Guides to the

Freshwater Invertebrates of Southern Africa

Volume 10: Coleoptera

Editors: R Stals & IJ de Moor

TT 320/07

Water Research Commission

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Hygropetric habitat, Bridal Veil Falls, Chimanimani Mountains, Zimbabwe.
Photographer: Koos van der Lende.

Since there is a possibility that revised editions of this series of guides may be printed in the future, we welcome constructive suggestions, particularly in relation to keys used to identify various taxa. These suggestions should be submitted in writing to the Water Research Commission (address given above). All such correspondence must be marked 'For the attention of the Director, Water-linked Ecosystems, (Project K5/916/0/1)'.

CONTENTS

PREFACE

This identification guide is one of a series of ten books that include keys to most of the fresh- and brackish-water invertebrates in southern Africa. The paucity of identification guides suitable for non-specialists has become a yawning gap in the tools available to scientists, managers and scholars concerned with the assessment and management of water resources. It is hoped that the present guides will be of value to these and other users, and that the environment will benefit as a result. The principal aim of this series is therefore to synthesise much of the existing knowledge on the identification of freshwater invertebrates into a standard format that is accessible to users who wish to identify taxa beyond their field of expertise.

Identification guides tend to be perpetually out of date, particularly in terms of nomenclature, due to advances in systematics. To keep abreast with some of the changes in nomenclature, readers are referred to the checklists in *The Aquatic Arthropods (Insects, Crustaceans and Mites) of South(ern) Africa* (http://www.ru.ac.za/aquatalogue). There is also a possibility that the present series will be periodically revised, but this is contingent on future funding.

Identification of taxa to species level is the ideal to which we would like to strive, but for a number of reasons this is not always possible: the present knowledge of taxa does not often permit such detailed identification, and in instances where taxa are well known, identification to such a fine resolution is usually constrained by space considerations and cost effectiveness. In some instances, particularly for small, relatively well-researched groups such as the freshwater molluscs, taxa have however been identified to species level. Since new species are constantly being discovered, users of these guides are cautioned against attempting to 'make' unusual specimens 'fit' existing keys. Users are encouraged to inform experts of such specimens, to take note of new distribution records, and to lodge all collections with well-known museums, particularly those that are depositories for collections of freshwater invertebrates (e.g. the Albany Museum, the South African Museum, the Transvaal Museum, and the South African National Collection of Insects).

This series includes an initial introductory volume containing general information and a key to the families of invertebrates. Subsequent volumes contain keys to different invertebrate groups, most often logically clustered together but in some instances the need for cost-effectiveness has resulted in the creation of some rather uncomfortable 'bedfellows', such as the arachnids and molluscs that are combined in Volume 6.

The books in the series are the culmination of years of effort by a large number of people and organizations: Shirley Bethune, Jenny Day, Barbara Stewart, Nancy Rayner and Maitland Seaman started the project in 1986; Jenny Day, Bryan Davies and Jackie King initiated contact with authors and began the editing process, and Barbara Stewart and Elizabeth Louw later became involved in editing the Crustacea chapters. A decade later, Chris Dickens successfully obtained funding from the Water Research Commission (WRC) for the completion of the project and later took on the job of Project Leader; Steve Mitchell managed the project from the WRC; from 1998 Jenny Day took on the role of senior scientific editor, and Irene de Moor was contracted to take on the job of managing editor. All of those above (with the exception of Nancy Rayner and Elizabeth Louw) as well as Mark Chutter, Ferdy de Moor, Lil Haigh, Arthur Harrison, Rob Hart, and Martin Villet, are part of the Editorial Board that was initially formed in 1998.

The production of the Coleoptera volume has been a long and arduous process. Many obstacles have had to be overcome, particularly due to the untimely death of Sebastian Endrödy-Younga, who was to have been the editor of this book. Beetle specialists are relatively few and far between, so the loss of Sebastian was devastating. Fortunately, Riaan Stals was able to step into the breach as the main author and scientific editor. Besides being the author of numerous chapters, he has also had to update and rewrite many of the original chapters, recruit new authors and artists, compile a vast index of distribution records, and produce most of the figures in this book. It has been an exhausting and at times traumatic process, but the final product is a tribute to the enormous amount of time and dedication that he has spent on this volume.

For various reasons there have been some changes to the editorial format in the present volume compared to that of other volumes in the series. For ease of reading, taxonomic credits do not appear after species names but are listed in a comprehensive appendix, that also includes distribution records in Africa, at the end of the volume. In the case of non-African species, however, the taxonomic credits appear in the main text of the chapters. The geographical coverage, while focussing principally on southern Africa, also includes distribution records from elsewhere in Africa. Experts will notice certain omissions in this volume, particularly in relation to descriptions of immature stages.

Numerous authors, including those in this book, have contributed time and expertise towards the drafting of the keys. The authors were not paid for their efforts, which were given in the true spirit of science and a love of their work.

A small donation from the Zoological Society of Southern Africa helped to initiate this project, but the series is largely a product of the Southern African Society of Aquatic Scientists (SASAQS), whose members are acknowledged for their support.

Umgeni Water, the South African National Collection of Insects (SANC) (ARC–Plant Protection Research Institute), the Albany Museum, and the Water Research Commission have all given organisational support at various stages of the present publication.

Chris Dickens, Steve Mitchell & Irene de Moor

ACKNOWLEDGEMENTS

The publication of this series of guides would not have been possible without the enormous effort and dedication of a number of people and organisations who have been mentioned in the Preface.

The Editors also acknowledge, with grateful thanks, the following people and institutions: Elsa van Niekerk, Pretoria, for expert art and graphic support; Jenny Day, Cape Town, for perceptive comments on a previous version of this volume; the ARC-Plant Protection Research Institute (South African National Collection of Insects), Pretoria, for organisational support; James Harrison and Ruth Müller, Pretoria, for access to the Transvaal Museum specimen and reprint collections; Rolf Beutel, Jena, for coleopterology that inspires; Manfred Jäch, Vienna, for much goodwill; and colleagues all over, not the least Beth Grobbelaar, Gerhard Prinsloo and Elmé Breytenbach, for much patience and encouragement; Ferdy de Moor and Martin Villet for editorial and technical assistance; Nancy Bonsor, Grahamstown, for helping to compile the index, and Brian Garmin of the Department of Journalism, Rhodes University, for advice and help on computer software.

The following people and organisations are also acknowledged for their assistance in the production of this book: Bronwyn Tweedie, Debbie Brody and John Keulder of the Graphics Services Unit, Rhodes University, for drawing the maps and producing bromides and Drinie van Rensburg of the WRC for her advice on printing and text layout.

Further acknowledgements are given in the preface and, in the case of those pertaining to particular chapters in this volume, at the end of the chapters concerned. Artists who did original drawings from specimens or helped with redrawing figures, are acknowledged in the captions to figures.

DEDICATION

This guide to the water beetles of southern Africa is dedicated to the memory of Joyce Omer-Cooper (1899–1979), in recognition of the foundation she laid for the study of the Dytiscidae (including Noteridae) of Africa, a large and complicated group of beetles. She dedicated a large part of her fruitful life to the intricacies of water beetle taxonomy; she undertook great collecting expeditions with the vision of habitats and species lost before they could be studied; and she named one predacious diving beetle genus after the tokoloshe.

GEOGRAPHICAL REGION COVERED BY THIS GUIDE

The geographical area covered in this volume differs from what is traditionally considered 'southern Africa' by zoologists. Usually, 'southern Africa' would be defined as the area south of the Cunene, Kavango and Zambezi Rivers, i.e. the countries south of Angola and Zambia, plus the 'bottom half' of Mozambique. For aquatic animals, however, it makes much more sense to include the entire catchments of these rivers and then arrive at a redefinition of 'southern Africa' as is illustrated in Fig. 1. Hence, in this *Guide*, 'southern Africa' includes significant parts of Angola and Zambia, the southern tip of Malawi, and an extra sliver of Mozambique. In Appendix 1 (p. 205), these 'additional' areas have been taken into consideration where locality records of water beetles are listed.

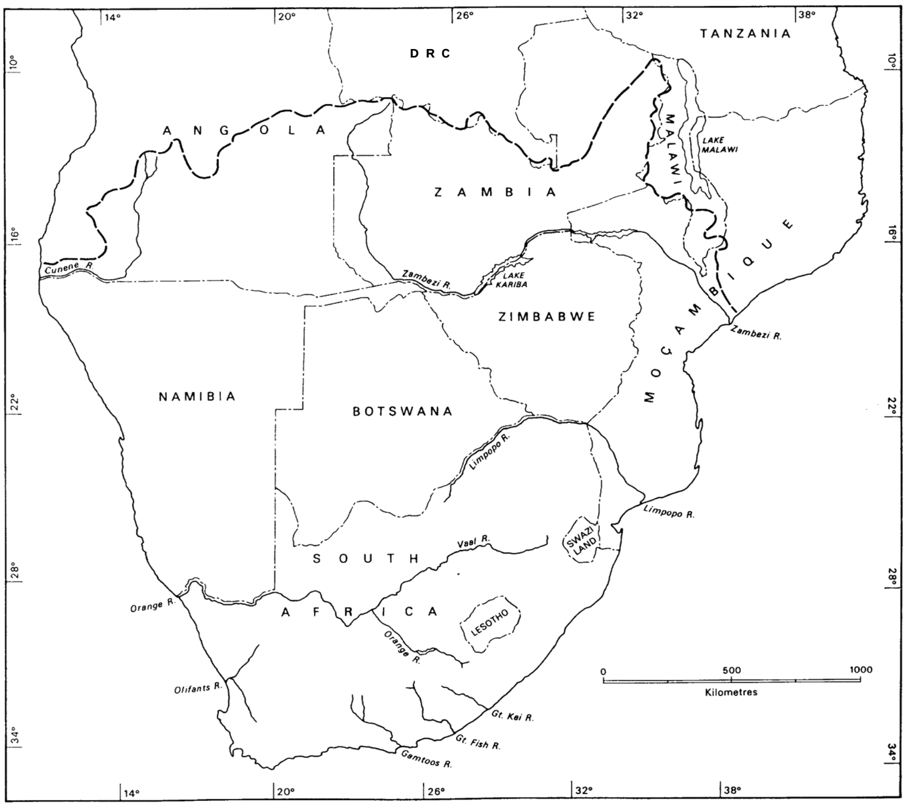

Fig. 1. The southern African subregion.

KEY: The dark dashed line represents the northern boundary of the Cunene Catchment in the west and the Zambezi Catchment in the east.

In the checklists of water beetle species (Appendix 1: p. 205), the localities opposite the taxon names are those territories for which collecting records, predominantly published, for the particular taxon presently exist. These are only indications of extents of occurrence and do not imply that any taxon occurs throughout a specific territory. The greatest collection effort has, however, focussed on catchments south of the Limpopo River (Figure 2), so the emphasis has naturally fallen on this region.

Collection efforts relating to most groups of freshwater invertebrates fall far short of adequate coverage. Consequently, locality records of many taxa are patchy and cannot be regarded as a good reflection of actual distributions.

Readers are also referred to the Glossary of Place Names (p. 247), regarding details of locality descriptions.

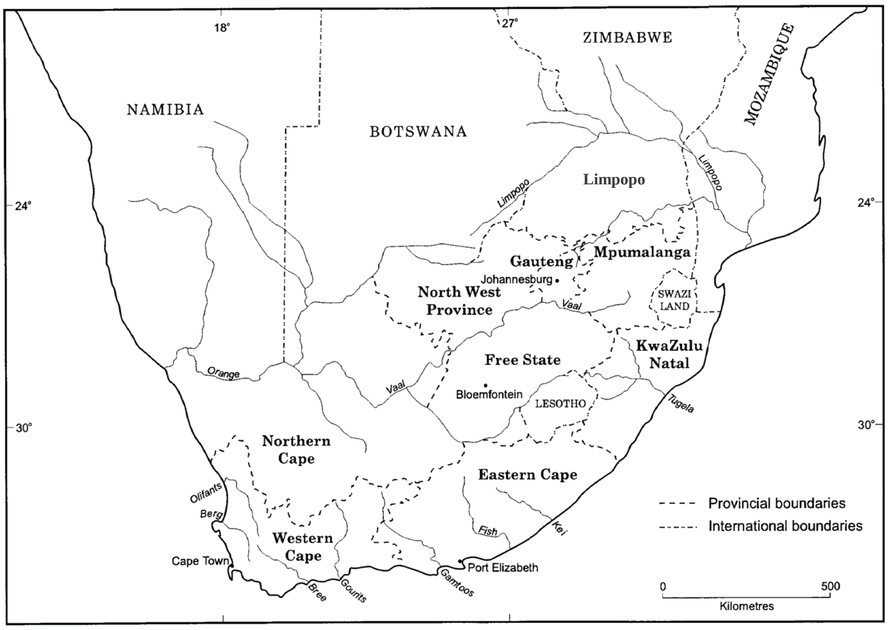

Fig. 2. The provincial boundaries of the Republic of South Africa.

ABOUT THE AUTHORS AND EDITORS

David Bilton of the University of Plymouth, UK, has had a lifelong interest in entomology and has studied water beetles for over 25 years, conducting fieldwork in many parts of the world. His research interests include historical biogeography and freshwater ecology, many of his papers being concerned with aquatic beetles.

Olof Biström is Professor and Director of the Zoological Museum, University of Helsinki, Finland. He has published numerous articles on the systematics and taxonomy of Dytiscidae, especially dealing with the fauna of Africa south of the Sahara.

Ferdy de Moor is the Head of the Freshwater Invertebrates Department of the Albany Museum in Grahamstown, South Africa. Although his main fields of interest are in the Trichoptera and Simuliidae (Diptera), he has also spent some time studying meloid beetles, and has always had an 'inordinate fondness for beetles'.

Irene de Moor is a freelance scientific editor, currently working at NISC (National Inquiry Services Centre) in Grahamstown, South Africa.

Sebastian Endrödy-Younga (1934–1999), a coleopterist of world-wide esteem, headed the Coleoptera Department of the Transvaal Museum, Pretoria, for many years. He published on several beetle groups, in particular the Clambidae, Cybocephalinae, Tenebrionidae and Myxophaga.

Beth Grobbelaar conducts research on the Chrysomeloidea, with particular emphasis on the family Chrysomelidae, at the South African National Collection of Insects, ARC–Plant Protection Research Institute, Pretoria. She has also spent some time submerging herself in the pursuit of semi-aquatic leaf beetles.

Chi-Feng Lee obtained a PhD from Ohio State University in 2003; he is currently at the Research Centre for Biodiversity, Academia Sinica, Taiwan. Already a leader in water penny systematics, he publishes revisionary works for various regions, including Africa. He started exploring South African streams in 2001.

Harry G. Nelson (1922–2006) was Adjunct Curator of Insects, Field Museum of Natural History, Chicago, USA. He published on Dryopidae and carried out extensive field work in the Oriental Region and North America. He passed away in March 2006.

Philip Perkins is Entomology Collection Manager at the Museum of Comparative Zoology, Harvard University, Massachusetts, USA. He started studying the Afrotropical Hydraenidae in the early 1990s. Since then he has described numerous new taxa and databased more than 40 000 hydraenid specimens from more than 1 000 African localities.

As Special Leverhulme Fellow at The Natural History Museum, London, **Ignacio Ribera** published on many aspects of Hydradephaga, from both morphological and molecular perspectives. He is principal author of the all-new family Aspidytidae (2002), and also finds time to describe new Limnichidae. In early 2004 he moved to the Museo Nacional de Ciencias Naturales, Madrid, in his native Spain.

William D. Shepard is Professor Emeritus at California State University and Visiting Scholar at Essig Museum of Entomology, University of California, Berkley, California, USA. He has published numerous articles on the systematics and ecology of aquatic byrrhoid Coleoptera (Dryopidae, Elmidae, Lutrochidae and Psephenidae) of the world.

When not staring at a cladistic matrix or being overwhelmed by the diversity of the beetles, **Riaan Stals** studies mainly weevils (Curculionidae) at the South African National Collection of Insects, ARC–Plant Protection Research Institute, Pretoria.

Clive Turner of Plymouth, England, is an independent researcher in insect ecology, with strong links to research institutions. He is devoted to the continued study and conservation of the Afrotropical aquatic Coleoptera, through publications, fieldwork, communication and taxonomy.

Martin Villet is a zoologist by training and entomologist by accident. Based at Rhodes University, Grahamstown, South Africa, he uses molecular and morphological phylogenetics to make more sense of behavioural ecology, biogeography, conservation and forensic entomology. Although working primarily on cicadas and blowflies, he could not pass up the challenge to write about myxophagans.

CHAPTER 1

INTRODUCTION

by

R. Stals

Beetles (Coleoptera) probably represent the largest order of living organisms, with around 370 000 species already described, and realistic estimates of the total number of extant beetle species ranging from one to five million (Gaston 1991). One in every four kinds of animal is a beetle. Protected by their tough exoskeletons, beetles have entered virtually all non-marine habitats on Earth.

The aquatic lifestyle of water beetles is a secondary development from a terrestrial way of life, as beetles and other insects are primarily terrestrial organisms. Within the Coleoptera there have been several phylogenetically independent origins of an aquatic way of life in the larval, the adult, or both the larval and adult life stages. Adaptations to a life in water involve whole groups of families in certain lineages (for example, the Hydradephaga and Hydrophiloidea), but an aquatic lifestyle also occurs sporadically, involving only a few genera or species in various predominantly terrestrial families (for example, the Chrysomelidae and Curculionidae). Very few insects are aquatic as adults but terrestrial as larvae; examples of this unusual lifestyle can be found among the Dryopidae and some Helophoridae. The littoral habitat represents a transition between terrestrial and aquatic habitats; here terrestrial beetles apparently tending towards aquatic habits, and members of aquatic beetle families apparently reverting back to a life on land, can be found. Another group, the shore beetle families, are specialised to live *next to* water.

THE MORPHOLOGY OF BEETLES

Beetles are beautiful insects that vary enormously in shape, size, special adaptations, biology and ecology across the approximately 165 currently-recognised extant families and myriads of genera and species. A comprehensive overview of beetle morphology falls outside the scope of this *Guide* and the interested reader may refer to the textbooks and other general references listed towards the end of this chapter.

The notes below summarise the most distinctive features of adult and immature beetles. Readers should refer to the 'Glossary of Terms' (p. 231) for explanations of unfamiliar terminology.

Adults

Adult beetles are characterised by the following features:

* The **exoskeleton** is strongly **sclerotised**.
* The first pair of wings (= **elytra**) are hard and rigid, usually covering the posterior part of the body; the second pair of wings are membranous and complexly folded beneath the elytra during rest. Various forms are flightless, in which case the elytra may be fused and the hind wings may be reduced or absent.
* The **pronotum** is large; the head plus the **prothorax** form a distinct fore body, and the elytra-covered **mesothorax** (reduced) and **metathorax** plus **abdomen** form a distinct hind body.
* **Compound eyes** are usually present and frequently large; **ocelli** are only rarely present.
* The **mouthparts** are biting and chewing, with the two strong **mandibles** moving in a lateral plane.
* The **maxillae** are bilobed, usually with four-segmented **maxillary palps**.
* The **labium** is well developed, usually with three-segmented **labial palps**.
* The **antennae** consist of eleven or fewer segments and are variously and characteristically shaped or modified.
* The **legs** are usually adapted for walking or running, but may be variously modified.
* The **trochanter**, **femur**, **tibia**, **tarsi** (with five or fewer segments) and **paired claws** are well developed.
* **Cerci** are absent.

The basic terminology applied to adult Coleoptera morphology is indicated on Figs 1.1A–B.

Beetles that fly use only the membranous **hind wings** (**metathoracic wings**) for flight. The elytra are the highly modified **mesothoracic wings**, and are characteristically shield-like, hard and protective. The ordinal name, Coleoptera, refers to these wings: *koleos* = sheath and *pteron* = wing, in Greek. In several beetle families the elytra are abbreviated, but in most water beetles they cover the whole abdomen. Reduction of the hind wings is known to occur commonly in various beetle groups, including some water beetle genera. Many water beetles are, however, capable of strong flight. This explains the presence of a variety of water beetles in ephemeral water bodies in remote arid or semi-arid regions.

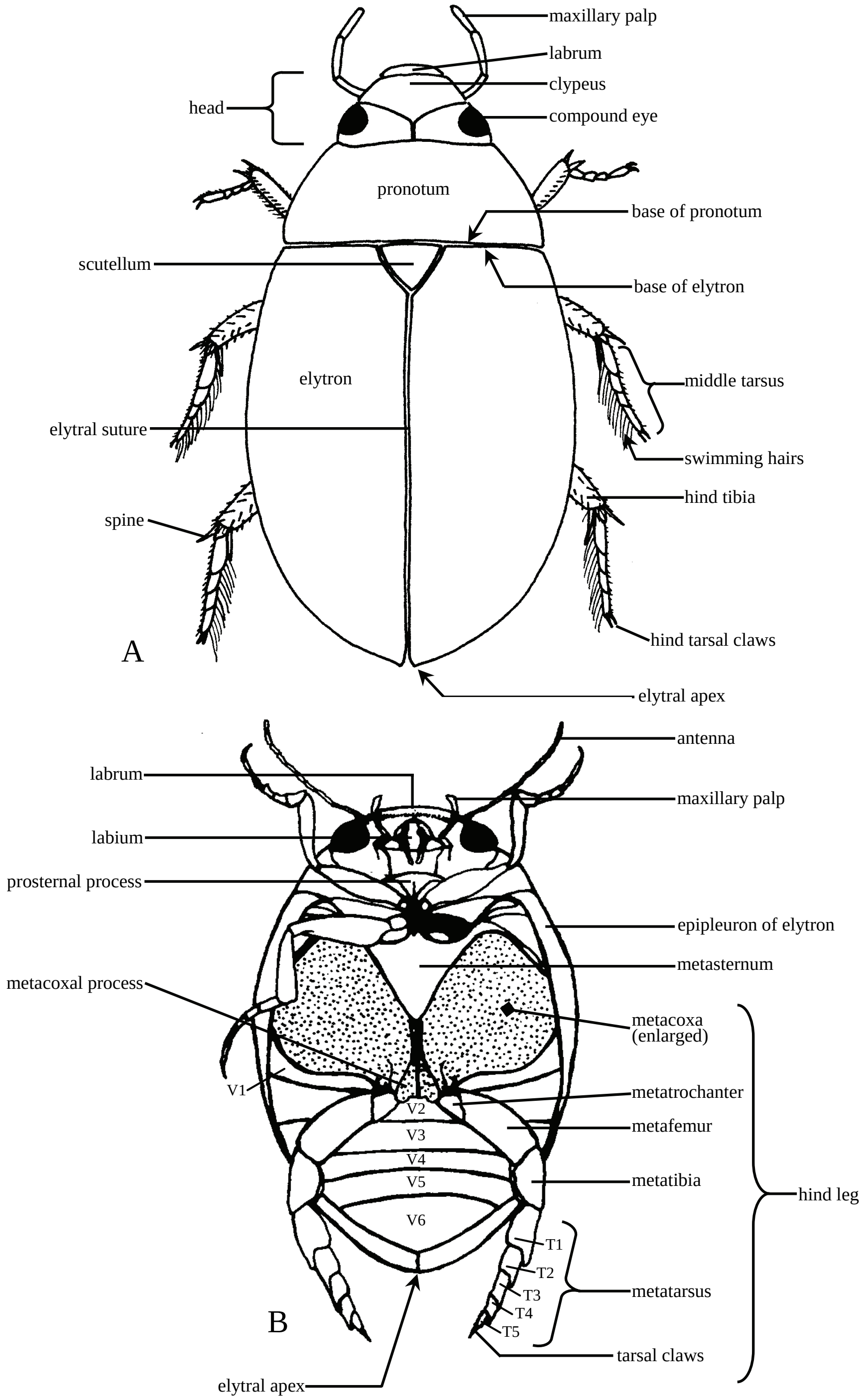

Fig. 1.1. Coleoptera, adult morphology. **A,** Hypothetical polyphagan water beetle, dorsal view; **B,** hypothetical hydradephagan water beetle, ventral view. T1–T5 = tarsal segments 1–5; V1–V6 = abdominal ventrites 1–6.

There may be a superficial resemblance between some adult water beetles and some aquatic bugs (Hemiptera: Heteroptera) (for example, the Corixidae, Notonectidae and Pleidae), but the two groups can immediately be distinguished by their mouthparts. Adult beetle mouthparts are of a biting/chewing kind, with a pair of mandibles (variously modified) that can move sideways. The mouthparts of all Heteroptera are highly modified into a single elongated, median, piercing and sucking tube termed a rostrum (not to be confused with the rostrum of the beetle family Curculionidae: see Chapter 22).

Immature Stages

Beetles are **holometabolous** (= **endopterygote**) insects, which means they undergo a 'complete' metamorphosis that — besides the egg, larval and adult stages — includes a **pupal stage**. As is typical of holometabolous insects, of which the Diptera (true flies) and Trichoptera (caddisflies) are two further examples, the adults and larvae of Coleoptera do not resemble each other morphologically, and the general biology of the adults and larvae is normally quite different. This is in contrast to the **hemimetabolous** insects like the true bugs (Hemiptera: Heteroptera), where the immatures (usually called '**nymphs**', and not '**larvae**') resemble the adults in terms of morphology and general biology, and where a pupal stage is absent.

The **eggs** of water beetles are usually laid in the water, on submerged substrates, on or in the tissues of water plants, or in moist substrates at the water's edge. Some female water beetles, especially the Dryopidae, have strong **ovipositors** with which eggs are inserted into a substrate. The presence of a well-developed ovipositor is unusual among beetles.

Larvae

The larvae of beetles (Figs 1.2A–K) are generally elongate animals, rounded or flattened in cross-section. As a rule, the **head capsule** is well **sclerotised**, but the rest of the body is usually poorly sclerotised and soft. As in adult beetles, the **mouthparts** of most beetle larvae are of a biting/chewing type, but may be variously modified. The larval **antennae** are short (one to three segments) and the **maxillary palps** are three- or four-segmented. A number of **stemmata** ('larval eyes') are usually present—up to six on each side of the head.

A pair of well developed, segmented **legs** is usually present on each of the three thoracic segments, but may occasionally be absent (for example, in the Curculionidae).

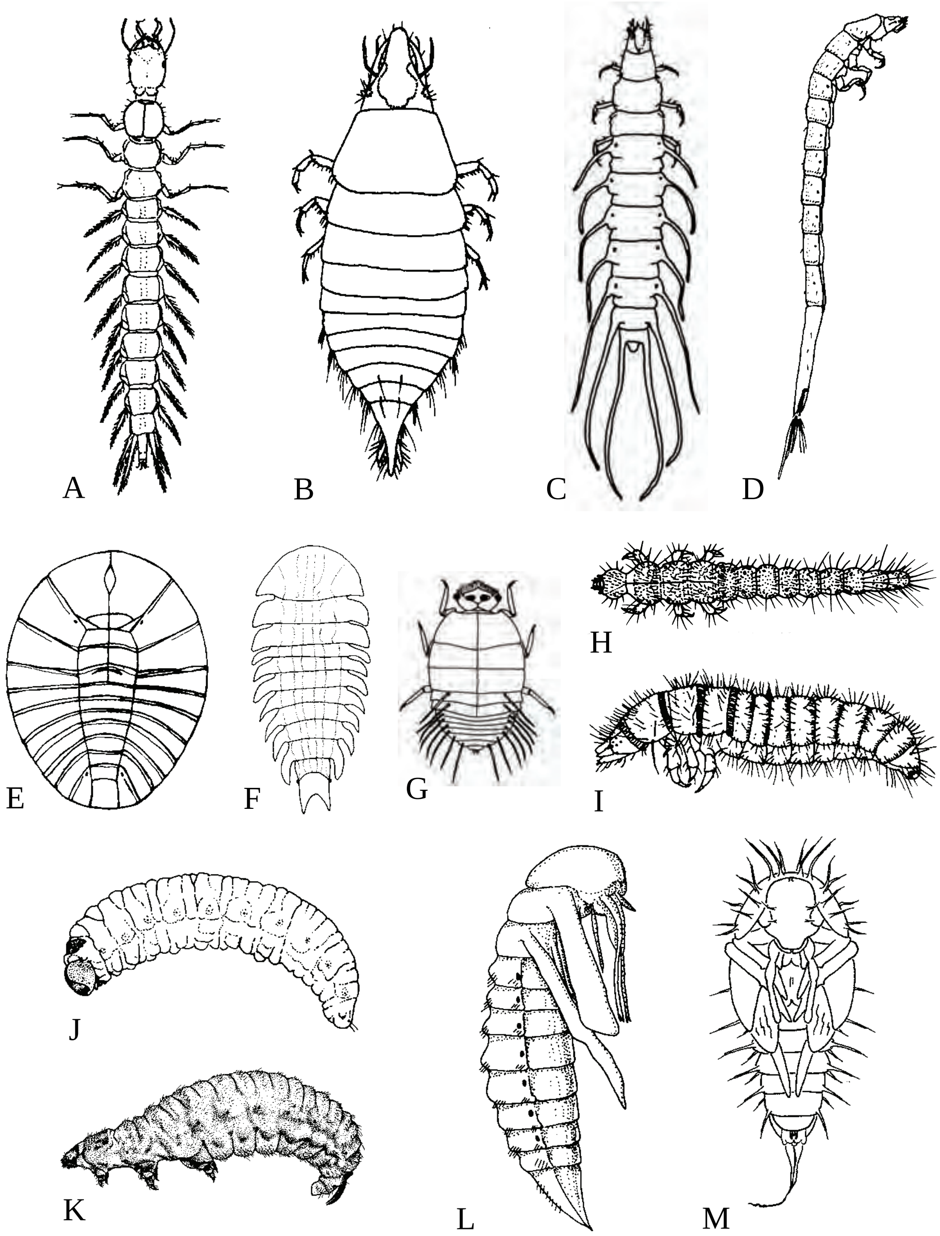

Fig. 1.2. Coleoptera, a menagerie of immature beetles. **A–K,** larvae: **A,** Gyrinidae, campodeiform larva; **B,** Dytiscidae, fusiform larva; **C,** Hydrophilidae: Hydrophilinae: Berosini; **D,** Elmidae, elateriform larva; **E–G,** onisciform larvae: **E–F,** Psephenidae; **G,** Torridincolidae; **H–I,** shore beetle larvae: **H,** Heteroceridae; **I,** Limnichidae; **J–K,** grub-like phytophilous larvae: **J,** Curculionidae, legless; **K,** Chrysomelidae: Donaciinae; **L–M,** exarate pupae: **L,** Dytiscidae, lateral; **M,** Hydrophilidae: Hydrophilinae, ventral. All much enlarged, not to the same scale.

The **abdomen** is normally ten-segmented, but in many groups it is reduced to nine or eight segments. The ninth abdominal segment frequently carries a pair of **urogomphi**, which may be fixed or articulated at the base, and may or may not be segmented. Most beetle larvae have **spiracles** on one thoracic and eight abdominal segments, but these are usually reduced in aquatic larvae. **Abdominal gills** are found in many aquatic forms (see below).

Larvae of aquatic Coleoptera are easily discernable from those of aquatic Diptera: the former — with the single exception of the Curculionidae — have thoracic legs, whereas Diptera larvae are always legless. Curculionidae larvae are typically grub-like and C-shaped (e.g. Fig. 1.2J), whereas aquatic Diptera larvae are usually rather straight-bodied maggots. Abdominal prolegs, as found in Lepidoptera larvae, are never present in beetle larvae.

Pupae

Beetle **pupae** (Fig. 1.2L–M) are typically **exarate**, meaning that the appendages are free and not fused to the rest of the body. The pupae of water beetles are, with very few exceptions, littoral or terrestrial. In most water beetle taxa the full-grown larvae crawl out of the water and pupate near the water's edge in the soil, in plant litter, or under stones. These pupae have no aquatic adaptations. In exceptional cases (at least some Noteridae, and Chrysomelidae: Donaciinae) pupation takes place in air-filled **cocoons** under water. Pupae are rarely truly aquatic (for example, Hydroscaphidae and *Hydrocyphon* of Scirtidae), sometimes having well developed **spiracular gills** in the pupal stage (Torridincolidae and one subfamily of Psephenidae).

FUNCTIONAL AND TAXONOMIC DIVERSITY OF SOUTHERN AFRICAN WATER BEETLES

Manfred Jäch (1998) proposed a useful functional/ecological classification of 'water beetles', in which he distinguished between true, false, phytophilous, parasitic and facultative water beetles, with shore beetles as the sixth group. Four of these groups are treated in this *Guide* (Table 1.1).

* In **true water beetles** the adult stage is submerged most of the time[1], and the larvae and pupae may be aquatic or terrestrial.
* **False water beetles** are aquatic only in the larval stage, the adults being predominantly terrestrial.
* **Phytophilous water beetles** are members of families that are predominantly terrestrial, but have close associations with aquatic host

[1] Many adult water beetles regularly fly above water and over land.

plants, so that they may stay submerged for at least some time in any developmental stage.

* **Shore beetles** are, strictly speaking, terrestrial animals, but in all their developmental stages they are found almost exclusively very close to the water’s edge or in very wet habitats.

The order Coleoptera consists of four suborders, namely Archostemata, Myxophaga, Adephaga and Polyphaga. The defining characteristics of these suborders, as well as keys to separate them, can be found in the general texts referenced at the end of this chapter. No aquatic forms are known among the extant Archostemata, phylogenetically the most basal of these suborders.

The family-group classification followed in this *Guide* is based on that of Lawrence & Newton (1995), except for the Hydrophiloidea, for which the scheme of Hansen (1991, 1995) is followed.

Suborder **Myxophaga**

All members of the four families (three in southern Africa, Table 1.1) of the Myxophaga are aquatic or semi-aquatic. Of all water beetles, the Torridincolidae are probably the 'most fully aquatic', with the larvae, pupae, adults, and perhaps also the eggs, being aquatic. This suborder is treated in more detail in Chapter 2.

Suborder **Adephaga**
Section **Hydradephaga**

The Adephaga consists mainly of the large family Carabidae, which includes familiar forms such as the ground beetles, tiger beetles and ants’ nest beetles. Whereas Carabidae are typically terrestrial, the Adephaga also contains eight extant aquatic families (five in southern Africa: Table 1.1), which together form the 'section' Hydradephaga. There is great morphological and behavioural diversity among these eight families. Whether the Hydradephaga constitutes a monophyletic group or not is an important question currently enjoying much attention. The 'traditional' perspective is that the Hydradephaga is indeed monophyletic (for example, Crowson 1981), and this has recently been corroborated by molecular investigations (Shull et al. 2001; Ribera et al. 2002b) and phylogenetic analysis of combined morphological and molecular data (Ribera et al. 2002a). On the other hand, studies based on morphology, including a recent comprehensive analysis of adult and larval morphology (Beutel et al. 2006), did not find the Hydradephaga to be monophyletic. This matter is still open to interpretation.

Table 1.1: Beetle families treated in this *Guide*, with their taxonomic placement and functional/ecological classification following the scheme of Jäch (1998)

Suborder Myxophaga	
Torridincolidae	true water beetles
Hydroscaphidae	true water beetles
Sphaeriusidae	shore beetles♦
Suborder Adephaga (section Hydradephaga)	
Gyrinidae	true water beetles
Haliplidae	true water beetles
Noteridae	true water beetles
Dytiscidae	true water beetles
Aspidytidae	true water beetles
Suborder Polyphaga	
Superfamily Hydrophiloidea	
Georissidae	shore beetles
Hydrochidae	true water beetles
Spercheidae	true water beetles
Hydrophilidae: Hydrophilinae	true water beetles and shore beetles ♦
Helophoridae	true water beetles ♦
Superfamily Staphylinoidea	
Hydraenidae	true water beetles♦
Superfamily Scirtoidea (= Eucinetoidea)	
Scirtidae	false water beetles
Superfamily Byrrhoidea	
Elmidae	true water beetles♦
Dryopidae	true water beetles♦
Limnichidae	shore beetles♦
Heteroceridae	false water beetles
Psephenidae	false water beetles
Ptilodactylidae	false water beetles
Superfamily Chrysomeloidea	
Chrysomelidae: Donaciinae	phytophilous water beetles
Superfamily Curculionoidea	
Curculionidae (water weevils)	phytophilous water beetles

♦ These groups include some terrestrial species (inapplicable to false water beetles)

The family Gyrinidae is either basal within the aquatic Adephaga, or within all the Adephaga (including the terrestrial groups). The Haliplidae is the sister group of the remainder of these families. The group of hydradephagan families excluding the Gyrinidae and Haliplidae is monophyletic and referred to as the superfamily Dytiscoidea (six families, three of which are known from southern Africa, Table 1.1). Monophyly of the Hydradephaga would imply a single origin of an aquatic lifestyle among these beetles. However, Ribera et al. (2002a) showed that the evolution of swimming in the Adephaga was no linear progression, but probably has a complex history with various independent origins of convergent morphologies and behaviours.

The Adephaga are predominantly carnivorous in both the larval and adult stages, but, among the Hydradephaga, most (or all?) Haliplidae and at least some Noteridae are phytophagous. Omnivory in nature may be more common than generally perceived, as is illustrated by a recent report of facultative herbivory in adults of a large dytiscid beetle (Rosenthal et al. 2005). Extra-oral digestion is an ancestral characteristic of larval Adephaga and is found in the larvae of all the predacious Hydradephaga (also see below).

Suborder **Polyphaga**

Most beetle species belong to the suborder Polyphaga (Table 1.1), exhibiting a remarkable diversity of morphology, behaviour and ecology. Following Lawrence & Newton (1995), the Polyphaga can be divided into five 'series' or infraorders, which are in turn divided into sixteen superfamilies. Six of these superfamilies have aquatic members that occur in southern Africa.

Superfamilies Hydrophiloidea and Staphylinoidea

Together, the superfamilies Hydrophiloidea, Staphylinoidea and Histeroidea[2] make up the infraorder Staphyliniformia, an enormously varied and speciose diversification of beetles. Most members of the Staphyliniformia are terrestrial and live in and among soil, decaying vegetation, dung, and similar substrates. However, the majority of the Hydrophiloidea, as well as a small proportion of the Staphylinoidea are, to a greater or lesser extent, aquatic. The Histeroidea are typically terrestrial.

The six water beetle families (five in southern Africa, Table 1.1) of the superfamily Hydrophiloidea together form a monophyletic group of which the common ancestor seems to have been aquatic. Some classification schemes treat these six families as subfamilies of a more inclusively-constituted family Hydrophilidae, but such a scheme is not followed in this *Guide*. Generally, the larvae of aquatic Hydrophiloidea are predacious and their adults omnivorous. A secondary return to a terrestrial lifestyle has

[2] Some authorities include the Histeroidea in the Hydrophiloidea.

occurred independently in more than one lineage of the Hydrophiloidea, the most significant being the subfamily Sphaeridiinae of the family Hydrophilidae.

In older classifications — at least up to about the middle of the 20th century and even later for some authors — the families of the Hydrophiloidea and the family Hydraenidae were frequently considered components of the same group, commonly referred to as 'Palpicornia'. Confusingly, some authors referred to the Palpicornia as 'Hydrophiloidea' or 'Hydrophilidae', which were then broad concepts different from what the Hydrophiloidea and the Hydrophilidae are currently considered to be. It is presently widely accepted that 'Palpicornia' is not a natural (monophyletic) grouping, but a polyphyletic assemblage that is phylogenetically untenable. The apparently unique and very similar aquatic adaptations found in both the Hydrophiloidea and the Hydraenidae are products of convergent evolution and not evidence of shared ancestry.

The systematic position of the Hydraenidae was for decades controversial, but currently there is general agreement (and growing evidence) that the Hydraenidae is correctly placed in the superfamily Staphylinoidea, not Hydrophiloidea. The vast majority of Staphyliniformia belong to the superfamily Staphylinoidea. This is arguably the most ecologically diverse of all beetle groups and its species richness may eventually exceed that of the Phytophaga (below), currently considered the most speciose beetle family-group. The principal family of the Staphylinoidea is the enormous family Staphylinidae (rove beetles and allies), which is predominantly terrestrial.

Superfamily Scirtoidea [= Eucinetoidea]

The Scirtoidea is a small superfamily of four rather small and unfamiliar families. Among these, only the Scirtidae [= Helodidae] is aquatic or semi-aquatic, in the larval stage. Scirtidae are considered very basal within the Polyphaga, as evidenced by several basal larval features.

Superfamily Byrrhoidea

Few families of the suborder Polyphaga have larvae that characteristically live in wet environments. Most of these are contained in the Byrrhoidea. In the byrrhoid families listed in Table 1.1 and treated in this *Guide*, the larvae of most species are aquatic, but in the adult stage they range from being truly aquatic (for example, Elmidae), through littoral (for example, Heteroceridae and Limnichidae), to terrestrial (Psephenidae and Ptilodactylidae). The peculiar life-history style of most Dryopidae (having terrestrial larvae and aquatic adults) has been noted above.

Different authorities have different points of view on the composition and limits of the superfamily Byrrhoidea. Following the classification of Lawrence & Newton (1995), the Byrrhoidea constitutes twelve families. This classification includes the more-or-less overlapping concepts of 'Dryopoidea' and 'Psephenoidea' of other authors. The reader will frequently find the name Dryopoidea in the technical literature, but in non-taxonomic practice the name Dryopoidea may be equated with the name Byrrhoidea. The latter name, however, is preferred.

Superfamily Elateroidea: Family Lampyridae

Among the family Lampyridae (fireflies, glow-worms) (Polyphaga: Elateroidea), a predominantly terrestrial group, a small number of species are known to have strictly aquatic larvae (Fu et al. 2006; Jeng et al. 2003). At least some of these larvae are known to be provided with gills. Lampyridae occur in southern Africa, but the local fauna suffers neglect with regard to taxonomic and ecological investigation. There is anecdotal evidence that aquatic lampyrids are present in the region and that there are perhaps more than one aquatic lampyrid species in the northern part of KwaZulu-Natal. Pending formal confirmation of their presence in southern Africa, the family is not further considered in this *Guide*. The matter should, however, be investigated. Further taxonomic and ecological research on this family is required.

Superfamilies Chrysomeloidea and Curculionoidea ('Phytophaga')

The two superfamilies Chrysomeloidea and Curculionoidea represent a spectacular radiation of species collectively known as the 'Phytophaga'. The Phytophaga is a monophyletic group that forms part of the infraorder Cucujiformia. As implied by the name 'Phytophaga', virtually all these beetles are plant feeders, being the second largest lineage of phytophagous animals after the Lepidoptera (caterpillars). Of the phytophagan species, 99% are narrowly associated with flowering plants, having diversified with the great radiation of the flowering plants in the mid-Cretaceous epoch (c. 135–90 m.y.a.). All the aquatic forms in these two superfamilies are, unsurprisingly, functionally classified as phytophilous water beetles.

The number of families recognised in the superfamily Chrysomeloidea varies somewhat according to the views of different specialists. Among these, the two principal families are the Cerambycidae (longhorn beetles) and Chrysomelidae (leaf and seed beetles); only in the Chrysomelidae are there a few semi-aquatic forms. The superfamily Curculionoidea (weevils and their close allies) includes anything from six to twenty-two families, this number again varying among different classification schemes and not agreed upon by different weevil specialists. Again, semi-aquatic kinds comprise a small fraction of weevil diversity, the water weevils all belonging to the family Curculionidae.

Other Aquatic Coleoptera

Aquatic lifestyles are predominant in an additional seven water beetle families that are not found in southern Africa.

* Lepiceridae (Myxophaga) — 'false minute mud-loving beetles' (one genus with two described species): Mexico to Venezuela; probably true water beetles, possibly shore beetles; adults in wet detritus at water margins; larvae as yet unknown.
* Amphizoidae (Adephaga) — 'troutstream beetles' (one genus with five described species): North America and China; true water beetles; adults and larvae in rather fast-flowing rivers.
* Paelobiidae [= Hygrobiidae] (Adephaga) — 'squeak beetles' (one genus with six described species): Europe, North Africa, China and Australia; true water beetles; adults and larvae mainly in stagnant water.
* Meruidae (Adephaga) — 'comb-clawed cascade beetles' (one known species, first described in 2005): Venezuela; true water beetles; adults in clear, cascading streams and at water's edge, larvae as yet unknown.
* Epimetopidae (Hydrophiloidea) — 'rugose water scavenger beetles' (three genera with 27 described species): southern USA to Argentina, tropical Africa, Asia; true water beetles (aquatic adults and larvae).

  Hebauer (1999: 12) noted the presence, in the Hungarian Natural History Museum, Budapest, of one specimen of the epimetopid *Eupotemus carinaticollis* (Basilewsky, 1956) that had been collected in Zimbabwe. The two species of the genus *Eupotemus* are known from west and central Africa and this family may indeed be present in southern Africa. However, pending confirmation, it is not herein treated as a part of the water beetle fauna of the region. No other published records of Epimetopidae in southern Africa could be found up to end-2006.
* Lutrochidae (Byrrhoidea) — 'false minute marsh-loving beetles' (one genus with c. 15 described species): USA to Argentina; true water beetles; adults and larvae reportedly in flowing water.
* Eulichadidae (Byrrhoidea) — 'forest stream beetles' (two genera with 21 described species): Asia and North America; false water beetles; larvae live in streams; adults strictly terrestrial.

In at least another sixteen primarily-terrestrial beetle families, some degree of aquatic adaptation is found at least in a few species of each family. Many of these adaptations are to a littoral lifestyle, fewer involving a truly aquatic lifestyle. Instances of a littoral lifestyle are in southern Africa known in, among others, the Carabidae, Staphylinidae and Scarabaeidae: Aphodiinae. These groups are not treated in this *Guide*. Especially noteworthy are the adults of some species of Staphylinidae that are able to run on the surface of the still water alongside their natural (littoral) habitats.

ADAPTATIONS TO AN AQUATIC LIFESTYLE

Aquatic adaptations in beetles primarily involve respiration and locomotion, both in larvae and adults. These adaptations are often different among, and characteristic for, higher taxonomic categories, a result of the fact that an aquatic lifestyle evolved independently in several beetle lineages.

Respiration

Most adult water beetles obtain oxygen from the air at the water surface. These are commonly good swimmers. When the beetle is submerged, air is stored either under the elytra in a **subelytral chamber** (for example, in the Hydradephaga), or kept in a bubble on the underside of the body (for example, in the Hydraenidae). Where air is stored in the subelytral space, the spiracles open into this space. Some water beetles, such as many Elmidae, can sequester the oxygen bubbles produced by photosynthesising green algae and aquatic plants.

Adults of several water beetle families (for example, Torridincolidae, Dryopidae and Elmidae) do not surface for air, but obtain dissolved oxygen from the water through a 'physical gill' or **plastron**. It is constructed of fine cuticular structures — for example, closely set, minute hairs, scales or microsculpture that trap a very thin film of air close to the body surface over the spiracles. The plastron is most frequently situated on the ventral body surface, but the surfaces of various other body parts, including the head, antennae and legs, may also be involved. Oxygen, dissolved in the surrounding water, diffuses into the plastron and passes through the spiracles to the **tracheal system**. Carbon dioxide may leave by the same route. If water temperatures are low enough, and oxygen concentrations high enough, some adult water beetles can remain submerged indefinitely. Plastron respiration is also known in a number of other kinds of aquatic invertebrates.

Most adult aquatic Hydrophiloidea and Hydraenidae are characterised by unusually long maxillary palps, at times longer than the antennae (e.g. Figs 1.5K–L; 11.1A–C; 13.1, 13.2). These antennae are variously modified and have a respiratory function in the aquatic forms. In the Hydrophiloidea, one of the antennal segments is usually modified, forming a mostly glabrous **cupule** that precedes a densely setose and hydrofuge **antennal club** (e.g. Figs 1.5G–I). The antennae of Hydraenidae have an equally setose and hydrofuge club (e.g. Figs 1.5E–F; 13.6B). This club is used to break the water surface and bring the air of the ventral or lateral plastron or air bubble in contact with the atmosphere, while the beetle remains submerged. The long maxillary palps (e.g. Figs. 1.5K–L; 13.1, 13.2) are hypothesised to have taken over the usual beetle antennal functions.

In water beetle larvae, oxygen is obtained in any of four basic ways. The simplest is directly from the atmosphere through a pair of usually-enlarged and posteriorly-situated spiracles. Here air is stored in inflated **tracheal reservoirs** for the duration of the submerged period (for example, in the Dytiscidae). Second, larvae may have **spiracular gills** or **tracheal gills**, situated laterally or terminally on the abdomen, that obviate the need to surface for air. Tracheal gills appear in different forms in various families, for example, in larvae of the Torridincolidae (Figs 1.2G; 2.1B), the Gyrinidae (Figs 1.2A; 3.1E: AP3), the tribe Berosini of the Hydrophilidae: Hydrophilinae (Figs 1.2C; 11.2A), and the Elmidae (Figs 1.2D; 1.7I). Third, aquatic larvae can obtain oxygen from the stems of submerged plants by tapping the air-filled plant tissues with a modified abdominal apex, where a pair of spiracles is situated. This is the case in at least some Noteridae (Fig. 5.1D: AP4) and in the Chrysomelidae: Donaciinae (Figs 1.2K; 1.7H). Lastly, larvae of some Myxophaga have plastrons.

Aquatic beetle larvae frequently show reduction, loss, or displacement of the spiracles. A common type of modification is the extreme reduction or loss of the abdominal spiracles, except for the last pair, situated on the eighth abdominal segment. In such **amphipneustic** or **metapneustic larvae** the apex of the abdomen is modified so that these spiracles are in a terminal position. This facilitates air intake, with only the tip of the abdomen breaking the water surface (for example, Dytiscidae, many Hydrophilinae, and Scirtidae). **Apneustic larvae**, where no spiracles are functional, are rare among beetles and, among the water beetles, only occur in the Gyrinidae and the subfamily Psephenoidinae of the Psephenidae. The aquatic larvae of some groups that pupate on land acquire a more-or-less full set of functional spiracles in the last larval instar.

Fast-flowing water, which is normally better aerated than stagnant or slow-flowing water, is generally the habitat of water beetle adults with plastrons and larvae with tracheal gills.

Locomotion

Underwater locomotion of water beetle adults manifests in different ways and at different levels of efficiency. Adult water beetles can roughly be divided into crawlers and swimmers. 'Crawlers' include beetles that do not surface for air and live in rapidly-flowing streams; they usually have large claws and an enlarged terminal tarsal segment. This allows them to crawl on the substrate (for example, the Torridincolidae and Elmidae). 'Swimmers' often have modified legs, which may be more-or-less widened and/or flattened, and may be fringed with swimming hairs. These beetles (for example, members of the Gyrinidae and most Dytiscidae) are mostly found in still or slow-flowing water.

The simplest form of active swimming is a kind of 'water walking' by means of alternate movements of opposing legs. This type of swimming is found in the Haliplidae, in which there are no significant modifications of the legs apart from slight flattening and the presence of fringes of swimming hairs. The fastest underwater movement is found in the Dytiscidae, where either the hind tibiae, or both the hind and middle tibiae, and their corresponding tarsi, are flattened to form swimming paddles. In the Gyrinidae the middle and hind legs form short and broad paddles. In some gyrinid genera the apex of the abdomen, with its lateral mobility, functions as a rudder. Members of the Dytiscidae and Noteridae move opposite legs synchronously.

The phytophilous water beetles in southern Africa do not have any morphological adaptations for underwater locomotion. Some aquatic Curculionidae in other parts of the world have long swimming hairs on their legs, but their swimming abilities are limited.

Adaptations for underwater locomotion are limited in water beetle larvae. Most kinds move about by crawling or floating. Larvae of Gyrinidae, some Dytiscidae, and a few Hydrophilinae can propel themselves through water by means of a dorsoventral undulation of the body. Swimming larvae often have swimming hairs on the legs, the sides of the abdomen, or on the urogomphi.

Other Adaptations

Apart from respiratory and locomotory adaptations, water beetles also exhibit special adaptations involving the **sense organs**, **mouthparts**, **Malpighian tubules**, and the **closing apparatus** of the larval spiracles.

The senses of smell and of taste become blurred in an aquatic environment. In beetles these are normally and primarily the functions of the antennae and the maxillary palps, respectively. Indeed, water beetles usually show modifications of the antennae at both the ultrastructural and macroscopic levels. In the Hydrophiloidea and the Hydraenidae the modified antennae of the adult aquatic species function as accessory respiratory organs, while the greatly-elongated maxillary palps probably adopt the functions of the antennae (see above).

Special modification of the mouthparts of water beetles is found particularly in those lineages where extra-oral digestion is a larval characteristic. For these larvae (for example, the Hydradephaga and the Hydrophilidae: Hydrophilinae) the aquatic environment poses the threat of dilution of their secreted digestive juices as well as the digested tissue of their prey. In the Hydradephaga this problem is overcome by the presence of more-or-less grooved, or tubular, mandibles.

The Hygropetric Microhabitat

The so-called hygropetric microhabitat deserves separate mention as it harbours remarkable water beetles with a specialised suite of adaptations. The hygropetric (= madicolous) microhabitat is the thin water film on the surface of rocks, as found on emergent boulders in fast-flowing streams, on wet rock faces at the margins and in the spray zone of waterfalls and rapids, at seepage trickles, wet road cuttings, et cetera. Much evolutionary convergence is found in the morphology of hygropetric beetles, all having a much-flattened ventral surface, broad head, short antennae and enlarged tarsal claws in the adult stage. Hygropetric taxa are highly specialised and include all known members of the families Torridincolidae and Aspidytidae, many members of the Hydraenidae, some taxa in the Dytiscidae, Elmidae (subfamily Larainae), and others.

BIOGEOGRAPHY OF SOUTHERN AFRICAN WATER BEETLES

In the checklists in this *Guide* (Appendix: p. 205), the 'known occurrence' given for each taxon is very broad-based, noted at the scale of provinces (South Africa), or countries. Particulars of localities can be found in the taxonomic literature, which is the main source of the checklists. Some taxa (for example, most species of the Hydraenidae, or the Cape-endemic taxa of the dytiscid tribe Hyphydrini) are, in all likelihood, genuinely restricted to small or very small areas. Yet again, a few water beetle species are known to be exceptionally widespread — for example, the dytiscid *Eretes sticticus*. Only for a small number of species can we be modestly confident about the extents of their occurrences. Much specialised collecting is still required before the ranges of southern African water beetles can be delimited with any confidence.

Given the rather paltry current knowledge of the ranges of southern African water beetles, together with the fact that new taxa (many species, genera, and recently even a family) are continuously being added to this fauna, generalisations may be premature and data are insufficient for formal analysis. Some apparent patterns are, however, emerging from the information hitherto accumulated.

Endemism and Species Richness

According to current knowledge, several of the water beetle families occurring in southern Africa display a high degree of endemism to the region, at both generic and specific levels (Table 1.2). Almost all the species enumerated in Table 1.2 are true water beetles. Additionally, among the shore beetles, the Heteroceridae has eight (35%) of its 23 known southern African species endemic to the subcontinent. This large proportion is probably a true reflection, as this family is unusually well known in the region.

Remarkably, much of this southern African endemism is, for the principal water beetle families, concentrated in the winter rainfall area of the Cape Provinces of South Africa. This 'Cape Region' — more-or-less delimited in the north by the east-west running Cape fold mountains and their north-south running counterparts in the east — is home to a disproportionate number of endemic genera and species (Table 1.3). The number and proportion of Cape endemics are likely to grow, with many undescribed Cape taxa already known, or at least suspected, in a couple of water beetle families. Indeed, the south-western Cape is the unique home of the first described species of the new beetle family Aspidytidae, only discovered in 2001.

The 'Cape Region' of water beetle endemism corresponds to the famously species-rich and endemic Cape Floristic Region (for example, van Wyk & Smith 2001). Within this 'Cape Region', there is a remarkable concentration of endemic water beetles on the Cape Peninsula. As far as cur-

Table 1.2. Species richness in, and endemism to, southern Africa of the genera and species of five water beetle (sub)families

Family / Subfamily	Total number of southern African genera [species]	Number of genera [species] endemic to southern Africa	% of southern African genera [species] endemic to southern Africa
Gyrinidae	4 [55]	0 [30]	0 [55]
Dytiscidae	40 [313]	8 [100]	20 [32]
Hydrophilinae	18 [138]	1 [50]	6 [36]
Hydraenidae	16 [97]	10 [95]	63 [98]
Elmidae	20 [52]	3 [34]	15 [65]

rent knowledge allows, some other centres of endemism for southern African water beetles appear to exist, examples of which are the high Drakensberg, the Kamiesberg area in the Northern Cape Province, and the eastern highlands of Zimbabwe, all three of which correspond to centres of floristic endemism as defined by van Wyk & Smith (2001), and two of which (besides the 'Cape Region') correspond to 'Endemic Bird Areas' as defined by BirdLife International (Long et al. 1996).

It is known that, at a national or regional scale, 'hotspots' of endemism and of species richness are generally not coincident. After formal analysis of distribution patterns of six South African vertebrate taxa, Lombard (1995) concluded that centres of species richness are concentrated in the north-eastern areas of South Africa, whereas endemism is concentrated in the south-west. This pattern is also discernible among the water beetles of the region, although formal analyses are still to be performed, if and when adequate data become available.

WATER BEETLES, ECOSYSTEMS, AND HUMANKIND

In their various freshwater habitats, water beetles play vitally important roles in ecosystem functioning: in the decomposition of organic matter, the consumption of freshwater plants, as predators on other freshwater animals (including other beetles), and as prey to yet other aquatic animals (again, including other beetles). Besides all this, certain water beetles also have direct and indirect relationships with humankind.

Biological Monitoring

Many aquatic invertebrate organisms, including water beetles, are sensitive to changes in water quality and habitat. Because of their short life

Table 1.3. Species richness in, and endemism to, the Cape winter rainfall region of the genera and species of five water beetle (sub)families

Family/ Subfamily	Number of genera [species] present in the Cape Region	Number of genera [species] endemic to the Cape Region	% of Cape genera [species] endemic to the Cape Region	% of total southern African genera [species] restricted to Cape Region	% of southern African endemic genera [species] restricted to Cape Region
Gyrinidae	4 [15]	0 [8]	0 [53]	0 [15]	– [27]
Dytiscidae	27 [78]	6 [31]	22 [40]	15 [10]	75 [31]
Hydrophilinae	11 [35]	0 [17]	0 [49]	0 [12]	– [34]
Hydraenidae	12 [62]	4 [51]	33 [82]	25 [53]	40 [54]
Elmidae	4 [18]	2 [10]	50 [56]	10 [19]	67 [29]

cycles, changes in the composition and structure of aquatic invertebrate communities are often the first signs of changes in the overall condition of freshwater habitats. Aquatic invertebrates are particularly good indicators of localised conditions, over the short term (months). Many bottom-dwelling macroinvertebrates are sensitive to environmental disturbances in freshwater ecosystems and such groups (including certain water beetles) are extremely useful as 'indicator species' for environmental monitoring.

Different invertebrate taxa respond differently to environmental impacts, such as water pollution; based on their particular tolerances to pollution these taxa can be scored differentially on sensitivity scales (Dickens & Graham 2002). For example, among water beetles, and generalised at the family level, adult and larval Gyrinidae, Dytiscidae and Hydrophilidae score as highly tolerant to water pollution, albeit at the low end of the category; Hydraenidae are moderately tolerant to pollution; whereas larval Scirtidae have very low tolerance to pollution.

Water Beetles: Conservation and Biocontrol Aspects

The conservation of water beetles, other aquatic life, and aquatic ecosystems is contingent on habitat conservation. Taxonomic constraints are a severe burden when it comes to assessing the conservation status of water beetles in southern Africa. Indeed, excruciatingly little is known about these creatures in our region and it is a sincere wish of the author that this *Guide* will promote the study of water beetles in southern Africa.

There are no invasive water beetles, either native or alien, known to be present in southern Africa. The weevils (Curculionidae) that have been introduced into southern Africa for the biological control of aquatic weeds (see Chapter 22) are, per definitions, alien and naturalised (de Moor & Bruton 1988: p2). However, following de Moor & Bruton's (1988) definitions, these weevils are neither invasive species nor pest species. To the contrary, they are beneficial to the freshwater environment.

As for how many water beetle species may be threatened or endangered, we stand ignorant. Centinelan extinctions (extinctions unknown to humankind, and even extinctions of species never known to humankind before their extinction) may be rampant (Samways 2005).

METHODS USED IN THE STUDY OF WATER BEETLES

Methods used in the collection and study of water beetles are outlined in Chapter 23. Readers should also consult the following publications for more information on this topic and the preservation of specimens: Volume 1 of the present series of *Guides* (Day, in prep.), Uys & Urban (2006) and McCafferty (1998).

NOTES ON THE USE OF TAXONOMIC KEYS

Taxonomic keys can be daunting and are sometimes the cause of much despair to biologists. The 'useful hints' mentioned below should be of assistance.

* Do not force an identification upon an unknown specimen if it does not key out readily. Remember that non-aquatic beetles are often found in natural waters and that certain methods of obtaining water beetles, especially shore-washing, may lead to the inadvertent capture of non-aquatic taxa.
* Not all species of all families will always key out correctly. Once having arrived at a family name in the key, the figures and descriptions in the chapters to follow should help to confirm or reject the identification. Furthermore the 'Useful References' may be of help, or you may consider consulting a professional entomologist.
* In dry specimens, long hairs usually fall flat and may stick to the surfaces of the body or appendages, where they may be overlooked.
* Hydrofuge pubescence appears dull.
* As it is most often necessary to examine structures on the underside of adult beetles, it is advisable to mount them on card triangles ('points') rather than card platforms. This is not the ‘traditional’ method in South Africa, but a good, clean break with tradition is sometimes advisable. The handbook by Uys & Urban (2006) is readily available and should be consulted about specimen preparation and preservation. Immature specimens should be retained in preservative fluid, preferably 70–80% ethanol.
* Arbitrary size classes have been standardised throughout this *Guide* and are explained at the beginning of the Glossary of Terms on p 231. The given lengths are only for southern African species, as far as is known.
* There are always exceptions.

NOTE: In the keys to adults and larvae that follow, cross-references are frequently given to figures that appear in other chapters of this *Guide*. To facilitate the use of the keys, selected figures that illustrate important features have been duplicated and printed as 'Additional Plates' (abbreviated as 'AP1'–'AP5') at the end of this chapter (pp. 39–43). If readers wish for more detail, however, they are advised to also consult the figures in other chapters.

KEY TO THE FAMILIES OF SOUTHERN AFRICAN WATER BEETLES: ADULTS

NOTE: Scirtidae, Psephenidae and Ptilodactylidae are not included in this key, as they are 'false' water beetles with terrestrial adults.

1. Head anteriorly formed into a distinct cylindrical rostrum ('snout', 'beak') (Fig. 1.3A); antenna markedly elbowed, with a symmetrical club at the end (Fig. 1.3A); body length[3] 1.5–5 mm ..... Curculionidae (habitus Fig. 22.1A)

– Head without a rostrum; antenna not markedly elbowed, with or without a club; body length various, 1–50 mm 2

2. Hind wings with fringes of hairs along their anterior and posterior margins (arrowed in Fig. 1.3B); apical portion of hind wing rolled in resting position, not folded; tarsi may be three-segmented (four- or five-segmented in Torridincolidae); minute or small beetles (body length 1–2.5 mm) (MYXOPHAGA) 3

– Hind wings without fringes of hairs along their margins; apical portion of hind wing folded in resting position (as is usual with beetles); at least hind tarsi with more than three segments; usually larger beetles (body length various, 1–50 mm, but rarely minute or small[4]) 5

3. Body fusiform; elytra shortened (arrowed in Fig. 1.3D), leaving three or four abdominal tergites exposed (Fig. 1.3D); antenna five- or eight-segmented, with apical segment enlarged; six abdominal sternites visible, narrowing to the rear; body length 1–2 mm .... Hydroscaphidae[5] (habitus Fig. 2.2A)

– Body not fusiform, distinctly convex or somewhat flattened; elytra not shortened, covering abdominal tergites (as in Figs 2.1A: AP1; 2.3A: AP1); antennae nine- or eleven-segmented; fewer than six abdominal sternites visible, not narrowing to the rear 4

4. Minute beetles, about 1 mm in length; strongly convex, almost globose; black, smooth and shiny (Fig. 2.3A:AP1); antenna relatively long, not stout, eleven-segmented, including an apical three-segmented club (Fig. 2.3A:AP1); first two antennal segments not modified as in Torridincolidae, below; tibiae expanded (arrowed in Fig. 2.3A: AP1); tarsi small, three-segmented, with small claws; three abdominal sternites visible .... Sphaeriusidae (habitus Fig. 2.3A: AP1)

– Larger beetles, about 1.5–2.5 mm in length; convex and laterally rounded, but not globose (*Delevea*), or flattened, with distinct pronotal/elytral angle (*Torridincola*, Fig. 2.1A: AP1); very dark or black, frequently with metallic sheen; antenna short, stout, nine- or eleven-segmented, not distinctly clubbed, but segments may enlarge towards apex (Fig. 1.3C), with first two antennal segments modified into an urn-shaped structure (Fig. 1.3C); tibiae not expanded; tarsi of 'normal' size, four- or five-segmented, with comparatively large claws (arrowed in Fig. 2.1A: AP1); four or five abdominal sternites visible .... Torridincolidae (habitus Fig. 2.1A: AP1)

[3]Length without rostrum.
[4] If minute or small, then habitus not as in Fig. 2.1A, 2.2A: AP1 or 2.3A: AP1.
[5] Not to be confused with the common littoral family Staphylinidae, of which the antennae are eleven-segmented and filiform or gradually expanding towards the apex.

5. First abdominal ventrite completely divided (interrupted in the middle) by hind coxae (arrowed in Figs 1.3E; 1.4C, F–G), or entirely overlaid (not visible) by hind coxae that are expanded into large plates (Fig. 1.3G) (HYDRADEPHAGA) 6
– First abdominal ventrite extending (and visible) for its entire breadth behind the hind coxae (arrowed in Fig. 1.3F) (POLYPHAGA) 10

6. Each eye completely divided into two parts by lateral margin of the head, with one part dorsal and the other part ventral (Fig. 1.4A); fore legs conspicuously longer than other legs (arrowed in Fig. 1.4B); middle and hind legs extremely flattened and very short, hind legs scarcely extending beyond the margin of the body (Fig. 1.4B); body length 4–17 mm .... Gyrinidae (habitus Figs 3.1A–B)
– Eyes never divided into dorsal and ventral parts; fore legs not conspicuously longer than other legs; middle and hind legs flattened or not so, hind legs usually extending well beyond the margin of the body (e.g. Figs 1.3G; 1.4C, F–G) 7

7. Hind coxae expanded into large plates that reach the elytra laterally, and which entirely conceal the first two or three abdominal ventrites and the bases of the hind femora (Fig. 1.3G); legs hardly modified for swimming, at least hind tarsi may be slightly flattened and fringed with long swimming hairs (Fig. 4.1A: AP1); body length 2–4.5 mm ....Haliplidae (habitus Fig. 4.1A: AP1)
– Hind coxae not expanded into large plates, not concealing hind femora nor more than the first abdominal ventrite; hind coxae sometimes large, but then mainly restricted to middle section of abdomen (Figs 1.3E; 1.4C, F–G); hind legs modified for swimming or not so (i.e. flattened or not, with swimming hairs or not) 8

8. Underside of body with 'noterid platform' present (conspicuous, flat, elevated ventral structure, frequently arrowhead-shaped, extending from prosternum to hind coxae) (Fig. 1.4C); abdomen with five ventrites (including interrupted first ventrite) easily recognisable (Fig. 1.4C); strong, hooked burrowing spur present on fore tibia (Fig. 1.4D); body length 2–7 mm .... Noteridae (habitus Fig. 5.1A)
– No 'noterid platform' present (Figs 1.3E; 1.4F–G); abdomen with six ventrites (including interrupted first ventrite) easily recognisable (Figs 1.3E; 1.4F–G); no burrowing spur on fore tibia 9

9. Hind coxae large, extended anteriorly, with evenly-rounded anterior margin (shaded in Figs 1.3E; 1.4F); legs (especially hind legs, including hind tarsi) usually flattened, usually fringed with swimming hairs (Fig. 1.4E); body length 1–45 mm .... Dytiscidae (habitus Figs 6.1A–B)
– Hind coxae not strongly extended anteriorly (Fig. 1.4G); legs not flattened, without swimming hairs (lower arrow in Fig. 1.4G); body length 5–7 mm .. .. Aspidytidae (habitus Fig. 7.1A)

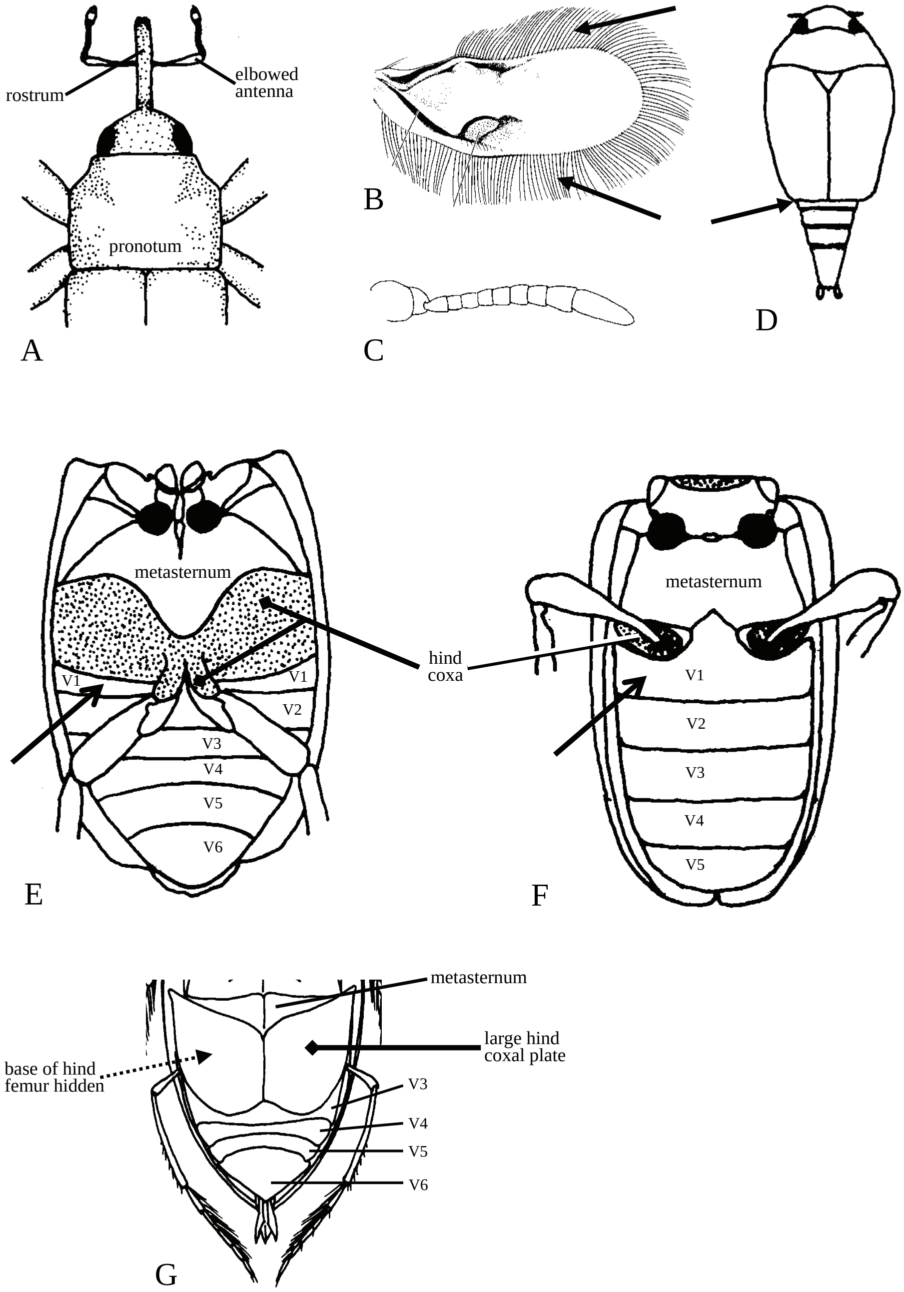

Fig. 1.3. Coleoptera, adult key diagrams. **A,** Curculionidae, fore body, dorsal; **B–D,** Myxophaga: **B,** Sphaeriusidae, *Microsporus* sp., hind wing; **C,** Torridincolidae, *Delevea* sp., antenna; **D,** Hydroscaphidae, whole insect, dorsal; **E,** Hydradephaga, Dytiscidae, thorax and abdomen, ventral; **F,** Polyphaga, thorax and abdomen, ventral; **G,** Hydradephaga, Haliplidae, thorax and abdomen, ventral. All much enlarged, not to the same scale.

