biström, 1988; Nilsson et al., 1995). **Singapore!**

Ecology. – A lentic species living in very shallow water at the edge of small, exposed, and well vegetated pools, puddles and slow flowing streams and ditches. *Hydroglyphus inconstans* also occurs in artificial habitats such as paddy fields (Yano et al., 1983a; Hendrich & Balke, 1995).

***Hydroglyphus mysorensis* (Régimbart, 1903)**

Bidessus mysorensis Régimbart, 1903a: 332.
Bidessus (s.str.) *mysorensis* Régimbart - Zimmermann, 1920: 55.
Guignotus mysorensis Régimbart - Vazirani, 1968: 317; 1977: 34.
Hydroglyphus mysorensis Régimbart - Biström, 1988: 14; Nilsson, 2001: 124.

Material examined. – 1 specimen - **Central catchment area** - 1 ex., Nee Soon Swamp Forest, at blacklight, 22 Apr.1997, coll. M. Balke & L. Hendrich, L.-J.Wang det. (ZRC).

Distribution. – India (Vazirani, 1977). First record for the Malaysian Peninsula and **Singapore!**

Ecology. – The single female in Singapore was collected at light, at the edge of a freshwater swamp.

***Leiodytes nicobaricus* (Redtenbacher, 1867)**
 (Fig. 19)

Hydroporus nicobaricus Redtenbacher, 1867: 21; Sharp, 1882: 802.
Bidessus nicobaricus (Redtenbacher) - Régimbart, 1899: 228.
Bidessus (s.str.) *nicobaricus* (Redtenbacher) - Zimmermann, 1920: 55.
Guignotus nicobaricus (Redtenbacher) - Vazirani, 1977: 34.
Clypeodytes (*Lioclypeus*) *nicobaricus* (Redtenbacher) - Wewalka, 1982: 124.
Leiodytes nicobaricus (Redtenbacher) - Biström, 1988: 27; Hebauer et al., 1999: 337; Nilsson, 2001: 128.

Material examined. – 59 specimens - **Central catchment area** - 10 ex., Nee Soon Swamp Forest, 16 Jan.1992, y 786A, coll. C. M. Yang (ZRC); 1 ex., Nee Soon Swamp Forest, 22 May.1992, coll. K. L. Yeo (ZRC); 1 ex., Nee Soon Swamp Forest, 9 May.1992, 795D, coll. K. L. Yeo et al. (ZRC); 1 ex., Chestnut Drive, Gangsa stream, 23 Jun.1994, coll. C. M. Yang (ZRC); 2 ex., MacRitchie Reservoir, 21 Apr.1994, NS 124 F/H, coll. K. L. Yeo (ZRC); 4 ex.,

MacRitchie Reservoir, 21 Apr.1997, coll. M. Balke & L. Hendrich & C. M. Yang (CBH); 5 ex., Nee Soon Swamp Forest, at blacklight, 22 Apr.1997, coll. M. Balke & L. Hendrich (ZRC); 5 ex., Lower Peirce Reservoir, after the concrete water runoff, 22 Apr.1997, 230a, coll. H. K. Lua (ZRC). **Bukit Timah** - 1 ex., Bukit Timah N.R., swampy meadow near fishpond, 9 Apr.1997, coll. M. Balke, L. Hendrich & H. K. Lua (CBH). **Other areas** - 23 ex., Botanical Garden, small artificial pond, 21 Apr.1997, coll. M. Balke, L. Hendrich, H. K. Lua & C. M. Yang (CBH); 1 ex., Bukit Batok Nature Park, pond, 23 Apr.1997, coll. M. Balke & L. Hendrich (CBH); 2 ex., Lorong Banir, pond 1, 29 Jun.1995, NS 193, coll. H. K. Lua & C. M. Yang (ZRC); 1 ex., Lorong Banir, pond 2, 16 Jun.1995, NS 192, coll. H. K. Lua & C. M. Yang (ZRC).

Distribution. – India: Nicobar Islands (Vazirani, 1977); Thailand (Wang, in litt.). First record for the Malaysian Peninsula and **Singapore!**

Ecology. – *Leiodytes nicobaricus* is the most widespread species of Bidessini in Singapore. The species inhabits exposed or semi-shaded, temporary and permanent water bodies rich in vegetation and plant debris, such as ponds, pools and drainage ditches in primary and cultivated areas. The beetle occupies the very shallow zone just at the edge of the water bodies.

Pseuduvarus vitticollis (Boheman, 1848)

Hydroporus vitticollis Boheman, 1848: 256.

Bidessus gentilis Sharp, 1890: 344.

Pseuduvarus vitticollis (Boheman) - Biström, 1988: 10; Nilsson et al., 1995: 363, and references therein; Nilsson, 2001: 136.

Material examined. – 22 specimens - **Bukit Timah** - 19 ex., Nature Reserve, swampy meadow near fishpond, 9 Apr.1997, coll. M. Balke, L. Hendrich & H. K. Lua (CBH, ZRC). **Other areas** - 3 ex., Sembawang Senoko, grassland on eastern side of Sembawang, 10 Jan.1992, Y 777 B, coll. C. M. Yang & K. L. Yeo (ZRC).

Distribution. – Africa, Madagascar, Pakistan, India, Sri Lanka, West Malaysia (Nilsson et al., 1995). **Singapore!**

Ecology. – A lentic species living in very shallow water at the edge of small, exposed, and well-vegetated pools and puddles. In Singapore it is found exclusively near forested areas. The puddles in Bukit Timah Nature Reserve were fed by small helocrenes.

TRIBE HYDROVATINI

Hydrovatus jaechi Biström, 1996

Hydrovatus jaechi Biström, 1996: 543; Nilsson, 2001: 191.

Material examined. – 15 specimens - **Central catchment area** - 1 ex., Nee Soon Swamp Forest, 19 Sep.1991, coll. K. L. Yeo (ZRC); 9 ex., idem, 26 Aug.1992, y 840, coll. K. L. Yeo (ZRC); 4 ex., idem, blacklight, 22 Apr.1997, coll. M. Balke & L. Hendrich (CBH). **Bukit Timah** - 1 ex., Nature Reserve, 13 Dec.1995, coll. T. Wong, H. K. Lua et al. (ZRC).

Distribution. – Indonesia: Siberut (Biström, 1996). First record for the Malaysian Peninsula and **Singapore!**

Ecology. – The species inhabits shallow, muddy water of open or semi-shaded freshwater swamps. The habitat is rich in rotten leaves and dense submerged vegetation. *Hydrovatus jaechi* was also collected at light at the edge of a freshwater swamp.

Hydrovatus maai Biström, 1996

Hydrovatus maai Biström, 1996: 304; Balke et al., 1999: 325; Nilsson, 2001: 194.

Material examined. – 12 specimens - **Central catchment area** - 1 ex., Nee Soon Swamp Forest, 20 Sep.1993, y 843, coll. C. M. Yang (ZRC); 9 ex., Nee Soon Swamp Forest, 6 Dec.1996, coll. L. Hendrich (CBH, ZRC); 1 ex., Nee Soon Swamp Forest, 26 Apr.1997, coll. M. Balke & L. Hendrich (ZRC). **Sungai Buloh** - 1 ex., Nature Reserve, 10 Jul.1992, y 804, coll. K.P. Lim (ZRC).

Distribution. – Myanmar ? (Biström, 1996), Malaysia [West Malaysia (coll. Hendrich) and Sarawak], Singapore (Balke et al., 1999), Indonesia [Siberut, Nias] (Biström, 1996).

Ecology. – *Hydrovatus maai* inhabits shallow, muddy water of open or semi-shaded freshwater swamps. The habitat is rich in rotten leaves and dense submerged vegetation.

Hydrovatus pisiformis Biström, 1996

Hydrovatus pisiformis Biström, 1996: 323; Balke et al., 1999: 325; Nilsson, 2001: 200.

Material examined. – 6 specimens – **Other areas** - 3 ex., Singapore, Bi 6.22 flew/ Singapore C. J. Saunders BM 1929-369 (BMNH); 1 ex., Bi 9.22 flew/Singapore C. J. Saunders BM 1929-369 (BMNH). **Central catchment area** - 1 ex., Nee Soon Swamp Forest, blacklight, 22 Apr.1997, coll. M. Balke & L. Hendrich (CBH) - 1 ex., Lorong Banir, pond 1, 14 Jul.1995, NS 200, coll. H. K. Lua (ZRC).

Distribution. – Thailand, West Malaysia, Singapore (Biström, 1996; Balke et al., 1999).

Ecology. – The rare *Hydrovatus pisiformis* is an inhabitant of lowland, shady freshwater swamps (pers. observ. in West Malaysia). The two specimens in Singapore were collected near a freshwater swamp at light, and in a small natural pond.

Remarks. – Singapore is the type locality of the species.

Hydrovatus pudicus (Clark, 1863)

Hydroporus pudicus Clark, 1863: 426; Sharp, 1882: 807.

Hydrovatus pudicus (Clark) - Hendrich & Balke, 1995: 36; Biström, 1996: 314, and references therein; Balke et al., 1999: 325; Nilsson, 2001: 200.

Material examined. – 20 specimens - 5 ex., “Singapore” (without additional data), det. J. Balfour-Browne (BMNH) (Biström 1996). **Central catchment area** - 6 ex., Nee Soon Swamp Forest, 7 Sep.1991, coll. H. K. Lua (ZRC); 1 ex., idem, 20 Sep.1993, y 843, coll. K. L. Yeo (ZRC); 2 ex., idem, 26 Apr.1997, coll. M. Balke & L. Hendrich (CBH). **Other areas** - 3 ex., Bukit Batok Nature Park, pond 2, 23 Apr.1997, coll. M. Balke, L. Hendrich & H. K. Lua (CBH); 3 ex., Bukit Batok Nature Park, large quarry, 23 Apr.1997, coll. M. Balke, L. Hendrich & H. K. Lua (CBH).

Distribution. – Myanmar, Thailand, Laos, West Malaysia, Singapore, Indonesia: Sumatra, Java, Bali, and the Philippines (Hendrich & Balke, 1995; Biström, 1996; Balke et al., 1999).

Ecology. – *Hydrovatus pudicus* is an inhabitant of shallow, muddy water of open swamps, at the edge of artificial ponds (e.g., fish ponds, paddy fields), and in slow flowing drainage ditches. The habitat is rich in rotten leaves, submerged plants, and dense stands of sedges (Hendrich & Balke, 1995; Biström, 1996).

***Hydrovatus rufoniger rufoniger* (Clark, 1863)**
(Fig. 20)

Hyphidrus [sic!] *rufoniger* Clark, 1863: 423.

Hydrovatus rufoniger rufoniger (Clark) - Biström, 1996: 388, and references therein; Balke et al., 1999: 325; Nilsson, 2001: 198.

Material examined. – Number ? - „Singapour“ after Régimbart (1899) (Biström 1996). Not seen.- 57 specimens - **Central catchment area** - 10 ex., Nee Soon Swamp Forest, 16 May.1992, coll. C. M. Yang (ZRC); 3 ex., Nee Soon Swamp Forest, 6 Dec.1996, coll. L. Hendrich (CBH, ZRC); 1 ex., Nee Soon Swamp Forest, 20 Sep.1993, y 843, coll. Yang (ZRC); 41 ex., Nee Soon Swamp Forest, 21 Apr.1997, coll. Balke & Hendrich (CBH). **Sungai Buloh** - 1 ex., Nature Park, 5 Dec.1996, coll. L. Hendrich & A. Wong (ZRC).

Distribution. – India, Bangla Desh, Sri Lanka, Myanmar, China, Thailand, Cambodia, West Malaysia, Singapore, Indonesia: Sumatra, Java, Ceram, New Guinea (Biström, 1996, Balke et al., 1999).

Ecology. – *Hydrovatus rufoniger rufoniger* inhabits shallow, gloomy water of open swamps, artificial ponds (e.g., fish ponds, paddy fields), and slow flowing drainage ditches. The habitat must be rich in rotten leaves, submerged plants, and dense stands of sedges. The species is also attracted to light (Biström 1996).

***Hydrovatus saundersi* Biström, 1996**

Hydrovatus saundersi Biström, 1996: 321; Balke et al., 1999: 325; Nilsson, 2001: 200.

Material examined. – 107 specimens – **Area ?** - 1 ex., Singapore, Bi 4.23 flew/ Singapore, C. J. Saunders BM 1929-369; 1 ex., Bi 9.22 flew/ Singapore, C. J. Saunders BM 1929-369 (BMNH). **Central catchment area** - 6 ex., Nee Soon Swamp Forest, 6 Dec.1996, coll. L. Hendrich (CBH); 1 ex., Nee Soon Swamp Forest, 26 Aug.1992, y 840, coll. K. L. Yeo (ZRC); 89 ex., Nee Soon Swamp Forest, 21 Apr.1997, coll. Balke & Hendrich (CBH, ZRC); 9 ex., Nee Soon Swamp Forest, 26 Apr.1997, coll. M. Balke & L. Hendrich (CBH, ZRC).

Distribution. – West Malaysia, Singapore (Biström, 1996; Balke et al., 1999).

Ecology. – *Hydrovatus saundersi* is an inhabitant of shallow, open or semi-shaded water of primary freshwater swamps. The habitat is rich in submerged vegetation and sedges, the bottom chiefly of mud and rotten leaves.

***Hydrovatus sinister* Sharp, 1890**

Hydrovatus sinister Sharp, 1890: 343; Biström, 1996: 521, and references therein; Balke et al., 1999: 325; Nilsson, 2001: 192.

Material examined. – 160 specimens - **Central catchment area** - 21 ex., Nee Soon Swamp Forest, 20 Sep.1993, y 843, coll. C. M. Yang (ZRC); 1 ex., idem, 26 Aug.1993, coll. K. L. Yeo (ZRC); 2 ex., Nee Soon Swamp Forest, 26 Aug.1992, coll. K. L. Yeo (ZRC); 1 ex., Nee Soon Swamp Forest, 16 May.1992, coll. C. M. Yang (ZRC); 38 ex., idem, 6 Dec.1996, coll. L. Hendrich (CBH, ZRC); 150 ex., idem, 21 Apr.1997, coll. M. Balke & L. Hendrich (CBH, ZRC); 8 ex., idem, 26 Apr.1997, coll. M. Balke, L. Hendrich & C. M. Yang (CBH). **Sungai Buloh** - 10 ex., Nature Park, pond, 5 Dec.1996, coll. L. Hendrich & A. Wong (CBH, ZRC). **Other areas** – 4 ex., Lorong Banir, pond 1, 14 Jul.1995, NS 200, coll. H. K. Lua (ZRC); 7 ex., Lorong Banir, pond 1, 28 Apr.1997, coll. M. Balke & L. Hendrich (CBH); 16 ex., Lorong Banir, pond 2, 16 Jun.1995, NS 191, coll. H. K. Lua (ZRC); 6 ex., Bukit Batok Nature Park, pond, 23 Apr.1997, coll. M. Balke & L. Hendrich (CBH).

Distribution. – Sri Lanka, India, Myanmar, Laos, West Malaysia, Indonesia [Sumatra, Kalimantan] (Biström, 1996) and Singapore (Balke et al., 1999).

Ecology. – The most common species of the genus in Singapore. *Hydrovatus sinister* is an inhabitant of shallow, muddy water of open swamps, artificial ponds (garden and park ponds, quarry ponds), and slow flowing irrigation ditches. The habitat is rich in rotten leaves, sedges and submerged plants.

***Hydrovatus stridulus* Biström, 1996**

Hydrovatus stridulus Biström, 1996: 529; Balke et al., 1999: 325; Nilsson, 2001: 192

Material examined. – 68 specimens - **Bukit Timah** – 1 ex., Bukit Timah, 13 Dec.1995, coll. T. Wong & H.K. Lim (ZRC); 1 ex., Bukit Timah Nature Reserve, coll. C.F. Lim (ZRC). **Central catchment area** – 2 ex., Nee Soon Swamp Forest, 7 Sep.1991, coll. H. K. Lua (ZRC); 1 ex., Nee Soon Swamp Forest, 19 Sep.1991, coll. K. L. Yeo (ZRC); 1 ex., Nee Soon Swamp Forest, 26 Aug.1992, coll. K. L. Yeo (ZRC); 7 ex., Nee Soon Swamp Forest, 20 Sep.1993, y 843, coll. C. M. Yang (ZRC); 6 ex., Nee Soon Swamp Forest, 15 May.1992, NS 4C, coll. C. M. Yang et al. (ZRC); 2 ex., Nee Soon Swamp Forest, 17 Jun.1992, NS 22, coll. K. L. Yeo et al. (ZRC); 1 ex., Nee Soon Swamp Forest, 26 Aug.1993, y 840, coll. K. L. Yeo (ZRC); 1 ex., Lower Peirce Reservoir, 4 Jun.1992, NS 18/19, coll. C. M. Yang et al. (ZRC); 3 ex., Seletar Reservoir West, 25 Jan.1992, y 780, coll. C. M. Yang & K. L. Yeo (ZRC). **Sungai Buloh** - 5 ex., Nature Reserve, 10 Jul.1992, y 804, K.K.P. Lim coll. (ZRC). **Other areas** - 1 ex., “22 flew/Singapore, C.J. Saunders B.M. 1929-369 / *Hydrovatus stridulus* mihi j. Balfour-Browne det.”

(BMNH) [4 ex., with same data as holotype in BMNH and MZH] (Biström 1996); 37 ex., Kent Ridge Park, Kent Ridge Pond, 6 Dec.1996, coll. L. Hendrich & C. M. Yang (CBH, ZRC).

Distribution. – Thailand, West Malaysia, Singapore (Biström, 1996; Balke et al., 1999).

Ecology. – *Hydrovatus stridulus* inhabits shallow, muddy water of open or semi-shaded primary swamps. The habitat is rich in rotten leaves. Dense submerged vegetation and sedges are usually present. The species also occurs in brackish waters of coastal swamps (Sungai Buloh Nature Park).

Remarks. – Singapore is the type locality of this species.

Hydrovatus sumatrensis Sharp, 1882

Hydrovatus sumatrensis Sharp, 1882: 327; Biström, 1996: 388, and references therein; Balke et al., 1999: 325; Nilsson, 2001: 192.

Material examined. – 73 specimens - **Central catchment area** - 5 ex., Nee Soon Swamp Forest, 20 Sep.1993, y 843, coll. Yang (ZRC); 20 ex., Nee Soon Swamp Forest, 6 Dec.1996, coll. L. Hendrich (CBH, ZRC); 29 ex., idem, 21 Apr.1997, coll. Balke & Hendrich (CBH, ZRC); 19 ex., Nee Soon Swamp Forest, 26 Apr.1997, coll. M. Balke & L. Hendrich (CBH, ZRC).

Distribution. – West Malaysia (coll. Hendrich), Indonesia [Sumatra, Siberut, Nias, Java, Sulawesi] (Biström, 1996) and Singapore (Balke et al., 1999).

Ecology. – In Singapore, all records are from shallow, open or semi-shaded waterbodies in a primary freshwater swamp. The habitat is rich in rotten leaves and dense submerged vegetation. *Hydrovatus sumatrensis* may be attracted to light (Ullrich, in litt.).

TRIBE HYPHYDRINI

Hyphydrus lyratus lyratus Swartz, 1808

Hyphydrus lyratus Swartz in Schönherr, 1808: 29; Yano et al., 1983b: 109.

Hyphydrus lyratus lyratus Swartz: Biström, 1982: 22, and references therein; Biström et al., 1993: 293; Hendrich & Balke, 1995: 37; Nilsson, 2001: 223.

Material examined. – 3 specimens - **Sungai Buloh** - 1 ex., Nature Park, 10 Apr.1991, 34E, coll. K. Lim (ZRC); 2 ex., Nature Park, mercury light trap, 10 Jul.1992, y 804, coll. K. Lim (ZRC).

Distribution. – Australia, China, Japan [Okinawa, in coll. Hendrich], Fiji Islands, Indonesia [Bali, Sumbawa], Laos, Malaysia [Peninsular Malaysia], Myanmar, New Guinea, Thailand, Vietnam (Biström, 1982; Biström et al., 1993; Hendrich & Balke, 1995). **Singapore!**

Ecology. – *Hyphydrus lyratus* inhabits different kinds of exposed lentic habitats. The species is found in muddy pools, ponds, paddy fields and ditches preferable in disturbed areas. The species is often attracted to light. It is the most common

species of the genus in Southeast Asia (Yano et al., 1983b; Biström, 1982; Hendrich & Balke, 1995).

