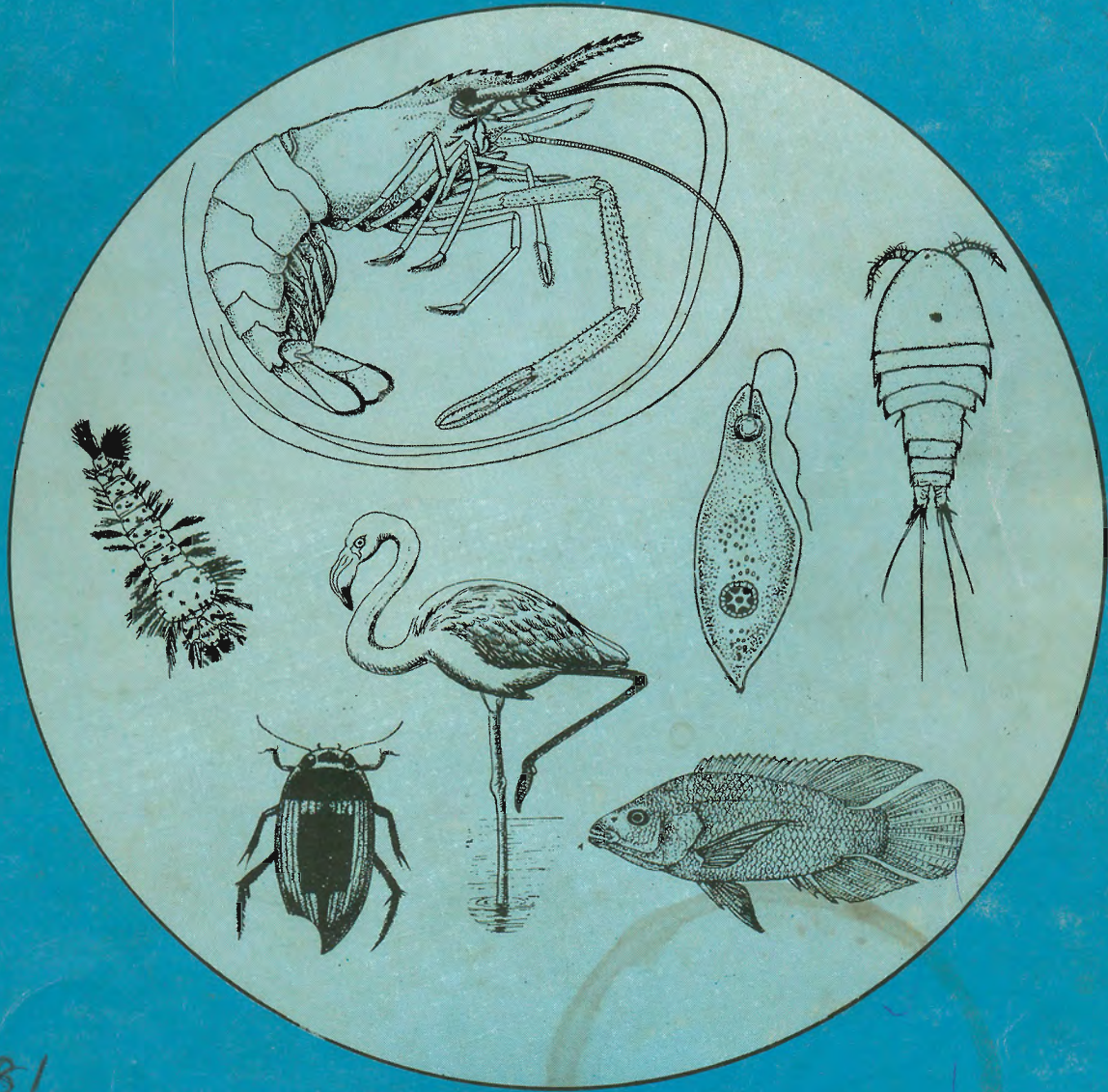


NA-181-1

ZOOLOGICAL SURVEY OF SRI LANKA

# FRESHWATER FAUNA AND FISHERIES OF SRI LANKA



C. H. Fernando

NA-181

NATURAL RESOURCES, ENERGY & SCIENCE AUTHORITY

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THE FRESHWATER FAUNA AND FISHERIES OF SRI LANKA



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A Collection of Published papers by C.H. Fernando and Collaborators  
(1962-1980), with taxonomic and common name indexes.

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## FOREWORD

Culture and capture fisheries of South Asian and South East Asian freshwaters have grown rapidly in importance over the years. Improved culture techniques and exploitation of reservoir fish stocks account for the rapid growth. Throughout the region however, the knowledge of the freshwater fauna (apart from fishes) is meagre, with few exceptions. A knowledge of the freshwater invertebrates is a very important component in the proper management of fisheries.

In 1962, Mendis and Fernando produced a guide to the freshwater fauna of Sri Lanka, after which Fernando added 4 supplements. In addition, monographs have been produced on the Rotifera and parasitic Copepoda by Fernando and co-workers. In all these contributions a considerable body of knowledge has accumulated on the freshwater fauna of our region.

The Guide of 1962 has a comprehensive coverage of the Sri Lanka freshwater fauna and with suitable additions, such as are found in this compilation, it can be used as a basis for providing a guide to the freshwater fauna of both the South and South East Asia Regions (the Original Region of Zoogeographers). Such a publication will be useful to university teachers, freshwater biologists and fishery biologists in Sri Lanka. Although considerable work has been done since 1980, putting together the relevant papers of Fernando and his colleagues in a single volume will help also in gaining access to material published in a number of scattered journal issues.

The publication of this compilation may not have been possible if not for the untiring efforts of late Prof Hilary Cruz. Prof Cruz as Scientific Co-ordinator of NARESA's Zoological Survey was totally responsible for the preparation of the index and structuring of the publication.

R.P. Jayewardene  
Director General, Natural Resources, Energy &  
Science Authority of Sri Lanka.

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FISHERIES RESEARCH STATION  
DEPARTMENT OF FISHERIES, CEYLON

Bulletin No. 12

A GUIDE TO THE  
FRESHWATER FAUNA OF  
CEYLON

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\* These are references to material of a general nature. Other references are given at the end of each section pertaining to the corresponding phylum.

## ADDITIONS AND CORRECTIONS

Page 35	<i>Euchlanis dilatata</i>	should read	<i>Euchlanis dilatata</i>
	<i>Colurus bicuspidatus</i> Ehrb.	" "	<i>Colurella bicuspidata</i> (Ehrb.)
	<i>Colurus uncinatus</i> Ehrb.	" "	<i>Colurella uncinata</i> (Ehrb.)
	<i>Metopidia lepadella</i> Ehrb.	" "	<i>Lepadella accuminata</i> (Ehrb.)
	<i>Metopidia ovalis</i> Ehrb.	" "	<i>Lepadella ovalis</i> (Müller)
	<i>Metopidia triptera</i>	" "	<i>Lepadella triptera</i> Ehrb
	<i>Coelopus tenuior</i> Gosse	" "	<i>Dilurella tenuior</i> (Gosse)

Page 36	<i>Euchlanis dilatata</i>	" "	<i>Euchlanis dilatata</i>
	<i>Coelopus tenuior</i>	" "	<i>Dilurella tenuior</i>
	<i>Colurus bicuspidatus</i>	" "	<i>Colurella bicuspidata</i>
	<i>Anuraea</i>	" "	<i>Keratella</i>

Page 38	<i>Brachionus falcatus</i> Bär	" "	<i>Brachionus falcatus</i> Zacharias
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To list of species in Anuraeidae add *Anuraeopsis navicula* Rousselet *Anuraea valga* Ehrb. var *tropica* Daday should read *Keratella valga tropica* (Daday)

Page 39 Before references add :

### FAMILY LECANIDAE

*Lecane leontina* (Turner)  
*Lecane ludwigii* (Eckstein)  
*Lecane unguolata* (Gosse)

Add reference : Hauer, J. 1937. Die rotatarien von Sumatra, Java und Bali nach der Ergebnissen der Deutschen Limnologischen Sunda-Expedition. *Arch. Fur Hydrobiol.* 15 : 276-384, 507-602

Page 45 *Brachiodrilus semperi* (Bourne), *Aulodrilus remex* Steph. and *A. pluriseta* Pignet have been recently identified by K. Vanamala Naidu of Chittor, A.P., India from a collection of fresh-water oligochaetes sent to him. These are new records for Ceylon.

Page 82 Insert *Micronecta thyesta* Distant

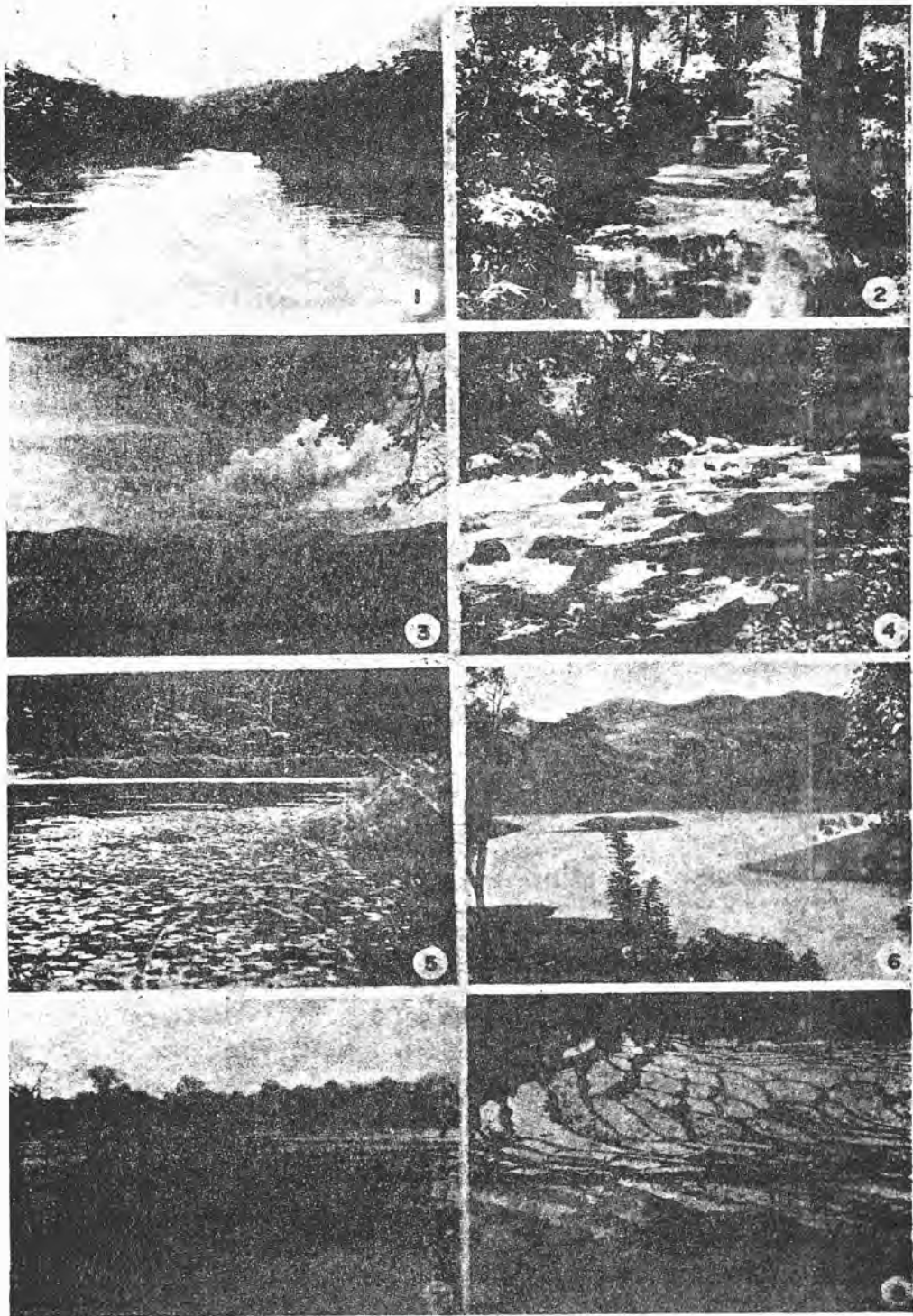
Page 89 Insert *Orectocheilus sinhalensis* Ochs

Page 100 Add reference : Ochs, G. 1937 Nachtrag zur Gyriden Fauna, Javas und der benachbarten Sunda-Inseln. *Arch. Fur Hydrobiol.* 15 : 109-118.

R 19576 (9/61)

Page 71 Add to list of *Caridina*:

*Caridina gracilirostris* De Man  
*Caridina nilotica zeylanica* Arud. and Coates



1. A river—The Kelani River at Karawanella.
2. A stream near Meegahatenne.
3. A lake—Minneriya Tank.
4. A torrential stream at Belihuloya.
5. A pond at Pita Rath Malie Estate, Haputale.
6. Castlereagh Hydro-electric Reservoir.
7. A paddy field without water (after harvesting).
8. A terraced paddy field with water.

2\*—R 19576 (9/61)

# INTRODUCTION

## SCOPE OF THE PUBLICATION

FRESHWATER animals are of importance in the economy of most countries. In recent years the scientific cultivation of freshwater fish for food has been spreading throughout South-East Asia and the Far-East. New and useful species of fish have been introduced into many countries including Ceylon where the older system of trapping any variety of fish that is available is being replaced by scientifically planned management with a view to increasing the production of good quality fish. Considerable quantities of food mainly in the form of fish are being taken from our freshwaters, providing a cheap source of much needed protein in the diet of the villager. More recently large quantities of freshwater fish are being consumed by the urban population.

To evaluate the productivity of inland waters it is essential to study its fauna and flora.

One of the remarkable features of animal life in freshwater is its great diversity. The animals range in size from microscopic protozoa to fish, reptiles and mammals which may measure several feet in length. The interrelationships between the various types of animals and plants have an important and intimate bearing on fish productivity. Fish feed on some of the smaller animals and plants while they themselves are food for predators.

For a faunal study of our freshwaters it is necessary to enlist the services of as many workers as possible. This publication is offered to them as a guide to the species of freshwater fauna recorded from Ceylon. It is written in as simple a form as possible and provided with sufficient keys and illustrations for the easy identification of recorded freshwater animals down to at least its family. The illustrations have been made from freshly collected or preserved specimens. In the absence of such specimens, illustrations have been adopted from other published material.

In this publication the authors have endeavoured to collect the previous work on the subject whilst adding their own findings in the field. The species of freshwater animals recorded so far from Ceylon have been included except those insects such as dragonflies, mayflies, stoneflies, mosquitoes &c., which are present in water only in their larval and pupal stages. However keys, diagrams and descriptions are provided for the identification of such larvae. This publication will be useful to the research biologist as well in that he will have a complete listing of the freshwater faunal species hitherto recorded from Ceylon.

The authors appeal for specimens of freshwater animals from all those in a position to collect them. The specimens should be immersed in rectified or methylated spirits or formalin (10 per cent.)

contained in a bottle. A label, written in pencil, indicating the locality and date of collection should also be placed inside the bottle. The label could contain any additional information regarding the type of habitat and other observations. The bottle containing the specimen could be handed over to the nearest fisheries office (from where bottles and formalin could be obtained) or mailed to the Freshwater Division, Fisheries Research Station, P. O. Box 531, Galle Face, Colombo.

#### ACKNOWLEDGEMENTS

An attempt has been made to bring the nomenclature in line with recent work and in this task the authors are deeply indebted to the help received from Dr. L. B. Holthuis, Rijksmuseum van Natuurlijke Histoire, Leiden (Caridea); Dr. W. S. S. Benthem Jutting, Zoological Museum, Amsterdam (Mollusca); Prof. H. B. Hungerford, University of Kansas (Hemiptera); Prof. G. E. Hutchinson, Yale University (Corixidae); Mr. R. A. Crowson, Glasgow University (Coleoptera); Mr. J. Balfour-Browne, British Museum (Natural History), London (Coleoptera); and Dr. E. L. Bousfield, National Museum of Canada (Natural History), (Amphipoda). However, these specialists are in no way responsible for any errors or omissions that may occur in this publication.

Material for this publication has been freely drawn from other workers but they have not always been individually acknowledged. The illustrations adapted from those in other publications have been acknowledged under the explanations to the respective illustrations. The authors are indebted to Mr. G. D. Kariyawasam, the artist attached to the Fisheries Research Station, for the great care and pains taken in illustrating this publication.

Grateful acknowledgement is made to the Director and Staff of the Colombo Museum for their courtesy and assistance in providing library facilities and access to their collection of fresh water fauna.

The authors are indebted to many of their associates, colleagues and others for their assistance in various ways, particularly for criticisms and suggestions during the compiling of the manuscript. The authors wish to thank Mr. K. A. Alfred for his clerical assistance.

## THE FRESHWATER HABITATS IN CEYLON

THE centre of the southern half of Ceylon is mountainous, ranging from about 3,000 to 8,000 feet and is referred to as the hill-country or up-country (page 10). This is surrounded by an upland belt sometimes called the mid-country of 1,000 to 3,000 feet. The rest of the land stretching to the coast is called the low-country. This coastal plain broadens out to a vast tract in the North, and is narrow elsewhere.

During the South-West Monsoon (May to September) the central hills cause precipitation in the form of rain in the South-Western sector of the Island, while the rest of the Island receives little or no rain at all. During the North-East Monsoon (November to February) the precipitation is to the North-West, North and East of the hills, with frequent afternoon thunderstorms in the South-West. In the inter-monsoon periods winds are light, and rains are mainly due to the depressional activity either in the Bay of Bengal or the Arabian Sea. These depressions are most frequent in October and November. The South-Western sector of the Island receives, in a well distributed manner, an average rainfall of over 75 inches per annum and is termed the wet zone (page 10). The rest of the Island is called the dry or arid zone as it receives under 75 inches rainfall per annum. The dry zone may be said to consist of the entire coastal plain (except the South-Western sector) and the Eastern slopes of the hill-country.

The rivers in Ceylon flow in a radial pattern from the central hill country (page 10), where there are numerous water falls, the rivers flowing to the West, East and South being shorter than those flowing to the North, North-West and North-East. Several streams and tributaries join these rivers. Some of the streams in the hill-country and mid-country are quick flowing and are referred to as torrential streams.

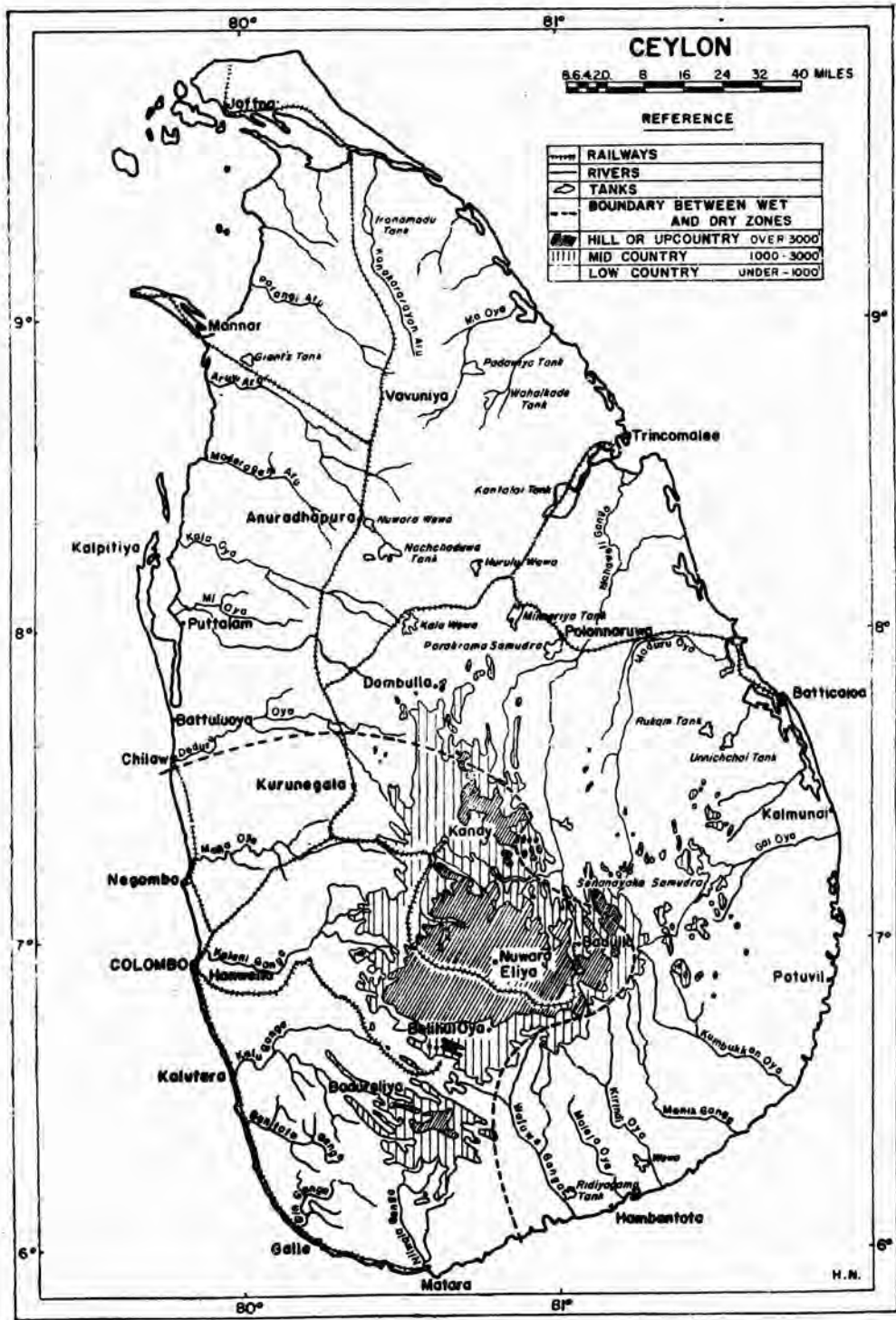
Irrigation reservoirs or lakes have been formed by damming small rivers and streams or by channelling the water from larger rivers. The larger irrigation reservoirs (or tanks as they are commonly called in Ceylon) are perennial and rarely dry up. There are hundreds of smaller reservoirs scattered throughout the country, particularly in the dry zone. They are rain fed and fill up during the rainy season. With the advent of the drought they dry up and are therefore called seasonal lakes or ponds depending on their size. After heavy rains some of the larger rivers overflow their banks into large tracts of low lying land from which the flood waters are not drained for several months after the rivers subside. These flood lakes called "Villus" are very large, some of them being over a hundred acres in surface area.

Freshwater habitats can be classified in various ways using different criteria such as size, depth, rate of flow, type of bottom and so on. A simple classification of habitats found in Ceylon is as follows :—

Rivers (S. Ganga T. Aru).<sup>1</sup> (Page 5, Fig. 1). Large with flowing water, generally deep and perennial. The bottom may be muddy, sandy, stony, or rocky. Rivers have very little plankton (floating plant and animal life). Many local terms are used for intermediate sizes (S. Oya) is one of them.

Streams (S. Ela, T. Aruvi). (Page 5, Fig. 2). Smaller than rivers but similar to them. They vary greatly in speed of flow from torrential or relatively fast flowing (S. Dhola T. Tiravaka Aruvi) (Page 5, Fig. 4), to more or less stationary types in the low country.

<sup>1</sup> The Sinhalese (S) and Tamil (T) local names are given within brackets. The format will be repeated throughout this publication.



**Lakes (S. Wewa, T. Eri).** A natural lake could be defined as a body of confined water situated in a depression of the ground, without direct communication with the sea. The majority of the lakes in Ceylon are irrigation reservoirs (tanks) constructed several hundred years ago by building bunds (dams), (Page 5, Fig. 3). A few have been constructed for hydro-electric power (Page 5, Fig. 6). Lakes in Ceylon are therefore artificial ones in that the water is confined by means of bunds and are not mere depressions of the ground. Lakes are usually very rich in small animal and plant life. Higher plants are often abundant only at the shallow edges of lakes.

**Ponds (S. Pokuna, T. Phadakam),** (Page 5, Fig. 5). These are very small shallow "lakes" in which varying quantities of higher plants are present within it.

**Flood Lakes or Villu (S. Pitaravila, T. Perukkeri, Villu).** They may be ephemeral or have a long life. Some of the flood lakes are very large in extent and support fisheries of considerable importance, particularly around the Manampitiya area in the Polonnaruwa District and the Hanwella area of the Kelani Ganga.

**Paddy fields (S. Kumbura, T. Nell Vayal),** (Page 5, Fig. 8). A very widespread habitat which is temporary in the sense that all the water is drained off when the paddy begins to ripen (Page 5, Fig. 7). They are very rich in animal life especially of the smaller sizes.

### ADAPTATIONS OF THE FAUNA TO HABITATS

The life-history of an animal is generally divisible into a period of development, followed by a period of rapid growth when the animal has a voracious appetite. In the final period as an adult the animal breeds at regular intervals and continues to grow slowly.

Most freshwater animals breed during or after the monsoonal floods when plenty of water is available for the young to spread over a wide area where crowding is less and there is a plentiful supply of food in the form of minute plants and animals. Some animals take advantage of the abundance of food and breed again shortly afterwards. The small cyprinid fish *Puntius vittatus* (Day) (S. Bandi Titteya) breeds many times in a single period between the monsoonal rains and the onset of the drought, but this is rather unusual. Some like the beetles lay their eggs during the drought and the larvae survive in moist places till the arrival of the rains. The young animals utilise the abundant food to grow rapidly and the adults build up their reserves for adverse conditions to come.

With the advent of the dry season, conditions in temporary habitats become less and less favourable for aquatic animals. Those cut off in small habitats are quickly killed off, others in larger habitats survive longer. During this period food becomes scarce and the water area diminishes in size. The animals become weakened or diseased and die or are eaten by larger animals which find them easy prey. Even in the larger bodies of water like rivers, tanks and large ponds which are perennial the competition for food and shelter may become severe.

Many species of aquatic animals have developed adaptations to survive drought conditions. The "air-breathing" fishes *Anabas testudineus* (S. Kavaia), *Ophiocephalus* spp. (S. Loola, Mada Kanaya), *Clarias teymanni* (S. Magura), and *Heteropneustes fossilis* (S. Hunga) have developed special respiratory organs connected with the gill chamber which can utilize atmospheric air unlike gills which utilize oxygen dissolved in the water. These species can survive under conditions of severe drought in water which has been seriously depleted of oxygen by the decay of organic material.

The spiny eels *Macrognathus aculeatus* and *Mastacembelus armatus* (S. Theliya) and the freshwater crabs *Paratelphusa* spp. can utilize atmospheric oxygen as long as their gills are kept moist. These species are found burrowing in the mud close to the water level during the drought.

Certain species such as *Puntius vittatus* and *Macrones vittatus* (S. Ankutta) survive drought conditions in ways not well understood.

The smaller crustacea, namely the Copepoda, Cladocera and Ostracoda, produce eggs with a hard resistant covering, capable of surviving even a severe drought. The Protozoa encyst and are thus protected during the drought. These cysts are blown by wind and the species is dispersed.

Freshwater crabs and prawns carry their eggs until they hatch out, while leeches carry the young in a pouch as protection from the rigours of the drought.

Every rainy season animals colonize the newly available habitats. Different animals accomplish this in different ways. Some fishes move with the expanding water bodies and reach very shallow water whilst others remain in deeper waters. Most aquatic insects can fly to new habitats where they lay eggs. Species with resistant eggs or cysts emerge with the onset of the rains and develop rapidly.

### FISHES, THEIR HABITATS AND THEIR BIOLOGY

A few notes are included on the observations and studies that have been made so far in the biology of the freshwater fishes of Ceylon. No group of freshwater animals has been so extensively studied in Ceylon as the fishes. This is partly because of their large size but mainly because of their use as food.

If we study the normal range of a fish species in the various types of habitats it is quite clear that some species are restricted and others have a wide range. The following chart will illustrate this.

	Tanks	Rivers	Large streams	Small streams and Ponds	Paddy Fields
<i>Wallago attu</i> (S. Valaya) ..	P	P	B		
<i>Labeo dussumieri</i> (S. Hiri kannaya) ..	P	P	P	B	
<i>Ophiocephalus striatus</i> (S. Loola) ..	P	P	P	P	P
<i>Macrones vittatus</i> (S. Iri ankutta) ..	P		P	P	P
<i>Puntius vittatus</i> (S. Bandi titteya) ..				P	P

P Indicates presence.

B Indicates presence for breeding only.

The chart indicates that *Wallago attu* is present only in rivers and tanks and that it enters large streams for breeding. *Labeo dussumieri* is common in rivers, tanks and large streams, entering small streams and ponds to breed. *Ophiocephalus striatus* is common in all types of waters. *Macrones vittatus* is not generally found in rivers. *Puntius vittatus* is present only in streams, small ponds and paddy fields. Some species are confined to a very limited type of habitat. This study could be extended to the other species of fish. The factors that limit the range of a species provide interesting problems for further study.

A few species of fish which are surface feeders are found near the surface of the water while the majority of species live at all depths and move freely from one level to another. Some species like *Puntius vittatus* are found only in relatively shallow water and others like *Wallago attu* live at considerable depths. Bottom feeders generally live at the bottom of their habitats. Among such species are the spiny eels (*Mastacembelidae*), the catfishes of the families *Clariidae*, *Heteropneustidae* and *Bagridae*, the loaches and the goby *Glossogobius giuris*.

In the early stages, all larval fishes feed on minute plants (diatoms and desmids) and minute animals (cladocerans, copepods). Later different species diverge into herbivores, omnivores and carnivores. Some of the smaller species like *Puntius vittatus* feed on algae (such as *Spirogyra*). Others like *Etiopius*, *Ospironemus* and *Tilapia* feed on larger aquatic plants. Some species like *Anabas* live on a very mixed diet of plants, small animals and fishes. A few species like *Ophiocephalus* and *Wallago* become carnivores. Many species are capable of varying their diet considerably according to circumstances. During severe droughts most species eat mud and utilize the decaying organic matter and small animals found in the mud.

Some species assume brilliant colours during the breeding season. Among these are *Puntius nigrofasciatus*, *P. titteya*, and *P. vittatus*. Most fishes lay their eggs in large numbers without protection for them. A few species make nests of various sorts where the eggs are deposited. The giant gouramy makes use of dead leaves, fibres and soft debris for building its nest. *Ophiocephalus striatus* builds a nest by making a clearing in the vegetation at the edge of the habitat. *Tilapia* excavates the pond bottom to make a saucer like depression in which the eggs are laid. This latter species protects the young in its mouth for a time after they are hatched and is commonly called "mouth breeders".

Protective mechanisms play an important part in determining the abundance and therefore the distribution of species. Loaches and various cyprinids have protective colour patterns. The behaviour of the fish is also a very important protective mechanism. When *Etiopius suratensis* is disturbed it lies flat on the mud thus reducing the chance of it being captured by its enemies. Some species of carps such as *Puntius dorsalis* and *P. sarana* have a stiff dorsal spine which may act as a protective device. Anabantids and cichlids have erectile spines on the dorsal and anal fins. The catfishes have stout lateral spines near the head which can be erected. Some catfishes like the bagrids have in addition a dorsal spine.

#### REFERENCES

The following references are of a general character and cover the introduction and many sections of the publication. Other references which deal only with a particular section (phylum) of the freshwater fauna of Ceylon are given at the end of the corresponding section.

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# THE FRESHWATER FAUNA OF CEYLON

EACH member of the fauna can be classified into one of several groups or phyla. These phyla are divided into progressively smaller groups, namely classes, orders, families and finally genera and species. Each animal species is usually given two names. The first name is the generic name and the second the specific name. This is followed by the name of the author who first described the species. For example, *Agraptocorixa hyalinipennis* (Fabr.) is the name given to a species of hemipteran water insect of the genus *Agraptocorixa*. This species was first described by Fabricius. Whenever the name of the author is given within brackets it shows that the generic name of the species has been subsequently altered from that originally assigned by the author. In each family the species are arranged in alphabetical order. Wherever possible the common English, Sinhalese and Tamil names are given. In some instances short ecological notes are also included.

To facilitate the identification of the freshwater fauna, keys based mainly on external characters are provided. The characteristics of each member of the fauna will conform with one of two opposing descriptions provided under each serial number in each set of keys. In this publication keys are provided to "trace" an animal up to its family level.

## HOW TO USE THE KEYS

The method for using the keys is best illustrated by following the identification of an animal. A "Water boatman" which is a hemipteran insect is used as an example below.

The first task is to determine which phylum the animal belongs to. For this purpose it will be necessary to follow the set of keys given on page 15.

1. With a vertebral column..... Vertebrata 12
- Without a vertebral column ..... Invertebrata 2

In the introductory note on page 15 it is said that unless the animal in question is a mammal, reptile, bird, amphibian or fish it could be safely assumed that the animal is an invertebrate. The animal under discussion is an invertebrate and therefore leads to serial number 2 which states :

2. Each individual of one cell only ..... Protozoa, page 17
- Each individual of several cells ..... 3

Since the animal is made up of several cells it directs attention to 3 which states :

3. Anterior end of animal with a "corona", which besides other structures has long vibrating whorls of cilia ..... Rotifera, page 32
- Does not possess a 'corona' ..... 4

The animal under discussion does not have a "corona", indicating reference to 4, which states

4. The animals (they are always colonial) form encrustations on submerged stones, plants, twigs and other objects ..... Porifera, page 24
- Do not form encrusting growths ..... 5

Since the animal under discussion does not form encrusting growths and since it is not colonial attention is directed to 5 :

5. With jointed (arthropodous) limbs..... Arthropoda, page, 60
- Limbs if present are not jointed ..... 6

The animal in question has jointed limbs and reference has therefore to be made to the set of keys on page 60. The first set of characters in this key states :

1. Three pairs of legs.....Insecta, page 72
- More than three pairs of legs ..... 2

The animal has three pairs of legs indicating that page 72 should be referred :

1. Hind end of insect with a forked organ with which it can spring in the air (Page 95, Fig. 16).....Collembola, page 93
- Do not have such an organ ..... 2

The insect does not have such an organ. Attention is therefore drawn to 2 :

2. Head prolonged into a proboscis (beak). Forewings not hardened.....Hemiptera, page, 74
- Head not prolonged into a proboscis. Forewings shiny and hardened to form a protective covering (elythra) for the hind wings.....Coleoptera, page 83

The animal under discussion has no proboscis and the forewings are not hardened. The latter character signifies that the insect is a hemipteran. Since the example under discussion does not have a conspicuous proboscis the indication is that it could also be a coleopteran. However, the footnote on page 73 states that the insects belonging to the family Corixidae do not have a conspicuous proboscis. The insect is therefore taken to be a hemipteran and attention is drawn to the set of keys on page 74 :

1. Live beneath the water surface. Antennae shorter than the head..... 2
- Live on the surface of the water. Antennae prominent and are longer than the head ..... 8

The insect under discussion lives beneath the water surface and its antennae are shorter than the head. Reference must be made to

2. Head has no pointed proboscis (beak).....Corixidae, page 79
- Head with a sharp pointed proboscis (beak)..... 3

The insect has no pointed proboscis and hence belongs to the family Corixidae.

The characteristics of the insects belonging to the family Corixidae are given on page 79. Eight species of corixid hemipterans have been recorded from Ceylon. A diagram (Page 77, Fig. 5) is given of one of these species.

#### KEY TO THE FRESHWATER FAUNA OF CEYLON

Before using the key the animal has to be identified as a vertebrate or invertebrate. This can be done by dissecting the specimen to find out whether it possesses a vertebral column. However it is sufficiently well known that mammals, reptiles, birds, amphibians (frogs, toads, caecilians and their tadpoles) and fishes are vertebrates and nearly all the other animals are invertebrates. The first set of characters in the key below refers to the vertebral column and if the specimen in question is not one of the vertebrates mentioned above it is safe to assume that it is an invertebrate.

1. With a vertebral column.....Vertebrata 13
- Without a vertebral column.....Invertebrata 2
2. Each individual of one cell only.....Protozoa, page 17
- Each individual of several cells..... 3

3. Anterior end of animal with a "corona" which besides other structures has long vibrating whorls of cilia.....	Rotifera, Page 32
Does not possess a "corona".....	4
4. The animals (they are always colonial) form encrustations <sup>1</sup> on submerged stones, plants, twigs and other objects. ....	Porifera, page 24
Do not form such encrusting growths.....	5
5. With jointed (Arthropodous) limbs <sup>2</sup> .....	Arthropoda, page 60
No jointed limbs.....	6
6. With a non-flexible shell.....	Mollusca, page 51
Without a shell.....	7
7. With a segmented (vermiform) body <sup>3</sup> .....	Annelida, page 44
Body not segmented.....	8
8. Body with cilia.....	Gastrotricha, page 28
Body without cilia.....	9
9. With tentacles around the mouth.....	10
No tentacles around the mouth.....	11
10. Solitary individuals with 4-8 tentacles each. (Sometimes one or two young individuals in the form of "buds" may be present, attached to the parent).....	Coelenterata, page 25
Colonial forms in which each individual has a circlet of more than eight tentacles.....	Ectoprocta, page 26
11. Typically worm-like cylindrical animals.....	12
Dorso-ventrally flattened animals.....	Platyhelminthes, page 40
12. Worms in extricably coiled masses giving the appearance of entangled cotton. Body surface sculptured or bear warts.....	Nematomorpha, page 43
Not as above.....	Nematoda, page 42
13. Provided with hair on skin.....	Mammalia, page 146
No hair.....	14
14. Animal covered with feathers.....	Aves, page 137
No feathers.....	15
15. Scales absent.....	Amphibia, page 126
Scales present <sup>3</sup> .....	16
16. Gills and gill covers (operculum) present. Equipped with both paired and median fins.....	Pisces, page 101
Gills and gill covers absent. No paired fins. (Limbs should not be confused with fins.).....	Reptilia, page 132

<sup>1</sup> The Ectoproct colonies sometimes give the appearance of encrustations on submerged plants, etc. Individuals of a Ectoproct colony possess tentacles and could easily be separated from the Porifera which have no tentacles. Ectoprocta come lower down in the key.

<sup>2</sup> Some of the (arthropod) insect larvae particularly those of the Diptera do not have jointed legs and have segmented vermiform bodies and are liable to be mistaken for Annelids or Nematodes.

<sup>3</sup> Scales of freshwater eels (Family Anguillidae) are inconspicuous. Their gill openings are narrow vertical slits. They could easily be mistaken for water snakes (reptiles) but close examination will reveal the gill slits and the paired pectoral fins indicating that they are fish.

# INVERTEBRATA

## PROTOZOA

PROTOZOA are microscopic animals which always consist of a single cell each and are therefore referred to as unicellular organisms. They are also called non-cellular organisms since some members possess several nuclei within the cell. Protozoa are abundant in both running and stagnant waters and are common in the body fluids and tissues of other animals where many exist as parasites. Only a fraction of the species present in Ceylon have been recorded in scientific literature ; students of zoology would have seen live specimens of unrecorded species such as *Paramoecium*, *Euglena*, and *Vorticella*.

Protozoa are important as food for the smaller animals like water fleas (Cladocera). Together with bacteria they cause decomposition of the organic matter on which they feed.

The non-parasitic protozoa have been recorded from three orders : (1) Sarcodina, (2) Mastigophora, and (3) Ciliata.

1. Do not have cilia or flagella ; locomotion by means of temporary extensions of protoplasm termed pseudopodia.....Sarcodina, page 17  
Possess either cilia or flagella..... 2
2. Provided with one or more slender whip-like flagella generally found only at one end of the animal.....Mastigophora, page 20  
Provided with numerous short hair like cilia which are, generally, evenly distributed on the body surface .....Ciliata, page 20

### SARCODINA

These protozoans move about by means of temporary extensions of protoplasm termed pseudopodia. Some of the Sarcodina are naked while others are provided with a protective covering or shell varying in form and composition depending on the genus and species. The shell may be secreted by the animal itself or it may consist of fragments of debris and sand firmly cemented together. The sarcodine protozoans are found in diverse habitats and within wide ranges of climatic and topographical conditions. They feed by engulfing solid particles of food which consist of smaller unicellular plants and animals and decomposing matter.

The following sarcodine protozoans have been recorded from Ceylon :—

*Actinophrys sol* (O. Fr. M.), (Page 19, Fig. 1)

*Amoeba verrucosa* Ehrb. (Page 19, Fig. 8)

*Arcella discoides* Ehrb.

*Arcella vulgaris* Ehrb. (Page 19, Fig. 7)

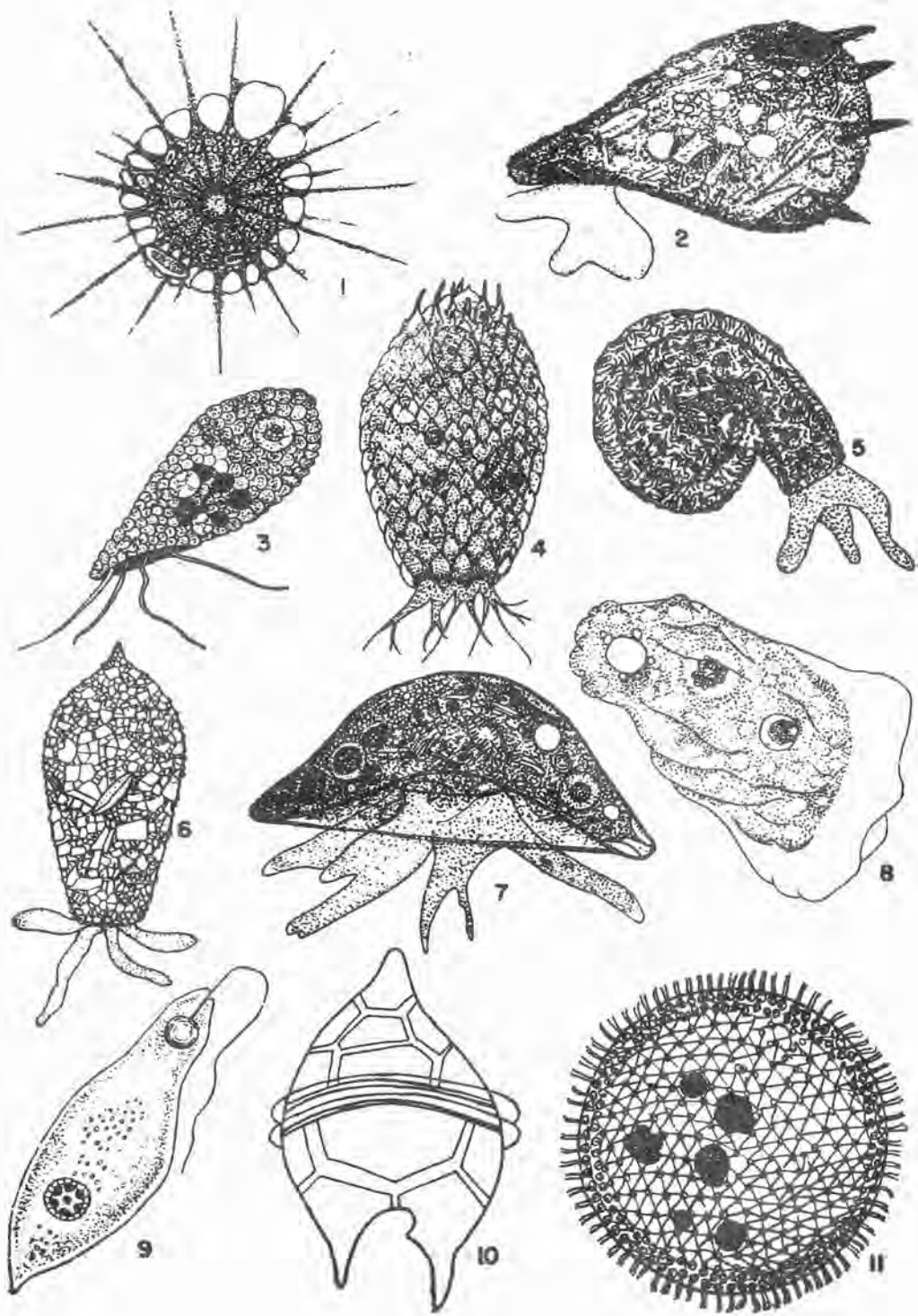
**Explanation to figures on page 19**

1. *Actinophrys sol* 120  $\mu$ <sup>1</sup>
2. *Centropyxis* 80  $\mu$
3. *Trinema* 100  $\mu$ .
4. *Euglypha* 100  $\mu$
5. *Lequerousia* 110  $\mu$
6. *Diffugia urceolata* 100  $\mu$
7. *Arcella vulgaris* 130  $\mu$
8. *Amoeba verrucosa* 60  $\mu$
9. *Euglena* sp. 150  $\mu$
10. *Peridinium tabulatum* 50  $\mu$
11. *Volvox aureus* 850  $\mu$

All the above illustrations are after various authors.

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<sup>1</sup> 1  $\mu$  = 1/1000th of a millimetre.



*Centropyxis aculeata* (Ehrb.) (Page 19, Fig. 2)  
*Clathrulina elegans* Cienk. (Page 23, Fig. 4)  
*Diffugia acuminata* Ehrb.  
*Diffugia arcuata* Leidy.  
*Diffugia constricta* (Ehrb.)  
*Diffugia corona* Wall.  
*Diffugia globulosa* Duj.  
*Diffugia lobostoma* Leidy  
*Diffugia pyriformis* Perty.  
*Diffugia urceolata* Cart. (Page 19, Fig. 6)  
*Euglypha alveolata* Duj. (Page 19, Fig. 4)  
*Euglypha ciliata* (Ehrb.)  
*Hyalosphaenia elegans* Leidy  
*Hyalosphaenia papilio* Leidy  
*Lequereusia spiralis* (Ehrb.) (Page 19, Fig. 5)  
*Pelomyxa quarta* (Grub.)  
*Sphaenoderia lenta* Schlumb.  
*Trinema enchelys* (Ehrb.), (Page 19, Fig. 3)

### MASTIGOPHORA

These are considered to be the most primitive among the protozoans. Some forms are closely allied to plants and live by photosynthesis. Some of them like *Volvox aureus* are colonial. Mastigophora possess one or more slender, flexible whip-like processes termed flagella which are usually located at one end of the body. The locomotion or movement of these protozoa is by the vibratory movement of flagella.

Only a few have been recorded from Ceylon, although several more have been observed in our waters :—

*Ceratium hirudinella* (O. Fr. M.), (Page 23, Fig. 5)  
*Euglena* sp. (Page 19, Fig. 9)  
*Peridinium tabulatum* (Ehrb.), (Page 19, Fig. 10)  
*Volvox aureus* Ehrb. (Page 19, Fig. 11)

### CILIATA

These protozoans, sometimes referred to as Infusoria, are characterised by the possession of numerous cilia which are short hair-like processes. Cilia originate almost at the surface in contrast to the deep seated nature of flagella. Usually, cilia are evenly distributed over the body surface and their waving movements propel the animal. The current so created also carries food to the "mouth". Sometimes the cilia are concentrated in particular areas or even united together to form

vibrating organs in the form of stiff bristles or cirri which may be used for locomotion in the fashion of "legs" of higher animals. Some forms are permanently fixed onto a substratum.

*Codonella lacustris* Entz.

*Colpoda cucullus* O. Fr. M. (Page 23, Fig. 6)

*Cyclochaeta domerguei* Wallengren (Page 23, Fig. 8)

*Epistylis anastatica* Ehrb. (Page 23, Fig. 1)

*Ichthyophthirius* sp.<sup>2</sup>

*Oxytricha mystacea* Stein.

*Paramoecium* sp. (Page 23, Fig. 7)

*Stylonchia pustulata* O. Fr. M. (Page 23, Fig. 3)

*Tintinnopsis ovalis* Daday

*Vorticella* sp. (Page 23, Fig. 2)

#### REFERENCES

- BATIA, B. L. 1936. *The Fauna of British India including Ceylon and Burma. Protozoa: Ciliophora.* London 493 pp.  
DADAY, E. VON 1898—*Microskopische Susswasserthiere aus Ceylon. Termeszetr. Fuz.* 21: 1-123.

<sup>1</sup>The parasitic protozoan *C. domerguei* was found on the body surface of fish fry in the nursery ponds at the Fisheries Research Station in Colombo. They were present in very large numbers on the skin, fins and gills of the fry of common carp and giant gourami. The attachment ring surrounding the "mouth" of the protozoan had twenty-three anchors. Around the "mouth" were two rings of cilia. A third ring of cilia was present at the opposite end of the animal.

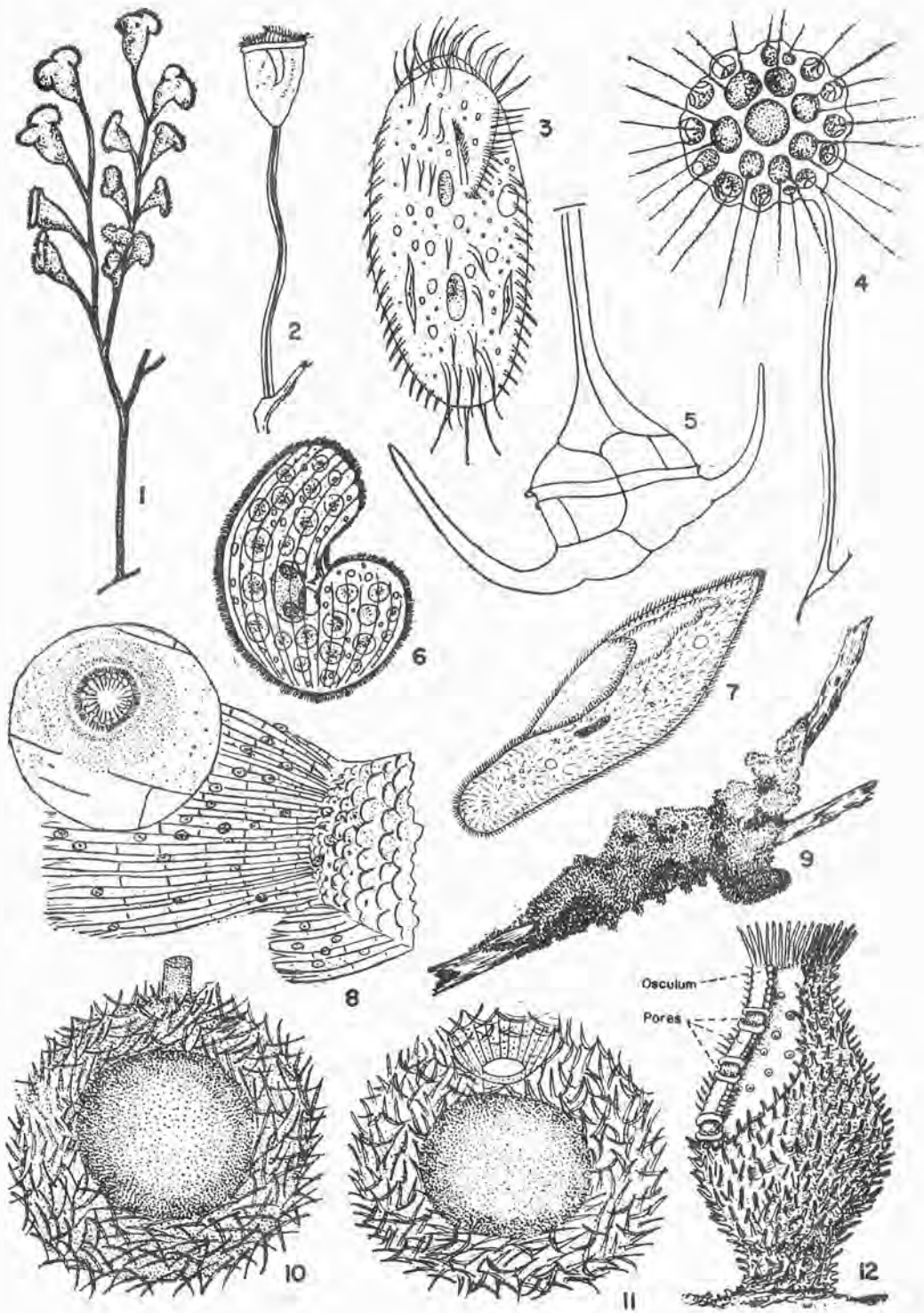
The fry, infected with *Cyclochaeta* appeared to be sluggish in their habits and did not feed well. Some of the infected fry had white blotches on the head and on the dorsal surface of the body. The fry were freed of infection by treating with a dilute solution of kitchen salt (NaCl). There were only a few deaths among the infected fish fry.

<sup>2</sup>The fish fry and fingerlings in the nursery ponds at the Fisheries Research Stations in Colombo and Polonnaruwa have been attacked by *Ichthyophthirius* sp. in epidemic proportions. This usually occurred when there was a sudden change in the weather. *Ichthyophthirius* is a moderately large protozoan visible to the naked eye. They usually live just beneath the outermost layer (epidermis) of the skin of fish, thereby causing the fish to produce an excessive supply of slime. The infected areas appear as white spots on a cursory examination of the fish. When the condition of the fish deteriorates *Ichthyophthirius* begins to leave the host and form cysts at the bottom of the habitat. Each cyst gives rise to hundreds of young ones which infect new fish. *Ichthyophthirius* is unable to live on dead fish and the young ones emerging from a cyst would also die if they are unable to find a host fish quickly.

Explanation to figures on page 23

1. *Epistylis* sp. Length of zooid 90  $\mu$
2. *Vorticella* sp. Length of zooid 50-150  $\mu$
3. *Stylonchia* sp. Body length 70-150  $\mu$
4. *Olithurlina* sp.
5. *Ceratium* sp.
6. *Oolpoda* sp. Body length 40-12  $\mu$
7. *Paramoecium* sp.
8. Caudal (Tail) fin of a Giant Gourami fry infected with *Cyclochaeta domerguei*. Inset—A single specimen much enlarged.
9. Encrustation of the sponge *Spongilla carteri* on a twig. Encrustation 15 cms. long.
10. Gemmule of *Spongilla proliferans* \* 35 mm.
11. Gemmule of *Spongilla carteri* \* 35 mm.
12. Diagrammatic representation of an individual of a sponge to show its structure.

Figures 1 to 6 are after various authors, 10 and 11 are after Annandale.



# PORIFERA

(Sponges)

PORIFERA are multicellular animals with very little or no differentiation of cells into organs. The surface of a simple sponge is covered by a delicate membrane formed of flattened cells and pierced by several small pores which lead into a single central cavity (Page 23, Fig. 12). This cavity is lined by cells (choanocytes) each bearing a flagellum whose combined movement sucks water into the central cavity through the small pores. The water leaves the central cavity through the large opening at the top termed the osculum (Page 23, Fig. 12). The current of water brings along with it food particles and takes away any undigested material and excreta. As growth proceeds the sponge forms an encrustation (Page 23, Fig. 9) on some object such as a leaf or stem of a water plant, or a dead twig or similar structure. On careful examination it will be seen that such an encrustation has several oscula which communicate with each other by way of the central cavities.

Between the outside membrane of flattened cells and the special cells lining the central cavity there is a structureless substrate containing various types of other cells and a supporting framework or skeleton. This skeleton is made up of spicules of calcium carbonate or silica bound together by a horny, unreactive substance termed spongin. The cells in the substrate perform different functions. Digestion is performed by particular individual cells and the products of digestion are passed on to other cells for absorption. If the need arises the cells can change their functions. Thus the cells which are digestive in function can when necessary serve as absorptive cells.

Sponges reproduce in three ways : (1) by means of eggs which are fertilised by spermatozoa, (2) by means of buds which appear and break off giving rise to new individuals, and (3) by means of structures called gemmules (Page 23, Figs. 10 and 11) which are living cells enclosed by a firm chitinous coat or shell. An outer crust of air cells, make the gemmules buoyant and help in their dispersal. Gemmules are capable of withstanding unfavourable conditions such as seasonal drought.

Only one family of sponges, namely Spongillidae with monaxon spicules, is found in freshwater. Two species have been recorded from Ceylon.

*Spongilla carteri* Bowerbank (Page 23, Fig. 9). As a rule this sponge is large with smooth and rounded surfaces occasionally bearing ridges. It has a particularly strong and an offensive odour. The spicules are smooth, pointed and nearly straight and are less than twenty times as long as they are broad.

*Spongilla proliferens* Annandale. This is a sponge forming soft shallow cushions, rarely more than 10 cms. in diameter on the leaves of water plants, or small irregular masses on their roots and stems. The colour of the sponge is green, the shade depending on the amount of sunlight available. The spicules are long, smooth and sharply pointed and are at least twenty times as long as they are broad. This species is found in ponds that do not dry up.

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- WILLEY, A. 1907. Notes : Freshwater sponge and *Hydra* in Ceylon. *Spolia zeylan.*, 4 : 184-5.

# COELENTERATA

(Hydra, Jellyfishes, Corals.)

COELENTERATES are radially symmetrical animals. The body wall is composed of two layers of cells, the ectoderm on the outside and endoderm on the inside with a structureless jelly-like substance termed the mesogloea in between. The body wall surrounds a central cavity called the enteron which serves as a digestive cavity. The enteron communicates with the outside through a single aperture at the top which serves as the mouth and also as the exit for any unwanted and undigested material. The mouth is surrounded by a ring of hollow tentacles which are usually constant in number for any particular species.

The Coelenterata include marine forms such as corals, sea-anemones, sea-firs and jelly-fish and a few freshwater species belonging to the division Hydrozoa. This division is represented in Ceylon freshwaters by *Hydra*.

*Hydra* exist as solitary individuals, often attached to water plants, &c., by their base. They are sometimes found floating on the surface of the water with their tentacles and trunk hanging down below the water level. They can also crawl with considerable rapidity in leech-like fashion. If conditions are favourable they could remain in one spot for quite a long time. *Hydra* is generally attracted to light but repelled by heat. A sudden rise in temperature, lack of aeration and growth of bacterial scum on the water surface can kill *Hydra*. They feed on small animals like cladocerans, copepods and even the larvae of chironomids. Two species of *Hydra* have been recorded from Ceylon.

*Hydra vulgaris* Pallas (Page 31, Fig. 1). They are usually found in stagnant water in ponds containing plenty of aquatic vegetation. The colour of individuals of this species varies from pale to deep orange and dull brown to dark green depending on the quantity and kind of food material they have consumed. When hungry the tentacles are greatly extended and may exceed the length of the trunk. The body is slender and cylindrical but takes on the shape of a wine glass when gorged with food or when it contracts on being disturbed (Page 31, Fig. 2). They have 4 to 6 tentacles but occasionally an individual may be found with 8 tentacles. Reproductive organs are confined to the upper part of the body and occasionally produce eggs with a protective shell so that they can withstand adverse conditions. Usually, reproduction takes place by budding. A small bud appears as a protusion of the body wall of the adult. At the terminal end of this bud is the mouth. The enteron of the bud communicates with that of the adult. After a time a constriction occurs at the base of the bud which has taken the form of a small individual (Page 31, Fig. 1) and eventually separates off from the parent.

*Hydra zeylanica* Burt. These *Hydra* are similar to *H. vulgaris* but are smaller in size. They live in slightly acid water. The colour varies, some individuals being almost transparent while others are light brown in colour. This difference in colour is correlated with the food supply. There are typically 4 hollow tentacles which may be extended to more than twice the length of the body. Propagation takes place both sexually and by budding, the latter being the more frequent and commoner method.

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# ECTOPROCTA

(Moss animalcules)

ECTOPROCTA are a small group of animals which are sedentary and often colonial. The records of their occurrence are few. The Ectoprocta are exceedingly delicate though attractive looking creatures. The ectoproct animals are somewhat transparent and almost the entire structure of each animal could be made out under the microscope. The freshwater species are all colonial. On casual examination a colony of ectoproct animals looks like an aggregation of several *Hydra* but under the microscope the complex nature of each individual of the colony is revealed. The colonies take the form of branching threads spread on the surface of stones, sticks and submerged plants in the water.

Each individual of an ectoproct colony consists of a living, transparent jelly-like cage termed the zoecium in which is enclosed a contractile portion termed the polypide. At its base each zoecium is attached to another zoecium or to some sort of supporting structure. Each zoecium is open to the exterior by an aperture or orifice which lies opposite the base.

The polypide with its fully extended tentacles appears to be similar in structure to a *Hydra*. Certain portions of the polypide could be extended out from the aperture in the zoecium but when disturbed, the entire polypide withdraws into the zoecium. A characteristic feature of the polypide is the tentacle-bearing "lophophore" which in most species is horse-shoe shaped. The tentacles are not so contractile as in *Hydra* but they are covered with cilia which are in constant motion.

Most of the ectoproct species are hermaphrodites, both male and female sex organs being present in each individual. They reproduce in three ways (1) by means of fertilised ova or eggs, (2) by budding which as a rule does not produce independent organisms but add to the colony, and (3) by means of special asexually produced bodies called "statoblasts" (Page 31, Fig. 5). These statoblasts are present only in the freshwater Ectoprocta. The statoblasts consist of masses of cells containing abundant food material, enclosed in a capsule with a thick horny resistant wall and are capable of lying dormant under unfavourable conditions for months and sometimes years without losing their vitality. In many species the statoblasts are provided with a mass of horny walled chambers filled with air sacs giving bouyancy to the entire statoblast. The shape and form of the statoblasts are important features in the identification and classification of the ectoproct species.

Very often other animals are associated with the colonies of Ectoprocta. It is not uncommon to find oligochaete worms, sponges, insect larvae and even snails within the ectoproct colony.

Three species of Ectoprocta have been recorded from Ceylon.

*Pectinatella burmanica* Annandale (Page 31, Fig. 3). A colony of *Pectinatella burmanica* is circular and measures nearly 2.5 centimeteres. The statoblasts are relatively large measuring over 1 mm. in diameter. The statoblasts are almost circular but one side is slightly flattened. The only recorded occurrence in Ceylon is a specimen obtained by Dr. Willey and reported by Annandale from a pool by the roadside between Maradankadawela and Galpitigalle at the foot of Ritigala in the North-Central Province.

*Plumatella emarginata* Allman (Page 31, Fig. 5). A colony of *Plumatella emarginata* covers a considerable area of flat surface and very often they are entirely recumbent. Each individual is of a dark brown or almost black colour but it has a conspicuous white marking which gives the colony a stippled appearance. Each individual has 40 tentacles. The presence of statoblasts of this species in the plankton of the Colombo Lake as reported by Apstein (1907) is the only record of it in Ceylon.

*Plumatella (Hyalinella) longigemmis* Annanadale. This species is commonly found attached to rocks and stones. Each individual in the colony is short and stout and attached to the substratum. Specimens in Ceylon were obtained in the Maligakande waterworks reservoir in 1912. They were found to be floating freely in the water. • A colony consist of elongate, slender, cylindrical stems and branches, more or less entangled together, and forming masses comparable to those formed by many filamentous algae.

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- KRAEPELIN, K. 1887. *Die Deutschen Susswasser-Bryozoen.* Pt. I, Anatomisch-systematischer Teil, Hamburg, 168 pp.

## GASTROTRICHA

GASTROTRICHA are a group of free-living microscopic animals which live among algae and debris. The largest species however, may grow upto 2 mm. in length. They are generally common in the company of rotifers and protozoans.

In shape the Gastrotricha are elongate animals with a flattened ventral surface. They could very easily be mistaken for rotifers but for the absence of a corona. Some forms look like nematode worms but the possession of cilia, shows that they are an entirely different group. In addition to the cilia, parts of the body of gastrochians are covered with wasty protruberances in the form of scales. The tail end is generally forked and bear adhesive organs.

Two species have been recorded from Ceylon :

*Chaetonotus larus* Ehrb. (Page 29, Fig. 1)

*Ichthydium podura* Ehrb. (Page 29, Fig. 2)

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- HYMAN, L. H. 1951 *The Invertebrates*, Vol. 3 Acanthocephala, Aschelminthes, and Entoprocta. The pseudocoelomata Bilateria. McGraw-Hill, New York 572 pp.



**Fig. 1** *Chaetonotus* sp. after Hyman 0.5 mm.

**Fig. 2.** *Ichthydium* sp. after Hyman 0.5 mm.

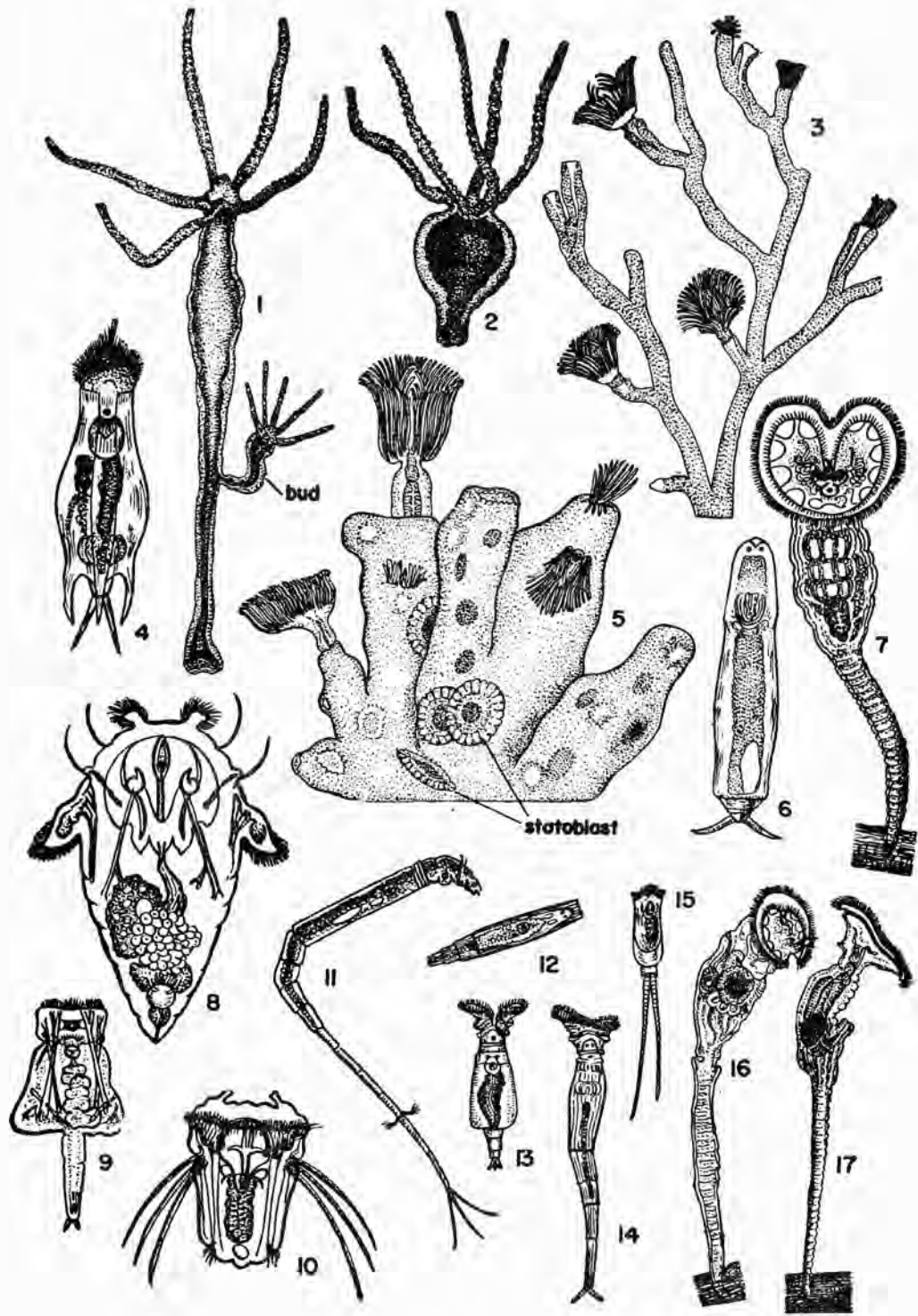
Explanation to figures on page 31

1. *Hydra vulgaris*. 5 mm. long
2. *Hydra vulgaris* (contracted). 2 mm. long
3. *Pectinatella burmanica*
4. *Salpina macracantha* 300 $\mu$ .
5. *Plumatella emarginata*
6. *Diglena forcipata* 280 $\mu$ .
7. *Megalotrocha* sp. 2 mm.
8. *Synchaeta pectinata* 350  $\mu$ .
9. *Notops branchionus* 420 $\mu$ .
10. *Polyarthra platyptera* 125 $\mu$ .
11. *Actinurus neptunius* 1140 $\mu$ .
12. *Actinurus neptunius* with segments telescoped 350 $\mu$ .
13. *Philodina citrina* 500 $\mu$ .
14. *Rotifer vulgaris* 500 $\mu$ .
15. *Furcularia longiseta* 250  $\mu$ .
16. *Conochilus volvox* 630 $\mu$ .
17. *Lacinularia socialis* 2 mm.

Figures 3 and 5 are after Kraeplin, 4 and 6 to 17 are from Hudson and Gosse.

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<sup>1</sup> 1  $\mu$  = 1/1000th of a millimetre.



# ROTIFERA

(Wheel animacules)

ROTIFERA are usually microscopic freshwater animals, the largest species attaining a length of 2 mm. They are present in both stagnant and running water. It is only rarely that they are encountered in saline water.

The rotifers are distinguished by the presence of a complicated feeding and locomotor organ called the "corona" which consists of long vibrating cilia variously arranged in the different families. The rest of the body, except in a few species, is without cilia. The corona lies at the anterior end of the animal. The movement of the coronal cilia creates a current of water towards the mouth.

The bodies of most rotifers are elongated. The posterior end of each animal is extended in the form of a stalk termed the "foot", which may be used for attachment and sometimes for locomotion. The skin of a rotifer is generally flexible but in species belonging to certain families the skin is hardened to form an outer shell termed the lorica or shield. Most rotifers provided with a lorica have a definite shape and are therefore not difficult to identify. The sexes are distinct but the males in most species are very much smaller than the females and are so degenerate that they even lack an alimentary canal. The males have a much shorter life span than the females. Some rotifers are able to encyst during adverse conditions and live for long periods within the cyst till the return of normal conditions.

The species recorded from Ceylon are grouped in fifteen families.

## KEY TO THE ROTIFERA

1. Fixed onto some object. Foot not retractile but wrinkled and ending in a sucking disc.....Melicertidae, page 33  
Free swimming.....2
2. Unwrinkled foot which is wholly retractile within body (telescopic)....Philodinidae,  
page 33  
Foot not wholly retractile or foot may be wanting..... 3
3. Foot replaced by two appendages ending in ciliated expansions.....Pedalionidae,  
page 35  
Foot may or may not be present but no ciliated appendages replacing foot..... 4
4. Lorica<sup>1</sup> present..... 5  
Lorica<sup>1</sup> absent..... 12
5. Foot when present transversely wrinkled and wholly retractile..... 6  
Foot not transversely wrinkled nor is it wholly retractile..... 8
6. Foot ending in a ciliated cup.....Pterodinidae, page 39  
Foot when present not ending in a cup..... 7
7. Lorica box-like and generally symmetrical. Foot absent.....Anuraeidae, page 38  
Lorica depressed and dorsally arched. Foot when present forked.....Brachionidae,  
page 38
8. Lorica of a single piece..... 9  
Lorica made up of two or more pieces..... 11

<sup>1</sup> Lorica is the term given to the hardened outer skin of rotifers.

9.	Lorica hardened on all sides.....	10
	Lorica not hardened on ventral surface.....	Coluridae, page 35
10.	Lorica cylindrical without angles.....	Rattulidae, page 35
	Lorica vase-shaped, sometimes faceted.....	Dinocharidae, page 35
11.	Lorica depressed and of two dissimilar pieces.....	Euchlanidae, page 34
	Lorica compressed and appears to be formed of three or four pieces.....	Salpinidae, page 34
12.	Ciliary wreath of corona <sup>1</sup> interrupted.....	13
	Ciliary wreath of corona <sup>1</sup> not interrupted.....	14
13.	Ciliary wreath consists of interrupted curves and clusters.....	Notommatidae, page 33
	Ciliary wreath of a single interrupted marginal curve.....	Synchaetidae, page 34
14.	Ciliary wreath single, foot absent.....	Asplanchnidae, page 38
	Ciliary wreath of two parallel curves, foot present.....	Notopsidae, page 34

#### FAMILY MELICERTIDAE

The rotifers in this family are either fixed on to some object (usually water weed) by their "feet" or live inside tubes. The foot is transversely wrinkled, not retractile into the body and ends in a sucking disc. The corona is a large disc having round its outer edge two transverse rings of cilia placed parallel to one another. Most of them are hardy individuals and are prolific breeders. Four species have been recorded from Ceylon.

*Conochilus volvox* Ehrb. (Page 31, Fig. 16)

*Lacinularia socialis* Ehrb. (Page 31, Fig. 17)

*Limnias annulatus* Bail.

*Megalotrocha simibullata* Huds. (Page 31, Fig. 7)

#### FAMILY PHILODINIDAE

The bodies of these rotifers appear to be divided into several segments some of which telescope into each other when the animal contracts (Page 31, Figs. 11 and 12). The foot is wholly retractile within the body. The corona is in the shape of two transversely placed lobes or wheels. They swim with the aid of the coronal cilia and also creep in leech-like fashion. They can remain for long periods in a dried up condition and recommence an active life as soon as a small quantity of water becomes available. Three species have been recorded from Ceylon.

*Actinurus neptunius* Ehrb. (Page 31, Figs. 11 and 12)

*Philodina citrina* Ehrb. (Page 31, Fig. 13)

*Rotifer vulgaris* Schrank (Page 31, Fig. 14)

#### FAMILY NOTOMMATIDAE

Externally these small sluggish rotifers give the appearance of being segmented. The corona which is narrower than the rest of the body, has a ring of cilia round its edge in some forms while

<sup>1</sup> The corona is the complicated feeding and locomotor organ which is characteristic of rotifers. This organ consists of vibrating cilia.

in others the cilia are uniformly arranged all over its surface. The short slender "foot" which is not sharply marked off from the body, ends in two toes. Two species have been recorded from Ceylon.

*Diglena forcipata* Ehrb. (Page 31, Fig. 6)

*Furcularia longiseta* Ehrb. (Page 31, Fig. 15)

#### FAMILY NOTOPSIDAE

They are fairly large cylindrical rotifers. Corona is provided with two parallel curved rings of cilia. The "foot" ends in two small toes. Two species have been recorded from Ceylon.

*Notops branchionus* Ehrb. (Page 31, Fig. 9)

*Notops macrurus* Barr. et Daday

#### FAMILY SYNCHAETIDAE

They are powerful swimmers with cone-shaped bodies which are at times furnished with spine-like structures which aid in locomotion. The corona is very large, much flattened and provided with a single ring of cilia. The foot is reduced while in some forms it is absent altogether. Two species have been recorded from Ceylon.

*Polyarthra platyptera* Ehrb. (Page 31, Fig. 10)

*Synchaeta pectinata* Ehrb. (Page 31, Fig. 8)

#### FAMILY SALPINIDAE

The lorica (outer shell) which is well defined has three or four longitudinal furrows and gives the rotifer a definite shape. The lorica appears to be formed of three or four plates. The corona and foot can be partially withdrawn into the lorica. Five species have been recorded from Ceylon.

*Diplax ornata* Daday

*Salpina brevispina* Ehrb.

*Salpina macracantha* Gosse (Page 31, Fig. 4)

*Salpina macracantha* var. *ceylonica* Daday

*Salpina spinigera* Ehrb.

#### FAMILY EUCHLANIDAE

These rotifers are common among aquatic vegetation. The lorica consists of two plates one of which is larger than the other. Sometimes a lorica may be lacking and the body is soft. The larger one is curved over the back of the animal while the shorter one is flat. Seven species have been recorded from Ceylon.

*Cathypna luna* Ehrb.

*Cathypna macrodactyla* Daday

*Cathypna unguolata* Ehrb.

*Euchlanis dilatata* Ehrb. (Page 37, Fig. 1)

*Monostyla bulla* Gosse (Page 37, Fig. 2)

*Monostyla lunaris* Ehrb.

*Monostyla quadridentata* Ehrb.

#### FAMILY COLURIDAE

They are common among aquatic vegetation and debris. Lorica is of one piece but is usually soft on the ventral surface. A portion of the lorica extends over the head as a hood. Five species have been recorded from Ceylon.

*Colurus bicuspidatus* Ehrb. (Page 37, Fig. 8)

*Colurus uncinatus* Ehrb.

*Metopidia lepadella* Ehrb.

*Metopidia ovalis* Ehrb.

*Metopidia triptera* Ehrb.

#### FAMILY RATTULIDAE

Usually present among aquatic vegetation. The lorica is of one piece and is more or less cylindrical, but curved. One "toe" is greatly extended to form a spine while the other toe is absent or vestigial. Six species have been recorded from Ceylon.

*Coelopus tenuior* Gosse (Page 37, Fig. 7)

*Mastigocerca carinata* Ehrb.

*Mastigocerca elongata* Gosse (Page 37, Fig. 3)

*Mastigocerca rattus* Ehrb.

*Mastigocerca scipio* Gosse

*Rattulus tigris* Müll. (Page 37, Fig. 4)

#### FAMILY DINOCHARIDAE

The lorica is vase-shaped but sometimes flattened and often spinous. These rotifers skip about by making powerful strokes with their prominent foot and toes. Two species have been recorded from Ceylon.