10. Tarsal formula 4-4-4 or apparently 4-4-4; body not hydrodynamically streamlined 11
– All tarsi almost always five-segmented (tarsal formula 5-5-5); body hydrodynamically streamlined or not so 12

11. All tarsi appear four-segmented, but actually are five-segmented, the fourth segment being very small and nearly concealed within the lobes of the third segment (pseudotetramerous condition, Fig. 1.5A); third tarsal segment bilobed (Fig. 1.5A); none of the tibiae broadened or spinose; labrum and mandibles not visible from above; antennae long, filiform (arrowed in Fig. 1.5B); body length 6–8 mm; phytophilous water beetles .... Chrysomelidae: Donaciinae (habitus Fig. 21.1A)
– All tarsi truly four-segmented, last segment shorter than rest, third segment not bilobed (Fig. 1.5C); fore and middle tibiae broad and strongly spinose along their outer edges (Fig. 18.1A: AP1); large labrum visible from above; mandibles pointing forward and visible from above; antennae short, much thickened (Fig. 1.5D); body length 2.2–5.8 mm; shore beetles .... Heteroceridae (habitus Fig. 18.1A: AP1)

12. Antennae rather short, more-or-less distinctly and symmetrically clubbed; antennal segment 4, 5 or 6 modified to form a cupule (Figs 1.5E–I); maxillary palps usually very prominent, at least half as long as the antennae, to much longer than the antennae (e.g. Figs 1.5L–N; 11.1A–C; 13.1–13.2) 13
– Antennae either long and filiform, and then with or without a loosely articulated club (e.g. Fig. 1.6A), or short, with a compact or pectinate club (Figs 1.6B–C); no antennal cupule present; maxillary palps not prominent, usually much shorter than the antennae 18

13. Abdomen with six or seven ventrites clearly visible (Figs 1.5J; 13.4A–B); small sternite present between hind coxae (arrowed in Figs 1.5J; 13.4B); antennal club (segments past cupule) with five segments, loosely articulated (Fig. 1.5E)[6]; body flattened rather than convex; extremely small to small beetles, body length 1–3 mm .... Hydraenidae (habitus Figs 13.1–13.2)
– Abdomen with five ventrites clearly visible[7]; no separate small sternite between hind coxae; antennal club (segments past cupule) with three segments[8] (Figs 1.5G–I); body weakly to highly convex; very small to very large beetles, body length 1–50 mm 14

[6] If club segments fewer than five, then segments connate (Fig. 1.5F).
[7] If a sixth ventrite is present, it is membranous (Hydrochidae) or more-or-less retracted under the fifth (*Berosus* and *Laccobius* of Hydrophilidae).
[8] Georissidae sometimes with fewer than three club segments, but then habitus typical, as in Fig. 8.1A: AP2.

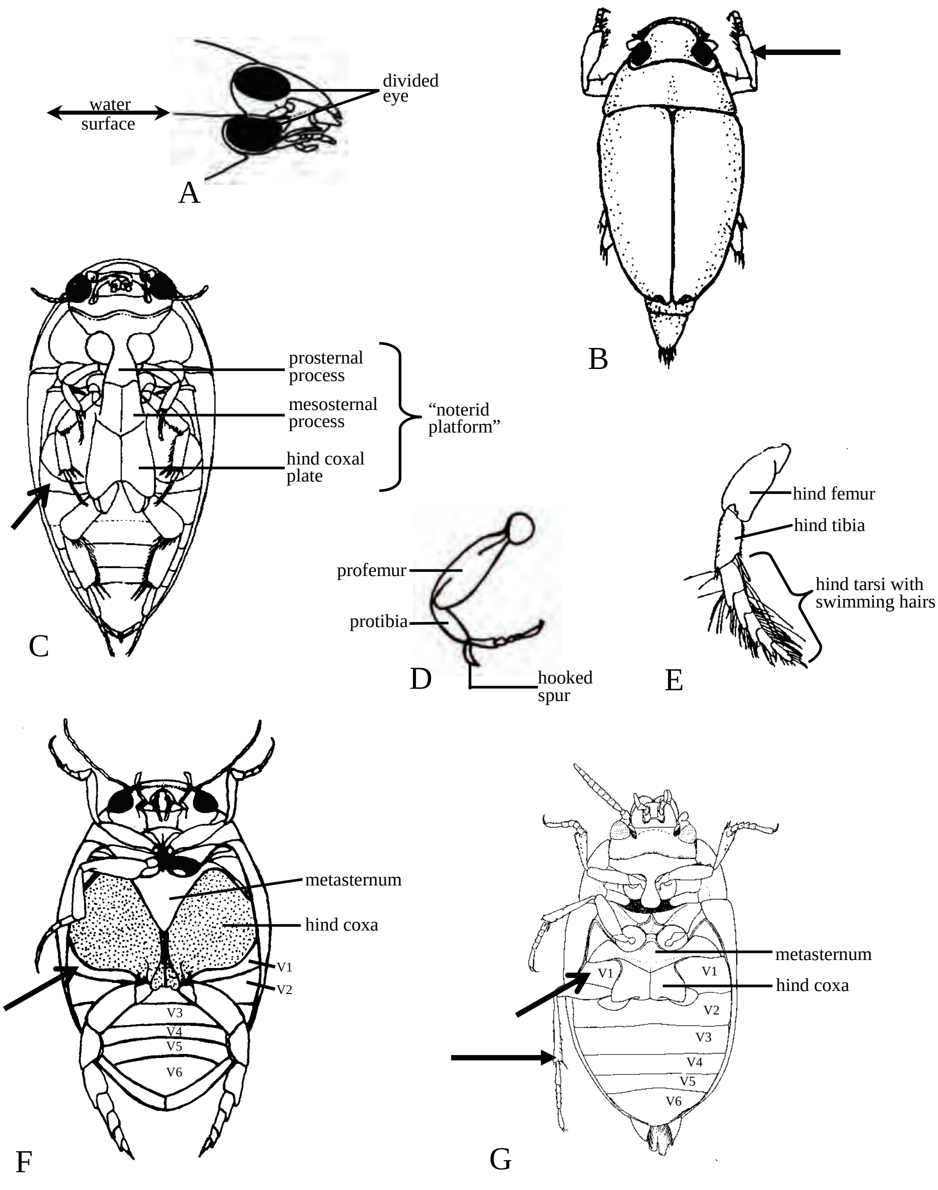

Fig. 1.4. Coleoptera, adult key diagrams. **A–B,** Gyrinidae: **A,** head with divided eye, lateral; **B,** *Orectogyrus* sp., whole insect, dorsal; **C–D,** Noteridae: **C,** whole insect, ventral; **D,** front leg with protibial spur; **E–F,** Dytiscidae: **E,** flattened hind leg with swimming hairs; **F,** *Laccophilus* sp., whole insect, ventral; **G,** Aspidytidae, *Aspidytes* sp., whole insect, ventral. All much enlarged, not to the same scale.

14. Pronotum transverse, pronotal disc with five longitudinal grooves separated from one another by raised longitudinal areas (Fig. 1.5K); body length 3.5 mm .... Helophoridae (habitus Fig. 12.1A)
– Pronotum and pronotal disc various, but never with five longitudinal grooves as in Fig. 1.5K 15

15. Cupule of antenna glabrous and preceded by five segments (as in Fig. 1.5H) 16
– Cupule of antenna glabrous or hairy, preceded by fewer than five segments (as in Figs 1.5G, I) 17

16. Body globose; head strongly directed downwards, hidden by anterior 'shelf' of pronotum (Fig. 8.1A: AP2); dorsal surface with prominent tubercles and uneven ridges (Fig. 8.1A: AP2); maxillary palps and short antennae not prominent; body length 1–3 mm ....Georissidae (habitus Fig. 8.1A: AP2)
– Body of various possible shapes, including globose; head not strongly directed downwards, usually at least partially visible from above; dorsal surface without prominent tubercles or uneven ridges as in Fig. 8.1A: AP2; maxillary palps prominent, usually as long as, or longer than, the antennae (e.g. Fig. 1.5L); body length 1–50 mm ... Hydrophilidae (habitus Figs 11.1A–C)

17. Elongate, moderately convex beetles; front margin of head (clypeus) truncate or evenly rounded (Fig. 9.1A: AP2); pronotum more-or-less square, with a typical pattern of round depressions arranged in two transverse rows (Fig. 9.1A: AP2); pronotal and elytral margins more-or-less rounded, not sharp nor toothed; antennal cupule and all preceding antennal segments glabrous (Fig. 1.5G); body length 1.5–4 mm .... Hydrochidae (habitus Fig. 9.1A: AP2)
– Broadly ovate, convex beetles; front margin of head (clypeus) produced into two points[9], sharply emarginate in-between (Figs 1.5M–N); pronotum somewhat transverse, without rows of round depressions; pronotal margin sharp and sometimes finely toothed; elytral margin sharp; second antennal segment setose, antennal cupule pubescent (Fig. 1.5I); body length 3.5–5 mm .... Spercheidae (habitus Fig. 10.1A: AP2)

[9] Sharply angulate in males (Fig. 1.5M), somewhat rounded in females (Fig. 1.5N).

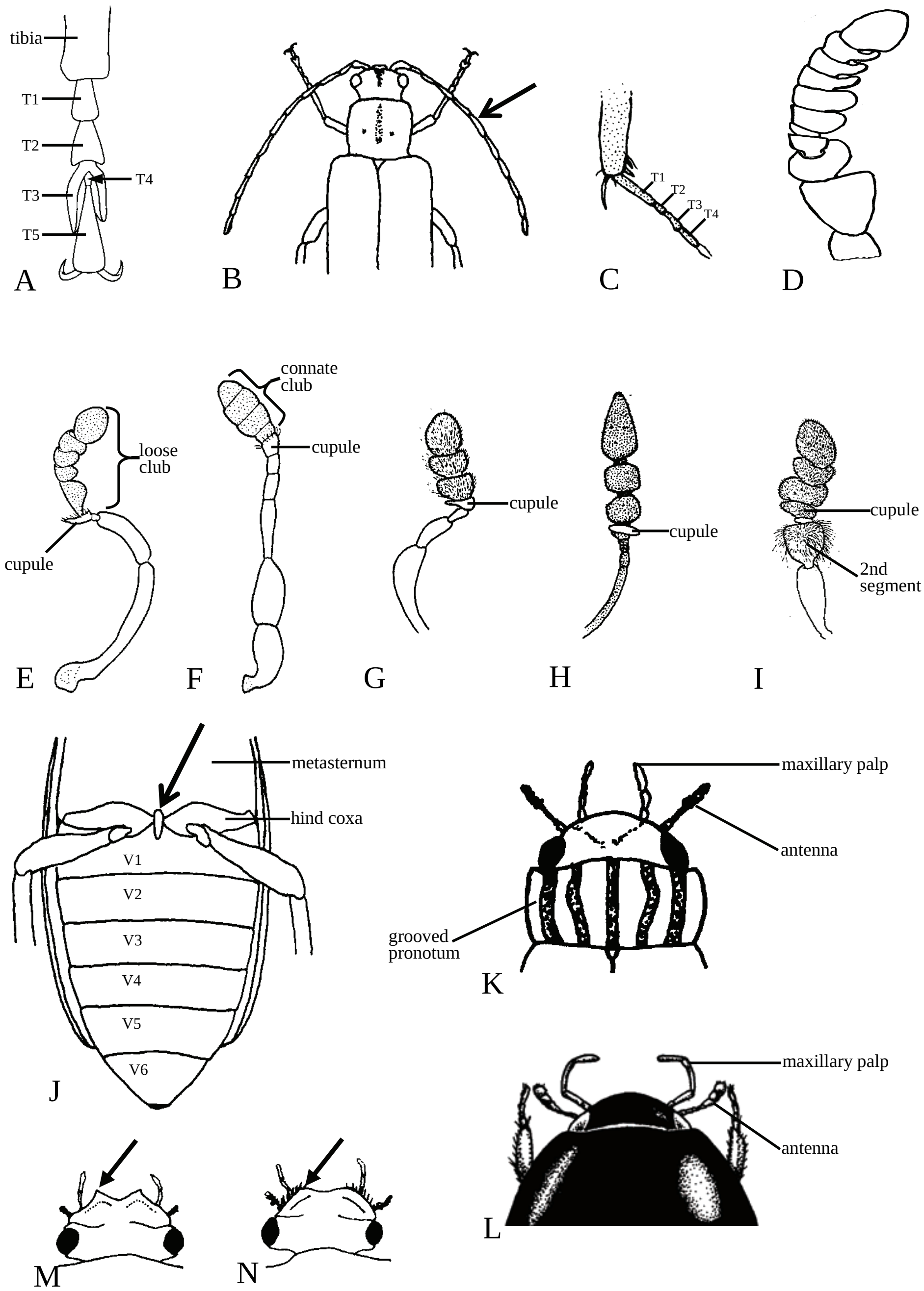

Fig. 1.5. Coleoptera, adult key diagrams. **A–B,** Chrysomelidae: Donaciinae: **A,** pseudotetramerous tarsus, dorsal; **B,** fore body with long antennae, dorsal; **C–D,** Heteroceridae: **C,** fore tarsi; **D,** antenna; **E–F,** Hydraenidae, antennae: **E,** Hydraeninae, *Hydraena* sp; **F,** Prosthetopinae, *Mesoceration* sp.; **G,** Hydrochidae, antenna; **H,** Hydrophilidae: Hydrophilinae, antenna; **I,** Spercheidae, antenna; **J,** Hydraenidae, hind body, ventral; **K,** Helophoridae, pronotum and head, dorsal; **L,** Hydrophilidae: Hydrophilinae, pronotum and head, dorsal; **M–N,** Spercheidae, heads, dorsal: **M,** male; **N,** female. All much enlarged, not to the same scale.

18. Body evenly convex and ovate; pronotal/elytral bases sinuous (arrowed in Fig. 1.6D); dorsum never with conspicuous ridges or depressions; legs slender; last tarsal segment shorter than preceding segments together, claws feeble; legs in resting position retracted into cavities extending laterally along coxae; body length 1–3 mm .... Limnichidae (habitus Fig. 17.1A)
– Body variously shaped, only rarely evenly convex; pronotal/elytral bases not sinuous as in Fig. 1.6D; dorsum often with conspicuous ridges or depressions; legs strongly built; last tarsal segment often very long (usually as long as, or longer than, preceding segments together), claws strong (Fig. 1.6E); legs not retractile, not protected in cavities 19

19. Antennae usually slender and filiform (Fig. 1.6A), usually long, easily visible, and at times capable of reaching the base of the pronotum (e.g. Figs 15.4–15.6A: AP2); second antennal segment not transverse nor much larger than other antennal segments (e.g. Fig. 1.6A); antennae never distinctly clubbed, but if clubbed, then with the segments of the club more-or-less symmetrical and loosely articulated (Figs 1.6A; 15.1A–B; 15.2B); anterior coxae rounded; body length 1–8 mm .... Elmidae (habitus Figs 15.1–15.8)
– Antennae very short and stout (Figs 16.1A: AP2; 16.1D), antennae and maxillary palps at times inconspicuously small; second antennal segment more-or-less transverse, asymmetrical, and much larger than other antennal segments (Figs 1.6B–C); six or more apical segments of antenna forming a compact or pectinate club (Figs 1.6B–C); anterior coxae transverse; body length 2–8 mm .... Dryopidae (habitus Figs 16.1–16.2)

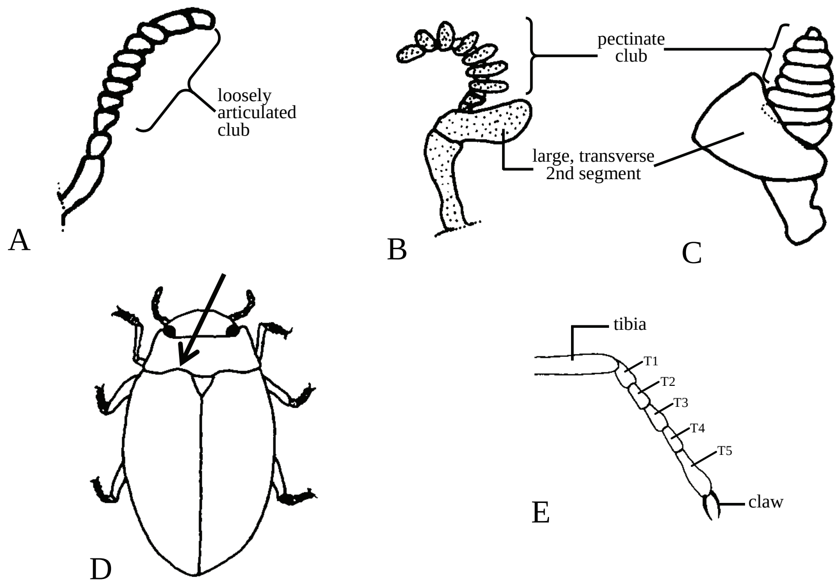

Fig. 1.6. Coleoptera, adult key diagrams. **A,** Elmidae, *Potamogethes* sp., antenna; **B–C,** Dryopidae, antennae: **B,** *Ahaggaria* sp.; **C,** *Dryops* sp.; **D,** Limnichidae, whole insect, dorsal; **E,** Elmidae, *Potamodytes* sp., hind tarsi. All much enlarged, not to the same scale.

KEY TO THE PRINCIPAL FAMILIES OF SOUTHERN AFRICAN WATER BEETLES: LARVAE

NOTE: Because the larvae of the Helophoridae and the Dryopidae are terrestrial, these families are not included in this key. The larvae of the southern African shore beetle families (Sphaeriusidae, Georissidae, Limnichidae and Heteroceridae) are also not included in this key, nor are the tiny larvae of the Hydroscaphidae. Shore beetle larvae may, however, be found in water, especially when using the shore-washing technique.

Larvae of all families, including those excluded from this key, are diagnosed and illustrated in the chapters to follow.

1. Larva without legs; body grub-like (Fig. 1.2J); narrowly associated with a host food plant (aquatic or emergent plants) .... Curculionidae (habitus Figs 1.2J; 22.1B)
– Larva with thoracic legs present; body variously shaped, including grub-like; not necessarily narrowly associated with a host food plant 2

2. Antennae remarkably long, with a multi-segmented flagellum[10], as long as or (much) longer than the thorax (Fig. 1.7A) .... Scirtidae (habitus Figs 14.1B–C)
– Antennae short, without long flagellum (antennae clearly shorter than the thorax) 3

3. Body onisciform, i.e. strongly flattened, broadly oval, with body margins expanded, and more-or-less smooth in outline (Figs 1.2E–G; 1.7B–C) 4
– Body not onisciform, but more-or-less elongate and more-or-less cylindrical (e.g. Figs 1.2A–D) 6

4. Head entirely ventral, completely concealed by thoracic segment(s) and not visible from above (Figs 1.7B–C); dense spiracular brushes either present ventrally on four or more of the first seven abdominal segments (Fig. 1.7C), or present posteriorly as anal gill tufts (Figs 19.1C–D: AP3); larvae live flatly appressed onto stones in running water .... Psephenidae (habitus Figs 19.1A–D: AP3)
– Head more-or-less directed to the front, clearly visible from above; no ventral spiracular brushes present (e.g. Figs 1.2A–D) 5

5. Abdominal segments 1 to 8 with lateral or dorsolateral gills which are long, narrow and segmented (Fig. 1.2G); head clearly separated from pronotum, having a 'neck' posteriorly (Fig. 1.2G); abdomen without operculum or opercular hooks; mature larvae very small .... Torridincolidae (habitus Fig. 2.1B)
– Abdominal segments without lateral gills; head somewhat retracted into pronotum; abdomen with operculum at base of segment 9 covering abdominal gills, opercular hooks present (Figs 1.7I; 15.9A–C); mature larvae not necessarily very small .... Elmidae (part)

[10]multiarticulate third antennal segment

6. Mesothoracic (middle) leg with six segments (including pretarsus); one or two claws per leg (Figs 1.7D–E) (HYDRADEPHAGA) 7
– Mesothoracic (middle) leg with fewer than six segments (including pretarsus); a single claw per leg (Fig. 1.7F) (POLYPHAGA) 11

7. Ten abdominal segments clearly visible in dorsal view[11] (Figs 3.1E: AP3; 4.1C–D: AP3); body in dorsal view parallel-sided rather than spindle-shaped (e.g. Fig. 1.2A) 8
– Eight or nine abdominal segments visible in dorsal view (Figs 5.1.D: AP4; 6.1C–D: AP4); body in dorsal view frequently more-or-less spindle-shaped (e.g. Fig. 1.2B) 9

8. Tarsi each with two claws (Fig. 1.7D); body feebly sclerotised; tenth (last) abdominal segment formed into a pygopod and bearing two pairs of conspicuous apical hooks (Fig. 1.7G); abdominal segments 1 to 8 each with a pair of feathery lateral gills, segment 9 with two pairs (Figs 1.7G; 3.1E: AP3 ....Gyrinidae (habitus Fig. 3.1E: AP3)
– Tarsi each with one claw (Fig. 1.7E); body well sclerotised; no pygopod or apical hooks present at end of abdomen; thoracic tergites and abdominal tergites 1 to 7 with explanate lateral edges (*Haliplus*, Fig. 4.1C: AP3), or thoracic and abdominal segments each with four or more long, tergal processes that are not feathery (*Peltodytes*, Fig. 4.1D: AP3) .... Haliplidae (habitus Figs 4.1C–D: AP3)

9. Legs short, stout, adapted for digging; abdominal segments 9 and 10 either absent or completely concealed from above (eighth abdominal segment produced over ninth segment to form a pointed, wedge-shaped apex that bears the small spiracles, Fig. 5.1D: AP4); urogomphi shorter than the last abdominal segment; often in mud around the roots of aquatic plants .... Noteridae (habitus Fig. 5.1D: AP4)
– Legs not short and stout, adapted for crawling or swimming; eighth abdominal segment not produced over ninth segment to form a pointed apex; urogomphi usually longer than the last abdominal segment[12] (Figs 6.1C–D; 7.1D: AP4) 10

10. Eighth abdominal segment with large, dorsally orientated spiracles (arrowed in Fig. 7.1D: AP4); legs without adaptations for swimming; hygropetric .... Aspidytidae (habitus Fig. 7.1D: AP4)
– No spiracles dorsally orientated, spiracles of last segment apically orientated; legs frequently modified for swimming; microhabitats various, including hygropetric .... Dytiscidae (habitus Figs 6.1C–D: AP4)

11. Strong, curved respiratory hooks present on tergum of eighth abdominal segment (Figs 1.7H; 21.1D: AP4); body somewhat grub-like and lightly sclerotised (Fig. 1.2K); narrowly associated with a host food plant (aquatic or emergent plants) ... Chrysomelidae: Donaciinae (habitus Figs 1.2K; 21.1C)
– No curved respiratory hooks present towards end of abdomen; body not grub-like, but more-or-less elongate and cylindrical; not narrowly associated with a host food plant 12

[11] Tenth abdominal segment may be rather small or rudimentary, apparently absent, but only apparently.
[12] If the urogomphi are shorter than the last abdominal segment, then the legs are elongate and fringed with swimming hairs.

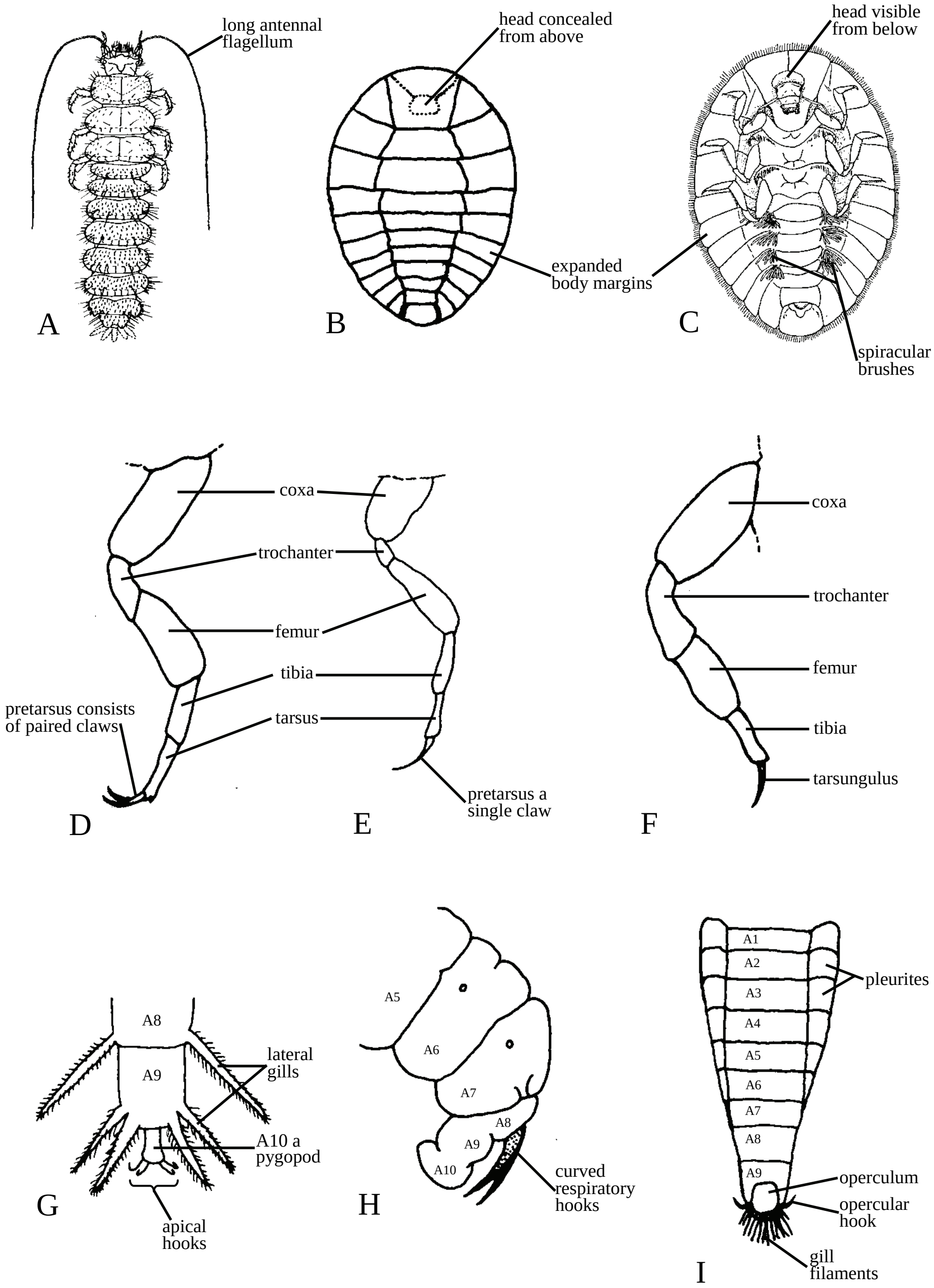

Fig. 1.7. Coleoptera, larval key diagrams. **A,** Scirtidae, *Elodes* sp., dorsal; **B–C,** Psephenidae: **B,** dorsal; **C,** ventral; **D–E,** hypothetical hydradephagans, mesothoracic legs; **F,** hypothetical polyphagan, mesothoracic leg; **G,** Gyrinidae, hind end of body, ventral; **H,** Chrysomelidae: Donaciinae, hind end of body, lateral; **I,** Elmidae, hind end of body, ventral. All much enlarged, not to the same scale.

12. Abdomen with six or more pairs of pleurites (Fig. 1.7I); ninth abdominal sternum forming a movable operculum that usually covers a terminal chamber (Figs 1.2D; 1.7I; 15.9C); chamber laterally with a prehensile opercular hook ('claw') on each side (Figs 1.7I; 15.9C); retractile anal gills present under operculum, forming three tufts (Fig. 1.7I; 15.9C) .... Elmidae (part) (habitus Figs 15.9A–B)
– Abdomen without pleurites; last abdominal segments without an operculum or opercular hooks, anal gills present or absent 13

13. Nine strongly sclerotised abdominal segments with subterminal membranes (Fig. 20.1A: AP5), tenth abdominal segment with two spine-bearing, cone-shaped prolegs (Fig. 20.1B: AP5) .... Ptilodactylidae (habitus Fig. 20.1A: AP5)
– Tenth segment, if discernable, not forming two spine-bearing, cone-shaped prolegs 14

14. Apex of abdomen forms a respiratory chamber[13] (atrium) where the terminal, and usually only functional, spiracles are situated (Figs 1.12B–C) 15
– Apex of abdomen without a respiratory chamber 16

15. Body cylindrical and parallel-sided; all segments (particularly thoracic segments) well sclerotised and distinct .... Hydrochidae (habitus Fig. 9.1C)
– Body usually dilated in middle, less firmly sclerotised; segmentation less distinct .... Hydrophilidae (part) (habitus Figs 11.2B–C)

16. Abdomen with long, tubular, lateral tracheal gills (Figs 1.2C; 11.2A) .... Tribe Berosini (Hydrophilidae) (habitus Fig. 11.2A)
– Abdomen without long lateral gills 17

17. Legs well developed but not conspicuously long (Fig. 13.8C: AP5); abdomen ten-segmented, tenth segment transformed into a pygopod, usually bearing a pair of ventrally-pointing hooks .... Hydraenidae (habitus Fig. 13.8C: AP5)
– Legs conspicuously long (Fig. 10.1B: AP5); abdomen nine-segmented (Fig. 10.1B: AP5); first eight abdominal segments with lateral setose processes (Fig. 10.1B: AP5) .... Spercheidae (habitus Fig. 10.1B: AP5)

[13] Respiratory pocket formed by the eighth and ninth terga, enclosing the enlarged spiracles of the eighth abdominal segment.

GENERAL STATE OF KNOWLEDGE AND RELEVANT LITERATURE

The aquatic beetle fauna of southern Africa is reasonably well described taxonomically, but the level of treatment is uneven among the various groups. For the southern African fauna, 'adequate' revisionary studies have only been published on some Myxophaga, Gyrinidae, Dytiscidae (in part), Aspidytidae, Spercheidae, much of the Hydrophilidae, most of the Hydraenidae, and some byrrhoid genera. References are given in the chapters to follow. Some of these studies are several decades old, and although taxonomic publications have a long shelf life, additions, reassessments, reanalyses and updates are continuously required.

Of the various types of taxonomic literature, systematic catalogues are perhaps the most useful. As biotic inventories, systematic catalogues summarise current knowledge and serve as an entry point to that knowledge. It is gratifying to learn of numerous current cataloguing efforts, at local and global scales, both in print and on-line. These are also referred to in chapters to follow.

Much descriptive work remains to be done, with many undescribed taxa lurking in specimen collections, and probably even more still to be collected. For some groups — for example, the Hydrochidae, Elmidae and Dryopidae — species descriptions are scattered through mostly-obscure scientific literature, and revisionary work is sorely needed to make sense of what is known. Quite a number of groups of southern African water beetles are suffering serious neglect (for example, Scirtidae and Georissidae). Fortunately, a number of other groups (viz. Hydraenidae, Limnichidae, Heteroceridae, Psephenidae) are presently being studied and undergoing taxonomic revisions.

In general, very little is known of water beetle immature stages, but there is a contemporary surge of activity in describing water beetle larvae in minute detail, especially within a phylogenetic framework, and including southern African kinds. Published accounts of the life histories, biology or ecology of southern African water beetles are very scarce, and this kind of information is mostly 'hidden' in taxonomic treatments.

As has been the case for other guides published in this series, the text has not been fully referenced, and the lists of references may also include some publications not cited in the text, but that are useful for further study. Throughout, there are references to phylogenetic studies, which may seem out of place in an identification guide such as this. The contrary is true, however: phylogenetics papers are frequently a valuable source of in-depth information on the morphology and diversity of the organisms under scrutiny.

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SELECTED USEFUL INTERNET RESOURCES (WATER BEETLES, GENERAL)

Cautious of the ephemeral nature of some websites, and mindful of new ones springing into life relentlessly and unexpectedly, only a smattering of internet resources are suggested in this *Guide*. Modern search engines, or whatever will supersede them, can be used to track down water beetle information on the internet, information of which there is a very large amount.

The Aquatic Arthropods (Insects, Crustaceans and Mites) of South(ern) Africa. http://www.ru.ac.za/aquatalogue or http://www.ru.ac.za/academic/departments/zooento/Martin/Aquatics.html [accessed April 2007].

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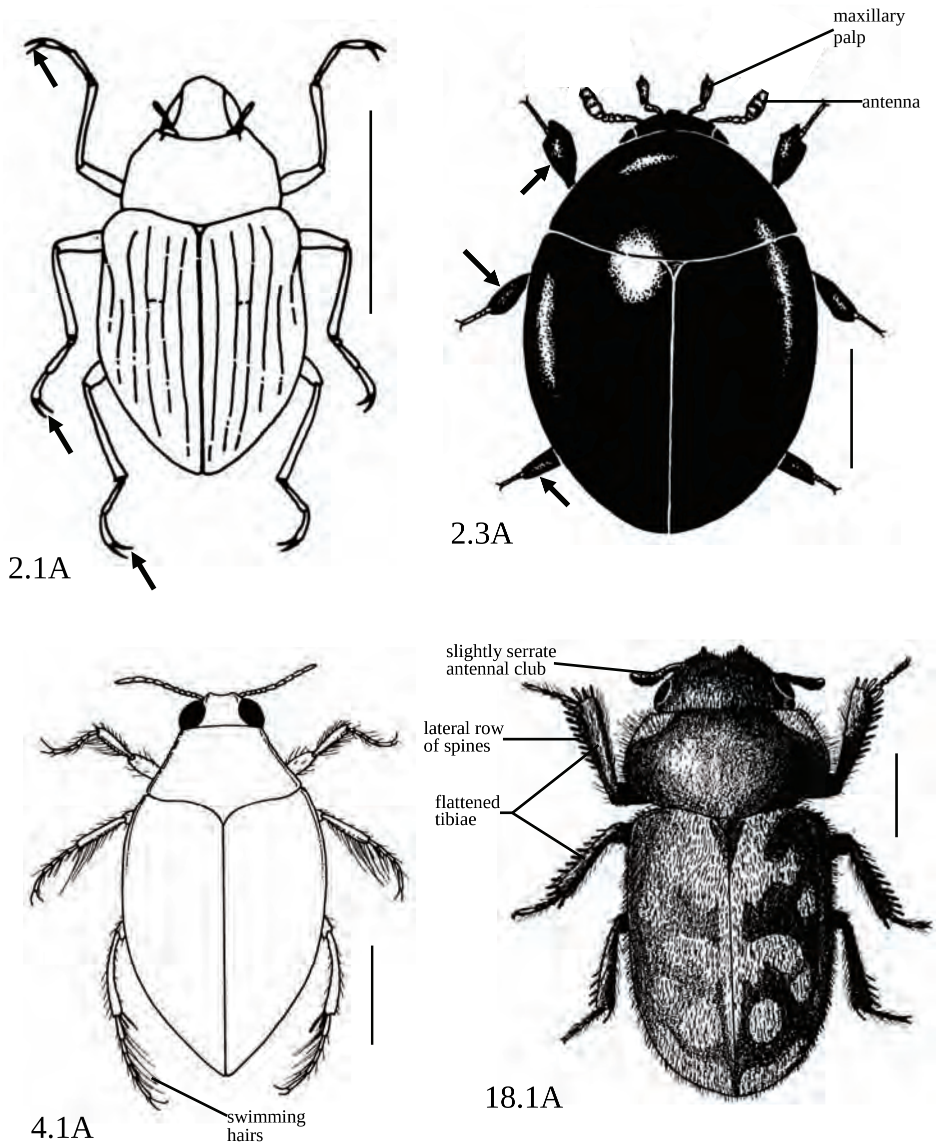
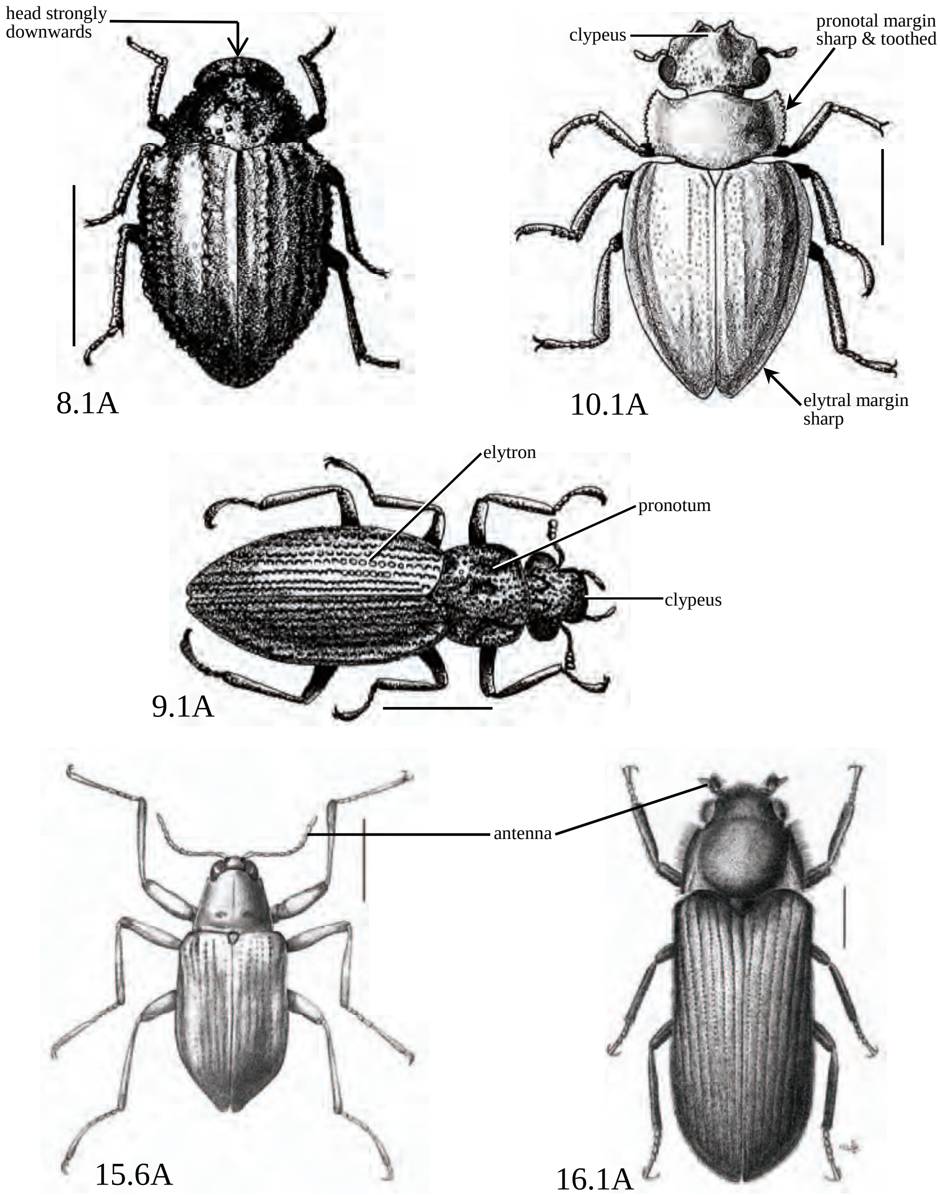
CHAPTER 1 APPENDIX: ADDITIONAL PLATES



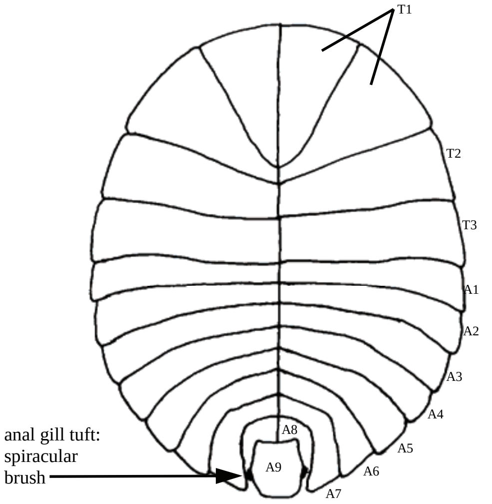
Additional Plate 1 (AP1)

Fig. 2.1A. Torridincolidae, *Torridincola rhodesica,* adult, dorsal view. Scale bar = 1 mm.
Fig. 2.3A. Sphaeriusidae, *Microsporus* sp., adult, dorsal view. Scale bar = 0.2 mm.
Fig. 4.1A. Haliplidae, *Haliplus* sp.**,** adult, dorsal view. Scale bar = 1 mm.
Fig. 18.1A. Heteroceridae, *Heterocerus* sp., adult, dorsal view. Scale bar = 1 mm.



Additional Plate 2 (AP2).

Fig. 8.1A. Georissidae, *Georissus* sp., adult, dorsal view. Scale bar = 1 mm.
Fig. 9.1A. Hydrochidae, *Hydrochus* sp., adult, dorsal view. Scale bar = 1 mm.
Fig. 10.1A. Spercheidae, *Spercheus* sp., adult, dorsal view. Scale bar = 1 mm.
Fig. 15.6A. Elmidae: Elminae, *Pseudomacronychus scutellatus*, adult, dorsal view. Scale bar = 1 mm.
Fig. 16.1A. Dryopidae, *Ahaggaria* sp., adult dorsal view. Scale bar = 1 mm.



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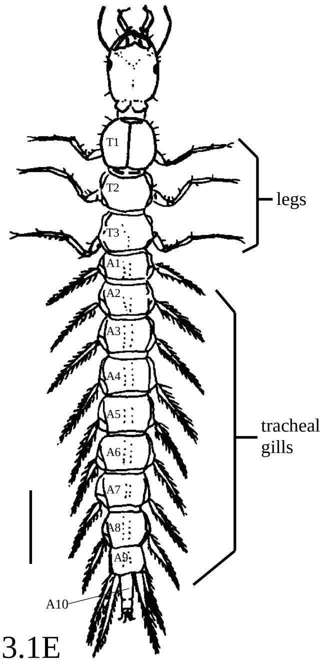

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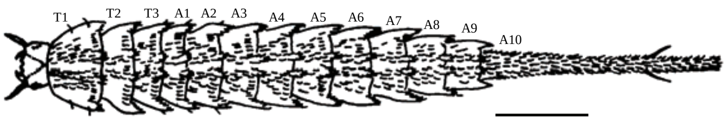
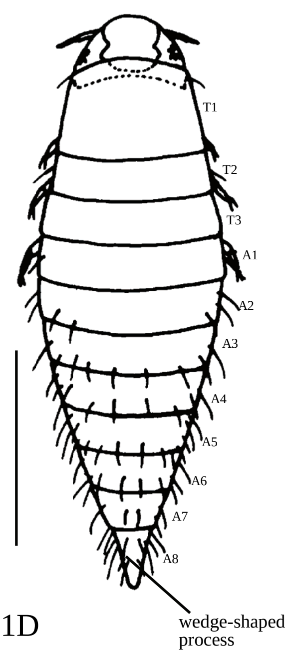


4.1C

4.1D

Additional Plate 3 (AP3)

Fig. 19.1D. Psephenidae: Eubriinae, *Afroeubria sebastiani*, larva, dorsal view. Much enlarged.
Fig. 3.1E. Gyrinidae, *Dineutus* sp., larva, dorsal view. Scale bar = 1 mm.
Fig. 4.1C. Haliplidae**,** *Haliplus* sp., larva, dorsal view. Scale bar = 1 mm.
Fig. 4.1D. Haliplidae, *Peltodytes* sp., larva, dorsal view. Scale bar = 1 mm.



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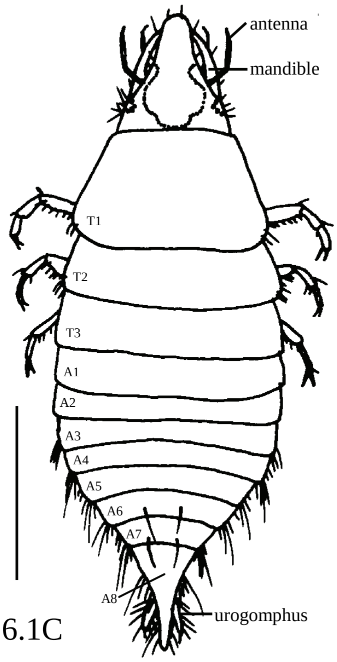
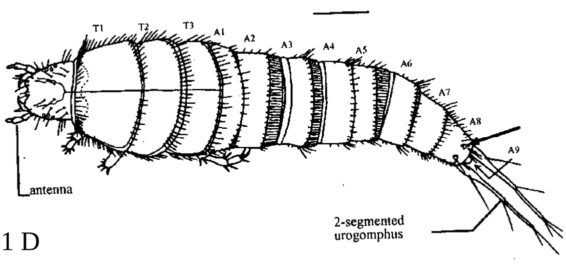
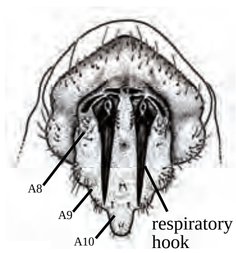


6.1C



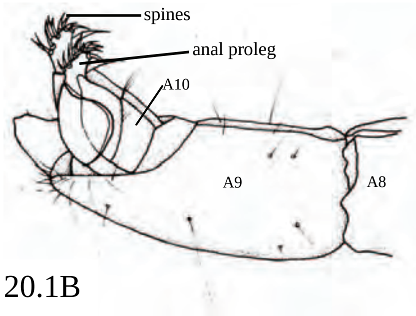
7.1 D



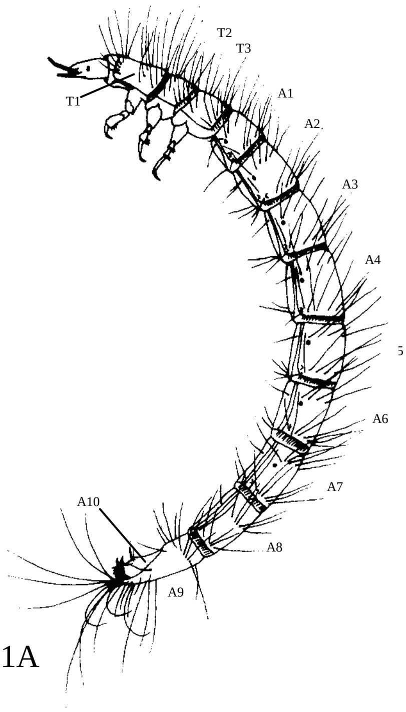
21.1D

Additional Plate 4 (AP4)

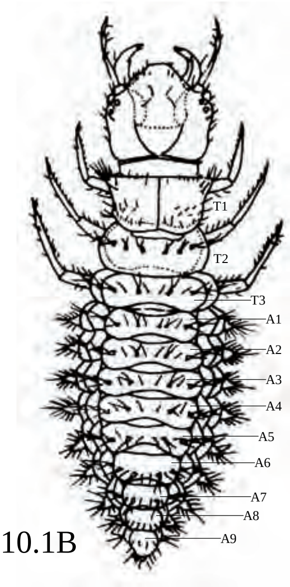
Fig. 5.1D. Noteridae, *Hydrocanthus* sp., larva, dorsal view. Scale bar = 1 mm.
Fig. 6.1C. Hydroporinae, *Hydrovatus* sp., larva, dorsal view. Scale bar = 1 mm.
Fig. 7.1D. Aspidytidae, *Aspidytes niobe*, larva, dorsal view. Scale bar = 1 mm.
Fig. 21.1D. Chrysomelidae: Donaciinae, *Donaciasta goeckei*, larva, posterior view, showing curved, channeled respiratory hooks. Much enlarged.



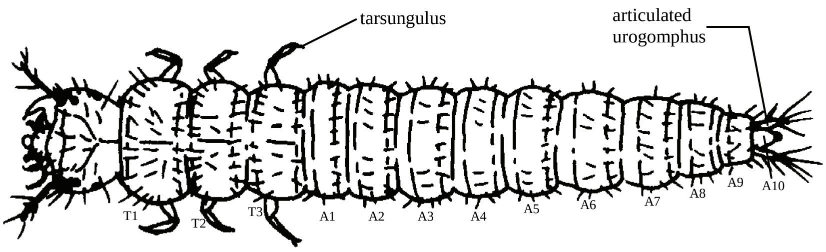
20.1B



21.1A



10.1B



13.8C

Additional Plate 5 (AP5)

Fig. 20.1A. Ptilodactylidae, unidentified larva, lateral view. Much enlarged.
Fig. 20.1B. Ptilodactylidae, unidentified larva, abdominal apex, lateral view (ventral above). Much enlarged, not to scale.
Fig. 10.1B. Spercheidae, *Spercheus* sp., larva, dorsal view. Much enlarged.
Fig. 13.8C. Hydraenidae, *Ochthebius* sp., larva, dorsal view. Much enlarged.

CHAPTER 2

MYXOPHAGA

by

M.H. Villet & S. Endrödy-Younga†

Beetles of the families making up the suborder Myxophaga are characteristically small: adults of the largest species reach lengths of 2.7 mm, and most representatives are much smaller. Larvae and adults are usually found on submerged rocks (Torridincolidae and Hydroscaphidae) or moist riverside substrates (Sphaeriusidae). They all apparently feed, chiefly or entirely, on chlorophytic algae or Cyanophyta. Adult myxophagans trap air in plastrons or beneath their elytra, while their larvae have balloon-like spiracular gills that are unique among the Coleoptera. Pupation occurs in the last larval exuviae.

Unique, identifying, but easily discernible, features of the Myxophaga adults that occur in southern Africa include the presence of fringes of hairs along the anterior and posterior margins of the hind wings (Fig. 1.3B) and the rolling of the apices of the hind wings when they are furled. The hind margins of the abdominal tergites may bear regular rows of lancet-shaped setae (arrowed in Fig. 2.2A).

Myxophagan larvae vary in shape from subcylindrical to disc-like, and from convex to flattened. They characteristically have a broadened head and short, two-segmented antennae.

The Myxophaga comprises four families: the Lepiceridae (false minute mud-loving beetles), the Torridincolidae (minute hygropetric beetles), the Sphaeriusidae (= Sphaeriidae [preoccupied], = Microsporidae) (minute bog beetles), and the Hydroscaphidae (skiff beetles). Lepiceridae are not known from southern Africa.

Family **TORRIDINCOLIDAE**

Larvae and adults of the small family Torridincolidae (minute hygropetric beetles) are aquatic and mostly hygropetric, crawling on submerged rocks in rapid waters, and apparently feeding on algae. Functionally they are true water beetles. Members of the endemic southern African genus *Delevea* live in temporary mountain streams. Adults of the genus *Torridincola* have ventral cuticular reticulations that enable the formation of a plastron for respiration, while larvae and pupae breathe by means of elongated spiracular gills. The reproductive biology of the Torridincolidae is poorly known.

Adults (Fig. 2.1A) are very small, 1.5–2.5 mm long, ovate, moderately convex, and very dark to black. The head is strongly retracted, with forward-facing mandibles and short, stout antennae that have the first two segments modified into an urn-shaped structure of uncertain function (Fig. 1.3C). The pronotum is rounded. The legs are long, slender and strongly clawed (arrowed in Fig. 2.1A). Variations in this basic design are summarised in the key to adults.

Larvae are subcylindrical (*Delevea*) or disc-shaped and strongly flattened (*Torridincola*) (Fig. 2.1B), with mandibles that face forward. A distinct swelling on the side of the head bears three or four stemmata. The gills of larval Torridincolidae occur on abdominal segments 1 to 8 and are segmented (Fig. 2.1B).

Pupation takes place in the water and it is not impossible that the eggs, which are apparently not yet known, are also deposited underwater. Torridincolidae are probably the "most aquatic" of the beetle families.

KEY TO THE SOUTHERN AFRICAN GENERA OF TORRIDINCOLIDAE: ADULTS

1. Body distinctly convex, rounded laterally; antennae nine-segmented; eyes kidney-shaped; elytra striated and bare; tarsi four-segmented; sternite 7 with plastron .... *Torridincola* (Fig. 2.1A)

– Body flattened, with distinct pronotal-elytral angle; antennae eleven-segmented; eyes not kidney-shaped; elytra not striated, bearing short recumbent hairs; tarsi five-segmented; sternite 7 without plastron…………*Delevea*

KEY TO THE SOUTHERN AFRICAN GENERA OF TORRIDINCOLIDAE: LARVAE

1. Body subparallel and subcylindrical; thorax not strongly broadened, shorter than abdomen, thoracic tergites bearing long contact hairs on their lateral margins; spiracular gills lateral on abdominal segments; abdominal segment 9 with fixed, relatively elongate urogomphi on posterolateral margins; sternite 9 well developed .... *Delevea*

– Body disc-shaped and strongly flattened; thorax strongly broadened, semicircular, approximately as long as abdomen, thoracic tergites lacking long contact hairs; spiracular gills dorsolateral on abdominal segments; abdominal segment 9 lacking urogomphi; sternite 9 triangular and reduced in size ....*Torridincola* (Fig. 2.1B)

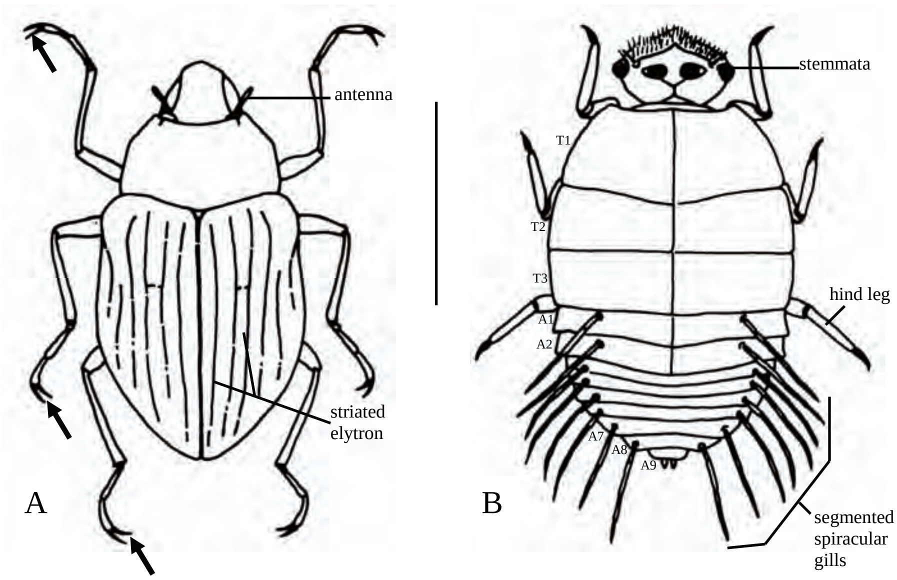


Fig. 2.1. Torridincolidae, *Torridincola rhodesica*. **A,** adult, dorsal view; **B,** larva, dorsal view. (A adapted from Steffan 1973; B redrawn from Steffan 1964). Scale bar = 1 mm.

Checklist and distribution records of known and described species of Torridincolidae in southern Africa

Globally, the family Torridincolidae contains about 60 species placed in seven genera. Two genera are known from southern Africa, one of which is endemic to the region. All the southern African species are endemic or probably endemic to the region.

The reader is referred to the Appendix (p. 207) for a checklist of the known and described southern African Torridincolidae species.

Family **HYDROSCAPHIDAE**

Both larvae and adults of the small, true water beetle family Hydroscaphidae (skiff beetles) are found in stagnant water or slow-flowing streams, crawling rather than swimming, and feeding on algae in the hygropetric environment. Adults store air under the elytra. Their reproductive biology and life histories are poorly explored, but pupation takes place in the water within the last larval exuviae.

A single adult beetle belonging to this family was found by Dr Jürgen Buening, in August 1999, while shore-washing in shallow, slow-flowing water in a small creek near Graskop, Mpumalanga Province, South Africa.

The identity of this specimen, which has been lodged in the Transvaal Museum, Pretoria, is as yet unknown.

Adult skiff beetles (Fig. 2.2A) are 1–2 mm long and characteristically fusiform, with a broad, relatively large head and a tapered abdomen. The elytra are truncate, leaving the terminal two to four segments of the abdomen exposed (Fig. 2.2A). Rows of lancet-shaped setae are present on each of the exposed abdominal terga (arrowed in Fig. 2.2A). Even though the tergite and sternite of each of these abdominal segments are fused into a ring, these segments are highly mobile. The whole body is covered by fine hairs. The eyes are large, but do not protrude. The apical segment of the antenna forms a club. Although skiff beetles are usually black, the South African species is yellow and is smaller than the well-known *Hydroscapha natans* LeConte from the south-western USA, which is c. 1.5 mm long.

Larvae (Fig. 2.2B) are fusiform like the adults, with long tergal contact hairs. The larvae are easily distinguished by their small size and the presence of somewhat elongated vesicular spiracular gills on the hind margin of the pronotum, on the first abdominal tergite, and on a process (arrowed in Fig. 2.2B) on abdominal segment 8 (Fig. 2.2B). The antennae are very short. The mouthparts are partially internalised and the labrum is unusually large (Fig. 2.2B). These features may be related to miniaturisation and feeding on algae in running water.

The New World genera *Scaphydra* and *Yara* appear to be closely related, while the more widespread genus *Hydroscapha* forms their sister group. It is not clear to which genus the South African species belongs, but *Hydroscapha* has been reported from North Africa and Madagascar.

KEY TO GENERA OF HYDROSCAPHIDAE: ADULTS

Because it is not certain to which genus the undescribed South African species belongs, two likely candidate genera are included in this key.

1. Antennae eight-segmented .... *Hydroscapha*
– Antennae five-segmented .... *Scaphydra*

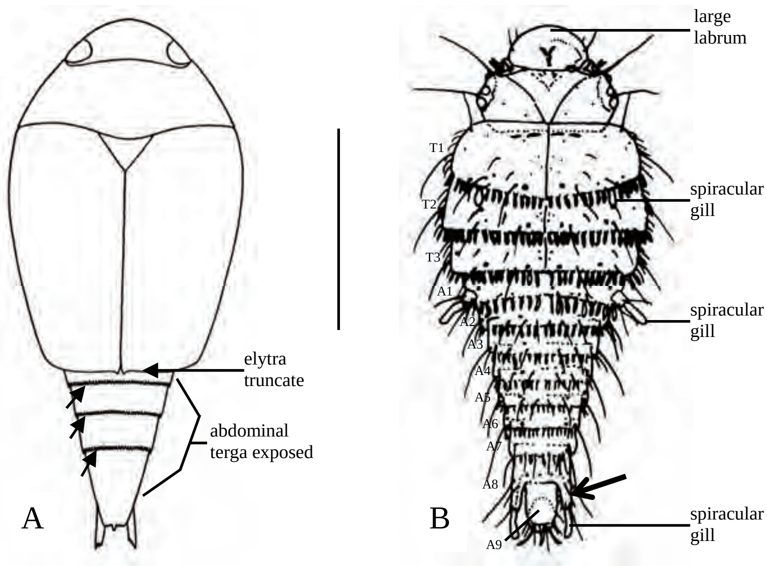


Fig. 2.2. Hydroscaphidae. **A,** *Scaphydra* sp., adult, dorsal view; **B,** *Hydroscapha* sp., larva, dorsal view. (A redrawn from Reichardt 1973; B redrawn from Böving & Craighead 1931). Scale bar = 0.5 mm.

Family **SPHAERIUSIDAE**

Adults of the family Sphaeriusidae (minute bog beetles) (Fig. 2.3A) are minute to extremely small beetles, about 1 mm long. The 23 described species currently known world-wide are all placed in the genus *Microsporus*. The adults of these beetles are globose or spherical, smooth, shiny and black (Fig. 2.3A). The strongly convex elytra cover the entire abdomen, which consists of three apparent segments only. The legs are short, with expanded tibiae (arrowed in Fig. 2.3A) and conspicuously short, three-segmented tarsi. The antennae are relatively long: eleven-segmented, including a three-segmented club (Fig. 2.3A).

As shore beetles, *Microsporus* species usually spend their entire life cycle in the littoral biotope, living in the mud or gravel of river edges, but *Microsporus africanus* apparently inhabits moist forest soil some distance from water.

Microsporus larvae have pairs of two- or three-segmented, vesicular spiracular gills laterally on abdominal segments 1 to 8 (Fig. 2.3B). The larval gills are an indication of an aquatic lifestyle, even in the moist soil or mud environment, but the adults of the southern African species do not show any aquatic adaptations. It is not known to what degree the adults and larvae of the different species of *Microsporus* live permanently or occasionally under water, very close above the water line, or in wet terrestrial microhabitats. Detailed study of the bionomics of these Lilliputian beetles is sorely needed.

The pale larvae (Fig. 2.3B) are ovate and flattened. The tergites have long lateral contact hairs. As in the Torridincolidae, there is a swelling on the side of the head that bears four large stemmata, but the mouthparts are partially internalised, as in the Hydroscaphidae. The antennae are strongly developed, while the legs are short, with very strong claws. The segmented vesicular spiracular gills on abdominal segments 1–8 are unique.

The family name Sphaeriidae was used first for a bivalve mollusc family, but later the same name was inadvertently introduced for these small water beetles. In 1985 the beetle family's name (a homonym) was changed to Microsporidae by a ruling of the International Committee on Zoological Nomenclature. Unfortunately, this decision compromised nomenclatural stability within the family, and in 2000 the name of the beetle family was changed to Sphaeriusidae.

Checklist and distribution records of the known and described species of Sphaeriusidae in southern Africa

The single genus of this family, *Microsporus* (= *Sphaerius* [preoccupied]), is cosmopolitan, but has only one described Afrotropical species. It appears to be endemic to southern Africa, but more specialised collecting (and collector's luck!) is needed to establish the possibilities of a wider distribution and the existence of other Afrotropical species of this family.

The reader is referred to Appendix 1 (p. 207) for a checklist of the known and described southern African Sphaeriusidae species.

ACKNOWLEDGEMENT

We gratefully acknowledge the discoverer of the first continental Afrotropical specimen of the family Hydroscaphidae, Dr Jürgen Buening of the University of Erlangen, Germany, who kindly shared his unpublished notes on this specimen and its discovery with us.

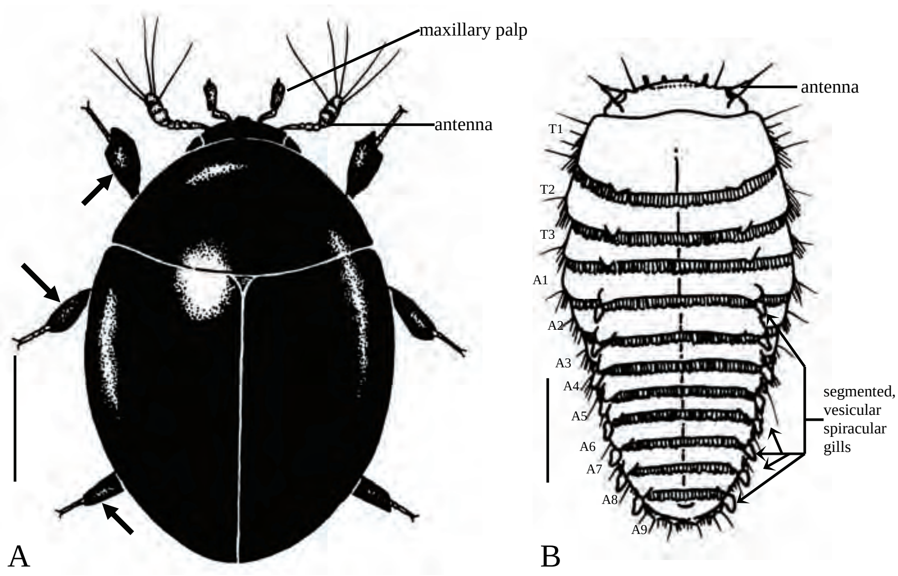


Fig. 2.3. Sphaeriusidae, *Microsporus* sp. **A,** adult, dorsal view; **B,** larva, dorsal view. (Redrawn from Britton 1966). Scale bars = 0.2 mm.

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CHAPTER 3

GYRINIDAE

by

R. Stals

Adult Gyrinidae (whirligig beetles) are highly adapted to the aquatic environment, being the only beetles that normally use the water surface film for support. They are, however, equally at home under the water. Both adults and larvae of all Gyrinidae are strictly aquatic. The family is cosmopolitan in distribution.

ADULT MORPHOLOGY

In southern Africa, adult gyrinids are medium-sized to moderately large, true water beetles, ranging from 4–17 mm in length. The upper side is black or metallic in colour, shiny, and either glabrous or (partly) pubescent. Some species have a pale lateral border on the pronotum and elytra (Fig. 3.1B).

The body shape of the adults (Figs 3.1A–B) is ovate or elongate-ovate, convex, with a sharp lateral edge around the whole body. This edge separates the hydrofuge dorsal surface of the insect from its wettable ventral surface, an adaptation to the unique lifestyle on the water surface. The lateral edge divides the compound eyes into dorsal and ventral halves (Fig. 3.1C), with the dorsal part looking up out of the water, whereas the ventral part looks down into the water. Although Gyrinidae and many Dytiscidae look superficially similar, the gyrinids are easily recognised by their divided eyes and habit of swimming mainly on water surfaces.

The front legs of gyrinids are long and adapted for seizing prey (Figs 3.1A–B). These legs are also used for clinging to substrates when the adult beetles dive below the water surface. The tarsi of the front legs are expanded in males. The middle and hind legs are adapted for swimming: they are short and dorsoventrally compressed, with fringes of swimming hairs. The apex of the abdomen is more-or-less laterally compressed and movable and is used as a rudder for swimming or—on dry ground—for jumping, particularly in the genus *Orectogyrus* (Fig. 3.1B).

The antennae of adult gyrinids are short, stout and highly specialised (Fig. 3.1D). A large Johnston organ (used for sensing movements of the antenna) is found in the pedicel. The antennae normally rest in the water surface film and the Johnston organ apparently acts as a receptor for vibrations on the water surface. This assists in the location of prey and, possibly, also in the avoidance of collisions with other whirligig beetles in a 'swarm'.

IMMATURE STAGES

Gyrinids lay their eggs in rows or masses on submerged or floating vegetation. The larvae (Fig. 3.1E) are elongate, slender and cylindrical, and generally pale in colour. Mature larvae are 6–25 mm in length. The antennae (four-segmented), maxillary palps (four-segmented) and labial palps (three-segmented) are all slender and elongate. The 'nasale' is an anterior, median projection from the frons (the anterior margin of the clypeus) and is an important identification feature in the larvae (Figs 3.2A–C). The legs are well developed — each leg is six-segmented, including two movable claws. The larval respiratory system is apneustic, except in the last instar. Long, paired, articulated, and frequently feathery, lateral appendages are found on the first nine of the ten abdominal segments. The first eight pairs are tracheal gills. The ninth abdominal segment carries two pairs of appendages, the ultrastructure of which indicates that they probably have an osmoregulatory function. At the apex of the tenth segment there are two pairs of decurved hooks (cf. Fig. 1.7G). Urogomphi are not present.

Larvae undergo three moults; the final-instar larvae leave the water to pupate outside, under stones, in the soil, or on plants close to the water's edge. A cell or 'cocoon' is constructed of debris and a secreted adhesive substance. Several genera of Hymenoptera are known to parasitise gyrinid pupae.

GENERAL ECOLOGY AND BEHAVIOUR

Both larval and adult gyrinids are voracious predators. Extra-oral digestion is a groundplan characteristic of the larvae of Hydradephaga, hence the normal mouth opening in these larvae is closed and the mandibles are modified into perforated tubes (Fig. 3.1E). The prey of the adults consists of any relatively small insects that may fall onto the water surface. The larvae prey on soft-bodied invertebrates on the bottom of the water body.

While the larvae breathe under water by means of their tracheal gills (Fig. 3.1E), the adults cannot stay submerged for long periods. When they dive they hold an air supply under the elytra.

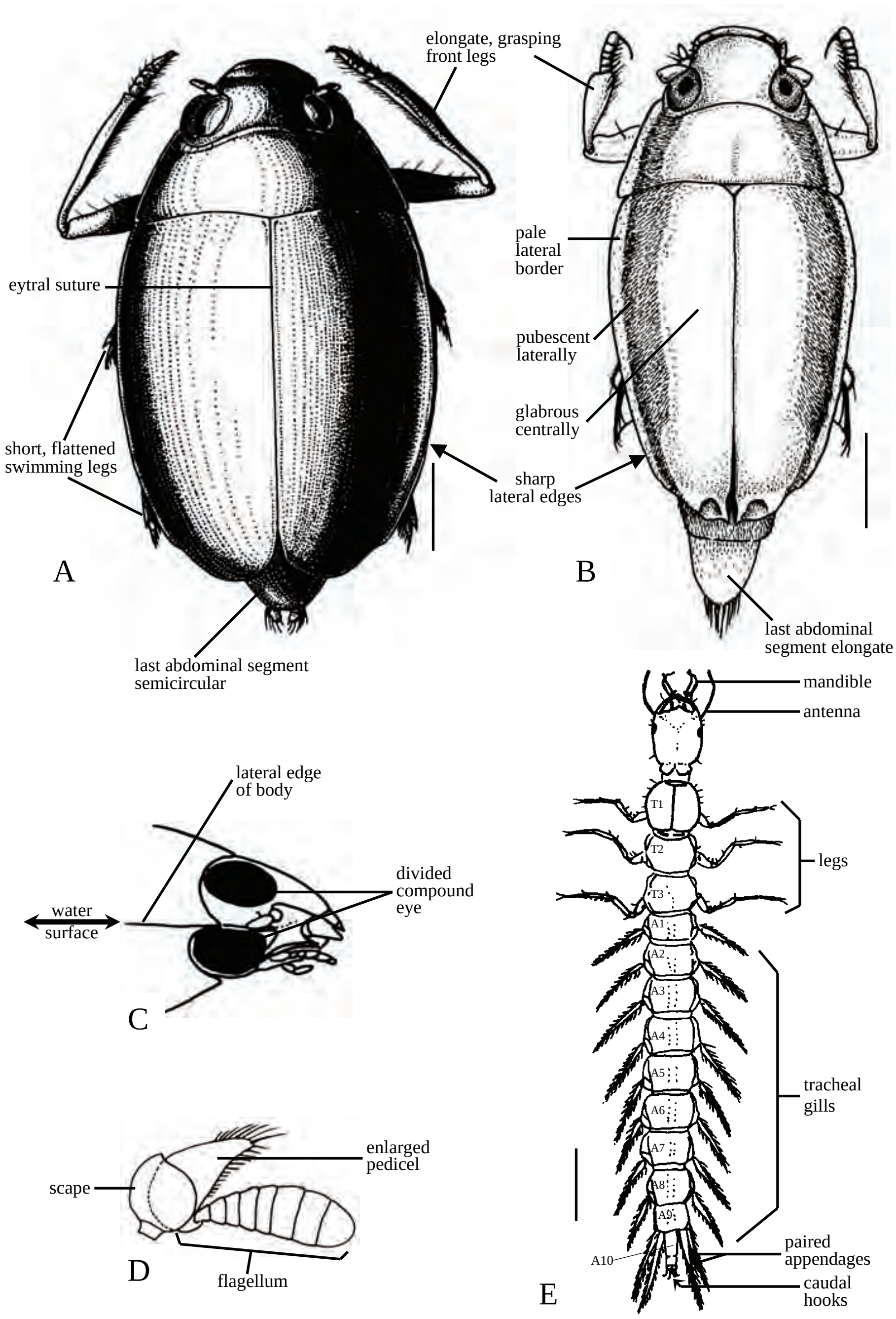

Fig. 3.1. Gyrinidae. **A–B,** adults, dorsal view: **A,** Enhydrini, *Dineutus* sp; **B,** Orectochilini, *Orectogyrus* sp.; **C,** lateral view of adult head; **D,** adult antenna; **E,** *Dineutus* sp., larva, dorsal view. (A & C redrawn from Scholtz & Holm 1985; B: original, Elsa van Niekerk; D redrawn from Crowson 1981; E redrawn from Böving & Craighead 1931). Scale bars: A, B, E = 1 mm; C & D much enlarged, not to scale.