Microdytes elgae Hendrich, Balke & Wewalka, 1995 (Fig. 15)

Microdytes elgae Hendrich, Balke & Wewalka in Hendrich & Balke, 1995: 42; Wewalka, 1997: 23; Balke & Hendrich, 1999: 15; Balke et al., 1999: 325; Nilsson, 2001: 228.

Material examined. – 20 specimens - **Bukit Timah** - 6 ex., 27 Aug.1993, y 1841, Taban Valley, coll. M. Balke & C. M. Yang (ZRC); 2 ex. Taban Valley, 14 Dec.1995, NS 216, coll. H. K. Lua and others (ZRC); 4 ex., Taban Valley, small streamlet in primary forest, 9 Apr.1997, coll. M. Balke & L. Hendrich (CBH); 8 ex., Taban Valley, small streamlet in primary forest, 24 Apr.1997, coll. M. Balke & L. Hendrich (CBH, ZRC).

Distribution. – Bhutan, Indonesia [Bali, Lombok, Kalimantan], Malaysia [Peninsula, Sarawak], Singapore (Wewalka, 1997; Balke et al., 1999).

Ecology. – *Microdytes elgae* inhabits small shaded or semi-shaded helocrenes streams in primary rain forest. The beetles usually hide beneath leaves and in the gravel under only a very thin film of water. In Singapore the species was collected along with *Microdytes pasiricus* (Csiki), *Laconectus krikkeni* Brancucci and *Hydraena* spp. It is confined to a very small stream in the forest of the Bukit Timah Nature Reserve (Balke et al., 1999).

Microdytes pasiricus (Csiki, 1937)

Hydrovatus pasiricus Csiki, 1937: 126.

Microdytes pasiricus (Csiki) - Wewalka, 1997: 30; Balke & Hendrich, 1999: 15; Balke et al., 1999: 325; Nilsson, 2001: 229.

Material examined. – 11 specimens - **Bukit Timah** - 2 females, 27 Aug.1993, y 844, Taban Valley, small streamlet in primary forest, M. Balke & C. M. Yang coll. (ZRC); 1 male, 1 female, Taban Valley, small streamlet in primary forest, 18 Apr.1997, M. Balke & L. Hendrich coll. (CBH); 7 ex., Taban Valley, small streamlet in primary forest, 25 Oct.2001, coll. M. Balke (CBH, ZRC).

Distribution. – Indonesia [Java], Peninsular Malaysia, Philippines [Palawan, Luzon], Singapore, Thailand (Wewalka, 1997; Balke et al., 1999).

Ecology. – See *Microdytes elgae*. This species was rarely collected, but appeared more commonly on 25 Oct.2001, while *M. elgae* was much rarer then.

SUBFAMILY LACCOPHILINAE

Laccophilus medialis Sharp, 1882 (Fig. 21)

Laccophilus medialis Sharp, 1882: 309.

Laccophilus cingulifer Guignot, 1956a: 60; Brancucci, 1983: 326, and references therein.

Laccophilus medialis Sharp, 1882: 309 Nilsson, 2001: 246.

Material examined. - 1 female, "Singapore, 1897, Biro" (TDMB). (Guignot, 1956a; Brancucci, 1983). Not seen.

Distribution. - India, Bhutan, Myanmar, Thailand, Laos, Vietnam, West Malaysia, Singapore, Indonesia [Java, Sumbawa, Timor] (Brancucci, 1983).

Ecology. - A lentic species restricted to forested areas. In West Malaysia the species was collected from shallow and shaded, more permanent forest pools in primary and second growth (older rubber plantations) lowland forest. The bottom consists of mud and a thick layer of rotten leaves. Probably the species still occurs in the Swamp Forest of Nee Soon.

Remarks. - We have not found this species in our survey and it is perhaps extinct in Singapore.

Laccophilus parvulus parvulus Aubé, 1838

Laccophilus parvulus Aubé, 1838: 429; Fernando, 1961: 23; 1964: 87; Yano et al., 1983b: 109; Brancucci, 1983: 355, and references therein; Nilsson, 2001: 248.

Material examined. - 4 specimens - 1 ex., «Singapour», in coll. Bonvouloir, MNHN (Brancucci, 1983). Not seen. **Central catchment area** - 1 ex., Nee Soon Swamp Forest, transect "D", 15 May.1992, NS 4a, coll. C. M. Yang et al. (ZRC). **Sungai Buloh** - 1 ex., Nature Park, mud pool, 15 Nov.1990, y 707c, coll. K. L. Yeo et al. (ZRC); 1 ex., 16 Jan.1991, Sungai Buloh, 34 E, coll. K. L. Yeo et al. (ZRC).

Distribution. - India, Malaysia, Myanmar, Indonesia [Sunda Islands], Pakistan, Philippines, Singapore, Sri Lanka (Brancucci, 1983).

Ecology. - The species inhabits different kinds of standing waters in open areas, such as muddy pools, swamps, ponds, paddy fields and ditches. The species is often attracted to light (Fernando, 1961; Yano et al., 1983b, Hendrich & Balke, 1995).

Laccophilus pulicarius Sharp, 1882

Laccophilus pulicarius Sharp, 1882: 313; Brancucci, 1983: 309, and references therein; Balke et al., 1999: 325; Nilsson, 2001: 249.

Material examined. - 13 specimens - 5 ex., «Singapore, C.J. Saunders» (in BMNH: Brancucci, 1983). Not seen. **Central catchment area** - 1 ex., Nee Soon Swamp Forest, transect "G", 17 Jun.1992, NS 23, coll. K. L. Yeo et al. (ZRC); 1 ex., Nee Soon Swamp Forest, 21 Apr.1997, coll. M. Balke & L. Hendrich (CBH). **Bukit Timah** - 1 ex., Jalan Senapang, stream under bamboo grove, 14 Dec.1995, NS 217, coll. H. K. Lua (ZRC). **Sungai Buloh** - 1 ex., Sungai Buloh, 4 Dec.1990, coll. K. L. Yeo et al. (ZRC); 2 ex., fish pond, 5 Dec.1996, coll. L. Hendrich (CBH, ZRC). **Other areas** - 1 ex., Lorong Banir, stream, 3 Jun.1994, 149B, coll. C. M. Yang (ZRC); 1 ex., Lorong Banir, 10 Jun.1994, NS 157 B, coll. C. M. Yang (ZRC).

Distribution. - Indonesia [Java, Kalimantan, Sumatra], Japan [Ryukyu Islands], Peninsular Malaysia, Singapore, Thailand, Vietnam (Brancucci, 1983).

Ecology. - A lentic species which is found in muddy pools, swamps, ponds and ditches in open, exposed or semi-shaded areas. In general the habitat is rich in submerged vegetation, the bottom consisting of mud with a thick layer of rotten leaves.

Laccophilus ritsemae Régimbart, 1880

Laccophilus ritsemae Régimbart, 1880: 209; Brancucci, 1983: 335, and references therein; Balke et al., 1999: 325; Nilsson, 2001: 250.

Material examined. - 13 specimens - **Central catchment area** - 3 ex., Nee Soon Swamp Forest, 9 May.1992, Y 795D, coll. K. L. Yeo (ZRC); 1 ex., Seletar Reservoir West, 25 Jan.1992, 780c, coll. C. M. Yang & K. L. Yeo (ZRC). **Bukit Timah** - 7 ex., 13 Dec.1995, NS 214, coll. T. Wong & H. K. Lua (CBH, ZRC). **Sungai Buloh** - 1 ex., Nature Reserve, 19 Dec. 1990, coll. K. L. Yeo (ZRC). **Other areas** - 1 ex., Lorong Banir, pond 1, 16 Jul.1995, NS 190, coll. H. K. Lua (ZRC).

Distribution. - India [Andaman and Nikobar Islands], Indonesia [Bali, Java, Kalimantan, Sumatra], Philippines (Brancucci, 1983) and Singapore (Balke et al., 1999).

Ecology. - See *L. pulicarius*.

Laccophilus siamensis siamensis Sharp, 1882

Laccophilus siamensis siamensis Sharp, 1882: 306; Brancucci, 1983: 299, and references therein; Hebauer et al., 1999: 339; Nilsson, 2001: 251.

Laccophilus sp.: Ng, 1991: 93.

Material examined. - 62 specimens - **Central catchment area** - 1 ex., Chestnut Drive, 10 May.1994, NS 130A, coll. H. K. Lua et al. (ZRC); 1 ex., Lower Peirce bank, 9 May.1995, NS 179, coll. H. K. Lua (ZRC); 1 ex., Lower Peirce, 1 Oct.1990, coll. H. K. Lua (ZRC); 2 ex., Nee Soon Swamp Forest, 28 May.1992 (ZRC); 4 ex., Nee Soon Swamp Forest, 18 Jun.1994 (ZRC); 2 ex., Nee Soon Swamp Forest, pool, 21 Jan.1992, Y 8144, coll. C. M. Yang (ZRC); 4 ex., Nee Soon Swamp Forest, Transect "G", 17 Jun.1992, NS 22, coll. K. L. Yeo (ZRC); 1 ex., Seletar Reservoir by Mandai Lake Road, 27 Apr.1993, NS 60, coll. K. L. Yeo (ZRC); 1 ex., Seletar Reservoir, 10 May.1994, NS 134C, coll. H. K. Lua et al. (ZRC); 7 ex., Seletar Reservoir, Mandai Lake Road, 16 May.1994, NS 134A, coll. H. K. Lua et al. (ZRC); 1 ex., Mandai Lake Road, 16 May.1994, NS 134B, coll. K. L. Yeo et al. (ZRC); 1 ex., Mandai Lake Road, 17 May.1994, NS 136A, coll. H. K. Lua et al. (ZRC); 2 ex., Mandai Forest, 15 Oct.1996, NS 155, coll. C. M. Yang (ZRC); 2 ex., Seletar Reservoir inlet, 18 May.1994, NS 137B, coll. K. L. Yeo et al. (ZRC); 3 ex., Chestnut Drive, 26 May.1994, NS 142E, coll. H. K. Lua et al. (ZRC); 2 ex., MacRitchie Reservoir, Sime Road, 'H' stm. pool, 8 Apr.1997, coll. M. Balke, L. Hendrich & C. M. Yang (ZRC). **Bukit Timah** - 1 ex., 3 Dec.1995, NS 214, coll. T. Wong & H. K. Lua (ZRC). **Other areas** - 18 ex., Kranji, pond, 10 Oct.1990, 691/YCM 31, coll. K. L. Yeo (ZRC); 3 ex., Lorong Banir "K" stagnant pond, 10 Jun.1994, NS 157F, coll. T.M. Lim et al. (ZRC); 1 ex., Lorong Banir, pond 1, 28 Apr.1997, coll. M. Balke & L. Hendrich (CBH, ZRC); 8 ex., Bukit Batok Nature Park, pond 2, 23 Apr.1997, coll. M. Balke, L. Hendrich & H. K. Lua (CBH, ZRC).

Distribution. – Myanmar, Vietnam, Thailand, Laos, Cambodia, Peninsular Malaysia, Indonesia [Sumatra, Java, Kalimantan] (Brancucci, 1983). **Singapore!**

Ecology. – In Singapore *L. siamensis* is the most common species of the genus. It inhabits more permanent, standing and slow flowing waters such as muddy pools, ponds and irrigation ditches in open or semi-shaded areas. The species is also attracted to light.

SUBFAMILY COPELATINAE

Copelatus minutissimus Balfour-Browne, 1939 (Fig. 22)

Copelatus minutissimus Balfour-Browne, 1939a: 79; Guéorguiev, 1968: 22; Vazirani, 1970: 315; 1977: 56; Balke, 1994: 32; Balke et al., 1999: 325; Nilsson, 2001: 70.

Material examined. – Type material: 1 male: “Singapore” (BMNH). Additional material: 2 specimens - **Central catchment area** - 1 ex., Nee Soon Swamp Forest, Range II Training Shed, Transect “E”, UV Light Trap, 22 May.1992, NS 10d, coll. H. K. Lua & K. Lim (ZRC); 1 ex., Nee Soon Swamp Forest, 26 Aug.1993, y 840, coll. M. Balke, Murphy & C. M. Yang (ZRC).

Distribution. – India [Orissa] needs to be confirmed, Malaysia (Vazirani, 1977), Indonesia: Kalimantan, Sumatra (Hendrich vid.), Thailand (Balfour-Browne, 1939a), Vietnam (in coll. Balke & Hendrich) and Singapore (Balke, 1994; Balke et al., 1999).

Ecology. – A forest species which occurs among leaf litter, roots and submerged plants of very small, temporary, shallow puddles in or near forested areas. This species is confined to the forests of the Central Catchment Area.

Copelatus oblitus Sharp, 1882

Copelatus oblitus Sharp, 1882: 582; Régimbart, 1899: 298; Zimmermann, 1920: 141; Balfour-Browne, 1939a: 79; Guéorguiev, 1968: 22; Vazirani, 1977: 56; Nilsson, 2001: 70. *Copelatus andamanicus* Régimbart, 1899: 302; Guéorguiev, 1968: 20; Vazirani, 1971: 310; 1977: 53; Satô 1983: 35; 1985: 58; 1990: 81; Balke et al., 1999: 325. **Syn. Nov.** *Copelatus subfasciatus* Zimmermann, 1919b: 76. *Copelatus socienus ryukyuensis* Satô, 1961: 8. *Copelatus tokaraensis* Nakane, 1963: 25.

Material examined. - Type material of *C. oblitus* Sharp: 1 male (holotype) - “Singapore”, “Type” (BMNH). Type material of *C. andamanicus* Régimbart: 1 male (lectotype) - : “Ills Andaman”, “Cotype”, “*Copelatus andamanicus* Rég. Cotype”, “Lectotype” (MNHN).

Additional material: 44 specimens - **Central catchment area** - 11 ex., Nee Soon Swamp Forest, puddle on track, 16 Dec.1996, coll. L. Hendrich (CBH, ZRC); 16 ex., MacRitchie Reservoir, 21 Apr.1997, coll. M. Balke & L. Hendrich & C. M. Yang (CBH, ZRC); 1 ex., Lower Peirce Reservoir, after the concrete water runoff, 22 Apr.1997, 230a, coll. H. K. Lua (ZRC). **Bukit Timah** – 6 ex., Bukit Timah Nature Reserve, coll. C.F. Lim (ZRC); 1 ex., at pipeline,

MTB track, swampy area near pond, 9 Apr.1997, coll. L. Hendrich (CBH); 4 ex., MTB track at pipeline, 22 Dec.2001, coll. M. Balke & C. M. Yang (CBH). **Other areas** - 1 ex., Sembawang Senoko, mud track, 10 Jan.1992, 177 b, coll. C. M. Yang & K. L. Yeo (ZRC); 4 ex., ditch on grassy patch near road, Singapor gun club, close to Bukit Timah MTB track, 22 Dec.2001, coll. M. Balke & C. M. Yang (CBH).

Distribution. – India [Andaman Islands], Japan [Yaku-shima and Ryukus Islands], Malaysia [Sarawak], Taiwan (Satô, 1985, 1990) and Singapore (Vazirani, 1977). The record for Indonesia: Sulawesi (Balfour-Browne 1939a) needs to be confirmed.

Ecology. – The species is found among leaf litter, roots and submerged plants of very small, temporary, shallow puddles in or near forested areas. The species seems to be restricted to the second growth forests of the Central Catchment Areas and Bukit Timah Nature Reserve.

Copelatus tenebrosus Régimbart, 1880

Copelatus tenebrosus Régimbart, 1880: 210; Zimmermann, 1919a: 217; 1920: 143; Fernando, 1964: 87; Guéorguiev, 1968: 23; Vazirani, 1970: 317; 1977: 57; Yano et al., 1983b: 107; Hendrich & Balke, 1995: 44; Nilsson, 2001: 71.

Material examined. – 3 specimens – 1 ex., Singapore, 10 Jan.1972, T3751, coll. Gräf (CHF). **Sungai Buloh** - 2 ex., Nature Park, shallow pool, No.1, 4 Dec.1990, coll. C. M. Yang & K. L. Yeo (ZRC).

Distribution. – Northern Australia, India, Thailand, Peninsular Malaysia, Indonesia [Sumatra, Java, Bali], Laos, Myanmar, Vietnam (Zimmermann, 1920; Vazirani, 1977; Watts, 1978; Hendrich & Balke, 1995). **Singapore!**

Ecology. – *Copelatus tenebrosus* inhabits different kinds of standing waters in open, exposed areas, such as pools, ponds and irrigation ditches. The species is often attracted to light and is the most common species of the genus can be found in deforested and cultivated areas in Southeast Asia. In Indonesia, Vietnam, Thailand and in the Philippines it was also recorded from paddy fields (Yano et al., 1983b; Hendrich & Balke, 1995).

Lacconectus corayi Brancucci, 1986 (Fig. 16)

Lacconectus corayi Brancucci, 1986: 133; Hendrich & Yang, 1999: 257-258; Nilsson, 2001: 78.

Material known. – 4 specimens – “Singapore, H.N. Ridley” (holotype and three paratypes in BMNH, Brancucci, 1986). Not seen.

Distribution. – Singapore (Brancucci, 1986), Malaysia [West Malaysia, Sabah, Sarawak] (Hendrich & Yang, 1999).

Ecology. – A common forest species in West Malaysia, Sabah and Sarawak, where it is widespread in the lowland and lower mountain forests. It is found in small pools fed by small springs, pools of intermittent streams, rock pools at the edge

of forest streams and in water filled tree and bamboo hollows. In general the habitat is rich in mud and rotten leaves (Hendrich & Yang, 1999).

Remarks. – Singapore is the type locality of this species. It seems that the species disappeared in the last decades in Singapore.

***Lacconectus krikkeni* Brancucci, 1986**

Lacconectus krikkeni Brancucci, 1986: 130; 1987: 93; Hendrich & Yang, 1999: 258; Balke et al., 1999: 325; Nilsson, 2001: 78.

Material examined. – 136 specimens – **Central catchment area** – 2 ex., Nee Soon Swamp Forest, 18 May.1993, NS 86 A 23, coll. C. M. Yang (ZRC); 3 ex., Nee Soon Swamp Forest, near pipeline, flight intercept trap, 23-29 Apr.1997, coll. M. Balke & L. Hendrich (CBH); 1 ex., Nee Soon Swamp Forest, small waterhole at pipeline, 26 Apr.1997, coll. M. Balke & L. Hendrich (CBH); 2 ex., Upper Peirce Reservoir, 26 Apr.1997, coll. H. K. Lua (ZRC). **Bukit Timah** – 5 ex., Bukit Timah, 2 Apr.1997, coll. H. K. Lua (ZRC); 1 ex., Bukit Timah, 6 Dec.1995, NS 204, coll. H. K. Lua (ZRC); 4 ex., Nature Reserve (N.R.), waterhole on track leading to Catchment Hut, 18 Jan.1991, coll. C. M. Yang (ZRC); 34 ex., N.R. (70 m), 27 Aug.1993, coll. M. Balke & C. M. Yang (CBH, ZRC); 22 ex., N.R., stream n. plot 13, 3 May.1993, coll. C.Y. Chang (ZRC); 51 ex., N.R., 14 Dec.1995, NS 216, coll. H. K. Lua (ZRC); 1 ex., N.R., 8 Dec.1995, NS 208A, coll. H. K. Lua (ZRC); 12 ex., N.R., small stream, 9 Apr.1997, coll. M. Balke & L. Hendrich (CBH).

Distribution. – Brunei, Malaysia [Peninsular Malaysia, Sabah, Sarawak] (Brancucci, 1986; Hendrich, in prep.), Singapore (Balke et al., 1999).

Ecology. – See *L. corayi*. One of the most common *Lacconectus* species in Malaysia and widespread in the lowland and lower mountain forests. In many areas *L. krikkeni* occurs in association with *L. corayi* Brancucci (Hendrich & Yang, 1999). In Singapore this species is confined to the forests of Bukit Timah Nature Reserve and Nee Soon Swamp Forest.

SUBFAMILY DYTISCINAE

TRIBE ERETINI

***Eretes griseus* (Fabricius, 1781)** (Fig. 23)

Dytiscus sticticus Linnaeus, 1767: 666.

Dytiscus griseus Fabricius, 1781: 293.

Eretes sticticus (Linnaeus) - Castelnau, 1833: 450.

Eretes sticticus (Linnaeus) - Fernando, 1964: 87; Vazirani, 1977: 73, and references therein; Chen et al., 1998: 27; Nilsson, 2001: 99.

Eretes griseus (Fabricius, 1781) - Miller, 2002: 247-272.

Material examined. – 3 specimens – **Central catchment area** - 2 ex., Rifle Range Road, 22 Jul.1982, coll. D. H. Murphy (ZRC). **Other areas** - 1 ex., Kent Ridge Pond, 20 Jul.1982, coll. D. H. Murphy (ZRC).