*Dinocharis pocillum* Ehrb. (Page 37, Fig. 6)

*Scaridium longicaudum* Ehrb. (Page 37, Fig. 5)

#### FAMILY PEDALIONIDAE

The rotifers belonging to this family have six limbs which are apparently jointed limbs, (some authors refer to them as arthropodous limbs), which help them to make skipping or jerky

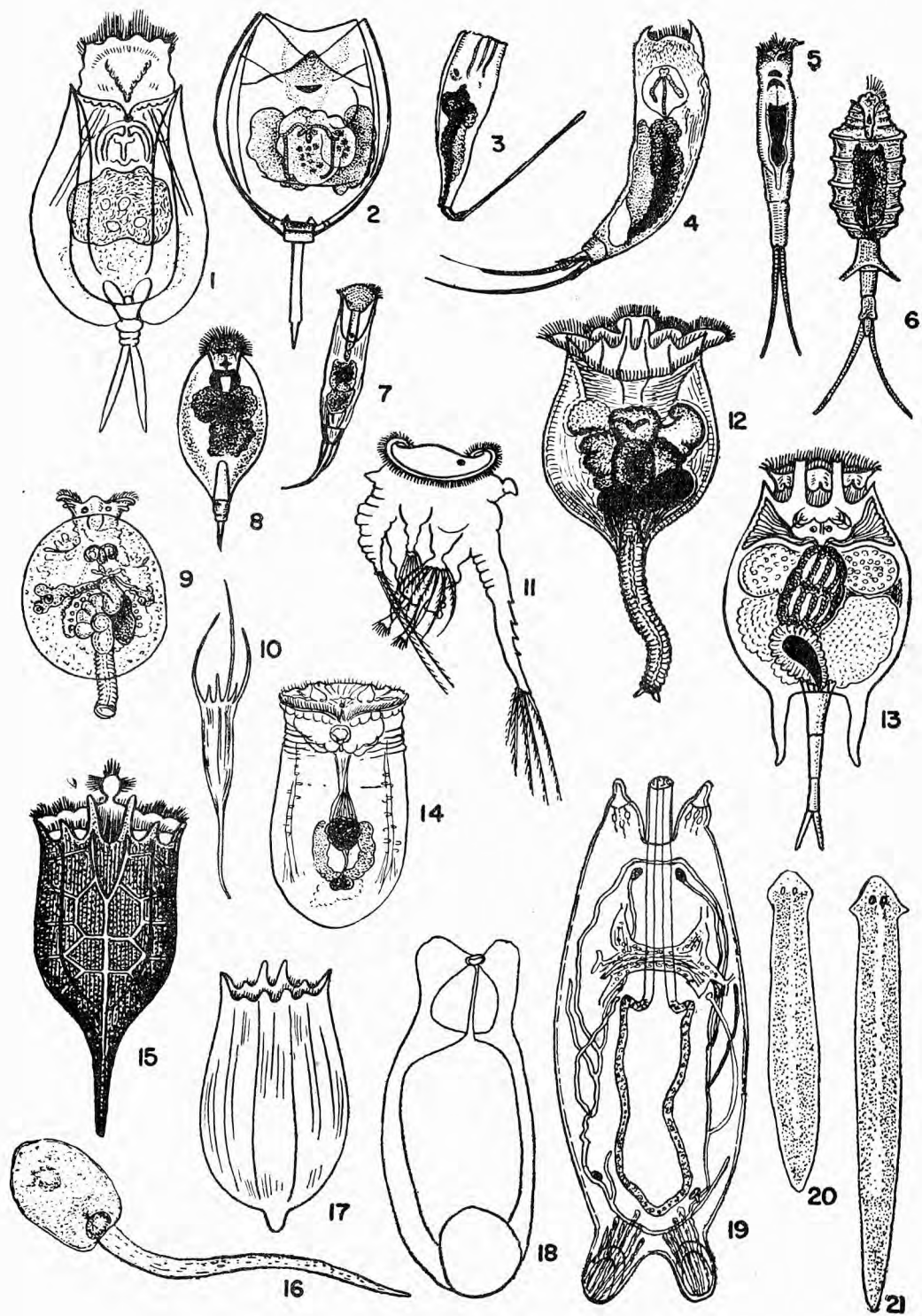
Explanation to figures on page 27

1. *Euchlanis dilatata* 360 $\mu$ <sup>1</sup>
2. *Monostyla bulla* 230 $\mu$ .
3. *Mastigocerca elongata* 500 $\mu$ .
4. *Rattulus tigris* 1200 $\mu$ .
5. *Scaridium longicaudum* 420 $\mu$ .
6. *Dinocharis pocillum* 310 $\mu$ .
7. *Coelopus tenuior* 250 $\mu$ .
8. *Coturus bicuspidatus* 80 $\mu$ .
9. *Pterodina elliptica* 120 $\mu$ .
10. *Notholca* after various authors 210 $\mu$ .
11. *Pedalion mirum* 210 $\mu$ .
12. *Brachionus rubens* 280 $\mu$ .
13. *Noteus quadricornis* 360 $\mu$ .
14. *Asplanchna brightwelli* 500 $\mu$ .
15. *Anuraea* after various authors 310 $\mu$ .
16. Free living trematode larva (Cercaria).
17. *Notholca* after various authors 250 $\mu$ .
18. Outline drawing of *Monodiscus macbridei* after Fernando 0.285 mm. long.
19. *Caridinicola* after Hyman.
20. and 21. Triclad turbellarians after various authors.

Figures 1 to 9 and 11 to 14 are from Hudson and Gosse.

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<sup>1</sup> 1 $\mu$  = 1/1000th of a millimetre.



movements. The corona is in the shape of two transversely placed lobes or wheels and has two rings of cilia round the edge. One species has been recorded from Ceylon.

*Pedalion mirum* Huds. (Page 37, Fig. 11)

#### FAMILY BRACHIONIDAE

The lorica is made up of two plates, one of which is flattened and the other curved. The foot which is very prominent has ring-like markings on its surface. There are two small "toes". Surrounding the mouth *Brachionus* has three prominences which stand high above the general surface of the corona. Nine species have been recorded from Ceylon.

*Brachionus amplicerus* Ehrb. var. *levis* Apst.

*Brachionus caudatus* Bär et Daday

*Brachionus falcatus* Bär

*Brachionus forficula* Wierz var. *levis* Apst.

*Brachionus melheni* Bär et Daday

*Brachionus militans* Ehrb.

*Brachionus pala* Ehrb. var. *wilkyi* Apst.

*Brachionus rubens* Ehrb. (Page 37, Fig. 12)

*Noteus quadricornis* Ehrb. (Page 37, Fig. 13)

#### FAMILY ANURAEIDAE (Page 37, Figs. 10, 15 and 17)

The lorica is box-shaped and is formed of two plates, one curved and the other flat. These rotifers are usually armed with numerous spines. They do not possess a foot. Probably there are more species of Anuraeidae than the single species recorded for Ceylon. Although no species of *Notholca* has been recorded from Ceylon, this genus has been observed by the present authors.

*Anuraea valga* Ehrb. var. *tropica* Daday (Page 37, Fig. 15)

*Notholca* sp. (Page 37, Fig. 17)

#### FAMILY ASPLANCHNIDAE

The body is soft and sac-shaped, a lorica being totally absent. Corona consists of two transverse, flattened cones with distinct summits. The alimentary canal is not well developed, there being no posterior or anal opening, the undigested waste being disgorged through the mouth. The foot is very often lacking or inconspicuous and there are no toes. Four species have been recorded from Ceylon.

*Asplanchna brightwelli* Gosse (Page 37, Fig. 14)

*Asplanchna brightwelli* Gosse var. *ceylonica* Daday

*Asplanchna myrmeleo* Ehrb.

*Asplanchna syrinx* Ehrb.

#### FAMILY PTERODINIDAE

Corona provided with two rings of cilia round its edge. A lorica is present. The foot is usually absent or inconspicuous, wrinkled, wholly retractile and ending in a ciliated cup or disc. Two species have been recorded from Ceylon.

*Pterodina elliptica* Ehrb. (Page 37, Fig. 9)

*Pterodina patina* Ehrb.

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# PLATYHELMINTHES

(Flatworms)

PLATYHELMINTHES are bilaterally symmetrical, dorso-ventrally flattened worms which do not have an anus. In structure they are more complex than the Coelenterata and have three layers of cells and well developed internal organs. The group is divisible into three distinct classes, namely Turbellaria, Trematoda and the Cestoda.

With a few exceptions the Turbellaria are free living forms. The members of this group are easily recognised by their flattened leaf-like shape. They measure 10-40 mm. in length. Several forms are present in freshwater.

A group of large turbellarians are the triclads (Page 37, Figs. 20 and 21) which are found beneath stones and leaves in all freshwater habitats ranging from hill country torrential streams to stagnant pools in the low country. They are entirely carnivorous, feeding on insects and small crustaceans.

They are rare in tropical regions and there are no records of triclads being present in Ceylon.

Another group of turbellarians are the Rhabdocoela in which the gut takes the form of a simple sac. They resemble the triclads in shape but they are smaller and are usually covered with cilia. They are usually found in stagnant water and feed on cladocerans, copepods, lower plants such as algae and diatoms.

Two species "*Convoluta*" *anostica* Schmarnda and *Mesostoma rostratum* Dug. are recorded for Ceylon. In addition the cosmopolitan species *Mesostoma erhenbergi* (Focke) is probably present in Ceylon together with *Stenostomum* spp. which are widely distributed in the tropics.

An interesting sub-division of Rhabdocoela is the Temnocephalida which contain small (less than 3 mm. in length), transparent unciliated forms with tentacles and adhesive organs. The temnocephalids live in the gill chamber of freshwater "shrimps". Rarely specimens may be found on the external surface of the "shrimps". Three species from two genera have been recorded from Ceylon: *Caridinicola platei* Fern. (Page 37, Fig. 19), *Monodiscus parvus* Plate and *M. macbridei* Fern. (Page 37, Fig. 18). They were all taken from the branchial chamber (under the carapace) of freshwater "shrimps," *Caridina* spp. Temnocephalids do not generally depend for their food on the host which harbours them but feed on small animals and plants that come their way. Fernando 1952 stated "*C. platei* is found throughout Ceylon; in the Kandy Lake and in the Central Province, it is found living with *M. parvus*: in the low-country and dry zone of Ceylon, *C. platei* and *M. macbridei* are found living together. It must be admitted that a few specimens of *M. parvus* are sometimes found in the dry zone collections, but I have not been able to find *M. macbridei* in the Kandy or Peradeniya collections."

The Trematoda (flukes) and Cestoda (tapeworms) are parasitic forms. Some of them have complicated life cycles involving two or more hosts.

The trematodes are typically leaf like and usually possess suckers; one at the anterior end surrounding the mouth and the other on the ventral surface. Trematodes which have only one host, are usually found as external parasites on gills of fishes and the urinary bladder of amphibia. The trematodes that parasitize more than one host are generally found as adults in the internal organs of the final host. In some cases all the hosts are freshwater animals, but in most cases the final host

in which the trematode becomes adult is a vertebrate which may be a land form. Trematodes pass their larval stages in a mollusc. Free living larval stages (Miracidia and Cercaria) (Page 37, Fig. 16) occur in freshwater.<sup>1</sup>

The cestodes<sup>2</sup> are ribbon shaped without an alimentary canal. They have suckers or sucking grooves at the head end. They parasitize several hosts but the adult is always found in the alimentary canal of a vertebrate animal. When all the hosts of cestodes are freshwater animals, the adult worm lives in the alimentary canal of a fish. Others parasitize a number of freshwater invertebrates and finally reach maturity in the alimentary canal of a mammal, bird, reptile or amphibian.

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<sup>1</sup> Dissanaike and Fernando (1960) have reported that 90 per cent. of the freshwater crabs, *Paratelphusa ceylonensis*, collected from a paddy field in Nugegoda, near Colombo, Ceylon, were infected with metacercaria of *Pleurogenoides sitapuri* (Srivastava). A large number of snails from the same habitat were examined and were found to possess larvae which were suspected to be those of *P. sitapuri*.

<sup>2</sup> *Senga lucknowensis* Johri (Ptychobothridae) and a protocephalid cestode were collected by the authors from *Mastacembelus armatus* and *Wallago attu* respectively.

# NEMATODA<sup>1</sup>

(Roundworms)

NEMATODA are unsegmented worms with cylindrically shaped bodies tapering towards both ends. Free living nematodes have adapted themselves to a wide variety of habitats such as desert, rivers, lake beds, and the waters of hot springs. In addition, there are numerous parasitic forms which play an important role in causing disease in animals and plants. Nematodes found in freshwater can be divided into three groups: Free-living, Parasites of Insects<sup>2</sup> and Parasites of Vertebrates<sup>3</sup>.

A number of small free living nematodes are common in freshwater especially in the mud, at the bottom of lakes. These thread-like worms, measuring only a few millimetres in length, are seen to whip themselves about by means of rapid contortions of the whole body. Weerakoon and Samarasinghe (1958) estimated that there were as much as 118,000 angullid nematodes (*Dorylaimus* sp.) per square mile of soil in a paddy field at Meegoda. This species is probably *D. stagnalis* Duj. (Page 47, Fig. 14) which is a cosmopolitan species.

A closely related species *D. palustris* (Carter) occurs in India. *Anguina tritici* (Stein) (Page 47, Fig. 15) is common in the rice fields of S. E. Asia.

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<sup>1</sup> A closely allied group the Acanthocephala (spiny-headed worms) also occur as parasites in fishes. Two species were recorded by the authors in *Ophiocephalus striatus* and *Macrones vittatus*.

<sup>2</sup> Most of the parasitic forms have at least a brief free living stage during which they achieve the transfer to a new host. Weerakoon and Samarasinghe state ". . . it is worthy of note that two of the chironomid larvae (*Spaniotoma* sp.) collected on February 28, 1950, contained a large larval nematode each, within its body-cavity." These nematodes belong to the family Mermithidae.

<sup>3</sup> Kulasiri and Fernando (1956) and Yeh (1960) record seven species of camallanid nematoda from an examination of the guts of several species of freshwater fish. The seven species are *Zeylanema anabantis* Pearse, *Z. pearsi* Yeh, *Z. kulasirii* Yeh, *Z. fernandoi* Yeh, *Z. sweeti* Moorthy, *Procamallanus spiculogubernaculus* Agarwal and *P. planoratus* Kulkarni. These nematode parasites have an interesting life-history. From the hosts intestine newly hatched larvae reach the water along with the faeces. The larvae undergo further development when they are eaten by copepods. After a time they encyst in the body cavity of the copepod. When the infected copepod is eaten by a fish, the nematode develops further and attains adulthood.

Two species of spiruroid larvae were found in the mesenteries of *Wallago attu*, *Ompok bimaculatus* and *Glossogobius giuris* by the authors.

# NEMATOMORPHA

(Horsehair worms or Gordian worms)

NEMATOMORPHA which often occur as inextricably coiled masses are referred to as gordian worms after the mythical gordian knot (Page 47, Fig. 9). The term horsehair worms originated with the myth that these worms were transformed horsehairs. The larvae are parasitic on arthropods, chiefly insects. The adult worms do not feed, but a few cases are recorded of the adult accidentally "parasitic" in man. Generally the adults are free-living and aquatic being found in ditches, ponds and various shallow freshwater habitats.

Superficially the Nematomorpha resemble nematodes but they differ from them in internal structure. They vary in size from 10-70 cms. in length and 0.3-3 mms. in breadth. The diameter of the body is constant throughout except at the very extremities where a slight narrowing is noticeable. The mouth is hardly visible and there is no functional alimentary canal both in the adult and juvenile stages. The gordiids take no food into the digestive tract at any stage of their life cycle and therefore must obtain their nutrition by absorption through the body surface. At the posterior end is a cloaca into which the reproductive canals (or genital ducts) open. The tail of the male is usually bifid or trifid. The body is covered by a hard cuticle which is much stiffer than that of the nematodes. The body surface is usually covered with minute warts (areoles) (Page 47, Figs. 11 and 12).

The adult worms mate in the water and each egg hatches out into a larva with a simple body having a proboscis and several hooks. The larvae encyst on vegetation near the water and when they are swallowed by an aquatic animal along with the vegetation, the larvae bore through the gut wall of the animal and reach its body cavity. The larvae can penetrate into almost any small aquatic animal but can develop further only in an appropriate host, usually an insect. Within the host the larva gradually grows into a juvenile worm losing the larval stylets and hooks of the proboscis but without undergoing any definite metamorphosis.

Insects harbouring adult gordian worms are known to seek water. The juvenile worms leave the host by piercing through the body wall of the insect, which injury usually kills the insect.

Three species of gordian worms belonging to 2 genera have been recorded from Ceylon.

*Chordodes skorikowi* Camerano

*Chordodes verrucosus* (Baird)

*Paragordius tricuspidatus* (Dufour)

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# ANNELIDA

(Earthworms, Leeches)

ANNELIDS are elongate and cylindrical worms with soft segmented bodies covered externally by a cuticle which is a secretion of the skin. Some annelid groups, collectively termed the Chaetopoda, have chaetae or bristles which are embedded in the skin. These chaetae which are composed of chitin (a secretion of the skin) are arranged in definite patterns. The mouth of an annelid occupies a ventral position overhung by a small preoral lobe. The anus is terminal, i.e., it is at the posterior end of the body. The anterior and posterior ends of annelids, particularly the smaller chaetopods, appear to be alike.

The annelids found in fresh water belong to two groups, namely the Oligochaeta (earthworms) which is a sub-division of the Chaetopoda, and the Hirudinea (leeches).

## KEY TO THE ANNELIDS

1. No suckers. Chaetae present. Body generally cylindrical....Oligochaeta, page 44  
Suckers present. No chaetae. Body generally flattened.....Hirudinea, page 48

## OLIGOCHAETA

These are chaetopod annelids with a comparatively small number of chaetae. The chaetae are arranged in four groups on each segment, two on the dorsal side and two on the ventral side. The structure and size of these chaetae are an important diagnostic feature of the various oligochaete families.

The aquatic oligochaetes or as they are more commonly called the "aquatic earthworms" inhabit the bottom ooze and debris where they could burrow deeply into the mud like terrestrial forms. Some of them are capable of constructing burrows which project above the surface of the mud as a tube made of sand and debris. The worm lives inside the tube with its anterior end at the bottom of the burrow feeding on the mud while its posterior end extends out of the tube into the water. Most aquatic oligochaetes reproduce asexually by fission. When a worm is ready to multiply a number of new segments are formed at some point along the body. At this point it breaks up into two new individuals. Some of the new segments go to form the posterior end of one new worm while the rest of the segments form the front or anterior region of the other.

Aquatic oligochaetes are important as food for fishes. The bottom feeding fishes often feed on them and the undigested chaetae are commonly seen when the gut contents of these fishes are examined.

Aquatic earthworms may sometimes reach very great numbers in muddy soils rich in decaying organic matter. The Lumbricidae, of which one species has been recorded from Ceylon plays a role similar to that of the common earthworm in the soil, i.e., bringing up and mixing the soil.

The aquatic oligochaetes recorded from Ceylon fall into four families, namely, Aeolosomatidae, Naididae, Tubificidae and Lumbricidae

1. Only two chaetae per bundle (i.e. eight in all) on each segment.....Lumbricidae, page 45  
More than eight chaetae in each segment..... 2
2. Zones of budding visible, reproduction by fission takes place at these zones..... 3  
No zones of budding. Reproduction sexual.....Tubificidae, page 45
3. Preoral lobe (Prostomium) with cilia on the ventral side..... Aeolosomatidae, page 45  
No cilia on ventral side of preoral lobe.....Naididae, page 45

#### FAMILY AELOSOMATIDAE

These are small freshwater worms which are usually less than 10 mm. in length. The number of chaetae per segment varies from species to species. The paired testes of each animal tend to become fused together as happens with the paired ovaries. Although these worms possess well developed sex organs their chief means of reproduction is by fission.

Only one species has been recorded from Ceylon. It has three chaetae per group (i.e., 12 chaetae in all).

*Aeolosoma ternarium* Schmarda (Page 47, Fig. 7)

#### FAMILY NAIDIDAE

They are small aquatic worms, the largest forms growing up to 25 mm. in length. Although the sex organs are better developed than in the Aeolosomatidae, their usual mode of reproduction is by fission.

Ten species of Naididae have been recorded from Ceylon. They are very common in muddy soils like in paddy fields. *Dero* sp. construct tubes. At the posterior end of these worms are a number of ciliated "gills" in which red blood may be seen, giving the entire worm a pink colour. *Chaetogaster* is usually found associated with tube building insect larvae.

*Allonais paraguayensis paraguayensis* (Mich.)

*Aulophorus michaelsoni* Steph.

*Aulophorus tonkinensis* (Vejd.)

*Chaetogaster* sp. (Page 47, Fig. 8)

*Dero limosa* Leidy (Page 47, Fig. 5)

*Dero zeylanica* Steph. (Page 47, Fig. 5)

*Pristina breviseta* (Bourne)

*Pristina minutum* (Steph.)

*Pristina proboscidea* Bedd.

#### FAMILY TUBIFICIDAE (Page 47, Fig. 10)

These aquatic worms are usually small but there are certain species growing up to 200 mm. in length. They are more slender than the other three families and do not reproduce by fission. They have red blood cells and they usually construct tubes in the mud out of which their tails project into the water (Page 47, Fig. 13). Two species of Tubificidae have been recorded from Ceylon.

*Bothrioneurum iris* Bedd.

*Limnodrilus socialis* Steph.

#### FAMILY LUMBRICIDAE

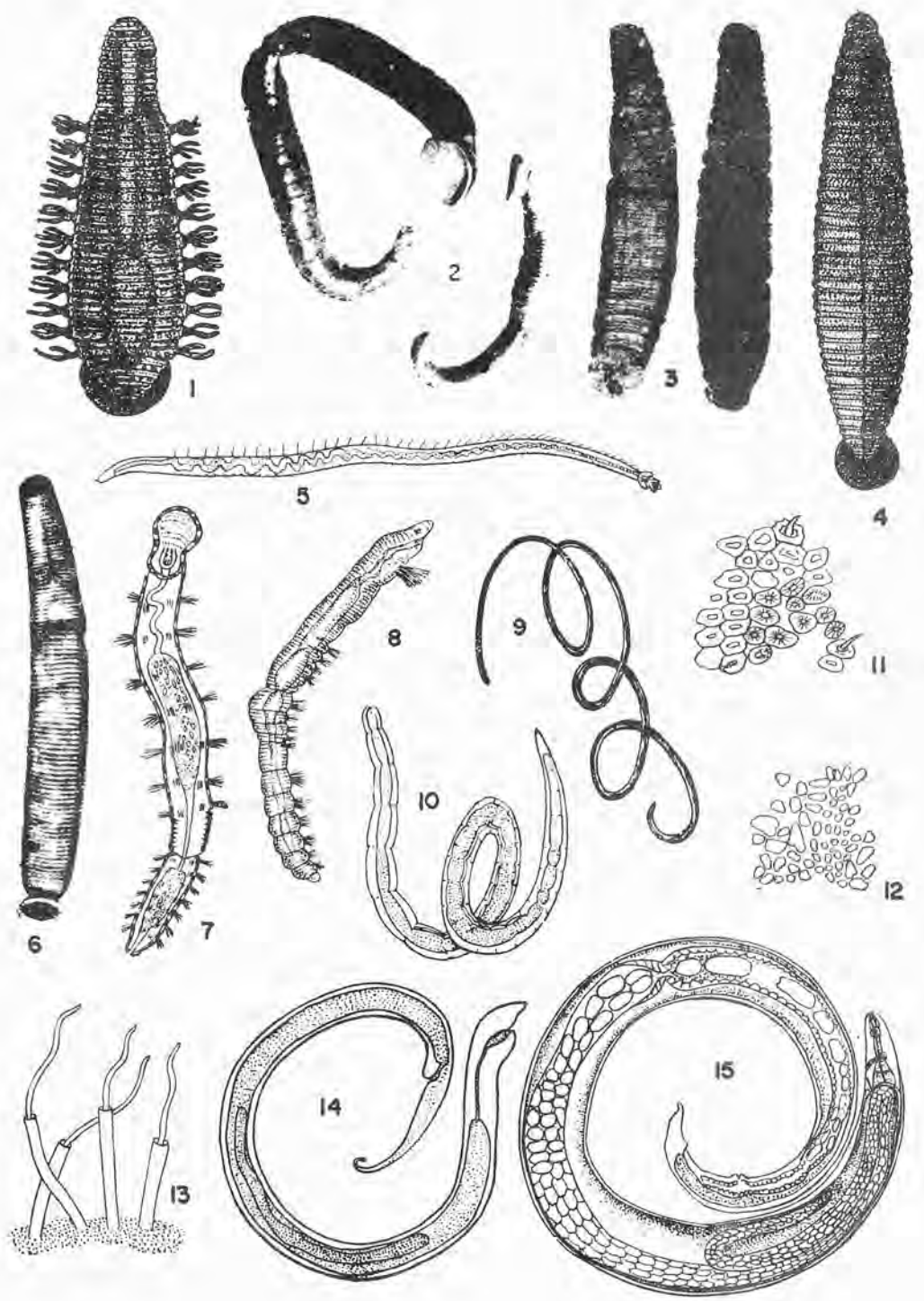
These are long worms that may measure up to 150 mm. in length. They are not truly aquatic forms, being usually found in marshy localities. They are deep red to reddish brown in colour due to the colour of their blood. Only two S-shaped chaetae are present in each of the four segmental groups (i.e., 8 chaetae per segment). They do not reproduce by fission.

One unidentified species has been recorded by Weerakoon and Samarasinghe (1958).

*Glyphidrilus* sp.

Explanation to figures on page 47

1. *Ozobranchius shipleyi* 20 mm. long.
2. *Dinobdella ferox*, from Dhanapala and Fernando 17 cms. long.
3. Ventral and dorsal views of *Hirudinaria manillensis*, from Dhanapala and Fernando 11 cms. long.
4. *Placobdella emydae* 13·5 mm. long.
5. *Dero* sp., from Mellanby 19 mm. long.
6. *Hirudo birmanica*, from Dhanapala and Fernando 7 cms. long.
7. *Aeolosoma* sp., from Mellanby 1-2 mm. long.
8. *Chaetogaster* sp., after Mellanby 7 mm. long.
9. A diagrammatic representation of a gordian worm.
10. *Tubifex* sp., after Mellanby 3 cms. long.
11. Surface view of *Chordodes* sp.
12. Surface view of *Gordius* sp., showing areoles.
13. *Tubifex* worms in mud tubes, after Mellanby.
14. *Dorylaimus stagnalis*, after Mellanby 5-8 mm. long.
15. *Anguina tritici*, from Goodey 3·5 mm. long.



## HIRUDINEA

THESE are annelids with flattened and shortened bodies, which when extended take on a cylindrical form. They have a small and regular number of segments (usually 32), which are sub-divided into annuli. They usually have no chaetae and are distinguished from all other annelids in having two ventral suckers, one at each end of the animal. The sucker at the posterior end of the animal is very clearly visible but the anterior sucker with the mouth at its centre is not always well marked. The number of eyes vary with the species.

The Hirudinea are divisible into two sub-orders, namely Rhynchobdellae and Arhynchobdellae

1. Relatively small forms with a protrucible pharynx.....Rhynchobdellae, page 48  
Relatively large forms with teeth in their jaws. No protrucible  
pharynx.....Arhynchobdellae, page 49

### SUB-ORDER RHYNCHOBDELLAE (Sucking Leeches)

THE rhynchobdellid leeches are 6-20 mm. in length, and are parasitic forms which suck the blood and body juices from their hosts. For this purpose the leech is provided with a protrucible proboscis. The proboscis which is a highly muscular adaptation of the pharynx, is thrust through the small oral opening at the centre of the anterior sucker into the flesh of the host. The rhynchobdellid leeches cause damage to the body surface of aquatic vertebrates including fishes. This may lead to secondary infection by fungi and bacteria. They may also cause considerable loss of blood if large numbers are present in a single host. Some species also act as intermediate hosts of blood parasites like trypanosomes and haemogregarines.

An interesting feature in these leeches is that the young are carried on the ventral surface of the parent. The rhynchobdellid leeches exhibit considerable diversity of forms as will be seen in the description below. Five species have been recorded from Ceylon.

#### *Ozobranchus shipleyi* Harding (Page 47, Fig. 1)

This leech is commonly found attached to the soft parts of the black terrapin (tortoise), *Melanochelys trijuga thermalis* (Lesson). Its body is translucent, the entire dorsal surface being dull yellow with dark green margins. The posterior sucker has dark green spots. A characteristic feature of this leech is that the posterior region has eleven pairs of lateral digitate branchiae or gills which are colourless and almost transparent. It has one pair of eyes. This leech is the intermediate host of a blood parasite (*Haemogregarina* sp.) of the black terrapin.

#### *Placobdella ceylonica* Harding

#### *Placobdella emydae* Harding (Page 47, Fig. 4)

#### *Placobdella undulata* Harding

These leeches are greatly flattened forms. The anterior sucker is fused with the ventral body wall, but the posterior sucker is free. Generally the leeches of this genus have only one pair of eyes but *P. ceylonica* has three pairs. They usually parasitize the soft terrapin (tortoise) *Lissemys punctata celonicus* (Gray) but it is not uncommon to find them on other freshwater vertebrates particularly fishes. *P. undulata* has been found on *Etioplus* (S. Koraliya). Placobdellid leeches are intermediate hosts of blood parasites of vertebrates.

*Paraclepsis vulnifera* Harding

The body of this leech is more rounded than the preceding forms. The mouth is sub-terminal leaving the anterior sucker imperforate. The dorsal surface of body is roughened due to the presence of numerous minute papillae. It has 3 pairs of eyes. This is a common parasite in the branchial cavities of freshwater crabs.

SUB-ORDER ARHYNCHOBDELLAE (Biting Leeches)

The Arhynchobdellae are relatively large forms ranging from 25 mm. to 300 mm. or more in length. They have teeth in their jaws and their bites can cause considerable loss of blood in the host. The arhynchobdellid leeches are common parasites of vertebrates, sometimes even in man. They do not have a protrusible proboscis.

Into this sub-order fall the so called "cattle leeches" namely *Limnatus* and *Dinobdella*. In Ceylon two species are on record.

*Limnatus paluda* (Tennant)

This leech is also called the "horse leech", and it grows to about 60 mm. in length. Both anterior and posterior suckers are large, the latter sometimes exceeding the maximum width of the body. It is uniformly brown in colour with longitudinal dark stripes.

*Dinobdella ferox* (Blanchard) (Page 47, Fig. 2)

This is a very large "cattle leech", the adults ranging from 200 to 300 mm. in length. They are uniformly dark green in colour, an uniformity which distinguishes this species. The posterior sucker is prominent and circular with its diameter exceeding the width of the body. The jaws are small and without teeth. There are numerous records of these leeches being present in the nasal passages of cattle and other animals. The "cattle leeches" have relatively small jaws with rudimentary teeth and are unable to penetrate the outer skin and hence suck blood from the highly vascular mucous membrane of the mouth, nasal passage, pharynx and larynx of their hosts (cattle, domestic animals and even man). The leeches get into these cavities when the animals visit stagnant pools. Several leeches may be present in the nasal passages of one host from where they are difficult to dislodge and they can cause the death of the host by suffocation.

The "Medicinal leeches" represented in Ceylon by *Hirudinaria manillensis* and *Hirudo birmanica* are two other species of arhynchobdellid leeches present in Ceylon.

*Hirudinaria manillensis* (Lesson) (Page 47, Fig. 3)

This species grows up to about 100 mm. in length and 25 mm. in breadth. The leech is brownish green on its dorsal surface and lighter green on its ventral side. In the median line of the dorsal surface is a series of elongated black spots on a broad light green stripe. On each side of this stripe are two narrow longitudinal yellowish stripes with black borders. The entire dorsal surface is flecked with black. There are two broad black stripes on the ventral surface. The anterior end of the leech is broad and the diameter of the posterior sucker is less than the width of the body. This leech is found in the low country in stagnant waters of paddy fields and slow running streams. The jaws are well developed and numerous teeth are present. They are often found attached to the skin of buffaloes. In addition to being called "medicinal" leeches, they are sometimes referred to as "paddy field" or "buffalo" leeches.

*Hirudo birmanica* (Blanchard) (Page 47, Fig. 6)

This leech is about 60mm. long and is slender in comparison to *Hirudinaria manillensis*. It is olive brown in colour with seven thin black stripes on its dorsal side. The leech is narrower at its anterior end. The posterior sucker is less than the width of the body. The jaws and teeth are well developed. This species is found in rivers and streams and sometimes in swamps and irrigation reservoirs. They are not as common as *Hirudinaria manillensis*.

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# MOLLUSCA

(Snails and Mussels)

**MOLLUSCS** are relatively advanced invertebrates whose bodies are not segmented but a well developed "head" is usually present. Molluscs have complex internal organs with well developed digestive, respiratory and reproductive systems. Most molluscs possess a shell formed by secretions from the skin. The shell is composed of calcium compounds and is never discarded but constantly added to as growth proceeds. If the shell is removed from the fleshy portion, the animal dies. This is in direct contrast to the arthropods where with growth of the animal, the chitinous exoskeleton is being periodically discarded and replaced by a larger one.

Molluscs are hardy animals and survive periods of drought buried in the mud. They are scavengers and eat decaying organic matter and the aquatic species thereby help in purifying water. Molluscs form an important item in the diet of some fishes and other aquatic and non-aquatic animals. Some species are intermediate hosts of parasites particularly the digenetic flukes which are found in man, domestic animals and nearly all vertebrates. The control of flukes depends largely on the control of the mollusc involved. Two groups of molluscs are common in the freshwater; (1) the univalve molluscs or snails termed the Gastropoda, and (2) the bivalve molluscs or mussels termed the Lamellibranchia.

1. Shell of a single piece.....Gastropoda, page 51  
Shell of two valves which are hinged together.....Lamellibranchia, page 58

## GASTROPODA

(Univalve Molluscs or Snails)

In this group the shell of each mollusc is of one piece and hence they are termed "univalve molluscs". The shells of the various species take on different forms and shapes (flattened, cone shaped, spirally coiled, &c.). Gastropods possess a distinct "head" with a pair of contractile tentacles. At the base of the tentacles are a pair of eyes. (Land gastropods have the eyes on the tip of the tentacles). The mouth which occupies a ventral position lies just below and between the two tentacles. The upper jaw is chitinous while in the lower part of the mouth is a radula or rasp which is a muscular ribbon covered with rows of minute teeth. Gastropods feed by rasping off plant material with the aid of the chitinous jaw and the radula. As the front portion of the radula wears off the ribbon grows forward bringing fresh teeth into use. The head is continuous with the flattened foot on the ventral side. The gastropods glide over any object lying in the water by muscular action of the foot. Sometimes they even move about on the surface of the water with the body hanging downwards. All that portion of the animal which lies within the shell excluding the head and foot is referred to as the visceral hump which contains the organs of digestion, circulation, respiration and reproduction.

For reproduction to take place in gastropods two individuals must come together although some molluscs possess both male and female sex organs. Most gastropods deposit eggs but the members of some families such as Thiaridae and Viviparidae are viviparous. These viviparous molluscs are provided with pouches, referred to as "marsupia", in which the young remain until they are sufficiently developed to be liberated.

The fresh water gastropods are divided into two groups: (1) Operculate, and (2) Pulmonate.

1. Horny plate on foot which serves as an operculum.....Operculate Gastropods,  
page 52  
No horny plate on foot.....Pulmonate Gastropods, page 57

## OPERCULATE GASTROPODS

These gastropods have a horny plate attached to the foot. The plate is of a peculiar chitinous or calcareous structure and closes the opening of the shell when the animal retracts. During the drought the snail can hibernate within the closed shell. The operculate gastropods breathe dissolved oxygen present in the water through special gills and they are generally present in water which is well aerated. Most operculate gastropods have separate male and female individuals (unisexual).

Operculate gastropods in Ceylon are represented by about 80 recorded species belonging to five families.

1. Shell subglobular or subpatelliform, i.e., flattened from top to bottom. May have a very small spire.....Neritidae, page 52  
Shell globose, oval or carrot shaped and usually with a prominent spire.....2
2. Shell distinctly carrot shaped, spire prominent.....Thiarinae<sup>1</sup>, page 52  
Shell globose or ovately fusiform.....3
3. Shell large and globose.....Pilidae, page 56  
Shell ovate or ovately fusiform.....Paludominae<sup>1-2</sup>, page 53, Paludetrinidae<sup>2</sup>, page 56, and Vivaparidae<sup>2</sup> page 56

### FAMILY NERITIDAE

This family consists of flattened forms similar to the common limpets present on wave washed rocks in the sea shore and rounded forms like the marine periwinkles. The shells are small and have a low spire. Most species have coloured patterns of lines and bands. The operculum is semicircular in shape. The freshwater species may extend to brackishwater bodies with rocky bottoms.

*Septaria livesayi* (Dohrn)

*Septaria reticulata* (Reeve)

*Septaria squamata* (Dohrn), (Page 55, Fig. 1)

*Theodoxis perotetiana* (Reclus)

### FAMILY THIARIDAE

These operculate gastropods are viviparous. *Faunus*, *Melanoides* and *Thiara* spp. have turreted shells with many whorls, *Paludomus* spp. have ovoid shells with a low spine and few whorls. *Faunus*, *Melanoides* and *Thiara* have adapted themselves to inhabit stagnant or slow running waters in which decaying vegetable matter and mud are present. *Thiara* and *Paludomus* spp. are abundant in up-country streams with rocky bottoms. *Paludomus* spp. are chiefly rocky mountain stream forms but certain species are present in low country streams and even in paddy fields. *Faunus ater* is present in fresh and brackish water. *Melanoides* is found both in the low and up-country.

### SUB-FAMILY THIARINAE

*Faunus ater* (L.) (Page 55, Fig. 5)

*Faunus ater perdecollata* Nevill.

*Melanoides broti* (Dohrn)

*Melanoides broti subviridis* (Nevill)

<sup>1</sup> Sub-families of the family Thiaridae.

<sup>2</sup> There is much variation in the shape of the shell of the species of operculate gastropods belonging to these three groups. Hence no attempt has been made to separate them by simple external characters.

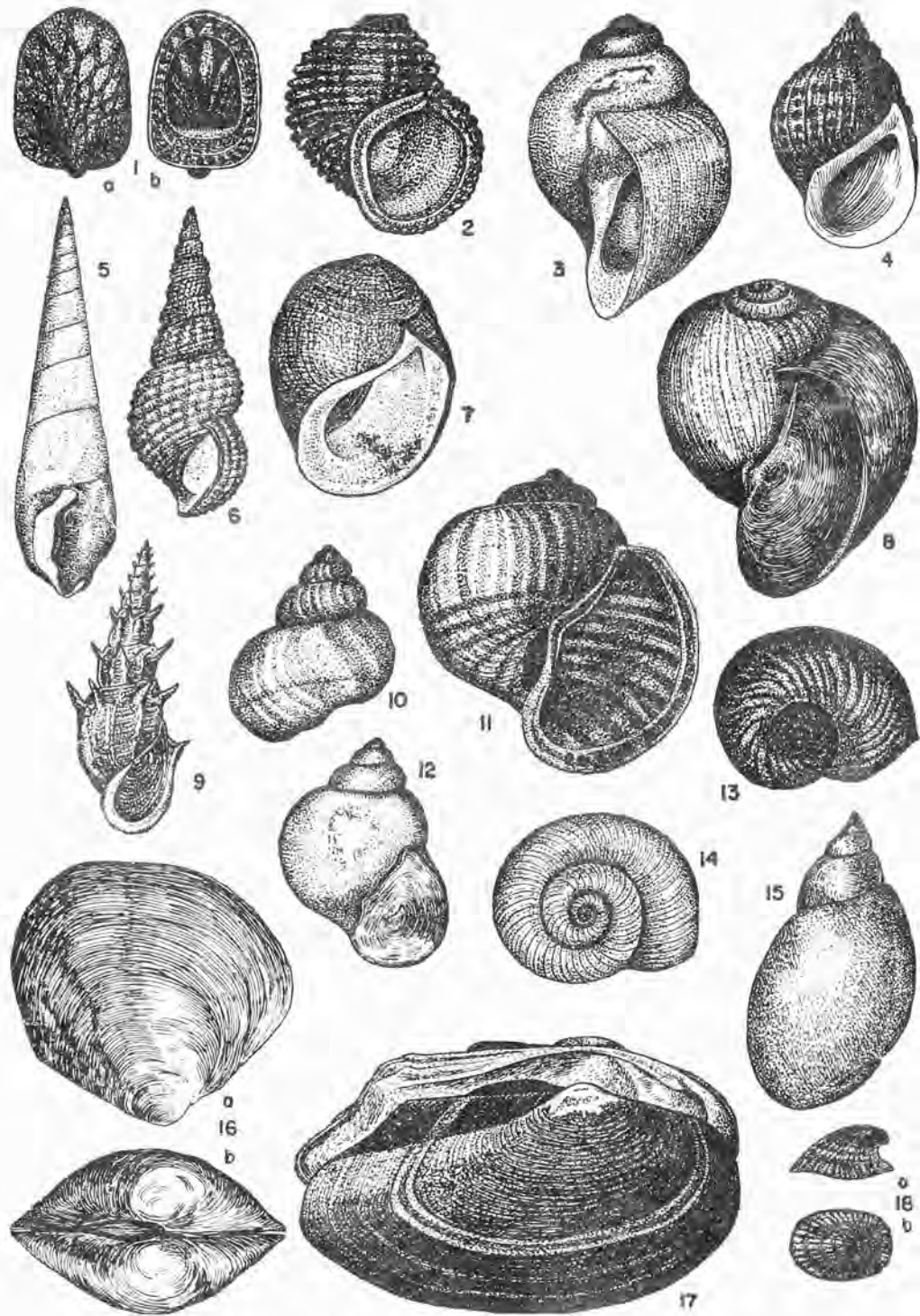
*Melanoides crenulata* (Deshayes)  
*Melanoides crenulata confusa* (Dohrn)  
*Melanoides lineata* (Gray)  
*Melanoides tuberculata* (Müller), (Page 55, Fig. 6)  
*Melanoides tuberculata layardi* (Dohrn)  
*Melanoides tuberculata subcreba* (Nevill)  
*Thiara acanthica* (Lea) (Page 55, Fig. 9)  
*Thiara datura* (Dohrn)  
*Thiara rudis* (Lea)  
*Thiara scabra* (Müller)

#### SUB-FAMILY PALUDOMINAE

*Paludomus abbreviatus* Reeve  
*Paludomus bicinctus* Reeve  
*Paludomus chilinoides* Reeve (Page 55, Fig. 3)  
*Paludomus clavatus* Reeve  
*Paludomus constrictus* Reeve  
*Paludomus cumingianus* Dohrn  
*Paludomus decussatus* Reeve  
*Paludomus dilatatus* Reeve  
*Paludomus distinguendus* Dohrn  
*Paludomus dromedarius* Dohrn  
*Paludomus erinaceus* Reeve  
*Paludomus erroneus* Nevill  
*Paludomus fulgurata* Dohrn  
*Paludomus funiculatus* Reeve  
*Paludomus gardneri* Reeve  
*Paludomus globulosus* Gray  
*Paludomus hanleyi* Dohrn  
*Paludomus hanleyi major* Nevill  
*Paludomus laevis* Layard  
*Paludomus loricatus* Reeve (Page 55, Fig. 2)  
*Paludomus melanostomus* Hanl. & Theob.  
*Paludomus nasutus* Dohrn  
*Paludomus neritoides* Reeve (Page 55, Fig. 7)  
*Paludomus neritoides globosus* Brot.  
*Paludomus nigricans* Reeve  
*Paludomus nigricans subgranulosa* Nevill  
*Paludomus nodulosus* Dohrn  
*Paludomus palustris* Layard  
*Paludomus pictus* Reeve  
*Paludomus pyriformis* Dohrn

Explanation to figures on page 55

1. Dorsal (a) and ventral (b) views of *Septaria squamata* from Hanley and Theobald. Diameter 20 mm.
2. *Paludomus loricatus* 30 mm. high.
3. *Paludomus chilinoidea* 2 cms. high.
4. *Paludomus zeylanica*, from Han. and Theo.
5. *Faunus ater* 8 cms. high.
6. *Melanoides tuberculata* 20 mm. high.
7. *Paludomus neritoides* 2 cms. high.
8. *Pila globosa* 4.5 cms. high.
9. *Thiara acanthica*, from Han. & Theo.
10. *Bellamyia ceylonica* 2 cms. high.
11. *Pila loyardi*, from Han. & Theo. 5 cms. high.
12. *Eithynia inconspicua* 5 mm. high.
13. *Indoplanorbis exustus*. Diameter 15 mm.
14. *Gyraulus saigonensis*. Diameter 4 mm.
15. *Lymnaea pinguis* 15 mm. high.
16. A single valve (a) and hinge view (b) of *Polymesoda impressa* from Preston.
17. *Lamellidens marginalis* from Han. & Theo.
18. Side view (a) and dorsal view (b) of *Ancylus zeylanicus* from Han. & Theo.



*Paludomus reevei* Layard  
*Paludomus regalis* Layard  
*Paludomus rupaeformis* Brot.  
*Paludomus similis* Layard  
*Paludomus skinneri* Dohrn  
*Paludomus solidus* Dohrn  
*Paludomus sphaerica* Dohrn  
*Paludomus spiralis* Reeve  
*Paludomus striatula* Nevill  
*Paludomus subdentatus* Nevill  
*Paludomus sulcatus* Reeve  
*Paludomus sulcatus compactus* Nevill  
*Paludomus sulcatus contractus* Nevill  
*Paludomus sulcatus minor* Nevill  
*Paludomus swainsoni* Dohrn  
*Paludomus tennanti* Reeve  
*Paludomus thwaitesi* Layard  
*Paludomus torrenticolus* Dohrn  
*Paludomus violaceus* Layard  
*Paludomus zeylanica* Lea (Page 55, Fig. 4)

#### FAMILY PALUDESTRIDAE

The shell is pyramid like. The last whorl of the shell is large and inflated. Members of this family inhabit stagnant or slow running water, especially those with a plentiful supply of mud and decaying vegetable matter.

*Bithynia inconspicua* (Dohrn) (Page 55, Fig. 12)  
*Bithynia stenothyroides* (Dohrn)  
*Mysorella costigera*<sup>1</sup> (Küster)

#### FAMILY VIVAPARIDAE

The shell has a pointed apex and a rounded base and its profile is like that of a pyramid. The operculum has several concentric rings. These gastropods liberate young and not ova.

*Bellamyia ceylonica* (Dohrn) (Page 55, Fig. 10)  
*Bellamyia ceylonica ecarinata* (Han. & Theob.)

#### FAMILY PILIDAE

Their shells are large or moderately large, being almost the size of the common garden snail, *Acatina*. The shell is light brown coloured. The operculum has several concentric rings round an

<sup>1</sup> New Record for Ceylon.

eccentric nucleus. The sexes are separate and eggs are laid in clusters containing several eggs. These gastropods live in stagnant or slow running water that is amply provided with decaying vegetable matter and mud.

- Pila alucinans* (Sowerby)
- Pila carinata* (Swainson)
- Pila cinerea* (Reeve)
- Pila dolioides* (Reeve)
- Pila globosa*<sup>1</sup> (Swainson) (Page 55, Fig. 8)
- Pila layardi* (Reeve) (Page 55, Fig. 11)
- Pila moesta* (Reeve)
- Pila tischbeini* (Dohrn)
- Pila woodwardi* (Dohrn)

### PULMONATE GASTROPODS

These gastropods do not have an operculum, nor do they have special gills. Within the visceral hump is a special chamber where air is stored. This chamber, which is always kept moist, acts as a lung. They come periodically to the surface of the water to replenish the supply of air in the "lung". Because of this ability to store air in the "lung", pulmonate gastropods can live in all types of water. All pulmonate gastropods are hermaphrodites and eggs are usually fertilized by another individual or in special cases by themselves. The eggs are laid in clear, transparent, gelatinous capsules attached to pond weeds, stones or floating objects.

Pulmonate gastropods in Ceylon are represented by 20 recorded species belonging to three families.

1. Shell similar to that of a marine limpet. (Page 55, Fig. 18) Ancyliidae, page 57  
Shell with several whorls, i.e., they are coiled.....2
2. Shell spirally coiled and is taller than it is broad.....Lymnaeidae, page 57  
Shell coiled in one plane and it is broader than it is tall.....Planorbidae, page 58

### FAMILY ANCYLIDAE

These molluscs have flattened limpet-like shells. They are generally found attached to rocks and stones or stems and leaves of plants.

- Ancylus verruca* Benson
- Ancylus zeylanicus* Benson (Page 55, Fig. 18)

### FAMILY LYMNAEIDAE

The shell of gastropods belonging to this family have a thin shell. The whorls of the shell are rounded. The spire is moderately high. They have broad feet. They inhabit stagnant or slow running water habitats. Eggs are deposited in gelatinous strings on water plants, stones and similar objects.

- Lymnaea ovalis*<sup>1</sup> Gray
- Lymnaea pinguis*<sup>2</sup> (Dohrn) (Page 55, Fig. 15)

<sup>1</sup>New Record for Ceylon.

<sup>2</sup>Hubendick, B. (1951) states that *Lymnaea luteola* Lsmark the common Indian species occurs in Ceylon. The record of *L. pinguis* for Ceylon = *L. luteola*. (*Proc. zool. Soc. Lond.* 26, p. 134).

*Lymnaea tigrina* (Dohrn)  
*Lymnaea tigrina minor* (Preston)

#### FAMILY PLANORBIDAE

The shells of the snails belonging to this family are coiled in one plane only and broader than they are high. This family includes the extremely common species *Indoplanorbis exustus* which is found in paddy fields, ponds and tanks throughout the low country. It also includes many species which are important intermediate hosts of flukes.

*Gyraulus saigonensis* (Crosse et Fischer) (Page 55, Fig. 14)  
*Indoplanorbis exustus* (Desh.) (Page 55, Fig. 13)  
*Indoplanorbis exustus eburneus* (Gray)  
*Indoplanorbis exustus zonatus* Dunker  
*Planorbis associatus* Westl.  
*Planorbis caenosus* Benson  
*Planorbis calathus* Benson  
*Planorbis demissus* Westl.  
*Planorbis elegantulus* Dohrn  
*Planorbis hypsicyclos* Benson  
*Planorbis liratus* Westl.  
*Planorbis spirodelus* Westl.  
*Planorbis stelzneri* Dohrn  
*Planorbis versicolor* Westl.

#### LAMELLIBRANCHIA

(Bivalve Molluscs, Mussels)

These molluscs are bilaterally compressed and symmetrical. They secrete a shell consisting of two symmetrical, opposing valves which could be closed ventrally by the contraction of two powerful muscles enclosing the soft parts of the animal. Lamellibranchs breathe by means of gills. Unlike in the gastropods the head is rudimentary. Eyes, tentacles, jaws and radula are all absent. They capture their food through a series of cilia or hairs which act as a sieve or filter, collecting small food particles present in the water and passing them onto the mouth. The foot which is not flattened but wedge shaped can dig into the sand or mud. Lamellibranchs are capable of very slow movements, by attaching their foot in the sand and dragging themselves towards it. They are bisexual, but fertilisation does not take place by the union of the two sexes. When mature, the male discharges spermatozoa into the water which enter a mature female animal and fertilizes her ova.

Ten species of lamellibranch molluscs have been recorded from Ceylon. They belong to two families.

#### FAMILY UNIONIDAE

These lamellibranchs are most often found on sandy or muddy bottoms in clear running water. *Lamellidens* is a large mussel about 2-3 inches long and 1-2 inches broad. The eggs develop into larvae called "glochidia" which are parasitic on the gills or fins of fish during the early stage of their

life, later dropping off to become free living mussels. They are very common in streams and ponds where they burrow into the sand or mud.

*Lamellidens marginalis* (Lamarek) (Page 55, Fig. 17)

*Lamellidens marginalis consobrina* (Lea)

*Lamellidens marginalis lamellata* (Lea)

*Lamellidens marginalis thwaitesi* (Lea)

*Parreysia corrugata* (Müller)

#### FAMILY CORBICULIDAE

These are relatively uncommon species.

*Corbicula solida* Clessin

*Corbicula subnitens* Clessin

*Polymesoda impressa* (Desh.) (Page 55, Fig. 16)

*Polymesoda tennentii* (Hanley)

*Polymesoda zeylanica* (Lam.)

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# ARTHROPODA

ARTHROPODA are numerically dominant over all other animals on land as well as in the water. These animals possess an outer covering of chitin which in some arthropods is made harder by the presence of organic and inorganic substances particularly calcium salts. This external hard covering forms a supporting skeleton (exoskeleton) to which the muscles are attached. The body of an arthropod is divided into several segments. Each segment usually bears a pair of jointed limbs. These limbs which may be absent in some segments in some crustaceans are modified to perform different functions in others. The limbs at the front end are modified to serve a sensory function as antennae or feelers. The limbs behind the feelers are modified for feeding as jaws or mouth parts. The rest of the limbs behind the mouth parts are used for walking and swimming. The limbs may bear structures which are respiratory in function.

The fresh water Arthropoda are divisible into three groups (classes), namely (1) Crustacea, (2) Insecta, and (3) Arachnida.

## KEY TO ARTHROPODA

1. Possess paired limbs, some of which are biramous, i.e., forked into two branches...2  
Paired limbs not branched.....3
2. Only three or four pairs of appendages, the second and third pair being biramous.....Immature Crustacea (Naupilii), page 63, Figs. 19 and 20  
Two pairs of feelers (antennae) in front of mouth and more than four pairs of legs behind the mouth.....Adult Crustacea, page 60
3. Globular body, the greater part of which is unsegmented. Four pairs of legs (three pairs in immature stages).....Arachnida, page 98  
Segmented body with three pairs of legs (sometimes the legs may be absent).....Insecta, page 72

## CRUSTACEA

The body is divisible into head, thorax and abdomen. The first two divisions, namely the head and thorax are often fused together to form a cephalothorax. The cephalothorax is often covered by a carapace which protects the anterior region of the body. Crustaceans have two pairs of antennae or feelers in front of their mouth. Behind the mouth parts, all free-living crustaceans, have at least 5 pairs of limbs. Sometimes the limbs perform more than one function, i.e., locomotion, feeding and respiration, the last function being through special processes on limbs or through the thin walled limbs themselves.

There are 5 sub-classes of Crustacea represented in Ceylon's fresh waters, namely (1) Branchiopoda, (2) Copepoda, (3) Ostracoda, (4) Branchiura, and (5) Malacostraca.

## KEY TO THE CRUSTACEA

1. At least ten pairs of similar consecutive appendages.....Branchiopoda (Part only) Anostraca, Conchostraca, page 61  
Less than ten pairs of similar, consecutive limbs.....2
2. Thorax with eight pairs of legs, of which the first three pairs may be provided with claws. Six pairs of abdominal appendages, the last pair modified to form a tail fan.....Malacostraca, page 67  
Less than eight pairs of thoracic legs, none of which have claw.....3

3. A bivalve "shell" encloses the entire animal.....Ostracoda, page 66  
     No "shell" or if a "shell" is present at least the head is outside the shell.....4
4. Body compressed (flattened from side to side) and enclosed by a carapace in the form of two valves ..... Branchiopoda (part only) Cladocera, page 61  
     Body depressed (flattened from top to bottom).....5
5. Two suckers and carapace present .....Branchiura, page 66  
     No suckers nor carapace. Antennae prominent.....Copepoda, page 65

#### **Sub-Class Branchiopoda**

As the name implies they are "gill footed crustacea". The limbs of these animals are broad and leaf-like and wave to and fro creating a current of water which aerates the respiratory organs. The respiratory organs are gills on the limbs or they are the thin walled limbs themselves. The Branchiopoda are divisible into three groups namely the Anostraca, Cladocera, and Conchostraca.

1. At least 10 pairs of similar consecutive appendages.....2  
     Less than 10 pairs of similar consecutive appendages.....Cladocera, page 61
2. No carapace. Swim with their appendages up.....Anostraca, page 61  
     Carapace present.....Conchostraca, page 64

#### **ANOSTRACA**

(Fairy Shrimps)

Anostraca are considered to show more primitive features than the other crustaceans. They swim upside down with their feet up. They do not possess a shell fold or carapace. The body which consists of many segments is elongated and worm-like. The head is clearly marked off from the rest of the body, but the thorax and abdomen are not distinguishable unless the section of the body behind the limbs is termed the abdomen. There are about ten pairs of trunk limbs which are very similar in size and shape. The female carries an egg pouch attached to the first segment behind those carrying the limbs. Only one species, *Stegocephalus spinifer* Gurney (Page 63, Fig. 1), has been recorded from Ceylon. Recently this species has been collected in the Jaffna peninsula.

#### **CLADOCERA**

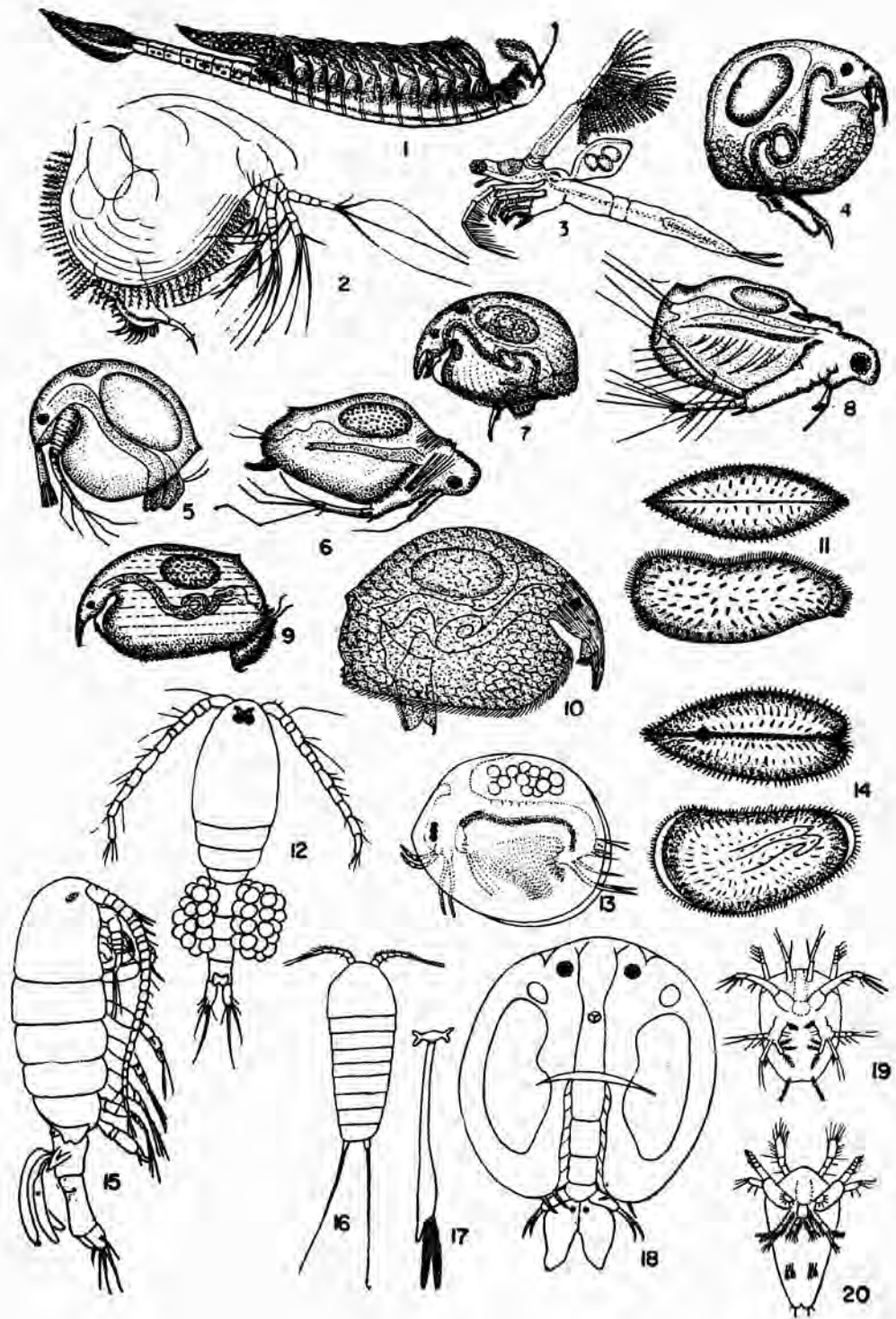
(Water Fleas)

Cladocera are microscopic animals and are usually found in large numbers in most types of waters. They usually move about in the water in a series of hops or jumps and hence they are termed "water fleas". These branchiopods possess a transparent, compressed carapace which is open on its ventral side giving the impression that they are covered by a pair of symmetrical shells, but in reality it is a single piece without a hinge. Cladocerans have five or six pairs of leaf-like limbs, which are in constant motion and propel a current of water to pass between the limbs and the shell for aeration. The posterior portion of the body has no limbs but ends in two terminal claws. Cladocerans feed on microscopic plant life (Desmids and Diatoms), and are themselves important as food for young fishes. They are able to reproduce both sexually and parthenogenetically, i.e., the unfertilized eggs can develop into young. The rate of reproduction is so rapid that the progeny of a single female has been estimated to reach the astounding number of 13,000,000,000 in 60 days. The female carries its eggs in a brood pouch which is dorsal in position. The eggs produced before the drought are very resistant and survive considerable drying. These eggs develop with the onset of the rains.

Explanation to figures on page 63

1. *Stegocephalus spinifer* after Gurney.
2. *Illicryptus halyi* after Brady 0.7 mm.
3. *Leptodora kindti* after various authors 1 cm.
4. *Ohydorus sphaericus* after Ward and Whipple 0.3 mm.
5. *Guernella ceylonica*.
6. *Pseudosida szalay* 2 mm.
7. *Alonella karua* 0.7 mm.
8. *Diaphanosoma singalense* 2.8 mm.
9. *Dunhevedia serrata* 0.9 mm.
10. *Pleurozus laevis* 0.7 mm.
11. *Stenocypris ceylonica*.
12. *Cyclops prasinus* after Gurney up to 3 mm.
13. *Cyclestheria histopi* from Weerakoon 3 mm.
14. *Cypricercus reticulatus*.
15. *Diaptomus viduus* after Gurney 2 mm.
16. *Canthocamptus (Elaphiodella) grandievi* after Gurney.
17. *Lernaea cyprinacea* del. P. Kirtisingha 20 mm.
18. *Argulus foliaceus* del. P. Kirtisingha 9 mm.
19. Nauplius larva after various authors.
20. Nauplius larva after various authors.

Figures 5 to 11 and 14 are after Daday.



The Cladocera recorded from the fresh waters of Ceylon are :

*Alonella excisa* Fisch.  
*Alonella globulosa* (Daday)  
*Alonella karua* (King) (Page 63, Fig. 7)  
*Alonella macronyx* (Daday)  
*Alonella punctata* (Daday)  
*Alonopsis orientalis* Daday  
*Alonopsis singalensis* (Daday)  
*Bosmina japonica* Poppe et Richard  
*Ceriodaphnia cornuta* Sars  
*Chydorus barroisi* (Richard)  
*Chydorus leonardi* King  
*Chydorus ovalis* Kurz  
*Chydorus reticulatus* Daday  
*Chydorus sphaericus* (O. Fr. M.) (Page 63, Fig. 4)  
*Chydorus ventricosus* Daday  
*Dadaya macrops* (Daday)  
*Daphnia carinata* Sars  
*Daphnia galeata* Sars  
*Daphnia lumholtzi* Sars  
*Diaphanosoma singalense* Daday (Page 63, Fig. 8)  
*Dunhevedia crassa* King.  
*Dunhevedia serrata* Daday (Page 63, Fig. 9)  
*Euryalona orientalis* (Daday)  
*Graptolebris testudinaria* (Fisch.)  
*Guernella ceylonica* Daday (Page 63, Fig. 5)  
*Illicryptus halyi* Brady (Page 63, Fig. 2)  
*Leptodora kindti* (Focke) (Page 63, Fig. 3)  
*Leydigia acanthocercoides* (Fisch.)  
*Macronyx spinosa* King  
*Macrothrix triserialis* Brady  
*Moinodaphnia macropa* Straus  
*Moinodaphnia submucronata* Brady  
*Pleuroxus laevis* Sars  
*Pseudalona longirostris* (Daday)  
*Pseudosida szalayii* Daday (Page 63, Fig. 6)  
*Scapholeberis mucronata* (Müller)  
*Simocephalus elizabethae* (King.)  
*Simocephalus exspinosus* de Geer

### CONCHOSTRACA

Conchostraca look like small bivalve molluscs but the presence of jointed limbs (up to 27 pairs) identifies them as arthropod crustaceans. They make slow gliding movements by the rhythmic beating of their leaf-like limbs which are also used for respiration. The eggs are carried in a brood pouch within the valves of the shell. Conchostraca are generally found at the bottom of the water body and feed on detritus.

One species, *Cyclestheria hislopi* (Baird) (Page 63, Fig. 13) has been recorded from Ceylon. It is a pale yellow coloured species which occurs in paddy fields and ditches. This species is widely distributed in S.E. Asia.

### Sub-Class Copepoda

They are small crustaceans, the majority being under 5 mm. in length. The body is divisible into two regions namely the cephalothorax and the abdomen. They have two pairs of antennae and on each member of the 1st pair there is only one filament which is made up of 6 to 25 segments. There are two filaments on each member of the 2nd pair of antennae. In some species the antennae of the males are modified to form grasping organs. Most of the copepods have a single median eye. The eggs are retained by the female in an egg sac attached to its body. Some copepods have two egg sacs attached to them. Copepods are present in all types of habitats but are especially common in standing water.

Copepods may act as intermediate hosts for parasites. Some are intermediate hosts for parasitic worms (Nematoda & Cestoda) which reach their final host, usually a fish, when the fish eats the infected copepods.

Copepods are divisible into Calanoida, Cyclopoida and Harpactoida.

1. Antennae with 10 or fewer segments. Abdomen not clearly marked off from the thorax.....Harpactoida, page 66
- Antennae with more than 10 segments. Abdomen clearly demarkated from the thorax..... 2
2. Antennae with less than 18 segments. Egg sac is paired.....Cyclopoida, page 65
- Antennae with more than 22 segments. Egg sac is single.....Calanoida, page 65

#### Calanoida

*Diaptomus annae* Apstein  
*Diaptomus doriai* Richard  
*Diaptomus drieschi* Poppe et Mrazek  
*Diaptomus lumholtzi* Sars.  
*Diaptomus orientalis* Brady  
*Diaptomus singalensis* Daday  
*Diaptomus strigilepis* Gurney  
*Diaptomus viduus* Gurney (Page 63, Fig. 15)  
*Paradiaptomus greeni* Gurney

#### Cyclopoida <sup>1</sup>

*Cyclops* <sup>1</sup> *distinctus* Richard  
*Cyclops fimbriatus* Fisch.  
*Cyclops hyalinus* Rehberg  
*Cyclops languides* Sars  
*Cyclops leuckarti* Cls.  
*Cyclops phaleratus* Koch.  
*Cyclops prasinus* Fisch. (Page 63, Fig. 12)  
*Cyclops serrulatus* Fisch.  
*Cyclops varicans* Sars  
*Cyclops varius* var. *proximus* Lilly  
*Cyclops vernalis* Fisch.

<sup>1</sup> The genus *Cyclops* has been divided into a number of new genera by recent authors.

## Harpactoida

*Canthocamptus (Atteyella) cingalensis* Brady

*Canthocamptus (Elaphiodella) grandievi* Gurney et Richard (Page 63, Fig. 16)

## Parasitic Copepoda

They pass all or part of their lives as parasites of fishes or other animals and are modified in various ways to lead a parasitic life. Due to the modifications it is difficult to make out the copepod characters of such parasites. In Ceylon observations have been made by the authors on two species of freshwater parasitic copepods namely, *Lernaea cyprinacea* L. var. and *Lamproglena chinensis*.

*Lernaea cyprinacea* L. var. (Page 63, Fig. 17)

From time to time there have been outbreaks of this parasite on fishes in the Fisheries Research Station ponds in Colombo. Some mirror carp brought to Colombo from the Ceylon Fishing Club's hatchery in Nuwara Eliya were also found to harbour the parasite. In *Lernaea* the limbs around the mouth are modified for sucking and attachment. The rest of the limbs are greatly reduced or are completely absent as they are of no use to the animal. The head of the animal is distinct from the rest of the body which is sac shaped and unsegmented.

*Lamproglena chinensis* Yu.

Females of this species have been recorded in Ceylon from the gill filaments of the snake-head (S. Loola), *Ophiocephalus striatus*. *Lamproglena* induces a distorted growth of the tip of the gill filaments of the host causing an enlargement of the connective tissue and a degeneration of the blood capillaries in the filaments.

## Sub-Class Branchiura

The Crustaceans belonging to this class are, at least temporarily, parasitic on fish. The freshwater forms are referred to as carp-lice. The head is laterally expanded into a structure resembling a carapace. These animals have four pairs of thoracic limbs. The abdomen is unsegmented, limbless and bilobed. Only one species has been recorded from Ceylon.

*Argulus foliaceus* (L.) (Page 63, Fig. 18) has been reported from Ceylon only in the Fisheries Research Station experimental ponds in Colombo. These may have been introduced with the fish (Carp) imported for breeding. A pair of limbs is greatly modified to function as a pair of sucking discs in *Argulus*. The parasites are commonly found in the gill chamber of fish but they may attach themselves on other parts of the body as well. *Argulus* is strictly dependent on fish blood. They may be occasionally found swimming about in the water but sooner or later they must find a fish host.

## Sub-Class Ostracoda

The Ostracoda are minute bean-shaped crustaceans, common in all types of fresh water. Each ostracod possesses a two-valved "shell" which is hinged dorsally. It is difficult to recognise the crustacean characters of ostracods because of this shell, which has to be partially removed to examine the internal structure. If an ostracod is disturbed the shell closes tightly enclosing the entire animal. When moving about a pair of antennae and a pair of limbs are the only parts of the body that project out of the bivalved shell. Some ostracods are free swimming, some move about on the surface of the water while others are creeping forms that live among plants or burrow in the mud at the bottom of the pond. Ostracoda are omnivorous, i.e., they can feed on decaying vegetable matter and on smaller animals particularly crustaceans and their larvae. Ceylon records are :

*Cypricercus reticulatus* Daday (Page 63, Fig. 14)

*Cypridopsis assimilis* Sars

*Cypridopsis globulus* Sars  
*Cypridopsis minna* (King.)  
*Cyprinotus cingalensis* Brady  
*Cyprinotus dentatmarginatus* Baird  
*Cypris granulata* Daday  
*Cypris subglobosa* Sowerby  
*Iliocypris australiensis* Sars  
*Notodromas entzi* Daday  
*Stenocypris ceylonica* Daday (Page 63, Fig. 11)  
*Stenocypris major* Baird  
*Stenocypris malcolmsoni* (Brady)

#### Sub-Class Malacostraca

Included in this class are a large number of species which show a great diversity in form. The cephalothorax is generally covered by a carapace and the eight thoracic and six abdominal segments all bear appendages. The abdominal appendages are always bifid, the first five pairs being slender and fringed with hairs for swimming. The pair of limbs in the last abdominal segment is broad and usually turned backward to form a tail fan, which is used in moving backwards. The thoracic limbs are used for walking and sometimes for grasping food. The mouth parts are modified for chewing. They have two pairs of antennae. The antennae have two filaments each (the members of other crustacean sub-classes have only one filament in each of the first antennae). These crustacea have compound eyes which in most members of the group are stalked. The fresh water malacostracans are divisible into 3 Orders, Amphipoda, Isopoda and Decapoda.

1. Carapace present. Eyes stalked.....Decapoda, page 70  
    No carapace. Eyes not stalked.....2
2. Body depressed (i.e., flattened from top to bottom).....Isopoda, page 70  
    Body compressed (i.e., flattened from side to side).....Amphipoda, page 67

#### ORDER AMPHIPODA

(Sand Hoppers and "Shrimps"<sup>1</sup>)

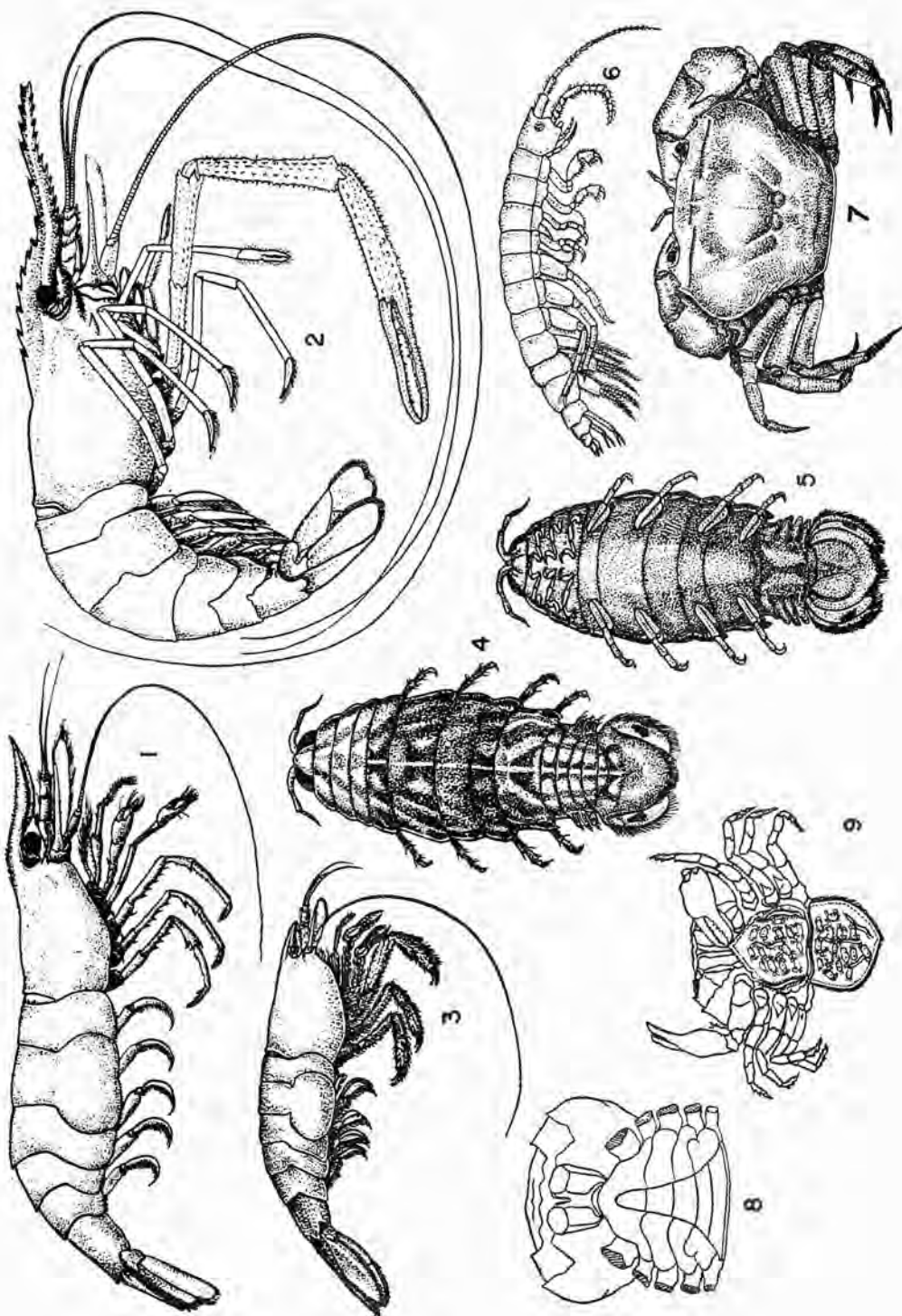
These malacostracan crustaceans do not have a carapace and their bodies are laterally compressed, i.e., flattened from side to side. They do not possess a tail fan and their eyes are not stalked. A typical member of the group is the sand hopper (this is not a freshwater form) which is exceedingly common on the sea beach particularly among debris which have been cast ashore. The freshwater amphipods usually live among water plants which is their food. The females carry their young in a brood pouch until the young are well developed. The females are usually carried about by the males. Amphipoda are not common in Ceylon freshwaters, their place being taken by *Caridina*. It is generally found that where *Caridina* are found Amphipoda are relatively few or absent. Amphipoda are quite common in saline waters such as in lagoons.

In 1958 a new species, *Paracallipe fernandoi* Wignarajah, obtained from tap water was described. Amphipods obtained from the Colombo (Beira) lake were indentified as *Grandidierella magna* (Page 69, Fig. 6). A specimen of *Parorchistia* sp. was found in a tank at Angunuwila.

<sup>1</sup> The term "shrimp" has been used rather indiscriminately by different authors to include various crustaceans like Amphipoda, Anostraca and Caridea.

**Explanation to figures on page 69**

1. *Caridina nilotica* var. *simoni* 22 mm. long.
2. *Macrobrachium rosenbergii* 30 cms. long.
3. *Atya typus* 7 cms. long.
4. *Alitropus typus* (dorsal view) 13 mm. long.
5. *Alitropus typus* (ventral view). 13 mm. long.
6. *Grandidierella megnae* (female) 8 mm. long.
7. *Paratelphusa ceylonensis* carapace 48 mm. wide.
8. Male crab to show the narrow abdomen.
9. Female crab with abdomen flexed back to show developing young.



## ORDER ISOPODA

(Water Loglice)

The members of this order have flattened (depressed) bodies. There is a distinct cephalothorax which represents the head and the first thoracic segment. The rest of the thorax consists of seven segments expanded laterally. The abdomen is relatively short and projects as a shield at the posterior end. The thoracic appendages are well developed but those of the abdomen are reduced, except the last pair which project backwards.

Specimens of *Alitropus typus* Milne Edw. (Page 69, Figs. 4 and 5) were collected from the gill chambers of the fishes *Rasbora daniconius* in Angunuwila (tank) and *Wallago attu* taken in the Kala-Oya. This species was also found free living in the Battulu Oya, Nedimala (Dehiwela) and the Fisheries Department ponds at Narahenpitiya. *Alitropus typus* is a facultative ectoparasite and lives in freshwater, close to the sea and in lagoons, from where it has probably migrated.

It has been reported that during the drought in Angunuwila, the fish are infested with *A. typus*, many specimens occurring within the gill chambers of a single fish, where they probably affect respiration.

## ORDER DECAPODA

(Prawns, "Shrimps<sup>1</sup>" and Crabs)

These crustacea have a conspicuous carapace which covers all the thoracic segments. In the Decapoda the eyes are stalked and they have the usual mouth parts. The first three pairs of thoracic limbs are modified to aid in feeding and are called maxillipeds. The last five pairs of thoracic limbs are typical walking legs, a characteristic which has earned the order the name Decapoda (meaning 10 legs). Often one or more pairs of these walking legs are greatly enlarged and bear large claws. These chelate walking legs have lost their locomotory function and aid in feeding and defence. Such modified walking legs are seen in most crabs and certain species of prawns.

The Decapoda include the most highly organised crustaceans. Ceylon freshwater Decapoda are divided into two groups namely Caridea and the Potamonidae.

1. Body crab-like. Abdomen greatly reduced.....Potamonidae, page 71  
Body prawn-like. Abdomen not reduced.....Caridea, page 70

## GROUP CARIDEA

(Prawns and "Shrimps<sup>1</sup>")

This group includes the freshwater prawns and "shrimps" and are closely allied to the large marine prawns (Penaeidae). In the Caridea the body is long and somewhat laterally compressed. The abdomen is long and ends in a tail fan. The members of the third pair of walking legs are not equipped with claws. The lateral chitinous plate of the second abdominal segment overlaps the first and second lateral plates.

The Caridea are represented in Ceylon by two families, Atyidae and Palaemonidae.

1. Small forms, less than 5 cms. long. The clawed appendages have conspicuous terminal tufts of hair.....Atyidae, page 70  
Large forms, more than 5 cms. long. The clawed appendages do not have terminal tufts of hair.....Palaemonidae, page 71.

## FAMILY ATYIDAE

A group of freshwater forms in which the first pair of walking legs are provided with well developed claws or chelae, having conspicuous terminal tufts of hair. The mandibles have no palps. The last three pairs of thoracic limbs are not conspicuously enlarged. *Caridina* and *Atya* are two genera of Atyidae represented in Ceylon.

<sup>1</sup>The term "shrimp" has been used rather indiscriminately by different authors to include various crustaceans like Amphipoda, Anostraca and Caridea.

The commonest species, *Caridina nilotica* var. *simoni* is found in paddy-fields, streams and the irrigation reservoirs throughout the low-country. It is an important constituent of the food of fishes and occurs in very large numbers. The female carries the eggs under her abdomen. *Caridina pristis* has been recorded from the Mahaweli ganga at Peradeniya and *Caridina singalensis* which is distinguished by the very short rostrum was recorded in Nuwara Eliya. All the species of *Caridina* are small, measuring about 1-2 cms. in length, and are generally called "shrimps".

The *Caridina* recorded from Ceylon are:

- Caridina fernandoi* Arudpragasam and Costa
- Caridina nilotica* var. *bengalensis* de Man
- Caridina nilotica* var. *simoni* Bouvier (Page 69, Fig. 1)
- Caridina pristis* Roux
- Caridina singalensis* Ortmann

The genus *Atya* contains relatively large forms which reach a length of about 5 cms. They have relatively short limbs and can be called "prawns" rather than "shrimps". In Ceylon there is only one species namely, *Atya typus* Milne Edw. (Page 69, Fig. 3) and specimens have been secured from the fast flowing Kuda-Oya near Tissamaharama.