Swimming, non-agitated adults are partly immersed: only the hydrofuge dorsum is above the water surface film. Their surface-dwelling habit is aided by surfactants secreted by pygidial glands. Whirligigs can often be seen where they swim around on the water surface in groups in seemingly frantic motion, but keeping in a 'swarm'. Such 'swarms' may consist of more than one species. The group usually keeps close to the water's edge, especially on larger water bodies. If disturbed, the group may move further away from the water's edge, and if disturbed even more, individuals may disperse, dive, and seek shelter in submerged vegetation. Adults of probably all species are capable of flight. Locomotion in larvae is restricted to crawling and floating.

Gyrinidae inhabit almost all freshwater habitats and may be eurytopic or stenotopic. Different species can be found either in still waters, slow-flowing rivers, or rapid-flowing streams. A few species may occur in brackish water bodies. Whirligigs are frequently found in the southern, eastern and northern parts of southern Africa, wherever there is permanent water. They are much scarcer in the dry western regions and the central plateau. Some species can be found in temporary water bodies.

IDENTIFICATION

Species-level identification is possible with recourse to the keys in the various revisions by Per Brinck, listed under 'Useful References'.

The different species within any particular gyrinid genus are morphologically very homogeneous, something that is likely to be correlated with the conservatism in the life history style of these beetles. Examination of the male genitalia is necessary for the reliable identification of many species. Reticulations and punctation of the exoskeleton are very important taxonomic characters. Other useful characters are, amongst others, the sculpture of the elytra, patterns of setae and pubescence, and characteristics of the legs. The female genitalia are also sometimes used for identification. In many species there is a high degree of intraspecific variation in body size and certain superficial sculptural details.

KEY TO THE SOUTHERN AFRICAN GENERA OF GYRINIDAE: ADULTS
(*after Brinck 1955a*)

1. Pronotum and elytra glabrous; last abdominal segment semicircular (Fig. 3.1A); free abdominal sternites without a median row of hairs 2

– Pronotum and elytra at least laterally densely pubescent; last abdominal segment elongate, conical (Fig. 3.1B); at least the hindmost two abdominal sternites with a ventral median row of hairs................. *Orectogyrus* (Fig. 3.1B)

2. Posterior corners of pronotum each with a small pit carrying a tuft of setae; elytral suture not bordered .... *Dineutus* (Fig. 3.1A)
– Posterior corners of pronotum without small seta-carrying pits; elytral suture bordered 3
3. Pronotum with transverse impressions; elytral striae are rows of isolated punctures ....*Gyrinus*
– Pronotum without transverse impressions, smooth; elytra uniformly reticulated; elytral striae are (at least laterally) furrows with linear punctures, or with rudimentary reticulation forming longitudinal strips .... *Aulonogyrus*

KEY TO THE SOUTHERN AFRICAN GENERA
OF GYRINIDAE: LARVAE
(*after Bertrand 1969 and Brinck 1955a*)

1. Nasale square, without lobes or 'teeth' (Fig. 3.2A); head capsule laterally barely constricted to form 'neck' ....*Orectogyrus*
– Nasale not square, divided into lobes, sometimes carrying small secondary divisions ('teeth') (Figs 3.2B–C) 2
2. Nasale with three lobes, the largest in the centre and sometimes slightly incised, lateral lobes asymmetrical (Fig. 3.2B); prosternal plate more or less strongly sclerotised .... *Dineutus* (Fig. 3.1E)
– Nasale with two or four lobes; prosternal plate not sclerotised centrally ... 3
3. Nasale with two lobes ('teeth') (Fig. 3.2C) ....*Gyrinus*
– Nasale with four lobes ('teeth') ....*Aulonogyrus*

Checklist and distribution records of known and described species of Gyrinidae in southern Africa

Four genera, containing 55 species, of whirligig beetles have so far been recorded and described for southern Africa. Brinck (1955a) predicted that more species, especially in the genus *Aulonogyrus*, probably still await discovery; such hitherto undescribed taxa are likely to be relictual and endemic.

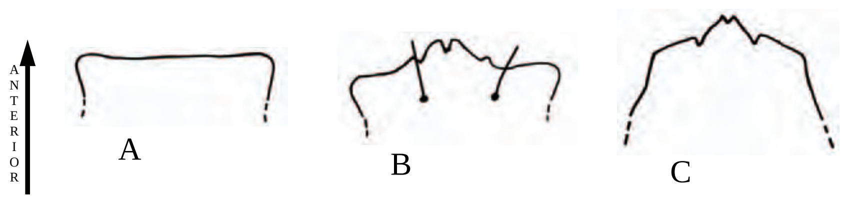

Fig. 3.2. Gyrinidae, larvae, anterior margin of clypeus (“nasale”), dorsal view. **A,** *Orectogyrus* sp.; **B,** *Dineutus* sp.; **C,** *Gyrinus* sp. (Redrawn from Stehr 1991). Much enlarged, not to scale.

Currently the Gyrinidae is divided into two subfamilies. Only the Gyrininae occurs in southern Africa, and its three tribes (Enhydrini, Gyrinini and Orectochilini) were previously afforded subfamily rank. The other subfamily, Spanglerogyrinae, contains only the unusual North American genus *Spanglerogyrus*.

The reader is referred to the Appendix (pp. 207–209) for a checklist of the known and described southern African Gyrinidae species.

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[*includes key to species*]

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CHAPTER 4

HALIPLIDAE

by

S. Endrödy-Younga† *& R. Stals*

The members of the Haliplidae (crawling water beetles) are small true water beetles with an adult body length of about 2–4.5 mm. The family is strictly aquatic in both adult and larval stages. Adults are characterised by a very convex body, a trapezoid pronotum, and ovate elytra that are pointed apically (Fig. 4.1A). The elytra usually have coarsely punctate lines, and the pronotum and head are usually moderately- to coarsely-punctate. The scutellum is absent. The antennae are filiform and unmodified (Fig. 4.1A).

The primary diagnostic character of adult crawling water beetles is the unusually explanate hind coxal plates (Fig. 4.1B), not found in any other beetle family. These broad plates cover the basal sternites and most of the hind femora. The legs are long and slender with long, fine swimming hairs on the tibiae and, especially, on the tarsi.

Eggs are laid on submerged plants (e.g. by *Peltodytes* species) or inside water plant tissue (e.g. by *Haliplus* species). Larvae of the Haliplidae (Fig. 4.1C–D) are elongate, cylindrical or slightly compressed dorsoventrally, and usually have ten abdominal segments. Six stemmata are found on each side of the head. Haliplid larvae are unique among adephagan larvae in having only one claw, instead of two, on each six-segmented leg. Spiracles are absent in the first two instars, but the final instar has a peri-pneustic respiratory system. For extra-oral digestion, characteristic of the larvae of Hydradephaga, haliplid larvae have mandibles that are either hollow or have a channelled inner surface.

Haliplid larvae are of two types. Larvae of *Haliplus* and allied genera (Fig. 4.1C) taper from the prothorax to the apex of the last abdominal segment, which ends in a spine-like process that may be bifurcate. The cuticles of these larvae are rough and rigid; the body is therefore restricted in its ability to bend. Conspicuous gills are absent. The larvae of *Peltodytes* species (Fig. 4.1D) represent the second larval type, having long, slender, rather stiff gills: three pairs on the prothorax, two pairs each on the meso- and metathorax, the first eight abdominal segments each with two pairs, and one pair each on abdominal segments 9 and 10. The body of *Peltodytes* larvae is moderately stiff, but it can assume a C-shape. The last abdominal segment of *Peltodytes* larvae ends bluntly, without a spinelike process. It appears that the larvae of the endemic genus *Algophilus* are still unknown.

Haliplid larvae pass through three instars, the last instar leaving the water. Pupation takes place in a pupal cell in moist soil. Both adults and larvae feed on algae, which is highly unusual among the otherwise predominantly carnivorous Adephaga.

Adults obtain their oxygen from the atmosphere. They store air under the elytra — as do all Hydradephaga — and also under the expanded hind coxal plates. The air under the hind coxal plates usually protrudes posteriorly as a bubble; anteriorly it is connected with the subelytral space. During the day adult haliplids can also replenish their oxygen supply from bubbles produced by photosynthesising algae. Larval respire under water, through the large gills (if present), or, in the case of species of *Haliplus*, through so-called microtracheal gills.

Adults usually crawl under water, or may swim weakly by alternately moving their opposing legs, reminiscent of terrestrial insect locomotion. The larvae do not swim, but are crawlers.

All the known southern African Haliplidae live in clean, still, or slowly-flowing waters, mostly not far below the surface.

KEY TO THE SOUTHERN AFRICAN GENERA OF HALIPLIDAE: ADULTS

(*after Guéorguiev 1967)*

1. Last segment of maxillary palp cone-shaped, as long as or longer than, penultimate segment; elytra posteriorly with a finely punctate subsutural margin; hind coxal plates margined; only last abdominal sternite completely exposed .... *Peltodytes*

– Last segment of maxillary palp slender and tapering to a point (awl-shaped), much smaller than penultimate segment; elytra without subsutural margins; hind coxal plates not margined; at least three sternites exposed (Fig. 4.1B) 2

2. Dorsal surface glabrous; head small, much narrower than pronotum; metacoxal plate broad, laterally reaching edge of elytron (Fig. 4.1B) .... *Haliplus* (Fig. 4.1A)

– Dorsal surface finely pubescent; head large, almost as broad as pronotum; metacoxal plate narrow, laterally not reaching edge of elytron ... *Algophilus*

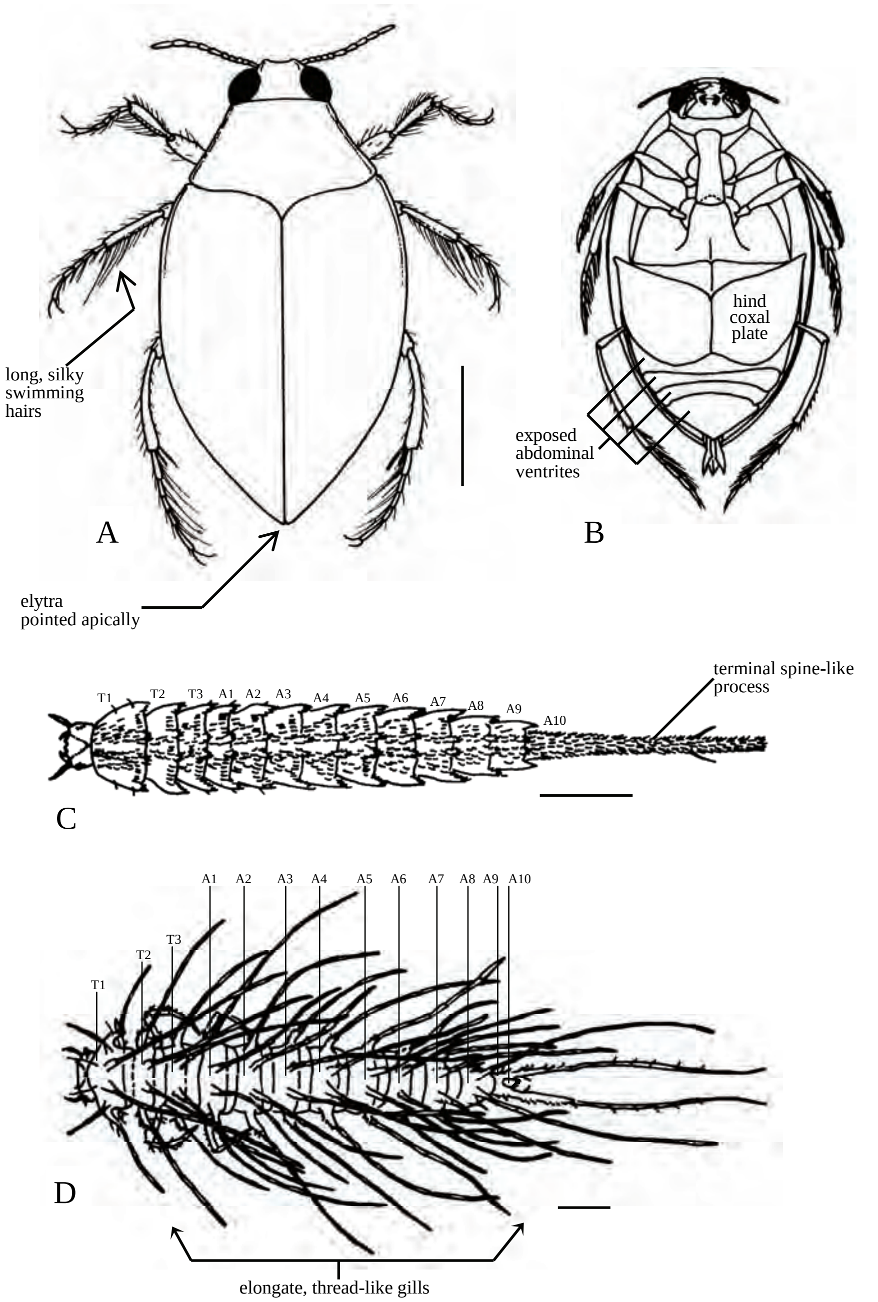

Fig. 4.1. Haliplidae. **A–C,** *Haliplus* sp.: **A,** adult, dorsal view; **B,** adult, ventral view, showing hind coxae enlarged into broad plates; **C,** larva, dorsal view; **D,** *Peltodytes* sp., larva, dorsal view. (A redrawn from Scholtz & Holm 1985; B after CSIRO 1991; C & D redrawn from Stehr 1991). Scale bars: A, C, D = 1 mm; B enlarged, not to scale.

Checklist and distribution records of known and described species of Haliplidae in southern Africa

In southern Africa three genera and 12 species of this family are presently known. More species are likely to be added to the regional list, and Guéorguiev (1967) thought it likely that the total southern African haliplid fauna would comprise between 15 and 20 species.

The reader is referred to the Appendix (pp. 209-210) for a checklist of the known and described Haliplidae species of southern Africa.

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[*contains keys to all southern African Haliplidae known at the time*]

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CHAPTER 5

NOTERIDAE

by

S. Endrödy-Younga† *& R. Stals*

The Noteridae (burrowing water beetles) are small to smallish true water beetles, 2–7 mm in length. The adults (Figs 5.1A, B) are elongate and ovate, rounded anteriorly and pointed posteriorly. The dorsum is strongly convex but the ventral surface is flat. The body surface is smooth, usually shiny, and sometimes iridescent due to microsculpture of the cuticle. The middle and hind legs are flattened and usually fringed with swimming hairs, forming swimming legs.

The family Noteridae was previously considered a subfamily (Noterinae) of the Dytiscidae, but on morphological, molecular and biological grounds it is now considered a separate family. Adult Noteridae are distinguished from the Dytiscidae by their greater dorsal convexity, their longitudinally oriented hind coxal plates, the absence of a scutellum, and the presence of a flattened ventral keel (Figs 5.1A, B). The ventral keel of noterid adults (the 'noterid platform') (shaded in Fig. 5.1B) is a flattened and continuous median elevation that is formed by three components: an apophysis of the prosternum, an apophysis of the mesosternum, and the hind coxal plates. The ventral keel is often more or less arrowhead-shaped.

Eggs are apparently laid on submerged plant parts or in underwater mud. The larvae of Noteridae (Fig. 5.1D) are usually compact and fusiform (sometimes cylindrical), with short, six-segmented legs (with two slender claws) and very short urogomphi. Based on these characters, they are easily distinguished from dytiscid larvae. Moreover, their mandibles are not grooved or hollow as in dytiscid larvae. The antennae are slender and moderately elongate. There are six pairs of stemmata. The prothorax is about as long as the rest of the thorax (Fig 5.1D).

The larval abdomen has eight visible segments. It has a characteristic pointed process on the 8th segment that carries paired, modified spiracles. It is metapneustic in the first and second instars, but late instars have spiracles on abdominal segments 1 to 8. The ninth segment of the abdomen is small, lying under the wedge of the eighth segment. Noterid larvae are not able to swim.

Uniquely among the Hydradephaga, at least some Noteridae (documented for the genus *Noterus*) pupate underwater. The pupae are found in watertight, air-filled cocoons made by the larvae and attached to submerged plants or plant parts, commonly to the roots.

The feeding habits of noterids are not known with any certainty. There are reports that both the adults and the larvae are herbivorous, or that they feed on small dead aquatic invertebrates, or that they are vegetation-detritus feeders!

Adult noterids utilise atmospheric air, storing it under their elytra. The larvae of at least some genera obtain oxygen from the stems of submerged plants by means of tapping air spaces in plant stems with the wedge-shaped process of the abdomen (where the spiracles are situated).

Larvae live in the mud and debris under water in still, or gently-flowing, waters. Adults and larvae are commonly found among the roots and other submerged parts of water plants or emergent vegetation. Both adults and larvae live in shallow water. As is the case for many aquatic beetles, the adults are competent flyers and are readily attracted to light at night.

KEY TO THE SOUTHERN AFRICAN GENERA OF NOTERIDAE: ADULTS

1. Anterior tibia with a terminal strong, hooked spine (Fig. 5.1C) 2
– Anterior tibia without a terminal hooked spine ....*Neohydrocoptus*

2. Inner apical angle of hind femur with an isolated group of setae (arrowed in Fig. 5.1B) 3
– No such isolated group of setae on inner apical angle of hind femur ....*Synchortus*

3. The longer of the hind tibial spurs serrate under high magnification; hind tibiae broad; body length more than 4 mm .... *Hydrocanthus*
– Neither of the hind tibial spurs serrate (under high magnification); hind tibiae slender; body length less than 4 mm .... *Canthydrus*

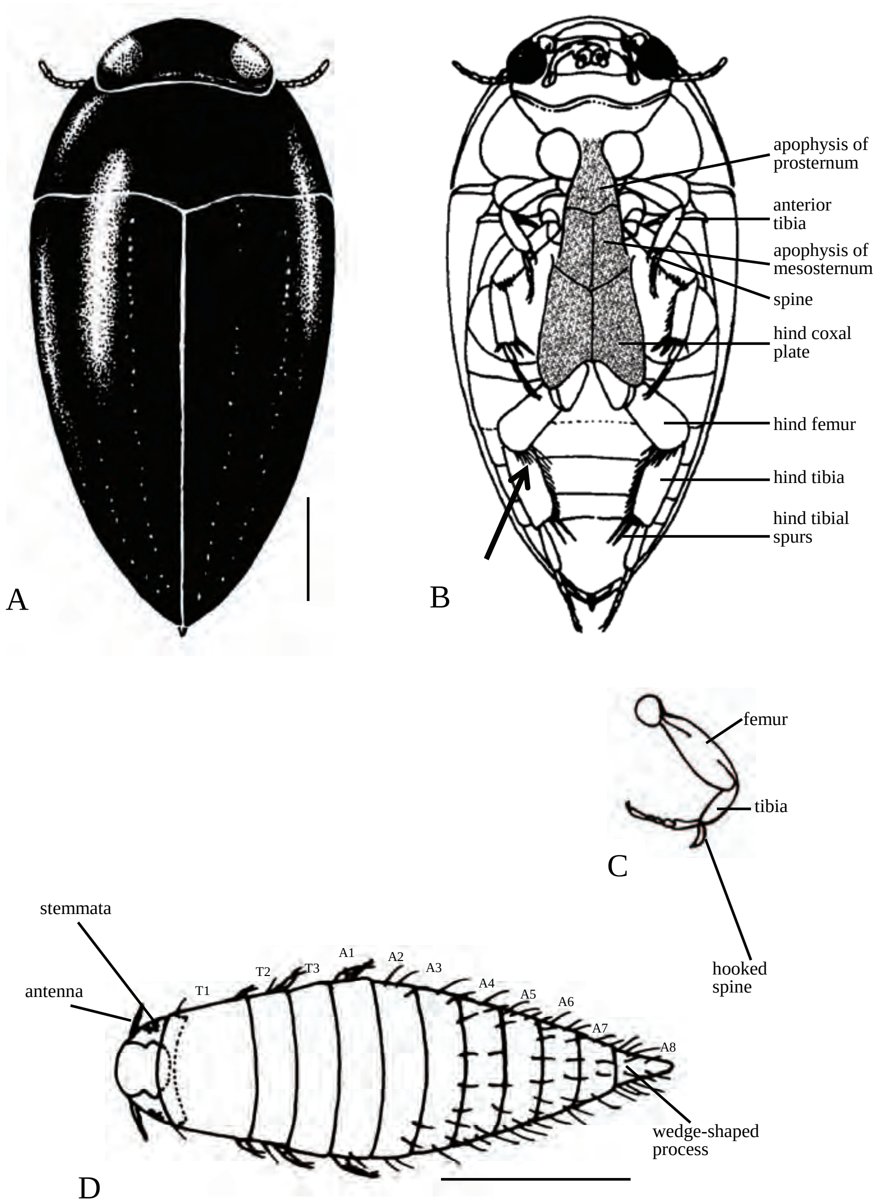

Fig. 5.1. Noteridae, *Hydrocanthus* sp. **A,** adult, dorsal view; **B,** adult, ventral view, showing continuous median elevation (ventral keel) (shaded); **C,** adult, fore leg, showing hooked tibial spine; **D,** larva, dorsal view. (A & B adapted from CSIRO 1991; A: artist: F. Nanninga; C redrawn from Arnett 1968; D redrawn from Stehr 1991). Scale bars: A–B, D = 1 mm; C much enlarged.

KEY TO THE SOUTHERN AFRICAN GENERA OF NOTERIDAE: KNOWN LARVAE

(*after Bertrand (1969, 1972)*)

1. Urogomphi clearly visible from above, on either side of narrow posterior lobe of eighth abdominal segment (Fig. 5.2A); mandibles grooved, with denticles on inner margin (Fig. 5.2C) .... *Synchortus*

– Urogomphi scarcely visible from above, not separated by posterior lobe of eighth abdominal segment, but that segment conically elongated (Fig. 5.2B) 2

2. First abdominal sternite complete; mandibles partially bifid, with a strong subapical tooth (Fig. 5.2D) .... *Canthydrus*

– First abdominal sternite with a membranous sagittal area; mandibles simple, without a subapical tooth (Fig. 5.2E) .... *Hydrocanthus*

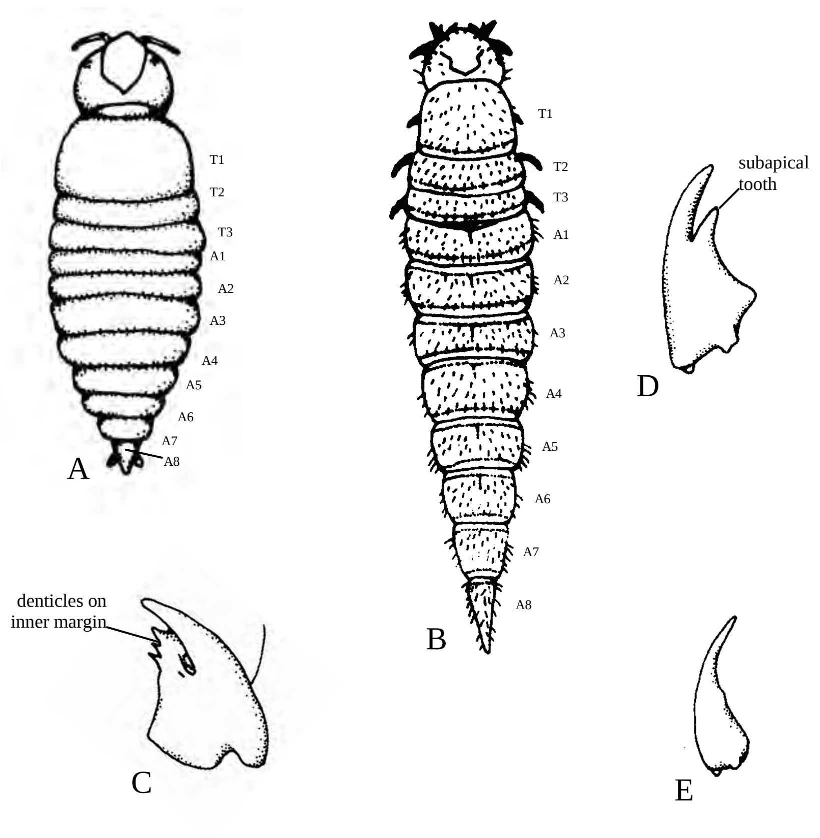

Fig. 5.2. Noteridae, larvae. **A,** *Synchortus* sp., dorsal view; **B,** *Canthydrus* sp., dorsal view; **C–E,** mandibles: **C,** *Synchortus* sp.; **D,** *Canthydrus* sp.; **E,** *Hydrocanthus* sp. (All redrawn from Bertrand 1972). All much enlarged, not to scale.

Checklist and distribution records of known and described species of Noteridae in southern Africa

World-wide, fourteen genera are currently recognised in the family Noteridae. Four genera, all belonging to the subfamily Noterinae, and with a total of 31 species, are presently known from southern Africa. The majority of the southern African *Neohydrocoptus* species were — up until June 2005 — erroneously placed in the genus *Hydrocoptus*, which belongs in the Dytiscidae (Nilsson & van Vondel 2005).

The reader is referred to the Appendix (pp. 210–211) for a checklist of the known and described southern African Noteridae species.

ACKNOWLEDGEMENT

The key to larvae was translated by Martin Villet and Sophie Kohler, Grahamstown, South Africa.

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CHAPTER 6

DYTISCIDAE

by

O. Biström

The Dytiscidae (predacious diving beetles) are very small to large insects — the length of the adult body varies between 1 and 45 mm — that are well adapted to life in water. They are true water beetles, both adults and larvae being aquatic. This is the largest of all aquatic beetle families and is found world-wide.

ADULT MORPHOLOGY

External adaptations to a life in water are particularly obvious in the shape of the adult body (Figs 6.1A–B), which is generally smooth and streamlined (but in a few genera, such as *Hyphydrus* and *Clypeodytes*, the body is fairly globular) and also in the hind legs of the adults, which are usually distinctly flattened, elongate, and provided with swimming hairs. The colour of the body is variable: many species are almost unicoloured dark (dark brown, dark olive, black) but there are also species with a distinctly paler body (yellowish brown, red-brown, brown). A distinct colour pattern is characteristic for many species. The eyes are well developed (except in some obligate inhabitants of caves, so far not recorded from southern Africa) and the antennae are slender, but moderate in length and generally unmodified. The mandibles are strong and biting. The male foretarsi, and often also the middle tarsi, are broad and flattened and, in some species provided with suckers, while the corresponding tarsi in the females are narrower and unmodified.

IMMATURE STAGES

Dytiscid females oviposit in water, for instance under stones, on vegetation, or within plant tissue.

The larvae of predacious diving beetles are variously shaped but are generally elongate or fusiform and cylindrical or flattened to some degree

(Figs 6.1C–D). The head is prominent and prognathous. In the subfamily Hydroporinae the head capsule is anteriorly prolonged into a frontoclypeal process called the 'nasale' (Fig. 6.1C); this structure is important in identifying hydroporine genera. The larval mouthparts are adapted for piercing and sucking, with the mandibles curved and usually long and slender. The mandibles differ in development, ranging from having a rather shallow open groove to having fully closed tubular channels. The antennae and maxillary palps are elongate and slender, but moderately long. Six pairs of stemmata are present. The prothorax of the larva is usually longer than the meso- and metathorax combined. The legs are six-segmented, with two movable terminal claws. Some genera have swimming hairs on the legs.

The larval abdomen has eight visible segments and a reduced ninth segment; the eighth segment may be variably elongate. Early instar larvae are metapneustic, with a single pair of large posterior spiracles. The middle and last larval instars have spiracles on the first eight abdominal segments and the last instar usually has additional spiracles on the mesothorax. The main longitudinal tracheal trunk of dytiscid larvae is inflated and serves as an air reservoir. A small number of species have tracheal gills laterally on the abdomen. Urogomphi are always present and are usually long and slender (Fig. 6.1C–D).

The larvae of Dytiscidae can easily be distinguished from those of the Hydrophiloidea by their six-segmented legs, two claws on each leg, and the absence of a breathing atrium at the apex of the abdomen (compare Figs 11.2B–C).

As far as is known, the larvae of all dytiscid species pass through three instars. Pupation generally takes place in a chamber constructed on land close to the water's edge.

GENERAL ECOLOGY AND BEHAVIOUR

Both adults and larvae are predators, feeding on aquatic insects and other invertebrates, tadpoles, and even small fish.

For respiration the adults and most larvae must at intervals visit the water surface to replenish an air bubble, which the adults keep in a subelytral chamber and also attached to the apical part of the body. In some species the larvae do not visit the surface and respiration takes place through the cuticle or, if present, via tracheal gills.

Predacious diving beetles are found in many surface water biotopes: fresh and brackish waters, and still or running waters. Since many species are capable of flight, they may also be found in temporary water bodies.

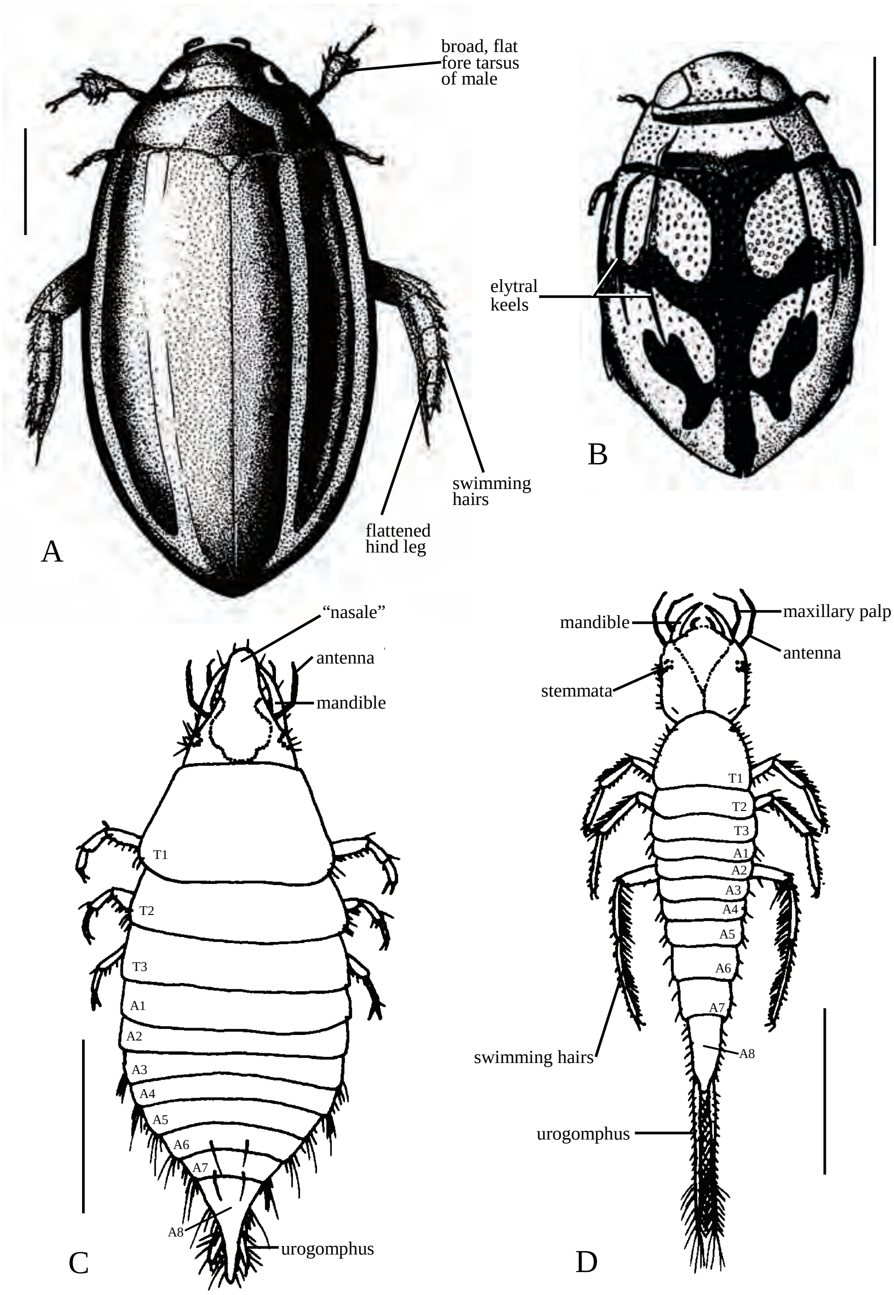

Fig. 6.1. Dytiscidae. **A,** Dytiscinae, *Hydaticus* sp., adult, dorsal view; **B,** Hydroporinae, *Yola* sp., adult, dorsal view; **C,** Hydroporinae, *Hydrovatus* sp., larva, dorsal view; **D,** Laccophilinae, *Laccophilus* sp., larva, dorsal view. (A–B after Scholtz & Holm 1985; artist: E. Holm; C–D adapted from Stehr 1991). Scale bars: A = 2 mm; B–D = 1 mm.

KEY TO THE SOUTHERN AFRICAN GENERA OF DYTISCIDAE: ADULTS

(partly based on keys by Omer-Cooper (1965) and Guignot (1959–1961))

1. Metepisternum does not form part of the mesocoxal cavity, i.e. medial angle of metepisternum does not reach margin of mesocoxal cavity (Fig. 6.2A) 2

– Metepisternum forms part of mesocoxal cavity, i.e. medial angle of metepisternum reaches margin of mesocoxal cavity (arrowed in Fig. 6.2B) 7

2. Prosternal process and its apex not on same plane as prosternum; prosternal process does not reach metasternum (Fig. 6.2C) .... *Derovatellus*

– Prosternal process and its apex on same plane as middle of prosternum (Fig. 6.2D); prosternal process reaches metasternum (arrowed in Fig. 6.2D) 3

3. Metatibial spines (minutely) bifid (arrowed in Fig. 6.2E).......... *Laccophilus*

– Metatibial spines pointed (arrowed in Fig. 6.2F) 4

4. Prosternal process trifid (Fig. 6.2G); posterior corners of pronotum extended backwards (arrowed in Fig. 6.2H) ....*Neptosternus*

– Prosternal process not trifid 5

5. Base of pronotum in scutellar region extended backwards angularly (arrowed in Fig. 6.2J) ....*Philodytes*

– Base of pronotum in scutellar region not extended backwards angularly (arrowed in Fig. 6.2K) 6

6. Metacoxal lines anteriorly parallel (arrowed in Fig. 6.2I) ....*Africophilus*

– Metacoxal lines anteriorly divergent .... *Philaccolus*

7. Apex of elytra and abdomen sharply pointed (arrowed in Fig. 6.2L) ....*Methles*

– Apex of elytra and abdomen not sharply pointed (in *Hydrovatus* elytral apex somewhat acuminate, cf. arrow in Fig. 6.4H) 8

8. Scutellum hidden (e.g. top arrow in Fig. 6.2M) 9

– Scutellum visible (arrowed in Fig. 6.2N) 31

9. Pronotum striated (top right arrow in Fig. 6.2M) 10

– Pronotum not striated 21

10. Head lacks cervical line (Fig. 6.2M–N) 11

– Head with cervical line (arrowed in Fig. 6.2O) 13

11. Elytra with distinct sutural lines (bottom arrow in Fig. 6.2M) .... *Hydroglyphus*

– Elytra lack distinct sutural lines 12

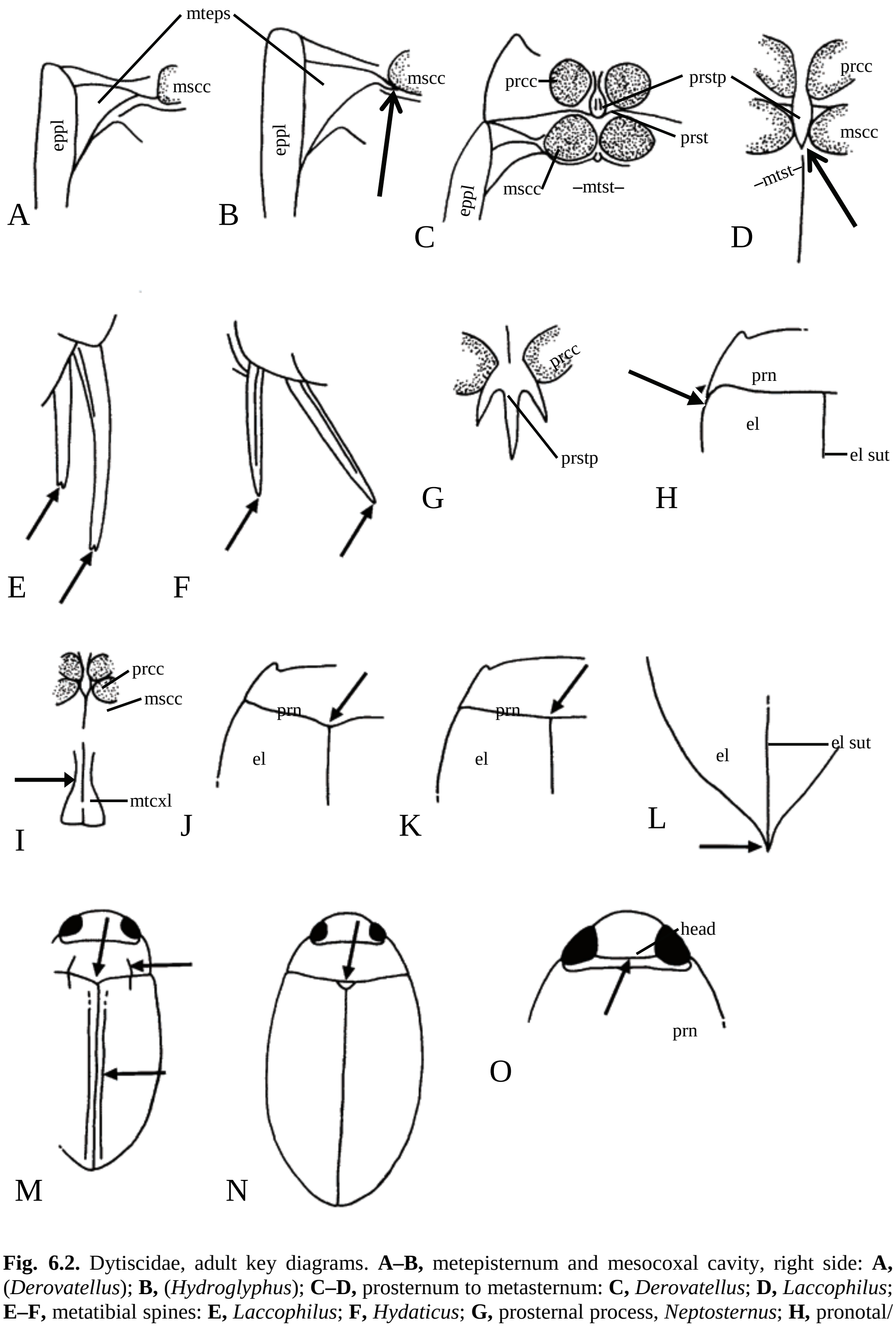

Fig. 6.2. Dytiscidae, adult key diagrams. **A–B,** metepisternum and mesocoxal cavity, right side: **A,** (*Derovatellus*); **B,** (*Hydroglyphus*); **C–D,** prosternum to metasternum: **C,** *Derovatellus*; **D,** *Laccophilus*; **E–F,** metatibial spines: **E,** *Laccophilus*; **F,** *Hydaticus*; **G,** prosternal process, *Neptosternus*; **H,** pronotal/elytral bases, *Neptosternus*; **I,** prosternum to metasternum, *Africophilus*; **J–K,** pronotal/elytral bases: **J,** *Philodytes*; **K,** *Africophilus*; **L,** apex of elytra, dorsal, *Methles*; **M–N,** whole beetle, dorsal view: **M,** *Hydroglyphus*; **N,** *Copelatus*; **O,** head and pronotum, *Clypeodytes*. Not to scale. el = elytron; el sut = elytral suture; eppl = epipleuron; mscc = mesocoxal cavity; mtcxl = metacoxal line; mteps = metepisternum; mtst = metasternum; prcc = procoxal cavity; prn = pronotum; prst = prosternum; prstp = prosternal process.

12. Paramere three-segmented (Fig. 6.3B) .... *Pseuduvarus*
– Paramere two-segmented (Fig. 6.3C) .... *Uvarus*

13. Epipleuron with a basal cavity (top arrow in Fig. 6.3D), posteriorly limited by a transverse carina (bottom arrow in Fig. 6.3D) ....
– Epipleuron lacks basal cavity posteriorly limited by a transverse carina (arrowed in Fig. 6.3E) 14

14. Elytra with longitudinal keels (sometimes rather low and indistinct) (e.g. Fig. 6.1B) 15
– Elytra lack longitudinal keels (e.g. Fig. 6.1A) 16

15. Elytral punctation does not form rows (Fig. 6.1B) (incl. *Sharphydrus capensis*: elytral keels generally distinct) .... *Yola* (Fig. 6.1B)
– Elytral punctation forms rows; elytral keels low, sometimes indistinct .... *Yolina*

16. Prosternal process does not reach metasternum (mesocoxal cavities contiguous) (Fig. 6.3F) .... *Tyndallhydrus*
– Prosternal process reaches metasternum (mesocoxal cavities separated by prosternal process) (Fig. 6.3G) 17

17. Anterior margin of head finely bordered, sometimes turned upwards 18
– Anterior margin of head not bordered, never turned upwards 19

18. Elytra lack striae (Fig. 6.3H) .... *Platydytes*
– Elytra with striae (Fig. 6.3A) ....*Leiodytes* (1)

19. Elytra generally with distinct sutural lines (as in Fig. 6.2M: bottom arrow) . ... *Bidessus*
– Elytra lack sutural lines (Fig. 6.3A) 20

20. Elytra lack striae (Fig. 6.3H) .... *Sharphydrus*
– Elytra with striae (Fig. 6.3A) .... *Leiodytes* (2)

21. Base of metatrochanter completely visible (Fig. 6.3I); metatarsal claws unequal in size (arrowed in Fig. 6.3J) 22
– Base of metatrochanter partly or completely concealed by metacoxal process (Fig. 6.3K); metatarsal claws equal in size 27

22. Elytra with longitudinal keels ....*Darwinhydrus*
– Elytra lack longitudinal keels 23

23. Anterior margin of head bordered (arrowed in Fig. 6.3L) .... *Hyphydrus*
– Anterior margin of head not bordered (arrowed in Fig. 6.3M) 24

24. Prosternal process does not reach metasternum (as in Fig. 6.3F) ....*Andex*
– Prosternal process reaches metasternum (Fig. 6.3N) 25

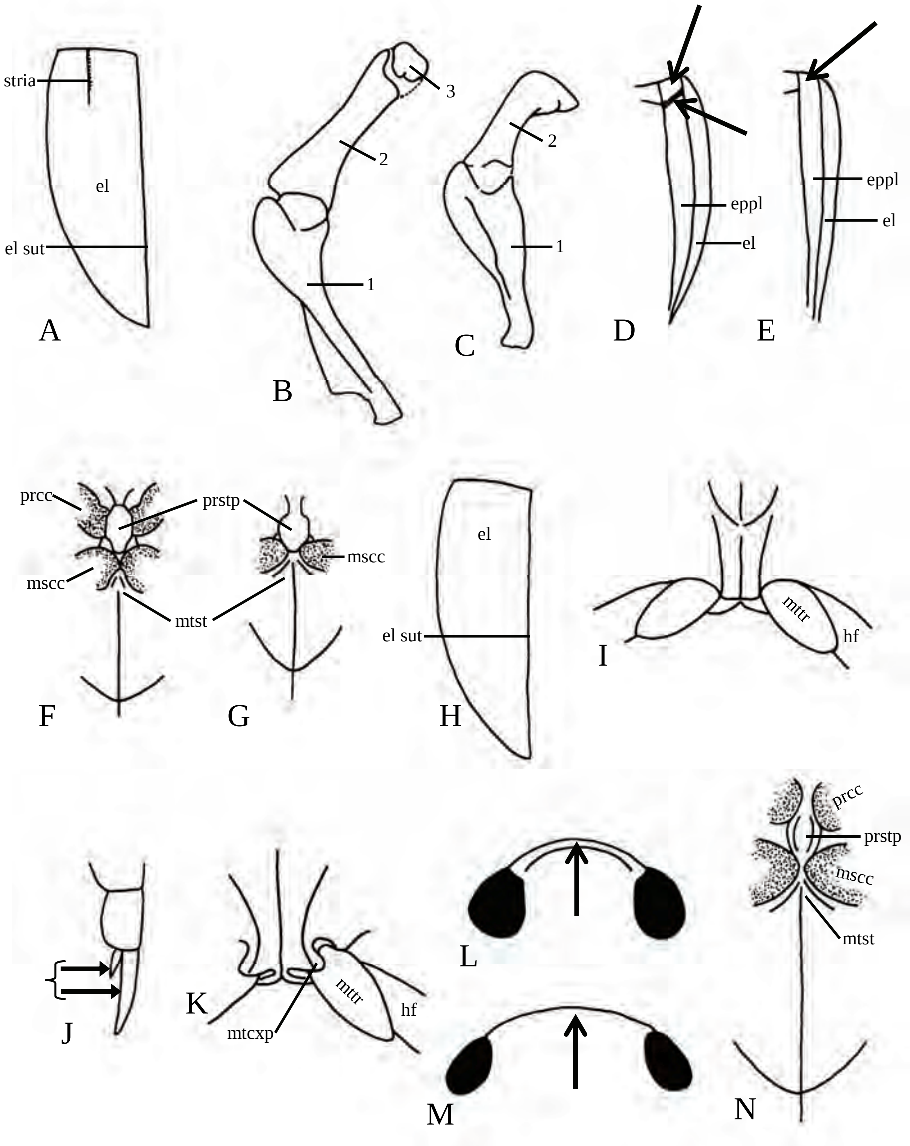

Fig. 6.3. Dytiscidae, adult key diagrams. **A,** left elytron, *Leiodytes*; **B–C,** parameres: **B,** *Pseuduvarus*; **C,** *Uvarus*; **D–E,** left epipleuron: **D,** *Clypeodytes* / *Herophydrus*; **E,** *Nebrioporus*; **F–G,** prosternum to metasternum: **F,** *Andex*; **G,** *Leiodytes*; **H,** left elytron, *Platydytes* / *Sharphydrus*; **I,** base of hind legs (*Darwinhydrus)*; **J,** metatarsal claws (*Darwinhydrus*); **K,** base of hind legs (*Hydrovatus*); **L–M,** anterior part of head: **L,** *Hyphydrus*; **M,** (*Andex)*; **N,** prosternum to metasternum (*Hydropeplus*). Not to scale. el = elytron; el sut = elytral suture; eppl = epipleuron; hf = hind femur; mscc = mesocoxal cavity; mtcxp = metacoxal process; mtst = metasternum; mttr = metatrochanter; prcc = procoxal cavity; prstp = prosternal process.

25. Fifth segment of front and middle tarsi subequal in length to third tarsal segment (note that fourth segment is hidden) (Fig. 6.4A); metatibial spine distinctly sinuate (arrowed in Fig. 6.4B) .... *Coelhydrus*
– Fifth segment of front and middle tarsi distinctly longer than third tarsal segment (note that fourth segment is hidden) (Fig. 6.4C); metatibial spine only slightly sinuate (arrowed in Fig. 6.4D) 26

26. Posterior corners of pronotum acute (arrowed in Fig. 6.4E) .... *Primospes*
– Posterior corners of pronotum not acute (arrowed in Fig. 6.4F) .... *Hydropeplus*

27. Apex of prosternal process broad, subtriangular or spatulate (Fig. 6.4G); elytra apically acuminate (arrowed in Fig. 6.4H) .... *Hydrovatus*
– Apex of prosternal process lanceolate or sublanceolate (Fig. 6.4I); elytra apically not acuminate (arrowed in Fig. 6.4J) 28

28. Elytra with keels ....*Peschetius*
– Elytra lacking keels 29

29. Metacoxal process distinctly extended backwards (arrowed in Fig. 6.4K) .... *Canthyporus*
– Metacoxal process less distinctly extended backwards (as in Fig. 6.3K) ..30

30. Epipleuron with a basal cavity, posteriorly limited by a carina (as in Fig. 6.3D: two arrows); anterior margin of head bordered (border sometimes only visible anterior to eyes) (arrowed in Fig. 6.4L) .... *Herophydrus*
– Epipleuron lacks basal cavity posteriorly limited by a carina (arrowed in Fig. 6.3E); anterior margin of head not bordered (arrowed in Fig. 6.4M) ....*Nebrioporus*

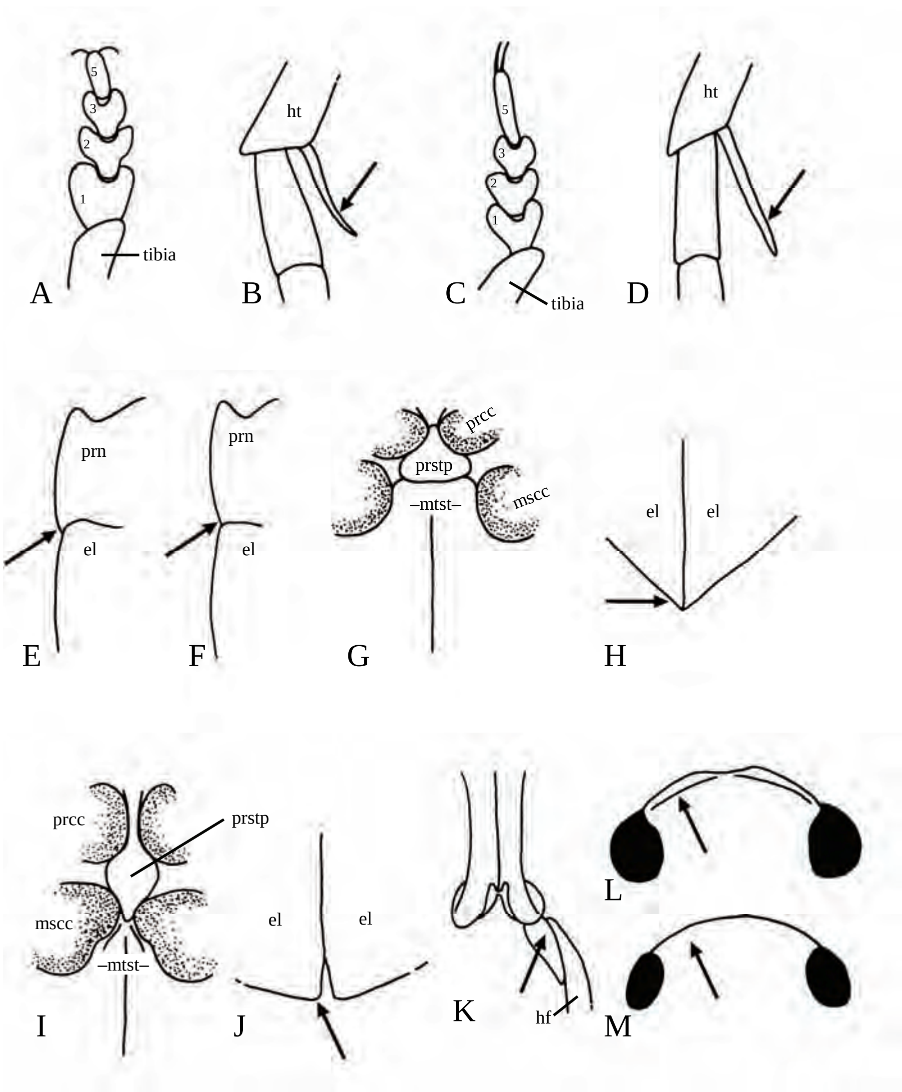

Fig. 6.4. Dytiscidae, adult key diagrams. **A,** front or middle tarsi, *Coelhydrus*; **B,** metatibial spine, *Coelhydrus*; **C,** front or middle tarsi (*Hydropeplus*); **D,** metatibial spine (*Hydropeplus*); **E–F,** pronotal/elytral bases: **E,** *Primospes*; **F,** *Hydropeplus*; **G,** prosternum to metasternum (*Hydrovatus)*; **H,** apex of elytra, dorsal (*Hydrovatus)*; **I,** prosternum to metasternum (*Canthyporus*); **J,** apex of elytra, dorsal (*Canthyporus*); **K,** base of hind legs (*Canthyporus)*; **L–M,** anterior part of head: **L,** *Herophydrus*; **M,** *Nebrioporus*. Not to scale. el = elytron; hf = hind femur; ht = hind tibia; mscc = mesocoxal cavity; mtst = metasternum; prcc = procoxal cavity; prn = pronotum; prstp = prosternal process.

31. Anterior outline of eye interrupted by a clypeal process (arrowed in Fig. 6.5A) 32
– Anterior outline of eye not interrupted by a clypeal process (arrowed in Fig. 6.5B) 34

32. Hind femur apically with a group of setae (arrowed in Fig. 6.5C) ....*Agabus*
– Hind femur lacks an apical group of setae (arrowed in Fig. 6.5D) 33

33. Hind tarsal claws equal in size (arrowed in Fig. 6.5E); elytra generally with longitudinal striae ....*Copelatus*
– Hind tarsal claws unequal in size (arrowed in Fig. 6.5F): elytra lacking longitudinal striae …………………………………………………… *Rhantus*

34. Hind tarsal joints lack apical fringes of setae (arrows in Fig. 6.5G) ....*Cybister*
– Hind tarsal joints with apical fringes of setae (arrows in Fig. 6.5H) 35

35. Elytral apices somewhat expanded (arrowed in Fig. 6.5I) ....*Eretes*
– Elytra apically not expanded (arrowed in Fig. 6.5J) 36

36. Metatibial spines apically acuminate (as in Fig. 6.2F: arrows) ....*Hydaticus* (Fig. 6.1A)
– Metatibial spines apically (minutely) bifid (as in Fig. 6.2E: arrows) 37

37. Metacoxal lines obsolete (arrowed in Fig. 6.5K) ....*Rhantaticus*
– Metacoxal lines distinct (arrowed in Fig. 6.5L) 38

38. Elytra finely and densely punctate; hind tibia spiny on outer edge .... *Aethionectes*
– Elytra finely but not densely punctate; hind tibia smooth on outer edge ....*Tikoloshanes*

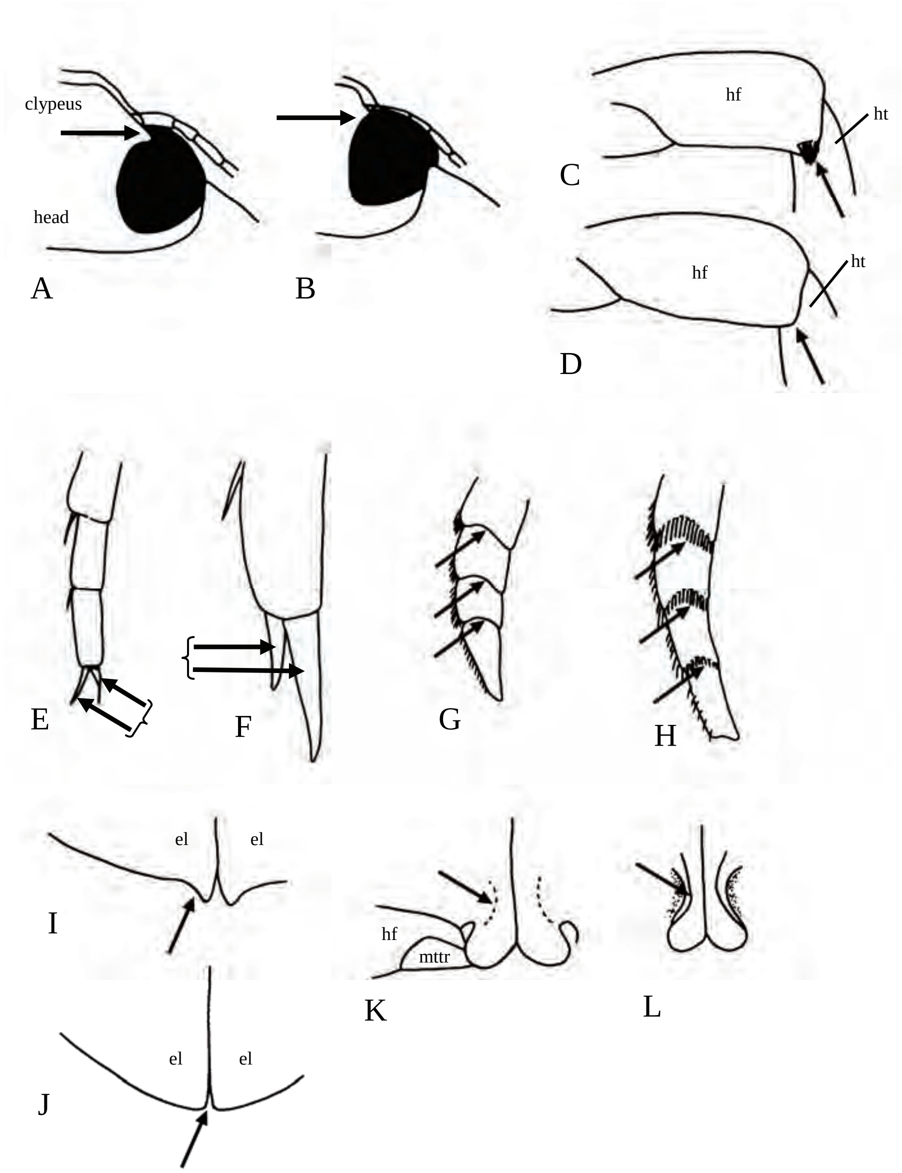

Fig. 6.5. Dytiscidae, adult key diagrams. **A–B,** right side of head, dorsal: **A,** *Agabus*; **B,** *Cybister*; **C–D,** hind femur/tibia articulation: **C,** *Agabus*; **D,** *Copelatus* / *Rhantus*; **E–F,** apex of hind tarsi with claws: **E,** *Copelatus*; **F,** *Rhantus*; **G–H,** hind tarsi: **G,** *Cybister*; **H,** *Eretes*; **I–J,** apex of elytra, dorsal: **I,** *Eretes*; **J,** *Hydaticus*; **K–L,** base of hind legs: **K,** *Rhantaticus*; **L,** *Aethionectes* / *Tikoloshanes*. Not to scale. el = elytron; hf = hind femur; ht = hind tibia; mttr = metatrochanter.

TAXONOMY

Miller (2001) and Nilsson (2001) divided the Dytiscidae into ten subfamilies, six of which are represented in southern Africa. The family Noteridae was previously considered a subfamily of Dytiscidae, but they are currently considered a separate family (see Chapter 5). The largest and most striking dytiscid species are found in the subfamilies Dytiscinae and Colymbetinae, and the smallest in the tribe Bidessini of the subfamily Hydroporinae. The rest of the Hydroporinae and the subfamily Laccophilinae consist of rather small to medium-sized species.

The subfamilies and tribes of Dytiscidae that have been recorded in southern Africa are listed below:

Subfamily AGABINAE
Tribe Agabini
Subfamily COLYMBETINAE
Tribe Colymbetini
Subfamily COPELATINAE
Tribe Copelatini
Subfamily DYTISCINAE
Tribe Aciliini
Tribe Cybistrini
Tribe Eretini
Tribe Hydaticini
Subfamily HYDROPORINAE
Tribe Bidessini
Tribe Hydroporini
Tribe Hydrovatini
Tribe Hygrotini
Tribe Hyphydrini
Tribe Methlini
Tribe Vatellini
Subfamily LACCOPHILINAE
Tribe Laccophilini

Checklist and distribution records of known and described species of Dytiscidae in southern Africa

Nearly 4000 species of Dytiscidae are known and described worldwide. Forty genera and about 310 species of Dytiscidae have so far been recorded from southern Africa. It must be noted that the systematic status of some taxa, both on generic and species level, is still unclear.

The reader is referred to the Appendix (pp. 211–219) for a checklist of the known and described Dytiscidae taxa of southern Africa.

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Older, but still important, works dealing with Dytiscidae are those of Sharp (1882) — a monograph taking into consideration all dytiscids known at the time — and of Régimbart (1895), which is a revision of the Dytiscidae of Africa. The many papers by Omer-Cooper are of great value in the study of southern African Dytiscidae (especially Omer-Cooper 1965b), as are the series of papers by Biström, dealing mainly with the subfamily Hydroporinae.

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CHAPTER 7

ASPIDYTIDAE

by

I. Ribera & D.T. Bilton

The Aspidytidae, baptised 'cliff water beetles' by its original describers, is a small family of true water beetles, first described in October 2002. Specimens of the new family were discovered in the Shaanxi Province of China in 1995 and in the Western Cape Province of South Africa in 2001. The formal description of the family was based on the South African species. The discovery of an all-new beetle family is a rare occurrence — representatives of almost all the currently recognised beetle families had already been described by the end of the 18th century. Only one genus (*Aspidytes*) and two species are known: *A. niobe* (Fig. 7.1A) in the Western Cape, and *A. wrasei* Balke, Ribera & Beutel (Fig. 7.1B) in China.

Aspidytes is a primitive member of the Dytiscoidea, showing a close resemblance to some Jurassic and Cretaceous fossils. Phylogenetic analyses with molecular and morphological (adult and larval) information showed that, among the extant families of the aquatic Hydradephaga, *Aspidytes* is a relatively basal lineage of the Dytiscoidea.

ADULT MORPHOLOGY

Aspidytes adults are smallish beetles (c. 5–7 mm in length), with an oval shape and a continuous, hydrodynamic outline (Fig. 7.1A). They are very convex dorsally and almost flat ventrally (Figs 7.1A–B). The South African species is reddish-brown, with slightly paler appendages. Despite being a family of the Dytiscoidea, they do not have any of the leg modifications typical of the superfamily, since their limbs are not flattened and lack swimming hairs (Fig. 7.1B).

Aspidytes adults have a number of morphological modifications frequently found in other hygropetric species, such as robust, enlarged antennae (Fig. 7.1C), a broad head, a body form that is very convex dorsally and flattened ventrally (protecting structures on the ventral side), and short robust legs with strong spines (Fig. 7.1A–B).

Among the genera of Dytiscoidea, *Aspidytes* is best characterised by the following features: the presence of a metasternal transverse suture (very weakly impressed) (Fig. 7.1B) with a corresponding internal ridge of the metaventrite; the absence of prothoracic glands; the absence of spermathecal glands; the pedicel of the antenna being very short and partly enclosed by the scape (Fig. 7.1C); and legs without swimming hairs or any other modification for swimming (arrowed in Fig. 7.1B). There are some morphological similarities between *Aspidytes* and the fossil family Liadytidae, recorded from the Jurassic (Toarcian, 187 million years ago) to the Cretaceous (Albian, 97 Mya).

IMMATURE STAGES

Larvae were collected together with adults in the Western Cape in September 2002, all three instars being present and associated with adults.

Aspidytes larvae are elongate, dark brown animals, with the general appearance shown in Fig. 7.1D. They have an ovate head, relatively wide thoracic segments, and a nine-segmented abdomen bearing two-segmented urogomphi. The ninth abdominal segment is reduced to a small plate, and—uniquely within the Adephaga — the larvae have dorsally orientated spiracles on the eighth abdominal segment (arrowed in Fig. 7.1D); these probably represent an adaptation for aerial gas exchange in a thin film of flowing water. *Aspidytes niobe* larvae have relatively short legs and urogomphi, features that are also seen in some hygropetric dytiscid larvae such as *Hydrotrupes palpalis* Sharp (USA) and *Agabus aubei* Perris (Europe). Larvae were found actively crawling in films of water flowing over wet rock, or taking refuge amongst algae in small crevices.

GENERAL ECOLOGY AND BEHAVIOUR

Beetles belonging to the genus *Aspidytes* live in hygropetric habitats, i.e. areas of exposed rock with a thin overflow of water. Such habitats are typically flanked by mosses, ferns and other vegetation (at their margins and in crevices), but *Aspidytes* is found on areas of bare rock with a very thin trickle of permanent water and green algal growth. Adults are found resting on the surface of exposed rock, covered by a shallow layer of flowing water (a few millimetres deep at most), with the legs either covered by the body or held tightly to it. Many specimens are also found beneath algal growth in small crevices on the rock face.

Aspidytes niobe co-occurs with a number of other hygropetric water beetles, including *Canthyporus* spp. and *Africophilus* sp. (Dytiscidae), *Delevea* sp. (Torridincolidae), *Coelometopon* spp. (Hydraenidae), and hy-

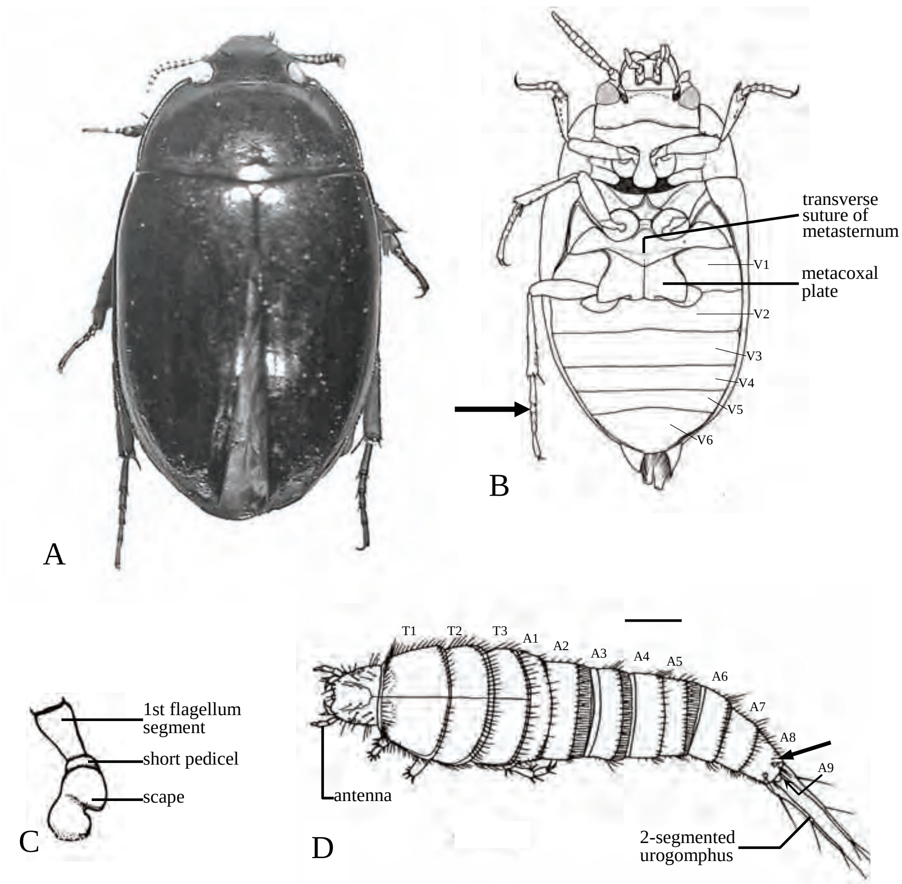

Fig. 7.1. Aspidytidae, *Aspidytes* spp. **A,** *Aspidytes niobe*, adult, dorsal view; **B–C,** *Aspidytes* sp.: **B,** adult, diagram of underside; **C,** adult, base of antenna; **D,** *Aspidytes niobe*, larva, dorsal view. (A: photograph by I. Ribera; image © The Natural History Museum, London; B after Balke *et al.* 2003; C adapted from Ribera *et al.* 2002; D after Alarie & Bilton 2005). A: length c. 7 mm; B not to scale; C much enlarged, not to scale; D: scale bar = 1 mm.

gropetric Dryopidae and Elmidae. To date, the species has only been found in two localities close to Ceres and to Wellington in the Western Cape Province, and searches of similar habitats in the Cederberg and on the Cape Peninsula have not yet turned up additional specimens. It is possible, however, that the species is more widespread in distribution, or that other taxa of the family remain to be discovered in southern Africa.

Although the precise food habits are not known, cliff water beetles are assumed to be predatory, probably feeding on other small aquatic invertebrates, such as dipteran larvae, that are present in the same habitat.

Checklist and distribution record of the known and described species of Aspidytidae in southern Africa

Aspidytes, with two known species, is the only genus of this family; one species (*A. niobe*) is presently known from southern Africa. The reader is referred to the Appendix (p. 219) for further details on this species.

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[*Aspidytidae on p. 19*]

USEFUL INTERNET RESOURCE

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CHAPTER 8

GEORISSIDAE

by

S. Endrödy-Younga†

The Georissidae (minute mud-loving beetles) are a lineage of hydrophiloid beetles that have reverted to a terrestrial habitat in both the adult and larval stages. They are extremely small to small, globose, strongly sculptured shore beetles, with an adult length of 1–3 mm (Fig. 8.1A). The head is directed downwards (hypognathous) and the mouthparts are not

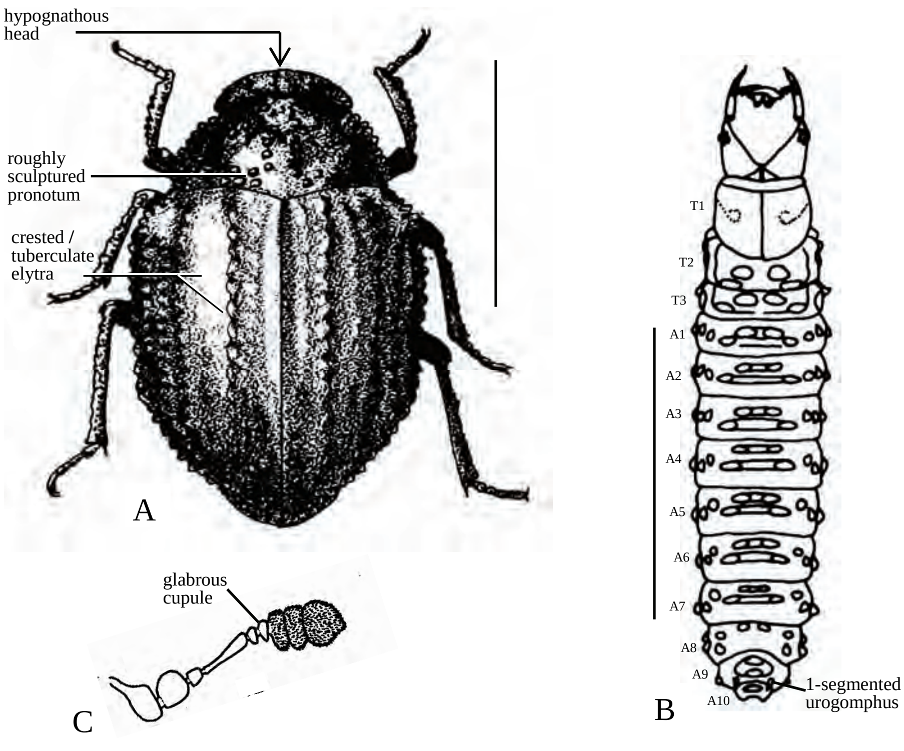

Fig. 8.1. Georissidae, *Georissus* sp. **A,** adult, dorsal view; **B,** larva, dorsal view. **C,** adult antenna. (A after Scholtz & Holm 1985; artist: L. Walles; B redrawn from Van Emden 1956; C after Hansen 1991). Scale bars: A, B = 1 mm; C much enlarged, not to scale.

visible from above. The antennae have a compact one- to three-segmented club, and the glabrous antennal cupule is preceded by five segments (Fig. 8.1C). The antennae are longer than the maxillary palps. The surface of the pronotum is sculptured and uneven. The elytra are seriate-punctate and conspicuously tuberculate or crested (Fig. 8.1A). Adults are black or brown, sometimes with patches of metallic lustre.

