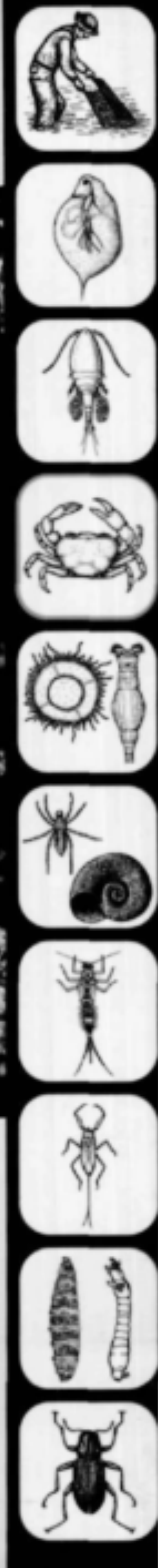
Guides to the

Freshwater Invertebrates of Southern Africa



Volume 4: Crustacea III

Bathynellacea, Amphipoda, Isopoda, Spelaeogriphacea, Tanaidacea and Decapoda

Editors: JA Day, BA Stewart, IJ de Moor & AE Louw

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Prepared for the Water Research Commission

March 2001

WRC Report No. TT 141/01

Obtainable from:

Water Research Commission
PO Box 824
Pretoria
0001

The publication of this guide emanates from a project entitled:
The Invertebrates of South Africa - Identification Keys
(WRC Project No. 916)

ISBN 1 86845 676 5

Printed in the Republic of South Africa

Cover photograph: The Eerste River, Western Cape, in the foothill zone by WR Harding

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 Executive Director, Water Research Commission (address given above). All such correspondence must be marked "For the attention of Project K5/916/0/1").

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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 principle aim of this series is therefore to synthesize 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.

It is a truism that identification guides are perpetually out of date, particularly in terms of nomenclature, due to advances in systematics.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 *Checklist of Aquatic Insects and Mites* (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 to species level. 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 and the Transvaal Museum).

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.

It should be noted that references have been limited to key publications that will assist the reader in finding valuable sources of information. They are therefore referred to as 'Useful References' and may include some publications not cited in the text.

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, and Irene de Moor was contracted to take on the job of managing editor from 1998. 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.

Numerous authors, including those in this book, have contributed time and expertise towards the drafting of the keys. The original 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 South 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 Albany Museum, the South African Museum and the WRC have given organizational support at various stages of the 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 following people and organisations are also acknowledged for their assistance in the production of this book: Ferdy de Moor, Fred Gess, Sarah Gess, Helen James and Carlos Lugo-Ortiz of the Albany Museum for providing constant advice on editorial and technical details relating to the systematics of freshwater invertebrates; Nikki Köhly for her excellent drawings of invertebrates and Nancy Bonsor for her assistance in tracing and touching up figures; 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 pertaining to particular chapters in this volume are given at the end of the chapters concerned.

GEOGRAPHICAL REGION COVERED BY THIS GUIDE

This series of invertebrate guides covers the southern African region, defined as 'south of (and including) the Cunene Catchment in the west and the Zambezi Catchment in the east' (Fig. 1). Distribution records from further afield are, however, sometimes included for various reasons, particularly in cases where keys to particular groups have historically been composed to cover a wider region in Africa. The greatest collection effort has, however, focussed on catchments south of the Limpopo, 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

Fig. 1. Southern Africa: the region covered by this series of invertebrate guides.
KEY: The dark dashed line represents the northern boundary of the Cunene Catchment in the west and the Zambezi Catchment in the east.

distributions. For this reason the term 'records' has been used in preference to 'distribution'.

It is hoped that this series of guides will stimulate a greater collection effort, which will in turn lead to the upgrading of geographical information on the diversity of freshwater invertebrates in southern Africa.

In order to avoid meaningless references to place-names such as the ubiquitous 'Rietfontein', all records are related to countries, provinces or acceptable regional names. To avoid the confusion which often arises in association with regional names, a 'Glossary of place-names' has been compiled (see page 135), and a map of the new provincial boundaries in South Africa is given below (Fig. 2).

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

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INTRODUCTION

MALACOSTRACAN CRUSTACEANS

by

J.A. Day

This volume deals with some very familiar types of crustaceans — the shrimps, prawns and crabs — as well as a number of much less familiar animals like the amphipods and isopods. The next few pages provide an introduction to these interesting and ecologically-important organisms. Some general information on the biology of invertebrates from inland waters is provided in Volume 1 of this series (Day In Prep.) and details of the biology of each of the orders within the Malacostraca are given in the appropriate chapters below.

SYSTEMATIC POSITION OF THE MALACOSTRACA

As pointed out in Volume 2 in this series (Day 1999), crustacean systematists regularly argue about details of the taxonomic relationships between crustaceans and other groups, as well as between one crustacean group and another (e.g. Schram 1986). Indeed, they do not even agree as to whether the Crustacea should be included within the largest of all phyla, the Arthropoda, or whether it should itself be elevated to the level of phylum: the phylum Crustacea (e.g. Manton 1977). Since arthropod systematists have not yet settled the issue, in these volumes we treat the Arthropoda as a single phylum and the taxa Crustacea, Chelicerata and Insecta as subphyla.

Regardless of the arguments of the systematists, all of the crustaceans dealt with in the present volume fall within the class Malacostraca. (The branchiopod crustaceans and so-called 'maxillopods' are the subjects of Volumes 2 and 3 of this series— Day *et al.* 1999 and Day *et al*. In Prep.).

All of the freshwater Malacostraca are placed in the subclass Eumalacostraca, which includes a number of taxa that are of interest to us. The systematists have been busy here too, and many of them will not agree with what follows. That having been said, a relatively simple classification divides the Malacostraca into a number of superorders (sometimes called divisions), three of which are represented in inland waters. They are the Syncarida, which includes the order Bathynellacea; the Peracarida, which includes the orders Amphipoda, Isopoda, Tanaidacea and Spelaeogriphacea; and the Eucarida, which includes the order Decapoda. While most of these are orders of small animals that are so unobtrusive as to have no common names, the Decapoda includes two suborders of well-known animals: the Macrura or prawns and shrimps, and the Brachyura or crabs.

MALACOSTRACAN STRUCTURE

Somites

Internally the malacostracans are generally rather uniform: their bodies always consist of nineteen serially-repeated units called *somites* or (commonly but less correctly) *segments* arranged in three regions or *tagmata*. The head tagma, or cephalon, consists of five somites, the thoracic tagma of eight and the abdominal tagma of six somites. Posteriorly the anus opens ventrally on the last true abdominal somite. The body usually ends in a post-segmental flap or cylinder of tissue called the telson. Minor variations on the theme occur in some taxa, notably the Brachyura or crabs, whose abdomens are much reduced and lie tucked under their bodies.

Appendages

Crustacean appendages come in a bewildering array of shapes and sizes (e.g. Fig. 3) and perform a number of different functions. The key to the remarkable flexibility in structure and function of these appendages lies in the structure of the basic limb. It is perhaps easiest to explain the homologies between limbs of different crustaceans by examining the thoracic limbs of the cephalocarid *Hutchinsoniella*, which is considered by most crustacean authorities to be close to the early crustacean stock. A thoracic limb of *Hutchinsoniella* (Fig. 3A) consists of a basal segment, the *protopodite*, (= protopod) from which arise a number of lobe-like branches. From the midline outwards, these are a series of endites, then an endopodite (= endopod), then an exopodite (= exopod) and finally, most laterally, one or more epipodites (= epipods). Each lobe may become

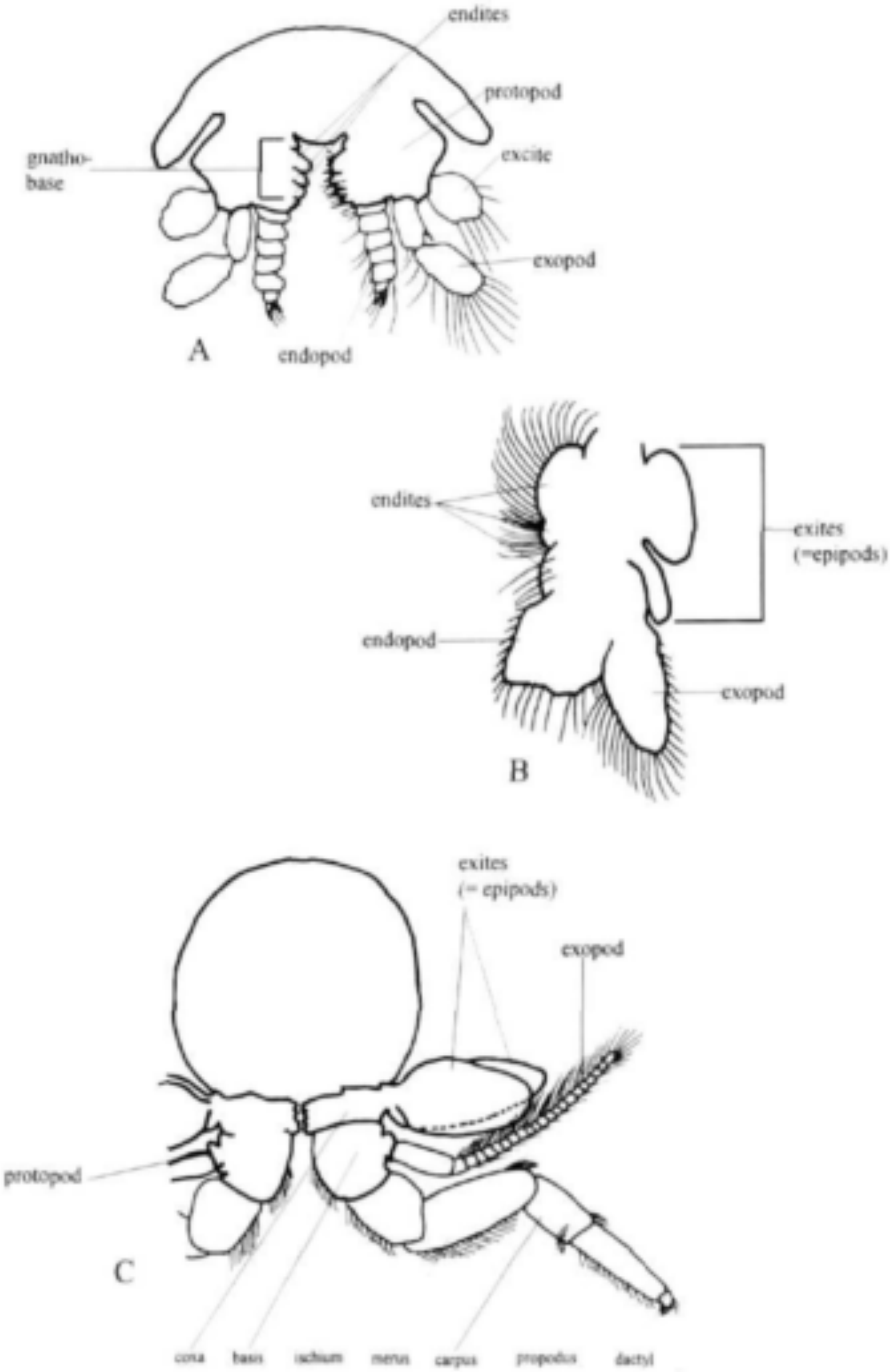

Fig. 3. Diagrammatic representations of trunk limbs of crustaceans: A, a primitive crustacean (*Hutchinsoniella*); B, an anostracan crustacean; C, a syncarid crustacean (not to scale).

highly enlarged, modified or reduced, the pattern of modifications being characteristic of the different taxa. Thus crustacean limbs exhibit an entire spectrum from the very delicate, flattened, leaflike phyllopodous limbs or phyllopods of branchiopods like *Artemia* (Fig. 3B, also see Volume 2 — Day *et al*. 1999), to the strong, sub-cylindrical stenopodous walking limbs or stenopods of the malacostracans (Fig. 3C).

All the lobes of the limbs of branchiopods are flattened and unsegmented. Because these limbs move backwards and forwards metachronally, they provide locomotory power for swimming, as well as generating a filter-feeding current; since they are flattened, they also provide respiratory surfaces.

The stenopodous limbs (Fig. 3C) of malacostracans are more complex. The two proximal segments, the coxa and the basis, which are sometimes called the protopod, subtend a number of branches.

* The *endopod* becomes large and sturdy, with a fixed number of segments (Fig. 3C gives the names of the segments), and is usually used for walking or burrowing.
* During the evolution of the group, the *endites* became heavily chitinized to form a pair of apposable gnathobases (Fig. 3A), used for pushing food forwards towards the mouth and for grinding it up on the way. It is supposed that the mandibles of crustaceans developed from the gnathobases of one pair of limbs by increasing their size, heaviness and musculature whilst reducing the rest of the limb. Some crustacean mandibles still possess sensory or manipulative palps which are the remains of the endopod of the primitive gnathobasic limb.
* An *exopod* may be present and is normally used for swimming. Since the number of segments of an exopod is not fixed, they do not have names.
* One or more *exites* may be present. If they are flattened and respiratory in function they are normally called *epipods* or epipodites.

One of the diagnostic features of crustaceans is the presence of 'biramous' limbs. This idea seems to come from appendages like the antennae, which bear two flagella, or the most common sort of pereiopod found in most malacostracan crustaceans, where only an exopod and an endopod are evident. But since the protopod may bear exites/epipodites as well as an exopod and endopod, the word 'biramous' is sometimes misleading.

The names used for the different kinds of appendages can also be confusing, especially since specialists sometimes use different words for homologous structures. Even the word 'appendage' is sometimes used interchangeably with the words 'leg' and 'limb'. With rare exception, in malacostracans the appendages of the head are two pairs of sensory antennae; a pair of mandibles, used for chewing; and two pairs of maxillae, used for 'tasting' and handling food. All eight pairs of thoracic appendages or thoracopods are stenopodous and are primitively used for walking. In most groups, though, the first one, two or three pairs may be food-handling structures, in which case they are called maxillipeds. The locomotory thoracopods are also known as walking legs or pereiopods (variously spelled as peraeopods or pereopods). Except in the bathynellids and the crabs, each of the first five abdominal somites bears a pair of pleopods, which have different functions in the different groups. The paired appendages of the last abdominal somite (the last three in amphipods) are known as uropods.

Table 1 lists the terminology of the somites, tagmata and appendages of the malacostracans, as used by the authors in this volume. The reader is also referred to the Glossary for further details of terminology.

BIOGEOGRAPHY AND BIODIVERSITY

The number of species of freshwater malacostracans in southern Africa is limited, and many have narrow distribution ranges. In contrast, in most cases there seem to be far more, and more diverse, species of the same orders of malacostracans in Australia. Given that Australia is presently at least as arid as large parts of southern Africa, and that malacostracans are not capable of surviving any extended period of desiccation, we can speculate that at some time since the two continents separated at the end of the Cretaceous Period, some 65 million years ago, southern Africa has been subjected to a period of intense dryness in which taxa like many of the syncarids became extinct.

The malacostracan groups that occur in southern Africa, and that are dealt with in this volume, nonetheless exhibit a wide range of habitat requirements and geographic distributions.

The bathynellids belong to the superorder Syncarida, which is confined entirely to fresh waters and occurs preponderantly in the southern hemisphere. The centre of endemism seems to be Tasmania, where a variety of species occurs. The bathynellids are minute, particularly widespread, syncarids that live in the interstitial spaces between sand grains on or in the beds of streams or ponds in different parts of southern Africa. Because little collecting has been done in interstitial habitats, it is likely that more — perhaps many more — species remain undescribed.

Table 1. Terminology of some morphological features of the malacostracans as used in this volume. The appendages of the head are the same in all taxa.

Tagma	Somite	name(s) of appendage	bathynellids	amphipods	isopods	tanaids	speleogriphaceans	macrurans	brachyurans
Head	1	antenna 1, antennule							
	2	antenna 2, antenna							
	3	mandible							
	4	maxilla 1, maxillule							
	5	maxilla 2, maxilla							
Thorax	1	maxilliped 1	thoracopod 1	maxzilliped	maxilliped	maxilliped	maxilliped	maxilliped 1	maxilliped 1
	2	maxilliped 2	thoracopod 2	gnathopod 1	pereiopod 1 often chelate	pereiopod 1	pereiopod 1	maxilliped 2	maxilliped 2
	3	maxilliped 3	thoracopod 3	gnathopod 2	pereiopod 2	pereiopod 2	pereiopod 2	maxilliped 3	maxilliped 3
	4	pereiopod 1, peraeopod 1	thoracopod 4	pereiopod 1	pereiopod 3	pereiopod 3	pereiopod 3	pereiopod 1	pereiopod 1 (=cheliped)
	5	pereiopod 2	thoracopod 5	pereiopod 2	pereiopod 4	pereiopod 4	pereiopod 4	pereiopod 2	pereiopod 2
	6	pereiopod 3	thoracopod 6	pereiopod3	pereiopod 5	pereiopod 5	pereiopod 5	pereiopod 3	pereiopod 3
	7	pereiopod 4	thoracopod 7	pereiopod 4	pereiopod 6	pereiopod 6	pereiopod 6	pereiopod 4	pereiopod 4
	8	pereiopod 5	Thoracopod 8 often reduced	pereiopod 5	pereiopod 7	pereiopod 7	pereiopod 7	pereiopod 5	pereiopod 5
Abdomen	1	pleopod 1	reduced or absent	pleopod 1	pleopod 1	pleopod 1	pleopod 1	pleopod 1	♂ only
	2	pleopod 2	–	pleopod 2	pleopod 2	pleopod 2	pleopod 2	pleopod 2	♂ and ♀
	3	pleopod 3	–	pleopod 3	pleopod 3	pleopod 3	pleopod 3	pleopod 3	♀ only
	4	pleopod 4	–	uropod 1	pleopod 4	pleopod 4	pleopod 4	pleopod 4	♀ only
	5	pleopod 5	–	uropod 2	pleopod 5	pleopod 5	pleopod 5	pleopod 5	♀ only
	6	uropod	uropod	uropod 3	uropod	uropod	uropod	uropod	none
Telson			pleotelson	telson	telson	pleoteslon	telson	telson	telson

Throughout the world the number of marine species of amphipod far outweighs the number of freshwater species. Freshwater amphipods in southern African do, however, exhibit interesting habitat requirements. The majority of species occur in mountain streams of the south-western Cape, where they exhibit extreme endemism, each of several species being confined to a single tributary of a single different stream. Others — in a different family — are confined to streams in caves, mostly in the Gauteng region, and yet others — in a third family — to stygial waters, primarily in Namibia. Incidentally, two genera (one probably introduced) of semi-terrestrial amphipods are known from forest floors, primarily in the moist regions of South Africa.

Like the amphipods, isopods and tanaids are more commonly found in marine environments than in fresh waters. The few species of freshwater isopods from southern Africa are confined to mountain torrents in the south-western Cape, or to coastal lakes and the upper reaches of estuaries, and all four species of freshwater tanaids occur in coastal lakes and estuaries on the east coast.

Until recently the order Spelaeogriphaceae was monospecific, being known from a single species found in a single cave on Table Mountain (Western Cape). In the last few years two other species, in different genera, have been found in Brazil and Western Australia, indicating a Gondwana origin for the group.

The freshwater decapods of southern Africa provide an interesting contrast to the decapods of most other continents. Whereas the commonest kinds in most areas, including Europe, North America and Australia, are crayfish (some other names are crawfish, marron and yabbies), freshwater crayfish do not occur anywhere in Africa (Hobbs 1988), crabs being the commonest decapods found in southern Africa. Some alien species of crayfish have been introduced into various parts of Africa, but most are presently kept in captive (aquaculture) situations. At least two species have, however, established breeding populations in natural waters. The Louisiana red swamp crayfish, *Procambarus clarkii*, was purposefully introduced into Lake Naivasha in Kenya and has had a major impact on the lake ecology (Lowery & Mendes 1977). A naturalised population of *P. clarkii* has also established in the Crocodile River catchment in Mpumalanga (Schoonbee 1993). The Australian redclaw, *Cherax quadricarinatus*, has recently escaped into the Sand River Dam in the Nkomati catchment in Swaziland and is reported to be rapidly spreading into neighbouring irrigation canals (Dr Johan Engelbrecht, Mpumalanga Department of Environment, Agriculture and Tourism, pers. comm.). Crabs occur throughout southern Africa and probably form the greatest biomass of

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CHAPTER 1

BATHYNELLACEA

by

H.J. Dumont

The members of the Order Bathynellacea (Class Syncarida) are blind, colourless, small crustaceans (usually of 1–2 mm in total length) that occur exclusively in groundwater habitats, the exception being those found in ancient Lake Baikal (Russia). The group has not been extensively studied in southern Africa. Only nine species have been described, but each new collection yields new taxa, usually at the generic level. The known fauna represents but a fraction of the total bathynellid fauna expected to occur in the region. Both the extant families (Bathynellidae and Parabathynellidae) of the Bathynellacea are represented in southern Africa.

Bathynellids are detritivores, but little is known about their habitat requirements, mode of reproduction, and population dynamics. The two families are more or less cosmopolitan, but the genera are not. Quite a few have been used in support of the theory of continental drift, with several cases of amphi-Atlantic disjunct distributions between Africa and South America (e.g. in the genera *Nannobathynella, Cteniobathynella, Leptobathynella*). Species tend to be highly endemic and the majority of species have only been found once. Around 150 species have been described from all over the world (Schminke 1986), including even the Sahara (Dumont 1981). This almost certainly represents only a fraction of the total number of extant species, since almost every new collection yields new genera and species. Asia has been particularly poorly explored, but 22 species are known from Africa (Schminke 1986).

Morphology (Fig 1.1)

The head bears five pairs of appendages, in addition to an unpaired labrum. Antenna 1 is usually composed of five to seven segments, each bearing a number of naked, plumose, or modified setae, and hollow receptor organs or aesthetes. In the family Bathynellidae an exopodite and an endopodite have been retained on antenna 2 and the labrum is flanked by sclerotized outgrowths, the paragnaths. In the Parabathynellidae the exopodite of antenna 2 is absent or reduced to a seta, and the labrum is usually fringed by a number of teeth (Fig. 1.8 D).

The mandibles are composed of a palp and a structure adapted for chewing. These structures are quite different in the two families and the homologies are not well established. In the Bathynellidae the strongly sclerotized mandible ends distally in a cutting edge with a number of strong teeth, whereas in the Parabathynellidae the mandible is characterized by the presence of a proximal process, composed of teeth and spines, which is separated from the cutting edge by an isolated tooth. The mandibular palp in the Bathynellidae is well developed and composed of several segments, whereas this structure is reduced to a seta in the Parabathynellidae (Fig. 1.8B).

Maxilla 1 is simple and composed of two endites. It is conservative in structure throughout the Bathynellidae (Fig. 1.5D). In the more advanced members of the Parabathynellidae, the apical endite may develop one or two claws.

Maxilla 2 is rather generalized in the Bathynellidae and composed of four segments, each ornamented with a number of setae (Figs 1.5E & 1.6E). In the more advanced members of the Parabathynellidae, it may be reduced to two segments, and the apical segment may be armed with one or two strong claws.

The thoracopods are eight in number. The first seven are similar in structure. Each is composed of a protopodite, an exopodite, an endopodite, an epipodite and a number of setiform appendages (Fig. 1.1). The number of segments of the endo- and exopodites varies in different families and genera. The eighth thoracopod is reduced, but still recognizable as a limb (in the Bathynellidae — Fig. 1.1A), whereas it is either rudimentary or absent in the Parabathynellidae (Fig. 1.1B). In males, thoracopod 8 is modified to form a copulatory organ. In the Bathynellidae the degree of modification of the eighth thoracopod is less extreme than in the Parabathynellidae. In the former, a basipodite, exopodite, endopodite and epipodite are usually present (Fig. 1.5 K,L). In advanced Parabathynellidae, the eighth thoracopod is transformed into a compact structure in which the various components are fused and difficult to distinguish (Figs 1.7E, 1.7F, 1.8H).

A reduced pair of pleopods is present on the first abdominal segment in the Bathynellidae (Fig. 1.1A) but not in the Parabathynellidae (Fig. 1.1B).

The conspicuous uropods insert on the terminal segment of the body, which has become fused with the telson to form a pleotelson; they are composed of a basis or sympodite, an exopodite, and an endopodite. The pleotelson is usually provided with (but sometimes lacks), a pair of lateral setae in a subterminal position. The inner margin of the basis and/or endopodite is often fringed with strong spines. The furcal rami insert medially and distally to the uropods, are plate-shaped, and are adorned with spines and bristles (Figs 1.1, 1.5E, 1.6 D, 1.8 G, 1.9 H)

Collection and preservation

Bathynellids can be collected by means of the Chappuis Method in which a hole is dug in the sand or gravel of a riverbed and the upwelled groundwater is scooped up in a plankton net. Animals can be separated from sand and other debris by sieving. They are retained on the coarser mesh sizes (usually above 0.1 mm). Formalin 4% or ethanol 70 % can be used as preservatives and storing agents. Fixation should be done in the field immediately after collecting, unless laboratory facilities are close at hand.

Dissection

Animals are pipetted from a raw sample and transferred to a glass slide onto which a drop of glycerin is added. After clearing, animals can be dissected under a stereoscopic microscope using sharp tungsten needles. If only a few animals are available (as is often the case), a drawing should be made of the whole animal prior to dissecting. The two pairs of antennae (antenna 1 and antenna 2), the mandibles, and both pairs of maxillae must be isolated, as well as thoracopod 8 and the pleotelson.

KEY TO THE FAMILIES OF BATHYNELLACEA

1. Antenna 2 stretched anteriorly, as long as antenna 1, with single-segmented exopodite (e.g. Fig. 1.3B); mandibular palp three-segmented (e.g. Fig. 1.5B); paragnaths present; labrum smooth (Fig. 1.4C); exopodites of thoracopods 1–7 single-segmented (Fig. 1.1A); last thoracopod reduced but leg-like in both male and female; pleopod present and bi-segmented .... **Bathynellidae** (Fig. 1.1A)

– Antenna 2 curved upwards and backwards, shorter than antenna 1, either without an exopodite, or with exopodite reduced to a seta, not a segment (Fig. 1.6A); mandibular palp a single segment or seta (Fig. 1.6G); no paragnaths; labrum denticulate (Fig. 1.8D); exopodites of thoracopods 1–7 usually two-segmented, sometimes one- or up to seven-segmented; thoracopod 8 of female usually reduced to a small tubercle (Fig. 1.1B); pleopod, if present, one-segmented .... **Parabathynellidae** (Fig 1.1B)

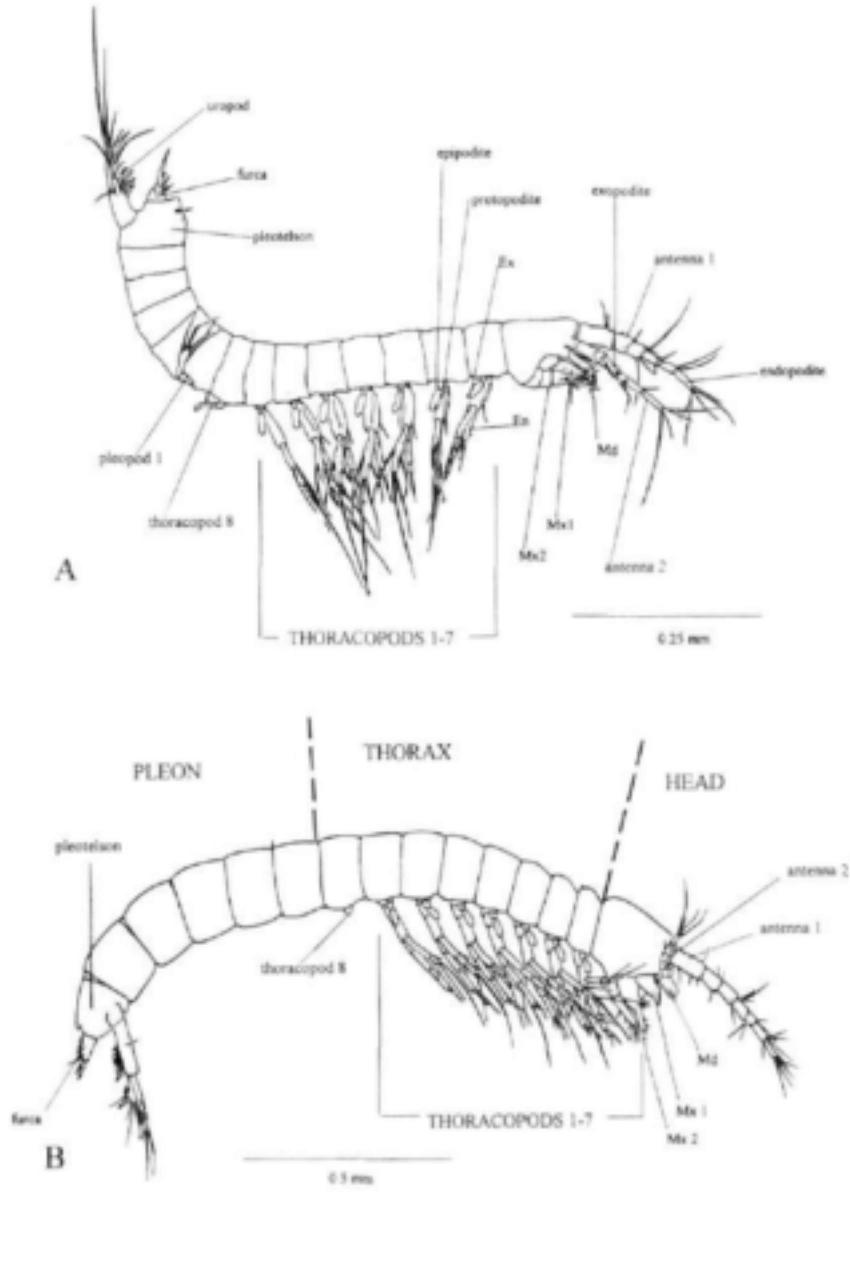

Fig. 1:1. General morphology of Bathynellacea: A, bathynellid; B, parabathynellid.
KEY: En = endopodite; Ex= exopodite; Ep= epipodite; Md = mandible; Mx1 = maxilla 1; Mx2 = maxilla 2; Pr = protopodite.

KEY TO THE SPECIES OF BATHYNELLIDAE IN SOUTHERN AFRICA

1. Endopodites of thoracopods 1–7 four-segmented (Fig. 1.2C) 2
– Endopodites of thoracopods 1–7 three-segmented (Fig. 1.4F)........................... 3

2. Paragnaths each with an apical claw (Fig. 1.2A); cutting tip of mandible with three teeth (arrowed in Fig. 1.2B); endopodite on the last thoracopod of the male longer than exopodite (Fig. 1.2D) .... *Transvaalthynella coineaui* (Fig. 1.2)
– Paragnaths apically produced to form a spine (arrowed in Fig. 1.3C); cutting tip of mandible with four teeth (arrowed in Fig. 1.3); exopodite on the last thoracopod of the male longer than endopodite (Fig. 1.3D) .... *Transkeithynella paradoxa* (Fig. 1.3)

3. Mandibles without teeth (Fig. 1.4C); two apical setae on mandibular palp naked and apically widened (arrowed in Fig. 1.4C); the last thoracopod of male without a penis but with four setae on exopodite (Fig. 1.4D).............. .... *Agnathobathynella ecclesi* (Fig. 1.4)
– Mandibles with two apical teeth and three proximal teeth (Fig. 1.5 B,C); two apical setae on mandibular palp setiform, one naked, the other plumose (Fig. 1.5B); the last thoracopod of male with a penis, and with five setae on exopodite (Fig. 1.5L) .... *Nannobathynella africana* (Fig. 1.5)

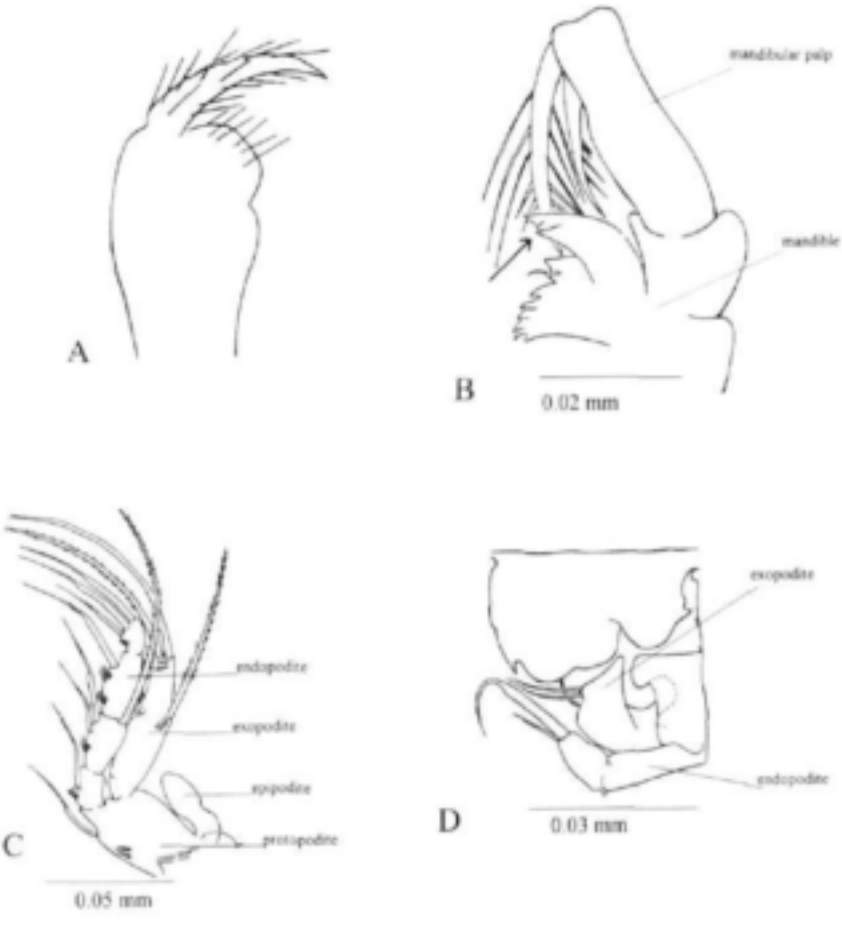

Fig. 1:2. *Transvaalthynella coineaui.* A, paragnath; B, mandible and palp; C, thoracopod 5; D, thoracopod 8 (male).

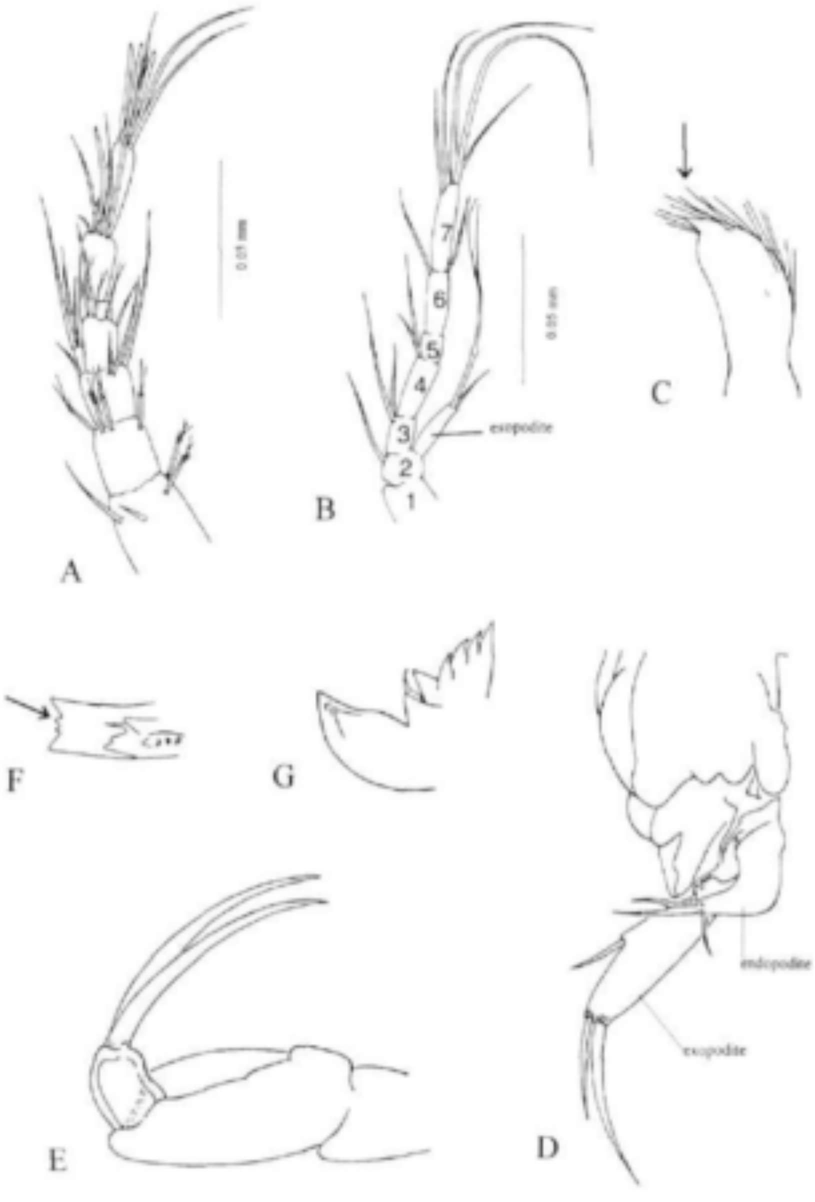

Fig. 1:3. A–G. *Transkeithynella paradoxa*: A, antenna 1; B, antenna 2; C, paragnath; D, thoracopod 8 (male). E, maxillary palp; F–G, tip of mandible in front and side views respectively.