#### FAMILY PALAEMONIDAE

Includes freshwater and marine forms. They are separable from the *Atyidae* in that the chelate legs have no terminal tufts of hairs. The second pair of pereopods is very greatly enlarged and in mature specimens is often longer than the body.

Only one genus, *Macrobrachium* (*Palaemon*) is represented in Ceylon. *M. rosenbergii* is a very large form (30 cms.) occurring in brackish water. It is especially common in the Chilaw and Moratuwa areas where it is often seen in the markets. *M. malcolmsonii* is slightly smaller than *M. rosenbergii*. A few specimens have been collected from the Parakrama Samudra, Polonnaruwa. *M. idella* is known in Ceylon from only a few specimens taken near Dehiwela. *M. scabriculum* is a very common species found throughout the low-country. It bears a tuft of hairs at the base of the chelae on each member of the second pair of legs in the male. *M. latimanus* occurs exclusively in hilly streams and is a stoutly built prawn much smaller in size than *M. rosenbergii*.

- Macrobrachium idella* (Hilgendorf)
- Macrobrachium latimanus* (Von Martens)
- Macrobrachium malcolmsonii* (Milne Edwards)
- Macrobrachium rosenbergii* (De Man) (Page 69, Fig. 2)
- Macrobrachium rude* (Heller)
- Macrobrachium scabriculum* (Heller)

#### GROUP POTAMONIDAE

(Freshwater Crabs)

The potamonid crabs (Page 69, Fig. 7) resemble marine and lagoon crabs. The body consists of a large cephalothorax dorsoventrally depressed and expanded laterally. The abdomen is greatly reduced and flexed under the cephalothorax. The female carries her eggs between the abdomen and the cephalothorax. The young are developed in this space (Page 69, Fig. 9) till they are old enough to feed by themselves. The young are generally released with the onset of the monsoon rain. The male has a narrower abdomen than the female (Page 69, Fig. 8). The abdominal limbs of both sexes are greatly reduced and are not used for swimming. The first pair of thoracic limbs are modified as chelipeds (bear claws). The other four pairs are used for walking and although somewhat compressed laterally they are not used for swimming.

The potamonid crabs are widely distributed in Ceylon occurring in freshwater from the coast to the mountains and are represented by the single genus *Paratelphusa*. In these crabs the carapace is broader than long and is generally smooth except for a long cervical groove. They live in burrows from which they emerge from time to time to feed. Their food is mainly decaying organic matter but they also attack animals such as small fishes, earthworms and arthropods. Freshwater crabs are eaten by many aquatic and terrestrial animals including fishes, amphibians, reptiles, birds and mammals. They also act as intermediate hosts for many parasitic animals such as nematodes and trematodes<sup>1</sup>.

Three species namely *P. hippocastanum*, *bouvieri* and *innominata* are inhabitants of the low-country and are only rarely found in the hill-country. *P. ceylonensis* is the commonest freshwater crab in Ceylon and is present in the low and mid-country but not in the hill-country. *P. rugosa*, *soror* and *enodis* are inhabitants of the hill-country.

The following eight species have been recorded from Ceylon.

- Paratelphusa bouvieri* (Rathbun)
- Paratelphusa ceylonensis* Fernando (Page 69, Fig. 7)
- Paratelphusa enodis* (Kingsley)
- Paratelphusa hippocastanum* (Müller)
- Paratelphusa innominata* Fernando
- Paratelphusa parvula* Fernando
- Paratelphusa rugosa* (Kingsley)
- Paratelphusa soror* (Zehntner)

## INSECTA

(The Insects)

The body of an insect is divisible into three parts: (1) A well marked head bearing a pair of feelers or antennae and three pairs of "jaws" which are modified according to the feeding habits of the insects and resemble shortened legs which are clustered around the mouth, (2) a central portion termed the thorax with three pairs of legs and two pairs of wings, and (3) a rear portion termed the abdomen which does not have any locomotory appendages. The most striking character of these animals is that the number of walking legs is constant, namely three pairs. It is therefore safe to assume that any animal with three pairs of jointed legs is an insect.

A characteristic feature among insects is that they pass through a free living larval phase. If the larva is similar to the adult except for the absence of well formed wings (short wings or wing pads may be present) and genitalia then it is called a nymph. This condition occurs in such groups as the Hemiptera, Odonata, Ephemeroptera and Plecoptera and it is quite easy to identify a nymph of a particular family or even genus. On the other hand if the larva undergoes considerable alteration of structure in reaching the adult condition then it is called a true larva. This condition is found in the Coleoptera, Diptera and Lepidoptera where larvae do not resemble their adults but they have a characteristic structure. The nymphs and larvae shed their outer covering (moult) and undergo a series of changes before attaining the adult condition.

The insects are a terrestrial group of animals, some members of which have invaded freshwater and a few even the sea. Since insects are only secondarily aquatic, the degree of adaptation to the aquatic habitat varies greatly among the families and sometimes even among genera within a family. Most aquatic species are capable of surviving outside water for a considerable period of time and some habitually spend their larval life in damp places outside water like their terrestrial relatives. Some of the largest insects in the world are found in freshwater and belong to the group of belostomatid bugs.

<sup>1</sup> The human lungfluke *Paragonimus westermani* has been recorded in Ceylon recently in carnivorous animals like the leopard. The infective larval stages of this fluke occur in species of *Paratelphusa*.

The following ten orders of insects are found in the aquatic habitats: (1) Hemiptera—Bugs, (2) Coleoptera—Beetles, (3) Odonata—Dragonflies and Damselflies, (4) Ephemeroptera—Mayflies, (5) Plecoptera—Stoneflies, (6) Lepidoptera—Moths and Butterflies, (7) Trichoptera—Caddisflies, (8) Diptera—True flies, (9) Neuroptera—Alderflies, (10) Collembola<sup>1</sup>—Springtails.

Of the above orders only the aquatic Hemiptera, Coleoptera and Collembola<sup>1</sup> spend their full life-cycle in the water. Some of the hemipterans and coleopterans can fly and are therefore able to colonise new habitats.

#### KEY FOR THE IDENTIFICATION OF ADULT AQUATIC INSECTS

1. Hind end of insect with a forked organ with which it can spring in the air (Page 95, Fig. 16).....Collembola, page 93  
Do not have such an organ..... 2
2. Head prolonged into a proboscis. ~~Forewings not hardened~~.....Hemiptera, page 74  
Head prolonged into a proboscis. Forewings hardened to form a protective covering (elythra) for the hind wings.....Coleoptera, page 83

#### THE LARVAE OF AQUATIC INSECTS

There are a large number of insect larvae and pupae which live in the water while the adults lead a terrestrial or aerial life. It is not possible to give adequate treatment in this work to such insect larvae. However figures, ecological notes and other data that will aid in their field identification are given.

#### KEY FOR THE IDENTIFICATION OF THE LARVAE OF AQUATIC INSECTS

1. Larvae with visibly developed external wing pads (rudimentary wings) ..... 2  
Larvae without external wing pads..... 5
2. Mouth parts, which are modified for sucking, take the form of a jointed beak which is directed backwards beneath the head.....Hemiptera<sup>2</sup>, page 74  
Mouth parts not in the form of a beak..... 3
3. Lower lip (labium) modified to form a "mask" to capture prey.....Odonata, page 93  
No such mask..... 4
4. Three posterior processes (Page 95, Fig. 9).....Ephemeroptera, page 93  
Two posterior processes (Page 95, Fig. 5).....Plecoptera, page 96
5. With jointed thoracic legs..... 6  
Without jointed thoracic legs.....Diptera, page 96
6. Prolegs directed backwards and present only on last abdominal segment. (Prolegs are absent in *Sialis* which has a single long median tail at the end of the abdomen) ..... 7  
Prolegs often entirely wanting but if present they are found on more than one segment.....8

<sup>1</sup> Most authors disagree as to whether Collembola are aquatic insects, since they live in damp places or close to the water's edge and occasionally take to the water.

<sup>2</sup> The hemipteran insects belonging to the family Corixidae do not have a conspicuous proboscis.

7. Each abdominal segment has a pair of lateral fleshy lobes and at the base of each lobe is a large tuft of tracheal gills.....Neuroptera, page 96  
     No abdominal fleshy lobes but there may be minute gill filaments .....  
     .....Trichoptera, page 96
8. Five pairs of prolegs present.....Lepidoptera, page 96  
     Generally without prolegs but always less than five pairs...Coleoptera, page 83

## HEMIPTERA

### (Bugs)

These insects have mouth parts greatly modified for piercing and sucking. The head is prolonged into a proboscis which is usually backwardly directed except when feeding. It is grooved, stout and jointed and is the highly modified labium or second pair of maxillae (lower lip). Within the proboscis are two pairs of thin stylets, the two stylets forming the first pair are the modified mandibles while the other two are the first maxillae. The stylets of the second pair are placed close together forming two long narrow channels one of which leads to the alimentary canal. In feeding both pairs of stylets pierce the covering of the host and the juices of the latter are sucked up along this channel. The Hemiptera are adapted to feed on a liquid diet and some species (Corixidae) feed on thick suspensions of bottom ooze. Metamorphosis is gradual, the larvae resembling the adults except that the larvae do not have well formed wings.

The aquatic Hemiptera are divisible into two main groups :

(a) Those that live under water are collectively referred to as the Cryptocerata. They have very short concealed antennae. Their limbs are modified for swimming in the active forms like the Corixidae while they act as grasping organs in the Nepidae and Ranatridae, and they are modified for both swimming and for grasping in the Belostomatidae. Hemiptera are all dependant on an aquatic habitat and die if deprived of water for any considerable time. However some of them are capable of flying relatively long distances. The families Nepidae, Ranatridae, Belostomatidae, Naucoridae, Corixidae, Notonectidae, Pleiidae and Helotrepidae are included in the Cryptocerata.

(b) Those that live on the water surface and on vegetation very near the water are referred to as the Gymnocerata. They are generally light bodied and the limbs possess hydrofuge hairs. Their antennae are prominent and are longer than the head. They are incapable of swimming but "walk" on the surface of the water. They can withstand considerable desiccation and often aestivate under vegetation. They are however only active in water or moist situations. They have raptorial appendages and feed mainly on dead and dying insects on the water surface. The families Hydrometridae, Veliidae, Mesoveliidae, Gerridae and Hebridae are included in the Gymnocerata.

### KEY TO THE ADULT HEMIPTERA

The larvae (nymphs) of Hemiptera resemble the adults in general body form and hence a separate key is not provided for the larvae. In any case it is not advisable to identify species from the larvae.

1. Live beneath the water surface. Antennae shorter than the head..... 2  
     Live on the surface of the water. Antennae prominent, longer than head..... 8
2. Head provided with a beak which is not pointed.....Corixidae, page 79  
     Head provided with a sharp pointed beak..... 3
3. Respiratory tubes at posterior end of abdomen and no hairs on legs..... 4  
     No posterior respiratory tubes, hairs on the hind legs..... 5

4. Body flattened and leaf-like.....Nepidae, page 75  
Body cylindrical and stick-like.....Ranatridae, page 75
5. Swim on their backs with the belly towards the water surface.....6  
Swim normally with the back towards the water surface..... 7
6. Antennae four segmented.....Notonectidae, page 79  
Antennae three segmented.....Pleidae, page 78  
Antennae two segmented.....Helotrepidae, page 78
7. Middle and hind legs flattened for swimming. Tip of abdomen with two strap like retractile appendages ..... Belostomatidae, page 78  
Feet adapted for walking, not flattened. The hind feet have spines on them. No appendages at tip of abdomen.....Naucoridae, page 78
8. Head very long, body slender.....Hydrometridae, page 82  
Head almost as broad as long..... 9
9. Antennae with five segments.....Hebridae, page 83  
Antennae with four segments..... 10
10. Beak four jointed, two posterior pairs of legs long and slender.....Gerridae, page 82  
Beak three-jointed. None of the legs extremely long and slender..... 11
11. Legs inserted almost at middle of body on ventral surface.....Mesoveliidae, page 82  
Legs, particularly hind legs inserted towards or at sides of body on ventral side..... Veliidae, page 82

**FAMILY NEPIDAE—The Water Scorpions**

Superficially they resemble scorpions. The first pair of legs is raptorial, i.e., for capturing prey. These bugs can be recognised by the long "tail" which is a respiratory tube formed of two grooved filaments. They have flat, oval shaped bodies. The antennae or feelers are three segmented. Although they are provided with wings these insects rarely fly. When they float on the surface of the water they resemble small dead leaves. Their eggs are inserted into the stems of water plants. The Nepidae commonly live at the bottom of paddy fields and ditches where they prey upon small animals.

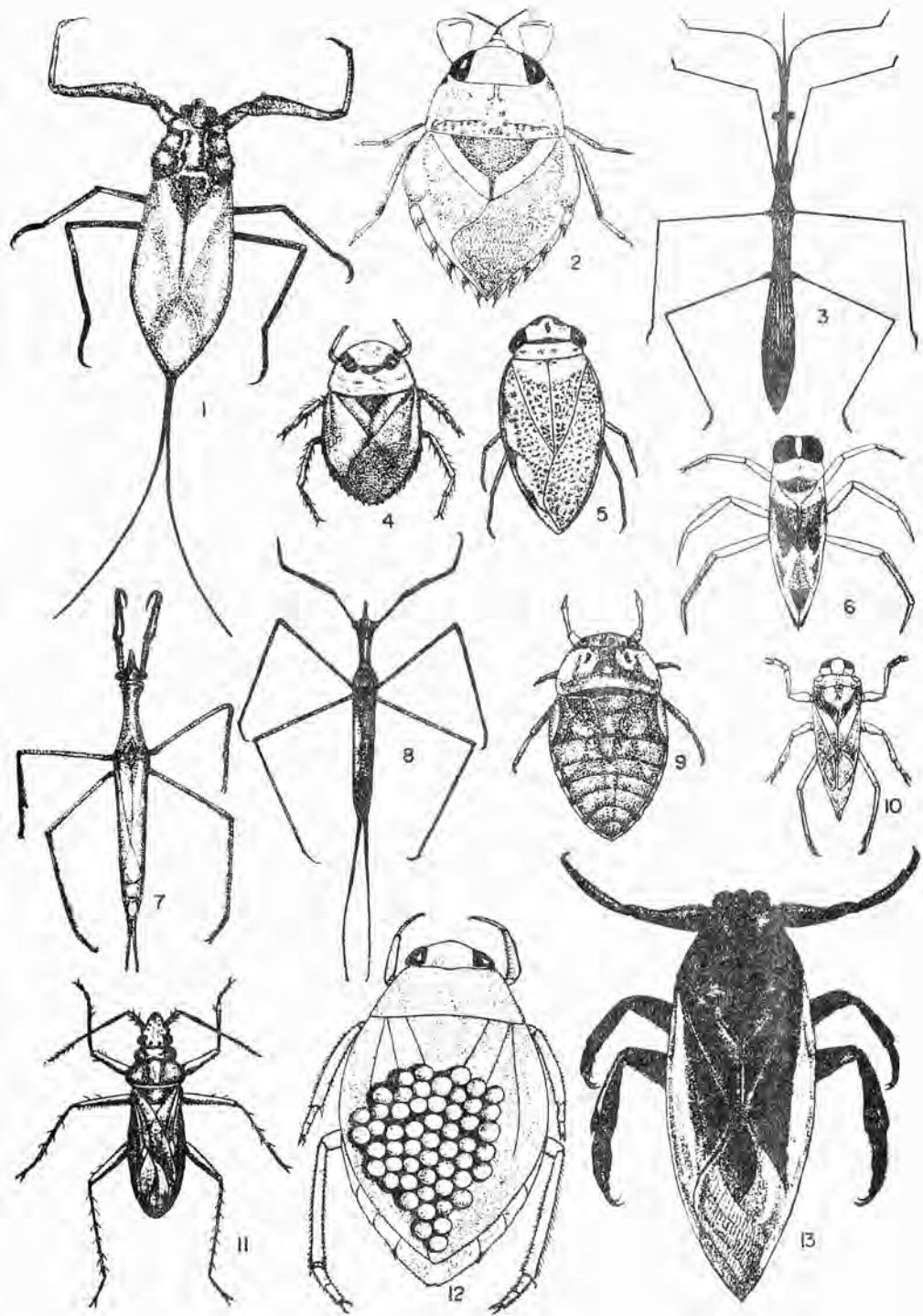
- Laccotrephes flavovenosus* Dohrn
- Laccotrephes griseus* (Guer.)
- Laccotrephes grossus* (Fabr.) (Page 77, Fig. 1)
- Laccotrephes maculatus* (Fabr.)

**FAMILY RANATRIDAE—The Water Stick Insects**

Characters are similar to those of the family Nepidae except that their bodies are narrower. These insects spend most of their time suspended from the surface of the water by the respiratory tube. This tube maintains communication between the atmosphere and the tracheal (respiratory) system of the insect. The insect remains for long periods in this position giving the appearance of a cluster of small twigs or roots thereby deceiving its prey. When the prey approaches within striking distance the insect captures it by means of its raptorial forelegs. *Ranatra* is a very common insect in paddy fields, ponds, tanks and slow running streams.

Explanation to figures on page 77

1. *Laccotrepes grossus* 60 mm. from tip of snout to origin of "tail".
2. *Naucoris scutellaris* 7 mm.
3. *Hydrometra greeni* 13 mm.
4. *Diaphorocoris punctatissimus* 8 mm.
5. *Micronecta punctata* 2.5 mm.
6. *Anisops barbata* 11 mm.
7. *Gercomastus fumosus* 60 mm.
8. *Ranatra filiformis* 23 mm. from snout to origin of "tail".
9. *Helocoris bengalensis* 8 mm.
10. *Enithares abbreviata* 12 mm.
11. *Mesovelia orientalis* 4 mm. after Distant.
12. *Sphaerodema rusticum* (male) with eggs cemented on its back, from Weerakoon 36 mm.
13. *Lethocerus indicus* 85 mm.



*Cercometus fumosus* Dist. (Page 77, Fig. 7)

*Cercometus strangulatus* Mont.

*Ranatra elongata* Fabr.

*Ranatra filiformis* Fabr. (Page 77, Fig. 8)

*Ranatra longipes* Stal.

*Ranatra varipes* Stal.

#### FAMILY BELOSTOMATIDAE—Giant Water Bugs

The largest insects are included in this family. Their forelegs are relatively unmodified while the hind legs are flattened and adapted for swimming. They have no respiratory tail processes. The feelers are four segmented. They are predatory and the larger species may even prey upon fishes. *Lethocerus* is capable of flying considerable distances and is often seen at night round electric and other lights. In the genus *Sphaerodema*, the female lays her eggs in neat rows cemented to the back of the male (Page 77, Fig. 12) which then acts as a "nurse maid" carrying the eggs on his back until they hatch. The male is therefore not able to fly till the eggs hatch out. *Sphaerodema* occurs in paddy fields and also in fast flowing streams of the low country.

*Lethocerus indicus* (Lep. et Serv.) (Page 77, Fig. 13)

*Sphaerodema*<sup>1</sup> *rusticum* (Fabr.) (Page 77, Fig. 12)

#### FAMILY NAUCORIDAE—Creeping Water Bugs

These insects have oval shaped bodies and four segmented feelers. *Naucoris scutellaris* is commonly found in tanks throughout the low country. *Diaphorocoris punctatissimus* occurs on moist rock faces in the hill country and is a rather slow moving insect. *Heleocoris bengalensis* is a very powerful swimmer and occurs in fast flowing rivers. It has been collected from the Kelani ganga at Kitulgala, from Welimada and the Kuda-Oya near Tissamaharama. It is capable of inflicting a very painful sting and should be handled with care.

*Diaphorocoris punctatissimus* (Kirby) (Page 77, Fig. 4)

*Heleocoris bengalensis* Mont. (Page 77, Fig. 9)

*Naucoris scutellaris* Stal. (Page 77, Fig. 2)

#### FAMILY HELOTREPHIDAE—Backswimmers

The head and thorax of these insects are fused. Three species are present in Ceylon.

*Helotrephes kirkaldyi* Esaki et China

*Limnotrephes campbelli* Esaki et China (Page 80, Fig. 4)

*Tiphotrephes indicus* Dist. (Page 80, Fig. 3)

#### FAMILY PLEUDAE—Small Backswimmers

They are very similar in structure to the Helotrephidae. Two species occur in Ceylon.

*Plea frontalis* Fieb. (Page 80, Fig. 2)

*Plea liturata* Kirk.

<sup>1</sup> Lauch et Menke 1961 changed the name *Sphaerodema* to *Diplonychus*.

#### FAMILY NOTONECTIDAE—Backswimmers

These insects are strong swimmers but they do so on their backs, propelling themselves by means of their long hind legs. When they dive into the depths of water, they carry with them a bubble of air between a series of hairs on either side of the body. They periodically come up to the surface to renew their supply of air. They have large broad heads with prominent eyes and four segmented feelers (antennae). The proboscis is short and made up of three or four segments. The forewings are well developed and they are capable of flight. These insects should be handled with care as they are capable of inflicting painful stings. *Anisops* spp. have silvery wings while *Enithares* spp. are drab brown to dark brown in colour. *Anisops* has a hair lined pit in the mid line at the junction of the thorax and abdomen. They are found throughout the low country in small habitats.

*Anisops ali* Dist.

*Anisops barbata* Brooks (Page 77, Fig. 6)

*Anisops batillifrons* Lundb.

*Anisops bowieri* Kirk.

*Anisops breddini* Kirk.

*Anisops crinata* Brooks

*Anisops extendofrons* Brooks

*Anisops nasuta* Fieb.<sup>1</sup>

*Anisops nivea* (Fabr.)

*Enithares abbreviata* (Kirby) (Page 77, Fig. 10)

*Enithares templetoni* (Kirby)

*Enithares triangularis* (Guer.)

*Enithares triangularis* var. *simplex* (Kirby)

*Nychia malayana* Lundb.<sup>2</sup>

*Nychia marshalli* (Scott)<sup>3</sup>

#### FAMILY CORIXIDAE—The Water Boatmen

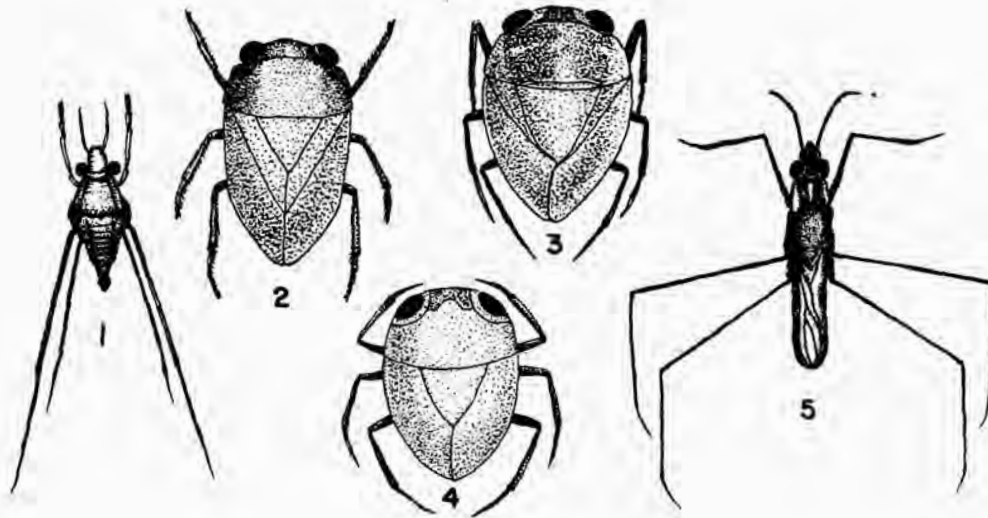
They are a family of minute water insects. However, *Agraptocorixa hyalinipennis* is relatively large being about 10 mm. in length. They are similar to the Notonectidae but do not swim on their backs. Like the Notonectidae they carry a bubble of air for respiration. They have oval and flattened bodies. They do not have a conspicuous proboscis. These insects suck up particles of debris, swept up with their spatulate forelimbs. The head is wider than the first segment (pronotum) of the thorax. The forelegs are short and thick and each consists of a single flattened segment which bears in the male, a row of small strong teeth giving it a rough surface. When the rough surfaces of the two feet are drawn across the inconspicuous proboscis a shrill note is produced. The middle and the hind legs are long. The hind legs are flattened and fringed with hairs to aid in swimming. The eggs are usually laid singly attached to the stems of plants or are attached to threads of floating algae. They are generally found in still waters being particularly numerous in paddy fields and the edges of irrigation reservoirs and are capable of flight. *Micronecta punctata* is often found in rock pools in river beds. *M. quadristrigata* is the commonest species.

*Agraptocorixa hyalinipennis* (Fabr.)<sup>3</sup>

<sup>1</sup> Doubtful record for Ceylon. The original *A. nasuta* has been broken up into several species.

<sup>2</sup> Doubtful species, they are probably *Anisops breddini*.

<sup>3</sup> New record for Ceylon.

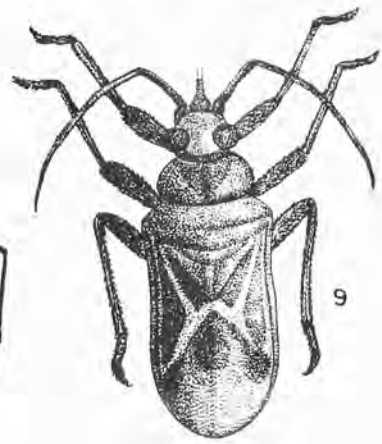
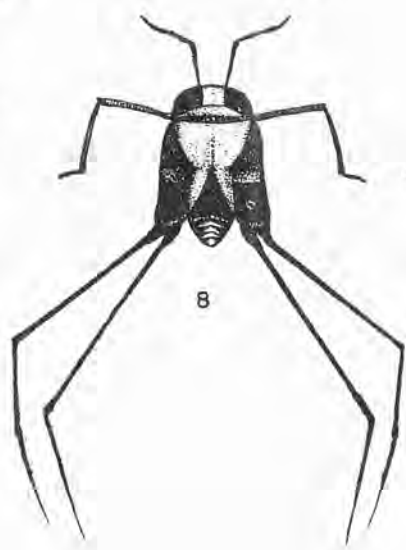
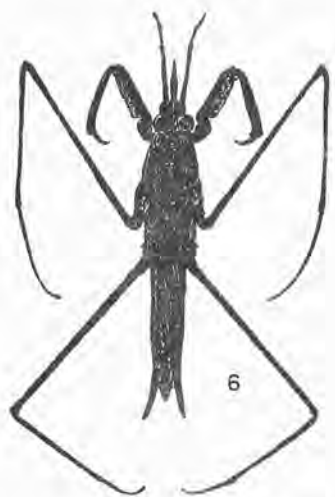
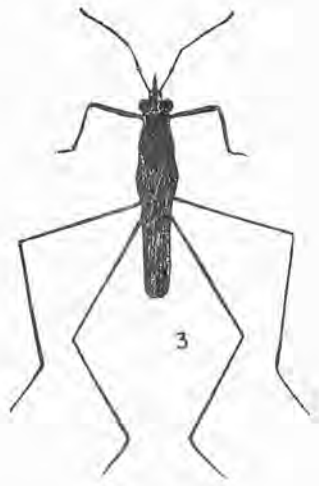
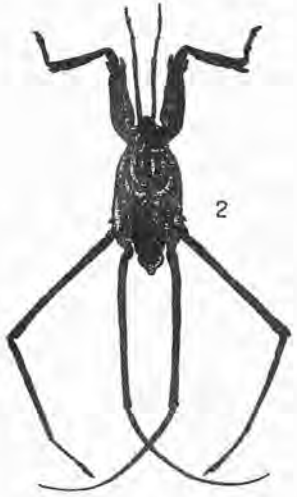


Explanation to figures above

1. *Rhagodotarsus kraepelini* 3.5 mm. from snout to end of abdomen.
2. *Plea frontalis* 2.5 mm.
3. *Tiphotrephes indicus* 1.5 mm.
4. *Limnotrephes campbelli* 1.5 mm.
5. *Gerris adelaidis* 15 mm.

Explanation to figures on page 81

1. *Rhagovelia ravana* 4 mm. from snout to end of abdomen.
2. *Metrocoris stali* 7 mm. from snout to end of abdomen.
3. *Limnogonus nitidus* 11 mm. from snout to end of abdomen.
4. *Ptilomera cingalensis* 14 mm. from snout to end of abdomen.
5. *Limnogonus parvulus* 6 mm. from snout to end of abdomen.
6. *Cylindrostethus productus* 24 mm. from snout to end of abdomen.
7. *Limnometra fluviorum* 13 mm. from snout to end of abdomen.
8. *Venidius henryi* 1.5 mm. from snout to end of abdomen.
9. *Timasius splendens* 3 mm.



*Micronecta albifrons* Motsch.  
*Micronecta fascioclavus* Chen.  
*Micronecta flavens* Wrobl.  
*Micronecta punctata* Fieb. (Page 77, Fig. 5)  
*Micronecta quadristrigata* Bredd.  
*Micronecta scutellaris* (Stal)  
*Micronecta tarsalis* Chen.  
*Sigara substriata* (Uhl.)

#### FAMILY HYDROMETRIDAE—The Water Measurers

This family is represented in Ceylon by one species only. It lives on the surface of the water in sheltered situations. The length of the head is several times its width and the portion in front of the eyes is very elongate. The body is narrow and stick-like; the hind portion of the abdomen is covered with a velvety pile of hair. The antennae are four segmented. They lay their eggs singly on plants above the water level. They feed on smaller aquatic creatures or on floating waste material. *Hydrometra greeni* Kirk. (Page 77, Fig. 3) is often found near stagnant water walking on weeds and on the edges of the water. It is very common in buffalo wallows in paddy fields along with veliids.

#### FAMILY MESOVELIIDAE—Pond Skaters

Only one species, namely *Mesovelvia orientalis* Kirk. (Page 77, Fig. 11) has been recorded from Ceylon. They live on the surface of the water and are similar to those of the families Veliidae and Gerridae. They frequent the leaves of plants and embed their eggs in the stems. The head is shorter than the thorax. The abdomen unlike in the Hydrometridae is not narrow. The insects of this family are similar to those of the families Veliidae and Gerridae.

#### FAMILY VELIIDAE—Water Skaters

In these insects the length of the head is about the same as the width across the eyes. The posterior legs are short. They possess the usual velvety pile of hair. These insects are generally found in streams, living in clusters or flocks on the surface of the water swimming against the current. *Microvelia longicornis* is a common inhabitant of small pools of water in the low country. It is capable of flight and is commonly seen in rain puddles.

*Microvelia diluta* Dist.  
*Microvelia longicornis* Bueno  
*Rhagovelia nigricans* Burm.  
*Rhagovelia ravana* Kirk. (Page 81, Fig. 1)  
*Peritoppus breddini* Kirk.

#### FAMILY GERRIDAE—The Water Striders

These insects live on the surface of the water. The head is short, its length being about the same as its width across the eyes. The posterior legs are very long, the femora (thigh or third division of leg) extending far beyond the abdominal apex. They possess a velvety pile of hairs beneath the abdomen. The eggs are deposited in a cluster surrounded by mucilage and attached to submerged plants.

*Cylindrostethus bituberculatus* Schmidt  
*Cylindrostethus nietneri* Schmidt  
*Cylindrostethus productus* Spin. (Page 81, Fig. 6)  
*Gerris adalaidis* Bohrn (Page 80, Fig. 5)  
*Gerris pectoralis* Mayr.

*Limnogonus fossarum* (Fabr.)  
*Limnogonus nitidus* (Mayr.) (Page 81, Fig. 3)  
*Limnogonus parvulus* (Stal) (Page 81, Fig. 5)  
*Limnometra anadyomene* (Kirk.)  
*Limnometra fluviorum* (Fabr.) (Page 81, Fig. 7)  
*Metrocoris illustrarius* Dist.  
*Metrocoris stali* (Dohrn) (Page 81, Fig. 2)  
*Onychotrechus sakuntala* (Kirk.)  
*Ptilomera cingalensis* (Stal) (Page 81, Fig. 4)  
*Rhagodotarsus kraepelini* Breddin (Page 80, Fig. 1)  
*Rheumatogonus custodiendus* (Dist.)  
*Rheumatogonus vittatus* Esaki  
*Venidius henryi* Esaki (Page 81, Fig. 8)

#### FAMILY HEBRIDAE

This is a family of minute insects with five segmented feelers. They usually live on floating pond weeds and even among damp weeds and moss on the shore.

*Timasius atratus* Dist.  
*Timasius splendens* Dist. (Page 81, Fig. 9)

#### COLEOPTERA

(The Beetles)

Among the various insect orders the Coleoptera contains the largest number of species. They are found in all types of terrestrial habitats and a number of species are aquatic and show various grades of adaptation to an aquatic life. Some like the Dytiscidae are confined to the water although pupation takes place in moist places outside the water itself. The Hydrophilidae are aquatic in the adult stage but the larvae of some species are found in moist soil (like many terrestrial beetles). Most aquatic beetles are capable of withstanding considerable desiccation and during the drought live under various moist or even dry objects.

There is a large group of beetles which live near the water and invade it from time to time and they seem to be equally at home in or out of the water. Such forms have not been included in this publication.

A striking character of the Coleoptera is the specially modified pair of horny, hard, shiny first, pair of wings, termed elytra, which form a protective covering for the normally large and membranous second pair of wings. In flying they use the second pair of wings. The beetles have strong biting mouthparts and their legs are flattened and fringed with hairs to help in swimming. The Coleoptera undergo extensive and complete metamorphosis, the larvae and adults being very different in appearance. The larvae of the different species are very variable in form and are difficult to recognise.

The list of aquatic beetles recorded for Ceylon can only be considered very tentative. Most of the records are very old and no recent revision of aquatic beetles of the area is available unlike the Hemiptera where many recent works deal with species from Ceylon.

The aquatic beetles recorded from Ceylon are placed in five families, namely, Dytiscidae, Noteridae, Haliplidae, Gyrinidae and Hydrophilidae. We have omitted from the present account some families, e.g., Helodidae, which are relatively rare.

## KEY TO ADULT COLEOPTERA

1. Maxillary palp generally longer than antennae. Each antenna is club shaped at its tip ..... Hydrophilidae, page 89  
Maxillary palp shorter than antennae ..... 2
2. Posterior end of abdomen not covered by wings. Each eye divisible into two parts  
Surface swimmers ..... Gyrinidae, page 88  
Entire abdomen covered by the wings. Each eye not divided into two parts.  
Live submerged in the water ..... 3
3. Large plates covering the bases of hind legs so that the point at which they are attached to the body cannot be seen (Page 91, Fig. 4) ..... Haliplidae, page 88  
No plates covering the base of hind legs and the point of attachment to the body is visible ..... 4
4. Feet not flattened but adapted for digging. Body somewhat crescentic in shape and slightly compressed ..... Noteridae<sup>1</sup>, page 88  
Feet generally flattened for swimming ..... Dytiscidae<sup>1</sup> page 84

## KEY TO THE COLEOPTERAN LARVAE

1. Last three segments of leg relatively long and well-developed, the last segment terminating in one or two movable claws ..... 2  
Legs with not more than two long segments and a single claw shaped segment at the tip. More or less maggot-like (Dipteran larvae) (Page 91, Fig. 9) ..... Hydrophilidae, page 89
2. Abdomen terminating in a long tapering tail process. Shape generally long and thin. Last segment of leg terminating in one claw (Page 91, Fig. 1) ..... Haliplidae, page 88  
Abdomen without long process. Last segment of leg terminating in two claws. General shape robust ..... 3
3. Four hooks at end of abdomen. Lateral abdominal gills present (Page 91, Fig. 6) ..... Gyrinidae, page 88  
Abdominal hooks and lateral abdominal gills absent ..... 4
4. Body cylindrical and tapering at the hind end. Legs short (Page 87, Fig. 7) ..... Noteridae, page 88  
Body spindle shaped. Legs not short. Swimming and crawling larvae (Page 87, Figs. 1, 4 and 6) ..... Dytiscidae, page 84

## FAMILY DYTISCIDAE—Diving Beetles

These beetles occur both in standing and in running water and are well adapted for an aquatic life. They can be characterised as follows: The first pair of wings are as long as the abdomen. The hind legs are widely separated from the second pair of legs and possess very large coxae (segment nearest the body). The first two pairs of legs are short. In some species there are adhesive pads on the first pair of legs of the males which enable them to hold onto the female while copulating. The antennae are long and filiform. The adults breathe by coming to the surface and thrusting the extreme end of the abdomen out of the water and larvae do the same with the tail-like processes at the hind end of the abdomen. Their larvae have large heads and long tapering bodies. The larvae and adults are armed with powerful mandibles which are grooved for sucking the body juices of their victims.

<sup>1</sup> It is difficult to give simple characters to separate the Dytiscidae and Noteridae. Some authors consider both families under Dytiscidae.

There are 43 species of diving beetles of which the commonest are *Cybister confusus*, *Hydraticus fabricii*, *Eretes sticticus*, *Laccophilus chinensis inefficiens* and *Bidessus<sup>1</sup> inconstans*.

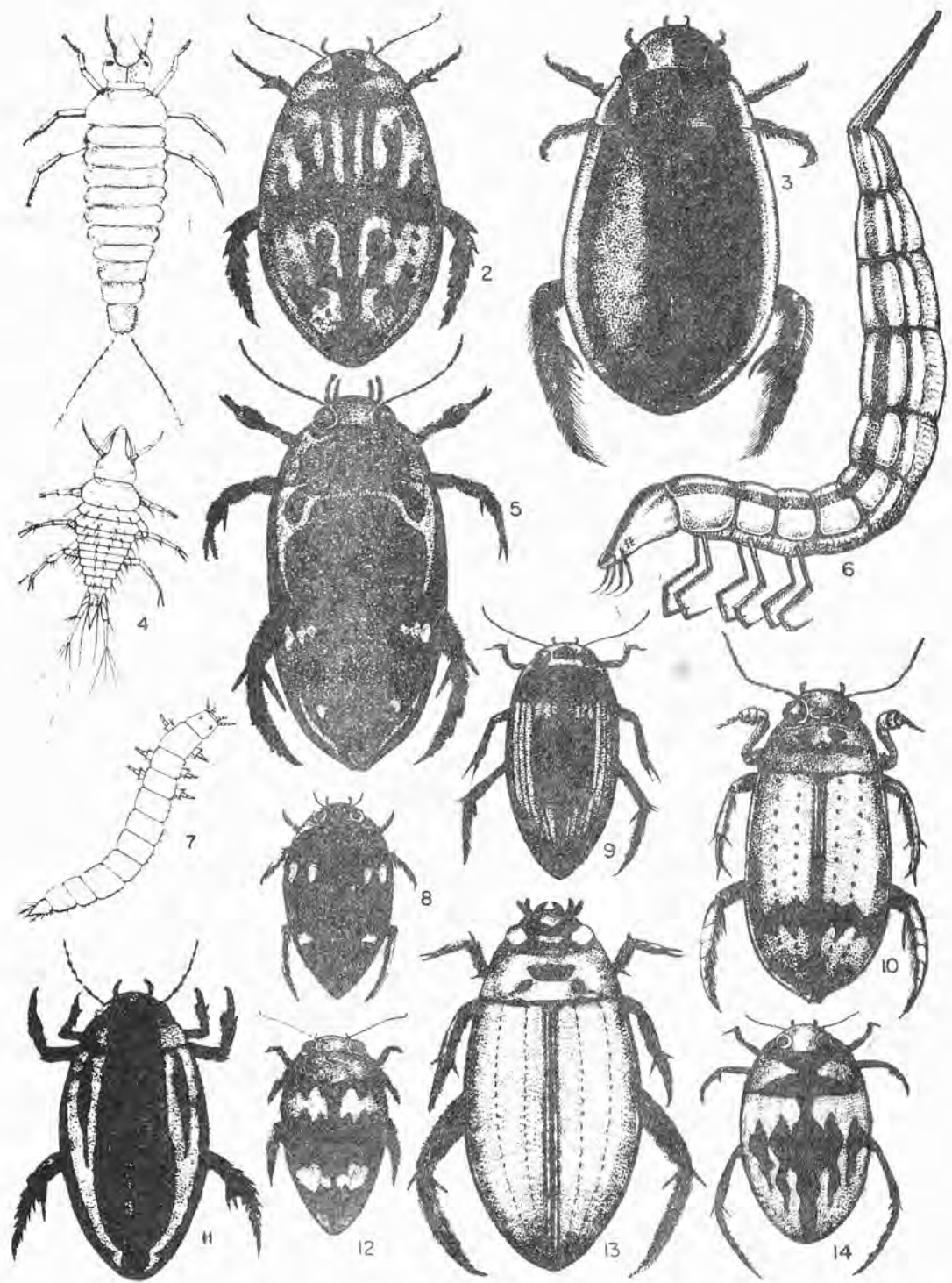
- Bidessus<sup>1</sup> inconstans* Reg.
- Bidessus (Bidessus) antennatus* Reg.
- Bidessus (Bidessus) flaviculus* Motsch.
- Bidessus (Bidessus) gentilis* Sharp
- Bidessus (Clypeodytes) bufo* Sharp
- Bidessus (Clypeodytes) griseoguttatus* Reg.
- Copelatus discoides* Sharp
- Copelatus horni* Reg.
- Copelatus indicus* Sharp (Page 87, Fig. 9)
- Copelatus pusillus* Sharp
- Cybister cardoni* Sever.
- Cybister confusus* Sharp (Page 87, Fig. 3)
- Cybister dejeani* Aube
- Cybister javanus* Aube
- Cybister sugillatus* var. *prolixus* Sharp
- Cybister ventralis* Sharp
- Eretes sticticus* L. (Page 87, Fig. 10)
- Hydraticus fabricii* MacL.
- Hydraticus fractifer* Walk.
- Hydraticus luczomicus* Aube
- Hydraticus pacificus* Aube (Page 87, Fig. 5)
- Hydraticus vittatus* var. *angustulus* Reg.
- Hydrovatus confertus* Sharp
- Hydrovatus ferrugatus* Reg.
- Hydrovatus fuscus* Sharp
- Hydrovatus obscurus* Motsch.
- Hydrovatus sinister* Sharp
- Hyphoporus interpulus* Clark
- Hyphydrus indicus* Sharp (Page 87, Fig. 14).
- Hyphydrus lyratus* Schwartz
- Hyphydrus renardi* Ser.
- Lacconectus simoni* Reg.
- Laccophilus anitcatus* Sharp
- Laccophilus ceylonicus* Zimm. (Page 87, Fig. 12)
- Laccophilus chinensis inefficiens* Walk
- Laccophilus ellipticus* Reg.
- Laccophilus flavescens* Motsch.
- Laccophilus flexuosus* Aube
- Laccophilus guttalis* Reg.

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<sup>1</sup> The Genus *Bidessus* in S. E. Asia has been given a new generic name—*Guignotus* after Prof. Guignot.

Explanation to figures on page 87

1. Dytiscid larva from Macan 5 mm. long.
2. *Sandracottus festivus* 15 mm.
3. *Cybister confusus* 40 mm.
4. Young larvae of *Hydrovatus confertus* after Williams
5. *Hydraticus pacificus* 16 mm.
6. Larva of *Cybister* 60 mm.
7. Noterid larva from Macan 7 mm. long.
8. *Canthydrus luctuosus* 3 mm.
9. *Cope'atus indicus* 4.5 mm.
10. *Eretea sticticus* 12 mm.
11. *Hydrocoptus subvittatus* 14 mm.
12. *Laccophilus ceylonicus* 5 mm.
13. *Rhantus punctatus* 13 mm.
14. *Hyphydrus indicus* 5 mm.



*Rhantus interclusus* Walk.  
*Rhantus punctatus* Four. (Page 87, Fig. 13)  
*Rhantus taprobanicus* Sharp  
*Sandracottus festivus* (Ill.) (Page 87, Fig. 2)

#### FAMILY NOTERIDAE—The Digging Beetles

These are small beetles often included in the family Dytiscidae which they agree with in structure except that the legs are adapted for digging. They are crescentic in shape and are slightly compressed. In Ceylon they are very common in paddy fields and often are present in large numbers. Four species have been recorded from Ceylon.

*Canthydrus laetabilis* Walk.  
*Canthydrus luctuosus* Aube. (Page 87, Fig. 8)  
*Hydrocoptus subvittatus* Motsch. (Page 87, Fig. 11)  
*Neptosternus taprobanicus* Sharp

#### FAMILY HALIPLIDAE—Crawling Beetles

These are closely allied to the Dytiscidae but are generally very small and oval in shape. The antennae are filiform and ten segmented. The hind coxae (segment nearest the body) have plate like structures which cover the origin of the hind legs and a portion of the ventral side of the insect (Page 91, Fig. 4). These larvae have each a long tail process.

A single specimen of *Haliplus pulchellus* was collected by the authors near an electric light at Maha Illupalama. This species is widely distributed in S. E. Asia. Only two species of this family has been recorded from Ceylon.

*Haliplus angustifrons* Reg.  
*Haliplus pulchellus* Clark

#### FAMILY GYRINIDAE—The Whirligig Beetles

These beetles are surface swimmers and are gregarious in their habits. They are to be found constantly darting about in graceful curves around one another and hence the name "Whirligig Beetles". When the beetles are disturbed they dive underneath the surface of the water, carrying along with them a bubble of air. They fly readily from one pond to another. They are black and shiny with a depressed body. The wings do not cover the posterior section of the abdomen. Their antennae are very short and stout. Each eye is divisible into two portions, one for aerial vision and the other for vision in the water. The second and third pair of legs are greatly flattened, paddle-like and provided with hairs. They lay their eggs on the leaves of submerged water plants. The larvae are similar to those of the Dytiscidae except that they do not have a breathing tube but a pair of tracheal gills on each abdominal segment (Page 91, Fig. 6). Pupation takes place in a cocoon attached to water plants.

Both the adults and larvae are scavengers feeding mainly on dead and drowning animals. They aestivate in the mud during the drought. Seventeen species of Gyrinidae are on record for Ceylon.

*Aulonogyrus obliquus* (Walk.) (Page 91, Fig. 2)  
*Dineutes indicans* Walk  
*Dineutes indicus* Aube. (Page 91, Fig. 7)  
*Dineutes spinosus* (Fab.)  
*Dineutes unidentatus* Aube.

*Gyrinus ceylonicus* Reg.  
*Gyrinus convexiusculus* MacL. (Page 91, Fig. 5)  
*Orectochilus ceylonicus* Redt. (Page 91, Fig. 3)  
*Orectochilus dilatatus* Redt.  
*Orectochilus disciter* Walk.  
*Orectochilus fairmairei* Reg.  
*Orectochilus fraternus* Reg.  
*Orectochilus indicus* Reg.  
*Orectochilus limbatus* Reg.  
*Orectochilus productus* Reg.  
*Orectochilus wehnckeii* Reg.  
*Porrorrhynchus indicans* Walk.

#### FAMILY HYDROPHILIDAE—Deep-water Beetles

A special feature of this family is that the first maxillae have each a pointed process (maxillary palp) which is exceptionally long and in most species is longer than the antennae. For this reason these beetles are called Palpicornia. However there are a few Hydrophilidae which do not have long maxillary processes. The eggs may be laid in the form of floating cocoons or they may be attached to grass or floating objects depending on the species. *Helochares* spp. and *Berosus* spp. attach the eggs on to their own bodies. The larvae show a great diversity in form and structure. They usually pupate in damp earth near the water.

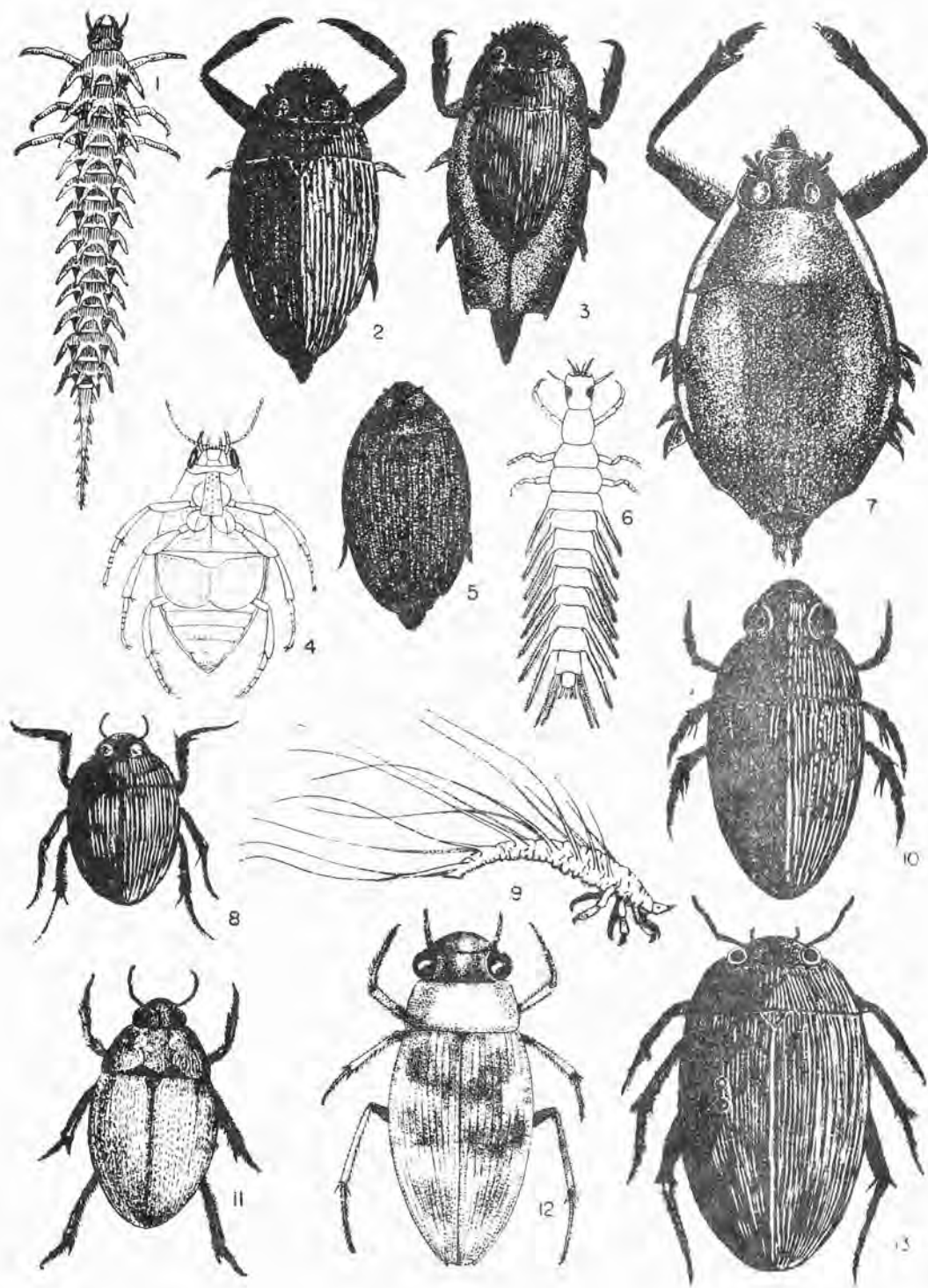
The hydrophilid beetles form an important item in the diet of many fishes both in the larval and adult stages. The large *Hydrophilus* is carnivorous and may even kill small fishes. The Hydrophilidae are poor swimmers and generally walk on aquatic vegetation and other objects at the bottom of the habitat. When the water is disturbed many of the smaller species float on the surface. Some of the larger species like *Hydrophilus*, and *Sternolophus* are relatively good swimmers. *Berosus indicus* which is one of the commonest of the hydrophilids makes a high pitched sound when taken in a net.

The hydrophilid beetles are common in standing water habitats. They occur in large numbers in mud, and paddy fields are a favourite habitat. Because of their small size and habit of living at the bottom they are often missed from collections and hence our present knowledge of this group in Ceylon is very incomplete. However, sixty-one species have been recorded from Ceylon.

*Amphiops gibbus* Ill.  
*Amphiops mirabilis* Sharp  
*Amphiops pedestris* Sharp  
*Amphiops simplex* Sharp  
*Anacaena advena* Sharp  
*Anacaena minima* Sharp  
*Armostus optatus* Sharp  
*Berosus (Berosus) aeneiceps* Motsch.  
*Berosus (Berosus) pulchellus* MacL.  
*Berosus (Berosus) viticollis* Boh.  
*Berosus (Enoplurus) indicus* Motsch. (Page 91, Fig. 12)  
*Cercyon aviarius* Knisch (Page 91, Fig. 8)  
*Cercyon hydrophiloides* Motsch.  
*Cercyon lineolatus* Motsch.

Explanation to figures on page 91

1. Haliplid larva from Macan 7 mm. long.
2. *Aulonogyrus obliquus* 8 mm.
3. *Orectochilus ceylonicus* 13 mm.
4. *Haliphus* sp. ventral view to indicate the plates covering the base of the hind legs, from Macan 4 mm. long.
5. *Gyrinus convexiusculus* 5 mm. long.
6. Gyrinid larva, after Mellanby 16 mm. long.
7. *Dineutes indicus* 16 mm. long.
8. *Cercyon aviarius* 3 mm. long.
9. Larva of *Berosus*, from Weerakoon 25 mm. long.
10. *Sternolophus (Neosternolophus) brachyacanthus* 11 mm. long.
11. *Helochaeres (Hydrobaticus) anchonalis* 6 mm. long.
12. *Berosus (Enoplurus) indicus* 6 mm. long.
13. *Enochrus (Lumetus) iteratus* 8 mm. long.



*Cercyon lunulatus* Germm. and Har.  
*Cercyon nigriceps* Marsham  
*Cercyon punctigerum* Knisch  
*Cercyon rufotestaceus* Motsch.  
*Cercyon uniformis* Sharp  
*Cercyon vicinalis* Walk.  
*Coelostoma horni* (Reg.)  
*Coelostoma stultum* (Walk.)  
*Cryptopleurum ferrugineum* Motsch.  
*Cryptopleurum sulcatum* Motsch.  
*Dactylosternum abdominale* (Fabr.)  
*Dactylosternum dytiscoides* (Fabr.)  
*Enochrus (Lumetus) esuriens* (Walk.)  
*Enochrus (Lumetus) fragilis* Sharp  
*Enochrus (Lumetus) fuscatus* (Motsch.)  
*Enochrus (Lumetus) iteratus* (Sharp) (Page 91, Fig. 13)  
*Enochrus (Lumetus) nigropiceus* (Motsch.)  
*Epimetopus flavidulus* Sharp  
*Globaria leachi* Hope  
*Helochares densus* Sharp  
*Helochares pallens* MacL.  
*Helochares (Chasmogenus) livornicus* Kuw.  
*Helochares (Helochares) taprobanicus* Sharp  
*Helochares (Hydrobaticus) anchonalis* Sharp (Page 91, Fig. 11)  
*Helochares (Hydrobaticus) lentus* Sharp  
*Hydraena fontana* Orch.  
*Hydrochus lacustris* Niet.  
*Hydrophilus inconspicuus* (Niet.)  
*Hydrous (Hydrous) cashmirensis* Redt.  
*Hydrous (Hydrous) olivaceus* Fabr.  
*Laccobius (Laccobius) rectus* Sharp  
*Limnebius rufipennis* Reg.  
*Neohydrophilus rufiventris* Niet.  
*Neohydrophilus spinicollis* (Esch.)  
*Neohydrophilus spinicollis elongatus* Reg.  
*Omicrogiton insularis* Orch.  
*Oocyclus latus* Orch.  
*Oosternum horni* Orch.  
*Pachysternum nigrovittatum* Motsch.  
*Paracymus evanescens* Sharp  
*Protosternum atomarium* Sharp  
*Regimbartia attenuata* Fabr.  
*Scoliopsis spinosa* Orch.  
*Sphaeridium dimidiatum* Gory  
*Sphaeridium quinquemaculatum* Fabr.  
*Sternolophus rufipes* Fabr.  
*Sternolophus (Neosternolophus) brachyacanthus* Reg. (Page 91, Fig. 10)

## COLLEMBOLA

(Springtails)

A group of wingless insects whose legs are very feeble. They move about by leaps made with the assistance of the furcula, a forked lever-like tail process, present at the end of the abdomen. Most Collembola live in damp places. A few are aquatic, living on the surface of the water. It is only rarely that they go below the surface of the water. A number of species live very close to the waters edge on damp vegetation and occasionally venture on to the water. Springtails are mainly detritus feeders but occasionally they feed on floating plants. *Isotomurus* sp. (Page 95, Fig. 16) which has been recorded from the Indian region.

## ODONATA

(Dragonflies and Damselflies)

The dragonfly larvae (nymphs) are completely aquatic and predacious and have resemblances to the adult. Each larva is equipped with a well developed prehensile "mask" (the labium) having claws or hooks for seizing prey. It is hidden under the head when not in use. The larvae are very clumsy and slow in locomotion. They have wing pads and well developed legs. The larvae are green, brown or grey varying in different species to match their background.

Two main types of larvae are recognisable. The first group termed the Anisoptera are broad forms (Page 95, Fig. 3) without posterior external gills. They have from 5-6 small projections at the hind end of the abdomen. The gills in this group line the hind part of the alimentary canal. Water is pumped in and out of the anus to aerate the gills. The other group termed the Zygoptera are narrower than the Anisoptera and have three flattened leaf-like caudal fins (Page 95, Fig. 8). The caudal fins contain a large number of tracheae and act as gills. The damselflies are included in the Zygoptera.

The larvae of the dragon and damselflies may also be divided into three groups on the basis of their habits, namely, climbers, sprawlers and burrowers. The climbers stalk their prey on the stems and roots of aquatic plants, the sprawlers lie in the bottom of the habitat and wait for their prey to come close to them and the burrowers do likewise after covering themselves with a thin layer of sand and silt.

Dragonfly larvae cause damage to fish fry in culture ponds. On the other hand they represent a source of food for the larger fish.

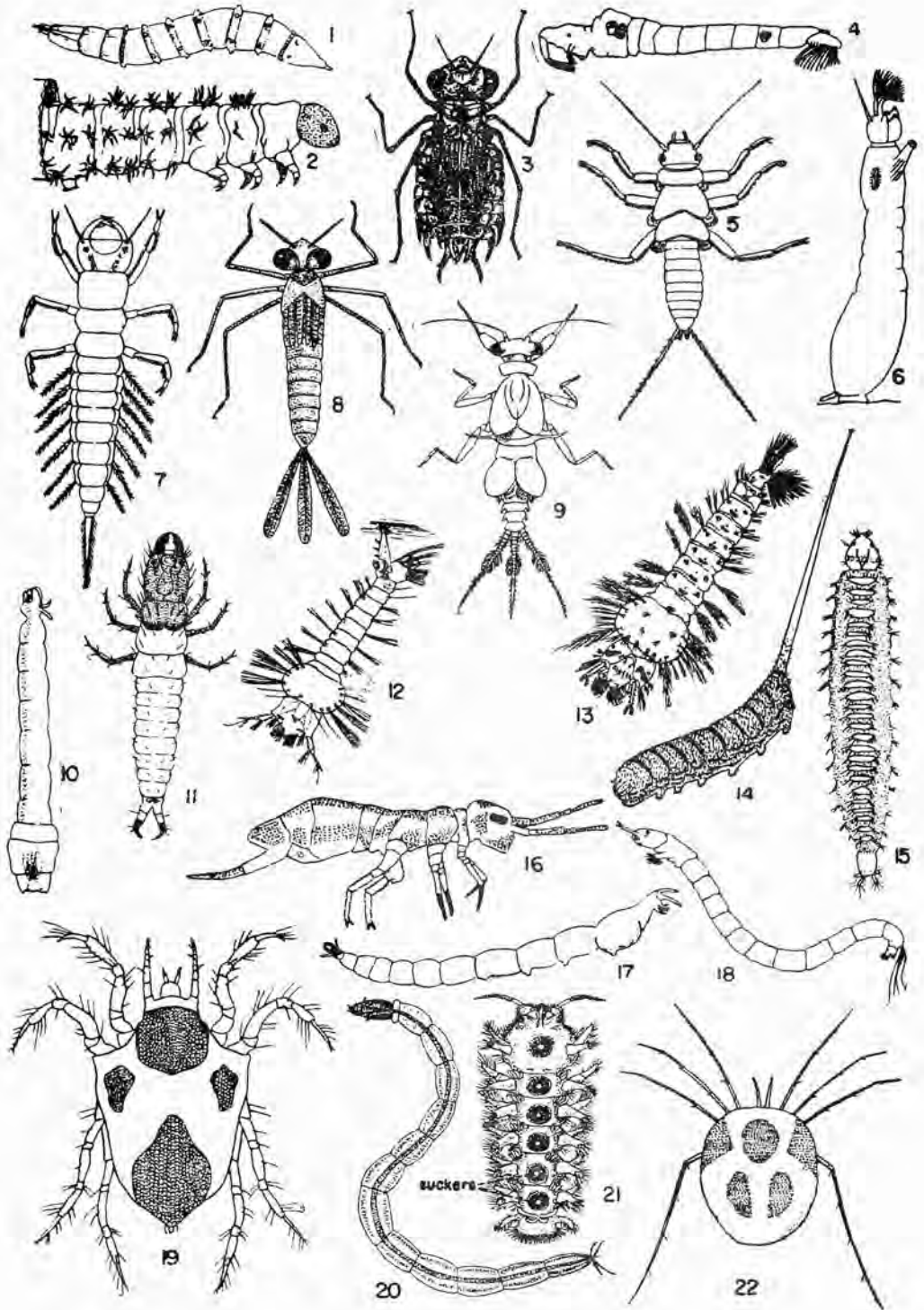
## EPHEMEROPTERA

(Mayflies)

These superficially resemble dragonfly larvae but are much more delicate in structure (Page 95, Fig. 9). They are characterised by the presence of three "tails" at the posterior end. These "tails" are not gills but cerci or the abdomen. The flattened and shortened bodies are adaptations to torrential life commonly found in this group. The very young larvae do not have gills but the older ones possess gills in the abdominal region. The gills are differently shaped in the various genera. The mayfly larvae (nymphs) are generally herbivorous feeding on algae. The larvae possess wing pads and well developed legs and resemble the adults.

Explanation to figures on page 95

1. Tabanid larva, after Macan, 15 mm. long.
2. Lepidoptera (*Nymphula*), from Weerakoon 19 mm. long.
3. Odonata—Dragonfly larva (*Pantala flavescens*), 25 mm. long.
4. Corethrid—Phantom midge larva, from Weerakoon 4 mm. long.
5. Plecoptera—Stonefly larva, from Macan 25 mm. long.
6. Simuliid—Blackfly larva from Macan 7 mm. long.
7. Neuroptera—Alderfly larva after various authors approximately 18 mm. long.
8. Odonata—Damselfly larva 24 mm. long.
9. Ephemeroptera—Mayfly (*Caenis*) larva, from Weerakoon 9 mm. long.
10. Tipulid—Crane-fly larva from Weerakoon 9 mm. long.
11. Trichoptera—Caddisfly larva without its case, from Macan 15 mm. long.
12. Culicine—Mosquito larva 9 mm. long.
13. Anopheline—Mosquito larva 8 mm. long.
14. Syrphid—Horsefly larva, from Macan 15 mm. long.
15. Psychodid larva, from Macan 4 mm. long.
16. Collembola—Springtail.
17. Limnobiid larva, from Macan 30 mm. long.
18. Chironomid—Lakefly larva, from Weerakoon 7 mm. long.
19. Arachnida—Water mite, from Macan 0.5 mm. long.
20. Ceratopogonid—Biting midge larva 6 mm. long.
21. Blepharocerid—Net winged midge larva, after various authors 10 mm. long.
22. Arachnida—Water mite, from Macan 1.5 mm. long.



## PLECOPTERA

(Stoneflies)

Resemble the mayflies closely but can be easily distinguished from them by the presence of only two "tails" at the posterior end and no gills on the abdominal segments (Page 95, Fig. 5). They have wing pads and well developed legs and resemble adults. Stoneflies are very common in fast flowing streams.

## LEPIDOPTERA

(Moths and Butterflies)

Only one family of the Lepidoptera is aquatic, namely the Pyraustidae. They do not have wing pads. They have three pairs of short thoracic legs and five pairs of prolegs on the abdomen. The second and third thoracic segments and all the abdominal segments bear tufts of tracheal gills. A common form present in paddy fields is *Nymphula* (Page 95, Fig. 2). It lives just below the surface of the water, in cases made of leaves and silk.

## NEUROPTERA

(Alderflies)

These larvae are in many respects similar to the larvae of aquatic beetles and quite unlike the adults (Page 95, Fig. 7). They differ from the aquatic beetle larvae in the possession of jointed lateral tracheal gills on each abdominal segment. The abdomen is prolonged into a tapering "tail". They do not have wing pads and their legs are relatively short. They are found in swift flowing streams beneath mud stones, vegetation, &c.

## TRICHOPTERA

(Caddis flies)

These larvae live in cases constructed of debris, sand and other materials. Some live in tunnels made of silken threads. They have relatively short legs of which the first pair is the shortest and stoutest. They have no wing pads. The last abdominal segment bears a pair of hooked appendages which is characteristic (Page 95, Fig. 11).

## DIPTERA

(True Flies)

Many families of Diptera have aquatic larvae. They can easily be recognised by the absence of walking legs (i.e., apodous). Some of their pupae are also very characteristic.

## KEY TO THE COMMONER FAMILIES OF AQUATIC DIPTERAN LARVAE

Only the commoner families of dipteran larvae are included in this key. There are numerous other families of diptera whose larvae may be present in water. There are no records of these forms

nor have the authors come across them in their field studies. However, diagrams of the larvae of the families Tabanidae Limnobiidae and Psycodidae are included in Page 95, although there are no descriptions of them in the text.

1. Larvae with suckers on ventral surface ..... Blepharoceridae, page 97  
    No ventral suckers ..... 2
2. Head indistinct and more or less retractile with thorax ..... 3  
    Head prominent and non-retractile ..... 4
3. Several pairs of prolegs present. Long telescopic tail ..... Syrphidae, page 98  
    No prolegs ..... Tipulidae, page 98
4. At least one pair of prolegs present ..... 5  
    Prolegs absent ..... 6
5. Posterior end with an adhesive disc ..... Simuliidae, page 98  
    No adhesive disc at posterior end ..... Chironomidae, page 97
6. Body not transparent. Mouth brushes present ..... Culicidae, page 97  
    Body transparent. No mouth brushes ..... 7
7. Thoracic segments fused into a mass of greater diameter than the abdomen.....  
    ..... Corethridae, page 97  
    Each thoracic segment distinct ..... Ceratopogonidae, page 98

**FAMILY BLEPHAROCERIDAE**—Net-winged midges (Page 95, Fig. 21)

Greatly flattened and elongated larvae. The body of each larva has seven distinct divisions and on the ventral surface of each of the first six divisions there is a sucker. By means of these suckers the larva attaches itself to the surface of rocks on the bed of streams in the hill-country. A pair of filamentous gill-tufts is present on each body division except on the first and the last.

**FAMILY CULICIDAE**—Mosquitoes (Page 95, Figs. 12 and 13)

The most widely distributed of the dipteran larvae. They can be easily distinguished because the thoracic segments are fused and the last abdominal segment bears anal flaps. Their antennae are always distinct. Two main types are worth noting.

1. Culicine. With respiratory siphons on the 8th segment (Page 95, Fig. 12)
2. Anophiline. With no respiratory siphons but a plate on the 8th segment for respiration (Page 95, Fig. 13).

**FAMILY CORETHRIDAE**—Phantom midges (Page 95, Fig. 4)

The phantom midge larva is transparent except for air sacs at the anterior and posterior ends. The head bears a long prehensile structure which is the modified antennae, used for seizing food. They frequent clear as well as muddy water and are even found in the mud at the bottom of lakes. Weerakoon and Samarasinghe found them in paddy fields and the authors have collected them in the Colombo (Beira) Lake as well as in the large tanks.

**FAMILY CHIRONOMIDAE**—Lakeflies (Page 95, Fig. 18)

The larvae of these insects are often red in colour and called "Blood-Worms". However there are larvae in this group which are yellow, blue, green or brown in colour. The head is quite distinct and the first thoracic segment bears a pair of false-legs. The second and third thoracic

segments are fused. The posterior end bears lappets and hairs. These larvae are scavengers and live in all types of freshwater habitats. They are found in the mud, in decaying vegetation and moss. Many of them are free-living but some make mud cases in which they live.

**FAMILY CERATOPOGONIDAE**—Biting Midges (Page 95, Fig. 20)

These are also called Heleidae. They are transparent and may be red in colour or colourless. They resemble the chironomidae but have a more chitinised head. They usually do not have false legs (prolegs). Retractable gills are present on the last segment. Generally they are not common in clear water but are associated with algae or mud.

**FAMILY SIMULIIDAE**—Blackflies (Page 95, Fig. 6)

These larvae are broadened posteriorly where a disc with hooks and gills are found. The head is small and provided with a pair of fan-shaped mouth brushes. The thorax bears a pair of false legs. The larvae live mainly in swift flowing water.

**FAMILY SYRPHIDAE**—Horsefly (Page 95, Fig. 14)

The larvae are characterised by a long "tail" which is really a respiratory tube and given them the name "rat-tailed maggots". They possess seven pairs of false legs (prolegs) and a pair of "respiratory horns". They occur in polluted water.

**FAMILY TIPULIDAE**—Crane-flies (Page 95, Fig. 10)

These wrinkled larvae are cylindrical or slightly flattened. They have an indistinct head which is retractile. They have five hairy projections and tracheal gills at the posterior end.

## ARACHNIDA

This group of arthropods includes such animals as scorpions, spiders, ticks and mites, most species of which are terrestrial. Two groups, the spiders (Aranaeda) and mites (Acarina) are represented in freshwater. Only Acarina have been recorded from Ceylon.

The mites that are present in water belong to the family Hydrachnidae. They are like the land mites in shape but are minute in size (average size is about 2 mm. only). The adults (Page 95, Figs. 19 and 22) possess a round or oval shaped, unsegmented body with four pairs of legs, which are six jointed and adapted for swimming by the provision of hairs. The last segment of each hind limb bears a pair of claws which can be retracted. In front, each mite has a pair of segmented palps, between which is the capitulum or "false head". The mouth parts of the water mites are modified for piercing and sucking. Water mites lay their eggs in water plants. The larvae resemble the adults except that they have only three pairs of legs.

Water mites and their larvae may be free living and carnivorous or parasitic in a large number of other animals. The adults have been found parasitizing the water scorpion *Ranatra elongata*, *Hydrometra greeni*, and *Eretes sticticus*. As many as sixteen larval mites were found in one specimen of an insect. Larval water mites are sometimes present on terrestrial insects which spend their larval phases in the water. A larval watermite has been collected from the under side of the thorax of the dragon fly *Diplocodes trivialis* Rambur. Because of their parasitic habits water mites and their larvae cause harm to a large variety of freshwater animals. Fourteen species of water mites have been recorded.

*Arrenurus ceylonicus* Daday

*Arrenurus congener* Daday

*Arrenurus madaraszii* Daday

*Arrenurus orientalis* Daday  
*Arrenurus rostratus* Daday  
*Arrenurus singalensis* Daday  
*Atax nodusus* Daday  
*Atax singalensis* Daday  
*Curvipes conglobatus* C. K.  
*Curvipes horvathi* Daday  
*Frontipoda ceylonica* Daday  
*Frontipoda picta* Daday  
*Hydrachna dilata* Daday  
*Hydryphantus silvestris* Daday

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# VERTEBRATA

## PISCES

(Fishes)

IN Ceylon there are approximately sixty species of freshwater fishes. Several foreign species have been introduced but it is not certain whether some of these introduced varieties have established themselves in Ceylon.<sup>1</sup> Some species have never been caught in the field after their introduction. Because the fishes are an important group among the freshwater fauna, keys are provided to identify them down to species. The material for the keys and the descriptions of the species that follow have been drawn freely from other workers, chiefly from Deraniyagala's *Colored Atlas* (1952) and Munro's *Marine and Freshwater Fishes of Ceylon* (1955).

In order that the description of a fish be kept down to a minimum, fin ray and scale formulae have been provided for each species. The use of the formulae is best illustrated by taking a specific example.

Thus the formula for *Puntius vittatus* is D. II, 8. A. II, 5. P. I, 11. L. lat. 20-22.

$3\frac{1}{2}$   
—  
 $3\frac{1}{2}$

This formula indicates that in *P. vittatus* the dorsal fin is made up of 2 spines and 8 rays, the anal fin of 2 spines and 5 rays and the pectoral fin of 1 spine and 11 rays. It also indicates that the fish has 20-22 scales along its lateral line,  $3\frac{1}{2}$  rows of scales above the lateral line and  $3\frac{1}{2}$  rows of scales below it.

### KEY TO THE PISCES

1. Fish without scales or with very small inconspicuous scales ..... Page 101  
Fish with prominent scales ..... Page 108

### FISHES WITHOUT PROMINENT SCALES

In this group are the catfishes, eels, spiny eels and loaches.

1. Body much elongated, eel-like ..... 2  
Body short, not eel like ..... 3
2. Fins not spinous ..... Anguillidae, page 106  
Front portion of dorsal and anal fins spinous ..... Mastacembelidae, page 106
3. Mouth on ventral side of head ..... Cobitiidae page 107  
Mouth terminal (i.e., at tip of snout) ..... Catfishes, page 102

<sup>1</sup>*Ctenopharyngodon idellus* (Valenciennes) *Hypophthalmichthys molitrix* (Valenciennes) *Aristichthys nobilis* (Richardson) and *Puntius javanicus* are some species which have been introduced but it is uncertain whether they have established themselves in Ceylon. Introduced species that are now established in Ceylon are included in the text.

## CATFISHES

All species of fish that are grouped under the name catfishes possess long feelers (whiskers) which are referred to as barbels. The number of barbels vary from 2-4 pairs. There are seven species of catfishes recorded from Ceylon and they belong to 4 separate families.

- |   |                            |
|---|----------------------------|
| 1. Tail (caudal) fin forked .....                                 | 2                          |
| Tail (caudal) fin rounded .....                                   | 3                          |
| 2. Laterally compressed body ; 2 pairs of barbels .....           | Siluridae, page 102        |
| Sub-cylindrical body ; 4 pairs of barbels .....                   | Bagridae, page 103         |
| 3. Dorsal fin very long extending about 2/3 the body length ..... | Clariidae, page 102        |
| Dorsal fin very short even smaller than the paired fins .....     | Heteropneustidae, page 103 |

### FAMILY SILURIDAE

Two species of Siluridae from two genera are found in Ceylon. They have elongate and laterally compressed bodies which are dull silvery white on the sides. The fins are yellow. They have two pairs of barbels on the head, one pair of which is on the upper jaw (maxillary) and the other on the lower jaw (mandibular). They have forked caudal fins.

- |  |                          |
|--|--------------------------|
| 1. Cleft of mouth extends beyond the eye posteriorly.....      | <i>Wallago attu</i>      |
| Cleft of mouth does not extend beyond the eye posteriorly..... | <i>Ompok bimaculatus</i> |

*Wallago attu* (Bloch and Schneider) [Freshwater Shark. (S. Maha Valaya, Valaya)].  
D. I, 4. A. 79-81. P. I., 13-14 (Page 105, Fig. 1).

A relatively large fish attaining a length of five feet and is greyish brown coloured on top (dorsal surface). A popular food fish in the North-Central Province where it is in great demand. The fish is common in the deeper waters of rivers and irrigation tanks of the low country.

*Ompok bimaculatus* (Bloch) [Butter Catfish (S. Kokussa, Pena Valapotta, Valapotta)].  
D. I. 3-4 A. 61-66. P. I., 12-15 (Page 105, Fig. 4).

Does not grow as large as *Wallago attu*, but specimens measuring one and a half feet in length are not uncommon. They are pale bluish olive coloured dorsally and their gill covers (opercles) have yellow markings.

### FAMILY CLARIIDAE

Fish belonging to this family have depressed heads and elongate but only slightly compressed bodies. They have four pairs of barbels. The caudal fin is rounded. They are adapted for breathing air when they leave the water for short periods. Two species have been recorded from Ceylon.

- |   |                                     |
|---|-------------------------------------|
| 1. Uniformly coloured with dark brown to various shades of green or yellow. Pectoral spine serrated .....                   | <i>Clarias teysmanni brachysoma</i> |
| Conspicuously blotched or clouded with dark olive brown on a greenish yellow background. Pectoral spine almost smooth ..... | <i>Clarias nebulosus</i>            |

*Clarias teysmanni brachysoma* (Gunther) [Teysmann's Spotted Catfish. (S. Kaha Magura, Magura, Vel Magura)]. D. 70. A. 53-60. P. I, 8 (Page 105, Fig. 3).

This fish grows up to a length of about one foot and may weigh as much as eight pounds. It is a very common fish in muddy streams and ponds and is nocturnal in its habits.

*Clarias nebulosus* Deraniyagala.

This species may grow to about one and a half feet in length. It is restricted to rivers at higher elevations. The first record of the species in 1958 was from the Kalu Ganga at Ratnapura.

**FAMILY HETEROPNEUSTIDAE**

Only one species is recorded from Ceylon.

*Heteropneustes fossilis* (Bloch) [Stinging Catfish (S. Hunga, Kaha Hunga, Lai Hunga, Vel Hunga)]. D. 7-8. A. 68-78. P. I, 7 (Page 105, Fig. 2).

It is an elongate laterally compressed fish with 4 pairs of barbels, attaining a length of 10-14 inches. It has a strong spine on each pectoral fin and is capable of inflicting a rather nasty sting. The caudal fin is rounded. The adults are dark brown coloured with two lateral yellow bands. They are very common in the ponds and irrigation reservoirs in the low country and may enter brackish water. They occur in enormous numbers in some irrigation reservoirs and are considered a delicacy.

**FAMILY BAGRIDAE**

This is a family of fishes having sub-cylindrically shaped bodies. These catfishes have a prominent stout dorsal spine. They have four pairs of barbels. The caudal fin is forked. They are dark coloured on their dorsal surface and light coloured on the belly. Three species have been recorded from Ceylon.

- 1. Three dark coloured lateral bands on each side of the body.....*Macrones vittatus*,  
No lateral bands..... 2
- 2. Adipose fin<sup>1</sup> long. The length of its base is equal to or longer than that of  
dorsal fin.....*Macrones keletius*  
Adipose fin short. The length of its base is much shorter than that of the  
dorsal..... *Macrones gulio*

*Macrones gulio* (Hamilton-Buchanan) [The Long-Whiskered Catfish (S. Mada Anguluwa, Mana Ankutta, Vel Anguluwa)]. D. II, 6-7 A. III-IV, 10-12. P. I, 7-9 (Page 105, Fig. 5).

They may attain a length of ten inches and are usually present in brackish water but capable of moving up rivers into fresh water.

*Macrones keletius* (Valenciennes) [The Dwarf Catfish (S. Path Ankutta)]. D. II, 7-8. A. II, 8. P. I, 8 (Page 105, Fig. 10).

A medium sized fish only growing up to five inches in length and common in rivers and streams.