The larvae (Fig. 8.1B) are elongate, but not particularly narrow. They resemble the larvae of Hydrophilidae but differ in that they lack a terminal respiratory chamber (atrium). The hydrophilid and helophorid genera *Berosus* and *Helophorus* also lack an atrium, but georissid larvae clearly have ten instead of eight (*Berosus*, Fig. 11.2A) or nine (*Helophorus*, Fig. 12.1B) visible abdominal segments (the 10th abdominal segment of georissid larvae is small and easily overlooked: Fig. 8.1B). Georissids also lack the lateral abdominal gills of *Berosus* species and have small, one-segmented urogomphi (large and three-segmented in *Helophorus*) and short, stout, three-segmented legs (five-segmented in *Helophorus*). Georissid larvae have pairs of spiracles on the mesothorax (large) and dorsolaterally on the first eight abdominal segments (Fig. 8.1B).

Little is known about the biology of this family. Georissid adults, and probably also the larvae, live in muddy, sandy or gravelly shores of freshwater bodies. They apparently feed on algae, although the larvae may perhaps be saprophagous or even predatory. The adults are at times attracted to light at night.

The family Georissidae is sometimes treated as a subfamily (Georissinae) of the family Hydrophilidae (the latter then considered in a broader sense than in this *Guide*). The spelling 'Georyssidae', however frequently encountered, is incorrect.

Checklist and distribution records of the known and described species of Georissidae in southern Africa

The family Georissidae has only one genus, *Georissus*. Although numerous species have frequently been collected in southern Africa, only six of these species have to date been identified and described, none from South Africa, Botswana or Zimbabwe. The Afrotropical species apparently all belong to the subgenus *Georissus* (*Neogeorissus*). Knowledge of these beetles and their distribution is so scant that an evaluation of possible endemism would be premature.

The reader is referred to the Appendix (p**.** 219) for a checklist of known and described southern African Georissidae species.

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CHAPTER 9

HYDROCHIDAE

by

S. Endrödy-Younga† *& R. Stals*

Hydrochidae (elongated water scavenger beetles) are small true water beetles, both the larvae and adults being aquatic. Little is known about their biology and, apart from a number of species descriptions, the southern African fauna has not yet been studied.

Hydrochid adults (Fig. 9.1A) resemble dull metallic Hydraenidae in general shape and size. They are elongate with semi-parallel sides and a distinctly sculptured dorsal surface. The pronotum typically has a pattern of rather large, round impressions arranged in two transverse rows, one row of four impressions basally and a second row of three impressions anteriorly. Hydrochidae can furthermore be distinguished from the Hydraenidae by having only five visible abdominal sternites (Hydraenidae have six or seven: Figs 13.4A–B), no intermetacoxal sternite (present in Hydraenidae: arrowed on Figs 13.4B and 13.5D), and a bisetose empodium. Additionally, the maxillary palps are not longer than the antennae, as is the case in the Hydraenidae. In Hydrochidae, the compact, pubescent, three-segmented antennal club is preceded by a glabrous cupule, which is itself preceded by three glabrous antennal segments (Fig. 9.1B).

Hydrochid larvae (Fig. 9.1C) are also similar to those of Hydraenidae, but have eight visible abdominal segments, instead of ten, and a respiratory pocket (atrium) is present in the last segment (none in Hydraenidae).

Hydrochidae have been reported from stagnant and slow-moving waters. The larvae are probably carnivorous. Pupation takes place on land.

This family is sometimes treated as a subfamily (Hydrochinae) of the family Hydrophilidae, the latter then considered in a broader sense than in this *Guide*.

Checklist and distribution records of known and described species of Hydrochidae in southern Africa

Specimens of this family are only infrequently found in southern Africa. Of the single currently valid genus of this small family, eleven described species have so far been reported from southern Africa. Any indication of endemism would be premature here: some African hydrochid species have recently been reported from distantly disjunct localities, no systematic collection of these beetles has yet been attempted, and the genus- and species-level taxonomy of the family is presently in flux. Future studies are necessary to evaluate the validity of the species described by Dewanand

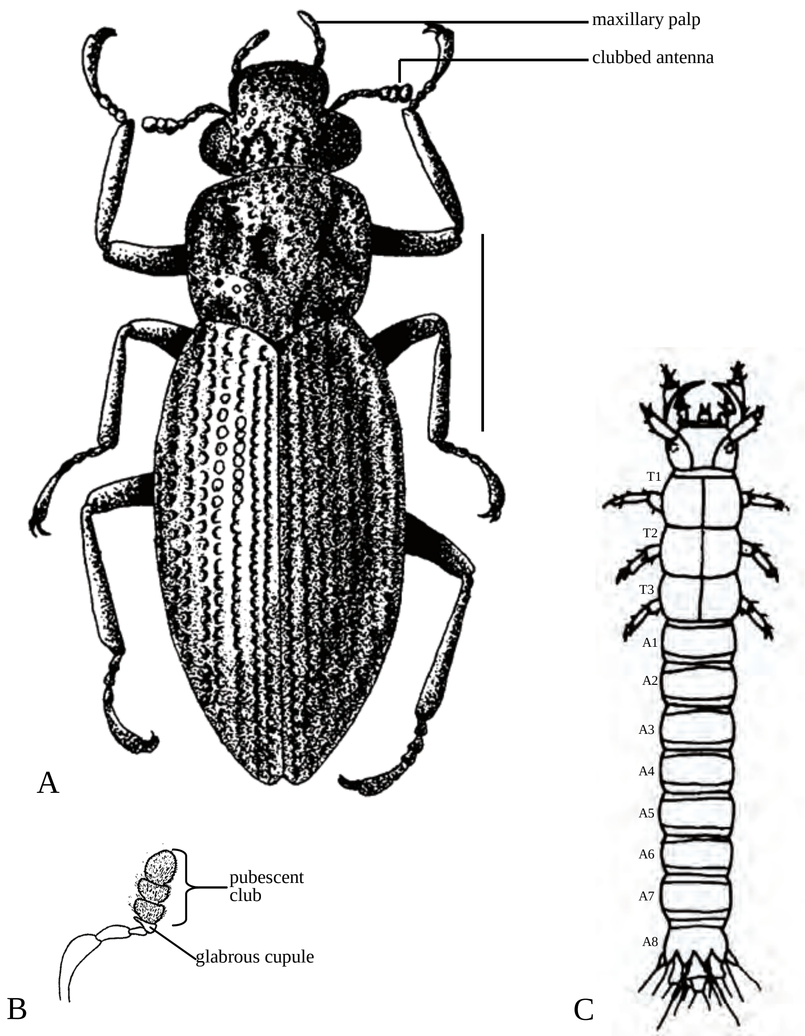

Fig. 9.1. Hydrochidae, *Hydrochus* sp. **A,** adult, dorsal view; **B,** adult antenna, showing glabrous cupule preceded by three glabrous segments; **C,** larva, dorsal view. (A after Scholtz & Holm 1985, artist: L. Walles; B after Hansen 1991; C redrawn from Böving & Craighead 1931). Scale bar: A = 1 mm; B & C much enlarged, not to scale.

Makhan. The many new genera that Makhan erected for some of his 'new' species are certainly not valid (see Hansen 1999: 51–52; Short & Hebauer 2006: 317).

The reader is referred to the Appendix (pp. 219–220) for a checklist of southern African Hydrochidae taxa.

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[*Hydrochidae on pp. 317–321*]

CHAPTER 10

SPERCHEIDAE

by

S. Endrödy-Younga†

The Spercheidae (filter-feeding water scavenger beetles) is a small, truly aquatic family of small beetles, the southern African species ranging from 3.5–5.0 mm in length. The adults (Fig. 10.1A) are broad and strongly convex, with sharp lateral margins. The margins of the pronotum may be denticulate. The clypeus is very large (Fig. 10.1A), with two triangular teeth on the anterior margin, angulate in the male and rounded in the female (Figs 10.1D–E). The body surface is dull brown, with rather dense and coarse, but shallow, punctation. The antennae (Fig. 10.1C) are seven-segmented, but since the third segment is very small (arrowed in Fig. 10.1C), the antenna may appear six-segmented. The second antennal segment is enlarged, with rather long hairs. The small third segment is glabrous, but the cupule is — like the three-segmented club — covered with dense hydrofuge pubescence (Fig. 10.1C). The antennae are accessory in respiration, as is the case for most Hydrophiloidea (see Chapter 1). A large empodium that bears more than two apical setae is situated between the tarsal claws.

Eggs are enveloped in a silky substance and carried under the female's abdomen. Spercheid larvae (Fig. 10.1B) are elongate and flattened, with the nine-segmented abdomen dilated in the middle. The head and thorax are strongly sclerotised and the legs are long. At the sides of the abdominal segments short outgrowths, which may function as gills, are present. They also have a complete set of small spiracles. Pupation takes place out of the water.

Spercheid larvae are predacious. The adults were previously also thought to be predacious but it has come to light that they are filter-feeders, the only adult coleopterans with such a feeding habit. Both adults and larvae are able to walk upside down under the surface film of the water, where they feed and obtain air. The tarsi of both the adults and larvae have special modifications that allow this habit. Spercheid beetles live in still waters of rivers or ponds.

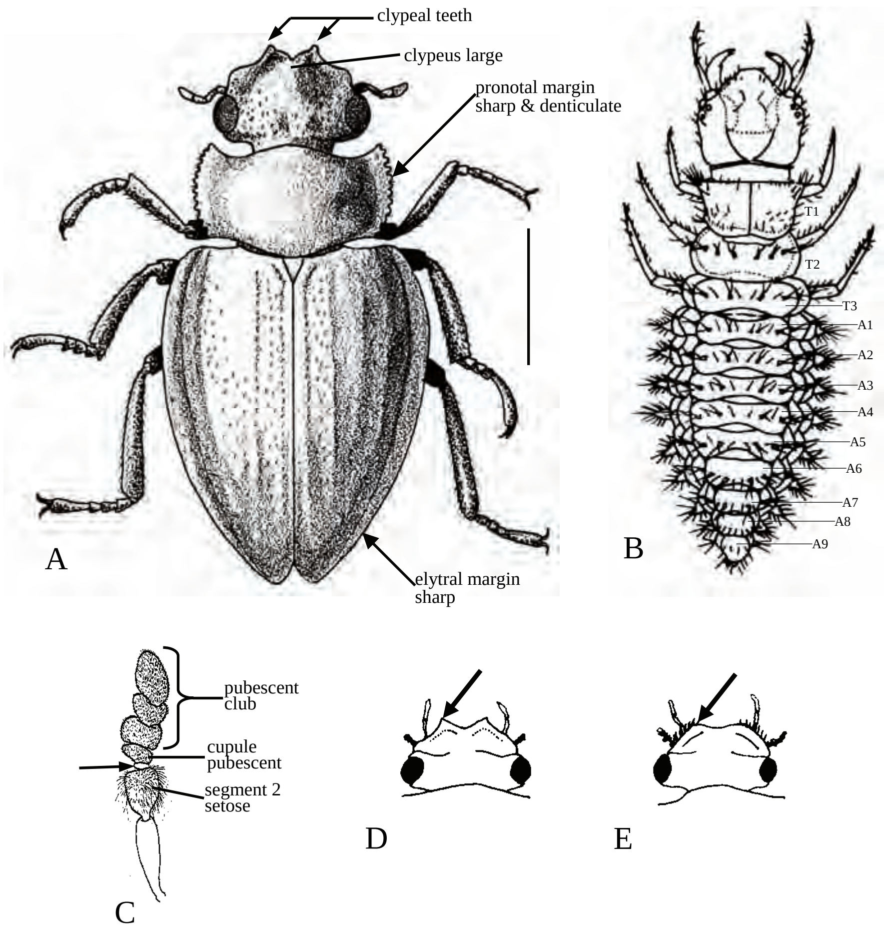

Fig. 10.1. Spercheidae, *Spercheus* sp. **A,** adult, dorsal view; **B,** larva, dorsal view; **C,** adult antenna; **D–E,** heads, dorsal view: **D,** male; **E,** female. (A after Scholtz & Holm 1985, artist: L. Walles; B redrawn from Böving & Craighead 1931; C after Hansen 1991). Scale bar: A, B = 1 mm; C–E much enlarged, not to scale.

The family Spercheidae is sometimes treated as a subfamily (Spercheinae) of the family Hydrophilidae, in which case the latter taxon is treated in a broader sense than is the case in this *Guide*.

Checklist and distribution records of known and described species of Spercheidae in southern Africa

Spercheus, the only genus of this small family, has five described species that are known to occur in southern Africa. The reader is referred to the Appendix (p. 220) for a checklist of these species.

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CHAPTER 11

HYDROPHILIDAE: HYDROPHILINAE

by

R. Stals & S. Endrödy-Younga†

The family Hydrophilidae (water scavenger beetles) is, after the Dytiscidae, the family with the largest number of water beetle species. Hydrophilids are very often encountered in almost any freshwater habitat. Almost all the aquatic forms belong to the subfamily Hydrophilinae. Species of another hydrophilid subfamily, the Sphaeridiinae, are terrestrial and live in damp and dirty habitats like herbivore dung or vegetation debris. Most members of the subfamily Hydrophilinae are true water beetles, living in water both as larvae and as adults. A few members of the Hydrophilinae have reverted to a terrestrial life, where they occupy damp microhabitats.

ADULT MORPHOLOGY

Hydrophilid adults (Figs 11.1A–C) in southern Africa vary from 1 to 50 mm in length. Their body shape is generally oval and sometimes very broadly oval or globose. Their outline is either uninterrupted between the pronotum and the elytra, or only weakly so (Figs 11.1A–C; 11.2G–H). In some genera (e.g. *Regimbartia*) the body is so highly convex that it is deeper than broad. The ventral surface is flat, frequently with plastron-forming hairs. The body surfaces are frequently smooth and shiny. The legs may be simple, or they may be flattened swimming legs and may be set with swimming hairs (Fig. 11.1A).

Hydrophilidae, as well as some other Hydrophiloidea and many Hydraenidae, are characterised by their unusually long maxillary palps (e.g. Fig. 11.1B). In the Hydrophilidae these are four-segmented; they are as long as, or even much longer than, the antennae, and function as tactile — and possibly also olfactory — organs. The antennae (Fig. 11.1D) are seven- to nine-segmented, frequently with a long basal segment, and with a three-segmented, densely setose and hydrofuge club of which the segments are connected more or less loosely and not very compactly. The segment preceding the club is a glabrous cupule. The antennae are almost always much shorter than the width of the head.

A peculiarity of adult female Hydrophilidae (and of some other Hydrophiloidea) is the presence of silk glands associated with the ovipositor; this enables the production of a silken cocoon that encloses the eggs and traps an air space around them when they are submerged. Many female Hydrophilidae carry an enclosed egg mass under the abdomen. In others the egg cocoons are deposited in or on water, and in the Hydrophilini the egg cocoon is a free-floating raft. Some of these egg cases have 'spikes', 'masts', 'ribbons' and other adornments that are distinctive for each genus, and can even be diagnostic for particular species.

The adults of Hydrophilidae and of Dytiscidae look superficially similar, but the hydrophilids are easily recognised by the modified antennae and long maxillary palps.

IMMATURE STAGES

Hydrophilid larvae (Fig. 11.3A–C) vary somewhat in form. Generally they are elongate, more or less cylindrical, and lightly sclerotised, except for the head capsule and tergal sclerites on the thorax and abdomen, which are more strongly sclerotised. The head is more-or-less directed upwards, an adaptation to their way of feeding (see below).

The larval respiratory system is metapneustic, with the last of the eight to ten abdominal segments forming a breathing pocket (or respiratory atrium) wherein the only pair of functional spiracles is situated (Figs 11.3B–C). In these forms the tip of the abdomen is brought into contact with atmospheric air for respiration. In the tribe Berosini, however, a respiratory atrium is absent and the abdominal segments bear pairs of long, tubular tracheal gills (Fig. 11.3A). In yet other Hydrophilinae the respiratory atrium is also absent and gills present, but in such cases the gills are feathery.

Hydrophilid larvae are easily distinguished from dytiscid and other hydradephagan larvae by their five-segmented legs (six-segmented in Hydradephaga), each with a single claw (two claws in the Hydradephaga, except for the Haliplidae). Most hydrophilid larvae can be distinguished from other aquatic beetle larvae by the presence of the respiratory atrium (Figs 11.3B–C) and by conspicuous mandibles that are usually toothed or serrate on the inner margins (as in Fig. 11.3B).

All known pupae of the Hydrophilidae are terrestrial; pupation usually occurs in moist soil.

GENERAL ECOLOGY AND BEHAVIOUR

Adult water scavenger beetles are phytophagous, saprophagous or omnivorous. The larvae are voracious predators. Like the larvae of the Hydradephaga, hydrophilid larvae exhibit extra-oral digestion, but most of the aquatic Hydrophilidae larvae lack the perforated or channelled mandibles found among the Hydradephaga. Generally, aquatic hydrophilid larvae lift their prey out of the water during feeding, a feeding mode that correlates with the head being markedly flexed dorsally and having a ventral surface that is longer than its dorsal surface. The larvae of the tribe Berosini live in deeper waters; at least one of the mandibles of *Berosus* individuals is channelled, similar to those of the Hydradephaga.

Swimming in adults always involves the alternate movement of the middle and hind legs, but not all hydrophilid adults are active swimmers. The adults of the Hydrophilini and Berosini are competent swimmers and in many species of these tribes the larvae are also active swimmers. Larvae of other tribes are not active swimmers and are carried around by water currents, although they may be capable of undulating movements. Some smaller hydrophilid adults run upside down under the water surface, as Spercheidae do. This habit is accompanied by modifications of the tarsi, antennae and eyes. In the adults of the genus *Amphiops* the eyes are completely divided into upper and lower parts, similar to those of the Gyrinidae. Some Hydrophilinae live in moss, or may be found in the hygropetric environment.

The adults of several water scavenger beetle species can fly well and are often found near lights at night.

KEY TO PRINCIPAL SOUTHERN AFRICAN GENERA OF AQUATIC HYDROPHILIDAE: ADULTS

(*partly based on keys by Hansen (1991)*)

1. Eyes completely divided into dorsal and ventral parts; body very strongly rounded and very strongly convex, almost semiglobular, a little compressed from the sides; middle tibiae with fringes of long swimming hairs, no swimming hairs on hind tibiae; body length 3–5 mm .... *Amphiops*

– Eyes not divided into dorsal and ventral parts; body shapes various; swimming hairs on legs present or absent 2

2. Middle and hind tibiae each with a conspicuous fringe of swimming hairs (Fig. 11.1A); scutellum much longer than wide (BEROSINI) 3

– Middle and hind tibiae without swimming hairs; scutellum not longer than wide, or hardly longer than wide 5

3. Body very strongly convex, more or less compressed from side to side; posterior corners of pronotum broadly rounded and received in excavations in elytral base; dorsal surface shiny, black or dark reddish brown; elytra very finely punctate, may appear smooth; eyes not protuberant or only a little protruberant 4

– Body only moderately convex, not compressed from the sides; posterior corners of pronotum obtusely angulate, not received in excavations in elytral base; dorsal surface paler, yellowish to brownish, never black; elytra often striate-punctate; eyes rather protuberant; body length 1.5–9 mm .... *Berosus* (Fig. 11.1A)

4. Elytra with rows of serial punctures, more or less attenuate posteriorly; abdominal ventrites not separated by grooves, their posterior margins serrate; body length 2.5–5.5 mm .... *Regimbartia*
– Elytra without rows of serial punctures, except at the sides, not attenuate posteriorly; abdominal ventrites separated by deep grooves, their posterior margins not serrate; body length 2.5–5 mm .... *Allocotocerus*

5. Abdomen with six distinct ventrites, with the first five ventrites rather shiny and sparsely pubescent, the last ventrite less shiny, densely pubescent and somewhat retractable; body length 1.5–4.5 mm ...... *Laccobius* (Fig. 11.1C)
– Abdomen with five ventrites 6

6. Posterior margin of fifth (last) abdominal ventrite usually with a small apical emargination fringed with stiff, yellowish setae (Fig. 11.2A); if not, then meso- and metasternum raised to form a common median keel (Fig. 11.2B); length of maxillary palp various, frequently as long as width of head or longer than that (Hydrophilini) 7
– Posterior margin of fifth (last) abdominal ventrite without an apical emargination; distinct median sternal keel absent; maxillary palp not more than half as long as width of head (ANACAENINI) 13

7. Mesosternum very strongly raised medially to a high keel that is intimately fused with median elevation of metasternum to form a common sternal keel (Fig. 11.2B), metasternum terminating posteriorly in a shorter or longer, horizontal spine between the hind coxae; large species, seldom shorter than 10 mm 8
– Mesosternum raised medially or not, but never with elevation intimately fused to median metasternal elevation to form a common sternal keel; small species, usually much shorter than 10 mm 11

8. Middle portion of prosternum highly tectiform, pointed posteriorly; mesosternal keel with a small notch and a few long setae near anterior apex 9
– Middle portion of prosternum somewhat hoodlike, deeply sulcate from behind to receive anterior apex of mesosternal keel, prosternum sometimes completely split into two lobes; anterior apex of mesosternal keel without notch and setae; first segment of antennal club deeply split into two asymmetrical lobes, the narrower lobe with long setae (Fig. 11.2C); body length 20–50 mm .... *Hydrophilus*

9. All femora with hydrofuge pubescence basally; prosternum with a rather long seta or small tuft of setae rising from an anteromedian puncture; apical segment of maxillary palp normally longer than penultimate segment; body length 7.5–14 mm .... *Sternolophus*
– Middle and hind femora without hydrofuge pubescence; prosternum without such seta(e); apical segment of maxillary palp not longer than penultimate segment 10

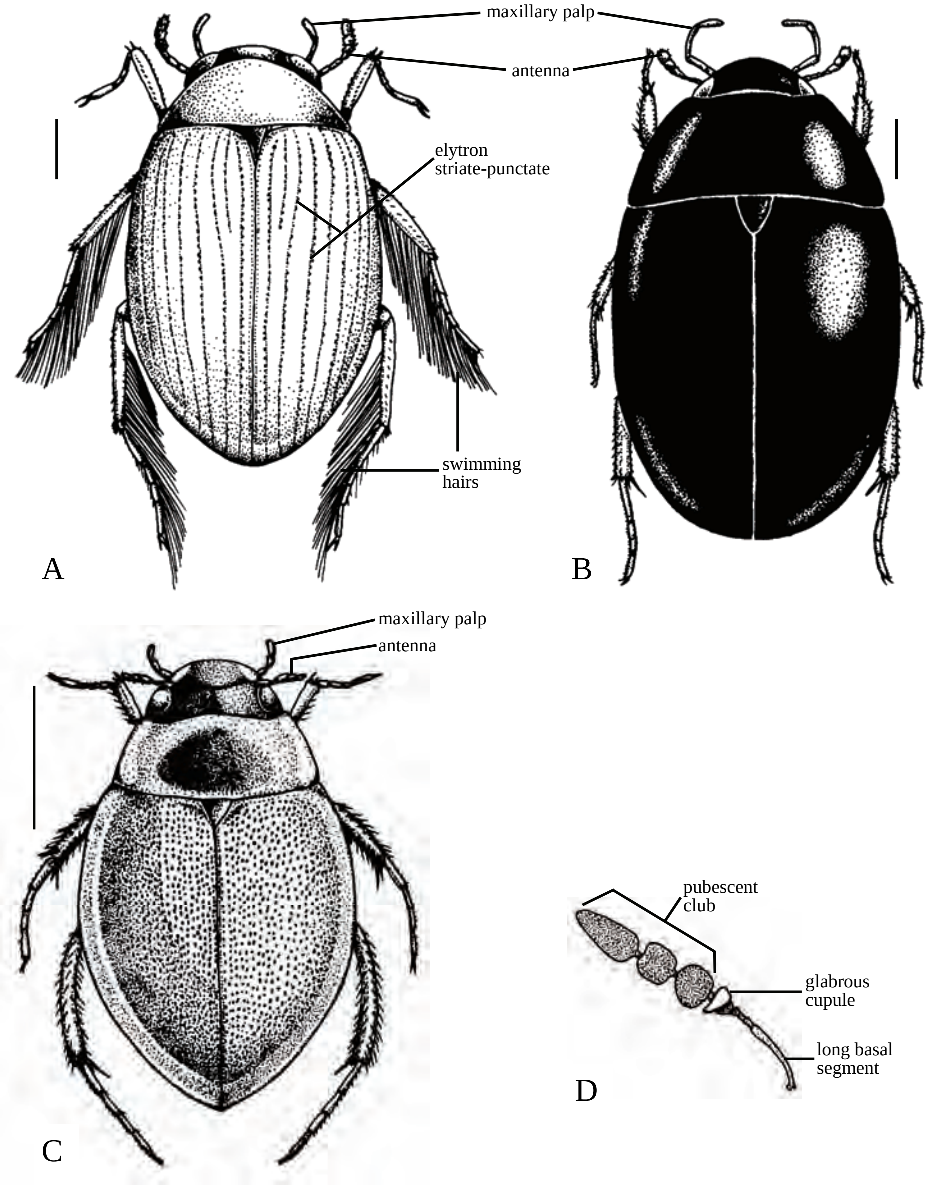

Fig. 11.1. Hydrophilidae, adults. **A,** Berosini, *Berosus* sp., dorsal view; **B,** Hydrophilini, *Enochrus* sp., dorsal view; **C,** Laccobiini, *Laccobius* sp., dorsal view; **D,** antenna, showing glabrous cupule preceded by five segments. (A–C adapted from Testa & Lago 1994, artist: Joe MacGown; D after Scholtz & Holm 1985). Scale bar: A–C = 1 mm; D much enlarged.

10. Anterior margin of clypeus emarginate so that articulation membrane to labrum is exposed; first segment of antennal club deeply split into two very asymmetrical lobes, the narrower lobe with long setae (as in Fig. 11.2C); body length 12–28 mm .... *Hydrobiomorpha*
– Anterior margin of clypeus truncate, articulation membrane to labrum not exposed; first segment of antennal club lunulate with only slightly asymmetrical lobes, the narrower lobe without long setae; body length 10–20 mm ... . *Hydrochara*

11. Maxillary palp with apical segment (MP4) bending a little outwards and second segment (MP2) more or less distinctly curving outwards (Figs 11.2D–E); elytra with sutural striae in approximately posterior half; body length 2–9 mm .... *Enochrus* (Fig. 11.1B)
– Maxillary palp with apical segment (MP4) bending a little inwards and second segment (MP2) straight or curved inwards (Fig. 11.2F); elytra with or without sutural striae 12

12. Elytra with sharp sutural striae in at least posterior half, otherwise without distinct striae or serial punctures (except sometimes for lateral vestiges); maxillary palp at least as long as width of head, often somewhat longer; body elongate oval, sometimes subparallel, rather weakly convex; body length 2.5–5.5 mm .... *Chasmogenus*
– Elytra without sutural striae, sometimes with ten rows of serial punctures; maxillary palp not more than 1.5 times as long as width of head; body elongate oval to rather broadly oval or somewhat ovoid and widest behind middle, weakly to moderately convex; body length 2.5–10 mm, rarely up to 14 mm .... *Helochares*

13. Prosternum a little tectiform, carinate medially; posterior femur without hydrofuge pubescence (except sometimes at extreme base); body length 1.0–3.2 mm... *Paracymus*
– Prosternum weakly convex or medially a little bulging, but not carinate; posterior femur with more distributed hydrofuge pubescence, only rarely restricted to extreme base 14

14. Posterior margin of pronotum distinctly bisinuate (arrowed on Fig. 11.2G); elytra normally with detectable (albeit often inconspicuous) rows of serial punctures; eyes normally slightly protruding (Fig. 11.2I); mesosternum posteriorly only with a small blunt transverse bulge or transverse ridge; body length 1.7–3.5 mm ....*Crenitis*
– Posterior margin of pronotum not distinctly bisinuate (arrowed on Fig. 11.2H); elytra normally without any trace of serial punctures; eyes never protruding, their outer margins forming continuous curves with lateral margins of head (Fig. 11.2J); mesosternum posteriorly with small, rather sharply defined transverse arcuate ridge, which often projects into a small acute tooth; body length 1.5–3.3 mm .... *Anacaena*

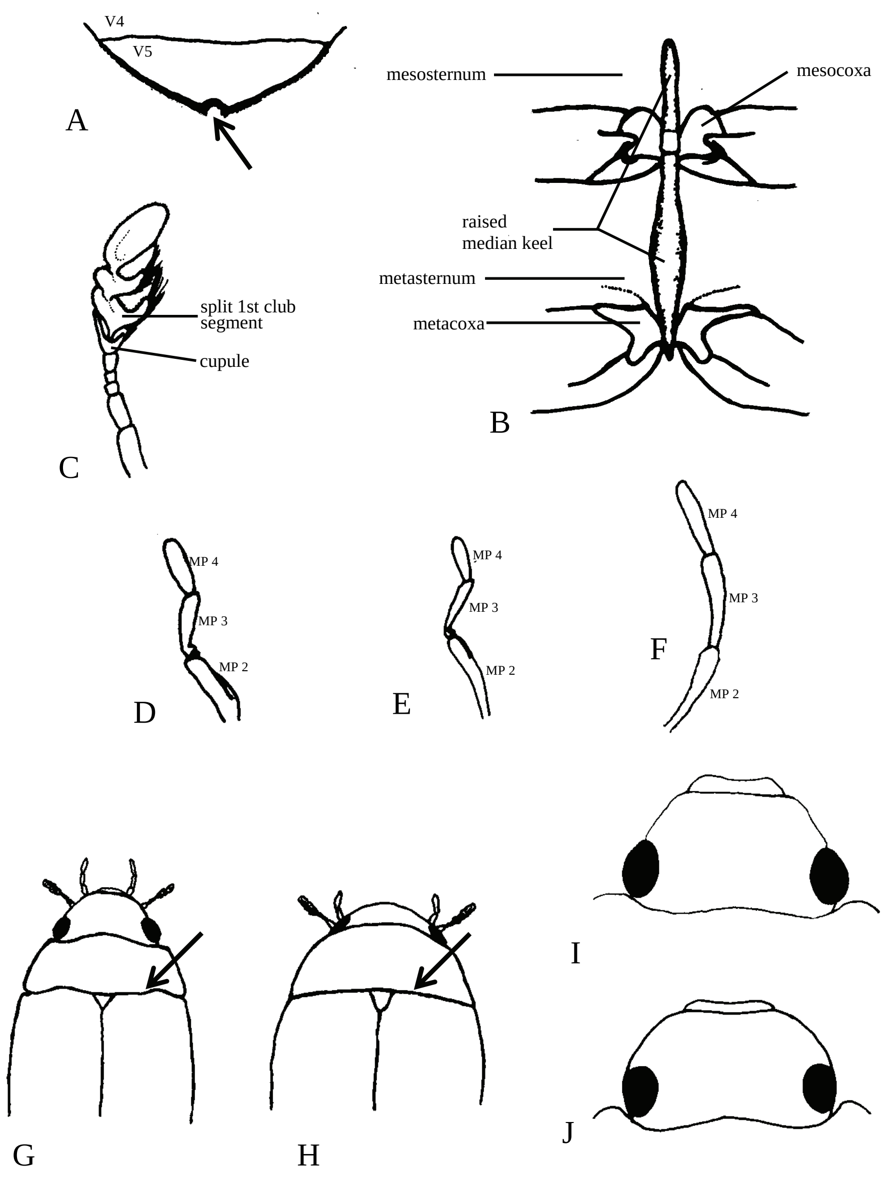

Fig. 11.2. Hydrophilidae, adult key diagrams. **A,** *Enochrus*, terminal abdominal segments, ventral; **B,** *Hydrochara*, thorax ventral, to show raised, median keel; **C,** *Hydrophilus*, antenna; **D–F,** anterior part of maxillary palps, with lateral side to the right: **D–E,** *Enochrus*; **F,** *Helochares*; **G–H,** anterior part of body, dorsal: **G,** *Crenitis*; **H,** *Anacaena*; **I**–**J,** head with eyes, dorsal: **I,** *Crenitis*; **J,** *Anacaena*. Not to scale. MP = maxillary palp segment.

KEY TO SOME SOUTHERN AFRICAN GENERA OF AQUATIC HYDROPHILIDAE: LARVAE

1. Abdomen with long lateral gills; last abdominal segment without atrium or spiracles .... *Berosus* (Fig. 11.3A)

– Abdomen without lateral gills, or with very short lateral gills only; last abdominal segment with respiratory atrium containing enlarged spiracles (Figs 11.3B–C) 2

2. Second segment of antenna with apical sensory appendage over and above third segment (antenna appears terminally bifurcate) 3

– Second antennal segment simple, bearing only the third segment 4

3. Abdomen with paired ventral outgrowths ('pseudopods') ....*Enochrus* (Fig. 11.3B)

– Abdomen without 'pseudopods' .... *Helochares*

4. Legs without swimming hairs .... *Amphiops*

– Legs with long swimming hairs on the femora .... *Hydrophilus*

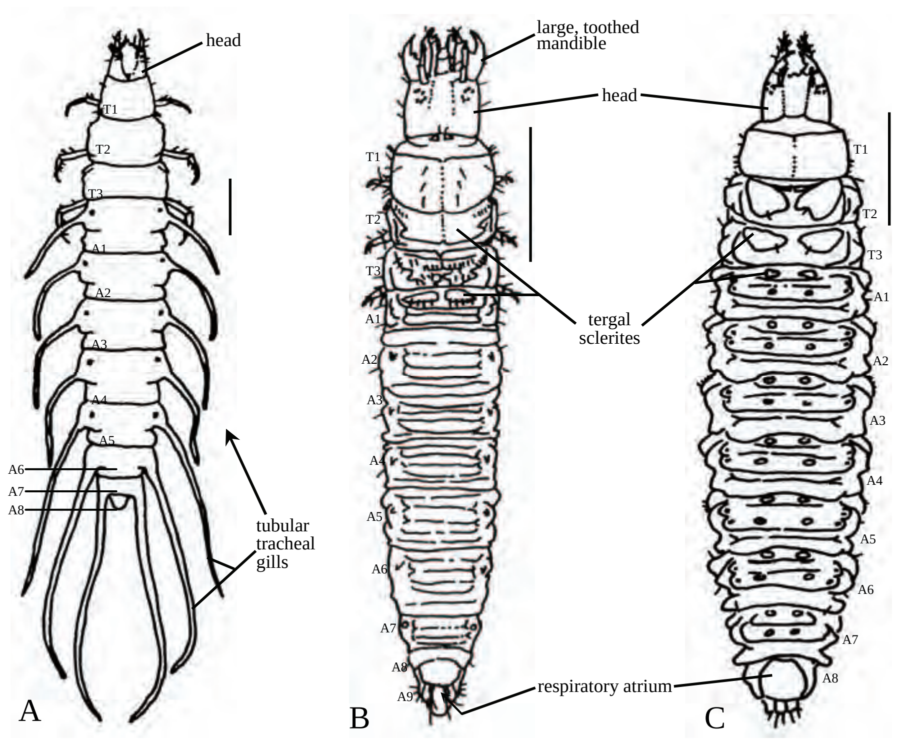

Fig. 11.3. Hydrophilidae, larvae, dorsal view. **A,** Berosini, *Berosus* sp.; **B,** Hydrophilini, *Enochrus* sp.; **C,** Laccobiini, *Laccobius* sp. (All figures redrawn from Stehr 1991). Scale bars = 1 mm.

Checklist and distribution records of known and described aquatic species of Hydrophilidae: Hydrophilinae in southern Africa

At the close of the 20th century, M. Hansen catalogued 58 genera and 1575 species for the world fauna of the Hydrophilinae (Hansen 1999b). A fair number of new taxa has been added to the subfamily since (Short & Hebauer 2006). Although the southern African hydrophilid fauna is reasonably well known, comprehensive revisions on the family were unavailable until rather recently. Since the 1990s this situation has been improving tremendously, especially through the work of Elio Gentili, Franz Hebauer, Albrecht Komarek, and the late workers Michael Hansen and Stefan Schödl. To date, 18 or 19 aquatic genera and about 138 aquatic species have been described and recorded from southern Africa.

Hebauer (1995, 1999) recorded the genus *Agraphydrus* Régimbart, 1903 (tribe Hydrophilini) from southern Africa, briefly listing one described species (Hebauer 1995) and four apparently still undescribed species (Hebauer 1999b) for the region. A few members of this genus are known from elsewhere in the Afrotropical Region but, pending formal description of the 'new' species and confirmation of their presence in southern Africa, *Agraphydrus* is not included in the checklist (Appendix: p.205). The genus *Grodum* Hansen, 1999, of which the two known species are endemic to South Africa, is not listed either. Although it is a member of the predominantly aquatic tribe Anacaenini, its members are apparently exclusively terrestrial (apparently humicolous).

The following tribes of Hydrophilinae have been recorded in southern Africa:

Tribe Anacaenini
Tribe Berosini
Tribe Chaetarthriini
Tribe Hydrophilini
Tribe Laccobiini

The reader is referred to Appendix 1 (pp. 220–224) for a checklist of the known and described aquatic Hydrophilinae taxa of southern Africa.

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CHAPTER 12

HELOPHORIDAE

by

R. Stals

Only one genus — *Helophorus*, with fewer than 200 known species — belongs to the family Helophoridae (grooved water scavenger beetles). From southern Africa only one, unfamiliar, species is known. The greatest diversity of this small family is found in the Palaearctic Region. Most Helophoridae can functionally be classified as true water beetles, with the adult stage being submerged most of the time and the larvae and pupae being terrestrial.

The morphology of *Helophorus* adults is very uniform among the various species. They can be discriminated easily from all other adult water beetles on the basis of their most conspicuous diagnostic feature: the presence of five longitudinal grooves on the disc of the pronotum (Fig. 12.1A). These grooves are more or less parallel and are separated from one another by raised areas that are equally longitudinal, but broader than the grooves. In the only southern African species of Helophoridae, the cuticle of the adult is yellowish to brownish, the pronotum has a feeble purplish-metallic iridescence, and each elytron has a characteristic median fleck (Fig. 12.1A).

Different *Helophorus* species vary in size from very small to medium-sized in the adult stage. The southern African species is about 3.5 mm long, with an elongate general body shape (Fig. 12.1A). The number of antennal segments of helophorid adults is very variable, but is seems that the southern African species always has eight yellowish antennal segments (including a three-segmented club with dense hydrofuge pubescence). The maxillary palps are rather elongate, with the apical segment almost twice as long as the penultimate segment. The pronotum is transverse, the scutellum is small and almost circular, and the elytra are somewhat parallel-sided, each with 10 longitudinal striae with deep, irregularly spaced punctures. Most of the underside of the body is covered with dense, hydrofuge pubescence. Five abdominal ventrites are visible. The legs are slender and yellowish.

The biology of the southern African species is entirely unexplored. Not all adult Helophoridae are aquatic, some being semi-aquatic and some even being terrestrial. Judging from the collection data of the known specimens of the southern African species, it can be safely claimed that this species is most probably aquatic in the adult stage.

In general, Helophoridae lay their eggs in silk cocoons consisting of an egg sac topped by a 'mast'. The cocoon is placed in mud beside the water, or among vegetation in very shallow water. *Helophorus* larvae (Fig. 12.1B) are exclusively terrestrial, but live close to water. They are elongate, and clearly recognisable by the presence of a fully developed ninth abdominal segment, which bears long, three-segmented urogomphi. *Helophorus* larvae lack both a respiratory atrium and tracheal gills; the former characteristic distinguishes them from Hydrophilidae larvae (except for the larvae of the hydrophilid, *Berosus*, which has conspicuous lateral gills**:** Fig. 11.2A).

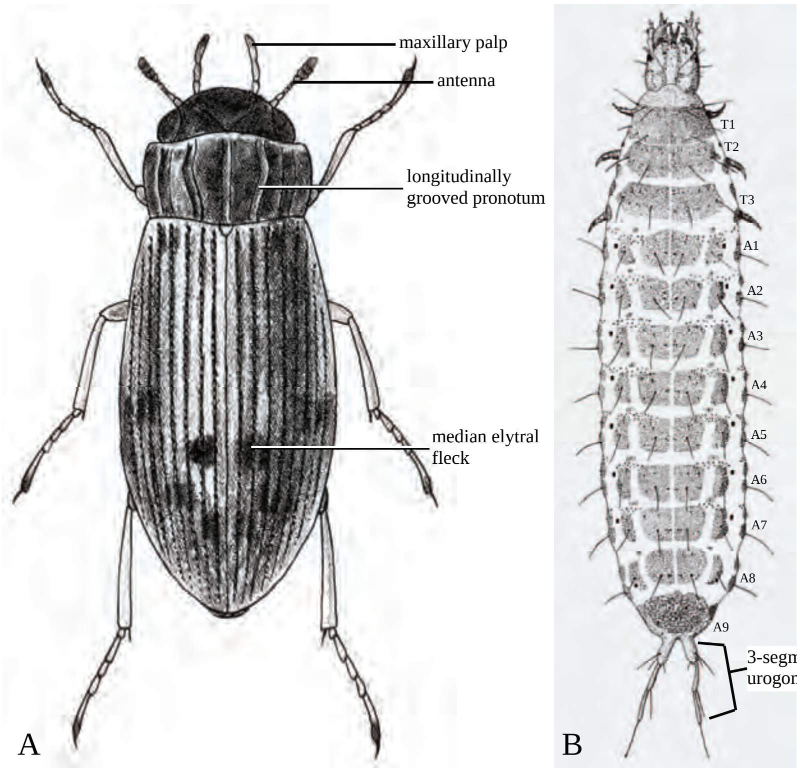

Fig. 12.1. Helophoridae, *Helophorus* sp. **A,** adult, dorsal view (length *ca.* 3 mm); **B,** larva, dorsal view (length 5.5 mm, excluding urogomphi). (A after Hansen 1991; artist: V. Hansen; B after Angus 1973).

Apart from a few European species of minor agricultural importance, all helophorid larvae are predacious.

Adult helophorids are phytophagous or saprophagous. Under water, they store air as a plastron on the underside of the body. Like other aquatic Hydrophiloidea and Hydraenidae, the antennae are used as accessory breathing organs. They are very poor swimmers, or have no swimming abilities and crawl around on the underwater substrate. Aquatic Helophoridae prefer small water bodies, which they willingly colonise, and they can occur together in very large numbers. Adults fly readily.

The family Helophoridae is sometimes treated as a subfamily (Helophorinae) of the family Hydrophilidae; in such cases the latter family would be treated in a broader sense than as considered in this *Guide*.

The Helophoridae of the Palaearctic and Nearctic Regions are remarkably well known, singularly through the indefatigable effort of R.B. Angus, who has been publishing on the family from 1969 to the present. Aspects of Angus's work on the Helophoridae include taxonomy and systematics, chromosome analysis, hybridisation experiments and species limits, biology and ecology, larvae, and palaeontology. Only one of his papers is listed in the 'Useful References' below, but the interested reader is advised to obtain other works by this author.

Checklist and distribution records of known and described species of Helophoridae in southern Africa

Only two *Helophorus* species (both in the subgenus *Rhopalohelophorus*) are known from the Afrotropical Region. One of these occurs in Ethiopia and Kenya, and the other (listed in the Appendix) is probably endemic to southern Africa.

The reader is referred to the Appendix (p. 224) for details of the southern African Helophoridae species.

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CHAPTER 13

HYDRAENIDAE

by

P.D. Perkins

Adults of the family Hydraenidae (minute moss beetles) are extremely small to small beetles, ranging in length from 1–3 mm. The family is cosmopolitan in distribution, with about 1500 species described world-wide and several hundred more in the process of being described. The southern African fauna, although not large in terms of the total number of species, is very diverse and highly endemic. In an attempt to comprehensively review the current (and expanding) knowledge of southern African Hydraenidae, truly aquatic, semi-aquatic and humicolous taxa are dealt with in this chapter.

ADULT MORPHOLOGY

Adult hydraenid beetles can be distinguished from all other aquatic beetles by the abdominal structure and the form of the antennae. The abdomen has six or seven visible sternites (Figs 13.2A–B) and a small intercoxal sternite between the metacoxae (arrowed in Figs 13.2B; 13.5D). The antenna has a pubescent club consisting of five loosely-articulated segments (Figs 13.1A; 13.2D), except for the members of the subfamily Prosthetopinae, in which the club segments are connate and have reduced articulations, resulting in fewer than five club segments (Fig. 13.1B; arrowed in Fig. 13.6B). Similar to most aquatic Hydrophiloidea, the highly specialised antennae of aquatic Hydraenidae serve mainly to break the water surface film and establish a connection between the atmosphere and the beetle’s ventral air bubble. The very long maxillary palps probably serve the 'standard functions' of the antennae of other beetles.

Hydraenids are most likely to be confused with small members of the superfamily Hydrophiloidea, but hydrophiloids have an antennal club consisting of three or fewer segments (loosely articulated in aquatic forms), preceded by a glabrous cupule (Figs 9.1B; 11.1D), and the hydrophiloid abdomen usually has five visible sternites and no intermetacoxal sternite.

IMMATURE STAGES

In general, the larvae of Hydraenidae (Fig. 13.8C) are small and usually campodeiform, elongate, and subcylindrical. Pronounced aquatic adaptations are generally lacking and most southern African species may have semi-aquatic or humicolous larvae. The thoracic and the first eight of the total of ten abdominal segments have large tergal sclerites. The cuticle carries numerous setae. The five-segmented legs are well developed and the tarsus and pretarsus are fused to form a single claw-like tarsungulus. The abdomen carries articulated urogomphi and a pair of stout, recurved terminal hooks on the last segment.

Larvae of several hydraenid genera have been described in detail in recent years, but larvae of the predominantly southern African Prosthetopinae are still unknown.

ECOLOGY AND MICROHABITAT PREFERENCES

The vast majority of the species in the family Hydraenidae are truly aquatic in the adult stage, but the larvae of most species are only semi-aquatic. Hence, the microhabitat of many hydraenid larvae is damp ground at the water's edge. Several southern African hydraenid taxa have humicolous adults and it can be assumed that their larvae would be found in the same microhabitats.

Most genera have at least some members of which the adults are either psammophilous, being found at the margins of sandy or gravelly streams, or live amongst emergent vegetation at the margins of streams and ponds, or live in rock pools. Members of some genera (e.g. *Mesoceration*) are typically found in stones-in-current biotopes, whereas others (e.g. *Coelometopon*) are typically found in hygropetric habitats such as seepage areas over rock outcrops or the splash zone at the margins of waterfalls. *Ochthebius capicola* occurs on algae-covered surfaces in hypersaline ocean rock pools above the high tide line, but within the splash zone. *Meropathus randi* of the sub-Antarctic islands is mostly found on coastal rocks, but also in Crassulaceae vegetation. A synopsis of microhabitats for each southern African genus is given in Table 13.1.

Both adult and larval hydraenids graze on wet surfaces, largely those of stones, sand grains and plant matter, feeding on microscopic organisms (algae, bacteria, protozoa) and decomposing organic matter.

SAMPLING METHODS

The adults of minute moss beetles found at the margins of clear, sandy streams are easily collected by stirring the sand and gravel at the waterline

Table 13.1. Principal microhabitats of adult southern African Hydraenidae
x denotes positive records; xx denotes a great majority of records; (x) denotes a minority of specimens

	Hygropetric [1]	Stream margins	Rock pools	Running freshwater	Stones-in-current	Brackish / saline / ocean water [2]	Ephemeral pools [3]	Moss	Marginal / emergent vegetation	Humicolous[4]	Shore-washing [5]
Prosthetopinae											
Coelometopon	xx			(x)	(x)			(x)			(x)
Mesoceration		x			xx				(x)		x
Nucleotops										xx	(x)
Oomtelecopon	x									x	
Parasthetops	x				x				x		x
Prosthetops			x	x	(x)						
Pterosthetops	x	(x)	(x)		x						(x)
Sebasthetops					x						
Hydraeninae											
Discozantaena										xx	(x)
Hydraena		x	x	x				x	x		x
Limnebius		x	x								x
Parhydraena	x									x	x
Pneuminion	x				x			x		x	x
Protozantaena											x
Ochthebiinae											
Aulacochthebius				x		x					x
Ochthebius		x	x			x	x				

[1] Hygropetric: wet rock faces, seepage trickles, margins and spray zone of waterfalls, etc.
[2] Brackish / saline / ocean water: includes saline pans, ponds, streams.
[3] Ephemeral pools: include water holes and roadside pools.
[4] Humicolous: humus substrates, leaf and forest litter, shore debris, etc.
[5] 'Shore-washing' is of course not a microhabitat, but a technique (see text and glossary). It is included in the table as it can reflect microhabitat preferences. Non-aquatic species may, however, be collected with this method should they occur in marginal, humicolous microhabitats, having been unwittingly sampled.

and waiting for the beetles to float to the surface, where they remain suspended, upside-down, in the surface film. They cannot swim, but can walk about on the underside of the surface film, appearing as tiny silvery flecks due to their ventral air bubbles. An effective method of collecting these species is by means of 'shore-washing', which entails splashing water onto the stream bank and collecting beetles (that will have floated to the surface) with a fine-mesh net in shallow water. Hydraenids are frequently overlooked by the general aquatic insect collector simply because the meshes of many general-purpose aquatic nets are large enough to allow hydraenids to pass through.

KEY TO THE KNOWN SOUTHERN AFRICAN GENERA OF HYDRAENIDAE: ADULTS

1. Penultimate (third) maxillary palp segment more robust and longer than the fourth segment (upper arrow in Fig. 13.1D); pronotum usually with a lateral translucent hyaline border (lower arrow in Fig. 13.1D) (OCHTHEBIINAE) .. 2
– Penultimate (third) maxillary palp segment never longer than, and never markedly more robust than, the fourth segment; pronotum never with a lateral hyaline border (e.g. Figs 13.1C, E) 3

2. Pronotal disc with two deep transverse grooves, one in front of and one behind the middle, connected by a median longitudinal groove (Fig. 13.1D); vestiture of ventrites consists of hydrofuge setae and stiff, erect spines; body size very small (total length c. 1.0 mm) .... *Aulacochthebius* (Fig. 13.1D)
– Pronotum not as above; vestiture of ventrites consists of hydrofuge hairs; body size larger (total length c. 1.7–2.4 mm) .... *Ochthebius*

3. Eyes protuberant and elevated, frons concave between eyes; dorsum granulate and tuberculate 4
– Head and dorsum not as above 5

4. Lateral margin of elytron formed by granules on prominently raised eighth interval (= pseudoepipleuron); female with fringe of strong spines on last tergite; strongly granulate, moderately setose .... *Coelometopon*
– Lateral margin of elytron not formed by pseudoepipleuron of eighth interval; last tergite of female without spines; weakly granulate, very strongly setose; with large callus in front of eye .... *Oomtelecopon*

5. Sides of pronotum and elytron together forming an even arc, and base of pronotum as wide as base of elytra (arrowed in Fig. 13.1C); dorsal surface even, without impressions; maxillary palps never elongate ....
.... *Limnebius* (Fig. 13.1C)
– Sides of pronotum and elytron together not forming an even arc, and base of pronotum narrower than base of elytra (e.g. Fig. 13.1E, lower arrow); pronotum with impressions; maxillary palps various 6

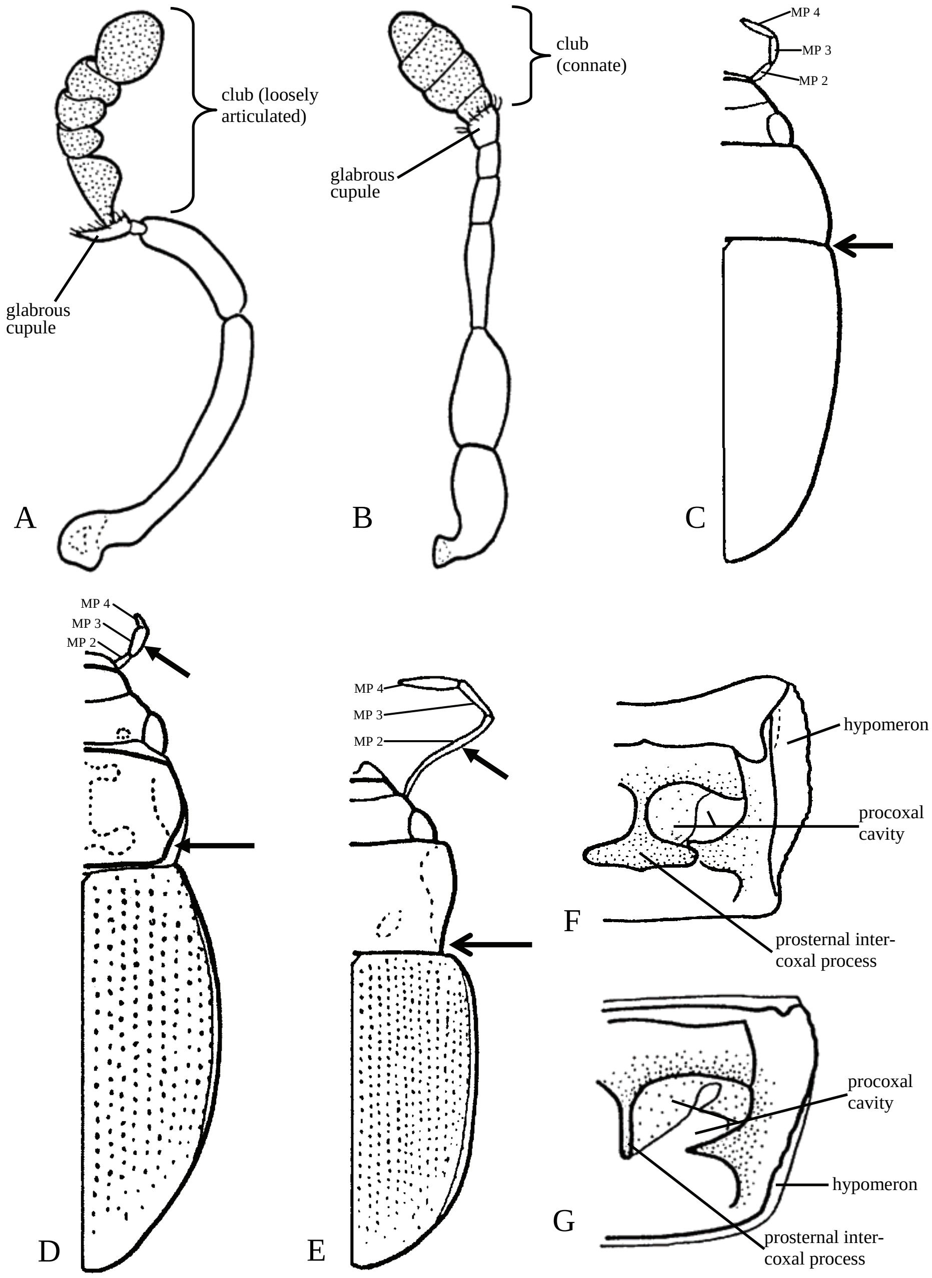

Fig. 13.1. Hydraenidae, adults. **A–B,** antennae (stippled segments with hydrofuge pubescence): **A,** *Hydraena* sp.; **B,** *Mesoceration* sp.; **C–E,** dorsum, right side: **C,** *Limnebius* sp.; **D,** *Aulacochthebius* sp.; **E,** *Hydraena* sp.; **F–G,** prosternum and hypomeron, left side, ventral view: **F,** *Hydraena* sp.; **G,** *Ochthebius* sp. All much enlarged, not to scale. MP = maxillary palp segment.

6. Prosternal intercoxal process expanded laterally behind procoxae, closing procoxal cavities (Fig. 13.1F); maxillary palps always elongate, second palp segment slender, slightly sinuate, much longer than third segment (upper arrow in Fig. 13.1E); ocelli absent .... *Hydraena* (Fig. 13.1E)
– Prosternal intercoxal process not expanded behind procoxae, procoxal cavities open posteriorly (e.g. Figs 13.1G; 13.2D); maxillary palps various; ocelli present (e.g. Figs 13.2C; 13.6A) 7

7. Anterior margin of pronotum with distinct postocular emarginations; underside of prothorax with anterior extreme of wet-hypomeron enclosing part of antennal pocket; first abdominal ventrite and basal part of second ventrite with hydrofuge pubescence, remainder with sparse, fine, long setae; antenna with eleven segments (six + club) .... *Pneuminion*
– Combination of characters not as above 8

8. Pronotal hypomeron anterolaterally with large, shallow pocket in which antennal club is held in repose (arrowed in Fig. 13.2D); antennal club always loosely articulated (Fig. 13.2D); venter with hydrofuge pubescence (Parhydraenini, in part) 9
– Pronotal hypomeron anterolaterally without large, shallow depressions (right arrow in Fig. 13.5C); antennal club usually compact, connate (Fig 13.1B; left arrow in Fig. 13.5C); venter often with dense, short, plastron-forming setae (Figs 13.2A–B; 13.5D) (Prosthetopinae, in part) 11

9. Pronotum explanate (upper arrow in Fig. 13.3A), widest slightly behind middle, then markedly attenuate to posterolateral angles, each of which is produced in a small acute point (middle arrow in Fig. 13.3A); hypomeral antennal pocket bordered posteriorly with very sparse, indistinct, flexible setae that lie flat on cuticle in dry specimens; explanate margin of elytron very wide (lower arrow in Fig. 13.3A), in dorsal view concealing tibial-femoral articulation; humicolous species .... *Discozantaena* (Fig. 13.3A)
– Pronotum not explanate, widest near midlength, posterolaterally subrectangular (as in Fig. 13.2C); hypomeral antennal pocket bordered posteriorly with long, stiff, arcuate setae (as in Fig. 13.2D) 10

10. Wet- and bubble-hypomeron separated by carina (Fig. 13.2D); maxillary palps of various lengths; aquatic and humicolous species .... *Parhydraena*
– Hypomeral carina absent; maxillary palp large, as long as antenna, apical segment wide, inner surface arcuate at base; aedeagus with long terminal flagellum and very short parameres .... *Protozantaena*

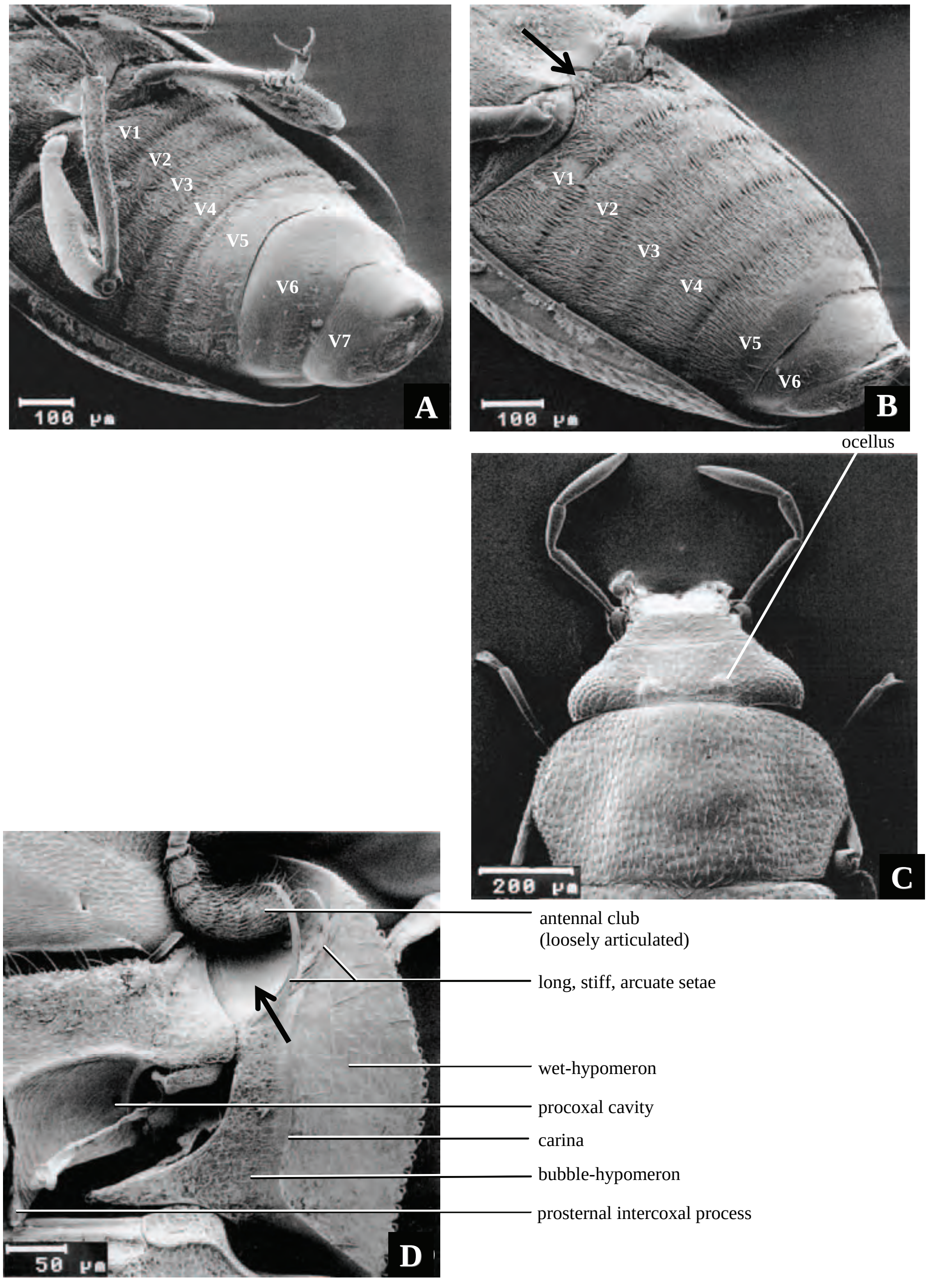

Fig. 13.2. Hydraenidae, adults (SEMs). **A–B,** *Mesoceration rubidum*, abdomen, oblique ventral view: **A,** male; **B,** female; **C–D,** *Parhydraena* sp.: **C,** head and pronotum, dorsal view; **D,** prosternum and hypomeron, left side, ventral view.

11. Pronotum with strong admedian longitudinal reliefs (Fig. 13.4D); elytral intervals 2, 4 and 6 costate (Fig. 13.4D); mentum fringed laterally with long setae; venter without hydrofuge or plastron vestiture; maxillary palps and tarsi very short (cf. Fig. 13.4D); humicolous species .... *Nucleotops* (Fig. 13.4D)

– Pronotum without strong longitudinal reliefs; mentum not fringed laterally with setae; venter, at least in part, clothed with dense hydrofuge or plastron vestiture; maxillary palps and tarsi more elongate; aquatic species 12

12. Maxillary palp robust and short, length equal to, or less than, width of anterior margin of clypeus (Figs 13.6A; 13.8A); maxillary palp, when extended backward, not reaching beyond posterior border of eye, or only very slightly so (Fig. 13.6A); first four abdominal ventrites posteriorly fringed with single row of flattened setae (flattened setae reflect light and are more shining compared to surrounding vestiture) (arrowed in Fig. 13.6C); vestiture of metasternal disc flattened or squamiform; hind coxa lacking plastron vestiture, at least medially 13

– Maxillary palp less robust and longer, always much longer than anterior margin of clypeus; maxillary palp, when extended backward, always reaching well beyond posterior border of eye (Figs 13.3B; 13.4A; 13.5C); first four abdominal ventrites with setae on posterior border similar in form to plastron-forming setae on other parts of ventrites (border setae overlapping adjacent ventrite reflect light similarly to other vestiture) (Figs 13.2A–B; 13.5D); vestiture of metasternal disc not squamiform; metacoxa entirely clothed with plastron vestiture, except small area opposite trochanter (as in Fig. 13.5D) 14

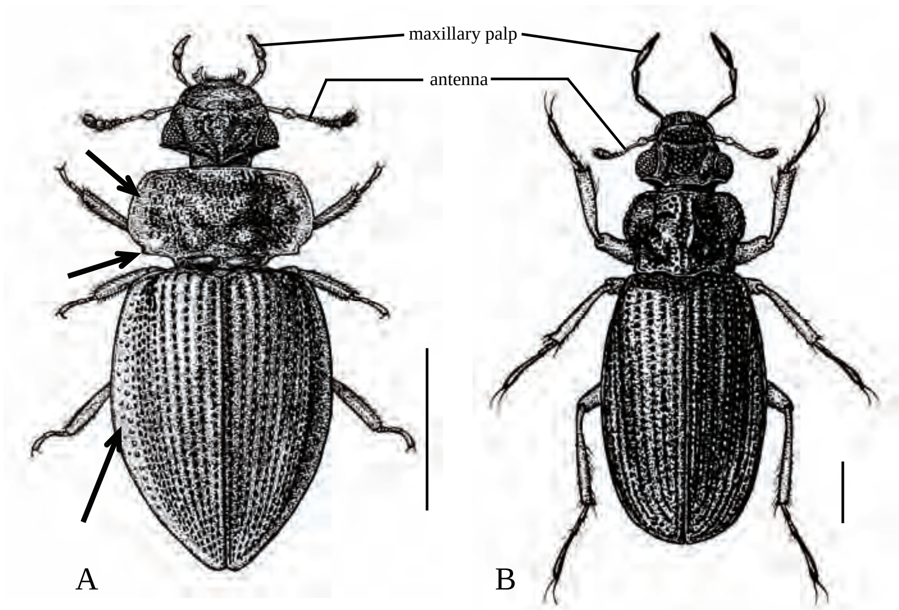

Fig. 13.3. Hydraenidae, adults, dorsal view. **A,** *Discozantaena genuvela*; **B,** *Parasthetops curidius*. (After Perkins & Balfour-Browne 1994; artist: C. O'Brien). Scale bars: A = 0.5 mm; B = 0.3 mm.

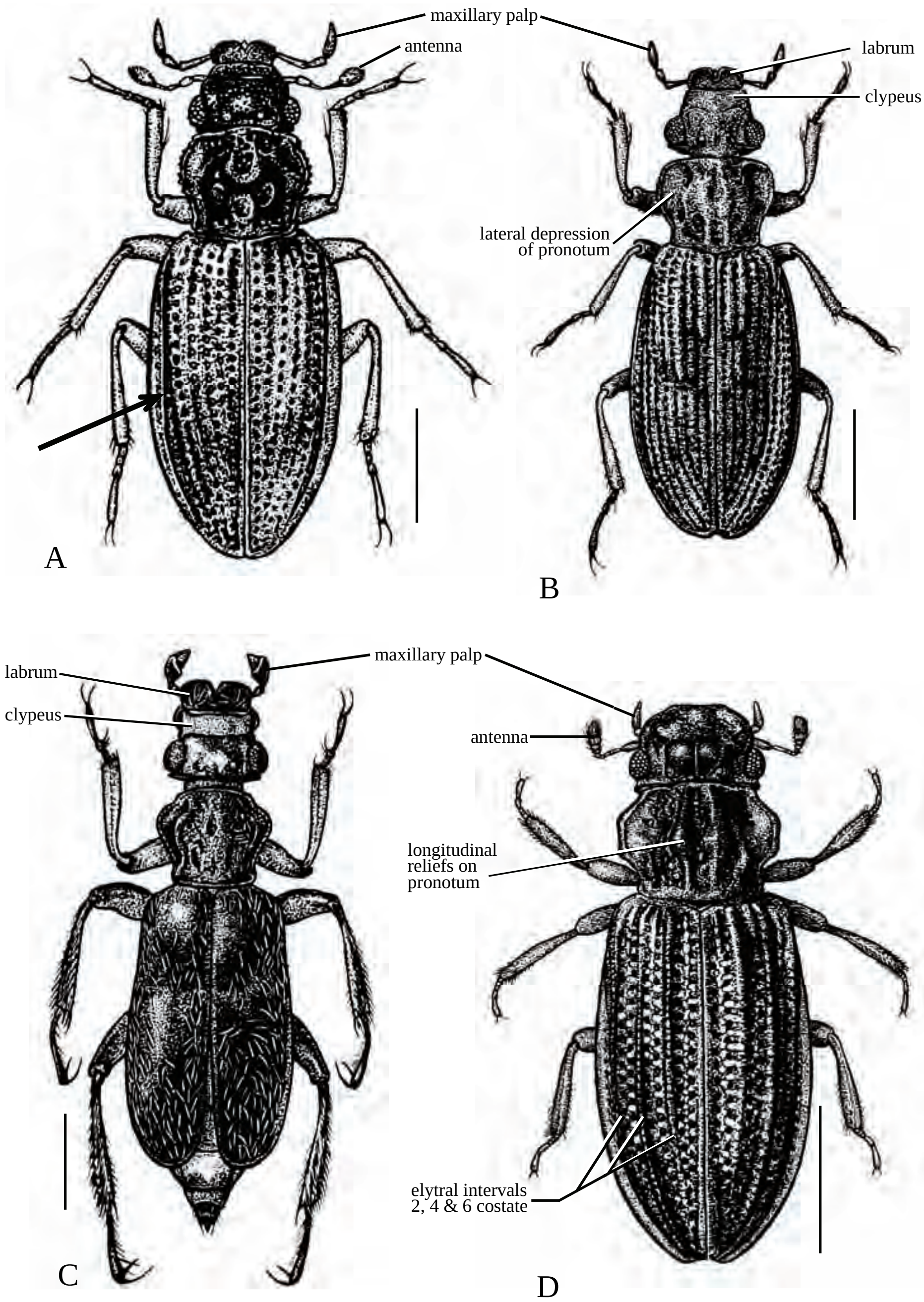

Fig. 13.4. Hydraenidae, adults, dorsal view. **A,** *Mesoceration jucundum*; **B,** *Pterosthetops brincki*; **C,** *Prosthetops grandiceps*; **D,** *Nucleotops nimbaceps*. (After Perkins & Balfour-Browne 1994; artist: C. O'Brien). Scale bars: A = 0.3 mm; B–D = 0.5 mm.