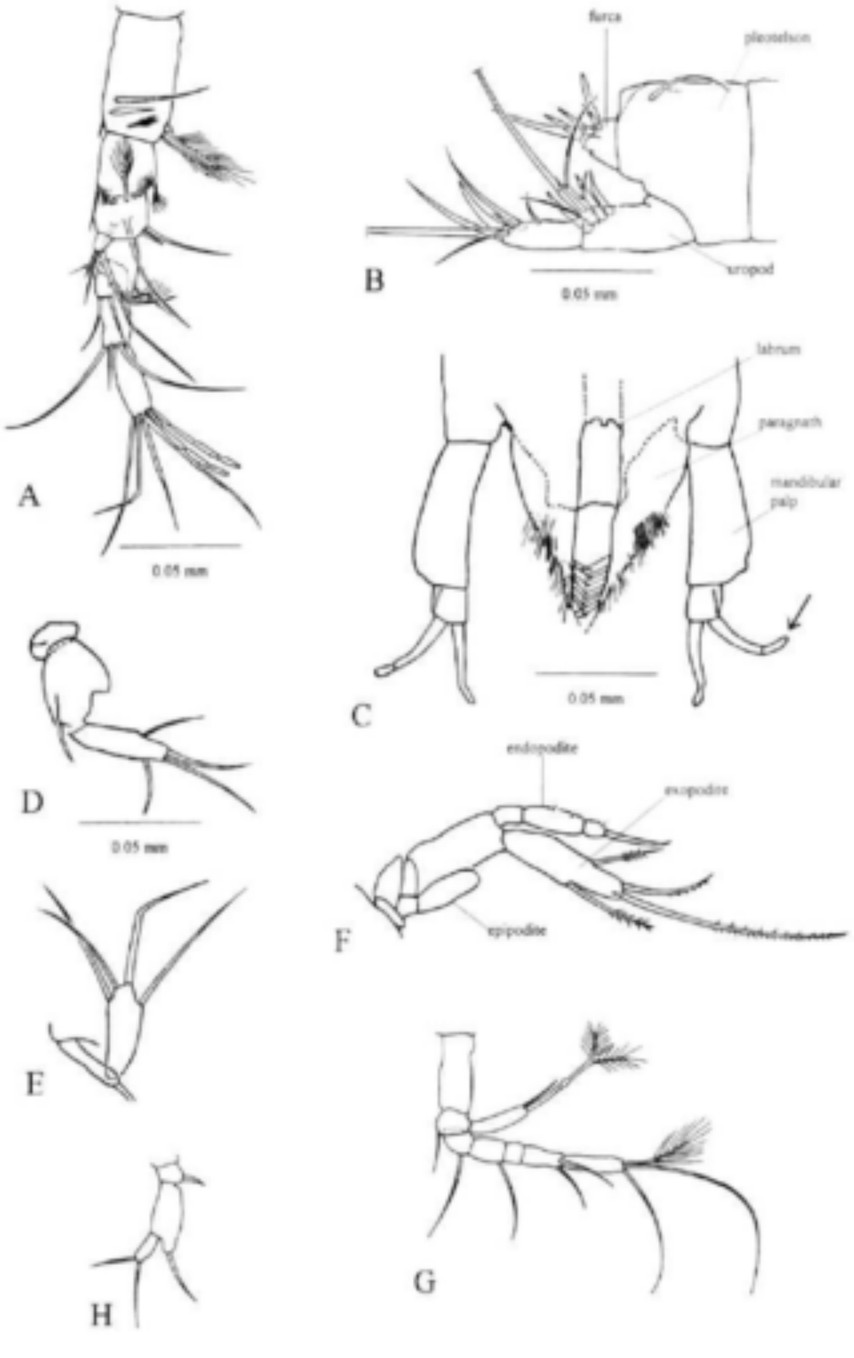

Fig. 1:4. *Agnathobathynella ecclesi*: A, antenna 1; B, pleotelson and furca, lateral view; C, labrum, paragnaths and mandibular palp; D, thoracopod 8 (male); E, pleopod; F, thoracopod 7; G, antenna 2; H, thoracopod 8 (female).

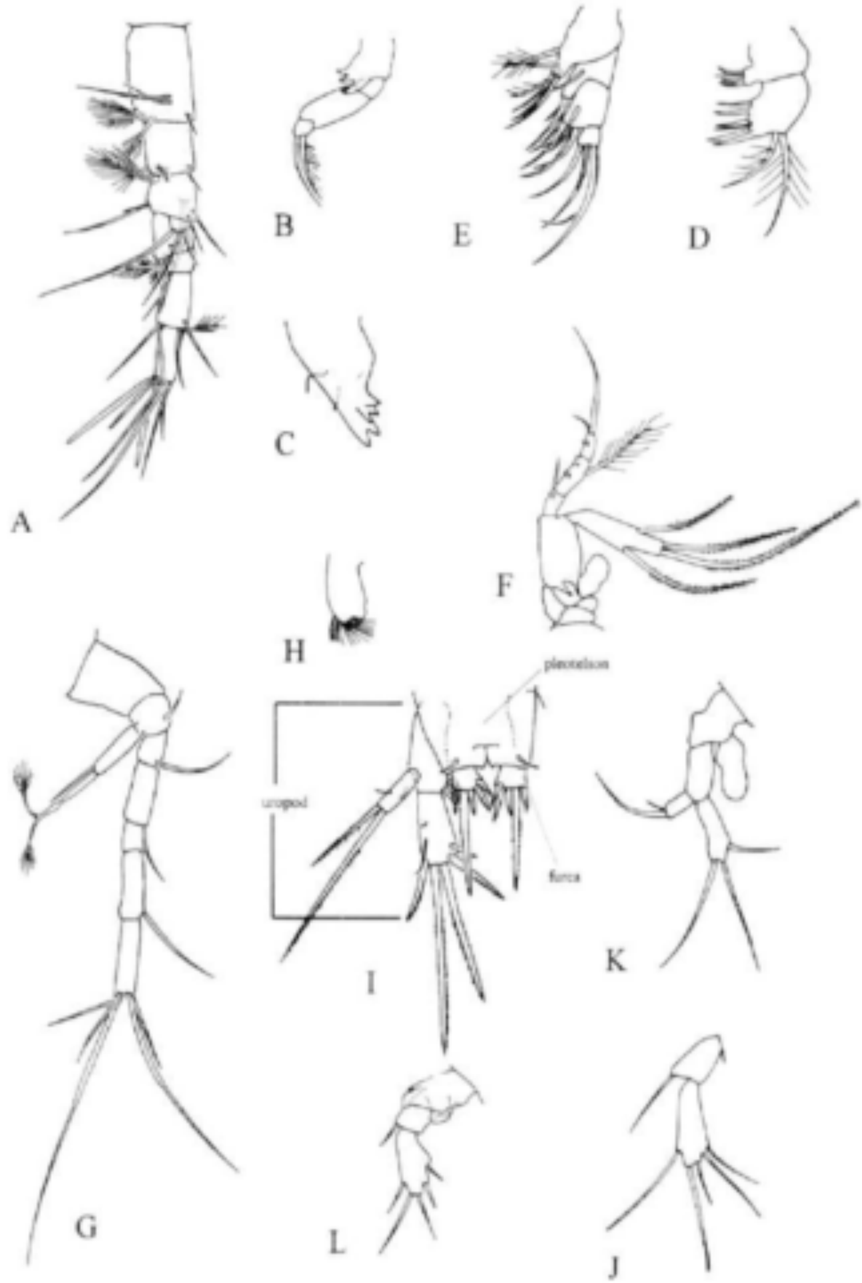

Fig. 1.5. *Nannobathynella africana*: A, antenna 1; B, mandible and palp; C, mandible, cutting edge, D, maxilla 1; E, maxilla 2; F, thoracopod 6; G, antenna 2; H, paragnath; I, pleotelson with left uropod and both furca (dorsal); J, pleopod 1 (female); K, thoracopod 8 (female); L, thoracopod 8 (male).

KEY TO THE SPECIES OF PARABATHYNELLIDAE IN SOUTHERN AFRICA

1. Maxilla 2 with one or two terminal claws (Fig. 1.8I, J); antenna 2 five-segmented (Fig. 1.8E)........ 2
– Maxilla 2 without terminal claws; antenna 2 two- (Fig. 1.7A) or three-segmented 3

2. Maxilla 2 with one strong terminal claw (Fig. 1.8J); pleotelson without a seta .... *Leptobathynella* (Fig. 1.8J)
– Maxilla 2 with two terminal claws; pleotelson with a pair of lateral setae (Figs 1.6D, 1.8G) 4

3. Antenna 2 three-segmented (Fig. 1.6A); antenna 1 seven-segmented; exopodites of thoracopods 1–7, two-, three- or four-segmented (Fig. 1.6B, C); apex of mandible with five teeth (arrowed in Fig. 1.6G) .... *Afrobathynella trimera* (Fig. 1:6)
– Antenna 2 two-segmented (Fig. 1.7A); antenna 1 six-segmented (Fig. 1.7B); exopodites of thoracopods 1–7 all single-segmented; apex of mandible with eight teeth (arrowed in Fig. 1.7C) .... *Nunubathynella dimera* (Fig. 1.7)

4. Spined processes of mandible with three teeth, proximal one not bifid (arrowed in Fig. 1.8B); basis of uropod with terminal spine (arrowed in Fig. 1.8G) at best one-third longer than proximal spine (in Fig. 1.8G) .... *Cteniobathynella caparti* (Fig. 1.8A–I)
– Spined processes of mandible with three teeth, but proximal one bifid (arrowed in Figs 1.9 F–G); basis of uropod with terminal spine (one arrow in Fig. 1.9C) more than twice as long as proximal spine (two arrows in Fig. 1.9C) .... *Ctenophallonella mutlumuviensis* (Fig. 1.9)

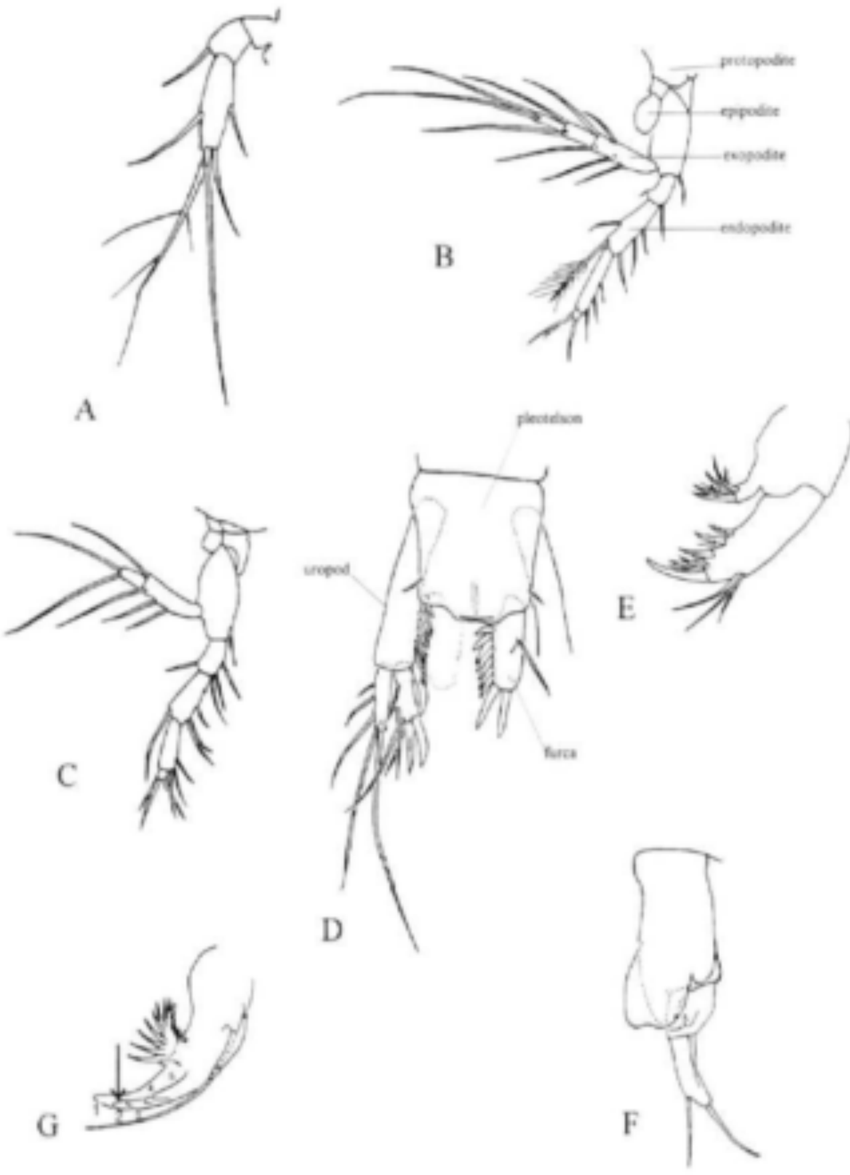

Fig. 1.6. *Afrobathynella trimera*: A, antenna 2; B, thoracopod 3; C, thoracopod 1; D, pleotelson with left uropod and right furca (dorsal); E. maxilla 2; F, thoracopod 8 and penis (male); G, mandible.

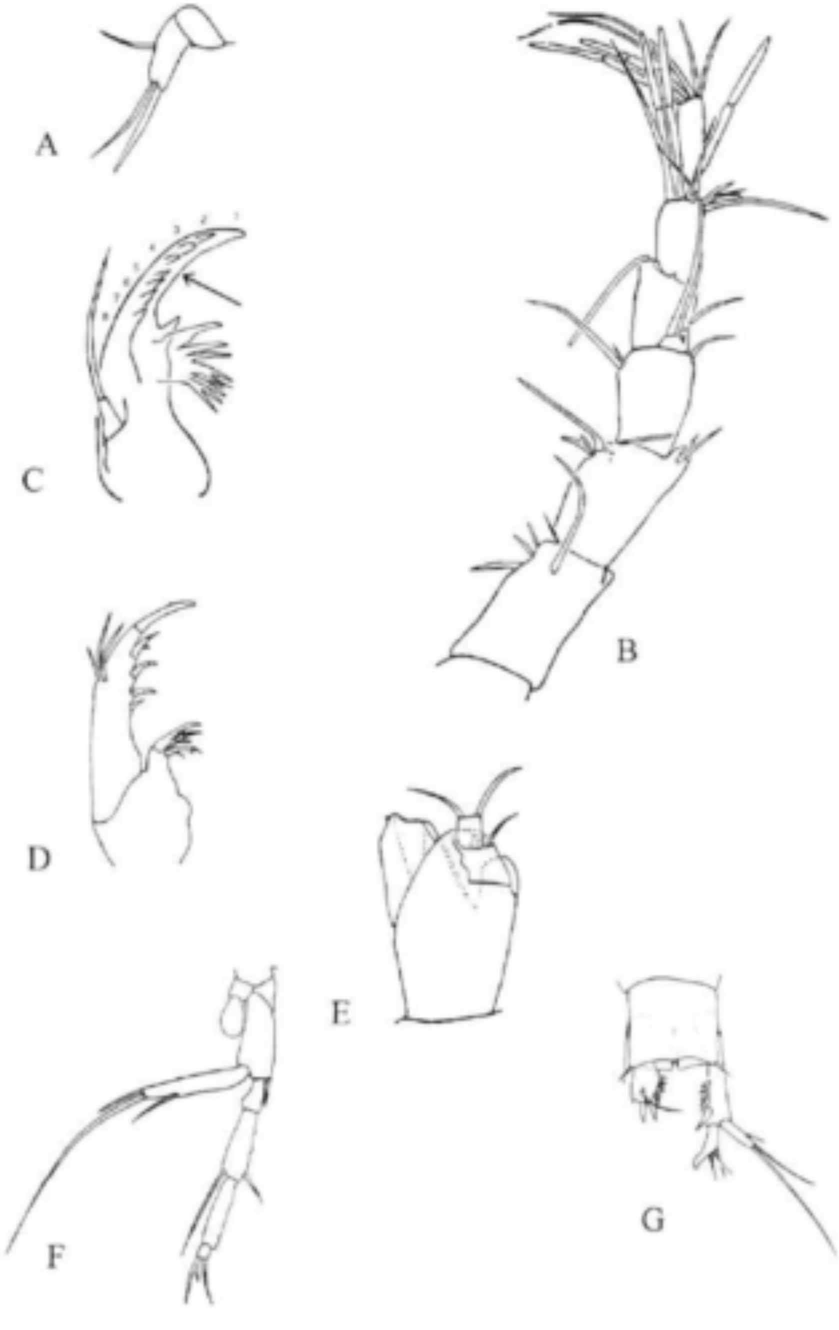

Fig. 1.7. *Nanubathynella dimera*: A, antenna 2; B, antenna 1; C, mandible; D, maxilla 2; E, thoracopod 8 (male); F, thoracopod; G, pleotelson and furca.

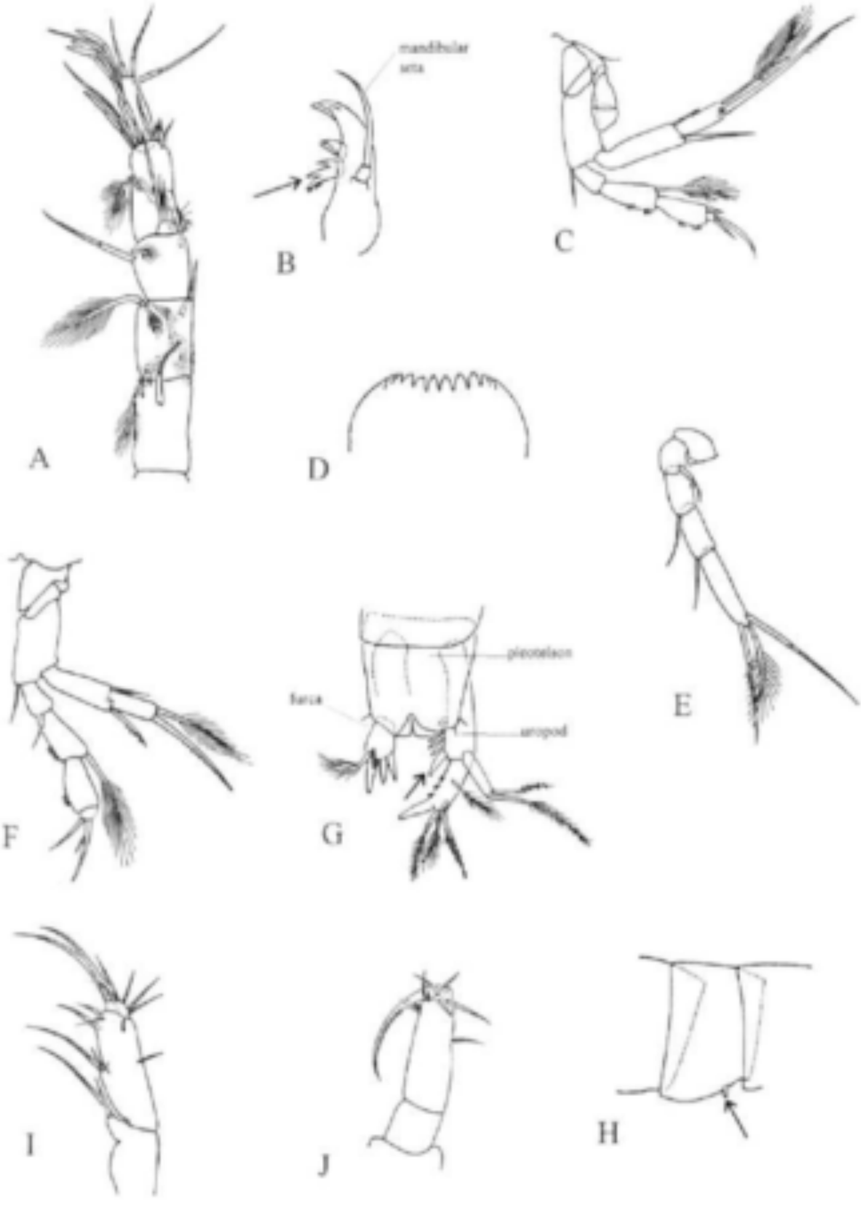

Fig. 1.8. A–I, *Ctenobathynella caparti*: A, antenna1; B, mandible; C, thoracopod 2; D, labrum; E, antenna 2; F, thoracopod 1; G, pleotelson, left furca and right uropod (dorsal view); H, reduced thoracopod 8 of female; I, maxilla 2. J, *Leptobathynella* sp., maxilla 2.

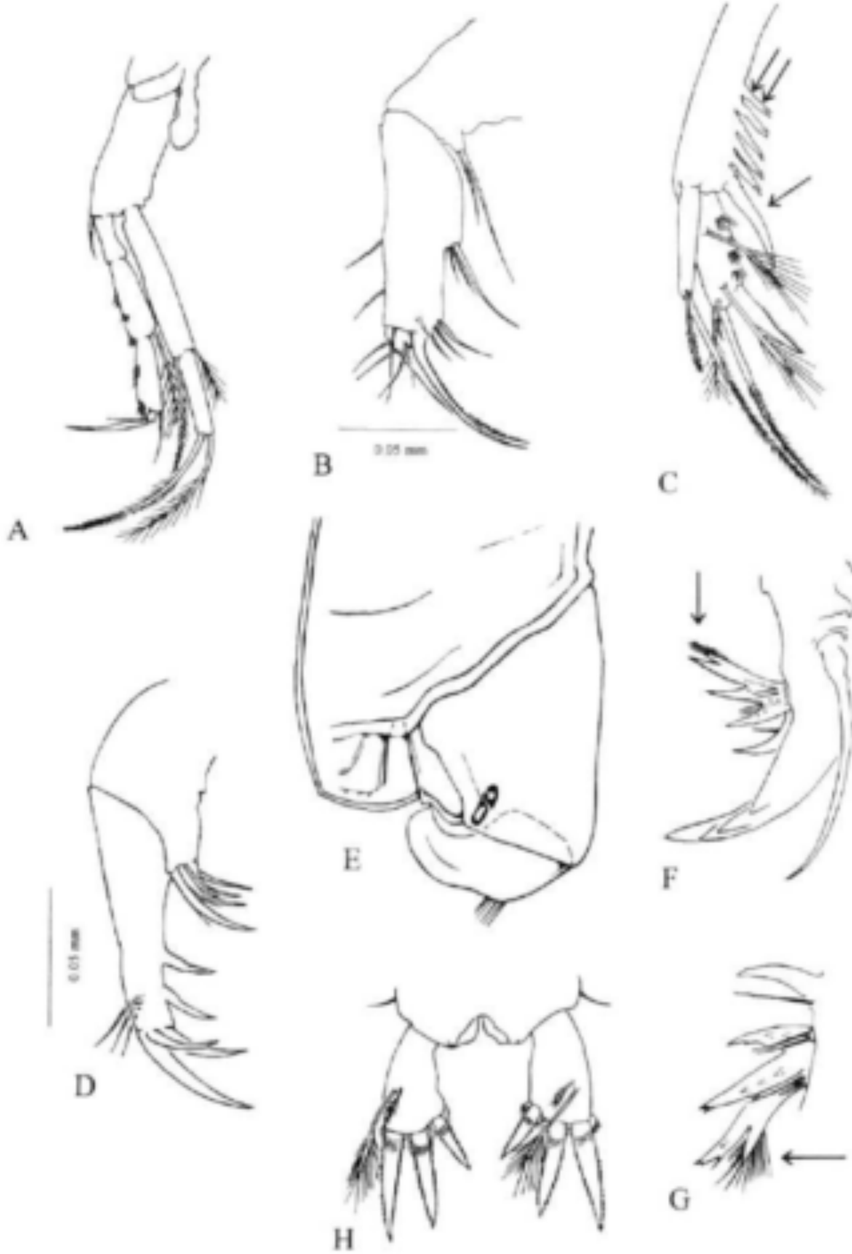

Fig. 1.9. *Ctenophallonella mutlumaviensis*: A, thoracopod 4; B, maxilla 2; C, uropod; D, maxilla 1; E, thoracopod 8 (male); F–G, mandible; H, furcal rami, dorsal view.

SPECIES LIST AND DISTRIBUTION RECORDS IN SOUTHERN AFRICA

Family **Bathynellidae**

Agnathobathynella ecclesi Schminke, 1980

This species was discovered in gravels of the Mwanza River, Malawi.

Nannobathynella africana Schminke & Wells, 1974

This species occurs in gravels of the Nuanetzi River, Zimbabwe. A second species in this genus is known from Brazil.

Transvaalthynella coineaui Serban & Coineau, 1975

This species was collected at the Kruger Park, in the bed of the Mutlumwi River, an tributary of the Sabie, near Skukusa (Mpumalanga).

Transkeithynella paradoxa Serban & Coineau, 1975

This species was discovered in the same sample as the preceding species.

Family **Parabathynellidae**

Leptobathynella sp.

An unnamed species of this largely South American genus was stated to occur in a sample ('Koega River near Smitskraal, Eastern Cape'), which also contained the next two species.

Afrobathynella trimera Schminke, 1976

This species represents a monotypic genus, discovered together with *Leptobathynella* sp. and *Nunubathynella dimera* Schminke.

Nunubathynella dimera Schminke, 1976

This species is only known from its type locality (see above).

Cteniobathynella caparti (Fryer, 1957)

This species is a representative of a predominantly African genus, with few species known from southern Africa, and one in The Levant. It was collected in groundwater from the beaches of Lake Bangweulu (Central Africa). It is probable that more species of *Cteniobathynella* (also see *Ctenophallonella*) will eventually be found in southern Africa.

Ctenophallonella mutlumuviensis Coineau & Serban , 1978

This species has been recorded from gravels of the Mutlumwi River, Kruger Park (Mpumalanga). The genus is extremely close to *Cteniobathynella*.

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CHAPTER 2

AMPHIPODA

by

C.L. Griffiths & B.A. Stewart

The order Amphipoda contains over 6 000 species worldwide and is divided into four suborders, two of which—the Hyperiidea and Caprellidea—are exclusively marine and are thus not considered further in this chapter. The two remaining suborders, the Gammaridea and Ingolfiellidea, each include both marine and freshwater forms.

The Gammaridea are by far the largest of the suborders and incorporate about 80% of all known amphipod species. Gammarids show a great range of morphological types, feeding adaptations and ecological habits and include numerous benthic marine and freshwater species, as well as a small number of terrestrial forms which are confined to moist forest habitats, mostly in the Southern Hemisphere (Griffiths 1999). Gammarids are amongst the most diverse and abundant macroscopic invertebrate groups in benthic marine environments. Most species are free living or tube dwelling, but a few are commensal or ectoparasitic. Feeding habits are equally varied, most species being scavengers or detritus feeders, while others are carnivorous or use their setose second antennae or other appendages to filter fine organic particles from the water. More than 300 species are known from the seas around southern Africa. The marine fauna of the region (as known at that time) is described by Griffiths (1976a) in his *Guide to the Benthic Marine Amphipods of Southern Africa*. Readers wishing to identify material from marine or estuarine systems are referred to the keys in that volume.

The transition from marine to freshwater appears to have occured many times within the Amphipoda and a large number of freshwater groups occur, most with clear relationships to a marine taxon (Barnard & Barnard 1983). The southern African freshwater gammarid fauna presently consists of two taxonomically and geographically distinct clusters of species.

These are a group of 26 species of the family Paramelitidae from streams and sometimes caves in the western and southern Cape and eight described species of *Sternophysinx* (family Sternophysingidae), most of which are restricted to cave habitats along a more northerly arc from Kwa-Zulu–Natal and the former Transvaal to the Northern Cape and central Namibia. Paramelitids are amongst the most abundant macroscopic organisms in the headwaters of mountain streams in the Western Cape, where they have shown remarkable diversification (for phylogenetic analysis see Stewart & Griffiths 1995), and perform an important ecological function as shredders of leaves. Little is known about the biology of sternophysingids, but they are presumed to subsist on bat guano and other organic debris falling into cave pools. The Paramelitidae are also represented in Australia, but the Sternophysingidae are endemic to southern Africa.

The Ingolfiellidea are a small and aberrant suborder of some 30 very elongate, blind species with greatly reduced coxae, epimeral plates and pleopods. Its members are found only in the groundwaters of springs, caves and wells, or in the interstitial spaces of marine sediments. Their distribution shows a remarkable range from the deep sea (over 4 800 m), through shallow water and intertidal sands to freshwater springs, wells and caves. There are only two families, one of which (the Metaingolfiellidae) comprises a single monospecific genus recorded from a well in southern Italy and which is somewhat intermediate in structure between the Gammaridea and the remaining Ingolfiellidea. The second and larger family (the Ingolfiellidae) contains two distinct elements: a group of small (< 3 mm) interstitial forms of the genus *Ingolfiella*, that are widely distributed in marine and freshwater sands, and a smaller number of large, cave-dwelling forms that are restricted to Africa and that concern us here.

The habits of African ingolfiellids, all of which are known from only a handful of isolated samples, are poorly understood. They are thought to subsist on bat manure, micro-organisms, or rotting plant debris. In contrast to gammarids, their brood plates are poorly developed and incapable of holding the eggs, which are thus presumed to be deposited on the substratum. The southern African freshwater ingolfiellid fauna presently consists of five species, all restricted to subterranean caves and groundwaters in northern Namibia. A sixth species is known from Zambia, Zaire and Zimbabwe (Griffiths 1989, unpublished records), but is not included here since it lies outside the study area. Another possible species has been reported from the Northern Cape, but is yet to be described. Since the cave environment has been poorly sampled, and most of the existing species have only recently been described, it is very likely that additional species will be discovered in the near future.

General description

Amphipods are generally small (5–20 mm), slender, shrimp-like crustaceans with laterally compressed bodies and no carapace. The typical body plan is illustrated in Figure 2.1. The mouthparts—which consist of an upper and lower lip, a pair of mandibles, two pairs of maxillae and a pair of maxillipeds—are clustered beneath the head, which bears two pairs of well-developed antennae, and generally a single pair of sessile eyes (absent in some species). This is followed by seven clearly visible thoracic or pereon segments, each of which gives rise to a pair of legs. The first two pairs usually bear prehensile claws and are termed gnathopods 1 and 2, whereas the remaining five pairs are termed pereopods 3–7. The first or basal segment (coxa) of each limb is modified into a flattened, shield-like coxal plate, emphasizing the appearance of lateral body compression. The remaining segments, usually referred to as 'articles', are numbered sequentially from 2–7, article 7 being the pointed dactyl or 'finger'. In the gnathopods, article 6 is expanded and article 7 closes against it (like a finger) to form the claw. The portion of article 6 against which the dactyl closes is termed the palm. Bladder-like gills originate from the inner surface of the coxae of some or all the pereopods. A series of ventral brood plates are also found on the medial surface of the anterior pereopods of females and interlock to form a brood pouch, or marsupium, in which the eggs are incubated.

The abdomen is not strongly differentiated from the thorax and consists of six body segments. The first three of these are termed pleon segments and typically have lateral epimeral plates and paired feather-like ventral limbs (called pleopods), which are used both for swimming and to generate a respiratory current. The last three segments are called urosomites and together form the urosome. Each bears a pair of uropods, which typically consist of a basal peduncle and paired one- or two-segmented rami, although they can be variously reduced. The telson or terminal flap of the last urosomite can be fleshy or flattened, and entire or cleft, and is a useful taxonomic feature.

The following keys apply only to the strictly freshwater Amphipoda of South Africa and Namibia. Estuarine forms—some of which can penetrate into regions of very low salinity—are not included, but are dealt with by Griffiths (1976a). One aberrant freshwater site which has also been excluded is Lake Sibaya in northern KwaZulu–Natal. This is now functionally a freshwater lake, but it is of marine origin, having been formed by the blocking up of an old estuary. As a result it contains a fauna made up of relict estuarine forms, which are dealt with by Griffiths (1976a). One

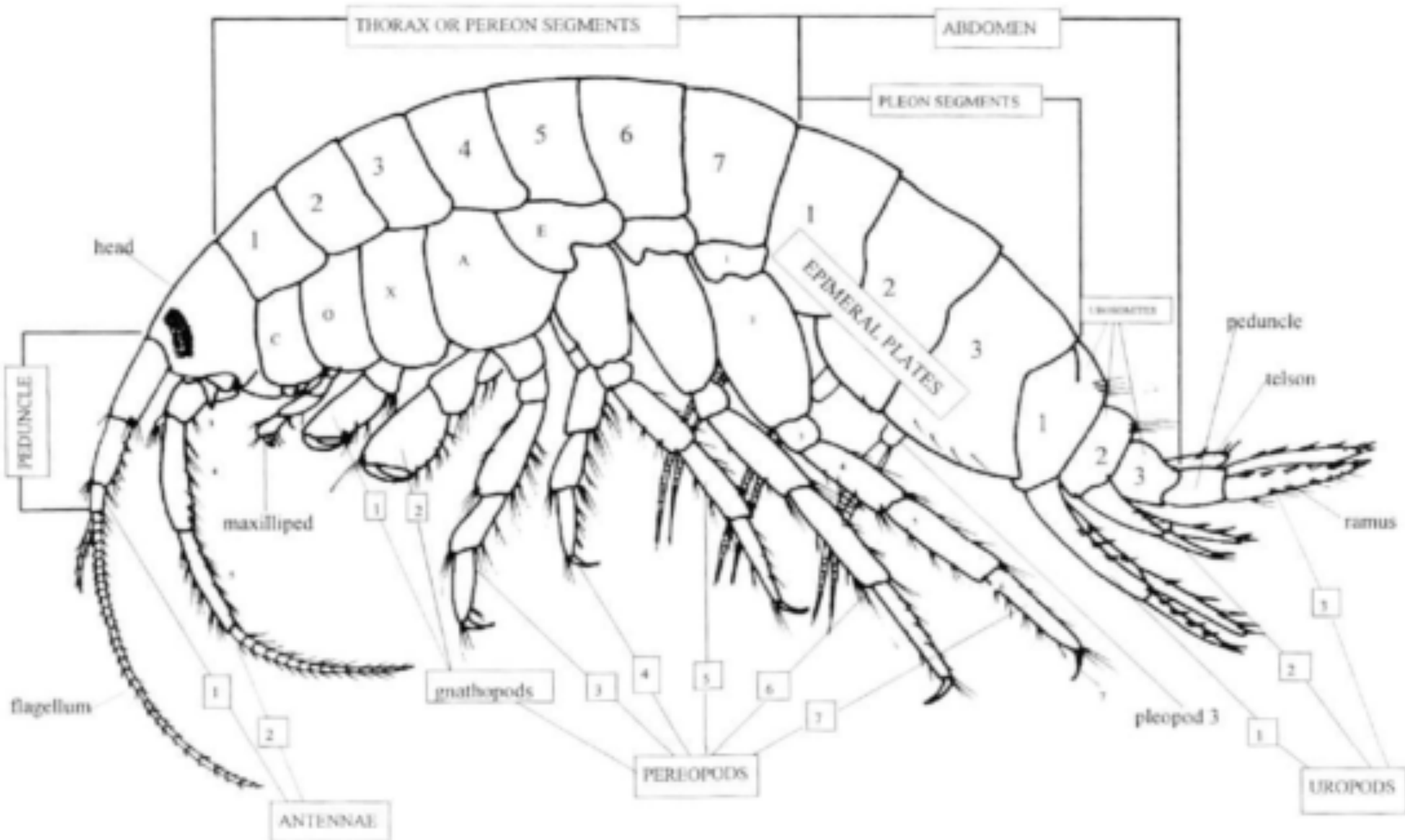

Fig. 2.1. The typical amphipod body plan showing terminology applied to the main body parts.

additional species, also of marine evolutionary origin, but endemic to Lake Sibaya, has also been described by Griffiths (1976b) and subsequently placed into its own endemic family—Bolttsiidae. Although included in the list of fauna at the end of this chapter, this and other 'estuarine' species found in Lake Sibaya are excluded from the keys below.