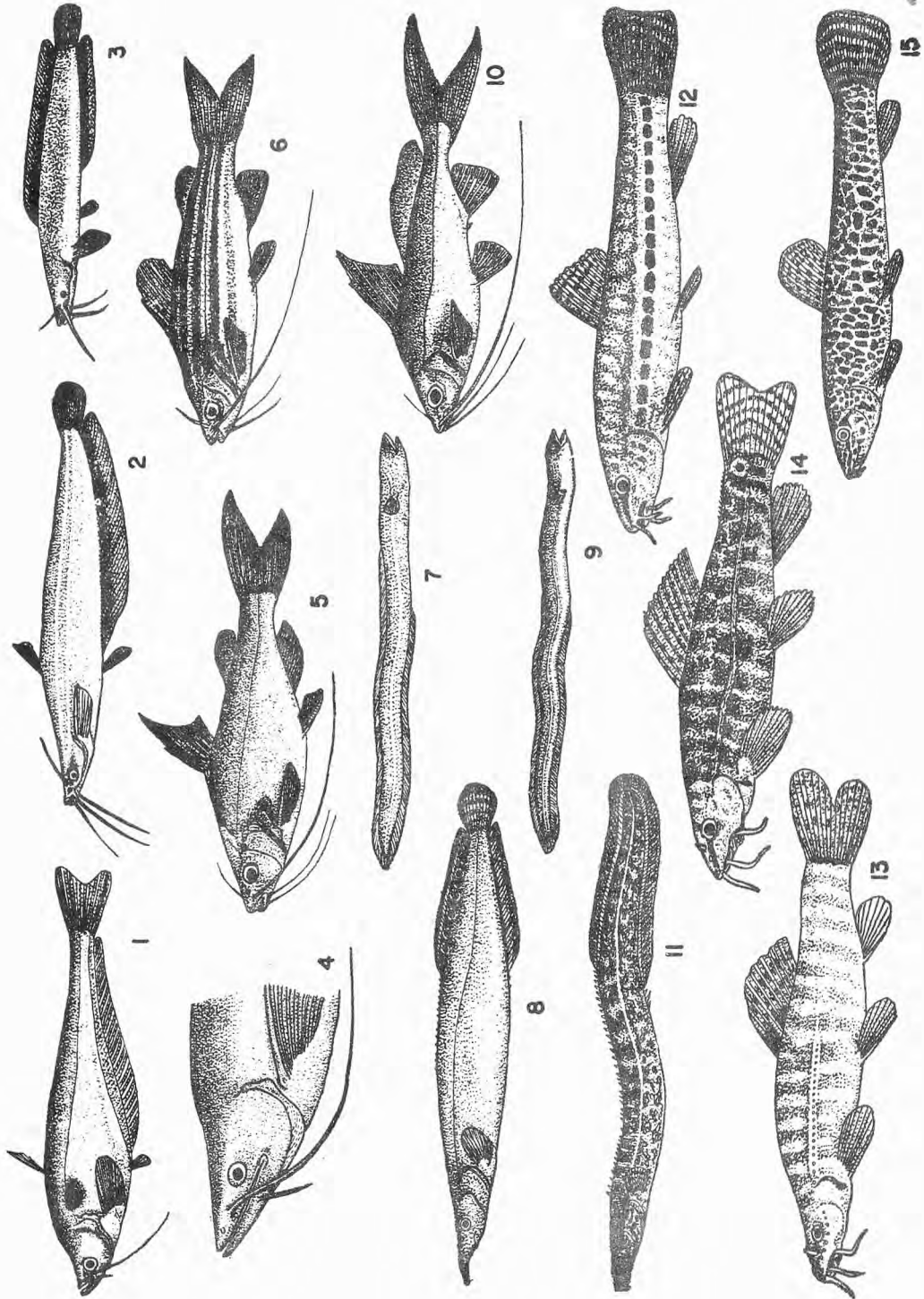
*Macrones vittatus* (Bloch) [Striped Dwarf Catfish (S. Hiri Ankutta, Iri Ankutta)]. D. II, 7-8. A. II-III, 7-8. P. I, 8 (Page 105, Fig. 6).

This is a relatively small species attaining a maximum length of four inches. Present in ponds and streams of the low and mid-country.

<sup>1</sup> A fleshy fin without any fin rays or spines. It lies between the dorsal and caudal fins.

Explanation to figures on page 105

1. *Wallago attu* 150 cms. long.
2. *Heteropneustes fossilis* 30 cms. long.
3. *Clarias teysmanni brachysoma* 30 cms. long.
4. *Ompok bimaculatus* 40 cms. long.
5. *Macrones gulis* 25 cms. long.
6. *Macrones vittatus* 10 cms. long.
7. *Anguilla nebulosa nebulosa* 105 cms. long.
8. *Macragnathus aculeatus* 25 cms. long.
9. *Anguilla bicolor bicolor* 60 cms. long.
10. *Macrones keletius* 12.5 cms. long.
11. *Mastacembelus armatus* 65 cms. long.
12. *Lepidocephalus thermalis* 5 cms. long.
13. *Noemacheilus notostigma* from Deraniyagala 5.5 cms. long.
14. *Noemacheilus botia* 4.5 cms. long.
15. *Lepidocephalus jonklaasi* from Deraniyagala 3.5 cms. long.



## FAMILY ANGUILLIDAE Eels

They are elongate fishes with cylindrical snake-like bodies. They have no pelvic fins. Scales are minute. The ventral surface is yellow in colour. The anus is in the anterior half of the body length. They migrate to the sea for breeding and the larval forms enter rivers and grow to maturity in fresh water. Two species are found in Ceylon.

1. Dorsal fin about the same length as anal and originates approximately above anus. Bluish tinge on dorsal surface. Sides brown in colour.....*Anguilla bicolor bicolor*  
Dorsal fin noticeably longer than anal. Dorsal surface and sides brown in colour and mottled with a darker shade of brown.....*Anguilla nebulosa nebulosa*

*Anguilla bicolor bicolor* McClelland. [The Level Finned Eel (S. Kakkutu Arndha, Kalu Arndha, Mada Arndha)]. (Page 105 Fig. 9)

These eels grow up to two feet in length. They are common in the freshwater streams, rivers and swamps near the coast but have not been recorded from the hill-country.

*Anguilla nebulosa nebulosa*. McClelland. [The Long Finned Eel (S. Kaha Arndha, Pol Mal Arndha, Polon Arndha, Vali Arndha. T. Pulli Vilangu)]. (Page 105 Fig. 7)

This species grows to larger size than *A. bicolor bicolor*. They are present in the hill-country pools and descend to the sea to spawn during the rainy season.

## FAMILY MASTACEMBELIDAE Spiny Eels

This is a group of mud-loving, spiny, eel-like fishes with elongated and laterally compressed bodies. They have a characteristic pointed snout and a row of spines in front of the soft dorsal fin. In Ceylon they are represented by two genera with a single species in each genus.

1. Caudal fin distinct from dorsal and anal fins. Dorsal fin with several yellow edged blotches. Spinous portion of dorsal with 13-17 spines.....*Macrognathus aculeatus*  
Caudal, dorsal and anal fins confluent. No yellow edged blotches on dorsal fin. Spinous portion of dorsal with 34-37 spines.....*Mastacembelus armatus*

*Macrognathus aculeatus* (Bloch). [Lesser Spiny Eel (S. Batakola Theliya)]. D. XIII-XVII, 50-54, A. II-III, 50-52, P. 22-25 (Page 105. Fig 8).

The body is covered with a very large number of minute scales which are absent from the upper surface of the snout. Dorsally the fish is reddish brown to olive coloured with a light coloured stripe and a yellow coloured lateral band from the eye to the tail. Between these two bands is an indistinct row of light spots. The sides are greenish yellow and the belly is pink yellow or white. The fins are dusky brown. The fish grows up to 10 inches and inhabits, streams, ponds and tanks in the low country.

*Mastacembelus armatus* (Lacépède). [Spiny Eel (S. Theliya, Gan Theliya, Oya Theliya)]. D. XXXIV-XXXVII, 64-80. A. II-III, 64-78. P. 25 (Page 105, Fig. 11).

A much larger fish than the former species, growing up to 25 inches. Scales are very minute. Top of snout is scaleless. The dorsal and lateral surfaces are brownish coloured while the ventral surface is yellow. The entire body is mottled with blotches of dark brown. The fins are brown coloured. The fish inhabits flowing and still waters up to 4,000 feet above sea level.



### FISHES WITH PROMINENT SCALES

There are a large number of species of fish with prominent scales. They include the carps and carplets with very conspicuous scales, the surface swimming top minnows with a prominent spot on the head, the snake heads with heads resembling those of snakes and the spiny finned fishes.

1. Two distinct dorsal fins.....Gobiidae, page 124  
Dorsal fin single, a portion of which may be spinous..... 2
2. Dorsal fin placed far back near the tail ; surface feeding fish.....  
..... Cyprinodontidae, page 117  
Dorsal fin generally midway between head and tail..... 3
3. Snake-like heads ; more or less cylindrical elongated bodies.....  
.....Ophiocephalidae, page 118  
Typical fish like heads..... 4
4. Front portions of dorsal and anal fins spinous..... 5  
No spinous dorsal—(Carp-like fishes)..... Cyprinidae, page 108
5. Either pelvic fins with filamentous portion : or spines on gill cover (Air breathers)  
..... Anabantidae, page 119  
Pelvic fins without filamentous portion, no prominent spines on gill covers .....  
..... Cichlidae, page 123

#### FAMILY CYPRINIDAE Carps and Carp-like Fishes

The bodies of the fishes belonging to this family are compressed laterally and are provided with very conspicuous scales. The head is however devoid of scales. They do not have more than two pairs of barbels,<sup>1</sup> but one or both pairs may be absent in some species.

1. Belly compressed into a sharp edge..... Sub-family Abraminae, page 108  
Belly rounded..... 2
2. Lateral line, passes through ventral portion of tail, incomplete or.....  
absent..... Rasborinae, page 108  
Lateral line when complete passes through centre of tail.....Cyprininae, page 110

#### SUB-FAMILY ABRAMINAE

*Chela labuca*<sup>2</sup> (Hamilton-Buchanan) [Winged Rasbora (S. Kara Adaya, Tatu Dandiya)].  
6½-7½

D. II, 7-8. A. III, 17-19. P. I., 9-11, L. lat. 33-35. Tr. — (Page 113, Fig. 7)  
1½-3½

This species has a more or less hyaline or transparent body. It has a characteristic compressed body. The ventral surface or belly unlike all other carps and carplike fishes is not rounded but is compressed into a sharp edge (i.e., it is culturata). The body colour is a metallic blue and the fins are hyaline. It has a dark coloured spot behind the gill cover. It grows up to 2½ inches and inhabits ponds, irrigation reservoirs and rivers in the dry parts of the low country.

#### SUB-FAMILY RASBORINAE

1. Barbels present..... 2  
Barbels absent..... 3

<sup>1</sup> *Cyprinus carpio* is an exception with 4 pairs of barbels.

<sup>2</sup> Silas (1958) *J. Bombay Nat. Hist. Soc.* 55, 1, 54-100, indicated that the Ceylon forms of this species had different body proportions to the Indian ones. Deraniyagala 1960 gave the subspecific name *lankensis* to the Ceylon fish.

2. Anal fin with 5 rays.....	<i>Esomus danrica thermoicos</i>
Anal fin with 13-16 rays.....	<i>Danio aequipinnatus</i>
3. Lateral line absent.....	<i>Horadandiya atukorali</i>
Lateral line present.....	4
4. Lateral line complete.....	<i>Rasbora daniconius</i>
Lateral line incomplete.....	5
5. 11-12 scales in front of dorsal fin.....	<i>Rasbora vaterifloris</i>
28-30 scales in front of dorsal fin.....	<i>Amblypharyngodon melettinus</i>

*Rasbora daniconius* (Hamilton Buchanan). [Common Rasbora (S. Kehel Dandiya, Kiri Dandiya, Kudu Massa, Dandiya, Pethiya)]. D. II, 6-7, A. II, 5, P. I., 13-14, L. lat.

30-34. Tr.  $\frac{4\frac{1}{2}-6\frac{1}{2}}{1\frac{1}{2}-2\frac{1}{2}}$  (Page 113, Fig. 2)

This species is olive coloured on its dorsal surface and white on the ventral. The fins are tinged yellow. Along its body there is a narrow dark stripe which is tinged on either side with yellow. The fish attains a length of four inches. One of the commonest fish in streams, ponds and irrigation reservoirs. Also found in large numbers in paddy fields.

*Rasbora vaterifloris*<sup>1</sup> Deraniyagala. [Vateria Flower Rasbora (S. Hal Mal Dandiya, Hal Mal Titteya)]. D. II, 8, A. II, 6, P. I., 11, L. lat. 25. Tr. 6 (Page 113, Fig. 3).

An indigenous fish which is much in demand by aquarists. It is a very delicate and translucent fish which will not stand much handling. The body colour varies from a very light shade of greenish grey dorsally to light yellowish blue on the sides and on the ventral surface. The dorsal and tail fins are orange while the other fins are hyaline. It is a small fish attaining a length of  $1\frac{1}{2}$  inches. Found in the streams in the Ratanapura and Badureliya Districts.

*Amblypharyngodon melettinus* (Valenciennes) [Attentive Carplet (S. Soreya)]. D. II, 7, A. III, 5, P. I., 13-14, L. lat. 45-50 Tr.  $\frac{8\frac{1}{2}-10\frac{1}{2}}{4\frac{1}{2}-5\frac{1}{2}}$  (Page 113, Fig. 4)

This is another species with a more or less translucent body which is somewhat compressed. The dorsal surface of the fish is brownish yellow, the vertex being bright green. The sides are silvery. It grows up to three inches in length and inhabits ponds and streams.

*Horandandiya atukorali* Deraniyagala. [Green Carplet (S. Hora Dandiya)]. D. II, 6, A. III, 5, P. 10, L. lat. 22. Tr. 6-7 (Page 113, Fig. 6).

This is not a common fish. It is pale yellowish green on the dorsal surface while its sides are silvery with pink reflections. It has a green longitudinal line on each side of the body. The ventral surface is silvery. The fins are hyaline. Its a small fish growing up to 1 inch or less and lives in streams and ponds of the Ratnapura and Badureliya Districts.

<sup>1</sup> Deraniyagala (1958) indicated that there are three varieties of *Rasbora vaterifloris* namely *ruber*, *rubrioculis* and *pallida*.

*Esomus danrica thermoicos*<sup>1</sup> (Valenciennes). (Flying Barb (S. Ravul Dandiya)].

D. II, 6. A. III, 5. P. I. 10-12, L. lat. 31-34, Tr.  $5\frac{1}{2}$   
 $1\frac{1}{2}$  (Page 113, Fig. 10).

The dorsal surface is pale olive coloured while the sides and ventral surface are silvery. On each side of the fish there is a faint blue lateral stripe and above this another one of greenish yellow. The fins are hyaline and pale yellow. It has a pair of long feelers directed backwards. They grow up to  $2\frac{1}{2}$  inches and are common in ponds, ditches and irrigation tanks.

*Danio aequipinnatus* (McClelland). [Giant Danio (S. Dankola Salaya, Rath Kailaya,

Salaya, Suddara)]. D. II, 10-12. A. III, 13-16. P. I., II. L. lat. 37-40, Tr.  $7\frac{1}{2}$ - $8\frac{1}{2}$   
 $1\frac{1}{2}$ - $2\frac{1}{2}$  (Page 113, Fig. 1).

The body is compressed and bright greenish blue coloured. There are two or three lateral bands which are not continuous along the entire length of the body. The fin colour varies from yellow to deep orange red. There is a dark blotch behind the gill cover. Grows up to 3 inches and is common in streams, ponds and irrigation reservoirs. Also found in paddy fields.

#### SUB-FAMILY CYPRININAE

- |  |   |
|--|---|
| 1. Mouth terminal.....                                       | 2   |
| Mouth on ventral side of head for sucking.....               |   |
| ..... Carp-like fishes with sucking mouths. page 116         |   |
| 2. Post labial groove* continuous (Fig. 1 below).....        | <i>Tor khudree longispinis</i> , page 111 |
| Post labial groove* interrupted in front (Fig. 2 below)..... | 3   |
| 3. Dorsal fin with 17-21 rays.....                           | 4   |
| Dorsal fin with 7-9 rays.....                                | <i>Puntius</i> , spp., page 111           |
| 4. Barbels on head.....                                      | <i>Cyprinus carpio</i> , page 111         |
| No barbels on head.....                                      | <i>Carassius carassius</i> , page 111     |

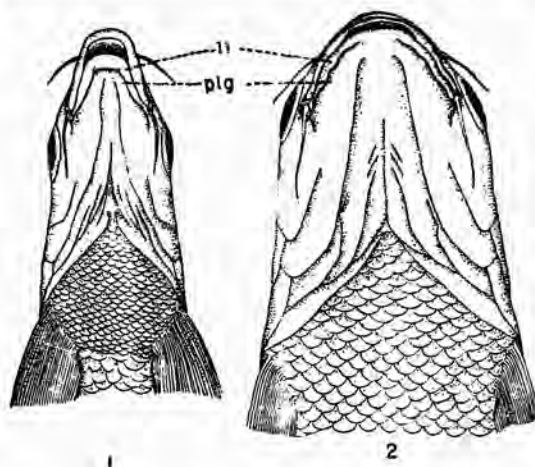


Fig. 1 Ventral view of head of *Tor khudree longispinis* and 2. of *Puntius sarana*.  
 ll—lower lip. plg—post labial groove

<sup>1</sup> Deraniyagala (1958) described a new sub-species *Esomus danrica brevibabartus*.

\* Post labial groove is the groove behind the lower lip.

*Cyprinus carpio* (L.). [Common Carp (S. Rata Pethiya)]. D. III, 17-22. A. III, 5.

P. I., 15. L. lat. 35-39, Tr.—(Page 113, Fig. 8.)  
 $5\frac{1}{2}$   
 $7\frac{1}{2}$

Around its mouth there are four pairs of barbels. The dorsal fin is longer in this fish than in the other members of this family. This species has been cultivated for over a thousand years in Asia and Europe. Several varieties of the species are now common. The fish are usually olive coloured but a golden or yellow type, often referred to as Golden Carp, is also common. Spawn from the same parent very often produces both olive or grey coloured and golden carp. Introduced into Ceylon waters recently and a few large specimens weighing as much as twelve pounds have been captured by commercial fishermen in Polonnaruwa. They are also common in the Norton Bridge reservoir. A variety of *Cyprinus carpio* the mirror carp, in which certain scales are reduced in size or in which certain scales are absent altogether had been introduced into the Nuwara Eliya lake and are now breeding there.

*Carassius carassius* (L.) Golden or Prussian Carp (S. Ran Pethiya). D. 15-25, A. 8-9,  
 6-7

V. 9-10. P. 13-18. L. lat. 28-35, Tr.—  
 9

There are no barbels around the mouth in this species. The fish is olive brown on the dorsal surface, yellow grey on the sides and drab white on its ventral surface. It is very much like the ornamental gold fish. Introduced into the Nuwara Eliya lake in 1930.

*Tor khudree longispinis* (Gunther). [Mahsier (S. Hora Paleya, Lehella)]. D. IV, 9.

A. III, 5. P. I., 15-17, L. lat. 23-24. Tr.—(Page 113, Fig. 11)  
 $3\frac{1}{2}$   
 $2\frac{1}{2}$

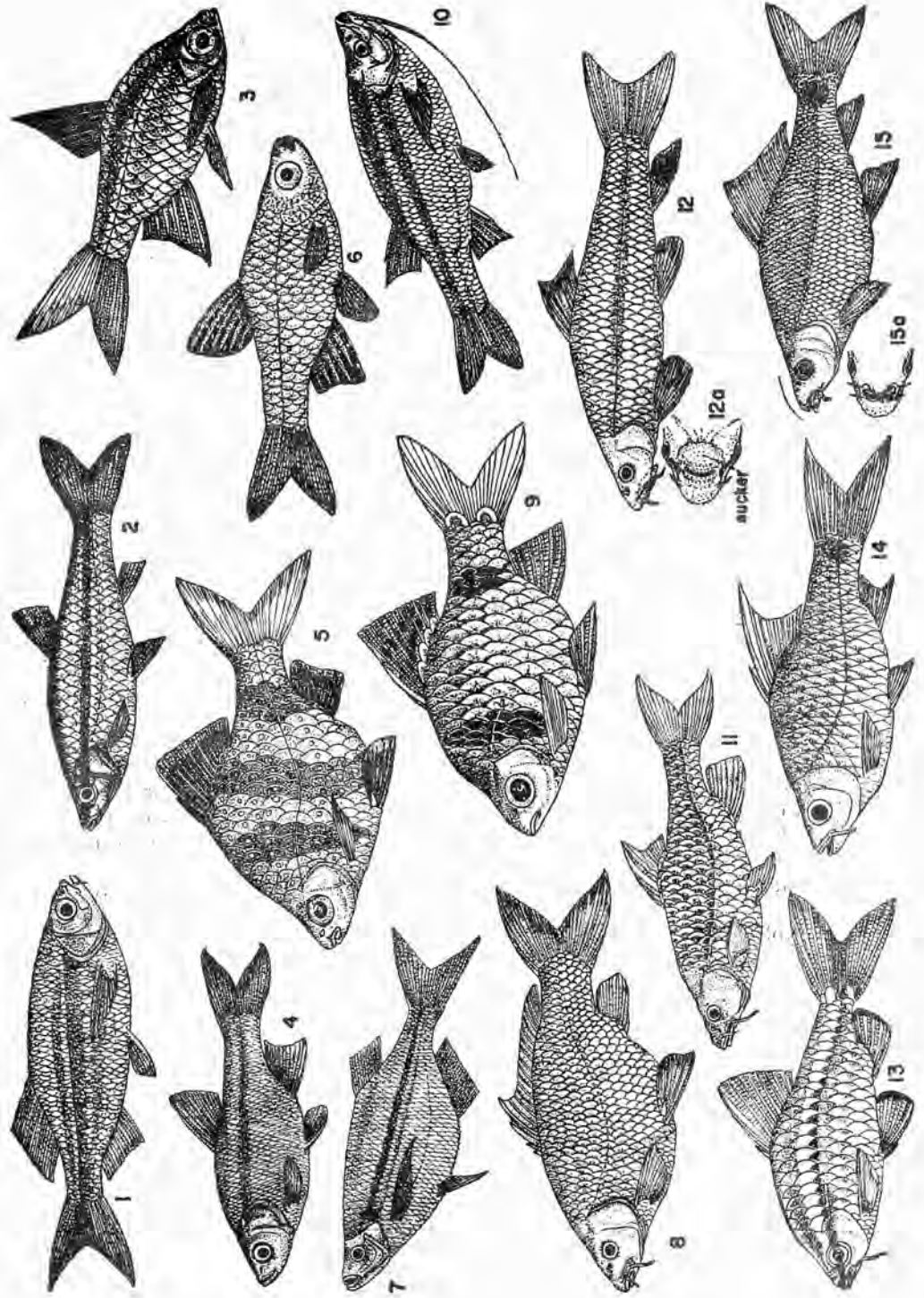
The dorsal surface of this species is pale olive coloured with blue and bronze reflections. The sides and belly are lighter coloured. It is a popular game fish and is common in the hill country streams and in the Castlereagh and Norton Bridge reservoirs. In Ceylon, fish weighing over twenty pounds are on record. It is sometimes caught in the larger irrigation reservoirs and the lower reaches of the Mahaweli ganga.

*Puntius* spp. There are thirteen species of *Puntius* recorded from Ceylon.

1. Lateral line incomplete .....	2
Lateral line complete .....	5
2. Dorsal spine smooth.....	<i>Puntius vittatus</i>
Dorsal spine serrated .....	3
3. Barbels present.....	<i>Puntius litteya</i>
Barbels absent.....	4
4. Two dark bands across body.....	<i>Puntius cumingi</i>
A dark spot on shoulder and another on tail.....	<i>Puntius ticto</i>
5. Dorsal spine serrated.....	6
Dorsal spine smooth.....	8
6. Barbels absent, three dark bands across body.....	<i>Puntius nigrofasciatus</i>
Barbels present.....	7

Explanation to figures on page 113

1. *Danio aequipinnatus* 7.5 cms. long.
2. *Rasbora daniconius* 12.5 cms. long.
3. *Rasbora vaterifloris* 3.8 cms. long.
4. *Amblypharyngodon melettinus* 7.5 cms. long.
5. *Puntius nigrofasciatus* after Deraniyagala 5.5 cms.
6. *Horadandiya atukorali* 2.5 cms. long.
7. *Chela laubuca* 5.5 cms. long.
8. *Cyprinus carpio* 42 cms. long.
9. *Puntius cumingi* after Deraniyagala 5 cms. long.
10. *Esomus danrica thermoicos* 6.5 cms. long.
11. *Tor khudree longispinis* 35 cms. long.
12. *Garra ceylonensis* 17.5 cms. long.
- 12a. Ventral view of head of *Garra ceylonensis* showing the sucker (s .
13. *Puntius titteya* after Deraniyagala 5 cms. long.
14. *Puntius dorsalis* 24 cms. long.
15. *Labeo dussumieri* 36 cms. long.
- 15a. Ventral view of head of *Labeo dussumieri*.



7. A dark lateral band from eye to tail fin.....*Puntius pleurotaenia*  
 No lateral band but a dark spot near tail.....*Puntius sarana*
8. Barbels absent.....*Puntius melanampyx sinhala*  
 A pair of barbels present.....9
9. Dorsal spine strong .  $4\frac{1}{2}$  scales above lateral line and  $2\frac{1}{2}$  below....*Puntius dorsalis*  
 Dorsal spine slender..... 10
10. Black spot over base of anal fin.....*Puntius filamentosus*  
 No black spot or if present it is behind the base of anal..... 11
11.  $5\frac{1}{2}$  scales above lateral line (and  $3\frac{1}{2}$  scales below).....*Puntius chola*  
 Less than  $5\frac{1}{2}$  scales above lateral line..... 12
12.  $4\frac{1}{2}$  scales above lateral line (and  $2\frac{1}{2}$  scales below)..... *Puntius amphibius*  
 $3\frac{1}{2}$  scales above (and  $2\frac{1}{2}$ — $3\frac{1}{2}$  below)..... *Puntius bimaculatus*
- Puntius sarana* (Hamilton-Buchannan). [Olive Barb (S. Mas Pethiya,  $4\frac{1}{2}$ — $5\frac{1}{2}$   
 Vellan Kola Pethiya)]. D. IV, 8. A. III, 5. P. I., 12-16, L. lat. 26-29, Tr.  $3\frac{1}{2}$

The largest among the species of *Puntius* in Ceylon attaining a length of 12 inches. It has a dark coloured spot in front of the tail. Has a prominent spine on the dorsal fin. It is a very common fish in streams, rivers, ponds, lakes and irrigation reservoirs.

*Puntius dorsalis* (Jerdon). (Long Snouted Barb (S. Bingataya, Honda Pethiya, Kattu Kuriya, Kattu Pethiya, Kandhaya, Kureya, T. Kendhai)]. D. IV, 8. A. III, 5. P. I.,

$4\frac{1}{2}$   
 11-13, L. lat. 23-25. Tr.—(Page 113, Fig. 14)  
 $2\frac{1}{2}$

It has no dark coloured spot in front of the tail but has a black blotch on the tail itself. It has a thick spine in the dorsal fin and hence the name Katu Pethiya. It grows up to  $9\frac{1}{2}$  inches in length and is common in streams, rivers, ponds and irrigation reservoirs.

*Puntius filamentosus* (Valenciennes). [Filamented Barb (S. Dankolla Pethiya, Goma Kadeya Goma Kolla, Ipilli Kadeya)]. D. IV, 8. A. III, 5. P. I., 15, L. lat. 22-23. Tr.—  
 $4\frac{1}{2}$   
 $2\frac{1}{2}$

This species grows to a moderate size attaining a length of  $4\frac{1}{2}$  inches. It has a prominent dark coloured blotch in front of the tail above the posterior half of the anal fin. It inhabits rivers, large streams and irrigation reservoirs.

*Puntius pleurotaenia* Bleeker. [Side Striped Barb (S. Hitha Massa)]. D. IV, 8. A. III-IV, 4-5. P. I., 15, L. lat. 28-30 Tr.—  
 $4\frac{1}{2}$ — $5\frac{1}{2}$   
 $2\frac{1}{2}$

This fish is found in streams at high elevations. The body colour is somewhat dark being greenish brown on the dorsal surface, and silvery on the rest of the body surface. There is a prominent dark band from the eye to the tail along the lateral line. This species grows up to six inches in length.

*Puntius chola* (Hamilton-Buchanan). [Green Barb (S. Kottu Ippilla, Kotu Pethiya)].  
 $5\frac{1}{2}$   
 D. IV, 8. A.III, 5.P. I., 15.L. lat. 24-27. Tr.—  
 $3\frac{1}{2}$

*Puntius amphibius* (Valenciennes). [Scarlet Banded Barb (S. Ippilli Kadaya, Mada Ippilla)].  
 $4\frac{1}{2}$   
 D. IV, 8. A. III, 5.P. I., 15. L. lat. 23-24 Tr.—  
 $2\frac{1}{2}$

These are both medium sized fish growing up to  $3\frac{1}{2}$  inches in length and inhabit streams and irrigation reservoirs of the low country. Compared to the other species of *Puntius* these two species are light coloured. Dorsally they are pale olive coloured. *P. amphibius* has a dark blotch at the end of the lateral line and the sexually mature fish possess a scarlet lateral band from eye to tail.

*Puntius vittatus* Day. [Striped Barb (S. Bandi Titteya)]. D. II, 8. A. II, 5. P.I., 11. L.  
 $3\frac{1}{2}$   
 lat 20-22. Tr.—  
 $3\frac{1}{2}$

It has a more or less oblong body. On the dorsal surface it is pale olive in colour while the sides are silvery. It has three black spots, one on the dorsal fin, one near the base of the caudal fin and the other near the anus. It assumes a bright green or red colour during the breeding season. It is the commonest carp in the low country and occurs in large numbers in paddy fields. It grows up to about one inch.

*Puntius melanampyx sinhala* (Duncker). [Black Banded Barb (S. Goma Titteya, Iri titteya, Pulli titteya, Thirelliya, Titha Kadaya)].  
 $4\frac{1}{2}$   
 D. III, 8. A. III, 5. P. I.14-16. L. lat.  
 20-22. Tr.—  
 $2\frac{1}{2}$

It has a rather elongate body which is brownish coloured on the dorsal surface and has three dark vertical bands across the body. The dorsal and tail fins are reddish with black tips. Grows up to a little over an inch in length.

*Puntius bimaculatus* (Bleeker). [Two Spot Barb (S. Ippilli Kadaya)]. D. IV, 7-8.  
 $3\frac{1}{2}$   
 A.III, 5.P. I.,15. L. lat. 24-25. Tr.—  
 $2\frac{1}{2}$ - $3\frac{1}{2}$

It is a rather elongate carp with a black spot at the base of the dorsal fin, another on the lateral line near the tail and sometimes a third one on the anal fin. Spawning individuals have a crimson lateral band. It grows up to  $2\frac{1}{2}$  inches and is found at all elevations in slow running as well as in torrential streams.

*Puntius nigrofasciatus* (Gunther). [Three Banded Crimson Barb, Black Ruby.  
 $4\frac{1}{2}$   
 (Bulath Sapeya, Manamalya)]. D.III, 8.A. III, 5.P.I., 12.L. lat. 20-22. Tr.—(Page 113,  
 Fig. 5).  
 $3\frac{1}{2}$

A popular aquarium fish with a more or less oval shaped body. The head is orange-red in colour whilst the rest of the body is drab olive green with golden spots on some of the scales. It has three black vertical bands. Dorsal and anal fins blackish. When stimulated

the males assume a glowing dark shiny-red colour in the front portion of the body and the fins. Grows up to  $2\frac{1}{2}$  inches in length and inhabits the shady parts of slow running streams.

*Puntius titteya*<sup>1</sup> Deraniyagala. [Cherry Barb, Crimson Carplet (S. Kondhaya, Dola Titteya, Lai Titteya, Vairan Titteya)]. D. III, 7. A. III, 5. P. I., 10. L. lat. 19-20,  $3\frac{1}{2}$   
Tr.—(Page 113, Fig. 13).  
 $3\frac{1}{2}$

A small fish attaining a maximum length of a little under two inches. Its colour is variable, usually it is purplish brown on the dorsal surface while its sides are silvery and occasionally there is a slight redness on the head of males. There is a brown lateral stripe from the eye to the caudal fork and above this stripe is another of yellow. Found in the small streams and rivulets at the foot hills.

*Puntius cuningi* (Gunther). [Cuming's Two Banded Barb (S. Pothaya)]. D. II, 8. A. III, 5. P. I. 11. L. lat. 19-21. Tr.—(Page 113, Fig. 9).  
 $3\frac{1}{2}$   
 $3\frac{1}{2}$

The body is silvery with yellow reflections around the base of the pectoral fins. There is a rhomboid black patch on each side above the pectoral fin and another above the anal fin. The dorsal and ventral fins are orange and the former has two horizontal rows of 5-7 black spots. The other fins are yellow. It grows up to 2 inches in length and inhabits streams at high elevations.

*Puntius ticto*<sup>2</sup> (Hamilton-Buchanan). [Fire Fin Barb]. D. II, 8. A. III, 5. P. I., 11. L. lat. 20-22. Tr.—  
 $4\frac{1}{2}$   
 $2\frac{1}{2}$ - $3\frac{1}{2}$

This species of *Puntius* is an inhabitant of the ponds and irrigation reservoirs in the dry zone. It can attain a length of a little over  $1\frac{1}{2}$  inches. It is pale olive coloured on the dorsal surface while its sides are silvery. There are two black spots between the gill cover and tail below the lateral line. There are two rows of indistinct spots on the dorsal fin. The male has an arched band of red on the dorsal fin which becomes more vivid during the breeding season.

#### Carp like fishes with sucking mouths

These fishes have their mouth adapted for sucking. Two genera of such fishes are present in Ceylon, namely *Garra* with a single species and *Labeo* with three species.

- |   |                               |
|---|-------------------------------|
| 1. Sucker behind the mouth (Page 113, Fig. 12a).....            | <i>Garra ceylonensis</i>      |
| No sucker behind the mouth (Page 113, Fig. 15a).....            | 2                             |
| 2. 48-53 scales along lateral line.....                         | <i>Labeo dussumieri</i>       |
| 40-42 scales along lateral line.....                            | 3                             |
| 3. Origin of dorsal fin in mid back.....                        | <i>Labeo fisheri</i>          |
| Origin of dorsal closer to tip of snout than to caudal fin..... | <i>Labeo porcellus lankae</i> |

<sup>1</sup> Deraniyagala (1958) has described a colour variety *Puntius titteya rubripinnis*.

<sup>2</sup> Deraniyagala (1956 and 1958) has indicated that the Ceylon species is a new sub-species *Puntius ticto melanomaculatus*.

*Garra ceylonensis* Bleeker. [Stone-sucker (S. Gal Panderuwa, Gal Pandiya, Pandiya, T. Kal Koravai)]. D. III, 8-9. A. II, 5. P. I., 9-12. L. lat. 33-35. Tr.  $\frac{4\frac{1}{2}}{2\frac{1}{2}-3\frac{1}{2}}$  (Page 113, Fig. 12).

These fishes are olive green coloured on the dorsal surface and silvery yellow on the sides and belly. They have a dark coloured blotch just behind the gill cover and a pinkish longitudinal lateral streak along the body. They inhabit flowing streams, mainly in the hill country and grow up to about six inches in length. They are capable of climbing vertical rock faces against the current with the aid of their suckers.

*Labeo dussumieri* (Valenciennes). [Common Labeo (S. Hiri Kanaya, Gan Kanaya)]. D. III, 12-13. A. III, 5. P. I., 15. L. lat. 48-53. Tr.  $\frac{8\frac{1}{2}-9\frac{1}{2}}{6\frac{1}{2}-7\frac{1}{2}}$  (Page 113, Fig. 15).

Body is oval shaped. The dorsal surface of the fish is golden brown coloured, pale on the sides while the belly at the anterior end is pinkish. The fins are golden brown coloured. A large black spot is present on the tail. Very common in the large irrigation reservoirs. Grows up to 14 inches and is an important food fish.

*Labeo fisheri* Jordon and Starks. [Green Labeo, Mountain Labeo (S. Gadaya, Kalu Gadaya, Vali Gadaya)]. D. III, 10-12. A. III, 5. P. I., 15. L. lat. 40-42. Tr.  $\frac{7\frac{1}{2}}{5\frac{1}{2}}$

Pale olive coloured dorsally, while the sides are golden with red reflections. A greenish lateral stripe along upper half of body. Dark brown spot on tail. Inhabits hill country streams. Grows up to 15 inches.

*Labeo procellus lankae* Deraniyagala. [Orange Fin Labeo (S. Seva Kanaya Tambala Vanna, Tambalaya)]. D. III, 11-12. A. III, 5. P. I., 16. L. lat. 40-42 Tr.  $\frac{7\frac{1}{2}-8\frac{1}{2}}{5\frac{1}{2}-6\frac{1}{2}}$

This species is olive coloured on its dorsal surface and white ventrally. The throat has a flush of pink. The fins are vermilion coloured, the caudal fin being edged with olive. There is a dark blotch on the tail. Common in the irrigation reservoirs of the dry zone. Grows up to 15 inches.

#### FAMILY CYPRINODONTIDAE Top Minnows

This is a group of small, essentially surface feeding fish. They usually have a silver or white coloured spot on the head. This spot is very prominent when the fish is swimming in the water. The dorsal fin is placed far back on the body. They are very common in shallow water and at the edges of deeper habitats. They feed on small drowning terrestrial animals and mosquito larvae. There are three species in Ceylon.

1. Anal fin with less than eighteen rays.....2  
Anal fin with more than nineteen rays.....*Panchax melastigma*
2. 32 or 33 scales along lateral line.....*Panchax lineatus dayi*  
27 to 29 scales along lateral line.....*Panchax panchax blochii*

*Panchax melastigma* McClelland. [Estuarine Top-Minnow (S. Diya Pita Handeya, Handhe Tittaya)]. D. 6-7. A. 20-24. L. lat. 27. Tr. 9-11.

The dorsal surface of the fish is a dull green and the abdomen is white. The outer edge of the anal fin is also white. There is a narrow dark line along the middle of each side terminating in the base of the caudal fin. Grows to 1½ inches and inhabits the estuaries round the coast.

*Panchax lineatus dayi* (Steindachner). [Striped Top-Minnow (S. Handhe Nalaya, Iri Nala Handheya, Iri Udda)]. D. 3-4. A. 13-16. L. lat. 32-33. Tr. 9.

The largest of the Ceylon Top-Minnnows attain a length of 2½ inches. The dorsal side of the fish is olive coloured with bright green reflections. The sides are yellow with red spots and there are a few dark cross bars on the body. Fins are yellow with red or orange rays. The anal and tail fins are edged with red. The females have more cross bars than the male and their fins are hyaline. Common in the fresh waters of the coastal plains, principally in the wet zone. Found in paddy fields.

*Panchax panchax blochii* (Arnold) [Lesser Top-Minnow (S. Udda)]. D. 3-6. A. 14. L. lat. 27-29. Tr. 9 (Page 121, Fig. 5).

A fairly small species of top-minnnows which only grow up to 1½ inches in length. Light olive coloured and has a black spot on the dorsal fin. Common in the fresh and brackish waters of coastal plains.

#### FAMILY OPHIOCEPHALIDAE—Snake Heads

The fish included in this group have elongate bodies which are more or less cylindrical in front but are compressed towards the tail. These hardy fishes have large mouths and are adapted for breathing atmospheric air in addition to the normal branchial breathing of fishes. This enables them to migrate on land from one freshwater body to another. They build nests in which they lay their eggs. They are carnivorous fishes. Five species from two genera have been recorded from Ceylon.

- |  |                                      |
|--|--------------------------------------|
| 1. No ventral fins.....  | <i>Channa orientalis</i>             |
| Ventral fins present.....  | 2                                    |
| 2. More than 40 dorsal fin rays.....   | 3                                    |
| Less than 35 dorsal fin rays.....  | 4                                    |
| 3. A diffuse lateral band crossed by 5-6 incomplete cross bars on each side of the body..... | <i>Ophiocephalus marulius ara</i>    |
| About 15 dark W-shaped cross bars on each side of the body....                               | <i>Ophiocephalus striatus</i>        |
| 4. Lateral line scales (10-12) + (28-32).....  | <i>Ophiocephalus gachua kelaarti</i> |
| Lateral line scales (13-15) + (21-24).....   | <i>Ophiocephalus punctatus</i>       |

*Channa orientalis* Bloch [Smooth Breasted Snake-head (S. Gas Kannaya, Kola Kannaya)]. D. 31-34. A. 20-22. P. 13-15. L. lat. (9-12) + (27-30). Tr. — (Page 121, Fig. 1).  
5-6  
6-7

A comparatively small species which grows up to a length of 4 inches. The entire body has a ground colour of yellow brown. On the dorsal surface it is greenish coloured with bluish cross bars. The long dorsal fin is orange coloured with a greenish longitudinal band. The anal fin is also long and it is greenish coloured. It has a dark coloured longitudinal band. The other fins are yellow with several blue cross bands. This species is found in clear fresh water ponds near streams.

*Ophiocephalus marulius ara* Deraniyagala. [Giant Snake head. (S. Ara. Gang Ara, 6-7 Kalumaha)]. D. 45-49, A. 23-31, P. 16-18, L. lat. (16-21) + (40-44) Tr.  $\frac{5-7}{10-12}$

This is a very large fish growing up to a length of over two and half feet. It is pale olive to yellow in colour and has a diffuse violet lateral band crossed by 5 to 6 incomplete cross bars. Fins are dark olive to dusky violet and spotted with white. Present in streams, rivers and irrigation reservoirs up to an elevation of 1,500 feet and is a popular food fish amongst the people living in inland districts. There is a regular fishery for this species and for *O. striatus* in some of the tanks in the North-Central Province.

*Ophiocephalus striatus* Bloch. [Striped Snake-head, Murrel (S. Hal Pathmaha, Loolla)]. D. 42-46, A. 25-28, P. 15-17, L. lat. (15-18) + (39-42). Tr.  $\frac{5-8}{10-14}$

This is also a large species and may attain a length of about 2½ feet. It is more common than *O. marulius ara*. It is olive to dark brown dorsally and white to yellow with brownish mottling on the sides and ventrally. In addition there are about 15 W-shaped dark bars, transversely across its body. Fins are olive coloured. They are common in ponds, irrigation reservoirs, streams and paddy fields.

*Ophiocephalus punctatus* Bloch. [Green Snake-head (S. Mada Ara, Madaya, Mada Kanaya, Mada Kariya)]. D. 29-30, A. 20-22, P. 15-18, L. lat. (13-15) + (21-24), Tr.  $\frac{5-6}{8}$  (Page 121, Fig. 4).

This is not a very large fish, growing up to a length of 8 inches. The dorsal surface of this fish is olive coloured while its sides are yellow-green and the ventral surface is yellow-white. There are 6 to 7 dark transverse triangular patches dorsally and 10 ventral dark streaks. The fins are olive to yellow with several dark bands. Common in streams, ditches and paddy fields of the low-country.

*Ophiocephalus gachua kelaarti* Gunther. [Brown Snake-head (S. Parandal Kanaya, T. Para Korruvai)]. D. 30-33, A. 20-23, P. 14-15, L. lat. (10-12) + (28-32). Tr.  $\frac{5-7}{7-8}$

Comparatively small fish which does not exceed 6 inches in length. The dorsal surface is brown coloured with W-shaped bars on it. The sides and ventral surface are lighter. The margin of the dorsal fin is orange and the anal fin is green-blue. This species is present in waters below an elevation of 3,600 feet. It has been recorded from the hot springs at Trincomalee.

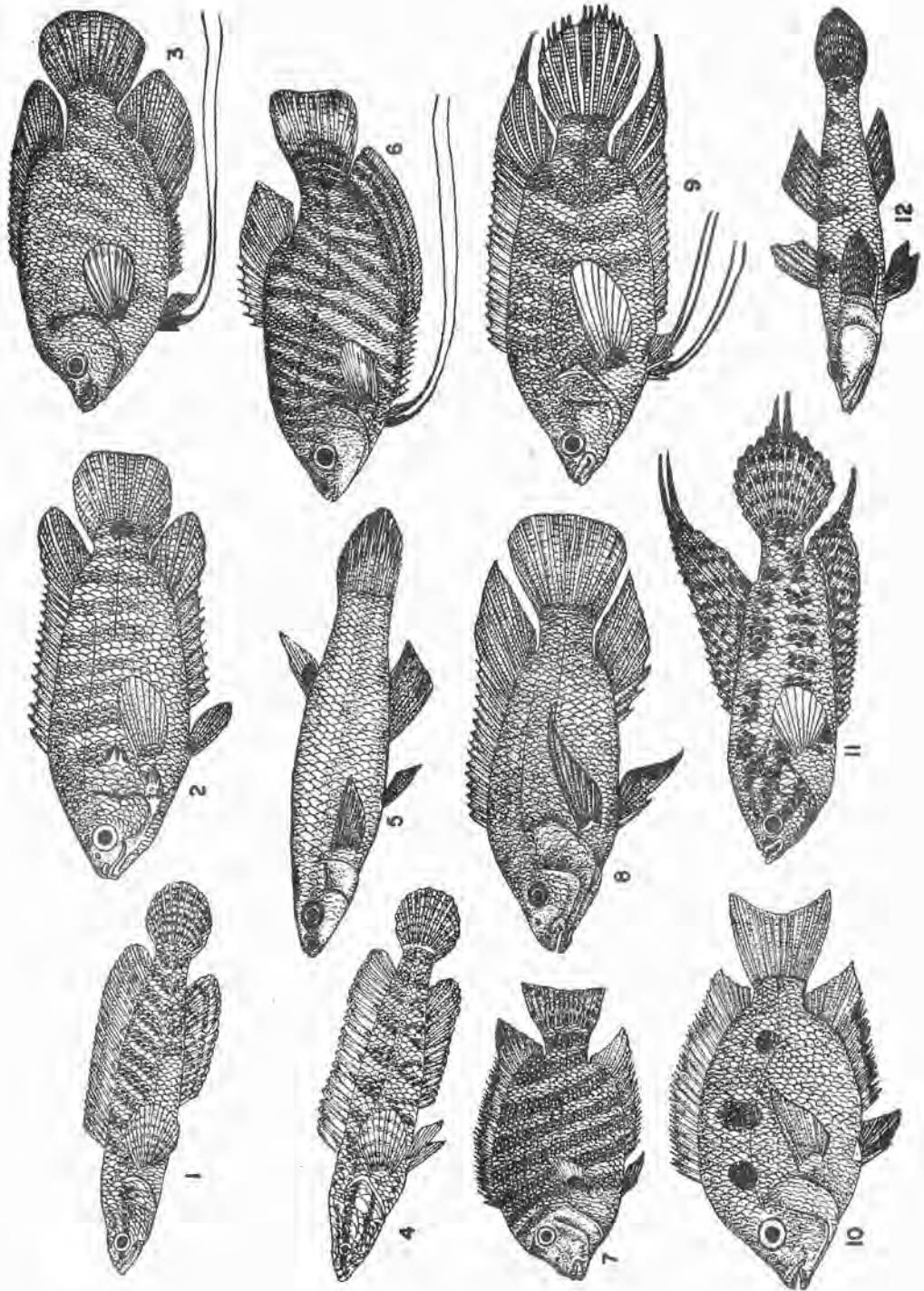
#### FAMILY ANABANTIDAE Climbing Perches and Bubble Nest Builders

These spiny finned fishes have a special respiratory organ formed by an expansion of a gill arch. They are therefore able to breathe atmospheric air. They have elongate, filamentous pelvic fins. *Anabas* has a pair of stout spines on the pelvic fins in addition to opercular spines but its pelvic fins are not filamentous.

1. At least one of the ventral fin rays filamentous.....2  
None of the ventral rays filamentous.....*Anabas testudineus*
2. Ventral fin filament long, extending at least up to caudal fin.....3  
Ventral fin filaments short.....4

Explanation to figures on page 121

1. *Channa orientalis* 10 cms. long.
2. *Anabas testudineus* 16 cms. long.
3. *Oephroneurus goramy* 60 cms. long.
4. *Ophiocephalus punctatus* 22 cms. long.
5. *Panchax panchax blochii* 3·8 cms. long.
6. *Trichogaster pectoralis* 15 cms. long.
7. *Eitropus suratensis* 30 cms. long.
8. *Tilapia mossambica* 40 cms. long.
9. *Belontia signata* 13 cms. long.
10. *Eitropus maculatus* 8 cms. long.
11. *Malpulutta kretseri* from Deraniyagala 3·8 cms. long.
12. *Glossogobius giuris* 35 cms. long.



- |  |                                |
|--|--------------------------------|
| 3. Seven spines on dorsal fin.....   | <i>Trichogaster pectoralis</i> |
| Twelve to thirteen spines on dorsal fin.....                               | <i>Osphronemus goramy</i>      |
| 4. Body oval shaped, caudal fin not filamentous.....                       | <i>Helostoma temmincki</i>     |
| Body elongate, caudal fin filamentous.....                                 | 5                              |
| 5. Anal fin not filamentous.....   | <i>Macropodus cupanys</i>      |
| At least one of the anal rays filamentous.....                             | 6                              |
| 6. Outer ventral ray bifid and extends out as two elongated filaments..... | <i>Belontia signata</i>        |
| Outer ventral ray single.....  | <i>Malpulutta kreiseri</i>     |

*Anabas testudineus* (Bloch) [Climbing Perch (S. Kavaiya, Pol Kavaiya, T. Kavaiyen)].

D. XV-XVII, 9-10, A. IX-XI, 9-11, L. lat. (15-19), + (10-15). Tr.  $\frac{3-5}{9-11}$  (Page 121, Fig. 2).

This fish is light to dark green coloured on the dorsal surface and the sides are greenish yellow to orange. There are about ten indistinct olive cross bars on each side of the body. There is a black blotch on the tail and sometimes one behind the gill cover. The dorsal fin is green coloured. The eye is orange. It grows up to 6 inches in length. The fish can live out of water for short periods and even cross land from one water body to another, usually at night. It is very common in the low country inhabiting ditches, ponds and paddy fields, and it can live in polluted water.

*Osphronemus goramy* Lacepede. [Giant Gourami (S. Gourami, Seppali)]. D. XII-XIII, 11-13, A. IX-XI, 19-21, P. II, 13, L. lat. 30-33. Tr.  $\frac{5-6}{13-14}$  (Page 121, Fig. 3).

The fish can be recognised at once because of its strongly compressed body which is oblong and much elevated. Even more striking are the two long filaments which are extensions of a portion of the ventral fin. The fish is brown to olive coloured on the dorsal side and silvery or yellowish below. In the young there are about 8 dark coloured cross bars on each side. The gourami is an excellent food fish. It was first introduced into Ceylon's fresh-waters about 50 years ago. They are able to live in rivers and ponds and they can even withstand brackish water. Eggs are laid in nests constructed out of decaying plant material or any similar soft material lying in the water. The fish take care of their young. They grow up to two feet in length and specimens weighing fifteen pounds are not uncommon.

*Trichogaster pectoralis* (Regan) Snake Skin Gourami. D. VII, 10-11, A. IX-XII, 33-38, L. lat. 55-63 (Page 121, Fig. 6).

This species looks like an *Osphronemus goramy*, but it is much smaller and more slender. It is brownish in colour with several dark brown vertical bands on the sides. It can grow up to about 10 inches and weigh about  $\frac{1}{4}$  pound. Recently introduced into Ceylon and is now common in the marshes around Colombo.

*Helostoma temmincki* Cuvier. (Kissing Gourami). D. XVI-XVIII, 13-16, A. XIII-XV, 17-19.

P. II, 11, L. lat. 44-48. Tr.  $\frac{8}{15-16}$

A flattened, broad fish whose jaws are provided with thick lips. The ventral fin filament is elongated but not to the extent in *Oosphronemus* and *Trichogaster*. The fish is olive or grey coloured on the dorsal side and much lighter below with dark longitudinal stripes along rows of scales. They grow upto 12 inches in length. This species has been recently introduced into Ceylon and large numbers have been released into various water bodies but none have yet been captured from such waters.

*Belontia signata* (Gunther) (S. Pulutta, Kola Modaya). D. XVI-XVIII, 8-10, A. XIV-XVI, 10-12, P. 10-12, L. lat. 2-3) + (10-15) (2-3) + (13-16), Tr.  $\frac{4}{10-11}$  (Page 121, Fig. 9).

A strongly compressed oblong fish. Each ventral fin has two filaments. The dorsal and anal fins are prolonged posteriorly. The fish is olive coloured dorsally and green on the sides and ventral surface, sometimes with blue reflections. A black blotch is present at the base of the dorsal fin posteriorly. A similar but smaller blotch is present at the base of the pectoral fin. The fin colour varies between shades of yellow and orange. The eyes are yellow. They grow up to 5 inches in length. They are present in ponds, tanks and streams of both the hill and low country.

*Malpulutta kretseri*<sup>1</sup> Deraniyagala. (S. Mal Pulutta). D. VIII-X, 6, A. XVI-XVII, 9-11, P. 12, V. I, 5. L. lat. 29-30, Tr. 9-10 (Page 121, Fig. 11).

This species could be easily recognised by the form of the fins. The ventral fin has a short filament. The caudal fin in the adult has two filamentous rays. The posterior portions of the dorsal and anal fins are produced into filament like projections. The fish are cinnamon brown coloured on the dorsal side and are lighter below. There are three dark coloured bands extending from the eye to the posterior end of the gill cover and there are two rows of similar coloured blotches along the sides. The fins are yellowish with black spots and blue margins. The filaments of the fins are also blue. These fish grow up to 1½ inches and inhabit small ponds adjacent to streams. They are not common.

*Macropodus cupanus* (Cuvier). (S. Tal Kossa, Tal Kadaya, Tal Padada). D. XIII-XV, 4-5, A. XVII-XX, 10-13, P. 11, V. I, 5, L. lat. (9-13) + (17-20). Tr.  $\frac{7}{7}$

It has a compressed body. The ventral fin has a moderately long filament. The fish is green coloured, the shade of colour being darker on the dorsal side. Sometimes a brown stripe extends from the eye to the posterior end of the gill cover and there are brown spots on the head. The fins are pale green except for the ventral fin filaments which are red. They grow up to 1½ inches in length and inhabit ponds and ditches of the low country.

#### FAMILY CICHLIDAE Cichlids

This group of fishes have compressed, oblong bodies which are provided with moderate sized scales. There are numerous spines on the dorsal fin and a few on the anal. There are two genera with three species in Ceylon. Though these resemble the *Anabantids* superficially, the pelvic fins

<sup>1</sup> Deraniyagala (1958) indicated that there is another race of this species, namely *minor*.

are not elongate nor are opercular spines present.

1. Anal fin with three spines.....*Tilapia mossambica*,  
Anal fin with 12 or more spines.....2
2. Yellowish in colour with 3 dusky blotches on each side of body...*Etroplus maculatus*,  
Green in colour with several conspicuous transverse bands on the  
side.....*Etroplus suratensis*

*Etroplus maculatus* (Bloch). [Spotted Etroplus (S. Ran Koraliya, Kaha Koraliya, Ralliya)]. D. XVII-XX, 8-10, A. XII-XV, 8-9, L. lat. 35, Tr.  $\frac{6}{19}$  (Page 121, Fig. 10).

This is a relatively small species, only growing up to a length of about 3 inches. It is yellowish in colour with a shade of pale green on the dorsal side. There are several rows of golden coloured spots, on its body and fins. These fish are found in the coastal fresh waters and also in the large irrigation reservoirs.

*Etroplus suratensis* (Bloch). [Banded Etroplus (S. Koraliya, Sethala, T. Sethel)].  
D. XVIII-XIX, 14-15, A. XII-XIII, 11-12, L. lat. 35-40, Tr.  $\frac{6}{17}$  (Page 121, Fig. 7).

This is a large species which grows upto about a foot in length. Most of the scales on the dorsal half of the body have on each of them a central pearly spot. There are some irregular black spots on the abdomen. Originally this species was very common in the brackish waters. They have been introduced into most of the fresh water bodies in the low country where they now flourish. A desirable food fish and is found in large numbers in some of the tanks of the North-Central Province.

*Tilapia mossambica* (Peters) [*Tilapia* (S. Japan Koraliya)]. D. XV-XVI, 11-12, A. III, 10. L. lat. 30. Tr.  $\frac{4}{12}$  (Page 121, Fig. 8).

This fish is dark green to drab golden coloured and the scales have dark centres. The adult males are dark coloured and are sometimes almost black. *Tilapia* was introduced into Ceylon waters in 1951. It established itself with amazing rapidity and is now the predominant species in the fish harvest of the commercial fishermen of the coastal fresh and brackish water bodies and also the major tanks of the North-Central Province. *Tilapia* grows to a weight of 3 lb. It is also called a "mouth breeder" as the mother protects the young in her mouth for a time after they are hatched.

#### FAMILY GOBIIDAE Gobies

These are fish with elongated bodies. They have two dorsal fins which are generally separated from each other. The first or more anterior dorsal fin is spinous while the other is not. Only one species in fresh water.

*Glossogobius giuris* (Hamilton-Buchanan). [Bar-eyed Goby (S. Weligowa, Gal Katta, T. Ulavai)]. D. VI, I, 8-9, A. I, 7-8, P. 17-21, L. lat. 28-36, Tr. 8-14, (Page 121, Fig. 12).

The body of this species is elongate. Anteriorly the body is cylindrical while posteriorly, it is compressed. The head is pointed and depressed. On the dorsal side it is drab green coloured and on the ventral side it is a lighter shade of green. The head has a few dark spots laterally. The body has two rows of 4 to 6 dark blotches. The fins are yellow green with spots and dark margins. This is essentially an estuarine species common in the coastal

waters and harbours. It has entered fresh waters and moved up rivers. Today it is a common fish even in the large irrigation tanks of the North-Central Province.

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# AMPHIBIA

(Frogs, Toads and Cæcilians)

AMPHIBIA spend part of their life in water and part on land and therefore are not strictly aquatic animals. As a rule their eggs are laid in or near the water and the fish-like larvae (tadpoles) are aquatic. By a series of changes these larvae become adults. The adults of some species may continue to live in the water and only rarely go on land (e.g., certain frogs), while others become terrestrial and return to the water only to lay eggs (e.g., the toads).

Frogs and toads (Anura) are very common in shallow water and in moist places, many species being found in paddy fields. A few species are present in torrential streams.

Although frogs are used as food in some countries, in Ceylon they are not fancied for this purpose. They are of importance as scavengers and may eat small fish. They are reputed to keep drinking wells clean and as a whole cause little damage to other animals and crops. They form an important component in the diet of birds. The larvae are sometimes eaten by fishes.

The Cæcilians (Apoda) are a primitive group of worm-like amphibians.

The amphibians present in Ceylon fall into two orders.

1. Limbs absent, eel-like body.....Apoda, page 131
- Two pairs of limb .....Anura, page 126

## ORDER ANURA

(Frogs and Toads)

These are tailless Amphibia with the hind limbs greatly enlarged for jumping. They are represented by 31 species belonging to 4 families.

### KEY TO ADULT ANURA

1. Upper jaw toothed.....2
- No teeth on either jaw.....3
2. Tips of digits enlarged.....Rhacophoridae, page 130
- Tips of digits not enlarged.....Ranidae, page 127
3. Skin with prominent tubercles and spiny warts.....Bufonidae, page 127
- Skin generally smooth and without spiny warts.....Microhylidae, page 130

## KEY TO THE ANURAN TADPOLES (LARVAE)

1. Spiraculum on mid ventral line.....Microhylidae, page 130  
Spiraculum to the left of mid central line ..... 2
2. Anal opening median.....Bufonidae, page 127  
Anal opening directed to the right side of the body..... 3
3. Anal opening at the end of a tube.....Ranidae, page 127  
Anal opening not at the end of a tube but flush with the body.....  
.....Rhacophoridae, page 130

### FAMILY BUFONIDAE Toads

They are generally short limbed, and broad waisted. The skin is rough to the touch due to the presence of numerous tubercles and spiny warts. The jaws do not have teeth. There is a slight webbing at the base of the toes (rear limbs) but the fingers (front limbs) are free. They are terrestrial forms frequenting damp shady localities and entering the water to breed. They deposit their eggs in two long gelatinous strings.

The larvae which have horny mandibles are more or less black in colour. The anal opening is in the mid ventral line.

Five species of the genera *Bufo* have been recorded in Ceylon.

*Bufo fergusonii* Boulenger

*Bufo kelaartii* Günther (Page 129, Fig. 2)

*Bufo melanostictus* Schneider (Page 129, Figs. 1 and 5)

*Bufo microtypanum* Boulenger

*Bufo stomaticus* Lütken

### FAMILY RANIDAE Frogs

They are generally long-legged and slim-waisted. The skin is smooth. The upper jaw is toothed. *Rana* spp. have webbed toes while the fingers are free. *Nannophrys* spp. have both fingers and toes free. The two species within the subgenera *R. (Hylarana)* have the tip of their digits enlarged into flat discs. Eggs are laid in the water in relatively large, rounded, grape like clusters.

The larvae have horny mandibles. The anal opening is at the end of a tube or spout and is on the right side of the mid ventral line.

Eleven species from two genera are represented in Ceylon. They vary considerably in size and are confined to aquatic habitats.

*Rana corrugata* Peters

*Rana cyanophlyctis cyanophlyctis* Schneider (Page 129, Fig. 6)

*Rana hexadactyla* Lesson (Page 129, Figs. 10 and 16)

*Rana (Hylarana) gracilis* Gravenhorst

*Rana (Hylarana) temporalis* Günther (Page 129, Fig. 9)

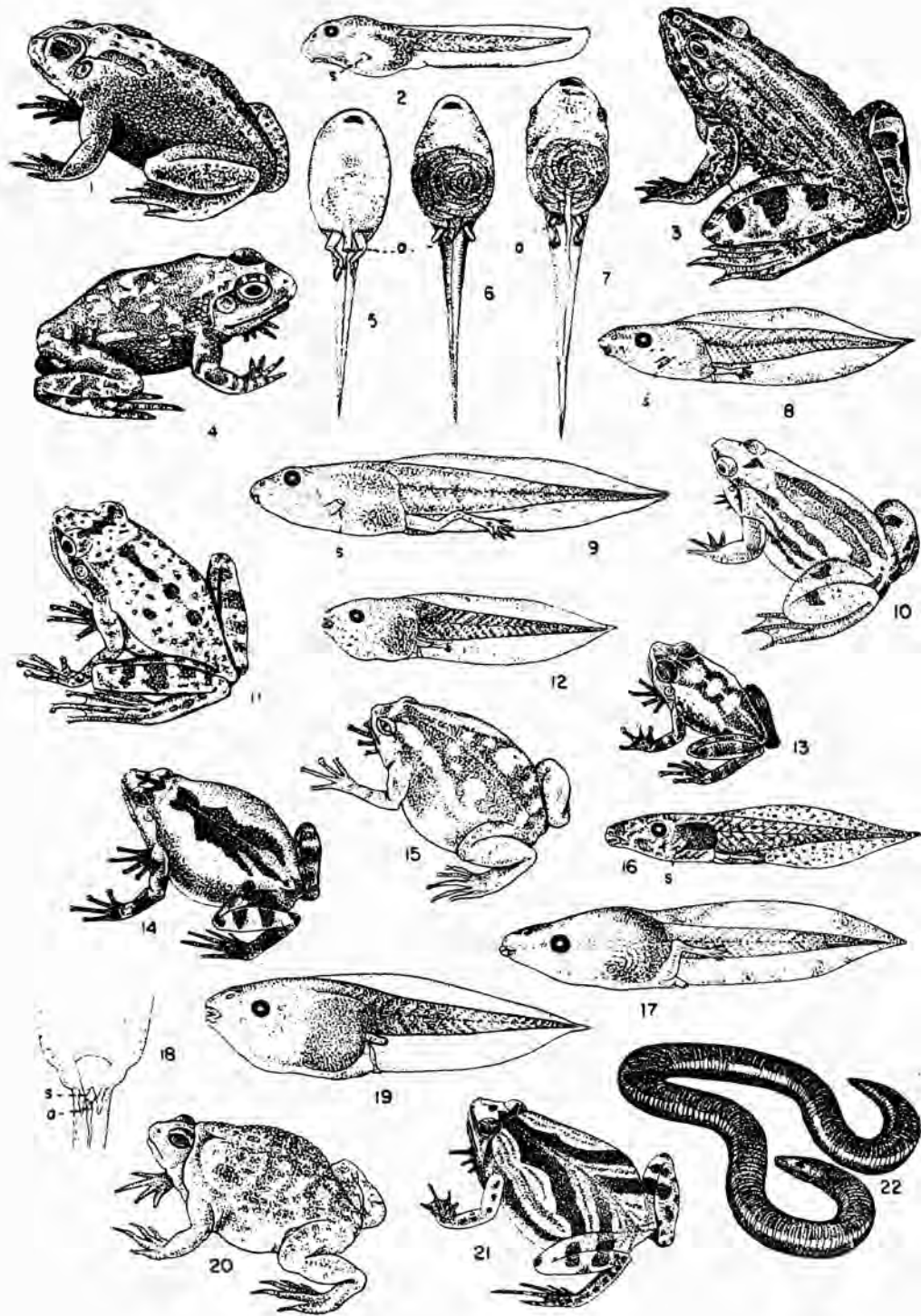
*Rana limnocharis greenii* Boulenger

*Rana limnocharis limnocharis* Wiegmann

Explanation to figures on page 129

1. *Bufo melanostictus*, length from snout to vent up to 100 mm.
2. Larva of *B. kalaartii*, from Kirtisinghe, total length 11 mm.
3. *Rana tigrina crassa*, length from snout to vent up to 132 mm.
4. *Nannophrys ceylanensis marmorata*, length from snout to vent 44 mm.
5. Ventral view of larva of *Bufo melanostictus*, total length 20 mm.
6. Ventral view of larva of *Rana cyanophlyctis cyanophlyctis*, total length 30 mm.
7. Ventral view of larva of *Rhacophorus leucomystax maculatus*, total length 40 mm.
8. Larva of *Rana tigrina crassa*, total length 60 mm.
9. Larva of *Rana (Hylarana) temporalis*, total length 48 mm.
10. *Rana hexadactyla*, length from snout to vent 130 mm.
11. *Rhacophorus leucomystax maculatus*, length from snout to vent 64 mm.
12. Larva of *Kaloula pulchra taprobanica*, total length 21 mm.
13. *Philaunus leucorhinus*, length from snout to vent 31 mm.
14. *Ramanella obscura*, length from snout to vent 31 mm.
15. *Kaloula pulchra taprobanica*, length from snout to vent 45 mm.
16. Larva of *Rana hexadactyla*, total length 40 mm.
17. Larva of *Uperodon systoma*, total length 30 mm.
18. Ventral view of spiracular and anal region of larva of *Microhyla rubra* from Kirtisinghe.
19. Larva of *Ramanella* sp., total length 30 mm.
20. *Uperodon systoma*, length from snout to vent 56 mm.
21. *Microhyla ornata*, length from snout to vent 23 mm.
22. *Ichthyophis glutinosus*, length up to 450 mm.

a—anus.  
s—spiracle.



*Rana tigrina crassa* Jerdon (Page 129, Figs. 3 and 8)  
*Rana (Tomopterna) breviceps* Schneider  
*Nannophrys ceylonensis ceylonensis* Günther  
*Nannophrys ceylonensis marmorata* Kirtisinghe (Page 129, Fig. 4)  
*Nannophrys guentheri* Boulenger

#### FAMILY RHACOPHORIDAE Tree Frogs

These tree frogs have long limbs and slim waists. The tips of the digits are provided with adhesive discs. The toes are webbed but the fingers are free. Perhaps the webbing of the toes is an adaptation for supporting the animal in the air during its leaps from trees. The jaws are toothless. The eggs are usually laid outside the water in frothy masses. Certain species of *Rhacophorus* produce masses of green frothy spawn which are found sticking to the walls of wells, perpendicular rock faces in quarries or trunks of trees in such a position as to allow the larvae to readily drop into the water when they are old enough to move about and feed on their own.

The larvae have horny mandibles. The anal opening is not at the end of a tube or spout but is flush with the body and it lies to the right of the mid ventral line.

Eight species from two genera are represented in Ceylon.

*Philautus leucorhinus* (Lichtenstein and Martens) (Page 129, Fig. 13)  
*Philautus nasutus* (Günther)  
*Philautus schmardanus* (Kelaart)  
*Philautus variabilis* (Günther)  
*Rhacophorus cruciger cruciger* (Blyth)  
*Rhacophorus cruciger eques* (Günther)  
*Rhacophorus leucomystax maculatus* (Gray) (Page 129, Figs. 7 and 11)  
*Rhacophorus microtympanum* (Günther)

#### FAMILY MICROHYLIDAE

They are generally small with short limbs and smooth skin. The head is small with a pointed snout. This family comprises frogs which live amongst trees (arboreal), others on the ground (terrestrial) and some are burrowing forms. The arboreal forms usually have adhesive discs on their toes.

The majority of the species either pass the larval stage within the egg or hatch out as distinctive tadpoles without a sucking disc round the mouth. The larvae do not have any teeth and they do not have nostrils till just before transformation into the adult.

Eight species from four genera are represented in Ceylon.

*Kaloula pulchra taprobanica* Parker (Page 129, Figs. 12 and 15)  
*Microhyla ornata* (Dumeril and bibron) (Page 129 Fig. 21)  
*Myrohyla rubra* (Jerdon) (Page 129, Fig. 18)  
*Microhyla zeylanica* Parker and Hill  
*Ramanella obscura* (Günther) Page 129, Fig. 14)  
*Ramanella palmata* Parker (Page 129, Fig. 19)  
*Ramanella variegata* (Stoliczka)  
*Uperodon systoma* (Schneider) (Page 129, Figs. 17 and 20)

## ORDER APODA

They are limbless, wormlike amphibia.

### FAMILY CAECILIDAE

A family of burrowing terrestrial amphibians which are more or less blind, although the eyes are clearly marked. There is a protrucible tentacle between the eye and the nostril on each side. There are teeth on the lower jaw. The body is externally marked into rings by numerous annular grooves in the leathery skin.

The female lays from 10 to 24 large eggs, each 6 to 9 mm. in diameter strung together by a prolongation of the outer capsule gathered to a cluster and deposited in a burrow near the water. This egg mass is protected by the female who coils herself round it. Each embryo has three pairs of long external gills. The eggs hatch into eel-like larvae.

In Ceylon there are two species from a single genus.

*Ichthyophis glutinosus* (L.) (Page 129, Fig. 22)

*Ichthyophis monochrous* (Bleeker)

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# REPTILIA

(Reptiles)

THE aquatic reptiles are represented in Ceylon by three species of terrapins, two species of crocodiles, three species of snakes and a single species of monitor lizard. The terrapins are mainly herbivores but sometimes consume dead animal matter and young fish and small animals. The others are carnivorous and pests in fish cultivation. The monitor lizard is at home on land as well as in the water. All reptiles are air breathers and have to come to the water surface to take in air.

The reptiles are divisible into 3 orders :—

1. Jaws without teeth. Body enclosed within a bony corselet....Testudinata, page 132  
Jaws with teeth. Body not enclosed in a bony corselet..... 2
2. Cloacal opening longitudinal. Teeth set in alveoli (sockets).....Crocodylia, page 133  
Cloacal opening transverse. Teeth not set in alveoli (sockets)....Squamata, page 133

## ORDER TESTUDINATA

(Turtles—Terrapins—Tortoises)

Two families of Testudinata are represented in the freshwaters of Ceylon.

1. Five claws on each fore limb. Corselet with bony scutes. No lips on beak  
..... Emydida, page 132  
Three claws on each fore limb. Corselet covered by smooth skin. The beak  
has lips..... Trionychidæ, page 133

### FAMILY EMYDIDAE Hard Terrapins

The oval body is enclosed in an exoskeleton and there are scutes on the exoskeleton. The head, tail and limbs which project through apertures in the exoskeleton are retractible. The limbs are flattened. There are five claws on each fore limb. The hard terrapins are dark brown or black in colour and the body surface appears to be corrugated.

*Melanochelys trijuga parkeri* Deraniyagala. [Parker's Terrapin (S. Parkerge Gal Ibba)].

This is the larger of the two sub-species of *Melanochelys* present in Ceylon growing up to 38 cms. in length. It is common in the dry zone up to an elevation of 3,000 feet. Feeds on plants and dead animal matter and is therefore a useful scavenger. During the daylight hours it spends its time in water and comes ashore at night.

*Melanochelys trijuga thermalis* (Lesson). [Common, Hard or Black Terrapin (S. Gal Ibba, Goo Ibba, Thumba Ibba, Valan Gebba, T. Kal Amai, Pe Amai, Karuppu Amai)], (Page 135, Fig. 7).

Smaller (grows up to 29 cms. in length) and more common than the previous sub-species with the same habits but more abundant particularly in polluted water. Common in the wet zone up to an elevation of 4,200 feet.

**FAMILY TRIONYCHIDAE** Soft Terrapin

The exoskeleton is covered by a soft skin and not by scutes. Limbs modified to serve as paddles. Only one species is present in Ceylon.

*Lissemys punctata ceylonensis* (Gray). [Soft Terrapin (S. Kiri Ibba, T. Pal Amai)]. (Page 135 Fig. 6).

They are usually present in stagnant water such as small tanks and pools. It does not come on land so frequently as the hard terrapins. They sometimes burrow into the mud at the bottom of ponds and tanks. They feed on earthworms, water snails crustacea, frogs and fishes. The flesh of this species is edible and is supposed to have medicinal properties.

**ORDER CROCODYLIA**

**FAMILY CROCODYLIDAE** Crocodiles

Reptiles in which the body surface is covered with rows of sculptured bony scutes (osteoderms). They are the largest reptiles found in freshwater and may be dangerous to man. Young crocodiles feed on insects and other small animals but as they grow older they feed mainly on fish.

1. Snout blunt. Most osteoderms ("scutes") sub-quadrangular and not separated by skin.....*Crocodylus palustris kimbula*

Snout pointed. Osteoderms ovoid and separated by skin.....*Crocodylus porosus*

*Crocodylus palustris kimbula* Schneider Deraniyagala. [Ceylon Swamp Crocodile, Ceylon Mugger (S. Ela Kimbula, Ali Kimbula, T. Kulathi Muthelai)] Page 135, Fig. 2).

This species is present in the coastal lagoons and fresh waters such as swamps, tanks and rivers.

*Crocodylus porosus* Schneider. [Marsh, Estuarine or Sea Crocodile (S. Pita Gatteya, Gatte Kimbula, Gorekeya, T. Semmukham Muthelai)] Page 135, Fig. 1).

Found at the mouths of muddy rivers and canals near the sea and are capable of moving from one river mouth to another by way of the sea. Occasionally they have been found to travel upstream and there are records of specimens found in the Kalu-ganga at Ratnapura.

**ORDER SQUAMATA** Snakes and Lizards

The order is split up into two sub-orders.

1. Limbs absent.....Serpentoidea, page 133

Limbs present.....Lacertoidea, page 136

**SUB-ORDER SERPENTOIDEA** Snakes

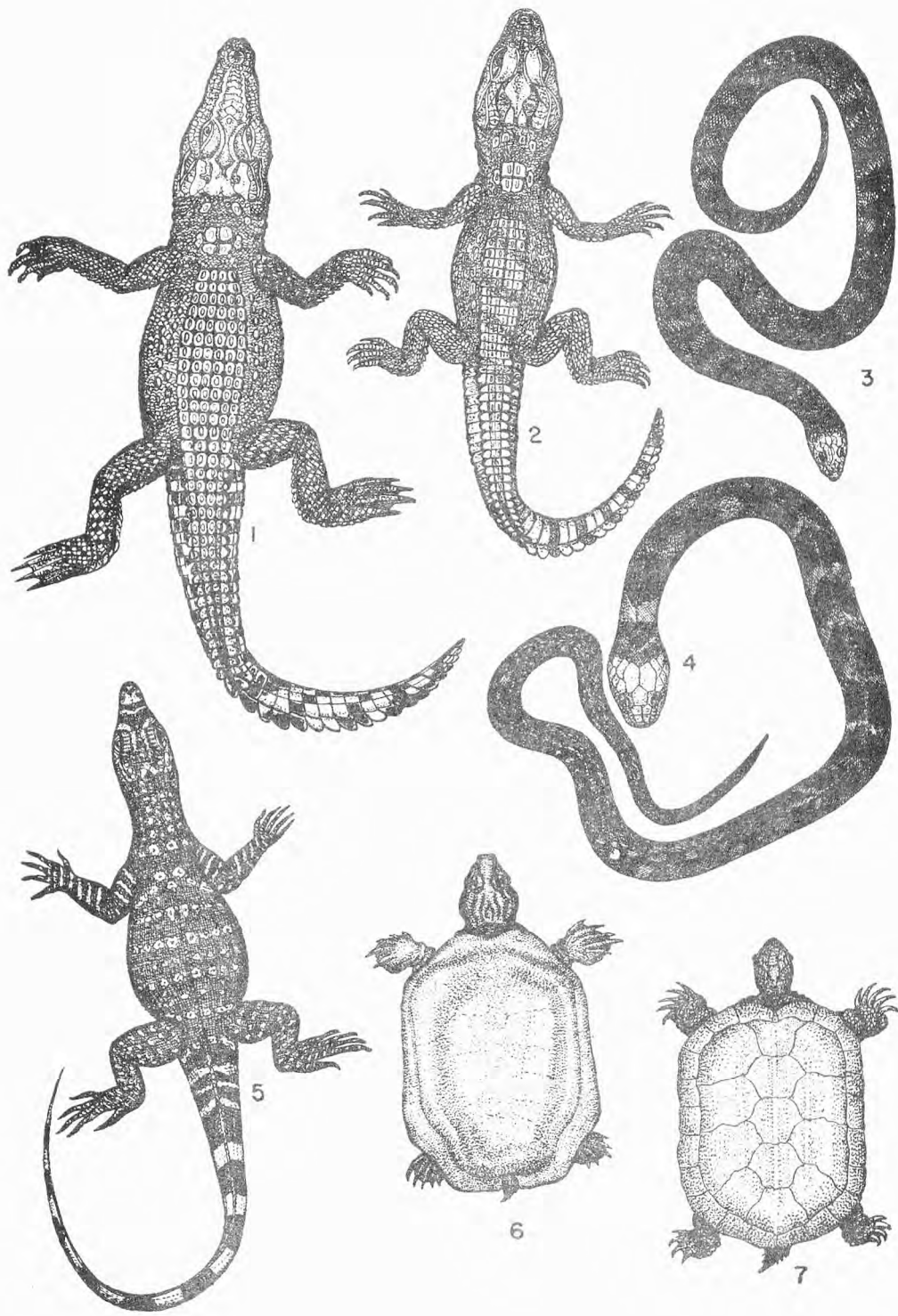
Elongate reptiles without limbs.

**FAMILY COLUBRIDAE**

A family of reptiles in which the body is elongate, narrow and cylindrical. The head is covered with a large shield.

**Explanation to figures on page 135**

1. *Crocodylus porosus* up to 610 cms. long.
2. *Crocodylus palustris kimbula* up to 40 cms. long.
3. *Cerberus rhyncops* 70 cms. long.
4. *Natrix piscator asperrimus* 75 cms. long.
5. *Varanus monitor kabaragoya* up to 200 cms. long.
6. *Lissemys punctata ceylonensis* shell up to 37 cms. long.
7. *Melanochelys trijuga thermalis* shell up to 29 cms. long.