13. Pronotum distinctly wider than head, distinctly cordiform, lateral pronotal depressions strongly produced at sides, each with very flat surface distinctly larger than dorsal surface of eye (Figs 13.4B; 13.8A); eyes not enlarged, length of eye in dorsal view subequal to or shorter than distance between eye and anterolateral angle of clypeus (double arrow in Fig. 13.8A); labrum not particularly large, not strongly produced, never longer than clypeus (Fig. 13.8A); second maxillary palp segment about as long as stipes; elytra with ten distinct series of punctures, at least in anterior half (Fig. 13.8B); abdominal sternite 6 with variable microreticulation, not microspiculate; legs relatively short (Fig. 13.4B) .... *Pterosthetops* (Figs 13.4B; 13.8A–B)
– Pronotum at most only very slightly wider than head, feebly cordiform, each lateral pronotal depression not strongly produced or flattened, each about same size as dorsal surface of eye (Figs 13.4C; 13.6A); eyes enlarged, length of eye in dorsal view greater than distance between eye and anterolateral angle of clypeus (double arrow in Fig. 13.6A); labrum very large and strongly produced, at least 1.5 times as long as clypeus (Figs 13.4C; 13.6A); second maxillary palp segment about half the length of stipes; elytra with nine or ten series of punctures, rarely virtually impunctate; abdominal sternite 6 microspiculate, at least in part; legs elongate (Fig. 13.4C) .... *Prosthetops* (Figs 13.4C; 13.6A–C)

14. Elytra wide, c. 1.5 times as wide as pronotum; elytra abruptly truncate posteriorly, leaving three terminal abdominal tergites exposed; sutural angles of elytra together acutely projecting; each elytron with three granulate costae .... *Sebasthetops*
– Combination of characters not as above 15

15. Elytron with seventh interval non-carinate (arrowed in Fig. 13.5B); fifth abdominal ventrite totally clothed with plastron vestiture (V5 in Fig. 13.5D); pronotum anteriorly with narrow hyaline border (arrowed in Fig. 13.5A); fifth and sixth elytral striae never confluent, usually well separated by fifth interval (very rarely [in *P. aeneus*] fifth interval consisting of narrow walls in area behind humerus) .... *Parasthetops* (Figs 13.1B; 13.5A–D)
– Elytron with seventh interval carinate, costate or tectiform (except in some specimens of *M. rubidum*) (arrowed in Figs 13.4A; 13.7B, D); fifth abdominal ventrite not totally clothed with plastron vestiture, posteriorly glabrous and shining (V5 in Figs 13.2A–B); pronotum without anterior hyaline border; in many members, fifth and sixth elytral striae confluent in small area near base, fifth interval absent in this area; seventh and eighth striae not interdigitating or confluent basally .... *Mesoceration* (Figs 13.2A–B; 13.4A; 13.7A–D)

TAXONOMY AND IDENTIFICATION

Most of the southern African hydraenid genera were revised by Perkins & Balfour-Browne (1994) and in a series of papers by Perkins (2004a, b; 2005a, b). The reader is referred to these publications for keys to species,

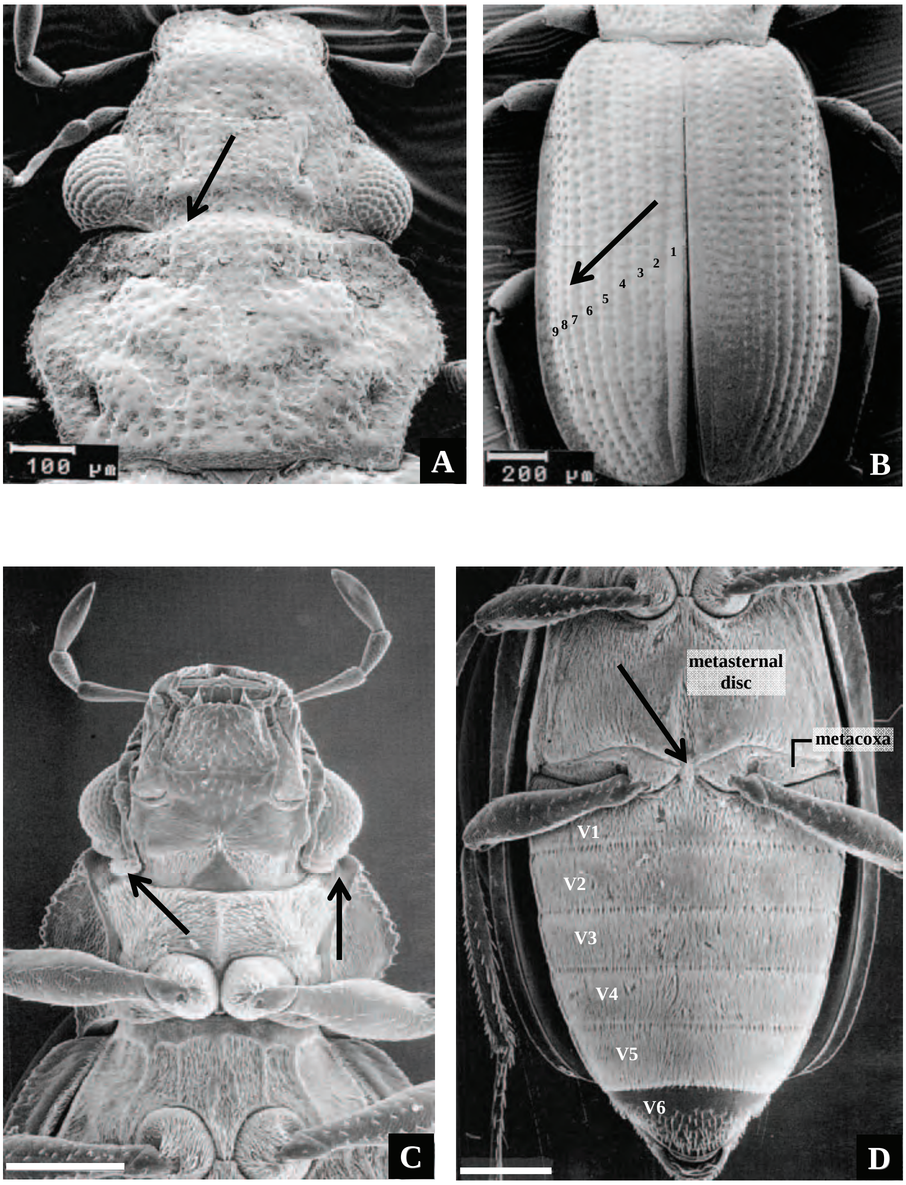

Fig. 13.5. Hydraenidae. *Parasthetops nigritus*, adult female (SEMs). **A,** head and pronotum, dorsal view; **B,** elytra, dorsal view; **C,** venter of head, prosternum and mesosternum; **D,** metasternum and abdomen, ventral view. Scale bars: A = 100 µm; B–D = 200 µm.

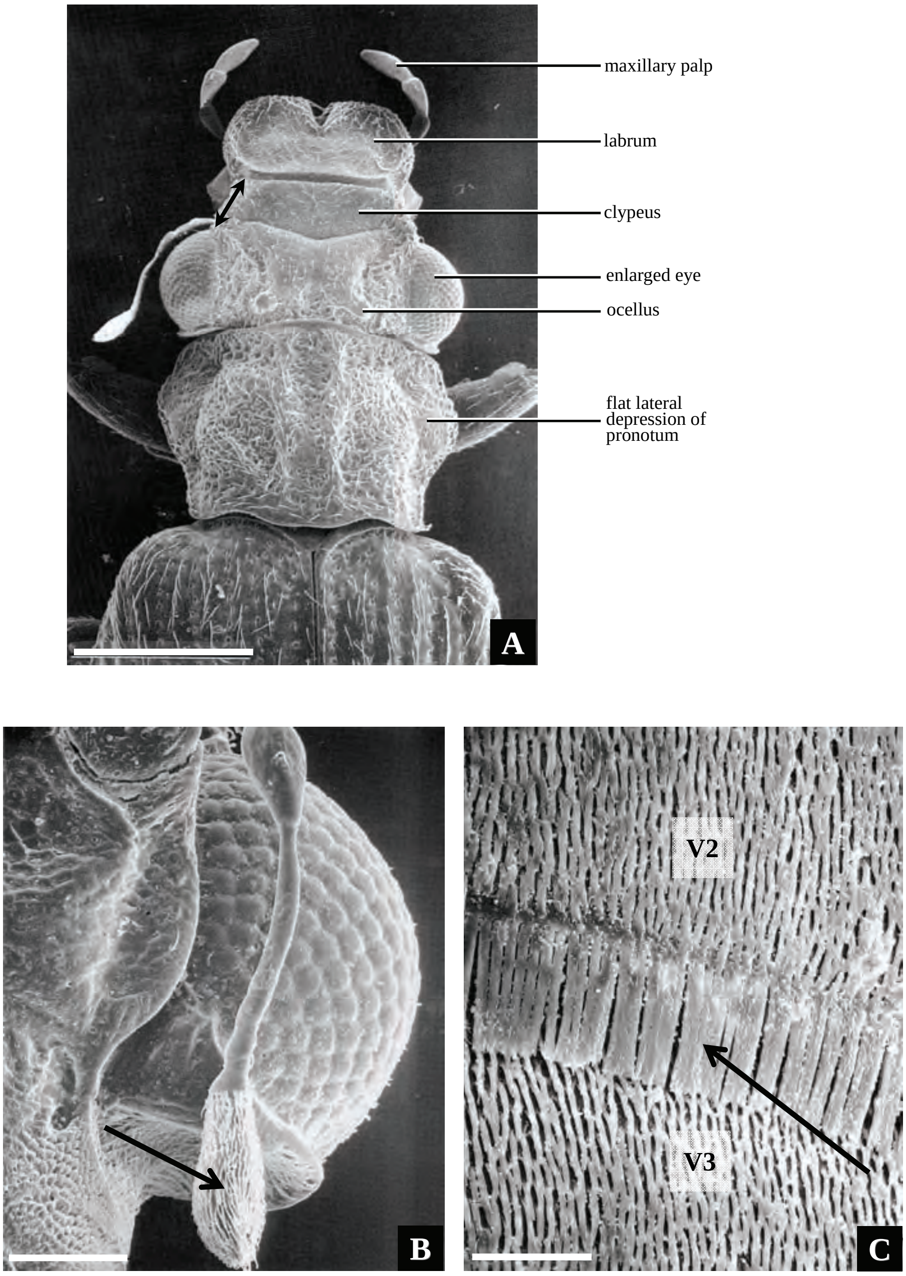

Fig. 13.6. Hydraenidae (SEMs), *Prosthetops setosus*, adult. **A,** head and pronotum, dorsal view; **B,** antenna and ventral surface of eye; **C,** vestiture of 2nd and 3rd abdominal ventrites (V2, V3).
Scale bars: A = 400 µm; B–C = 60 µm.

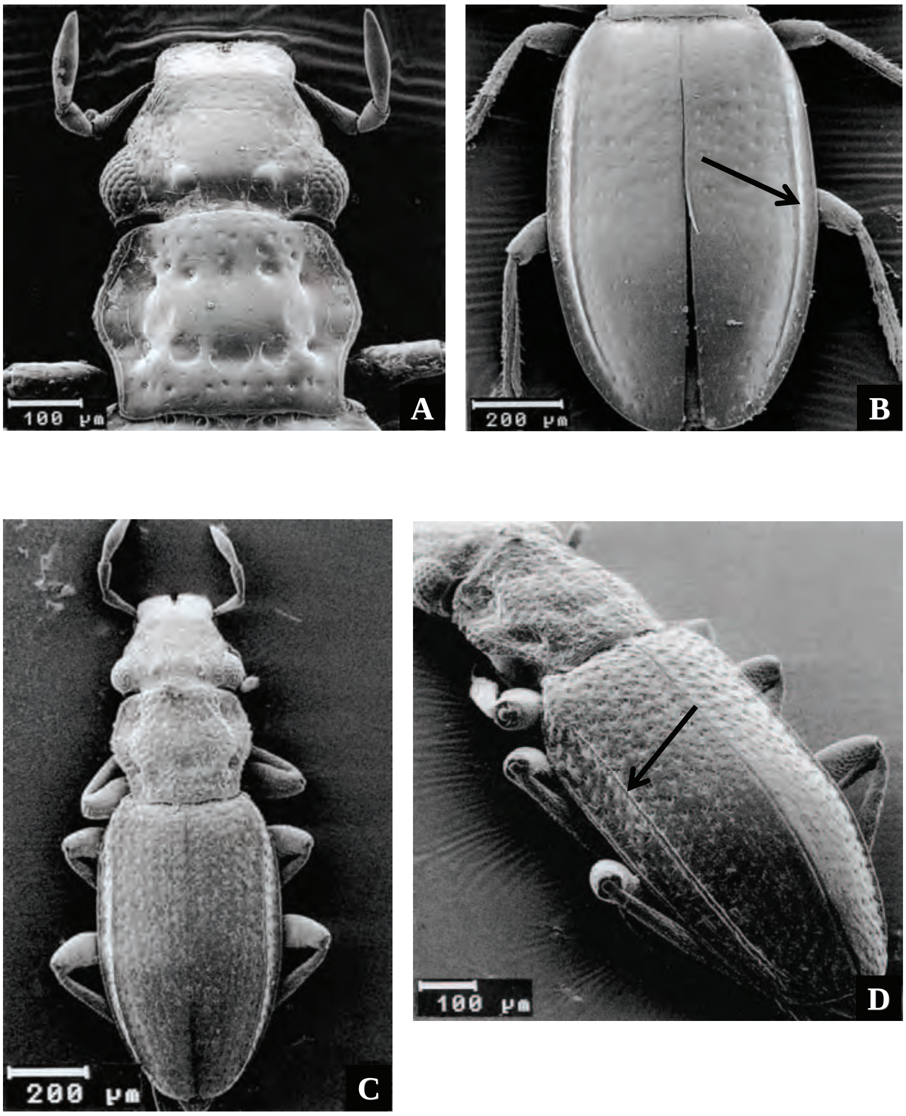

Fig. 13.7. Hydraenidae, adults (SEMs). **A–B,** *Mesoceration rivulare*: **A,** head and pronotum, dorsal view; **B,** elytra, dorsal view; **C–D,** *Mesoceration languidum,* whole insect: **C,** dorsal view; **D,** oblique dorsal view.

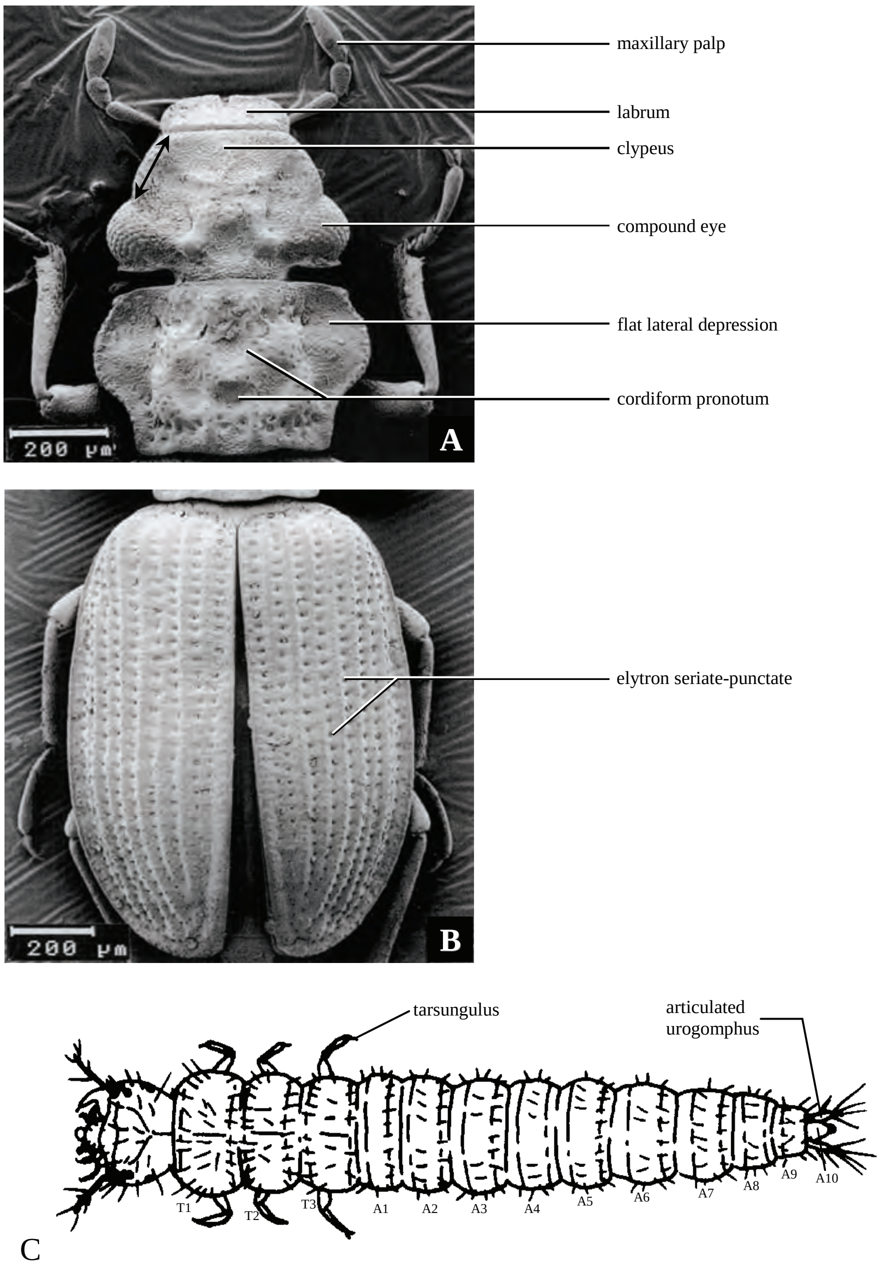

Fig. 13.8. Hydraenidae. **A–B,** *Pterosthetops impressus*, adult, dorsal view (SEMs): **A,** head and pronotum; **B,** elytra; **C,** *Ochthebius* sp., larva, dorsal view. (C redrawn from Stehr 1991).

distribution maps, habitus figures (many in colour), figures of the male genitalia, and other species-specific characters. Also included are comments on hydraenid habitats and conservation. More genera represented in southern Africa are currently being revised or updated by the author of this chapter. The phylogeny and higher classification within the family Hydraenidae requires further investigation and future studies based both on morphology and molecular data are expected.

Checklist and distribution records of known and described species of Hydraenidae in southern Africa

Currently there are 97 described hydraenid species in 16 genera recognised in continental southern Africa. A fair number of undescribed southern African species in several of these genera are known, and their descriptions are forthcoming.

Included in the checklist is the single species of Hydraenidae that occurs on the sub-Antarctic Prince Edward Islands. Today this two-island group, annexed by South Africa in 1947–1948, is a Special Nature Reserve of South Africa, and sometimes referred to as the eighth biome of South Africa.

The following subfamilies and tribes of Hydraenidae have been recorded in southern Africa:

Subfamily PROSTHETOPINAE
Tribe Coelometoponini
Tribe Nucleotopini
Tribe Parasthetopini
Tribe Prosthetopini
Tribe Pterosthetopini
Subfamily HYDRAENINAE
Tribe Hydraenini
Tribe Parhydraenini
Tribe Limnebiini
Subfamily OCHTHEBIINAE
Tribe Ochthebiini

The reader is referred to the Appendix (pp. 224–226) for a checklist of the known and described Hydraenidae taxa of southern Africa.

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CHAPTER 14

SCIRTIDAE

by

S. Endrödy-Younga† *& R. Stals*

Scirtidae [= Helodidae], commonly called marsh beetles, are false water beetles: the adults are invariably terrestrial, but the larvae are usually aquatic.

Adult scirtid beetles (Fig. 14.1A) are small to medium-sized (2–8 mm long), ovate or oblong, and more or less flattened. They are usually uniformly brown or yellowish, although some species have a colour pattern on the dorsal surface. The adult beetles are weakly sclerotised. The head is strongly deflexed and carries antennae that are long and filiform, or sometimes slightly serrate. Beneath each eye is a characteristic ridge that fits against a procoxal keel when the beetle retracts its head. The pronotum is short and transverse, with a sharp lateral edge. The tarsal formula is 5-5-5 and the penultimate tarsal segment is bilobed. Many species can jump and, as in the flea beetles (Chrysomelidae: Alticinae), they have enlarged hind femora and enlarged tibial spurs (morphological features associated with jumping). Except in the jumping forms, hind coxal plates are present.

The larvae of several scirtid genera (Figs 14.1B–C) are truly aquatic. They are campodeiform, somewhat elongate, convex or flattened, and narrowed posteriorly. The whole body is moderately and uniformly sclerotised. The abdomen has eight well-developed segments and a reduced ninth segment. Five retractable anal papillae are located on the ninth abdominal segment. These are typically simple tubes, but they are extensively branched in at least one genus.

The larval antennae have two large basal segments, followed by a flagellum consisting of several to many segments; in some cases the antennae are longer than the body. These long, multi-segmented antennae are unique among beetle larvae and almost all other holometabolous insect larvae. The long antennae may have a tactile function similar to that of the long antennae of cockroaches. The legs of scirtid larvae are well developed and five-segmented (including a long, claw-like tarsungulus).

Several unusual structures are found in and on the mouthparts of scirtid larvae, and in several genera these are associated with a filtering apparatus that allows small organic particles to be filtered from the water, crushed, and packed into a ball. Several of these unusual mouthpart structures yield useful taxonomic characters.

Swimming hairs are known on the legs of some species and these seem to correlate with a still-water habitat. Species found in running waters have unusual spinose setae on the legs and body; in these forms the whole body is generally flattened.

The larval respiratory system is metapneustic. A slit between the eighth and ninth abdominal segments opens into an atrium-like chamber, at the bottom of which two large spiracles are found. The larva regularly surfaces to take in air through these spiracles. *Elodes* [= *Helodes*] larvae (Fig. 14.1C) are known to have several tracheal air sacs. The larva forces out a bubble of air through the spiracles and it is maintained in position by semi-hydrofuge hairs. This air bubble is in contact with the tracheal system and acts as a physical gill, extracting (by diffusion) oxygen dissolved in the water. It seems that the anal papillae are not gills, but have an osmoregulatory function.

Aquatic scirtid larvae can be found in larger water bodies (still or flowing waters) or in small pools. In general, they are found among marginal vegetation and in shallows. They are also known from tree holes containing water and similar microhabitats. All scirtid larvae are probably phytophagous or detritivorous, feeding on living or dead vegetable matter. Some are shredders, while others are filter feeders.

Pupation usually takes place in pupal cells in damp soil, moss or dead leaves, although there are records of the genus *Hydrocyphon* pupating under water.

The Scirtidae of southern Africa remain unstudied. Adults of this family are frequently found in the region and they can be relatively common in riparian vegetation. They are often attracted to light at night. Larvae of at least one genus are very commonly found in mountain streams in the south-western Cape. From the many species hitherto collected in the region, fewer than ten have been described. The southern African species are provisionally assigned to the genera *Cyphon*, *Elodes* [= *Helodes*] and *Scirtes*; this list is probably incomplete.

TAXONOMIC NOTES

The correct name for this family is Scirtidae. Frequently, but incorrectly, it is referred to as 'Helodidae', among others in the ambit of water quality studies, and generally throughout the South African limnological

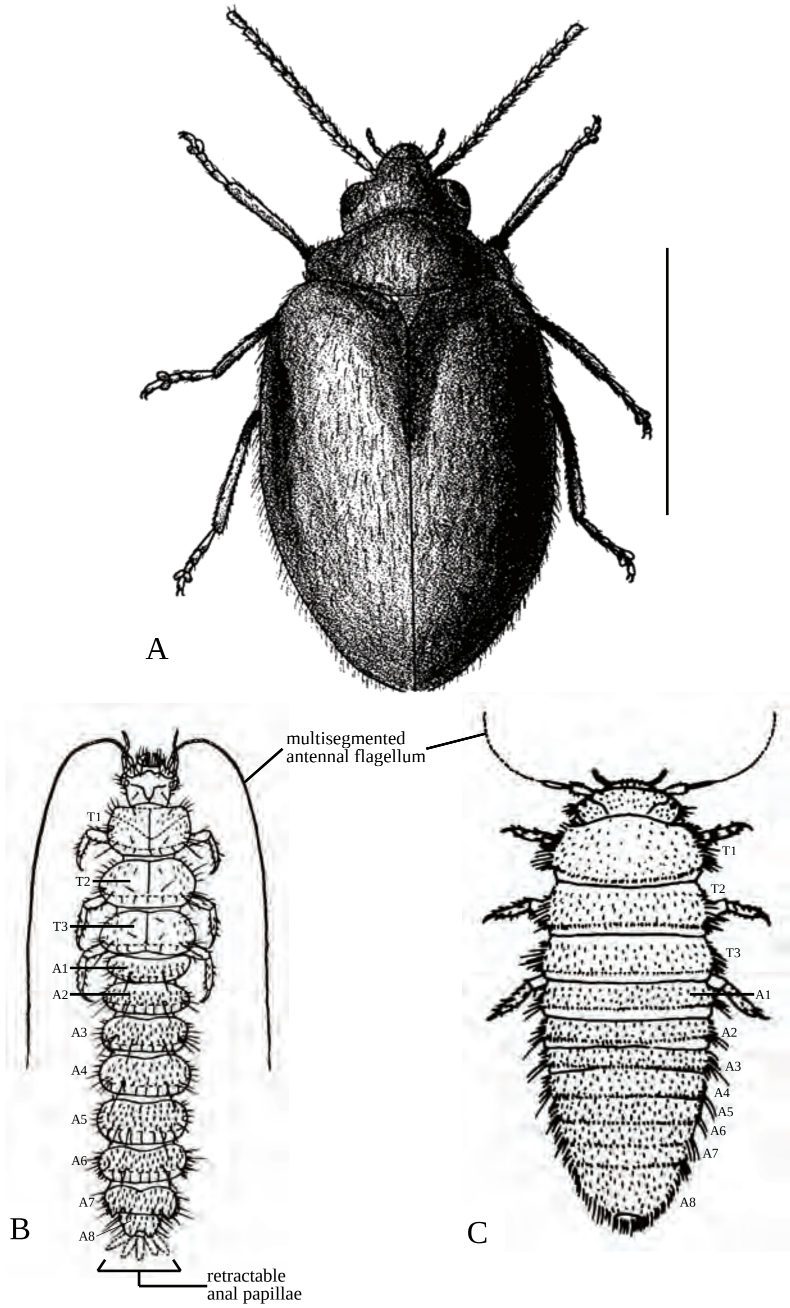

Fig. 14.1. Scirtidae, dorsal views. **A,** unidentified genus, adult; **B,** *Cyphon* sp., larva; **C,** *Elodes* (= *Helodes*) sp., larva (length *c*. 8 mm). (A & B after Scholtz & Holm 1985; A: artist: L. Walles; C after Stehr 1991). Scale bar: A = *c*. 1 mm; B & C much enlarged, not to scale.

literature. The use of the name 'Helodidae' should be discouraged, as already pointed out and motivated by R.D. Pope in 1976. In accordance with the principles of the *International Code of Zoological Nomenclature*, Scirtidae Fleming, 1821 has priority over Elodidae Shuckard, 1840 and Helodidae Agassiz, 1846. The latter name, which is an improper modification and should not be used, is based on the unjustified emendation *Helodes* Agassiz, 1846, for *Elodes* Latreille, 1796. Moreover, *Helodes* Agassiz, 1846 is also a junior homonym of *Helodes* Paykull, 1799 in the Chrysomelidae (the leaf beetle family) (Pope 1976; Lawrence & Newton 1995). This family has also, at times, been known as Cyphonidae, but Scirtidae also has nomenclatural priority over this name.

Because so little is known about the southern African scirtid taxa, a checklist of species is not included in the Appendix.

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There are no really useful publications that deal with the Scirtidae of southern Africa. The older, more general papers listed below can serve as a general introduction to this family. The numerous works by Bernhard Klausnitzer are particularly important: only one Klausnitzer reference is listed below, but he has published an important and significant body of work on various aspects of Scirtidae from 1968 to the present. Unfortunately he has not (yet) studied the Afrotropical marsh beetles, but his work from other biogeographical regions is a solid, modern basis for the study of all Scirtidae.

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CHAPTER 15

ELMIDAE

by

H.G. Nelson†

Members of the family Elmidae (riffle beetles) are found on all continents except Antarctica. The family contains two subfamilies. Most members of the subfamily Elminae are extremely small to small (1–3 mm), but the subfamily Larainae includes beetles (*Potamodytes* species; Fig. 15.1B) that may exceed 8 mm in length. The adult body is elongate to ovate and more or less convex (Figs 15.1–15.8). The head is usually retracted into the prothorax and may be visible or invisible from above. The antennae are seven- to eleven-segmented and filiform to slightly serrate; an antennal club may be present apically. The prosternum usually projects well in front of the procoxae, and a more or less broad intercoxal prosternal process extends to the rear (Figs 15.2C–D). The long legs each have five tarsal segments, the last being elongate and bearing a pair of strong claws. The first three abdominal segments are fused ventrally.

Elmids feed on almost any organic matter: diatoms, algae and fungi, decaying leaves and wood, and occasionally small dead insects. When submerged, adult riffle beetles secure oxygen by means of a plastron, which is mainly situated ventrally, maintaining an air bubble. In well-aerated water they need not surface for air. Larvae respire under water, by means of the retractable tracheal gills.

Elmidae are aquatic in all stages (i.e. they are true water beetles). Most adults are capable of flight and are often attracted to light at night. Adult Larainae may at times fly rapidly above water. Adult Elminae and the larvae of both subfamilies live on the bottoms of running-water habitats, where they crawl about, on and under stones and submerged wood. Larvae are commonly found among sand particles. Species of some genera of both subfamilies are confined to submerged decaying wood.

After entering the water, usually in late summer or autumn, adult Elminae feed voraciously, becoming less active as temperatures fall. As the water temperature increases in spring, courtship and mating occur. By this time the flight muscles have degenerated. Eggs are fastened to stones or

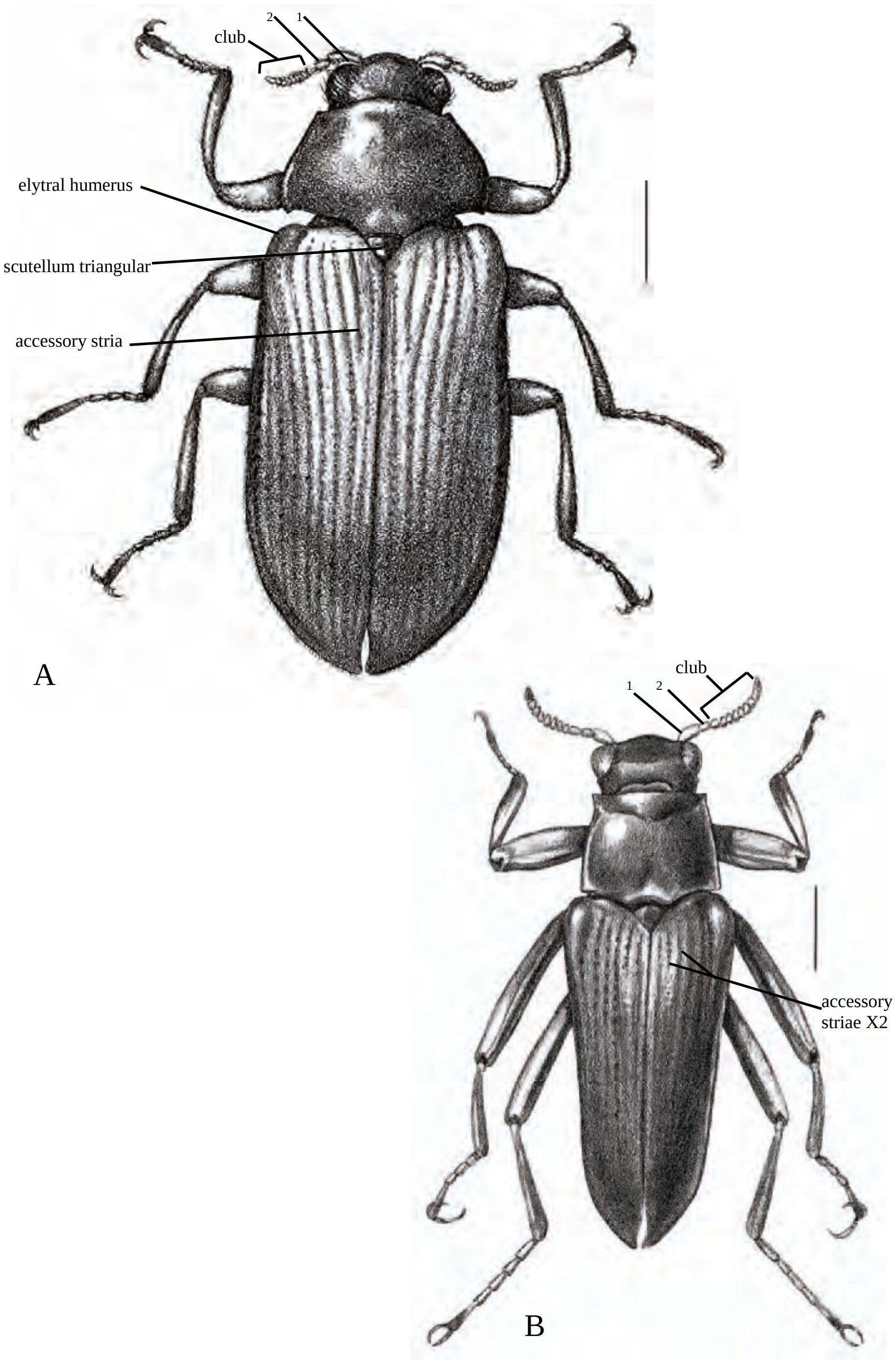

Fig. 15.1. Elmidae: Larainae, adults, dorsal views. **A,** *Potamogethes major*; **B,** *Potamodytes overlaeti*. (Both illustrations original, Maureen Donnelly). Scale bars = 1.0 mm.

wood and hatch in several days. It is probable that Elminae adults have only one reproductive season. Although members of the Larainae have not been as well studied, it seems likely that the adults, which are less compact and less strongly sclerotised than those of the Elminae, are short-lived and complete all their activities within weeks of emerging from the pupal stage.

IMMATURE STAGES

Elmid larvae (Figs 15.9A–B) are elongate, subcylindrical to distinctly flattened, usually heavily sclerotised, and ornamented with surface features such as granules and tubercles. Pleurites are present on the abdominal segments (Fig. 15.9C). Three pairs of tracheal gills (often hard to discern) are protrusible from a posterior terminal chamber, which can be closed by an operculum bearing a pair of claw-like hooks (Fig. 15.9A, C).

After one to a few years of growth, mature larvae leave the water to excavate small cavities beneath rocks or pieces of wood or in moist soil near water, and transform into pupae. Adults appear after several days.

TAXONOMIC NOTES

Although the correct name of this family is Elmidae, it has been variously known as Elminthidae, Helminthidae, Elmididae or Limniidae. The subfamily Larainae was at a time known as Larinae, but this caused confusion with the bird family Laridae (the gulls, terns and skuas).

KEY TO THE SOUTHERN AFRICAN GENERA OF ELMIDAE: ADULTS

1. Antennae distinctly pubescent, with first segment elongate, second segment globular and the remainder of segments forming a loose or compact club (e.g. Figs 15.1A–B; 15.2B); dorsum densely pubescent (LARAINAE; Figs 15.1–15.2) 2

– Antennae nearly naked, with first segment short (arrowed in Figs 15.3A–B; 15.4A–B) and apical segments rarely forming a club; dorsum only sparsely pubescent, but often with micropubescence (ELMINAE; Figs 15.3–15.8) 5

2. Elytra at base with two short accessory striae between stria 1 and stria 2 (Fig. 15.1B); prosternum slightly prolonged in front of procoxae; prosternal process broadly truncate or feebly rounded behind .... *Potamodytes* (Fig. 15.1B)

– Elytra with one accessory stria usually present at base (Figs 15.1A; 15.2B); prosternum distinctly elongate anteriorly; prosternal process pointed behind (e.g. Figs 15.2C–D) 3

3. Scutellum subquadrate or rounded (Fig. 15.2A); elytral humeri very prominent (arrowed in Fig. 15.2A); elytral striae feeble, obscured near scutellum; prosternal process large and broad (Fig. 15.2C); aedeagus with basal piece small, median lobe large, laminate ………………… *Omotonus* (Fig. 15.2A)

– Scutellum triangular; elytral humeri not very prominent (Figs 15.1A; 15.2B); all elytral striae visible; prosternal process subtriangular or tapering from base (Fig. 15.2D); aedeagus with different combination of these characters.. 4

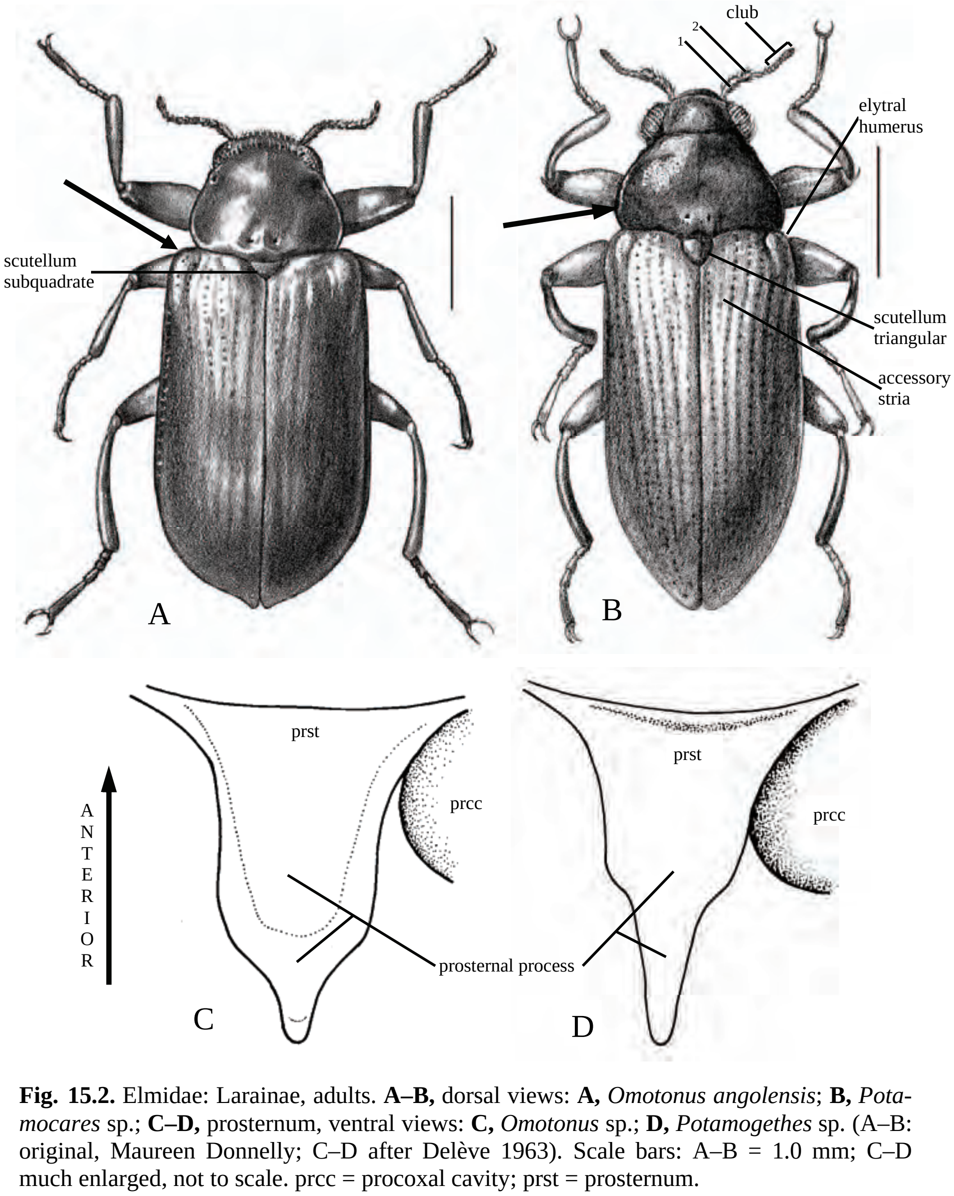

Fig. 15.2. Elmidae: Larainae, adults. **A–B,** dorsal views: **A,** *Omotonus angolensis*; **B,** *Potamocares* sp.; **C–D,** prosternum, ventral views: **C,** *Omotonus* sp.; **D,** *Potamogethes* sp. (A–B: original, Maureen Donnelly; C–D after Delève 1963). Scale bars: A–B = 1.0 mm; C–D much enlarged, not to scale. prcc = procoxal cavity; prst = prosternum.

4. Prosternal process a narrow triangle; lateral margins of pronotum turned sharply upwards, forming a broad basal ‘gutter’ (arrowed in Fig. 15.2B); aedeagus with basal piece well developed, median lobe narrow; hind wing with five veins reaching border .... *Potamocares* (Fig. 15.2B)
– Prosternal process a large broad triangle (Fig. 15.2D); pronotal margins not as sharply turned up, no ‘gutter’ present; aedeagus with basal piece short, median lobe large and flattened; hind wing with four veins reaching border... .... *Potamogethes* (Fig. 15.1A)

5. Anterior tibia without tomentose fringe on inner border; body elongate 6
– Anterior tibia with inner tomentose fringe (e.g. Fig. 15.3A); body not markedly elongate 7

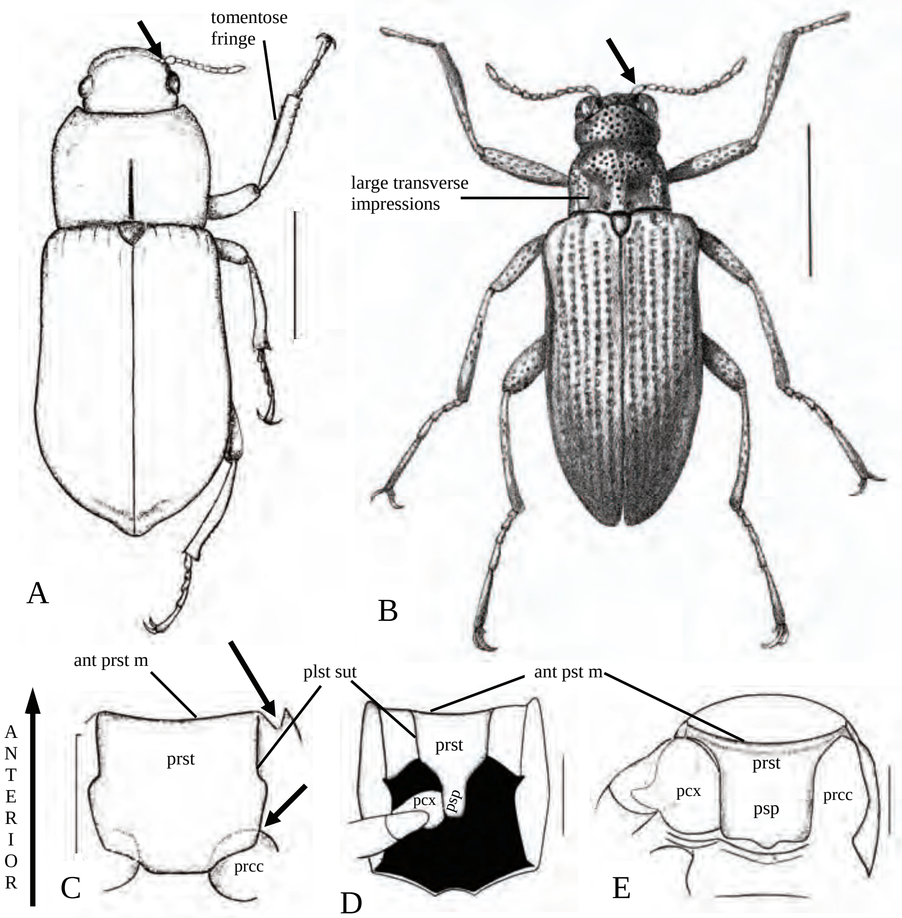

Fig. 15.3. Elmidae: Elminae, adults. **A–B,** dorsal views: **A,** *Protelmis* sp.; **B,** *Leptelmis seydeli*; **C–E,** prosternum, ventral views: **C,** *Pachyelmis* sp.; **D,** *Tropidelmis* sp.; **E,** *Pseudancyronyx* sp. (A, C–E after Delève 1966; B: original, Maureen Donnelly). Scale bars: A = 0.5 mm; B = 1.0 mm; C–E = 0.2 mm. ant prst m = anterior prosternal margin; pcx = procoxa; prcc = procoxal cavity; plst sut = pleurosternal suture; psp = prosternal process; prst = prosternum.

6. Pronotum with large transverse impression(s), no median longitudinal groove .... *Leptelmis* (Fig. 15.3B)
– Pronotum without transverse impressions, usually with a median longitudinal groove .... *Stenelmis* (Fig. 15.4A)

7. Conspicuous indentation present near junction of pleurosternal suture and anterior prosternal margin (upper arrow in Fig. 15.3C) 10
– No such indentation at junction of pleurosternal suture and anterior prosternal margin (e.g. Fig. 15.3D) 8

8. Procoxae large, nearly reaching anterior prosternal margin (Fig. 15.3E); prosternal process large, quadrate (Fig. 15.3E); pronotum with shining, 'polished' gibbosities .... *Pseudancyronyx* (Fig. 15.4B)
– Procoxae of 'normal' size, removed from anterior prosternal margin (e.g. Fig. 15.3D); prosternal process smaller (e.g. Fig. 15.3D); elytra costate (Fig. 15.5A–B) 9

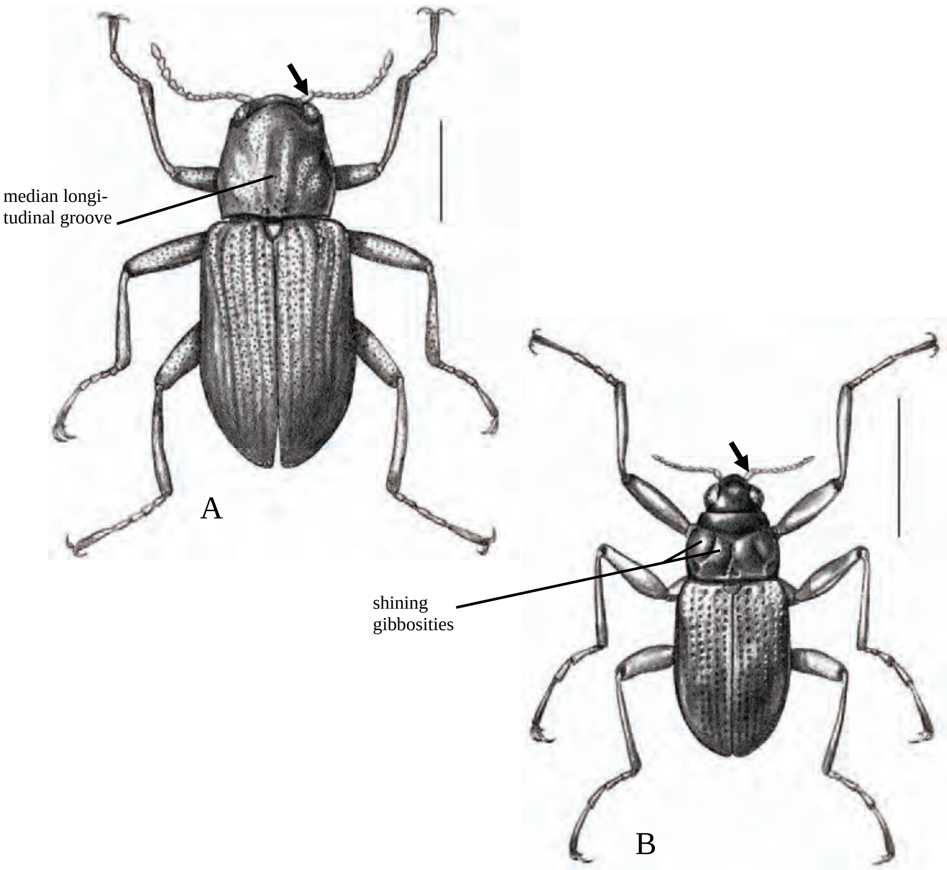

Fig. 15.4. Elmidae: Elminae, adults, dorsal views. **A,** *Stenelmis prusias*; **B,** *Pseudancyronyx basilewskyi*. (Both illustrations original, Maureen Donnelly). Scale bars = 1.0 mm.

9. Pronotum without median sulcus or sublateral carinae, but with small median fossa (Fig. 15.5A); tarsal claws toothed basally (arrows in Fig. 15.5A) .... *Tropidelmis* (Fig. 15.5A)
– Pronotum with median sulcus (not fossa) and sublateral carinae (Fig. 15.5B); tarsal claws with inner margins toothed or pectinate (arrows in Fig. 15.5B) ....*Ctenelmis* (Fig. 15.5B)

10. Pleurosternal suture distant (removed) from procoxal cavities (cf. Fig. 15.3D); prosternal process elongate; pronotum with a pair of entire sublateral carinae (Fig. 15.5C); body extremely small (length *ca*. 1 mm), strongly narrowed behind (Fig. 15.5C); femora conspicuously swollen distally (arrows in Fig. 15.5C); tarsal claws without teeth .... *Helminthocharis* (Fig. 15.5C)
– Pleurosternal suture joining procoxal cavity (lower arrow in Fig. 15.3C); pronotum with or without carinae; body longer than 1 mm, not strongly narrowed behind; femora not swollen distally; tarsal claws toothed or without teeth 11

11. Tarsal claws toothed (arrows in Figs 15.6A–B); pronotum with or without carinae or sulci 12
– Tarsal claws not toothed; pronotum usually with carinae or sulci (e.g. Figs 15.7A, C; 15.8A–C) 13

12. Prosternal process broad; pronotum without sublateral carinae, median pronotal sulcus very narrow or absent (Fig. 15.6A); elytra at most with feebly granulate costae .... *Pseudomacronychus* (Fig. 15.6A)
– Prosternal process narrow; pronotum with two short prescutellar carinae, often with short sublateral carinae and short median sulcus (Fig. 15.6B) .... *Microdinodes* (Fig. 15.6B)

13. Pronotum strongly narrowed in front (arrows in Fig. 15.7A); sublateral pronotal carinae entire .... *Pachyelmis* (Fig. 15.7A)
– Pronotum either narrowed in front (e.g. Fig. 15.7B) or not so (e.g. Fig. 15.7C); sublateral pronotal carinae at most present only basally (e.g. Figs 15.7C; 15.8A) 14

14. Pronotum strongly narrowed in front (upper arrow in Fig. 15.7B), without carinae or sulci; prosternal process parallel behind; elytra with simple lines of punctures; body strongly narrowed behind (lower arrow in Fig. 15.7B) ....*Leielmis* (Fig. 15.7B)
– Pronotum not strongly narrowed in front (Figs 15.3A; 15.7C; 15.8A–C), at least with short, basal sublateral carinae (e.g. Fig. 15.7C; 15.8A–C); elytra sometimes costate; body less strongly narrowed behind 15

15. Last sternite transverse; ventral border of epipleuron widened into apical flange 16
– Last sternite triangular; ventral border of epipleuron without apical flange... 17

16. Antenna with eleven segments .... *Haplelmis*
– Antenna with ten segments (first segment small; arrow in Fig. 15.3A) .... *Protelmis* (Fig. 15.3A)

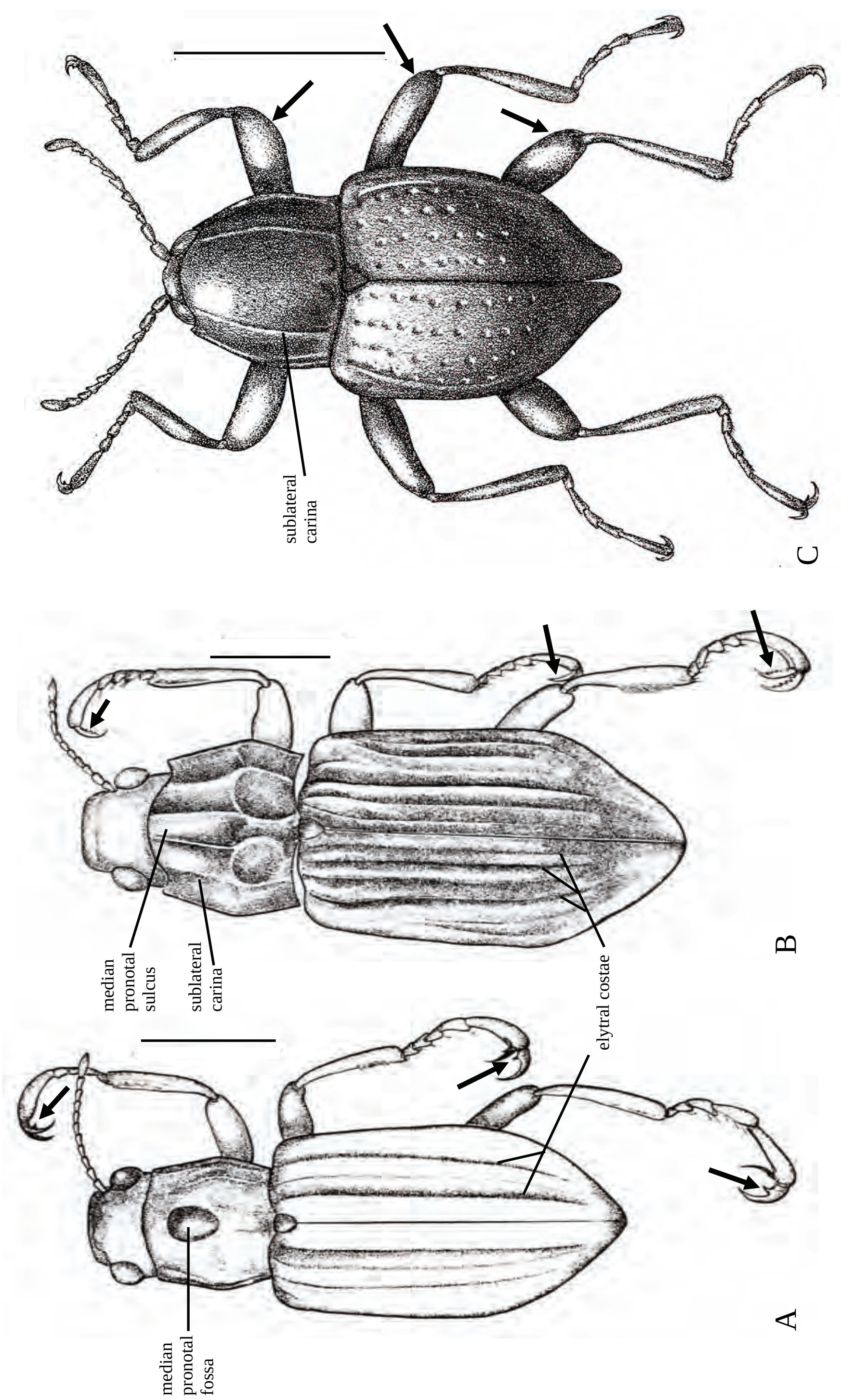

Fig. 15.5. Elmidae: Elminae, adults, dorsal views. **A,** *Tropidelmis hintoni*; **B,** *Ctenelmis* sp.; **C,** *Helminthocharis abdominalis*. (A–B after Delève 1966; C: original, Maureen Donnelly). Scale bars = 0.5 mm.

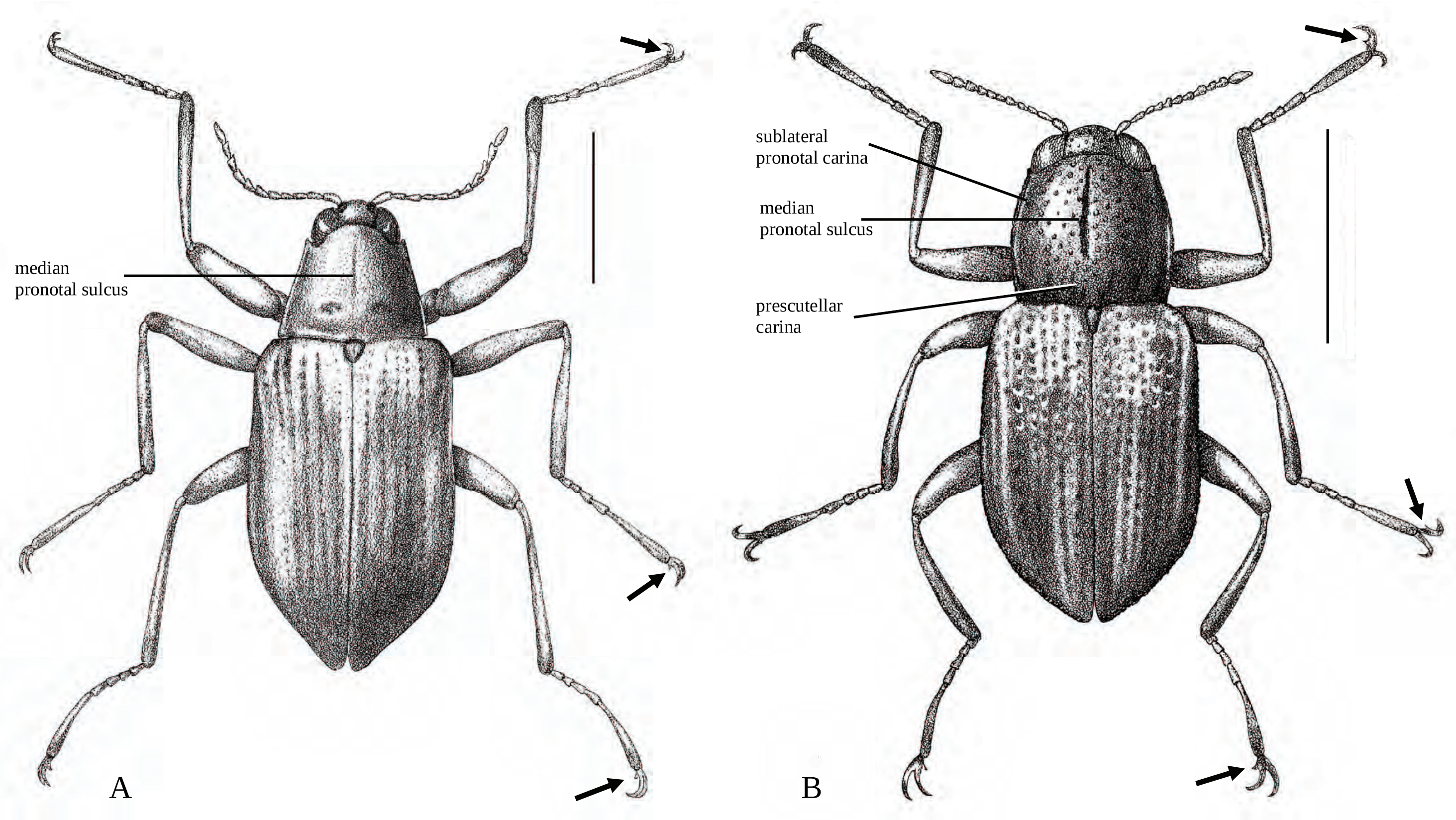

Fig. 15.6. Elmidae: Elminae, adults, dorsal views. **A,** *Pseudomacronychus scutellatus*; **B,** *Microdinodes transvaalicus*. (Both illustrations original, Maureen Donnelly). Scale bars = 1.0 mm.

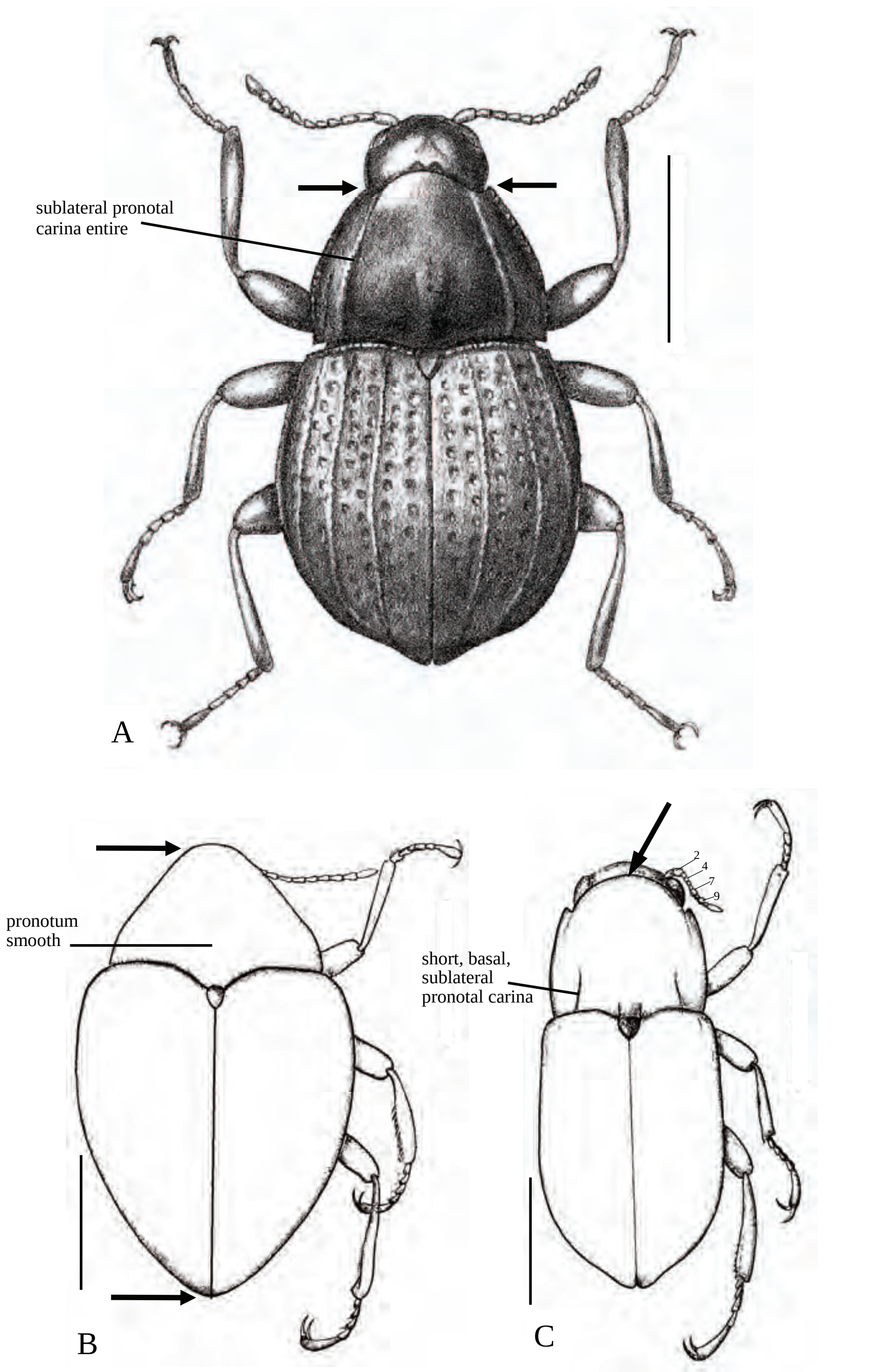

Fig. 15.7. Elmidae: Elminae, adults, dorsal views. **A,** *Pachyelmis convexa*; **B,** *Leielmis georyssoides*; **C,** *Lobelmis* sp. (A: original, Maureen Donnelly; B–C after Delève 1966). Scale bars = 0.5 mm.

17. Antennal segments 2, 4, 7 and 9 distinctly larger than the others (Fig. 15.7C); pronotum strongly produced in front (arrow in Fig. 15.7C) .... *Lobelmis* (Fig. 15.7C)
– Antennal segments all more or less the same size (Figs 15.8A–C); pronotum not as strongly produced in front (Figs 15.8A–C) 18

18. Pronotum without median sulcus .... Peloriolus (Fig. 15.8A)
– Pronotum with median sulcus (Figs 15.8B–C) 19

19. Pronotal disc with broad, deep median sulcus or a small fossa; sublateral pronotal carinae strongly curved medially (arrow in Fig. 15.8B); elytra costate; antennae robust .... *Elpidelmis* (Fig. 15.8B)
– Median pronotal sulcus narrow, entire; sublateral pronotal carinae, if present, nearly straight (arrow in Fig. 15.8C); elytra not markedly costate; antennae slender .... *Helminthopsis* (Fig. 15.8C)

Checklist and distribution records of known and described taxa of Elmidae in southern Africa

World-wide, about 120 genera and 1100 species of Elmidae are known. To date, 20 genera and about 52 described and recognised species of riffle beetles have been reported from southern Africa; undoubtedly many more remain to be named. In a long series of papers, Joseph Delève described many species especially from central Africa, some species of which have since been found in southern Africa. It is unclear whether these are true cases of disjunct distributions, sampling artefacts, or artefacts due to a failure to discriminate among different species, some of which are still undescribed. It is reasonable to expect the discovery of significant numbers of undescribed southern African elmid species, some of which are surely already present in museum collections, but are as yet undetected and undescribed.

Two subfamilies of Elmidae — Larainae and Elminae — have been recorded in southern Africa. The reader is referred to the Appendix (pp. 227–228) for a checklist of the known Elmidae taxa of the region.

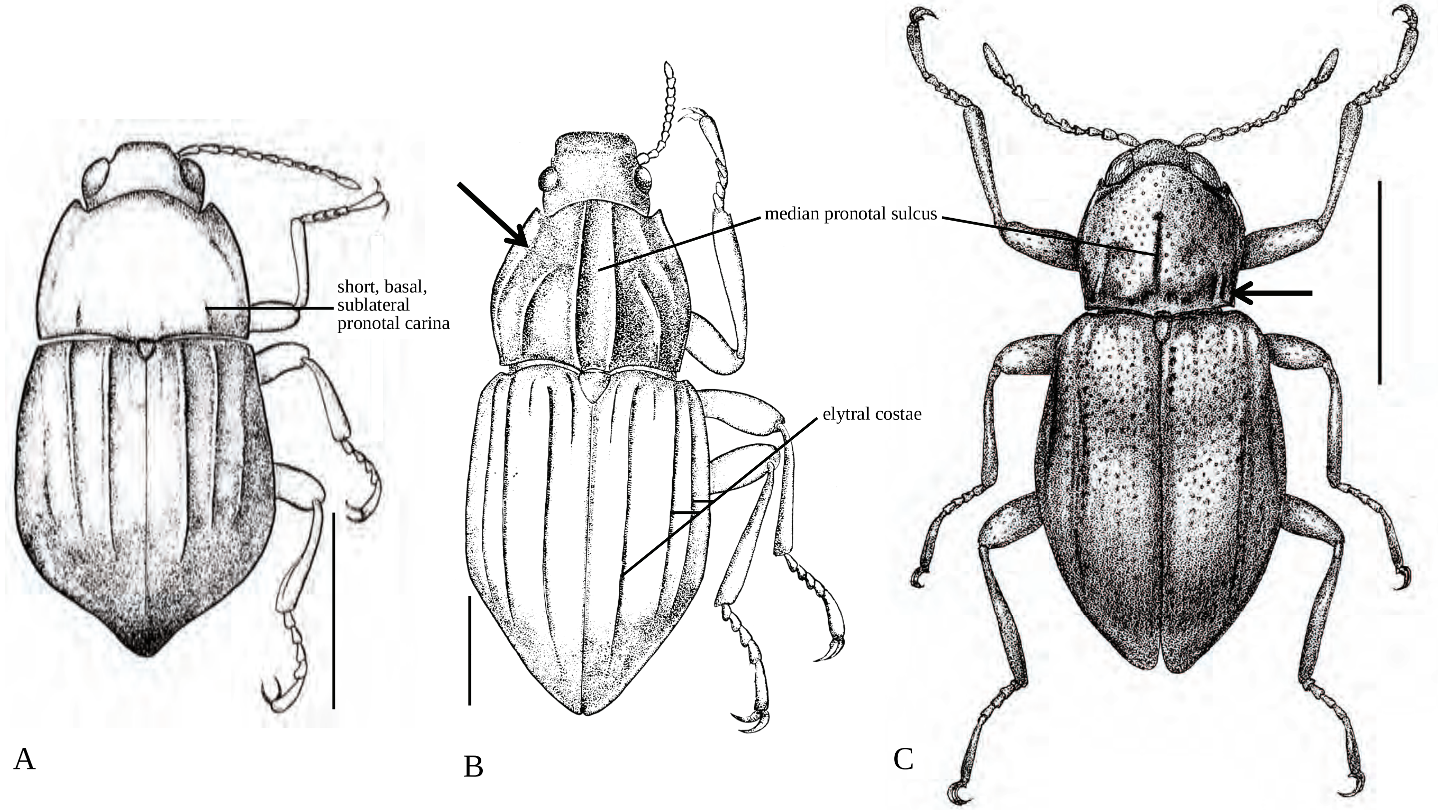

Fig. 15.8. Elmidae: Elminae, adults, dorsal views. **A,** *Peloriolus* sp.; **B,** *Elpidelmis capensis*; **C,** *Helminthopsis compacta*. (A–B after Delève 1966; C: original, Maureen Donnelly). Scale bars: A–B: 0.5 mm; C = 1.0 mm.

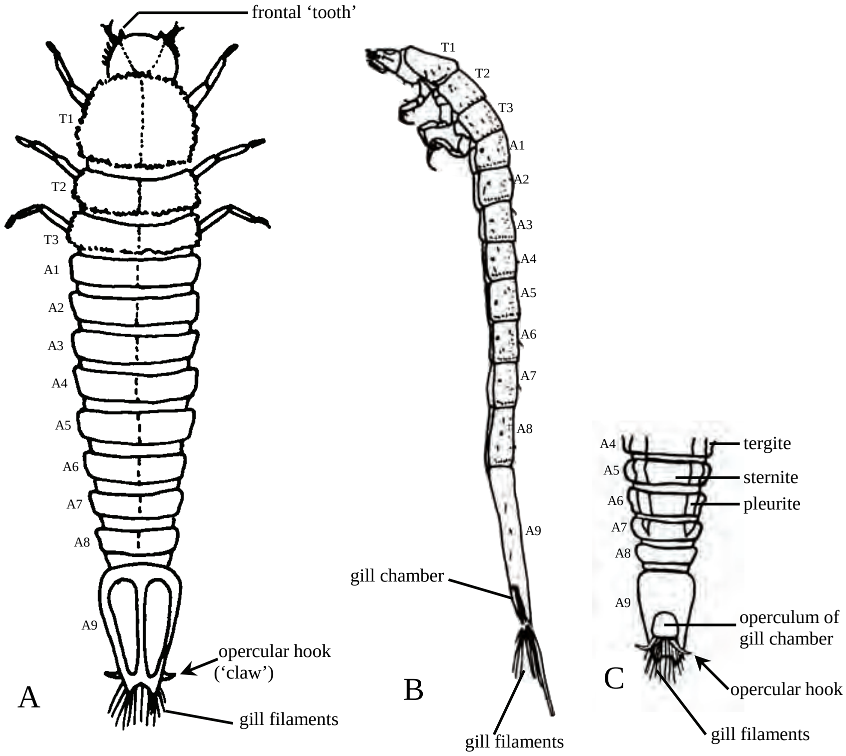

Fig. 15.9. Elmidae, larvae. **A,** Larainae, dorsal view; **B,** Elminae, lateral view; **C,** posterior part of abdomen, ventral view, showing anal area with respiratory chamber (A, C adapted from Stehr 1991; B redrawn from Böving & Craighead 1931). Much enlarged, not to scale.

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CHAPTER 16

DRYOPIDAE

by

H.G. Nelson†

Members of the family Dryopidae (long-toed water beetles) are found on all continents except Australia and Antarctica. About 20 genera and 250 species are known world-wide. Three genera and eight species are known from southern Africa; additionally, the genus *Dryops* has not yet been recorded from the region, but it is suspected that it occurs there.

Adults (Figs 16.1A, D; 16.2A) are 2–8 mm in length, elongate to ovate, compact, and moderately convex. Aquatic species are strongly sclerotised. Fine hairs, often of two lengths, are found over much of the body in most adults. The head is deeply retracted into the prothorax, but still visible from above. The last six to eight segments of the usually eleven-segmented antennae are laterally expanded into a short pectinate club (Figs 16.1B–C); the first antennal segment, or the first and second antennal segments, are enlarged (Figs 16.1B–C). The long legs each have five tarsal segments, the last segment being elongate and bearing large, paired claws (e.g. Fig. 16.1A). Ventrally, the prosternum extends prominently in front of the front coxae. The posterior margin of the prosternum extends backward as a median process between the front coxae, inserting into a pit in the mesosternum. The first two (or three) abdominal segments are fused ventrally, at least internally. Females — uncommonly among Coleoptera — usually bear a large, conspicuous ovipositor (Figs 16.2B, C), evidently used to insert eggs into plant material or soil.

Adult dryopids may be found on stones or woody debris in streams, although they may also occur in terrestrial habitats in leaf litter and rotting logs in the tropics. They appear to feed primarily on decaying plant material (e.g. dead leaves).

Adult dryopids secure oxygen underwater by means of plastron respiration.

The larvae of long-toed water beetles are elongate and cylindrical (Fig. 16.2D); they are not aquatic, but occur in leaf litter or soil near the water. No aquatic dryopid larvae are known. This life-history style where larvae are terrestrial and adults aquatic is unusual among the insects. Dryopid larvae feed on plant material. Larvae have to date been reported from Europe, the western USA and New Zealand, but not from Africa.