KEY TO FAMILIES OF SOUTHERN AFRICAN FRESHWATER AMPHIPODS

1. Body elongate, cylindrical; coxae minute, well separated; pleopods reduced to unbranched lobes; epimeral plates absent (Fig. 2.2A); presently known only from caves in Namibia .... **Ingolfiellidae** (p. 32)
– Body laterally compressed; coxae large, touching or overlapping one another; pleopods large, with peduncle and two branching rami; epimeral plates conspicuous (Fig. 2.1) 2

2. Gnathopod 2 larger than gnathopod 1 (Fig. 2.2B); coxal gills on pereopod 7 usually present (one exception); pereon segments lacking mid-ventral sternal processes; telson deeply cleft; Western Cape .... **Paramelitidae** (p. 38)
– Gnathopod 2 smaller than, or equal to, gnathopod 1 (Fig. 2.2C), no coxal gill on pereopod 7; pereon segments with bladder-like sternal processes on mid-ventral surface; telson entire or notched; KwaZulu–Natal to Namibia, very rarely Western Cape .... **Sternophysingidae** (p. 34)

Family **Ingolfiellidae** Hansen, 1903

The classification and distribution patterns of southern African Ingolfiellidae have been reviewed by Griffiths (1989). Subsequently, one further species has been described (Griffiths 1991a), bringing the total number of freshwater species within the geographical limits of the present study to five. A sixth species has recently been reported from the Northern Cape Province , but this remains undescribed. All species are confined to caves and wells and have very restricted distributions, making their conservation status a cause for concern (Irish 1991).

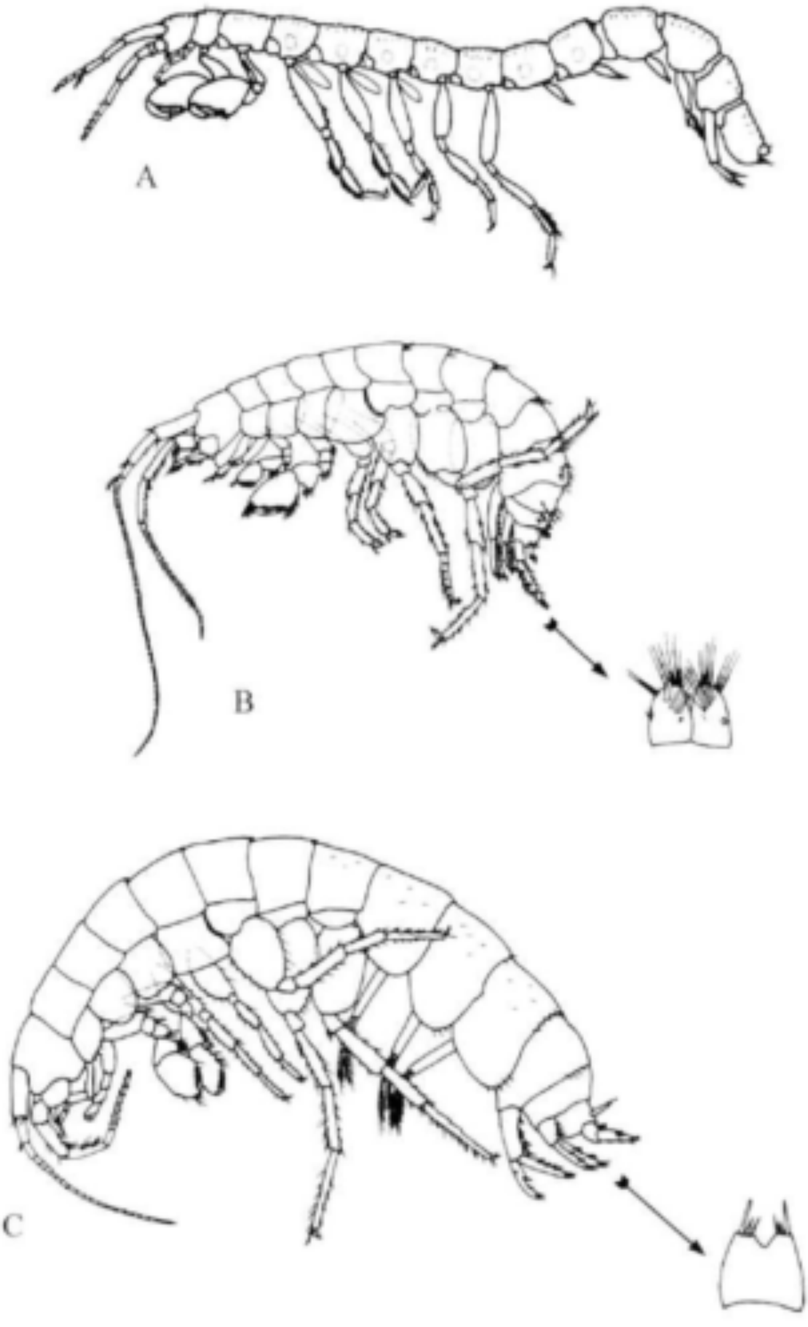

Fig. 2.2. Representatives of the three families of freshwater amphipod found in southern Africa: A, Ingolfiellidae — *Trogloleleupia gobabis*; B, Gammaridae — *Paramelita capensis*; C, Sternophysingidae — *Sternophysinx hibernica*. Details show telson of B and C in dorsal view

KEY TO THE SOUTHERN AFRICAN SPECIES OF INGOLFIELLIDAE

1. Pleopods and uropod 3 reduced to minute unsegmented conical projections; gnathopod 2 as long as pereopod 3 (Fig. 2.3A)........ *Stygobarnardia caprellinoides*
– Pleopods flattened triangular or pointed plates; uropod 3 consisting of a peduncle and single, often minute, ramus (Fig. 2.3B–D); gnathopod 2 shorter than pereopod 3 (Fig. 2.2A) (*Trogloleleupia*) 2

2. Pleopods broadly triangular; uropod 3 extending well beyond tip of telson (Fig. 2.2B, C) 3
– Pleopods slender, tapering to a point posteriorly; uropod 3 minute, not extending beyond tip of telson (Fig. 2.3D, E) 4

3. Uropods 2 and 3 slender, not spinose dorsally (Fig. 2.3B) .... *Trogloleleupia eggerti*
– Uropods 2 and 3 robust, rami of uropod 2 and peduncle of uropod 3 each with a prominent row of spines dorsally (Fig. 2.3C) .... *Trogloleleupia dracospiritus*

4. Lenticular organs (large opaque rings on lateral surfaces of body segments) visible (Fig. 2.2A); palm of gnathopod 2 with two spines proximally (Fig. 2.3F); articles 4 and 5 of pereopods 3 and 4 densely setose anteriorly (Fig. 2.3I) .... *Trogloleleupia gobabis*
– Lenticular organs not visible; palm of gnathopod 2 with one stout spine proximally (Fig. 2.3G); articles 4 and 5 of pereopods 3 and 4 with only a few isolated setae (Fig. 2.3H) .... *Trogloleleupia nudicarpus*

Family **Sternophysingidae** Holsinger 1992

The first representative of this group to be described was named *Eucrangonyx robertsi* by Methuen (1911), but was later transferred to the genus *Crangonyx* by Schellenberg (1936), and then once again to a new genus, *Sternophysinx*, by Holsinger & Straskraba (1973). At the same time these authors described two additional species from caves and spring runs in South Africa. Other *Sternophysinx* species have been described by Griffiths (1981, 1991b), and Griffiths & Stewart (1996), bringing the total number of species in the genus to eight. The family Sternophysingidae is endemic to southern Africa and all its members are restricted to pools and streams in caves or, more rarely, to spring runs. Although they may be common within these water bodies, they are thus very restricted in distribution and most are known only from a few samples.

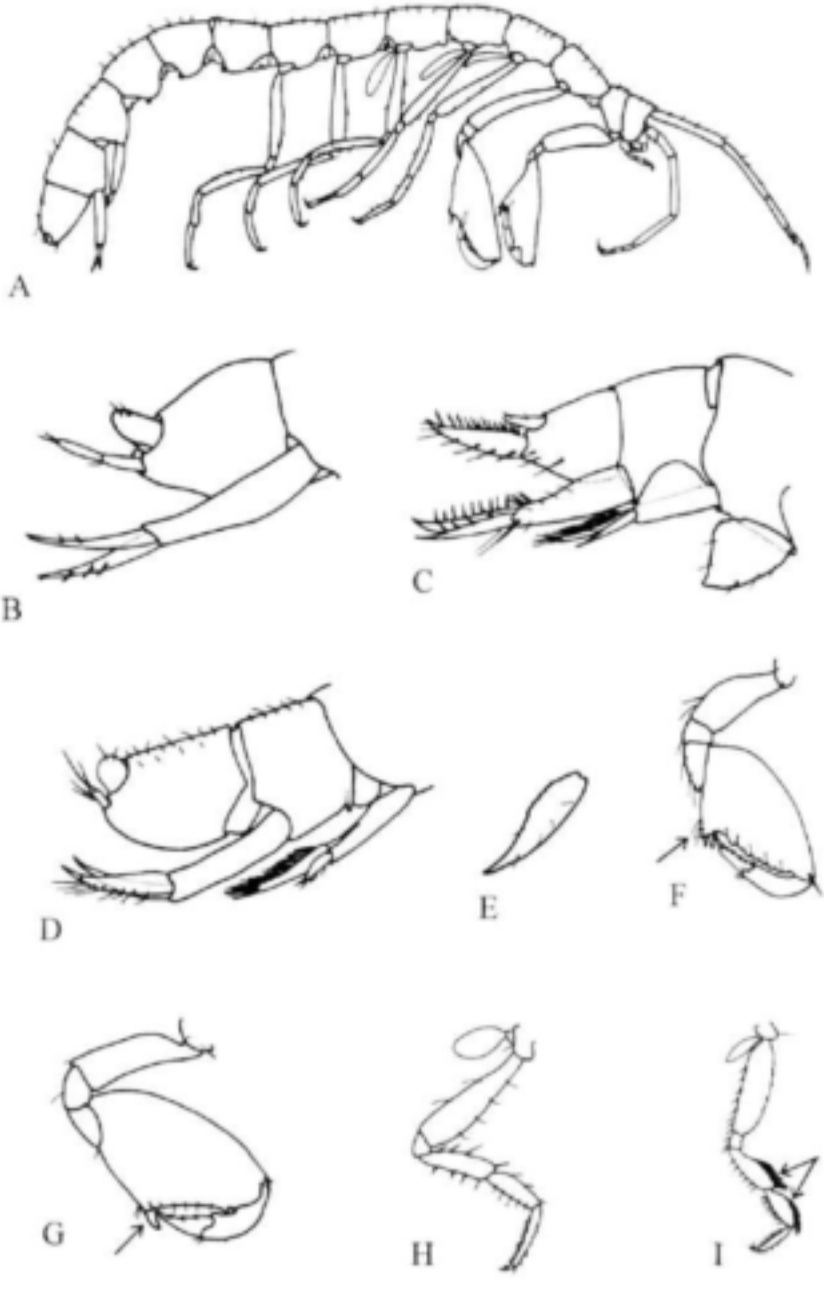

Fig. 2.3. Ingolfiellidae: A, *Stygobarnardia caprellinoides*, lateral view; B, *Trogloleleupia eggerti*, posterior part of urosome; C, *T. dracospirinus*, posterior part of urosome and pleopod 3. D–E, *T. gobabis*: D, posterior part of urosome; E, pleopod 3. F, *T. gobabis*, gnathopod 2. G, *T. nudicapus*, gnathopod 2. H, *T. nudicarpus*, pereopod 3. I, *T. gobabis*, pereopod 4.

KEY TO THE SOUTHERN AFRICAN SPECIES OF *STERNOPHYSINX*

1. Article 2 of pereopod 5 (and usually of 6 and 7) broad and expanded into a posterior lobe (Fig. 2.4H) 2
– Article 2 of pereopods 5–7 narrow and distally tapering, not expanded into a posterior lobe (Fig. 2.4A).......... 6

2. Article 2 of pereopods 3 and 4 expanded anteriorly into a rounded lobe (Fig. 2.4B).......... 3
– Article 2 of pereopods 3 and 4 more or less parallel-sided, not swollen anteriorly (Fig. 2.4C).......... 4

3. Uropod 3 long (outer ramus about four times length of peduncle—Fig. 2.4D), projecting well beyond tip of uropod 2; posterior margin of telson slightly concave (Fig. 2.4 E) .... *S. basilobata*
– Uropod 3 short (outer ramus 2.5 times length of peduncle—Fig. 2.4F), hardly projecting beyond tip of uropod 2; apex of telson cut into a V–shaped notch (Fig. 2.4G) .... *S. hibernica*

4. Articles 5 and 6 of pereopod 5 (and article 6, or 5 and 6, of pereopods 6 and 7) with combs of long setae (Fig. 2.4I); dactyls of pereopods 5–7 with two or more accessory spines 5
– Articles 5 and 6 of pereopods 5–7 spinose, but without elongate setae (Fig. 2.4H); dactyls each with a single accessory spine .... *S. robertsi*

5. Gnathopod 1 with article 6 or 'hand' broad and powerful, hind margin (from tip of dactyl to origin of segment) longer than palm and distinctly separated from it by change in angle (Fig. 2.4J); adult size *c.* 15 mm .... *S. megacheles*
– Gnathopod 1 with article 6 or 'hand' not as broad or powerful, hind margin much shorter than palm and indistinctly separated from it (Fig. 2.4K); adult size < 8 mm .... *S. filaris*

6. Antenna 2 bearing paddle-like calceoli (small globular sense organs) along article 5 and flagellum (Fig. 2.4L) .... *S. calceola*
– Antenna 2 without calceoli 7

7. Palms of article 6 or 'hand' of gnathopods 1 and 2 evenly convex (Fig. 2.4M); adult size about 5 mm .... *S. transvaalensis*
– Palms of article 6 of gnathopods 1 and 2 each with a semicircular notch and tooth at midpoint (Fig. 2.4N); adult size about 15 mm .... *S. alca*

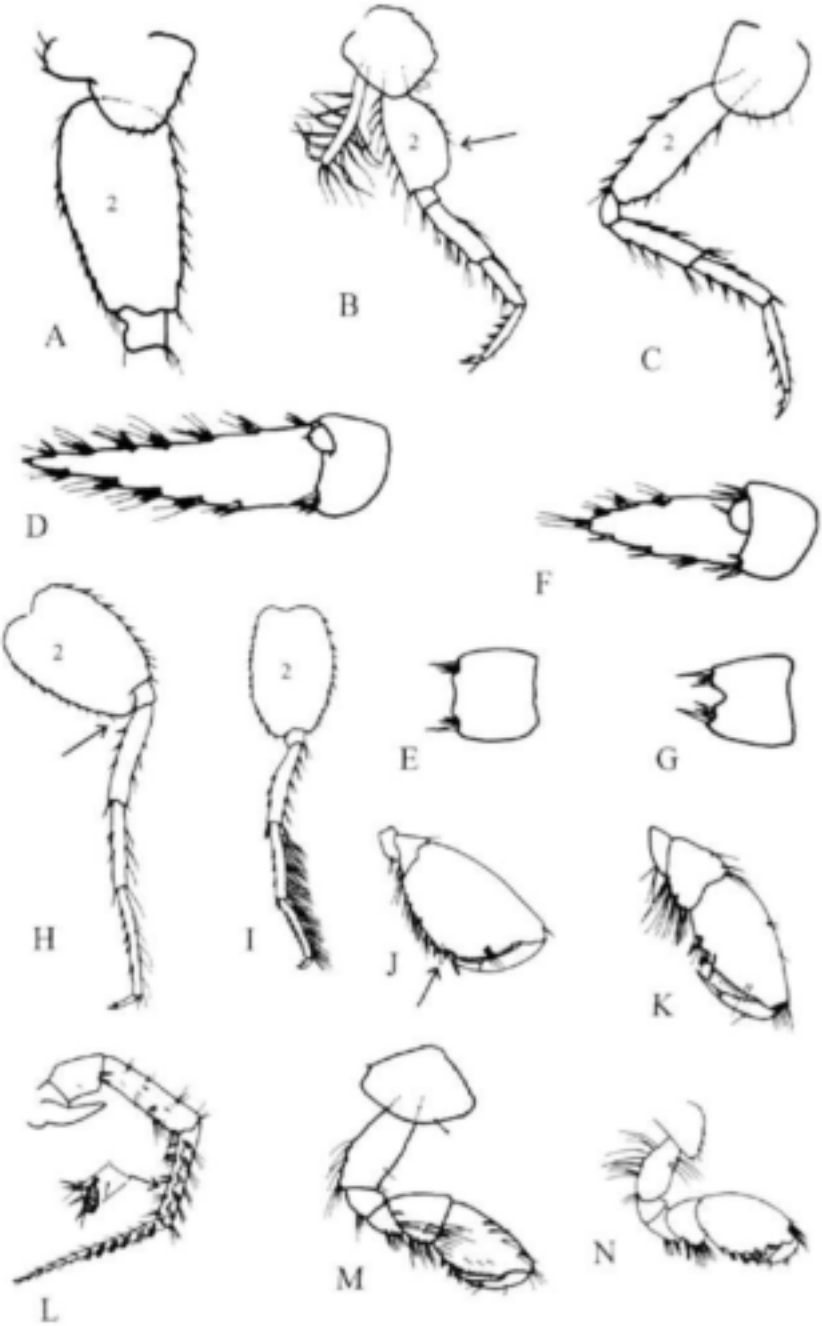

Fig. 2.4. Sternophysingidae. A, *Sternophysinx calceola*, pereopod 5. B, *S. basilobata*, pereopod 3. C, *S. robertsi*, pereopod 3. D–E, *S. basilobata*: D, uropod 3; E, telson. F–G, *S. hibernica*: F, uropod 3; G, telson. H, *S. robertsi*, pereopod 5. I–J, *Sternophysinx megacheles*: I, pereopod 7; J, gnathopod 1. K, *S. filaris*, gnathopod 1. L, *S. calceola*, antenna 2. M, *S. transvaalensis*, gnathopod 1. N, *S. alca*, gnathopod 1.

Family **Paramelitidae** Bousfield, 1977

Early South African representatives of this family were described as members of the well-known Northern Hemisphere genus *Gammarus* (Barnard 1916, 1927), but were transferred to their own genus, *Paramelita*, by Schellenberg (1937). Bousfield (1977) subsequently placed this genus in a separate family, the Paramelitidae. Additional South African species have been described by Thurston (1973), Griffiths (1981), Stewart & Griffiths (1992a, 1992b, 1992c) and Stewart *et al.* (1994). In a recent revision of the family in South Africa, Stewart & Griffiths (1995) described yet another new form, and allocated the 25 known species to three genera. The addition of yet another species in 1996 by Griffiths & Stewart (1996) brings the total number of described species to 26. The three South African genera, and hence all their component species, are endemic, but the family Paramelitidae is also represented by seven genera from Australia (Williams & Barnard 1988).

KEY TO THE SOUTH AFRICAN GENERA OF THE PARAMELITIDAE

1. Coxal gill absent from pereopod 7 .... *Mathamelita*
– Coxal gill present on pereopod 7 2

2. Article 4 of antenna 2 laterally swollen (Fig. 2.6 A–B); dactyls of pereopods 3 (Fig. 2.5 B–E) and 4 with a single spinule; dactyls of pereopods 5–7 usually with one posterior spinule, rarely two ...*Aquadulcaris*
– Article 4 of antenna 2 sometimes elongate and stout (Fig. 2.6 E, F) but rarely laterally swollen; dactyls of pereopods 3 (Fig. 2.5 F–J) and 4 usually with 2–8 posterior spinules, rarely one; dactyls of pereopods 5–7 usually with 2–14 spinules, rarely one .... *Paramelita*

Genus *Mathamelita* Stewart & Griffiths, 1995

This unusual genus is only known from a single sample of the type species of the genus, *Mathamelita aequicaudata*, collected from a stream in the Outeniqua Mountains near Knysna (WC). The absence of a coxal gill on pereopod 7 is unique amongst the Paramelitidae. The form of uropod 3 is also most unusual, in that the inner ramus starts shorter than the outer in juveniles, but grows to almost the same length in adults.

KEY TO THE SPECIES OF *AQUADULCARIS*

1. Pereopod 3 unmodified .... *A. dentata*
– Pereopod 3 modified: either article 4 posterodistally protruded to form a lobe or spur (Fig. 2.5B, E), or article 5 posteriorly lobed (Fig. 2.5C), or article 5 with 1–4 tooth-like spines (Fig. 2.5D) 2

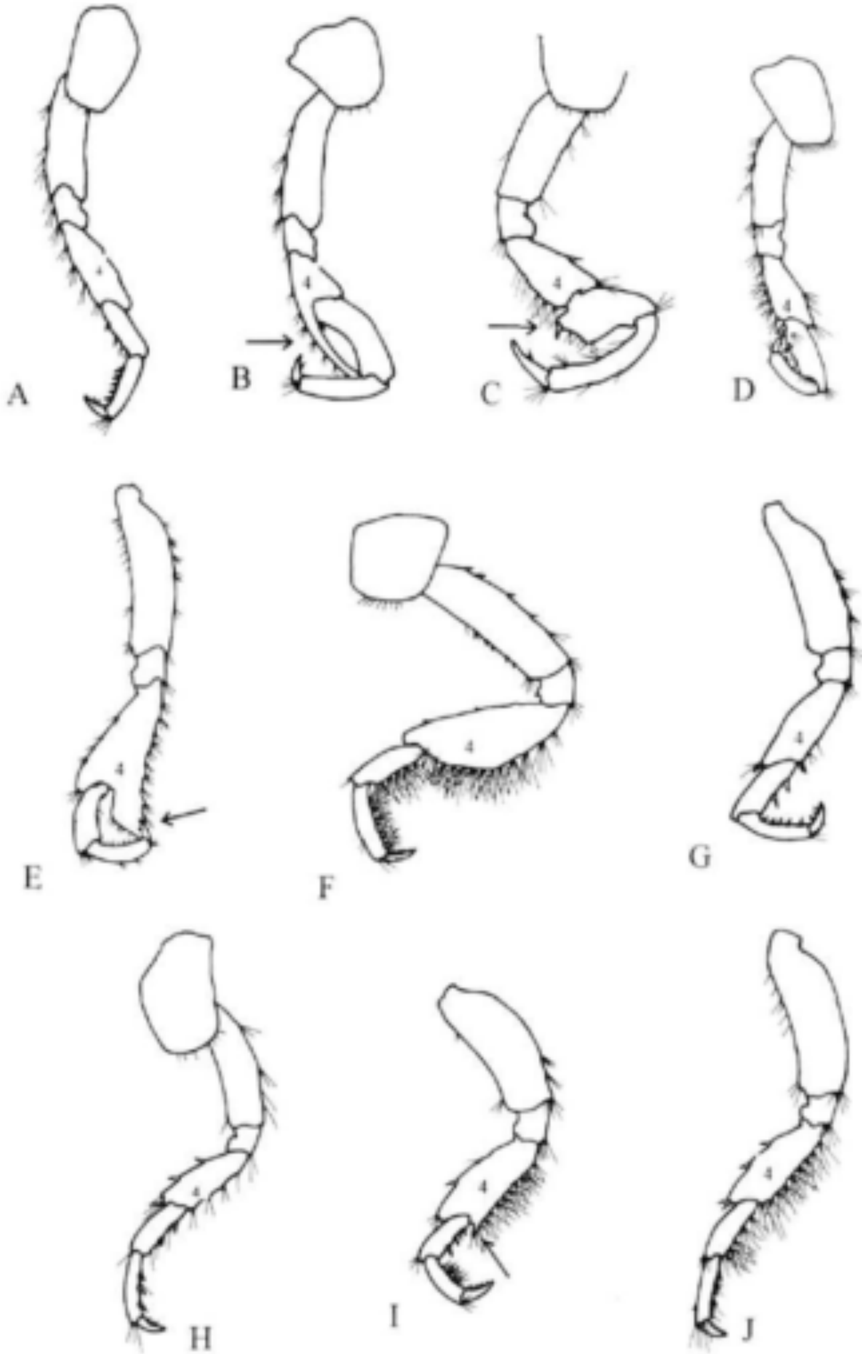

Fig. 2.5. Pereopod 3 of species of *Aquadulcaris* and *Paramelita*:
A, *P. tulbaghensis*; B, *A. pheronyx*; C, *A. auricularia*; D, *A. marunguis*. E, *A. andronyx*; F, *P. platypus*; G, *P. granulicornis*; H, *P. aurantia*; I, *P. magnicornis*; J, *P. magna*.

2. Article 3 of antenna 2 bearing a semicircular lobe (Fig. 2.6A) 3
– No lobe on article 3 of antenna 2 5

3. Article 4 of pereopod 3 not posterodistally protruded; article 5 usually posteriorly lobed, always bearing a tooth-like spine (Fig. 2.5C) ....*A. auricularia*
– Article 4 of pereopod 3 posterodistally protruded (Fig. 2.5 B, E); article 5 lacking tooth-like spine 4

4. Article 4 of pereopod 3 short, posterodistally protruded into a long, narrow spur (Fig. 2.5 B); article 3 of antenna 2 strongly swollen and enlarged ....*A. pheronyx*
– Article 4 of pereopod 3 long, posterodistally protruded into a triangular-shaped lobe (Fig. 2.5 E); article 3 of antenna 2 moderately swollen (Fig. 2.6 A) ....*A. andronyx*

5. Article 5 of pereopod 3 attached normally to article 6 .... *A. crassicornis*
– Article 5 of pereopod 3 attached at right angles to article 6 to form a 'claw' (Fig. 2.5D) .... *A. marunguis*

KEY TO THE SPECIES OF *PARAMELITA*

1. Eyes black 2
– Eyes white 3

2. Posterior margins of antenna 2 and posterior surfaces of pereopods 3–7 densely setose .... *P. nigroculus* var. *persetosa*
– Posterior margins of antenna 2 and posterior surfaces of pereopods 3–7 sparsely to moderately setose, lacking setal brushes ....*P. nigroculus*

3. At least one article of peduncle of antenna 2 toothed, lobed or ridged (Figs 2.6 C, D, F, I).. 4
– Peduncle of antenna 2 lacking any teeth, lobes or ridges............................... 7

4. Article 4 and/or article 5 of peduncle of antenna 2 toothed (Figs 2.6 D, I)...... 5
– Article 3 of peduncle of antenna 2 posteriorly lobed (Fig. 2.6C), or article 5 with lateral ridges (Fig. 2.6 F) 6

5. Antenna 2 shorter than antenna 1; article 4 of peduncle of antenna 2 strongly laterally swollen and with a posterodistal, terminal tooth and a proximal, medial lobe (Fig. 2.6D) .... *P. spinicornis*
– Antenna 2 extremely elongate, exceeding antenna 1 in length; article 4 of peduncle not strongly swollen, with a posterodistal, subterminal tooth but no proximal medial lobe (Fig. 2.6I) ....*P. odontophora*
6. Article 3 of peduncle of antenna 2 posteriorly lobed (Fig. 2.6 C); pereopod 3 normal .... *P. flexa*
– Article 5 of peduncle of antenna 2 with lateral ridges (Fig. 2.6 F); pereopod 3 subchelate (formed into a claw) .... *P. pinnicornis*

7. Antenna 2 densely setose (Fig. 2.6G, H) 8
– Antenna 2 sparsely to moderately setose 9

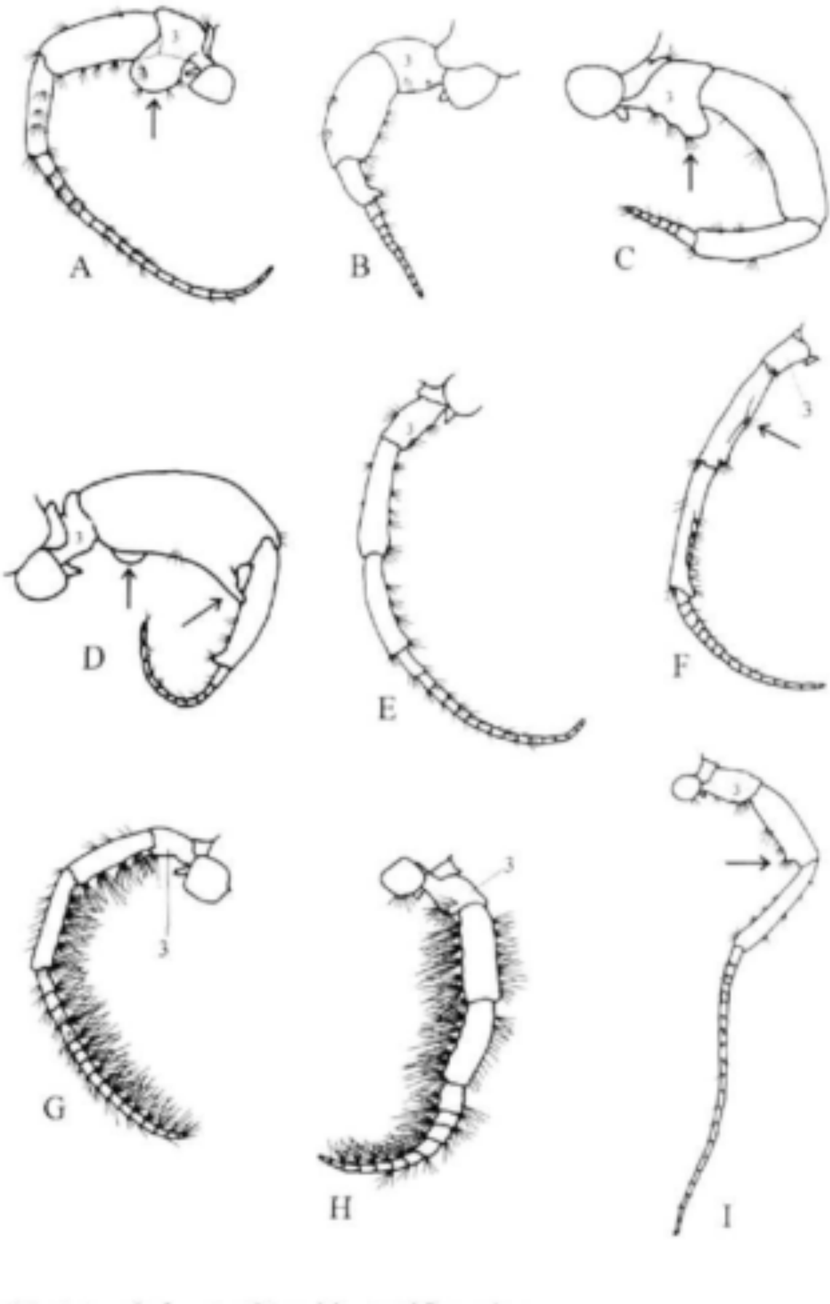

Fig. 2.6 Antenna 2 of species of *Aquadulcaris* and *Paramelita*:
A, *A. andronyx*; B, *A. dentata*; C, *P. flexa*; D, *P. spinicornis*; E, *P. magnicornis*; F, *P. pinnicornis*; G, *P. pillicornis*; H, *P. seticornis*; I, *P. odontophora*.

8. Peduncle of antenna 2 stout; flagellum shorter than peduncle and with 8–12 articles (Fig. 2.6 H); article 2 of pereopods 5–7 moderately expanded; uropod 1 lacking setae on outer ramus; uropod 2 usually with some setae on inner ramus .... *P. seticornis*
– Peduncle of antenna 2 elongate and slender; flagellum as long as peduncle and with 13–16 articles (Fig. 2.6 G); article 2 of pereopods 5–7 poorly expanded; uropod 1 with some setae on outer ramus; uropod 2 with inner ramus lacking setae .... *P. pillicornis*

9. Posterior margin of coxa 4 poorly emarginate (Fig. 2.7 A)........................ 10
– Posterior margin of coxa 4 moderately to strongly excavate (Fig. 2.7 B) 14

10. Palm of gnathopod 2 moderately convex, lacking tooth at defining angle (arrowed in Fig. 2.7 D).. 11
– Palm of gnathopod 2 strongly convex, defining angle forming a small projecting rounded tooth (arrowed in Fig. 2.7 C) 13

11. Article 4 of pereopod 3 triangular, markedly wider distally than proximally .... *P. triangula*
– Article 4 of pereopod 3 not triangular, not markedly wider distally than proximally 12

12. Peduncle of antenna 2 laterally swollen; flagellum 9- to 12-articulate .... *P. tulbaghensis*
– Peduncle of antenna 2 not markedly laterally swollen; flagellum 12- to 13-articulate .... *P. aurantia*

13. Article 4 of pereopod 3 greatly expanded laterally (Fig. 2.5 F); inner ramus of uropod 3 about 0.2 times length of outer ramus .... *P. platypus*
– Article 4 of pereopod 3 not markedly expanded laterally (Fig. 2.5 G); inner ramus of uropod 3 about 0.4 times length of outer ramus .... *P. granulicornis*

14. Antenna 2 almost as long as, or longer than, antenna 1, peduncle markedly stout (Fig. 2.6E) 15
– Antenna 2 distinctly shorter than antenna 1, peduncle slender to moderately stout.. 17

15. Outer ramus of uropod 3 three times length of peduncle (Fig. 2.7 E); uropods 1 and 2 with a few setae on inner rami, lacking setae on outer rami .... *P. validicornis*
– Outer ramus of uropod 3 2.0–2.6 times length of peduncle (Fig. 2.7 J); uropods 1 and 2 with or without setae on inner rami and sometimes with setae on outer rami 16

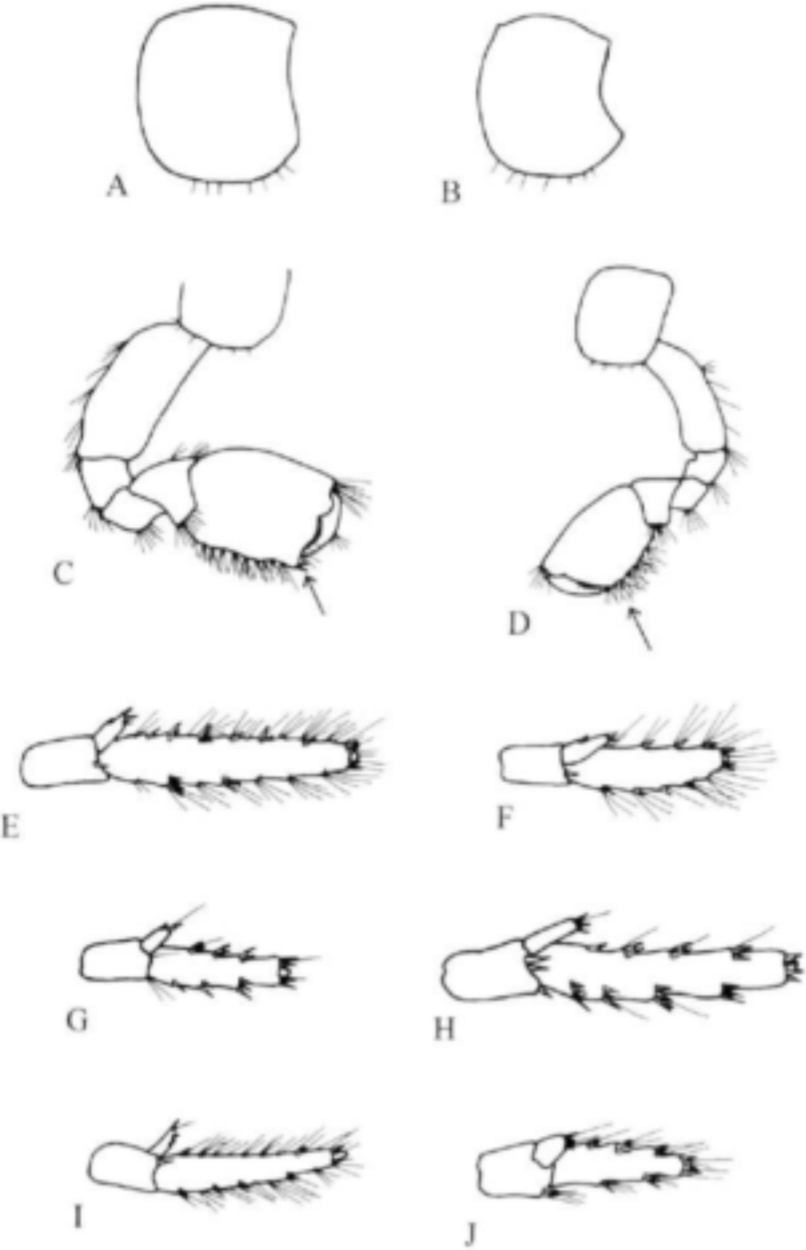

Fig. 2.7. Species of *Paramelita*. A–B, coxa 4: A, *P. aurantia*; B, *P. validicornis*. C–D, gnathopod 2: C, *P. platypus*; D, *P. aurantia*. E–J, uropod 3: E, *P. validicornis*; F, *P. parva*; G, *P. kogelensis*; H, *P. barnardi*; I, *P. capensis*; J, *P. magnicornis*.