Three freshwater snakes belonging to this family are present in Ceylon.

1. Dorsal surface prominently chequered with black blotches and greyish coloured areas.....*Natrix piscator asperrimus*  
Not chequered.....2
2. Dorsal surface crossed by ill defined but conspicuous cross bars....*Cerberus rhyncops*  
Dorsal surface uniformly coloured without cross bars.....*Gerardia prevostiana*

*Natrix piscator asperrimus* (Boulenger). [Chequered Keel Back S. Diya Polonga, Diya Naya, T. Tanni Pambu] (Page 135, Fig. 4).

Common in all types of freshwater habitats especially where the surrounding vegetation is damp. A non-poisonous snake. It is most active in the morning and at dusk when it can be seen in shallow waters. The body colour varies from dark olive green to dark olive brown. A series of black blotches and greyish areas form a chequered pattern giving the snake its name. Two black streaks on head extending backwards from eye is characteristic of this snake. Its food is small fish and amphibians.

*Cerberus rhyncops* Schneider. [Dog-faced Water Snake (S. Diyabariya)] (Page 135, Fig. 3).

This species is common in both fresh and brackish water. Rather an aggressive snake but its bite is quite harmless. This snake is dark slate coloured with ill defined darker bars.

*Gerardia prevostiana* (Eydoux et Gervais). (Gerard's Water Snake).

This is a small non-poisonous snake frequenting tidal rivers and estuaries. Not a very common species.

#### SUB-ORDER LACERTOIDEA Lizards

##### FAMILY VARANIDAE—Monitor Lizards

Reptiles whose bodies are covered with overlapping bony scales. They have four strong limbs.

*Varanus monitor kabaragoya* Deraniyagala (Page 135, Fig. 5).

This species readily takes to the water. They are excellent scavengers, feeding on both dead and live freshwater crabs, insects, centipedes, snakes and rats.

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# AVES

(Birds)

ALL freshwater habitats support bird life of various species in varying numbers. Birds cannot be strictly classified as aquatic animals although they visit aquatic habitats to feed on fish, insects and crustaceans. Certain birds like herons, rails, jacanas and coots live in areas close to the water. Other birds like the cormorants, teal, and ducks breed and feed in aquatic habitats.

When birds are present in large numbers their faeces help in fertilising the water. This increases the quantity of microscopic plant food for the smaller animals which in turn are preyed upon by the larger aquatic fauna. Some birds indirectly influence the aquatic fauna further through various parasites which they harbour. The early developmental stages of these parasites are present in other aquatic fauna which are intermediate hosts.

A list of the more frequent visitors to the aquatic habitats is given below. For a further account on birds the reader is directed to G. M. Henry's *A Guide to the Birds of Ceylon*, from which work the present list was compiled. The illustrations of the birds on page 143 are also after Henry.

## ORDER PASSERIFORMES

(Sparrow-like Birds)

An order containing a very large number of species of birds, of which only a few live near water among reed-beds. Their toes are not webbed. The young which are born blind do not possess any down when they hatch out and they have to be looked after by the parents in a nest for some time.

Representatives of two families live near water habitats.

### FAMILY SYLVIDAE Warblers

This is a family of small birds. Their beaks are small and slender. They are seldom seen on the ground. The food consists entirely of insects. Members of this family which frequent freshwaters are—

*Acrocephalus dumetorum* Blyth. [Blyth's Reed Warbler (S. Hambu-Kurulla, T. Tinu Kuruvi)].

*Acrocephalus stentoreus meridionalis* (Legge). [Ceylon Great Reed Warbler], (Page 143, Fig. 1).

*Cisticola juncidis omalura* Blyth. [Ceylon Fantail Warbler (S. Thanacola Kurulla, T. Tinu Kuruvi, Vayalan)].

*Prinia inornata insularis* Legge. [Ceylon White Browed Prinia (S. Hambu Kurulla, T. Tinu Kuruvi)].

*Prinia socialis brevicauda* Legge. [Ceylon Ashy Prinia, Ashy Wren-Warbler (S. Hambu Kurulla, T. Tinu Kuruvi)].

### FAMILY MOTACILLIDAE Wagtails

Only one species frequents freshwater.

*Motacilla cinerea melanope* Pallas. [Grey Wagtail]

## ORDER CORACIIFORMES

### FAMILY ALCEDINIDAE—The Kingfishers

The toes of the birds belonging to this order and family are fused together except at the extremities. The young hatch out blind and are devoid of down. They are carnivorous birds. The kingfishers are large headed birds with long, straight powerful beaks. They nest in burrows which they dig into the banks of rivers and ponds. Many of them feed almost exclusively on fish. Six species frequent freshwater.

*Alcedo atthis taprobana* Kleinschmidt. [Ceylon Common Kingfisher (S. Mal Pilihuduwa, T. Meen Kutti)].

*Alcedo meninting phillipsi* Stuart Baker. [Ceylon Blue-Faced Kingfisher (S. Mal Pilihuduwa, T. Meen Kutti)].

*Ceyx erithacus* (L.). [Three-toed Kingfisher (S. Rang Pilihuduwa, T. Sinna Meen Kutti)].

*Ceryle rudis leucomelanura* Reichenbach. [Indian Pied Kingfisher (S. Kallapu Pilihuduwa, Gomera Pilihuduwa, T. Meen Kutti)].

*Halcyon smyrnensis fusca* (Boddaert). [Ceylon White-Breasted Kingfisher (S. Pilihuduwa, T. Meen Kutti)].

*Pelargopsis capensis gural* (Pearson). [Stork-Billed Kingfisher (S. Wattura Anduwa, Maha Pilihuduwa, T. Meen Kutti, Kukuluppan)], (Page 143, Fig. 14).

## ORDER STRIGIFORMES

### FAMILY STRIGIDAE—Owls

Owls are not ordinarily seen during daylight hours because of their nocturnal habits. There are several species of owls in Ceylon but only one frequents the freshwater habitats. It is a common bird in all parts of Ceylon up to an elevation of 6,000 feet in forests along river banks, tanks and lakes. It feeds mainly on fish but may consume freshwater crabs, insects, lizards, snakes and small mammals.

*Ketupa zeylonensis zeylonensis* (Gmelin). [Ceylon Fish Owl (S. Bakamuna, T. Periya Andai, Unatan Kuruvi)]. (Page 143, Fig. 8).

## ORDER FALCONIFORMES

### FAMILY PANDIONIDAE—The Osprey

They are highly specialised for an exclusive diet of fish. One species frequents the water habitats. It captures fish by diving into the water from a reasonable height in the air, capturing its prey by means of its claws. In doing so it submerges itself more or less completely. Common near coastal lagoons and estuaries between September and April. Also present near tanks and may even venture to elevations of 6,000 feet.

*Pandion haliaetus haliaetus* (L.). [Osprey (T. Viral Addippan)].

### FAMILY ACCIPITRIDAE—Eagles and Allied Birds

Some species of the family frequent the forests bordering the larger tanks and rivers of the dry zone. Six species frequent freshwater habitats.

*Circus aeruginosus aeruginosus* (L.). [Marsh Harrier (S. Ukussa, Kurulla-goya, T. Punai Parandu)].

*Circus macrourus* (Gmelin). [Pallid Harrier (S. and T. same as former species)].

*Circus melanoleucos* (Pennant). [Pied Harrier (S. and T. same as former species)].

*Circus pygargus* (L.). [Montagu's Harrier (S. and T. same as former species)].

*Elanus caerulus vociferus* (Latham). [Black Winged Kite (S. Kurullu goya T. Parandu)].

*Haliaeetus leucogaster* (Gmelin). [White-Bellied Sea Eagle (S. Muhudu Rajaliya, T. Kakal Ali)].

*Haliastur indus indus* (Boddaert). [Brahminy Kite (S. Ukussa, T. Sem parandu)]. (Page 143, Fig. 12).

*Ichthyophaga ichthyaetus plumbeiceps* Stuart Baker. [Ceylon Grey-headed Fishing Eagle, Tank Eagle (S. Wewa Rajaliya, Loolu Mara, T. Vidai Ali)].

#### FAMILY FALCONIDAE—The Falcons

In this family the birds of prey reach their highest degree of specialization. The beak is short, stout and strongly hooked, with a well marked "tooth" on the upper portion of the beak and a corresponding notch on the lower. The wings are developed to give the bird both speed and staying power in flight. Only one species frequents freshwater habitats.

*Falco peregrinus calidus* Latham. [Eastern Peregrine (S. Kurulla-goya, T. Valluru)].

#### ORDER CHARADRIIFORMES

(Waders and Allied Birds)

The birds belonging to this order are waders or swimmers. Some of them are able to wade as well as swim. In the wading forms the legs are generally long and the toes are only moderately webbed. The wings are well developed for powerful flight. Their food consists of insects, crustaceans, molluscs and fish. The young possess down and are able to run almost immediately after hatching from the egg.

#### FAMILY JACANIDAE—Jacanas and Allies

These birds have long, slender, unwebbed toes with long, nearly straight claws. Only one representative in Ceylon. It is present in the low country wherever there are large weedy ponds particularly those covered with lotus. In such a habitat these birds are a common sight spending their time walking or resting on the floating vegetation, supported by the enormously long toes and claws.

*Hydrophasianus chirurgus* (Scopoli). [The Pheasant-tailed Jacana (S. Pan Kukkula, Ballal Seru, Vil Girrawa, Gnavva. T. Miwa, Manal Pura)]. (Page 143, Fig. 15).

#### FAMILY CHARADRIIDAE—Lapwings and Allies

They are all ground birds, never perching on trees and are carnivorous. They can walk and run soon after hatching, their wings are long, tails short. They can fly well. Two species frequent freshwater.

*Himantopus himantopus ceylonensis* Whistler. [Ceylon Black-winged Stilt. (S. Kalapu Kirala, T. Pavali Kali)].

*Lobivanellus indicus indicus* (Boddaert). [Red-Wattled Lapwing or Did-he-do-it (S. Kiraluva, Kirala, T. Al-Katti)]. (Page 143, Fig. 6).

#### FAMILY SCOLOPACIDAE Sandpipers, Snipe etc.

They are wading and shore birds, legs are long and slender. Six species frequent fresh water habitats.

*Actitis hypoleucos* (L.). [Common Sandpiper (S. Sili Watuwa, T. Kottan)].

*Capella gallinago gallinago* (L.). [The Fantail Snipe, Common Snipe, (S. Keswatuwa, T. Ullan-Kuruvi)].

*Capella stenura* (Bonaparte). [Pintail Snipe (S. and T. same as for Fantail Snipe)].

*Tringa glareola* L. [Wood Sandpiper (S. Sili Watuwa, T. Kottan)]. (Page 143, Fig. 5).

*Fringa nebularia* (Gunnerus). [Green Shank (S. Maha Watuwa, T. Periya Kottan)].

*Tringa stagnatilis* (Bechstein). [Marsh Sandpiper (S. Sili Watuwa, T. Kottan)].

#### FAMILY ROSTRATULIDAE Snipe

In general form they resemble the birds of the family Scolopacidae.

*Rostratula benghalensis benghalensis* (L.) [Painted Snipe (S. Raja Watuwa, Ulu Keswatuwa, T. Ullan-Kuruvi)].

#### FAMILY LARIDAE—Terns

These birds have long wings adapted for sustained and powerful flight. They frequent the water and have their front toes webbed. Three species have been recorded in the freshwater habitats.

*Chlidonias hybrida indica* Stephens. [Indian Whiskered Tern (S. Lihiniya, T. Kadal Kuruvi)]. (Page, 143, Fig. 3).

*Gelochelidon nilotica nilotica* (Gmelin). [Gull-Billed Tern (S. and T. names, same as the former)].

*Hydroprogne caspia* (Caspian Tern).

*Sterna albifrons sinensis* Gmelin. [Little Tern (S. and T. names, same as the former)].

### ORDER RALLIFORMES

#### FAMILY RALLIDAE—Rails, Waterhens, Coots

The miniature, domestic hen like birds of this order are small or medium sized water birds which can swim well. They have long legs and toes which are not webbed. They feed on both animal and vegetable matter. The young can walk and swim almost as soon as they are hatched. There are eight species which frequent the coastal marshy areas.

*Amaurornis fuscus fuscus* (L.) [Ruddy Crake (S. Punchi Korawaka, T. Kanan Koli)].

*Amaurornis phoenicurus phoenicurus* (Pennant). [White-Breasted Waterhen (S. Korawaka, T. Kanan Koli)].

*Fulica atra atra* L. (Common Coot).

*Gallinula cinerea* (Gmelin). [Kora, Watercock (S. Vil Kukkula, T. Tannir Koli)]. (Page 143, Fig. 2).

*Gallinula chloropus indicus* Blyth. [Indian Waterhen (S. Vil Kukkula, T. Tannir Koli, Kanan Koli)].

*Hypotaenidia striata gularis* (Horsefield). [Blue-Breasted Banded Rail (S. Kirimeti Korawaka, T. Kanan Koli)].

*Porphyrio poliocephalus poliocephalus* (Latham). [Purple Coot (S. Kitala, Kitta, T. Kanan Koli)].

*Rallina eurizonoides nigrolineata* (Gray). [Banded Crake (S. Kirimeti Korawaka, T. Kanan Koli)].

## ORDER PELICANIFORMES

(Pelicans, Cormorants)

The birds of this order have all toes united by webs. They are capable of strong flight and most of them are good swimmers but they are all poor walkers. They depend entirely on the aquatic habitat for their food which consists of fish and other aquatic animals. On hatching the young are blind and devoid of down. The young are fed on partly digested food of the parents supplied by regurgitation.

### FAMILY PELICANIDAE Pelicans

These are large, ungainly swimming birds which have long, flattened beaks with a strong hook, at the tip of the upper portion of the beak. The legs are short and strong. The wings are long and powerful. The floor of the mouth is composed of a great pouch of extensible skin, used by the bird as a scoop for engulfing fish. Only one species is represented in Ceylon.

*Pelicanus roseus* Gmelin. [Spotted-Billed or Grey Pelican (S. Pas Boruwa, Pas Bars, T. Kulai Kida)].

### FAMILY PHALACROCORACIDAE Cormorants

These birds are adapted for swimming and diving. Their wings are powerfully built. Four species frequent the freshwater habitats.

*Ahinga melanogaster* Pennant. [Indian Darter or Snake-bird (S. Hanseya, T. Pambu Kuruvi, Nedung Kilaththi, Nedung Kaluththan)]. (Page 143, Fig. 9).

*Phalacrocorax carbo sinensis* (Shaw). [Southern Cormorant or Indian Cormorant (S. Diya Kawa, T. Nir Kakam)].

*Phalacrocorax fuscicollis* Stephens. [Indian Shag. (S. Diya Kawa, T. Nir Kakam)].

*Phalacrocorax niger* (Vieillot). [Little Cormorant (S. Diya Kawa, T. Nir Kakam)]. (Page 143, Fig. 10).

## ORDER CICONIIFORMES

(Ibises, Storks, Herons)

These birds have long beaks, necks and feet. They are adapted to lead a wading life. They are capable of powerful flight as their wings are well developed. Swamps and marshes are their usual habitats.

### FAMILY THRESKIORNITHIDAE Ibises and Spoonbills

These birds fly with the neck extended. They are closely related to the storks. Two species frequent freshwater habitats.

*Platalea leucorodia* L. [Spoonbill (S. Handi Alawa, T. Chappai Chondan)]. Page 143, Fig. 7).

*Threskiornis melanocephala* (Latham). [White Ibis (S. Tattu Kokka, Dahakatti Kokka, T. Thalkaththi Chondan)].

Explanation to figures on page 143

1. *Acrocephalus stentoreus meridionalis*
2. *Gallinago cinerea* (male)
3. *Chlidonias hybrida indica*
4. *Anastomus ositans*
5. *Tringa glareola*
6. *Lobivanellus indicus indicus*
7. *Platalea leucorodia*
8. *Ketupa zeylonensis zeylonensis*
9. *Ahinga melanogaster*
10. *Phalacrocorax niger*
11. *Phoenicopiterus ruber roseus*
12. *Haliastur indus indus*
13. *Ibis leucocephalus*
14. *Pelargopsis capensis gural*
15. *Hydrophasianus chirurgus*
16. *Ardea purpurea manilensis*
17. *Podiceps ruficollis capensis*

All figures are after Henry.



#### FAMILY CICONIIDAE—Storks

Mostly large birds with long, heavy looking straight beaks. Except the Lesser Adjutant they all fly with their necks extended. Five species frequent Ceylon freshwater habitats.

*Anastomus oscitans* (Boddaert) [Open-Bill (S. Bellan Kokka, Beli Kawa, T. Naththai Kuththi Narai)]. (Page 143, Fig. 4).

*Dissoura episcopus episcopus* (Boddaert). [Indian White Necked Stork (S. Padili Kokka, T. Vannati Narai)].

*Ibis leucocephalus* (Pennant). [Painted Stork (S. Dae Tuduwa, T. Sangu Valai Narai)]. (Page 143, Fig. 13).

*Leptoptilos javanicus* (Horsfield). [Lesser Adjutant (S. Mana, T. Mana, Meva, Kokku)].

*Xenorhynchus asiaticus asiaticus* (Latham). [Black-necked Stork (S. Ali Kokka, T. Periya Narai)].

#### FAMILY ARDEIDAE Herons, Egrets and Bitterns

The long necks of the birds in this family are distinctly kinked in the middle due to the structure and arrangement of the vertebrae; this enables the neck to be retracted into a very compact S, and extended quickly with great force for the capture of fish. In flight the neck is always retracted. Toes are long and thin. Twelve species frequent freshwater habitats.

*Ardea cinerea rectirostris* Gould. (Eastern Grey Heron (S. Kalapu Kokka, T. Narayan, Narai Kokku)).

*Ardea purpurea manilensis* Meyen. [Eastern Purple Heron (S. Karawala Kokka, Barendi Kokka, T. Chen Varai)]. (Page. 143, Fig. 16).

*Ardeola grayii* (Sykes). [Pond Heron, Paddy Bird (S. Kane Kokka, T. Kuruttu Kokku, Nuli Madayan)].

*Bubulcus ibis coromandus* (Boddaert). [Cattle Egret (S. Harak Kokka, T. Unni Kokku)].

*Butorides striatus javanicus* (Horsfield). [Little Green Heron (S. Podi Kokka, T. Thosi Kokku)].

*Dupetor flavicollis flavicollis* (Latham). [Black Bittern (S. Kalu Kokka, T. Karuppu Narai)].

*Egretta alba modesta* (Gray). [Eastern Large Egret, Great White Heron (S. Lokku Sudu Kokka, Badadel Kokka, T. Periya Vellai Kokku)].

*Egretta garzetta garzetta* (L.) [Little Egret (S. Sudu Kokka, T. Vellai Kokka)].

*Egretta intermedia intermedia* (Wagler). [Median Egret (S. Sudu Kokka, T. Vellai Kokku)].

*Gorsachius melanolophus melanolophus* (Raffles) (Bittern).

*Izobrychus cinnamomeus* (Gmelin). [Chestnut Bittern (S. Meti Kokka, T. Kuruttu Kokku)].

*Izobrychus sinensis sinensis* (Gmelin). [Yellow Bittern (S. Meti Kokka, T. Mannal Narai)].

*Nycticorax nycticorax nycticorax* (L.) [Night Heron (S. Re Kana Kokka, T. Vakka)].

#### FAMILY PHOENICOPTERIDAE Flamingo

The beak is bent downwards at an angle. They fly with their necks extended and the long legs stretched out behind. They never perch. The young are able to run soon after the hatching. Only one species visit the Ceylon freshwater habitats.

*Phoenicopterus ruber roseus* Pallas. [Flamingo (S. Siyak Karaya, T. Pu Narai, Urian)]. (Page 143, Fig. 11).

## ORDER ANSERIFORMES

### FAMILY ANATIDAE Geese and Ducks

These are water birds with broadened and flattened bills. Legs are short with the three front toes fully webbed. The body is generally boat shaped. Six species visit the freshwater habitats.

*Anas crecca crecca* L. [Teal (S. Seruwa, T. Tara)].

*Anas poecilorhyncha poecilorhyncha* Forster. [Spotted-billed Duck (S. Seruwa, T. Tara)].

*Casarca ferruginea* (Pallas). [Ruddy Sheldrake, Brahminy Duck (S. Loku Seruwa, T. Tara)].

*Dendrocygna bicolor bicolor* (Vieillot). [Large Whistling Teal (S. and T. same as former species)].

*Dendrocygna javanica* (Horsfield). [Whistling Teal, Whistling Tree Duck (S. Seruwa, Thumba Seruwa, T. Chilli Tara)].

*Nettapus coromandelianus coromandelianus* (Gmelin). [Cotton Teal, " Quacky-Duck " (S. Mal Seruwa, T. Raja Tara)].

*Sarkidiornis melanota* (Pennant). [Comb Duck, Nukhta (S. Kabalittiya, T. Mukkan Tara)].

## ORDER PODICIPITIFORMES

### FAMILY PODICIPITIDAE—Grebes

This order contain birds which are well adapted for swimming and diving. Their bills are short, pointed and tapering. The toes are not webbed as in other birds. It appears as if each toe is individually webbed and is shaped like a leaf. The feet are placed very far back beneath the body. Only one species in Ceylon.

*Podiceps ruficollis capensis* Salvadori. [Little Grebe, Dabchick (S. Diya Seruwa, Gembi-Sera, T. Mukkuluva, Kuluppai)]. (P. 143, Fig. 17).

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# MAMMALIA

(Mammals)



*Lutra lutra ceylonica* body 61 cms. long—tail 40 cms. long.

There is only one species of mammal inhabiting freshwater in Ceylon, namely the otter.

*Lutra lutra ceylonica* Pohle. [The Ceylon Otter (S. Diya Balla, Mudiya Balla, T. Nair Nai)].

The body of this carnivore is rather long (61 cms.), while the limbs are short and the toes are webbed for swimming. The tail is thick at the base and flattened. The otter is found in and near rivers, streams, lakes, lagoons and paddy fields all over the Island. Its home is usually a burrow constructed beneath the roots of a large tree or beneath a rock at the water's edge. It has more than one entrance, one of which is invariably under water. It is an excellent swimmer, capable of diving and travelling long distances under water.

It is a shy animal, seldom seen, nocturnal in its habits and feeding on a wide variety of aquatic animals like insects, crabs, fishes, frogs, waterfowl and small rodents. The largest specimen on record had a body length of 61 cms. and a tail length of 40 cms.

## REFERENCES

PHILLIPS, W. W. A. 1935. *Manual of the Mammals of Ceylon*. Ceylon. J. Sci. spec. publ., 373 pp.

# INDEX

The index includes both scientific and common names. The numbers in the index are references to pages.

Specific and generic names are in italics. Names of higher natural groupings such as classes, orders and families are in capitals. The common English, Sinhalese and Tamil names are in ordinary type. The Sinhalese and Tamil names are in phonetic English and are followed by (S) and (T) respectively. References to illustrations are in bold type.

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# A guide to the Freshwater Fauna of Ceylon

## Supplement 1

C. H. FERNANDO

Zoology Department, University of Singapore

### Introduction

This is the first of what is hoped will be a series consequent to "A guide to the freshwater fauna of Ceylon" by A. S. Mendis and C. H. Fernando, Bull. Fish. Res. Stn. Ceylon No. 12, 160 pp. (1962). The purpose of this series is to make the above-mentioned work more comprehensive. As additional work is done on the fauna it will be necessary to make additions or deletions and also bring the nomenclature upto date. Where past work comes to notice alterations may become necessary. It is also hoped that gradually keys will become available for the identification of local species. Wherever possible notes on the biology of individual species or groups will be given.

The general format will be maintained as far as possible. Additional references to the fauna will be included even when not specifically dealt with in the supplement. The present supplement is restricted to the Arthropoda.

### Class—CRUSTACEA

#### Sub-class—Cladocera

*Ceriodaphnia rigaudi* Richard

*Oxyurella sinhalensis* (Daday)

Delete *Alonopsis orientalis*. *Ceriodaphnia cornuta* = *C. rigaudi* and *Alonopsis sinhalensis* = *Oxyurella sinhalensis*.

A useful popular account and a generic key to the local forms is given by Johnson (1962).

#### Family—Atyidae

*Atya spinipes* Newport

*Caridina gracilirostris* de Man

*Caridina nilotica* var *zeylanica* Arud. and Costa

Delete *Atya typus* Milne Edwards. This is an unfortunate error; no such species exists even in synonymy.

### Class—INSECTA

#### Family Gerridae

*Cryptobates raja* (Dist.)

#### Family—Notonectidae

*Anisops exigera* Horv.

*Anisops occipitalis* Breddin

Delete *Anisops crinita* which is a misidentification of *A. exigera*

## Family—Corixidae

*Micronecta ludibunda* Breddin*Micronecta prashadana* Hutch.*Micronecta punctinotum* Chen*Micronecta siva* (Kirk.)*Tropocorixa pruthiana* Hitch.

*Micronecta ludibunda* has been referred to as *M. albifrons* Motsch. However *Microrecta albifrons* has been described from Ceylon and is probably *M. fascioclavus* Chen. In addition the status of a closely related species *M. thelxinoe* Kirk. described from Ceylon has not been authenticated. It is also possible that *M. albifrons* is a good species.

Delete *Sigara substriata* which is a very doubtful record.

## Family—Velidae

*Microvelia douglasi* Scott

## Coleoptera

Only the Gyrinidae, Haliplidae, Hydrophilidae, Dytiscidae and Noteridae have been dealt with so far. In this supplement the Noteridae are included in the Dytiscidae. The Hydrophilidae are subdivided into the Hydrophilidae and Hydraenidae and five new families are included namely, Psephenidae, Donaciidae, Helodidae, Dryopidae and Elmidae (Helmidae). Mention is also made of two other families whose members occur in aquatic habitats. They are the Ptilodactylidae and Curculionidae. Keys are provided for the separation of the aquatic species to family level. The records available are meagre and it is likely that even the genera have not been fully recorded. The Oriental fauna of the less common aquatic Coleoptera is poorly known as a whole and the keys given are therefore necessarily very tentative. It is hoped however that together with the illustrations they will prove a useful guide. The classification of many of the families is still very controversial. I have followed Pennak (1953) and the keys are modified from this publication. Illustrations include the larval forms of two common hydrophilids and of *Dineutes indicus* Aube in addition to the members of families specifically dealt with in the present work.

## Family—Donaciidae

Only a few members of the large terrestrial group the chrysomelids are represented in aquatic habitats. They belong to the family Donaciidae and in Ceylon are represented by a single genus *Donacia*. The adults are characterised by the four segmented tarsi of which the third is deeply bilobed. They also have brilliant colours as is usual in the chrysomelids. The larvae are bottom dwellers and are somewhat atypical for coleopteran larvae. They have a reduced head and inconspicuous mandibles. At the posterior end are a pair of spines which are used to pierce the stems and roots of aquatic plants for obtaining air.

Two species have been recorded from Ceylon—

*Donacia delesserti* Guerin*Donacia javana* Weidemann

## Family—Dryopidae

The adults are characterised by the antennae which form a pectinate club. The larvae are usually flattened and superficially resemble those of Psephenidae but the margins are not smooth as in the latter.

Only one species namely *Pachyparnus erichsoni* Champ nas so far been recorded from Ceylon. The genus *Helichus* occurs in India and Indonesia and very probably in Ceylon too.

#### Family—Psephenidae

Although no published records are available of their occurrence, they probably do. A common genus in the Indo-Malayan region is *Eubrianax* which is very common in Malaya and has been recorded in India.

The adults vary somewhat in size but are usually small and blackish in colour with depressed bodies. They are found in torrential streams creeping along the bottom. They are characterised by the great elongation of the last tarsal segment. In *Eubrianax* the antennae are short and stout. The larvae are easily recognised. They are referred to as "water pennies" and are flattened, oval and have a smooth outline. The dorsal surface is smooth but the segmentation is distinct. They adhere strongly to stones on the bottom and considerable force is necessary to release them. The ventral surface bears four tufts of gills in *Eubrianax*.

#### Family—Helodidae

This family includes a large number of species living close to the water as adults and in water in the larval stages. The adults have five segmental tarsi. The fourth segment is bilobed. A common form is *Scirtes* which is somewhat atypical of this group and has its hind legs modified for jumping with greatly expanded femur. They are usually dull coloured with filiform antennae and small head.

Fifteen species are on record from Ceylon—

- Cyphon affinis* Motsch.
- Cyphon flavescens* Motsch.
- Cyphon infuscatus* Motsch.
- Cyphon ovalis* Motsch.
- Cyphon pictus* Motsch.
- Cyphon rufithorax* Gemm.
- Hydrocyphon atratus* Motsch.
- Ora picta* F.
- Mescirtes gagantinus* Motsch.
- Parelodes mollis* Rettenb.
- Scirtes axillaris* Motsch.
- Scirtes canescens* Motsch.
- Scirtes convexinisculus* Motsch.
- Scirtes grandis* Motsch.
- Scirtes nigropunctatus* Motsch.

*Ptilodactyla humaralis* Motsch. (Ptilodactylidae) recorded from Ceylon is sometimes included in the Helodidae. The Ptilodactylidae are a tropical family the larvae of which are sometimes aquatic. The adults have enlarged eyes and flabellate antennae with mid coxae closely approximated. The larvae are elaterid in form.

Note :—Members of the Curculionidae (Weevils) also occur in aquatic habitats in Ceylon. They are easily recognised by the prominent "snout" bearing the antennae and terminally the mouthparts.

Family—Elmidae (Helmidae)

Small beetles with filiform antennae. In some forms the terminal portion of the antenna is expanded but never pectinate. The tarsal claws are prominent. Some species have patches of dense hairs or scale-like structures on the body. They can be separated from the Dryopidae by the antennae and from the Psephenidae (*Eubrianax*) by the lack of projecting fore coxae. The larvae are variable in form and are difficult to separate from the Dryopidae except on detailed morphological features.

Three species have been recorded from Ceylon—

- Ancyronyx quadriplagiatus* Motsch.
- Helmis\* foveicollis* Grouv.
- Stenelmis ceylonica* Motsch.

Family—Hydraenidae†

This family is sometime included with the Hydrophilidae but both larvae and adults are characteristic. The adults are usually small and flattened dorsoventrally. The antennae are clubbed. The club consisting of five distinct pubescent segments. In the hydrophilids there are never five pubescent segments in the club. The larvae are generally more streamlined than those of the Hydrophilidae. They have nine complete segments and a small and indistinct tenth. In the Hydrophilidae there are eight complete abdominal segments.

They occur in a wide range of habitats including streams and paddy fields.

Two genera are known from Ceylon and two species have so far been recorded.—

- Hydraena fontana* Orch.
- Limnebius rufipennis* Reg.

KEY TO THE ADULTS OF CEYLONESE AQUATIC  
COLEOPTERA (FAMILIES)

1. Eyes completely divided into two. Surface swimmers .....	GYRINIDAE
Eyes not divided : Live in the water or damp places .....	2
2. Hind coxae forming large plates .....	HALIPLIDAE
Hind coxae not thus modified .....	3
3. Hind tarsi 4 segmented, third segment broadly bilobed .....	DONACIIDAE
	<i>Donacia</i>
Hind tarsi usually of more than 4 segments, third segment not broadly bilobed .....	4
4. (3) Antennae clubbed .....	5
Antennae not clubbed .....	7
5. Antennae with pectinate club .....	DRYOPIDAE
Antennae club of distinct separate segments .....	6
6. Antennal club of five pubescent segments .....	HYDRAENIDAE
Antennal club of less than five pubescent distinct segments .....	HYDROPHILIDAE

\* The genus *Helmis* is supposed to be an European genus Pennak (1953).

† Included under the Hydrophilidae in the previous work. Bull. Fish. Res. Stn., Ceylon. No. 12, p. 92.

7. Fourth tarsal segment bilobed .....	HELODIDAE
Fourth tarsal segment not bilobed .....	
8. Hind legs flattened for swimming .....	DYTISCIDAE
Hind legs not thus modified .....	9
9. Fore coxae projecting .....	PSEPHENIDAE ( <i>Eubrianax</i> )
Fore coxae not projecting .....	ELMIDAE

KEY TO THE LARVAE OF CEYLONESE AQUATIC  
COLEOPTERA (FAMILIES)

1. Legs six segmented. Tarsus distinct with one or two claws .....	2
Legs five segmented with tarsus and claw fused or less than five segmented or vestigial .....	4
2. Tenth abdominal segment with four apical hooks .....	GYRINIDAE
No apical hooks on tenth abdominal segment .....	3
3. Ninth abdominal segment present .....	HALJPLIDAE
Ninth abdominal segment rudimentary or absent .....	DYTISCIDAE
4. Body flattened with smooth outline .....	PSEPHENIDAE
Body shape otherwise .....	5
5. Antennae longer than thorax .....	HELODIDAE
Antennae shorter than thorax .....	6
6. Mandibles short and inconspicuous .....	DONACIIDAE
Mandibles prominent .....	7
7. Ninth abdominal sternite with operculum covering terminal cloacal chamber and retractile gills .....	DRYOPIDAE, ELMIDAE
Ninth abdominal sternite simple .....	8
8. Nine complete abdominal segments and tenth present though sometimes indistinct .....	HYDRAENIDAE
Only eight complete abdominal segments .....	HYDROPHILIDAE

Class—ARACHNIDA

Order Hydracarina (Water mites)

Considerable changes in nomenclature of this group which the authors were not aware of has necessitated a revised list of names. Only two species have been added however to the list already given namely *Piona coccinea* var. *imminuta* (Piersig) and *Lamienna falcipes* Koenike.

Fifteen species are on record from Ceylon—

*Arrhenurus ceylonicus* Daday

*Arrhenurus congenger* Daday

*Arrhenurus madaraszi* Daday  
*Arrhenurus orientalis* Daday  
*Arrhenurus rostratus* Daday  
*Arrhenurus sinhalensis* Daday  
*Eupatra silvestri* (Daday)  
*Hydrachna dilatata* Daday  
*Lamienia falcipes* Koenike  
*Neumania nodosa* (Daday)  
*Ozus ceylonicus* (Daday)  
*Ozus pictus* (Daday)  
*Piona coccinea* var *imminuta* (Piersig)  
*Piona conglobata* (C. L. Koch)  
*Piona horvathi* (Daday)  
*Unionicola sinhalensis* (Daday)

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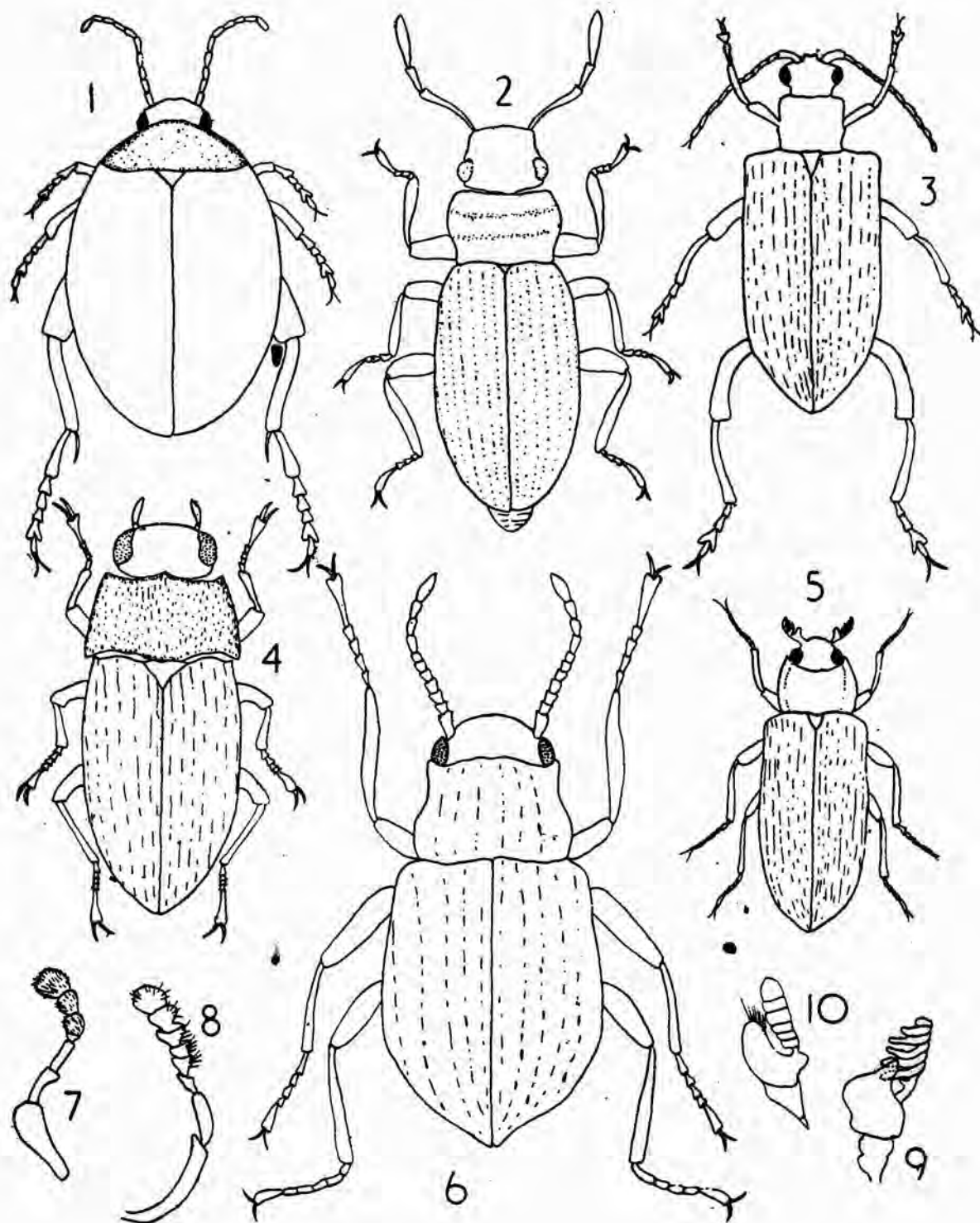
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Explanation to figures on page 36

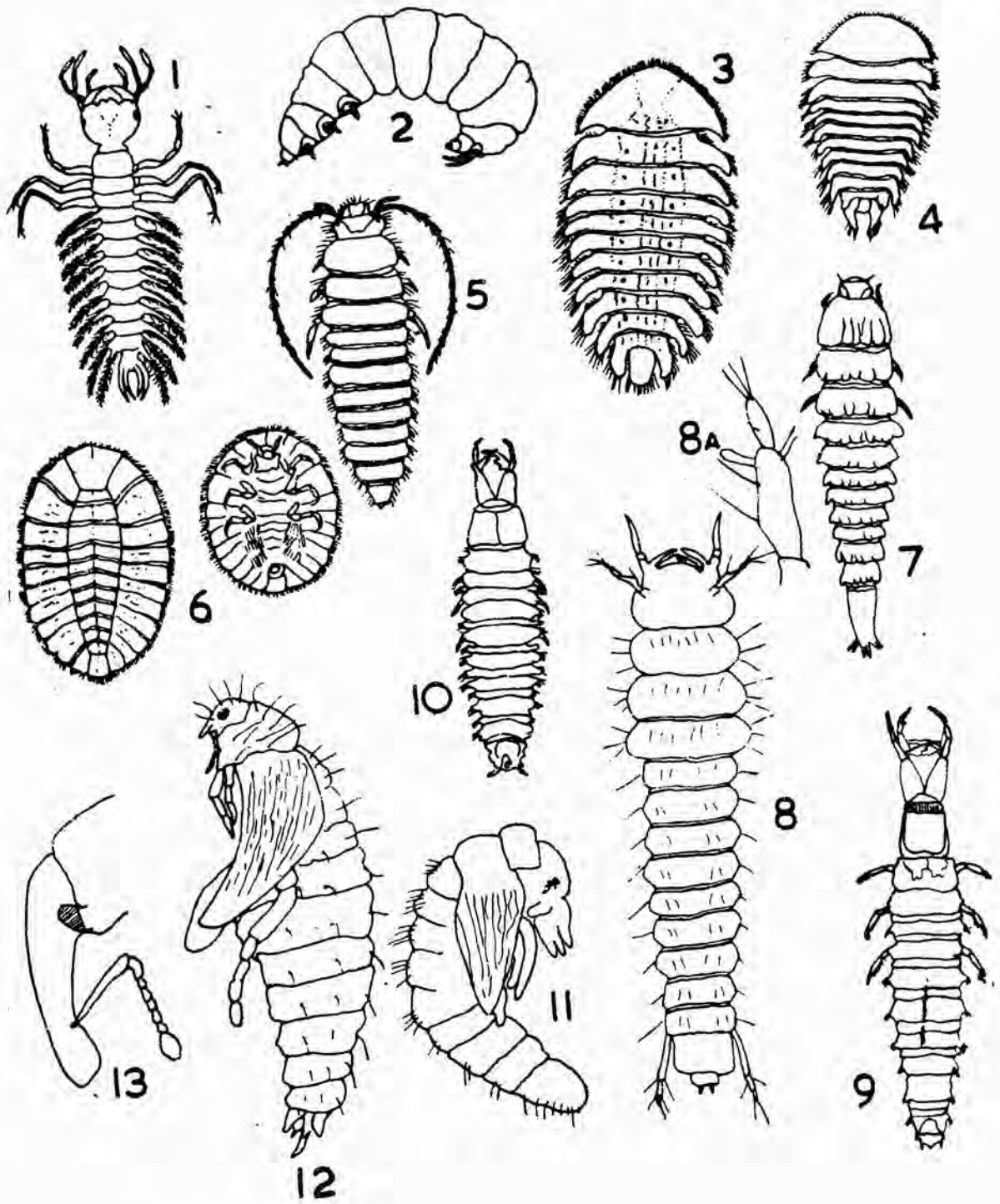
1. *Scirtes* sp.
2. *Hydraena* sp.
3. *Donacia* sp. (redrawn from Pennak)
4. *Eubrianax* sp.
5. *Helichus* sp. (redrawn from Bertrand).
6. *Stenelmis* sp. (redrawn from Pennak).
7. Antenna of Hydrophilidae (Adult).
8. Antenna of Hydraenidae (Adult).
9. Antenna of Dryopidae (Adult).
10. Antenna of Gyrinidae (Adult).

Figs. 7-10 after various authors.



Explanation to figures on page 38

1. Larva of *Dineutes indicus* Aube (after Tonapi).
  2. Larva of *Donacia* (redrawn from Pennak).
  3. *Helichus* Larva (after Bertrand).
  4. Dryopid larva (after Bertrand).
  5. Larva of *Scirtes* (after Bertrand).
  6. Larva of *Eubrianax* (after Bertrand).
  7. Elmid larva (after Bertrand).
  8. Hydraenid larva 8A, antenna of *Hydraena*
  9. Larva of *Sternolophus* (after Bertrand).
  10. Larva of *Amphiops* (after Bertrand).
  11. Gyrinid pupa.
  12. Hydrophilid pupa.
  13. Anterior end of Curculionidae showing antenna and "Snout".
- Figs. 8, 11, 12, 13 semidiagramatic, after various authors.



# A Guide to the Freshwater Fauna of Ceylon.

## Supplement 2

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### INTRODUCTION

This is the second supplement to "A guide to the freshwater fauna of Ceylon" by A. S. Mendis and C. H. Fernando, Bull. Fish. Res. Stn., Ceylon, No. 12, 160 pp. (1962). In the present supplement additions and corrections are made in the sections on Protozoa, Annelida and Arthropoda. The sections on Platyhelminthes and Nematoda have been expanded and the Acanthocephala added. A list of species recorded and the hosts of the parasitic forms are included. In the "Guide", the insects with only larval stages in aquatic habitats were mentioned only briefly and no species lists were included. In this supplement this gap is largely filled by added notes and inclusion of species lists of all these groups except the Neuroptera, Lepidoptera, Tabanidae, Syrphidae and Stratiomyidae. The orders Neuroptera and Lepidoptera have relatively few members in freshwater habitats and the families Tabanidae, Syrphidae and Stratiomyidae have forms with larvae in aquatic habitats and also in moist places which are not true freshwater habitats. At the present time it is not possible to separate those forms living in freshwater habitats. Short diagnoses of six additional families are given, namely, the Dixidae, Psychodidae, Tabanidae Stratiomyidae, Rhagionidae and Sciomyzidae.

Keys are provided for the Odonata and Ephemeroptera larvae down to the family level.

An attempt has been made to make the references more comprehensive. Works dealing specifically with the Ceylonese fauna are of course included, but in addition those which are of use in diagnosis of local genera and species have been cited.

### Phylum—PROTOZOA

The free-living Protozoa, although by no means completely known as regards the species present, have nevertheless been recorded in some numbers. Two genera of ectoparasitic ciliates are already known from Ceylon and a third *Trichodina* is almost certainly present. The endoparasitic species consisting of the Sporozoa and Trypanosomes are practically unknown. The Myxosporidia (Sporozoa) are of great importance in that they cause serious epizootics among fishes both in culture and the wild state. No species has so far been recorded from Ceylon. The Indian fauna is better known and the literature and a complete species list is given by Tripathi (1952). These parasites are found in the skin, gills and various internal organs. The other sporozoan group found in fishes are the Haemogregarina. They are blood parasites and as far as known do not seem to cause severe disease in fishes. The Trypanosomes (Mastigophora) are not uncommon in fishes but there is only one record, *Trypanosoma saccobranchi* Castellani and Willey from *Heteropneustes fossilis*.

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## Phylum—PLATYHELMINTHES

A general diagnosis has already been given in the "Guide". In this supplement the parasitic groups Trematoda and Cestoda occurring in fishes will be dealt with.

## Class—Trematoda

Ecto and endoparasitic forms are common in fishes. The Ceylonese fauna is practically unknown. The recent work of Gussev (1963) has shown both a rich and varied fauna of Monogenea. Until this work appeared not a single species of Monogenea had been recorded. He recorded twenty species of which nineteen were new from a small sample of eleven species of fish. The Monogenea are of considerable importance as disease agents in fishes.

Of the Digenea there is only one record *Transversotrema patialense* metacercaria from *Macropodus cupanus* and a doubtful record of *Clinostomum piscidium* Southwell and Prasad from "Nandus nandus".

No Aspidobothria have so far been recorded.

The Indian fauna of these three groups is far better known and some of the more important papers are given in the references. The various types of trematodes are illustrated in Fig. A 1-6 using Ceylonese and Indian genera.

The Trematoda are divided into three sub-classes. They are given below with a short diagnosis.

## Sub-class—Monogenea

Oral sucker if present weak. Have paired adhesive structures at the anterior end. Adhesive disc at posterior end provided with hooks. Paired excretory pores opening anteriorly. No alternation of hosts.

e.g., *Dactylogyrus* (Fig. A 1.)

*Dactylogyroides* (Fig. A 2.)

## Sub-class—Aspidobothrea

No oral sucker. No paired adhesive organs at anterior end. Ventral sucker enormous sub-divided or smaller suckers within. No alternation of host.

e.g., *Aspidogaster* (Fig. A 3.)

## Sub-class—Digenea

Oral and ventral suckers usually present. No hooks. Excretory pore posterior. Alternation of hosts, one of which is usually a mollusc.

Two groups of Digenea occur in fishes.

Gasterostomata : with the mouth situated near the middle of the body. Oral sucker not in communication with the gut.

e.g., *Bucephalus* (Fig. A 4.)

Prososomata : Oral sucker in communication with gut. Placed at or near anterior end.

e.g., *Transversotrema* (Fig. A 6.)

*Ophichorchis* (Fig. A 5.)

## Trematodes recorded from Ceylonese Freshwater Fishes

Parasite	Host	Location
<b>MONOGENEA</b>		
<i>Ancylodiscus jaini</i> Gussev	<i>Macrones keletius</i>	gills
<i>Ancyrocephalus aequalis</i> Gussev	<i>Rasbora daniconius</i>	gills
<i>Ancyrocephalus daniconii</i> Gussev	<i>Rasbora daniconius</i>	gills
<i>Ancyrocephalus danionis</i> Gussev	<i>Danio aequipinnatus</i>	gills
<i>Ancyrocephalus esomi</i> Gussev	<i>Esomus danrica</i>	gills
<i>Ancyrocephalus etropli</i> Gussev	<i>Etroplus suratensis</i>	gills
<i>Ancyrocephalus heteranchoris</i> Gussev	<i>Rasbora daniconius</i>	gills
<i>Ancyrocephalus kirtisinghei</i> Gussev	<i>Rasbora daniconius</i>	gills
<i>Ancyrocephalus rasborae</i> Gussev	<i>Rasbora daniconius</i>	gills
<i>Ancyrocephalus tripathi</i> Gussev	<i>Rasbora daniconius</i>	gills
<i>Ceylonotrema colombensis</i> Gussev	<i>Etroplus suratensis</i>	gills
<i>Dactylogyrus aequipinnati</i> Gussev	<i>Danio aequipinnatus</i>	gills
<i>Dactylogyrus curiosus</i> Gussev	<i>Rasbora daniconius</i>	gills
<i>Dactylogyrus dorsalis</i> Gussev	<i>Puntius dorsalis</i>	gills
<i>Dactylogyrus fernandoi</i> Gussev	<i>Puntius dorsalis</i>	gills
<i>Dactylogyrus saranae</i> Gussev	<i>Puntius sarana</i>	gills
<i>Dactylogyroides bimaculati</i> Gussev	<i>Puntius bimaculatus</i>	gills
<i>Dactylogyroides macracanthus</i> (Tripathi)	<i>Puntius filamentosus</i>	gills
	<i>Puntius sinhala</i>	gills
	<i>Puntius sarana</i>	gills
<i>Dactylogyroides vittati</i> Gussev	<i>Puntius vittatus</i>	gills

**DIGENEA**

<i>Clinostomum piscidium?</i> Southw. and Pras.	<i>Nandus nandus?</i>	intestine
<i>Transversotrema patialense</i> (only metacercaria known)		skin

**Class—Cestoda**

They are not common in freshwater fishes. The three species recorded so far probably represent a high proportion of those present and one of them *Bothriocephalus gowkongensis* Yeh appears to have been introduced into Ceylon recently with fish imported for stocking. The species recorded from Ceylon are—

**Family—Bothriocephalidae**

*Bothriocephalus gowkongensis* Yeh (Fig. B 1.) from *Puntius sarana*

**Family—Ptychobothriidae**

*Senga lucknowensis* Johri (Figs. B 2, 3.) from *Mastacembelus armatus*

**Family—Proteocephalidae**

*Gangesia bengalensis* (Southwell) (Fig. B 4.) from *Wallago attu*

Another family probably represented in Ceylon are the Caryophyllidae. They are small unsegmented forms and a common genus in South-East Asia is *Lytocestus*.

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## Phylum—ACANTHOCEPHALA

(Spiny headed worms)

Endoparasitic forms found in all classes of vertebrates. The body is divided into an anterior portion (presoma) made up of a spiny proboscis and a neck. The proboscis can be withdrawn into a sheath. The posterior portion consists of a trunk. There is no alimentary canal. A pair of structures called lemnisci project from the junction of the presoma and trunk into the "body cavity". The sexes are separate. The testes are paired and the accessory glands consist of cement glands and a Saeftigens pouch. The ovary breaks up into masses of cells which lie in the general body cavity. The eggs pass out through a complicated apparatus by an opening at the posterior end. The life cycle involves an intermediate host which is usually an arthropod.

Two species have so far been recorded :

*Zelanechinorhynchus longinuchalis* Fernando and Furtado (Figs. B 5, 6.) from *Mystus vittatus*.

*Pallisentis nagpurensis* Bhalerao (Fig. B 7.) from *Ophiocephalus striatus*.

Both these species were found in the intestine.

It is likely that the common Indo-Malayan genus *Acanthosentis* also occurs in Ceylon.

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## Class—NEMATODA

Records of both free-living and parasitic forms are at present very meagre. Nematodes are very common in freshwater habitats. The use of suitable extraction techniques will show their abundance. The orders of Nematoda found commonly in freshwater habitats or parasitic in fishes are given, with a short diagnosis and illustrations of South-East Asian genera. Short notes are given on the parasitic species recorded. They are listed together with the hosts.

**Order—Rhabditida**

Oesophagus with two broadened portions, the anterior corpus and the posterior bulb with a thin isthmus in between. No buccal stylet. Includes free living saprophytic forms, e.g., *Rhabditis* (Fig. C 1.); *Diplogastero des* (Fig. C 2.)

This order also includes the Strongylina (true bursate) forms including the hookworms and their numerous allies and the *Ascaridina* (*Ascaris*, "the roundworm"). All of these are parasitic.

**Order—Spirurida**

No buccal stylet. Oesophagus usually with an anterior muscular portion and a posterior glandular portion, without bulbs or isthmus. Parasitic in vertebrates. Require intermediate host.

**Family—Camallanidae**

Three genera have been recorded from freshwater fishes in Ceylon, *Camallanus* (Fig. D 1. 1 A.) with a buccal capsule having two distinct valves with vertical thickenings, *Zeylanema* (Fig. D 2.) similar to *Camallanus* except that the buccal thickenings have teeth and *Procamallanus* (Fig. D 3, 4.) with a continuous buccal capsule. The larvae are found in copepods and small fishes.

**Family—Hedruridae**

Female with a characteristic posterior sucker. Larvae in freshwater fishes. Adults in Fishes Amphibia and reptiles, e.g., *Hedruris* (Fig. D 5.)

**Order—Araeolaimida**

Head with four cephalic bristles well back from labial papillae. Oesophagus with anterior and terminal bulbs. The latter may be absent. No buccal stylet.

e.g., *Plectus* (Fig. C 3.)

**Order—Monohysterida**

Cuticle often with bristles. Oesophagus cylindrical. With or without terminal bulb. Ends of oesophageal radii convergent. No buccal stylet. Free living.

e.g., *Monohystera* (Fig. C 4.)

**Order—Chromodorida**

Head with papillae or bristles. Oesophagus with or without terminal bulb. Oesophageo-intestinal valve triradiate or vertically flattened. No buccal stylet. Free living.

e.g., *Monochromodora* (Fig. C 6, 7.)

**Order—Enoplida**

Head with many setae. Oesophageal glands opening in region of stoma. No buccal stylet. Free living.

e.g., *Tobrilus* (Figs. C 8, 9.)

*Actinolaimus* (Fig. C 15.)

*Bathyonchus* (Figs. C 10)

**Order—Dorylaimida**

No setae on head or body. Glands within oesophagus. Stoma with teeth on wall or with buccal stylet. Very common in freshwater habitats.

eg., *Dorilaimus* (Figs. C 12-14.)

*Mononchus* (Fig. C 16.)

**Order—Dioctophymida**

Large forms. Female with a single ovary. Male with a single spicule. Parasitic in vertebrates; Larvae in fishes and amphibians. Adults in birds and mammals.

e.g., *Eustrongylides* (Fig. D 6.) Larva

**Order—Trichosyringida**

No setae, alimentary canal degenerate or forms a narrow one-celled portion in the anterior region. Parasitic.

An unidentified mermithid was recorded by Weerakoon and Samarasinghe (1958) from a chironomid. A common Asiatic genus *Hydromermis* found in chironomids is shown in (Figs. D 7-9.)

**List of Parasitic Nematoda recorded from freshwater fishes in Ceylon**

Parasite	Host
<i>Camallanus ceylonensis</i> Fern. and Fur.	<i>Wallago attu</i>
<i>Eustrongylides</i> sp. (larva)	<i>Heteropneustes fossilis</i> <i>Ompok bimaculatus</i> <i>Wallago attu</i>
<i>Hedruris</i> sp. (larva)	<i>Glossogobius giuris</i> <i>Ompok bimaculatus</i> <i>Wallago attu</i>
<i>Procamallanus confusus</i> Fern. and Fur.	<i>Heteropneustes fossilis</i>
<i>Procamallanus planoratus</i> Kulk.	<i>Clarias teysmanni</i> <i>Ophiocephalus punctatus</i> <i>Ophiocephalus striatus</i>
<i>Procamallanus spiculogubernaculus</i> Agarwal	<i>Clarias teysmanni</i>
<i>Procamallanus</i> sp.	<i>Wallago attu</i>
<i>Zeylanema anabantis</i> (Pearse)	<i>Anabas testudineus</i> <i>Puntius filamentosus</i> <i>Rasbora daniconius</i>
<i>Zeylanema fernandoi</i> Yeh	<i>Ophiocephalus punctatus</i> <i>Ophiocephalus striatus</i>
<i>Zeylanema kulasirii</i> Yeh	<i>Anabas testudineus</i> <i>Ophiocephalus punctatus</i>
<i>Zeylanema moesti</i> (Moorty)	<i>Clarias teysmanni</i> <i>Rasbora daniconius</i> <i>Ophiocephalus punctatus</i> <i>Ophiocephalus striatus</i>

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Phylum—ANNELIDA

Family—Aeolosomatidae

*Aeolosoma ternarium* Schmarda is of doubtful validity. Probably refers to *Aeolosoma bengalense* Steph. a common Indo-Malayan species.

Family—Tubificidae

*Limnodrilus hoffmeisteri* Clap. Delete *Limnodrilus socialis* which is a synonym of the above species.

Class—Hirudinea

*Zelanicobdella arugumensis* De Silva

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Phylum—ARTHROPODA

Class—Crustacea.

Order Anostraca

*Streptocephalus spinifer* Gurney.  
not *Stegocephalus spinifer*

## Sub-Class—Ostracoda

There are so many omissions and corrections in the species list that a fresh list of Ceylonese species is given.

<i>Cypriceruus reticulatus</i> Daday	<i>Cypris halyi</i> Brady
<i>Cypridopsis assimilis</i> Sars	<i>Cypris luzata</i> Brady
<i>Cypridopsis globosa</i> Brady	<i>Cypris monilifera</i> Brady
<i>Cypridopsis marmorata</i> Brady	<i>Cypris tenuicauda</i> Brady
<i>Cypræta globulus</i> (Sars)	<i>Cypris subglobosa</i> (Sowerby)
<i>Cypræta minna</i> (King)	<i>Ilhocypris australiensis</i> Sars
<i>Cypria purpurescens</i> (Apstein)	<i>Notodromas entzi</i> Daday
<i>Cyprinotus cingalensis</i> Brady	<i>Pseudocypris</i> sp
<i>Cyprinotus dentatomarginatus</i> Sars	<i>Stenocypris ceylonica</i> Daday
<i>Cypris furfuracea</i> Brady	<i>Stenocypris major</i> (Baird)
<i>Cypris granulata</i> Daday	

## Order—Decapoda

*Macrobrachium kistensis* (Tiwari)

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## Class—Insecta

## Order—Collembola

The earlier records of Ceylonese species in the references given below are in most if not all cases doubtful. Often they refer to species complexes or are not good species. Two truly aquatic genera are certain to occur namely *Sminthurides* and *Isotomurus*. A number of other genera commonly found either on the edges or on emergent vegetation include:—*Hypogastrura* (one species *H. communis* (Folsom) is pantropical and often aquatic); *Onychiurus*, *Proisotoma*, *Homidia*; *Setogaster*; and *Salina*.

I am indebted to Mr. D. H. Murphy, Zoology Department, University of Singapore, for these comments on Ceylonese Collembola.

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Order—Hemiptera

Family—Hydrometridae

*Hydrometra lineata* Esch.

Family—Veliidae

*Rhagovelia ceylanica* Lundb.

*Tetraripis ravana* (Kirk).

Delete *Rhagovelia nigricans* which is Ethiopian in distribution. *Tetraripis ravana* has been referred to as *Rhagovelia ravana* in the "Guide".

Family—Gerridae

Delete *Cylindrostethus bituberculatus*

*Cylindrostethus nieneri*

Both these are synonyms of *Cylindrostethus productus*.

Delete *Metrocoris illustrarius* which is a synonym of *M. stali*.

Family—Notonectidae

*Anisops projectus* Brooks.

Family—Corixidae

*Micronecta ceylanica* Wrobl.

*Micronecta fernandoi* Wrobl.

*Micronecta memonides* Kirk.

*Micronecta* sp.

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Order—Ephemeroptera

Ephemeropteran larvae are very common in all types of freshwater habitats. Some occur in standing waters of lakes, ponds and even small pools. Others are stream dwellers and occur even in torrential streams. The Ceylonese fauna is poorly known. Members of eight families numbering 17 species are on record, but it is likely that genera and even families have gone unrecorded. The adults can be identified down to the family level using the key of Ulmer (1936). The keys of Kimmins (1942) and Macan (1961) are useful for the nymphs.

A key has been drawn up for the families (nymphs) of the Ceylonese Ephemeroptera on record so far.

Key to the Families (nymphs) of Ceylonese Ephemeroptera :

1. Body consists of large, smooth, ovoid anterior portion and a small posterior portion. (Fig. E 1.)  
 .....PROSOPISTOMIDAE  
 Body not so shaped.....2
2. Mandibles visible dorsally, extending beyond anterior margin of head.....3  
 Mandibles not extending beyond anterior margin of head.....5
3. Mandibles long, tusk shaped (Fig. E 4.)  
 .....EPHEMERIDAE  
 Mandibles short (Fig. E 2.).....4
4. Legs short and stout (Fig. E 2.)  
 .....POLYMITARCHIDAE  
 Legs slender (Fig. E 3).  
 .....POTAMANTHIDAE
5. Outer tails with hairs only on inner side (Fig. 6.)  
 .....BAETIDAE  
 Outer tails with hairs on inner and outer sides.....6
6. Seven pairs of gills (Fig. E 5.)  
 .....LEPTOPHLEBIIDAE  
 Five or six pairs of gills.....7
7. Gills on segments 3-7, more or less equal in size (Fig. E 7.)  
 .....EPHEMERELLIDAE  
 Gills on segments 1-6, second pair greatly enlarged (Fig. E 8.)  
 .....CAENIDAE

The following species have been recorded from Ceylon :—

Family—Prospistomidae  
*Prospistoma* sp.

Family—Ephemeridae  
*Ephemera supposita* Etn.

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Family—Polymitaecidae

*Ephoron indicus* (Pictet)  
*Povilla corporali* (Lestage)

Family—Potamanthidae

*Rheonanthus posticus* Banks

Family—Baetidae

*Baetis consetus* (Hagen) *Cloeon marginale* (Hagen)  
*Baetis feminalis* Etn. *Procloeon bimaculatum* (Etn.)  
*Baetis solidus* (Hagen)

Family—Leptophlebiidae

*Atalophlebia annulata* (Hagen) *Atalophlebia taprobanes* (Walker)  
*Atalophlebia fasciatus* (Hagen) *Thraulius signatus* (Hagen)  
*Atalophlebia femoralis* (Hagen)

Family—Ephemerellidae

*Teloganodes major* Etn.

Family—Caenidae

*Caenis perpusilla* Walker

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## Order—Plecoptera

Only four species have been recorded so far, namely—

*Neoperla angulata* (Walker)

*Panoperla testacea* (Hagen)

*Panoperla limosa* (Hagen)

*Tetropina fulgescens* (Enderlein)

Recently Professor Per Brinck of the Zoological Institute, University of Lund, collected Plecoptera from Ceylon. He informed me in reply to my queries about Ceylonese species that *Neoperla angulata* will probably remain unchanged whilst the others are very likely to need alteration when his material is worked out.

*Neoperla* in shown is Fig. F 1.

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## Order—Odonata

The general features of odonata larvae have been given in the "Guide" p. 93. Lieftinck (1955) has given a synopsis of Ceylonese species. The present list is essentially the same as his except that the order of the species is different and no sub-family divisions are given. The larval forms are not well known in many cases but some have been described in the literature given below.

A key to the families of Ceylonese Odonata larvae has been drawn up by Mr. J. I. Furtado of the Zoology Department, University of Malaya, and is included.

Of the 106 species recorded from Ceylon 42 are endemic. For quick reference a table has been drawn up with the numbers in each family and the number of endemic species.

Families	Endemic	Total
<b>Zygoptera</b>		
Chlorocyphidae ..	3	4
Epallagidae ..	1	1
Calopterygidae ..	1	2
Lestidae ..	3	5
Platystictidae ..	14	14
Protoneuridae ..	5	5
Platycnemidae ..	—	1
Caenagrionidae ..	1	14
<b>Anisoptera</b>		
Libellulidae ..	3	40
Corduliidae ..	2	2
Gomphidae ..	12	13
Aeschnidae ..	—	5
<b>Total</b> ..	<b>42</b>	<b>106</b>

## Key to families of Ceylonese Odonata larvae

1. Larva slender, usually with cylindrical abdomen not widening behind thorax; cercibranchiate, with 2-3 caudal appendages (gill lamellae) projecting externally from tip of abdomen; Suborder ZYGOPTERA or damselflies; ..... 2
- Larva stout, with abdomen somewhat widened behind thorax; proctobranchiate, without external caudal gills but with numerous gills in a rectal gill-chamber; anus surrounded externally by an anal pyramid consisting of 3 stiff pointed valves (1 medio-dorsal and 2 latero-ventral) and 2 lateral cercoids; Suborder ANISOPTERA or dragonflies ..... 9
2. Antennal segment 1 as long as or longer than remaining 6 segments; labial mask without setae; ..... 3
- Antennal segment 1 much shorter than the remaining segments combined; labial mask with or without setae; ..... 5
3. Median lobe of prementum with a deep open apical cleft; lateral lobes of prementum (labial palps) narrow, with distal margin deeply incised and a long movable hook; long and slender larvae, with long spidery legs and elongate caudal gills; ..... CALOPTERYGIDAE = AGRIONIDAE
- Median lobe of prementum with a shallow closed apical cleft; labial mask flat ..... 4
4. Caudal gills saccoid with acuminate terminations; 7 pairs of lateral abdominal gills present; larva of robust build; labial palps narrow and terminating distally into 1-2 teeth and a long movable hook; ..... EPALLAGIDAE
- Caudal gills consisting of 2 long sharply-triquetral lateral spines armed with strong spines, and a rudimentary triangular medio-dorsal gill; larval head subtriangular, strongly projecting in front; labial palps narrow terminating distally into sharp and a movable hook; ..... CHLOROCYPHIDAE
5. Median lobe of prementum apically cleft; ..... 6
- Median lobe of prementum apically entire ..... 8
6. Prementum subtriangular to claviform, distally concave; labial mask with setae on prementum, palp and movable hook; labial palp distally expanded and terminating in movable hook and teeth; caudal lamellae elongate, with main trachea parallel and secondary tracheae arising at right angles to main stems; larvae elongate and slender ..... LESTIDAE
- Prementum subpentagonal, short and flat; setae absent on movable hook; secondary tracheae never arising at right angles to main stems ..... 7
7. Premental and palpal setae absent; labium flat; prementum large, somewhat parallel-sided; labial palps relatively small; caudal lamellae inflated into elongate oval sacs with acuminate tips ..... PLAYSTICTIDAE
- Premental and palpal setae present; labium flat; labial palp terminating into short movable hook and shortly-dentate distal margin; gills slightly inflated, vertical, elongate-oval lamellae, obtuse apically; ..... PROTONEURIDAE
8. Premental setae arranged in single horizontal row; palpal setae present, with palps distally dentate; caudal gills petiolated basally, broadened apically, subnodate or denodate, with secondary tracheae arising obliquely from primary; ..... PLATYCNEMIDIDAE
- Premental setae arranged in 2 oblique rows; palpal setae present; distal margin of palps dentate, labium short and flat; caudal gills nodate, subnodate or entire, with secondary tracheae arising obliquely from main stems; ..... COENAGRIONIDAE
9. Labial palp zygopterous, flat, without setae; labial palp narrow with long robust movable hook; ..... 10
- Labial mask broad, spoon-shaped (deeply concave), with numerous setae; labial palps broad, with distal margin deeply incised, crenate or serrate; palpal setae present; median lobe of prementum entire; fore and mid tarsi 3-segmented; antennae 7-segmented; ..... 11
10. Fore and mid-tarsi 3-segmented; antenna 7-segmented; median lobe of prementum cleft apically; palpal setae absent except in *Gynacantha*; ..... AESCHNIDAE
- Fore and mid-tarsi 2-segmented; antenna 4-segmented; median lobe of prementum entire; palpal setae absent; ..... GOMPHIDAE
11. Abdominal length less than twice width; long legged; ..... CORDULIIDAE
- Abdominal length greater than twice width; larva stocky ..... LIBELLULIDAE

The species recorded from Ceylon are as follows :

Sub-order—Zygoptera

Family—Chlorocyphidae

*Libellago adami* Fraser  
*Libellago finalis* (Selys)

*Libellago greeni* (Laidlaw)  
*Libellago indica* (Fraser)

Family—Epallagidae

*Euphaea splendens* Selys

Family—Calopterygidae (=Agrionidae)

*Neurobasis chinensis chinensis* (L).  
*Vestalis apicalis nigrescens* Fraser

Family—Lestidae

*Lestes divisa* Selys  
*Lestes elata* Selys  
*Lestes gracilis gracilis* Selys

*Lestes orientalis* Selys  
*Lestes praemorsa decipens* Kirby.

Family—Platystictidae

*Drepanosticta adamsi* (Fraser)  
*Drepanosticta crusteni* Lieftinck  
*Drepanosticta digna* Selys  
*Drepanosticta fraseri* Lieftinck  
*Drepanosticta hilaris* (Selys)  
*Drepanosticta lankanensis* (Fraser)  
*Drepanosticta montana* (Selys)

*Drepanosticta nietneri* (Fraser)  
*Drepanosticta submontana* (Fraser)  
*Drepanosticta sub-tropica* (Fraser)  
*Drepanosticta tropica* (Selys)  
*Drepanosticta walli* (Fraser)  
*Platysticta apicalis* Kirby  
*Platysticta maculata* Selys

Family—Protoneuridae

*Elatoneura caesia* (Selys)  
*Elatoneura centralis* (Selys)  
*Elatoneura leucostigma* (Fraser)

*Elatoneura tenax* (Selys)  
*Prodasiineura sita* (Kirby)

Family—Platycnemididae

*Copera marginipes* (Ramb.)

Family—Coenagriidae

*Aciagrion occidentale* Laidlaw  
*Agriocnemis famina* (Brauer)  
*Agriocnemis pygmaea* (Ramb.)  
*Ceriagrion cerinorubellum* (Brauer)  
*Ceriagrion coromandelianum* (F.)  
*Coenagrion malayanum* (Selys)  
*Enallagma parvum* Selys

*Ischnura aurora aurora* Brauer  
*Ischnura senegalensis* (Ramb.)  
*Onychagrion atrocyana* Selys  
*Pseudagrion malabaricum* Fraser  
*Pseudagrion microcephalum* (Ramb.)  
*Pseudagrion rubiceps ceylonicum* (Kirby)  
*Mortonagrion* sp.

## Sub-order—Anisoptera

## Family—Libellulidae

- |  |  |
|--|--|
| <i>Acisoma panorpoides</i> (Ramb.)               | <i>Orthetrum luzonicum</i> (Brauer)              |
| <i>Aethriamanta brevipennis</i> (Ramb.)          | <i>Orthetrum pruinatum neglectum</i> (Ramb.)     |
| <i>Brachydiplax sobrina</i> (Ramb.)              | <i>Orthetrum sabina sabina</i> (Drury)           |
| <i>Brachythemis contaminata</i> (F.)             | <i>Orthetrum triangulare triangulare</i> (Selys) |
| <i>Bradinopyga geminata</i> (Ramb.)              | <i>Onychothemis testacea ceylanica</i> Ris       |
| <i>Cratilla lineata calverti</i> Forster         | <i>Pantala flavescens</i> (F.)                   |
| <i>Crocothemis servilia</i> (Drury)              | <i>Rhodothemis rufa</i> (Ramb.)                  |
| <i>Diplocodes nebulosa</i> (F.)                  | <i>Rhyothemis triangularis</i> Kirby             |
| <i>Diplocodes trivialis</i> (Ramb.)              | <i>Rhyothemis variagata variagata</i> (L.)       |
| <i>Hydrobasilaris croceus</i> (Brauer)           | <i>Sympetrum fonscolombei</i> (Selys)            |
| <i>Hyaothemis frustorferi</i> (Korsh.)           | <i>Tholymis tillarga</i> (F.)                    |
| <i>Indothemis caesia</i> (Ramb.)                 | <i>Tramea basilaris burmisteri</i> Kirby         |
| <i>Indothemis limbata sita</i> Campion           | <i>Tramea limbata similis</i> (Ramb.)            |
| <i>Lathrecista asiatica asiatica</i> (F.)        | <i>Trithemis aurora</i> (Brun.)                  |
| <i>Macrodiplax cora</i> (Brauer)                 | <i>Trithemis festiva</i> (Ramb.)                 |
| <i>Neurothemis intermedia intermedia</i> (Ramb.) | <i>Trithemis kirbyi</i> Selys                    |
| <i>Neurothemis tullia tullia</i> (Drury)         | <i>Trithemis pallidinervis</i> (Kirby)           |
| <i>Orthetrum chrysis</i> (Selys)                 | <i>Urothemis signata signata</i> (Ramb.)         |
| <i>Orthetrum glaucum</i> (Brauer)                | <i>Zygonyx iris ceylanici</i> (Kirby)            |
|  | <i>Zyzomma petiolatum</i> Ramb.                  |

## Family—Corduliidae

- Epopthalmia vittata cyanocephala* (Hagen)  
*Macromia zeylanica* Fraser

## Family—Gomphidae

- |   |   |
|---|---|
| <i>Burmagomphus pyramidalis sinuatus</i> Fraser | <i>Ictinogomphus rapax</i> (Ramb.)              |
| <i>Cyclogomphus gynostylus</i> Fraser           | <i>Macrogomphus lankanensis</i> Fraser          |
| <i>Gomphidia pearsoni</i> Fraser                | <i>Macrogomphus annulatus keiseri</i> Lieftinck |
| <i>Heliogomphus ceylonicus</i> (Selys)          | <i>Megalogomphus ceylonicus</i> (Laidlaw)       |
| <i>Heliogomphus lyratus</i> Fraser              | <i>Microgomphus wijaya</i> Lieftinck            |
| <i>Heliogomphus nietneri</i> (Selys)            | <i>Paragomphus henryi</i> (Laidlaw)             |
| <i>Heliogomphus walli</i> Fraser                |   |

## Family—Aeshnidae

- |                                   |                                    |
|-----------------------------------|------------------------------------|
| <i>Anax immaculifrons</i> (Ramb.) | <i>Gynacantha</i> sp.              |
| <i>Anax guttatus</i> (Burm.)      | <i>Hemianax ephippiger</i> (Burm.) |
| <i>Anax indicus</i> Lieftinck     |                                    |

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## Order—Trichoptera

The Trichoptera are amongst the commonest larvae in large bodies of water. Many species also occur in fast flowing streams including torrents. The Ceylonese fauna is relatively well known (adults), thanks to the recent paper by Schmid (1958). The present list of species has been compiled by Mr. D. E. Kimmins of the British Museum (Nat. Hist.) and includes some from a paper by him in the press.

The Ceylonese species are as follows :—

## Family—Rhyacophilidae

<i>Agapetus anuragoda</i> Schmid	<i>Agapetus rawana</i> Schmid
<i>Agapetus ayodhia</i> Schmid	<i>Agapetus rudis</i> Hagen
<i>Agapetus hanumata</i> Schmid	<i>Agapetus sita</i> Schmid
<i>Agapetus ohiya</i> Kimmins	<i>Apsilochorema diffinis</i> Banks
<i>Agapetus rama</i> Schmid	<i>Rhyacophila castanea</i> Hagen

## Family—Hydroptilidae

<i>Baliotrichia guruluhela</i> Schmid	<i>Orthotrichia indica</i> Martynov
<i>Baliotrichia hinipitigola</i> Schmid	<i>Oxydroptila furcata</i> Martynov
<i>Baliotrichia medipitigola</i> Schmid	<i>Oxydroptila kirilawela</i> Schmid
<i>Baliotrichia udawarama</i> Schmid	<i>Oxyethira bogambara</i> Schmid
<i>Chrysotrichia aranawa</i> Schmid	<i>Oxyethira galekotuma</i> Schmid
<i>Chrysotrichia dotalugola</i> Schmid	<i>Parastactbia talakalahena</i> Schmid
<i>Chrysotrichia hapitigola</i> Schmid	<i>Plethus amogawarsa</i> Schmid
<i>Chrysotrichia hatuagola</i> Schmid	<i>Plethus bodhikatuwa</i> Schmid
<i>Hydroptila dikirilagoda</i> Schmid	<i>Plethus cilamegha</i> Schmid
<i>Hydroptila kurukepetiya</i> Schmid	<i>Plethus cursitans</i> (Hagen)
<i>Hydroptila mitirigalla</i> Schmid	<i>Plethus udawasadenna</i> Schmid
<i>Macrostactobia elawalikanda</i> Schmid	<i>Pseudoxythira asgirikanda</i> Schmid
<i>Microptila nikataruwa</i> (Schmid)	<i>Stactobia fisheri</i> Schmid

## Family—Philopotamidae

<i>Chimarra actinifera</i> Schmid	<i>Chimarra lankana</i> Kimmins
<i>Chimarra akarawitta</i> Schmid	<i>Chimarra lewisi</i> Kimmins
<i>Chimarra auriceps</i> Hagen	<i>Chimarra sandhamma</i> Schmid
<i>Chimarra auricoma</i> Kimmins	<i>Chimarra sepulchralis</i> Hagen
<i>Chimarra ceylanica</i> Kimmins	<i>Chimarra uana</i> Kimmins
<i>Chimarra circularis</i> Hagen	<i>Chimarra wiharawela</i> Schmid
<i>Chimarra confusa</i> Ulmer	<i>Gunungiella madakumbura</i> Schmid
<i>Chimarra godagama</i> Schmid	<i>Gunungiella nietneri</i> Banks

## Family—Polycentropidae

<i>Dipseudopsis horni</i> Ulmer	<i>Polyplectropus amarawathi</i> Schmid
<i>Dipseudopsis morosa</i> Banks	<i>Polyplectropus maladapaya</i> Schmid
<i>Dipseudopsis stellata</i> McLachlan	<i>Polyplectropus nubigens</i> (Hagen)
<i>Nyctiophylax abaya</i> Schmid	<i>Polyplectropus parakrama</i> Schmid
<i>Nyctiophylax devanampriya</i> Schmid	<i>Pseudoneureclipsis funesta</i> Hagen
<i>Nyctiophylax hittigegama</i> Schmid	<i>Pseudoneureclipsis nissanka</i> Schmid
<i>Nyctiophylax vetulya</i> Schmid	<i>Pseudoneureclipsis thuparama</i> Schmid
<i>Pahamunaya layagammeda</i> Schmid	<i>Pseudoneureclipsis watagoda</i> Schmid

Family—Psychomyiidae

*Abaria margaritifera* Schmid  
*Ecnomus ceylanicus* Mosely  
*Ecnomus duthagamini* Schmid  
*Ecnomus helakanda* Schmid  
*Ecnomus hinayana* Schmid  
*Ecnomus indicus* Martynov  
*Ecnomus lohapresada* Schmid  
*Ecnomus pusanus* Mosely  
*Ecnomus saddhatissa* Schmid  
*Ecnomus tenellus* (Rambur)  
*Ecnomus vaharika* Schmid

*Ecnomus vahasaba* Schmid  
*Paduniella ceylanica* Ulmer  
*Paduniella mahanawana* Schmid  
*Paduniella mahindra* Schmid  
*Panduniella pandya* Schmid  
*Panduniella sangamitra* Schmid  
*Panduniella subbakara* Schmid  
*Panduniella vattagamani* Schmid  
*Panduniella vikarmasinha* Schmid  
*Tinodes mitis* (Hagen)  
*Tinodes pullulans* Navas

Family—Hydropsychidae

*Aethaloptera sexpunctata* (Kolenati)  
*Amphipsyche indica* Martynov  
*Diplectrona kirimaduhela* Schmid  
*Diplectrona maligna* (Hagen)  
*Diplectrona papillonacea* (Hagen)  
*Diplectronella taprobanae* (Hagen)  
*Hydropsyche fryeri* Ulmer  
*Hydropsyche katugahakanda* Schmid  
*Hydropsyche malassanka* Schmid  
*Hydropsychodes curvata* (Martynov)  
*Hydropsychodes galahittigama* Schmid  
*Hydropsychodes galapitikanda* Schmid  
*Hydropsychodes kirimadawa* Schmid

*Macronema multifarium* (Walker)  
*Macronema nebulosum* Hagen  
*Macronema obliquum* Hagen  
*Macronema pseudoneura* Brauer  
*Macronema sepultum* Hagen  
*Macronema splendidum* Hagen  
*Oestropsyche vitrina* (Hagen)  
*Polymorphanisus ocularis* Ulmer  
*Pseudoleptonema ceylanicum* Hagen  
*Pseudoleptonema godapitigama* Schmid  
*Pseudoleptonema katukandama* Schmid  
*Synaptopsyche nikalandugola* Schmid

Family Calamoceratidae

*Anisocentropus annulicornis* (Hagen)  
*Anisocentropus brevipennis* (Ulmer)  
*Anisocentropus decipens* (Ulmer)  
*Anisocentropus immunis* McLachlan

*Anisocentropus ittikulama* Schmid  
*Ganonema elyakatuwa* Schmid  
*Ganonema falcata* (Banks)  
*Ganonema palliorne* McLachlan

Family—Odontoceridae

*Marilia mixta* (Hagen)

Family—Leptoceridae

*Adicella agastya* Schmid  
*Adicella biramosa* Martynov  
*Adicella ino* (Hagen)  
*Adicella najas* (Hagen)  
*Athripsodes isurumuniya* (Schmid)  
*Athripsodina martynovi* (Forsslund)  
*Nietnerella hageni* Kimmins  
*Oecetis biramosa* Martynov  
*Oecetis ceylanica* (Ulmer)  
*Oecetis dhatusena* Schmid  
*Oecetis fahieni* Schmid  
*Oecetis hamorta* (Ulmer)  
*Oecetis lais* (Hagen)  
*Oecetis lingua* Schmid  
*Oecetis maligawa* Schmid  
*Oecetis meghadonta* Schmid  
*Oecetis naravitta* Schmid  
*Oecetis nerviciliata* (Schmid)

*Oecetis nervisquamosa* (Schmid)  
*Oecetis punctatissima* (Schmid)  
*Oecetis sumanasara* Schmid  
*Parasetodes maculata* (Banks)  
*Setodes anuradha* Schmid  
*Setodes argentoaurea* Ulmer  
*Setodes argentonigra* Ulmer  
*Setodes inlensis* Martynov  
*Setodes iris* Hagen  
*Setodes mahasena* Schmid  
*Setodes maharansa* Schmid  
*Triaenodes cloe* (Hagen)  
*Triaenodes gazella* (Hagen)  
*Triaenodes lankarama* Schmid  
*Triaenodes ornata* Ulmer  
*Trichosetodes argentolineata* Ulmer  
*Trichosetodes megharwanabaya* Schmid  
*Tripletides ceylanicum* Mosely

## Family—Goeridae

*Goera katugalkanda* Schmid  
*Goera katugastota* Schmid  
*Goera kirilagoda* Schmid

*Goera paragoda* Schmid  
*Goera vulpina* (Hagen)

## Family—Lepidostomatidae

*Goerodes fuscata* (Navas)  
*Goerodes kan'la* Mosely  
*Goerodes mustellina* (Hagen)

*Goerodes piscina* (Hagen)  
*Goerodes punda* (Hagen)  
*Goerodes ursina* (Hagen)

## Family—Helicopsychidae

*Helicopsyche amarawathi* Schmid  
*Helicopsyche rupawathi* Schmid  
*Noleca asaka* Mosely  
*Noleca hapugowala* Schmid

*Noleca kabaragola* Schmid  
*Noleca koluandura* Schmid  
*Noleca nittimaluna* Schmid  
*Noleca watukaragoda* Schmid

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Order—Coleoptera

Hardly any work is available of recent date on the taxonomy of the Ceylonese species. The literature given should serve to some extent in the diagnosis of genera and species although it deals with species from other countries or is considerably out of date as regards nomenclature.