Distribution. – Oriental and East Palaearctic realms (Miller, 2002). **Singapore!**

Ecology. – This species occurs in large, unshaded standing water bodies with sandy or gravelly bottom, and without or sparse aquatic vegetation (Fernando, 1964). In Southeast Asia, *Eretes griseus* is therefore more common in cultivated areas than in forested areas. *Eretes griseus* is a good flyer and often attracted to light.

Remarks. – This species is sold as food in Northern Thailand (Chen et al., 1998).

TRIBE HYDATICINI

***Hydaticus bipunctatus conjungens* Régimbart, 1899** (Fig. 17)

Hydaticus bipunctatus Wehncke, 1876: 196.

Hydaticus vittatus var. *conjungens* Régimbart, 1899: 329.

Hydaticus bipunctatus conjungens Régimbart - Wewalka, 1975: 94, and references therein; Hendrich & Balke, 1995: 46; Balke & Hendrich, 1999: 16; Balke et al., 1999: 325; Nilsson, 2001: 100.

Material examined. – 10 specimens - **Central catchment area** - 1 ex., Nee Soon Swamp Forest, Shelter near Range II U. May light trap, 22 May.1992, NS 10D, coll. C.Y. Chang (ZRC). **Bukit Timah** - 7 ex., Nature Reserve, 13 Dec.1995, NS 214, coll. T. Wong, H. K. Lua et al. (ZRC). **Other areas** – 1 ex., Lorong Banir, pond 2, 14 Jul.1995, NS 198, coll. H. K. Lua (ZRC); 1 ex., Lorong Banir, pond 1, 28 Apr.1997, coll. M. Balke, L. Hendrich & C. M. Yang (CBH).

Distribution. – Indonesia [Sunda Islands] (Wewalka, 1975; Hendrich & Balke, 1995), Singapore (Balke & Hendrich, 1999; Balke et al., 1999).

Ecology. – *Hydaticus bipunctatus* inhabits various types of more permanent, eutrophic standing waters such as ponds, paddy fields, fish ponds, lakeshores and drainage ditches (Hendrich & Balke, 1995). The habitat should be rich in detritus and submerged vegetation. The species is also collected under lighted conditions (Hendrich pers. observ. on Bali, Indonesia).

***Hydaticus ?concolor* Sharp, 1882**

Hydaticus concolor Sharp, 1882: 662; Régimbart, 1899: 327; Zimmermann, 1920: 219; 1927: 6; Vazirani, 1977: 76; Wewalka, 1979: 135; Nilsson, 2001: 101.

Material examined. – 1 specimen – **Other areas** - 1 female, Lorong Banir, pond 1, 16 Jun.1990, NS 190, coll. Lua et al. (ZRC).

Ecology. – Unknown. Probably a freshwater swamp forest species like *H. reductus*.

Remarks. – *Hydaticus concolor* and other species such as *Hydaticus sexguttatus* Sharp, 1882 and *H. reductus* Régimbart, 1899 form an assemblage of small, comparably dark species that remain to be revised. Our specimens were

compared with identified beetles in CGW and MNHN. *Hydaticus concolor* is recorded from Vietnam, Indonesia (Vazirani, 1977; Wewalka, 1979). If the determination is correct it will be the first record for the Malaysian Peninsula and Singapore.

***Hydaticus fabricii* (MacLeay, 1825)**

(Fig. 18)

Colymbetes fabricii MacLeay, 1825: 134.

Hydaticus fabricii (MacLeay, 1825) - Fernando, 1961: 19, 24; 1964: 87; Wewalka, 1979: 121, and references therein; Yano et al., 1983a: 17; Hendrich & Balke, 1995: 46; Nilsson, 2001: 101; *Hydaticus* sp.: Yang, 1991: 93.

Material examined. – 19 specimens - **Central catchment area** - 1 ex., Nee Soon Swamp Forest, slow flowing stream, 21 Jan.1992, y 844, coll. C. M. Yang (ZRC); 2 ex., Nee Soon Swamp Forest, 9 May.1992, 795D, coll. K. L. Yeo et al. (ZRC). **Bukit Timah** - 3 ex., Nature Reserve, 13 Dec.1995, NS 214, coll. H. K. Lua et al. (ZRC). **Sungai Buloh** - 1 ex., Sungai Buloh, 4 Dec.1990, coll. C. M. Yang & K. L. Yeo (ZRC); 2 ex., Nature Park, mudpool, 4 Dec.1990, ZRC 6.3812, coll. C. M. Yang & K. L. Yeo (ZRC); 1 ex., Nature Park, 15 May.1991, ZRC 6.3813, coll. C. M. Yang & K. L. Yeo (ZRC); 4 ex., Nature Park, Mangrove Swamp Forest, 30 Jan.1992, y 776, coll. T.B. Lim (ZRC). **Other areas** - 1 ex., Kent Ridge Park, pond, 20 Jan.1992, coll. W.H.J. Yong (ZRC); 2 ex., Warwick Road, 13 Nov.1998, Y 929, coll. K. L. Yeo (ZRC); 1 ex., Lorong Banir, pond 1, 16 Jun.1995, NS 190, coll. H. K. Lua & C. M. Yang (ZRC).

Distribution. – India, Indonesia [Bali, Java, Kalimantan, Sumatra, Sumba], Laos, Malaysia [West Malaysia, Sarawak], Thailand (Wewalka, 1979; Hendrich & Balke, 1995). **Singapore!**

Ecology. – The species prefers various types of exposed, permanent, eutrophic standing waters such as ponds, paddy fields, fish ponds, shallow lakes and slow flowing ditches. The habitat is rich in detritus and submerged vegetation. *Hydaticus fabricii* is often collected under lighted conditions (Fernando, 1961).

***Hydaticus reductus* Régimbart, 1899**

Hydaticus reductus Régimbart, 1899: 357; Zimmermann, 1920: 224; Vazirani, 1977: 80; Nilsson, 2001: 105.

Hydaticus sexguttatus Régimbart, 1899: Balke et al., 1999: 325 (part).

Material examined. – 1 specimen – **Central catchment area** - 1 male, MacRitchie Reservoir, 21 Apr.1994, NS 124 F/H, coll. K. L. Yeo (ZRC).

Distribution. – Indonesia [Kalimantan, Pontianak] (Régimbart, 1899; Vazirani, 1977), West Malaysia and Singapore (Balke et al., 1999).

Ecology. – *Hydaticus reductus* inhabits shaded and shallow freshwater pools in lowland forests. In general the habitat is rich in rotten leaves and wood. The population density of the

species seems to be very low (pers. observ. in West Malaysia). Thus it is difficult to sample and quite rare in collections.

Remarks. – *Hydaticus reductus* and other species (*Hydaticus concolor* Sharp, 1882; *H. sexguttatus* Régimbart, 1899) form an assemblage of small to medium sized, comparably dark species that remain to be revised.

TRIBE CYBISTRINI

***Cybister dehaanii* Aubé, 1838**

Cybister dehaani Aubé, 1838: 101; Sharp, 1882: 726; Régimbart, 1899: 356; Zimmermann, 1920: 259; Guignot, 1956b: 397; Vazirani, 1968: 286; 1977: 88; Hebauer et al., 1999: 339. *Cybister dehaanii* Aubé, 1838: Nilsson, 2001: 91.

Material known. – Number ? – “Singapour”, in TDMB (Guignot, 1956b). Not seen.

Distribution. – India: West Bengal (Vazirani, 1977), Indonesia [Sumatra, Kalimantan] (Régimbart, 1899), Thailand (in coll. Hendrich), West Malaysia [Pahang: Tasek Cini] (Hebauer et al., 1999), Singapore (Guignot, 1956b).

Ecology. – *Cybister dehaanii* lives in permanent water bodies in freshwater swamps and in shallow lakes. In general the water is shaded and rich in plant debris such as leaf litter and rotten trunks (pers. observ. at Tasek Cini/West Malaysia). There is no such habitat in Singapore. The species is thus considered locally extinct. *Cybister dehaanii* is less frequently attracted to light than other species of the genus. It is quite rare in museum collections.

***Cybister rugosus* (MacLeay, 1825)**

Trochilus rugosus MacLeay, 1825: 136.

Cybister indicus Aubé, 1838: 62.

Cybister rugosus Sharp, 1882: 745; Régimbart, 1899: 347; Zimmermann, 1920: 264.

Cybister rugosus (MacLeay) - Vazirani, 1977: 92; Yano et al., 1983a: 17; Chen et al., 1998: 27; Nilsson, 2001: 89.

Material examined. – 1 specimen – **Other areas** - 1 ex., from fish food, 10 Jul.1990, coll. C.H. Teo (ZRC). No further data available.

Distribution. – Southern Vietnam, Thailand, Cambodia, Peninsular Malaysia, Indonesia: Batam, Sumatra, Java and Kalimantan (MacLeay, 1825; Régimbart, 1899; Zimmermann, 1927). **Singapore!**

Ecology. – In other parts of Southeast Asia *Cybister rugosus* has been collected in various types of mostly perennial standing waters such as ponds, paddy fields (Yano et al., 1983a), fish ponds, shallow lakes and ditches. *Cybister rugosus* is frequently attracted to light but much rarer than *C. tripunctatus lateralis*. The species is sold as food in Thailand (Chen et al., 1998).

***Cybister sugillatus* Erichson, 1834**

(Fig. 24)

Cybister sugillatus Erichson, 1834: 227.*Cybister bisignatus* Aubé, 1838: 88.*Cybister notasicus* Aubé, 1838: 90.*Cybister olivaceus* Boheman, 1858: 21.*Cybister sugillatus* Erichson - Régimbart, 1899: 355; Fernando, 1964: 82, 86, 88; Vazirani, 1977: 89; Nilsson, 1995: 78, and references therein; 2001: 93.**Material known.** – Number ? - One old record: “Singapour” cited in Régimbart (1899). Specimens not seen. Possibly deposited in MNHN.**Distribution.** – This species is widespread in the Oriental Region, where it is known from Sri Lanka, India, Malaysia, Singapore, Indonesia and North to the Ryukyu Islands and China (Régimbart, 1899; Nilsson, 1995).**Ecology.** – *Cybister sugillatus* has been collected in various types of mostly shaded, perennial standing waters, such as forest pools, ponds, shallow lakes, ditches and slow flowing streams. Also in blackwater habitats in freshwater swamp forests (Selangor, West Malaysia, specimens deposited in ZRC).***Cybister tripunctatus lateralis* (Fabricius, 1798)***Dytiscus tripunctatus* Olivier, 1795: 14.*Dytiscus lateralis* Fabricius 1798: 64.*Cybister tripunctatus* (Olivier) - Sharp, 1882: 727; Zimmermann, 1927: 43; Csiki, 1937: 130; Hendrich & Balke, 1995: 47; Chen et al., 1998: 27.*Cybister tripunctatus orientalis* Gschwendtner, 1931: 99.*Cybister asiaticus* Sharp, 1882: 731.*Cybister tripunctatus* var. *asiaticus* Sharp, 1882 - Gschwendtner, 1923: 108.*Cybister tripunctatus asiaticus* Sharp, 1882 - Régimbart, 1899: 352; Balfour-Browne, 1945: 122; Fernando, 1961: 24; 1964: 82, 86, 88; Vazirani, 1968: 290; 1977: 92; Nilsson, 1995: 79, and references therein.*Cybister* sp.: Yang, 1991: 93.*Cybister tripunctatus lateralis* (Fabricius, 1798) - Nilsson, 2001: 90.**Material examined.** – 5 specimens - **Sungai Buloh** - 1 ex., ponds, Apr.1989, ZRC. 6.1062, coll. P. Ng (ZRC); 3 ex., ponds, 15 Nov.1990, coll. K. Lim & K. L. Yeo (ZRC); 1 ex., ponds, Turut track, concrete tank by chicken farm, 6 Dec.1990, coll. C. M. Yang & K. L. Yeo (ZRC).**Distribution.** – Widespread throughout the warmer Old World areas (Régimbart, 1899; Zimmermann, 1920 & 1927; Vazirani, 1977; Watts, 1978; Hendrich & Balke, 1995; Nilsson, 1995). **Singapore!****Ecology.** – The species lives in various types of perennial, mainly open, standing and slow flowing waters, such as swamps, ponds, paddy fields, fish ponds, shallow lakes and irrigation ditches. The habitat must be rich in detritus and submerged vegetation. *Cybister tripunctatus lateralis* is frequently attracted to light and is one of the most common larger dytiscids in Southeast Asia.**Remarks.** – Only selected synonyms are given here. The species and its subspecies are in need for a modern revision. According to Balfour-Browne (1945), this polymorphic species is represented in the Oriental Region by the subspecies *C. t. lateralis* (Nilsson, 2001).

It is sold as food in Northern Thailand and Hong Kong (Chen et al., 1998); “particularly abundant in the autumn [...] large numbers are captured easily because at this time of the year they disperse to seek new bodies of water and they collect at lights at night” (Hill et al., 1982).

FAMILY GYRINIDAE

The gyrids or whirligig beetles have strongly adapted to life on the water surface film. The compound eyes are divided into a dorsal and a ventral one, probably mainly to detect predators, since the food, consisting mostly of drowning insects on the water surface, is located by the specially modified antennae that are sensitive to wave action. The long forelegs are used for grasping the prey. The extremely modified, paddle-like middle and hind legs propel the beetles with astonishing speed. They are often gregarious and move in circles on the water. Larvae breathe by gills and, like the adults, are primarily predacious. Pupation occurs on land in a cocoon formed by gluing particles of sand or debris around the mature larva. All Southeast Asian species are restricted to clear, oxygen rich, mostly fast flowing streams and rivers, some in ponds and reservoirs.

Orectochilus (Patrus) andamanicus* Régimbart, 1884Orectochilus andamanicus* Régimbart, 1884: 435; Ochs, 1929: 403; Balke et al., 1999: 326.**Material examined.** – 8 specimens - **Central catchment area** - 2 ex., Seletar Reservoir, 16 May.1994, NS 134c, coll. H. K. Lua (ZRC); 3 ex., Nee Soon Swamp Forest, 14 Jun.1994 (ZRC); 2 ex., Chestnut Drive, 9 Jun.1994 (ZRC); 1 ex., Seletar Stream, May.1991(ZRC).**Distribution.** – India, Andaman Islands, Myanmar, Thailand, West Malaysia (Ochs, 1929 and Mazzoldi, in litt.), Singapore (Balke et al., 1999).**Ecology.** – In Singapore specimens were collected in clear and well shaded streams. *Orectochilus andamanicus* is a rare whirligig and belongs to a group of species (*O. spiniger*-group) which occur in shaded clearwater streams, mainly in forested areas of the lowlands. The beetles usually circle under fallen logs and in undercut riverbanks (Mazzoldi, in litt.).***Orectochilus (Patrus) corniger* Zaitzev, 1910***Orectochilus corniger* Zaitzev, 1910: 224; Zimmermann, 1917: 168; Peschet, 1923a: 11; Ochs, 1927b: 117, 122; 1928: 101; 1930b: 69; 1931: 474, 477; 1953: 221; Balke et al., 1999: 326.*Orectochilus corporaali* Peschet - Yang, 1992 (part).

Material examined. – 58 specimens – 1 ex, Bukit Timah, NS168A, 1 Jul.1994 (ZRC). **Central catchment area** – 23 ex, Seletar stream, 20 Jan.1992 (ZRC); 8 ex, Nee Soon Swamp, 6 May.1992 and 13 Jun.1994 (ZRC); 3 ex, Mandai Lake Road, 16 May.1994 (ZRC). **Other areas** - 23 ex, Lorong Banir, June1994 (ZRC).

Distribution. – The typical form has a wide distribution including Vietnam, Thailand, West Malaysia, Indonesia: Sumatra, Java, Borneo (Ochs, 1927b, 1928, 1953; Mazzoldi, in litt.). We have previously reported this new subspecies from Singapore (Balke et al., 1999).

Ecology. – Most specimens were collected in clear and oxygen rich water in well shaded forest streams.

Remarks. – This is the smallest and most common *Orectochilus* in Singapore, and was formerly identified as *O. corporaali* (Yang, 1992). Singapore specimens belong to a new subspecies which is restricted to southern tip of the Malay Peninsular and the island of Bintan, Indonesia (Paolo Mazzoldi, in litt.). He is currently revising the genus.

Orectochilus (Patrus) corporaali Peschet, 1923

Orectochilus corporaali Peschet, 1923b: 293; Ochs, 1927a: 244; 1927b: 116, 122; 1929: 401; 1931: 473.

Material known. – Number ? – **Other areas** - St. George Road, 10 Apr.1927, coll. N. Smedley (NMKL), (Ochs, 1929). Not seen.

Distribution. – West Malaysia, Singapore, Indonesia: Sumatra, Java (Ochs, 1927a, 1929 & 1931).

Ecology. – In West Malaysia (Sungai Ampang, Selangor) *O. corporaali* was collected in shady forest streams, where the water was very still (Dover, in litt, ref. Ochs, 1927a). Mazzoldi (in litt.) has collected the species from fast flowing, shaded streams in Johore, West Malaysia.

Orectochilus (Patrus) klynstrai Ochs, 1927

Orectochilus klynstrai Ochs, 1927b: 117, 122; 1929: 402; 1953: 220.

Material known. – Number ? – **Other areas** - St. George Road, 10 Apr.1922, coll. N. Smedley (NMKL); Katong, July1922, coll. F.N. Chasen (NMKL) (Ochs, 1929). Not seen.

Distribution. – Thailand, West Malaysia, Singapore, Indonesia: Sumatra (Ochs, 1929 and Mazzoldi, in litt.).

Ecology. – See *Orectochilus andamanicus* and *O. corporaali*.

Orectochilus (Patrus) oxygonus Régimbart, 1907

Orectochilus oxygonus Régimbart, 1907: 203; Ochs, 1927a: 2; Balke et al., 1999: 326.

Material known. – Number ? - «Singapour» (Régimbart, 1907). Not seen. – 106 specimens - **Central catchment area** – 13 ex., Seletar Reservoir, 16-27 May.1994 [NS 134C, 137A,140, 143A]

(CPM, ZRC); 5 ex., Upper Peirce Reservoir, 24 May.1993, NS92, coll. C.Y. Chang et al. (ZRC); 18 ex., MacRitchie Reservoir, May1994, NS122A & 178, and 7 Jun.1995, NS 183 (CPM, ZRC); 25 ex., Nee Soon Swamp Forest, May1994, NS126A & 127 (CPM, ZRC); 45 ex, Chesnut Drive 5-10 May.1994 [NS 128B, 130, 154 &155] (ZRC).

Distribution. – Southernmost part of West Malaysia, Johor State (Mazzoldi, in litt.) and Singapore (Régimbart, 1907; Ochs, 1927a; Balke et al., 1999).

Ecology. – A common species in forest streams. Most specimens were collected in clear and oxygen rich water in well-shaded small streams and edges of reservoirs in the Central Catchment Area. Mazzoldi (in litt.) has collected some specimens from a very small, completely shaded stream in thick secondary forest in Johor (West Malaysia) but this species seems to be common only in Singapore.

Remarks. – Singapore is the type locality of *O. oxygonus*.

Orectochilus (Patrus) productus Régimbart, 1884

Orectochilus productus Régimbart, 1884: 422; Ochs, 1927a: 2; 1929: 402; Fernando, 1964: 82, 86; Balke et al., 1999: 326.

Material examined. – 81 specimens – **Central catchment area** - 18 ex., MacRitchie Reservoir, Apr.1994 [NS 36, 123B, 124A, 125, 161D] (ZRC); 49 ex., Seletar Reservoir, 12-23 May 1994 (NS 132, 134a, 136A, 140B) (CPM, ZRC); 9 ex, Chestnut Drive, NS 142E, 26 May.1994 (ZRC) **Other areas** - 2 ex., Bukit Batok Nature Park, 9 Jul.1995, LHK 282, coll. H. K. Lua (ZRC); 3 ex, Lorong Banir, NS 141C, 24 May.1994 (ZRC).

Distribution. – India, Sri Lanka, Southern China, Vietnam, Thailand, Malaysia [Sarawak], Indonesia [Kalimantan and Java] (Ochs, 1927a & 1929; Mazzoldi, in litt.), Singapore (Balke et al., 1999).

Ecology. – This is the common *Orectochilus* found in both forest and open habitats, especially in ponds and edges of reservoirs.

Orectochilus (Patrus) vitalisi smedleyi Ochs, 1929

Orectochilus vitalisi smedleyi Ochs, 1929: 403.