From the 1800s to at least the 1970s, larvae of other groups (e.g. Eubriinae of Psephenidae, and Ptilodactylidae) were mistakenly identified as dryopid larvae and erroneous descriptions and illustrations of 'Dryopidae' can be found in much of the scientific literature. It can be categorically stated that all known dryopid larvae are elateriform (Fig. 16.2D) and never onisciform (as in the Psephenidae: Figs 19.1A–D). This confusion is elaborated upon by Brown (1991).

The family Dryopidae is occasionally referred to as Parnidae, but the former name has won general acceptance and is preferred in terms of the provisions of the International *Code of Zoological Nomenclature*. The old concept of Parnidae included the Elmidae and, at times, also the Psephenidae. In earlier classifications the Dryopidae were often lumped with Elmidae and Lutrochidae.

KEY TO THE SOUTHERN AFRICAN GENERA OF AQUATIC DRYOPIDAE: ADULTS

1. Eyes conspicuously pubescent (Fig. 16.1A); antennae ten-segmented; second antennal segment enlarged (Figs 16.1B–C) 2
– Eyes nearly or completely naked (not pubescent) (Figs 16.1D; 16.2A); antennae with fewer than ten segments; second antennal segment not enlarged 3

2. First antennal segment elongate, second segment large, transverse, and more or less rectangular (Fig. 16.1B) .... *Ahaggaria* (Fig. 16.1A)
– First antennal segment not elongate, second segment enlarged, ear-shaped (Fig. 16.1C), with distal border angular (arrowed in Fig. 16.1C) ..... *Dryops*

3. Antennae nine-segmented; pronotum more convex, with or without posterior transverse impression(s) (Fig. 16.1D); sublateral pronotal carinae with lateral flange (arrowed in Fig. 16.1D); prosternal process large posteriorly, gradually narrowed apically; ovipositor toothed (arrowed in Fig. 16.2B) .... *Strina* (Fig. 16.1D)
– Antennae seven-segmented; pronotum less convex, without transverse impression(s); sublateral pronotal carinae without flange (Fig. 16.2A); prosternal process very large, abruptly narrowed apically; ovipositor without teeth (arrowed in Fig. 16.2C) .... *Rapnus* (Fig. 16.2A)

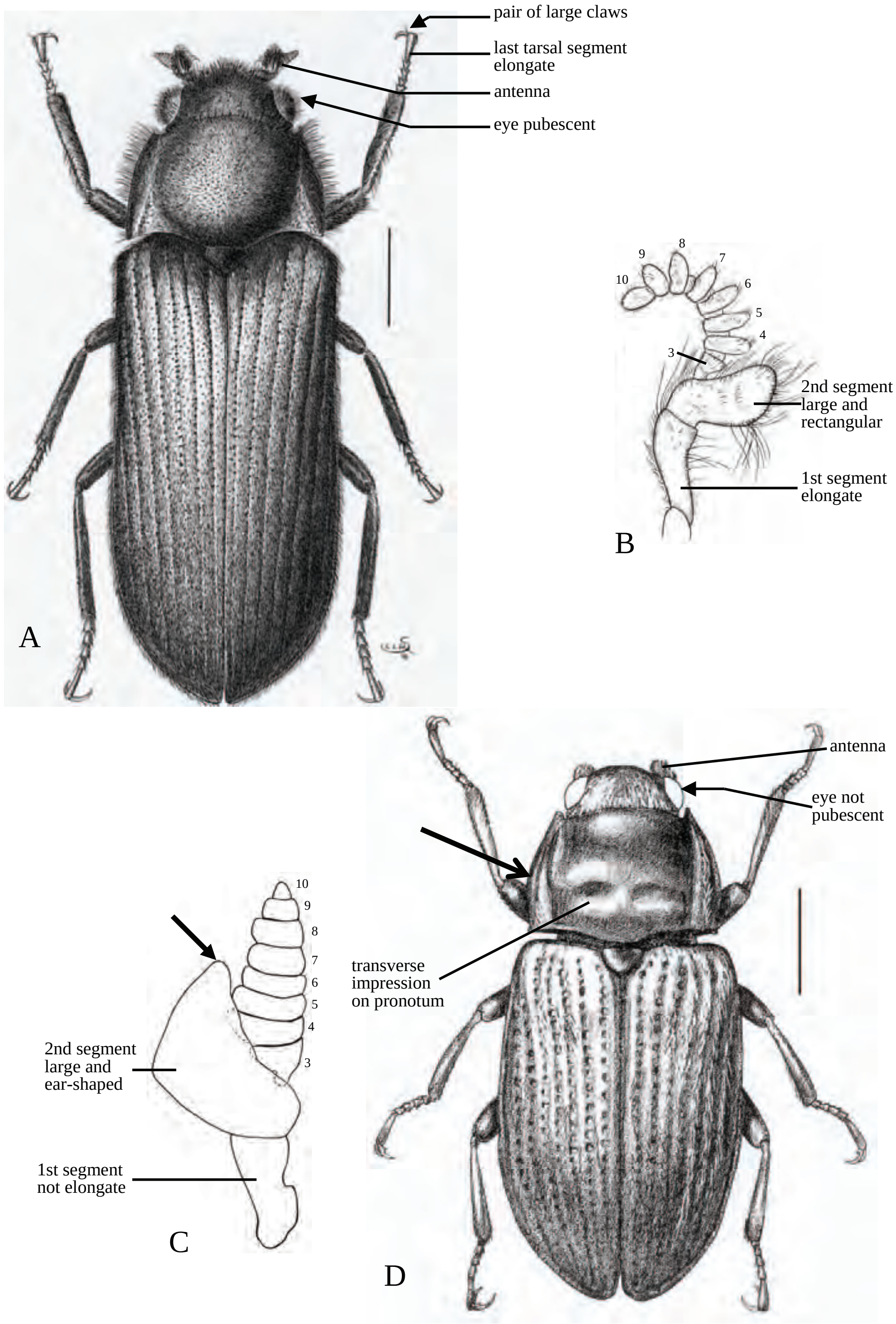

Fig. 16.1. Dryopidae, adults. **A,** *Ahaggaria* sp., dorsal view; **B,** *Ahaggaria australis*, antenna; **C,** *Dryops lutulentus*, antenna; **D,** *Strina promontorii*, dorsal view. (A: original, Clara R. Simpson; B after Delève 1966; C after Olmi 1976; D: original, Maureen Donnelly). Scale bars: A & D = 1 mm; B & C much enlarged, not to scale.

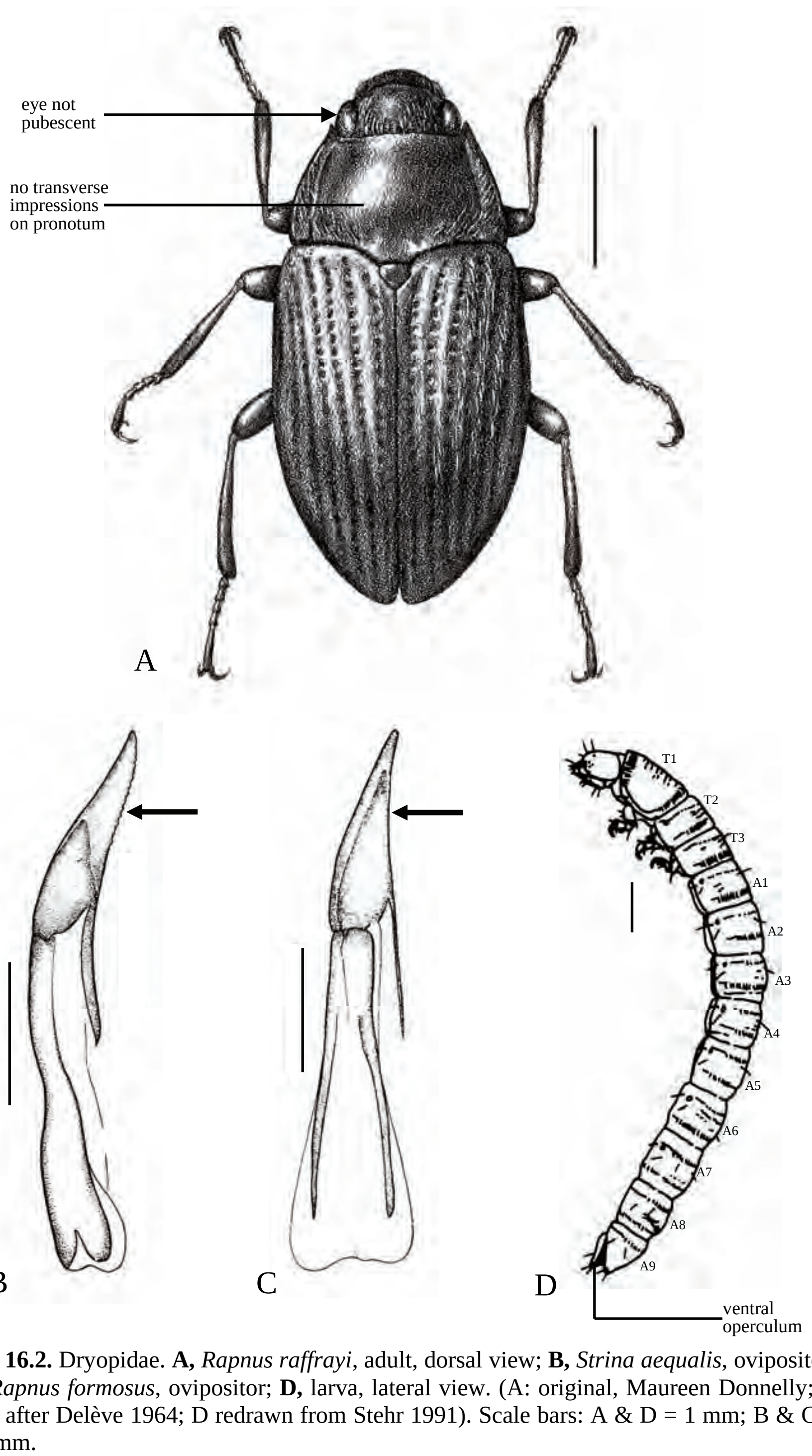

Fig. 16.2. Dryopidae. **A,** *Rapnus raffrayi*, adult, dorsal view; **B,** *Strina aequalis*, ovipositor; **C,** *Rapnus formosus*, ovipositor; **D,** larva, lateral view. (A: original, Maureen Donnelly; B & C after Delève 1964; D redrawn from Stehr 1991). Scale bars: A & D = 1 mm; B & C = 0.5 mm.

Checklist and distribution records of known and described species of Dryopidae in southern Africa

The aquatic genus *Dryops* is known from most parts of Africa and Madagascar and it probably occurs in southern Africa, but has not yet been recorded from this region. *Pedestrodryops endroedyi* Kodada, 2001 — so far known only from South Africa — is excluded from this checklist, as it is clearly terrestrial.

The reader is referred to the Appendix (p. 228) for a checklist of the known and described southern African aquatic Dryopidae species.

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CHAPTER 17

LIMNICHIDAE

by

S. Endrödy-Younga†

The members of the family Limnichidae (minute marsh-loving beetles) are shore beetles. They do not live in free water, but are often associated with muddy or sandy banks. The family is in need of study and apparently no complete life histories have yet been described.

Limnichid adults (Fig. 17.1A) are 1–3 mm in length, moderately convex, and ovate to broadly ovate. The head is somewhat deflected and fits deeply into the prothorax. The pronotum fits into the elytra along a characteristically impressed, undulating line (arrowed in Fig. 17.1A). The dorsal surface is clothed either with semi-erect setae or with a dense, recumbent and pattern-forming pubescence. The antennae are filiform or have slightly enlarged apical segments. The legs can fold back into ventral cavities.

The larvae of Limnichidae (Fig. 17.1B) are subcylindrical, slightly curved, and adorned with erect setae. The head is large but partially retracted. The posterior margins of the thoracic and first eight abdominal segments are striated. The thorax is a little wider than the head, and the abdomen, which is subequal in width to the metathorax, is cylindrical, with parallel sides and a rounded apex. Posteriorly, the abdomen is curved ventrally. The ninth, apical, segment of the abdomen carries either an operculum, which is unable to close (different from the truly aquatic byrrhoid families) or an apparent tenth segment.

Limnichid larvae are terrestrial (in damp soil or humus on the shores of water bodies) and therefore lack anal gills. They apparently feed on decaying organic matter.

Pupation occurs in the larval habitat.

The apparent scarcity of Limnichidae in southern Africa is probably merely a reflection of inadequate collecting or inappropriate collecting techniques. The adults are most often found in shore-line debris, and they fly readily. Some may have a burrowing life style and can be collected by shore-washing. Large numbers of adults sometimes fly to lights at night.

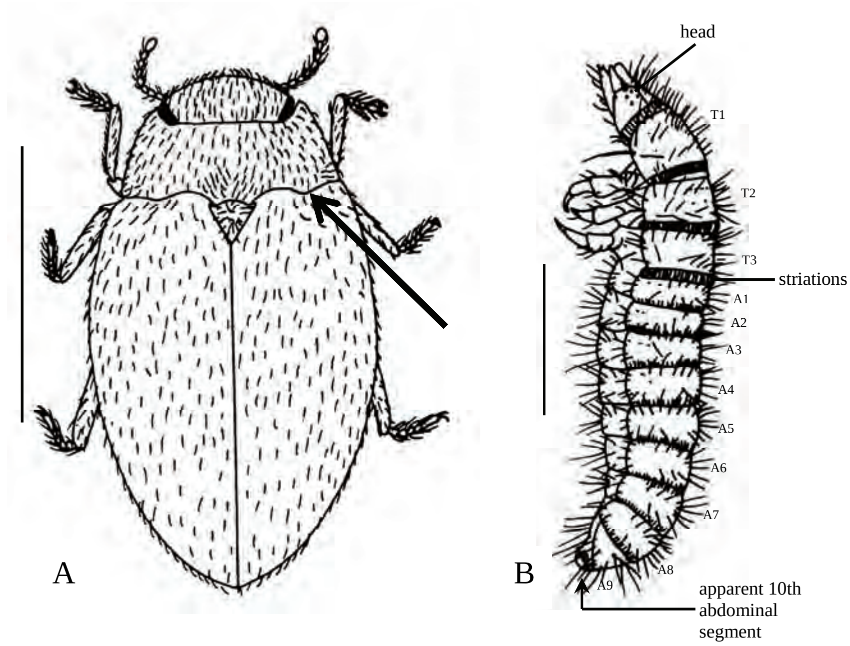

Fig. 17.1. Limnichidae. **A,** unidentified genus, adult, dorsal view; **B,** *Limnichites* sp., larva, lateral view. (A redrawn from Scholtz & Holm 1985; B redrawn from Stehr 1991). Scale bars = 1 mm.

Checklist and distribution records of the known and described species of aquatic Limnichidae in southern Africa

The Limnichidae of the Afrotropical Region were neglected for a long time, but the group is now being studied by C. Hernando and I. Ribera. Only one southern African species has been described and identified (see the Appendix, p. 228), but other taxa are now known from the region. These include a few undescribed species of the genera *Limnichus*, *Pelochares* and *Byrrhinus*, plus several undescribed genera of the subfamily Limnichinae. Hernando & Ribera (2004) recently described a new genus of terrestrial Limnichidae from South Africa; these are not listed in the Appendix.

ACKNOWLEDGEMENT

Dr Ignacio Ribera of the National Museum of Natural Sciences, Madrid (previously of The Natural History Museum, London), kindly made constructive comments on this chapter.

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CHAPTER 18

HETEROCERIDAE

by

R. Stals

The Heteroceridae (variegated mud-loving beetles) are small to smallish, brown or yellowish-brown shore beetles. No member of the family is known to be strictly terrestrial. Both larvae and adults live in shallow tunnels or galleries in the mud or sand on the shores of inland water bodies.

ADULT MORPHOLOGY

The adults (Fig. 18.1A) of the southern African Heteroceridae vary from 2.2 to 5.8 mm in length, with most species being about 3–4 mm long. They are elongate, with parallel sides and a moderately convex dorsal side. They are densely clothed with setae of different lengths: fine, short, recumbent hydrofuge setae, as well as longer and thicker, semi-erect, light-coloured setae. Beneath the pubescence the elytra and pronotum often have macular brown or black colour patterns on a lighter-coloured background (Fig. 18.1A).

The head of the adult is prognathous, with a large exposed labrum. The mandibles are strongly developed, especially in the males, and have serrated inner edges. The relatively short and thick antennae are (for Afrotropical species) 10- or 11-segmented, with the terminal six or seven segments forming a slightly serrate club.

The legs of the adults are clothed with a dense layer of hydrofuge setae, especially on the front tibiae. The legs are fossorial, with the tibiae, particularly the front pair, broad, flattened, and laterally fringed by a row of long spines. The tarsi are four-segmented, with the first and fourth tarsal segments being elongated.

The adult abdomen has five visible sternites (Figs 18.1B–C). The first sternite carries an arching stridulatory ridge (= stridulatory file, = post-metacoxal ridge) on each side (Figs 18.1B–C), which is scraped by a ridge on the hind femur to produce a screeching sound. The stridulatory ridge may be complete (arrowed in Fig. 18.1B) or incomplete (arrowed in Fig. 18.1C), and is more developed in the male. Stridulation is probably an important means of communication between adults in their burrows.

IMMATURE STAGES

The small, oblong, whitish eggs are laid in small masses in breeding chambers. Heterocerid larvae (Fig. 18.1D) are campodeiform, elongate, convex to slightly flattened, and clothed with long, stiff setae. The dorsal surfaces are darkly pigmented. The head is broad and slightly flattened, bearing strongly toothed, symmetrical mandibles. The body tapers posteriorly, and the thoracic segments are wider than those of the abdomen. The legs are well developed and each leg terminates in a single claw. The abdomen is ten-segmented, without hooks, gills or an operculum. The tenth segment is well developed and conical, with a soft, fleshy, unpaired pygopod on the ventral side of its apex. Pupation takes place fairly deep within the soil, within a mud cell.

GENERAL ECOLOGY AND BEHAVIOUR

Both adults and larvae feed on organic particles in the soil. They may be entirely planktivorous — feeding on washed-up zooplankton — or omnivorous, in which case they also feed on algae.

Variegated mud-loving beetles are frequently found on shores of fresh and brackish water in all regions of southern Africa, almost exclusively at still waters or slowly-flowing rivers. They can be found in both mesic and quite arid regions. They tend to live in distinct colonies, always close to the water's edge. The adults excavate the tunnels with their fossorial legs and enlarged mandibles. Adults and larvae occupy separate galleries in the soil and the entrances to the tunnels of adults are frequently marked by sand chimneys. Males and females of the same species usually occupy single galleries, but more than one species have at times been found in a single colony.

Both larvae and adults can be collected by pouring water onto the tunnels. Adults are strongly attracted to light at night.

IDENTIFICATION

The development of the abdominal stridulatory ridge is a most useful character for the identification of Heteroceridae specimens. As far as the external morphology is concerned, the members of the family are very homogeneous, as are their habits. For separation of the species the male genital structures bear the most significant characters. Other morphological characters useful in species identification include, amongst others, the shape of the stridulatory ridge (file), the presence or absence of post-mesocoxal ridges on the metasternum (Fig. 18.1B), the number and shape of the antennal segments, the shape of the mouthparts, and the pattern formed by the elytral spots. Charpentier's (1965) monograph would be the point of departure in identifying southern African Heteroceridae, and the various papers by Mascagni & Monte are a useful adjunct.

KEY TO THE SOUTH AFRICAN GENERA OF HETEROCERIDAE: ADULTS

1. Stridulatory (post-metacoxal) ridges on first abdominal ventrite complete (arrowed in Fig. 18.1B) ....*Augyles*

– Stridulatory (post-metacoxal) ridges on first abdominal ventrite incomplete (arrowed in Fig. 18.1C) or absent .... *Heterocerus*

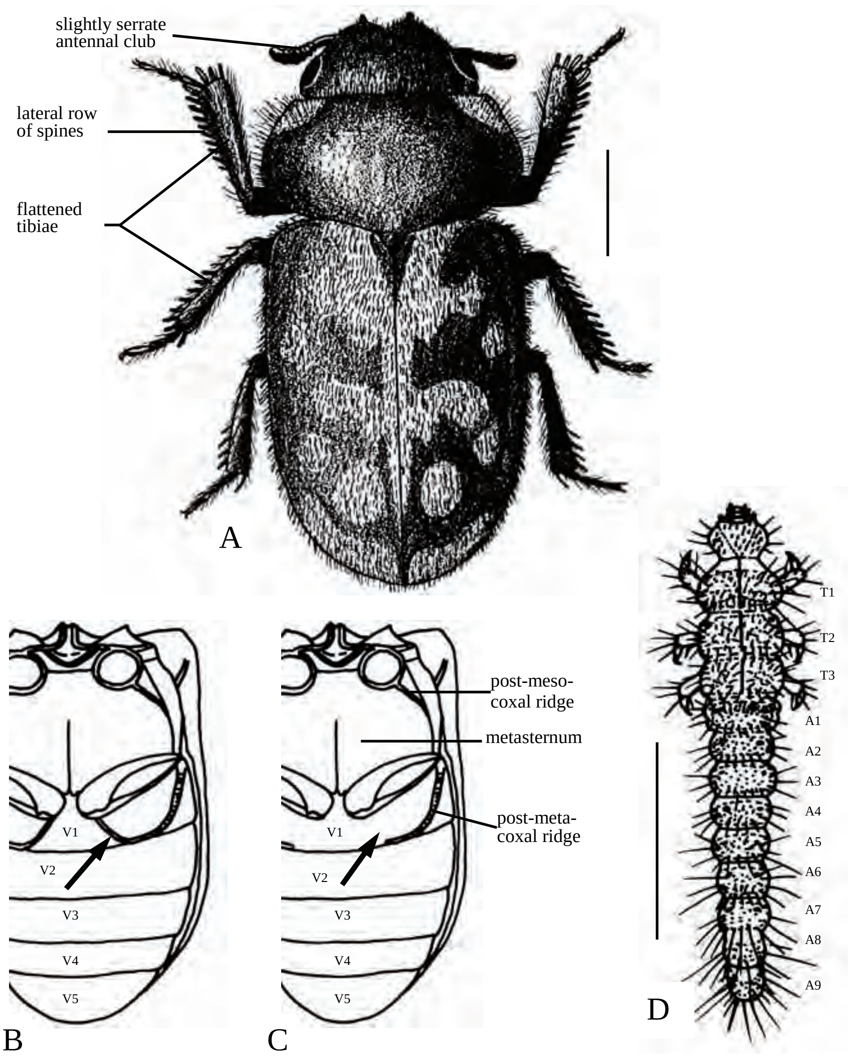

Fig. 18.1. Heteroceridae. **A,** *Heterocerus* sp., adult, dorsal view; **B–C,** adult, diagram of underside, left, illustrating curved stridulatory (post-metacoxal) ridge on first abdominal ventrite: **B,** *Augyles* sp., complete ridge arrowed; **C,** *Heterocerus* sp., incomplete ridge arrowed; **D,** *Heterocerus* sp., larva, dorsal view (A10 not visible from above). (A & D after Scholtz & Holm 1985; B & C adapted from Charpentier 1965). Scale bars: A & D = 1 mm; B & C not to scale.

Checklist and distribution records of known and described species of Heteroceridae in southern Africa

To date, 23 species, belonging to two genera, have been reported from this region. Alessandro Mascagni and Cinzia Monte are documenting the Afrotropical Heteroceridae in an ongoing series of papers. There is still a need for specialised collecting in many southern African regions, however.

The reader is referred to the Appendix (pp. 228–229) for a checklist of the region's known and described Heteroceridae.

ACKNOWLEDGEMENT

Dr Alessandro Mascagni, Florence, Italy, is thanked for kind correspondence and specialist advice on the variegated mud-loving beetles.

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[*contains keys to, and descriptions of, all Afrotropical Heteroceridae known at the time*]

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CHAPTER 19

PSEPHENIDAE

by

W.D. Shepard & C-F. Lee

Members of the family Psephenidae (water-penny beetles) occur on all continents except Antarctica, with most of the known diversity in the northern hemisphere. World-wide, 36 genera and 274 species are currently considered valid; three described genera with 13 described species are known from Africa south of the Sahara. Many undescribed taxa are, however, known to specialists, and many more await discovery. This is especially true for Africa and South America.

The family Psephenidae is divided into four subfamilies, the Eubriinae, Eubrianacinae, Psepheninae and Psephenoidinae. The basal taxa, currently placed in the Eubriinae, are Gondwanan and occur in Australia (genus *Sclerocyphon*) and southern South America (genus *Tychepsephus*). Three subfamilies — each with one described Afrotropical genus — have to date been recorded from sub-Saharan Africa: the Eubriinae (genus *Afroeubria*, with three known Afrotropical species), the Eubrianacinae (genus *Afrobrianax*, eight known Afrotropical species), and the Psephenoidinae (genus *Afropsephenoides*, two known Afrotropical species).

All water-penny beetles are aquatic as larvae and riparian as adults; hence they are false water beetles.

Adults are recognised by their weakly sclerotised exoskeleton, serrate to pectinate antennae, front coxae with exposed trochantin, and association with streams. The adult body is somewhat flattened dorsoventrally and the elytra may not always fit together evenly. The maxillary palps often have the terminal segment elongate and armed with variously-shaped projections. The abdomen has five to seven visible sternites.

Larvae (water pennies) are brownish, flattened and disc-like (Figs 19.1A–D). The pleural regions of most of the thoracic and abdominal segments are expanded and often meet laterally to form an even margin. The head and legs are entirely concealed under the prothorax and the lateral expansions (Fig. 1.7C). The antennae are three-segmented and relatively long. The abdominal sternites may have exposed tracheal gills (Eubrianacinae), or the tracheal gills may be under a terminal operculum (Eubriinae, Psephenoidinae).

The life cycle is univoltine to semivoltine. Eggs are laid in sheet-like masses on submerged logs and rocks, usually hatching in two weeks. Larvae feed on epilithic algae under water, mostly at night. During the day they are found, under water, on the underside of logs and rocks. Typically, there are six larval instars. The last instar larvae crawl to the water's edge and out of the water to pupate.

Pupae are exarate and weakly sclerotised. Functional spiracles may occur on abdominal segments 1 to 7. Pupation is mainly under leaves, stones, logs, et cetera, or in moss and among emergent plants. Many species pupate under the exuviae of the last larval instar. Only in the subfamily Psephenoidinae do larvae pupate underwater, their unique pupal gills allowing for respiration without drowning. Pupation lasts 10 to 14 days.

After their emergence, adults remain near the streams in which the larvae lived. In many cases, the females submerge for oviposition after mating, and eventually die. Males remain on riparian vegetation or emergent stones, continually looking for females with which to mate. Adults of some species will come to light at night; most of these are members of either Eubriinae or Psephenoidinae.

The family Psephenidae was, until recently, one of the beetle families of southern Africa of which the least was known. In 2001, Chi-Feng Lee and co-workers embarked on a study of this fauna. To date, a new genus, *Afrobrianax* Lee, Philips & Yang, 2003, was established for all African species previously placed in the genus *Eubrianax*, and two new species — *Afrobrianax ferdyi* (Fig. 19.1A) and *Afroeubria sebastiani* (Fig. 19.1D) — were described from South Africa. Both *Afrobrianax* and *Afroeubria* have been revised and phylogenetically considered. Recent investigations have shown that *Afropsephenoides* (Fig. 19.1B) and at least one undescribed genus ('Genus A', Fig. 19.1C) occur in southern Africa. *Afropsephenoides* has been revised, and these studies are continuing.

KEY TO THE KNOWN AFROTROPICAL GENERA OF PSEPHENIDAE: LARVAE
(*after Hinton 1955*)

1. Spiracles present dorsally on mesothorax (T2) and eighth abdominal segment (A8) (Fig. 19.1A); gills present on four abdominal sternites, anal gills absent; tergopleural sutures distinct on meso- and metathorax and first eight abdominal segments (Fig. 19.1A); marginal fringe distinctly segmented; middorsal pronotal plate present (Fig. 19.1A) .... *Afrobrianax*

– Without spiracles, or spiracles only on eighth abdominal segment (A8); gills present under a terminal, ventral operculum; tergopleural sutures absent; marginal fringe not distinctly segmented; pronotum without middorsal plate 2

2. Spiracles present on eighth abdominal segment (A8), surrounded by spiracular brushes; eighth abdominal segment (A8) with lateral expansions (Figs 19.1C–D) 3

– Spiracles absent; eighth abdominal segment (A8) without lateral expansions (Fig. 19.1B) .... *Afropsephenoides*

3. Body elongate; lateral expansions distinctly separate (Fig. 19.1C); ninth (terminal) abdominal segment (A9) with a deep notch (arrowed in Fig. 19.1C); sulcus 1 on pronotum (T1) absent (Fig. 19.1C) ....Genus A

– Body oval; lateral expansions tightly connected (Fig. 19.1D); ninth (terminal) abdominal segment (A9) not deeply notched; sulcus 1 (S1) present on pronotum (T1) (Fig. 19.1D) .... *Afroeubria*

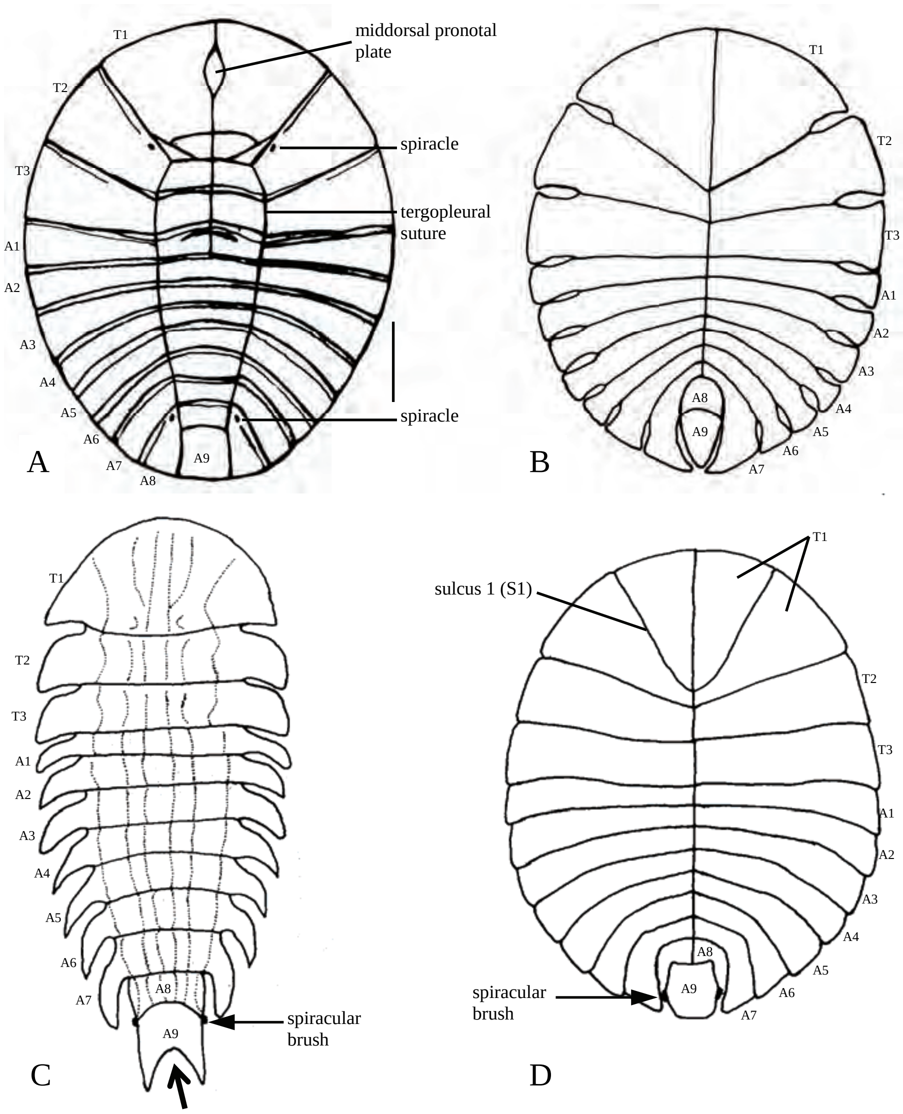

Fig. 19.1. Psephenidae, larvae, dorsal views. **A,** Eubrianacinae, *Afrobrianax ferdyi*; **B,** Psephenoidinae, *Afropsephenoides* sp.; **C–D,** Eubriinae: **C,** Genus A (undescribed); **D,** *Afroeubria sebastiani*. Scale bar = 1mm.

KEY TO THE KNOWN AFROTROPICAL GENERA OF PSEPHENIDAE: PUPAE
(*after Hinton 1955*)

1. Larval cuticle only partly shed (three apical abdominal segments of larval cuticle shed together with whole ventral region); abdominal sternites 7–9 heavily sclerotised and resembling corresponding segments of larva; a number of fine spiracular openings scattered on seventh abdominal sternite .... *Afrobrianax*
– Larval cuticle entirely shed; functional spiracles confined to abdominal segments 2–7 2

2. Spiracles at the tips of small cylindrical tubercles .... *Afroeubria*
– Spiracular gills present; gill branches always dorsal .... *Afropsephenoides*

KEY TO THE KNOWN AFROTROPICAL GENERA OF PSEPHENIDAE: ADULTS

1. Elytra relatively soft, without impressed punctures on disc .... *Afropsephenoides*
– Elytra relatively hard, with impressed punctures on disc 2

2. Impressed punctures randomly spread over entire dorsum; body convex dorsally; mesosternal process acute .... *Afroeubria*
– Impressed punctures forming lines on elytra; body dorsoventrally flattened; mesosternum without apical process .... *Afrobrianax*

Checklist and distribution records of known and described species of Psephenidae in southern Africa

The reader is referred to the Appendix (p. 229) for a checklist of the known and described southern African Psephenidae species. Knowledge of these beetles and their distributions is so scant that an evaluation of possible endemism would be premature. More taxa from southern Africa are to be described.

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[*a more current version can be requested from* <*william.shepard@csus.edu*>]

CHAPTER 20

PTILODACTYLIDAE

by

F.C. de Moor

The Ptilodactylidae is a large and diverse family of byrrhoid beetles with the common name 'toed-winged beetles'. They are distributed almost world-wide, but are absent from Europe. The larvae of several ptilodactylid species are known to be aquatic (usually in flowing water), but adults seem to be terrestrial throughout; these kinds are hence false water beetles. Other forms are terrestrial in all life stages.

Adult Ptilodactylidae are small to medium-sized (4–15 mm long), oblong to somewhat elongate, soft-bodied beetles. The 11-segmented antennae are long and filiform, serrate, pectinate or flabellate. The base of the pronotum may have one or three posteriorly directed mediobasal teeth, and it is at times very typically crenulate, but may be smooth. The scutellum is heart-shaped or triangular, its base either with a single median notch, crenulate, or smooth.

Adult beetles referable to Ptilodactylidae and collected in South Africa, are present in some South African insect collections. It is currently problematic, or impossible, to place them in any existing genus and they remain unidentified and, most likely, undescribed. It is not known which of these unidentified beetles may have aquatic larvae. Further taxonomic and ecological research is required here.

IMMATURE STAGES

There are three types of larval Ptilodactylidae, two of which are terrestrial, but those referable to the subfamily Anchytarsinae are aquatic. These larvae resemble those of Dryopidae and Elmidae, but the aquatic forms of Ptilodactylidae lack a ventral operculum. Bertrand (1966, 1972) recorded the presence of two unnamed ptylodactylid genera in southern Africa. Aquatic larvae are found in acidic, swift-flowing streams and small rivers in the southern Cape and south-western Cape. These closely resemble those

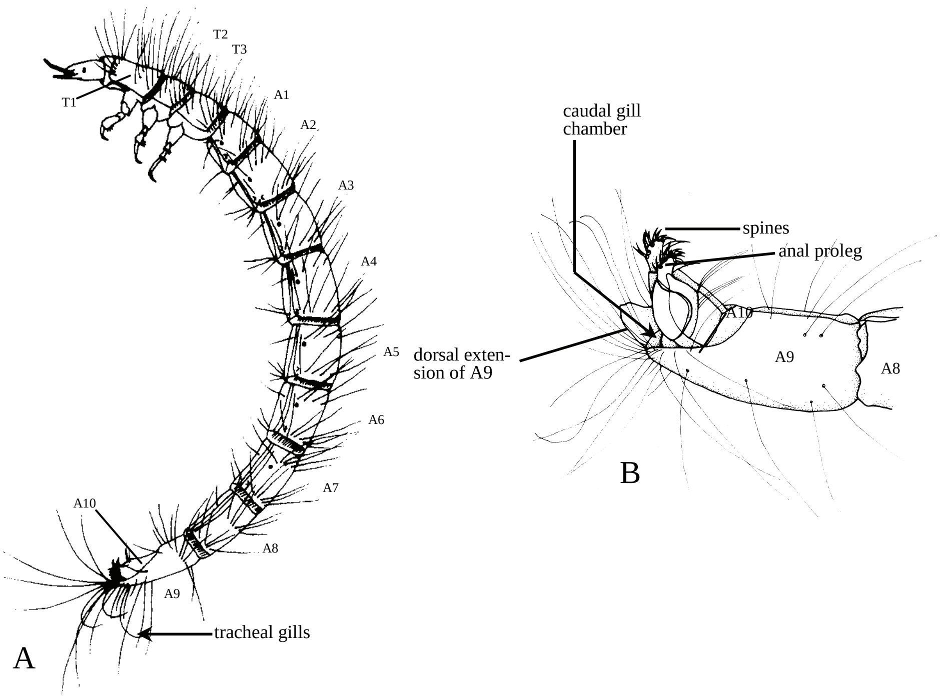

Fig. 20.1. Ptilodactylidae, unidentified larva. **A,** lateral view; **B,** abdominal apex, lateral view (ventral above). (Both figures original, Nancy Bonsor). Much enlarged, not to the same scale.

of the genus *Anchytarsus*, a New World genus of the Anchytarsinae. However, until a taxonomic study of these larvae and associated adults is undertaken, their taxonomic placement must remain *incertae sedis.*

The ptilodactylid larvae recorded in South Africa (Figs 20.1A–B) are elongate and subcylindrical, up to 15 mm long. On the abdomen they have many very long thin hairs, which is an obvious feature if viewed under the microscope against a dark background (Fig. 20.1A). The head bears a pair of conspicuous, three-segmented antennae. The prothorax is subequal in length to the mesothorax plus metathorax. The thoracic and first nine abdominal segments are strongly sclerotised, whilst the tenth is small, fleshy and situated ventrally to the terminal ninth segment (Fig. 20.1B). The tenth segment bears a pair of spiny anal prolegs and terminal tracheal gills or osmoregulatory papillae below a caudal gill chamber that is formed by the dorsal extension of abdominal segment 9 (Fig. 20.1B).

Nothing is known about the biology of these undescribed ptilodactylids except that the larvae are fairly common in swift-flowing acidic streams (pH = 4.4–6.0) in the Cape Floristic Region. It is assumed that all ptilodactylid larvae feed on decaying plant material.

TAXONOMIC NOTES

The family Ptilodactylidae is badly in need of taxonomic study, at both the species level and above, and in all biogeographical regions, not least the Afrotropical Region. The only comprehensive study of the group is Stribling's (1986) thesis, which has regrettably never been published. The subfamily Anchytarsinae is almost certainly paraphyletic.

Because so very little is known about the southern African Ptilodactylidae, a checklist of species has not been compiled for the Appendix.

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CHAPTER 21

CHRYSOMELIDAE: DONACIINAE

by

E. Grobbelaar

The members of the Donaciinae (longhorn leaf beetles), a small subfamily of the large and diverse family Chrysomelidae (the leaf beetles), are either aquatic or semi-aquatic phytophilous water beetles. The subfamily is mainly distributed in the northern hemisphere, but it is also known from the Afrotropical Region, the Oriental Region and northern Australia; it is absent from South America. Only two genera are known to occur in southern Africa, namely *Donacia* (subgenus *Donacia*) and *Donaciasta*, both belonging to the tribe Donaciini. To date, only three species have been recorded from this region: one undescribed species of *Donacia* (*Donacia*), and two species of *Donaciasta*.

ADULT MORPHOLOGY

Southern African donaciines are smallish to medium-sized (5.6–8.0 mm in length), semi-aquatic beetles. Although Donaciinae from other regions are typically brightly metallic in colour, all the known southern African species lack conspicuous metallic colouration and are yellowish brown, reddish brown or dark brown, with only a slight metallic lustre. Only the immature stages are aquatic; adults appear to spend only short periods of time (during oviposition) submerged. However, as the adults are usually short-lived, the major part of the life cycle is completed under water.

Adult donaciine beetles (Fig. 21.1A) are elongate, although the females of *Donaciasta* sometimes appear ovate in shape. Females are larger than males. The head is prognathous, and the mandibles are armed with apical teeth. The antennae are long — about half the length of the body in *Donaciasta*, and two-thirds the length of the body in *Donacia* (*Donacia*). The elytra are glabrous, with punctate striae, and are truncate apically. The hind femur has an acute tooth on the underside towards the apex (arrowed in Fig. 21.1B). The tarsi are pseudotetramerous (Fig. 1.5A); the third tarsal segment is bilobed. The abdomen has five visible sternites, the basal (anteriormost) sternite being much longer than the others.

Over their ventral surfaces, from the head to the abdomen, donaciine adults have a dense, velvety, hydrofuge tomentum that traps air when they go under water. In species of genera other than *Donacia* (*Donacia*) and *Donaciasta*, known to spend most of their adult life submerged (often in brackish water), the ventral tomentum becomes a true plastron.

IMMATURE STAGES

Of the southern African species, the eggs of only *Donaciasta goeckei* are known. Batches of between five and 32 eggs are deposited, under water, in the space between overlapping leaves of water lilies. They are enveloped by an opaque, gelatinous substance known as the extrachorion, which attaches the leaves to one another. The extrachorion is thought to contain symbiotic bacteria and yeast-like fungi that are ingested by the hatching larva and thought to be essential to the nutrition of the beetles. Egg bursters, used by the first-instar larvae of some Chrysomelidae to rupture the egg shell in the process of hatching, are absent from the first instar larvae of *D. goeckei*. In *Donacia* (*Donacia*) species from other regions, females are known to cut a hole in the floating leaf and lower the abdomen through this hole to oviposit on the lower leaf surface, under the water.

Of the southern African species, the larva of only *Donaciasta goeckei* is known. The larva (Fig. 21.1C) is C-shaped and grub-like, pale in colour, elongate and cylindrical — wider in the posterior two thirds and tapering towards the front. The head is relatively small, prognathous and well sclerotised. The antennae are stout and three-segmented. Five stemmata occur on each side of the head. Each mandible is pointed, with the inner surface widened and concave, and carries two apical teeth. The larval thorax is rounded, with a lightly sclerotised prothoracic shield extending halfway down either side of the prothorax. The legs are conspicuous, stout, widely separated, and four-segmented. The abdomen has ten segments, rounded in cross section, with the eighth abdominal segment being effectively terminal.

Early larval instars are metapneustic, but the final instar is peripneustic, an adaptation to that part of the life cycle spent in the cocoon before pupation. The spiracles of the eighth abdominal segment are enlarged and displaced to a dorsal, membranous area at the base of a pair of channelled hooks. These appendages are projections of the body wall that are drawn out posteriorly to form a pair of curved, channelled hooks (Fig. 21.1D). The larva uses these hooks to make incisions into the host plant's stem or root to extract air from spaces within the plant tissue. They are probably also used to anchor the larva to the host plant. In *Donaciasta goeckei* and the

Donacia (*Donacia*) species of which the larvae are known, these hooks are particularly elongate, an adaptation for utilisation of their particular host plants, in these cases water lilies of the family Nymphaeaceae.

When the larva of *Donaciasta goeckei* is ready to pupate, a brownish, semi-transparent silken cocoon is constructed and firmly attached to the larger roots of the host plant (Fig. 21.1E). This cocoon is filled with air. The part of the cocoon that is attached to the host plant is thinner than the rest of the cocoon. It appears that final instar larvae and pupae are entirely dependent on oxygen reaching them through two sets of paired slits, one pair at either end of this thin wall of the cocoon. The pupa of *Donacia* (*Donacia*) sp.n. from southern Africa are not known, but some *Donacia* species from the northern hemisphere can live for ten months or more inside a similar cocoon. Adult beetles emerge by breaking open one end of the cocoon and crawling out. The hydrofuge hairs of the ventral surface of the adult trap air from the cocoon, so providing an air supply until the beetle reaches the atmosphere.

Larvae of *Donaciasta* appear to feed on the submerged parts of water lilies, generally in the mud amongst the roots. *Donaciasta goeckei* larvae have been collected off the roots of *Nymphaea nouchali* (Nymphaeaceae). Feeding holes, probably caused by the larvae, were observed in these roots. Published records indicate that the genus *Donaciasta* is associated with water lilies (*Nymphaea* species), water-chestnut (*Trapa natans*, Trapaceae) and pondweed (*Potamogeton* species, Potamogetonaceae).

GENERAL ECOLOGY AND BEHAVIOUR

Endosymbiontic relationships with bacteria and yeast-like fungi are known to exist in at least some donaciine genera. The symbionts are usually found in special structures ('mycetomes') associated with the alimentary canal, primarily in the larval stages of the beetles. Their principal function is the synthesis of substances essential for the nutrition of the beetles, which are lacking in the food ingested. When the eggs are deposited, the extrachorion contains a cluster of these endosymbionts.

From other parts of the world both the larvae and adults of Donaciinae are known to be herbivorous. The food of the adults of the southern African donaciines remains unknown. *Donacia* adults in other regions have been reported to feed on pollen of the flowers of Nymphaeaceae. Adults of *Donacia* (*Donacia*) sp.n. have been collected in association with a *Nymphaea* species and *Trapa natans*, but their exact association with these plants is not known.

The adults of Donaciinae are generally active, sun-loving, and readily take flight. They may often be seen sitting on the surface of leaves. Adults of *Donaciasta goeckei* have been collected on water lilies in flowing streams as well as in stagnant pools. To date, larvae have only been collected from plants in stagnant pools. The larvae live on the floating and submerged parts of water plants, mostly in the mud among the roots. They move about by crawling.

KEY TO THE SOUTHERN AFRICAN GENERA OF DONACIINAE: ADULTS

1. Antennae about half the length of the body; frons and vertex with distinct calli (Fig. 21.1A) and largely glabrous; pronotum without anterolateral tactile setae; elytron with some intervals with unordered punctation; punctures of pronotal disc, if individually distinct, not confluent to form irregular rugae; hind femora less than double the length of the middle femora, stout .... *Donaciasta* (Fig. 21.1A)

– Antennae about two-thirds the length of the body; frons and vertex without distinct calli and uniformly pubescent; pronotum with anterolateral tactile setae prominent, of normal length; elytron with intervals without punctation; punctures of pronotal disc not individually distinct, the disc irregularly rugose; hind femora double the length of the middle femora, slender ....*Donacia* (*Donacia*)

Checklist and distribution records of known species of Donaciinae in southern Africa

The reader is referred to the Appendix (p. 229) for a checklist of the known southern African Donaciinae taxa.

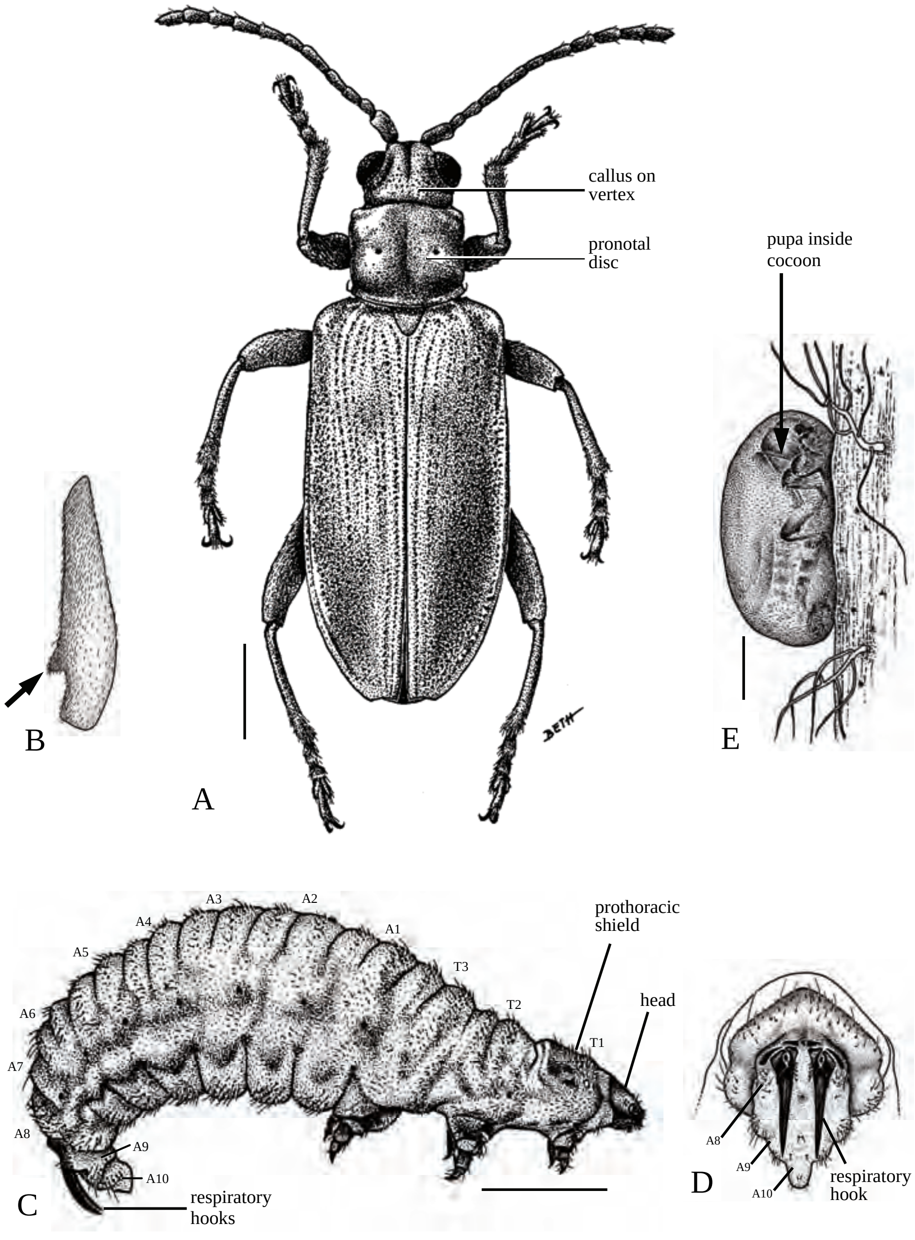

Fig. 21.1. Chrysomelidae: Donaciinae, *Donaciasta goeckei*. **A,** adult male, dorsal view; **B,** adult, hind femur, inner side, anterior to top of page; **C,** larva, lateral view; **D,** larva, posterior view showing curved, channelled respiratory hooks; **E,** pupa in cocoon, attached to submerged root of host plant. (All figures original, Beth Grobbelaar). Scale bars: A = 1 mm; C & E = 2 mm; B & D much enlarged, not to scale.

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CHAPTER 22

CURCULIONIDAE

by

R. Stals

Currently, of all animal families, the Curculionidae (weevils, snout beetles) contains the most described species and it may eventually prove to be the most speciose family of all organisms. Despite its size and ubiquity, the family contains only a small fraction of aquatic forms. The Curculionidae can be divided into approximately 120 tribes. An aquatic life-history style has evolved independently in a number of these tribes, of which the Phytobiini (subfamily Ceutorhynchinae), Bagoini, and Stenopelmini (subfamily Erirhininae) are the most significant. Since the weevil groundplan is terrestrial, the aquatic weevils should be considered phytophilous water beetles, following the functional/ecological classification presented in Chapter 1; these weevils are also often referred to as 'semi-aquatic' or 'subaquatic'.

Among indigenous southern African weevils, very few species — all belonging to the tribe Bagoini — are known to be aquatic. A number of semi-aquatic weevil species, indigenous to the New World, have been introduced into southern Africa as biological control agents of invasive aquatic plants. These weevils all belong to the tribes Stenopelmini and Rhythirrinini.

ADULT MORPHOLOGY

Coupled with the great species diversity of the Curculionidae is an almost equally great variety of body shapes and sizes. The most characteristic feature of a typical adult weevil (Fig. 22.1A) is the rostrum or snout, a long or short anterior projection of the head, approximately cylindrical, and often curved downwards or projecting obliquely downwards. The mouthparts are placed at the very end of the rostrum, and the typically elbowed (geniculate) and clubbed antennae are attached to the sides of the rostrum (Fig. 22.1A). Most weevils have grooves (scrobes) on the rostrum into which the proximal part of the retracted antenna fits (Fig. 22.1A). The head is rather small and globular. The pronotum is generally transversely or longitudinally rectangular. In the water weevils, the elytra are mostly somewhat elongate and parallel, rounded posteriorly, and declivous apically (Fig. 22.1A) but many Bagoini have the elytra angularly narrowed posteriorly before reaching the apex (lower arrow on Fig. 22.1A). The elytra may be longitudinally ridged. The ventral surface is more or less flat. In very many species the cuticle is covered with setae or scales of many types. The adults of water weevils in southern Africa range in body length from c. 1.5–5 mm.

Adult specimens of the Bagoini (*Bagous*, *Pseudobagous*) and some Stenopelmini (e.g. *Cyrtobagous*, *Neochetina*) are often encrusted with a layer of mud that obscures the beetle’s body surface. Adult Stenopelmini may or may not have a waterproof cuticular 'coating' (absent in *Stenopelmus* and *Neohydronomus affinis*).

The aquatic adaptations of adult water weevils found in southern African are, at most, the presence of hydrofuge scales or setae on various parts of the body, some of these possibly functioning as plastrons. Unlike some water weevil taxa from other parts of the world, the southern African forms do not have, in either the adult or larval stage, any other respiratory or locomotory adaptations for a life in water. Adults move about by walking or crawling on their host plants and at least some of the smaller species can walk on the water surface film. Oddly, the larvae of *Stenopelmus rufinasus* are known to drown if they consume all of their food plant and fall into the water. Aquatic members of the tribe Phytobiini (not present in southern Africa) are true — albeit weak — swimmers, with fringes of swimming hairs on the legs.

IMMATURE STAGES

Aquatic weevils lay their eggs inside the tissues, or among structures, of the host plant. Their larvae are either confined to burrows inside the host plant, or feed externally on plant tissue. Weevil larvae (Fig. 22.1B) are pale, grub-like or slender, subcylindrical, and without any legs. Among all water beetle larvae, only weevil larvae are legless. The larval head capsule is strongly sclerotised and hard, but the rest of the body is soft and curved (gently or markedly), sometimes even assuming a C-shape. Projections may be present or absent on the dorsum and the body may taper posteriorly into a pygopod (e.g. *Cyrtobagous*).

Pupation again differs among species, ranging from pupation in a cocoon attached to the host plant above the water surface, to pupation in stems below the water line, to pupation in a submerged but water-tight cocoon attached to underwater parts of the host plant.

GENERAL ECOLOGY AND BEHAVIOUR

With a negligible number of exceptions, the Curculionidae are phytophagous, most frequently exhibiting a large degree of host plant specificity. The family contains many species that are pests in agriculture and forestry and destroyers of stored produce. A number of aquatic weevils, of various genera, are rice pests in various parts of the world, but these are not known in southern Africa. As a general rule, the adults of water weevils feed on the same plant species as the larvae but the larvae inflict the most damage.

Although an association with aquatic habitats is inferred for the indigenous southern African Bagoini (these weevils are indeed found in water, close to the water's edge, or on emergent vegetation) the biology of the Afrotropical Bagoini is almost completely unknown. It seems that *Pseudobagous longulus* is not uncommon locally and is associated with water lilies of the genus *Nymphaea* (Nymphaeaceae). The adults can be found under the leaves of water lilies, in still or slow-flowing water. No immature stages of the indigenous southern African water weevils have yet been collected.

The frequent oligophagy, or even monophagy, of weevils makes them excellent candidates for the biological control of alien invasive plant species. Many success stories in weed biocontrol can be attributed to weevils, of which the impact of water weevils on aquatic weeds might be the most impressive. In southern Africa, biological control of water weeds is spearheaded by the Weeds Research Division of the Plant Protection Research Institute in Pretoria, South Africa, but this research team has close ties with colleagues both in the rest of southern Africa and in the rest of the world. A relatively small number of aquatic plants are very serious alien invaders in various parts of the world. Several successful biocontrol programmes, utilising weevils against these aquatic weeds, have been initiated, as summarised below. Additional weevil species that target other water weeds are currently being tested and may be released in southern Africa in due course.

TAXONOMY

The very large genus *Bagous* is widely distributed on all continents except Antarctica and South America. The genus is presently the subject of long-term revisionary studies by C.W. O'Brien and his co-workers and a revision of the Afrotropical fauna is forthcoming. A large number of Afrotropical *Bagous* species probably await description and experience with the *Bagous* fauna of other parts of the world indicates that many species will probably be almost indistinguishable externally, showing a great deal of structural convergence. Some *Bagous* species from the Palaearctic have been released or evaluated to serve as biocontrol agents of water weeds in the USA. More species of *Bagous* may be candidate biocontrol agents, but a strong taxonomic underpinning is essential for such an exploit.

KEY TO THE KNOWN SOUTHERN AFRICAN GENERA OF (SEMI-)AQUATIC CURCULIONIDAE (INCLUDING INTRODUCED GENERA): ADULTS

NOTE: the body length of adult Curculionidae is the length of the pronotum plus the elytra, *excluding* the head and rostrum. Because of the great dorsoventral flexibility of the rostrum, the body length measurement cannot be standardised if the head and rostrum are included.

1. Prosternum with central groove to receive rostrum when head is retracted, this groove laterally more or less sharply delimited; third segment of hind tarsus simple, never deeply emarginate or bilobed (Bagoini)........................2
– Prosternum without groove to receive rostrum when head is retracted; third segment of hind tarsus emarginate or bilobed, or not so 3

2. Frons with small prominence above eye; elytra elongate; third tarsal segment of front leg distinctly broader than second (Fig. 22.2A); body length *c.* 3.5–6.5 mm; frequently associated with water lilies ... *Pseudobagous* (Fig. 22.1A)
– Frons without prominence above eye; elytra subrectangular to almost square; third tarsal segment of front leg not distinctly broader than second; body length very variable, mostly 2.8–4.0 mm; associated with various aquatic or emergent plants ....*Bagous*

3. Rostrum stout, very short and broad, shorter than head (Fig. 22.2B); tip of rostrum reddish; funicle of antenna seven-segmented; body length *c.* 1.7 mm; associated with *Azolla filiculoides* ....*Stenopelmus*
– Rostrum elongate, more or less subcylindrical, much longer than head (e.g. Fig. 22.2C); tip of rostrum not reddish; funicle of antenna six- or seven-segmented 4

4. Dorsal surface with only small, mostly inconspicuous, scattered scales; first antennal club segment glabrous, only apical club segments pubescent; tarsal segments slender, segments of equal width, segment 5 about as long as segments 1–3 together (Fig. 22.2D); body length *c.* 1.7–2.1 mm; associated with *Salvinia molesta* .... *Cyrtobagous*
– Dorsal surface densely covered with scales; all antennal club segments equally pubescent, not glabrous; tarsal segments 2 and 3 dilated, each much broader than segment 1; segment 5 not elongate (Fig. 22.2E)........................ 5

5. Body shorter than 2.6 mm; first funicle segment of antenna globular, much larger than second (Fig. 22.2F); ocular lobes on prothorax feeble at most; associated with *Pistia stratiotes* ....*Neohydronomus*
– Body longer than 3 mm; first funicle segment of antenna club-shaped, second segment longer than first (Fig. 22.2G); ocular lobes on prothorax moderately to strongly developed 6

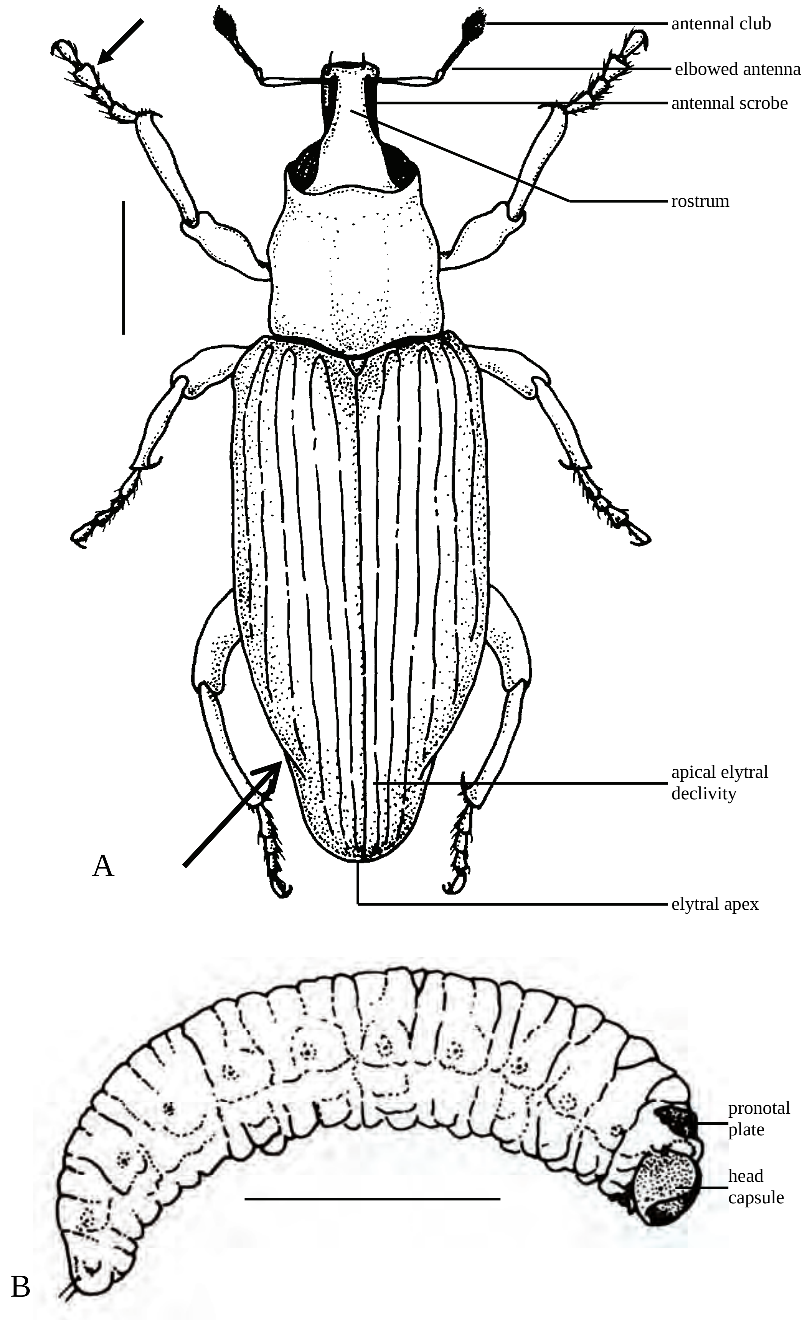

Fig. 22.1. Curculionidae, Bagoini. **A,** *Pseudobagous longulus*, adult, dorsal view. **B,** *Bagous* sp., larva, lateral view. (A: original, Elsa van Niekerk; B redrawn from Cuppen & Heijerman 1995). Scale bars: A = 1mm; B = 2 mm.

6. Body bulky; funicle of antenna six-segmented; ocular lobes on prothorax notably large (Fig. 22.2H); scales on body appearing 'varnished'; each elytron in mid-length with a short, scaleless, smooth, shiny ridge on the first interval; body length *ca*. 3.2–4.5 mm; associated with *Eichhornia crassipes* ....*Neochetina*

– Body slender; funicle of antenna seven-segmented; ocular lobes on prothorax only moderately developed; scales on body not appearing 'varnished'; elytra without short, shiny ridges in mid-length; body length c. 3.3–3.9 mm; associated with *Myriophyllum aquaticum* ....*Listronotus*

BIOCONTROL AGENTS

Details of the introduced water weevil species, their countries of origin, and their status in terms of water weed biocontrol are summarised below.

Tribe Rhythirrinini

Listronotus marginicollis

Countries of origin: Brazil, Argentina.

Presently being evaluated for release against *Myriophyllum aquaticum* (parrot's feather, Haloragidaceae).

Tribe Stenopelmini

Cyrtobagous singularis

Country of origin: Trinidad.

Introduced into Namibia, Botswana and Zambia to control *Salvinia molesta* (water fern, Salviniaceae); populations did establish in the 1970s, but the effect on the weed was negligible; current status of populations unknown.

Cyrtobagous salviniae

Country of origin: Brazil.

Widely introduced to control *Salvinia molesta* (water fern, Salviniaceae); control of weed successfully accomplished.

Neochetina eichhorniae and *Neochetina bruchi*

Countries of origin: Argentina, Brazil.

Introduced to control *Eichhornia crassipes* (water hyacinth, Pontederiaceae); good control of weed accomplished in association with or without other biocontrol agents

Neohydronomus affinis

Country of origin: Argentina.

Introduced to control *Pistia stratiotes* (water lettuce, Araceae); control of weed successfully accomplished.

Stenopelmus rufinasus

Country of origin: Florida, USA.

Introduced to control *Azolla filiculoides* (red water fern, Azollaceae); control of weed successfully accomplished.

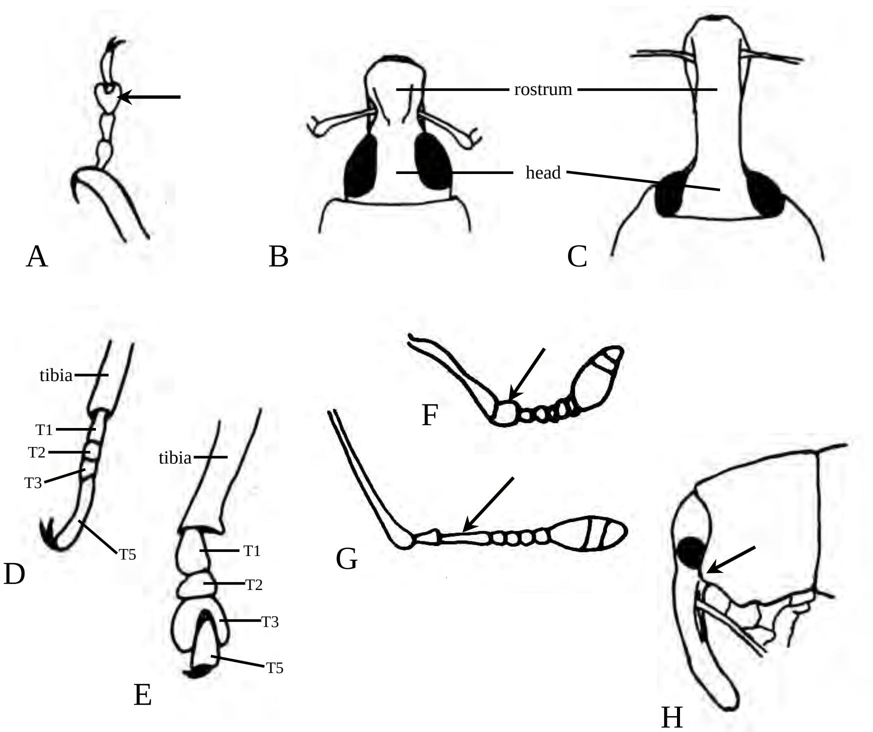

Fig. 22.2. Curculionidae, key figures. **A,** *Pseudobagous*, fore tarsus; **B,** *Stenopelmus*, head and rostrum; **C,** *Neochetina*, head and rostrum; **D,** *Cyrtobagous*, hind tarsus; **E,** *Neochetina*, hind tarsus; **F,** *Neohydronomus*, antenna; **G,** *Neochetina*, antenna; **H,** *Neochetina*, head and pronotum in lateral view. All much enlarged, not to the same scale.

CHECKLIST OF THE KNOWN AND DESCRIBED SOUTHERN AFRICAN (SEMI-)AQUATIC SPECIES OF CURCULIONIDAE (INCLUDING INTRODUCED SPECIES)

The reader is referred to the Appendix (p. 229) for a checklist of (semi-aquatic) Curculionidae taxa in southern Africa, including species that have been introduced into the region. The list of *Bagous* species in the Appendix is very preliminary, since the Afrotropical complement of the genus has at yet not been revised, and revisions of the *Bagous* of other biogeographical regions have indicated the existence of many cryptic species. For the same reason, only the type locality is given for the *Bagous* species and an assessment of endemism can also not be made at this stage.

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[key to all continental Afrotropical *Bagous* species known at the time on p. 940]

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[key to larvae of some biocontrol Erirhininae on p. 304]

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CHAPTER 23

COLLECTING WATER BEETLES: AN INTRODUCTION

by

C.R. Turner

In the study of aquatic Coleoptera, where diverse techniques are essential components of any inventory process, projects may succeed or fail depending on the quality of the surveyor. Effective fieldwork may take some years to develop and is frequently a process of continual personal development. Increasingly, the field surveyor is obliged to locate the maximum diversity of species in the minimum amount of time, to preserve the data for future generations of scientists and to collect data to assist in studies of distribution and ecology. It is therefore essential to take the utmost care in collection, preservation and long-term curation of material and data. This chapter concentrates on the first of these, providing a brief outline of fundamental and adaptable methods to ensure maximisation of species encounters.

Methods used for the collection, preservation and study of water beetles are, generally, similar to those used for other aquatic macroinvertebrates. For this reason, the reader is advised to consult additional references like McCafferty (1983), Uys & Urban (2006), and Volume 1 of the present series of *Guides* (Day, in prep.). The author of this chapter will publish elsewhere a more detailed account of the study of water beetles.

Even though the main focus of studies of aquatic beetles relate primarily to the aquatic environment, it is impossible to avoid consideration of the terrestrial/aerial stages of their life cycles. Researchers are frequently concerned with matching particular (aquatic) immatures with adults (aquatic or terrestrial) of the same species. For this reason, many sampling methods focus on trapping adults as they emerge from the water, or trapping adults flying close to freshwater habitats. Thus, in addition to sampling in a variety of aquatic habitats, aquatic coleopterists are also necessarily involved in the capture and study of beetles from terrestrial environments.

Standard collecting equipment and more specialised field gear are described in the publications mentioned above and are not treated here.

Specialised sampling for water beetles

— The methods employed to collect water beetles are almost as diverse as the water beetle taxa and the habitats they occupy —

Collecting methods are largely dictated by particular features of the principal freshwater habitats, as well as the life history and behaviour of the taxa targeted. This section focuses on collecting methods aimed at specialist niches, for particular taxa. Nevertheless, it is impossible to exclude entirely some notes on generalised sampling methods, creating some overlap between this account and the generalised account of sampling methods outlined in Volume 1 of this series of *Guides* (Day, in prep.).

Methods to find niche specialists do not always proffer success, but must be attempted regularly. There is no substitute for being in the right place, at the right time, with the right methods and field craft. Location and timing are not always easy to control, but methods may be learnt, devised and improved with experience.

A SAMPLING PROTOCOL FOR AQUATIC HABITATS

Table 23.1 provides a sampling protocol (which can be considered a 'bioinventory method') for generalised aquatic habitats, recommending choices of technique per habitat type.

This flexible sampling regime should be recorded in the field and indicated on labels inside collection vials. Pre-printed data labels should be made for this purpose: all the symbols from Table 23.1 can be printed onto data labels. The applicable symbols are circled, to indicate the techniques that are employed to produce the sample. Standard collection information, such as locality and date, is written on the blank side of the label. Such labels are then placed, together with the specimens collected and a suitable preservative, inside the vials in which samples are stored in the field.