A few changes to the names are as follows:—

*Hydraticus* has been wrongly spelt *Hydraticus* in the "Guide".

<i>Clypeodytes bufo</i> (Sharp)	<i>Uvarus antennatus</i> (Reg.)
<i>Clypeodytes griseoguttatus</i> (Reg.)	<i>Uvarus flaviculus</i> (Motsch.)
<i>Guignotus inconstans</i> (Reg.)	<i>Uvarus genitalis</i> (Sharp)

All these species have been given under the generic name *Bideanus* in the "Guide."

*Copelatus tenebrosus* Reg.

*Copelatus irinus* Reg.

*Copelatus tenebrosus* has been referred to as *Copelatus pusillus* and *C. irinus* as *C. horni* in the "Guide".

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## Order—Diptera

This order includes families with aquatic and non-aquatic larvae. In some both truly aquatic and semi-aquatic or detritus inhabiting larvae are found. In the "Guide" no species list was given but the following families have been dealt with briefly, namely: Tipulidae, Culicidae, Corethridae, Chironomidae, Heleidae, Simuliidae and Blepharoceridae (Nematocera) and Syrphidae (Brachycera). In this supplement the Corethridae are included in the Culicidae as a sub-family. Brief diagnoses with notes on biology are given for the Psychodidae, and Dixidae (Nematocera) and Stratiomyidae and Tabanidae (Brachycera). A few remarks are made on two other brachyceran families Rhagionidae and Sciomyzidae which have aquatic larvae.

A list of species recorded is included for all the families except the Stratiomyidae, Syrphidae, Tabanidae, Rhagionidae and Sciomyzidae. The references cover relevant literature in all the families mentioned.

## Family—Tipulidae

They are common in the larval and pupal stages in moist habitats and many are truly aquatic. The adults are very characteristic, appearing like mosquitoes with enormously elongated legs. The larva has already been illustrated in the "Guide", Fig. 10, p. 95. The Ceylonese records though numerous probably represent only a fraction of the species found. The absence of a generic revision makes the placing of species rather difficult since so many changes have taken place at various times.

The Ceylonese records are as follows:—

- |   |   |
|---|---|
| <i>Antocha salikensis</i> Alex.             | <i>Hexatoma tuberculifera</i> (Edw.)        |
| <i>Conosia irrorata</i> (Wied.)             | <i>Geranomyia fletcheri</i> Edw.            |
| <i>Conosia minuscula</i> Alex.              | <i>Geranomyia genitaloides</i> Senior White |
| <i>Cryptolabis pollicis</i> Alex.           | <i>Gonomyia conchiformis</i> Alex.          |
| <i>Cryptolabis triquestra</i> Alex.         | <i>Gonomyia hedys</i> Alex.                 |
| <i>Ctenascrocelis ochripes</i> (Brun.)      | <i>Gonomyia lanka</i> Alex.                 |
| <i>Dicranomyia abeensis</i> Brun.           | <i>Gonomyia persimilis</i> Alex.            |
| <i>Dicranomyia columbina</i> Brun.          | <i>Gonomyia pictalis</i> Alex.              |
| <i>Dicranomyia fascipennis</i> Brun.        | <i>Gonomyia pollicis</i> Alex.              |
| <i>Dicranomyia subtesselata</i> Brun.       | <i>Gonomyia rohuna</i> Alex.                |
| <i>Dolichocheza gutturalis</i> Alex.        | <i>Gonomyia serendibensis</i> Alex.         |
| <i>Dolichocheza palifera</i> Alex.          | <i>Gymnastes cyanea</i> (Edw.)              |
| <i>Dolichocheza sinhalica</i> Alex.         | <i>Gymnastes kandyana</i> Alex.             |
| <i>Epiphragma kempi</i> Brun.               | <i>Gymnastes maya</i> Alex.                 |
| <i>Erioptera ornatipes</i> Edw.             | <i>Gymnastes simhale</i> Alex.              |
| <i>Eupilaria sinhalica</i> Alex.            | <i>Libnotes rotata</i> (Van der Wulp)       |
| <i>Eupilaria taprobanica</i> Alex.          | <i>Libnotes notatinervis</i> Brun.          |
| <i>Eupilaria thysantos</i> Alex.            | <i>Libnotes poeciloptera</i> Ost. Sack.     |
| <i>Hexatoma albonotata</i> (Loew)           | <i>Libnotes punctipennis</i> Brun.          |
| <i>Hexatoma badia badia</i> (Brun.)         | <i>Libnotes thwaitesiana</i> West.          |
| <i>Hexatoma crystalloptera</i> (Ost. Sack.) | <i>Limnobia albipes</i> Senior White        |
| <i>Hexatoma ctenophorides</i> (Edw.)        | <i>Limnophila simplex</i> Brun.             |
| <i>Hexatoma fusca</i> (Edw.)                | <i>Longurio errans</i> (Edw.)               |
| <i>Hexatoma greeni</i> (Edw.)               | <i>Longurio zeylanica</i> Alex.             |
| <i>Hexatoma humberti</i> (Ost. Sack.)       | <i>Mitopeza flavicans</i> Edw.              |
| <i>Hexatoma meleagris</i> (Ost. Sack.)      | <i>Molophilus kandyensis</i> Alex.          |
| <i>Hexatoma ochripleuris</i> (Edw.)         | <i>Molophilus rachus</i> Alex.              |
| <i>Hexatoma pachyrrhina</i> (Ost. Sack.)    | <i>Molophilus veddah</i> Alex.              |
| <i>Hexatoma pachyrrhinoides</i> (Edw.)      | <i>Molophilus wejaya</i> Alex.              |
| <i>Hexatoma seredib</i> Alex.               | <i>Molophilus yakko</i> Alex.               |
| <i>Hexatoma rufithorax</i> (Brun.)          | <i>Nephrotoma pleurinotata</i> (Brun.)      |
| <i>Hexatoma scullata</i> (Edw.)             | <i>Olbiogaster orientalis</i> Edw.          |
| <i>Hexatoma subnitens</i> (Edw.)            | <i>Orimarga asignata</i> Senior White       |
| <i>Hexatoma subpaenulata</i> (Edw.)         |   |

**Family—Tipulidae—Contd.**

*Pachyrhina javensis* (Dol.)  
*Paradelphomyia indulcata* Alex.  
*Polymera zeylanica* Alex.  
*Pselliophora elongata* Edw.  
*Pselliophora henryi* Edw.  
*Pselliophora laeta* (F.)  
*Pselliophora taprobanes* (Walk.)  
*Pseudolimnophila zeylanica* Alex.  
*Rhabdomastix schmidiana* Alex.  
*Styringomyia ceylonica* Brun.  
*Styringomyia crassicoستا* (Spies.)  
*Styringomyia fryeri* Brun.  
*Styringomyia marmorata* Senior White

*Teucholabis fenestra* Ost. Sack.  
*Teucholabis ornata* Brun.  
*Thrypticomys longineva* Edw.  
*Thrypticomys saltens* (Dol.)  
*Tipula brunettiella* Alex.  
*Tipula ceylonica* Edw.  
*Tipula flavescens* Brun.  
*Tipula gracillina* Brun.  
*Tipula hampsoni* Edw.  
*Trentepholia nigriapicalis* (Brun.)  
*Trentepholia pennipes* Ost. Sack.  
*Trentepholia spieseri* Edw.  
*Trentepholia trentepholi* Wied.

**Family—Psychodidae**

Although usually found in moist habitats, some species have truly aquatic larvae and pupae. The larva has already been illustrated in the "Guide", Fig. 15, p. 95. The larvae are somewhat flattened, lack prolegs and the body segments are divided into annuli. The head is small and the terminal end of the abdomen usually bears a circle of hairs.

The Ceylonese records are —

*Psychoda geniculata* Brun  
*Psychoda albopicta* Brun.  
*Parabrunetiella albohumeralis* Brun.

*Parabrunetiella flavicollis* Brun.  
*Pericoma proxima* Brun.

Some species are found in highly polluted habitats like catch pits of latrines. A very common species in this habitat is a Pan-tropical species *Telmatoscopus albipunctatus* Say.

**Family—Culicidae**

This family includes the mosquitoes, phantom midges and some "gnats". The mosquitoes belong to the sub-family Culicinae and the phantom midges and gnats to the sub-family Corethrinae.

The Corethrinae are represented by two genera *Chaoborus*, which is truly planktonic and abundant in the larger lakes, and *Corethrella* found in a variety of habitats including marshes and pitcher plants (*Nepenthes*). They are characterised by the prehensile antennae.

The Ceylonese records are —

*Chaoborus asiaticus* Giles  
*Corethrella inepta* (Annandale) (Fig. F 2, 3.)

*Chaoborus asiaticus* has already been illustrated in the "Guide" (Fig. 4., p. 95)

The mosquitoes are all characterised by the paired mouth brushes. They do not have prehensile antennae. In the anophelines the hairs of the head and thorax numbered in Fig. H 1. are used in specific diagnosis together with the palmate hairs which vary in shape and size. In the culicines the structure of the terminal segments of the abdomen including the siphon are of prime importance in specific diagnosis (Fig. G 1.). The comb teeth, pecten teeth, hair tufts and the distribution of various setae in this region serve in diagnosis both in the culicines proper and most other non-anophelines too.

Mosquito larvae and pupae are essentially inhabitants of shallow, still waters. They live amongst vegetation and removal of this protection often means their elimination. A few species, e.g., *Anopheles fluviatilis* are found in streams, but even here they live in the relatively calm backwaters. Some live in collections of water in leaf axils or fallen leaves, others are exclusively found in pitcher plants. A number of species of Culicines are found in polluted waters.

## FIG. G

The mosquitoes are the best known group of insects because of their importance as transmitters of diseases. In groups known to transmit diseases like the Anophelines and Culicines much work has been devoted to the taxonomy and in recent years to the biology. The freshwater biologist often comes across mosquito larvae and should be able to identify them at least to the major groups. There are keys available for the diagnosis of the Ceylonese larvae in Carter (1925) and Senior White (1925, 1927). The features used in the diagnosis of larvae are illustrated in Fig. G 1. for Culicines and Fig. H 1. for Anophelines. Also the larvae of a few species are shown in Figs. G and H.

The mosquitoes recorded from Ceylon have been taken from the world compilation of Stone, Knight and Starcker (1959).

They are as follows —

- |   |  |
|---|--|
| <i>Aedes aegypti</i> (L.) (Fig. H 7.)                   | <i>Anopheles gigas</i> var <i>simlensis</i> (James)    |
| <i>Aedes albopictus</i> (Theo.)                         | <i>Anopheles hyrcanus</i> (Pallas)                     |
| <i>Aedes alboscuteellatus</i> (Theo.)                   | <i>Anopheles insulaeflorum</i> (Swell. and Swell.)     |
| <i>Aedes albotaeniatus</i> (Leicester)                  | <i>Anopheles jamesi</i> Theo. (Fig. H 2.)              |
| <i>Aedes aureostriatus</i> var <i>greeni</i> (Theo.)    | <i>Anopheles kawari</i> James                          |
| <i>Aedes aureostriatus</i> var <i>kanaranus</i> (Barr.) | <i>Anopheles maculatus</i> Theo.                       |
| <i>Aedes bulleri</i> Theo.                              | <i>Anopheles nigerrimus</i> Giles                      |
| <i>Aedes chrysolineatus</i> (Theo.)                     | <i>Anopheles pallidus</i> Theo.                        |
| <i>Aedes gubernatoris</i> (Giles)                       | <i>Anopheles pediotaeniatus</i> (Leicester)            |
| <i>Aedes harveyi</i> (Barr.)                            | <i>Anopheles pseudobarbistrois</i> Theo.               |
| <i>Aedes indicus</i> (Theo.)                            | <i>Anopheles ramseyi</i> Covell                        |
| <i>Aedes jamesi</i> (Edw.)                              | <i>Anopheles subpictus</i> Grassi                      |
| <i>Aedes laniger</i> (Wied.)                            | <i>Anopheles tessellatus</i> Theo.                     |
| <i>Aedes lankaensis</i> Stone and Knight                | <i>Anopheles vagus</i> Donitz                          |
| <i>Aedes longirostris</i> (Leicester)                   | <i>Anopheles varuna</i> Iyenger                        |
| <i>Aedes macdougalli</i> Edw.                           | <i>Armigeres aureolineatus</i> (Leicester) (Fig. G 5.) |
| <i>Aedes medipunctatus</i> (Theo.)                      | <i>Armigeres magnus</i> (Theo.)                        |
| <i>Aedes niveus</i> Ludlow                              | <i>Armigeres omissus</i> (Edw.)                        |
| <i>Aedes novalbopictus</i> Barr.                        | <i>Armigeres subalbatus</i> (Coq.)                     |
| <i>Aedes ostentatio</i> (Leicester)                     | <i>Culex bahri</i> (Edw.)                              |
| <i>Aedes pallidostriatus</i> (Theo.)                    | <i>Culex bailyi</i> (Barr.)                            |
| <i>Aedes pipersalatus</i> (Giles)                       | <i>Culex barraudi</i> Edw.                             |
| <i>Aedes pseudomediofasciatus</i> (Theo.)               | <i>Culex bitaeniorhynchus</i> Giles                    |
| <i>Aedes pseudotaeniatus</i> Giles                      | <i>Culex brevipalpis</i> Giles                         |
| <i>Aedes reginae</i> Edw.                               | <i>Culex campilunati</i> Carter and Wijesundera        |
| <i>Aedes scatophogoides</i> (Theo.)                     | <i>Culex castrensis</i> Edw.                           |
| <i>Aedes secalatus</i> Menon                            | <i>Culex cinctellus</i> Edw.                           |
| <i>Aedes simplex</i> (Theo.)                            | <i>Culex edwardsi</i> Barr.                            |
| <i>Aedes spermathecus</i> Wijesundera                   | <i>Culex epidemus</i> (Theo.)                          |
| <i>Aedes stenoestrus</i> (Theo.)                        | <i>Culex fragilis</i> Ludlow                           |
| <i>Aedes taeniorhynchoides</i> (Christophers)           | <i>Culex fuscianus</i> Wied. (Fig. G 4.)               |
| <i>Aedes thomasi</i> (Theo.)                            | <i>Culex fuscifurcatus</i> Edw.                        |
| <i>Aedes vexans</i> (Meigan)                            | <i>Culex fuscocephalus</i> Theo.                       |
| <i>Aedes vittatus</i> (Bigot)                           | <i>Culex gelidus</i> Theo.                             |
| <i>Aedes w-albus</i> (Theo.)                            | <i>Culex halifaxi</i> Theo.                            |
| <i>Aedes yerburyi</i> Edw.                              | <i>Culex infantulus</i> Edw.                           |
| <i>Anopheles aconitus</i> Donitz                        | <i>Culex malayi</i> (Leicester)                        |
| <i>Anopheles aitkenii aitkenii</i> James                | <i>Culex mammalifer</i> (Leicester)                    |
| <i>Anopheles annandalei interruptus</i> Puri            | <i>Culex mimulus</i> Edw.                              |
| <i>Anopheles annularis</i> Van der Wulp                 | <i>Culex minor</i> (Leicester)                         |
| <i>Anopheles barbistrois</i> Van der Wulp               | <i>Culex minutissimus</i> (Theo.)                      |
| <i>Anopheles culicifaciens</i> Giles                    | <i>Culex nigropunctatus</i> Edw.                       |
| <i>Anopheles elegans</i> James                          | <i>Culex pallidothorax</i> Theo.                       |
| <i>Anopheles fluviatilis</i> James                      | <i>Culex pipiens quinquefasciatus</i> Say              |
| <i>Anopheles gigas</i> Giles                            | <i>Culex fatigans</i> (Figs. G 2, 3.)                  |
| <i>Anopheles gigas</i> var <i>refutans</i> Alcock       | <i>Culex raptor</i> (Edw.)                             |

*Culex rubithoracis* (Leicester)  
*Culex shebbearei* Barr.  
*Culex spathifurca* (Edw.)  
*Culex sinensis* Theo.  
*Culex tritaeniorhynchus* Giles (Fig. G 1.)  
*Culex uniformis* Theo  
*Culex vorax* (Edw.)  
*Ficalbia chamberlaini chamberlaini* Ludlow  
*Ficalbia chamberlaini clavipapus* (Theo.)  
*Ficalbia hybrida* (Leicester)  
*Ficalbia intermedia* (Barr.)  
*Ficalbia luzonensis* (Ludlow) (Fig. H 5.)  
*Ficalbia minima* (Theo.)  
*Heizmannia greeni* (Theo.)  
*Hodgesia bailyi* Barr.

*Hodgesia malayi* Leicester.  
*Malaya genuirostris* Leicester  
*Mansonia annulifera* (Theo.)  
*Mansonia crassipes* (Van der Wulp)  
*Mansonia indiana* Edw.  
*Mansonia uniformis* (Theo.) (Fig. G 6.)  
*Orthopodomyia anopheloides anopheloides* (Giles)  
*Orthopodomyia anopheloides maculata* (Theo.)  
*Orthopodomyia flavithorax* Barr.  
*Toxorhynchites minimus* (Theo.)  
*Toxorhynchites splendens* (Wied.) (Fig. H 4.)  
*Tripteroidea affinis* (Edw.)  
*Tripteroidea aranoides* (Theo.)  
*Tripteroidea dostleiri* (Gunther)

#### Family—Dixidae

They resemble mosquito larvae superficially but can usually be recognised in life by their characteristic U Shape. They differ from mosquito larvae in having discrete thoracic segments and two pairs of prolegs on abdominal segments 1 and 2. They are rare. One species has been recorded in Ceylon namely *Dixa zeylanica* Senior White. *Dixa* is illustrated in Figs. F 4-7.

#### Family—Chironomidae

The larvae are common in habitats with decaying organic matter. They often reach enormous numbers in suitable habitats. Many species occur in paddy fields in the moist soil. They form an important constituent of the bottom fauna of tanks and ponds. Some species are red in colour and are referred to as bloodworms. They are used to feed fish in aquaria. Many species are pale yellow or greenish in colour.

The records from Ceylon are only a small fraction of the number certainly found in aquatic habitats. They are as follows:—

*Cardiocladius ceylanicus* Kieff.  
*Chironomus allothrix* Kieff.  
*Chironomus elatus* Kieff.  
*Chironomus fuscitarsus* Kieff.  
*Chironomus gloriosus* Kieff.  
*Chironomus heptatomus* Kieff.  
*Chironomus nigromarginatus* Kieff.  
*Chironomus perichlorus* Kieff.  
*Chironomus praetiosus* Kieff.  
*Chironomus stratipennis* Kieff.  
*Chironomus sumptuosus* Kieff.

*Chironomus superbus* Kieff.  
*Chironomus varicornis* Kieff.  
*Chironomus* sp.  
*Dactylocladius ceylanicus* Kieff.  
*Pentaneura* sp.  
*Polypedilum nubifer* (Skuse)  
*Procladius* sp.  
*Spaniotoma* sp.  
*Tanyptus annulatipes* (Kieff.)  
*Tanyptus pallidipes* (Kieff.)  
*Tanytarsus* sp.

#### Family—Helidae

The larvae occur in a variety of habitats. Some are found in moist soil, amongst moss and decaying vegetation. Some are truly aquatic. These forms swim with an eel-like movement and are often slender and live amongst vegetation. The adults of some species bite man and may be of nuisance value or even transmit parasitic diseases to domestic animals and man.

The Ceylonese records are—

*Bezzia indecora* Kieff.  
*Calyptopogon gibbosa* Wied.  
*Culicoides anophelis* Edw.  
*Culicoides bilobatus* Kieff.  
*Culicoides ceylanicus* Kieff.  
*Culicoides flaviscutatus* Wirth and Hubert  
*Culicoides paraflavescens* Wirth and Hubert  
*Dibezzia ceylonica* Kieff.  
*Forcipomyia calcarata* Kieff.  
*Forcipomyia hirtipes* Meij.  
*Forcipomyia jacobsoni* Meij.

*Forcipomyia longicalcar* Kieff.  
*Forcipomyia noctivaga* Kieff.  
*Forcipomyia ornaticrus* Kieff.  
*Forcipomyia semipilosus* Kieff.  
*Forcipomyia simulans* Edw.  
*Forcipomyia tetracлада* Kieff.  
*Forcipomyia theobromae* Kieff.  
*Palpomyia* sp.  
*Probezzia* sp.  
*Stilobezzia festiva* Kieff.  
*Stilobezzia inermipes* Kieff.

#### Family—Simuliidae

There has been only two species recorded from Ceylon so far. The larvae inhabit flowing water and the adults are bloodsucking. Some species are known to transmit parasitic diseases to man and domestic animals and in these cases have been intensively studied. The larvae have been recorded in the branchial chambers of potamonid crabs in Africa.

The Ceylonese records are :—

*Simulium atratum* Meij.

*Simulium striatum* Brun.

#### Family—Blepharoceridae

Only two species are known from Ceylon at present, namely. *Hammatorhina bella* Loew and *Hammatorhina pulchra* Edw. The Indian fauna has been better studied and larvae and pupae and adults of a number of genera are known.

#### Family—Stratiomyiidae

These larvae are flattened dorso-ventrally and appear like leeches at first sight. They are characterised by the circlet of bristles at the posterior end which may be in one or two groups (Fig. F 8.) These bristles when spread out on the surface act as a float. There is an opaque deposit of calcium carbonate in the integument. These larvae are easily missed in collections because they are apparently lifeless. They are rare in freshwater collections. Only a few stratiomyid species occur in water; the rest are found in terrestrial habitats, hence no list of species is included.

#### Family—Tabanidae

The larvae of most species are semi aquatic whilst only a few are truly aquatic in the immature stages. The adults are very common and some species bite man and other mammals.

The larva which has already been illustrated ("Guide" page 95, Fig. 1.) is elongate and tapers towards both ends. The body consists of a reduced head, three thoracic segments and eight abdominal segments of which the first seven bear small prolegs which are often greatly reduced. The terminal end of the abdomen has a respiratory siphon.

Many species have been recorded from Ceylon. The larvae are poorly known.

#### Family—Rhagionidae (Leptidae)

The larvae have a reduced head and each abdominal segment bears a pair of pseudopods with terminal spines. The last abdominal segment (anal) carries two hairy processes. The genus *Atherix* has aquatic larvae (Fig. F 9.) and a single species has been recorded from Ceylon, namely, *Atherix labiata* Bigot.

## Family—Sciomyzidae

The head of the larva is rudimentary. The segments bear paired lateral projections in each segment. The last abdominal segment has a two pairs of flattened structures. The commonest genus is *Sepedon* (Fig. F 10.) and although it has not been recorded from Ceylon it is probably found. Other species, e.g., *Saltisella* are parasitic in snails and attempts have been made to use them to control snails which act as intermediate hosts to trematodes by introducing suitable sciomyzids.

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## Order—Hydracarina

*Diplodontus silvestri* (Daday)*Piona dadayi* Piersig*Piona* sp.DELETE *Piona conglobata* and *Lamienia filcipes**Diplodontus silvestri* has been referred to as*Hydraphantis silvestri* and *Eupatsa silvestri* in the Guide and in Suppl. I respectively.

Two references which will be of use in determining Ceylonese species are given.

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#### ACKNOWLEDGMENTS

I am very grateful to the following for their help in compiling species lists: Mr. D. E. Kimmins, British Museum (Nat. Hist.), —Ephemeroptera, Trichoptera; Dr. J. P. Harding, British Museum (Nat. Hist.) — Ostracoda. Dr. M. A. Lieftinck, Rijksmuseum, Leiden, gave me much help with literature and brought to my notice the record of *Prosopistoma*. Professor Per Brinck, Zoological Institute, Lund, made critical comments on the Plecopteran records. Mr. J. I. Furtado, Zoology Department, University of Malaya, made a key to the larvae of Odonata families. I wish to thank Mrs. L. Karunakaran and Mr. Khoo Soo Ghee for permission to use their unpublished drawings.

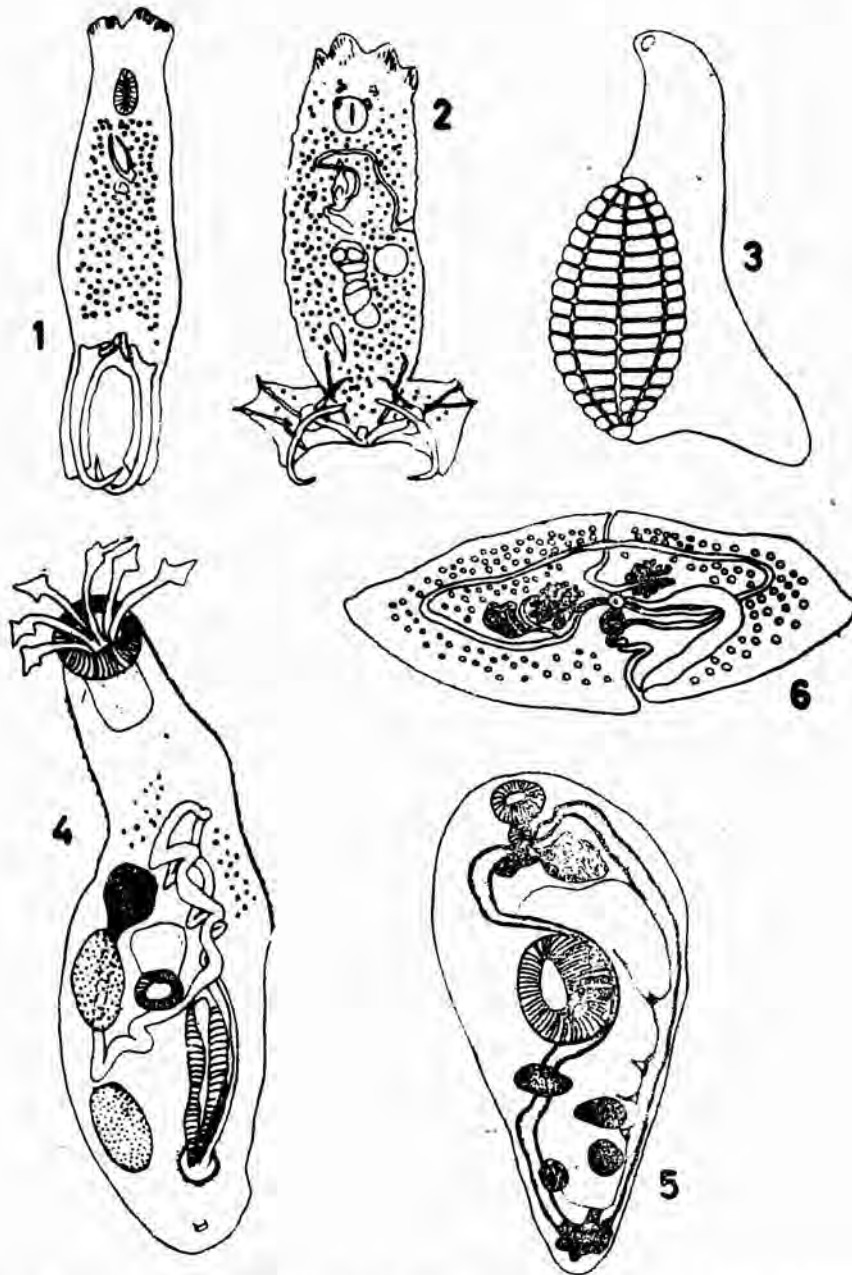


Fig. A. (1) *Dactylogyrus longicirrus* Tripathi. After Tripathi (1957). (2) *Dactylogyroides macracanthus*. After Gussev (1963). (3) *Aspidogaster indicus* Dayal, After Chauhan (1953). (4) *Bucephalus tridenticularia* Verma, After Chauhan (1953). (5) *Ophichorchis lobatum* Srivastava, After Chauhan (1953). (6) *Transversotrema*. From Hymen: Invertebrata Vol. 2.

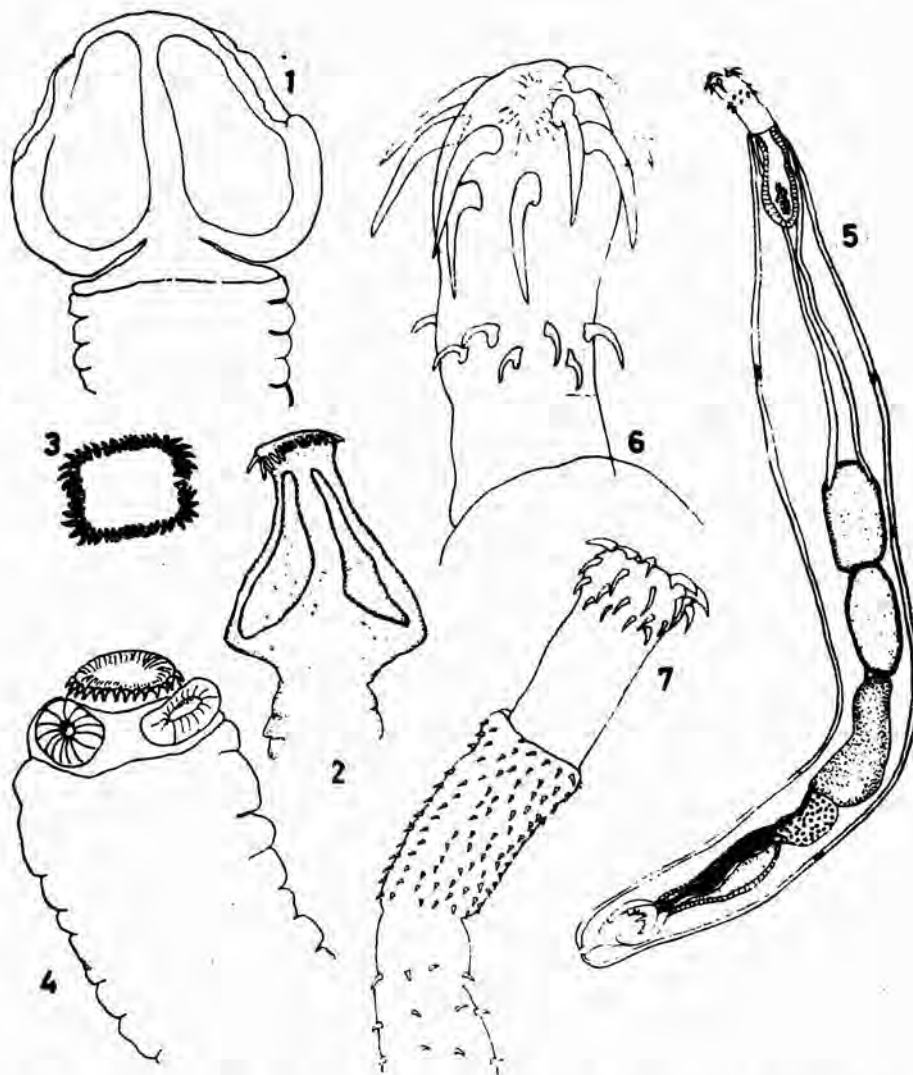


Fig. B. (1) *Bothriocephalus gowkongensis*; Scolex. (2) *Senga lucknowensis*; Scolex. (3) En face view of apical disc of *Senga lucknowensis*. (4) *Gangesia bengalensis*; scolex and anterior end of body. (5) *Zeylanechinorhynchus longinuchalis*. (6) Proboscis of *Z. longinuchalis*. (7) Proboscis and anterior portion of body of *Pallisentis nappurensis*. All figures after Fernando and Furtado (1963b)

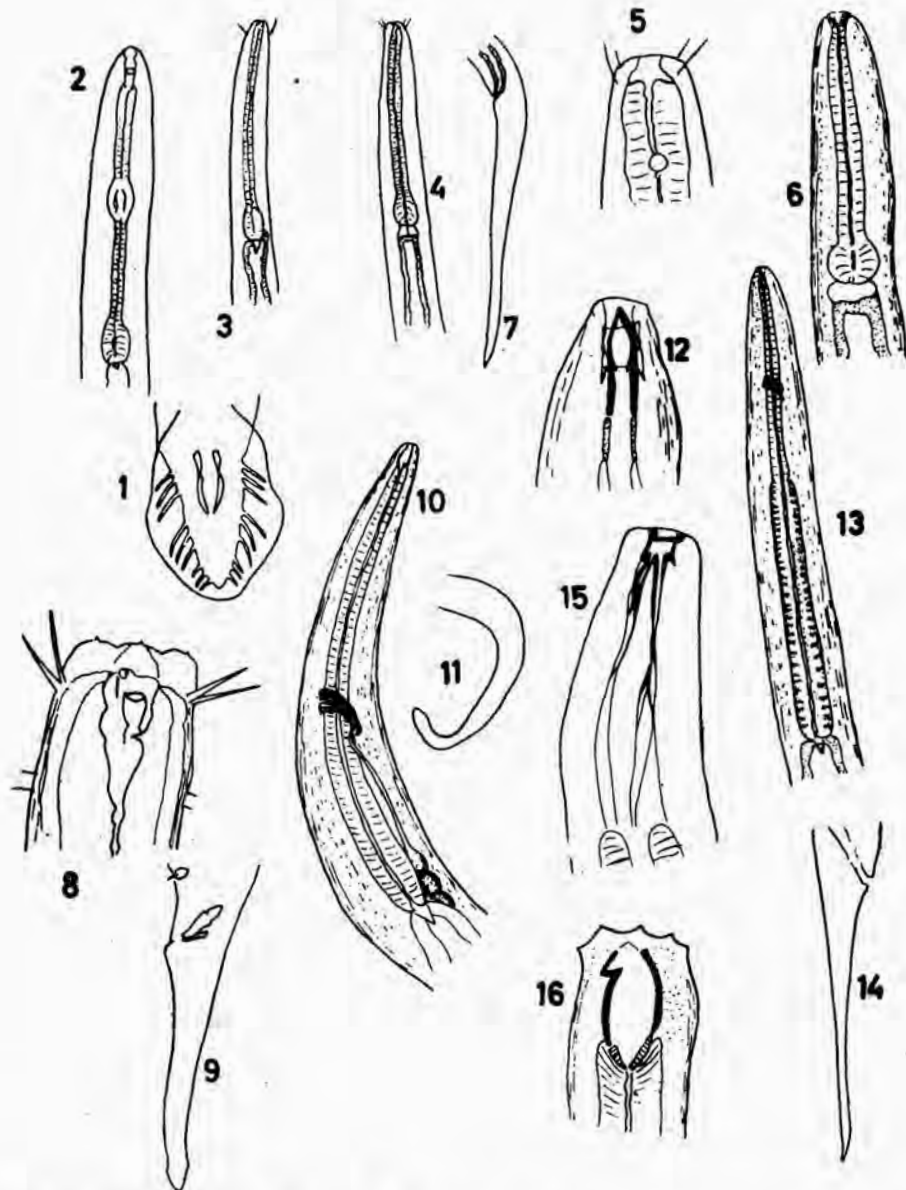


Fig. C. (1) Terminal portion of *Rhabditis* male. (2) *Diplogasteroides*; fore part of body. (3) *Plectus*; fore part of body. (4) *Monohystera*; fore part of body. (5) *Monohystera*; anterior end. (6) *Monochromadora vulgaris*, anterior portion. (7) Tail of *Monochromadora vulgaris*. (8) Cephalic region of *Tobrilus gracilis* (Bastian). (9) Male tail of *Tobrilus gracilis*. (10) *Bathyonchus indicus*, Kreis; anterior portion. (11) *Bathyonchus indicus*; tail. (12) *Dorylaimus stagnalis*; cephalic portion. (13) *Dorylaimus stagnalis*; fore part of body. (14) *Dorylaimus stagnalis*; tail of female. (15) *Actinolaimus*; anterior end. (16) *Mononchus*; anterior end.

Figs. 10, 11 and 15 after Kreis (1936); others after Goodey (1963). All figures redrawn.

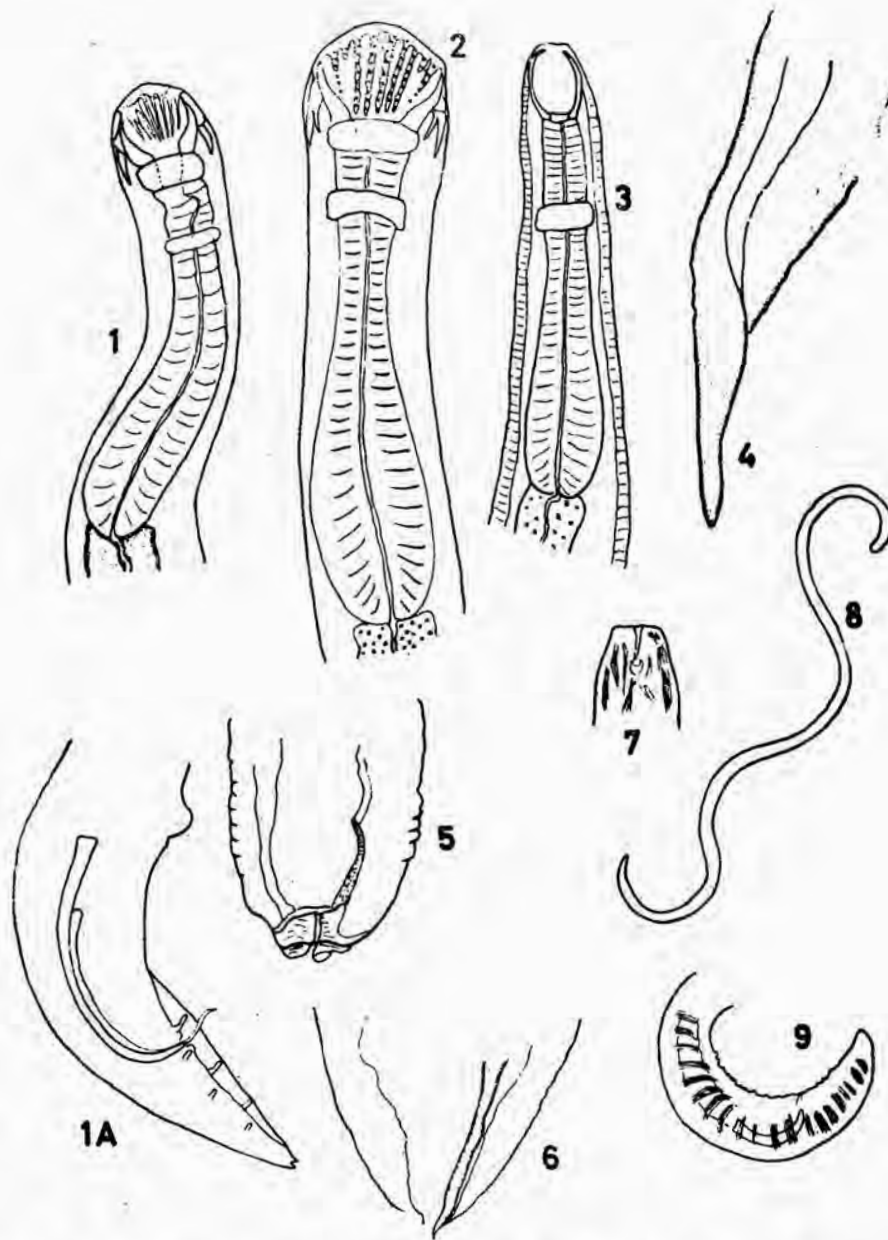


Fig. D. (1) *Camallanus ceylanicus*; fore part of body. 1A. Posterior portion of male, *C. ceylanicus*. 2) *Zeylanema anabantis*; fore part of body. (3) *Procamallanus*; fore part of body. (4) Tail of *Procamallanus* female. (5) Terminal portion of *Hedruris* larva (female). (6) Terminal portion of *Eustrongylides* larva (female) (7) Anterior end of *Hydromermis*. (8) *Hydromermis*. (9) Terminal portion of *Hydromermis* male.

Figs. 1-4 after Fernando and Furtado (1963a). 7-9 after Schurmanns-Stekhoven (1954). All figures redrawn.

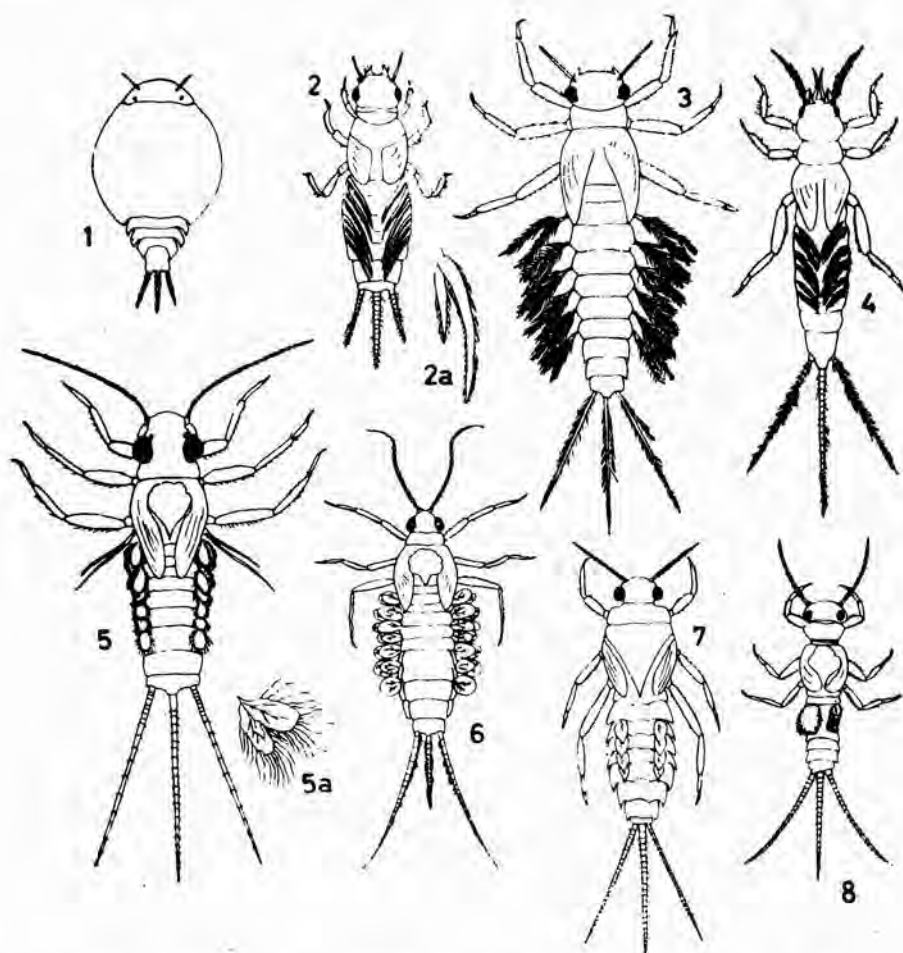


Fig. E. (1) *Prosopistoma*. (2) *Povilla corporaali*. (3) *Potamanthus luteus* L. (4) *Ephemera vulgata* L. (5) *Thraulius*. (6) *Cloeon*. (7) *Ephemerella ignita* Poda. (8) *Caenis*.

Fig. 3 after Ulmer (1937); 1-4 and 7 after Eaton (1884-1888). 5, 6 and 8 from unpublished thesis of Mrs. S. Karunakaren, Zoology Department, University of Singapore.

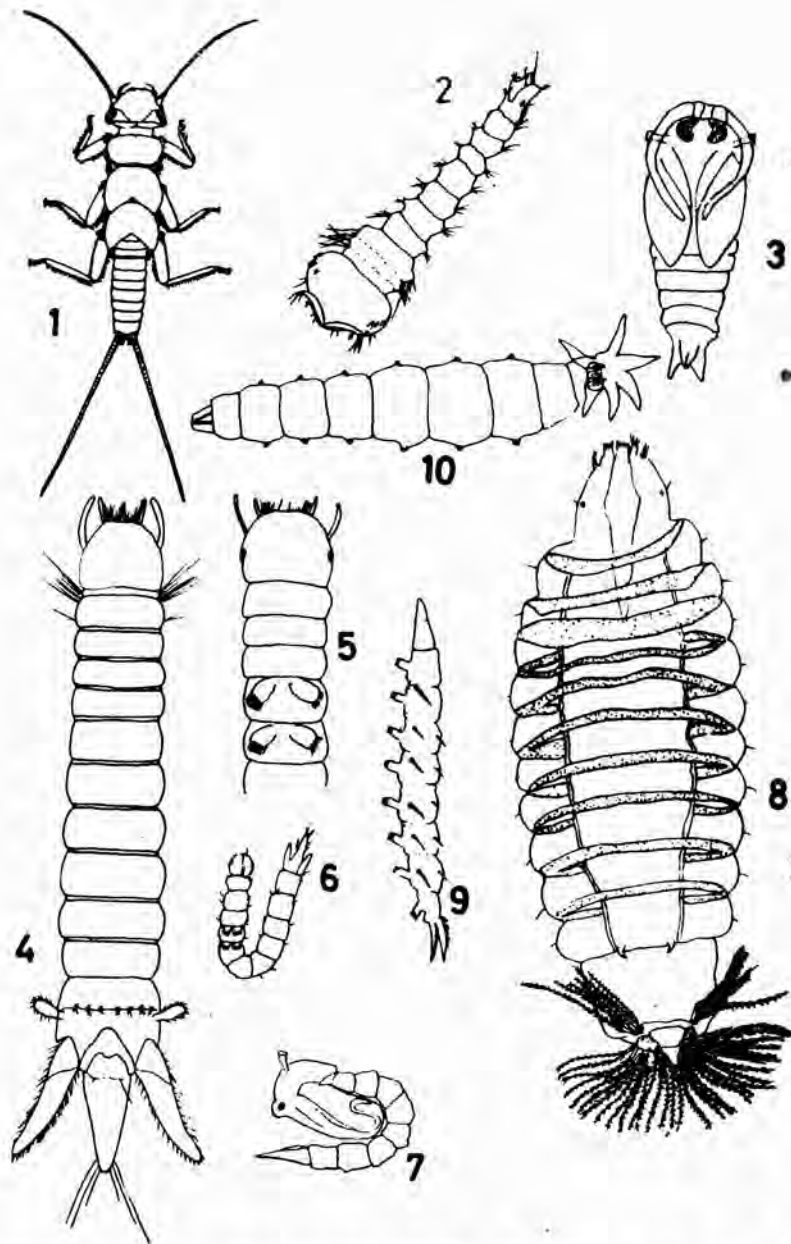


Fig. F. (1) *Neoperla* sp.; larva. (2) Larva of *Corethrella*. (3) Pupa of *Corethrella*. (4) *Dixa* larva; dorsal view. (5) *Dixa* larva; anterior segments showing prolegs. (6) *Dixa* larva in position assumed in life. (7) Pupa of *Dixa*. (8) Stratiomyid larva; dorsal view. (9) Larva of *Atherix*. (10) Larva of *Sepedon*.

Fig. 1. From a drawing by Mr. Khoo Soo Ghee, Zoology Department, University of Singapore. 4, 5, and 7. after Prasad (1918). 6. Semidiagrammatic. 9. After Wesenberg—Lund (1953).

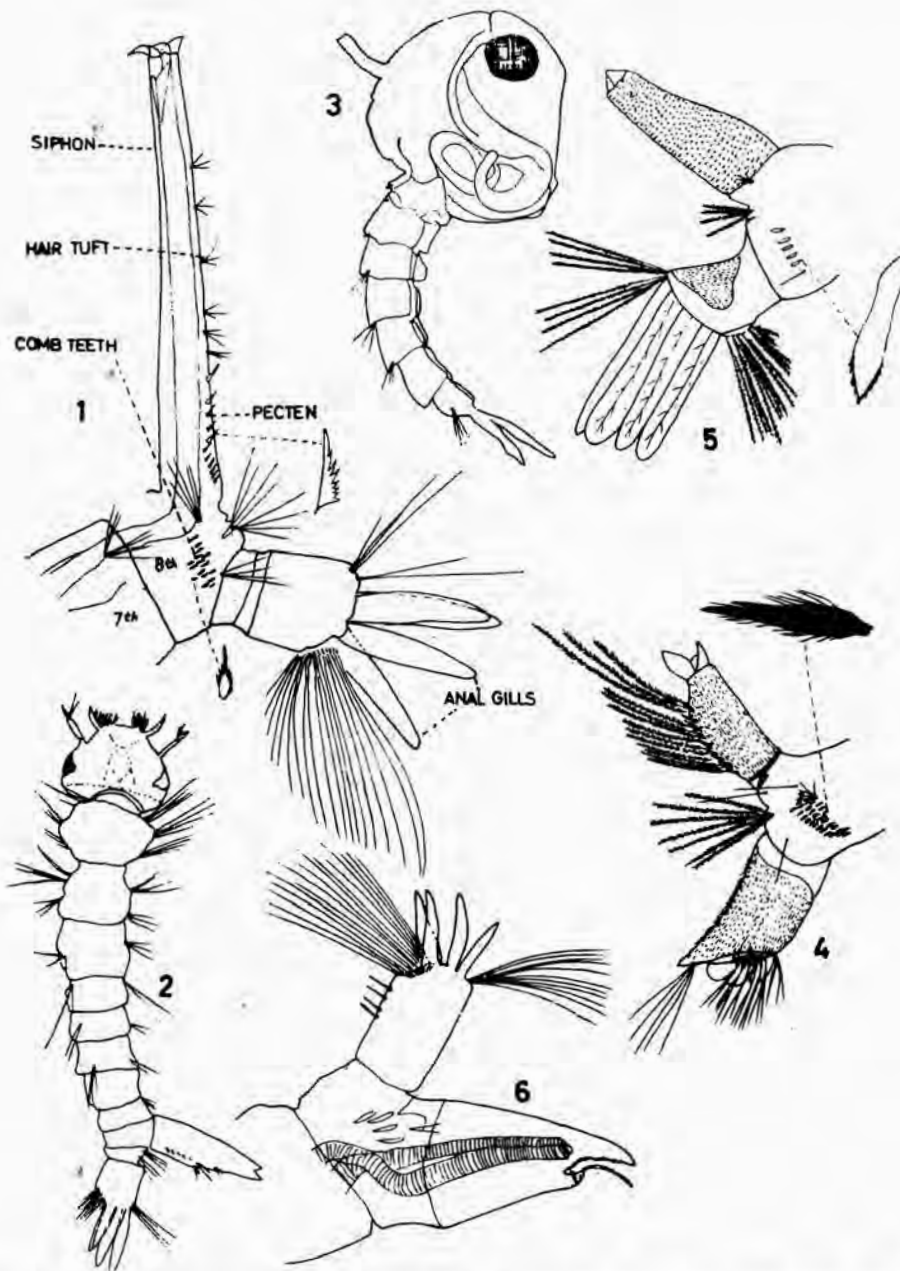


Fig. G. (1) Siphon and terminal segments of *Culex tritaeniorhynchus* larva. (2) Larva of *Culex fatigans*. (3) Pupa of *Culex fatigans*. (4) Terminal portion of *Culex fuscus*. (5) Terminal portion of *Armigeres aureolineatus*. (6) Terminal segments of *Mansonia*.

Figs. 4 and 5 after Senior-Whi

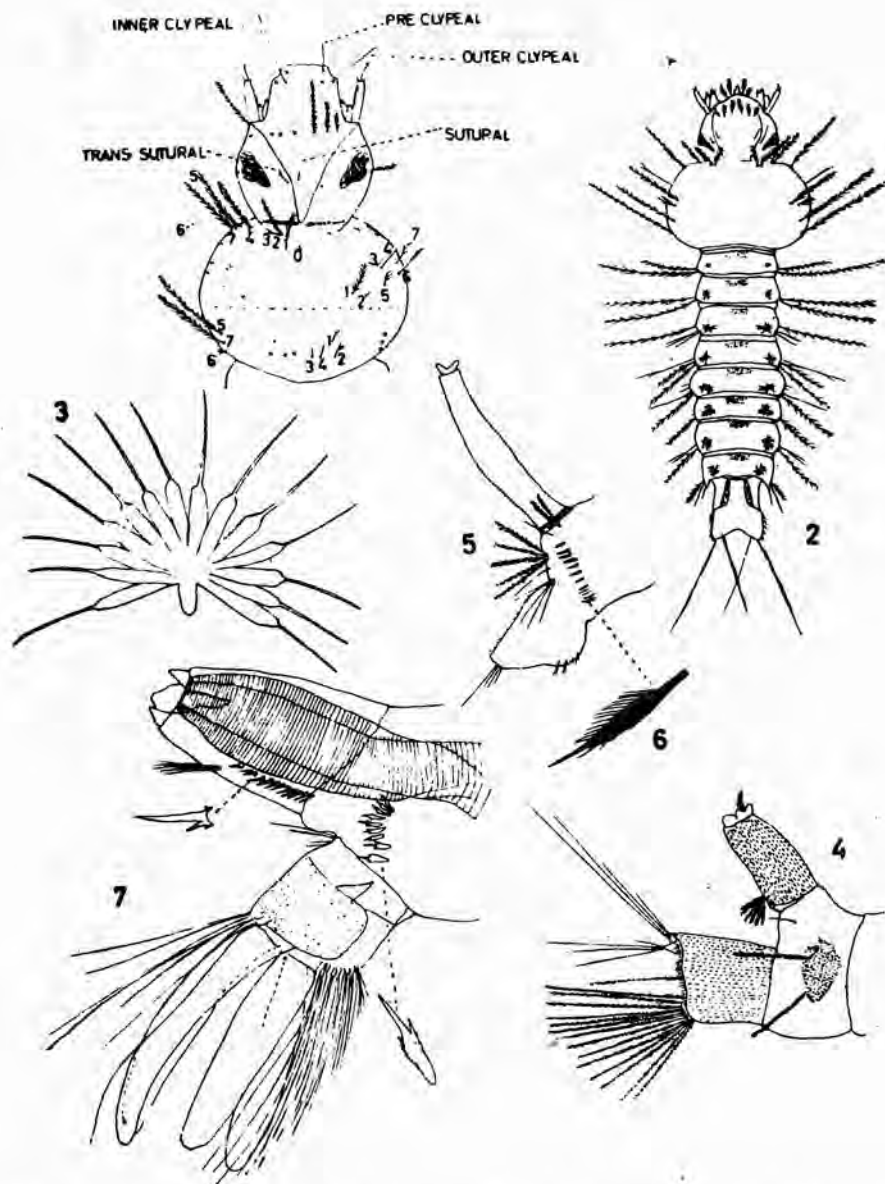


Fig. H. (1) Diagram of *Anopheles* head and thorax. The taxonomically important hairs are named or numbered. (2) Larva of *Anopheles jamesi*. (3) Palmate hairs of sixth abd. segment of *Anopheles jamesi*. (4) *Tozorrhynchites splendens*; terminal portion of larva. (5) *Ficalbia luzonensis*; terminal portion of larva. 6. Comb scale, (7) *Aedes aegypti*; terminal portion of larva.

Figs. 2-5 After Senior White 1925 b, 1927.

# A Guide to the Freshwater Fauna of Ceylon

SUPPLEMENT 3.

C. H. FERNANDO

(Department of Biology, University of Waterloo, Canada)

## INTRODUCTION

This supplement to the "Guide to the freshwater fauna of Ceylon" by A. S. Mendis and C. H. Fernando. *Bull. Fish. Res. Stn. Ceylon* 12, 160 pp. (1962) includes a number of additional records to the fauna and nomenclatural changes designed to bring the names of the Rotifera and Hydracarina up to date. This latter involves a complete change in naming of Rotifera to keep in line with modern nomenclature synonymizing species where necessary. A major study on the water mites of India by Cook (1967) has necessitated considerable changes in the naming of Ceylonese species. Besides the Rotifera and Hydracarina the Hemiptera-Heteroptera have received attention as regards the Corixidae and new generic and specific records from published and unpublished material has been included.

A major difficulty in studying freshwater animals (for that matter any animals) is the lack of suitable illustrations of local forms. An attempt has been made to fill this gap for the Rotifera and Turbellaria. It is hoped that in future supplements other groups can be similarly dealt with.

## TURBELLARIA

### Rhabdocoela

Only two species are on record (see Guide p. 40). In the present paper three cosmopolitan species belonging to genera most likely to be found in Ceylon have been illustrated namely *Stenostomum unicolor* (Schmidt), Fig. A4, Fig. A6, *Macrostomum tuba* Graff Fig. A5 and *Mesostomum ehrenbergi* (Focke). One of the reasons why the Rhabdocoela have been so poorly studied is perhaps the difficulty of preserving them for study. The ideal method to study them is in the living state when their simple structure can often be clearly made out. Some of the larger forms can be fixed in Steimann's fluid: Conc. HNO<sub>3</sub>—1 part, Saturated Solution of Mercuric Chloride in 5% NaCl—1 part and Distilled water—1 part. The animals should be allowed to extend themselves in a minimum of water and the preserving fluid poured on. After a minute the specimens should be transferred into 70% Ethyl Alcohol. Rhabdocoelae can be located rather easily by bringing vegetation from ponds and keeping them in the laboratory in glass jars. The larger forms can be seen very easily. The smaller forms can be spotted with low power binoculars. Some rhabdocoelae and alloeocoelae are capable of aestivating as resistant eggs. They are likely to be found in temporary habitats.

In 10 or 12 years of collecting freshwater animals in Ceylon the author has frequently seen rhabdocoelae especially smaller forms. It is likely that both Rhabdocoela and Alloeocoela are quite common if a search is made for them.

### Tricladida

No freshwater triclad has been recorded from Ceylon so far. In the author's experience in Ceylon he has seen them very, very rarely. A number of species are on record from the Indian region belonging to two genera *Planaria* and *Dugesia*. The distinguishing features of these two genera are illustrated in Figs. A 1-3. Whitehouse (1913) described two freshwater triclads from India under the names *Planaria kempfi* and *P. aborensis*. Ball, Reynoldson and Warwick (1968) have stated that *Planaria kempfi* is probably *P. torva* (Müller), a common European form. Meixner (1928) puts Whitehouse's *Planaria aborensis* under the name of *Dugesia gonocephala* (Dug.). These two species

are illustrated in Figs. A1 and 2. Kaburaki (1918, 1925) described three other planarians from the Indian region: *Dugesia annandalei*, *D. andamanensis* and *D. burmaensis*. A useful reference to triclad of the Oriental region is that of Kawakatsu (1964).

Planarians are somewhat easier to study and preserve than rhabdocoels and alloeocoels. However planarians are extremely rare in the tropics. It is likely that some species may be found in the hill country streams and ponds. Planarians can be fixed for study using Steinmanns fluid as for rhabdocoels and alloeocoels.

I am obliged to one of my graduate students Ian R. Ball for his comments on the Turbellaria and for locating for me relevant references on Turbellaria of the Indian Region.

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#### Rotifera

The list of species given in the "Guide" is nomenclaturally out of data. Dr. M. G. George, Department of Biology, University of Waterloo has kindly revised the names for me according to Wisniewski (1954). A totally new list is given in the present supplement arranged in alphabetical order for families. Five new records have been added to the Ceylonese list namely *Brachionus diversicornis* Daday, *Brachionus patulus* Muller, *B. angularis* Gosse *B. budapestiensis* Daday, and *Lecane papuana* (Murray). These were identified by Dr. E. H. Ahlstrom from material sent by the author. Mendis (1965) records *Trochosphaerium* sp. from Ceylon. This is probably *Trochosphaera aequatorialis* Semper the only species in the genus.

A monogonate and bdelloid-rotifer have been illustrated in Fig. B 1 and 2. Genera not illustrated in the "Guide" have been illustrated in Fig. B 3-7. Since extensive nomenclatural changes have been made, a list of the generic names in the guide and their revised names are given so that the figures in the guide can be used with the new list.

The rotifers recorded from Ceylon consist almost entirely of planktonic forms. It is hoped that some bdelloid rotifers can be collected and identified in the not too distant future. Rotifera should be collected with a fine mesh (No. 25) plankton net and preserved in very dilute formalin.

Excellent works on the Rotifera are available for those embarking on a study of this interesting group. Donner's (1965) work translated into English is an excellent guide to start with. Some of the more important works are given for limnologists and taxonomists.

FERNANDO

List of Ceylonese species :—

- |        |   |  |
|--------|---|--|
| Family | — | Asplanchnidae<br><i>Asplanchna brightwelli</i> Gosse<br><i>Asplanchnopus multiceps</i> (Schrank)   |
| Family | — | Brachionidae<br><i>Anuraeopsis navicula</i> Rousselet<br>* <i>Brachionus angularis</i> Gosse<br><i>Brachionus budapestensis</i> Daday<br><i>Brachionus calcyciflorus</i> Pallas<br><i>Brachionus caudatus</i> Barrois and Daday<br>* <i>Brachionus diversicornis</i> (Daday)<br><i>Brachionus falcatus</i> Zacherias<br><i>Brachionus forficula</i> Wierzejski<br>* <i>Brachionus patulus</i> Muller<br><i>Brachionus quadridentatus</i> Hermann<br><i>Brachionus rubens</i> Ehrenberg<br><i>Epiphanes macrourus</i> Barrois and Daday<br><i>Euchlanis dilatata</i> Ehrenberg<br><i>Keratella tropica</i> Apstein<br><i>Lepadella ovalis</i> Muller<br><i>Lepadella triptera</i> Ehrenberg<br><i>Mytilina mucronata</i> Muller<br><i>Mytilina uentralis</i> Ehrenberg<br><i>Notholca</i> sp.<br><i>Platyias quadricornis</i> (Ehrenberg)<br><i>Scaridium longicaudum</i> (Muller)<br><i>Trichotria pocillum</i> (Muller) |
| Family | — | Conochilidae<br><i>Conochilus hippocrepis</i> (Schrank)  |
| Family | — | Dicranophoridae<br><i>Dicranophorus robustus</i> Harring and Myers   |
| Family | — | Flosculariidae<br><i>Lacinularia flosculosa</i> (Muller)<br><i>Limnias melicerta</i> Weisse<br><i>Sinantheria semibullata</i> (Thorpe)   |
| Family | — | Lecanidae<br><i>Lecane leontina</i> (Turner)<br><i>Lecane ludwigi</i> (Eckstein)<br><i>Lecane ungulata</i> (Gosse)<br><i>Lecane luna</i> Muller  |

\* New Record for Ceylon

B1\*—J 2274(9/69)

		* <i>Lecane papuana</i> (Murray)
		<i>Monostyla bulla</i> Gosse
		<i>Monostyla quadridentata</i> Ehrenburg
Family	—	Philodinidae
		<i>Rotaria neptunia</i> Ehrenberg
		<i>Rotaria rotaria</i> Pallas
Family	—	Synchaetidae
		<i>Polyarthra vulgaris</i> Carlin
		<i>Synchaeta pectinata</i> Ehrenberg
Family	—	Testudinellidae
		<i>Hexarthra mira</i> Hudson
		<i>Testudinella elliptica</i> Ehrenberg
		<i>Testudinella patina</i> (Hermann)
		<i>Tetramastix opoliensis</i> Zacharias
		<i>Trochosphaera aequatorialis</i> Semper
Family	—	Trichocercidae
		<i>Trichocerca tenuior</i> Gosse
		<i>Trichocerca rattus</i> (Muller)
		<i>Trichocerca elongata</i> (Gosse)
		<i>Trichocerca scipio</i> (Gosse)
		<i>Trichocerca figris</i> (Muller)

The following list of the generic names in the " Guide " and the revised names are given for use with figures in the " Guide " :—

<i>Megalotrocha</i>	=	<i>Sinantheria</i>
<i>Diglena</i>	=	<i>Dicranophorus</i>
<i>Furcularia</i>	}	= <i>Epiphanes</i>
<i>Notops</i>		
<i>Salpina</i>	=	<i>Mytilina</i>
<i>Cathypna</i>	=	<i>Lecane</i>
<i>Metapodia</i>	=	<i>Lepadella</i>
<i>Mastigocerca</i>	}	= <i>Trichocerca</i>
<i>Coelopus</i>		
<i>Rattulus</i>		
<i>Dinocharis</i>	=	<i>Trichotria</i>
<i>Pedalion</i>	=	<i>Hexarthra</i>
<i>Noteus</i>	=	<i>Platyias</i>
<i>Pterodina</i>	=	<i>Testudinella</i>
<i>Colurus</i>	=	<i>Colurella</i>
<i>Rotifer</i>	}	= <i>Rotaria</i>
<i>Actinurus</i>		

\* New record for Ceylon

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## Crustaceae

### Copepoda

#### *Egarsilus* sp.

Specimens of *Egarsilus* sp. were found on the gills of the fish *Puntius sarana* in Parakramasamudra, Polonnaruwa, by the author. This genus of parasitic copepoda has not been recorded Ceylon so far.

## Insecta

### Hemiptera

#### Family — Hydrometridae

New records of this family are as follows :—

*Hydrometra zeylanica* Gunawardene and Karunaratne.

*Hydrometra butleri* Hung. and Evans.

*Hydrometra kahallensis* Karunaratne

Mr. P. B. Karunaratne, National Museum, Ceylon, has kindly allowed me to quote from his unpublished paper his new species.

#### Family — Notonectidae

Mr. I. Lansbury, Hope Department of Entomology, Oxford, has revised the genus *Enithares*. While this paper is still in press he has permitted me to quote his findings.

Only two species of *Enithares* are on record after the synonymy has been sorted out.

*Enithares ciliata* F. This species refers to records of *E. abbreviata* over which it has priority.

*Enithares simplex* (Kirby). *E. tempeltoni* refers to the female of *E. simplex*.

## Family — Corixidae

This is the best studied group of aquatic Hemiptera in Ceylon. Both taxonomic and ecological work on this group has indicated a rich and varied composition. The genus *Micronecta* is represented by 17 species and subspecies largely due to intensive collecting by the author. In comparison the Micronectinae known from India and Indonesia amount to only 17 and 10 species respectively.

The best of *Micronecta* spp. has undergone a series of nomenclatural changes which have been embodied in the guide and subsequently in supplements 1 and 2. Dr. A. Wroblewski of the Polish Academy of Sciences has made extensive studies on *Micronecta* from the Oriental region. He has a paper in press which revises a number of names. The amended Ceylonese list according to him is as follows ; —

- M. albifrons* (Motsch)
- M. ceylonica* sp. nov.
- M. fernandoi* Wrobl.
- M. flavens* Wrobl.
- M. grisea* (Fieb.)
- M. ludibunda langkana* ssp. nov.
- M. ludibunda ludibunda* Bredd.
- M. memonides* Kirk
- M. prashadana* Hutch
- M. punctata* (Fieb.)
- M. punctinotum* Chen
- M. quadririgata* Bredd.
- M. santae-catherinae* Hutch
- M. scutellaris* (Stal)
- M. striata* Fieb
- M. tarsalis* Chen
- M. (synaptonecta)* sp.

The following changes and synonymy have been made. ;—

- M. grisea* = *M. thyesta* Dist.
- M. striata* = *M. siva* Kirk
- M. albifrons* = *M. facioclavus* Chen.

## Family — Gerridae

The gerrid fauna is being actively studied by Mr. P. B. Karunaratne with my assistance. He has found a number of new species and new generic records for Ceylon.

The new generic records for Ceylon are *Strongylovelia*, *Naboandelvs* and *Halovelis*. A number of new species have been found in the following genera *Ptilomera*, *Rhogodotarsus* and *Ventidivus* besides.

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- DEN DOER, M. H. 1965. Revisionary notes on the genus *Metrocoris* Mayer (Heteroptera, Gerridae), with descriptions of four new species. *Zool. Verh.*, 74, pp. 1-38.
- FERNANDO, C. H. 1965a. A preliminary survey of 21 Ceylon lakes. 3 Parasites and Predators, food of fish and marginal fauna. *Bull. Fish. Res. Stn. Ceylon.*, 18, pp. 17-28.
- 1965b—A preliminary account of the water bugs of the family Corixidae in Ceylon. *J. Bombay nat. Hist. Soc.*, 61, pp. 603-613.
- GUNAWARDENE, W. T. T. P. and KARUNARATNE, P. B. 1965. The genus *Hydrometra* (Hemiptera, Heteroptera) in Ceylon, with description of a new species. *Spolia Zeylan.*, 30, pp. 233-244.
- KARUNARATNE, P. B. 1968. *Hydrometra kahallensis* sp. nov. (Hemiptera, Heteroptera) from Ceylon. *Spolia Zeylan.* 31, (in Press).
- WROBLEWSKI, A. 1967. Further notes on Micronectinae from Viet-Nam (Heteroptera, Corixidoi). *Bull. Ent. Polon.* 37, pp. 229-251.

### Ephemeroptera

The taxonomy of this group has been neglected in Ceylon. A few species are on record (see Suppl. 2 "Guide", pp. 186-187).

An extensive collection of Ephemeroptera from Ceylon is being worked on by Dr. William L. Peters, Florida Agricultural and Mechanical University, Tallahassee, Florida. In a personal communication he states that an estimated 30 new genera and 150 new species are in this collection. A new species of *Prosopistoma* has been described from this collection by him.

*Prosopistoma lieftincki* Peters

#### Reference

- PETERS, W. L. 1967. New species of *Prosopistoma* from the Oriental region (*Prosopistoma*: Ephemeroptera). *Tidsch. norv. Ent.*, 110, pp. 207-222

### Coleoptera

Family — Dytiscidae

Brinck (1949) has revised the genus *Cybister* breaking it up into a number of subgenera. The Ceylonese list remains unchanged except for the elevation of *Cybister prolixus* Sharp to a specific rank from its status as a variety of *Cybister suajillatus* Er.

#### References

- BRINCK, P. 1945. Nomenclature und Systematische Studien über dytisciden. III. Die klassifikation der cybistinen. *Kungl. Fysvår Sällsk. Handl.*, 56, pp. 1-20.
- OCHS, G. 1967. Über die arten der familie Dytiscidae (Coleoptera). *Opusc. zool. Bpest.*, 7, pp. 229-235.

### Hydracarina

The recent paper by Cook (1967) has necessitated a further revision of the names given in the "Guide" and Suppl. I to the Guide (1963). The list of Ceylonese species is probably only a small portion of the actual number present. Cook's (1967) revision of the water mites of India should provide a suitable basis for a detailed study of the Ceylonese species:

*Hydrachna dilatata* Daday  
*Diplodontus silvestrii* (Daday)  
*Oxus pictus* (Daday)  
*Unionicola singalensis* (Daday)  
*Neumania nodosa* (Daday)  
*Encentridophorus horvathi* (Daday)  
*Piona dadayi* (Piersig)  
*Piona conglobata* (Koch)  
*Piona coccinea* (Piersig)  
*Arrenurus singalensis* Daday  
*Arrenurus madarasi* Daday  
*Arrenurus ceylonicus* Daday  
*Arrenurus rostratus* Daday  
*Arrenurus orientalis* Daday

*Arrenurus liberatus* Walter  
*Arrenurus congener* Daday  
*Arrenurus gottlandicus* (Neuman)

According to Cook *Arrenurus gottlandicus* is a very doubtful record being known otherwise only from Sweden *Piona coccinea* var. *imminuta* (Piersig) which occurs in Europe is another rather doubtful record.

#### Reference

COOK, D. R. 1967. The water mites of India. *Mem. Amer. Ent. Inst.*, 9, pp. 1-411.

#### General Remarks

A number of workers are actively engaged in taxonomic studies on Ceylonese freshwater material Professor Per Brinck, Zoological Institute, Lund, Sweden, made extensive collections of freshwater insects and Crustaceae (Swedish Ceylon Expedition in 1962). This material is under study by him and other specialists. The present author and Mr. P. B. Karunaratne are studying the Hemiptera-Heteroptera. Dr. D. G. Frey, Indiana University, collected Cladocera which he is working on Professor A. Wroblewski, Polish Academy of Sciences, is monographing the Micronectinae of the Oriental region and has access to much Ceylonese material. Dr. William L. Peters, Agricultura and Mechanical University, Tallahassee, Florida, is engaged in a project in Asiatic mayfly ecology.

We still have many wide gaps in the taxonomy of Ceylonese freshwater animals. Very little has been done on the plankton in this century. The smaller fauna, e.g. Protozoa, Rotifera and Rhabdocoela, are very poorly known.

It is hoped that local students will take up the study of Ceylonese freshwater animals. The author is willing to help by providing references, specialist advise in the groups he has worked on or names of specialists interested in Ceylonese or Asian freshwater animals.

#### General References

This includes references not given under the various groups of the fauna but referring to Ceylonese forms.

- BRINKHURST, R. O. 1963. Taxonomical studies on the Tubificidae. *Arch. fur. Hydrobiol. Suppl.* 2, pp. 1-89.
- CRUSZ, H., RATNAYAKE, W. E. and SATHANANTHAN, A. H. 1964. Observations on the structure and life-cycle of the Digenetic fish trematode *Transversotrema patialense* (Soparkar). *Ceylon J. Sci. (Bio-Sci.)*, 5 pp 8-17.
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- NAIDU, K. V. 1965. Studies on the freshwater Protozoa of South India, II. *Hydrobiologia*, 25, pp. 545-570.
- 1966—Check list of the freshwater Oligochaeta of the Indian Sub-Continent and Tibet. *Hydrobiologia*, 27, pp. 208-226.
- STRASKRABA, M. 1965. Re examination of the taxonomic status of *Niphargus indicus* Chilton (Amphipoda, Gammaridae) and its zoogeographical relations. *Proc. Summ. Crustaceae. India (1964)*, pt. 1, pp. 126-132.

## ADDENDUM

## Turbellaria

## Order Rhabdocoela

A variety of species belonging to this group have been noted among freshwater material collected during the last six months from Ceylon. *Catenula* sp. was identified definitely. This is the first record of this genus in Ceylon.

## Order Tricladida

*Dugesia* sp. was collected from a number of localities in Ceylon by the author and other collectors during August–November, 1968. This is the first definite record of a genus of this group in Ceylon. It appears that there are two species in the material collected. Sexual specimens are very few in our material, perhaps there is a seasonality in the development of sex organs.

The following new records were made by Costa (1967) :—

<i>Aeolosoma hemprichi</i> Ehr.	<i>Dero nivea</i> Aiyer
<i>Aeolosoma bengalense</i> Steph.	<i>Dero sawayi</i> Marcus
<i>Chaetogaster diastrophus</i> (Gruithuisen)	<i>Aulophorus furcatus</i> (Muller)
<i>Chaetogaster langi</i> Brescher	<i>Aulophorus hymanae</i> Naidu
<i>Chaetogaster crystallinus</i> Vejdovsky	<i>Allonais inaequalis</i> (Steph.)
<i>Nais communis</i> Pignet	<i>Allonais rayalaseemensis</i> Naidu
<i>Nais menoni</i> Naidu	<i>Pristina longiseta longiseta</i> Ehr.
<i>Slavina appendiculata</i> (d'Udekem)	<i>Pristina evelinae</i> Marcus
<i>Dero cooperi</i> Steph.	<i>Pristina minuta</i> (Steph.)

To this must be added the record of *Phreodrilus* (*Phreodriloides zeylanicus* (Stephenson) overlooked previously but included in Brinkhurst (1965).

## Coleoptera

Vazirani (1969) has described two new species from Ceylon, namely *Canthydrus pseudomorsbachi* and *Copelatus ceylonicus*. He has also added a number of new records to the Ceylonese list. These are *Laccophilus basalis* Aube, *Hydrovatus ufoniger* Clark, *Guignotus flammulatus* (Sharp) and *Orectocheilus neglectus* Ochs.