16. Article 4 of pereopod 3 unmodified (Fig. 2.5 J); urosome densely setose dorsally; uropods 1 and 2 with setae on inner and outer rami; body colour brown .... *P. magna*
– Article 4 of pereopod 3 posterodistally protruded to form a tooth (Fig. 2.5 I); urosome moderately setose dorsally; uropod 1 with a few setae on inner ramus, outer ramus without setae; uropod 2 with rami lacking setae; body colour white .... *P. magnicornis*

17. Flagellum of antenna 1 with 22–27 articles; flagellum of antenna 2 with 11–18 articles 18
– Flagellum of antenna 1 with 33–80 articles; flagellum of antenna 2 with 15–35 articles 19

18. Pereopods 3 and 4 with 2–3 spinules on dactyl; inner ramus of uropod 2 lacking marginal setae; outer ramus of uropod 3 moderately to densely setose (Fig. 2.7 F) .... *P. parva*
– Pereopods 3 and 4 with four spinules on dactyl; inner ramus of uropod 2 with a few marginal setae; outer ramus of uropod 3 poorly setose (Fig. 2.7 G) .... *P. kogelensis*

19. Flagellum of antenna 2 with 15–17 articles; dactyl of pereopods 3 and 4 with 2–3 spinules; dactyls of pereopods 5–7 with 5–7 spinules; coxa 4 distinctly, but moderately, excavate posteriorly; rami of uropods 1 and 2 lacking setae; outer ramus of uropod 3 poorly setose (Fig. 2.7 H) .... *P. barnardi*
– Flagellum of antenna 2 usually with more than 17 articles; dactyls of pereopods 3 and 4 with 3–6 spinules; dactyls of pereopods 5–7 with 8–13 spinules; inner rami of uropods 1 and 2 with marginal setae; outer ramus of uropod 3 strongly setose (Fig. 2.7 I) .... *P. capensis*

SPECIES LIST OF SOUTHERN AFRICAN AMPHIPODA

FAMILY	SPECIES/AUTHORITY	DISTRIBUTION	REFERENCE
Bolttsiidae	*Bolttsia minuta* Griffiths, 1976	Lake Sibaya (KZ–N)	Griffiths (1976b)
Corophiidae	*Corophium triaenonyx* Stebbing, 1904	Lake Sibaya (& estuaries) (KZ–N to WC)	Griffiths (1976a)
	Grandidierella lignorum Barnard, 1935	Lake Sibaya (& estuaries) (KZ–N to WC)	Griffiths (1976a)
Ingolfiellidae	*Stygobarnardia caprellinoides* Ruffo, 1985	Caves, N. Namibia	Griffiths (1989)
	Trogloleleupia dracospiritus Griffiths, 1989	Caves, N. Namibia	Griffiths (1989)
	Trogloleleupia eggerti (Ruffo, 1964)	Caves, N. Namibia	Griffiths (1989)
	Trogloleleupia gobabis Griffiths, 1989	Caves, central Namibia	Griffiths (1989)
	Trogloleleupia nudicarpus Griffiths, 1991	Caves, N. Namibia	Griffiths (1991a)
Paramelitidae	*Aquadulcaris andronyx* (Stewart & Griffiths, 1992)	Kasteelberg (WC)	Stewart & Griffiths (1992a, 1995)
	Aquadulcaris auricularia (Barnard, 1916)	Cape Peninsula (WC)	Stewart & Griffiths (1992b, 1995)
	Aquadulcaris crassicornis (Barnard, 1916)	Table Mountain (WC)	Stewart & Griffiths (1992b, 1995)
	Aquaculcaris dentata (Stewart & Griffiths, 1992)	Cape Peninsula (WC)	Stewart & Griffiths (1992b, 1995)
	Aquadulcaris marunguis (Stewart & Griffiths, 1992)	Cape Peninsula (WC)	Stewart & Griffiths (1992b, 1995)
	Aquadulcaris pheronyx (Stewart & Griffiths, 1992)	Cape Peninsula (WC)	Stewart & Griffiths (1992b, 1995)
	Mathamelita aequicaudata Stewart & Griffiths, 1995	Knysna region (WC)	Stewart & Griffiths (1995)
	Paramelita aurantia (Barnard, 1927)	S.W. Cape mountains	Stewart & Griffiths (1995)
	Paramelita barnardi Thurston, 1973	Kalk Bay caves (WC)	Thurston (1973), Stewart & Griffiths (1995)
	Paramelita capensis (Barnard, 1916)	WC, widespread	Griffiths (1981), Stewart & Griffiths (1995)
	Paramelita flexa Griffiths, 1981	Elgin region (WC)	Griffiths (1981), Stewart & Griffiths (1995)
	Paramelita granulicornis (Barnard, 1927)	Hottentots Holland Mts. (WC)	Stewart & Griffiths (1995)

KEY: KZ–N = KwaZulu–Natal; NW = North Western Province; SWC = South Western Cape; MPL = Mpumalanga; WC = Western Cape

SPECIES LIST OF SOUTHERN AFRICAN AMPHIPODA (Cont.)

FAMILY	SPECIES/AUTHORITY	DISTRIBUTION	REFERENCE
Paramelitidae (cont.)	*Paramelita kogelensis* (Barnard, 1927)	Hottentots Holland Mts. (WC)	Stewart & Griffiths (1995)
	Paramelita magna Stewart & Griffiths, 1992	Cape Peninsula (WC)	Stewart & Griffiths (1992c, 1995)
	Paramelita magnicornis Stewart & Griffiths, 1992	Cape Peninsula (WC)	Stewart & Griffiths (1992a, 1995)
	Paramelita nigroculus (Barnard, 1916)	widespread in WC	Griffiths (1981), Stewart & Griffiths (1995)
	Paramelita odontophora Stewart, Snaddon & Griffiths, 1994	Palmiet River (WC)	Stewart *et al.* (1994), Stewart & Griffiths (1995)
	Paramelita parva Stewart & Griffiths, 1992	Storms River (E.C)	Stewart & Griffiths (1995)
	Paramelita pillicornis Stewart & Griffiths, 1992	Ceres region (WC)	Stewart & Griffiths (1992c, 1995)
	Paramelita pinnicornis Stewart & Griffiths, 1992	Peninsula and Hangklip (WC)	Stewart & Griffiths (1992c, 1995)
	Paramelita platypus Stewart & Griffiths, 1992	Hermanus region (WC)	Stewart & Griffiths (1992a, 1995)
	Paramelita seticornis (Barnard, 1927)	Hottentots Holland Mts (W.C)	Stewart & Griffiths (1995)
	Paramelita spinicornis (Barnard, 1927)	widespread in WC	Stewart *et al.* (1994), Stewart & Griffiths (1995)
	Paramelita triangula Griffiths & Stewart, 1996	Ceres, (WC)	Griffiths & Stewart (1996)
	Paramelita tulbaghensis (Barnard, 1927)	Tulbagh–Paarl (WC)	Stewart & Griffiths (1992a, 1995)
	Paramelita validicornis Stewart & Griffiths, 1992	Hermanus–Bredasdorp (WC)	Stewart & Griffiths (1992c,1995)

KEY: KZ–N = KwaZulu–Natal; NW = North Western Province; SWC = South Western Cape; MPL = Mpumalanga; WC = Western Cape

SPECIES LIST OF SOUTHERN AFRICAN FRESHWATER AMPHIPODA (cont.)

FAMILY	SPECIES/AUTHORITY	DISTRIBUTION	REFERENCE
Sternophysingidae	*Sternophysinx alca* Griffiths, 1981	Caves, Makapansgat (NP)	Griffiths (1981)
	Sternophysinx basilobata Griffiths, 1991	Caves, Kuruman area (N. Cape)	Griffiths (1991)
	Sternophysinx calceola Holsinger, 1992	Caves (NP, MPL)	Holsinger (1992)
	Sternophysinx filaris Holsinger & Straskraba, 1973	Caves & Springs (NP, MPL)	Holsinger & Straskraba (1973)
	Sternophysinx hibernica Griffiths, 1991	Cave, Central Namibia	Griffiths (1991b)
	Sternophysinx megacheles Griffiths & Stewart, 1996	Cave, Kuruman (N. Cape)	Griffiths & Stewart (1996)
	Sternophysinx robertsi (Methuen, 1911)	Caves, Makapansgat (NP)	Holsinger & Straskraba (1973)
	Sternophysinx transvaalensis Holsinger & Straskraba, 1973	Springs (KZ–N, MPL, WC)	Holsinger & Straskraba (1973)

KEY: KZ–N = KwaZulu–Natal, NW = North Western Province, SWC = South Western Cape; MPL = Mpumalanga, WC = Western Cape

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CHAPTER 3

ISOPODA

by

B. Kensley

The Isopoda form a group of crustaceans of which over 10 000 species have been described, with many new species constantly being discovered. Although primarily aquatic in habitat, one suborder, the Oniscidea, has invaded the terrestrial world with greater success than any other group of crustaceans. The other eight suborders have exploited aquatic habitats, primarily in the marine environment, and can be found from the upper intertidal zone to the abyss of the oceans. Whereas the majority of species are benthic dwellers, many species have adapted to highly specialized environmental niches, and accordingly display great morphological specialization. There are active predators, swarming scavengers, and parasites or micro-predators of fishes among the Flabellifera. The Limnoriidae burrow into wood, frequently wooden piers, where they can do considerable damage. The Gnathiidea are often commensals of sponges. One suborder, the Epicaridea, is entirely parasitic on other crustaceans.

Being peracaridans, the isopods bear their eggs in a marsupium formed by a variable number of ventral plates or oostegites of the pereonites. Transfer of spermatophores is usually accomplished with the aid of a copulatory stylet on the endopod of the second pleopods of males. The first and second pleopods are adapted for this purpose in the Oniscidea. There is direct development of the egg into a manca — which resembles the adult but lacks the seventh pereonite and leg — in all groups except the parasitic Epicaridea. In the latter a dramatic metamorphosis includes a pelagic epicaridium stage.

Although primarily marine, some members of most of the suborders have entered freshwater environments. Some of these, like the phreatocoideans (which are exclusively freshwater), and certain Asellota and

Microcerberidea, have long evolutionary histories in these environments. Others show indications of geologically far more recent invasions via estuaries, coastal lagoons, anchialine cave systems, and ground water.

The southern African freshwater isopod fauna has representatives of both of these groups. Among the forms with long histories in fresh water are the asellote genera *Namibianira*, *Protojanira* and *Protojaniroides*, the microcerberideans *Afrocerberus* and *Protocerberus*, and all the phreatocoideans. More recent invaders are the flabelliferan, *Pseudosphaeroma*, the anthuridean, *Cyathura*, and the asellote, *Uromunna*.

Morphological features of the Isopoda (Figs 3.1A, 3.3A, 3.8)

Body usually dorso-ventrally depressed, occasionally subcylindrical, rarely bilaterally compressed. Carapace lacking. First thoracic segment fused with head. Antennules and antennae uniramous (scale on antenna in some asellotes may represent rudimentary second ramus). Eyes present or absent; if present, sessile (eyes on non-mobile stalks in some asellotes). Mouthparts consisting of one pair of mandibles, two pairs of maxillae, one pair of maxillipeds (first thoracic or pereonal appendages). Mandible usually having palp of one to three articles; incisor, lacinia mobilis, and molar usually present; lacinia mobilis often differing on left and right sides; molar variable. Maxilliped usually having palp of no more than five articles; lamellar endite often carrying coupling hooks; epipod lamellar. Pereonites usually separate, but pereonite 1 sometimes fused with head. Pereopods (thoracic legs) consisting of seven articles: 1—coxa, 2—basis, 3—ischium, 4—merus, 5—carpus, 6—propodus, 7—dactylus. Coxae of pereopods variously fused with, and forming expanded lateral processes (coxal plates) of, pereonites. Pereopod 1 forming additional mouthpart appendage (pylopod) only in suborder Gnathiidea. Pereopods generally similar, ambulatory; pereopods 1–3 secondarily variously modified, becoming subchelate or prehensile. Pereopod 7 occasionally not developed (neotenous condition). In gnathiideans, second thoracic appendage a maxillipedal cheliped, last thoracic appendage missing. Thoracic brood pouch or marsupium of female formed by varying number of oostegites attached ventrally to pereopods; eggs held in anterior or posterior pockets or in internal pouches in some sphaeromatids. Abdomen (pleon) consisting of six free or variously fused pleonites, plus telson; if one or more pleonites fused with telson, resulting structure referred to as pleotelson. Pleopods (appendages of pleonites) on pleonites 1–5 biramous, lamellar, primarily for respiration; anterior pleopods occasionally forming operculum over remaining pleopods. Pleopod 2 in male (additionally pleopod 1 in some Oniscidea) with inner ramus (endopod) bearing copulatory stylet. One pair of uropods on pleonite 6, sometimes forming tailfan together with telson; uropods forming operculum over ventral pleon in suborder Valvifera and in some oniscideans. Young leave brood pouch as manca, resembling adult but lacking pereopod 7.

KEY TO THE SUBORDERS OF ISOPODA

1. Parasitic on crustaceans; body of female nearly always asymmetrical .... EPICARIDEA*
– Free-living or parasitic on fishes; body of female bilaterally symmetrical or, if parasitic, female somewhat distorted 2

2 Body more or less bilaterally compressed (Fig. 3.7) .... PHREATOICIDEA (p 68)
– Body more or less dorsoventrally depressed (Figs 3.2, 3.3, 3.5) or subcylindrical (Figs 3.1, 3.4) 3

3. Having six pereonites and five pairs of pereopods .... GNATHIIDEA*
– Having seven pereonites and six or seven pairs of pereopods (Fig. 3.1) 4

4. Body usually more than six times longer than wide, subcylindrical; uropods never operculiform (Figs 3.1, 3.5) 5
– Body usually less than six times longer than wide, usually dorsoventrally depressed (Figs 3.2, 3.3, 3.4); if subcylindrical, uropods operculiform 6

5. Uropodal exopod often folding dorsally over pleotelson (Fig. 3.5); rarely interstitial forms .... ANTHURIDEA (p 63)
– Uropods terminal (Fig. 3.1); minute interstitial forms .... MICROCERBERIDEA (p 53)

6. Antennules minute; terrestrial forms, pleopods having respiratory trachea .... ONISCIDEA*
– Antennules rarely minute; aquatic forms, pleopods never tracheate 7

7. Uropods ventral, operculiform, covering pleopods .... VALVIFERA*
– Uropods never operculiform over pleopods 8

8. Uropods usually lateral or ventrolateral, forming tailfan with pleotelson (Fig. 3.6); pleopods 1 and 2 rarely operculiform .... FLABELLIFERA (p 64)
– Uropods usually terminal or subterminal (Fig. 3.3); pleopods 1 and 2 variously operculiform .... ASELLOTA (p 56)

*—Not represented in southern African freshwater fauna.

A few exceptional epicarideans have been recorded from fresh water; although primarily terrestrial, a few oniscideans have returned to freshwater habitats as well as to the marine intertidal; one species of valviferan has been recorded from fresh water; the gnathiideans are exclusively marine.

Suborder MICROCERBERIDEA
Family **Microcerberidae**

The microcerberideans are almost without exception interstitial forms, and have been collected from marine sediments, upper beach sediments, and many phreatic habitats. Part of their success in the invasion of such habitats lies in their tolerance of euryhaline and eurythermal conditions. These minute forms are thought to feed on suspended organic material in the interstitial water. Reproduction also shows adaptation to the interstitial habitat which, combined with the very small size, dictates only one or two eggs or larvae in the female marsupium (brood pouch). All forms lack eyes. Only three genera, representing four species (two undetermined), have been recorded from southern Africa. Undoubtedly, many forms remain to be discovered. Their small size makes them difficult to dissect. For further information, the reader is referred to such works as Coineau (1971, 1986).

KEY TO THE SOUTHERN AFRICAN SPECIES

1. Uropods uniramous .... *Microcerberus* sp. (Fig. 3.1B)
– Uropods biramous 2

2. Uropods longer than last pleonite ....
.... *Protocerberus schminkei kruegeri* (Fig 3.1C)
– Uropods shorter than pleotelson segment .... *Afrocerberus letabai* (Fig. 3.1A)

Afrocerberus letabai Wägele, 1983
Fig. 3.1A

Characteristic features

Ovigerous female 1.9 mm total length. Body elongate, cylindrical. Pereopod 1 subchelate, propodus inflated. Pereopods 2–7 ambulatory, dactyli biunguiculate. Pleon consisting of two relatively elongate pleonites plus pleotelson. Pleopods 1 and 2 lacking. Uropodal sympod half length of endopod; exopod tiny.

Records

Riverbed sediments, 1.1 m depth, Letaba River, Kruger National Park (Mpumalanga).

Remarks

This genus and species is known from a single specimen.

Microcerberus sp.
Fig. 3.1B

Characteristic features

Adults under 2.0 mm total length. Body elongate, cylindrical. Pereopod 1 subchelate, propodus inflated. Pereopods 2–7 ambulatory, basis having spinose process at midlength, dactyli biunguiculate. Pleon consisting of two segments, anterior usually shorter than posterior, plus relatively elongate pleotelson. Uropod uniramous.

Records

Coineau (1986) recorded two unspecified *Microcerberus* specimens from 'interstitial beach sands in South Africa and Namibia' (no further details of localities were given). As species of this genus have been recorded from marine sediments as well as stenohaline and freshwater habitats, a freshwater record from South Africa would not be unexpected.

Protocerberus schminkei kruegeri Wägele, 1983
Fig. 3.1C

Characteristic features

Adult 1.2 mm total length. Body elongate, cylindrical. Pereopod 1 subchelate, inflated. Pereopods 2–7 ambulatory, dactyli biunguiculate. Pleon consisting of two subequal segments plus pleotelson. Pleopod 1 absent. Uropod elongate, endopod subequal to sympod in length, exopod about one-third length of endopod.

Records

Riverbed sediments, 1.3 m depth, Olifants River, Kruger National Park (Mpumalanga).

Remarks

Protocerberus schminkei kruegeri is distinguished from the nominate subspecies *P. s. schminkei* Wägele, 1983 (from the Mwanza River, Malawi) by subtle differences in the spination of the mouthparts and pereopod 1.

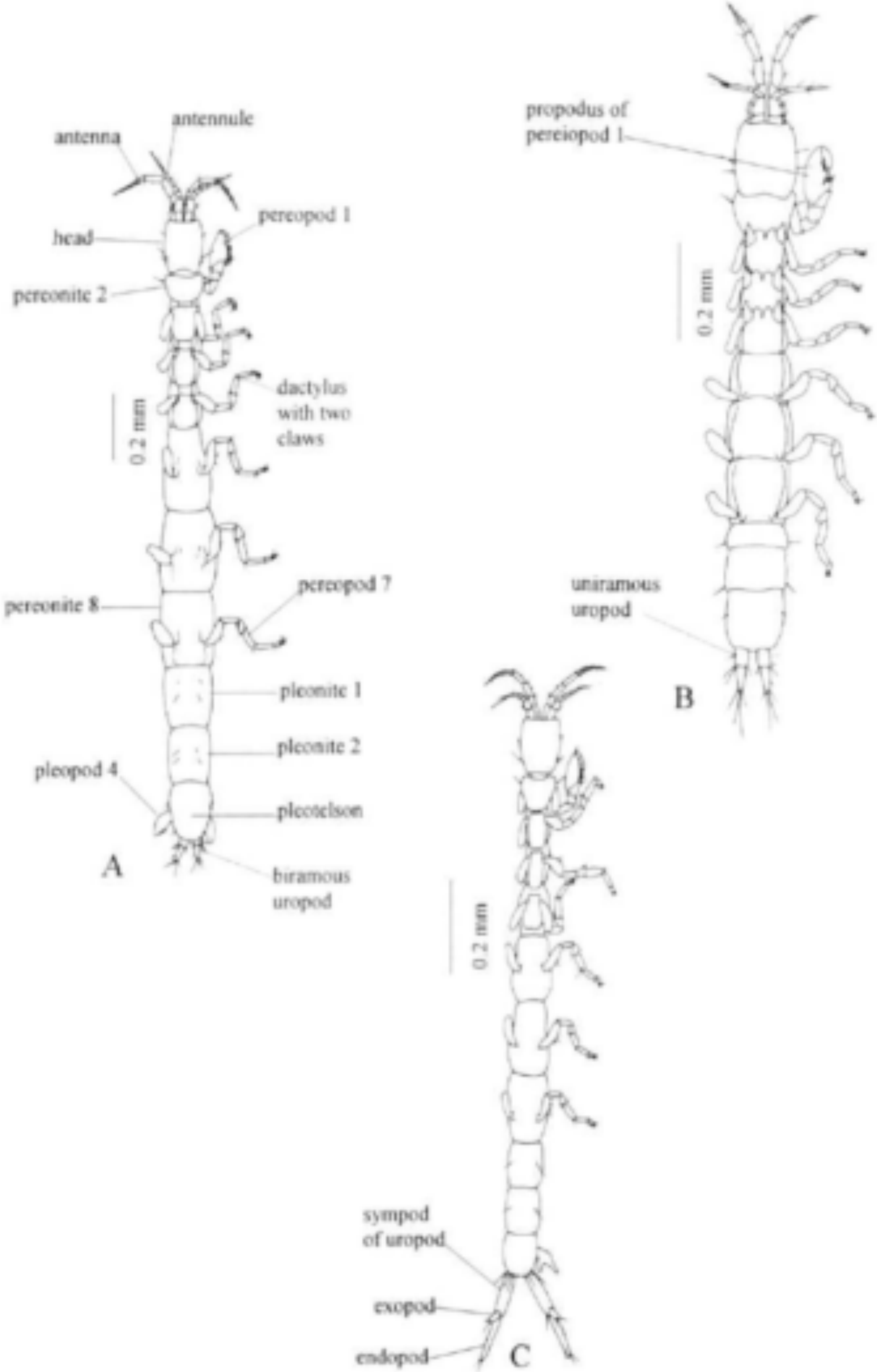

Fig. 3.1. A, *Afrocerberus letabai*, dorsal view: pleopod 4 shown projecting beneath pleotelson. B, *Microcerberus* sp., dorsal view. C. *Protocerberus schminkei kruegeri*, dorsal view: pleopod 4 shown projecting ventrally on right side. (Figs A and C adapted from Wagele 1983).

Suborder ASELLOTA
Family **Protojaniridae**

The protojanirids are generally superficially similar, lacking eyes, having an elongate body form — with six free pereonites — and a pleon consisting of a single free pleonite plus pleotelson, with terminal or subterminal projecting uropods. The animals live in the organically-rich bottom mud of mountain and cave streams. Examination of gut contents reveals minute organic particles and diatom tests, suggesting that they are detritivores. Nothing is known of the reproduction of the group. The taxonomy and relationships of the protojarinid and janiroid asellotes is unsettled, and reassignment of families and genera can be expected.

KEY TO SOUTHERN AFRICAN GENERA OF PROTOJANIRIDAE

1. Pereopod 1 ambulatory (Fig. 3.3C, D) 2
– Pereopod 1 subchelate (Fig. 3.3F) .... *Protojaniroides*

2. Mandibular molar cylindrical, distally truncate (Fig. 3.3B) .... *Protojanira*
– Mandibular molar conical, distally subacute (Fig. 3.2G) .... *Namibianira*

Namibianira Kensley, 1995

KEY TO THE SOUTHERN AFRICAN SPECIES OF *NAMIBIANIRA*

1. Female marginal opercular setae fewer than ten per side (Fig. 3.2I) .... *N. arnhemensis*
– Female marginal opercular setae more than ten per side 2

2. Female marginal opercular setae fewer than 18 per side (Fig. 3.2B); mandibular palp article 2 with nine spines .... *N. dracohalitus*
– Female marginal opercular setae more than 18 per side; mandibular palp article 2 with five or eight spines 3

3. Female marginal opercular setae 20–22 per side (Fig. 3.2F); 7–12 antennular articles .... *N. aigamasensis*
– Female marginal opercular setae 26–29 per side (Fig. 3.2D); 22–24 antennular articles .... *N. aikabensis*

Nambianira aigamasensis Kensley, 1995
Fig. 3.2E–G

Characteristic features

Female 3.0–3.6 mm total length. Antennule consisting of 7–12 articles. Mandibular palp, article 2 bearing five spines, article 3 with nine to

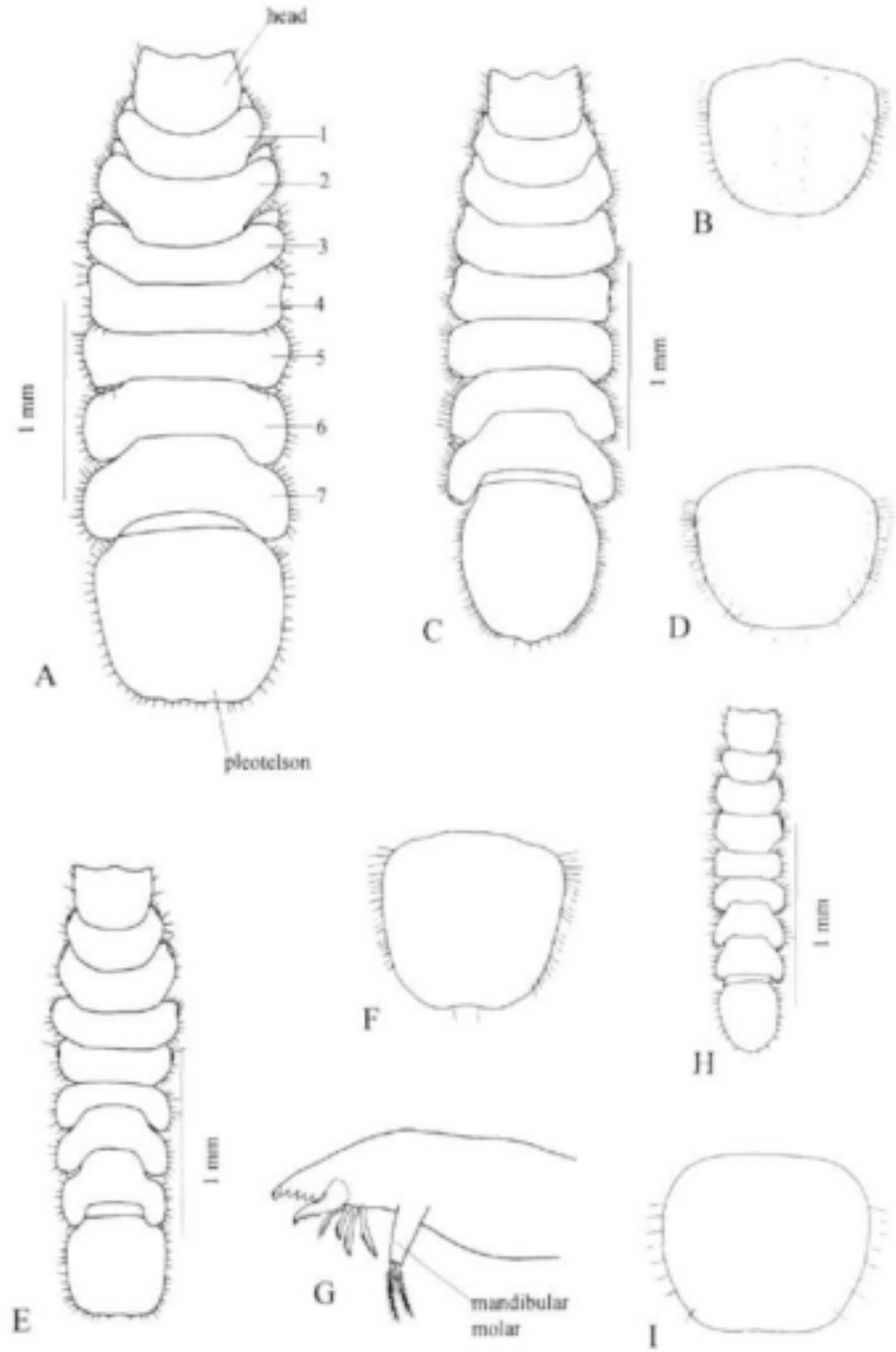

Fig. 3.2. A–B, *Namibianira dracohalina*: A, dorsal view; B, female operculum.
C–D, *N. aikabensis*: C, dorsal view; D, female operculum.
E–G, *N. aigamasensis*: E, dorsal view; F, female operculum; G, right mandible, palp omitted.
H–I, *N. arnhemensis*: H, dorsal view; I, female operculum.

ten spines. Ratio of pleotelsonic length/width 0.94. Female pleopod 2 operculum bearing 20–22 marginal setae per side.

Records

Aigamas Cave, Otavi District, Namibia.

Namibianira aikabensis Kensley, 1995
Fig. 3.2C–D

Characteristic features

Female 4.2–4.9 mm total length; male 3.9–4.4 mm total length. Antennule consisting of 22–24 articles. Mandibular palp article 2 bearing eight spines, article 3 with 15 spines. Ratio of pleotelsonic length/width 1.15. Female pleopod 2 operculum bearing 26–29 marginal setae per side.

Records

Aikab Hemicenote, Etosha National Park, Namibia.

Namibianira arnhemensis Kensley, 1995
Fig. 3.2H–I

Characteristic features

Female 2.1–2.9 mm total length; male 1.8–2.0 mm total length. Antennule consisting of eight articles. Mandibular palp article 2 bearing four spines, article 3 with 10–12 spines. Ratio of pleotelsonic length/width 1.14–1.18. Female pleopod 2 operculum bearing eight marginal setae per side.

Records

Arnhem Cave, Windhoek District, Namibia.

Namibianira dracohalitus Kensley, 1995
Fig.3.2A–B

Characteristic features

Female 5.0 mm total length. Antennule consisting of 12–15 articles. Mandibular palp article 2 bearing nine spines, article 3 with 15 spines. Ratio of pleotelsonic length/width 0.91. Female pleopod 2 operculum bearing 18 marginal setae per side.

Records

Dragon's Breath Cave, Grootfontein District, Namibia.

Protojanira Barnard, 1927

KEY TO SOUTHERN AFRICAN SPECIES OF *PROTOJANIRA*

1. Uropodal rami distinctly unequal in length (Fig. 3.3A)........................ *P. leleupi*
– Uropodal rami subequal in length (Fig. 3.3E) ....*P. prenticei*

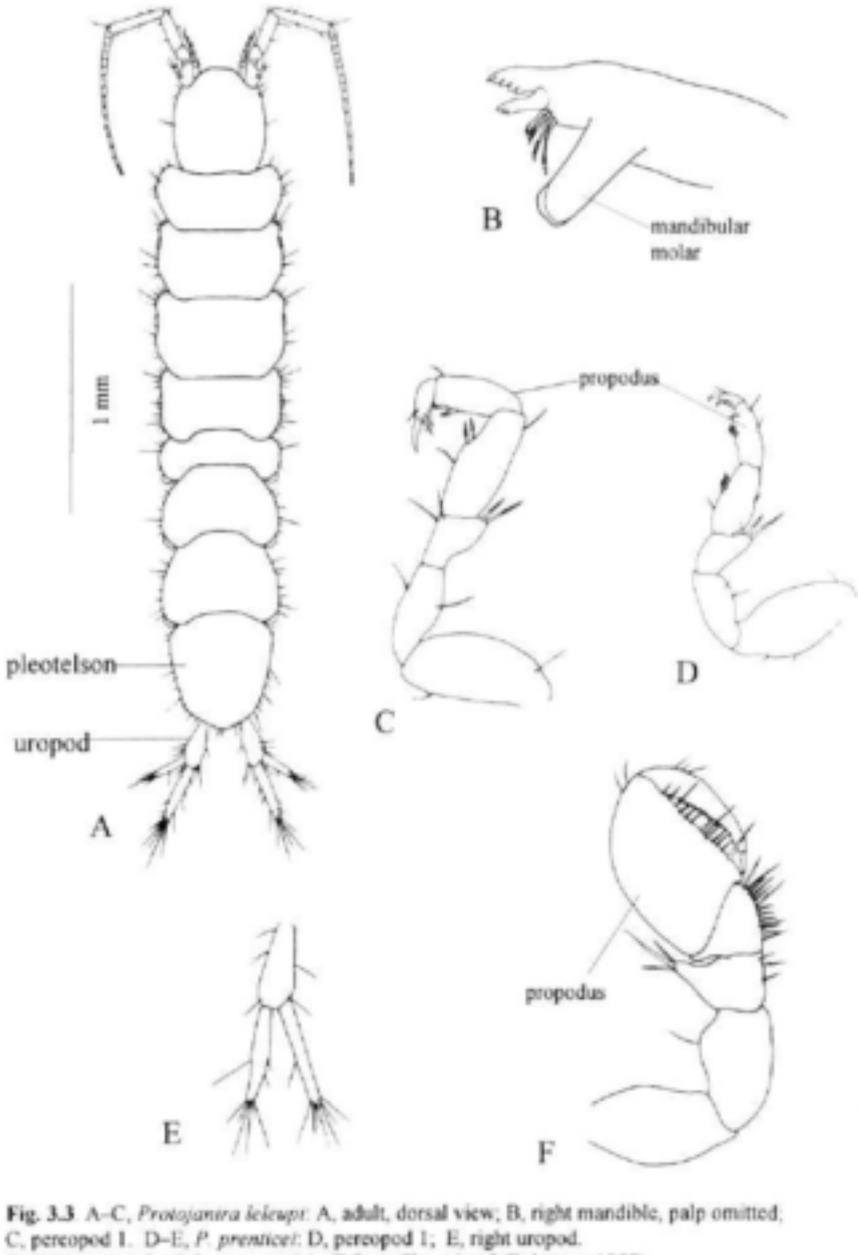

Fig. 3.3 A–C, *Protojanira leleupi*: A, adult, dorsal view; B, right mandible, palp omitted; C, pereopod 1. D–E, *P. prenticei*: D, pereopod 1; E, right uropod. F, *Protojaniroides ficki*, pereopod 1. (F from Chappius & Delamare 1957).

Protojanira leleupi Grindley, 1963
Fig. 3.3A–C

Characteristic features

Ovigerous female 2.8 mm total length; with about 12 eggs in marsupium. Body with scattered integumental setae. Antennular flagellum of four articles. Antennal peduncle having small lateral scale. Pereopod 1, propodus roughly rectangular, not expanded; dactylus having large terminal spine or unguis plus two smaller accessory spines. Uropodal endopod longer than sympod, exopod about two-thirds length of endopod.

Records

Pools in Boomslang and Tartarus Caves, Kalk Bay Mountains, Cape Peninsula (Western Cape). In summer, these pools are reduced to a depth of less than two inches (50 mm), with the fine ooze-like black mud on the bottom inhabited by copepods (*Paracyclops chiltoni*), as well as nematodes, fly larvae, and oligochaetes. The isopods can be seen walking on the surface of the mud.

Protojanira prenticei Barnard, 1927
Fig. 3.3D–E

Characteristic features

Ovigerous female 2.5 mm total length, with about six eggs in marsupium. Body with scattered integumental setae. Antennular flagellum of six articles. Antennal peduncle having small lateral scale. Pereopod 1, propodus roughly rectangular, not expanded; dactylus having large terminal spine plus two subterminal accessory spines. Uropodal endopod longer than sympod, exopod subequal in length to endopod.

Records

Stream in the Kogelberg, Hottentots Holland Mountains (Western Cape).

Protojaniroides Fresi, Idato & Scipione, 1980

KEY TO SOUTH AFRICAN SPECIES OF *PROTOJANIROIDES*

1. Antennular flagellum of about eight articles; antennal flagellum of about 65 articles .... *P. ficki*
– Antennular flagellum of about 12 articles; antennal flagellum of about 18–24 articles .... *P. perbrincki*

Protojaniroides ficki (Chappuis & Delamare, 1957)
Fig. 3.3F

Characteristic features

Male and female 5.0 mm total length. Pereopod 1 subchelate, propodus expanded, with row of spines on cutting edge, dactylus with row of tiny spines on posterior margin. Operculum (pleopod 2) of female having two pairs of low rounded lobes on distal margin.

Records

Under stones in a freshwater spring near Kaapsehoop (Drakensberg Mountains, Mpumalanga) at an elevation of 1 500 m.

Protojaniroides perbrincki (Barnard, 1955)

Characteristic features

Male and female 4.0 mm total length. Pereopod 1 subchelate, propodus expanded, with dense row of short spines on cutting edge, dactylus with row of tiny spines on posterior margin. Operculum (pleopod 2) in female subcircular to ovate, distal margin undulate.

Records

Tugela River system, 6 000 ft (1 828 m), KwaZulu–Natal; Hluhluwe Game Reserve, KwaZulu–Natal.