COLLECTING METHODS IN RELATION TO PARTICULAR HABITATS AND BEETLE TAXA

Netting

The collecting net is the primary tool of a water beetle researcher. The hints and comments below may well be taken to heart, even if the efficient use of a net in a variety of habitats is a complex art.

The use of a net must be energetic, but vary in intensity among habitats. Nettings consist of a number, say five to twenty, or more, sweeps with the net, depending on the habitat. The key to efficient netting is maximising the amount of water passing through the net before the net becomes filled with debris, or the area to be sampled has been covered. Keep the net as upright as possible to ensure the full mouth area is utilised. Allow water to drain completely from the net bag before sorting the catch. Your submerged feet are invaluable for moving objects, agitating the substrate or vegetation. Always sweep the net right past your feet to capitalise on this disturbance.

Various approaches are used in different habitats. The reader can consult general texts (see above) for information on techniques for 'netting' in emergent marginal vegetation, submerged vegetation, and substrate sampling in fully aquatic habitats (stones-in-current, gravel, sand, and bedrock sampling).

Sorting the net contents

The net is everted and the bolus inside placed on the sorting surface. The inside of the net must then be quickly examined. The bolus is not immediately broken up, but observed for some minutes. Once the initial exodus has ceased, the bolus can be gently broken up and examined in sections. The sorting surface may be flooded to encourage the slower-moving species to emerge.

The 'gyrinid skim' with a net

Whirligigs swimming individually or in groups on the water surface need to be stalked. Use a slow and deliberate approach. Avoid covering them with your shadow or making your silhouette obvious against the sky. Once within reach, the net is rapidly pulled through the water surface. As soon as you have retracted the net, make a few return-sweeps to catch any stragglers. Surprise and speed are of the essence.

Hand-searching in marginal habitats

* Exposed areas at the waterside: semi-aquatic beetle species or shore beetles may be found throughout this marginal zone, even where vegetation is dense. Kneel down, put your face close to the ground, and wait for the beetles to move. Specimens may be collected by pooter or gently picked up.
* Hygropetric habitats: specialist beetle fauna is often found in the thin water film that flows over rocks and other surfaces. Observe the surface, with your nose at times almost in contact with the algal film. Wipe your hand over the algal film, against the current, and observe.

Stamping-and-splashing (= shore-washing)

The interface between land and water often harbours a number of species. Flood water over a small area of the shore, then collect the floating debris and beetles, using a net or sieve, and observe the flooded substrate.

Table 23.1: Water beetle sampling protocol for generalised freshwater habitats

	Stillwaters	Very small stillwaters (pools/puddles)	Flowing water – pools	Flowing water – riffles	Wells & water pumps	Eulittoral zone
Open water	■ ⍓ ⇊	👁 ● ⚲ ✹	■ ⍓ ⇊	■ ⍓ ⇊		
Unvegetated margins	■ ● ⍓ ⚲ ⇊	● ⚲ ⍓ 👁 ✹	■ ● ⍓ ⚲ ⇊	■ ● ⍓ ⚲ ⇊		
Emergent vegetation	■ ● ⚲ ⍓ 👁 ⇊	● ⚲ ⍓ 👁 ✹	■ ● ⚲ ⍓ 👁 ⇊	■ ● ⚲ ⍓ 👁 ⇊		
Aquatic vegetation	■ ● ⇊ ⍓ 👁	👁 ● ⚲ ⍓ ✹	■ ● ⇊ ⍓ 👁	■ ● ⇊ ⍓ 👁		
Marginal vegetation	■ ● ⍓ 👁 ⇊	👁 ● ⚲ ⍓ ✹	■ ● ⇊ ⍓ 👁	■ ● ⇊ ⍓ 👁		
Substrate	■ ● ⇊	👁 ● ⚲ ✹	■ ● ⇊	■ ● ⚲ ⇊		
Underwater features	■ ↺R ↺W	■ ⚲ ↺R ● S ↺W ✹	■ ↺R ↺W	■ ↺R ↺W		
Unvegetated shore	👁 ✋ ≋ ⧈ ⍓ ϟ	👁 ✋ ≋ ⧈ ⍓ ϟ	👁 ✋ ≋ ⧈ ⍓ ϟ	👁 ✋ ≋ ⧈ ⍓ ϟ		👁 ✋ ℧ ϟ
Vegetated shore	👁 ✋ ≋ ⧈ ⍓ ϟ	👁 ✋ ≋ ⧈ ⍓ ϟ	👁 ✋ ≋ ⧈ ⍓ ϟ	👁 ✋ ≋ ⧈ ⍓ ϟ		👁 ✋ ℧ ϟ
Alluvial deposits			℧ ϟ ⍓ 👁 ✋ ≋	℧ ϟ ⍓ 👁 ✋ ≋		
Gyrinids visible	➣	➣	➣	➣		
Flood debris	✋ 👁 ❖ ϟ	✋ 👁 ❖ ϟ	✋ 👁 ❖ ϟ	✋ 👁 ❖ ϟ		
Hygropetric zone	👁 S G ✋ ϟ	👁 S G ✋ ϟ	👁 S G ✋ ϟ	👁 S G ✋ ϟ	👁 S G ✋ ϟ	
Flow meets water body	treat area separately as flowing water	treat area separately as flowing water				
Outflow pipe or channel	P	P	P	P	P	
Generalised habitat divisions include	salt pans, ephemeral & seasonal stillwaters, water troughs, springs, wet depressions, tree root hollows, marshes & bogs, hygropetric habitats, ephemeral puddles, caves & caverns	ephemeral puddles, hygropetric habitats, tree root hollows, wet depressions, springs, coastal pools, phytotelmata, caves & caverns	upland streams, springs, lowland rivers & streams, ditches & canals, marshes & bogs, hygropetric habitats, saline river sections, waterfalls, caves & caverns	upland streams, springs, lowland streams & rivers, ditches & canals, marshes & bogs, hygropetric habitats, saline river sections, waterfalls, caves & caverns	abstraction facilities, bore holes	salt marshes, rocky shores

Then gently tread over the entire surface area, flood it with more water, retread the area, and net-collect or sieve the floating debris and beetles.

Stamping-and-netting

Areas in which the water surface is below the emergent vegetation or the substrate may be stamped until water is driven to the surface. The resultant pools can then be netted or sieved.

Digging

In areas of gravel, shingle, sand and other coarse sediment, bank-digging may be necessary to produce some of the more cryptic species. Dig a hole in the loose substrate at the water's edge until the water table is reached. The available water is then vigorously agitated to flush insects from the surroundings. Adjacent substrate may then be pushed into the hole.

Rock-turning

Rocks are lifted from the water and carefully examined on all sides, paying particular attention to parts not exposed to direct light and not firmly lodged in the substrate. When first sampling a site, select a range of rock sizes, from both fast- and slower-flowing sections, and rocks with or

Table 23.1 legend.

	stamping-and-splashing & sieve/net/strain	❖	dry-sieving	↺R	rock-turning
	hand-searching		rock-pooling	↺W	wood-turning
	visual searching	●	sieving		grubbing
	stamping-and-netting & sieve/strain		straining		the gyrinid skim
	suction-sampling (where conditions allow)		trapping (where conditions allow)		digging (coarse and fine sediments)
■	netting				

P:	place net bag over outlet flow and examine the contents at regular intervals
S:	search fissures and algal masses for concealed individuals
G:	splash and sieve where pools gather below rock face
Note:	All recommended sampling strategies should be considered, but not all necessarily carried out.

without algal or plant growth. Try to return the rocks to their original positions.

Wood-turning
Submerged wood should be pulled from the water and allowed to dry for a few minutes: careful observation of the surface and cracks in the wood may reveal individual beetles.

Dry-sieving
Place riverside debris into a large garden sieve with a mesh size of approximately 1 cm. Agitate it over a sheet or tray. Spend some time looking carefully among the resultant small pieces of debris.

Sieving-and-straining
A kitchen sieve or a tea strainer is an effective substitute for a net when small habitats are encountered or microhabitat resolution is required.

Breaking up moss
This method can occasionally be very productive. Moss must be broken up and either washed, agitated, or compressed to release the beetles, usually into a sieve or strainer.

Grubbing
Dig with your hands into low vegetation or moss where a water body has recently disappeared, or along the shoreline.

Rock-pooling
Where rain water, sea spray, or condensed mist gathers in depressions on rocks, observe the pools carefully: adult or larval beetles may be seen moving with impunity. You can also try agitating the water with your hand and looking for floating beetles.

Salt-marshing
In salt marshes receding tides may expose muddy pools on the vegetated flats. It should be possible to locate hydraenids living on the mud surface in this habitat.

Trapping
This includes floating traps and other trapping methods (such as emergence traps, light traps and Malaise traps) described elsewhere.

Habitats

In southern Africa the form, transition and variation of water beetle habitats are as diverse as the landscape. Where multiple habitats occur within a site, segregation of the samples from each habitat is desirable as an invaluable source of ecological data. The following is the maxim for the recognition of water beetle habitat:

— *Where there is water there may be water beetles,*
and each habitat deserves at least a cursory investigation —

It is easy to focus only on preconceived or stereotypical habitats. Therefore, every field worker must constantly keep an open mind despite the natural inclination to mentally categorise 'good' and 'bad' habitats.

There is no substitute for local knowledge, but, given that entomologists travel extensively, other approaches must be employed to grasp the type and quality of local habitats. Maps, containing information on topography and vegetation, assist in habitat location. Microhabitats are reflected by vegetation types, substrate, water flow, sunlight/shade, disturbance, water quality or chemical composition, water depth, open/enclosed water, and water temperature. Many of these factors may vary within a small area.

Springs

Springs occur where the ground water reaches the surface: they may be permanent, seasonal or ephemeral. Springs in isolated mountain ranges are often of particular interest, as are those with unusual thermal regimes.

Upland streams

Some high-altitude members of *Canthyporus, Nebrioporus* and *Hydropeplus* (Dytiscidae: Hydroporinae) often occur along with interesting Dryopidae such as *Rapnus*. Rock-turning in riffles may produce elmid species such as *Leielmis georyssoides* and *Ctenelmis incerta* or some of the diverse Hydraenidae — like the rare *Prosthetops megacephalus* — all of which are only occasionally caught by netting. Investigations of the margins may reveal species of the genus *Africophilus* (Dytiscidae: Laccophilinae), whose inclination to jump like a flea can result in some interesting collection experiences. Overhangs are worth investigating, as the shaded water surface may conceal whirligigs (Gyrinidae) like the ubiquitous *Dineutus grossus* or rare *Aulonogyrus sharpi*.

Waterfalls

The elevated levels of dissolved oxygen, high flow rates and enlarged splash zones often encourage specialist species. Waterfalls may be approached as a combination of hygropetric, marginal and stream habitats.

Lowland streams and rivers

Larger riffles, pools and deposits may be explored in these habitats. Flood debris and dead waterside vegetation may be sieved and sifted to produce Georissidae and Limnichidae. Reed beds may reveal interesting members of the Haliplidae and Gyrinidae and open water margins are often occupied by *Herophydrus* and *Hyphydrus* species (Dytiscidae: Hydroporinae) and *Agabus ruwenzoricus* (Dytiscidae: Agabinae). The shores may be home to several species of *Enochrus* (Hydrophilinae), Limnichidae, Heteroceridae and Carabidae.

Saline environments

First to disappear with increasing salinity are the Dytiscidae, leaving the more tolerant genera like *Hyphydrus*, *Herophydrus*, *Hydrovatus* (Hydroporinae), a few specialist species like the rare *Coelhydrus brevicollis* (Hydroporinae) and a number of hydrophiloid species, especially *Berosus* species (Hydrophilinae: Berosini), several of which specialise in hypersaline environments.

Ephemeral or seasonal streams and rivers

The optimal time to visit these habitats, that are often adjacent to mountainous areas, is when the waters are receding. There is a chance of finding more unusual species, belonging to *Canthyporus* (Dytiscidae: Hydroporinae), Hydraenidae, Elmidae and Dryopidae, in such habitats. Slower-flowing temporary lowland waterways often attract dytiscids of various subfamilies: *Hyphydrus* species, *Herophydrus* species and *Nebrioporus capensis* (Hydroporinae); *Rhantus capensis* (Colymbetinae), and *Copelatus capensis* (Copelatinae). Hydrophilids such as *Berosus* and *Enochrus* species (Hydrophilinae) may also be collected in such habitats.

Ditches and canals

Man-made habitats retain water later into the dry season than is the case in natural waters. When seasonal waters recede many species move to any available water source, including artificial habitats. These habitats often possess a high ratio of margin versus surface area and may be successfully exploited by entomologists.

Still waters

A number of robust dytiscid beetles may be found in still waters, which are usually characterised by a high amount of marginal, emergent and submerged vegetation: *Cybister, Hydaticus* (Dytiscidae: Dytiscinae) and *Rhantus,* including the Cape endemic *Rhantus cicurius* (Dytiscidae: Colymbetinae). Margins with rich organic debris may harbour a variety of Hydrophilinae, such as large *Hydrophilus, Hydrochara* and *Sternolophus* species, as well as other genera such as *Amphiops, Allocotocerus, Enochrus, Crenitis,* *Helochares* and *Paracymus.* Where aquatic vegetation exhibits 'shot-holes' or other feeding damage, the plants should be examined for Chrysomelidae and Curculionidae.

Salt pans

These support several specialist species and should not be disregarded, although generally the fauna is poor unless the salinity is low. Beetles to expect when salinities are higher are hydrophilids such as *Berosus* and *Enochrus* species (Hydrophilinae), together with *Ochthebius* (Hydraenidae: Ochthebiinae), but only few, if any, Dytiscidae.

Ephemeral and seasonal still waters

Like other temporary systems, these ponds are at their best when the water is receding. Specialist Cape endemic Hydroporinae (Dytiscidae) species like *Primospes suturalis*, *Tyndallhydrus caraboides* and *Sharphydrus coriaceus* are found in these habitats, together with more widespread taxa like *Herophydrus* and *Hyphydrus* (Hydroporinae), *Eretes sticticus* (Dytiscidae: Dytiscinae), and hydrophilids such as *Sternolophus* and *Berosus*, to name a few examples.

Ephemeral puddles

It is surprising how productive a roadside puddle or scrape is in areas of fast-draining soils. They often teem with life and support specialist water beetle communities. Specific to these habitats are *Rhantaticus congestus* (Dytiscinae) and the riparian genus *Rhyssemus* (Scarabaeidae: Aphodiinae: Psammobiini).

Wet depressions

These are difficult to observe and may be located by changes in ground level and vegetation. They vary from thick vegetation masking deep water, to just a few wet patches on the surface.

Livestock water troughs

In arid areas, especially where surface water is scarce, water beetles and other aquatic life may be found associated with any water source. In fact, the rare *Canthyporus alvei* (Dytiscidae: Hydroporinae) has, as yet, only been found in water troughs.

Tree root hollows

The water-filled hollows created by the raising of the roots when a tree falls may harbour specialist species, particularly in indigenous forests.

Marshes and bogs

Marshes and bogs can be examined in the same way as you would for a combination of wet depressions and still waters.

Hygropetric habitats

On rock outcrops, scarps, road cuttings, and stream and river sides, water may run in a thin film over the rock surface, frequently with algal growth that is sometimes prolific. These habitats possess a variable fauna, some uninhabited, but others highly diverse, including the following taxa: members of the Torridincolidae such as the minute *Delevea* and *Torridincola* species, various Hydraenidae, including *Coelometopon* and *Mesoceration* species, some dytiscids such as *Canthyporus* (Hydroporinae) or *Africophilus* (Laccophilinae), and the recently-discovered *Aspidytes* (Aspidytidae).

Flood debris

This may be sieved and sifted for semi-aquatic species, particularly Georissidae and Limnichidae. Resultant isolated pools often contain rich aggregations.

Epilittoral zone

The epilittoral zone may comprise a variety of habitats with increasing salinity, reflecting their proximity to the sea. Halophilous genera can be expected in such habitats.

Salt marshes

Supralittoral and eulittoral species can be found on the coast at the base of plants at low tide, around the high tide mark, and on the patches of wet mud exposed by the retreating sea.

Coastal pools

Supralittoral pools at the top of a rocky shore should be investigated where replenished by rain water and sea spray. These hypersaline habitats contain *Ochthebius capicola* and *Ochthebius rubripes* (Hydraenidae: Ochthebiinae), as well as occasional specimens of *Canthyporus* (Dytiscidae: Hydroporinae) and *Enochrus* (Hydrophilinae) species.

Eulittoral zone

The only water beetle known from this habitat in sub-Saharan Africa is the limnichid *Hyphalus* from the Seychelles. Staphylinidae and some Carabidae usually occupy this niche.

Wells and water pumps

Place a net below the outlet and allow pumped water to flow through. In other parts of the world beetles occupy the rock fissures. In Africa this habitat is unexplored.

Caves and caverns

Hygropetric habitats occur on the walls of caves; underground waterways are all poorly studied.

Phytotelmata

Tree- and plant-associated hollows where water gathers, including tree holes, internodal hollows and water-retaining plant axils, should be examined for beetles.

Field work

— The best remedy for a lack of fieldwork experience is to engage in fieldwork! —

Certain common-sense field techniques can result in an enormous improvement in efficiency.

* Arrive at a site and take time to look around and explore. This facilitates site prioritisation.
* Rank locations in order of interest and convenience. Take into account the habitats you wish to investigate and the purpose of the visit, and reconcile these versus habitat mosaic and time. There is nothing worse than working hard to get the best out of the first area encountered, only to realise later that there are much better collecting sites 'just around the corner'.
* Mentally segregate the subdivisions of the habitats and ensure that they are all sampled.
* Move on to new sites when the number of new species encountered ceases, but quit in time if time is short. This is a matter of individual judgement, given prevailing priorities.
* Many diverse sites take extensive periods to assess adequately. There is no substitute for the luxury of long-term site surveys.

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APPENDIX

CHECKLISTS OF THE KNOWN SOUTHERN AFRICAN TAXA OF AQUATIC COLEOPTERA

by

R. Stals

Checklists are presented of the known southern African taxa for most of the water beetle families treated in this *Guide* are presented below. The geographical area covered in this *Guide* differs from what is traditionally considered ‘southern Africa’ by zoologists, as is explained in the section 'Geographical Region covered by this Guide' (see page ix). In the checklists, the localities opposite the taxon names are those territories for which collecting records for the particular taxon presently exist. These are very broad-based, and are only indications of extents of occurrence, not implying that any species occurs throughout a specific territory. The resolution of these distribution records is at the level of province (South Africa) or country (rest of the region). In a minority of cases, where other information is lacking, a river system or regional name is given. Particulars of localities can be found in the taxonomic literature, which is the main source of these checklists.

The checklists are mostly arranged alphabetically (i.e. not in phylogenetic sequence), which non-specialist users will probably find easier to use. Because of the constraint of space, no synonymies or previous combinations have been included. Nomenclatural details and possible updates can be found on the website *The Aquatic Arthropods (Insects, Crustaceans and Mites) of South (ern) Africa* (http://www.ru.ac.za/aquatalogue).

Species and genera endemic to southern Africa (as here defined) are indicated as such in most of the checklists. It must be noted that evaluations of endemism were made based on current knowledge, and that the 'status' of endemism may fall away when and if a taxon is discovered outside the geographical region considered. This is particularly applicable to those endemic taxa with distributions close to the northern margin of southern Africa. Some taxa (e.g. most species of the Hydraenidae, or the Cape-endemic taxa of the dytiscid tribe Hyphydrini) are, in all likelihood, genuinely restricted to small or very small areas. A few water beetle species, yet again, are known to be exceptionally widespread, for example the dytiscid *Eretes sticticus*. Only for an unassuming number of species can we be modestly confident about the extent of occurrence. Much specialised collecting is still required before the ranges of our water beetles can be delimited with any confidence.

Lastly, it has to be noted that in probably each of the water beetle families of southern Africa undescribed taxa are awaiting study in natural history collections, and a large number of species have not yet been collected and await discovery.

The reader is advised to consult the 'Glossary of Place Names' (page 247) as well as the regional map (page ix) for further details on some localities mentioned in the checklists. The introductory chapter, particularly Table 1.1 (page 8), should be consulted for further details on the higher classification of Coleoptera.

Abbreviations

Provinces and regions within South Africa

EC	Eastern Cape Province
FS	Free State
GAU	Gauteng
KZN	KwaZulu-Natal
LIM	Limpopo Province
MPL	Mpumalanga
NC	Northern Cape Province
NW	North-West Province
WC	Western Cape Province
RSA	Republic of South Africa (used when a record could not be traced to a specific locality)
'Cape'	Province of the Cape of Good Hope (pre-1994 name used where it was impossible to pinpoint a locality to one of the three modern "Cape Provinces")
SW Cape	South-western Cape
'TVL'	Transvaal (pre-1994 name used where it was impossible to place a locality in any of the five current provinces into which the Transvaal was relimited)

Other countries and regions in southern Africa and beyond

ANG	Angola
BOTS	Botswana
DRC	Democratic Republic of the Congo
LES	Lesotho
MAD	Madagascar
MWI	Malaŵi

MOZ	Mozambique
NAM	Namibia
SWZ	Swaziland
ZAM	Zambia
ZIM	Zimbabwe
W Africa	West Africa
C Africa	Central Africa
E Africa	East Africa

Symbols used in checklists

‡‡	Genus endemic to southern Africa
‡	Species endemic or probably endemic to southern Africa
?‡	Species possibly endemic to southern Africa
§	Introduced species

SUBORDER MYXOPHAGA

Family TORRIDINCOLIDAE

‡‡ *Delevea bertrandi* Reichardt, 1976: SW Cape
‡‡ *Delevea namibensis* Endrödy-Younga, 1997: NC, NAM

‡ *Torridincola natalesica* Steffan, 1973: KZN
‡ *Torridincola rhodesica* Steffan, 1964: MPL, ZIM

Family HYDROSCAPHIDAE

Because the known southern African Hydroscaphidae species has not been identified yet, no checklist is included here. It is most probably an undescribed species.

Family SPHAERIUSIDAE

Microsporus africanus Endrödy-Younga, 1997: KZN, MPL, LIM, MOZ

SUBORDER ADEPHAGA

SECTION HYDRADEPHAGA

Family GYRINIDAE

Subfamily GYRININAE

Tribe ENHYDRINI

Dineutus (*Protodineutus*) *aereus* (Klug, 1834): EC, NC, KZN, NW, GAU, MPL, LIM, SWZ, NAM, BOTS, ZIM, MOZ, MWI, to W, C & E Africa
(eurytopic, but not in fast-flowing water; also in alkaline pans and temporary pools)

Dineutus (*Protodineutus*) *grossus* (Modeer, 1776): WC, EC, KZN, NW, GAU, MPL, LIM, SWZ, ANG, ZIM, MOZ, MWI, to W, C & E Africa
(mostly in still or slow-moving water bodies)

Dineutus (*Protodineutus*) *micans* (Fabricius, 1792): ZIM, to W, C & E Africa
(in quiet waters or mountain streams)

‡ *Dineutus* (*Protodineutus*) *punctatus* Aubé, 1838: WC, EC, NC, KZN, FS, NW, GAU, MPL, ZIM (in still or slow-moving water bodies, including temporary pools)

Dineutus (*Spinosodineutes*) *fauveli* Régimbart, 1884: NAM, to W & C Africa
(? in still or slow-flowing water bodies)

Dineutus (*Spinosodineutes*) *sharpi* Régimbart, 1883: 'Zambezi', to W & C Africa
Dineutus (*Spinosodineutes*) *subspinosus* (Klug, 1834): MPL, LIM, NAM, BOTS, ZIM, MOZ, ZAM, to W, C & E Africa
(in still or slow-flowing water bodies, including temporary pools)

Subfamily **GYRININAE**

Tribe GYRININI

‡ *Aulonogyrus* (*Afrogyrus*) *abdominalis* (Aubé, 1838): WC, EC, KZN, NW, GAU, MPL, LIM, NAM, BOTS, ZIM, MOZ
(eurytopic)
‡ *Aulonogyrus* (*Afrogyrus*) *acutus* Brinck, 1955: ANG
(in a fast-flowing river)
Aulonogyrus (*Afrogyrus*) *algoensis* Régimbart, 1883: EC, KZN, MPL, NAM, ZIM, MOZ, MWI, to W, C & E Africa
(widespread, eurytopic)
‡ *Aulonogyrus* (*Afrogyrus*) *alternatus* Régimbart, 1892: WC, EC, NC, KZN, FS, NW, GAU, LES, BOTS, ZIM
(in fast-flowing mountain streams ('Cape') and loamy streams & rivers (further north); also in temporary water bodies)
Aulonogyrus (*Afrogyrus*) *amoenulus* (Boheman, 1848): KZN, MPL, LIM, MOZ, to C Africa
(in slow-flowing, loamy rivers)
‡ *Aulonogyrus* (*Afrogyrus*) *aureus* Brinck, 1955: WC
(in gushing mountain streams)
‡ *Aulonogyrus* (*Afrogyrus*) *bachmanni* Ochs, 1937: EC
Aulonogyrus (*Afrogyrus*) *caffer* (Aubé, 1838): EC, KZN, NW, MPL, LIM, SWZ, ZIM, MOZ, MWI
(predominantly in mountainous areas)
‡ *Aulonogyrus* (*Afrogyrus*) *capensis* (Thunberg, 1781): WC, EC, ?NC
(largely in mountain streams & rivers)
?‡ *Aulonogyrus* (*Afrogyrus*) *depressus* Brinck, 1955: probably EC
Aulonogyrus (*Afrogyrus*) *flavipes* (Boheman, 1848): EC, KZN, NW, GAU, MPL, LIM, SWZ, ANG, NAM, BOTS, ZIM, MOZ, MWI, to C & E Africa
(widespread, eurytopic)
‡ *Aulonogyrus* (*Afrogyrus*) *formosus* (Modeer, 1776): WC, EC, ?NW
(in fast-flowing mountain streams)
‡ *Aulonogyrus* (*Afrogyrus*) *inyanganensis* Mazzoldi, 1996: ZIM
‡ *Aulonogyrus* (*Afrogyrus*) *knysnanus* Brinck, 1955: WC
(in fast-flowing forest streams)
‡ *Aulonogyrus* (*Afrogyrus*) *latens* Brinck, 1955: MPL
(? in mountain streams)
‡ *Aulonogyrus* (*Afrogyrus*) *marginatus* (Aubé, 1838): all nine RSA provinces, LES, BOTS
(extremely eurytopic, including temporary pools)
‡ *Aulonogyrus* (*Afrogyrus*) *naviculus* Brinck, 1955: WC, EC
(in fast-flowing mountain & forest streams)
‡ *Aulonogyrus* (*Afrogyrus*) *rhodesianus* Brinck, 1955: ZIM
‡ *Aulonogyrus* (*Afrogyrus*) *sesotho* Brinck, 1955: EC, LES
(in small, fast-flowing mountain streams)
‡ *Aulonogyrus* (*Afrogyrus*) *sharpi* Régimbart, 1883: EC, LIM
(in mountainous areas; disjunct distribution)
‡ *Aulonogyrus* (*Afrogyrus*) *splendidulus* (Aubé, 1838): WC, EC
(in more or less fast-flowing streams & rivers in and below mountainous areas)
‡ *Aulonogyrus* (*Afrogyrus*) *varians* Brinck, 1955: WC, EC
(in fast-flowing mountain streams)
Gyrinus (s.str.) *haasi* Ochs, 1933: ANG, ?NAM, ZAM, to C Africa

Gyrinus (s.str.) *natalensis* Régimbart, 1892: KZN, NW, GAU, BOTS, ZIM, MOZ, ZAM, to W, C & E Africa

‡ *Gyrinus* (s.str.) *vicinus* Aubé, 1838: WC, EC
(lowlands: in still waters, fresh or slightly brackish)

Subfamily **GYRININAE**

Tribe ORECTOCHILINI

Orectogyrus (*Allogyrus*) *alluaudi* Régimbart, 1889: ZIM, ZAM, to W, C & E Africa

‡ *Orectogyrus* (*Amaurogyrus*) *lunai* Brinck, 1958: ANG

‡ *Orectogyrus* (*Capogyrus*) *dorsiger* Régimbart, 1884: EC, KZN

‡ *Orectogyrus* (*Chipogyrus*) *rustibus* Brinck, 1956: MWI

‡ *Orectogyrus* (*Lobogyrus*) *eversor* Brinck, 1956: KZN, ZIM
(outer reaches of large, slow-flowing rivers)

Orectogyrus (*Lobogyrus*) *polli* Régimbart, 1884: NC, KZN, NW, LIM, ZIM, ZAM, to C Africa
(in slow-flowing, loamy rivers)

‡ Orectogyrus (Monogyrus) *capicola* Brinck, 1955: WC, EC
(in fast-flowing streams)

Orectogyrus (*Monogyrus*) *fusciventris* Régimbart, 1895: MOZ, MWI, to W & E Africa

‡ *Orectogyrus* (*Monogyrus*) *lanceolatus* Régimbart, 1884: EC, KZN

‡ *Orectogyrus* (*Monogyrus*) *mirabilis* Régimbart, 1883: EC, KZN, MPL, LIM, SWZ, ZIM, MOZ
(in fast-flowing mountain streams)

Orectogyrus (s.str.) *bicostatus* (Boheman, 1848): KZN, NW, MPL, LIM, ZIM, MOZ, MWI, to W, C & E Africa
(in slow-flowing parts of mountain streams)

‡ *Orectogyrus* (s.str.) *costatus* (Aubé, 1838): WC, EC, KZN, NW, GAU, MPL, LIM, BOTS, MOZ
(mostly in small mountain streams)

Orectogyrus (s.str.) *cuprifer* Régimbart, 1884: MPL, LIM, ZIM, MOZ, MWI, to E Africa
(in large rivers with loamy water)

Orectogyrus (s.str.) *elongatus* Régimbart, 1886: ANG, NAM, to C Africa
(in large rivers with loamy water)

Orectogyrus (s.str.) *kelleni* Régimbart, 1888: ANG, ZAM, to C & E Africa

Orectogyrus (s.str.) *pallidiventris* Ochs, 1934: ZIM, MOZ, MWI, to E Africa

Orectogyrus (s.str.) *posticalis* Ochs, 1930: ZIM, ZAM, to C & E Africa

‡ *Orectogyrus* (s.str.) *rhodesianus* Ochs, 1933: EC, KZN, ZIM, MOZ

Orectogyrus (s.str.) *schistaceus* (Gerstaecker, 1867): MWI, to E Africa

‡ *Orectogyrus* (s.str.) *vermiculatus* Ochs, 1952: ZIM

Orectogyrus (s.str.) *wittei* Ochs, 1928: ZAM, MWI, to C & E Africa

Orectogyrus (Tricho*gyrus*) *oscari* (Apetz, 1854): KZN, MPL, LIM, ZIM, ZAM, to W, C & E Africa

Orectogyrus (*Trichogyrus*) *sericeus* (Klug, 1834): MOZ, ZAM, to W, C & E Africa

Family **HALIPLIDAE**

‡‡ *Algophilus lathridioides* Zimmermann, 1924: WC

‡ *Haliplus (Liaphlus)* af*ricanus* Aubé, 1838: 'South Africa'

‡ *Haliplus* (*Liaphlus*) *exsecratus* Guignot, 1936: KZN, ZIM

Haliplus (*Liaphlus*) *maculipennis* Schaum, 1864: WC, EC, KZN, GAU, to W, C & E Africa, also Egypt

Haliplus (*Liaphlus*) *mimulus* Guignot, 1956: BOTS, also E Africa

Haliplus (*Liaphlus*) *methneri* Zimmermann, 1926: NAM, ZIM, to W, C & E Africa
Haliplus (*Liaphlus*) *natalensis* Wehncke, 1880: NC, KZN, GAU, MPL, BOTS, ZIM, to W, C & E Africa
‡ *Haliplus* (*Liaphlus*) *rufescens* Régimbart, 1894: WC, NC, KZN
‡ *Haliplus* (*Liaphlus*) *uniformis* Zimmermann, 1920: FS
‡ *Haliplus* (*Liaphlus*) *varicator* Guignot, 1954: MOZ
Haliplus (*Liaphlus*) *venustus* Régimbart, 1894: GAU, NAM, ZIM, MOZ, to W, C & E Africa
Peltodytes (s.str.) *quadratus* Régimbart, 1895: KZN, also MAD

Family **NOTERIDAE**

‡ *Canthydrus* (s.str.) *apicicornis* Régimbart, 1895: KZN, MOZ
Canthydrus (s.str.) *imitator* Guignot, 1942: KZN, also MWI, to W, C & E Africa
Canthydrus (s.str.) *marshalli* Balfour-Browne, 1939: KZN, also C Africa
Canthydrus (s.str.) *natalensis* Balfour-Browne, 1939: KZN, also C Africa
‡ *Canthydrus* (s.str.) *nigerrimus* Omer-Cooper, 1957: KZN, MPL, LIM, SWZ
Canthydrus (s.str.) *notula* (Erichson, 1843): WC, EC, KZN, MPL, SWZ, NAM, BOTS, ZIM, MOZ, ZAM, MWI, to W, C & E Africa and further
Canthydrus (s.str.) *quadrivittatus* (Boheman, 1848): EC, KZN, MPL, LIM, SWZ, NAM, BOTS, ZIM, ZAM, to C Africa
‡ *Canthydrus* (s.str.) *rossanae* Bilardo & Rocchi, 1987: BOTS
Canthydrus (s.str.) *sedilloti* Régimbart, 1895: EC, KZN, SWZ, ZIM, MWI, to W, C & E Africa
Hydrocanthus (Sternocanthus) acrobeles Guignot, 1953: MPL, also C Africa
Hydrocanthus (*Sternocanthus*) *adrasus* Guignot, 1950: BOTS, to W & C Africa
Hydrocanthus (*Sternocanthus*) *colini* Zimmermann, 1926: BOTS, ZIM, MOZ, to W & C Africa
Hydrocanthus (*Sternocanthus*) *constrictus* Régimbart, 1895: EC, KZN, ZIM, to W, C & E Africa, also MAD
Hydrocanthus (*Sternocanthus*) *ferruginicollis* Régimbart, 1895: KZN, BOTS, ZIM, MOZ, to C & E Africa
Hydrocanthus (*Sternocanthus*) *funebris* Fairmaire, 1869: MOZ, also Tanzania, MAD
Hydrocanthus (*Sternocanthus*) *grandis* (Laporte, 1835): BOTS, ZIM, MOZ, to W, C & E Africa
Hydrocanthus (*Sternocanthus*) *impunctatus* Gschwendtner, 1932: ZIM, to W & C Africa
‡ *Hydrocanthus* (*Sternocanthus*) *insolitus* Bilardo & Rocchi, 1987: BOTS
Hydrocanthus (*Sternocanthus*) *klarae* Gschwendtner, 1930: MPL, LIM, ZIM, MOZ, to C Africa
Hydrocanthus (*Sternocanthus*) *micans* Wehncke, 1883: EC, KZN, BOTS, ZIM, MOZ, ZAM, to W, C & E Africa
Hydrocanthus (*Sternocanthus*) *mocquerysi* Régimbart, 1895: BOTS, ZIM, MOZ, to W, C & E Africa
Hydrocanthus (*Sternocanthus*) *parvulus* Gschwendtner, 1930: RSA, LES, ZIM, MWI, to W & C Africa
Neohydrocoptus aethiopicus (Balfour-Browne, 1961): WC, EC, KZN, MPL, LIM, SWZ, BOTS, ZIM, MOZ, to C & E Africa
Neohydrocoptus africanus (Gschwendtner, 1930): BOTS, ZIM, to W & C Africa
Neohydrocoptus angolensis (Peschet, 1925): KZN, BOTS, W, C & E Africa
Neohydrocoptus garambanus (Guignot, 1958): BOTS, to C Africa
Neohydrocoptus koppi (Wehncke, 1883): EC, KZN, MPL, LIM, SWZ, ZIM, MOZ, to W, C & E Africa

‡ *Neohydrocoptus megas* (Omer-Cooper, 1957): ZIM

Synchortus desaegeri Gschwendtner, 1935: BOTS, to C & E Africa
Synchortus imbricatus (Klug, 1853): KZN, MOZ, to W, C & E Africa
Synchortus simplex Sharp, 1882: KZN, MPL, SWZ, BOTS, ZIM, MOZ, ZAM, to W, C & E Africa

Family **DYTISCIDAE**

Subfamily **AGABINAE**

Tribe AGABINI

Agabus (*Acatodes*) *ruwenzoricus* Guignot, 1936: WC, EC, GAU, MPL, ZIM, to C & E Africa

Subfamily **COLYMBETINAE**

Tribe COLYMBETINI

Rhantus capensis (Aubé, 1838): WC, EC, KZN, NW, GAU, MPL, LES, to E Africa
‡ *Rhantus cicurius* (Fabricius, 1787): WC, EC
‡ *Rhantus concolorans* (Wallengren, 1881): WC, EC, KZN, FS, GAU, MPL, LIM, LES, BOTS

Subfamily **COPELATINAE**

Tribe COPELATINI

‡ *Copelatus amatolensis* Omer-Cooper, 1965: EC
‡ *Copelatus caffer* Balfour-Browne, 1939: EC, KZN
‡ *Copelatus capensis* Sharp, 1882: WC, EC, GAU, MPL, LES
Copelatus carinatus Sharp, 1882: MWI, to W & C Africa
Copelatus edax Guignot, 1955: EC, KZN, LIM, SWZ, ZIM, MOZ, to C Africa
‡ *Copelatus ejactus* Omer-Cooper, 1965: LIM
Copelatus erichsoni Guérin-Méneville, 1849: WC, EC, KZN, MPL, LIM, LES, SWZ, ZIM, MOZ, MWI, to W, C & E Africa
Copelatus ferus Guignot, 1953: BOTS, also W Africa
‡ *Copelatus hardenbergi* Balfour-Browne, 1950: MOZ
‡ *Copelatus johannis* Guignot, 1961: EC
Copelatus kalaharii Gschwendtner, 1935: KZN, MPL, NAM, BOTS, ZIM, ZAM, to E Africa
‡ *Copelatus latus* Balfour-Browne, 1950: ZIM
?‡ *Copelatus mulangensis* Bameul, 2003: MWI
Copelatus nangaensis Guignot, 1952: ZIM, to W & C Africa
‡ *Copelatus neavei* Balfour-Browne, 1950: ZIM
‡ *Copelatus notius* Omer-Cooper, 1965: EC
Copelatus owas Régimbart, 1895: LIM, SWZ, to C & E Africa
‡ *Copelatus piriensis* Omer-Cooper, 1965: EC
‡ *Copelatus platynotus* Régimbart, 1895: ‘Cape’, LIM
Copelatus pulchellus (Klug, 1834): EC, KZN, NW, GAU, BOTS, ZIM, to W & E Africa
Copelatus rivalis Guignot, 1952: ZIM, to C Africa
Copelatus striatellus Boheman, 1848: GAU, MPL, LIM, ZIM, to C Africa
Copelatus striatulus Aubé, 1838: EC, ?MPL, ?LIM, to W, C & E Africa
Copelatus sylvaticus Guignot, 1952: EC, KZN, GAU, MPL, LIM, SWZ, ZIM, MOZ, MWI, to W, C & E Africa
Copelatus thrasys Guignot, 1952: ZIM, to W & C Africa
Copelatus tostus Balfour-Browne, 1950: MOZ, ZAM, ?also C Africa

Subfamily **DYTISCINAE**
Tribe ACILIINI

Aethionectes apicalis (Boheman, 1848): 'Caffraria', EC, KZN, to C & E Africa

Rhantaticus congestus (Klug, 1833): KZN, GAU, LIM, NAM, BOTS, ZIM, MOZ, to W, C & E Africa and further

‡‡ *Tikoloshanes eretiformis* Omer-Cooper, 1956: EC, NW, MPL, MOZ

Subfamily **DYTISCINAE**
Tribe CYBISTRINI

Cybister (s.str.) *buqueti* Aubé, 1838: ZIM, MOZ, to W, C & E Africa
Cybister (s.str.) *gschwendtneri* Guignot, 1935: 'TVL', BOTS, ZIM, MOZ, to W & E Africa
Cybister (s.str.) *guignoti* Gschwendtner, 1936: KZN, BOTS, ZIM, ZAM, to C Africa
Cybister (s.str.) *marginicollis* Boheman, 1848: KZN, BOTS, ZIM, MOZ, to W, C & E Africa
Cybister (s.str.) *natalensis* (Wehncke, 1876): KZN, NAM, ZIM, MOZ, ZAM, to C Africa
?‡ *Cybister* (s.str.) *nebulosus* Gschwendtner, 1931: ZIM
Cybister (s.str.) *schoutedeni* Gschwendtner, 1932: ZIM, to C Africa
Cybister (s.str.) *senegalensis* Aubé, 1838: 'Caffraria', MPL, LIM, NAM, BOTS, ZIM, to W, C & E Africa
Cybister (s.str.) *tripunctatus africanus* Laporte, 1835: throughout Afrotropics and further

Cybister (*Melanectes*) *bimaculatus* Aubé, 1838: KZN, ZIM, MOZ, to W, C & E Africa and further
Cybister (*Melanectes*) *distinctus* Régimbart, 1878: MOZ, to W, C & E Africa
Cybister (*Melanectes*) *ertli* Zimmermann, 1917: SWZ, ZIM, MOZ, MWI, to C & E Africa
Cybister (*Melanectes*) *immarginatus* (Fabricius, 1794): 'Caffraria', 'TVL', MOZ, to W, C & E Africa
Cybister (*Melanectes*) *longulus* Gschwendtner, 1932: KZN, to W & C Africa
Cybister (*Melanectes*) *lynceus* Balfour-Browne, 1950: ZIM, MOZ, ZAM, to C Africa
Cybister (*Melanectes*) *mocquerysi* Régimbart, 1895: MOZ, to W & C Africa
Cybister (*Melanectes*) *owas* Laporte, 1835: 'Caffraria', KZN, ZIM, MOZ, to C & E Africa
Cybister (*Melanectes*) *thermolytes* Guignot, 1947: ZIM, to C Africa
Cybister (*Melanectes*) *vicinus* Zimmermann, 1917: MPL, SWZ, BOTS, ZIM, MOZ, to C & E Africa
Cybister (*Melanectes*) *vulneratus* Klug, 1834: KZN, BOTS, ZIM, MOZ, MWI, to W, C & E Africa

Subfamily **DYTISCINAE**
Tribe ERETINI

Eretes griseus (Fabricius, 1781): widespread throughout Afrotropics, to Palaearctic and Oriental Regions
Eretes sticticus (Linnaeus, 1767): widespread throughout Afrotropics, to Middle East and Americas

Subfamily **DYTISCINAE**
Tribe HYDATICINI

Hydaticus (*Guignotites*) *arcuatus* Régimbart, 1895: ZIM, to W & C Africa
Hydaticus (*Guignotites*) *bivittatus* Laporte, 1835: EC, KZN, FS, NW, GAU, LIM, SWZ, ANG, NAM, BOTS, ZIM, MOZ, ZAM, to W, C & E Africa
Hydaticus (*Guignotites*) *caffer* Boheman, 1848: WC, EC, NW, MPL, LIM, LES, SWZ, ZIM, MOZ, to C & E Africa

Hydaticus (*Guignotites*) *capicola* Aubé, 1838: WC, EC, KZN, GAU, to C & E Africa
Hydaticus (*Guignotites*) *dorsiger* Aubé, 1838: 'Caffraria', EC, LIM, SWZ, NAM, BOTS, ZIM, MOZ, to W, C & E Africa
Hydaticus (*Guignotites*) *dregei* Aubé, 1838: WC, EC, LIM, ZIM, MOZ, to W, C & E Africa
Hydaticus (*Guignotites*) *exclamationis* Aubé, 1838: WC, EC, KZN, MPL, LES, NAM, ZIM, MWI, to W, C & E Africa
Hydaticus (*Guignotites*) *flavolineatus* Boheman, 1848: EC, KZN, LIM, SWZ, ZIM, ZAM, MWI, to W, C & E Africa
‡ *Hydaticus* (*Guignotites*) *fulvoguttatus* Guignot, 1951: NAM
Hydaticus (*Guignotites*) *galla* Guérin-Méneville, 1849: WC, EC, KZN, MPL, LIM, SWZ, ZIM, MOZ, MWI, to W, C & E Africa
Hydaticus (*Guignotites*) *guignoti* Gschwendtner, 1938: ZIM, to C Africa
Hydaticus (*Guignotites*) *intermedius* Régimbart, 1895: 'South Africa', to E Africa
Hydaticus (*Guignotites*) *jeanneli* Guignot, 1936: RSA, SWZ, ZIM, to ANG, C & E Africa
Hydaticus (*Guignotites*) *latior* Régimbart, 1895: MOZ, to C Africa
Hydaticus (*Guignotites*) *matruelis* Clark, 1864: WC, EC, KZN, LIM, BOTS, ZIM, MWI, to W, C & E Africa
‡ *Hydaticus* (*Guignotites*) *natalensis* Guignot, 1951: KZN
Hydaticus (*Guignotites*) *servillianus* Aubé, 1838: WC, EC, KZN, GAU, MPL, LIM, LES, SWZ, NAM, BOTS, ZIM, MOZ, ZAM, MWI, to W, C & E Africa

Subfamily **HYDROPORINAE**

Tribe BIDESSINI

Bidessus cacozelus Omer-Cooper, 1931: KZN, to E Africa
Bidessus ceratus Guignot, 1941: ?WC, ZIM, to C & E Africa
Bidessus complicatus Sharp, 1904: NAM, BOTS, to C & E Africa
‡ *Bidessus fraudator* Omer-Cooper, 1958: EC, KZN, LIM, SWZ
Bidessus glabrescens Biström, 1983: NAM, to W & C Africa
‡ *Bidessus imitator* Omer-Cooper, 1953: WC
‡ *Bidessus mundulus* Omer-Cooper, 1965: WC
Bidessus nero Gschwendtner, 1933: NAM, ZAM, to C & E Africa
Bidessus ovoideus Régimbart, 1895: EC, KZN, GAU, MPL, LIM, SWZ, BOTS, MWI, to C & E Africa, also Egypt
‡ *Bidessus perrinae* Biström, 1985: ANG
Bidessus rossi Omer-Cooper, 1974: WC, also C Africa
Bidessus rothschildi Régimbart, 1907: KZN, to C & E Africa
Bidessus seydeli Biström, 1985: NAM, BOTS, to C Africa
Bidessus sharpi Régimbart, 1895: WC, EC, KZN, FS, GAU, NW, MPL, LIM, LES, NAM, BOTS, ZIM, MOZ, ZAM, to W, C & E Africa
Bidessus toumodiensis Guignot, 1939: ZIM, to W, C & E Africa
Bidessus udus Biström, 1985: MPL, LIM, also ANG

Clypeodytes bedeli Régimbart, 1895: ZIM, to W & C Africa
Clypeodytes densepunctatus Biström, 1988: ANG, NAM
Clypeodytes meridionalis Régimbart, 1895: WC, EC, KZN, GAU, MPL, LIM, NAM, BOTS, ZIM, MWI, to W, C & E Africa
Clypeodytes procerus Omer-Cooper, 1959: GAU, ZIM, to C Africa
‡ *Clypeodytes roeri* Biström, 1988: NAM

Hydroglyphus aethiopicus (Régimbart, 1907): MPL, BOTS, to C & E Africa
‡ *Hydroglyphus bilardoi* Biström, 1986: BOTS
Hydroglyphus dakarensis (Régimbart, 1895): NAM, ZIM, ZAM, MWI, to C & W Africa

Hydroglyphus farquharensis (Scott, 1912): WC, EC, KZN, NW, GAU, MPL, LIM, NAM, ?BOTS, ?MOZ, to E Africa
Hydroglyphus flavoguttatus (Régimbart, 1895): NAM, BOTS, ZIM, MOZ, ZAM, MWI, to W, C & E Africa
Hydroglyphus flumineus (Omer-Cooper, 1959): ZIM, ZAM, to E Africa
Hydroglyphus geminodes (Régimbart, 1895): EC, GAU, LIM, ANG, NAM, ZIM, MOZ, ZAM, MWI, to W, C & E Africa
Hydroglyphus infirmus (Boheman, 1848): all southern African territories, to C & E Africa
‡ *Hydroglyphus kalaharii* (Pederzani, 1982): NAM, BOTS, ZIM
Hydroglyphus koppi (Régimbart, 1895): NAM, ZIM, to W & C Africa
Hydroglyphus lineolatus (Boheman, 1848): all southern African territories, to MWI
Hydroglyphus paludivagus (Omer-Cooper, 1959): EC, NAM, BOTS, ZIM, to ANG & C Africa
Hydroglyphus roeri Biström & Wewalka, 1984: NAM, to C Africa
Hydroglyphus sordidus (Sharp, 1882): MWI, to E Africa
Hydroglyphus transvaalensis (Régimbart, 1894): EC, FS, NW, GAU, MPL, LIM, ANG, NAM, BOTS, ZIM, ZAM, MWI, to C & E Africa
Hydroglyphus zanzibarensis (Régimbart, 1906): KZN, NW, MPL, LIM, ANG, NAM, BOTS, ZIM, MOZ, ZAM, MWI, to E Africa
‡ *Leiodytes australis* Biström, 1987: EC, NAM, ZIM
Leiodytes evanescens (Boheman, 1848): EC, KZN, NW, MPL, LIM, LES, SWZ, ANG, NAM, BOTS, ZIM, MOZ, ZAM, MWI, to W, C & E Africa
Leiodytes hieroglyphicus (Régimbart, 1894): EC, KZN, GAU, MPL, LIM, NAM, ZIM, MOZ, ZAM, to W, C & E Africa
Liodessus guttatus Biström, 1988: ANG
Platydytes coarcticollis (Régimbart, 1894): widespread throughout Afrotropics
Platydytes cooperae Biström, 1988: KZN, ?FS, MPL, LIM, MOZ, to E Africa
Pseuduvarus vitticollis (Boheman, 1848): EC, KZN, GAU, MPL, LIM, SWZ, NAM, ZIM, MWI, to W & E Africa
‡‡ Sharphydrus *capensis* (Omer-Cooper, 1955): SW Cape
‡‡ *Sharphydrus coriaceus* (Régimbart, 1894): WC, EC
‡‡ *Tyndallhydrus caraboides* Sharp, 1882: WC, EC, NC, FS, GAU, MPL, LES
Uvarus captiosus (Guignot, 1948): ZIM, to C & E Africa
Uvarus devroyei (Gschwendtner, 1932): WC, EC, ?GAU, NAM, ZIM, to C & E Africa
Uvarus infimus (Guignot, 1953): ANG, ZIM, to C Africa
Uvarus opacus (Gschwendtner, 1935): EC, FS, GAU, MPL, LIM, ANG, NAM, ZIM, MOZ, ZAM, MWI, to C & E Africa
Uvarus peringueyi (Régimbart, 1895): WC, EC, KZN, FS, NW, MPL, LIM, LES, SWZ, BOTS, ZIM, ZAM, MWI, to E Africa
Uvarus pinheyi Biström, 2000: ZAM
Yola babaulti Peschet, 1921: ?LIM, SWZ, ZIM, to C & E Africa
Yola bicostata Zimmermann, 1926: ZIM, ZAM, MWI, to E Africa
Yola dilatata Régimbart, 1906: MPL, LIM, ZIM, MWI, to E Africa
Yola dohrni (Sharp, 1882): NW, GAU, MPL, LIM, ANG, NAM, BOTS, ZIM, to C Africa
‡ *Yola endroedyi* Biström, 1983: ANG, NAM
Yola frontalis Régimbart, 1906: WC, EC, NC, KZN, LIM, SWZ, ZIM, ZAM, to C & E Africa
‡ *Yola grandicollis* Peschet, 1921: 'TVL', ZIM, ANG
Yola natalensis (Régimbart, 1894): KZN, MPL, LIM, LES, SWZ, ZIM, ZAM, to C & E Africa
Yola nigrosignata Régimbart, 1895: ZIM, to W, C & E Africa, also Algeria
‡ *Yola peringueyi* Guignot, 1942: EC, MPL, LIM, NAM, ZIM
Yola pinheyi Biström, 1983: ZAM, to C Africa
Yola simulantis Omer-Cooper, 1965: EC, MOZ, MWI, to E Africa

‡ *Yola subopaca* Régimbart, 1895: WC, EC, KZN, FS, GAU, MPL, LES, NAM
‡ *Yola swierstrai* Gschwendtner, 1935: EC, KZN, GAU, ?MPL, LES
Yola tuberculata Régimbart, 1895: EC, KZN, FS, GAU, MPL, LIM, LES, NAM, BOTS, ZIM, ZAM, to W, C & E Africa

Yolina baerti Biström, 1983: NAM, to C Africa
‡ *Yolina brincki* (Omer-Cooper, 1965): NAM
‡ *Yolina elegantula* (Boheman, 1848): EC, KZN, MPL, LIM, ZIM, MOZ, ZAM, MWI, to E Africa
‡ *Yolina inopinata* (Omer-Cooper, 1955): WC, EC
Yolina sima (Omer-Cooper, 1965): NAM, also ANG

Subfamily **HYDROPORINAE**
Tribe HYDROPORINI

‡ *Canthyporus alvei* Omer-Cooper, 1965: WC
‡ *Canthyporus angustatus* Omer-Cooper, 1965: SW Cape
‡ *Canthyporus bicinctus* (Régimbart, 1895): WC
‡ *Canthyporus brincki* Omer-Cooper, 1965: LES
‡ *Canthyporus canthydroides* (Régimbart, 1895): WC, EC
‡ *Canthyporus consuetus* Omer-Cooper, 1965: SW Cape
‡ *Canthyporus cooperae* Guignot, 1951: EC
‡ *Canthyporus exilis* (Boheman, 1848): WC, 'Caffraria'
‡ *Canthyporus fluviatilis* Omer-Cooper, 1956: EC
‡ *Canthyporus guignoti* Omer-Cooper, 1956: EC, NC
‡ *Canthyporus guttatus* Omer-Cooper, 1956: NAM
‡ *Canthyporus hottentottus* (Gemminger & Harold, 1868): WC, EC, NC
‡ *Canthyporus lateralis* (Boheman, 1848): WC, ?EC
‡ *Canthyporus latus* Omer-Cooper, 1965: SW Cape
‡ *Canthyporus lowryi* Omer-Cooper, 1965: SW Cape
‡ *Canthyporus navigator* Guignot, 1951: SW Cape
‡ *Canthyporus nebulosus* Omer-Cooper, 1965: WC, KZN
‡ *Canthyporus parvus* Omer-Cooper, 1955: SW Cape
‡ *Canthyporus petulans* Guignot, 1951: WC, EC
‡ *Canthyporus planus* Omer-Cooper, 1965: WC
‡ *Canthyporus regimbarti* Nilsson, 2001: 'Cape'
‡ *Canthyporus similator* Zimmermann, 1923: WC, EC
‡ *Canthyporus swaziensis* Omer-Cooper, 1956: EC, SWZ, ZIM
‡ *Canthyporus testaceus* Zimmermann, 1923: WC, EC
‡ *Nebrioporus* (s.str.) *capensis* (Omer-Cooper, 1953): WC, EC
‡ *Nebrioporus (Zimmermannius*) *solivagus* (Omer-Cooper, 1965): EC
‡ *Nebrioporus* (*Zimmermannius*) *vagrans* (Omer-Cooper, 1953): WC, EC, NC, KZN, FS, MPL, LES
Peschetius aethiopicus Omer-Cooper, 1964: ZIM, to C Africa
Peschetius ultimus Biström & Nilsson, 2003: KZN, FS, NW, LIM, ZIM, ZAM, to MWI & MOZ

Subfamily **HYDROPORINAE**
Tribe HYDROVATINI

Hydrovatus abraeoides Régimbart, 1895: KZN, NAM, to W & C Africa
Hydrovatus absonus Guignot, 1948: NAM, BOTS, to C & E Africa

Hydrovatus acuminatus Motschulsky, 1859: KZN, NAM, MOZ, to W & E Africa & Oriental Region
‡ *Hydrovatus amplicornis* Régimbart, 1895: WC, EC, KZN, GAU, MPL, LIM, SWZ, NAM
‡ *Hydrovatus angusticornis* Biström, 1997: ANG
Hydrovatus bicolor Guignot, 1956: NAM, to C Africa
Hydrovatus bredoi Gschwendtner, 1943: MPL, SWZ, ANG, ZAM, to C & E Africa
Hydrovatus brevipilis Guignot, 1942: ANG, NAM, ZIM, to W & C Africa
‡ *Hydrovatus brownei* Omer-Cooper, 1955: EC, KZN, FS, NW, LIM
Hydrovatus charactes Guignot, 1955: ANG, to C Africa
Hydrovatus collega Guignot, 1955: ZIM, ZAM, to C & E Africa
Hydrovatus contumax Guignot, 1954: WC, KZN, NAM, ZAM, to C Africa
Hydrovatus cribratus Sharp, 1882: KZN, GAU, LIM, MOZ, ZAM, to W, C & E Africa
Hydrovatus dentatus Bilardo & Pederzani, 1990: KZN, ZAM
Hydrovatus deserticola Guignot, 1950 [species complex]: KZN, NAM, to W, C & E Africa
Hydrovatus difformis Régimbart, 1895: KZN, GAU, LIM, NAM, BOTS, ZIM, MOZ, to C & E Africa
‡ *Hydrovatus* e*ximius* Biström, 1997: ZIM, MOZ
Hydrovatus facetus Guignot, 1942: ZIM, to W, C & E Africa
‡ *Hydrovatus fernandoi* Biström, 1997: ANG
‡ *Hydrovatus flammulatus* Sharp, 1882: EC, KZN, FS, GAU, MPL, LIM, LES, ZIM, MOZ
Hydrovatus frater Régimbart, 1895: LIM, NAM, ZIM, MOZ, to W, C & E Africa
‡ *Hydrovatus galpini* Omer-Cooper, 1957: WC, FS, LIM, NAM, ZIM
Hydrovatus glaber Guignot, 1953: MPL, ZIM, to C & E Africa
Hydrovatus granosus Guignot, 1958: BOTS, to C Africa
Hydrovatus guignoti Omer-Cooper, 1957: EC, MPL, SWZ, ZIM, MOZ, to C & E Africa
Hydrovatus hamatus Guignot, 1950: NAM, to W & C Africa
Hydrovatus impunctatus Guignot, 1953: BOTS, to W & C Africa
Hydrovatus insolitus Guignot, 1948: NAM, ANG, BOTS, to W & C Africa
Hydrovatus macrocerus Régimbart, 1895: WC, EC, FS, MPL, LIM, SWZ, BOTS, ZIM, to C Africa
Hydrovatus madagascariensis Régimbart, 1903: KZN, MOZ, to C & E Africa
Hydrovatus mucronatus Régimbart, 1908: NAM, ZIM, to C & E Africa
Hydrovatus nefandus Omer-Cooper, 1957: EC, NC, KZN, FS, GAU, MPL, LIM, NAM, BOTS, ZIM, MOZ
Hydrovatus nigricans Sharp, 1882: KZN, MOZ, to C & E Africa, also ANG
Hydrovatus oblongipennis Régimbart, 1895: KZN, MOZ, ANG, ZAM, to W, C & E Africa
Hydrovatus oblongiusculus Régimbart, 1895: ZIM, to C Africa
Hydrovatus oblongus Omer-Cooper, 1957: EC, MPL, SWZ, MOZ, to E Africa
Hydrovatus obsoletus Peschet, 1922: KZN, NAM, BOTS, MOZ, to C & E Africa
Hydrovatus parvulus Régimbart, 1900: BOTS, to W, C & E Africa
Hydrovatus pescheti Omer-Cooper, 1931: WC, EC, KZN, MPL, SWZ, ZIM, to E Africa
Hydrovatus pictulus Sharp, 1882: KZN, SWZ, ANG, NAM, BOTS, ZIM, to W, C & E Africa
Hydrovatus postremus Guignot, 1942: NAM, ?ZIM, to E Africa
‡ *Hydrovatus pilitibiis* Omer-Cooper, 1957: MPL, LIM
Hydrovatus pulcher Gschwendtner, 1934: ZIM, to W, C & E Africa
Hydrovatus regimbarti Zimmermann, 1919: NAM, BOTS, to W, C & E Africa
Hydrovatus reticuliceps Régimbart, 1895: NAM, to W, C & E Africa
Hydrovatus senegalensis Régimbart, 1895: SWZ, BOTS, ZIM, MOZ, ZAM, to W, C & E Africa
Hydrovatus simoni Régimbart, 1894: WC, EC, NC, GAU, MPL, LIM, SWZ, NAM, BOTS, ZIM, to C & E Africa

Hydrovatus sitistus Omer-Cooper, 1963: ANG, ZIM, to E Africa
Hydrovatus sobrinus Omer-Cooper, 1957: KZN, MPL, LIM, SWZ, NAM, BOTS, ZIM, to C Africa
Hydrovatus soror Biström, 1997: ZIM, to E Africa
‡ *Hydrovatus uhligi* Biström, 1995: NAM
Hydrovatus validicornis Régimbart, 1895: EC, KZN, GAU, MPL, LIM, SWZ, ZIM, to C & E Africa
‡ *Hydrovatus verisae* Bilardo & Rocchi, 1987: ANG, BOTS
Hydrovatus villiersi Guignot, 1955: KZN, ZIM, to W, C & E Africa
Hydrovatus visendus Biström, 1997: ZIM, to E Africa
Hydrovatus vulneratus Biström, 1997: KZN, to C Africa
‡ *Hydrovatus vulpinus* Biström, 1997: ZIM

Subfamily **HYDROPORINAE**
Tribe HYGROTINI

‡ *Herophydrus bilardoi* Biström & Nilsson, 2002: BOTS
‡ *Herophydrus capensis* Régimbart, 1895: SW Cape
‡ *Herophydrus endroedyi* Biström & Nilsson, 2002: EC, NC, KZN, FS, MPL, LIM, NAM, BOTS
Herophydrus gigas Régimbart, 1895: ZIM, to C & W Africa
‡ *Herophydrus gschwendtneri* Omer-Cooper, 1957: EC, MPL, ZIM
Herophydrus guineensis (Aubé, 1838): KZN, LIM, NAM, BOTS, ZIM, MOZ, ZAM, MWI, to W, C & E Africa
?‡ *Herophydrus inquinatus* (Boheman, 1848): WC, EC, NC, KZN, FS, NW, GAU, MPL, LIM, LES, NAM, BOTS, ZIM, ?MOZ, ZAM; ? to C & E Africa
Herophydrus kalaharii Gschwendtner, 1935: BOTS, to C Africa
Herophydrus natator Biström & Nilsson, 2002: ANG, NAM, BOTS
‡ *Herophydrus nigrescens* Biström & Nilsson, 2002: KZN
Herophydrus nodieri (Régimbart, 1895): KZN, LIM, NAM, BOTS, ZIM, MOZ, to W, C & E Africa
‡ *Herophydrus obscurus* Sharp, 1882: WC, EC
Herophydrus ovalis Gschwendtner, 1932: ‘Caffraria’, BOTS, to C Africa
Herophydrus ritsemae Régimbart, 1889: ANG, NAM, BOTS, MWI, to C & W Africa
Herophydrus variabilis secundus Guignot, 1954: ZIM, to C Africa
Herophydrus wewalkai Biström & Nilsson, 2002: ANG, NAM, ?GAU

Subfamily **HYDROPORINAE**
Tribe HYPHYDRINI

‡‡ *Andex insignis* Sharp, 1882: ?WC, NC
‡‡ *Coelhydrus brevicollis* Sharp, 1882: WC, EC
‡‡ *Darwinhydrus solidus* Sharp, 1882: WC, EC
Heterhydrus senegalensis (Laporte, 1835): KZN, MOZ, ZAM, to W, C & E Africa
‡‡ *Hydropeplus montanus* Omer-Cooper, 1965: WC
‡‡ *Hydropeplus trimaculatus* (Laporte, 1835): WC, EC
Hyphydrus caffer Boheman, 1848: KZN, MPL, NAM, BOTS, MOZ, ZIM, to C & E Africa
Hyphydrus circumflexus Klug, 1853: KZN, MOZ, to C & E Africa
‡ *Hyphydrus concii* Bilardo & Rocchi, 1986: BOTS
Hyphydrus conradsi Gschwendtner, 1933: NAM, BOTS, to C & E Africa
Hyphydrus cycloides Régimbart, 1889: EC, KZN, LIM, SWZ, ZIM, to W, C & E Africa
‡ *Hyphydrus esau* Biström, 1982: NAM, BOTS

Hyphydrus grandis Laporte, 1835: LIM, MOZ, to W, C & E Africa
Hyphydrus impressus Klug, 1833: WC, EC, MPL, LIM, SWZ, NAM, BOTS, ZIM, MOZ, ZAM, MWI, to W, C & E Africa
‡ *Hyphydrus komghaensis* Omer-Cooper, 1965: EC
Hyphydrus parvicollis Sharp, 1882: NAM, BOTS, ZIM, ZAM, to W, C & E Africa
‡ *Hyphydrus prozeskyi* Biström, 1982: NW
Hyphydrus residuus Omer-Cooper, 1971: NAM, BOTS, ZAM, to E Africa
Hyphydrus signatus Sharp, 1882: widespread from WC to W, C & E Africa
‡ *Hyphydrus soni* Biström, 1982: WC, EC
‡ *Hyphydrus spangleri* Biström, 1985: BOTS, ZIM

‡‡ *Primospes suturalis* Sharp, 1882: SW Cape

Subfamily **HYDROPORINAE**
Tribe METHLINI

Methles cribratellus (Fairmaire, 1880): EC, KZN, MPL, SWZ, ZIM, MWI, to W, C & E Africa

Subfamily **HYDROPORINAE**
Tribe VATELLINI

Derovatellus africanus Régimbart, 1889: ANG, to C Africa
Derovatellus bisignatus Ahlwarth, 1921: MOZ, to MWI & E Africa
Derovatellus macrocolus Guignot, 1956: MWI, to W & E Africa
‡ *Derovatellus natalensis* Omer-Cooper, 1965: KZN, ZIM, MOZ
‡ *Derovatellus satoi* Biström, 2003: NAM
Derovatellus taeniatus Biström, 1979: ZIM, to C Africa

Subfamily **LACCOPHILINAE**
Tribe LACCOPHILINI

‡ *Africophilus jansei* Omer-Cooper & Omer-Cooper, 1957: WC, EC, LES, SWZ
Africophilus nesiotes Guignot, 1951: EC, ZIM, MWI, also MAD

Laccophilus addendus Sharp, 1882: NAM, to ?C & ?E Africa, also MAD
Laccophilus adspersus Boheman, 1848: EC, KZN, LIM, SWZ, NAM, BOTS, ZIM, MOZ, to W, C & E Africa
Laccophilus bergeri Guignot, 1953: MPL, SWZ, ZIM, MOZ, MWI, to C & E Africa
‡ *Laccophilus canthydroides* Omer-Cooper, 1957: MPL
Laccophilus concisus Guignot, 1953: WC, EC, MPL, LIM, to C Africa
Laccophilus congener Omer-Cooper, 1957: WC, EC, KZN, MPL, LIM, LES, SWZ, NAM, BOTS, ZIM, MWI, to W, C & E Africa
Laccophilus continentalis Gschwendtner, 1935: KZN, MPL, SWZ, NAM, BOTS, ZIM, MOZ, to E Africa
Laccophilus contiro Guignot, 1952: EC, KZN, ZAM, to C & E Africa
‡ *Laccophilus cyclopis* Sharp, 1882: WC, EC, KZN, FS, MPL, LIM, LES, SWZ, NAM, BOTS
Laccophilus evanescens Régimbart, 1895: MOZ, to W, C & E Africa
Laccophilus flaveolus Régimbart, 1906: GAU, MPL, ZIM, MWI, to W, C & E Africa
‡ *Laccophilus immundus* Sharp, 1882: SW Cape
Laccophilus laeticulus Régimbart, 1895: ZIM, MWI, to W & E Africa
Laccophilus lineatus Aubé, 1838: WC, EC, NC, KZN, MPL, LIM, LES, SWZ, NAM, BOTS, ZIM, MWI, to C & E Africa
Laccophilus modestus Régimbart, 1895: KZN, to W, C & E Africa
Laccophilus necopinus Guignot, 1942: GAU, MPL, SWZ, ZIM, MWI, to C & E Africa

Laccophilus pallescens Régimbart, 1903: KZN, MPL, ZIM, MWI, to W & E Africa
Laccophilus pellucidus Sharp, 1882: WC, EC, KZN, FS, GAU, MPL, LIM, LES, SWZ, ZIM, MWI, to E Africa
‡ *Laccophilus perplexus* Omer-Cooper, 1970: MOZ
Laccophilus propinquus Omer-Cooper, 1958: ZIM, MOZ, MWI, to E Africa
Laccophilus remex Guignot, 1952: KZN, MPL, LIM, ZIM, MOZ, to W, C & E Africa
Laccophilus secundus Régimbart, 1895: BOTS, to W & C Africa
‡ *Laccophilus shephardi* Omer-Cooper, 1965: EC
Laccophilus simplicistriatus Gschwendtner, 1932: SWZ, NAM, BOTS, ZIM, MOZ, ZAM, to C & E Africa
Laccophilus simulator Omer-Cooper, 1958: MWI
Laccophilus torquatus Guignot, 1956: KZN, MWI, to W, C & E Africa
Laccophilus vermiculosus Gerstaecker, 1867: LIM, BOTS, ZIM, MOZ, MWI, to W, C & E Africa
Laccophilus vitshumbii Guignot, 1959: ZIM, to E Africa

Neptosternus alluaudi Régimbart, 1903: NC, Vaal River (?MPL), also MAD
‡ *Neptosternus meridianus* Omer-Cooper, 1970: NC, NW, GAU
Neptosternus ornatus Sharp, 1882: KZN, LIM, to W, C & E Africa
Neptosternus pumicatus Guignot, 1949: KZN, ZIM, to W & C Africa
Neptosternus resartus Guignot, 1954: LIM, ZIM, to ANG & C Africa
Neptosternus simulator Omer-Cooper, 1970: LIM, ZIM, MWI

Philaccolus lineatoguttatus (Régimbart, 1894): EC, NC, KZN, MPL, LIM, SWZ, ZIM, to C Africa

Philodytes umbrinus (Motschulsky, 1859): NAM, BOTS, to W, C & E Africa

Family **ASPIDYTIDAE**

Aspidytes niobe Ribera, Beutel, Balke & Vogler, 2002: SW Cape

SUBORDER POLYPHAGA

SUPERFAMILY HYDROPHILOIDEA

Family **GEORISSIDAE**

Georissus alticosta flavidus Brancsik, 1914: MOZ
Georissus granifer Grouvelle, 1909: MOZ, also Sudan
Georissus laevigatus Brancsik, 1914: MOZ
Georissus marlieri Delève, 1967: NAM, also C Africa
Georissus perrieri Alluaud, 1902: MOZ, also C Africa & MAD
Georissus tuberifer Grouvelle, 1909: MOZ, to E Africa

Family **HYDROCHIDAE**

Hydrochus amrishi (Makhan, 1998): LIM
Hydrochus aschnaae (Makhan, 1994): NAM, also DRC, Ethiopia
Hydrochus boedhani Makhan, 1994: NAM, also Tanzania
Hydrochus capensis Péringuey, 1892: WC
Hydrochus harryi Makhan, 1994: NAM
Hydrochus irmae Makhan, 2001: WC
Hydrochus lachmoni Makhan, 1996: WC, EC
Hydrochus lucidus Balfour-Browne, 1954: EC, KZN

Hydrochus niloticus Sharp, 1903: MOZ, ZAM, to E Africa
Hydrochus perforatus Régimbart, 1905: EC, ZAM, to E Africa
Hydrochus sewnathi Makhan, 1994: NAM, also DRC