Material known. – Number ? – **Other areas** - St. George Road, 10 Apr.1922, coll. N. Smedley (Ochs, 1929). Not seen.

Distribution. – Singapore (Ochs, 1929); Trengganu (West Malaysia) (Mazzoldi in prep.).

Ecology. – The habitat in Singapore is unknown. In West Malaysia the species was collected in clear and oxygen rich water of a fast flowing stream (Mazzoldi, in litt.).

Orectochilus (Patrus) spinosus Zimmermann, 1917

Orectochilus spinosus Zimmermann, 1917: 156.

Material examined. – 25 specimens – **Central catchment area** - 14 ex., Nee Soon Swamp Forest, NS 159B, 14 Jun.1994 (ZRC); 11 ex, Chestnut Drive, NS 165, 23 Jun.1994 (ZRC).

Distribution. – The species was originally described from Borneo (Zimmermann, 1917). New records are from the Riau Islands and Kalimantan (Mazzoldi, in litt.).

Ecology. – The specimens were collected from a relatively clear, slow-flowing and oxygen-rich, well-shaded stream in the Central catchment area.

Dineutus (Spinosodineutes) spinosus (Fabricius, 1781)

Gyrinus spinosus Fabricius, 1781: 298.

Dineutus (Spinosodineutes) spinosus: Ochs, 1929: 401, 1930a: 10; Brinck, 1981: 353; Vazirani, 1984: 16, and references therein; Balke et al., 1999: 326.

Material examined. – 1 specimen - **Central catchment area** - 1 ex., stream of MacRitchie Reservoir, 20 Apr.1994, NS 123a, coll. K. L. Yeo et al. (ZRC).

Distribution. – India, Bangladesh, Myanmar, Thailand, Laos, Vietnam (Vazirani, 1984); Malaysia, Indonesia: Sumatra (Ochs, 1929) and Borneo (Mazzoldi, in litt.); Singapore (Ochs, 1930a; Balke et al., 1999).

Ecology. – The single specimen was collected from a relatively clear, slow-flowing and oxygen-rich, well-shaded part of a stream in the Central catchment area. In West Malaysia this species is common in medium-sized streams with slow-flowing water in the forest. It is rare in Singapore as all streams are shallow and small. Often found in association with *Orectochilus productus*.

FAMILY GROUP HYDROPHILOIDEA

FAMILY SPERCHEIDAE

This is a rather small family with 17 species worldwide which all belong to the genus *Spercheus*. Most species described are from the Ethiopian and Oriental regions. Just four species are reported from Southeast Asia (Hebauer, 1997; Hansen, 1999). Most species have coarsely punctuated and costate elytra. Spercheidae inhabit stagnant, often weedy pools, ponds, swamps and paddy fields. Adults and larvae have been reported to walk on the underside of the surface film. The life history of most species is still unknown, except for the central European *S. emarginatus* (Hansen, 1987).

***Spercheus stangli* Schwarz & Barber, 1917**
(Fig. 26)

Spercheus Stangli Schwarz & Barber, 1917: 133.

Spercheus stangli Schwarz & Barber - D'Orchymont, 1919: 70; Hebauer, 1997: 22; Hansen, 1999: 67, and references therein.

Material examined. – 2 specimens - **Other areas** - 2 ex., Kranji fish pond near Neo Tiew Road, 12 Oct.1990, coll. C. M. Yang (ZRC).

Distribution. – Sri Lanka, Cambodia, Thailand, Brunei, Philippines [Luzon] (Hebauer, 1997). First record for the Malaysian Peninsula and **Singapore!**

Ecology. – A lentic species which occurs in shallow and exposed swamps and ponds, rich in aquatic vegetation and plant debris.

FAMILY HYDROPHILIDAE

This rather large family comprises about 2400 described species. Around 400 species in 60 genera are reported from the Oriental realm (Hansen, 1999). Adult and larval hydrophilids have very different habits; the former are phytophagous or saprophagous, while the latter are predacious. Most members of the subfamily Sphaeridiinae are strictly terrestrial (except for the aquatic genus *Coelostoma*), living in decaying vegetable matter, dung, carrion, damp soil and ant or termite nests (Hansen, 1999). Like the Dytiscidae, the aquatic hydrophilids inhabit all kinds of freshwater habitats. Most of the aquatic species are oval to globose, smooth and glabrous, often resembling Dytiscidae, from which they differ in having short and clubbed antennae and long maxillary palps. A ventral plastron, which communicates with a small subelytral air reservoir, is also present. When the beetle rises to the surface, it breaks the surface film using its specialised antennal club, allowing communication between atmosphere and plastron (Lawrence & Britton, 1991). The plastron is held by a fine, golden setation, or hydrofuge pubescence, which covers the major part of the beetle's venter.

SUBFAMILY HYDROPHILINAE

TRIBE Berosini

***Berosus fairmairei* Zaitzev, 1908**
(Fig. 27)

Berosus acutispina Fairmaire, 1889: 336.

Berosus fairmairei Zaitzev, 1908: 355; Schödl, 1992: 146; Hansen, 1999: 76, and references therein.

Material examined. – 10 specimens - **Sungai Buloh** – 7 ex., muddy pool 2, 4 Dec.1990, coll. C. M. Yang & K. L. Yeo (ZRC); 3 ex., 18 Nov.1990, coll. H. K. Lua (ZRC).

Distribution. – Widespread and common species. East Palearctic and Oriental realms (Schödl, 1992; Hansen, 1999). **Singapore !**

Ecology. – A lentic species which occurs in shallow and exposed ponds, puddles and ditches rich in aquatic vegetation and plant debris.

***Berosus incretus* d'Orchymont, 1937**

Berosus indicus incretus d'Orchymont, 1937: 12.

Berosus incretus - Schödl, 1992: 148; Hansen, 1999: 78, and references therein.

Material examined. – 3 specimens - **Sungai Buloh** – 1 ex., 18 Nov.1990, coll. H. K. Lua (ZRC); 1 ex., 19 Dec.1990, coll. K. L. Yeo (ZRC). **Other areas** – 1 ex., Pasir Ris Mangrove, at light, 14 Nov.1989, coll. Y.H. Koo & K. Lim (ZRC).

Distribution. – Widespread and common in the Oriental region. In the Palearctic recorded from Japan (Schödl, 1992; Hansen, 1999). **Singapore !**

Ecology. – See *B. fairmairei*.

***Berosus pulchellus* MacLeay, 1825**

Berosus pulchellus MacLeay, 1825: 35.

Berosus pubescens Mulsant & Rey, 1859: 61.

Berosus decrescens Walker, 1859: 258.

Berosus vestitus Sharp, 1884: 456.

Berosus pulchellus MacLeay - Knisch, 1924b: 273; Yano et al., 1983a: 19; Schödl, 1993: 215; Hansen, 1999: 92, and references therein.

Berosus sp.: Yang, 1991: 95.

Material examined. – 14 specimens – **Central catchment area** - 7 ex., Nee Soon Swamp Forest, 23 Nov.1990, coll. H. K. Lua (ZRC); 1 ex., Nee Soon Swamp Forest, y 794 D, coll. K. L. Yeo (ZRC). **Sungai Buloh** – 5 ex., 18 Nov.1990, coll. H. K. Lua (ZRC); 1 ex., 19 Dec.1990, coll. K. L. Yeo (ZRC).

Distribution. – Southern Iran, Nepal, Oriental Region, Northern Australia and Japan (Schödl, 1993; Hansen, 1999). **Singapore!**

Ecology. – A lentic species which occurs in shallow and exposed ponds, slow-flowing streams and ditches. In Sri Lanka, Japan and Indonesia [Bali] *B. pulchellus* was collected in paddy fields (Yano et al., 1983a; Balke & Hendrich pers. observ.).

***Regimbartia attenuata* (Fabricius, 1801)**

Hydrophilus attenuatus Fabricius, 1801: 253.

Regimbartia attenuata (Fabricius) - Zaitzev, 1908: 362; d'Orchymont, 1913: 4; 1932: 709; 1941: 7; Knisch, 1924b: 276; Fernando, 1964: 87; Yano et al., 1983a: 21; Hansen, 1999: 97 and references therein.

Material examined. – 1 specimen – **Other areas** - 1 ex., Lorong Banir "K" stream, 10 Jun.1994, NS 157 E, coll. K.C. Queck et al. (ZRC).

Distribution. – India, Sri Lanka, Myanmar, Thailand, Cambodia, Vietnam, Peninsular Malaysia, Indonesia [Sumatra, Java, Sumbawa, Sunda], Philippines, Japan, Australia and New Guinea (d'Orchymont, 1913, 1932 & 1941; Hansen, 1999). **Singapore!**

Ecology. – A lentic species living in muddy water at the edge of more permanent water bodies such as ponds, pools, slow-flowing streams and ditches. The species was also collected in artificial habitats such as paddy fields (Yano et al., 1983a). In general the habitat is rich in rotten leaves and wood.

***Allocotocerus muelleri* (Kirsch, 1875)**

Globaria mülleri Kirsch, 1875: 27; Knisch, 1924: 277; d'Orchymont, 1939: 9.

Allocotocerus muelleri (Kirsch, 1875) - Balke et al., 1999: 325; Hansen, 1999: 99, and references therein.

Material examined. – 16 specimens – **Central catchment area** – 1 ex., MacRitchie Reservoir, 21 Apr.1994, NS 124c, coll. C. M. Yang et al. (ZRC); 4 ex., MacRitchie Reservoir, 24 Apr.1997, coll. M. Balke & L. Hendrich (CBH, ZRC); 5 ex., Nee Soon Swamp Forest, 21 Apr.1997, coll. M. Balke & L. Hendrich (CBH). **Other areas** - 2 ex., Lorong Banir, pond 2, 16 Jun.1995, NS 191, coll. H. K. Lua et al. (ZRC); 4 ex., Lorong Banir, pond 1, 29 Jun.1995, NS 193, coll. H. K. Lua et al. (ZRC).

Distribution. – Malaysia Peninsula, Indonesia [Sumatra] (Kirsch, 1875; d'Orchymont, 1939; Hansen, 1999) and Singapore (Balke et al., 1999).

Ecology. – A lentic species living in shallow, muddy water at the edge of ponds, pools, puddles, slow-flowing streams and ditches. In general the habitat must be rich in rotten leaves and plant debris. It is sometimes found in small puddles fed by helocrenes or small streams.

TRIBE CHAETARTHRIINI

***Chaetarthria indica* d'Orchymont, 1920**

Chaetarthria indica d'Orchymont, 1920: 19.

Chaetarthria almorana Knisch, 1924a: 39.

Chaetarthria indica d'Orchymont - Knisch, 1924b: 224; 1926: 383, 1932: 688; Hebauer, 1995a: 8; Hansen, 1999: 102, and references therein.

Material examined. – 1 specimen – **Central catchment area** - 1 ex., Chestnut Drive "Va" stream, 23 Jun.1994, NS 165A, coll. C. M. Yang (ZRC).

Distribution. – India, Nepal, Southern China, Thailand, West Malaysia, Indonesia [Sumatra, Java, Kalimantan], Philippines (d'Orchymont, 1932; Hebauer, 1995a; Hansen, 1999). **Singapore !**

Ecology. – The specimens from North Sumatra [Lake Toba area (RINSB)] were collected in a swampy area fed by small helocrenes. The Singapore specimen was found among packs of rotten leaves at the edge of a slow-flowing, shaded stream.

***Chaetarthria saundersi* d'Orchymont, 1923**

Chaetarthria saundersi d'Orchymont, 1923a: 420-421; Hebauer, 1995a: 9; Hansen, 1999: 104, and references therein.

Material known. – 2 specimens - 2 ex., "Spore" – "Singapore, Medan, 4 Sep.1921, J.B. Corporaal" (IRSNB) (Hebauer, 1995a). Not seen.

Distribution. – Nepal, Bangla Desh, Vietnam, Thailand, West Malaysia, Singapore (d'Orchymont, 1923a; Hebauer, 1995a).

Ecology. – Unknown.

Remarks. – The lectotype designation of Hebauer (1995a) is invalid, because the selected specimen is not identical with the one originally designated as “Type” (= holotype) (Hansen, 1999). The specimens in IRSNB were mislabeled so it is not clear whether the type locality is Singapore or Sumatra (Medan).

***Amphiops mater sumatrensis* Régimbart, 1903**
(Fig. 28)

Amphiops mater Sharp, 1873: 62; Balfour-Browne, 1937: 304-306; Yano et al., 1983a: 19; Balke et al., 1999: 325; Hebauer et al., 1999: 346.

Amphiops sumatrensis Régimbart, 1903b: 61.

Amphiops mater sumatrensis Régimbart - Balfour-Browne, 1939c: 304; Hansen, 1999: 107, and references therein.

Amphiops sp.: Yang, 1991: 94.

Material examined. – 205 specimens – **Central catchment area** – 9 ex., Chestnut Drive, 27 May.1994, NS143c (ZRC); 1 ex., Chestnut Drive, 26 May.1994, NS 142e (ZRC); 1 ex., MacRitchie Reservoir, Sime Road, 8 Apr.1997, coll. C. M. Yang et al. (ZRC); 4 ex., MacRitchie Reservoir, stream towards reservoir, 20 Apr.1994, NS 123B/G, coll. C. M. Yang et al. (ZRC); 1 ex., Nee Soon Swamp Forest n. pump house, 6 Dec.1996, coll. L. Hendrich (ZRC); 1 ex., Lower Peirce Reservoir, after the concrete water runoff, 22 Apr.1997, NS 230a, coll. H. K. Lua (ZRC); 3 ex., MacRitchie Reservoir, “Cc” inlet, 7 Jun.1994, NS 153, coll. Y.H. Lim (ZRC); 1 ex., Seletar Reservoir Park, 12 May.1994, NS 132C, coll. H. K. Lua et al. (ZRC); 1 ex., Seletar Reservoir, bank, “J” inlet, 16 May.1994, NS 134a, ZRC 6.18479, coll. H. K. Lua (ZRC). **Sungai Buloh** – 1 ex., fish pond, 15 Nov.1990, ZRC staff coll. (ZRC); 23 ex., pond, 5 Dec.1996, coll. L. Hendrich (CBH). **Other areas** – 1 ex., Ulu Sembawang Road, 17 May.1994, NS 135 (ZRC); 2 ex., Lorong Banir “K” stream, 10 Jun.1994, NS 157 E, coll. K.C. Queck et al. (ZRC); 2 ex., Lorong Banir, pond 2, 16 Jun.1995, NS 191, coll. H. K. Lua et al. (ZRC); 5 ex., Jalan Kayu, along muddy bank of fish ponds, 7 Jun.1994, LHK 257, coll. Y.H. Lim (ZRC); 10 ex., Bukit Batok Nature Park, former granite quarry pond, 18 Dec.1995, LHK 293, coll. H. K. Lua & S.L. Goh (ZRC); 1 ex., Bukit Batok Nature Park, former granite quarry pond, 9 Jul.1995, LHK 282, coll. H. K. Lua (ZRC); 2 ex., Bukit Batok Nature Park, pond 2, 23 Apr.1997, coll. M. Balke, L. Hendrich & H. K. Lua (CBH); 1 ex., Warwick Road, 13 Nov.1998, coll. K.L. Yeo (ZRC); 78 ex., fish pond near Kranji Reservoir, 10 & 12 Oct.1990, coll. C. M. Yang et al. (ZRC); 55 ex., Kampong Java Park, 6 Apr.1990, Y12-1, coll. C. M. Yang & H. K. Lua (ZRC).

Distribution. – Indonesia [Sumatra] and West Malaysia (Balfour-Browne, 1939c; Hebauer et al., 1999; Hansen, 1999). **Singapore!**

Ecology. – A very common species which inhabits very shallow water at the edge of weedy ponds, pools, puddles, slow-flowing streams, ditches and paddy fields (Yano et al., 1983a). It is sometimes found in small puddles fed by helocrenes or small streams. The beetles crawl among packs of rotten leaves, plant debris and mud (Hebauer et al., 1999).

TRIBE ANACAENINI

***Paracymus atomus* (d’Orchymont 1926)**

Paracymus punctillatus atomus d’Orchymont, 1926: 378.

Paracymus atomus (d’Orchymont) - Wooldridge, 1977: 127; Hansen, 1999: 109, and references therein.

Material examined. – 4 specimens – **Central catchment area** - 1 ex., Nee Soon Swamp Forest, 21 Apr.1997, coll. M. Balke & L. Hendrich (CBH). **Bukit Timah** - 2 ex., swamp near pond, 9 Apr.1997, coll. M. Balke & L. Hendrich (CBH, ZRC). **Other areas** - 1 ex., Bukit Batok Nature Park, large quarry, 23 Apr.1997, coll. M. Balke, L. Hendrich & H. K. Lua (ZRC).

Distribution. – Laos, Malaysia [Sabah], Philippines (Wooldridge, 1977; Hansen, 1999). First record for the Malaysian Peninsula and **Singapore!**

Ecology. – A lentic species living in very shallow water at the edge of small, exposed, and well-vegetated pools, puddles and slow-flowing streams and ditches mainly in or nearby forested areas. The puddles in Bukit Timah Reserve were fed by small helocrenes.

***Paracymus diligens* Wooldridge, 1977**

Paracymus diligens Wooldridge, 1977: 122; Hansen, 1999: 110, and references therein.

Material known. – 1 ex., Singapore, Saunders coll. (RINSB) (Wooldridge, 1977). Not seen.

Distribution. – Singapore (Wooldridge, 1977; Hansen, 1999).

Ecology. – Probably a lentic species. The type material was collected under lighted conditions (Wooldridge, 1977).

Remarks. – Singapore is the type locality of this species.

***Paracymus evanescens* Sharp, 1890**

Paracymus evanescens Sharp, 1890: 349; Knisch, 1924b: 166; d’Orchymont, 1927: 246-259; Fernando, 1961: 23; 1964: 87; Wooldridge, 1977: 126; Balke et al., 1999: 326; Hansen, 1999: 110, and references therein.

Material examined. – 37 specimens – **Central catchment area** - 2 ex., Chestnut Drive, Seletar Forest, 9 Jun.1994, NS 156, coll. H. K. Lua et al. (ZRC); 2 ex., Nee Soon Swamp Forest, 9 May.1992, Y 794D, coll. K. L. Yeo (ZRC). **Bukit Timah** - 6 ex., Bukit Timah Nature Reserve, 6 Dec.1995, NS 206, coll. T. Wong & H. K. Lua (CBH, ZRC); 16 ex., Bukit Timah Nature Reserve, 13 Dec.1995, NS 214, coll. T. Wong & H. K. Lua (CBH, ZRC); 10 ex., Bukit Timah Nature Reserve, swamp near fishpond, 9 Apr.1997, coll. M. Balke & L. Hendrich (CBH, NMW, ZRC). **Other areas** - 1 ex., Bukit Batok Nature Park, former granite quarry pond, 18 Nov.1995, LHK 293, coll. H. K. Lua & Goh S.L. (ZRC).

Distribution. – Sri Lanka (Wooldridge, 1977; Hansen, 1999), West Malaysia (Fernando, 1964), Singapore (Balke et al., 1999).

Ecology. – A lentic species living in very shallow water at the edge of small, exposed, and well-vegetated pools, puddles and slow-flowing streams and ditches mainly in or nearby forested areas. The puddles in Bukit Timah Reserve were

fed by small helocrenes. The species has been recorded under lighted conditions (d'Orchymont, 1927; Fernando, 1961).

Paracymus orientalis d'Orchymont, 1925

Paracymus evanescens orientalis d'Orchymont, 1925b: 201; 1926: 377.

Paracymus orientalis d'Orchymont - Wooldridge, 1975: 20; 1977: 124; Hansen, 1999: 112, and references therein.

Material examined. – 1 specimen – **Other areas** - 1 ex., Botanic Gardens, NIE Ecology Pond, 22 Apr.1997, NS 229, coll. C. M. Yang (ZRC).

Distribution. – Vietnam, Indonesia [Bali], Philippines, China, Japan (d'Orchymont, 1925b, 1926; Hansen, 1999), First record for the Malaysian Peninsula and **Singapore!**

Ecology. – A lentic species. The only record from Singapore is from an exposed, permanent and artificial pond in Botanic Gardens. The species was collected in shallow water among packs of rotten *Nymphaea* leaves and mats of green algae.

Paracymus pusillus Wooldridge, 1977

Paracymus pusillus Wooldridge, 1977: 124; Hansen, 1999: 112, and references therein.

Material examined. – 7 specimens - **Bukit Timah** - 7 ex., swampy meadow near pond, 9 Apr.1997, coll. M. Balke, L. Hendrich & H. K. Lua (CBH, ZRC).