Superfamily JANIROIDEA
Family **Munnidae**
Uromunna sheltoni (Kensley, 1977)
Fig. 3.4

Characteristic features

Male 1.2 mm, ovigerous female 1.6 mm total length. Antennule having single terminal aesthetasc. Mandible lacking palp; incisor of four cusps, spine-row of three or four spines; molar stout, distally truncate. Pereon

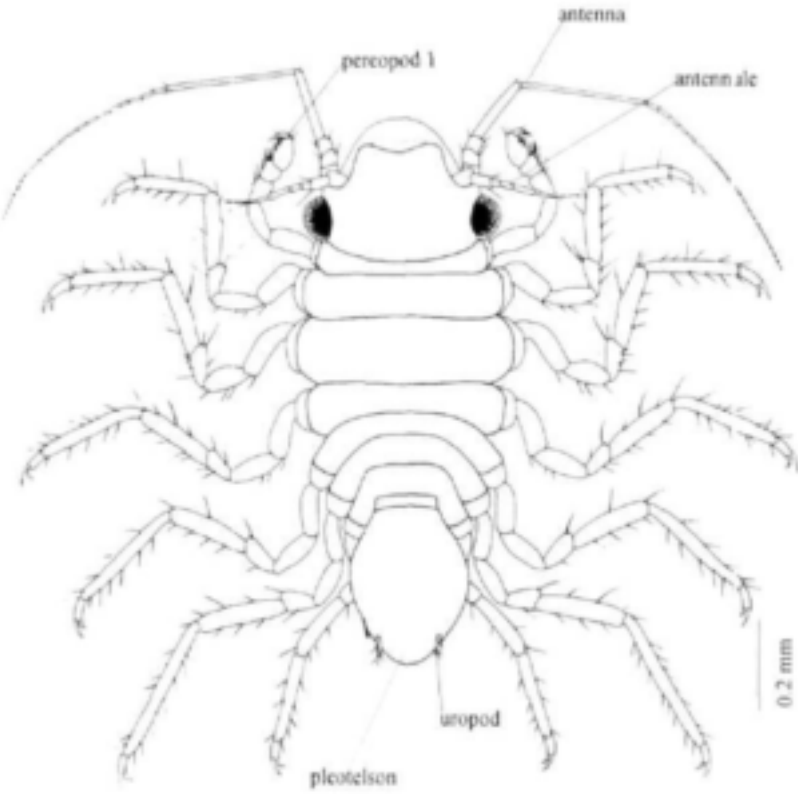

Fig. 3.4. *Uromunna sheltoni*, adult male, dorsal view.

dorsally lacking setae. Pereopod 1 in both sexes similar, shorter than following pereopods, with propodus ovate. Pereopods 2–7 elongate-slender, with sensory spines on posterior surface of propodi and carpi. Operculum of female (pleopod 2) roughly hexagonal, distal margin short, truncate. Pleopods 1 and 2 in male forming operculum over pleopods 3–5.

Records

Sandvlei Estuary, False Bay, Western Cape, on *Ruppia* weed in water of 9‰ salinity; Kosi Lake complex (Kwa–Zulu Natal), on *Potamogeton* weed; Lake Sibaya (KwaZulu–Natal) on submerged vegetation.

Remarks

In the various studies on the coastal lakes of KwaZulu–Natal, this species was erroneously referred to as *Paramunna laevifrons* Stebbing, a species originally described from 75 m off East London. Described from Sandvlei Estuary (where it was extremely abundant) this species is adapted to conditions of reduced salinity. Ovigerous females have been taken in water of 9‰ salinity.

The genus *Uromunna* has a world-wide distribution (Poore 1984), with some species being shallow-water marine inhabitants, others being adapted to euryhaline conditions.

Suborder ANTHURIDEA

The anthuridean isopods have been divided into four families: the Antheluridae, Anthuridae, Hyssuridae and Paranthuridae. All species characteristically have a slender and elongate, often worm-like, body form. All have lost the second maxilla in the mouthparts. The pleonites may be large and free, short and free, or short and fused. The telson which, with the uropods often forms a sclerotized cup-like structure, may lack statocysts, or have a single median one basally, or a basal pair. Many species are protogynous hermaphrodites, with some ovigerous females in the population becoming pre-males and then males via a series of moults. Males are characterized by the possession of larger eyes than females, increased numbers of articles in the flagellum of the antennule, and increased numbers of aesthetascs on these articles. Most anthurideans are benthic dwellers, where they are detritivores, but some species prey on tube-dwelling polychaete worms, whereas the paranthurids, with their piercing mouthparts, are thought to feed on algal saps or on soft-bodied invertebrates. The greatest diversity of species is found in and around the many cryptic habitats of coral reefs.

Family **Anthuridae**

The anthurids are characterized by having the first pereopod subchelate, with the propodus expanded or inflated and the dactylus folding against its palmar surface. The pleonites are short and fused, often with the fused segments indicated by lateral slits. The exopod of the first pleopod is operculiform and covers the rest of the pleopods. The telson possesses two basal statocysts that open to the exterior via narrow slits on the dorsal surface. Many species are protogynous hermaphrodites with females outnumbering males in the population. Primary males, which develop directly from the egg, have been recorded for a few species. The anthurids are almost exclusively benthic animals. With their mouthparts adapted for cutting and tearing, they feed on organic detritus in the cryptic niches they inhabit. The genus *Cyathura* has a worldwide temperate/tropical distribution, and is often found in coral reefs, but has also successfully invaded estuaries and freshwater cave systems.

Cyathura estuaria Barnard, 1914

Fig. 3.5

Characteristic features

Female 27.5 mm total length. Body elongate, cylindrical, about eight times longer than greatest width. Head with small dorsolateral eyes; low, rounded rostrum. Maxilliped consisting of four articles (including basal article fused to cephalon); endite lacking. Pereopod 1 subchelate, with propodus inflated; pereopods 2–7 ambulatory. Pleon consisting of anterior five fused pleonites (fusion lines being indicated by faint lateral grooves), plus pleonite 6 fused with telson; telson roughly parallel-sided for anterior three-fourths, then tapering to rounded apex; two basal statocysts indicated by oblique dorsal slits.

Records

Langebaan Lagoon (WC); east coast estuaries and coastal lakes from Knysna Lagoon (WC) to KwaZulu–Natal and Mozambique, including the Swartkops Estuary, Buffalo River Estuary (EC) and St Lucia Estuary, Lake Sibaya, and Lake Msingazi (KZ–N).

Remarks

This species has been taken from muds, often in *Zostera* beds, in salinities ranging from 0–35‰. In many genera of the Anthuridea, including *Cyathura*, protogynous hermaphroditism occurs. Once the ovigerous female has released the manca from the brood pouch, she moults one or more times, to become first a premale, and then a sexually mature male. The male is characterized by the possession of an increased number of articles and sensory aesthetascs on the antennular flagellum, and often by an increase in spination of the subchelate pereopod 1. As a result of this phenomenon, there are usually many more immature and mature females than pre-males and males in any population. The male of *Cyathura estuaria* has yet to be recorded.

Suborder FLABELLIFERA

Family **Sphaeromatidae**

The Sphaeromatidae includes all those forms capable of enrolling into a ball (conglobating) or folding in half transversely. Most have bodies that are strongly domed dorsally. The pleon consists of five partially or completely fused pleonites plus the pleotelson. In addition to the brood pouch or marsupium formed by oostegites, sphaeromatids may also have anterior

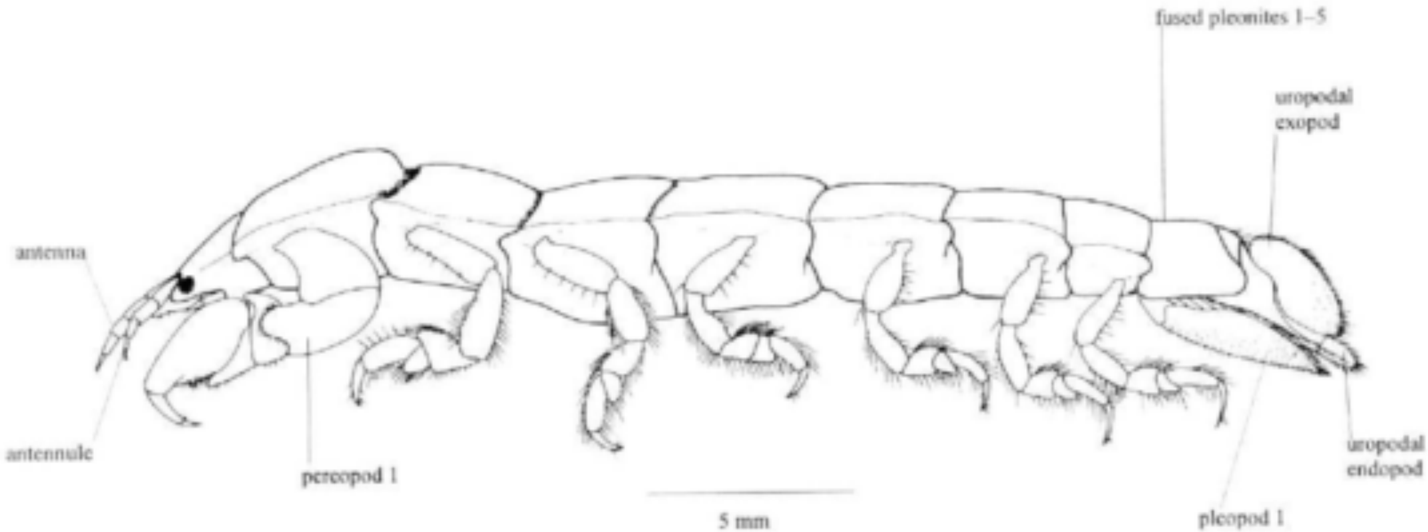

Fig 3.5. *Cyathura estuaria*, non-ovigerous female, lateral view.

or posterior sternal pockets, and invaginated internal pouches as part of the brood apparatus. There is often a marked sexual dimorphism in the structure of the pleon and telson, with the male being more ornamented, incised, or spinose than the female. The mouthparts of ovigerous females are often reduced and non-functional. The respiratory pleopods are tucked into the domed pleotelson, with the fourth and fifth pairs consisting either of two unpleated plates, or of one unpleated and one pleated plate, or with both rami pleated.

Most species are shallow marine dwellers, being detritivores and micrograzers in seagrass beds, on algal turfs and clumps, or on microbial films on submerged rocks. A few species are commensal in sponges, or are associated with molluscs. Species of the genus *Sphaeroma* are capable of burrowing into wood, including the growing tips of mangrove prop roots. In the latter case, this burrowing activity causes the root to divide, thereby increasing the number of prop roots that ultimately stabilize the mangrove plant.

'Pseudosphaeroma' barnardi Monod, 1931
Fig. 3.6

Characteristic features

Male 7.0 mm, ovigerous female 5.0–5.5 mm total length. Body strongly depressed, about 1.6 times longer than wide; capable of folding transversely in half ventrally. Plate-like and inverted V–shaped epistome apically subacute, fused posteriorly with clypeus and labrum (upper lip). Ovigerous female with mouthparts as in male. Two pairs of oostegites on pereonites 3–4, oostegites not reaching, or overlapping in, midline; eggs held in four pairs of internal pouches on pereonites 2–5. Pleotelson broadly triangular, apically rounded. Pleopods 4 and 5 with endopods having broad transverse branchial pleats. Uropodal sympod and endopod fused, not quite reaching apex of pleotelson; exopod short, ovate, articulating laterally on fused exopod and sympod.

Records

Western Cape in the following localities: Stream at Hout Bay; Palmiet River; stream at Hermanus; De Hoop Vlei, Bredasdorp; Storms River Mouth; Keurbooms River; Eiland Vlei, The Wilderness; Groenvlei; upper end of Knysna Estuary.

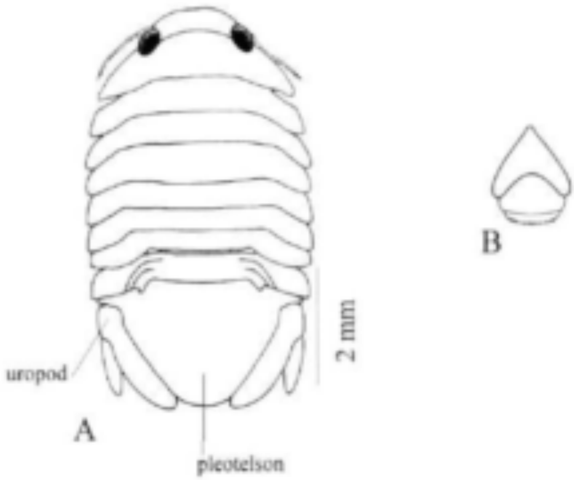

Fig. 3.6. A–B, *'Pseudosphaeroma' barnardi*: A, adult, dorsal view; B, epistome and labrum (upper lip) in frontal view (apex of epistome dorsal).

Remarks

'Pseudosphaeroma' barnardi would appear to be a brackish-water species that is also to some degree tolerant of fresh water.

The generic name '*Pseudosphaeroma*' is given here in quotation marks to signify an uncertain taxonomic position. True *Pseudosphaeroma* possess three pairs of oostegites overlapping the midline in the ovigerous female (Harrison 1984). Only three known genera of the sphaeromatids possess two pairs of non-overlapping oostegites, and all three are platybranchiate, i.e. lacking branchial pleats on both endopod and exopod of pleopods 4 and 5, in contrast to *P. barnardi* which has hemibranchiate pleopods 4 and 5, i.e. only the endopods have branchial pleats. *'Pseudosphaeroma' barnardi* requires a new genus to accommodate it.

Suborder PHREATOICIDEA

Characteristic features

Eyes sessile, compound, or lacking. Antennules and antennae uniramous. Palp usually present on mandible. Maxilliped (first pereonal appendage) well developed, incorporated into mouthparts. First pereopods (sometimes referred to as gnathopods) subchelate, with propodus inflated. Posterior three pairs of pereopods directed posteriorly. Pereopodal coxae not developed into plates. Brood pouch formed by thoracic oostegites. Penes in male arising near base of seventh pereopods. Pleopod 2 in male, endopod having moderately broad copulatory stylet. Pleopods natatory and branchial in function. Uropods biramous. Telson fused with sixth pleonal somite to form pleotelson.

The Phreatoicidea form a relatively ancient group, with a fossil record stretching back to the Palaeozoic and Mesozoic. The group demonstrates the evolution from marine ancestors, through brackish-water forms, into fresh water, and the eventual invasion of groundwater habitats. The present-day distribution of the group, typically Gondwanan, includes Australia, New Zealand, India, and South Africa. The surface-dwelling forms, a few of which are blind, may be found in a variety of habitats: temporary headwaters, swamps, superficial lacustrine sediments, on stream and swamp vegetation, or under stones in swiftly flowing streams. Those forms that have invaded subterranean habitats are usually found in well water, pumped up from boreholes, or in the waters of caves. These forms are blind, white, and somewhat vermiform. About 50 species, arranged in seven families, have been recorded.

The South African phreatoicideans were first reported by Barnard (1914*a*), who placed them in the Australian genus *Phreatoicus*. At that time the group was poorly known, but with more collecting many more forms have become known. Nicholls (1943a, 1943b) established a firm taxonomic base for the suborder, and referred the South African species to a new genus *Mesamphisopus*. Barnard eventually described three varieties of the original *Phreatoicus capensis* (all reaching about 15 mm in total length), from mountain areas in the south-western Cape. Nicholls (1943a) recognized two of these varieties as full species. The third variety was described by Barnard in 1940; Nicholls probably did not see this reference. This variety is recognized as a full species here. Many questions still remain concerning the evolutionary history, geographical distribution, biology and ecology of the South African phreatoicideans, these being surface-dwelling forms showing no proclivity for entering the hypogean world. Inter- and intraspecific variation have not been studied, an essential

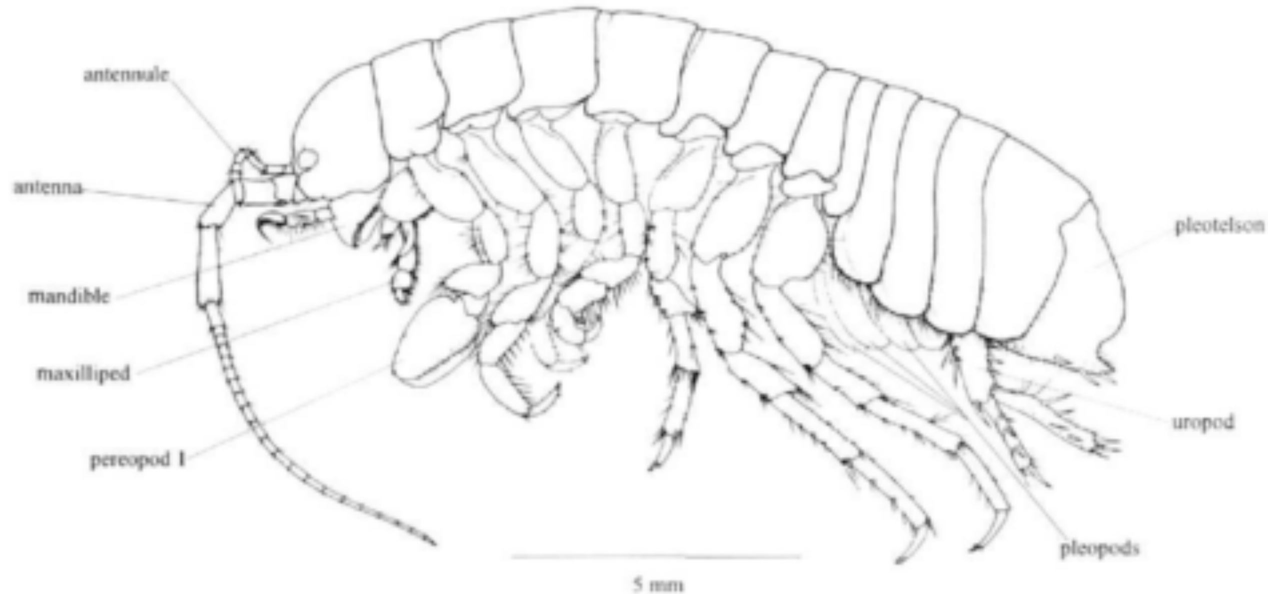

Fig 3.7. *Mesamphisopus capensis*, adult, lateral view.

requirement for an accurate interpretation of the distribution of the several currently accepted species. This is especially important given the very subtle characters that separate these supposed species. There is a real need for more fieldwork, to establish the range of species both in geographical areas and in terms of altitude. It is probable that considerable speciation has taken place on the relatively isolated mountain peaks of the Western Cape.

The southern African phreatoicideans appear to be able to withstand long dry periods. Barnard (1927: 154) observed this form of aestivation both in laboratory animals and in the field.

Family **Amphisopodidae**

Mesamphisopus Nicholls, 1943a

KEY TO THE SOUTH AFRICAN SPECIES OF *MESAMPHISOPUS*

1. Pleotelson having pair of subapical dorsal spines (Fig. 3.8A, E, G) 2
– Pleotelson lacking pair of subapical dorsal spines (Fig. 3.8C) .... *M. capensis*

2. Cephalon and lateral pereon to some degree setose 3
– Cephalon and lateral pereon not setose .... *M. abbreviatus*

3. Antennal peduncle sparsely setose; lateral pereon strongly setose .... *M. depressus*
– Antennal peduncle strongly setose; lateral pereon sparsely setose .... *M. penicillatus*

Mesamphisopus abbreviatus (Barnard, 1927)

Fig. 3.8A–B

Characteristic features

Pereopod 1 with three stubby spines on cutting edge of propodus. Spines on ventral margin of pleotelson slender. Cephalon and lateral pereonal segments lacking setae, or with very few short scattered setae. Female pleotelson and uropods with few elongate setae. Male pleotelson and uropods bearing dense elongate setae. Pleotelson with single pair of short subapical dorsal spines.

Records

Northern slopes of Kogelberg, Hottentots Holland Mountains (Western Cape).

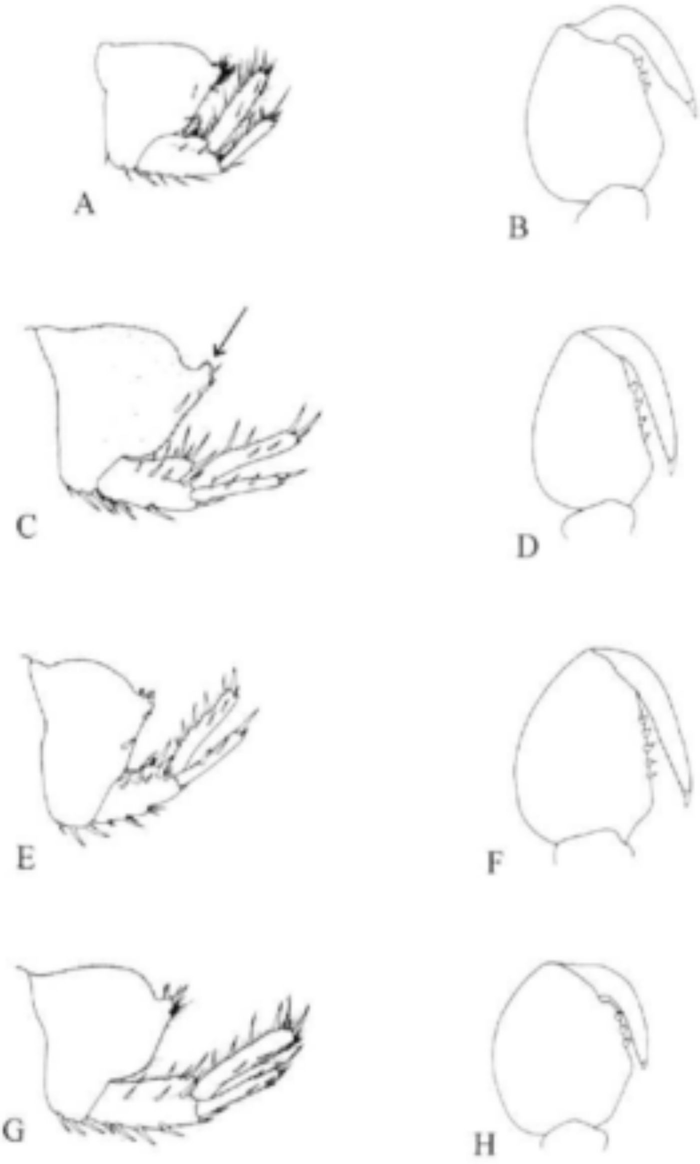

Fig. 3.8. A–B, *Mesamphisopus abbreviatus*: A, pleotelson and uropod, lateral view; B, pereopod 1. C–D, *M. capensis*: C, pleotelson and uropod, lateral view; D, pereopod 1. E–F, *M. depressus*: E, pleotelson and uropod, lateral view; F, Pereopod 1. G–H, *M. penicillatus*: G, pleotelson and uropod, lateral view; H, pereopod 1.

Mesamphisopus capensis (Barnard, 1914)
Figs 3.7, 3.8C–D

Characteristic features

Pereopod 1 with four stubby spines on cutting edge of propodus. Pleotelson with three stout spines on ventrolateral margin, but lacking a subapical dorsal pair. Cephalon and pereon with scattered setae. Middorsal length of pleotelson subequal to greatest lateral width. Uropodal sympod with mediodistal rounded lobe more pronounced and spinose than in other three species.

Records

Reservoir on Table Mountain, 915 m, Cape Peninsula (Western Cape).

Mesamphisopus depressus (Barnard, 1927)
Fig. 3.8E–F

Characteristic features

Pereopod 1 with five stubby spines on cutting edge of propodus. Body, and especially pereon, somewhat depressed; bearing moderately dense setae, especially on lateral pereon. Pleotelson with middorsal length distinctly less than greatest lateral width; short subapical dorsal pair of spines present.

Records

Steenbras Valley, Hottentots Holland Mountains (Western Cape).

Mesamphisopus penicillatus (Barnard, 1940)
Fig. 3.8G, H

Characteristic features

Antennular and antennal peduncles strongly setose, more marked in male. Cephalon and pereon lacking setae, but pleonal side-plates, ventral margin of pleotelson, and uropods bearing elongate dense setae, especially marked in male. Middorsal length of pleotelson slightly less than greatest lateral width; bearing pair of subapical dorsal spines. Pereopod 1 (gnathopod) in male subcircular, with propodal palm subequal in length to hind margin, three stubby spines on cutting edge of propodus; palm distinctly longer than hind margin in female and juvenile.

Records

Stream 18–21 m above sea-level, Hermanus (Western Cape).

ACKNOWLEDGMENTS

For the loan of material for this study, I thank Mr W. Haacke of the Transvaal Museum, Pretoria; Mrs M. van der Merwe, South African Museum, Cape Town; Dr B. Wilmot, formerly of the Albany Museum, Grahamstown; and Dr G. Wilson, Australian Museum, Sydney, Australia. I am grateful to Dr B. Knott of the University of Western Australia, Perth, for comments on the Phreatoicidea.

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CHAPTER 4

SPELAEOGRIPHACEA

by

B. Kensley

The Spelaeogriphacea are small (less than 10 mm in length), slender, transparent inhabitants of groundwater in caves and aquifers. They are thought to be detritivores, feeding on organic matter found in the groundwater. From 1957 to 1987, only one living species was known, viz. *Spelaeogriphus lepidops*, from a freshwater stream in Bats Cave, Table Mountain (Western Cape). A fossil form, *Acadiocaris novascotica* (Copeland, 1957) from marine Carboniferous sediments in Nova Scotia, Canada, was assigned to the Spelaeogriphacea by Schram (1974). A second living species, *Potiicoara brasiliensis* Pires, 1987, from a cave in the state of Mato Grosso do Sul, Brazil, was then added to the order in 1987. In 1998, as further confirmation of the Gondwanan affinities of the order, a third living species (*Mangkurtu mityula* Poore & Humphreys, 1998) was described from an aquifer in the Tertiary Dolomite of the Pilbara region of Western Australia.

Little of the biology of *Spelaeogriphus* has been published. It is assumed that the animal feeds on detritus, as the gut, visible through the almost transparent body, often appears dark and packed with tiny particles. Observation of live animals confirmed that the three anterior pereopodal exopods create a stream of water over the respiratory epipod of the maxilliped and over the respiratory exopods of the posterior four pairs of pereopods (Grindley & Hessler 1971). Grindley (1976) recorded that copulation was observed, with the male clasping the female with the aid of the antennular pads. Ovigerous females have been collected, with 10–12 eggs in the marsupium. Development of the egg is still undocumented.

Remarks

The presence of a lacinia mobilis in the mandible, and a ventral brood pouch formed by thoracic oostegites, place the Spelaeogriphacea in the much-disputed superorder Peracarida, along with the Isopoda, Amphipoda, Tanaidacea, Mysidacea, Mictacea, and Cumacea (see Gordon 1960; Watling 1983). The real phylogenetic relationships within this group remain the subject of heated discussion.

The Brazilian *Potiicoara brasiliensis* differs from *S. lepidops* in having a shorter carapace; a non-sexually-dimorphic antennule, and antennal scale as broad and as long as the peduncle article 3; a mandibular palp of three articles; a row of thick distal spines on the maxillipedal endite; oostegites on pereopods 1-5; and a biramous pleopod 5.

The Australian *Mangkurtu mityula* has the following distinguishing characteristics: a non-sexually dimorphic antennule; the antennal scale shorter and narrower than peduncle article 3, a mandibular palp of three articles, maxillipedal palp articles 2 and 3 with few mesial setae, the epipod short and digitiform, pleopods 1–5 present, and the endopods with a basal, laterally-directed lobe. Pleopod 2 in the male has a biarticulate endopod and a narrow exopod. The oostegites are unknown.

Order SPELAEOGRIPHACEA Gordon, 1957
Family **Spelaeogriphidae** Gordon, 1957
Spelaeogriphus Gordon, 1957
Spelaeogriphus lepidops Gordon, 1957
Fig. 4.1

Characteristic features

Male and female, total length up to 7.5 mm. Body elongate, slightly depressed, entirely lacking pigmentation. Cephalothorax formed by fusion of pereonite 1 with cephalon. Pereon consisting of seven free pereonites. Pleon consisting of six free pleonites. Freely articulating telson consisting of single broad lobe bearing few setae on rounded posterior margin.

Cephalothorax bearing anterior pair of flattened, ovate, ocular lobes lacking in pigment or visual components; ocular lobes separated by broadly triangular rostrum. One pair of sexually dimorphic antennules consisting of peduncle of three articles, and two flagella; inner flagellum slightly longer than outer; peduncle article 2 in male having mesiodistal lobe bearing conical papillae. One pair of antennae, consisting of peduncle of four articles with articulating scale (exopod) distolaterally on article 2, and elongate flagellum reaching posteriorly almost to the 6th pleonal somite. Mandible having palp of one article, incisor of three to four cusps,

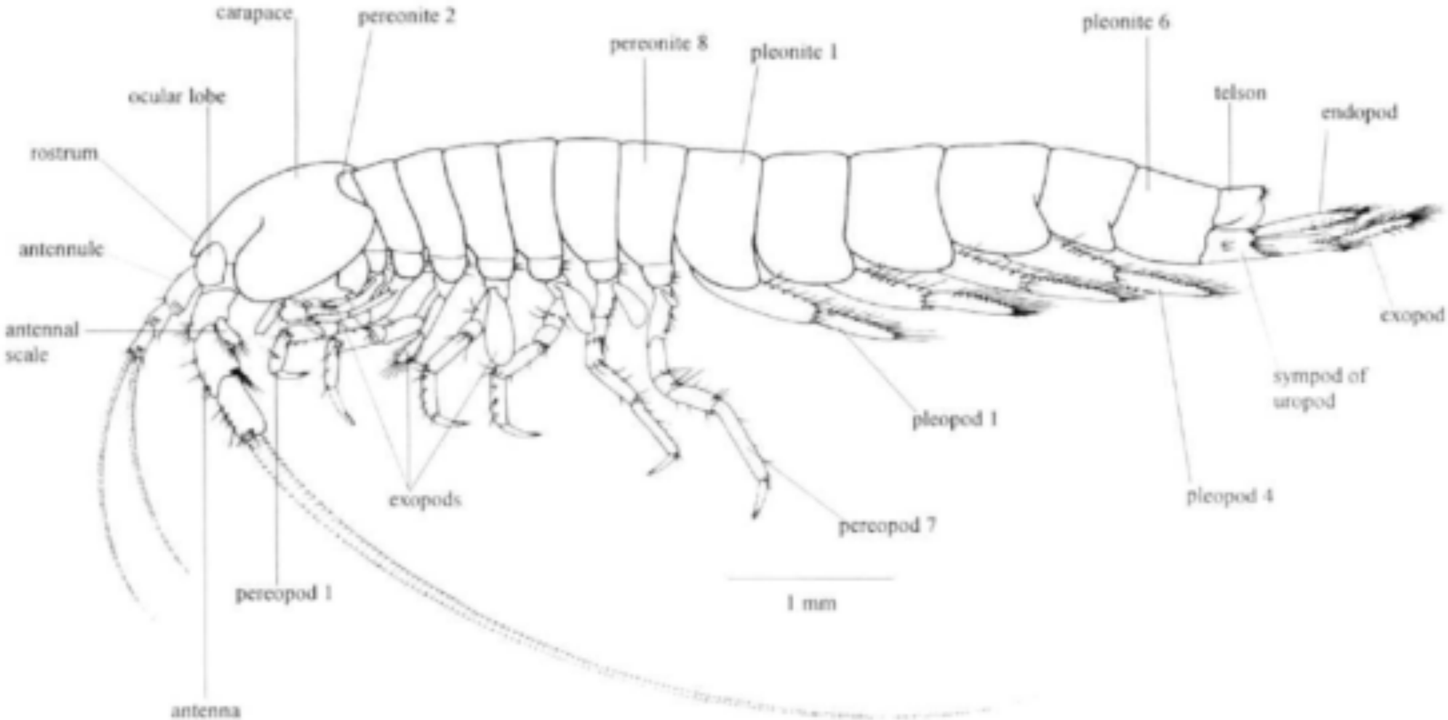

Fig. 4.1. *Spelaeogriphus lepidops*, adult in lateral view.

lacinia mobilis, spine row of 16–20 spines, and stout molar. Maxilla 1 having slender inner ramus bearing three terminal plumose papillae; outer ramus broad, with 16 distal spines. Maxilla 2 having inner ramus narrower than two lobes of outer ramus; latter broad, setose. Maxilliped having broad endite, distally setose; palp of five articles, articles 2 and 3 broad, setose on mesial margins; epipodite broad, cup-shaped, probably respiratory in function.

Short carapace present, partially covering second thoracic somite, broadening ventrolaterally into ovate lobe on each side, and obscuring mouthparts in lateral view. Seven pairs of pereopods ambulatory; coxae distinct. Anterior three pairs of pereopods each having biarticulate ventilatory exopod. Posterior four pairs of pereopods each having simple ovate respiratory exopod; exopods becoming smaller posteriorly. Brood pouch formed by four pairs of oostegites on pereopods 2–5 overlapping in midline.

Pleopod pairs 1–4 well developed, natatory, having broad protopod linked to its opposite member by two mesiodistal retinaculae (coupling hooks); endopod and exopod each consisting of single paddle-like and setose article. Pleopod 5 reduced, of single article concealed by epimeron of pleonite 5. Single pair of uropods, each consisting of sympod, endopod of single article, exopod of two articles; all margins heavily setose–spinose.

Records

Streams in Bat's Cave and several other caves on Table Mountain, Western Cape.

Remarks

The presence of a lacinia mobilis in the mandible, and a ventral brood pouch formed by thoracic oostegites, place the Spelaeogriphacea in the much-disputed superorder Peracarida, along with the Isopoda, Amphipoda, Tanaidacea, Mysidacea, Mictacea, and Cumacea (see Gordon 1960; Watling 1983). The real phylogenetic relationships within this group remain the subject of heated discussion.

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CHAPTER 5

TANAIDACEA

by

B. Kensley

The order Tanaidacea of the superorder Peracarida contains about 400 species, some superficially similar to the isopods. Their fossil history goes back to the Upper Permian. The great majority are marine in habit, and are found from the intertidal to the abyss. Many live in various types of sediments; some forms are commensal with sponges; others inhabit tubes spun from a mucous-like secretion into which faecal pellets or other detritus are embedded; a few forms live in empty mollusc or foraminiferan shells, rather like hermit crabs. A few species are estuarine in habit, and yet fewer have been found in fresh water.

Reproduction in some tanaidaceans shows a range of pathways involving hermaphroditism and protogyny. Males may develop from a neuter stage after moulting (primary males), or females may moult after brooding to become males (secondary males). Females may thus be either protogynous hermaphrodites, or gonochoristic, i.e. not having the ability to change to male.

The few South African freshwater tanaidacean species are clearly derived from marine stock; indeed, *Sinelobus stanfordi* has been recorded from fully marine to fully fresh water. Four species have been recorded from the freshwater coastal lakes of the east coast of South Africa; two of these, in the genera *Heterotanais* and *Leptochelia*, have not been identified and may represent undescribed species.

Characteristic features

Body usually cylindrical, occasionally slightly to strongly dorsoventrally depressed. Cephalon fused with first and second thoracic (pereonal) segments, and covered by carapace. The inner lateral surface of the carapace, along with maxillipedal epipods if present, functions as a respiratory organ. Six free pereonal segments present. Sixth pleonal segment fused with telson to form pleotelson. Eyes, when present, often on ocular stalks. Antennules uni- or biramous. Antenna uni- or biramous. Mandibular palp present or absent. First maxilla having one or two endites. Second maxilla present or reduced. One pair of maxillipeds (thoracic appendages) forming part of mouthpart complex. Seven pairs of legs of which first pair chelate, referred to as chelipeds, often much larger in male than in female. Exopods occasionally present on cheliped and next pair of appendages. Five pairs of biramous pleopods, number occasionally reduced. Uropods slender, uni- or biramous. Genital aperture in males on eighth thoracic segment opening on single or on pair of genital cones. The female carries eggs and later mancas in a marsupium formed by four or fewer thoracic oostegites.

KEY TO THE SUBORDERS OF TANAIDACEA

1. Antennule having two flagella; antenna with scale-like exopod (Fig. 5.1); mandible with palp .... **Monokonophora**
– Antennule having single flagellum; antenna lacking exopod (Fig. 5.2); mandible lacking palp .... **Dikonophora**

Each of the suborders is represented by a single identified species of freshwater tanaidacean in South Africa.

Order TANAIDACEA
Suborder MONOKONOPHORA
Family **Apseudidae**
Halmyrapseudes digitalis (Brown, 1956)

Synonym: *Apseudes digitalis* Stebbing

Fig. 5.1

Characteristic features

Adult male 6.0 mm, ovigerous female 5.8 mm total length. Body elongate, cylindrical. Eyes absent. Rostrum bluntly triangular. Free pereon segments subequal in length. Anterior five pleonites each with transverse row of plumose setae; pleotelson equal in length to posterior four pleonites together. Longer antennular flagellum of about nine articles; shorter accessory flagellum of three or four articles. Antennal flagellum of five articles. Cheliped in male robust, propodus expanded, with fixed finger having setose lobe interior to apical claw; dactylus reaching well beyond fixed propodal finger, with triangular tooth on inner margin near articulation. Cheliped in female subequal to succeeding leg, propodal finger acutely triangular, dactylus just overreaching propodus. Uropod biramous, endopod with 13–20 articles, shorter exopod of three articles.