Family **SPERCHEIDAE**

Spercheus cerisyi Guérin-Méneville, 1842: WC, EC, KZN, FS, GAU, MPL, LIM, LES, ANG, NAM, BOTS, ZIM, MOZ, ZAM, MWI, to W, C & E Africa, MAD, and further
Spercheus crenulatus Fairmaire, 1893: WC, LIM, MOZ, to E Africa
Spercheus gerardi d'Orchymont, 1929: KZN, ANG, NAM, BOTS, ZIM, MOZ, ZAM, to W, C & E Africa
Spercheus senegalensis Laporte, 1832: KZN, NW, GAU, MPL, LIM, NAM, BOTS, ZIM, MOZ, MWI, to W, C & E Africa, MAD, and further
Spercheus stasimus d'Orchymont, 1937: NAM, also W Africa

Family **HYDROPHILIDAE**

Subfamily **HYDROPHILINAE**

Tribe ANACAENINI

‡ *Anacaena capensis* Hebauer, 1999: WC
‡ *Anacaena glabriventris* Komarek, 2004: WC, EC, KZN, MPL
‡ *Anacaena reducta* Komarek, 2004: WC
‡ *Anacaena tenella* Hebauer, 1999: WC, KZN
‡ *Crenitis* (s.str.) *calva* Hebauer, 1994: WC
‡ *Crenitis* (s.str.) *capensis* (d'Orchymont, 1942): WC
‡ *Crenitis* (s.str.) *cinnamomea* Hebauer, 1994: GAU
‡ *Crenitis* (s.str.) *danielssoni* Hebauer, 1994: WC, KZN, LES
‡ *Crenitis* (s.str.) *excusa* Hebauer, 1994: LIM
‡ *Crenitis* (s.str.) *glabricollis* Hebauer, 1994: WC
‡ *Crenitis* (s.str.) *lineata* Hebauer, 2005: WC
‡ *Crenitis* (s.str.) *zimmermanni* Knisch, 1924: WC

‡ *Paracymus amplus* Woolridge, 1977: WC, EC, MPL
Paracymus chalceus Régimbart, 1903: WC, KZN, FS, MPL, LIM, ANG, NAM, BOTS, ZIM, to W, C & E Africa, also MAD, etc.
‡ *Paracymus exiguus* Woolridge, 1977: ZIM
Paracymus minor Régimbart, 1903: ANG, NAM, to C & E Africa, also MAD, etc.
‡ *Paracymus ornatus* Woolridge, 1977: KZN, LIM
‡ *Paracymus petulans* Woolridge, 1977: ZIM
‡ *Paracymus pisanus* Balfour-Browne, 1954: WC, EC, KZN, MPL, LIM, NAM, BOTS
‡ *Paracymus proprius* Woolridge, 1977: ZIM

Subfamily **HYDROPHILINAE**

Tribe BEROSINI

‡ *Allocotocerus mistus* (d'Orchymont, 1939): WC
‡ *Allocotocerus nitidus* (Guérin-Méneville, 1834): WC
Allocotocerus segrex (d'Orchymont, 1939): NAM, ZIM, MOZ, ZAM, to C & E Africa
Allocotocerus simplex (Régimbart, 1906): RSA, MOZ, to C & E Africa
Allocotocerus subaeneus (Erichson, 1843): 'TVL', ANG, NAM, to W, C & E Africa

Berosus (s.str.) *cooperi* d'Orchymont, 1948: KZN, ANG, ZIM, to C & E Africa
Berosus (s.str.) *corrugatus* Régimbart, 1906: GAU, LIM, ANG, NAM, BOTS, MOZ, to W & E Africa

‡ *Berosus* (s.str.) *crassipes* Schödl, 1995: WC, EC, NC, FS, GAU
Berosus (s.str.) *cribrosus* Fairmaire, 1897: ZIM, also MAD
Berosus (s.str.) *dibaphus* Schödl, 1995: ANG, ZIM, to E Africa
Berosus (s.str.) *dunguensis* Schödl, 1994: MPL, LIM, BOTS, ZIM, to C & E Africa
Berosus (s.str.) *gebieni* Knisch, 1922: RSA, 'Zambezi', NAM, BOTS, MOZ, to W & C Africa
Berosus (s.str.) *invisitatus* Balfour-Browne, 1952: NAM, to W & C Africa
Berosus (s.str.) *kalahariensis* d'Orchymont, 1936: ANG, NAM, BOTS, ZIM, ZAM, to E Africa
Berosus (s.str.) *lesnei* d'Orchymont, 1937: MOZ, to W & E Africa
Berosus (s.str.) *madagascariensis* Schödl, 1995: MOZ, also W Africa & MAD
‡ *Berosus* (s.str.) *maximiliani* Schödl, 1994: EC
Berosus (s.str.) *mucronatus* Schödl, 1994: ZIM, to E Africa
Berosus (s.str.) *neumanni* Knisch, 1922: GAU, LIM, NAM, BOTS, to W, C & E Africa
Berosus (s.str.) *nigriceps* (Fabricius, 1801): KZN, FS, NW, LIM, ANG, NAM, BOTS, ZIM, to W, C & E Africa and further
‡ *Berosus* (s.str.) *obesus* Schödl, 1995: EC, MPL, LES
‡ *Berosus* (s.str.) *punctulatus* Boheman, 1851: WC, EC, NC, KZN, FS, NW, GAU, MPL, LIM, LES, NAM, BOTS
Berosus (s.str.) *rubiginosus* Kuwert, 1890: WC, EC, KZN, GAU, MPL, LIM, NAM, BOTS, ZIM, to C & E Africa
Berosus (s.str.) *ugandanus* Balfour-Browne, 1948: BOTS, MOZ, to E Africa
‡ *Berosus* (s.str.) *uhligi* Schödl, 1997: NAM
Berosus (s.str.) *villosulus* Régimbart, 1903: ANG, NAM, ZIM, to W, C & E Africa, also MAD
Berosus (s.str.) *vitticollis* Boheman, 1851: KZN, NW, GAU, LIM, ANG, NAM, BOTS, ZIM, ZAM, to W, C & E Africa
‡ *Berosus* (*Enoplurus*) *brevilobus* Schödl, 1994: NAM, ZAM
‡ *Berosus* (*Enoplurus*) *continentalis* Knisch, 1922: WC, EC
Berosus (*Enoplurus*) *crassus* Balfour-Browne, 1952: NAM, to W, C & E Africa
Berosus (*Enoplurus*) *cuspidatus* Erichson, 1843: KZN, NW, GAU, MPL, LIM, NAM, BOTS, ZIM, MOZ, ZAM, to W, C & E Africa
Berosus (*Enoplurus*) *furcatus* Boheman, 1851: WC, EC, NC, KZN, FS, GAU, MPL, LIM, LES, ANG, NAM, BOTS, MOZ, ZAM, to W, C & E Africa
‡ *Berosus* (*Enoplurus*) *hammondi* Schödl, 1994: ANG, BOTS
‡ *Berosus* (*Enoplurus*) *pudens* Balfour-Browne, 1954: WC, EC, NC, MPL
Berosus (*Enoplurus*) *tetracanthus* Régimbart, 1906: LIM, ZIM, MOZ, to E Africa
Berosus (*Enoplurus*) *wewalkai* Schödl, 1994: NAM, BOTS, to W & C Africa
Regimbartia compressa (Boheman, 1851): LIM, NAM, BOTS, MOZ, ZAM, to W, C & E Africa
‡ *Regimbartia condicta* d'Orchymont, 1941: WC, EC
Regimbartia nilotica (Sharp, 1903): RSA, ANG, NAM, BOTS, MOZ, ZAM, to W & E Africa
Regimbartia obsoleta (Régimbart, 1906): NAM, BOTS, ZIM, MOZ, ZAM, to W, C & E Africa

Subfamily **HYDROPHILINAE**

Tribe CHAETARTHRIINI

Amphiops confusus Régimbart, 1903: NAM, also W Africa, MAD
Amphiops globus Erichson, 1843: EC, KZN, 'TVL', SWZ, ANG, NAM, ZIM, MOZ, ZAM, to W, C & E Africa, also MAD
Amphiops lasioides Régimbart, 1903: RSA, 'TVL', NAM, ZAM, to W, C & E Africa
‡ *Amphiops namibicus* Hebauer, 1995: NAM
Amphiops phallicus d'Orchymont, 1936: NAM, BOTS, to W & E Africa, MAD, and further
Amphiops senegalensis (Laporte, 1840): RSA, 'TVL', ANG, NAM, BOTS, ZIM, MOZ, ZAM, to W, C & E Africa

‡ *Amphiops uhligi* Hebauer, 1995: NAM, BOTS, ZAM

Thysanarthria atriceps (Régimbart, 1903): ?RSA, SWZ, ANG, NAM, BOTS, ZIM, MOZ, to W & C Africa

Subfamily **HYDROPHILINAE**

Tribe HYDROPHILINI

‡‡ *Acidocerus aphodioides* Klug, 1855: MOZ

Chasmogenus africanus (d'Orchymont, 1937): NAM, 'Zambezi', MOZ, to W & C Africa

Chasmogenus luctuosus (d'Orchymont, 1939): NAM, to W & C Africa

Chasmogenus lycetus (d'Orchymont, 1939): KZN, 'TVL', ANG, NAM, ZIM, to E Africa

Chasmogenus molinai Hebauer, 1992: NAM, also C Africa

‡ *Chasmogenus omissus* Hebauer, 1995: NAM

Chasmogenus paramollis Hebauer, 1992: 'TVL', NAM, to W, C & E Africa

Chasmogenus patrizii (Balfour-Browne, 1948): KZN, MPL, LIM, MOZ, to C & E Africa

Chasmogenus rutiloides (d'Orchymont, 1939): NAM, to W & C Africa

‡ *Enochrus* (*Hydatotrephis*) *hartmanni* Hebauer, 1998: WC

Enochrus (*Methydrus*) *anticus* (Régimbart, 1905): KZN, NW, 'TVL', SWZ, LES, ZAM, to W, C & E Africa

‡ *Enochrus* (*Methydrus*) *capucinus* Hebauer, 1988: NAM, ZIM

Enochrus (*Methydrus*) *circumductus* (Régimbart, 1905): WC, KZN, FS, GAU, MPL, LIM, NAM, LES, SWZ, BOTS, ZIM, ZAM, to C & E Africa

?‡ *Enochrus* (*Methydrus*) *excisus* Knisch, 1924: WC, EC, LES, SWZ, NAM, ANG

Enochrus (*Methydrus*) *fosteri* Hebauer, 2003: WC, also MWI

Enochrus (*Methydrus*) *frieseri* Hebauer, 2003: MWI

Enochrus (*Methydrus*) *hesperidum* (Sharp, 1870): WC, NAM, BOTS, ZIM, ZAM, ANG, to C & E Africa

Enochrus (*Methydrus*) *lavatus* Hebauer, 1999: LIM, NAM, to W & E Africa

Enochrus (*Methydrus*) *lucens* Hebauer, 2003: NAM, to W & C Africa

Enochrus (*Methydrus*) *meracus* Balfour-Browne, 1952: FS, BOTS, ZAM, to W Africa

Enochrus (*Methydrus*) *natalensis* (Gemminger & Harold, 1868): WC, EC, NC, KZN, FS, LIM, NAM, BOTS, ZIM, ZAM, to W, C & E Africa and further

‡ *Enochrus* (*Methydrus*) *rocchii* Hebauer, 2002: WC

Enochrus (*Methydrus*) *rubidus* Knisch, 1924: WC, EC, KZN, LIM, NAM, BOTS, ZIM, ZAM, MOZ, to MWI, E Africa

Helochares (s.str.) *dilutus* (Erichson, 1843): RSA, EC, ANG, NAM, BOTS, ZAM, to W, C & E Africa, also MAD

‡ *Helochares* (s.str.) *dollmani* Balfour-Browne, 1950: RSA, NAM, ZIM, ZAM

Helochares (s.str.) *longipalpis* (Murray, 1859): RSA, ANG, NAM, MOZ, ZAM, to W, C & E Africa, also MAD

Helochares (s.str.) *pallens* (MacLeay, 1825): RSA, EC, NAM, BOTS, ZAM, to W, C & E Africa and further

‡ *Helochares* (s.str.) *uhligi* Hebauer, 1999: WC

‡ *Helochares* (*Helocharimorphus*) *maculatus* Hebauer, 1988: NAM

Helochares (*Hydrobaticus*) *androgynus* Hebauer, 1996: RSA, ZAM, to E Africa

Helochares (*Hydrobaticus*) *blaesus* d'Orchymont, 1936: RSA, NAM, BOTS, to E Africa

Helochares (*Hydrobaticus*) *bohemani* d'Orchymont, 1936: EC, KZN, GAU, NAM, BOTS, ZAM, to E Africa
?‡ *Helochares* (*Hydrobaticus*) *conformis* Hebauer, 1995: NAM, ZAM
Helochares (*Hydrobaticus*) *congruens* d'Orchymont, 1939: RSA, NAM, to W & E Africa
Helochares (*Hydrobaticus*) *conjectus* d'Orchymont, 1939: ZIM, also E Africa
Helochares (*Hydrobaticus*) *egregius* Balfour-Browne, 1952: NAM, to W & C Africa
Helochares (*Hydrobaticus*) *mersus* d'Orchymont, 1939: 'Kalahari', NAM, to W, C & E Africa
?‡ *Helochares* (*Hydrobaticus*) *nigroseriatus* Hebauer, 1998: ZIM, ZAM
‡ *Helochares* (*Hydrobaticus*) *parallelus* Hebauer, 1999: BOTS
‡ *Helochares* (*Hydrobaticus*) *phallicus* d'Orchymont, 1936: NAM, BOTS, ZIM
‡ *Helochares* (*Hydrobaticus*) *serpentinus* Hebauer, 1998: WC
?‡ *Helochares* (*Hydrobaticus*) *skalei* Hebauer, 2002: MPL, MWI
‡ *Helochares* (*Hydrobaticus*) *steffani* Hebauer, 2002: NAM
Helochares (*Hydrobaticus*) *striatus* (Boheman, 1851): RSA, also W Africa
Helochares (*Hydrobaticus*) *structus* d'Orchymont, 1936: RSA, NAM, BOTS, to W & C Africa
Helochares (*Hydrobaticus*) *subtilis* d'Orchymont, 1936: RSA, NAM, BOTS, to C & E Africa

Hydrobiomorpha (s.str.) *celata* Mouchamps, 1959: NAM, to C Africa
Hydrobiomorpha (s.str.) *cultrifera* (Régimbart, 1903): BOTS, MOZ, to C Africa, also MAD
Hydrobiomorpha (s.str.) *wencki* (Paulino d'Oliveira, 1880): MOZ, to W, C & E Africa
Hydrochara elliptica (Fabricius, 1801): WC, EC, KZN, FS, NW, GAU, MPL, LIM, ANG, NAM, ZIM, to W, C & E Africa, also MAD
Hydrochara flavipalpis (Boheman, 1851): EC, NC, FS, MPL, LIM, ANG, NAM, BOTS, ZIM, MOZ, to W, C & E Africa, also MAD
Hydrochara fulvofemorata (Fairmaire, 1869): MOZ, to E Africa, also MAD
Hydrophilus (s.str.) *senegalensis* (Percheron, 1835): RSA, ANG, NAM, BOTS, MOZ, to W, C & E Africa and further
Hydrophilus (*Temnopterus*) *aculeatus* (Solier, 1834): NAM, BOTS, to W, C & E Africa and further
‡ *Limnoxenus sjostedti* Knisch, 1924: WC
Sternolophus (*Neosternolophus*) *angolensis* (Erichson, 1843): RSA, KZN, NC, ANG, NAM, BOTS, MOZ, to W, C & E Africa, also MAD, etc.
Sternolophus (s.str.) *solieri* Laporte, 1840: RSA, KZN, ANG, NAM, BOTS, MOZ, ZAM, to W, C & E Africa and further
Sternolophus (s.str.) *unicolor* Laporte, 1840: NAM, also E Africa, MAD

Subfamily **HYDROPHILINAE**

Tribe LACCOBIINI

‡ *Laccobius* (*Hydroxenus*) *balfourbrownei* Gentili, 1988: NC
Laccobius (*Hydroxenus*) *caffer* Boheman, 1851: RSA, LIM, NAM, ZIM, to W, C & E Africa
Laccobius (*Hydroxenus*) *leucaspis* Kiesenwetter, 1870: ANG, NAM, to E Africa
Laccobius (*Hydroxenus*) *revelieri* Perris, 1864: RSA, SWZ, NAM, ZIM, to W, C & E Africa, also MAD and further
‡ *Laccobius* (*Hydroxenus*) *tarsalis* Gentili, 1988: 'Cape'
‡ *Laccobius* (*Hydroxenus*) *venustus* Gentili, 1981: RSA, NAM

Laccobius (*Microlaccobius*) *afer* Gentili, 1980: ANG, NAM, BOTS, ZIM, to W & C Africa
Laccobius (*Microlaccobius*) *minor* (Wollaston, 1867): RSA, ANG, ZIM, to W & E Africa
Laccobius (*Microlaccobius*) *praecipuus* Kuwert, 1890: RSA, ANG, NAM, ZIM, to W & E Africa and further

‡ *Laccobius* (*Microlaccobius*) *recurvipennis* Gentili, 1989: KZN
‡ *Laccobius* (*Microlaccobius*) *uhligi* Gentili, 1995: NAM, BOTS

Family **HELOPHORIDAE**

‡ *Helophorus* (*Rhopalohelophorus*) *aethiops* Balfour-Browne, 1954: WC, EC, NAM

SUPERFAMILY STAPHYLINOIDEA

Family **HYDRAENIDAE**

Subfamily **PROSTHETOPINAE**

Tribe NUCLEOTOPINI

‡‡ *Nucleotops endroedyi* Perkins, 2004: WC
‡‡ *Nucleotops endroedyyoungai* Jäch, 1999♦♦: WC
‡‡ *Nucleotops interceps* Perkins, 2004♦♦: WC
‡‡ *Nucleotops nimbaceps* Perkins & Balfour-Browne, 1994: WC

♦♦ These two names may be synonyms; further study is required.

Subfamily **PROSTHETOPINAE**

Tribe PROSTHETOPINI

‡‡ *Prosthetops grandiceps* Perkins & Balfour-Browne, 1994: EC (Drakensberg)
‡‡ *Prosthetops megacephalus* (Boheman, 1851): SW Cape (Cape Peninsula only)
‡‡ *Prosthetops nitens* (Péringuey, 1892): SW Cape (Cape Peninsula only)
‡‡ *Prosthetops pronotus* Perkins & Balfour-Browne, 1994: WC
‡‡ *Prosthetops setosus* Perkins & Balfour-Browne, 1994: WC

Subfamily **PROSTHETOPINAE**

Tribe PTEROSTHETOPINI

‡‡ *Pterosthetops brincki* Perkins & Balfour-Browne, 1994: WC
‡‡ *Pterosthetops equestrius* Perkins & Balfour-Browne, 1994: SW Cape (Cape Peninsula only)
‡‡ *Pterosthetops harrisoni* Perkins & Balfour-Browne, 1994: SW Cape
‡‡ *Pterosthetops impressus* Perkins & Balfour-Browne, 1994: SW Cape

Subfamily **PROSTHETOPINAE**

Tribe PARASTHETOPINI

‡‡ *Mesoceration abstrictum* Perkins & Balfour-Browne, 1994: WC
‡‡ *Mesoceration apicalum* Perkins & Balfour-Browne, 1994: WC, EC
‡‡ *Mesoceration brevigranum* Perkins & Balfour-Browne, 1994: SW Cape
‡‡ *Mesoceration capense* Janssens, 1967: 'Cape'
‡‡ *Mesoceration concessum* Perkins & Balfour-Browne, 1994: SW Cape (Cape Peninsula only)
‡‡ *Mesoceration dissonum* Perkins & Balfour-Browne, 1994: WC, EC
‡‡ *Mesoceration distinctum* Perkins & Balfour-Browne, 1994: WC
‡‡ *Mesoceration endroedyi* Perkins & Balfour-Browne, 1994: SW Cape
‡‡ *Mesoceration fusciceps* Perkins & Balfour-Browne, 1994: SW Cape
‡‡ *Mesoceration jucundum* Perkins & Balfour-Browne, 1994: WC, EC (apparent disjunction)
‡‡ *Mesoceration languidum* Perkins & Balfour-Browne, 1994: WC
‡‡ *Mesoceration pallidum* Perkins & Balfour-Browne, 1994: SW Cape
‡‡ *Mesoceration rivulare* Perkins & Balfour-Browne, 1994: SW Cape
‡‡ *Mesoceration rubidum* Perkins & Balfour-Browne, 1994: KZN, FS, GAU, MPL

‡‡ *Mesoceration rufescens* Perkins & Balfour-Browne, 1994: WC
‡‡ *Mesoceration splendorum* Perkins & Balfour-Browne, 1994: WC, EC
‡‡ *Mesoceration sulcatulum* Perkins & Balfour-Browne, 1994: SW Cape
‡‡ *Mesoceration transvaalense* Janssens, 1971: MPL
‡‡ *Mesoceration truncatum* Perkins & Balfour-Browne, 1994: SW Cape
‡‡ *Parasthetops aeneus* Perkins & Balfour-Browne, 1994: WC, EC, NC, KZN, FS, GAU, MPL, LES, NAM
‡‡ *Parasthe*tops *andreaei* Perkins & Balfour-Browne, 1994: EC/FS
‡‡ *Parasthetops camurus* Perkins & Balfour-Browne, 1994: KZN, FS, GAU, MPL, LES
‡‡ *Parasthetops curidius* Perkins & Balfour-Browne, 1994: WC, EC, NC, LES
‡‡ *Parasthetops nigritus* Perkins & Balfour-Browne, 1994: WC
‡‡ *Parasthetops reflexus* Perkins & Balfour-Browne, 1994: KZN, FS, GAU, MPL
‡‡ *Parasthetops rufulus* Perkins & Balfour-Browne, 1994: WC, EC (apparent disjunction)
‡‡ *Parasthetops spinipes* Perkins & Balfour-Browne, 1994: EC, KZN, FS, NW, GAU, MPL, LES
‡‡ *Sebasthetops omaliniformis* Jäch, 1998: SW Cape

Subfamily **PROSTHETOPINAE**

Tribe COELOMETOPONINI

‡ *Coelometopon angulatum* Perkins, 2005: LES (Drakensberg)
‡ *Coelometopon balfourbrownei* Perkins, 2005: WC, EC, KZN, MPL, LIM
‡ *Coelometopon blinkwater* Perkins, 2005: WC
‡ *Coelometopon brincki* Perkins, 2005: EC, LES (Drakensberg)
‡ *Coelometopon clandestinum* Perkins, 2005: EC, KZN (Drakensberg)
‡ *Coelometopon coronatum* Perkins, 2005: LIM, LES (apparent disjunction)
‡ *Coelometopon costatum* Perkins, 2005: LIM
‡ *Coelometopon drakensbergense* Perkins, 2005: KZN (Drakensberg)
‡ *Coelometopon emarginatum* Perkins, 2005: MPL
‡ *Coelometopon endroedyi* Perkins, 2005: EC, KZN, MPL (mainly Drakensberg)
‡ *Coelometopon fimbriatum* Perkins, 2005: SW Cape
‡ *Coelometopon granulatum* Perkins, 2005: KZN, MPL, LIM
‡ *Coelometopon langebergense* Perkins, 2005: WC
‡ *Coelometopon minipunctum* Perkins, 2005: KZN (Drakensberg)
‡ *Coelometopon mussardi* Janssens, 1975: ZIM
‡ *Coelometopon natalensis* Perkins, 2005: MPL [not KZN!] (Drakensberg)
‡ *Coelometopon punctipennis* Perkins, 2005: EC, KZN (mainly Drakensberg)
‡ *Coelometopon zulu* Perkins, 2005: KZN

‡‡ *Oomtelecopon sebastiani* Perkins, 2005: SW Cape
‡‡ *Oomtelecopon setosum* Perkins, 2005: SW Cape

Subfamily **HYDRAENINAE**

Tribe HYDRAENINI

‡ *Hydraena* (s.str.) *monikae* Jäch & Díaz, 2000: SW Cape
‡ *Hydraena* (*Hydraenopsis*) *accurata* d'Orchymont, 1948: EC, KZN, FS, GAU
‡ *Hydraena* (*Hydraenopsis*) *cooperi* Balfour-Browne, 1954: EC, LIM (apparent disjunction)

Subfamily **HYDRAENINAE**

Tribe PARHYDRAENINI

‡‡ *Discozantaena brevicollis* Perkins, 2005: WC

‡‡ *Discozantaena drakensbergensis* Perkins, 2005: KZN, FS (Drakensberg)
‡‡ *Discozantaena endroedyi* Perkins, 2005: WC, EC
‡‡ *Discozantaena galea* Perkins, 2005: WC
‡‡ *Discozantaena genuvela* Perkins & Balfour-Browne, 1994: SW Cape
‡‡ *Discozantaena karroo* Perkins, 2005: WC
‡‡ *Discozantaena leleupi* Perkins, 2005: SW Cape (Cape Peninsula only)
‡‡ *Discozantaena ovata* Perkins, 2005: NC, KZN (apparent disjunction)
‡‡ *Discozantaena sepiola* Perkins, 2005: WC
‡‡ *Discozantaena sequentia* Perkins, 2005: SW Cape
‡‡ *Discozantaena tibiovela* Perkins, 2005: KZN, LIM (apparent disjunction)
‡ *Parhydraena lancicula* Perkins & Balfour-Browne, 1994: KZN
‡ *Parhydraena seriata* Balfour-Browne, 1954: EC, GAU, MPL
‡‡ *Pneuminion balfourbrownei* Perkins, 2004: SW Cape (Cape Peninsula only)
‡‡ *Pneuminion endroedyi* Perkins, 2004: SW Cape
‡‡ *Pneuminion impressum* Perkins, 2004: SW Cape
‡‡ *Pneuminion nanum* Perkins, 2004: WC
‡‡ *Pneuminion natalensis* Perkins, 2004: KZN (Drakensberg)
‡‡ *Pneuminion punctatum* Perkins, 2004: MPL (Drakensberg)
‡‡ *Pneuminion semisulcatum* Perkins, 2004: SW Cape (Cape Peninsula only)
‡‡ *Pneuminion tubum* Perkins, 2004: SW Cape
‡‡ *Pneuminion velamen* Perkins, 1997: WC, NC (apparent disjunction)
‡‡ *Protozantaena labrata* Perkins, 1997: NAM

Subfamily **HYDRAENINAE**

Tribe LIMNEBIINI

Limnebius spp. (unrevised): KZN, etc.

Subfamily **OCHTHEBIINAE**

Tribe OCHTHEBIINI

Aulacochthebius exaratus (Mulsant, 1844): RSA, to C & E Africa and further
Meropathus randi Jeannel, 1953: Sub-Antarctic: Prince Edward Island Group (= Marion and Prince Edward Islands), also Crozet Island
Ochthebius (*Asiobates*) *andronius* d'Orchymont, 1948: WC, EC, NC, KZN, FS, GAU, LIM, MPL, LES, NAM, BOTS, to E Africa
‡ *Ochthebius* (s.str.) *capicola* (Péringuey, 1892): WC, EC, NC
‡ *Ochthebius* (s.str.) *extremus* (Péringuey, 1892): SW Cape
‡ *Ochthebius* (s.str.) *namibiensis* Perkins & Balfour-Browne, 1994: NAM
‡ *Ochthebius* (s.str.) *pagotrichus* Perkins & Balfour-Browne, 1994: NAM
‡ *Ochthebius* (s.str.) *pedalis* Balfour-Browne, 1954: WC, NC, NAM
‡ *Ochthebius* (s.str.) *rubripes* Boheman, 1860: NC, NAM
‡ *Ochthebius* (s.str.) *salinarius* Balfour-Browne, 1954: WC, EC, KZN, MOZ
‡ *Ochthebius* (s.str.) *spatulus* Balfour-Browne, 1954: WC, EC, NC
‡ *Ochthebius* (s.str.) *spinasus* Perkins & Balfour-Browne, 1994: WC, EC, NC, NAM

SUPERFAMILY SCIRTOIDEA

Family **SCIRTIDAE**

Because so little is known about the southern African scirtid fauna, a checklist of taxa is not included here.

SUPERFAMILY BYRRHOIDEA

Family ELMIDAE
Subfamily LARAINAE

Omotonus notabilis (Grouvelle, 1898): MPL, ZAM, to C Africa
‡ *Potamocares jeanneli* Hinton, 1937: MOZ
Potamodytes africanus (Boheman, 1848): KZN, MPL, to E Africa
‡ *Potamodytes brincki* Delève, 1970: KZN, NC
?‡ *Potamodytes major* Kolbe, 1898: MOZ, 'Zambezi'
?‡ *Potamogethes major* Delève, 196#: LIM

Subfamily ELMINAE

?‡ *Ctenelmis crinipes* Delève, 1966: ANG
‡ *Ctenelmis discrepans* Delève, 1964: WC
?‡ *Ctenelmis elegans* Delève, 1966: WC, ANG
‡ *Ctenelmis harrisoni* Delève, 1964: WC
Ctenelmis incerta (Grouvelle, 1890): WC, also ANG
‡ *Ctenelmis lata* Delève, 1964: WC
?‡ *Ctenelmis rufipes* Delève, 1966: WC, ANG
?‡ *Ctenelmis tibialis* Delève, 1966: WC, EC, ANG
‡‡ *Elpidelmis capensis* (Grouvelle, 1890): WC
‡‡ *Elpidelmis fossicollis* Delève, 1964: WC
‡ *Haplelmis mixta* (Grouvelle, 1899): WC, EC, MPL
‡ *Helminthocharis cristula* (Delève, 1967): Vaal River (?MPL)
Helminthopsis (*Elmidoliana*) *elongata* Delève, 1965: MPL, ZIM, ZAM, to C Africa
‡ *Helminthopsis* (*Elmidoliana*) *rhodesiana* Delève, 1965: ZIM
Helminthopsis (*Elmidoliana*) *zambezica* Delève, 1965: ZIM, ZAM, to W & C Africa
‡ *Helminthopsis* (s.str.) *allansoni* Delève, 1967: MPL
‡ *Helminthopsis* (s.str.) *bifida* Delève, 1965: MPL, ZIM
‡ *Helminthopsis* (s.str.) *ciliata* Delève, 1965: MPL
Leielmis georyssoides (Grouvelle, 1890): WC, also ANG
‡ *Leptelmis fragilis* Delève, 1966: MPL
‡ *Leptelmis orchymonti* Delève, 1966: ZIM
‡ *Lobelmis harrisoni* Delève, 1967: ZIM
Microdinodes balfouri Delève, 1967: Zambezi River, ZAM, also ANG
Microdinodes lucida Grouvelle, 1906: Vaal River (?MPL), to W, C & E Africa
‡ *Microdinodes pilistriatus* Delève, 1965: Vaal River (?MPL)
Microdinodes simoni (Grouvelle, 1895): LIM, to ANG & E Africa
Microdinodes transvaalicus (Grouvelle, 1895): GAU, ?MPL, also C Africa
‡ *Microdinodes zambesinus* (Brancksik, 1914): MOZ
‡ *Microdinodes* (*Paramicrodinodes*) *vaalensis* Delève, 1965: MPL
Pachyelmis amaena Grouvelle, 1906: KZN, LIM, to E Africa
Pachyelmis convexa Grouvelle, 1911: Vaal River (?MPL), ZIM, to C & E Africa
Pachyelmis rufomarginata Delève, 1964: ZIM, to C Africa

‡‡ *Peloriolus costulatipennis* Delève, 1964: WC
‡‡ *Peloriolus difficilis* Delève, 1970: WC
‡‡ *Peloriolus granulosus* Delève, 1964: WC, EC
‡‡ *Peloriolus interstitialis* Delève, 1970: WC
‡‡ *Peloriolus parvulus* Delève, 1964: WC
‡‡ *Peloriolus patruelis* Delève, 1966: WC, ANG

‡‡ *Peloriolus pilosellus* Delève, 1966: EC
Protelmis sp.: ?RSA
Pseudancyronyx humeralis natalensis Delève, 1970: KZN, Vaal River (?MPL), SWZ
Pseudomacronychus decoratus Grouvelle, 1911: MPL, to W, C & E Africa
‡ *Stenelmis ares* Hinton, 1941: KZN, MPL
‡ *Stenelmis gades* Hinton, 1941: EC, KZN, MPL
‡ *Stenelmis noblei* Delève, 1966: MPL, LIM
Stenelmis prusias Hinton, 1941: KZN, also C Africa
Stenelmis thusa Hinton, 1941: MPL, also E Africa
‡‡ *Tropidelmis hintoni* Delève, 1964: WC

Family **DRYOPIDAE**

Ahaggaria australis (Grouvelle, 1899): EC, KZN, and further

‡‡ *Rapnus andreaei* Delève, 1964: WC
‡‡ *Rapnus formosus* Delève, 1964: WC, EC
‡‡ *Rapnus raffrayi* Grouvelle, 1899: WC

‡‡ *Strina acuminata* Delève, 1964: WC
‡‡ *Strina aequalis* Delève, 1964: WC, EC
‡‡ *Strina aurichalcea* Redtenbacher, 1867: WC
‡‡ *Strina promontorii* Péringuey, 1892: WC

Family **LIMNICHIDAE**

Afrolimnichus oblongus Delève, 1974: EC

Family **HETEROCERIDAE**

Augyles (*Littorimus*) *breviusculus* (Charpentier, 1962): NAM, BOTS, to W & C Africa
‡ *Augyles* (*Littorimus*) *namibiensis* Skalický, 1999: NAM
Augyles (*Littorimus*) *niloticus* (Grouvelle, 1896): NAM, ZIM, ZAM, to W & E Africa
Augyles (*Littorimus*) *pallens* (Charpentier, 1965): NC, KZN, FS, MPL, LIM, ZIM, ZAM, to E Africa
Heterocerus alluaudi Grouvelle, 1906: 'TVL', GAU, ANG, NAM, BOTS, ZIM, ZAM, also MAD
Heterocerus angolensis Charpentier, 1962: ANG
Heterocerus atroincertus Charpentier, 1965: KZN, LIM, BOTS, ZIM, ZAM, to C & E Africa
Heterocerus bredoi Mamitza, 1931: NAM, BOTS, to C Africa
‡ *Heterocerus capensis* Péringuey, 1892: SW Cape
Heterocerus dubitabilis Grouvelle, 1906: ZAM, to E Africa, also MAD
Heterocerus elongatus Grouvelle, 1896: KZN, FS, NW, GAU, MPL, LIM, SWZ, NAM, BOTS, ZIM, ZAM, to W, C & E Africa, also MAD
Heterocerus incertus Grouvelle, 1896: WC, KZN, ANG, ZIM, ZAM, to W, C & E Africa, also MAD
‡ *Heterocerus meridionalis* Péringuey, 1892: WC, EC, NC
‡ *Heterocerus microincertus* Charpentier, 1965: ANG
Heterocerus nodieri Grouvelle, 1919: ZIM, ZAM, to W, C & E Africa
‡ *Heterocerus novoincertus* Charpentier, 1965: ANG
Heterocerus ornatus Grouvelle, 1906: WC, ?EC, KZN, MPL, LIM, SWZ, NAM, BOTS, ZIM, ZAM, to W & E Africa, also MAD
‡ *Heterocerus pavliceki* Skalický, 1999: NAM
‡ *Heterocerus peringueyi* Grouvelle, 1919: WC, EC, NC
Heterocerus sennarensis Grouvelle, 1909: ZAM, to W & E Africa

Heterocerus thebaicus australis Charpentier, 1965: All nine RSA provinces, SWZ, NAM, BOTS, ZIM, ZAM, also ANG
‡ *Heterocerus uhligi* Mascagni & Monte, 2001: WC
Heterocerus vulpes Grouvelle, 1906: WC, KZN, NW, LIM, NAM, BOTS, ZIM, also MAD

Family **PSEPHENIDAE**

Afrobrianax ferdyi Lee, Philips & Yang, 2003: EC, KZN, GAU, MPL
Afroeubria sebastiani Lee, 2003: KZN, LIM
Afropsephenoides ruthae Jeng & Yang, 2006: MPL

Family **PTILODACTYLIDAE**

Because virtually nothing is known about the southern African ptilodactylid fauna, a checklist of taxa is not included here.

SUPERFAMILY **CHRYSOMELOIDEA**

Family **CHRYSOMELIDAE**

Subfamily **DONACIINAE**

(contributed by E. Grobbelaar)

‡ *Donacia* (*Donacia*) sp.n. [undescribed]: NAM (Kwando River), BOTS (Okavango Delta)
‡ *Donaciasta dentata* (Pic, 1936): KZN, MOZ
Donaciasta goeckei Monrós, 1958: KZN, LIM, ZIM, also ANG and C & E Africa

SUPERFAMILY **CURCULIONOIDEA**

Family **CURCULIONIDAE**

Tribe BAGOINI

Bagous beiranus Marshall, 1906: type locality: MOZ: Beira
Bagous bergensis Marshall, 1953: type locality: WC: Berg River, near Paarl
Bagous coenosus Gyllenhal, 1836: type locality: 'Caffraria'
Bagous humeralis Marshall, 1906: type locality: EC: Uitenhage
Bagous promontorii Marshall, 1906: type locality: WC: Cape Town
Bagous punctipennis Marshall, 1906: type locality: MOZ: Beira
Pseudobagous longulus (Gyllenhal, 1836): type locality: 'Caffraria'; also 'Cape', EC, KZN, MPL, LIM, NAM, BOTS, ZIM, MOZ

Family **Curculionidae**

Tribe RHYTHIRRININI

§ *Listronotus marginicollis* (Hustache, 1926): countries of origin: Brazil, Argentina

Family **Curculionidae**

Tribe STENOPELMINI

§ *Cyrtobagous salviniae* Calder & Sands, 1985: country of origin: Brazil
§ *Cyrtobagous singularis* Hustache, 1929: country of origin: Trinidad
§ *Neochetina eichhorniae* Warner, 1970: countries of origin: Argentina, Brazil
§ *Neochetina bruchi* Hustache, 1926: country of origin: Argentina
§ *Neohydronomus affinis* Hustache, 1926: country of origin: Argentina
§ *Stenopelmus rufinasus* Gyllenhal, [1835]: country of origin: USA (Florida)

GLOSSARY OF TERMS

compiled by

R. Stals

Body size classes

Throughout this *Guide*, the colloquial words used for different body sizes of beetles, words which are necessarily subjective, have been classed and standardised according to the following convention:

Body length	**Depiction**
< 1 mm	minute
~ 1 mm	extremely small
1–2 mm	very small
2–5 mm	small
5–7 mm	smallish
7–15 mm	medium-sized
15–25 mm	moderately large
25–50 mm	large
> 50 mm	very large

Abbreviations used in figure legends

A1–A10	abdominal segments number 1 to 10
MP1–MP4	maxillary palp segments 1 to 4
T1–T3	thoracical segments 1 to 3
V1–V7	abdominal ventrites 1 to 7

Technical terms

abbreviate(d)	(= truncate): of a body part or an appendage, apparently cut short or not of apparent usual length
abdomen	in insects, the third (posterior) major part of the body, housing

	the alimentary (q.v.) and reproductive organs, and bearing no functional legs in the adult
acuminate	tapering to a point
acute	(sharply) pointed
admedian	towards the middle
aedeagus	in the genitalia of male Coleoptera, the unpaired, terminal part of the copulatory apparatus, frequently sclerotised (q.v.) and most often of great taxonomic significance
Afrotropical Region	(= 'the Afrotropics'): the biogeographical region comprising Africa south of the Sahara Desert, southern Arabia, Madagascar, and associated islands
alien	not indigenous to a given geographic area, as opposed to native
alimentary canal	the gut or food tube, which runs from the mouth to the anus
anterolateral	toward the front and the side
apex	(adj. apical): the end or tip of any structure, as opposed to the base (q.v.)
apneustic	larval respiratory system in which there are no functional spiracles
apophysis	(pl. apophyses): an elongation or projection of the exoskeleton (q.v.), either internally or externally; also called 'process'
appendage	a leg, wing, antenna, et cetera
aquatic	living in water
arcuate	arched or bowlike
articulated	with subsequent segments, or the base, of a structure (apparently) independently movable and not immovably inserted
atrium	(= respiratory atrium, = respiratory pocket): in many larval Hydrophiloidea, the terminal respiratory chamber formed by the last abdominal segments
attenuate	gradually tapering apically
basal	(1) in morphology, referring to the base (q.v.); (2) in phylogenetics (q.v.), a taxon towards the root of an evolutionary history (sometimes called 'primitive')
basal piece	for adult male Coleoptera genitalia, the unpaired, usually sclerotised (q.v.), proximal part of the tegmen (q.v.)
base	(adj. basal) (1) that part of any appendage or structure that is closest to the body; (2) of the pronotum, the part nearest to the elytra; (3) of the elytra, the part nearest to the pronotum
bifid	cleft or forked into two
bifurcate	partly divided or forked into two
bilobed	with two lobes
biogeography	(adj. biogeographic): the study of the distributions of organisms and the mechanisms that underlie such distributions
biological control	(= biocontrol): the use of living organisms (natural enemies) to combat unwanted or invasive animals (pests) or plants (weeds)
biotope	the smallest geographical unit of the biosphere or of a habitat

	that can be delimited by convenient boundaries and is characterized by its biota
bisetose	with two setae (q.v.)
bisinuate	with two waves or wavy lines
bordered	of margins, with a marginal ridge or bead
bubble-hypomeron	in adult Hydraenidae, the part of the pronotal hypomeron (q.v.) closest to the body, over which the lateral part of the respiratory bubble is maintained, as opposed to the wet-hypomeron
callus	(pl. calli): a rounded swelling of the cuticle
campodeiform	an insect larval type, referring to larvae that are elongate, with a prognathous (q.v.) head and well-developed thoracic legs, usually active and predacious
carina	(pl. carinae; adj. carinate): an elevated ridge or keel
carnivorous	predacious (q.v.)
cervical	referring to the neck
club	of a clubbed antenna, the more-or-less enlarged distal anten nal segments
clypeus	(adj. clypeal): the (anterior) part of an insect head below the frons (q.v.), to which the labrum (q.v.) is attached anteriorly
connate	fused at the base or along the entire length; often with referral to antennal segments
cordiform	(more or less) heart-shaped, not necessarily emarginate (q.v.) at the middle of the base
Corixidae	the aquatic bug family commonly known as 'water boatmen' (Hemiptera: Heteroptera), treated in Volume 8 of this series of *Guides*
cosmopolitan	occurring throughout the world
costa	(pl. costae): an elevated ridge that is rounded at its crest
costate	with costae; coarser than carinate (q.v.); often with referral to elytral intervals (q.v.)
coxa	(pl. coxae; adj. coxal): the basal segment of the adult insect leg, articulating with the body and preceding the trochanter
coxal cavity	the space in which the coxa (q.v.) articulates
cryptic species	different species, usually closely related, that are morphologically identical or at least very difficult to discriminate from each other
cupule	a cup-shaped organ; in the Hydraenidae and Hydrophiloidea, a modified antennal segment preceding the antennal club (q.v.)
cuticle	(adj. cuticular): the integument or body covering of arthropods, covering the entire body as well as lining certain invaginations
decurved	curved downwards or backwards
deflected	abruptly bent downwards
denticulate	set with little teeth or notches
deplanate	dorsoventrally compressed; flattened from above and below
detritus	disintegrated and disintegrating organic material

Diptera	the insect order that contains the 'true flies', insects with only one pair of wings, the aquatic forms of which are treated in Volume 9 of this series of *Guides*
disc	the central, upper surface of any part (e.g. of pronotum, elytron, mesosternum, metasternum)
disjunction	(adj. disjunct): concerning the distribution of organisms, an 'interrupted' distribution pattern wherein the same taxon occurs in disjointed areas and not in-between
distal	referring to the far end
dorsal	referring to the upper side of an organism or structure
dorsolateral	toward the upper surface and the side
dorsoventral	referring to upper and lower sides (e.g. 'dorsoventrally flattened')
dorsum	the upper side of an organism or structure
ecology	the study of the components of, and interactions among, living organisms and their environments
elateriform	an insect larval type, being elongate, and having thoracic legs but, in Coleoptera, with no abdominal appendages
elongate	prolonged; much longer than broad
elytral humerus	humerus (q.v.)
elytron	(pl. elytra): the hardened, shield-like front wings of adult Coleoptera, covering the membranous hind wings when at rest
emargination	(adj. emarginate): a cut-out place or section in an edge or a margin
emergent	of aquatic plants, rocks, etc., projecting from below to above the water surface
empodium	a spine-like or lobe-like process between the claws
endemism	(adj. endemic): the natural restriction of a taxonomic group to a restricted geographical area
endosymbiont	(adj. endosymbiotic): a unicellular organism, usually a bacterium, protozoon or fungus, that occurs symbiotically (q.v.) in the body of a host organism, providing the host with essential nutrients or metabolic functions
entire	referring to a margin or longitudinal structure, uninterrupted and without teeth or notches or emarginations
ephemeral	lasting for a short time only; transient
epilithic	on stones
epipleuron	(pl. epipleura): in adult beetles, the deflexed or inflexed portion of the elytron, lateral when the elytra are closed, or ventral, if inflected
eurytopic	capable of living in a wide range of (micro)habitats; as opposed to 'stenotopic' (q.v.)
exarate	referring to pupae, a type of pupa in which the wings and legs are free from the body and the abdomen is moveable, as in Coleoptera
exoskeleton	the body wall or external skeleton of arthropods; in insects containing chitin, consisting of a hard cuticle (q.v.), with

	muscle attachments on the inner side
explanate	referring to a margin, spread out and flattened
extant	(= 'Recent'): referring to those taxa that are living presently, i.e. not extinct
extra-oral digestion	digestion of foodstuffs outside the alimentary canal (q.v.) or beyond the mouth
extrachorion	the outer coating of the egg of some groups of insects
exuviae	(adj. exuvial): the cast skin of the larva or pupa after moulting or emergence
false water beetles	water beetles that are aquatic only in the larval stage, with the adults being predominantly terrestrial
family	the principal taxonomic rank comprising a monophyletic (q.v.) assemblage of genera (sometimes grouped into tribes and subtribes) and containing all lower taxonomic ranks; family names of animals always end with the suffix '-idae'; e.g. 'Curculionidae'
femur	(pl. femora): the third segment of the adult insect leg, following on the coxa and trochanter and preceding the tibia; usually the stoutest segment of the leg
filiform	of insect antennae, slender and threadlike, with the segments of more-or-less equal diameter
flagellum	(pl. flagella): generally, any small whip-like process; (1) the terminal part of an elongate antenna (e.g. in larvae of Scirtidae); (2) in male Coleoptera, the sclerotised (q.v.) terminal prolongation of the ductus ejaculatorius
fossa	(pl. fossae): a more-or-less deep indentation of the cuticle
fossorial	referring to digging or burrowing
frons	the upper anterior portion of the head capsule of an insect, situated above or behind the clypeus (q.v.)
funicle	in the antennae of Curculionidae, the segments between the scape and the antennal club
fusiform	a body type, referring to insects that are, in dorsal view, the widest at the middle and narrowed at both ends
gallery	interlinked tunnels and chambers constructed by an insect
gibbosity	a rounded protuberance or prominence of the exoskeleton
gill	in many aquatic larvae, flattened, finger-like or hair-like cuticular processes with abundant tracheae and tracheoles, through which respiration takes place under water; also see spiracular gills and tracheal gills (q.v.)
glabrous	smooth; devoid of pubescence (q.v.) or sculpturing (q.v.)
globose	globular; spherical or nearly so
Gondwana	(adj. Gondwanan): the large southern landmass of the Mesozoic, consisting of the present-day South America, Antarctica, Africa, Madagascar, India and Australia
granulate	covered with, or made up of, very small grains or granules; usually referring to the exoskeleton
habitat	the combination of biotic and abiotic conditions that make up the 'home' of an organism

habitus	the general form or typical appearance of an organism
halophilous	partial to a very salty habitat, like ocean rock pools
head capsule	the fused sclerites (q.v.) of the head, which together form a hard, compact case
Hemiptera	insect order that contains the 'sucking insects', characterized by the presence of a sucking device called a rostrum; includes disparate forms such as aphids and giant water bugs
herbivorous	phytophagous (q.v.)
Heteroptera	one of the four suborders of the insect order Hemiptera, namely the so-called 'true bugs', the aquatic forms of which were treated in Volume 8 of this series of *Guides*
holometabolous	(= endopterygote): referring to those insect orders (including Coleoptera) with a so-called complete life cycle, i.e. including a pupal stage
humerus	(pl. humeri; adj. humeral): shoulder; in adult Coleoptera the basal exterior angle of the elytron
humicolous	referring to the microhabitat where organisms live in rich soils, organic detritus, or humus
hyaline	transparent, glassy
hydradephagan	belonging to or pertaining to the 'section' Hydradephaga of the beetle suborder Adephaga
hydrofuge	water-repelling
hygropetric	(= madicolous): referring to the microhabitat where organisms live in the thin water film on rock surfaces, as found on emergent boulders, on wet rock faces at the margins and in the spray zone of waterfalls and rapids, at seepage trickles, wet road cuttings, et cetera
Hymenoptera	the insect order that contains the ants, bees, and other wasps
hypognathous	having the head vertically orientated with the mouthparts directed downward
hypomeron	(adj. hypomeral): see pronotal hypomeron (q.v.)
impression	(adj. impressed): a depressed area of the cuticle or a structure
impunctate	without punctation (q.v.)
instar	in immature insects, each stage between moults; in Coleoptera, a larval stage
interdigitating	referring to linear structures, interwoven
interval	on an elytron (q.v.), the longitudinal area between two striae (q.v.)
intraspecific	referring to comparisons/relationships etc., within a species
iridescence	(adj. iridescent): colours produced by diffraction, which typically change with the viewing angle
Johnston organ	a sensory organ in the second antennal segment of insects, that functions to perceive movements of the antennal flagellum
keel	an elevated ridge or carina (q.v.)
labium	(adj. labial): the posterior-inferior mouthpart of most insects,

	behind the maxillae (q.v.) and opposed to the labrum (q.v.); the 'lower lip'
labial palp	appendage of the labium (q.v.), in Coleoptera usually three-segmented; the labium carries a pair of these
labrum	the anterior-inferior mouthpart of insects, following on the clypeus (q.v.); the 'upper lip'
laminate	sheet- or leaf-like
lanceolate	lance- or spear-shaped, oblong and tapering to an end
larva	in holometabolous (q.v.) insects, the actively-feeding immature developmental stage
lateral	referring to the side of a body or an appendage
Lepidoptera	the insect order that contains caterpillars, butterflies, and other moths
littoral	referring to the shore of a water body
longitudinal	longer than broad, as opposed to transverse
lunulate	crescent-shaped
macula	(pl. maculae; adj. macular): flecks, differently-coloured patches of integument
Malpighian tubules	internal excretory organs of insects
mandible	(adj. mandibular): one of the first pairs of mouthparts in arthropods, in Coleoptera being stout jaws
maxilla	(pl. maxillae; adj. maxillar): one of the second pair of mouth parts in arthropods with chewing mouthparts (including Coleoptera)
maxillary palp	appendage of the maxilla (q.v.), in Coleoptera usually four-segmented; the maxilla carries a pair of these by the stipes (q.v.)
medial	referring to the middle, or at the middle
median	(1) medial (q.v.); (2) along the midline of the body
median lobe	for adult male Coleoptera genitalia, aedeagus (q.v.)
mentum	the middle part of a three-part labium (q.v.)
meso-	in insects, prefix referring to structures of the mesothorax (q.v.) (e.g. mesosternum, mesocoxa, mesofemur, mesotarsi)
mesothorax	(adj. mesothoracic): the middle (second) segment of the three segments of the insect thorax, bearing the front wings and middle legs
meta-	in insects, prefix referring to structures of the metathorax (q.v.) (e.g. metasternum, metacoxa, metafemur, metatibia, metatarsi)
metapneustic	larval respiratory system in which only the terminal (posterior) pair of abdominal spiracles are functional
metathorax	(adj. metathoracic): the last (third) segment of the three segments of the insect thorax, bearing the hind wings and hind legs
metepisternum	the episternum of the metathorax (q.v.), i.e. the anterior sclerite (q.v.) on the pleuron (q.v.) of the metathorax (q.v.)
micropubescence	short, matted hairs or setae forming the tomentum

microsculpture	the very fine microscopic sculpturing (q.v.) of the cuticle (q.v.)
monograph	a taxonomic publication that exhaustively treats a taxon, including all information that relates to the taxon's systematics, morphology and anatomy, biology, ecology and biogeography
monophagous	(n. monophagy): feeding on only one species of host plant
monophyletic	(n. monophyly, monophylum): referring to a natural grouping, i.e. an ancestor and all of its descendents, and no other taxa
multiarticulate	made up of numerous small segments (articles), as are the antennae of larval Scirtidae
nasale	(pl. nasales): in some beetle larvae (e.g. Gyrinidae, Dytiscidae), an anterior, median projection from the frons; it may be a fused labrum and clypeus, the labrum, or the clypeus and the frons (q.v.)
native	indigenous to a given geographic area, as opposed to alien (q.v.)
niche	a multidimensional space which defines an organism's place in nature
Notonectidae	the aquatic bug family, commonly known as 'backswimmers' (Hemiptera: Heteroptera), treated in Volume 8 of this series of *Guides*
obligate	necessarily so
oblong	longer than broad
obtuse	blunt
ocellus	(pl. ocelli): in adult insects, a simple eye consisting of a single lens
olfactory	referring to the sense of smell
oligophagous	(n. oligophagy): feeding on only a (relatively) small selection of host plants
omnivorous	feeding on both plant and animal tissue
onisciform	an insect larval type, depressed and broadly spindle-shaped, frequently with expanded body margins
operculum	a lid or cover; in some water beetle larvae (Psephenidae, Byrrhoidea), a posterior abdominal sternite that covers a chamber containing retracted tracheal gills
order	(adj. ordinal): the principal taxonomic rank comprising a monophyletic (q.v.) assemblage of families (sometimes grouped into superfamilies), and containing all lower taxonomic ranks; e.g. Coleoptera, the beetles
Oriental Region	the biogeographical region comprising Asia east of the Indus River and south of the Himalayas and the Yangtze-kiang watershed, and including most of the south-east Asian islands
osmoregulation	(adj. osmoregulatory): the maintenance of the water and ion balance of an organism
ovate	broadly rounded to egg-shaped
oviposition	the act of depositing eggs
ovipositor	in female insects, the organ by which the eggs are deposited, in Coleoptera only infrequently well developed

palp	elongate, usually segmented, appendage of the maxilla (q.v.) or labium (q.v.)
Palaearctic Region	the biogeographical region comprising Africa north of the Sahara, Europe, and Asia as far south as the Himalayas and the Yangtze-kiang watershed
palpomere	one of the segments of a maxillary or labial palp (q.v.)
papilla	(pl. papillae): a small, soft projection
paramere	for adult male Coleoptera genitalia, each of the paired, usually sclerotised (q.v.), lateral parts of the tegmen (q.v.)
paraphyletic	an unnatural grouping, consisting of a group of taxa, which is not the full complement (i.e. all sister taxa) of descendents from a common ancestor, and/or with the exclusion of that ancestor
pectinate	comb-like; with evenly spaced projections, like the teeth of a comb (especially applied with regard to antennae and claws)
pedicel	of an insect antenna, the second segment of the antenna, carrying the flagellum (q.v.)
penultimate	in a linear or temporal series, the second-last item
peripneustic	larval respiratory system in which there are nine pairs of functional spiracles, one on the thorax and eight on the abdomen
phylogenetics	the science of objectively reconstructing the evolutionary history (phylogeny) of an organism or a group of organisms, with special emphasis on any and all genealogical relationships among the creatures studied
phylogeny	(adj. phylogenetic): see phylogenetics (q.v.)
phytophagous	(= herbivorous): feeding on live plant material
phytophilous water beetles	beetles that are generally terrestrial but have a close association with their aquatic host plants, so that they may stay submerged for at least some time in any developmental stage
phytotelma	(pl. phytotelmata): water-filled natural holes in plants, such as tree holes and leaf axils
pilosity	a covering of fine, more or less long hairs
plastron	in many aquatic arthropods, an air film on the outside of the body, kept in place by fine hydrofuge (q.v.) cuticular structures, e.g. closely set, minute, hairs, scales (q.v.) or microsculpture (q.v.) that trap an air film close to the body and over the spiracles (q.v.), providing an extensive air-water interface for the exchange of respiratory gases
Pleidae	the aquatic bug family commonly known as 'pygmy backswimmers' (Hemiptera: Heteroptera), treated in Volume 8 of this series of *Guides*
pleurite	a lateral or pleural (q.v.: pleuron) sclerite (q.v.)
pleuron	(pl. pleura; adj. pleural): the lateral region of any body segment
pleurosternal suture	in many Coleoptera, a suture (q.v.) that separates the prosternum from the proepisternum
polyphyletic	an unnatural grouping in which the members of the group has more than one immediate common ancestor

posterolateral	toward the rear and the side
postocular	behind an eye
predacious	(= predaceous; = predatory): feeding on live animal prey
prescutellar	referring to the scutellary region (q.v.), especially the pronotum (q.v.) anterior of the scutellum (q.v.)
pretarsus	the last segment of the insect leg, usually bearing one or two claws
pro-	in insects, prefix referring to structures of the prothorax (q.v.) (e.g. prosternum, procoxa, profemur, protibia, protarsi)
produced	extended, prolonged, or projected
prognathous	having the head horizontally orientated with the mouthparts directed forwards
proleg	leg-like process or appendage; comparable to pygopod (q.v.)
prominence	tubercle (q.v.)
pronotal hypermeron	in adult Coleoptera, the inflexed portion of the pronotum (q.v.), beneath the lateral margin
pronotum	(adj. pronotal): the dorsal part of the prothorax, in adult Coleoptera normally the only part of the prothorax visible from above
prosternal process	a posterior elongation of the prosternum behind the front coxae
prothorax	(adj. prothoracic): the front (first) segment of the three segments of the insect thorax, anteriorly articulating with the head
protrusible	capable of being extended
protuberant	rising above, or produced above, a surface, a margin, or a general level
proximal	referring to the closest part
psammophilous	associated with sand
pseudotetramerous	referring to the tarsi of certain Coleoptera (Chrysomeloidea and Curculionoidea), apparently having four segments, although five segments are actually present; the fourth segment being very small and hidden at the base of the fifth segment (Fig. 1.5A: p. 27)
pubescence	(adj. pubescent): soft, short, fine, loosely-set hairs or setae
punctate	with fine, impressed points or punctures
punctation	pits or depressions in the cuticle, of various sizes
pupation	the process of becoming a pupa
pupa	in holometabolous (q.v.) insects, the mysterious 'resting' immature developmental stage, following on the larval stages and preceding the adult stage
pygidium	(adj. pygidial): the tergum (q.v.) of the last visible segment of the abdomen of adult insects; in many adult Coleoptera, the segment left exposed by the elytra

pygopod	in some Coleoptera larvae, a more-or-less terminal foot-like structure formed from the tenth abdominal sternum or from the whole tenth abdominal segment
q.v.	*quod vide* (Latin): 'go see'
recumbent	lying down
relictual	referring to an organism persisting in a given area as a survivor of a previous era
respiration	the processes and physiology that have to do with gaseous exchange, also known as breathing
reticulation(s)	(adj. reticulate): on the cuticle, superficial networks of lines or (low) elevations
reverted	in phylogeny or evolutionary history, the condition of having returned from an advanced character state to the previous ('old') character state
revision	a taxonomic publication that systematically treats information on a delimited group of organisms (e.g. all the species of a genus), both summarising existing information and presenting new material or new interpretations
riparian	referring to the banks of rivers and streams
rostrum	in Coleoptera: Curculionidae, the anteriorly produced, cylindrical 'snout' of the head
ruga	(pl. rugae; adj. rugose): on the cuticle, a wrinkle
SASS5	'South African Scoring System', 5th edition (Dickens & Graham 2001): the standardised system of scoring freshwater macroinvertebrates on a sensitivity scale, currently in use in South Africa for the rapid assessment of the relative ecological health of streams and rivers.
s.str.	(= *sensu stricto*): 'in the narrow sense': in nomenclature referring to the nominal subgenus, where applicable, e.g. *Berosus* (s.str.) *corrugatus* = *Berosus (Berosus) corrugatus*; also see 'subgenus'
saprophagous	feeding on dead or decaying animal or plant matter
scale	a flat, variously shaped, derivative of a seta (q.v.), which is found on the integument of many insects
scape	of an insect antenna, the first or basal segment of the antenna
sclerite	any plate of the body wall, bounded by membranes or sutures
sclerotised	of the cuticle, hardened through sclerotisation, a process involving the development of cross links between protein chains
sculpture	(= sculpturing): of the cuticle, superficial elevations and/or depressions, arranged in some definable manner
scutellary region	the area around or adjacent to the scutellum (q.v.)
scutellum	in adult Coleoptera, the triangular piece at the base of and between the elytra; the dorsomedian part of the mesothorax (not visible in all beetles)
segment	(1) a subdivision of the arthropod body between areas of flexibility; (2) a subdivision of an appendage (leg, tarsus, antenna, labium, etc.)

semi-	prefix denoting 'half only'
semivoltine	taking two years for one generation
seriate-punctate	referring to elytra, striae (q.v.) with rows of punctures
serrate	saw-like, i.e. with notched edges like the teeth of a saw, frequently referring to antennae
seta	(pl. setae): a small, sclerotised hair-like projection of the cuticle, arising from a single cell and surrounded at its base by a small cuticular ring; cf. 'spine'
setose	furnished with or covered by setae
shore beetles	beetles that are strictly speaking terrestrial, but are found almost exclusively very close to the water's edge or in very wet habitats in all their developmental stages
shore-washing	a technique for collecting shore beetles (q.v.), in which water is splashed onto the shore, left to run down back into a water body, and insects carried along with the water are collected with an aquatic net or sieve a short distance downstream
shredder	an animal that feeds by breaking up large particles of dead organic matter
sinuate, sinuous	referring to edges and margins, not straight, but wavy
spatulate	rounded and broad at the tip and attenuate (q.v.) at the base
species richness	the number of species present in a selected area or assemblage, being one of the parameters of biological diversity
speciose	having many species, said of a higher taxonomic category
spine	a multicellular, more or less thorn-like process or outgrowth of the cuticle, not separated from it by a joint, as opposed to a seta
spinose	(= spinous): armed with spines (q.v.)
spiracle	in insects, external opening of the respiratory (tracheal, q.v.) system
spiracular gills	in some aquatic larval and pupal Coleoptera, extensions of the cuticle surrounding spiracles (q.v.) bearing a plastron (q.v.) connected to the spiracle
squamiform	having a flattened, scale-like form
stemma	(pl. stemmata): in holometabolous (q.v.) insects, a simple eye of the larva
stenotopic	incapable of living in various (micro)habitats; as opposed to 'eurytopic' (q.v.)
sternite	any subdivision of a sternum (q.v.)
sternum	(pl. sterna; adj. sternal): the entire ventral division of any segment
stipes	the basal sclerite (q.v.) of the maxilla (q.v.), bearing (among others) the maxillary palp (q.v.)
stria	(pl. striae): in adult Coleoptera, one of the longitudinal, depressed lines or furrows extending from the base to the apex of the elytra
striate, striated	marked with fine, longitudinal, parallel impressed lines or grooves

stridulary file	(= stridulatory file): ridged structure used in stridulation (q.v.)
stridulation	the production of sound by insects (and other animals) by rubbing one surface against another, both surfaces being suitably roughened
sub-	prefix denoting 'somewhat' or 'almost'
subelytral space	(= subelytral chamber): the space below the elytra and above the terga, enclosed in many Coleoptera
subfamily	the taxonomic rank intermediate between genus and species, but not applied in all taxa; subfamily names of animals always end with the suffix '-inae'; e.g. Donaciinae, the longhorn leaf beetles
subgenus	(adj. subgeneric): the taxonomic rank intermediate between genus and species, but not applied in all taxa; subgeneric names are always capitalised and italicised and inserted in brackets between the genus and species names
submerged	under-water
suborder	the taxonomic rank intermediate between order and (super) family, but not applied in all taxa; Coleoptera consists of four suborders
sublateral	just inside the lateral margin
subsutural	referring to the area narrowly adjacent to the elytral suture (q.v.)
sulcus	(pl. sulci; adj. sulcate): groove
superfamily	the taxonomic rank intermediate between order and family, being a monophyletic (q.v.) assemblage of families, but not applied in all taxa; superfamily names of animals always end with the suffix '-oidea'; e.g. Curculionoidea, the weevils and their close allies.
surfactant	a chemical compound that reduces the surface tension (of water)
suture	(adj. sutural): in Coleoptera, the line where the two elytra meet in resting position
symbiosis	(adj. symbiotic): any intimate, protracted and dependent relationship between members of one species and those of an other
tactile	referring to the sense of touch
tarsal formula	the number of tarsal segments of the front, middle and hind tarsi, respectively (e.g. 5-5-5)
tarsomere	tarsal segment
tarsungulus	in many Coleoptera larvae, the terminal claw-like segment of the leg, formed by fusion of the tarsus and the claw
tarsus	(pl. tarsi; adj. tarsal): the last leg segment of the insect leg, following on the tibia and usually carrying claws and other locomotory structures; consists of one to five tarsal segments
taxon	(pl. taxa): a defined and delimited natural group of organisms of any hierarchical level

tectiform	roof-like; sloping from a central raised area or ridge
tegmen	for adult male Coleoptera genitalia, the single or divided sclerite situated basally of the aedeagus (q.v.), usually divided into a basal piece (q.v.) and parameres (q.v.)
tergite	a dorsal sclerite, especially referring to a single cuticular subdivision
tergum	(pl. terga; adj. tergal): (1) the dorsal surface of any body segment of an insect; (2) the large sclerite (q.v.) on the dorsal surface of a body segment
terrestrial	living on land, not in water
thorax	(adj. thoracic): in insects, the second (middle) major part of the body, bearing the principal organs of locomotion (legs and wings, if present)
tibia	(pl. tibiae; adj. tibial): the fourth segment of the adult insect leg, following on the femur and preceding the tarsus
tomentum	(adj. tomentose): see micropubescence
trachea	(pl. tracheae; adj. tracheal): in insects, a spirally ringed, elastic, internal air tube, part of the respiratory system
tracheal gills	in aquatic insects, flattened or filamentous processes with thin cuticle and a network of tracheoles (q.v.) immediately below the surface, through which oxygen is absorbed from the water
tracheole	a fine tracheal (q.v.) branch
transverse	(1) running at right angles to the longitudinal axis of the body; (2) broader than long, as opposed to longitudinal
trapezoid	in the form of a four-sided figure of which two sides are parallel and two sides are not
tribe	(adj. tribal): the taxonomic rank intermediate between family and genus, being a monophyletic (q.v.) assemblage of genera, but not applied in all taxa; tribal names of animals always end with the suffix '-ini'; e.g. the weevil tribe Bagoini
Trichoptera	caddisflies, treated in Volume 8 of this series of *Guides*
trifid	cleft into three
trochanter	the second segment of the adult insect leg, following on the coxa and preceding the femur; sometimes fused with the femur
true water beetles	water beetles in which the adult stage is submerged for most of the time, and the larvae and pupae may be aquatic or terrestrial
truncate	cut off squarely at the tip
tubercle	(adj. tuberculate): a small knoblike or rounded protuberance of the cuticle
type locality	the geographical location where the primary type specimen(s) that define a scientific name has(have) been found
ultrastructure	(electron) microscopic structure at the tissue and (sub)cellular level
univoltine	having one generation per year

urogomphus	(pl. urogomphi): in many Coleoptera larvae, a sclerotised, paired, dorsal process projecting from the posterior edge of the ninth abdominal segment; may be fixed to the base or jointed, and may be segmented or not
venter	the under-surface of an organism
ventral	referring to the lower side of an organism or structure
vertex	in insects, the top of the head between the eyes and above the frons (q.v.)
ventrite	each of the visible sternites (q.v.) of the abdomen of an insect
vestiture	the general surface covering of an insect, consisting of cuticular outgrowths like setae, scales, etc.
wet-hypomeron	in adult Hydraenidae, the lateral part of the pronotal hypomeron (q.v.), outside of the respiratory bubble, as opposed to the bubble-hypomeron

GLOSSARY OF PLACE NAMES

compiled by

R. Stals

INTRODUCTORY COMMENT

The reader is advised to refer to page x (in the front section of this book) for a map illustrating the post–1994 provinces. The abbreviations described below have also been used extensively in the Appendix of taxa and distribution records (pages 205–229).

POST-1994 PROVINCES OF SOUTH AFRICA

The list below contains abbreviations used in the text as well as the relationships between the 'new' provinces to the previous provinces in South Africa that are often mentioned in older references.

Eastern Cape (EC)	the eastern part of the old 'Cape Province'; includes the former 'states' Transkei and Ciskei.
Free State (FS)	the south-central province of South Africa, equivalent to the old 'Orange Free State'.
Gauteng (GAU)	the small central province which is the economic powerhouse of South Africa, centred around Johannesburg and Pretoria.
KwaZulu-Natal (KZN)	the province on the northern Indian Ocean coast, equivalent to the old 'Natal'.
Limpopo (LIM)	the northern-most province of South Africa, prior to 1994 the northern part of the old 'Transvaal', and formerly the 'Northern Province' (1994–2002); includes the former 'state' of Venda.
Mpumalanga (MPL)	the land-locked north-eastern province, of which the name means 'place where the sun rises'; prior to 1994 the Eastern 'Transvaal'.
Northern Cape (NC):	the vast north-western province of South Africa, south of Namibia and Botswana and north of the other two 'Cape Provinces', in the west lying on

	the Atlantic Ocean; prior to 1994 the northern part of the old 'Cape Province'.
North-West (NW)	the north-central province of South Africa, its eastern half being the former 'western Transvaal' and its western half being the north-east part of the old 'Cape Province'; includes most of the former 'state' of Bophuthatswana. This province is actually neither North nor West, despite its name.
Western Cape (WC)	the south-western-most province of South Africa, prior to 1994 the south-western part of the old 'Cape Province'.

ABBREVIATIONS OF OTHER COUNTRIES AND REGIONS IN SOUTHERN AFRICA AND BEYOND

ANG	Angola
BOTS	Botswana
DRC	Democratic Republic of the Congo
LES	Lesotho
MAD	Madagascar
MWI	Malawi
MOZ	Mozambique
NAM	Namibia
SWZ	Swaziland
ZAM	Zambia
ZIM	Zimbabwe
W Africa	West Africa
C Africa	Central Africa
E Africa	East Africa

REGIONAL NAMES

Afrotropics	= Afrotropical Region, see 'Glossary of Terms'.
Caffraria	a historical name for an area of vague circumscription, at present included in the Eastern Cape Province, KwaZulu-Natal and 'Transvaal'.
'Cape'	refers to the pre-1994 Province of the Cape of Good Hope, and is used in the checklists where it was impossible to pinpoint a locality to one of the three modern 'Cape Provinces'.
Cape Peninsula	the south-western tip of Africa, including Cape Town and Table Mountain.
Cederberg	A mountain range south of Clanwilliam in the Western

	Cape Province.
Drakensberg	a significant mountain range stretching from the Eastern Cape Province, through Lesotho and KwaZulu-Natal, to Mpumalanga.
‘Kalahari’	the vast savanna semi-desert that stretches from the North-West and Northern Cape Provinces of South Africa through virtually the whole of Botswana to the eastern parts of Namibia.
Okavango Delta	vast wetland area in north-western Botswana.
'South Africa'	denoting the Republic of South Africa, and used as such in the checklists (sometimes abbreviated as 'RSA') where a geographical record could not be traced to a specific locality.
Transvaal	this pre-1994 name is used in the checklists (abbreviated to 'TVL') where it was impossible to place a locality in either of the five current provinces into which the 'Transvaal' was relimited.
'Zambezi'	used as such in the checklists where more accurate records are unavailable. This name may refer to an adjacent area in any of the three countries through which the Zambezi River flows.

INDEX OF SCIENTIFIC NAMES

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