Distribution. – West Malaysia (Wooldridge 1977; Hansen, 1999), **Singapore!**

Ecology. – A rare species which is restricted to the Bukit Timah Nature Reserve. *Paracymus pusillus* is a lentic species, which occurs in very shallow water, at the edge of small, exposed well-vegetated pools and puddles fed by small helocrenes.

TRIBE HYDROPHILINI

Chasmogenus abnormalis (Sharp, 1890)

Philydrus abnormalis Sharp, 1890: 351.

Helochaeres abnormalis (Sharp, 1890) - Fernando, 1961: 23; 1964: 87.

Chasmogenus abnormalis (Sharp, 1890) - Hebauer, 1992: 68; Hansen, 1999: 174, and references therein.

Material examined. – 5 specimens – **Central catchment area** - 1 ex., Nee Soon Swamp Forest, Fluorescent Light trap, 1930 – 2130 hrs., 22 May.1992 (ZRC); 2 ex., Lower Pierce Forest, H.R. Light trap, 2130-2330 hrs., 4 Jun.1992 (ZRC); 2 ex., Lower Peirce Reservoir, after the concrete water runoff, 22 Apr.1997, 230a, coll. H. K. Lua (ZRC).

Distribution. – The most widespread species of the genus in the Oriental region. Sri Lanka, Thailand, Vietnam, Cambodia, West Malaysia, Indonesia [Java, Sumatra, Sulawesi,

Kalimantan], Philippines [Luzon], Taiwan and Japan (Hebauer, 1992; Hansen, 1999). **Singapore!**

Ecology. – Some of our specimens were collected under lighted conditions. Like other species of the genus (Hendrich pers. observ.) it is most probably a lentic species, living in very shallow water at the edge of semi-shaded forest pools and puddles. The species has already been recorded from a light trap (Fernando, 1961).

Enochrus esuriens (Walker, 1858)

Philhydrus esuriens Walker, 1858: 209.

Philhydrus esuriens Sharp, 1890: 350; Régimbart, 1903b: 56; Knisch, 1924b: 208.

Pylophilus nigriceps Motschulsky, 1859: 46; Knisch, 1924b: 208.

Enochrus esuriens (Walker) - Knisch, 1924b: 208; d'Orchymont, 1927: 250; 1932: 688; Fernando, 1961: 19, 23; 1964: 87; Yano et al., 1983a: 20; Hebauer, 1995b: 10; Balke et al., 1999: 325; Hansen, 1999: 181, and references therein.

Material examined. – 119 specimens - **Central Catchment Area** – 3 ex., Nee Soon Swamp Forest, 6 Apr.1992, Y 794D (ZRC); 1 ex., Nee soon Swamp Forest, NS 22, 17 Jun.1992 (ZRC); 12 ex., Nee Soon Swamp Forest, blacklight, 22 Apr.1997, coll. M. Balke & L. Hendrich (CBH, ZRC); 3 ex., Lower Peirce Reservoir, after the concrete water runoff, 22 Apr.1997, NS 230a, coll. H. K. Lua (ZRC); 2 ex., MacRitchie Reservoir, "Cc" inlet, 7 Jun.1994, NS 153, coll. Y.H. Lim (ZRC); 4 ex., MacRitchie Reservoir, temporary pool, 13 Apr.1993, ZRC.6.18149, coll. C. M. Yang (ZRC); 5 ex., Seletar Reservoir, bank, "J" inlet, 16 May.1994, ZRC.6.18479, coll. H. K. Lua (ZRC); 7 ex., Seletar Reservoir, 16 May.1994, NS 134 A, coll. H. K. Lua et al. (ZRC); 2 ex., Lower Peirce bank, nr. "J" stream, 9 May.1995, NS 179, coll. H. K. Lua (ZRC). **Bukit Timah** – 11 ex., Bukit Timah N.R., C.F. Lim coll. (ZRC); 1 ex., Simpang Hut, 13 Dec.1989, coll. Y.H. Koo (ZRC); 2 ex., Nature Reserve, 6 Dec.1995, NS 206, coll. T. Wong & H. K. Lua (CBH, ZRC); 4 ex., Nature Reserve, small stream near entrance, 9 Apr.1997, coll. M. Balke & L. Hendrich (CBH, NMW, ZRC); 52 ex., Nature Reserve, swamp near pond, 9 Apr.1997, coll. M. Balke & L. Hendrich (CBH, NMW, ZRC). **Sungai Buloh** – 2 ex., fish pond, 15 Nov.1990, coll. ZRC staff (ZRC). **Pulau Ubin** – 1 ex., Y35, 12 Nov.1990, coll. K. Lim (ZRC). **Other areas** – 4 ex., Science center, ecogarden pond, 4 Dec.1990, coll. K. L. Yeo (ZRC); 1 ex., Lorong Banir, "K" stream, 16 Jun. 1994, NS 160B, coll. K. Lim (ZRC); 2 ex., Botanic Gardens, NIE Ecology pond, 22 Apr.1997, NS 227, coll. H. K. Lua (ZRC); 1 ex., Lorong Banir, pond 2, 16 Jun.1995, NS 191, coll. H. K. Lua et al. (ZRC); 1 ex., Bukit Batok Nature Park, artificial pond 2, 23 Apr.1997, coll. M. Balke & L. Hendrich (CBH).

Distribution. – Widespread the Oriental and Australasian realms. From India, Thailand, Vietnam, West Malaysia, Indonesia, New Guinea, Australia and Fiji (Hebauer, 1995b; Hansen, 1999), Singapore (Balke et al., 1999).

Ecology. – One of the most common species of the family in Southeast Asia and often attracted to light. Its flight is often associated with heavy rains and colonises a wide variety of habitats (Fernando, 1961; Yano et al., 1983a). It is mainly a lentic species living in very shallow water at the edge of small, exposed and weedy pools, puddles and slow flowing streams and ditches.

***Enochrus flavicans* Régimbart, 1903**

Philhydrus flavicans Régimbart, 1903b: 56.

Enochrus (Lumetus) flavicans (Régimbart) - Zaitzev, 1908: 386.

Enochrus (Methydrus) flavicans (Régimbart) - d'Orchymont, 1923b: 9; Hansen, 1999: 182, and references therein.

Material examined. – 1 specimen – **Sungai Buloh** – 1 ex., fish pond, 13 Nov.1990, coll. ZRC staff (ZRC).

Distribution. – India, China, Taiwan, West Malaysia and Vietnam (Hansen, 1999). **Singapore!**

Ecology. – A lentic species living in very shallow water at the edge of small, exposed and weedy pools, puddles and slow-flowing streams and ditches. It is also found in paddy fields in other parts of Southeast Asia (Yano et al., 1983a).

***Enochrus gaggermeieri* Hebauer, 1995**

Enochrus gaggermeieri Hebauer, 1995b: 10; Balke et al., 1999: 325; Hansen, 1999: 182, and references therein.

Material examined. – 18 specimens - **Central Catchment Area** – 2 ex., Chestnut Drive, 10 Apr.1994, 130B (ZRC); 1 ex., MacRitchie Reservoir, plot 12/13, 9 Oct.1993, ZRC 6.15149, coll. H. K. Lua (ZRC); 2 ex., Nee Soon Swamp Forest, 6 Dec.1996, coll. L. Hendrich (CBH); 1 ex., Sime Road, at black light, 27 Oct.1989, coll. Y.H. Koo (ZRC); 1 ex., Lower Peirce Reservoir, after the concrete water runoff, 22 Apr.1997, 230a, coll. H. K. Lua (ZRC). **Bukit Timah** - 6 ex., Nature Reserve, 6 Dec.1995, NS 206, coll. T. Wong & H. K. Lua (CBH, ZRC); 6 ex., Nature Reserve, 13 Dec.1995, NS 214, coll. T. Wong & H. K. Lua (CBH, ZRC).

Distribution. – Borneo (Hebauer, 1995b; Hansen, 1999) and Singapore (Balke et al., 1999).

Ecology. – A lentic species living in very shallow water at the edge of small, exposed, and well-vegetated pools, puddles and slow-flowing streams and ditches, mainly in or nearby forested areas. The puddles in Bukit Timah Reserve were fed by small helocrenes.

***Enochrus icterus* Knisch, 1924**

Enochrus icterus Knisch, 1924a: 38; Hebauer, 1995b: 10; Hansen, 1999: 182, and references therein.

Material examined. – 1 specimen – **Central catchment area** - 1 ex., MacRitchie Reservoir, stream near plot 13, 3 May.1993, NS 68, coll. C.Y. Chang (ZRC).

Distribution. – India [Uttar Pradesh] (Knisch, 1924a); West Malaysia (Hebauer, 1995b; Hansen, 1999). **Singapore!**

Ecology. – See *Enochrus gaggermeieri*.

Remarks. – The specimens from West Malaysia mentioned by Hebauer (1995b) probably belong to an undescribed species (Schödl, in litt.).

***Helochaes anchoralis* Sharp, 1890**

Helochaes anchoralis Sharp, 1890: 352; d'Orchymont, 1927: 249; Fernando, 1961: 23; 1964: 87; Hebauer, 1995b: 4; Hansen, 1999: 164, and references therein.

Material examined. – 2 specimens - **Sungai Buloh** – 1 ex., mud pool, 15 Nov.1990, coll. ZRC staff (ZRC). **Pulau Ubin** – 1 ex., 12 Nov.1990, ZRC.6.15657, coll. K. Lim (ZRC).

Distribution. – India, Sri Lanka, Bangladesh, Thailand, West Malaysia, Indonesia [Sumatra, Bali] Cambodia, Laos, China, Taiwan, Philippines and Japan (Hebauer, 1995b; Hansen, 1999). **Singapore!**

Ecology. – A lentic species living in very shallow water at the edge of exposed, well-vegetated ponds, pools, puddles and slow-flowing streams and ditches, in primary and cultivated areas very often in temporary habitats. The species is attracted to light and colonise a wide variety of habitats (Fernando, 1961).

***Helochaes lentus* Sharp, 1890**

Helochaes lentus Sharp, 1890: 352; Knisch, 1924b: 193; d'Orchymont, 1927: 248; 1932: 688; Hebauer, 1995b: 5; Balke et al., 1999: 325; Hansen, 1999: 168, and references therein.

Material examined. – 29 specimens - **Bukit Timah** – 2 ex., Bukit Timah N.R., coll. C.F. Lim (ZRC); 3 ex., 13 Dec.1995, NS 214, coll. T. Wong & H. K. Lua (CBH, ZRC); 1 ex., 4 Dec.1995, ZRC.6.18595, coll. H. K. Lua et al. (ZRC); 5 ex., swamp near fishpond, 9 Apr.1997, coll. M. Balke & L. Hendrich (CBH, NMW, ZRC). **Central catchment area** – 2 ex., Sime Road, at black light, 27 Oct.1989, coll. YH. Koo (ZRC); 1 ex., Rifle Range Road, "J" stream, 27 May.1993, NS 102, coll. C. M. Yang et al. (ZRC); 1 ex., Chestnut Drive, Seletar Forest, 9 Jun.1994, NS 156, coll. H. K. Lua et al. (ZRC); 1 ex., Lower Pierce Forest, H.R. Light trap, 21:30-23:30 hrs., 4 Jun.1992, NS 18 (ZRC); 1 ex., Lower Pierce bank, nr. "J" stream, 9 May.1995, NS 179, coll. H. K. Lua (ZRC); 3 ex., Lower Peirce Reservoir, after the concrete water runoff, 22 Apr.1997, 230a, coll. H. K. Lua (ZRC); 1 ex., Seletar Reservoir Park, 12 May.1994, NS 132C, coll. H. K. Lua et al. (ZRC); 2 ex., Nee Soon Swamp Forest, 6 Dec.1996, coll. L. Hendrich (CBH); 1 ex., Nee Soon Swamp Forest, 21 Apr.1997, coll. M. Balke & L. Hendrich (ZRC); 1 ex., Nee Soon Swamp Forest, blacklight, 22 Apr.1997, coll. M. Balke & L. Hendrich (ZRC); 2 ex., MacRitchie Reserve, near Sime Road, 24 Apr.1997, coll. M. Balke, L. Hendrich & C. M. Yang (ZRC). **Other areas** - 1 ex., Lorong Banir, pond 1, 28 Apr.1997, coll. M. Balke, L. Hendrich & C. M. Yang (ZRC); 1 ex., Botanical Garden, small artificial concrete pool, 22 Apr.1997, coll. M. Balke, L. Hendrich & C. M. Yang (ZRC).

Distribution. – India, Bangladesh, China [Tibet], Taiwan, Thailand, Cambodia, West Malaysia, Indonesia: Kalimantan, Sumatra, Java, Bali, Lombok (d'Orchymont, 1927 & 1932; Hebauer, 1995b; Hansen, 1999) and Singapore (Balke et al., 1999).

Ecology. – A lentic species living in very shallow water at the edge of exposed, well-vegetated ponds, pools, puddles and slow-flowing streams and ditches, in primary and cultivated areas, very often in temporary habitats. The species is also attracted to light.

Helochaeres minor d'Orchymont, 1925

Helochaeres minor d'Orchymont, 1925a: 293; Hansen, 1999: 169, and references therein.

Material examined. – 17 specimens - **Bukit Timah** – 1 ex., Bukit Timah N.R., 2 Apr.1997, NS 224, coll. H. K. Lua (ZRC). **Central catchment area** – 2 ex., Nee Soon Swamp Forest, 16 Apr.1992, Y 790, coll. H. K. Lua (ZRC); 2 ex., near Nee Soon Swamp Forest, blacklight, 22 Apr.1997, coll. M. Balke, L. Hendrich & H. K. Lua (CBH, ZRC). **Other areas** - 2 ex., Bukit Batok Nature Park, pond 2, 23 Apr.1997, coll. M. Balke, L. Hendrich & H. K. Lua (CBH, ZRC); 1 ex., Bukit Batok Nature Park, large quarry, 23 Apr.1997, coll. M. Balke, L. Hendrich & H. K. Lua (CBH); 2 ex., Lorong Banir, pond 1, 29 Jun.1995, NS 193, coll. H. K. Lua et al. (ZRC); 7 ex., Lorong Banir, pond 2, 16 Jun.1995, NS 191, coll. H. K. Lua et al. (ZRC).

Distribution. – India, Vietnam (d'Orchymont, 1925a; Hansen, 1999). First record for the Malaysia Peninsula and **Singapore!**

Ecology. – A lentic species living in very shallow water at the edge of exposed, well-vegetated, mostly temporary pools, puddles and slow-flowing ditches, in primary and cultivated areas. It is also attracted to light.

Helochaeres nebridius d'Orchymont, 1940

Helochaeres nebridius d'Orchymont, 1940: 157; Hebauer, 1995b: 5; Hansen, 1999: 169, and references therein.

Material known. – Number ? – “Singapore, BIRO'1898”, (Hebauer, 1995b). Not seen.

Distribution. – Singapore; Indonesia [Sumatra, Java, Bali and Lombok] (Hebauer, 1995b; Hansen, 1999).

Ecology. – Unknown. Probably a lentic species living in shallow, weedy puddles and pools.

Helochaeres neglectus (Hope, 1845)

Hydrobius neglectus Hope, 1845: 16.

Helochaeres neglectus (Hope, 1845) - Hebauer, 1995b: 6; Hansen, 1999: 170, and references therein.

Material examined. – 2 specimens – **Central catchment area** – 1 ex., Nee Soon Swamp Forest, H.R. Light Trap, 19:30-21:30 hrs., 17 Jun.1992, NS 22, coll. ZRC staff (ZRC). **Sungai Buloh** – 1 ex., muddy pool 2, 4 Dec.1990, coll. C. M. Yang & K. L. Yeo (ZRC).

Distribution. – China, Cambodia, Vietnam, Thailand, West Malaysia (Hebauer, 1995b; Hansen, 1999). **Singapore!**

Ecology. – A lentic species living in very shallow water at the edge of exposed, well-vegetated, mostly temporary pools, puddles and slow-flowing ditches, in primary and cultivated areas. It is also attracted to light.

Helochaeres pallens (MacLeay, 1825) (Fig. 29)

Enhydrus pallens MacLeay, 1825: 140.
Helochaeres lewisius Sharp, 1873: 60.

Helochaeres dispar Sharp, 1903: 7.

Enochrus pallens (MacLeay, 1825) - Knisch, 1924b: 211.

Helochaeres pallens (MacLeay, 1825) - d'Orchymont, 1932: 688; Fernando, 1961: 23; 1964: 82, 86; Yano et al., 1983a: 20; Hebauer, 1995b: 7; Hansen, 1999: 162, and references therein.

Material examined. – 3 specimens – **Sungai Buloh** – 2 ex., fish pond, 15 Nov.1990, coll. ZRC staff (ZRC). **Other areas** - 1 ex., Lorong Banir, Pond 2, 16 Jun.1995, 191, coll. H. K. Lua et al. (ZRC).

Distribution. – Widespread in the Afrotropical, Oriental and Australasian realms (d'Orchymont, 1932; Hebauer, 1995b; Hansen, 1999). **Singapore!**

Ecology. – A lentic species living in very shallow water at the edge of exposed, well-vegetated, mostly temporary pools, puddles and slow-flowing ditches, in primary and cultivated areas. In other parts of Southeast Asia the species was also collected in paddy fields (Yano et al., 1983a). The species has been recorded at light (d'Orchymont, 1927; Fernando, 1961)

Helochaeres taprobanicus Sharp, 1890

Helochaeres taprobanicus Sharp, 1890: 351.

Helochaeres atro-piceus Régimbart, 1903b: 53; Hebauer, 1995b: 8.
Helochaeres taprobanicus Sharp - Knisch, 1924b: 199; d'Orchymont, 1932: 690; Fernando, 1961: 23; Hebauer, 1995b: 8; Hansen, 1999: 163, and references therein.

Material examined. – 8 specimens – **Central catchment area** - 1 ex., Nee Soon Swamp Forest, 21 Apr.1997, coll. M. Balke & L. Hendrich (ZRC); 1 ex., Nee Soon Swamp Forest, at blacklight, 22 Apr.1997, coll. M. Balke & L. Hendrich (ZRC). **Sungai Buloh** - 1 ex., pond, 5 Dec.1996, coll. L. Hendrich (ZRC). **Pulau Ubin** – 2 ex., pond near Kampung Bahru, 28 May.1997, #y905c, coll. K. L. Yeo et al. (ZRC). **Other areas** – 1 ex., Lorong Banir, “K” stream, 24 May.1994, coll. K.C. Quek et al. (ZRC); 1 ex., Lorong Banir, pond 2, 16 Jun.1995, NS 191, coll. H. K. Lua et al. (ZRC); 1 ex., Lorong Banir, pond 1, 28 Apr.1997, coll. M. Balke, L. Hendrich & C. M. Yang (ZRC).

Distribution. – Sri Lanka, Bangladesh, Vietnam, Cambodia, Thailand, West Malaysia, Indonesia [Sumatra, Java, Kalimantan] and New Guinea (Hebauer, 1995b; Hansen, 1999). **Singapore!**

Ecology. – A lentic species living in very shallow water at the edge of half-shaded pools, puddles and slow-flowing streams and ditches mainly in or nearby forested areas. The population density of the species seems to be very low and it is difficult to collect larger amounts of specimens in a habitat. The beetles crawl deep among packs of rotten leaves and plant debris. *Helochaeres taprobanicus* has been recorded at light (Fernando, 1961).

Hydrophilus cavisternum (Bedel, 1891) (Fig. 30)

Stethoxus cavisternum Bedel, 1891: 310.

Hydrous cavisternum (Bedel) - Zaitzev, 1908: 364.

Hydrophilus cavisternum (Bedel) - Gentili et al. 1995: 212; Hansen, 1999: 228, and references therein.

Material examined. – 1 specimen – **Other areas** - 1 ex., Confederate Estate, July 1915, “P. de Fontaine Coll.” (ZRC).

Distribution. – China [Hainan] (d’Orchymont, 1935), Laos, Cambodia, Vietnam, Thailand, West Malaysia, Indonesia [Java] (Knisch, 1924b; Hansen, 1999) and New Guinea [Irian Jaya, in coll. Hendrich]. **Singapore!**

Ecology. – The species is living in various types of perennial standing and slow-flowing waters, such as swamps, ponds, paddy fields, fish ponds, shallow lakes and ditches. The habitat must be rich in detritus and submerged vegetation. *Hydrophilus cavisternum* is frequently attracted to light and is one of the most common larger hydrophilids in Southeast Asia.