Records

East coast river estuaries, including Mkomazi and Mzimkulu (KZ–N), Mbashe and Mzimvubu (Transkei) and Lake Sibaya (KZ–N)

Remarks

Boltt (1969) recorded densities of 100 to 1500 animals of *H. digitalis* per 0.0225 m² in depths of 20–40 m, on sandy substrata in Lake Sibaya, with lower densities at shallower depths. Although no ecological role was assigned to this species, it is probably one of the more important filter-feeding detritivores in the coastal lake systems.

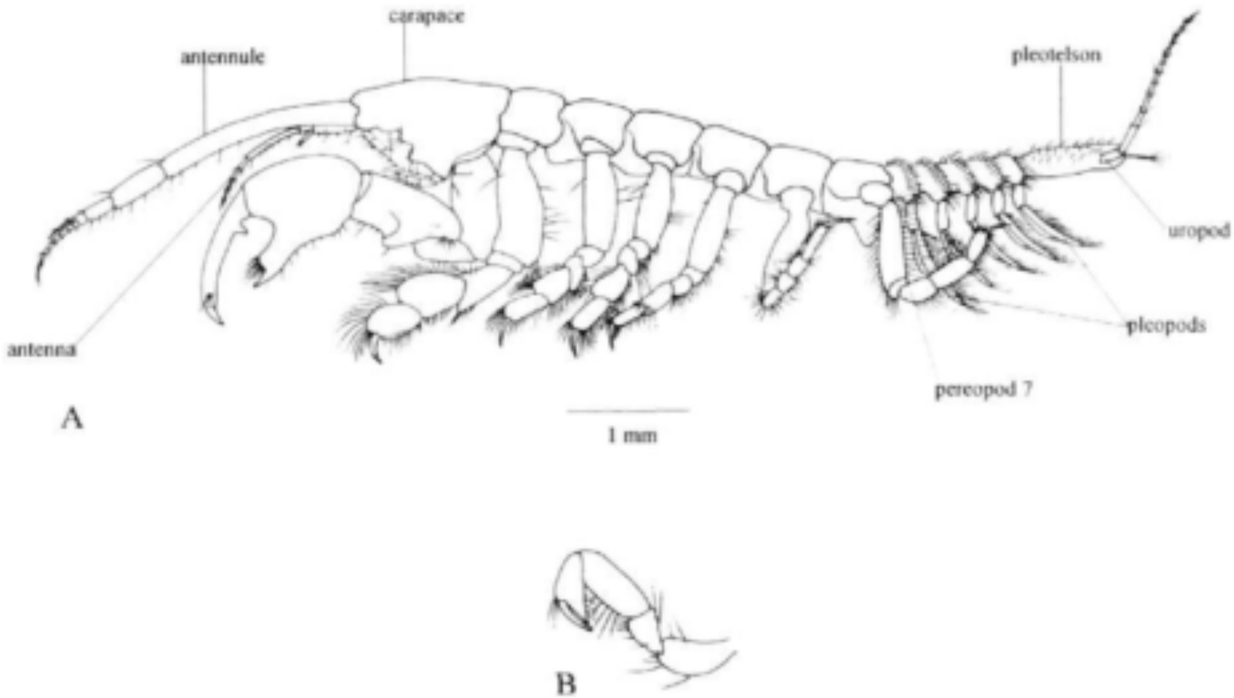

Fig. 5.1. *Halmyrapseudes digitalis*: A, male, lateral view; B, cheliped of female to same scale.

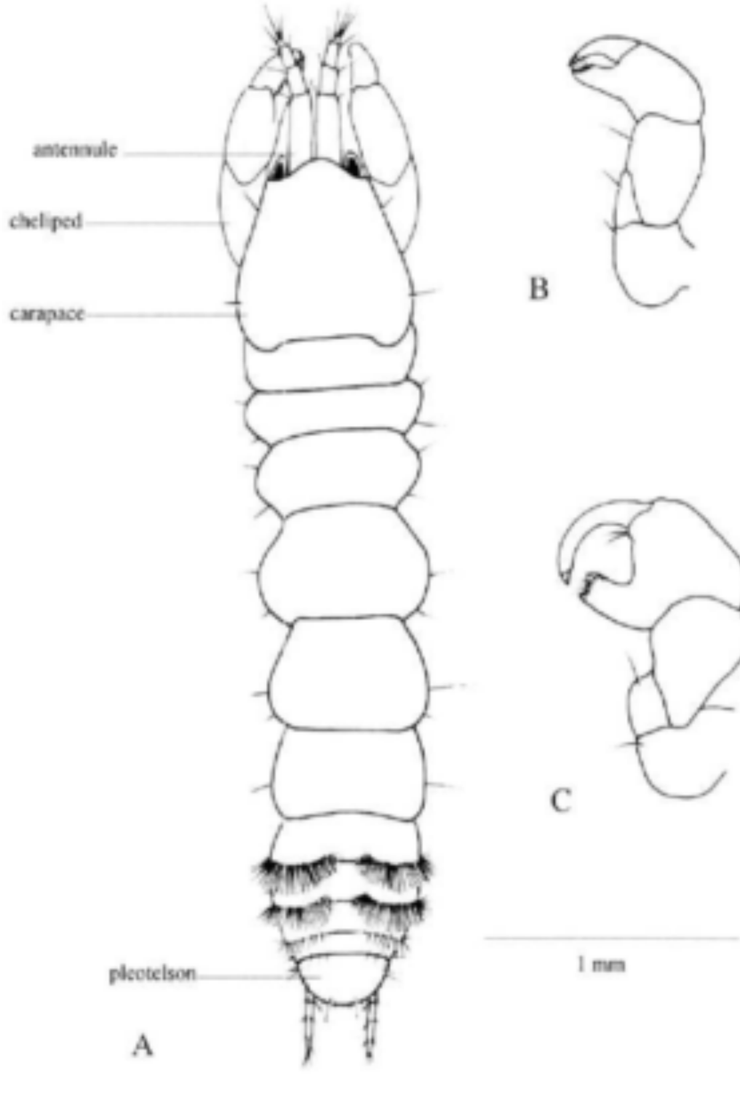

Fig. 5.2. *Sinelobus stanfordi*: A, adult female, dorsal view; B, cheliped of female; C, cheliped of male.

Suborder DIKONOPHORA

Family **Tanaidae**

Sinelobus stanfordi (Richardson, 1901)

Synonym: *Tanais philetaerus* Stebbing

Fig. 5.2

Characteristic features

Adult male 3.6 mm, ovigerous female 4.0 mm, total length. Body elongate, cylindrical. Eyes well pigmented, on short ocular lobes. Rostrum low, convex. First two free pereonites shorter than succeeding somites; pereonites 5–7 somewhat broader than long, subequal. Pleonites decreasing in length posteriorly; pleonites 1 and 2 each with distinctive pair of dense setal combs dorsally; pleotelson semicircular in outline. Antennular flagellum of single article bearing three aesthetascs in male, two in female. Antennal flagellum of single short article. Cheliped in male robust, propodus somewhat expanded, fixed propodal finger distally truncate, large gape between fixed finger and dactylus; latter strongly curved. Cheliped in female less robust than in male, with almost no gape between fingers.

Uropod uniramous, consisting of short sympod plus ramus of three poorly defined articles.

Records

Lake Nhlange, Kosi Lake complex (KZ–N); Lake Mpungwana (KZ–N); Saldanha Bay (WC).

Remarks

Originally referred to as *Tanais philetaerus* Stebbing in the South African literature, *S. stanfordi* has been shown to be a widely distributed species (Sieg 1980). It has been recorded from the southern United States, the Caribbean, Atlantic South America, California, the Galapagos, Pacific Central and South America, Polynesia, New Zealand, Australia, Japan, India, Sri Lanka, and the Red Sea. The species enters river mouths in Brazil and Argentina, and has also been taken from freshwater lakes in the Kuril Islands (Japan).

In South Africa, *S. stanfordi* has been taken from fully marine habitats, estuaries, and coastal lagoons and lakes. Brown (1957) reported this species as being commensal in the sponge *Hymeniacidon perlevis* from Saldanha Bay.

ACKNOWLEDGMENTS

I am grateful to the late Dr Jürgen Sieg of the University of Osnabrück for assistance with the systematics of the tanaidaceans.

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CHAPTER 6

DECAPODA

by

R. C. Hart, B. A. Stewart & I. B. Bickerton

The Crustacea, traditionally classified as a sub-group (Sub-phylum, Class or Super-class) of the Phylum Arthropoda (Bowman & Abele 1982), is now recognized by some systematists as a unique phylum (e.g. Schram 1986). In common with other arthropods, crustaceans are bilaterally symmetrical animals, with metamerically segmented bodies bearing jointed limbs on some or all body segments, encased in a cuticular exoskeleton, and accordingly requiring successive moults to develop and/or grow. In general, crustaceans are primarily aquatic and mostly marine animals, numbering more than 40 000 species globally. While proportionately few of these species are true freshwater forms, they nonetheless contribute significantly to the freshwater fauna.

The Decapoda (literally, ten–footed animals) comprises a major group in the Class Malacostraca within the Crustacea. Worldwide, about 10 000 species of decapods are known, which thus comprise a quarter of the recent (i.e. extant) Crustacea (Bowman & Abele 1982; Abele 1982). Decapods are generally macroscopic animals that show their greatest species diversity in tropical and subtropical waters.

The bulk of the group is marine, but some 10% of the Decapoda are freshwater forms, of which three categories are recognized: primary, secondary and peripheral. No *primary* freshwater decapods (species that evolved in freshwater) are known from southern Africa. The true freshwater crabs of this region are considered to be *secondarily* freshwater forms whose marine ancestors independently invaded and colonized fresh waters, leaving no residual marine relatives. The freshwater shrimps and prawns are classified as *peripheral* freshwater forms whose ancestors invaded continental waters, but which retain marine representatives (Bănărescu 1990). Some 24 indigenous species of freshwater decapods exist in South Africa, comprising at least 14 species of carid shrimp or prawn, and some 12 species of crab. These numbers increase somewhat by inclusion of estuarine 'relicts', which occur in freshwater coastal lakes of the region, and further slight increases in species richness are likely to arise with wider collection and improved taxonomic knowledge.

GENERAL MORPHOLOGY

Decapods are generally macroscopic arthropods bearing five pairs of pereiopods (ppd1–ppd5) or walking legs attached to the familiar body form of a crab, shrimp, or prawn. The head bears stalked eyes and, uniquely characteristic of all crustaceans, two pairs of generally sensory feelers or antennae — the antennules (A1) and antennae (A2) respectively. The thorax is encased in a carapace ('shell'), which also envelops the head; the terminal abdomen is either elongate, as in shrimps and prawns (Fig. 6.1A), or reduced, recurved and inconspicuous, as in crabs (Fig. 6. 1B). The entire body and all appendages are encased in a firm or rigid calcareous or calcium-containing exoskeleton which is shed periodically during the process of moulting. Concentrations of calcium dissolved in the medium in which they live may accordingly influence the distribution and occurrence of certain decapods in freshwater.

Decapods uniformly possess six pairs of feeding and accessory feeding appendages. In sequence posteriorly from the mandibles (Md), which bound the mouth, are two pairs of maxillae (Mx1 and Mx2), which are head appendages, and three pairs of maxillipeds (Mxp1–Mxp3), which derive from the anterior thoracic segments. The functional fusion of head and thoracic segments gives rise to the so-called cephalothorax, which is covered by the carapace. The five pairs of thoracic pereiopods, to which decapods owe their name, follow the third maxillipeds posteriorly. The first five segments of the six-segmented abdomen bear paired swimmerets or pleopods which are used for swimming and/or reproductively (egg-carrying in females or sperm transfer by the first pleopod in males). Uropods on the sixth segment function jointly with the terminal, unpaired telson as a powerful 'tail-fan' (see Fig. 6.9B) with which lobsters, prawns and shrimps execute strong backward escape movements. True crabs lack uropods. Important morphological features of shrimps and prawns are illustrated in Figs 6.1A, 6.2, 6.3, 6.4 and 6.5, and of crabs in Fig. 6.1B.

A major phyletic revision of the Crustacea proposed by Schram (1986) divides the Decapoda into five separate Orders, two of which encompass the southern African freshwater forms. In the interests of simplicity for this chapter, however, we retain the familiar and 'workable', if artificial,

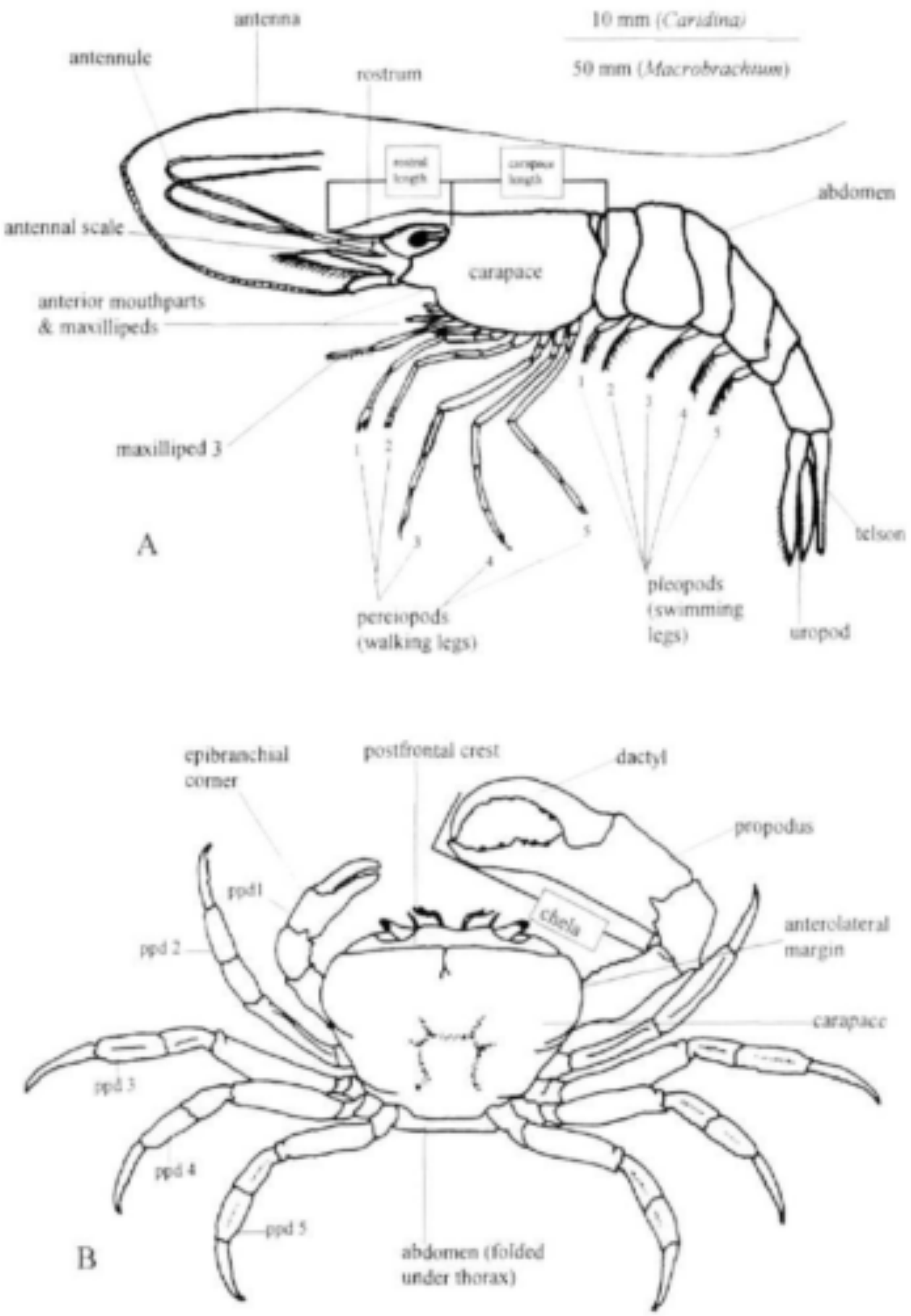

Fig. 6.1. General structure and body form of decapods, showing characters referred to in text: A, shrimp or prawn; B, freshwater crab.

division between a) 'large-tailed' (Macrura) swimming, 'natantian' forms, and b) 'short-tailed' (Brachyura) crawling, 'reptantian' forms.

BIOLOGY AND ECOLOGY

Habitat preferences

Decapods are generally restricted to permanent waters. While river crabs frequently move kilometres away from free water, they are generally restricted to cool, moist locations, seldom far from a permanent water source. Active dispersion overland is accomplished, especially under moist conditions, by the physical transport of water in their gill chambers to prevent desiccation of their respiratory gill surfaces, along with water-conservation strategies such as nocturnal activity patterns, and the retreat into self-dug burrows that are cooler and moister than the ambient environment. Shrimps and prawns lack this amphibious capability, and have no suitable means of locomotion over land. They are accordingly restricted to 'permanent' waters sufficiently deep for them to swim and crawl in, and are limited in their capacity to disperse actively. Certain river prawns that occupy fresh water as adults show an obligate dependency upon saline waters for the successful completion of their larval development. This serves as an additional constraint on their ability to penetrate upstream in rivers.

Consequently, the number of species of freshwater decapods on the subcontinent broadly mirrors the meridional rainfall gradient, and declines westwards. In the better-watered eastern regions, decapods are widespread and frequently abundant, although cryptic, and thus not conspicuous. Rather fewer species exist in western regions.

Feeding

Decapods are generally macrophagous, using their chelae (claws or pincers) on limbs which bear them (chelipeds), to pick up or capture sizeable morsels of food. Most of the shrimp-like freshwater forms are, however, more correctly designated as being microphagous, and use their chelipeds as delicate forceps to pick up small individual food items. In the atyid shrimps, the chelae are modified either into 'brush-chelae', used to scrape and brush small organisms and/or organic matter off submerged substrata, or as filtering fans. The actual feeding mechanisms may be extremely complex, matching the structural complexity of their feeding appendages (Fryer 1960). The precise nature of the food varies widely between representative taxa.

The truly freshwater river crabs appear to be highly opportunistic scavengers upon animal remains, but may actually subsist largely upon terrestrial vegetation collected during nocturnal forays away from water.

Reproduction and development

Reproduction in the decapods is exclusively sexual, with no resting stages evident in the life cycle. Sexes are distinguishable by the position of the external reproductive opening: female and male gonopores open medially on the coxae of the third and fifth pereiopods, respectively. These openings are obscure in small shrimps with lightly sclerotized exoskeletons. In such taxa, the presence or absence of the appendix masculina (Fig. 6.5B & C), which develops on the second pleopod of males, is a useful criterion for sexing adult specimens, but the process is absent in both sexes of smaller juveniles. In crabs, the width of the abdomen is strongly sexually dimorphic, being much narrower in males than in conspecific females.

The underlying pattern of ontogenetic development incorporates various larval stages such as the uniquely crustacean nauplius larva, along with metanauplius and zoea larvae, which principally serve a dispersive function in open marine environments. These stages are, however, strongly suppressed or abbreviated in the development of freshwater inhabitants, being passed in the egg stage. Thus obligate freshwater river crabs and atyid shrimps hatch from the egg superficially resembling diminutive adults, sometimes termed post-larvae. Conversely, the estuarine 'relict' crown crab, *Hymenosoma orbiculare*, which exists in freshwater coastal lakes, develops through zoeal larval stages which are not morphologically comparable with the resulting adult crab. The degree of larval suppression depends primarily on the magnitude of lipid reserves invested in the egg, and is related to the degree of independence from water exhibited by the various species.

Economic and ecological importance

In South Africa, indigenous freshwater decapods are commercially insignificant as a food source for humans, although river crabs and larger prawns are considered a delicacy by small sectors of the community. River crabs play an absolutely pivotal dietary role for various small mammals — water mongooses and otters in particular — as well as for some herons and the giant kingfisher. Surprisingly few indigenous fishes in southern Africa, with the partial exception of some Mormyridae, appear to rely extensively on freshwater shrimps as dietary constituents, although this is not the case in certain African great lakes, particularly Lake Victoria. Ironically, atyid shrimps appear to be more important in the diet of juvenile Nile crocodiles, and certain birds, including various herons, lake terns, and perhaps also jacanas.

River crabs potentially exert a small but direct economic impact on agriculture. They frequently burrow into stream banks, and similarly can structurally weaken the earthen walled dams commonly used to construct small farm impoundments.

Non-indigenous taxa

Several alien freshwater prawns and crayfishes — principally the Louisiana red crayfish (*Procambarus clarkii*) and certain Australian species (*Cherax quadricarinatus*, *C. tenuimanus* and some species in the *C. destructor* complex) have been introduced into the region for aquaculture in recent decades (de Moor & Bruton 1988, 1996; Copeland 1999). Both legal and illegal importations are known. As these animals are capable of burrowing or climbing barriers and moving considerable distances overland, the probability of escapes from captivity is particularly high. Already one population of *P. clarkii* has become established in the Crocodile River in Mpumalanga (Schoonbee 1993). The inordinate disruption to the Lake Naivasha ecosystem in Kenya by the purposeful release of this species (Lowery & Mendes 1977) has apparently not cautioned against the introduction of other freshwater prawns (Copeland 1999), despite the overwhelming contra-indications (Horwitz 1990).

The catadromous alien 'freshwater' prawn, *Macrobrachium rosenbergii*, is reputedly cultured in Lake Kariba in Zimbabwe (I. de Moor, Albany Museum, pers. comm.). In view of its obligate dependency on saline waters for breeding, *M. rosenbergii* is unlikely to establish feral populations in interior inland waters. It is, however, already well established in the lower reaches of rivers such as the Pungwe in central Mozambique, where it is exploited by restauranteurs (Bickerton, pers. obs.). Species known to be exotic are excluded from the subsequent accounts.

KEY TO THE SOUTHERN AFRICAN FRESHWATER DECAPODS

Introductory comments

This key deals exclusively with indigenous forms likely to be encountered in rivers and other continental waters, as well as in the coastal lakes and freshwater reaches of estuaries in the region. Known exotics, along with estuarine forms encountered only very sporadically in the freshwater reaches of estuaries, or in mangrove swamps, are specifically excluded. *Atyoida serrata*, a small shrimp recently discovered in South Africa, may have reached our region from its native habitat by natural dispersion. It is accordingly included to enhance recognition of expanding range distributions, and to assist in identifying future clandestine releases. Two species of river prawn have been discovered too recently for inclusion in the key. They are *Macrobrachium rosenbergii* (possibly exotic), and *M. lar*, from the north-eastern region of South Africa.

The key to the species of *Macrobrachium* is based upon various length ratios (c/m, c/ch, c/p and p/d) of the carpus (c), merus (m), chela (ch), palm (p) and articulating dactyl (d) of the second pereiopod of adult males (see Figs 6.5A, 6.7A) along with supplementary criteria. Adult males are more easily, and more reliably, identified than females. Males are characterized by genital openings on the coxae of the fifth pereiopods (cf. female openings on ppd3), and an appendix masculina (Fig. 6.5B) on the second pleopod. Note that specimens with a total body length of as little as 50–70 mm can be adult males. The only species of *Macrobrachium* known from the west coast is *M. vollenhovenii* (Fig 6.9C); this is not included in the key.

Measurements of crabs referred to in the key and/or in later descriptions of species are defined as follows:

carapace height is measured in the middle of the animal, i.e. along the median line half way along body length.

width of leg is measured half-way along the length of the leg.

KEY TO THE SOUTHERN AFRICAN FRESHWATER DECAPODA

1. Body elongate, cylindrical and/or laterally compressed with abdomen extended and terminating in a prominent telson (tail-fan); prominent sensory antennae arising below the stalked eyes are much longer than the carapace; locomotion by swimming or walking, mostly in direction of long axis of body; confined exclusively to water (shrimps and prawns — Suborder Macrura, Division **Natantia**) (Fig. 6.1A)........ 2

– Body square or rectangular, dorso-ventrally compressed, with abdomen folded ventrally beneath the carapace and urosome/telson reduced and covert; chelipeds with stout chelae often prominent; sensory antennae relatively short and not prominent; locomotion generally by walking at right angles to longitudinal axis of body ('crabbing'); frequently encountered away from water, sometimes at considerable distance (crabs: Suborder Brachyura, Division **Reptantia**) (Fig. 6.1B)........ 14

2. Ppd1 and ppd2 terminating in conspicuous opposable brush chelae (Figs 6.3, 6.4A & B) or filtering fans (Fig. 6.2); adults diminutive, total body length ≤50 mm (Family **Atyidae**)........3

– Ppd1 and ppd2 chelate or sub-chelate, without brush chelae; adults larger, total body length > 50 mm (Family **Palaemonidae**)........ 7

3. Small-bodied (total body length excluding antennae seldom exceeding 25–35 mm); rostrum generally >¼ or ⅓ of carapace length; brush chelae of ppd1 and ppd2 prominent, but generally uncoloured; finger and dactyl of chelae with terminal brushes of long hair-like setae and ornately sculpted shorter setae; extreme colour polymorphism of body possible; widely distributed in rivers and permanent standing waters (*Caridina*)........ 4

– Robust and relatively large-bodied (total adult body length excluding antennae up to 50 mm); rostrum very short (<<¼ of carapace length and shorter than dactyl of anterior pereiopods); brush chelae of ppd1 and ppd2 prominent and greatly elongated, functioning as filtering fans, with dark purple setae in large adults, and unusual but characteristic articulation of carpus with distal limb segments (Fig. 6.2); possibly exotic, known only from the proximity of Durban........ *Atyoida serrata*

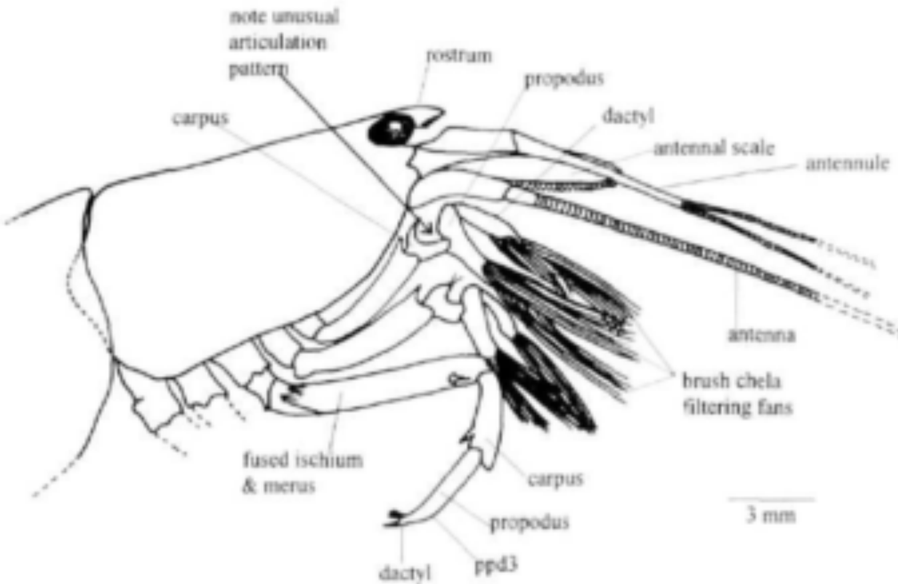

Fig. 6.2. *Atyoida serrata*, cephalothorax and anterior abdominal segments of non-ovigerous female (first and second antennae truncated and posterior pereiopods omitted).

4. Upper margin of rostrum smooth; carpus of ppd1 deeply excavate (both arrowed in Fig. 6.3) .... *Caridina typus*
– Upper margin of rostrum entirely or partially dentate (Figs 6.4 A–C); carpus of ppd1 not deeply excavate (Fig. 6.4A,B) 5

5. Rostrum noticeably shorter than carapace or than antennal scale (Fig. 6.4A) .... *C. africana*
– Rostrum sub-equal to, or longer than, carapace or antennal scale 6

6. Rostrum sub-equal to antennal scale, and equal to, or slightly longer than, carapace (Fig 6.4B) .... *C. nilotica*
– Rostrum at least 1.5 times longer than carapace (Fig. 6.4C) .... *C. indistincta*

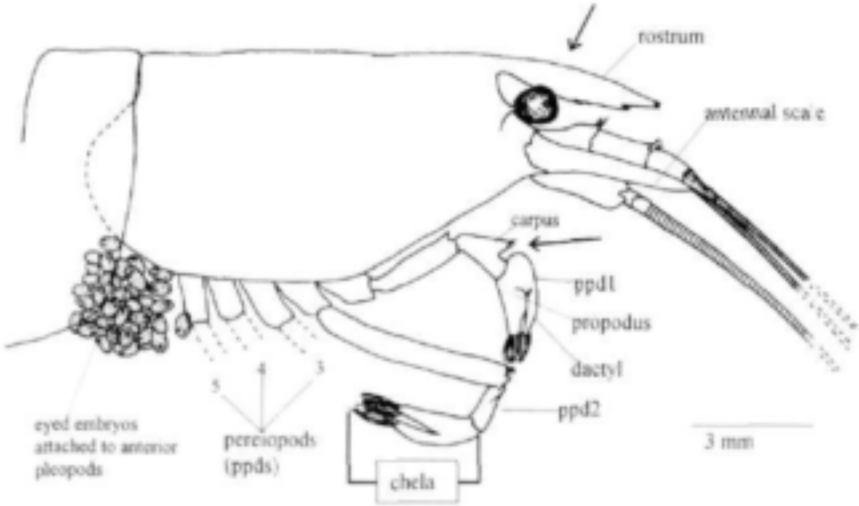

Fig. 6.3. *Caridina typus*, cephalothorax and anterior abdominal segments of berried female (with first and second antennae truncated, posterior pereiopods omitted). Note the smooth rostrum and deep excavation in the carpus (arrowed).

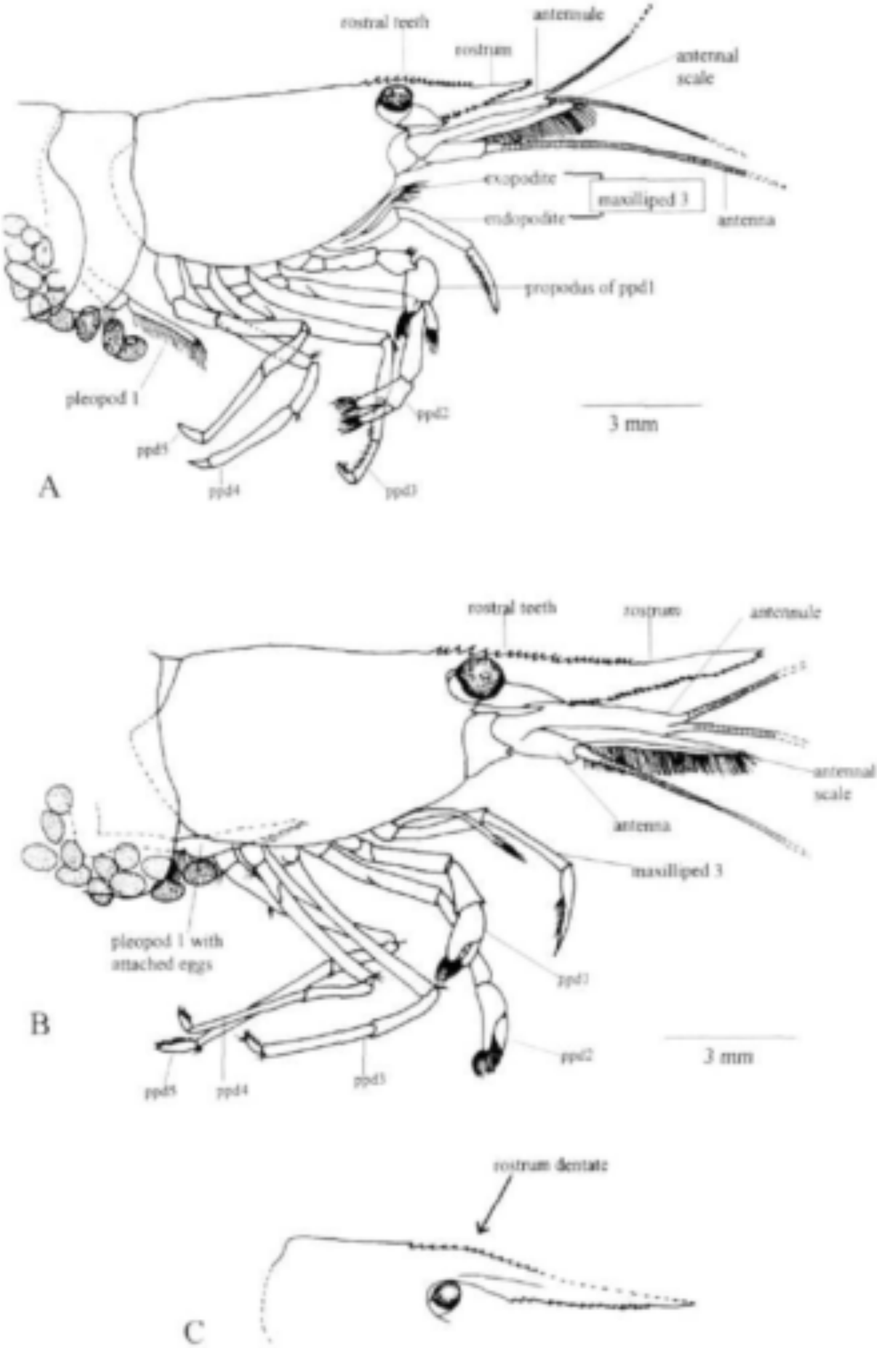

Fig. 6.4. *Caridina* spp. A – B, cephalothorax and anterior abdominal segments of berried females (with first and second antennae truncated, and not all eggs shown in the field of view): A, *C. africana*; B, *C. nilotica*; C, *C. indistincta*, carapace and rostrum.
(C elaborated from Kensley 1972).

7. Ppd2 of mature specimens chelate and conspicuously (1.5 to three or more times) longer than ppd1; carapace bearing antennal and hepatic spines but no branchiostegal spines (Fig. 6.5A); large, total body length of fully grown adults 80–180 mm; mostly in warm eastern waters (*Macrobrachium*) 8
– Ppd2 chelate but only slightly longer than ppd1; carapace with both antennal and branchiostegal spines (Fig. 6.6); total length of body around 30–80 mm; confined to southern and south-eastern coastline rivers and not penetrating far inland (*Palaemon*) 13

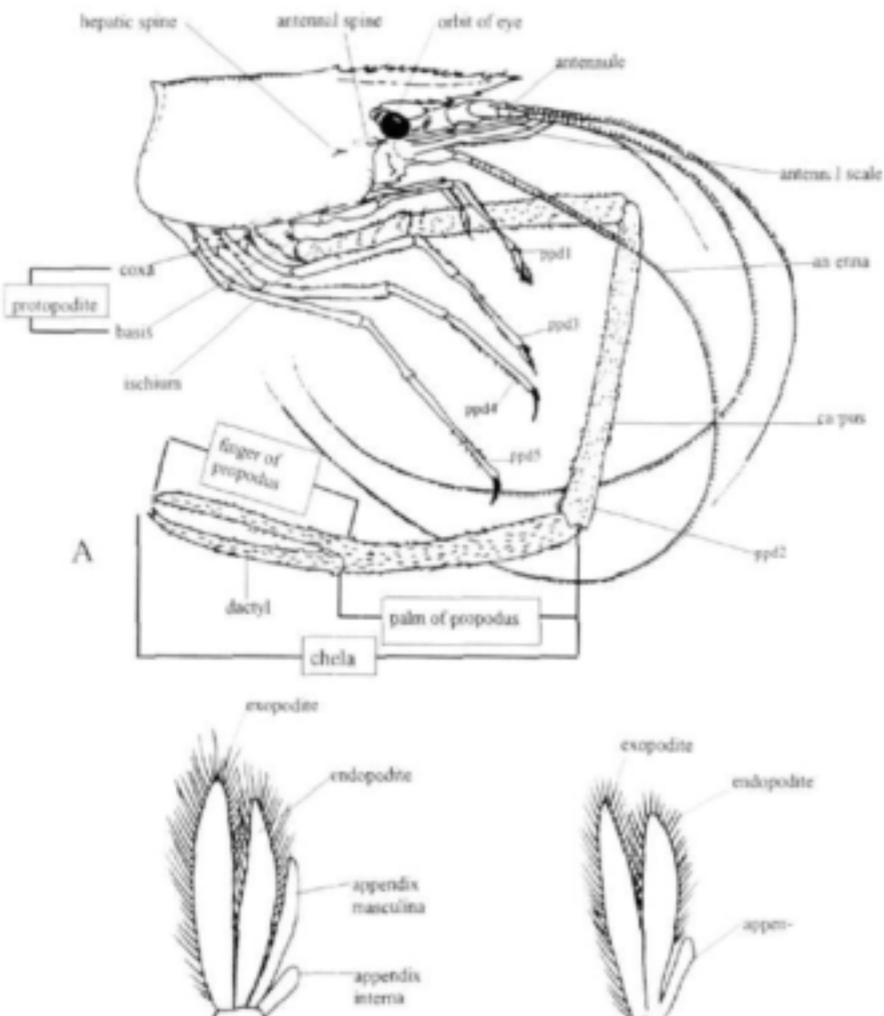

Fig. 6.5. *Macrobrachium* sp. A, schematic outline of carapace with pereiopods, showing characters referred to in the key. B—C, left-hand second pleopods showing characters used in sex-determination of adult prawns and shrimps: B, male; C, female. (A modified after Fischer & Bianchi 1984, B & C after Kensley 1972).