## References

- BRINKHURST, R. O. 1965. A taxonomic revision of the Phreodrilidae (Oligochaeta). *J. Zool.*, 147, pp. 363–386
- COSTA, H.H. 1967. A systematic study of freshwater Oligochaeta from Ceylon. *Ceylon J. Sci. (Bio. Sci.)*, 7, pp. 37–51.
- COSTA, H.H. AND FERNANDO, E.C.M. 1967 The food and feeding relationships of the common meso and macrofauna in the Maha Oya, a small mountainous stream at Peradeniya, Ceylon. *Ceylon J. Sci. (Bio. Sci.)*, 7, pp. 37–57
- FERNANDO, C. H. AND ELLEPOLA, W. B. 1969. A preliminary study of two village tanks (reservoirs) in the Polonnaruwa area with biological notes on these reservoirs in Ceylon. *Bull. Fish. Res. Stn. Ceylon*, 20, pp. 3–13.
- VAZIRANI, T. G. 1969. Two new species and notes on other species of aquatic Coleoptera from Ceylon. *Spolia zeylan.*, 31 (In press).

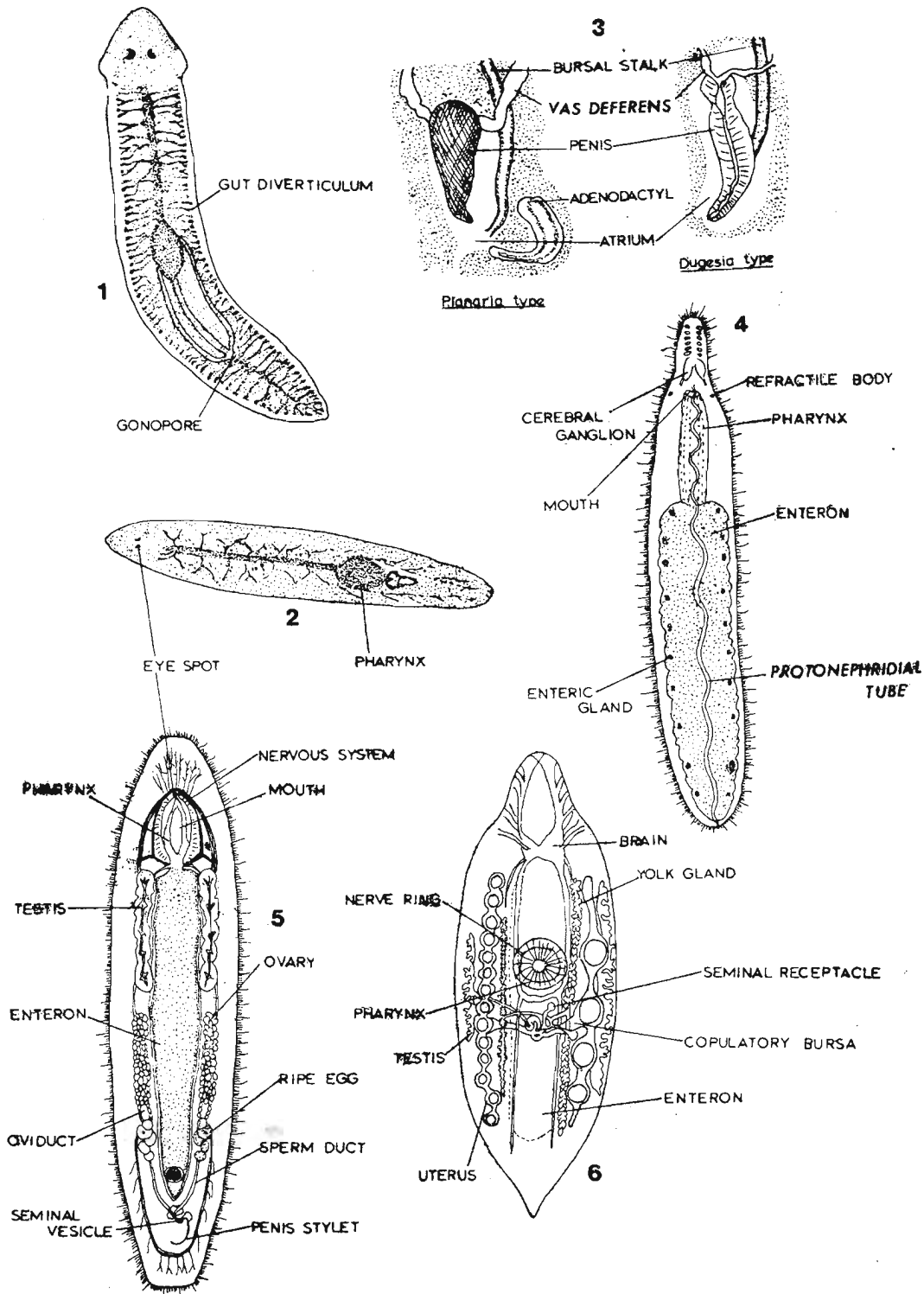


Fig. A 1. *Dugesia aborensis* (Whitehouse) = *D. gonocephala* (Dug).  
 2. *Planaria kempfi* Whitehouse = *P. torva* (Muller). The anterior end of *Planaria* and *Dugesia* are distinctive.  
 3. Squash preparation of the genital area of *Planaria* and *Dugesia* to show relations of organs and ducts. The *planaria* type has an adenodactyl or muscular pouch opening into the atrium.  
 4. *Stenostomum unicolor* (Schmidt).  
 5. *Macrostomum tuba* (Graff).  
 6. *Meoostomum ehrenbergi* Focke

218 All figures redrawn : 1 and 2 after Whitehouse, 1913 ; 3 and 4 from figures of Mr. Ian R. Ball ; 5 after Hyman 1946, and 6 after Luther 1963.

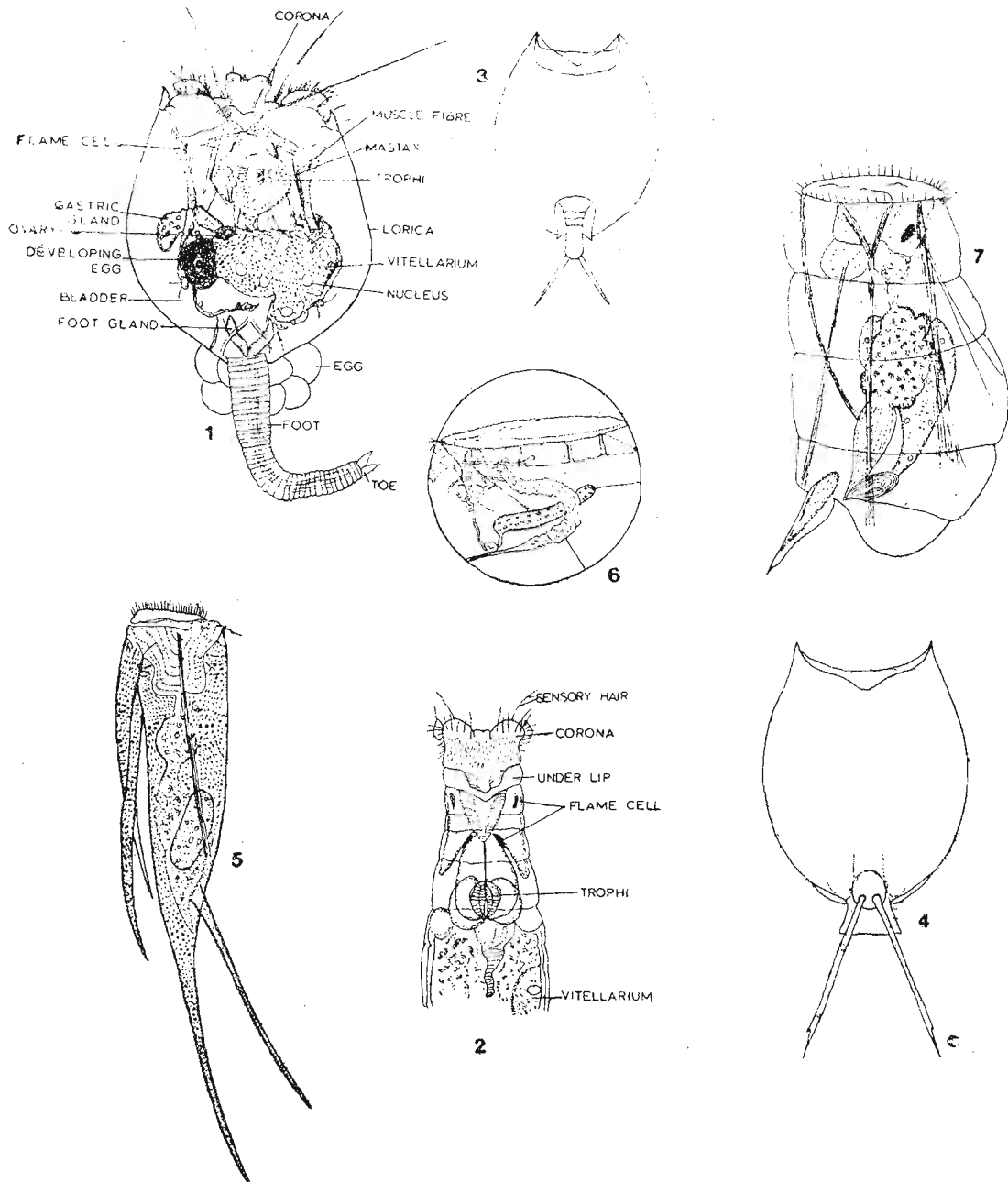


Fig. B. 1. *Brachionus urceolaris* mictic female (Monogonata).

2. Anterior portion of *Macrotrachela ehrenbergi* (Bdelloidea), ventral view with corona unfolded.
3. *Lepadella ovalis*, ventral view.
4. *Lecane leontina*, ventral view.
5. *Tetramastix opoliensis* lateral view.
6. *Trochosphaera aequatorialis* lateral view.
7. *Asplanchnopus multiceps* lateral view.

All figures redrawn. : 1 and 2 from Donner, 1956 ; 3 and 4 from Pejler, 1962 ; 5 and 7 from Rudescu, 19 and 6 from Ward and Whipple, 1959

# Guide to the Freshwater Fauna of Ceylon (Sri Lanka)

## Supplement 4

by

C. H. FERNANDO \*

### INTRODUCTION

Supplement 3 "Guide to the freshwater fauna of Ceylon" by A. S. Mendis and C. H. Fernando, *Fish. Res. Stn. Ceylon* 12, 160 pp. (1962) was published by the present author in 1969. The three supplements so far published have (a) Added new taxonomic units at all levels (b) Corrected errors and up-dated the nomenclature of species (c) Added references where these had been recently published or overlooked and (d) Given keys to identification of various groups with illustrations where possible.

In the present supplement all the above features are covered, in addition where records in the past have been few in a group new records are given of localities both as regards species previously recorded from Sri Lanka and especially for new records. This gives the new records more standing and may enable others to collect these species. Over 50 species are recorded for the first time in Sri Lanka (Appendix I). A general survey of the freshwater fauna is attempted. This is intended to give an indication of the groups as regards their numerical status in species and the extent to which different groups have been investigated. Using this data on the invertebrate fauna, the prospects for introduction of invertebrates is discussed. This field of scientific research is fast growing and is of particular significance to Sri Lanka where man-made lakes provide a situation where invertebrate introductions may prove beneficial. Fish introductions have already been discussed by Fernando (1965), Fernando and Indrasena (1969) and Fernando (1971, 1973).

Since 1968 the present author has collected and studied over 300 samples of invertebrates from lakes, ponds, rice fields, rivers and streams. Also the Swedish Lund University expedition (1962) to Sri Lanka has published a considerable amount of work on their collections which include some freshwater fauna. There have also been some general revisions which have added new species or new records to the Sri Lanka freshwater fauna.

An attempt has been made to illustrate as many species as possible with simple, clear illustrations. Wherever possible these reflect the level of sophistication in the taxonomy of the respective groups. Most of these illustrations have been made especially for this paper from specimens available to the author.

A special effort has been made to provide lists and illustrations of planktonic animals. This together with the paper of Chengalath and Fernando (1973) and Chengalath, Fernando and Koste (1973) should enable identification of practically all zooplankton species with accuracy.

A number of new species records for Sri Lanka are given under each section in the present supplement. A list of these species is given in Appendix I for easy reference.

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A table has been prepared giving a number of species in the different groups of invertebrates in Sri Lanka. The data used for this table are mainly from the Guide to the freshwater fauna of Ceylon (Mendis and Fernando 1972) and the supplements 1-2 (Fernando 1963, 1964, 1969) and the present supplement. Data on numbers of species in freshwater invertebrate groups in Malaya and Britain have been obtained from the authors unpublished and published data (Malaya) and the Freshwater Biological Association (Britain) publications.

### Present Knowledge of the Freshwater Fauna

Table I summarises the status of the present knowledge of the freshwater fauna of Sri Lanka. A simple, arbitrary classification has been adopted and the various groups divided into three categories according to whether they are poorly known, fairly well known or well known. As can be appreciated, the dividing lines between these categories are not strictly definable.

Knowledge of the Sri Lanka freshwater fauna has been considerably enhanced in the last twenty years or so in two ways. 1. The publication of world or regional monographs which enable identification of Sri Lanka species. The following group and publications belong to this category. Oligochaeta (Brinkhurst and Jamison 1971, Naidu 1965) Tardigrada (Ramoszotti 1967, Bartos 1967) Rotifera (Kutikova 1971) Potamonidae (Bott 1970) *Ranatra* (Lansbury 1972) *Anisops* (Brooks 1951) Coleoptera larvae (Bertrand 1972) Coleoptera (Vazirani 1968, 1970) and Hydracarina (Cook 1971). To this should perhaps be added the Culicidae (Stone, Knight and Starcker 1959). 2. Studies specifically devoted to Sri Lanka material but not exclusively to this material in some cases. Here I am listing only substantial contributions: Tricladida (Ball 1970), Monogenea (Gussev 1963), Parasitic helminths (Fernando and Furtado 1964) Oligochaeta (Costa 1967), Rotifera (Chengalath and Fernando 1973, Chengalath, Fernando and Koste 1973), *Parastenocaris* (Enckell 1972), Parasitic Copepoda, Branchiura and Isopoda (Fernando and Hanek 1973a, 1973b) Atyidae (Arudpragasam and Costa 1962), Potamonidae (Fernando 1956, Bott 1970a), Notonectidae (Leong and Fernando 1962, Fernando and Leong 1963), Micronectinae (Fernando 1964, Wroblewski 1972), Odonata (Liefertinck 1971), Trichoptera (Schmit 1958) and Mollusca (Fernando 1969).

A great deal of material from Sri Lanka freshwaters has been collected by the Swedish Expedition (Lund University) in 1962, the Smithsonian Institute, USA and the present author. Substantial contributions have already been made to the taxonomy of Sri Lanka species based on these collections and more can be expected in the near future.

There has been in general an increase in the sophistication of taxonomic work. This applies in different degrees to different groups of freshwater animals. Early records are sometimes unreliable and the synonymy of species has to be sorted out. Some of this work has been done in the present supplement e.g. in the Cladocera and Copepoda. An attempt has been made to provide illustrations that will enable diagnosis in these two groups to the species level.

From present records it is possible in most cases to deduce with a fair degree of accuracy the numerical species composition of the fauna. I have attempted this exercise to enable me to comment on the faunal composition later on in this paper. The bases for this deduction are as follows: 1. The number of species in some continental tropical islands of similar size, 2. The paucity or abundance of species of each group in the tropics, 3. The number of species recorded so far in relation to the intensity of investigations, 4. The present state of systematic knowledge as applied to species limits in the different groups (e.g. I have reduced the recorded number of Mollusca in my estimated number of species present) and, 5. The Fauna of Adjacent Regions.

The author is well aware that the estimates given are open to criticism as to their bases but he feels that these estimates are the best possible under the present circumstances and will prove useful to workers in these various groups even if it only provides a challenge to prove me wrong.

TABLE I

Present knowledge of the freshwater invertebrates of Sri Lanka as shown by numbers of species recorded and estimated. The level of knowledge is given by categories : (A) well known (B) fairly well known and (C) poorly known. Some species numbers recorded are given for Malaya and Britain for comparison.

FAUNAL GROUPS	Category	Species Numbers		Malaya Recorded	Britain Recorded	INTRODUCTIONS* SUGGESTED INTRODUCTIONS †
		Sri Lanka Recorded	Sri Lanka Estimated			
<b>PROTOZOA</b>						
Free living	.. C	.. 40	.. 150	.. —	.. —	
Parasitic	.. C	.. 5	.. 50	.. —	.. —	
<b>PORIFERA</b>						
	.. B	.. 2	.. 2	.. —	.. —	
<b>PLATYHEMINTHES</b>						
Rhaphidocoela	.. C	.. 4	.. 10	.. 0	.. —	
Tricladida	.. B	.. 2	.. 5	.. 1	.. 10	
Monogenea	.. B	.. 21	.. 50	.. —	.. —	
Digenea	.. C	.. 1	.. 20	.. 0	.. —	
Aspidobothrea	.. C	.. 0	.. 3	.. 0	.. —	
Cestoda	.. B	.. 3	.. 5	.. 4	.. —	Cestoda * <i>Bothriocephalus gowkonensis</i>
<b>MINOR PHYLA</b>						
Ectoprocta	.. B	.. 3	.. 5	.. —	.. —	
Gastrotricha	.. C	.. 2	.. 5	.. —	.. —	
Tardigrada	.. C	.. 3	.. 20	.. —	.. —	
Nematomorpha	.. B	.. 3	.. 5	.. —	.. —	
<b>ROTIFERA</b>						
Monogononta	.. A	.. 115	.. 200	.. —	.. —	
Bdelloida	.. C	.. 3	.. 75	.. —	.. —	
<b>NEMATODA</b>						
Parasitic	.. B	.. 9	.. 30	.. —	.. —	
Free living	.. C	.. 3	.. 300	.. —	.. —	
Acanthocephala	.. B	.. 2	.. 5	.. 4	.. —	
<b>ANNELIDA</b>						
Oligochaeta	.. B	.. 31	.. 60	.. —	.. 84	
Hirudinea	.. B	.. 9	.. 12	.. 10	.. —	
Branchiobdellidae	.. —	.. 0	.. 0	.. 1	.. —	
<b>MOLLUSCA</b>						
Gastropoda	.. C	.. 110	.. 40	.. —	.. —	
Pelecypoda	.. C	.. 10	.. 8	.. —	.. —	
<b>CRUSTACEA</b>						
Anostraca	.. B	.. 1	.. 3	.. 0	.. —	Branchiura * <i>Arugulus foliaceus</i>
Conchostraca	.. B	.. 3	.. 5	.. 1	.. —	Cladocera † <i>Daphnia magna</i> * <i>Leptodora kindti</i>
Branchiura	.. A	.. 1	.. 1	.. 2	.. —	* <i>Bosmina longirostris</i>
Cladocera	.. B	.. 53	.. 65	.. —	.. 90	* <i>Eposminia coregoni</i>
Ostracoda	.. C	.. 21	.. 60	.. —	.. —	
Copepoda	.. B	.. 27	.. 35	.. —	.. —	

TABLE I (contd.)

## Species Numbers

FAUNAL GROUPS	Category	Sri Lanka		Malaya	Britain	SUGGESTED INTRODUCTIONS †
		Recorded	Estimated			
Amphipoda	.. B	.. 2	.. 4	.. 0	.. 15	Copepoda * <i>Parastenocaris brevipes</i>
Isopoda	.. B	.. 2	.. 4	.. 2	.. 5	
Macrura	.. B	.. 17	.. 20	.. —	.. 1	* <i>Paraergasilus brevidigitus</i>
Brachyura	.. A	.. 8	.. 8	.. 12	.. 0	
INSECTA (larvae aquatic)						
Odonata	.. A	.. 112	.. 120	.. —	.. 40	Copepoda * <i>Lernaea cyprinacea</i>
Ephemeroptera	.. C	.. 18	.. 170	.. —	.. 47	Isopoda
Plecoptera	.. C	.. 4	.. 15	.. —	.. 30	† <i>Asellus</i>
Neuroptera	.. C	.. 0	.. 4	.. —	.. 6	Amphipoda
Lepidoptera	.. C	.. 1	.. 1	.. —	.. —	† Gammarids
Trichoptera	.. B	.. 184	.. 250	.. —	.. —	Macrura
Diptera						† Mysids
Chironomidae	.. C	.. 22	.. 400	.. —	.. 380	
Ceratopogonidae	.. C	.. 22	.. 75	.. —	.. —	
Culicidae	.. A	.. 122	.. 122	.. —	.. —	
Dixidae	.. C	.. 1	.. 2	.. —	.. —	
Psychodidae	.. C	.. 6	.. 10	.. —	.. —	
Simuliidae	.. C	.. 2	.. 4	.. —	.. 19	
Rhagionidae	.. C	.. 1	.. 2	.. —	.. —	
Blepharoceridae	.. C	.. 1	.. 2	.. —	.. —	
Sciomyzidae	.. C	.. 0	.. 2	.. —	.. —	
INSECTA (all stages, aquatic)						
Hemiptera	.. B	.. 120	.. 135	.. 110	.. 62	
Coleoptera	.. B	.. 140	.. 185	.. 160	.. —	
Hydracarina	.. C	.. 25	.. 125	.. —	.. —	

Included in Table I are the recorded numbers of some species from two countries (Britain and Malaya) as a comparison for species numbers. Both countries are of the same order of size the two differ in being tropical (Malaya) and temperate (Britain). The similarities between freshwater faunas in general and differences due to latitudinal and zoogeographical factors are thus illustrated.

### General Remarks on the Fauna

The freshwater fauna of Sri Lanka is quite rich in species. This is to be expected in a tropical country with an abundant rainfall (in some areas at least) and a wide range of habitats. However, Sri Lanka lacks natural lakes and a fauna typical of this habitat has not evolved. The only standing waters of any considerable area are the villus which are marshes connected intermittantly with rivers (Fernando 1971). Most of the country has a monsoonal climate with well-marked dry and wet seasons. During the dry seasons (inter-monsoon) most freshwater habitats dry up. The only habitats (natural) which are perennial are some rivers. The man-made lakes of which there are about 10,000 in Sri Lanka have been colonized via the rivers and have a relatively rich fauna except for typical lake species. If natural lakes were present typical lake forms may have reached these habitats. It is in the reservoirs of the hill country that a real paucity of species is evident. The zooplankton in these man-made lakes is very poor in species and they are also poor in littoral and benthic animals.

The small streams in the wet zone have a high proportion of endemic species at least in some groups. This is evident as shown by Fernando (1971) for fishes and from the extensive studies of Wroblewski (1972) on the Corixidae and Enckell (1972) on the genus *Parastenocaris* (Copepoda, Harpacticoida). It is very likely that intensive studies of stream fauna will show both a richness and a high endemism of species in this habitat. The small stream in the wet zone has probably been the most long standing and favourable habitat in Ceylon for freshwater species (Fernando 1971).

Table 1. shows the number of species in different invertebrate groups in Sri Lanka. Groups poor in species belong to three categories. (a) Those which have few freshwater representatives e.g. Coelenterata, Porifera (b) Groups with few species e.g. Gastrotricha, Conchostraca and (c) Groups which have relatively few species in the tropics e.g. Tricladida, Simuliidae, Plecoptera. The fauna lacks some groups e.g. Brachiobdellidae which are predominantly North American. It is rich in Trichoptera, Copepoda (mainly pond species), Hemiptera, Odonata, Macrura and Brachyura. The effects of the lack of natural lakes is seen in the relatively poor Cladocera, and lake Copepoda faunas. The richness of stream fauna has already been mentioned.

With comprehensive studies in the different groups a more accurate analysis will become possible. However the general composition of the fauna will not differ from what has been described above.

An unexpected richness of the fauna has so far been demonstrated in two groups of freshwater organisms namely the genus *Parastenocaris* (Copepoda, Harpacticoida) with eight species of a total described fauna of about 100 species. (Enckell 1971) in the world and the Micronectinae whose richness according to Wroblewski (1972) is "unmatched in any other land". Twenty-one species of this group are known from Sri Lanka. It is possible that some other groups may come within this category of "rich" when intensive studies have been done.

It is unwise in some cases to state categorically whether the paucity of species in a group is due to lack of study or to a natural poverty of the fauna. An example of this situation is the Digenetic Trematoda. Only one doubtful species is on record from freshwater fishes.

### Introduction of Fish and Invertebrates

A number of fish and invertebrates have been deliberately or by accident introduced into Sri Lanka freshwaters. The introductions of fish species has been documented by Fernando (1965, 1971) and Fernando and Indrasena (1969). The impact of fish introductions and the feasibility of new introductions have been discussed by Fernando (1971, 1973). Some introductions suggested by Fernando (1965) have already been carried out and an evaluation of their effects on the freshwater fisheries should be possible now. In the case of invertebrates a number of accidental introductions have occurred. Some of these introductions have been referred to by previous workers. Bar (1924) mentions the possibility that *Bosmina* spp. have been introduced. Fernando and Furtado (1963) mention that the Cestode *Bothrioccephalus gowkonensis* Yeh has probably been introduced. The likelihood of this introduction is substantiated by the evidence that it has spread to Eastern Europe from China (Fernando and Indrasena 1969). Fernando and Hanek (1973b) suggest that three of the seven species of parasitic crustaceans recorded so far from freshwater fishes have been introduced. It is likely that introductions may have gone unrecorded. For example *Parasetenocaris brevipes* (Kessel) and *Leptodora kindti* Focke recorded from Sri Lanka are probably recent introductions.

In a previous paper Fernando 1973, raised the question of the prospects of introducing invertebrates into Sri Lanka freshwater to fill gaps in the fauna. The reasons for suggesting these introductions and the existence of the gaps are discussed below. A list of suggested introductions are given in Table 1.

In general there is an aversion to introduction of species into natural habitats. The reasons for this are obvious in that the effects of introductions can rarely if ever be predicted. However, man's domestic and domesticated plants and animals have been introduced into new areas with

beneficial effects by and large. Although, apart from the obvious parasitic and pest species, introductions have had varied effects on native faunas, accidental introduction of freshwater invertebrates have been poorly documented. There are a number of references to such introductions in Allee and Schmidt (1951), Elton (1958) and Hynes (1970). In recent years there has been a great deal of planned introductions (acclimatization) of freshwater invertebrates in the USSR and their experience is worth considering in assessing prospective introductions. Dedyu (1963), Ioffe (1963, 1972), Karpevitch (1963) Melnikov and Chaplina (1963) and Karpevitch and Bokova (1970) refer to the introduction of Cladocera, Copepoda and mysids into freshwaters in the USSR with beneficial results to the fisheries. Karpevitch (1963) records that, of 45 species introduced into freshwaters in Central Asia 37 became acclimatized. The success rate was 63% individual transfers. Bogotova (1969) gives *Daphnia magna* as a good species for introduction. Ioffe (1972) records marked improvement of reservoir fish productivity as a result of invertebrate introduction. However, Sidorov (1963), and Zilenko (1963) point out that fish parasites had entered the ecosystem with introduced species of fish and invertebrates. In general only parasites with direct life histories i.e. Protozoa, Monogenea, Copepoda are carried by fish into new habitats.

Below are some reasons for introduction of invertebrates into freshwaters in Sri Lanka based on the composition of the indigenous fauna and ecological considerations, on the basis of the knowledge of the composition of the fauna some prospective introduction are given.

Sri Lanka has no natural lakes, yet over 10,000 "Lakes" have been constructed for irrigation of rice fields, water storage, for drinking and for the generation of hydro-electric power. The fauna of these lakes was not evolved in standing waters of large size i.e. lakes. It is therefore likely that many niches have remained unoccupied or inefficiently utilized. This has been well demonstrated by the success of *Tilapia mossambica* introduced in 1952 (Fernando 1965, 1971). Normally existing lakes and rivers supply faunal recruits to newly formed lakes. Sri Lanka lacks the former but is abundantly supplied with rivers. As shown by Hynes (1970) and Ioffe (1972) rivers can provide the bulk of zooplankters for man-made lakes. However in Sri Lanka the hill country has only torrential streams in which a fauna suitable for lake colonization can hardly be expected to develop. Also Sri Lanka is poor in certain groups of invertebrates which are prominent lake species. These include limnetic Cladocera, gammarids and isopods.

The present author has examined over 300 samples of "zooplankton" collected from lakes, ponds, rice fields and rivers in Sri Lanka during the period 1965-1972. As expected, all zooplankters found in lakes occur in natural habitats i.e. ponds and streams. The zooplankton in low country shallow lakes is diverse in species composition. The pond and river species have apparently supplied suitable recruits to these man-made habitats. However until standing crops and production of zooplankton are studied the richness or otherwise of the zooplankton cannot be compared with lakes elsewhere. In the up-country reservoirs however the zooplankton species are few and the standing crops appear low. This combined with a very low fish production in these lakes indicates a need for enriching the fauna if these habitats are to yield any quantity of fish.

Discussed briefly are the prospects for acclimatization (introduction) of invertebrates species into Sri Lanka freshwater in relation to possible increases in fish production.

On the basis of data available on the freshwater fauna of Sri Lanka it appears quite feasible that planktonic, benthic and nektonic invertebrates can be introduced into Sri Lanka freshwaters with beneficial effects on the fisheries. At present the poorest faunas found in the lakes are in the hill-country reservoirs e.g. (Castlereagh) and the deeper low-country reservoirs (e.g. Nalanda). For these habitats, species tolerant of lower temperatures (i.e. around 10-20°C) can be considered. The following invertebrates can be considered as good prospects for acclimatization in deeper reservoirs and streams up-country. The Cladocerans *Daphnia magna* Straus *Bosmina* (s.l.) and *Ceriodaphnia* spp. may well prove satisfactory species to raise the production of zooplankton. Besides these, mysids, of which there are at least three indigenous lagoon species namely *Heteromysis zeylanica* Tattersall, *H. proxima* Tattersall and *Mesopodopsis zeylanica* Nouvel (Tattersall 1923, Nouvel 1954) may well prove possible to acclimatize to these habitats.

In Europe there are a number of mysids in freshwater besides *Mysis relicta* Loven which is restricted to the Northern European lakes. Holmquist (1972) lists 18 mysids from Europe. The genus *Daphnia* is poorly represented in the tropics. However this may be a matter of geological history rather than temperature. In any case the temperatures in the up-country reservoirs are lower than in typical tropical lakes. Holzinger (1955) gives a temperature range of 0.6-24°C for Gregory's Lake, a lake in the hill country of Sri Lanka. mysids have been successfully acclimatized in reservoirs in the U.S.S.R. (Dedyu 1963).

There are two other groups of invertebrates which are poorly represented in Sri Lanka which contribute significantly to production in streams and lakes. There are the gammarids and the isopods. The only gammarids present in Sri Lanka fresh waters are *Paracalliope fernandoi* Wignarajah, a rare species and *Grandidierella bonneri* Stebbing (= *Grandidierella magna* Tattersall), a brackish water species. There are in the Indian region however many gammarids including 15 species of *Rivulogammarus* (Staskraba 1967). Some of these species might well prove valuable species to acclimatize to the hill country streams and lakes. There are only two species of isopods recorded from Sri Lanka freshwaters. One of them *Alitropus typus* (Milne Edw.) is an ectoparasite on fish (Fernando and Hanek 1973b). The other is a small interstitial species recorded by Enckell (1970). The prospects of introducing successfully some species of free-living Isopoda and gammarids seem favourable. However it is possible that the *Caridina* species (Atyidae) will eliminate any foreign isopods and gammarids. These two groups (*Caridina*—gammarids and isopods) appear to be mutually exclusive and *Caridina* is a tropical genus. However *Caradina* in Sri Lanka is not common in the up-country though one species *Caradina sinhalensis* Ortmann is restricted to this habitat.

It appears that the introduction of freshwater invertebrates into Sri Lanka has reasonable prospects for success and will likely have a positive effect on fish production especially in the up-country reservoirs. However caution should be exercised in selecting species for introduction and the progress of acclimatization should be carefully monitored. The introduction of parasites should be carefully guarded against. Fernando and Hanek (1973 b) suggest some methods for eliminating parasites from fish being used for introduction. Much work remains to be done on the biology of indigenous and introduced species if sustained long-term benefits are to be reaped. However the prospects for increased fish production warrant the expenditure of effort in this field in Sri Lanka.

#### NOTE—

A number of accidental and deliberate introduction of invertebrate species have been documented in recent years. Munro Fox, H. (1965) Ostracod Crustacea from Ricefields in Italy, Mem. Ist. ital. Idrobiol 18, 205-214 mentions that 8 species of Ostracoda have been introduced into Italian ricefields. These species originate from all the continents outside Europe and were presumably introduced with samples of rice imported from abroad. Abrahamsson (1972) has a number of papers dealing with the deliberate introductions of two American crayfish *Orconectes limosus* Rafinisque and *Pacifcastasus leniuscules* Dana into Europe. These introductions have enabled the "Crayfish industry" to recover from the disastrous effects of crayfish plague which appeared in Italy in 1890. Although undocumented I have reliable information that American crayfish have been introduced into East Africa.

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## PHYLUM — PLATYHELMINTHES

## Class Turbellaria

## ORDER TEMNOCEPHALIDA

In the Guide p. 40 three species of Temocephalida are listed from Sri Lanka. The work of Baer (1953) has necessitated a change in the nomenclature of one of these species namely *Caridinicola platci* Fern. which should be *Paracaridinicola platei* (Fern.) Also another species found in Ceylon by Plate (1914) was not listed in the guide. This is *Paracaridinicola indica* Plate. The other two Sri Lanka species are *Monodiscus parvus* Plate and *Monodiscus macbridei* Fern.

A comprehensive revision of this order was made by Baer (1931). Baer (1953) give notes on the geographical distribution and the relations of the ectoparasite with their hosts.

## ORDER TRICLADIDA

The first named triclad from Sri Lanka was described by Ball (1970). Besides this species *Dugesia nannophallus* Ball, he found material belonging to *Dugesia* spp. He is presently studying more material collected in Sri Lanka. It is evident from his work and intensive collecting in Sri Lanka that triclads are not uncommon in Sri Lanka especially at higher elevations. Ball (1970) gave a synopsis of *Dugesia* in the Oriental region. This work should enable more accurate diagnosis in this group, little known at present in the Oriental region. *Dugesia nannophallus* is shown in Fig. 16.

## ORDER RHABDOCOELA

While examining "plankton" samples from lakes, ponds, rice fields and streams in Sri Lanka I have come across Rhabdocoeles on many occasions. They have only been diagnose to the generic level and include *Mesostomum*, *Macrostomum* and *Catenula*. The Rhabdocoele are very poorly known in the Oriental region at present and accurate diagnosis to the species level is not possible except by a specialist. It is also likely that many new species will be found in this group. Study of Rhabdocoele taxonomy has been hindered by the difficulty of preservation and the total lack of specialists working on tropical freshwater forms.

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## PHYLUM—TARDIGRADA

Hitherto no member of this phylum has been recorded from Sri Lanka. I found three species in material collected in Sri Lanka for me by Mr. P. B. Karunaratne from two localities and in sorted material sent to me by Professor Per Brinck and collected by the Lund University Expedition to Ceylon in 1962.

The material identified is as follows:

1. *Macrobiotus dispar* Murray.  
Helanda, Ratnapura, Sabaragamuwa Province; stagnant pond; Coll. P.B. Fernando.
2. *Macrobiotus dispar*  
Ratnapura, Sabaragamuwa Province; Gem pit 10.7.72.  
Coll. P. B. Karunaratne.
3. *Macrobiotus dispar*  
Nuwar Eliya, Central Province; pond 27.7.71.  
Coll. P. B. Karunaratne.
4. *Macrobiotus dispar*  
Bopatella Falls. 9 miles NNW. Ratnapura.  
Sabaragamuwa Province; Swedish Lund. Univ. Expd. 19.11.72.
5. *Stygartus bradypus* Schulz  
Valalai Jaffina, Northern Province, brackish water;  
Swedish Lund. Univ. Expd. 19.11.62.
6. *Echiniscus (E.) crisbosus* Murray  
Nr. Trincomalee, Eastern Province, dry forest;  
Swedish Lund, Univ. Expd. 10.11.62.

Although widely distributed in aquatic habitats especially in the littoral, tardigrades are often missed in collections because they are seldom recognized and even when noticed they are put aside for lack of interest and the imagined difficulty of identifying them. According to Edmonson (1963) and Pennak (1953) only about 20 species have so far been recorded from the USA and another 20 from Canada. About 400 species are known from the world. These numbers do not represent anywhere near the actual number of species present. In Europe they are far better known and are dealt with extensively in the monographs of Bartos (1967), Ramazotti (1967) and Rudescu (1964). From the former two monographs I have made a list of 17 species so far recorded from the Indian sub-continent and South East Asia. They are as follows:

<i>Macrobiotus annae</i> Richters	<i>Echiniscus (E.) quadrispinosus</i> Richters
<i>Macrobiotus dispar</i> Murray	<i>Echiniscus (E.) reticulatus</i> Murray
<i>Macrobiotus hastatus</i> Murray	<i>Echiniscus (E.) spiniger</i> Richters
<i>Macrobiotus macronyx</i> Dujardin	<i>Echiniscus (Bryodelphax) tatrensis</i> Weglarska
<i>Macrobiotus rubens</i> Murray	<i>Pseudoechiniscus sullus</i> (Ehrenb)
<i>Echiniscus (E.) dubosci</i> Richters	<i>Hypsibius (Ischypsibius) indicus</i> (Murray)
<i>Echiniscus (E.) calvus</i> Marcus	<i>Hypsibius (I.) nodosus</i> (Murray)
<i>Echiniscus (E.) bais</i> Marcus	<i>Hypsibius (Diphascus) chiliensis</i> Plate

It is likely that Sri Lanka fauna of Tardigrada will amount to at least 20 species considering the wide range of aquatic habitats and the cooler temperatures in the hills. Tardigrades are commoner at lower temperatures. Their favourite habitat is moss and they are also often found in the littoral of lakes and among vegetation at the edge of ponds. Few species are marine. Most species have been recorded from wet moss.

Tardigrades are minute in size (about 1mm long) and have a characteristic easily diagnosed external and internal structure. They are usually preserved in 5% formalin and mounted for study in lactophenol or a stain mountant (CMC-S Turtox; gives good results). The body is flattened or slightly arched and carries ventrally four pairs of stubby legs bearing claws. This gives the animal the appearance of a miniature bear (Fig. 18) hence they are referred to as water bears. The body surface is covered with variously ornamented plates which sometimes bear spines or hairs. Anteriorly are a pair of eye spots. Some structural features of tardigrades are shown in Figs. 17-19.

Internally the main organs are a pair of piercing stylets opening into the anterior end of the alimentary canal. The alimentary canal is simple and has in its course a bulbous suctorial pharynx, a short oesophagus, stomach and rectum. It opens into the cloacal chamber which communicates with the outside ventrally and anterior to the fourth pair of legs. Opening into the posterior portion of the alimentary canal is the single, dorsally placed ovary (males are rare and unknown in some genera) and two or more laterally placed malpighian tubules and a third more dorsal malpighian tubule. The brain is dorsal and the ventral nerve cord bears ganglia. Detailed descriptions of morphology are given in Pennak (1953) and Edmonson (1963).

Tardigrades are capable of withstanding very adverse conditions by passing into a state of very low metabolic activity. This phenomenon is referred to as anabiosis and is also found in Bdelloid Rotifera.

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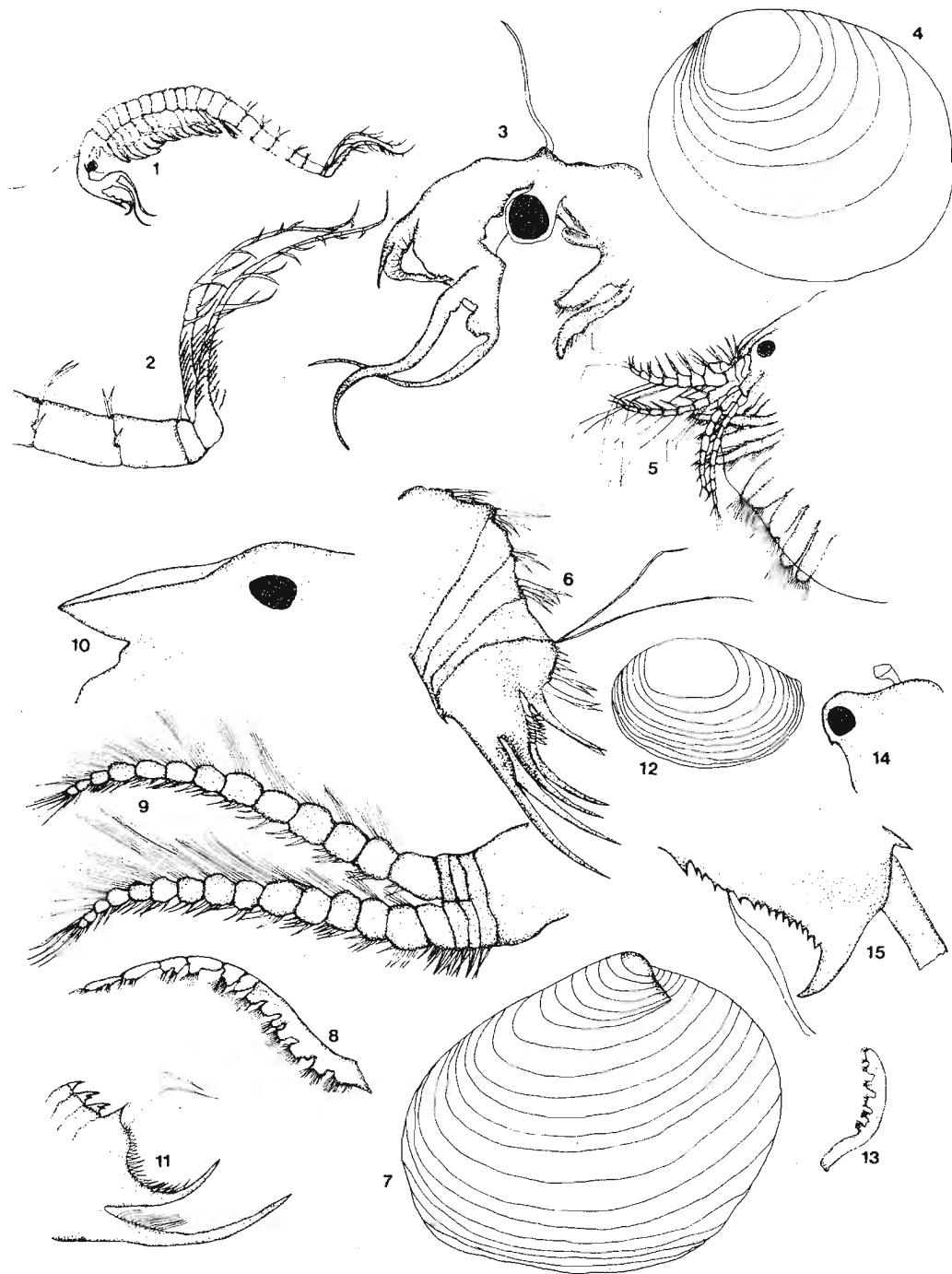
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#### CLASS — OLIGOCHAETA

In all 31 species of aquatic Oligochaeta have been recorded from Sri Lanka so far. They belong to the Aelosomatidae (1 species), Naididae (24 species), Tubificidae (4 species), Glas-soscolicidae (1 species) and Phreodrilidae (1 species). The total number of species present is perhaps around 60-100. So far relatively little material has been examined from Sri Lanka.

Naidu (1966) records the following numbers of species from the Indian subcontinent: 6 Aelosomatidae, 51 Naididae and 14 Tubificidae. Brinkhurst and Jamieson (1971) have given a comprehensive account of the freshwater Oligochaeta of the world. This book together with the papers of Brinkhurst (1965), Naidu (1962-63, 1965, 1966) and Gates (1945) enable the identification of Sri Lanka aquatic Oligochaeta. Costa (1967) has given a number of new records of species for Sri Lanka.

The following species of freshwater Oligochaeta were identified in samples of zooplankton collected for the study of microcrustaceans. Since records of freshwater Oligochaetes for Sri Lanka are few they have been included here.



CONCHOSTRACA. Fig. 1-3 *Streptocephalus spinifer*, male 1, tail 2, anterior portion 4-6. *Cyclestheria hislopi*, female 4, shell 5, anterior portion 6, postabdomen. 7-11 *Ganestheriella indica* 3, female 4, shell 5, Anterior portion 6. Postabdomen 7-11. *Caenestheriella indica* male 7. Shell 8. Antenna I 9. Antenna II 10. Anterior portion II. Postabdomen 12-14. *Eulimnadia michaeli* female 12. Shell 13. Antenna I 14. Anterior portion 15. Postabdomen of male

- Allonais galiorensis* (Stephenson). Marawila pond 6.12.70.
- Allonais inequalis* (Stephenson). Gurugoda, Nr. Padukka, pond 23.12.72., Legawatte Est. Badulla, well 8.10.72., Galwela, rice field 6.11.72., Battuluoya, river edge 2.6.72.,
- Allonais pectinata* (Stephenson). Madurankuliya tank 2.6.72.
- Aulophours hymenae* Naidu. Pond near Kirillapone 23.12.72., Dothalla, rice field 6.12.72.,
- Aulophorus michaelsoni* (Stephenson). Lahugala tank 28.8.72.
- Aulophorus tonkinensis* (Vejdovsky). Gurugoda near Padukka, pond 23.12.72., Nagadeepa wewa 1.10.72. Dothalla, rice field 16.12.72., Ratnapura, wayside ditch 18.8.72., Ganagama near Pelmadulla, rice field 18.8.72., Ratnapura, rice field 19.8.72.,
- Branchiura sowerdyi* Beddard. Nugegoda, rice field 7.8.72.
- Chaetogaster distrophus* (Gruithuisen). Punchivillu, Puttalam 1.6.72.
- Dero digitata* Muller. Nagadeepa wewa 10.11.72., Eppawela, small pond 11.8.72., Na-Eliya (near Battuluoya) tank 25.8.72., Polgaswita near Piliyandala, pond 23.12.72.,
- Dero zeylanica* (Stephenson). Panagoda, pond 23.12.72., Marawila, pond 29.12.72.
- Pristina proboscidea* Beddard. 19th MI. Piliyandala-Horana Road, pond 23.12.72. Panagoda, pond 23.12.72. Pelmadulla, small water collection 17.8.72.
- Pristina longiseta* Ehrenberg. Panagoda, pond 23.12.72., Galwewa tank 6.11.72., 19 MI. Piliyandala-Horana Road, pond 23.12.72., Ratnapura, wayside ditch 22.8.72.,
- Pristina aequiseta* Bourne. Divulwewa, rice field 11.8.72.

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#### PHYLUM MOLLUSCA

About 110 species of freshwater Mollusca have so far been recorded from Sri Lanka. However most of our present knowledge on the species is based on studies made over half a century ago. The only recent paper is that of Fernando (1969) which records thirty-seven species including one new record for Sri Lanka namely *Cerithidea fluviatilis* (Potiez and Michaud).

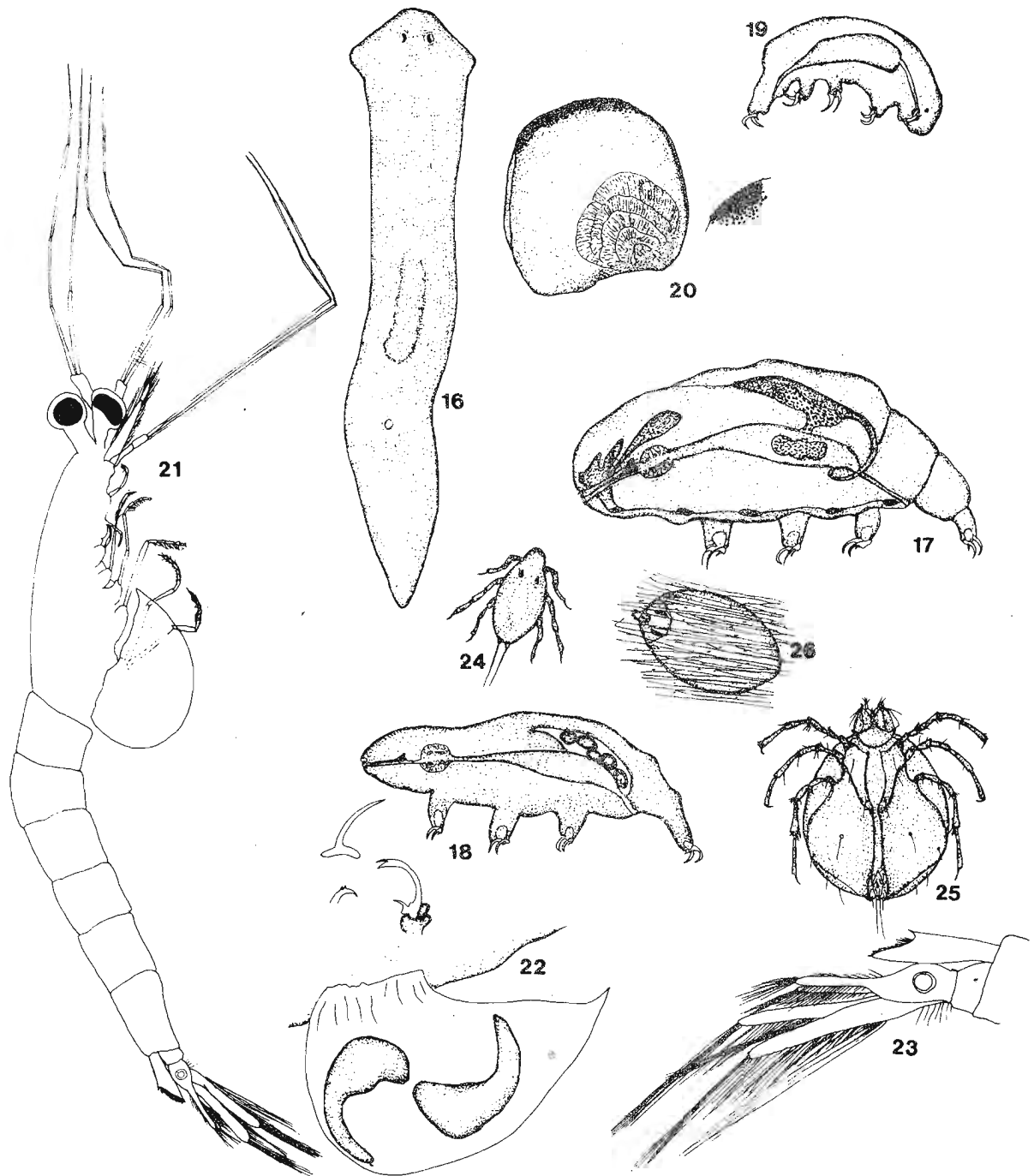
It is likely that evaluation of the specific status of Sri Lanka freshwater Mollusca in the light of recent work will lead to a reduction in the number of valid species. It is estimated that the reduction will be from the present 110 to about 50 species (Table 1).

The larval stages (Glochidia) of bivalve molluscs are parasitic on the gills and skin of fishes. Glochidia (have also been found) in plankton samples. These are presumably recently shed larvae or those which failed to become ectoparasitic. A glochidium of the common bivalve *Lamellidens marginalis* Lamark is shown in Fig. 20.

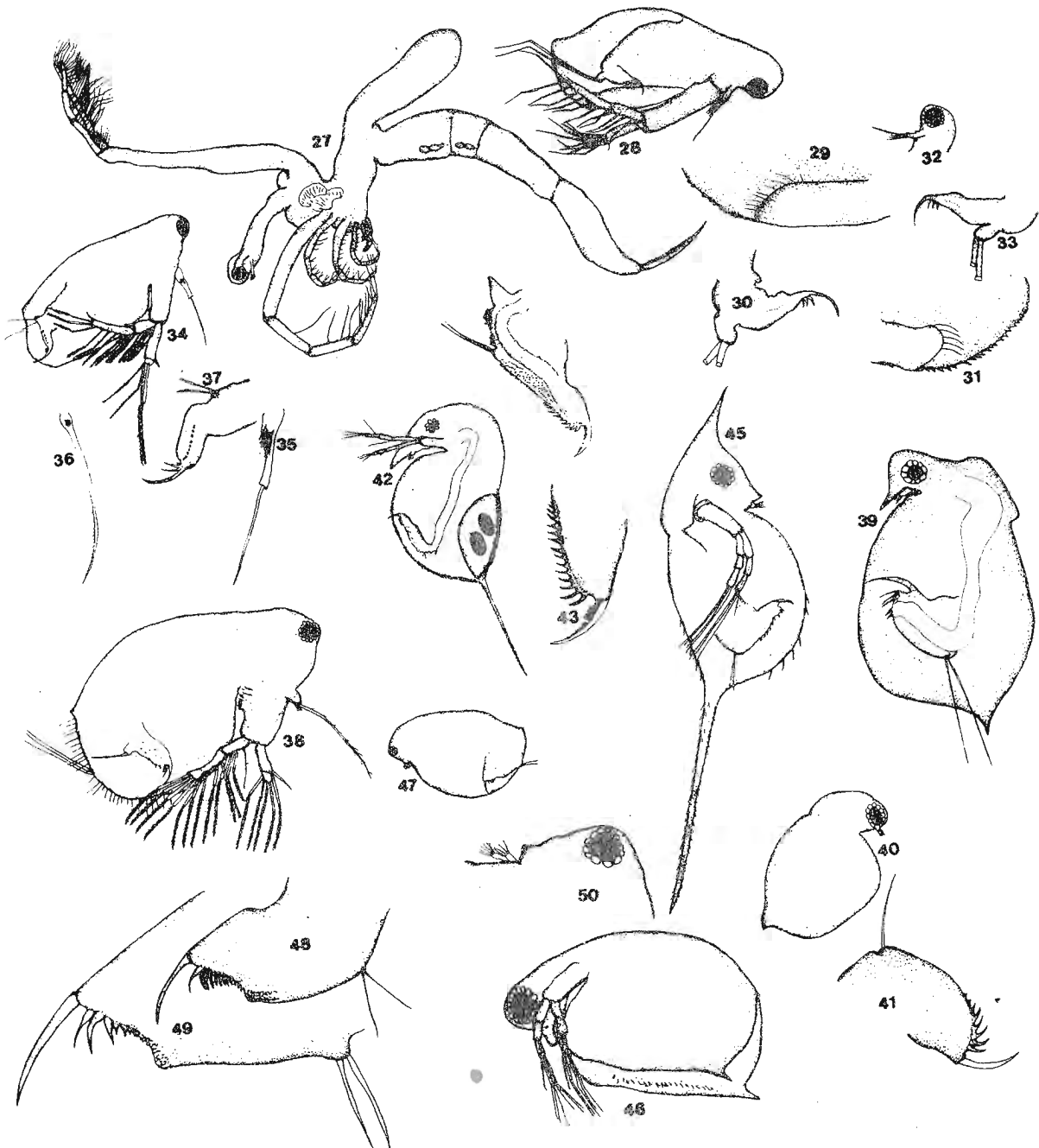
Some remarks on Glochidia and methods for preservation and study are given by Fernando et al. (1972).

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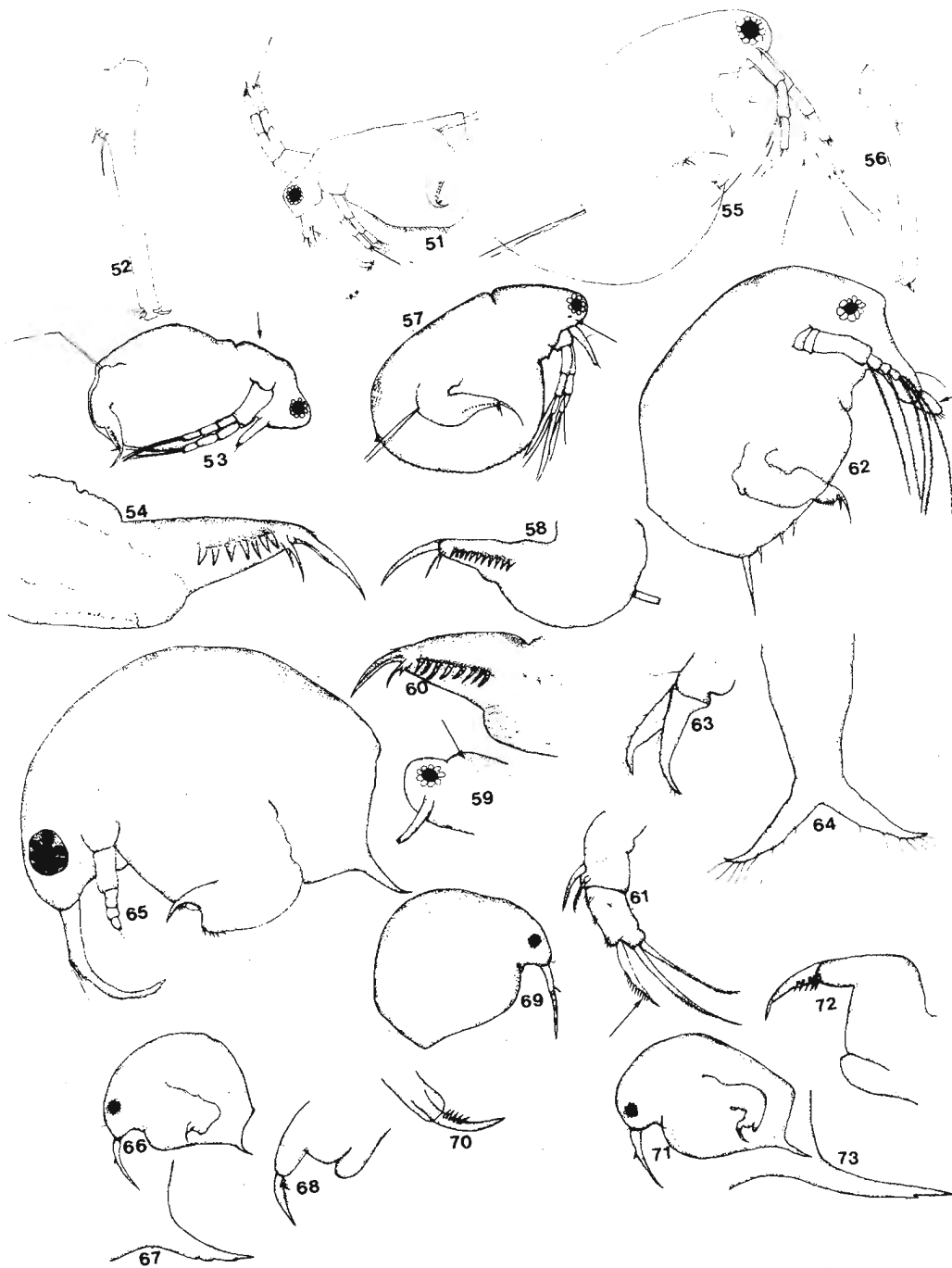
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PLATYHELMINTHES, TARDIGRADA, MOLLUSCA, CRUSTACEA (MYSIDACEA), HYDRACARINA.  
 Fig. 16 *Dugesia NANNOPHALLUS*; 17. *Macrobiotus hufandi*; 18. *Macrobiotus dispar*; 19. *Macrobiotus dispar*  
 20. Glochidium of *Lamellidens marginalis* 21-23 *Mesopodopsis zeylanica* female, 22. female brood pouch, 23,  
 posterior portion, 24 Hydracarina larva from plankton, 25 *Unionicola* larva. 26 Hydracarina larva from stomach  
 wall of the fish *Etroplus suratensis* (Bloch). fig. 16. redrawn from Ball (1970); 17-19. form Bartos (1967); 25  
 from Mitchell (1955).



CLADOCERA-LEPTODORIDAE, SIDIDAE AND DAPHNIDAE. Fig. 27. *Leptodora kindti* from Ontario, Canada. 28-30 *Diaphanosoma excisum* female, 29 postero-ventral portion of shell, 30 postabdomen. 31-33 *Diaphanosoma sarsi*, 31 postero-ventral portion of shell, 32 head, 33 postabdomen. 34-37. *Pseudosida bidentata*. 35, antenna of female, 36 antenna of male, 37 postabdomen of female. 38 *Latonopsis australis*. 39 *Ceriodaphnia cornuta* 40 *Ceriodaphnia quadrangula* 41 *C. quadrangula* postabdomen, 42-44 *Daphnia carinata*, 42 ehippial female, 43 postabdomen of same, 44 details of postabdomen of same. 45. *Daphnia lumholtzi*. 46 *Scapholeberis kingi*. 47-50. *Simocephalus vetulus* 47. *S. vetulus*, Ontario, Canada 48. Same, postabdomen, 49 *S. vetulus* postabdomen of female from Sri Lanka, 50 head of female from Ontario, Canada.



CLADOCERA-MOINIDAE, BOSMINIDAE. Fig. 51-54. *Moina micrura*, 51 male, 52 male antennule, 53 female, 54. female postabdomen, 55-58. *Moinodaphnia mcleayi*, 55 male, 56 male antennule, 57 female, 58 female postabdomen 59-61. *Moina macrocopa* female, 59 head of female, 60 postabdomen, 61. first leg 62-64. *Bosminopsis dietersi*. female 63 rostrum, lateral view, 64 rostrum, spread out : Ventral view. 65 *Bosmina* sp. from Madurai, India. 66-68. *Bosmina longirostris* from Ontario, Canada, 66. female, 67 postero-ventral spine, 68 postabdomen 69-70. *Eubosmina coregoni* from Ontario, Canada, 69 female, 70 terminal portion of postabdomen. 71-73 *Eubosmina longispina* from Ontario, Canada, 71 female, 72 postabdomen, 73 Postero-ventral portion of shell.

## SUB-CLASS BRANCHIOPODA

## ORDER CONCHOSTRACA

Only a single species *Cyclestheria hislopi* (Baird) has been recorded so far from Sri Lanka. Two new records are now added namely *Eulimnadia michaeli* Nayar and Nair and *Caenestheriella indica* (Gurney). All three species are illustrated in Figs. 4-15.

The collection data on the new records is as follows: *Eulimnadia michaeli* Mandativu, Jaffna; rainpools 3.12.57. *Caenestheriella indica* Colombo Museum gardens in rainpools 21.10.69. Coll. P. B. Karunaratne. Karainagar, rice fields 15.12.71. Coll. M. J. Fernando.

Both these species have been collected subsequently in other localities in Jaffna and appear to be fairly common *Cyclestheria hislopi* is common in all parts of Sri Lanka.

The relevant papers for Sri Lanka conchostracans are Baird (1859) Gurney (1906a, 1906b) and Nayar and Nair (1968).

## ORDER ANOSTRACA

The only member of this order known from Ceylon is *Streptocephalus spinifer* Gurney. In the "Guide" the female of this species is figured. The collection from Karainagar East, Jaffna; rice field 16.12.71 contains both males and females. The male is illustrated (Fig. 1-3).

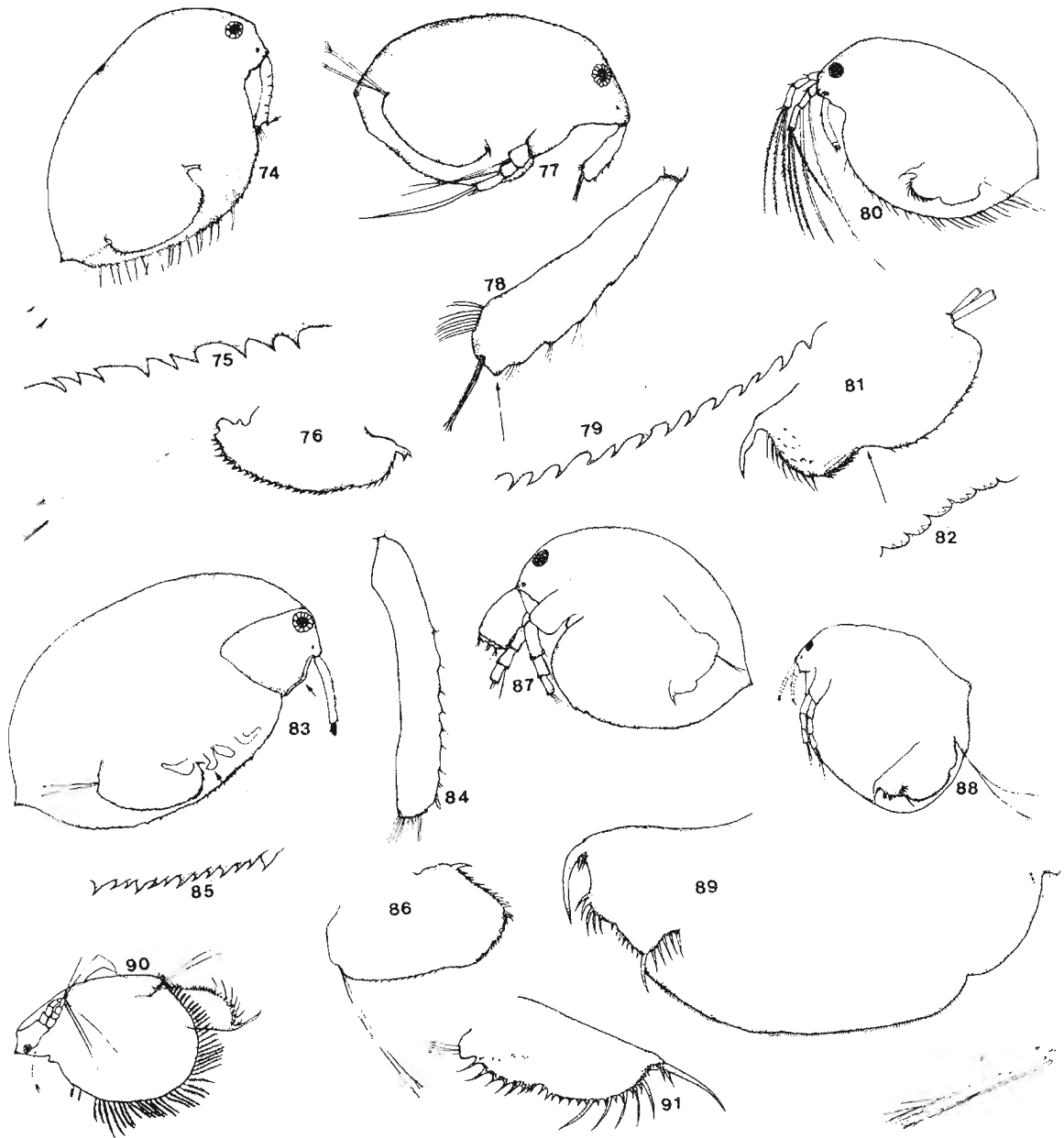
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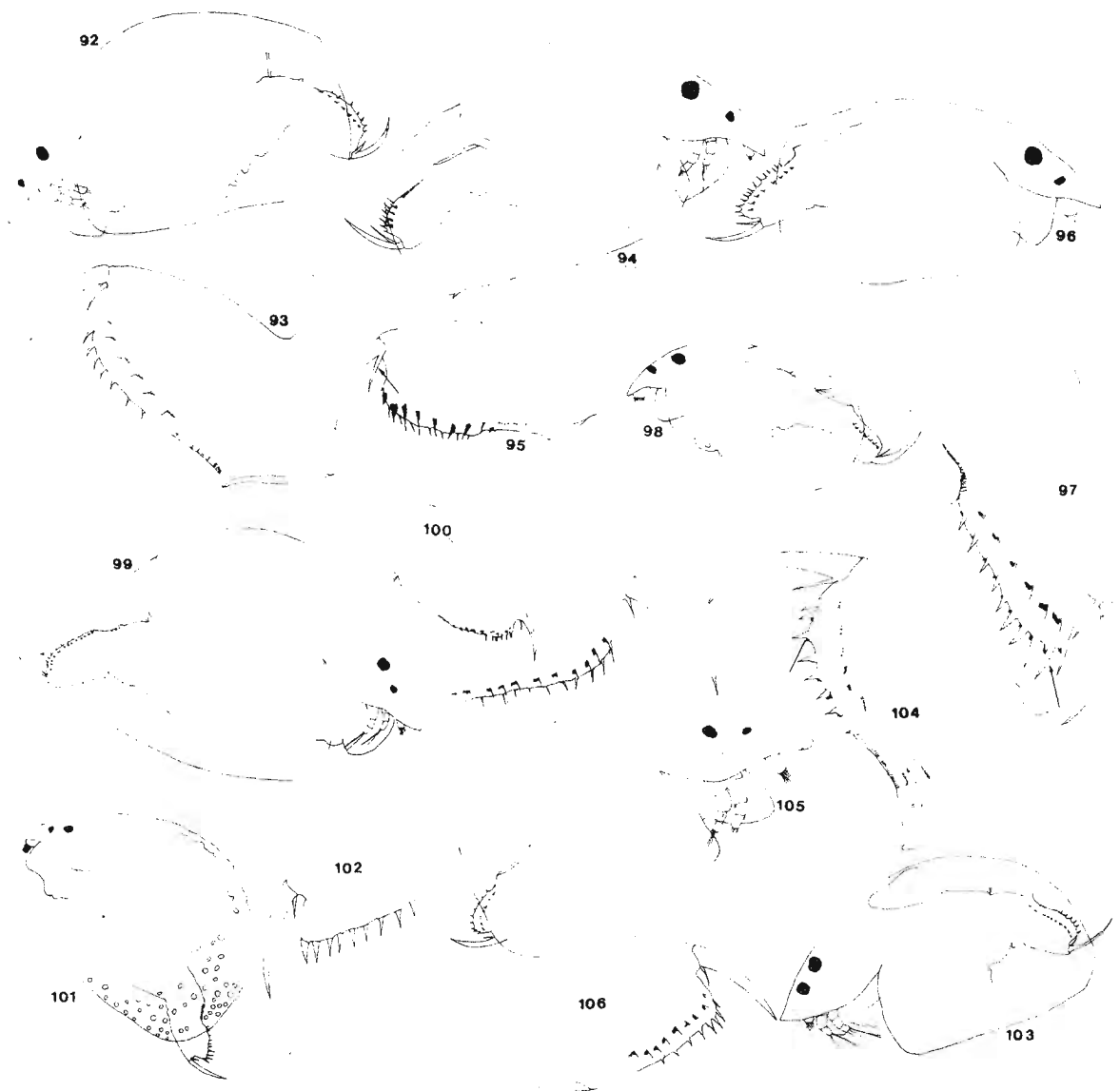
## ORDER CLADOCERA

The confusion that exists in the taxonomy of Cladocera is great at the present time in spite of a large number of revisions of genera and many monographic works on a regional or world basis. The present list is based on the study of over 300 samples of zooplankton and the perusal of the relevant literature. However, I have undertaken this work largely because of the help extended to me by three leading authorities on the Cladocera: Dr D. G. Frey, Indiana University, Bloomington, U.S.A.; Dr V. Korinek, Charles University, Prague and Dr. N. N. Smirnov, Institute of Animal Ecology, Moscow.

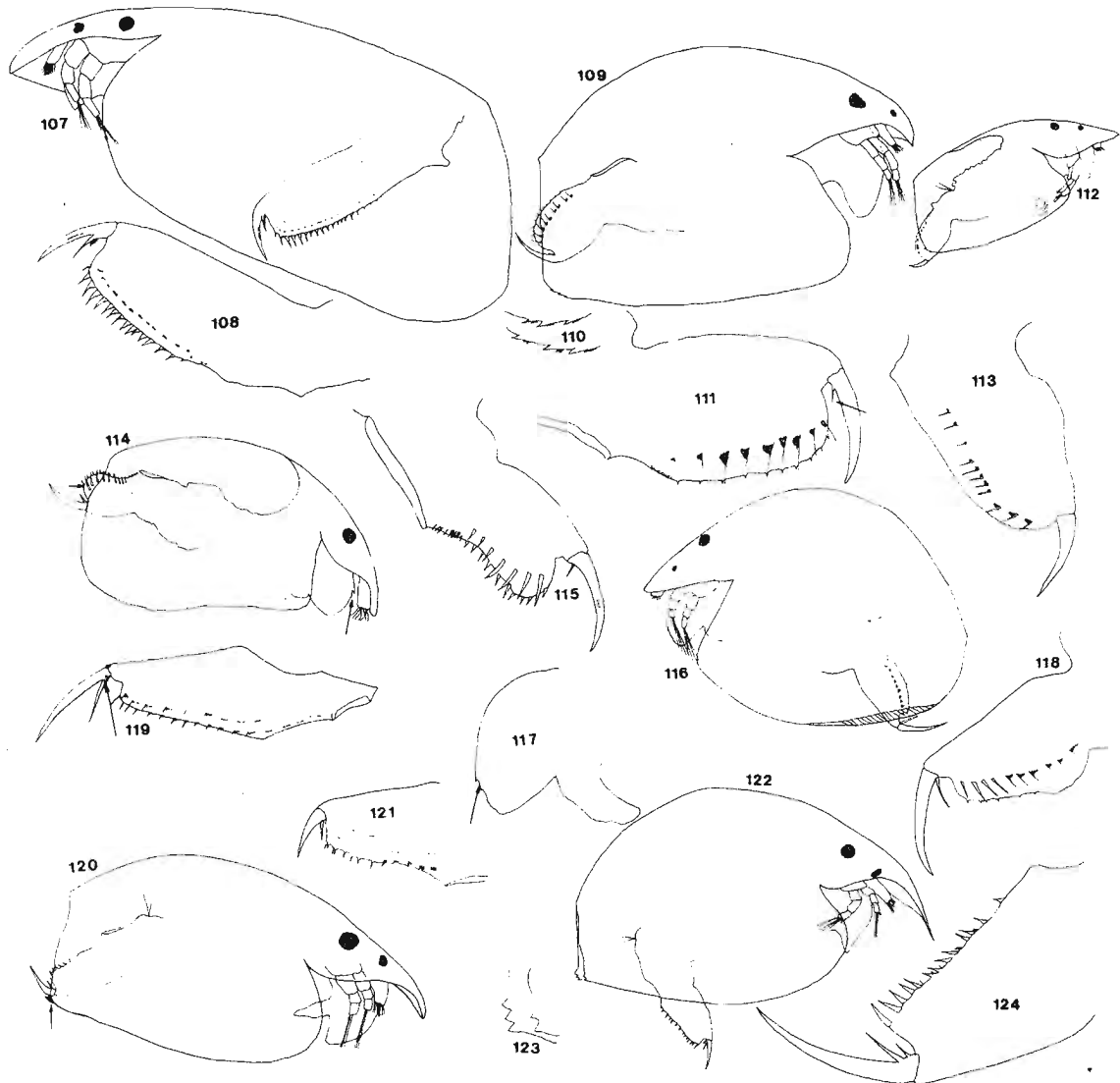
The literature relevant to the study of the Sri Lanka Cladocera can be divided into a number of categories (1) Those where Sri Lanka species have been recorded: Brady (1886), Poppe and Mrazek (1895), Daday (1898a, 1898b), Apstein (1907, 1910), Gurney (1916), Bar (1924) and Fernando and Ellepola (1969). (2) Literature referring to new records of species made in the present paper: Baird (1849), King (1852), Herrick (1882), Richard (1892, 1894, 1895), Vavra (1900), Sars (1901, 1916), Daday (1905), Gauthier (1930), Brehm (1933, 1957), Biraben (1939), and Megard (1967). (3) There are a number of classical papers on the Cladocera which describe presently accepted valid species from different parts of the world. Fortunately, one of these classics is the paper on Sri Lanka Cladocera of Daday (1898). The others of relevance to Sri Lanka species are: Müller (1785), King (1852a, 1852b) Fischer (1854), Leydig (1860), Kurz (1874), Sars (1885, 1888, 1896, 1901, 1916), Richard (1892a, 189b, 1894), (4) Monographs on the Cladocera incorporating currently accepted taxonomy are: Behning (1941), Scourfield



CLADOCERA-MACROTHRICIDAE. Fig. 74-76. *Macrothrix triserialis*, 74 female, 75 mid-ventral margin of shell, 76 postabdomen. 77-79. *Macrothrix spinosa*, 79 female 78 antennule, 79 mid-ventral margin of shell. 80-82 *Gurneyella odiosa* 80 female, 81 postabdomen, 82 mid-ventral margin of shell. 83-86 *Ecninisca capensis*, 83 female, 84 antennule. 85 mid-ventral margin of shell, 86 postabdomen. 87 *Gurnella raphaelis*. 88-89 *Grimaldina brazzai*, 88 female, 89 postabdomen. 90-91 *Ilyocryptus spinifer*, 90 female, 91 postabdomen.



CLADOCERA-CHYDORIDAE. Fig. 92-93 *Alona* cf. *harpularia*, 92 female, 93 postabdomen 94-95 *Alona monocantha*, 94 female, 95 postabdomen. 96-98 *Alona pulchella*, 96 female, 97 postabdomen, 98 male. 99-100 *Alona punctata*, 99 female, 100 postabdomen. 101-102. *Alona* sp. Nr. *guttata*, 101 female, 102 postabdomen. 103-104. *Alona setulosa*, 103 female. 104 postabdomen. 105-106 *Biapetura* cf. *intermedia*, 105 female, 106 Postabdomen.



CLADOCERA-CHYDORIDAE Fig. 107-108 *Biapetura affinis*, 107 female, 108 postabdomen. 109-113. *Biapetura karua*, 109 female, 110 spines of postero-ventral edge of shell, III postabdomen, 112 male, 113 postabdomen of male. 114-115. *Biapetura verrucosa*, 114 female, 115 postabdomen, 116-118. *Indialona globulosa*, 116 female, 117 labrum, 118 postabdomen. 119 postabdomen of *Indialona macraonyx*. 120-121 *Alonella excisa*, 120 female, 121 postabdomen. 122-124. *Pleuroxus cf. similis*, 122 female, 123 spines of postero-ventral end of shell, 124 postabdomen.

Kurz (1874), Sars (1885, 1888, 1896, 1901, 1916), Richard (1892a, 1892b, 1894). (4) Monographs on the Cladocera incorporating currently accepted taxonomy are: Behning (1941), Scourfield and Harding (1958), Brooks (1959), Sramek-Husek et al. (1962), Manuilova (1964), Smirnov (1971) and Flossner (1972). The papers of Frey, (1959, 1962 and 1967) on the head pores of the Chydoridae must be consulted for any detailed study of this group. Recent revisions of genera or families which must be consulted for accepted names and synonymy of Sri Lanka species are: Rzoska (1956), Thomas (1961, 1962), Harding and Petkovski (1963), Goulden (1968), and Deevey and Deevey (1971). (5) There is a considerable but scattered literature on the Cladocera of S.E. Asia most of which are relevant to the study of Sri Lanka species. I have listed only those I have consulted and found useful. They are as follows: Poppe and Richard (1890), Sars (1903), Stingelin (1904), Gurney (1906, 1907), and Brehm (1909, 1950, 1953).

The Cladocera are arranged in their respective families. A few comments are made on the species in each family with special reference to the Sri Lanka species. Illustrations are provided for all the species recorded so far. The author has been material from Sri Lanka of all the recorded species except for *Leptodora kindtii*, *Moina macrocopa*, *Bosmina longirostris*, *Eubosmina coregoni*, *Chydorus ceylonicus*, *Indialona macronyx* and *Graptoleberis testudinaria*. Through the generosity of Professor D. G. Frey his drawing of *Indialona macronyx* (Daday) made from Daday's material is copied. Daday's (1898) figures of *Chydorus ceylonicus* and Goulden's (1968) figures for *Moina macrocopa* are also copied. For the other species not seen from Sri Lanka material have been used.