Remarks. – The species has become extinct in Singapore. In Thailand [Pak Chong, Chaiyaphum and Bangkok] different species of this genus are sold as food throughout the year (Chen et al., 1998; Fritzsche & Gitsaga, 2000).

***Sternolophus rufipes* (Fabricius, 1792)**

Hydrophilus rufipes Fabricius, 1792: 97.

Tropisternus mergus Redtenbacher, 1844: 514; Zaitzev, 1909: 230.

Sternolophus fulvipes Motschulsky, 1853: 45; Knisch, 1924b: 227.

Sternolophus rufipes (Fabricius) - Zaitzev, 1909: 229; Knisch, 1924b: 227; d’Orchymont, 1927: 252, 1932: 707; Fernando, 1964: 87; Gentili et al., 1995: 214; Hendrich & Yang, 1999: 260; Hansen, 1999: 208, and references therein.

Hydrophilus sp.: Yang, 1991: 94.

Material examined. – 26 specimens – **Central catchment area** - 1 ex., Seletar Reservoir, October 1968 (ZRC); 2 ex., Sime Road, 2 Jan. 1969, coll. Koo & Lim (ZRC). **Sungai Buloh** – 23 ex., Sungai Buloh, November and December 1990, coll. C. M. Yang et al. (ZRC).

Distribution. – Widespread and common throughout Southeast Asia. In the Palearctic from Northern India, China, South Korea up to Japan (Gentili et al., 1995; Hansen, 1999). Singapore (as *Hydrophilus* sp. Yang, 1991).

Ecology. – *Sternolophus rufipes* is a lentic species living among wet leaf litter, floating vegetation and roots in all kinds of shallow, stagnant or slow-flowing water. In many Southeast Asian countries the species is often attracted in large numbers to light.

SUBFAMILY SPHAERIDIINAE

TRIBE COELOSTOMATINI

***Coelostoma fallaciosum* d’Orchymont, 1936**

Coelostoma fallaciosum d’Orchymont, 1936: 19; Fernando, 1961: 23; Hansen, 1999: 244, and references therein.

Material examined. – 4 specimens – **Central catchment area** - 1 ex., Chestnut Drive, Seletar Forest, 9 Jun. 1994, NS 156, coll. H. K. Lua et al. (ZRC). **Sungai Buloh** - 3 ex., pond, 5 Dec. 1996, coll. L. Hendrich (CBH).

Distribution. – Indonesia [Sumatra], Malaysia [West Malaysia, Sabah], Brunei, Vietnam, Southern China (d’Orchymont, 1936; Fernando, 1961; Hansen, 1999). **Singapore!**

Ecology. – A lentic species living in very shallow and muddy water at the edge of ponds, pools, puddles, and protected embayments of slow-flowing streams and ditches. In general the habitat must be rich in rotten leaves and plant debris. *Coelostoma fallaciosum* is not commonly attracted by light (Fernando, 1961).

***Coelostoma subditum* d’Orchymont, 1936**

Coelostoma subditum d’Orchymont, 1936: 20; Balke et al., 1999: 325; Hansen, 1999: 247, and references therein.

Material examined. – 3 specimens – **Central catchment area** - 1 ex., Nee Soon Swamp Forest, outflow stream near plot 27, 30 Jun. 1995, NS 194a, coll. H. K. Lua et al. (ZRC). **Other areas** - 2 ex., Lorong Banir, pond 2, 16 Jun. 1995, NS 191, coll. H. K. Lua et al. (ZRC).

Distribution. – Indonesia [Kalimantan], Brunei (d’Orchymont, 1936), Singapore (Balke et al., 1999).

Ecology. – A lentic species living in muddy water at the edge ponds, pools, puddles, slow-flowing streams and ditches. In general the habitat must be rich in rotten leaves and plant debris.

***Coelostoma vitalisi* d’Orchymont, 1923**

Coelostoma Vitalisi d’Orchymont, 1923a: 418; Hansen, 1999: 182, and references therein.

Material known. – Number ? – “Singapore” (Hansen, 1999). Not seen.

Distribution. – India, Sri Lanka, Vietnam, Malaysia [Sabah], Brunei, Indonesia [Sumatra, Java, Kalimantan], Singapore and Southern China (Hansen, 1999).

Ecology. – Probably a lentic species living in muddy water at the edge ponds, pools, puddles, slow-flowing streams and ditches. In general the habitat must be rich in rotten leaves and plant debris.

FAMILY GROUP STAPHYLINOIDEA

FAMILY HYDRAENIDAE

This family has about 1200 described species worldwide. Just a few species have been described from Southeast Asia but

countless species are waiting for description. Hydraenids are small beetles that feed on algae in a variety of aquatic, riparian and littoral habitats, including springs, streams, waterfalls, wet rock faces, ponds and puddles. Outside Southeast Asia this group has also been recorded from marine rock pools, inland salt lakes and seabird nests.

Singapore Hydraenidae cannot be identified with certainty and our assignment to sp.1 – sp.3 is tentative and operational.

Hydraena sp. 1

Hydraena sp. 1 - Balke et al., 1999: 326.

Material examined. – 73 specimens - **Bukit Timah** - 53 ex., Bukit Timah Nature Reserve, 2 Apr.1997, NS 224, coll. H. K. Lua (ZRC); 10 ex., Bukit Timah Nature Reserve, small streamlet in primary forest, 9 Apr.1997, coll. M. Balke & L. Hendrich (CBH); 10 ex., idem, 24 Apr.1997, coll. M. Balke & L. Hendrich (CBH).

Ecology. – A lotic species found in wet leaf litter of a small intermittent stream, shaded by primary forest.

Remarks. – Due the lack of suitable literature all specimens of *Hydraena* have not yet been identified to species level. The specimens from Bukit Timah forest may belong to one or more new species.

Hydraena sp. 2

Hydraena sp. 2 - Balke et al., 1999: 326.

Material examined. – 36 specimens - **Bukit Timah** - 35 ex., swampy meadow near pond, 9 Apr.1997, coll. M. Balke & L. Hendrich (CBH, ZRC). **Other areas** - 1 ex., Botanic Gardens, NIE Ecology Pond, 22 Apr.1997, coll. M. Balke & L. Hendrich (CBH).

Ecology. – A more lentic species found in small exposed, very shallow and weedy puddles (5 cm depth) of clear water situated close to the Bukit Timah forest. Another specimen was collected from a small puddle in Botanic Gardens, NIE Ecology Pond. All specimens were collected among wet leaf litter and mats of submerged grasses.

Remarks. – See *Hydraena* sp. 1.

Hydraena sp. 3

Hydraena sp. 3 - Balke et al., 1999: 326.

Material examined. – 24 specimens - **Central catchment area** – 2 ex., Nee Soon Swamp Forest, 28 Apr.1994, NS 126 E, coll. C. M. Yang (ZRC); 22 ex., Nee Soon Swamp Forest, 16 Apr.1992, Y 790, coll. D. H. Murphy & C. M. Yang (ZRC).

Ecology. – A lotic species found in wet leaf litter of a small stream, situated in the swamp forest of Nee Soon. Four specimens (probably a fourth species!) were collected in a flight intercept trap operated in the same forest. Near the pumphouse in Nee Soon another specimen was collected

among wet leaf litter in a slow-flowing stream, shaded by *Pandanus* and second growth forest.

Remarks. – See *Hydraena* sp. 1.

SHORE BEETLES

FAMILY LIMNICHIDAE

SUBFAMILY CEPHALOBYRRHINAE

The family Limnichidae belongs to the superfamily Dryopoidea (sensu Crowson, 1978) or Byrrhoidea (sensu Lawrence & Newton, 1995). Over 35 genera and more than 220 species of Limnichidae have been described worldwide. Around 40 species are reported from Southeast Asia. Very little is known about the biology and the habitats of limnichids. Larvae and adults of most members of this family inhabit shores of freshwater habitats; some limnichids live in intertidal marine habitats on rocky limestone, mud, or shores of mangroves. Other species have been collected from sugar cane fields, on blossoms or under bark. Adults and larvae feed on algae and moss. Most of the limnichids are capable of flying and many are widely distributed. Some species are attracted to light (Pütz, 1998). The genus *Parathroscinus* Wooldridge (1984) is only known to exist in Southeast Asia. One species is known from the Philippines, one from Burma, and three others from Singapore (Wooldridge, 1990). Almost nothing is known about its biology. All three species from Singapore were collected from the intertidal zone of mangrove and freshwater swamps.

Parathroscinus corrinae Wooldridge, 1990

Parathroscinus corrinae Wooldridge, 1990: 253.

Material examined. – Not seen – **Other areas** - 17 ex., Pasir Ris, 3 Jul.1988, coll. D. H. Murphy (BMNH, USNM); 1 ex., Lim Chu Kang mangrove forest, Site # 1, 18 Jul.1987, coll. D. H. Murphy

Distribution. – Singapore (Wooldridge, 1990).

Ecology. – All specimens were collected at surface of clayey soil in mangroves near extreme high tide level.

Remarks. – Singapore is the type locality of the species. The holotype is deposited in USNM.

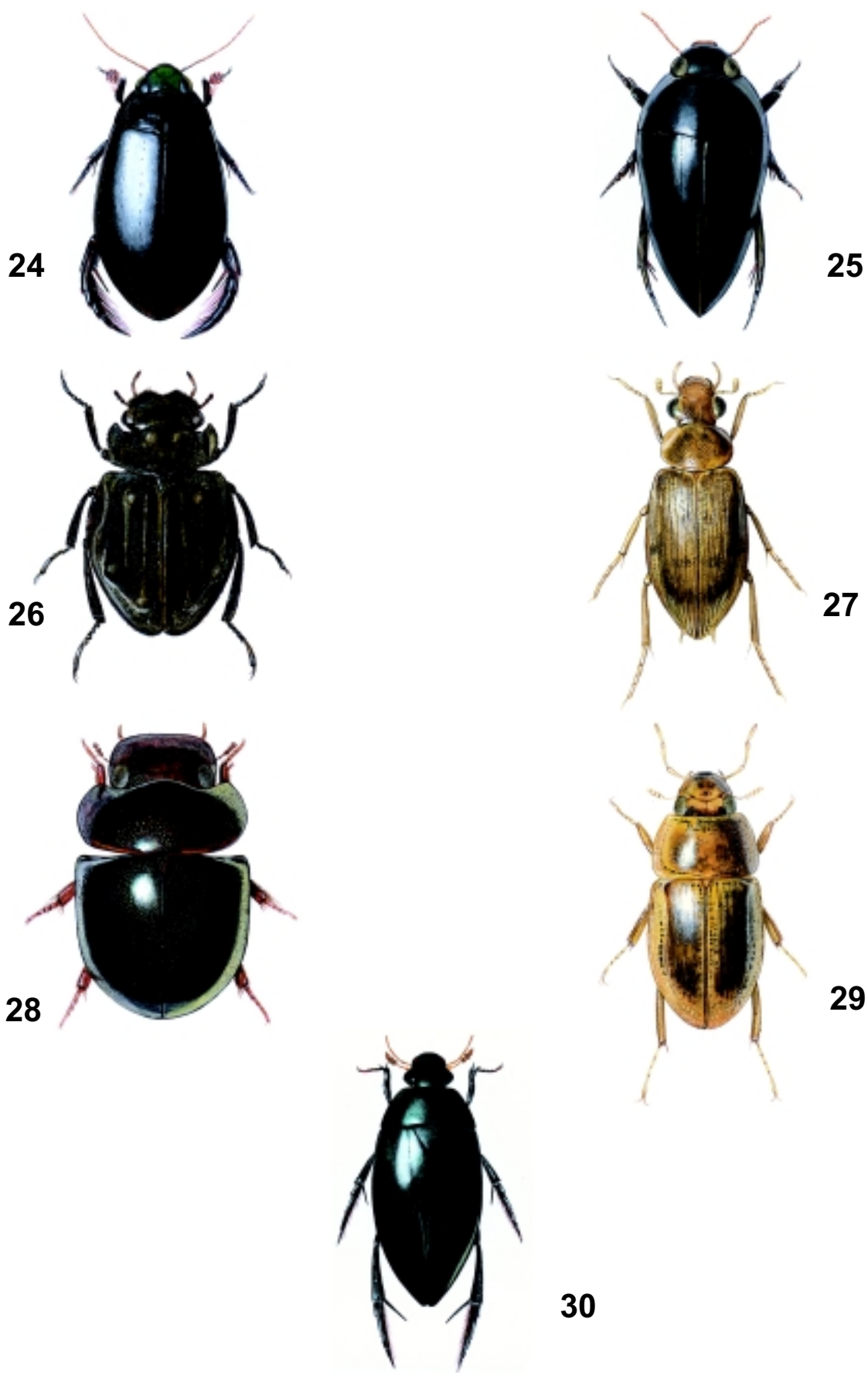
Parathroscinus magnus Wooldridge, 1990

Parathroscinus magnus Wooldridge, 1990: 254.

Material examined. – Not seen – 1 ex., Mandai mangrove, MD3, 11 May.1988, coll. D. H. Murphy (USNM).

Distribution. – Singapore (Wooldridge, 1990).

Ecology. – “Under rotten intertidal wood” (Wooldridge, 1990).



Figs. 24-30. 24. *Cybister sugillatus* Erichsin, 1834 (Fam. Dytiscidae, 22.0 mm); 25 *Hydrocanthus indicus* Wehncke, 1876 (Fam. Noteridae, 4.5 mm); 26. *Spercheus stangli* Schwarz & Barber, 1917 (Fam. Spercheidae, 4.2 mm); 27. *Berosus fairmairei* Zaitzev, 1908 (Fam. Hydrophilidae, 4.5 mm); 28. *Amphiops mater sumatrensis* (Sharp, 1873) (Fam. Hydrophilidae, 3.5 mm); 29. *Helochares pallens* (MacLeay, 1825) (Fam. Hydrophilidae, 3.1 mm); 30. *Hydrophilus cavisternum* Bedel, 1891 (Fam. Hydrophilidae, 32.0 mm).

Remarks. – Just the holotype is known.

***Parathroscinus murphyi* Wooldridge, 1990**

Parathroscinus murphyi Wooldridge, 1990: 252-253.

Material examined. – Not seen - 14 ex., Pasir Ris, 10 Oct.1985, coll. D. H. Murphy (BMNH, USNM); 2 ex., Pasir Ris, 3 Jul.1988, coll. D. H. Murphy (BMNH).

Distribution. – Singapore (Wooldridge, 1990).

Ecology. – All specimens were collected at surface of clayey soil or flying over mud in mangroves near extreme high tide level.

Remarks. – Singapore is the type locality of the species. The holotype is deposited in USNM.

PHYTOPHILOUS WATER BEETLES

FAMILY CHRYSOMELIDAE

SUBFAMILY DONACIINAE

The chrysomelid subfamily Donaciinae consists of a small, specialised group of genera which are all confined to aquatic habitats. The adults of most species feed and mate on the emergent portions of water-plants and the larvae feed on submerged roots and stems. The subfamily is primarily Holarctic, but is represented in the Indo-Malayan and Australasian region by three species of *Donacia* Fabricius, subgenus *Cyphogaster* Goecke (Borowiec, 1984; Reid, 1993). *Donacia javana* Wiedemann is the only species of the genus in the Indo-Malayan region.

***Donacia (Cyphogaster) javana* Wiedemann, 1821**

Donacia javana Wiedemann, 1821: 173; Clavareau, 1913: 22; Goecke, 1935: 286-291; Borowiec, 1984: 448; Reid, 1993: 104. *Donacia* sp. - Yang, 1991: 89.

Material examined. – 5 specimens – **Other areas** - 5 ex., Botanical Garden, lilie pond, 25 Apr.1997, coll. M. Balke. L. Hendrich & C. M. Yang (CBH, ZRC).

Distribution. – South India, Sri Lanka, Myanmar, Thailand, Vietnam, Laos, Malaysia: Peninsular, Sabah and Sarawak; Indonesia: Sumatra, Java, Kalimantan, Sulawesi (Goecke, 1935; Borowiec, 1984).

Ecology. – *Donacia javana* has been collected from water lilies of the genus *Nymphaea* L. (Nymphaeaceae) and *Nymphoides* Séguier (Menyanthaceae). Three other species of the subgenus *Cyphogaster*, [*Donacia lenzi* Schoenfeld, *D. australasiae* Blackburn and *D. provostii* Fairmaire] are also known to feed on *Nymphaea* and other host genera include *Brasenia* Schreber, *Nelumbo* Adanson, *Nuphar* L. and *Potamogeton* (Borowiec, 1984; Reid, 1993).

FAMILY CURCULIONIDAE

SUBFAMILY MOLYTINAE

TRIBE BAGOINI

Most species of the curculionid tribe Bagoini are associated with aquatic or semi-aquatic plants that grow floating on, submerged in, or emergent from water. The adults feed and mate on the emergent portions of water-plants and the larvae feed on submerged leaves and stems. The subfamily has a wide distribution with lots of species in the Asian and Australasian region (O'Brien et al., 1994; Caldara & O'Brien, 1995).

***Bagous* sp.**

Material examined. – 1 specimen - **Central catchment area** - 1 ex., MacRitchie Reservoir, 9 Oct.1993, NS 117 /12,13, ZRC 6.18064, coll. H. K. Lua et al. (ZRC).

Remarks: The Southeast Asian species of the genus are under revision. The single specimen collected in Singapore probably belongs to an undescribed species (O'Brien, in litt.).

***Neochetina eichhorniae* Warner, 1970**

Neochetina eichhorniae Warner, 1970: 487; O'Brien, 1976: 169-170; DeLoach & Cordo, 1976: 643-652; Wright, 1980: 529-535.

Material examined. – 2 specimens – **Other areas** - 2 ex., Lorong Banir, pond 1, 14 Jul.1995, NS 200, coll. H. K. Lua et al. (ZRC).

Distribution. – Argentina, west to the Andes, north to Panama and Trinidad and in southeastern Mexico. Introduced into the United States, Australia (Northern Territories and Queensland) and Southeast Asia as a biological control agent for the control of water hyacinth, *Eichhornia crassipes* (O'Brien, 1976; Wright, 1980). **Singapore !**

Ecology. – All of the six species of the New World genus *Neochetina* are believed to be semi-aquatic and possess specialized aquatic adaptations including hydrofuge hairs and scales. *Neochetina eichhorniae* is known to breed in waterhyacinth, *Eichhornia crassipes* and *E. azurea* (Sw.) Kunth (Warner, 1970). The life cycle and biology of *N. eichhorniae* have been described in detail by DeLoach & Cordo (1976). Adult weevils feed on the leaves and the larvae tunnel into petioles and crowns. Larval tunnelling is usually followed by rotting of the plant tissues and can result in death of the plant. The species is known to be primarily nocturnal in habit and is also attracted by light (O'Brien, 1976).

Remarks. – Water hyacinth *Eichhornia crassipes* Solms is a free-floating aquatic plant that was introduced into the United States, Africa, New Guinea, Australia and many parts of Southeast Asia from its native home in South America (Brazil) as an ornamental plant in garden ponds. In Singapore it was introduced in 1893 from Hong Kong. It has since

reproduced beyond control to become a serious aquatic weed in many countries where it completely covers slow-flowing streams, canals, and small lakes, and blocks the passage of boats. Since mechanical and chemical controls are expensive, pollute the water and require repeated applications, several Neotropical insects, feeding on *Eichhornia*, have been used as biological control agents (DeLoach & Cordo, 1976; Wright, 1980). *Neochetina eichhorniae* was first introduced to Thailand in the 1970's and later spread to Peninsular Malaysia (Wright pers. comm.).

RESULTS AND DISCUSSION

A total of 93 species of water beetles are reported from Singapore. They belong to the following families: Noteridae (9 species), Gyrinidae (9), Dytiscidae (35), Spercheidae (1), Hydrophilidae (30), Hydraenidae (3), Limnichidae (3), Curculionidae (2), and Chrysomelidae (1). In the present study at least 7 species are recorded for the first time from the Malaysian Peninsula, and 30 species are first records from Singapore (Table 1).

Eight species (*Notomicrus tenellus*, *Laccophilus medialis*, *Lacconectus corayi*, *Cybister dehaanii*, *C. sugillatus*, *Helochares nebridius*, *Hydrophilus cavisternum*, *Coelostoma vitalisi*) are believed to be extinct in Singapore. Thirty-three species are tentatively listed as endangered, vulnerable or rare here. Nineteen species can be considered as common. The most common species are: *Canthydrus morsbachii*, *Neohydrocoptus bivittis* and *N. subvittulus* [all Noteridae]; *Hydroglyphus inconstans*, *Leiodytes nicobaricus*, *Hydrovatus rufoniger rufoniger*, *H. sinister*, *H. stridulus* and *Laccophilus siamensis siamensis* [all Dytiscidae]; *Allocotocerus muelleri*, *Amphiops mater sumatrensis*, *Paracymus evanescens*, *Enochrus esuriens*, *Helochares lentus*, *H. minor* and *H. pallens* [all Hydrophilidae]. For at least 37 species the data are deficient (Table 1).