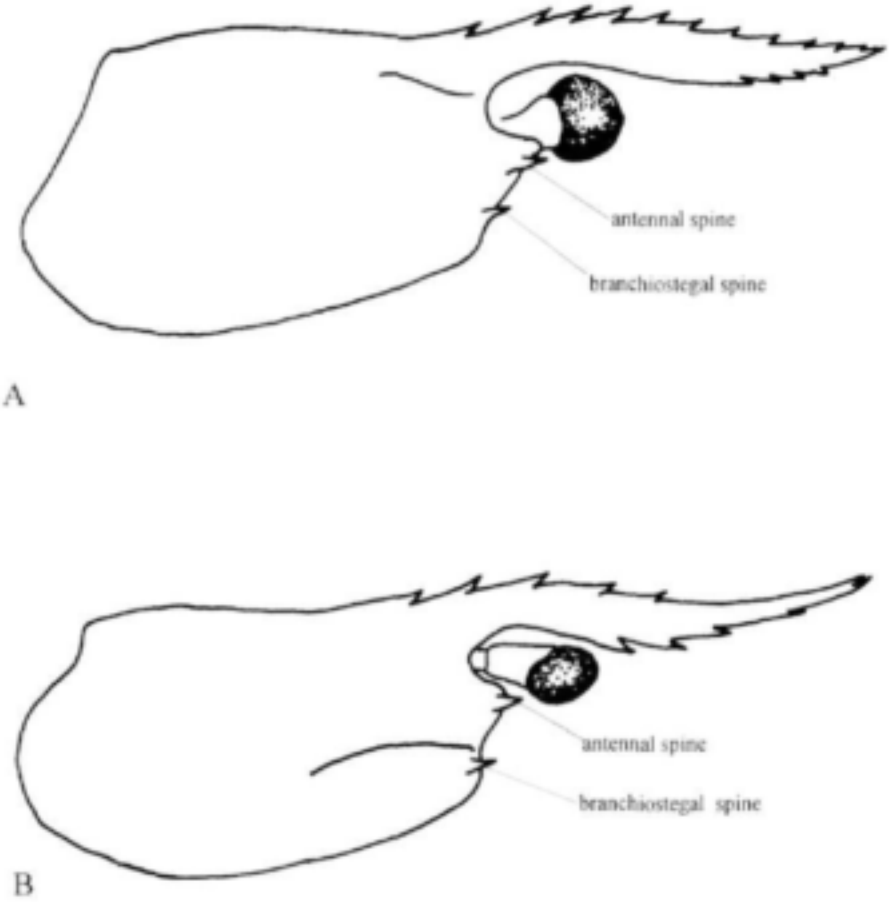

Fig. 6.6. Schematic carapace outlines of *Palaemon* spp. showing characters referred to in the key: A, *P. capensis*; B, *P. concinnus*. (After Kensley 1972).

8. Carpus (c) of adult male ppd2 distinctly longer than merus (m) (c/m =1.2 to 1.8) (Fig. 6.7A) 9
– Carpus of adult male ppd2 sub equal to or shorter than merus (c/m < 1.2) (Fig 6.9A).. 11

9. Carpus of adult male ppd2 distinctly shorter than chela; palm (=broader portion of propodus proximal to dactyl joint — see Fig. 6.5A) of chela sub-equal to or longer than dactyl; p/d = 0.7–1.6 (Figs. 6.8A,B) 10
– Palm of chela distinctly longer than dactyl (p/d = 1.4–2.4) (Fig. 6.7A); 12–17 dorsal rostral teeth, usually only two situated behind posterior limit of orbit (Fig. 6.7B) ....*M. idella*

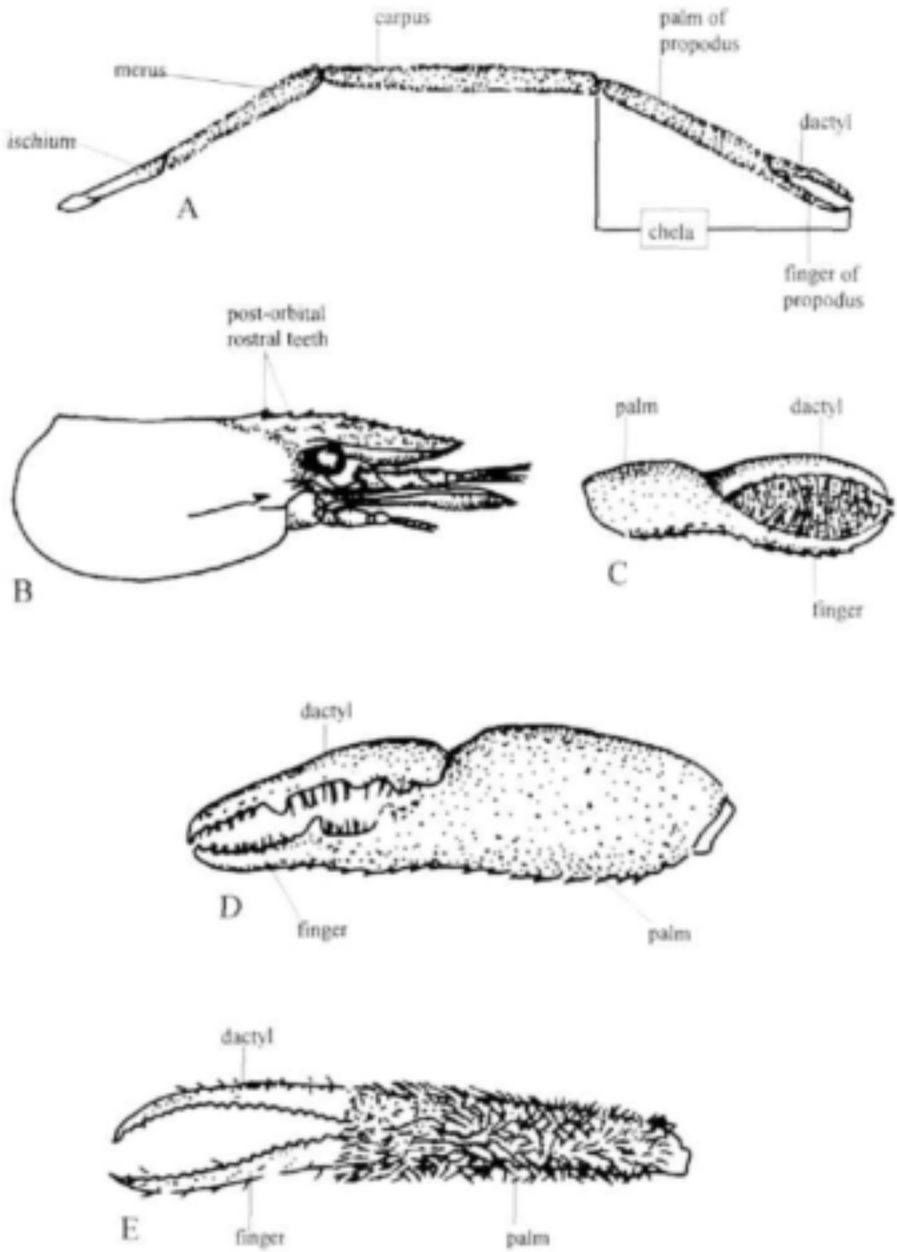

Fig. 6.7. *Macrobrachium* spp. A–B, *M. idella*, adult male: A, second pereiopod (cheliped) showing segment terminology; B, cephalothorax. C–D, *M. lepidactylus* adult male, showing unequal shapes of left and right ppd: C, small chela; D, large chela. E, *M. scabriculum*, adult male chela. (Modified after Bailey & Crichton 1971).

10. Chela of adult male ppd2 with tubercles in two rows, one along either side of opposing cutting edges of the dactyl and finger (Fig. 6.5A); Ppd2 uniformly pubescent; rostrum with slightly elevated basal crest not markedly upcurved, just shorter than antennal scale in mature specimens (rostrum may be longer than antennal scale and more upcurved in smaller immature specimens); ventral margin of rostrum with three to five teeth (Fig 6.8A) .... *M. rude*

– Chela of adult male ppd2 without tubercles other than a few proximal teeth on dactyl and finger, both of which are densely velvety pubescent, in strong contrast to the remainder of appendage; rostrum usually distinctly upcurved and reaching apex of antennal scale; ventral margin of rostrum with five to seven (seldom four) teeth (Fig. 6.8B) .... *M. equidens*

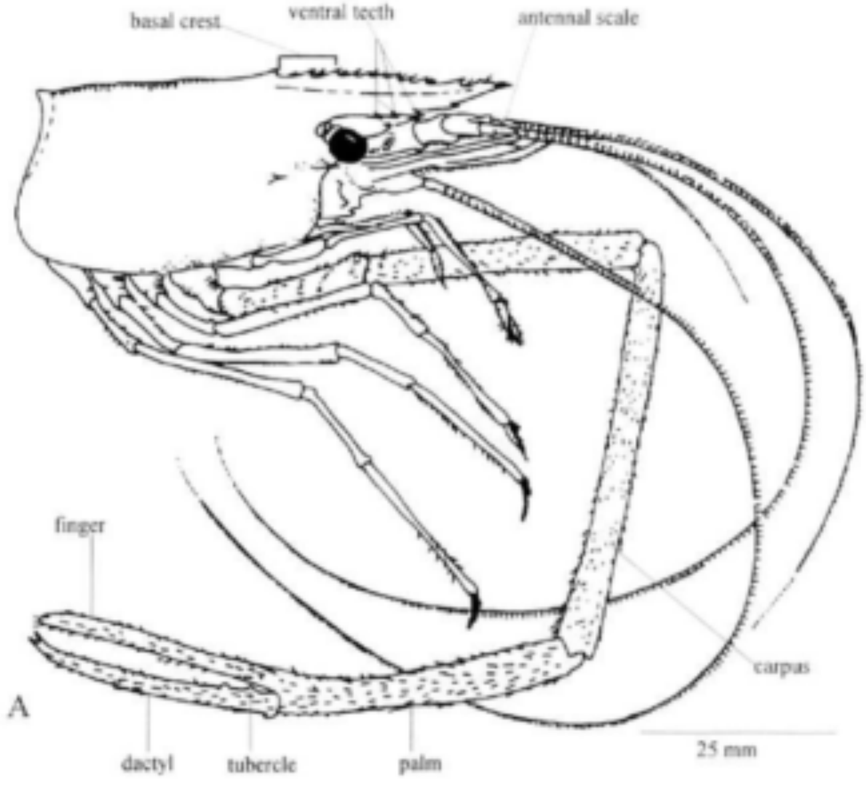

Fig. 6.8. *Macrobrachium* spp. A– B, Adult males: carapace, rostrum and ppd2: A, *M. rude*; B, *M. equidens*. (After Fischer & Bianchi 1984).

11. Left and right ppd2 equal or sub-equal in shape; dactyl and finger of smaller chela not gaping and not provided with stiff, inwardly-directed setae along opposing cutting edges (unlike Fig. 6.7C); no flattened ventral tooth between bases of uropods (unlike Fig. 6.9B) 12
– Left and right ppd2s very unequal in shape (Figs 6.7 C, D); finger and dactyl of smaller chela generally gaping, with stiff, inwardly-directed setae along the cutting edges (Fig. 6.7C); flattened ventral tooth between bases of the uropods (Fig. 6.9B) .... *M. lepidactylus*
12. Chela of adult male ppd2 with palm and basal parts of dactyl and finger covered with velvety hairs and having a woolly appearance (Fig. 6.7E); carpus, merus and ischium not densely covered with hairs .... *M. scabriculum*
– Chela of adult male ppd2 with palm, carpus, merus and ischium of both chelipeds covered with a thick coat of velvety hairs; only the dactyl, finger and a small distal portion of the chela naked (Figs 6.9E) .... *M. petersii*

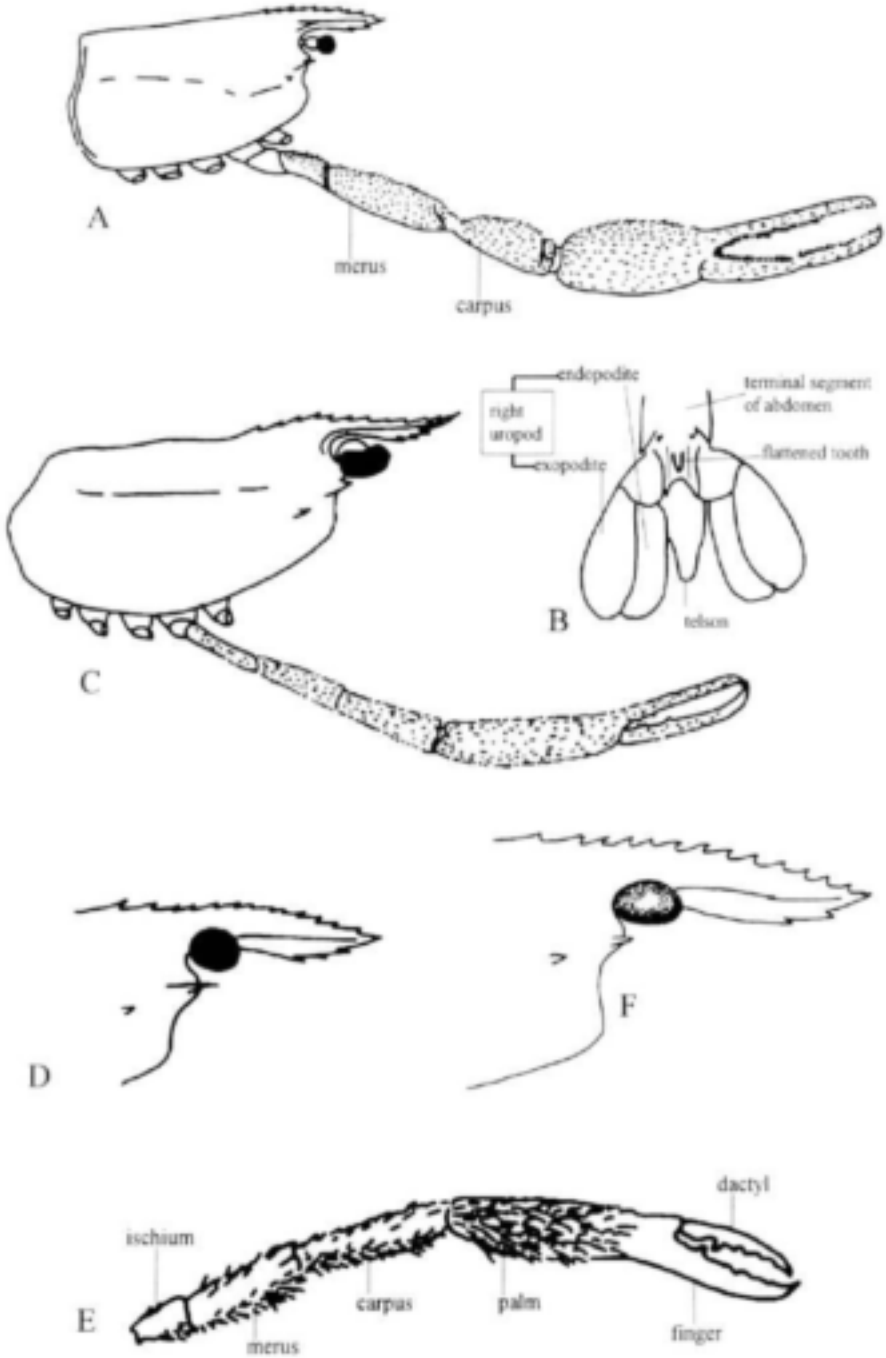

Fig. 6.9. *Macrobrachium* spp. A–B, *M. lepidactylus*: A, carapace, rostrum and large chela (ppd2) of adult male; B, uropods and telson (detail in ventral view) showing position of flattened tooth or spine. C, *M. vollenhovenii*, adult male, carapace, rostrum and ppd2. D–E, *M. petersii*, characteristics of adult male: D, rostrum and anterior thorax; E, ppd2. F, *M. scabriculum*, rostrum and anterior thorax of adult male (A–E after Kensley 1972; F modified from Kensley 1972).

13. Rostrum straight, its dorsal margin usually with 9–12 teeth (Fig. 6.6A) .... *Palaemon capensis*
– Rostrum upcurved, its dorsal margin usually with 5–8 teeth (Fig. 6.6B) .... *P. concinnus*
14. Pereiopods obviously setose; postfrontal crest (Fig. 6.1B) absent 15
– Pereiopods not distinctly setose; postfrontal crest present 16
15. Chelipeds small and delicate; dactyls of ppd2–ppd5 setose; small-bodied (carapace width ≤35 mm), dorso-ventrally compressed crabs with small rostrum triangular in dorsal view; marine/estuarine relict found in coastal lakes .... *Hymenosoma orbiculare*
– Chelipeds large and prominent; ppd2 to ppd5 setose; distal joints of posterior ppds flattened as swimming paddles; robust-bodied marine/estuarine crabs found in brackish or fresh waters in some coastal lakes and rivers .... *Varuna litterata*
16. Anterolateral margins of carapace bearing one to many distinct teeth (Figs 6.10A–E) 17
– Anterolateral margins without teeth, although sometimes moderately serrated (bead-like, not separate and distinct) or granulated (Figs 6.10F, 6.11A–F) ... 21
17. Anterolateral margins with many distinct teeth (Figs 6.10D,E) 18
– Anterolateral margin with a single epibranchial tooth at each corner (Figs 6.10A–C) 19
18. Epibranchial sinus absent; postfrontal crest complete along entire length (Fig. 6.10D) .... *Potamonautes warreni*
– Epibranchial sinus present; postfrontal crest usually interrupted posterior to exorbital teeth (Fig. 6.10E) .... *P. dentatus*
19. Postfrontal crest not continuous along entire length (Fig. 6.10B); merus of chelipeds with both antero- and postero-inferior granulate margins bearing a spine .... *P. obesus calcaratus*
– Postfrontal crest complete (Figs 6.10A,C); antero-inferior margin of merus of cheliped without a spine 20
20. Epibranchial sinus absent; postfrontal crest not sloping backwards near anterolateral margin (Fig. 6.10A) .... *P. unispinus*
– Epibranchial sinus present; postfrontal crest sloping backward (Fig. 6.10C) .... *P. parvispina*

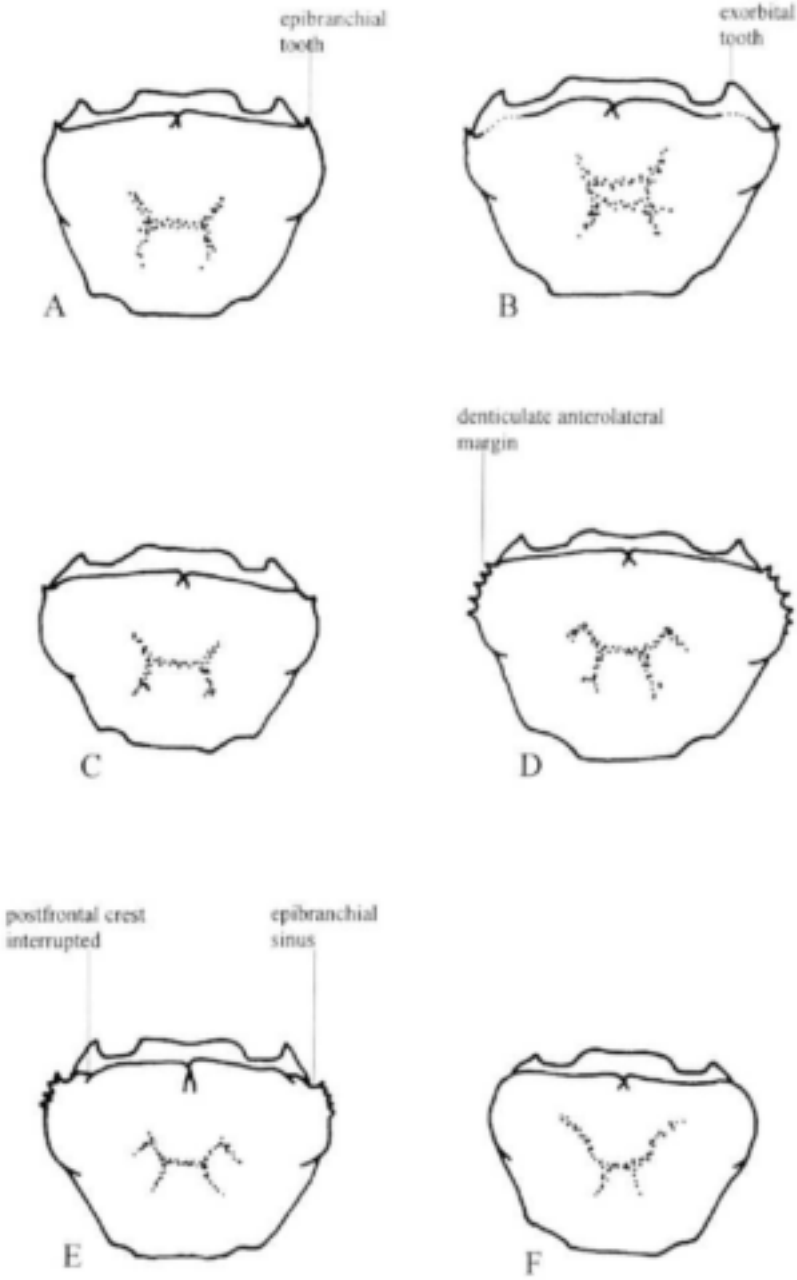

Fig. 6.10. Carapace outlines of potamonautid crabs: A, *Potamonautes unispinus*; B, *P. obesus calcaratus*; C, *P. parvispina*; D, *P. warreni*; E, *P. dentatus*; F, *P. depressus depressus*.
(For details on sizes, see relevant descriptions in the text).

21. Anterolateral margins rounded and smooth; epibranchial corner rounded; epibranchial region of carapace smooth, without granulation or scabrosity (Figs 6.10F, 6.11A–C) 22
– Anterolateral margin granulated; postfrontal crest forms distinct angle at epibranchial corner on joining the anterolateral margin; epibranchial region usually showing scabrosity or granulation (Figs 6.11D–F) 25

22. Carapace depressed and flattened dorsally, ratio of carapace length to height between 2.3 and 2.6; postfrontal crest complete (Fig. 6.10F) .... *P. depressus depressus*
– Carapace distinctly vaulted and arched; ratio of carapace length to height between 1.5 and 2.2; postfrontal crest sometimes diminished medially 23

23. Carapace dark brown (Fig. 6.11A) .... *P. brincki*
– Carapace bright orange or red 24

24. Carapace dark orange to red with distinct silver-blue sheen; tips of chelipeds dark orange to red (Fig. 6.11B) .... *P. lividus*
– Carapace bright orange, tips of chelipeds light orange to yellow (Fig.6 11C) .... *P. clarus*

25. Carapace and postfrontal crest moderately granulated, epibranchial region relatively smooth; carapace length in largest individuals 47 mm or less (Fig. 6.11D) .... *P. perlatus*
– Carapace and postfrontal crest strongly granulated, epibranchial region with strong scabrosity; carapace length in largest individuals commonly exceeding 50 mm 26

26. Confined to the Olifants River (WC) (Fig.6.11E) .... *P. granularis*
– Not occurring in the Western Cape (Fig. 6.11F) .... *P. sidneyi*

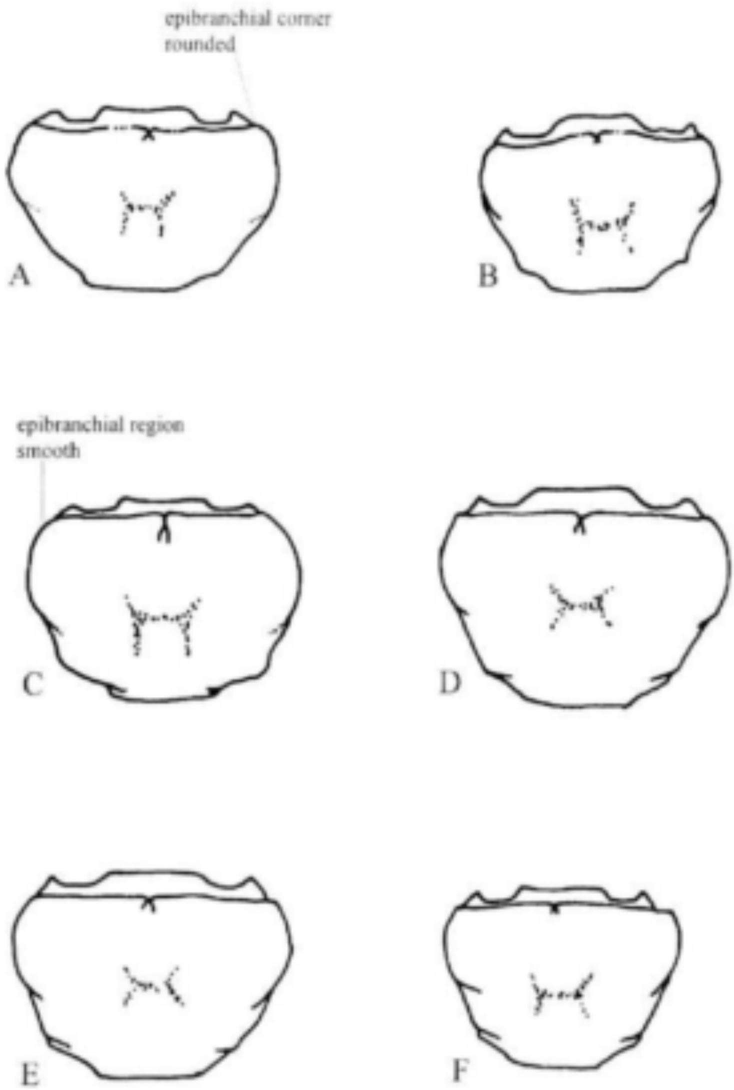

Fig. 6.11. Carapace outlines of potamonautid crabs; A, *P. brincki*; B, *P. lividus*; C, *P. clarus*; D, *P. perlatus*; E, *P. granularis*; F, *P. sidneyi*.
(For details on sizes, see relevant descriptions in text).

GENERAL NOTES ON SELECTED TAXA

Family **Atyidae**

Caridina Milne Edwards, 1837

Four species are known in this genus for the region. However, no comprehensive systematic evaluation has been undertaken, and in view of the wide infra-specific variability known to exist even within single species populations in this family (Smith & Williams 1980), the status of local species is uncertain, and *C. indistincta* may be doubtful. More comprehensive assessments of species distributions, and a thorough systematic revision of this genus, are clearly needed.

The status and ecology of all species in the genus apart from *C. nilotica* are virtually unknown, but all species are probably omnivorous, relying mostly on aufwuchs (periphyton) and detritus. Direct or abbreviated larval development occurs. Riverine species withstand flood conditions, and perhaps restrict their breeding seasonally, avoiding high-flow conditions. These taxa are collectively alluded to as 'freshwater shrimps (or) prawns'. No distinctive common names exist for the separate species in this genus.

Caridina nilotica (Roux, 1833)

(Fig. 6.4B)

This is the most common and widespread species of *Caridina*, found in rivers and standing waters of Mozambique, and much of eastern and northern South Africa, from as far south as the Gamtoos River, and westwards to the lower Orange River. It is reported from slightly saline conditions (2 to 3‰) in upper estuarine reaches, but is intolerant of temperatures maintained below 10°C and (surprisingly) those above 30°C (Hart 1983). Its oxygen tolerances are unknown. Populations were evidently decimated by DDT spraying for nagana control in Zululand. This shrimp is generally a shallow-water littoral inhabitant of fringing aquatic vegetation, but offshore benthic populations are known from depths of up to 40 m in Lake Sibaya. While *C. nilotica* is said to have planktonic larval or juvenile stages in certain central African lakes, no such stages are known in Lake Sibaya. It feeds principally on periphyton scraped from aquatic hydrophytes and on plant detritus, but readily scavenges on the corpses of animals such as fish, insects, and shrimps.

Large females (>7 mm carapace length) carry up to 100 eggs, which hatch into juvenile shrimps between 12 days (at 30°C) and 40 days (at 18°C) and mature after about three months. Large individuals may be two years old (Hart 1980a). This species breeds year-round in Lake Sibaya, where it occurs at densities in excess of 3000 m^{-2} (11g m^{-2} dry wt) in favourable sheltered and vegetated lake margins. More usually, biomass ranges between 2 and 5 g m^{-2} (Hart 1981). This widespread, and often abundant animal has attracted little study. It is cultured for use as natural food in warm-water fish hatcheries, and is reportedly consumed by humans. Its role in the trophic dynamics of natural ecosystems is largely unknown, although it appears to be taken by several aquatic birds such as herons and lake-terns, and has replaced small cichlids as a major dietary item of the predatory Nile perch (*Lates nilotica*) in Lake Victoria.

Caridina africana Kingsley, 1882
(Fig. 6.4A)

This endemic species appears to be exclusively lotic, occurring in coastal rivers along the eastern seaboard of South Africa as far as the central Transkei, and inland into the Vaal River. It may be merely a variety of *C. nilotica*.

Caridina typus H. Milne-Edwards, 1837
(Fig. 6.3)

Individuals of *Caridina typus* are considerably larger and more robust than other species of *Caridina* known in the region. *Caridina typus* appears to be restricted to rivers of the east coast as far south as the Keiskamma River.

Caridina indistincta (Calman, 1926)
(Fig. 6.4C)

Caridina indistincta, like *C. nilotica*, is a small-bodied species, which may be exclusively lotic. Recorded from the Zambezi River, it appears to be restricted to northerly inland waters in the region.

Atyoida serrata (Bate 1888)
(Fig. 6.2)

Specimens of *Atyoida serrata* recently collected from the Vungu and Molweni rivers in KwaZulu–Natal (near Margate and in Kloof respectively) are the first records of this species from Africa. This robust and relatively large atyid resembles *Caridina typus*, but has a proportionately shorter rostrum (less than a quarter of its carapace length, versus a third in *C. typus*), and a longer dactylus (twice its rostral length versus half the rostral length in *C. typus*). Setae of the brush chelae are dark purple in large adults. This species is known from Madagascar, Mauritius, Reunion, and the Seychelles and Comores Islands, from which it may have been introduced by hobbyist aquarists. Its presence in two separate rivers in southern Africa suggests either separate human-related releases, or the possibility that it may have reached Africa naturally. Further collecting may indicate a wider regional occurrence.

Family **Palaemonidae**

Palaemon capensis (de Man, 1897)
Cape river prawn (Fig. 6.6A)

The only truly freshwater species of the genus in South Africa, this endemic species occurs in coastal rivers of the southern Cape from the Palmiet River near Hermanus (WC) eastwards to the Keiskamma River (EC). It appears, however, that *P. capensis* requires brackish water for its larval growth and development, for which purpose females in particular migrate to estuarine waters in spring in the southern Cape (Coetzee 1989, 1991a, 1991b). Records from Barnard (1950) and Coetzee (1988) indicate that females of *P. capensis* attain larger sizes than do males. As is the case for *Palaemon* species in general, this species is considered to be an opportunistic omnivore.

Palaemon concinnus (Dana, 1852)
mangrove prawn (Fig. 6.6B)

This estuarine species is sometimes found in fresh water along the east coast of KwaZulu–Natal, but is also recorded as far south as the Gqunube (Gonube) River near East London (EC).

Macrobrachium Bate, 1868

Macrobrachium is primarily a tropical and subtropical genus of relatively large prawns that have attracted considerable aquacultural interest. Seven species occur in freshwater in South Africa, although the validity of some of these species is doubtful. *Macrobrachium idella* and *M. lepidactylus* are the most characteristic and perhaps truest freshwater forms, while *M. equidens* occurs most marginally in fresh water. The remaining species (*M. rude, M. scabriculum, M. petersii* and *M. vollenhovenii*) appear to be more euryhaline, occurring both in fresh and brackish water.

Individuals of *Macrobrachium* are generally omnivorous, but exhibit an increasing tendency towards carnivory as they grow. Large prawns are able to catch live fish, such as juvenile tilapias.

Macrobrachium prawns are thought to be quite long-lived. Sexual maturity is apparently attained within one to two years, depending upon the species. Larger animals, particularly males, may be older than four years (Bickerton, 1989). In tropical regions, with seasonally more consistent warm conditions, growth rates may be faster. Although individuals may breed throughout the year, peaks in breeding activity tend to follow the late summer seasonal floods on the south-east African coast (Bickerton, 1989). Development generally involves both larval and post-larval stages. Larval stages of most species (e.g. *M. petersii*) require access to saline waters to complete their development successfully. Given their euryhaline capacity, marine dispersion of larvae is probable, and the recent discoveries of *M. lar* in South Africa and *M. rosenbergii* in Mozambique may reflect natural immigration rather than the release of a non-native species, such as *M. rosenbergii* which is used extensively in aquaculture.

Macrobrachium idella (Hilgendorf, 1862)
rough-shelled river prawn (Fig. 6.7A,B)

This species, which reaches a total body length of 110 mm, occurs in fresh waters in rivers of the eastern littoral from Tanzania southwards to Mozambique and KwaZulu–Natal (the Sipingo and Mgeni Rivers). It is also found in Madagascar. The closely aligned and very similar *M. idae* was combined with *M. idella* by Bickerton (1989).

Macrobrachium lepidactylus (Hilgendorf, 1862)
scaly-armed river prawn (Fig. 6,7 C,D; Fig. 6.9A,B)

This species reaches a maximum total body length of about 140 mm, and its distribution extends from Somaliland, Kenya and Tanzania to well south of Mozambique. It has also been recorded from Madagascar. In our region it occurs in most KwaZulu–Natal rivers, where it is common in the lower freshwater reaches, particularly during late summer and autumn. It extends south to the Great Kei and Nahoon Rivers in the Eastern Cape. In Mpumalanga, the Northern Province and Zimbabwe, it penetrates deeply inland from the coast (up the Limpopo and other rivers of the Kruger National Park, for example), reflecting its freshwater status.

Macrobrachium rude (Heller, 1862)
furry-armed river prawn (Fig. 6.8A)

This fresh and brackish-water form occurs in rivers of the eastern littoral from Somaliland, Kenya and Tanzania southwards to Mozambique, as well as in Madagascar. It is common in KwaZulu–Natal rivers and extends to the Eastern Cape in the Buffalo and Chalumna Rivers. Breeding adults are often found in estuaries and the lower reaches of rivers, particularly after summer floods in KwaZulu–Natal. Maximum total body length is about 130 mm.

Macrobrachium scabriculum (Heller, 1862).
strong-arm river prawn (Fig. 6.7E; Fig. 6.9F)

Macrobrachium scabriculum occurs in coastal regions from Somaliland, Kenya and Tanzania southwards to Mozambique and KwaZulu–Natal and also in Madagascar. Individuals of this species are small (maximum total body length about 90 mm). They enter estuaries to breed when salinities are suitably low, usually after summer floods in KwaZulu–Natal.

M. petersii (Hilgendorf, 1878)
south-east coast river prawn (proposed) (Fig. 6.9D,E)

This small-bodied species (total body length ≤85 mm) is endemic to south-eastern Africa where it occurs in coastal regions from Mozambique (e.g. the Zambezi River) southwards to KwaZulu–Natal, where it is common in many rivers, and westwards to the eastern Cape (Keiskamma, Great Fish and Kowie Rivers) as far as Humansdorp (the Gamtoos River). It generally occurs only in the lower reaches of rivers, its inland penetration being restricted by its obligate dependence (for larval development) on salinity levels characteristic of estuaries. Breeding animals occur in the upper reaches of estuaries, usually after summer floods.

Macrobrachium vollenhovenii (Herklots, 1857)
west coast river prawn (Fig. 6.9C)

This large-bodied species (total body length ≤182 mm) is recorded from fresh, brackish and sometimes salt water along the West African coast as far south as the Cunene River in southern Angola. One doubtful record exists for Zululand. *M. vollenhovenii* has a flattened tooth or spine between the bases of the uropods similar to that described for *M. lepidactylus* (Fig. 6.9B).

Macrobrachium equidens (Dana, 1852)
smooth river prawn (Fig. 6.8B)

This moderately large-bodied species (total body length ≤100 mm) is the most marginal freshwater form. Recorded in coastal regions from Kenya and Tanzania southwards to Mozambique (Delagoa Bay), and KwaZulu–Natal (St Lucia, Mfolozi and Mlalazi Rivers), and also in Madagascar. Generally restricted to saline and brackish conditions in estuaries it does, however, also penetrate freshwaters.