Elmidae and Dryopidae, usually well-represented in other parts of Southeast Asia, but have not been found in this study. Aquatic species of these families usually inhabit permanent, clear, cool and oxygen-rich streams and rivers.

An inventory of water beetles of the surrounding regions is so far not available for making comparisons with the Singapore fauna. However, according to our unpublished data from Indonesia and Malaysia, it appears that Singapore still has a comparably diverse fauna, considering that this is one of the economic hot-spots of Southeast Asia. Because our sampling efforts do not yet represent a complete coverage of Singapore's wetlands, more species are expected to be discovered in future.

ZOOGEOGRAPHY

The distribution of the aquatic beetles in Singapore are presented in Table 1 and Fig. 31. Of the 93 species of water beetles recorded from Singapore, 46 species (50%) are widely

distributed in the Southeast Asian part of the Oriental region. Most of them are typical lowland species. Their presence often spans the Sunda Islands, Peninsular Malaysia, Myanmar, Thailand, up to southern Vietnam. Only a few species are widespread in the whole Oriental region (e.g., *Laccophilus parvulus parvulus*, and most of the Noteridae), some reaching Southern China, Taiwan, Southern Japan, Southern India and Sri Lanka. Twenty-nine species (32%) are so-called Sundaic species that occur in Peninsular Malaysia and the lowlands of Borneo and Sumatra. Six species (6%) are widespread in the Oriental and Australasian realms, and four species (4%) also occur in Africa. The introduced weevil *Neochetina eichhorniae* are cosmopolitan.

We found no evidence for the presence of Palearctic or Australian species. The fauna of Singapore is Oriental.

ECOLOGY

Of the 93 species treated here, 66 species (72%) are restricted to lentic sites in both open and forested areas, while 13 species (14%) are found in lotic habitats; the latter strictly within the reserve areas only. At least 11 species (12%) were found in both lotic and lentic habitats (Fig. 32). All members of Gyrinidae and the Singaporean species of the genus *Microdytes* are rheobionts.

However, in some cases this division is difficult to establish as different habitats often merge into one another, especially after heavy rainfalls. A good example is the dytiscid *Lacconectus krikkeni* that occurs in temporary forest pools. It was also found in shallow water of the small stream in Taban Valley, Bukit Timah nature reserve, where the stream does not flow but form small waterholes and leafpacks where the water actually disappears in the gravelly substrate, terminating the stream.

Of the 93 species, 26 (27%) are restricted to shaded forest habitats (Fig. 33). Most of the species which are now thought to be locally extinct (*Lacconectus corayi*, *Laccophilus medialis*, *Cybister dehaanii* and *C. sugillatus*), and many of the highly specialized and endangered species such as *Copelatus minutissimus*, *Lacconectus krikkeni*, *Microdytes* spp., and *Hydaticus reductus* belong to this group. The majority of species, 36 (40%) were collected in both open and forested sites. Most of these species were found in ecotones such as forest edges and exposed sites inside forested areas. One-third of the species (28 / 31%) were found exclusively in open and exposed water bodies such as pools, puddles, reservoirs, ditches and ponds in parks, gardens (Botanic Gardens) and rural areas. Almost all species belonging to this ecological group are widespread in the Oriental and Australasian realms and are able to colonize artificial habitats as well as natural water bodies (Fernando, 1961, 1964; Yano et al., 1983a, b; Hendrich & Balke, 1995).

Most species (51 species / 55%) were found in more or less permanent habitats such as streams, ponds, pools and freshwater swamps (Fig. 34). From time to time water bodies

Table 1. Checklist of water beetles from Singapore, with data on their distribution, ecology and conservation status: * - first record for Malaysian Peninsular and Singapore; ** - first record for Singapore; **t** - temporary habitats; **p** - permanent habitats; **lo** - lotic species; **ln** - lentic species; ? - unknown; **F** - forested sites; **O** - open sites; **EX** - extinct, **E** - endangered; **VU** - vulnerable; **R** - rare; **C** - common; **DD** - data deficient; **L** - literature and unpublished records; **Afr.** - Afrotropical; **Or.** - Oriental; **East Pal.** - East Palaearctic.

TABLE 1 CHECKLIST OF THE AQUATIC COLEOPTERA OF SINGAPORE		DISTRIBUTION	ECOLOGY	FOREST/OPEN	NATURE RESERVES	OTHER AREAS	SPECIES RECORDED AT LIGHT	STATUS
NOTERIDAE								
** <i>Canthydrus flavus</i> (MOTSCHULSKY, 1856)		Oriental	p/ ln (lo)	O	+	+	-	DD
<i>Canthydrus morsbachi</i> (WEHNCKE, 1876)		Oriental	p/ ln	O	-	+	+	C
<i>Canthydrus proximus</i> SHARP, 1882		Oriental	p/ ln	F/O	-	+	-	DD
<i>Canthydrus ritsemae</i> (RÉGIMBART, 1880)		Oriental	p/ ln	F/O	?	?	L	DD
<i>Hydrocanthus indicus</i> WEHNCKE, 1876		Oriental	p/ ln	F	+	-	-	E
<i>Neohydrocoptus bivittis</i> (MOTSCHULSKY, 1859)		Oriental	p/ ln	F/O	+	+	+	C
<i>Neohydrocoptus frontalis</i> (RÉGIMBART, 1899)		Oriental	p/ ln	F/O	+	-	-	DD
<i>Neohydrocoptus subvittulus</i> (MOTSCHULSKY, 1859)		Oriental	p/ ln (lo)	F/O	+	+	+	C
<i>Notomicrus tenellus</i> (CLARK, 1863)		Or., Austr.	p/ln	F/O	?	?	-	EX
DYTISCIDAE								
** <i>Hydroglyphus inconstans</i> (RÉGIMBART, 1892)		Oriental	p/ t/ ln	O	+	-	-	C
* <i>Hydroglyphus mysorensis</i> (RÉGIMBART, 1903)		Oriental	p/ t/ ln	? (O)	+	-	+	DD
* <i>Leiodytes nicobaricus</i> (REDTENBACHER, 1867)		Oriental	p/ t/ ln	O	+	+	-	C
** <i>Pseuduvarus vitticollis</i> (BOHEMAN, 1848)		Or., Afr.	p/ t/ ln	O	+	-	-	C
* <i>Hydrovatus jaechi</i> BISTRÖM, 1996		Sundaic	p/ ln	F/O	+	-	+	VU
<i>Hydrovatus maai</i> BISTRÖM, 1996		Sundaic	p/ ln	F/O	+	+	-	DD
<i>Hydrovatus pisiformis</i> BISTRÖM, 1996		Sundaic	p/ ln	F	+	-	+	VU
<i>Hydrovatus pudicus</i> (CLARK, 1863)		Oriental	p/ t/ ln	O	+	+	-	DD
<i>Hydrovatus rufoniger rufoniger</i> (CLARK, 1863)		Or., Austr.	p/ ln	F/O	+	+	+	C
<i>Hydrovatus saundersi</i> BISTRÖM, 1996		Sundaic	p/ ln	F	+	-	-	VU
<i>Hydrovatus sinister</i> BISTRÖM, 1996		Oriental	p/ ln	F/O	+	+	-	C
<i>Hydrovatus stridulus</i> BISTRÖM, 1996		Sundaic	p/ ln	F/O	+	+	-	C
<i>Hydrovatus sumatrensis</i> SHARP, 1882		Sundaic	p/ ln	F/O	+	-	L	DD
** <i>Hyphydrus lyratus lyratus</i> SWARTZ, 1808		Or., Austr.	p/ ln	O	-	+	+	DD
<i>Microdytes elgae</i> HENDRICH et al., 1995		Oriental	p/ lo	F	+	-	-	E
<i>Microdytes pasiricus</i> (CSIKI, 1937)		Sundaic	p/ lo	F	+	-	-	E
<i>Laccophilus medialis</i> SHARP, 1882		Oriental	p/ t/ ln	F	?	?	-	EX
<i>Laccophilus parvulus parvulus</i> AUBÉ, 1838		Oriental	p/ t/ ln	O	-	+	L	DD
<i>Laccophilus pulicarius</i> SHARP, 1882		Oriental	p/ ln (lo)	F/O	+	+	-	DD
<i>Laccophilus ritsemae</i> RÉGIMBART, 1880		Oriental	p/ t/ ln	O	+	+	-	DD
** <i>Laccophilus siamensis siamensis</i> SHARP, 1882		Oriental	p/ ln (lo)	F/O	+	+	+	C
<i>Copelatus oblitus</i> SHARP, 1882		Oriental	t/ ln	F/O	+	+	-	R
<i>Copelatus minutissimus</i> BALFOUR-BROWNE, 1939		Sundaic	t/ ln	F	+	-	-	E
** <i>Copelatus tenebrosus</i> RÉGIMBART, 1880		Or., Austr.	p/ t/ ln	O	-	+	L	DD
<i>Lacconectus corayi</i> BRANCUCCI, 1986		Sundaic	p/ t/ ln (lo)	F	?	?	-	EX
<i>Lacconectus krikkeni</i> BRANCUCCI, 1986		Sundaic	p/ t/ ln (lo)	F	+	-	-	VU
** <i>Eretes griseus</i> (FABRICIUS, 1781)		East Pal., Or.	p/ ln	O	-	+	L	DD
<i>Hydaticus bipunctatus conjungens</i> RÉGIMBART, 1899		Sundaic	p/ t/ ln	F/O	+	+	L	R
<i>Hydaticus concolor</i> SHARP, 1882		Sundaic	p/ ln	F	-	+	-	DD
<i>Hydaticus fabricii</i> (MACLEAY, 1825)		Or., Austr.	p/ t/ ln	O	+	+	+	C
<i>Hydaticus reductus</i> RÉGIMBART, 1899		Sundaic	p/ ln	F	+	-	-	E
<i>Cybister dehaani</i> AUBÉ, 1838		Oriental	p/ ln	F	?	?	L	EX
** <i>Cybister rugosus</i> (MACLEAY, 1825)		Oriental	p/ ln	F/O	-	+	L	R
<i>Cybister sugillatus</i> ERICHSON, 1834		Oriental	p/ ln	F/O	?	?	-	EX
** <i>Cybister tripunctatus lateralis</i> (FABRICIUS, 1798)		Afr., Or., Austr.	p/ ln	O	-	+	L	DD
GYRINIDAE								
<i>Orectochilus andamanicus</i> RÉGIMBART, 1883		Oriental	p/ lo	F	+	-	-	R/VU
<i>Orectochilus corniger</i> (undescribed subspecies)		Sundaic	p/ lo	F	+	+	-	C
<i>Orectochilus corporaali</i> PESCHET, 1922		Sundaic	p/ lo	F/O	?	?	-	R/VU
<i>Orectochilus klynstrai</i> OCHS, 1927		Sundaic	p/ lo	F	?	?	-	R/VU
<i>Orectochilus oxygenus</i> RÉGIMBART, 1907		Sundaic	p/ lo	F	+	-	-	C
<i>Orectochilus productus</i> RÉGIMBART, 1883		Oriental	p/ lo	F/O	+	+	-	C
<i>Orectochilus vitalisi smedleyi</i> OCHS, 1929		Sundaic	p/ lo	F	?	?	-	R/VU
<i>Orectochilus spinosus</i> ZIMMERMANN, 1917		Sundaic	p/ lo	F	+	-	-	R/VU
<i>Dineutus spinosus</i> (FABRICIUS, 1781)		Oriental	p/ lo	F	+	-	-	R/VU
SPERCEIDAE								
* <i>Spercheus stangli</i> SCHWARZER & BARBER, 1917		Oriental	p/ ln	O	-	+	-	R

TABLE 1 (cont.)
CHECKLIST OF THE AQUATIC COLEOPTERA OF
SINGAPORE

	DISTRIBUTION	ECOLOGY	FOREST/OPEN	NATURE RESERVES	OTHER AREAS	SPECIES RECORDED AT LIGHT	STATUS
HYDROPHILIDAE							
<i>Alloctocerus muelleri</i> KNISCH, 1875	Sundaic	p/ t/ ln	F/O	+	+	-	C
** <i>Berosus fairmairei</i> ZAITZEV, 1908	East.P, Oriental	t/ ln	O	-	+	-	DD
** <i>Berosus incretus</i> d'ORCHYMONT, 1937	East.P, Oriental	t/ ln	O	-	+	+	DD
** <i>Berosus pulchellus</i> MACLEAY, 1825	Afr., Or., Austr.	t/ ln	O	-	+	-	DD
<i>Regimbartia attenuata</i> (FABRICIUS, 1801)	Or., Austr.	t/ ln	F/O	-	+	L	DD
** <i>Amphiops mater sumatrensis</i> (RÉGIMBART, 1903)	Oriental	p/ t/ ln (lo)	F/O	+	+	-	C
** <i>Chaetarthria indica</i> d'ORCHYMONT, 1920	Oriental	p	F	-	+	-	DD
<i>Chaetarthria saundersi</i> d'ORCHYMONT, 1923	Oriental	?	?	?	?	-	DD
* <i>Paracymus atomus</i> (d'ORCHYMONT, 1926)	Oriental	p/ ln (lo)	F/O	+	+	-	DD
<i>Paracymus diligens</i> WOOLDRIDGE, 1977	Sundaic	?	?	?	?	+	DD
<i>Paracymus evanescens</i> SHARP, 1890	Oriental	p/ ln (lo)	F/O	+	+	L	C
* <i>Paracymus orientalis</i> d'ORCHYMONT, 1926	Oriental	p/ ln	O	-	+	-	DD
** <i>Paracymus pusillus</i> WOOLDRIDGE, 1977	Sundaic	p/ ln	O	+	-	-	DD
** <i>Chasmogenus abnormalis</i> (SHARP, 1890)	Oriental	t/ ln	F	+	-	+	R
<i>Enochrus esuriens</i> (WALKER, 1858)	Oriental	p/ t/ ln	F/O	+	+	+	C
<i>Enochrus flavicans</i> RÉGIMBART, 1903	Oriental	t/ ln	F/O	-	+	-	E
<i>Enochrus gaggermeieri</i> HEBAUER, 1995	Sundaic	t/ ln	F/O	+	-	-	R
** <i>Enochrus icterus</i> KNISCH, 1924	Oriental	p/ t/ ln	F/O	+	-	-	R
** <i>Helochaeres anchoralis</i> SHARP, 1890	Oriental	p/ t/ ln	O	-	+	L	DD
<i>Helochaeres lentus</i> SHARP, 1890	Oriental	t/ ln	O	+	+	+	C
* <i>Helochaeres minor</i> d'ORCHYMONT, 1925	Oriental	t/ ln	O	+	+	+	C
<i>Helochaeres nebridius</i> d'ORCHYMONT, 1940	Sundaic	t/ ln	F/O	?	?	-	EX
<i>Helochaeres neglectus</i> (HOPE, 1843)	Oriental	t/ ln	F/O	+	+	+	DD
** <i>Helochaeres pallens</i> (MACLEAY, 1825)	Afr., Or.	t/ ln	O	-	+	L	C
** <i>Helochaeres taprobanicus</i> SHARP, 1890	Oriental	p/ ln (lo)	F/O	+	+	+	DD
** <i>Hydrophilus cavisternum</i> BEDEL, 1892	Oriental	p/ ln	O	-	+	L	EX
<i>Sternolophus rufipes</i> (FABRICIUS, 1792)	Oriental	p/ t/ ln	O	+	-	L	DD
** <i>Coelostoma fallaciosum</i> d'ORCHYMONT, 1936	Oriental	p/ t/ ln	F/O	+	+	L	DD
<i>Coelostoma subditum</i> d'ORCHYMONT, 1936	Sundaic	p/ t/ ln	F/O	+	+	-	DD
<i>Coelostoma vitalisi</i> d'ORCHYMONT, 1923	Sundaic	p/ t/ ln	F/O	?	?	-	EX
HYDRAENIDAE							
<i>Hydraena</i> sp. 1	?	p/ lo	F	+	-	-	VU
<i>Hydraena</i> sp. 2	?	p/ ln (lo)	F/O	+	-	-	E
<i>Hydraena</i> sp. 3	?	p/ lo	F	+	-	-	VU
LIMNICHIDAE							
<i>Parathroscinus corrinae</i> WOOLDRIDGE, 1990	Sundaic	intertidal	F	+	-	-	DD
<i>Parathroscinus magnus</i> WOOLDRIDGE, 1990	Sundaic	intertidal	F	+	-	-	DD
<i>Parathroscinus murphyi</i> WOOLDRIDGE, 1990	Sundaic	intertidal	F	+	-	-	DD
CHRYSOMELIDAE							
<i>Donacia javana</i> WIEDEMANN, 1821	Oriental	p/ ln	O	-	+	-	DD
CURCULIONIDAE							
<i>Bagous</i> sp. (undescribed species)	?	p/ t/ ln	O	+	-	-	R
** <i>Neochetina eichhorniae</i> WARNER, 1970	Cosmopolitan	p/ ln	O	-	+	-	DD
93 species				58	50		

situated in the latter dried up but little water remained among packs of rotten leaves and emergent vegetation. Adult beetles and larvae survive among debris and very shallow water at the same place until new rainfall refill these sites. Some 23 species (25%) occur in both permanent and temporary habitats, and just 13 species (15%) (*Copelatus oblitus*, *C. minutissimus*, some *Helochares*, *Chasmogenus*, *Enochrus* and *Paracymus* species) were only found in ephemeral bodies of water mainly situated in forests, such as shallow puddles after heavy rainfalls and water filled tree and bamboo hollows (Fig. 34). These observations are initial results and should not be generalized.

Though rather isolated from potential source-areas that might have contributed to a re-colonization of wetlands in Singapore, our results suggest that many sites contain water beetle communities typical for lowland sites in Southeast Asia. The most diverse Singapore localities are situated in Nature Reserves (Fig. 35) and appear to represent relic sites (e.g., Bukit Timah, Nee Soon Swamp Forest). Twenty-eight of the 58 species recorded from within the Nature Reserves are restricted to these areas. Of the 50 species recorded from other areas 21 were exclusively found outside any public parks and reserves. Twenty-nine species occur in Nature Reserves and other areas as well.

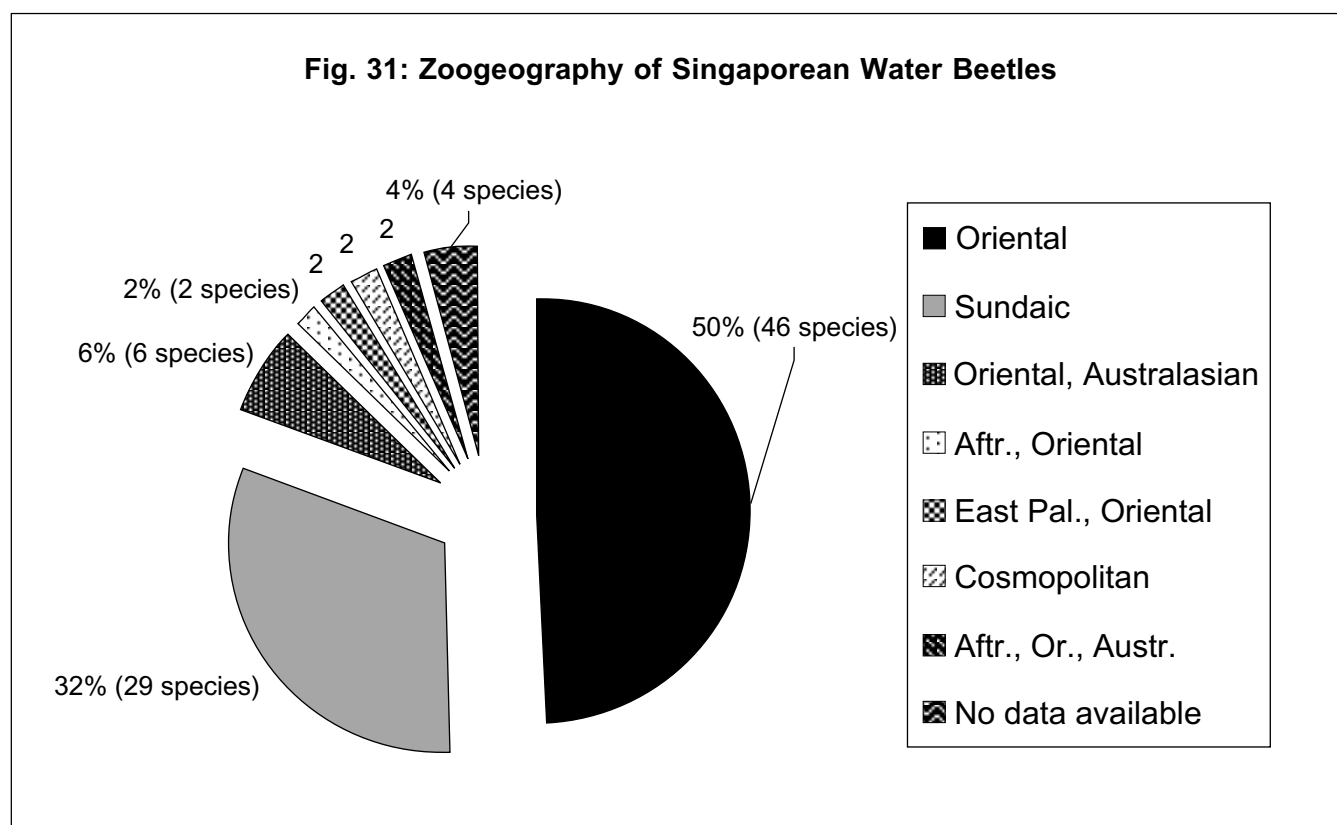
Generally, deep and permanent water bodies house a rich fish and dragonfly fauna while their water beetle fauna is rather poor. Predation by dragonfly nymphs, freshwater shrimps and tadpoles seems to have a significant effect on the distribution

and abundance of water beetles, especially during their larval stages (Hendrich, 1995).

We found 18 species at light. According to Fernando (1961), about one third of the Singaporean water beetle species were attracted to lights. Dytiscidae and Hydrophilidae are the most common aquatic Coleoptera captured using artificial lights, both in numbers and species, in the Oriental and Australian tropical regions (Fernando, 1961; Hendrich & Balke, pers. observ.). It is expected that species with a high power of dispersal will find it an advantage to survive in a wide variety of habitats. In tropical monsoon countries of Southeast Asia and India, flight of aquatic species is often associated with monsoon rains. In general, monsoonal rains are accompanied by winds of considerable speed or even storms. This is an ideal situation for the dispersal of aquatic insects in the air. The climatic conditions during the monsoon act as a proximate factor in causing these insects to take off to the air. They are then dispersed by the wind currents over considerable distances and the monsoonal rains provide suitable habitats which they then colonize (Fernando, 1961).

The larval instars and life cycles of most Singaporean water beetles remain unknown. It seems that adults of most species can be obtained throughout the year but much more quantitative studies are required to reveal seasonality in population densities.

Based on the results discussed above the following seven water beetle communities can be outlined. The most common species are in bold:



Figs. 31. Zoogeography of Singaporean water beetles.

Fig. 32: Distribution of Singaporean Water Beetles in Lentic and / or Lotic Sites

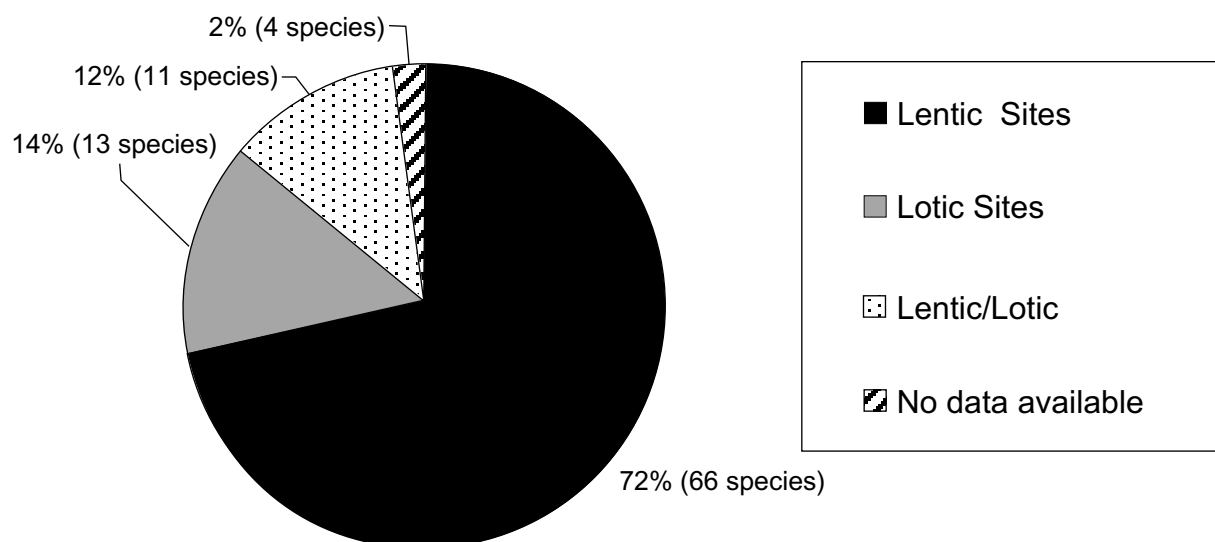


Fig. 32. Distribution of Singaporean water beetles in lentic and/or lotic sites.

Fig. 33: Distribution of Singaporean Water Beetles in Open and / or Forested Areas

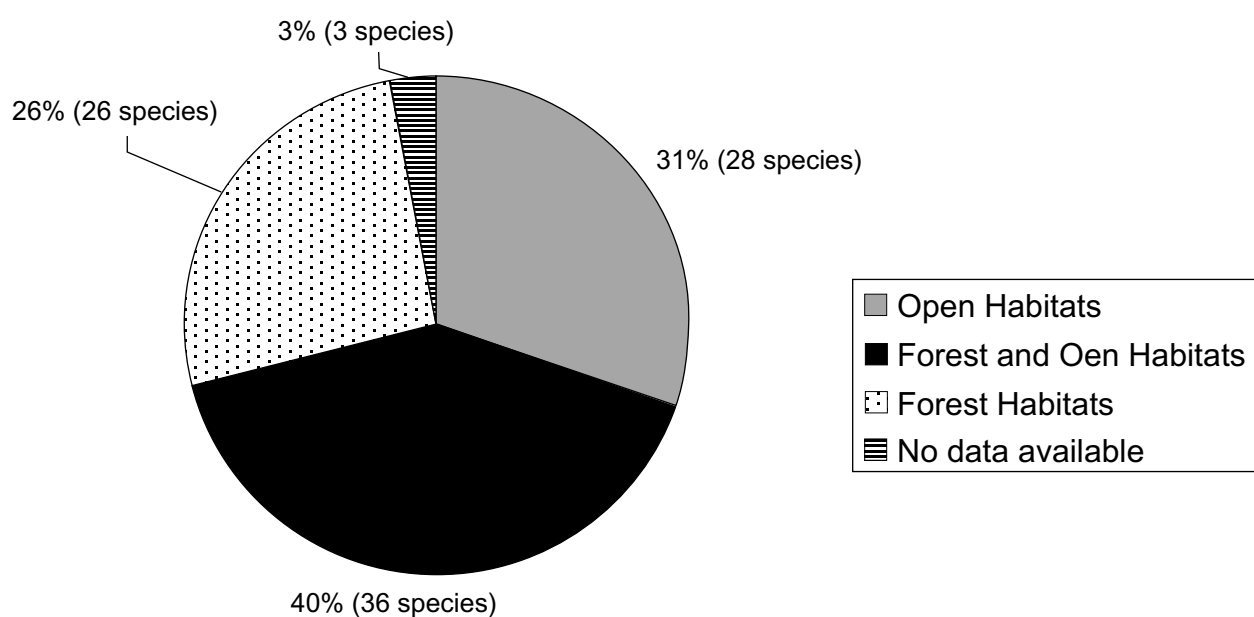


Fig. 33. Distribution in open and/or forested areas.

Communities of open fresh waters

– Artificial ponds and lakes in parks, gardens and woodlands, covered with *Nelumbo* sp., *Nymphaea* sp. and mats of floating grass: *Canthydrus morsbachii*, *Neohydrocoptus bivittis*, *Hydrovatus sinister*, *H. stridulus*, *Laccophilus siamensis siamensis*, *Amphiops mater sumatrensis*, *Allocotocerus muelleri*, *Enochrus esuriens*, *Helochaes lentus*, *H. minor* and *Paracymus orientalis*, *Donacia javanica*. The more temporary ones covered with *Pistia stratiotes*, *Salvinia molesta* and partially shaded by bamboo plants: *Hydroglyphus inconstans*, *Leiodytes nicobaricus*, *Helochaes* and *Enochrus* species.

– Permanent ponds on waste sites and in second growth vegetation. Rich in aquatic vegetation: Mats of floating grass, *Eichhornia crassipes*, *Utricularia* sp. and *Hydrilla verticillata*: *Canthydrus morsbachii*, *Hydrovatus sinister*, *Laccophilus siamensis siamensis*, *Hydaticus reductus*, *Hydaticus bipunctatus conjungens*, *Allocotocerus muelleri*, *Amphiops mater sumatrensis*, *Helochaes taprobanicus*, *H. lentus*, *H. pallens*, *Enochrus esuriens*, *Coelostoma subditum* and *Neochetina eichhorniae*.

– Permanent muddy ponds and former fish ponds in coastal areas, partly shaded by second growth mangrove vegetation. At the edge of the ponds *Sagittaria* sp. and *Limnocharis* sp., the surface partly covered with *Eichhornia crassipes*, *Wolffia* sp. and *Lemna* sp.: *Canthydrus morsbachii*, *C. proximus*, *Hyphidrus lyratus lyratus*, *Hydrovatus maii*, *H. rufoniger rufoniger*, *H. stridulus*, *H. sinister*, *Laccophilus parvulus*

parvulus, *L. pulicarius*, *L. ritesemae*, *L. siamensis siamensis*, *Copelatus tenebrosus*, *Hydaticus fabricii*, *Cybister tripunctatus lateralis*, *Spercheus stangli*, *Berosus* spp., *Amphiops mater sumatrensis*, *Helochaes anchoralis*, *H. neglectus*, *H. pallens*, *H. taprobanicus*, *Enochrus esuriens*, *E. flavicans* and *Coelostoma fallaciosum*.

Species communities of forest fresh waters

– Freshwater Swamp Forest: Shaded or semi-shaded temporary ponds, ditches and small puddles, rich in rotten leaves and without any vegetation: *Lacconectus corayi*, *L. krikkeni*, *Copelatus oblitus*, *C. minutissimus*, *Enochrus gaggermeieri*, *Chasmogenus abnormalis*, *Paracymus* and *Hydraena* species.

– Freshwater Swamp Forest: Partly shaded and weedy ponds, ditches and small swamps, rich in rotten leaves and emerged plants (e.g., mats of floating grass, sedges, *Eleocharis* sp., *Brachiaria* sp., *Erioclon* sp.): *Neohydrocoptus* (3 spp.), *Hydrocanthus indicus*, all Singaporean *Hydrovatus* species, *Laccophilus medialis*, *Hydaticus fabricii*, *Amphiops mater sumatrensis*, *Paracymus atomus*, *P. evanescens*, *Helochaes lentus*, *H. minor*, *H. neglectus*, *H. taprobanicus*, *Enochrus esuriens*, *E. gaggermeieri*, *E. icterus*, *Coelostoma subditum* and *Bagous* species.

– Forested springs and shallow streams, shaded by primary forest, without any aquatic vegetation. The bottom consisted of sand and a thin layer of rotten leaves and twigs: *Microdytes*

Fig. 34: Distribution of Singaporean Water Beetles in Temporary and/or Permanent Habitats

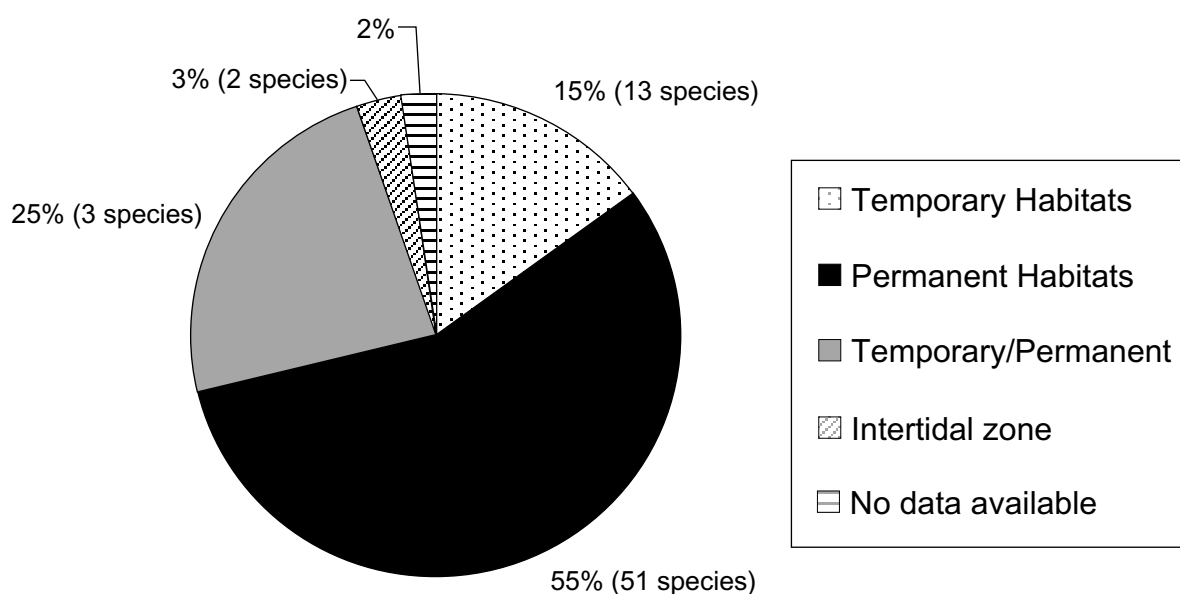


Fig. 34. Distribution in temporary and/or permanent habitats.

elgae, *M. pasiricus*, *Lacconectus corayi*, ***L. krikkeni*** and *Hydraena* species.

– Broad, permanent, oxygen rich, slow flowing and partly shaded streams, with sandy and/or muddy bottom and few submerged or emerged vegetation edges of reservoirs: All ***Orectochilus*** species and *Dineutes spinosus*.

CONSERVATION

Water beetle communities are reliable bioindicators. Presence of certain assemblages of water beetles are indicators of a healthy environment. Fortunately, increasing attention is now being paid to water beetles with respect to wetland conservation assessments. In fact, the group is now a widely accepted tool in wetland management and conservation (Foster, 1991; Balke & Hendrich, 1997; Balke et al. 1999). A worldwide Red List of endangered species has been published (IUCN 1996), and management plans for selected species are being prepared (Foster, 1996a, b). The most important areas with the highest number of stenotopic and often threatened species are discussed here:

Bukit Timah Nature Reserve - One of the most valuable sites is the small forest springlet at Taban Valley - a true relic site. It contains populations of four typical forest species, *Microdytes elgae*, *M. pasiricus*, *Lacconectus krikkeni* and *Hydraena* sp. 1. For three of these species, this is the only known locality in Singapore where they exist. Many

Microdytes species are rare and rather localized in general distribution in Southeast Asia (Hendrich, 1995; Hendrich & Balke, 1995; Wewalka, 1997). Thus, the Bukit Timah area must be attributed conservation value on both local and international scale (Balke & Hendrich, 1997; Balke et al., 1999). At the local level, the site should be considered as being a high potential source from which other suitable adequate Singapore sites could be re-colonized, assuming that vital populations could be maintained at Bukit Timah over longer periods of time. In fact, the above mentioned species are biodiversity indicators, and their protection will save many other yet unmapped species too.

With respect to management of the area, strategies to prevent further draining of the Bukit Timah sites must be observed as expressed by Briffet (1990). Fumigation of the reserve's edges should be minimized.

Nee Soon Swamp Forest - The primary freshwater swamp with a rich vegetation structure contains a species-rich assemblage of *Hydrovatus*. Species of this genus are typical inhabitants of semi-exposed to exposed sedge swamp sites and can be found in a wide variety of habitats, even in an open area such as Kent Ridge Park. However, a species-rich assemblage like the one at Nee Soon, with at least six species, can only be found in primary environments for reasons not yet fully understood. One of these species (*H. saundersi*) has not been collected from localities other than Nee Soon Swamp Forest, and is a threatened species in Singapore. This is also true for some of other species (e.g., *Copelatus minutissimus*,

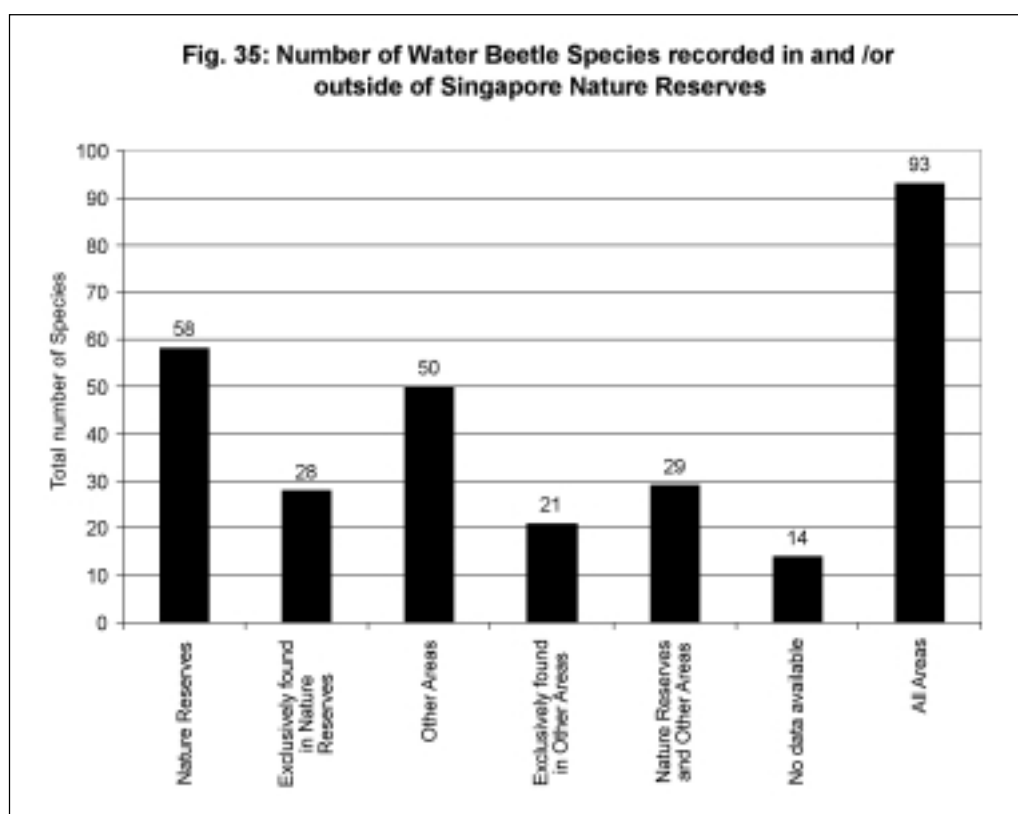


Fig. 35. Number of Water Beetle Species recorded in and/or outside of Singapore Nature Reserves.

Chasmogenus abnormalis, *Enochrus icterus*) collected in small temporary puddles in the area and it is notable that the populations of most *Hydrovatus* species appear vital.

The Gyrinae, or whirligig beetles, *Orectochilus andamanicus*, *O. corniger* ssp. and *O. spinosus*, were all found in the well shaded streams in the Central Catchment swamp forest, mainly distributed in the Nee Soon area. *Orectochilus andamanicus* is a very rare and threatened species in Singapore. Only one to two specimens per site have been collected from the bigger streams. It seems to be a very rare species distributed from India to Peninsular Malaysia (P. Mazzoldi per. comm.).

No doubt Nee Soon Swamp Forest is the most important site which deserves our full attention. Additional fieldwork will surely reveal many more species of interest. However, any lowering of the groundwater level would be disastrous to the swamp forest species. Management strategies should take into consideration the creation of small water holes in the forest which may serve as new habitats for the rare and localized *Copelatus* and *Lacconectus* species.

To maintain the diversity presently observed, the main tasks to be achieved are: (1) strict protection of sites already identified as valuable, (2) the creation of new habitats in the remaining forested areas and (3) establishing dispersal routes for animals to allow a faunal interchange between different wetland areas and forests.

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