Family **Grapsidae**

Varuna litterata (Fabricius, 1798)

Varuna litterata occurs in several northern freshwater coastal lakes with surface connections to the ocean, and also penetrates the freshwater upstream reaches of tidal rivers. It is a catadromous species, individuals being compelled to migrate to saline waters to complete their life cycles.

Family **Hymenosomatidae**

Hymenosoma orbiculare Desmarest, 1825
crown crab

Hymenosoma orbiculare is predominantly an estuarine/marine form that is also encountered in coastal fresh waters. It is common in coastal lakes, often living on, or partly buried in, deep offshore sandy sediments. The existence of relict populations in Lake Sibaya indicates its ability to breed in virtually fresh water. The significant amount of morphological variation between specimens of *H. orbiculare* from various localities in South Africa has prompted Lucas (1980) to suggest that several species might be represented.

Family: **Potamonautidae**

Potamonautes MacLeay, 1838

River crabs of the genus *Potamonautes* are endemic to the African continent, and are found in all suitable freshwater habitats, such as streams, rivers, ponds, dams and lakes across southern Africa. All species in this genus have a characteristic postfrontal crest (Fig. 6.1B) running across the carapace just behind the eyes. About 60 species have been described, with 12 species known to occur within the boundaries of South Africa. Early work on the group, based mainly on museum specimens (Barnard 1935, 1950), revealed the existence of seemingly transitional forms, and led

Barnard (1950) to suggest that intensive collecting and examination of material was needed. Thus, in 1992, a project was launched to resolve the taxonomy of the group by examining morphological and genetic variation in populations countrywide. Subsequently, a further six species of potamonautid crabs were described from South Africa (Stewart *et al.* 1995; Stewart 1997b; Daniels *et al.* 1998; Stewart & Cook 1998; Gouws *et al.* 2000, Gouws *et al.* In Press). While these efforts have gone a long way towards resolving the systematics of the river crabs of southern Africa, knowledge of the ecology and basic biology of members of the genus is still very limited.

Potamonautid crabs are generally omnivorous, reportedly feeding on aquatic insects during early life, and become increasingly herbivorous as they grow. Knowledge of the diets of South African river crabs is extremely superficial. Berried females occur in midsummer in KwaZulu–Natal. Their eggs develop directly in about 13 to 14 weeks, and the young hatchlings are retained under the maternal abdomen at least until the first moult. River crabs are major components of the diet of clawless and spotted-necked otters and water mongooses, and also specifically of giant kingfishers. They are also a delicacy for sectors of the human population in KwaZulu–Natal. Since they are known to act as secondary hosts of lung flukes, however, they should be consumed with caution. Blackfly larvae are reported to temporarily attach to, and thus be associated with, river crabs in East Africa and some socio-medical importance must accordingly attach to the crabs. Their burrowing activities may structurally weaken earthen-walled dams, imparting some potential economic significance to these crabs as well.

Potamonautes brincki (Bott, 1960)
Brinck's River crab (Fig. 6.11A)

Originally placed in the genus *Gecarcinautes* by Bott (1960), this crab is recognized by the smooth carapace with rounded epibranchial corners. Generally dark brown in colour, these rather small crabs (maximum length of 27 mm in males corresponding to a width of 38 mm) are confined to mountain streams in the Western Cape, where they favour clear, unpolluted water. Variable morphology of the terminal segment of the mandibular palp suggests that populations presently identified as *P. brincki* might in fact be representatives of two separate species (Stewart 1997a).

Potamonautes clarus, Gouws, Stewart & Coke 2000
bright river crab (Fig. 6.11C)

This species is characteristically a bright orange colour and can also be identified by the relatively depressed, rounded carapace. *Potamonautes clarus* is found in the pristine, fast-flowing mountain streams and rocky headwaters of the Tugela River draining the northern Drakensberg range in KwaZulu–Natal (Gouws *et al.* 2000). Males of up to 27 mm in length (40 mm at widest width) and females of up to 33 mm in length (44 mm in width) have been collected.

Potamonautes dentatus Stewart, Coke & Cook, 1995
toothed river crab (Fig. 6.10E)

One of five potamonautid species known to occur in KwaZulu–Natal, *P. dentatus* is characterized by the presence of distinct teeth on the anterolateral margin of the carapace. So far, this species has been collected from the Mgeni and Tugela river systems, but is possibly more widespread in the region (Stewart *et al.* 1995). The largest known specimen has a carapace length of 46 mm, corresponding to a width of 61 mm at the widest part.

Potamonautes depressus depressus (Krauss, 1843)
flattened river crab (Fig. 6.10F)

Potamonautes depressus can be recognized by its depressed carapace, flattened dorsally, with rounded anterolateral corners and smooth anterolateral margins and epibranchial corners. The legs are long and slender, being 3 to 3.5 times longer than wide, and the carapace is usually purple-brown to green-brown in colour. Males of up to 43 mm in length (59 mm in widest width) and females of up to 38 mm in length (52 mm in width) have been collected. *P. depressus depressus* is known from the faster-flowing tributaries of rivers in the Drakensberg and the higher-altitude areas of the KwaZulu–Natal midlands.

Potamonautes granularis Daniels, Stewart & Gibbons, 1998
granular river crab (Fig. 6.11E)

This crab, named for its strongly granulated carapace and postfrontal crest, is known only from the lower reaches of the Olifants River in the Western Cape (Daniels *et al.* 1998, 1999b). Where this species occurs in sympatry with *P. perlatus*, it can be distinguished from the latter by the fact that the tips of the chelipeds of *P. granularis* are light orange, whereas they are typically blue in *P. perlatus*. As is typical of species frequenting the lower reaches of rivers, individuals of this species are relatively large, and males up to 51 mm in length (69 mm in width) have been collected.

Potamonautes lividus Gouws, Stewart & Reavell In Press
blue river crab (Fig. 6.11B)

Endemic to the swamp forests of northeastern KwaZulu–Natal in the vicinity of Amatikulu, Richards Bay, Empangeni and the Mapelane Nature Reserve, the blue river crab is characterized by the possession of a highly vaulted carapace, a postfrontal crest that diminishes medially, a downward projecting frontal lobe, and inflated and arched chelipeds, particularly in males (Gouws *et al*. In Press). The carapace is orange to red in colour, with a distinct silver-blue sheen, while the chelipeds and walking legs are bright orange to red. Males attain a carapace length of 26 mm (widest width of 37 mm), and females a length of 28 mm (width of 37 mm).

Potamonautes parvispina Stewart, 1997
small-spined river crab (Fig. 6.10C)

The carapace in this species possesses a small but distinct spine at each epibranchial corner. Males reach a carapace length of up to 28 mm, corresponding to 42 mm in width. This is the only South African species apart from *P. unispinus*, which is characterized by a single epibranchial tooth at each corner of the carapace (Stewart 1997b). *Potamonautes parvispina* can be distinguished from *P. unispinus* in that the spines are considerably smaller in *P. parvispina* than in *P. unispinus*. To date, this Western Cape endemic is known only from the upper tributaries of the Olifants and Berg River systems.

Potamonautes perlatus (H. Milne Edwards, 1837)
Cape river crab (Fig. 6.11D)

The Cape river crab has a relatively smooth carapace with a well-developed postfrontal crest. Males with carapace lengths up to 35 mm (widest width of 47 mm) have been collected. This species is known from small mountain streams to middle and lower reaches of larger rivers, lakes and reservoirs, commonly sheltering under large boulders, and coming out to feed or to ward off intruding crabs. *Potamonautes perlatus* is widely distributed in the Western Cape (e.g. Daniels *et al*. 1999a, 1999b), and is also reported to occur further north and east, where it exhibits considerable morphological variation, forming a 'continuum' with *P. sidneyi*, a species with which it shares a close morphological similarity (Barnard 1935, 1950; Gouws *et al*. (In prep.).

Potamonautes obesus calcaratus (Gordon, 1929)
spurred river crab (Fig. 6.10B)

This subspecies was first described as *Potamon (Potamonautes) calcaratum* by Gordon (1929), based on specimens collected from Mozambique and southern Zimbabwe. Gordon (1929) believed that the presence of a discontinuous postfrontal crest, spines on the postero- as well as antero-inferior margin of the merus of the chelipeds, and spines on the carpus of the first and second pair of walking legs, distinguished this species from *Potamon (Potamonautes) bottegoi* (de Man, 1898) and *Potamon (Potamonautes) obesus* A. Milne Edwards, 1868. However, in a major revision of the group, Bott (1955) considered *P. calcaratum* to be a subspecies of *Potamonautes obesus*, and *P. bottegoi* to be a synonymy for *Potamonautes obesus obesus*. In both *P. obesus obesus* and *P. obesus calcaratus*, the major cheliped often has a broad flattened finger and dactyl. In the oldest males, the major chela often has the finger and dactyl strongly curved and widely gaping. Until recently, only a single specimen of this species existed in the country (Transvaal Museum, record TM 5377) but a more recent collection has been deposited in the South African Museum.

Potamonautes sidneyi Rathbun, 1904.
Natal river crab (Fig. 6.11F)

This species is distinguished by its strongly granulated carapace, which lacks teeth. The well-developed postfrontal crest forms a distinct corner at the anterolateral margin. Males can reach up to 66 mm in length (88 mm in widest width) and females up to 63 mm in length (85 mm in width). Barnard (1935, 1950) described a complete transition between *P. sidneyi* and *P. perlatus* forms, noting that the typically smooth *P. perlatus* occurred as far east as KwaZulu–Natal, and that the typically rough *P. sidneyi* had not been recorded further west than Still Bay in the southern Cape. Recent genetic analyses suggest that the two species are distinct, with a diffuse species boundary occurring in the Eastern Cape (Gouws *et al.* In Prep.).

Potamonautes sidneyi is the most widespread of all of the potamonautid species in South Africa, occurring in the Eastern Cape, KwaZulu–Natal, Mpumalanga, Northern Province, Gauteng, North West Province, Free State and the Northern Cape. Although most abundant at lower altitudes in slow-flowing rivers and standing waters, it is also found in small, pristine mountain streams. It commonly shelters in burrows dug into the side of muddy river banks.

Potamonautes unispinus Stewart & Cook, 1998
single-spined river crab (Fig. 6.10A)

The single-spined river crab has a complete postfrontal crest, which slopes only very slightly backwards to meet the epibranchial tooth. There is no cavity anterior to this tooth. Although the anterolateral margin can be strongly granulate, it does not bear large distinct teeth as found in *P. warreni* and *P. dentatus*. Both males and females with carapace lengths up to 57 mm (widest width up to 73 mm) are known. In his early assessment of the potamonautid crabs of southern Africa, Barnard (1935, 1950) designated specimens of *P. unispinus* as feebly dentate forms of *P. warreni*, and suggested that these and *P. sidneyi* were closely allied and difficult to separate. Recent research suggests that *P. unispinus* and *P. warreni* are closely related, but distinct taxonomic units which can be defined by both morphological and genetic criteria (Stewart & Cook 1998). *Potamonautes unispinus* is widespread in Mpumalanga, Northern Province, Gauteng, North West Province and Free State.

Potamonautes warreni Calman, 1918
Warren's river crab (Fig. 6.10D)

Originally described from a specimen from Potchefstroom, this species is known only from the Orange River System. It is one of two potamonautid species occurring in South Africa which have strongly toothed carapaces. The only other species of *Potamonautes* known from South Africa with strongly denticulate anterolateral margins of the carapace is *P. dentatus*, a species found in KwaZulu–Natal. In *P. dentatus*, there is however a cavity anterior to the epibranchial tooth where the postfrontal crest meets the anterolateral margin of the carapace, and there is usually a distinct break in the postfrontal crest posterior to the exorbital teeth. Mature adult male specimens of *P. warreni* are known to reach a carapace length of about 56 mm, corresponding to a width of 77 mm at the widest part.

ACKNOWLEDGEMENTS

Thanks are due to former and present systematists, and the many, mostly anonymous, collectors on whose efforts the present work is largely based. We are sure they echo our hope that this contribution will assist biological scientists and naturalists in the future.

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GLOSSARY

abdomen	posterior tagma of body of an arthropod
aberrant	with characteristics not according to type
abiotic	devoid of life; non-living; cf. *biotic* (q.v.)
abiotic factors	physical, chemical and other non-living environmental factors; cf. *biotic factors* (q.v.)
acute	at a sharp angle (less than 90°)
aesthetasc	(= aesthete): a delicate sensory seta, often annulate and usually projecting from the antennae or antennules
alien species	(= exotic species): a species that has been distributed intentionally or unintentionally by man to areas beyond its native range of distribution
ambulatory legs	legs that can be used for walking
amphi-	on both sides
antenna	(= antenna 2; second antenna): the jointed, sensory second appendage on the head of most crustaceans (see *antennule*)
antennal peduncle	the proximal stalk of the antenna, usually bearing the antennal flagella distally
antennal flagellum	the distal whip-like, multi-articulate part of the antenna, sometimes reduced to one to two articles
antennal scale	a flattened structure at the base of the second antennae in some crustaceans
antennal spine	a spine on the carapace immediately behind the antenna in some decapods
antennule	(= antennae 1; = first antennae): the first appendage on the head of most crustaceans
anterior	the 'front end'; cf. *posterior* (q.v.)
antero-inferior	antero-ventral
apex	tip
apical	referring to the tip
appendage	in crustaceans, any of the paired, articulated structures attached to each somite (e.g. antennae, maxillipeds, pereiopods — q.v.)
appendix masculina	(= copulatory stylet): a complex median process of the second pleopod of some male crustaceans; used in copulation
Arthropoda	a large phylum of animals (including crustaceans, insects, arachnids and myriopods), distinguished primarily by a segmented body and jointed limbs encased in a hard exoskeleton
article	(= segment' or 'joint'): a single subdivision of an appendage — e.g. the dactyl of a pereiopod or one of the elements of an antennal flagellum
articulation	the flexible connection or joint between articles or somites
aufwuchs	growths of fine material on rocks

basal crest	slightly elevated crest at base of rostrum
basis	the second segment from the body of the seven articles in a crustacean thoracopod (q.v.) (see Fig. 3, p. 3)
basiopodite	see *basis*
benthic	pertaining to, or living on, the bottom
biarticulate	composed of two articles
bilateral symmetry	symmetry such that left and right halves of body, when viewed dorsally, are mirror images
biramous	having two branches: many crustacean appendages are biramous, consisting of an outer exopodite and an inner endopodite
biunguiculate	having two claws
bivalved	having a carapace divided into two 'shells' or valves
branchial	(adj.) of the gills
branchial chamber	(= gill chamber): in decapods, the cavity between the body and the carapace (q.v.), that houses the gills
branchial plate	pleated respiratory surface of the pleopods (q.v.)n some isopods
Branchiopoda	class of Crustacea: appendages uniform and usually flattened; abdomen without appendages; includes fairy shrimps, brine shrimps, water-fleas
branchiostegal spine	a characteristic spine on the lower anterior part of the gill cover of some shrimps
branchiostegite	lateral part of the carapace covering the gills in decapod crustaceans
Brachyura	a group of decapod crustaceans containing the true crabs
brood plates	flattened extensions of the coxae, together forming a ventral brood chamber or marsupium in peracarid crustaceans
brood pouch	see *marsupium*
brush chela	a chela (q.v.) with a brush of setae between the 'finger' and 'thumb'
calceolus	minute, globular sense organs on the appendages of some amphipods
carapace	part of the crustacean exoskeleton forming a shield over the head and encasing some or all segments of the thorax; the carapace may be extended anteriorly as a rostrum (q.v.)
caridean	shrimp
carina	see *crest*
carpopodite	see *carpus*
carpus	(= carpopodite): the fifth from the body of the seven articles in a crustacean thoracopod (see Fig. 3, p. 3)
catadromy	(adj. catadromous): migration down a stream or river to the sea, generally to breed or mature, and thus complete the life cycle
caudal	concerning the tail; towards the tail

caudal furca	tail fork
cephalon	(adj. cephalic): the head: in crustaceans, bearing two pairs of antennae and three pairs of mouthparts (usually a pair of mandibles and two pairs of maxillae)
cephalothorax	fused head and thorax
chela	claw or pincer on the end of a limb of some crustaceans
chelate	pincer-like
cheliped	a limb of a crustacean bearing a pincer or chela
class	a taxon below the level of phylum and above the level of order
cladistic	of a group of animals sharing a recent common ancestry
claw	a tough, pointed, terminal spine
cleft	split
clypeus	the part of the head carrying the labrum (q.v.)
commensal	members of different species living in close association, usually sharing a food source
compound eye	an eye, consisting of numerous small light receptors and showing several to many facets
conglobating	the action of rolling into a ball (Isopoda)
conspecific	belonging to the same species
contiguous	touching
Copepoda	a class of small to minute crustaceans, free-living forms distinguished by a simple median eye, a trunk of ten somites and no abdominal appendages or carapace
copulatory stylet	see *appendix masculina* (q.v.)
cosmopolitan	of world-wide distribution
coxa	(= coxopodite): the most proximal segment or article of crustacean appendages closest to the body (see Fig. 3, p. 3)
coxal gill	a gill arising from the coxa (amphipods)
coxal plate	a lateral expansion of the coxa (amphipods)
coxopodite	see *coxa*
crest	(= carina): a ridge on the head
Crustacea	a group of arthropods distinguished by two pairs of antennae and at least some biramous appendages
cuticle	see *exoskeleton*
dactyl	(= dactylopodite; dactylus): the seventh and most distal segment of a crustacean thoracic appendage (see Fig. 3, p. 3)
dactylopodite	see *dactyl* (q.v.)
dentate	toothed
denticulate	with small teeth
detritivore	an animal that feeds on organic remains
digitiform	finger-like
distal	the part of a structure furtherest from the midline of the body or the point of its attachment; cf. *proximal* (q.v.)

distolateral	on the sides and away from the body
dorsal	referring to the upper surface (the 'back') of an organism; cf. *ventral* (q.v.)
dorsoventrally depressed	flattened from above
emarginate	notched or indented; cf. *entire* (q.v.)
endemic	referring to organisms found only in a particular area
endite	a flattened, medially-directed expansion of the coxa or basis of a crustacean limb
endopod	(= endopodite): the inner of the two jointed rami of a crustacean limb
endopodite	see *endopod*
entire	complete, without breaks or notches (cf. *emarginate*)
epibranchial	in crabs, the dorsal anterolateral part of the carapace
epibranchial corner	in crabs, the dorsal anterolateral corner of the carapace
epibranchial sinus	in crabs, the inflated anterolateral part of the carapace
epibranchial tooth	a tooth on the epibranchial (q.v.) region of the carapace
epicaridium	planktonic larval stage of parasitic epicaridean isopods
epimeral plates	plates formed by expansion of the epimera (q.v.) in amphipods
epimeron	(pl. epimera) (= pleuron = pleurite): the lateral part of the outer body wall of each somite
epipod	(=epipodite): any laterally-directed exite (q.v.), often respiratory in function
epipodite	see *epipod*
epistome	the plate situated between the bases of the antennae and the labrum
euryhaline	tolerant of a range of, and/or variable salinities
excavate	hollowed out
exite	a flattened, laterally-directed, expansion of the protopodite (coxa or basis — q.v.) of a crustacean limb; includes epipods (q.v.)
exopod	(= exopodite): the outer of the two jointed rami (q.v.) of a crustacean limb
exopodite	see *exopod*
exotic species	see *alien species*
exorbital tooth	in crabs, a tooth defining the lateral extent of the eye socket
exoskeleton	(= cuticle; = integument): the external chitinous covering of crustaceans and other arthropods, hardened in places with calcium carbonate or by tanning
family	a taxonomic category below the level of order and above the level of genus

finger	(= fixed finger): the expanded distal portion of the propodus (q.v.) that forms part of a chela (q.v.)
filter feeder	an animal that feeds by means of filtering small particles out of the water
filtering fan	a sieve-like fan of setae used to filter particles from the water
first antenna	see *antennule*
first maxilla	see *maxillule*
fixed finger	see *finger*
flagellum	(pl. flagella): the multi-articulate distal part of an antenna (q.v.) or exopod (q.v.)
forameniferan	one of a group of shelled protozoans found in marine waters
frontal	referring to the anterior 'face' of the head
frontal lamina	a plate-like part of the head immediately anterior to, and sometimes fused with, the clypeus (q.v.) (Isopoda)
frontal margin	in crabs, the anterior dorsal margin of carapace between the eyes
furca	a fork, usually referring to the caudal furca or tail fork
furcal ramus	one of the branches that makes up a caudal furca or tail fork
genital	reproductive
genital aperture	the opening to the outside of the male or female gonads
genital cone	cone-like structure bearing the male genital aperture, on the sternite of the eighth thoracic segment in tanaid crustaceans
genus	a taxonomic category below the level of family and above the level of species
gill	an organ, usually flattened and expanded, used for respiration in water
gnathopod	jaw-foot: in amphipods, the first two pairs of pereiopods (q.v.), often prehensile and with greatly expanded propodi, especially in males; in isopods, sometimes the modified first pereopod (q.v.)
Gondwanaland	a huge southern landmass, consisting of Africa, South America, Australia and India, that broke up some 60–100 million years ago to form present-day continents
gonochoristic	having the sexes separate; producing separate males and females
gonopod	a pleopod (q.v.) that is used to transfer sperm
gonopore	a genital aperture (q.v.)
granulate	appearing to be covered with granules
habitat	the combination of biotic and abiotic factors (q.v.) that make up the 'home' of an organism
hand	the flattened, expanded propodus (q.v.) of the gnathopods or chelae of some crustaceans

head	the first tagma (see *cephalon*)
hemibranchiate	a condition in which the endopods (q.v.) of the pleopods (q.v.) are pleated and used for respiration (isopods)
hepatic	referring to the liver, in decapods, to the lower middle part of the gill cover or branchiostegite
hepatic spine	characteristic spine situated on the lower middle part of the gill cover or branchiostegite
hermaphrodite	(= bisexual): bearing both male and female organs in a single individual
homologous	of similar evolutionary origin
hypogean	(= hypogeal): below the surface of the earth
indigenous	native to a particular area
incisor	the cutting edge of the mandible (q.v.)
inferior	ventral, below
inflated	enlarged, swollen
integument	see *exoskeleton*
interstitial	referring to the spaces (interstices) between sediment particles
invaginated	hollowed, sunken
ischiopodite	see *ischium*
ischium	(= ischiopodite): the third segment from the body of the seven articles in a crustacean thoracopod (q.v.) (see Fig. 3 p. 3)
labium	lower 'lip'
labrum	upper 'lip'
lacinia mobilis	a small, usually toothed, articulating process at the base of the incisor of the mandible (peracarids — q.v.)
lamellar	in the form of a thin sheet or plate
larva	any juvenile instar of different form from that of the adult
lateral	of the side of an animal
laterally	flattened from the sides compressed
lenticular organ	in amphipods, an opaque ring laterally on the body of somites
littoral	referring to the shore of a lake or sea
lentic	pertaining to static, calm or slow-moving aquatic habitats (cf. *lotic*)
lotic	pertaining to fast running-water habitats such as rivers and streams (cf. *lentic)*
macrophagous	feeding on food items that are large in relation to the size of the feeder (c.f. *microphagous*)
macroscopic	large enough to be visible to the naked eye
Macrura	a group of decapod crustaceans (q.v.) including shrimps, prawns and lobsters, in which the abdomen is extended and bears a well-developed tail fan

Malacostraca	a group of crustaceans distinguished by possessing at least some stenopodous limbs (q.v.) and five head, eight thoracic, and six abdominal somites (q.v.)
manca	postlarval stage at which peracarids are released from the marsupium; entire except for last pair of pereiopods (q.v.)
manus	see *palm*
mandibles	the first pair of mouthparts: hardened, laterally-moving jaws used for crushing or biting food
mandibular palp	an articulated portion of the mandible, distal to the chewing structure
marsupium	(= brood pouch): the cavity, formed between brood plates and body, that houses the eggs, in peracarids (q.v.)
maxillae	laterally-moving mouthparts situated behind the mandibles: two pairs in crustaceans, the first usually called the maxillules (= maxilla 1 = first maxilla) and the second the maxillae (= maxilla 2 = second maxilla) (q.v.) (see Table 1, p. 6)
maxillule	see *maxilla 1* (= first maxilla)
maxillipeds	accessory feeding appendages situated behind the maxillae (q.v.) and formed by the modification of up to three pairs of anterior thoracic appendages (q.v.) (see Table 1, p. 6)
Maxillopoda	a taxon of crustaceans that includes the copepods, ostracods and branchiurans
median	in the midline
medial	(= mesial): towards the midline
merus	(= meropodite): the fourth segment from the body of the seven articles in a crustacean thoracopod (q.v.) (see Fig. 3, p. 3)
meropodite	see *merus*
mesial	see *medial*
mesiodistal	towards the centre line and at the tip
metameric	referring to body segmentation where, in development, each somite is a sub-unit containing all of the organ systems of the body
metamorphosis	transformation from juvenile to adult form
metanauplius	second larval stage of many crustaceans
Metazoa	multicellular animals
microphagous	feeding on particles that are minute in relation to the size of the feeder (cf. *macrophagous*)
molar process	a grinding, cutting or piercing part of the mandible
monospecific	of a genus, containing only one species
morphological	pertaining to form and structure
mouthparts	appendages modified for feeding (mandibles, maxillae and maxillipeds (q.v.)
Natantia	a group of decapods distinguished by laterally compressed bodies and pleopods (q.v.) adapted for swimming (shrimps and prawns)

natatory	used for swimming
nauplius larva	the earliest (and uniquely characteristic) larval stage of crustaceans, characterized by a rounded or pear-shaped, unsegmented body, three pairs of appendages, and a single median eye
neotenous	of a feature, one normally found in the larva but retained in the adult
ocellus	simple light-receptor occurring in many invertebrates
ocular	pertaining to the eye
ocular lobe	a lobe-like structure of the head, bearing the eyes (not an eye stalk)
ocular stalk	eyestalk: the stalk-like structure bearing the eye
ontogeny	the origin and development of an organism from conception to maturity
oostegite	a lamellar outgrowth of the coxal article of a thoracic leg, several making up the brood pouch or marsupium (q.v.)
operculiform	like a lid
operculum	a 'lid' or covering
orbit	eye socket: in decapods, the depression in the exoskeleton from which the eye stalk arises
order	taxonomic category below the level of 'class' and above the level of 'family'
ovigerous	bearing eggs
palm	(= manus): the broadened portion of the propodus (q.v.) of a chela
palp	an articulated branch, usually of a mouthpart
papilla	a small lobe or nipple
paragnath	one of the lobes of the labium (q.v.)
peduncle	a stalk, or the enlarged proximal part of an appendage such as an antenna (q.v.) or uropod (q.v.)
pelagic	of organisms, those inhabiting the open waters of an ocean or lake
penis	(pl. penes): male copulatory organ
penultimate	the one before the last
Peracarida	a group of malacostracans distinguished by a *lacinia mobilis* (q.v.) and, in the female, a brood pouch
peraeopod	see *pereoipod*
pereiopod	(= peraeopod = pereopod): the stenopodous locomotory appendages of the pereon (thorax) of malacostracan crustaceans (q.v.) (see Table 1, p. 6)
pereon	the thorax: the middle body tagma (q.v.), in malacostracans consisting of eight somites bearing maxillipeds (q.v.) and pereiopods (q.v.)

pereonite	an individual somite of the thorax or pereon
pereopod	see *pereiopod*
periphyton	minute organisms attached to aquatic plants
phreatic	relating to ground water
phoretic	pertaining to the transportation of one non-parasitic organism by another larger organism of a different species
phyllopod	a flattened and leaf-like trunk limb (see *stenopod*)
phylum	the highest taxonomic category of animals
phytoplankton	planktonic plants
plankton	a collective term for the small organisms living suspended in the water column and at the mercy of currents
platybranchiate	the condition in some isopods in which both rami of pleopods 4 and 5 are lamellar (q.v.)
pleon	(adj. pleonal): the abdomen; the last of three body tagma (q.v.); in malacostracans usually consisting of five somites bearing pleopods and a terminal somite bearing a pair of uropods (q.v.) and a terminal telson (q.v.)
pleonite	one of the somites of the pleon (q.v.)
pleopod	(= swimmeret): one of the five pairs of abdominal appendages in malacostracan crustaceans
pleotelson	structure resulting from the fusion of one or more pleonal somites with the telson (q.v.)
pleurite	(= pleuron): see *epimeron* (q.v.)
plumose	feathery
Polychaeta	class of Annelida (q.v.) containing bristle-worms, tube-worms and fan-worms
Porifera	sponges
posterior	towards the tail end: cf. *anterior* (q.v.)
postero-distal	towards the tail and away from the centre of the body
postero-inferior	towards the tail and ventrally
postfrontal crest	ridge running transversely across the dorsal surface of the carapace just behind the frontal margin (q.v.), in some decapods
post-larva	first adult stage
prehensile	able to grasp or cling
process	a projection
propodus	(= propopodite): the sixth from the base of the seven articles or segments of a crustacean thoracic appendage (see Fig. 3, p. 3)
propopodite	see *propodus*
protandrous hermaphrodite	an animal that starts life as a male and later becomes a female
protogynous hermaphrodite	an animal that starts life as a female and later becomes a male
protogastric	pertaining to that part of the carapace covering the anterior part of the gut

protopodite	the proximal part of any crustacean limb, usually consisting of the coxa (q.v.) and basis (q.v.)
proximal	towards the point of attachment: cf. *distal* (q.v.)
pubescent	covered with a layer of fine, short hairs
ramus	(pl. rami): branch; one of the two branches making up the stenopodous (q.v.) crustacean limb
Reptantia	a group of decapods distinguished by legs used for walking or crawling and usually by enlarged, chelate first pereiopods (crabs, hermit crabs, crayfish, etc.) (see Natantia)
retinacula	(sing. retinaculum): small hooks on the medial edge of some pleopods (q.v) that interlock them so that each pair moves as a unit
robust	stout, sturdy
rostrum	a pointed dorsal extension of the crustacean carapace (q.v.) projecting anteriorly between the eyes
rostral length	the length of the rostrum relative to the length of the rest of the carapace
salinity	a measure of the saltiness of water
scale	a flattened projection of the base of the antenna
scabrous	rough, usually with a covering of short, stiff hairs
sclerotized	of the exoskeleton, hardened and tanned
second antenna	see *antenna*
second maxilla	see *maxilla*
segment	a sommite (q.v.) or a single article (q.v.) of an appendage
serrated	with a saw-like edge
sessile	without a stalk or, more commonly, animals permanently fixed in one spot
seta	(pl. setae): a chitinous hair or bristle
setiferous	bearing setae
setiform	in form, like a seta
setose	bearing setae
sexual dimorphism	difference in form between male and female of the same species
stenohaline	can only tolerate a narrow range of salinity
stenopod	(adj. stenopodous): a subcylindrical walking leg
somite	one of the repeated units that make up the body of a crustacean
species	a group of interbreeding individuals reproductively isolated from other such groups: the unit of biological diversity
spermatophore	a small package of sperm
spination	the arrangement (size and number) of spines
spine	a pointed, tooth-like expansion of the integument
spinose	spiny, or covered with spines

statocyst	a small sense organ, containing a hard rounded or oval structure, providing a sense of balance
sub–	a prefix indicating 'almost' or 'not quite'
subacute	not quite acute (q.v.)
subchelate	approaching the condition of being chelate (q.v.)
subcylindrical	almost cylindrical
subequal	almost equal
subspecies	in animals the only recognized taxon below species: populations that are recognizably different from each other but that can probably interbreed
subterminal	almost at the tip
sympodite	(= sympod): the proximal article of a uropod (q.v.)
synonym	in taxonomy, another name for the same species
tagma	a section of the body: head, thorax etc.
taxon	any unit of biological classification
taxonomy	the study of the classification of organisms
tailfan	a splayed terminal fan formed by the uropods (q.v.) and telson (q.v.)
telson	the terminal part of the body, behind the last abdominal somite
terga	(sing. tergum): thickened dorsal plate of cuticle
terminal	at the end (usually at the posterior end)
thorax	the central of three principal divisions (head, thorax, abdomen) of the body of most crustaceans
thoracopod	one of the appendages of the thorax
tracheate	of pleopod, bearing tubular respiratory structures
transverse	running from side-to-side of the animal
trophic	referring to food and feeding
truncate	bluntly ended, cut off
tubercle	a small rounded protuberance or nodule
unguis	the apical claw of the dactyl of a thoracic leg
uniramous	consisting of a single ramus or branch
uropod	'tail leg': the sixth and last pair (4th to 6th in amphipods) of abdominal appendages
urosome	in amphipods, the last three (uropod-bearing) somites plus the telson (q.v.)
ventral	referring to the underside of the body : cf. *dorsal*
vermiform	'worm-like'
vlei	any wetland or riverine reed-bed
zoea larva	a larval stage of some decapods
zooplankton	animal plankton (q.v.)

GLOSSARY OF PLACE NAMES

NEW PROVINCIAL NAMES IN SOUTH AFRICA TOGETHER WITH ABBREVIATIONS USED IN THE TEXT

Eastern Cape (EC)	formerly the eastern part of the Cape Province.
Free State (FS)	formerly the Orange Free State.
Gauteng (GT)	formerly the Pretoria/Witwatersrand/Vereeniging complex: part of the Transvaal.
KwaZulu–Natal (KZN)	formerly Natal, which included Zululand.
Mpumalanga (MPL)	formerly the 'eastern Transvaal'.
Northern Cape (NC)	formerly the north-western part of the Cape Province.
Northern Province (NP)	formerly the 'northern Transvaal'.
North West (NW)	formerly the 'western Transvaal'.
Western Cape (WC)	formerly the 'western Cape'.

ABBREVIATIONS OF OTHER COUNTRIES IN SOUTHERN AFRICA

BOTS	Botswana
LES	Lesotho
MWI	Malawi
MOZ	Mozambique
NAM	Namibia
SWZ	Swaziland
ZAM	Zambia
ZIM	Zimbabwe

REGIONAL NAMES

Bushmanland	(= Boesmanland): The north-eastern parts of Namibia, the south-western parts of Botswana and the drier northern areas of the Northern Cape.
Cape	One of the four former provinces of South Africa now named as follows: the north-western part is now the Northern Cape; the south-western part is now the Western Cape ; the eastern part, together with the former Ciskei and Transkei (qv), is now the Eastern Cape.
Caprivi	The north-eastern 'panhandle' of Namibia.
Damaraland	The west-central region of Namibia.
Delgoa Bay	(= Baia de Maputo): large bay on east coast of Mozambique, site of Maputo Harbour
Drakensberg Mountains	The mountain range stretching from the northern regions of the Eastern Cape through the highlands of KwaZulu/Natal, Lesotho and the eastern Free State to Mpumalanga.
Greater Namaqualand	The south-eastern part of Namibia (also see 'Namaqualand').
Griqualand East	Border region between the Transkei (qv) and KwaZulu/Natal.
Griqualand West	Arid region from Bloemfontein (Free State) westwards into the North West Province.
Highveld	High-altitude inland plateau characterized by grassland vegetation. Predominantly in Gauteng and the Free State.
Kalahari	The desert region of the northern North West Province, southern Botswana and south-eastern Namibia.
Karoo	Arid central region of southern Africa characterized by low scrub vegetation and very little grass cover: predominantly in the southern Northern Cape, the western parts of the Eastern Cape, the former Transkei (qv) and the northern border of the Western Cape.
Kaokoveld (Kaokoland)	The arid north-western coastal regions of Namibia.
Kruger National Park	Large nature reserve in the north-eastern region of Mpumalanga on the Mozambique border.

Makatini Flats	Pongola River floodplain, north-east of Jozini, Maputaland (q.v.)
Maputaland	Coastal plain in the north eastern region of KwaZulu/Natal and southern Mozambique, bounded by the Lebombo Mountains in the west and the Indian Ocean in the east.
Namaland	The coastal areas of the central Namib (qv) in Namibia.
Namaqualand	Arid region along the western parts of the Northern Cape and continuing into Namibia, where it is known as Greater Namaqualand (qv).
Namib Desert	The coastal desert of south-western Africa, extending roughly from the Orange River to Benguela in Angola.
Natal	One of the four former provinces of South Africa, which previously included the region variously known as Zululand and KwaZulu, now re-named KwaZulu/Natal.
Orange Free State	One of the four former provinces of South Africa, now known as the Free State.
Owamboland (Ovamboland)	Northern region of Namibia.
Southern Cape	The southern coastal strip from Cape Agulhas in the west to Cape St Francis in the east.
Transkei	The region colloquially known as the Transkei is now part of the Eastern Cape Province, stretching from the Kei River to Port Edward on the KwaZulu/Natal border.
Transvaal	One of the four former provinces of South Africa: the north ern part is now the Northern Province; the eastern part is now Mpumalanga; the southern part is now Gauteng and the western region is now part of the North West Province.
Zululand	in KwaZulu–Natal, the eastern coastal belt and adjacent interior from the Tugela River to the Mozambique border .

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