Thirteen new records of Cladocera have been added to the Sri Lanka list. Besides this the synonymy of the recorded species has been sorted out as far as possible. The 50 indigenous species will probably be increased considerably with more detailed studies on the Cladoceran fauna of Sri Lanka.

The author has not used trinominals. They have been used extensively by Smirnov (1971).

THE LIST OF SRI LANKA SPECIES IS AS FOLLOWS:—

Leptodoridae.

*Leptodora kindtii* Focke (Introduced)

Sididae

*Diaphanosoma excisum* Sars

*Diaphanosoma sarsi* Richard

*Pseudosida bidentata* Herrick (szalayi type)

\**Latonopsis australis* Sars

Daphnidae

*Ceriodaphnia cornuta* Sars

*Ceriodaphnia quadrangula* (O.F. Müller) = probably *C. dubia*

*Daphnia carinata* King

*Daphnia lumholtzi* Sars

*Scapholeberis kingi* Sars

*Simocephalus vetulus* (O. F. Müller)

Moninidae

*Moina macrocypa* (Straus)

*Moina micrura* Kurz

*Moinodaphnia mcleayi* King

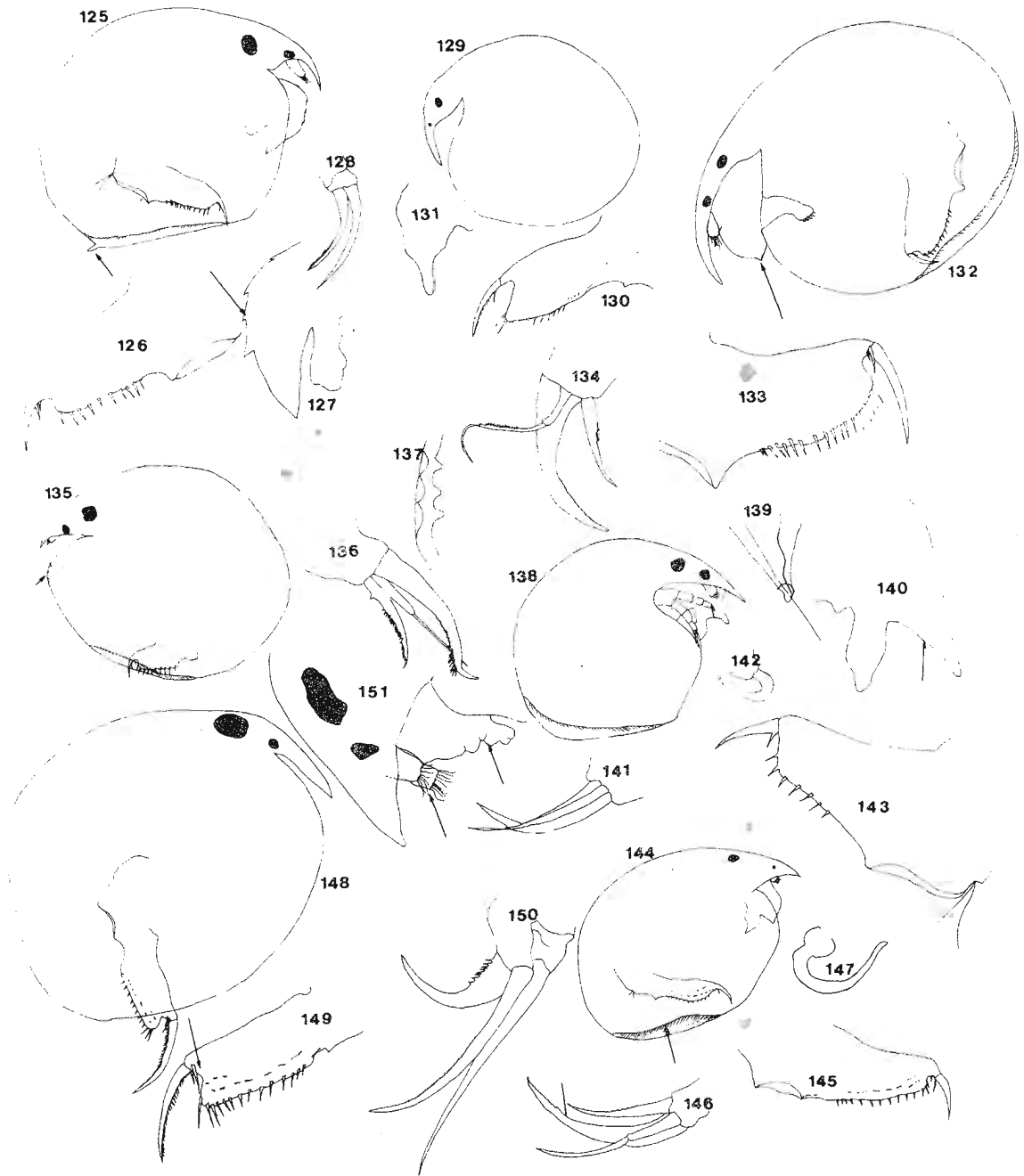
Bosminidae

\**Bosminopsis dietersi* Richard

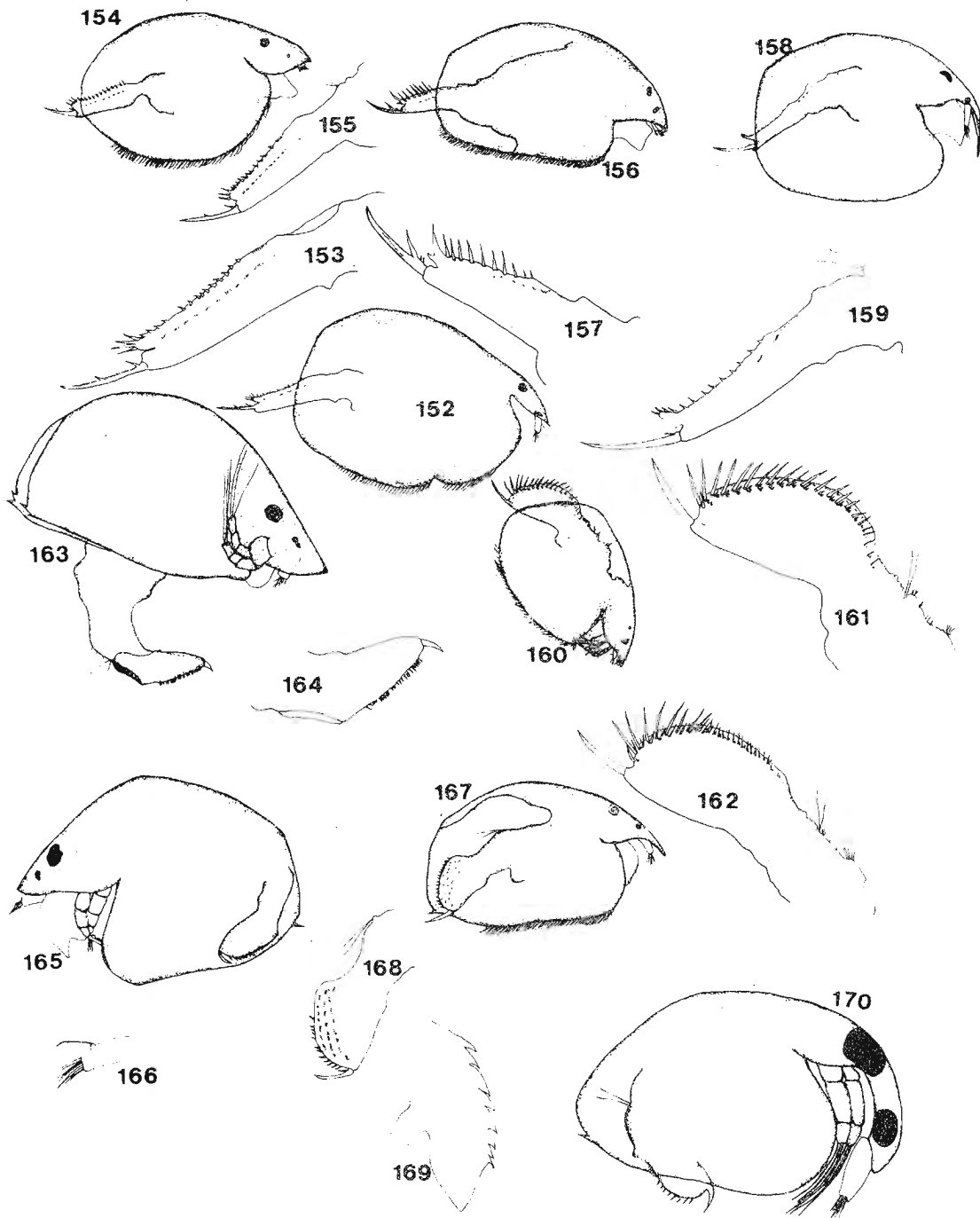
*Bosmina longirostris* (O. F. Müller) (Introduced)

*Eubosmina coregoni* (Baird) (Introduced)

\**Bosmina* sp. (*Sinobosmina*)



CALDOCERA-CHYDORIDAE. Fig. 125-128. *Chydorus barroisi*, 125 female, 126 postabdomen, 127 labrum, 128 leg. i. 129-131. *Chydorus ceylonicus*, 129 female, 130 postabdomen, 131 labrum. 132-134 *Chydorus eurynotus*, 132 female, 133 postabdomen, 134 leg. i. 135-137. *Chydorus paryus*, 135 female, 136 leg. i, 137 anteroventral edge of shell. 138-143 *Chydorus*, 138 female, 139 tip of rostrum, innervated showing notch, 140 labrum, 141 leg. i, 142 male claw, 143 female postabdomen. 144-147. *Chydorus ventricosus*, 144 female, 145 postabdomen, 146 leg. i, 147 claw of male. 148-151 *Pseudochydorus globosus*, 148 female, 149 postabdomen 150 leg. i, 151 ant. portion of body.



CLADOCERA-CHYDORIDAE. Fig. 152-153 *Euryalona orientalis* (juvenile), 153 postabdomen. 154-155 *Euryalona orientalis*, 154 female, 155 postabdomen. 156-157. *Oxyurella sinhalensis*, 156 female, 157 postabdomen. 158-159 *Kurzia longirostris*, 158 female, 159 postabdomen. 160-161 *Leydigia australis*. 160 female, 161 postabdomen. 162 postabdomen of *Laydigia acanthocercoides*. 163-164 *Graptoleberis testudinaria* from Waterloo, Ontario, CANADA, 163 female, 164 postabdomen. 165-166. *Dunhevedia crassa*, 165 female, 166 postabdomen. 167-169 *Dunhevedia serrata*, 167 female, 168 postabdomen, 169 lebrum. 170. *Dadaya macrops* female.

Macrothricidae

\**Echinisca capensis* Sars  
 \**Grimaldina brazzai* Richard  
*Gurnella raphaelis* Richard  
*Gurneyella odiosa* (Gurney)

*Ilyocryptus spinifer* Herrick  
*Macrothrix spinosa* King  
*Macrothrix triserialis* Brady

Chydoridae

\**Alona* cf. *harpularia* Sars  
 \**Alona monocantha* Sars  
 \**Alona pulchella* King  
*Alona punctata* (Daday)  
 \**Alona setulosa* Megard  
 \**Alona* sp. (Nr. *A. guttata* Sars)  
*Alonella excisa* (Fischer)  
 \**Biaperura affinis* (Leydig)  
*Biapetura* cf. *intermedia* (Stingelin)  
*Biapetura karua* (King)  
*Biapetura verrucosa* (Sars)  
*Indialona globulosa* (Daday)  
*Indialona macronyx* (Daday)  
*Pleuroxus* cf. *similis* Vavra  
*Chydorus barriosi* Richard

*Chydorus ceylonicus* Daday  
*Chydorus eurynotus* Sars  
*Chydorus parvus*  
*Chydorus sphaericus* (O. F. Müller)  
*Chydorus ventricosus* Daday  
 \**Pseudochydorus globosus* (Baird)  
*Euryalona orientalis* (Daday)  
*Kurzia longirostris* (Daday)  
*Oxyurella sinhalensis* Daday  
*Graptoleberis testudinaria* (Fischer)  
*Leydigia australis* Sars  
*Leydigia acanthocercoides* (Fischer)  
*Dunhevedria crassa* (King)  
*Dunhevedia serrata* Daday  
*Dadaya macrops* (Daday)

Locality records of species recorded for the first time in Sri Lanka.

*Latonopsis australis*  
*Bosminopsis dietersi*  
*Bosmina* sp.  
*Grimaldina brazzai*  
*Echinisca capensis*  
*Alona monocantha*  
*Alona* cf. *harpularia*  
*Alona pulchella*  
*Alona setulosa*  
*Alona* sp. (Nr. *A. guttata*)  
*Biapetura affinis*  
*Pseudochydorus globosus*  
*Pleuroxus* cf. *similis*  
 Rare species not listed above.  
*Indialona macronyx*  
*Graptoleberis testudinaria*

Mandativa, pond 17. 12. 71.  
 Castlereagh Res. 16. 7. 69.  
 Giarts tank  
 Marawila, ditch 7. 12. 70.  
 Karainagar, rice field 15. 12. 71.  
 Nugegoda, rice field 22. 12. 70.  
 Pond near Nikeweratiya 16. 12. 70.  
 Pond near Nikeweratiya 16. 12. 70.  
 Mankumban, Jaffna, pond 17, 12. 71.  
 Waga, pond 31. 12. 69.  
 Pond near Horana 23. 12. 72.  
 Unichchi tank 28. 12. 70.  
 Habarana tank 4. 1. 65.  
 Well near Kalawewa  
 Elephant pond, Mihintale

The illustrations (Figs. 27-171) have been prepared to make the diagnosis of Sri Lanka species as easy as possible. Some of the not too obvious features have been shown by arrows. For the accurate diagnosis of Cladocera careful preparation is necessary. For temporary mounts I have found CMC—S (Turtox) and Polyvinyl Lactophenol coloured with lignin Pink (Gurr. London) very satisfactory. For permanent preparations the method given by Brandlova, Brandl and Fernando (1972) is satisfactory if the technique is mastered. Ringing the coverslip with a sealing compound (e.g. Lactoseal ; Gurr. London) will prolong the life of the specimen in a satisfactory condition. Head shields should be mounted in the same way as whole specimens. Exuviae is very useful when mounted for the study of limb structure.

The Leptodoridae are represented by only one species which is characteristic. Among the Sididae the genera can be separated easily on the basis of the structure of the antennules in the female. Species diagnosis in *Diaphanosoma* can be made on the shape of the ridge on the ventral portion of the shell. The only daphnid which may cause difficulty in diagnosing is *Ceriodaphnia quadrangula* which can be recognised by the lack of a pointed prominence of the

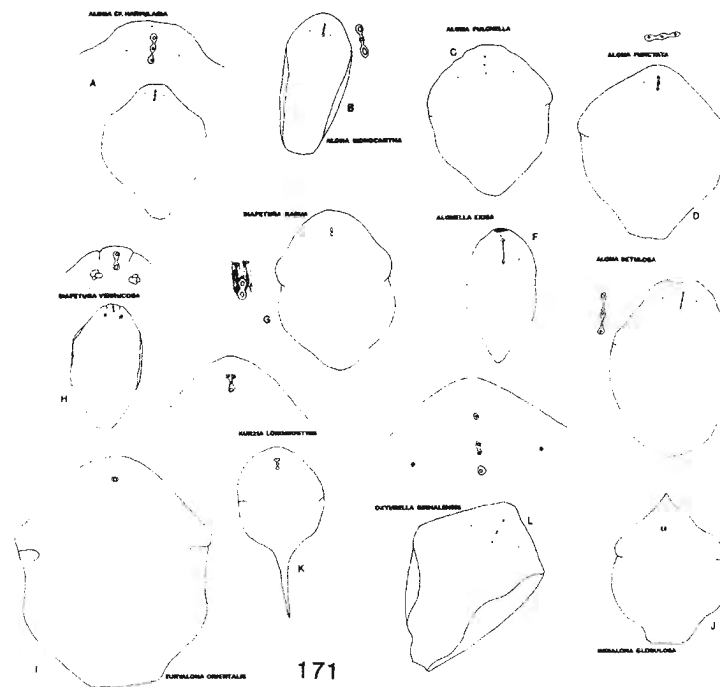
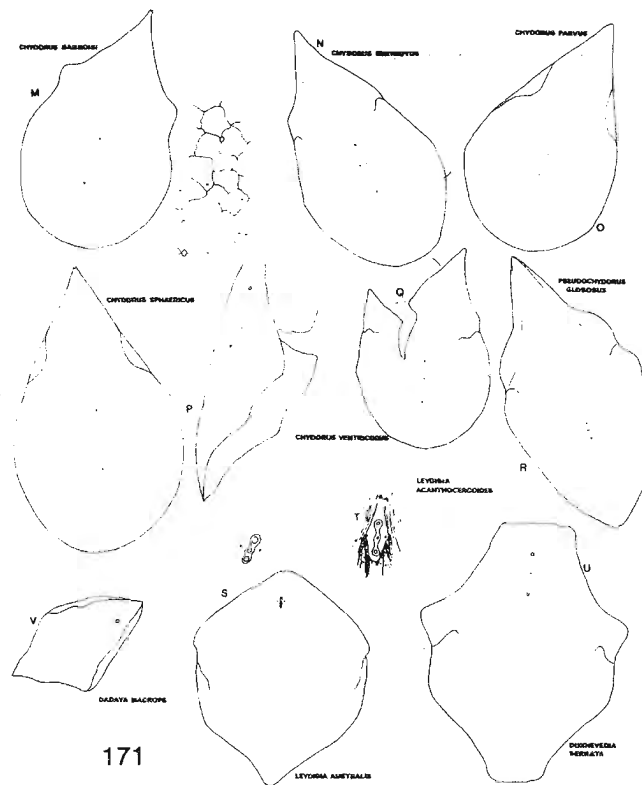


Fig. 171 Head shields and head pores of Chydoridae. All from Sri Lanka material except *Indialona globulosa* from Smirnov (1970) and the entire head shield of *Chydorus* (contd. page 53.)

head. *Moinodaphnia mcleayi* has an ocellus not present in *Moina* spp. *Moina macrocopa* has spines dorsally. The males of *Moina minorura* and *Moinodaphnia mcleayi* are characteristic and shown in Figs. 51 and 55. The diagnostic features of the Bosminidae are not easy to point out. The illustrations of the species recorded with the addition of *Eubosmina longispina* should prove adequate for diagnosis. The Macrothricidae can be diagnosed fairly easily. However, the status of *Macrothrix triserialis* and *M. spinosa* is not very clear. There are probably more than two species of *Macrothrix* in Sri Lanka.

It is in the Chydoridae that a great deal of difficulty will be encountered in species diagnosis. The genus *Alona* is probably represented in Ceylon by more than the six species recorded. At the present time the best that can be done in some cases is to approximate specimens to a valid species. *Chydorus* also often confronts the investigator with considerable difficulties. I have illustrated the first leg of the female in all *Chydorus* species reported from Sri Lanka except *C. ceylonensis* of which I have no specimens. The rest of the Chydoridae are relatively easy to diagnose to species. However, the *Pleuroxus* found in Sri Lanka is not *P. laevis* (= *hastatus*) as given by Daday (1898) and Smirnov (1971). It is a species close to *Pleuroxus similis* Vavra. It is also very rare in Sri Lanka.

Based on the examination of over 300 samples of zooplankton collected from all types of freshwater habitats in Sri Lanka and at different times of the year during the period 1962—1972. I have found the following species very rare. The rare indigenous species are: *Daphnia carinata*, *Ceriodaphnia quadrangula*, *Moina macrocopa*, *Sinobosmina* sp., *Echinisca capensis*, *Grimaldina brazzai*, *Gurnella rephaelis*, *Chydorus ceylonicus*, *Pseudochydorus globosus*, *Alona setulosa*, *Biapetura affinis*, *Indialona macronyx*, *Pleuroxus* cf. *similis* and *Graptoleberis testudinaria*. The three introduced species have not been recorded during the last 50 years and have probably been eliminated.



171

Fig. 171 (contd. from page 52) *Sphaericus* for which an Ontario specimen was used.

I have illustrated some of the head shields of Chydoridae. The study of Cladoceran remains so commonly found in samples enables identification of species which have been in the habitat besides those active stages when the samples were collected.

Males of Cladocera are rare but they are of considerable value in reaching accurate diagnoses of species. I have illustrated the few males I have found in the samples. A more careful study of all the specimens will certainly give males of most species since the collections were made throughout the year.

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### SUB-CLASS: COPEPODA

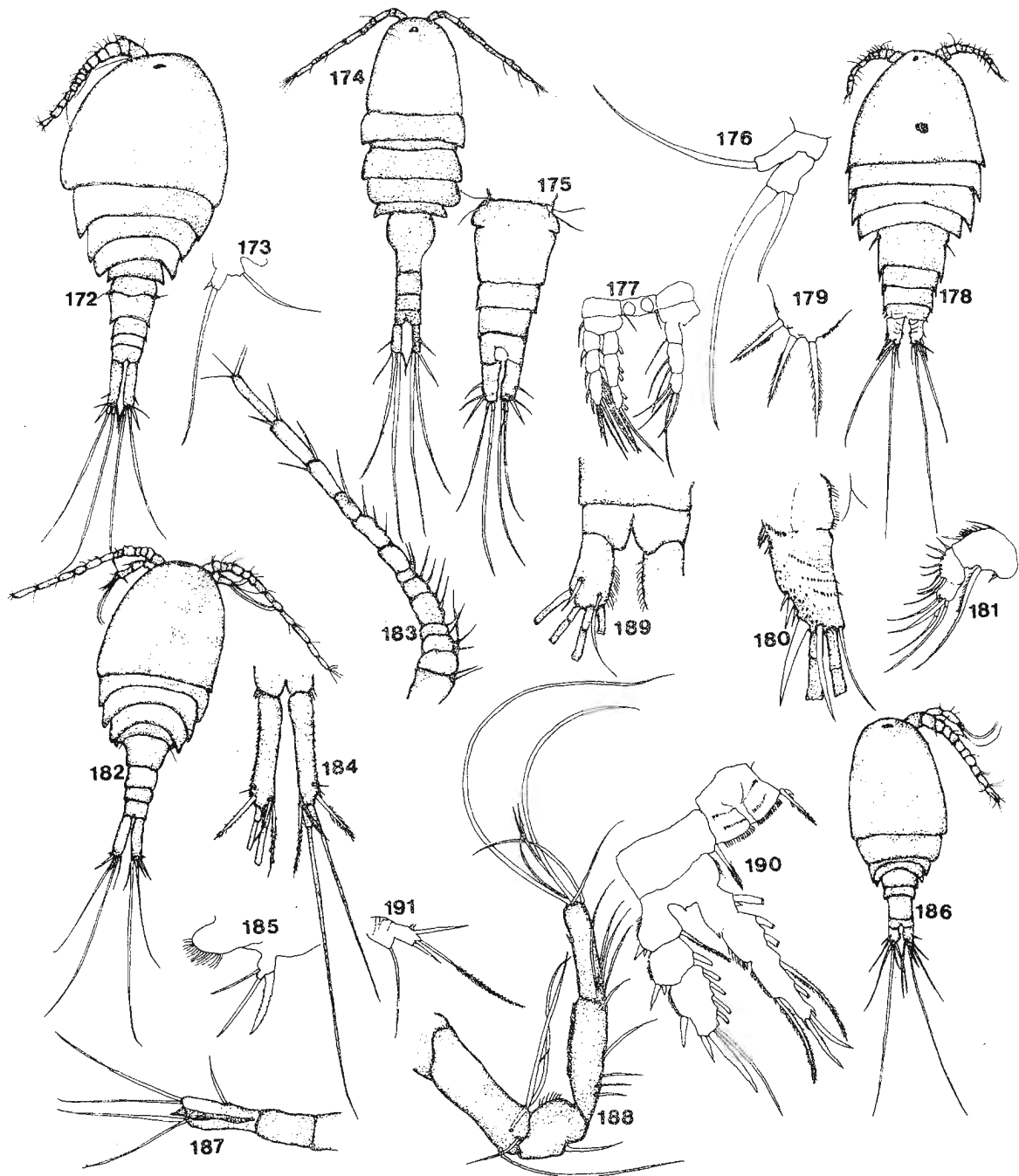
Three orders of this sub-class occur in Sri Lanka freshwater namely the Cyclopoida (free living and parasite, Calanoida and Harpacticoida. Although very common in all types of freshwater habitats, relatively little work has been done on these crustaceans in Sri Lanka. Many free-living cyclopoid species are widely distributed and can be identified using works of a general nature like Rylov (1948). Based on material from over 300 samples of zooplankton earlier examined and on the few previous records the list of Sri Lanka species has been built up. Practically all the records of species from Sri Lanka are not recent and many are inaccurate by present standards. I have attempted to sort out the valid species based on examination of material and the sorting out of past records in the light of recent literature.

### ORDER CYCLOPOIDA

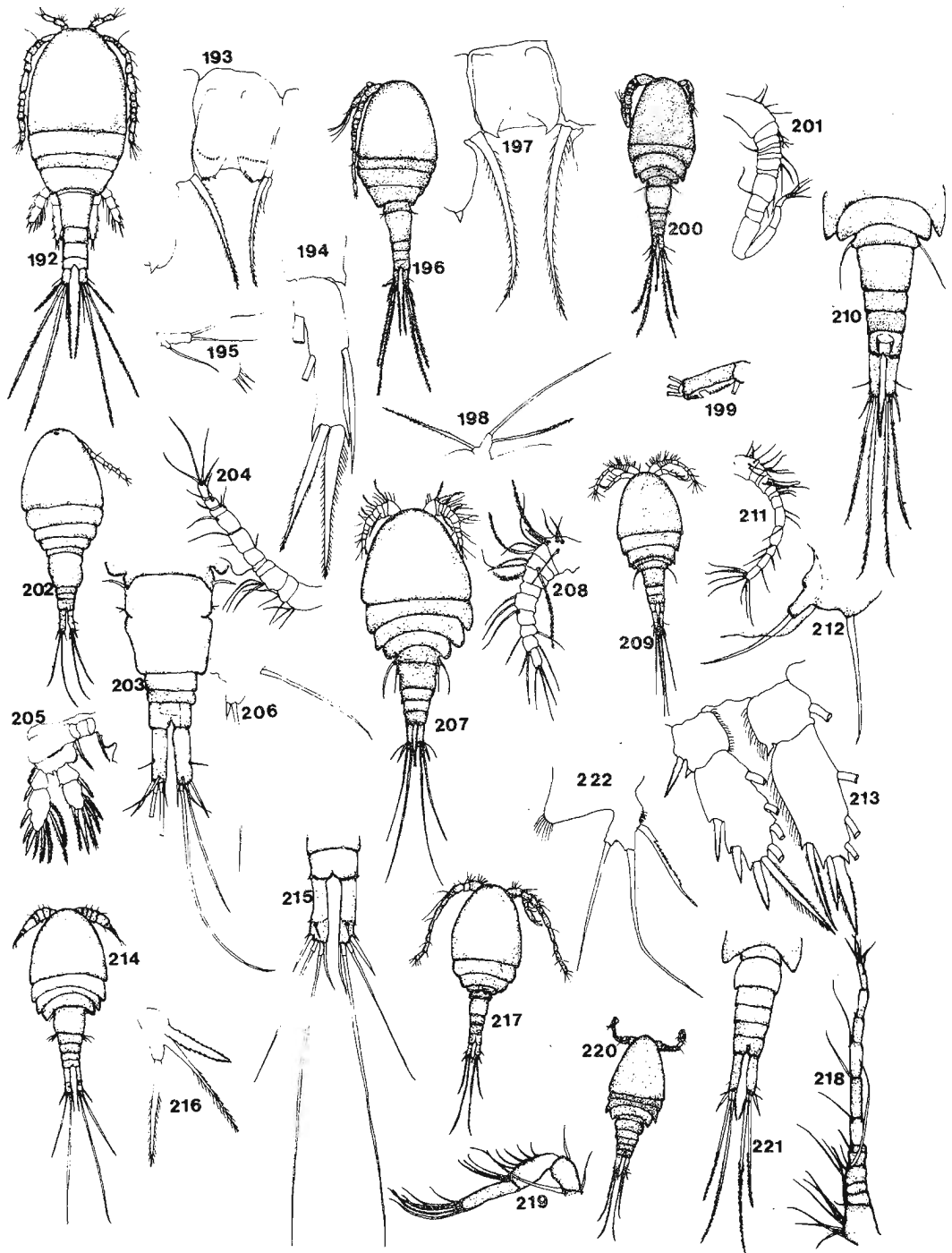
#### (a) Free Living Forms

The relevant literature to the Sri Lanka species are the papers of Brady (1867), Poppe and Mrazek (1895), Daday (1898), Apstein (1907, 1910), Gurney (1916), Lindberg (1939) and the monographs of Gurney (1931-33), Rylov (1948) and Dussart (1969).

The author has identified ten species in material examined. This includes two new records for Sri Lanka namely *Metacyclops minutus* (Claus) and *Microcyclops moghulensis* Lindberg. I have however not found two species recorded by previous works namely *Acanthocyclops vernalis* (Fischer) and *Diacyclops languidus* (Sars). The commonest species is *Mesocyclops leuckarti* (Claus) while *Macrocyclus distinctus* (Richard) is very rare. All the species recorded from Sri Lanka are illustrated in Figs. 172-222.



COPEPODA—CYCLOPOIDA. Fig. 172–173 *Acanthocyclops vernalis* from Ontario, CANADA, 172 female, 173 leg 5 of female. 174. *Diacyclops nanus*, female diagramatic. 175–177. *Diacyclops* cf. *languidus*. 175 female, posterior portion, 176 leg 5 of female, 177 leg 4 showing membrane. 178–181 *Ectocyclops phaleratus*, 178 female, 179 leg 5 of female, 180 furca of female, 181 antenna of female. 182–185 *Eucyclops serrulatus*, 182 female, 183 female, antennule, 184 furca for female, 185 leg 5 of female. 186–191. *Macrocyclus distinctus*, 186. female, 187 antennule of female, terminal portion, 188 antenna of female, 189 female furca, 190 leg 4 of female showing membrane, 191 leg 5 of female.



COPEPODA—CYCLOPOIDA Fig. 192-195 *Thermocyclops crassus*, 192 female, 193 leg 4 showing membrane in female, 194 female, endopodite of leg 4, 195 legs 5 and 6 of male. 196-201 *Mesocyclops leuckarti*, 196 female, 197 female leg 4 showing membrane, 198 female leg 5, 199 terminal segment of female antennule, 200 male, 201 male antenna. 202-206 *Metacyclops minutus*, 202 female, 203 posterior portion of female, 204 female antennule, 205 female leg 4 showing membrane, 206 leg 5 of female. 207-208. *Microcyclops moghulensis*, 207 female, 208 antennule of female. 209-213 *Microcyclops varicans*, 209 female, 210 posterior portion of female, 211 antennule of female, 212 leg 5 of female, 213 leg 4 of female showing two jointed ends and exopites. 214-216 *Paracyclops fimbriatus*, 214 female, 215 posterior portion of female, 216 leg 5 of female. 217-222 *Tropocyclops prasinus*, 217 female, 218 female antennule, 219 female antenna, 220 male, 221 posterior portion of male, 222 Female leg 5.

The Sri Lanka species are as follows:—

<i>Acanthocyclops vernalis</i> (Fischer)	<i>Metacyclops minutus</i> (Claus)
<i>Diacyclops cf. languidus</i> (Sars)	<i>Microcyclops moghulensis</i> (Lindberg)
<i>Ectocyclops phaleratus</i> (Koch)	<i>Microcyclops varicans</i> (Sars)
<i>Eucyclops serrulatus</i> (Fischer)	<i>Paracyclops fimbriatus</i> (Fischer)
<i>Macrocyclus distinctus</i> (Richard)	<i>Thermacyclops crassus</i> (Fischer)
<i>Mesocyclops leuckarti</i> (Claus)	<i>Tropocyclops prasinus</i> (Fischer)

The two new records for Sri Lanka were found in samples taken from a rice field in Nugegoda, Western Province. Included are locality records for the rare species *Macrocyclus distinctus*.

*Metacyclops minutus*. Nugegoda, Western Province, rice field 24. 2. 71.

*Microcyclops moghulensis*. Nugegoda, Western Province, rice field 19.3.71.

*Macrocyclus distinctus*. Nugegoda, Western Province, rice field 25. 7. 71. Gurugoda, Millewa-Padukka Road, Western Province pond, 23. 12. 72. Ratnapura, Sabaragamuwa Province, roadside ditch 22. 8. 72. Marawila, North Western Province, small pond 29. 12. 72.

All three species were recorded from a single habitat namely a rice field in Nugegoda. This habitat has been sampled regularly at fortnightly intervals during 1971 and 1972. It is likely that these three species are widely distributed in Ceylon although not common.

#### (b) PARASITIC FORMS

Five species have so far been recorded from Sri Lanka namely:

- Ergasilus ceylonensis*. Fernando and Hanek.
- Ergasilus mendisi*. Fernando and Hanek.
- Paraergasilus bevidigitus* Yin.
- Lamproglena chinensis sprostoni*. Kirthisinghe.
- Lernaea cyprinacea chackoensis*. Gnanamuthu.

The relevant papers to these species are Fernando and Hanek (1973 a and 1973 b). Besides describing two new species these papers mention that two of the five species namely *Paraergasilus bevidigitus* and *Lernaea cyprinacea chackoensis* have been introduced into Sri Lanka.

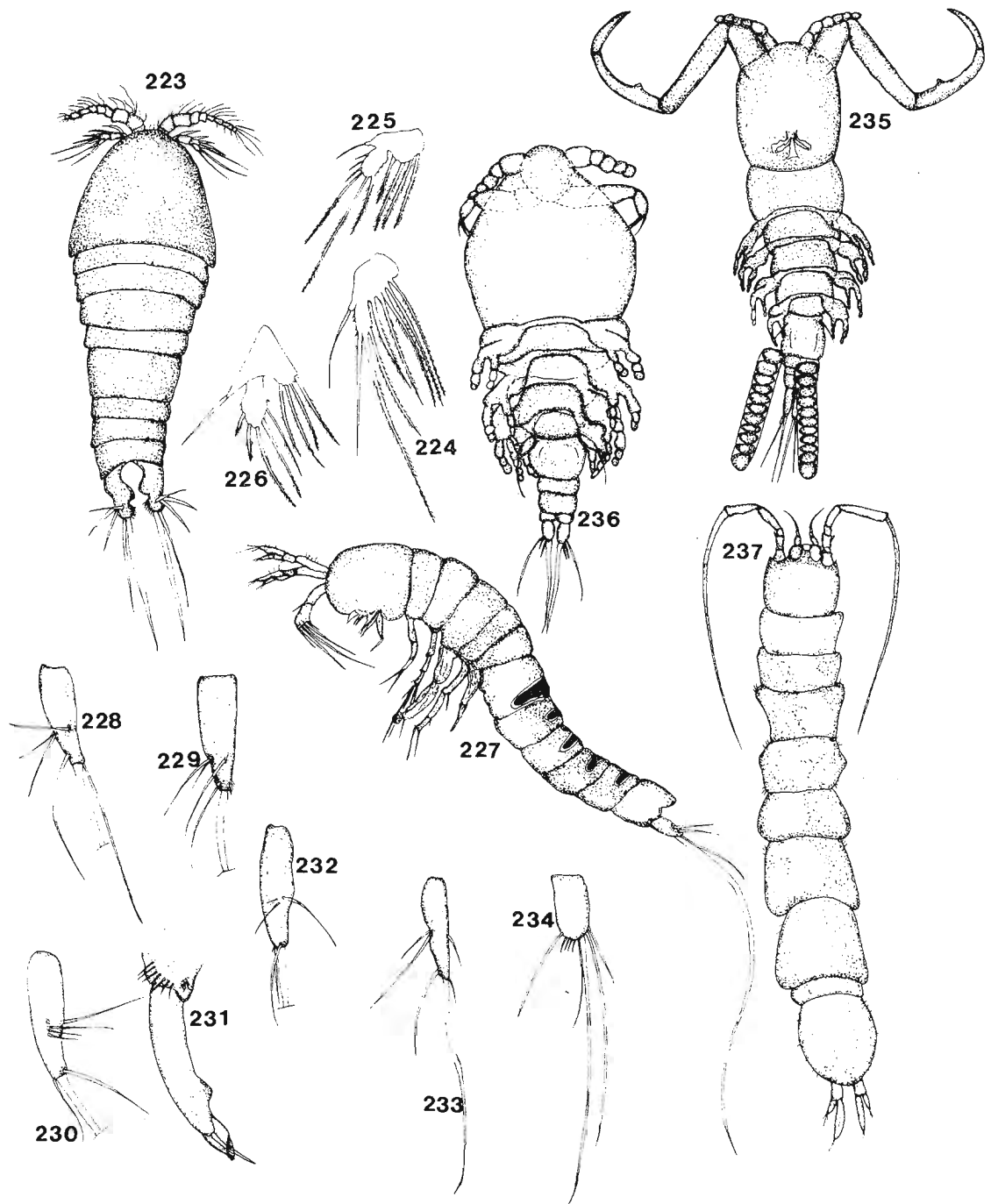
Two ergasilids are illustrated in Figs. 235 and 236.

### ORDER HARPACTICOIDA

Because of their small size and the interstitial habitat of many species this group has until very recently been poorly known in Sri Lanka. Three species of the family Canthocamptidae are known from earlier records of Brady (1867), Apstein (1910) and Gurney (1916).

Enckell (1970) recorded seven species of *Parastenocaris* (Family Parastenocarididae). Members of the genus *Parastenocaris* are interstitial in habitat and about 100 species have been described so far. Only two species of *Parastenocaris* occur in North America.

The Sri Lanka fauna is therefore quite rich in this group. In a sample from Amparai tank, was found a littoral species which is close to *Parastenocaris brevipes* Kessel. This species is not strictly subterranean *P. brevipes* is widely distributed and has been recorded from Europe, Asia and North America. Five species have been recorded in Northern Europe Enckell (1969).



COPEPODA-HARPACTICOIDA, PARASITIC CYCLOPOIDA. Fig. 223 *Canthocamptus* sp. female. 224 leg 5 female *Atthyella* sp. 225 leg 5 female *Elaphiodella grandidieri*. 226 leg 5 female *Elaphiodella bidens decorata*. 227 *Parastenocaris* cf. *brevipes*, male. 228–234. *Parastenocaris* spp. males, 228 furca of *P. irenae*, 229 furca of *p. noodti*, 230 furca of *P. sinhalensis*, 231 leg 3 of male *P. sinhalensis*, 232 furca of *P. brincki*, 233 furca of *P. lanceolatus*, 234 furca of *P. curvispinus*. 235 *Ergasilus ceylonensis* female. 236 *Paraergasilus brevidigitus* female. 237 *Protojanira lucci*, dorsal view. 228–237 after Enckell 1970.

The list of Sri Lanka species presently recorded is as follows:—

They are illustrated in Figs. 223-234.	<i>Parastenocaris curvispinus</i> Enckell
<i>Attheyella cigalensis</i> (Brady)	<i>Parastenocaris irenæ</i> Enckell
<i>Elaphiodella bidens decorata</i> (Daday)	<i>Parastenocaris lanceolatus</i> Enckell
<i>Elaphiodella grandidieri</i> (Guerne and Richard)	<i>Parastenocaris noodti</i> Enckell
<i>Parastenocaris cf. brevipes</i> Kessel	<i>Parastenocaris singalensis</i> Enckell
<i>Parastenocaris brincki</i> Enckell	<i>Parastenocaris</i> sp.

Identification of Harpacticoida of Sri Lanka can be done using the monographs of Lang (1948) and Borutski (1952) and the papers of Chappuis (1929, 1931, 1934) and Enckell (1970). Professor Per Brinck, Lund University, Sweden informs me that the Swedish Expedition to Sri Lanka in 1962 collected many Canthocumrtidae which are being studied. It is likely that there will be many new species among this material, hence a considerable lengthening of the species list can be predicted.

#### ORDER CALANOIDA

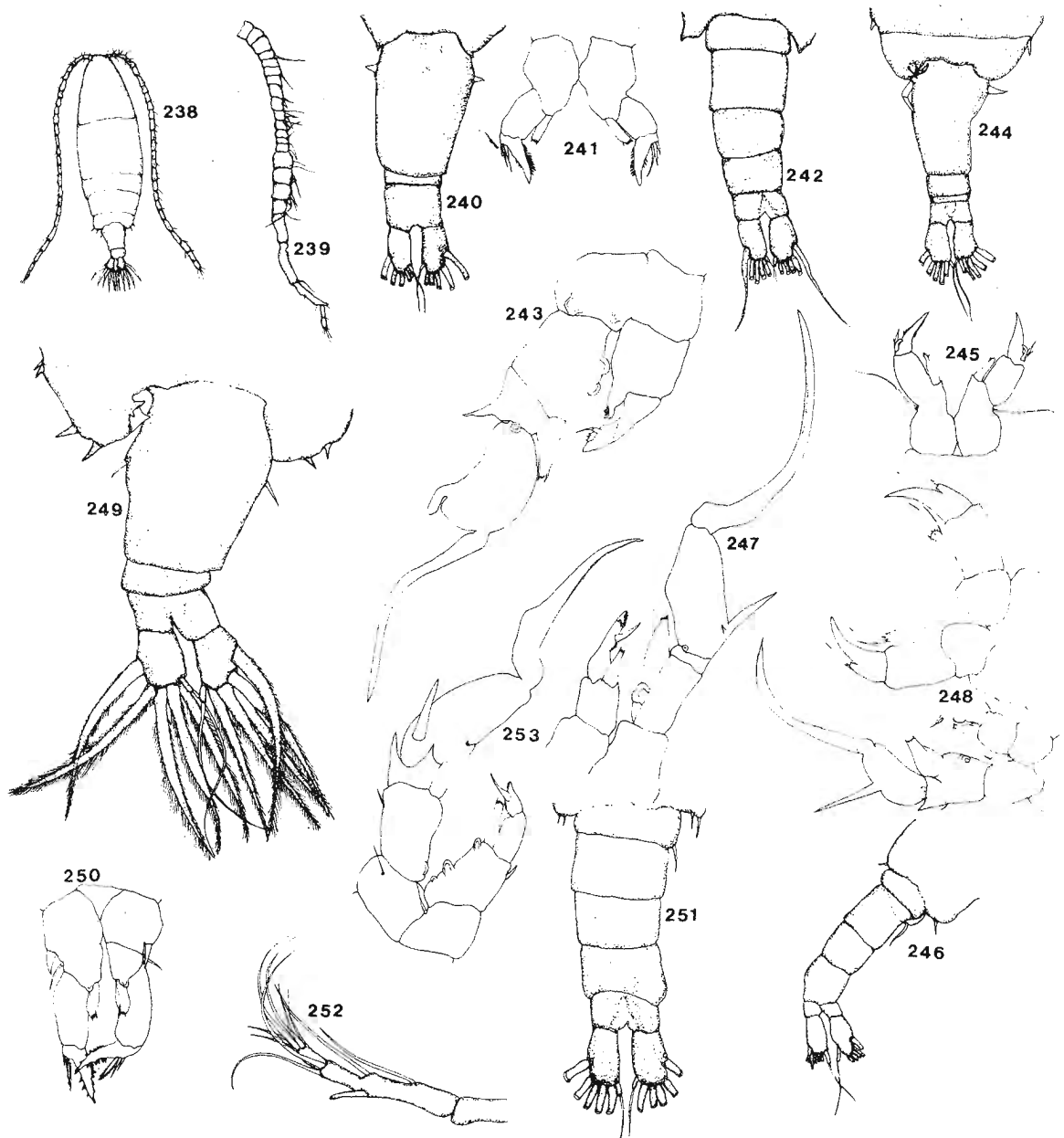
Relatively little material has been examined by previous workers although calanoid copepods are among the commonest freshwater microcrustaceans. The descriptions of many of the Sri Lanka species (Brady 1886), (Daday 1898) are inadequate to establish valid species. The Sri Lanka species are in need of a through study to establish their specific status. It is attempted to sort out the synonymy of Sri Lanka species and list the valid species. This is based on the examination of over 300 "plankton" samples from a wide range of habitats and covering most of the country. It is hoped that a more detailed study of the material will be published later.

The Sri Lanka species are illustrated in Figs. 238-273. The diagnostic features of both male and female for each species is shown.

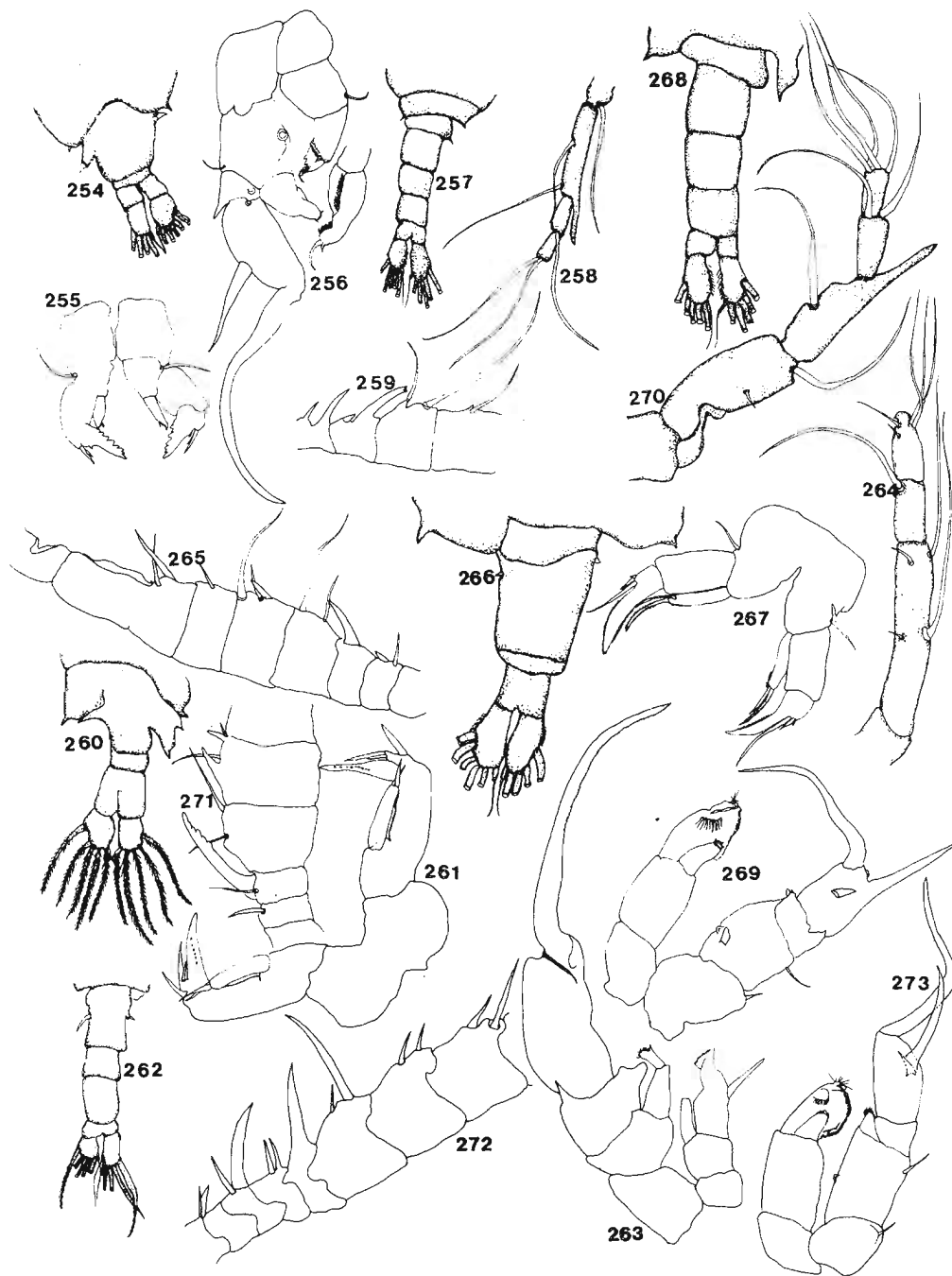
The Sri Lanka species which I consider valid are the following:—

<i>Eudiaptomus cinctus</i> (Gurney)	<i>Paradiaptomus greeni</i> (Gurney)
<i>Eudiaptomus drieschi</i> (Poppe and Mrazek)	<i>Phyllodiaptomus annae</i> (Apstein)
<i>Heliodiaptomus viduus</i> (Gurney)	<i>Tropodiaptomus niclsoni</i> (Brehm)
<i>Neodiaptomus schmackeri</i> (Poppe and Richard)	<i>Tropodiaptomus cf. doriae</i> (Richard)
Doubtful record:	<i>Eudiaptomus sinhalensis</i> (Daday)
<i>Eudiaptomus lumholtzi</i> (Sars)	= probably <i>Eudiaptomus drieschi</i>
Indeterminate species.	<i>Tropodiaptomus orientalis</i> (Brady)

There are at least two species of *Tropodiaptomus* in Sri Lanka. Brady's description could fit either of the two species recorded and also any other closely related species which may occur in Sri Lanka.



COPEPODA-CALANOIDA Fig. 238 *Heliodiaptomus viduus* female. 239-243 *Phylloidiptomus annae*, 239 prehensile antennule of male, 240 posterior portion of female, 241 leg 5 of female, 242 posterior portion of male, 243 leg 5 of male. 244-247. *Eudiaptomus cinctus*, 244 posterior portion of female, 245 leg 5 of female, 246 posterior position of male, 247 leg 5 of male. 248 *Eudiaptomus drieschi* leg 5 of male and female. 249-283. *Heliodiaptomus viduus*, 249 female, posterior portion, 250 leg 5 of female, 251 posterior portion of male, 252 terminal portion of prehensile antennule of male, 253 leg 5 of male.



COPEPODA-CALANOIDA Fig. 254-259 *Neodiaptomus schmackeri*, 254 Posterior portion of female, 255 leg 5 of female, 256 leg 5 of male, 257 posterior portion of male, 258 terminal portion of male prehensile antennule, 259 mid portion of same. 260-265 *Paradiaptomus greeni* from Madurai, India, 260 posterior portion of female, 261 leg 5 of female, 262 posterior position of male, 263 leg 5 of male, 264 terminal portion of prehensile antennule, 265 mid portion of same. 266-271. *Tropodiaptomus nielseni*. 266 posterior portion of female, 267 leg 5 of female, 268 posterior portion of male, 269 leg 5 of male, 270 terminal portion of prehensile antennule of male, 271 mid portion of same. 272-273 *Tropodiaptomus cf. doriae*, 272 prehensile antennule, 273 leg 5 of male.

**Synonymus:**

*Neodiaptomus strigilipes* (Gurney) = *Neodiaptomus schmackeri*

The Sri Lanka species list and the above comments on specific status of some species is based on the following papers and the examination of a large amount of material. The relevant papers are: Brady (1886), Poppe and Richard (1892), Poppe and Mrazek (1895), Daday (1889), Apstein (1907), Gurney (1906, 1916), Tollinger (1911), Kiefer (1930, 1932, 1939), Brehm (1953) and Bayly (1965).

The commonest species in Sri Lanka is *Phyllodiaptomus annae*. *Paradiaptomus greeni* was not found although this species was described from Sri Lanka. This species is illustrated from material kindly sent from Madurai, India by Dr. R. G. Michael.

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### ORDER ISOPODA

The only freshwater isopods recorded from Sri Lanka are the parasitic species *Alitropus types* (Milne Edwards) [see Fernando and Hanek 1973], and the stream dwelling species from the rheocene, *Protojanira lucei* Enckell (Fig. 273) described by Enckell (1969). The absence of isopods in tropical streams is probably due to elimination by other crustaceans like *Caridina* spp. though it is possible that their (isopod) niche has not been invaded due to zoogeographic reasons.

*Protojanira lucei* is shown in Fig.

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### ORDER MYSIDACEA

Although no strictly freshwater mysids are found in the tropics a number of species are found in estuarine waters. Included is a list of Sri Lanka species and some papers dealing with mysids because of the possibility that some estuarine mysid can be acclimatized to freshwater and thus be available for introduction into inland lakes.

*Mysis relicata* Loven found in cold water lakes in Northern Europe and Canada has been introduced into new habitats both in Europe and North America. Many mysids are found occasionally in freshwaters and regularly in brackish waters. Luther and Rzoska (1971) mention a mysid (presumably a brackish water species) in a small limestone lake in Lankawi Islands, Malaysia. Krishna Pillai (1967) has given an exhaustive review on shallow water mysidacea of the Indian region, Holmquist (1972) lists 18 European species. In Sri Lanka three species are known namely *Heteromysis zeylanica*, *H. proxima* and *Mesopodopsis zeylanica* (Tattersall 1922. Nouvel 1954). These species are referred to as Kuni (Sinhalese). *Mesopodopsis zeylanica* is illustrated in Figs. 21-23.

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### SUB-CLASS MALACOSTRACA.

### SUB-ORDER PARATHELPHUSOIDEA

The freshwater crabs of Asia have been monographed by Bott (1970 b) and the Sri Lanka species have been monographed by Fernando (1960) and Bott (1970 a). According to Bott (1970 b) the Sri Lanka species belong to two families—the Parathelphusidae represented by three genera *Spiralothelphusa*, *Oziothelphusa* and *Ceylonothelphusa* and the family Sundathelphusidae with a single genus *Perbrinckia*.

The list of Sri Lanka species is as follows:—

<i>Ceylonothelphusa rugosa</i> (Kingsley)	<i>Oziothelphusa senex minneriyaensis</i> Bott
<i>Ceylonothelphusa sorrow</i> (Zehntner)	<i>Spiralothelphusa hydrodroma</i> (Herbst)
<i>Ceylonothelphusa inflatissima</i> Bott	<i>Spiralothelphusa wuellerstorfi</i> (Heller)
<i>Oziothelphusa senex senex</i> (F.)	<i>Perbrinckia enodis</i> (Kingsley)

The following are synonyms:

<i>Parathelphusa ceylonensis</i> Fern. = <i>Oziothelphusa senex senex</i>
<i>Parathelphusa bouvieri</i> Rathbun (Sensu Fernando 1960) = <i>O. senex minneriyaensis</i>
<i>Parathelphusa parvula</i> Fern. = <i>Spiralothelphusa hydrodroma</i>
<i>Parathelphusa innominata</i> Fern. = <i>S. wuellerstorfi</i>
<i>Parathelphusa hippocastanum</i> Muller = <i>Oziothelphusa senex senex</i>

Fernando (1970) however found consistent differences in the colour pattern of *Parathelphusa hippocastanum* = *Oziothelphusa hippocastanum* and the other Sri Lanka species.

In a series of papers published recently it has been shown that freshwater crabs in Sri Lanka are intermediate hosts for human lung flukes of the genus *Paragonimus* besides other trematode parasites of man and vertebrates by Kannangara, (1969, 1971 a, 1971 b) and Kannangara and Karunaratne (1969 a, 1969 b). Previously Dissanaïke and Fernando (1960) found a frog metacercaria encysted in freshwater crabs. Freshwater crabs occupy a habitat frequented by a wide range of vertebrate hosts; fish, Amphibia, reptiles, birds and mammals. They also live in close proximity to snail intermediate hosts of trematodes. Freshwater crabs are also eaten by a wide range of vertebrates. It is very likely that further investigations will show freshwater crabs as intermediate hosts for a large number of parasites including Trematodes and Nematodes as shown recently by Poinar and Kannangara (1972).

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**CLASS INSECTA**  
**ORDER EPHEMEROPTERA**

This group is still relatively poorly known in Sri Lanka. Extensive collections made by the Swedish Lund University Expedition to Sri Lanka in 1962 are being studied and some new additions and name changes have been made.

Nomenclatural changes:

- Kimminsula annulata* (Hagen)
- Kimminsula fasciata* (Hagen)
- Kimminsula taprobanes* (Walker)

New species:

- Megaglena brincki*, Peters and Edmunds.
- Isca (Tanycola) serendiba*, Peters and Edmunds.

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**ORDER ODONATA**

Lieftinck (1971) has listed 112 species of odonates in his revised list of species for Sri Lanka. This includes six new species described by him in this paper. The adults of the Sri Lanka species are nearly all well known and relatively few species remain to be described as compared to most other groups of invertebrates. However, larvae of many species are still unknown or poorly known.

The Odonata fauna of Sri Lanka has been dealt with extensively by Laidlaw (1924, 1951) and Lieftinck (1940, 1955, 1971). These two authors besides dealing with systematics have discussed the derivation of the Sri Lanka fauna and endemism. Lieftinck (1964) found generic endemism was absent in Sri Lanka while marked in two tropical islands, New Guinea and Madagascar and slight in Borneo. At the specific level the percentage of endemics in Borneo and Sri Lanka were about the same, i. e. about 40 per cent. In another group of mobile insects the Corixidae Wroblewski (1972) found six endemics in a very rich fauna of twenty-two species, a figure considered high for endemic rates for this group.

New records in Lieftinck 1971:

- |  |  |
|--|--|
| <i>Anisogomphus solitaris</i> Lieftinck    | <i>Elattoneura bigeminata</i> Lieftinck  |
| <i>Disparoneura ramapana</i> Lieftinck     | <i>Gynecantha</i> sp.                    |
| <i>Drepanosticta brincki</i> Lieftinck     | <i>Mortonagrion ceylonicum</i> Lieftinck |
| <i>Drepanosticta sinhalensis</i> Lieftinck |  |

Name change:

- Indothermis carnatica* (F.)  
for *Libellula cassia* Rambur

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## SUB-ORDER HEMIPTERA-HETEROPTERA

In the "Guide" 70 species belonging to this group were recorded of this number five species are not found in Sri Lanka or have been shown to be synonyms. During the last ten years many new records have been added to the Sri Lanka list and at present about 120 species of aquatic Hemiptera Heteroptera are known. The largest increases of species have been in the Micronectinae studied by Fernando (1964) and Wroblewski (1972) and the Veliidae being studied by Mr. P. B. Karunaratne, National Museum, Colombo. The latter has permitted me to use his records to bring the species list up to date. Many new generic records are included and all except two of these genera have been illustrated in Figs. 274, 285. No locality data for the new records are included since these will be given in the publications on these species.

The identification of the new species recorded from Sri Lanka has been aided by the following publication: Cheng and Fernando (1969), China and Usinger (1949), Distant (1904, 1910, 1915), Esaki (1924), Hungerford and Matsuda (1962), Lansbury (1968, 1972) and Lundblad (1933, 1938). Some of the illustrations have been redrawn from Distant (1904, 1910, 1915) and Esaki (1924).

Two families of shore bugs, the Saldidae and Leptopodidae not given in the "Guide" or previous supplements have been added. They are represented by three records so far in Sri Lanka and are referred to in Distant (1915) and Drake and Hoberlandt (1950a, 1950b).

LIST OF AQUATIC HEMIPTERA OF CEYLON  
CRYPTOCERATA

## Family Nepidae

<i>Cercometus fumosus</i> Dist.	<i>Ranatra digitata</i> Hafi and Pradhan
<i>Cercometus strangulatus</i> Mont.	<i>Ranatra elongata</i> (F.)
<i>Laccotrephes flavovenosus</i> Dohrn.	<i>Ranatra filiformis</i> (F.)
<i>Laccotrephes griseus</i> (Guer.)	<i>Ranatra flagellata</i> Lansbury
<i>Laccotrephes grossus</i> (F.)	<i>Ranatra varipes</i> Stal
<i>Laccotrephes maculatus</i> (F.)	<i>Ranatra varipes atrophata</i> Mont.

## Family Belostomatidae

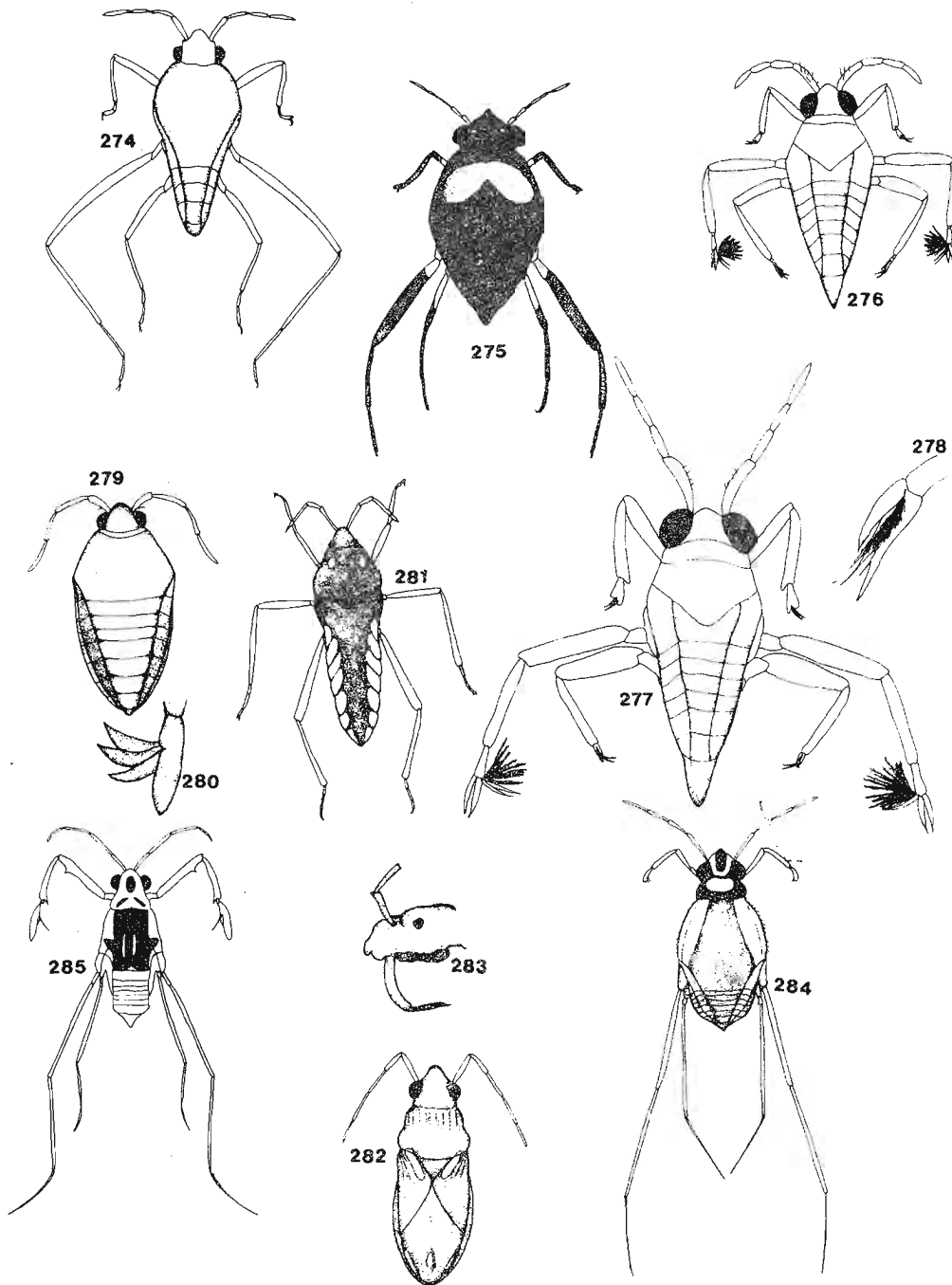
<i>Lethocerus indicus</i> (Lep. et Serv.)	<i>Sphaerodema rusticum</i> (F.)
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## Family Naucoridae

<i>Dianhorocoris punctatissimus</i> (Kirby)	<i>Naucoris scutellaris</i> Stal
<i>Heleocoris bengalensis</i> Mont.	

## Family Helotrephidae

<i>Helotrephes kirkaldyi</i> Esaki and China	<i>Tiphotrephes indicus</i> Dist
<i>Limnotrephes campbelli</i> Esaki and China	



HEMIPTERA-HETEROPTERA. Fig. 274 *Halovelia*. 275 *Strongylovelia*. 276 *Khaçovelia* sp. 21. *Tetraripis*. 278. Terminal portion of hind tarsus of *Tetraripis* showing hair brush. 279 *Xiphovelia* sp. 280 Terminal portion of middle leg of *Xiphovelia*. 281 *Velia currens*. 282 *Hebrus* sp. 283 *Hebrus*, lateral view of head showing buccula (heavily stippled). 284 *Naboandelus*. 285 *Ascelopios annandalei*. (275 after Esaki 1924, 278-289 after Lundblad 1938, 1933; 281 and after Distant 1904, 1910 and 1915.)

Family Pleidae

*Plea frontalis* Fieb.

*Plea liturata* Kirk.

Family Notonectidae

*Anisops ali* Brooks  
*Anisops barbata* Brooks  
*Anisops batillifrons* Lundb.  
*Anisops bouvieri* Kirk.  
*Anisops breddini* Kirk.  
*Anisops extendofrons* Brooks

*Anisops nivea* (F.)  
*Anisops occipitails* Breddin  
*Anisops projectus* Brooks  
*Enuthares ciliata* Fabr.  
*Enuthares simplex* Kirby

Family Corixidae

*Agraplocoriza hyalinipennis* (F.)  
*Micronecta albifrons* (Mots.)  
*Micronecta altera* Wrobl.  
*Micronecta anatolica* Lindberg  
*Micronecta ceylonica* Wrobl.  
*Micronecta desertana* Wrobl.  
*Micronecta Fernandoi* Wrobl.  
*Micronecta Fravens* Wrobl.  
*Micronecta grisea* (Fieb.)  
*Micronecta lubibunda* Breddin  
*Micronecta ludibunda langkani* Wrobl.  
*Micronecta prashadana* Hutch.

*Micronecta punctata* (Fieb.)  
*Micronecta punctinotum* Chen  
*Micronecta quadririgata* Breddin  
*Micronecta quadririgata* f. *minthe* Dist.  
*Micronecta sancta-catherine* Hutch.  
*Micronecta scutellaris* Stal  
*Micronecta siva* (Kirk.)  
*Micronecta taprobanica* Wrobl.  
*Micronecta tarsalis* Chen  
*Synaptonecta capillata* Wrobl.  
*Synaptonecta pruthiana* Hutch.  
*Tropocoriza pruthiana* Hutch.

GYMNOCERATA

Family Hydrometridae

*Hydrometra butleri* Hung. and Evans.  
*Hydrometra greeni* Kirk.  
*Hydrometra kahallensis* Karunaratne.

*Hydrometra zeylanica* Gunawardena and Karunaratne

Family Mesoveliidae

*Mesovelia orientalis* Kirk.

\**Mesovelia* sp.

Family Veliidae

\**Halovelia* sp.  
*Microvelia diluta* Dist.  
*Microvelia douglasi* Scott.  
*Microvelia longicornis* Bueno  
\**Microvelia* 3 spp.  
\**Neovalidus* sp.  
*Peritoppus breddini* Kirk.

*Rhagovelia ceylonica* Lundb.  
*Rhagovelia* sp.  
\**Strongylovelia* 2 spp.  
*Tetraripis ravana* Kirk.  
\**Tetraripis* sp.  
\**Velia currens* F.  
\**Xiphovelia* 2 spp.

Family Hebridae

\**Hebrus bengalensis* Dist.  
*Timasium atratus* Dist.

*Timasium splendens* Dist.

Family Gerridae

Sub-family Rhagodotarsinae

*Rhagodotarsus kraepelini* Breddin

\**Rhagodotarsus* sp.

## Sub-family Trepobotinae

*Cryptobates raja* Dist.\**Metrobatopsis* sp.\**Naboandelus* 2 spp.

## Sub-family Halobatinae

\**Asclepios annandalei* Dist.*Halobates germanus* White*Halobates micans* Esch.*Halobates flaviventris* Dist.*Halobates formidabilis* Dist.*Matrocoris stali* (Dohrn.)\**Metrocoris* sp.\**Ventidius aquarius* Dist.\**Ventidius pubescens* Cheng*Ventidius henryi* Esaki

## Sub-family Ptilomerinae

*Ptilomera cingalensis* Stal*Rheumatogonus custodiendus* (Dist.)\**Rheumatogonus vittatus* Esaki

## Sub-family Gerrinae

*Cylindrostethus productus* Spin.*Gerris adelaidis* Dohrn*Gerris pectoralis* Mayer*Limnogonus fossarum* F.*Limnogonus nitidus* Mayer*Limnogonus parvulus* Stal*Onychotrethus sakuntala* Kirk\**Onychotrethus* sp.*Tenagogonus anadyomene* (Kirk.)*Tenagogonus fluviorum* F.*Tenagogonus ceylonensis* Hung. and Mats.

## Family Saldidae

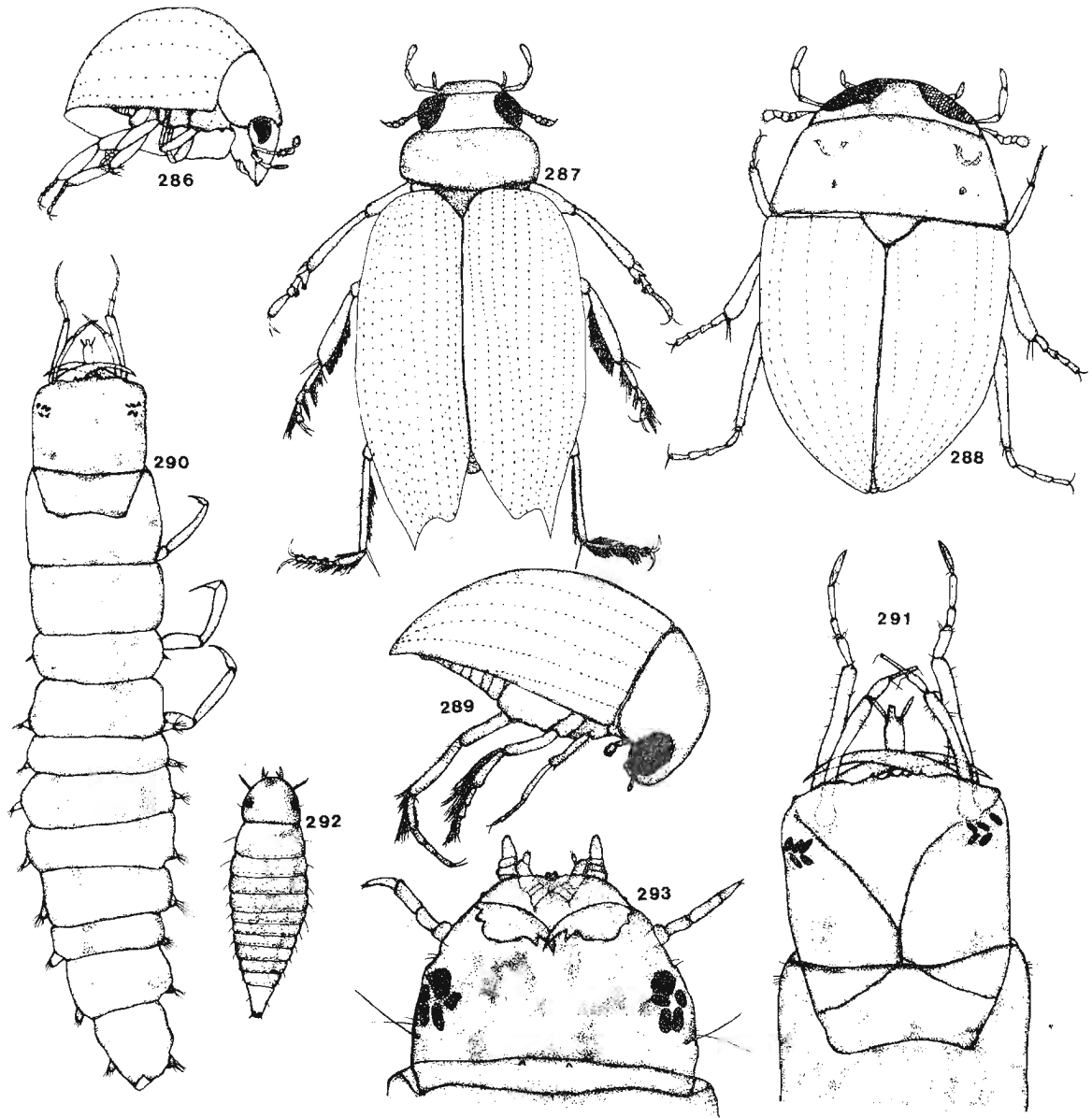
*Saldula fletcheri* (Dist.)*Saldula rutherfordi* (Dist.)

## Family Leptopodidae

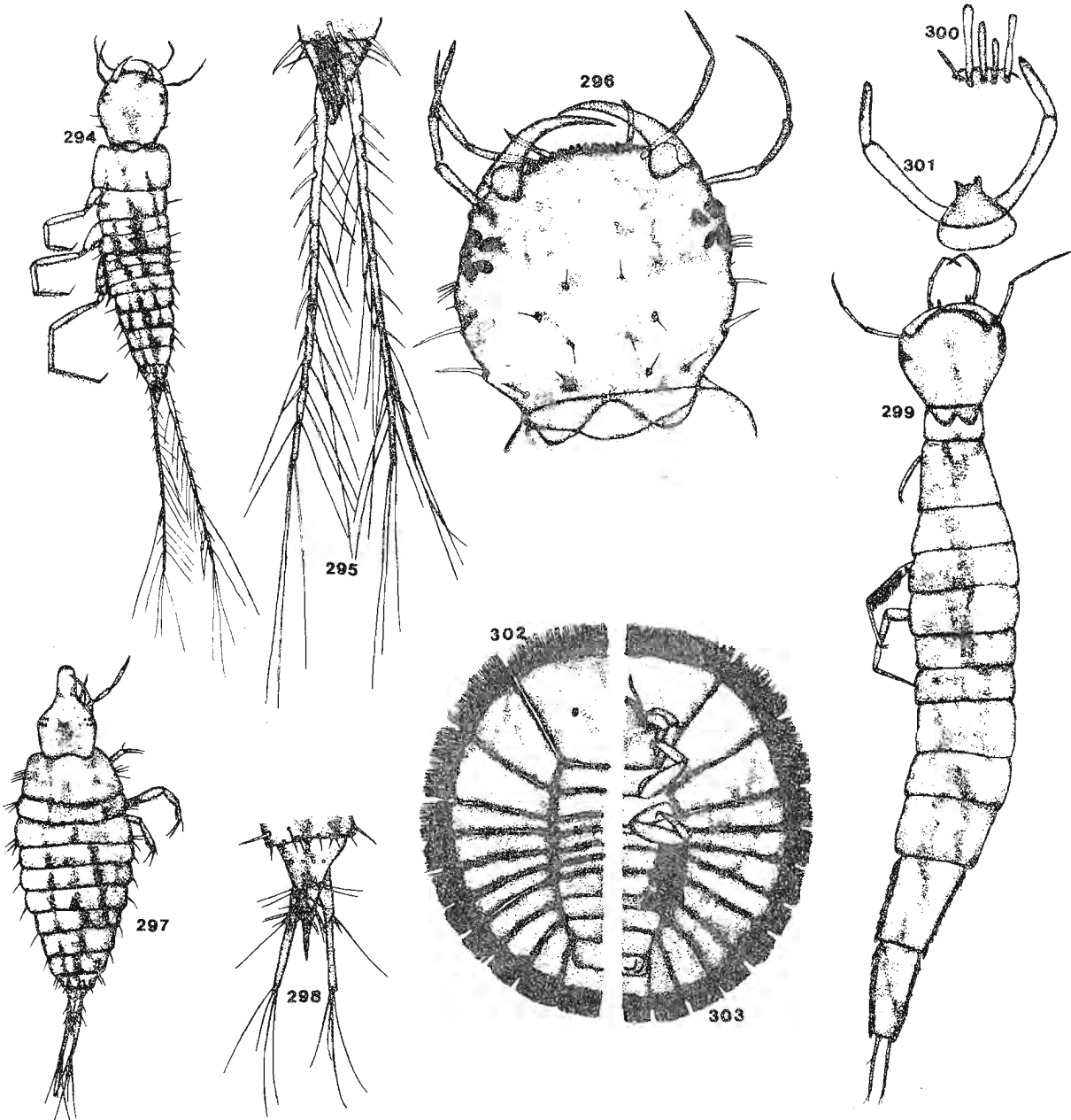
*Va leriola assounaensis* (Costa)

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COLEOPTERA-HYDROPHILIDAE, DYTISCIDAE. Fig. 286 *Amphiops gibbos*. 287 *Berosus* sp. 288 *Enochrus* sp. 289 *Regimbartia attenuata*. 290 Larva of *Sternolophus* sp. 291 Head of same. 292 *Canthydrus* sp. Larva. 293 Head of same showing mandibles in transparency.



COLEOPTERA-DYTISCIDAE, PSEPHENIDAE (Larvae). Fig. 294 *Laccophilus* sp. 295 Same. posterior end of body and cerci. 296 Head of same. 297 *Hyphidrus* sp. 298 Same, posterior end of body and cerci. 299 *Hydaticus* sp. 300 Anterior margin of clypeus of same. 301 Labium of same. 302 *Eubrianax*. dorsal view. 303 Same ventral view.

## ORDER COLEOPTERA

Beetles of the families Dytiscidae, Haliplidae and Amphizoidae of the Indian Region have been intensively investigated in a series of papers. Guignot (1953, 1954a, 1954b) and Vazirani (1955, 1963, 1964a, 1966a, 1966b, 1968a, 1968b, 1969b, 1969c, 1970a and 1970b). These papers make it possible to diagnose the Dytiscidae and Haliplidae of the Indian Region with accuracy. The Asian Hydrophilidae, Gyrinidae and beetles belonging to various other aquatic and semi-aquatic families e.g. Elminthidae are very poorly known.

The publication of the monograph on aquatic beetle larvae and pupa by Bertrand (1972) has made it easier to diagnose aquatic Coleoptera immature stages to the generic level at least. Also Vazirani (1964b) has contributed to the knowledge of *Cybister* larvae. The level of sophistication in taxonomic studies both for adults and larvae has been enhanced in recent years by the publication of numerous papers. Some larvae collected in Sri Lanka and identified to the genus have been illustrated. They belong to *Sternolophus* (Hydrophilidae), *Hydaticus*, *Hyphydrus* and *Laccophilus* (Dytiscidae), *Canthydrus* sNoterinaei and *Eubrianax* (Psephenidae) Fig. (290-303).

The following adult beetles have also been figured from Sri Lanka material. *Amphiops*, *Regimbarthia Enochrus* and *Berosus*, Figs. 286-289.

The Sri Lanka list of species given in the guide should be expanded by the inclusion of the following Dytiscidae:—

<i>Copeletus freudei</i> Guignot	<i>Hyphoporus pugnator</i> Sharp
<i>Hydaticies ceylonicus</i> Guignot	<i>Laccophilus basalis</i> Mots.
<i>Hydrovatus ischyryus</i> Guignot	<i>Laccophilus parvulus</i> Aube
<i>Hydrovatus picipennis</i> Mots	<i>Laccophilus rufulus</i> Reg.
<i>Hydrovatus rufoniger</i> Clark	<i>Microdytes maculatus</i> (Mots.)
<i>Hyphydrus intermixtus</i> Walker	

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#### SUB-ORDER HYDRACARINA

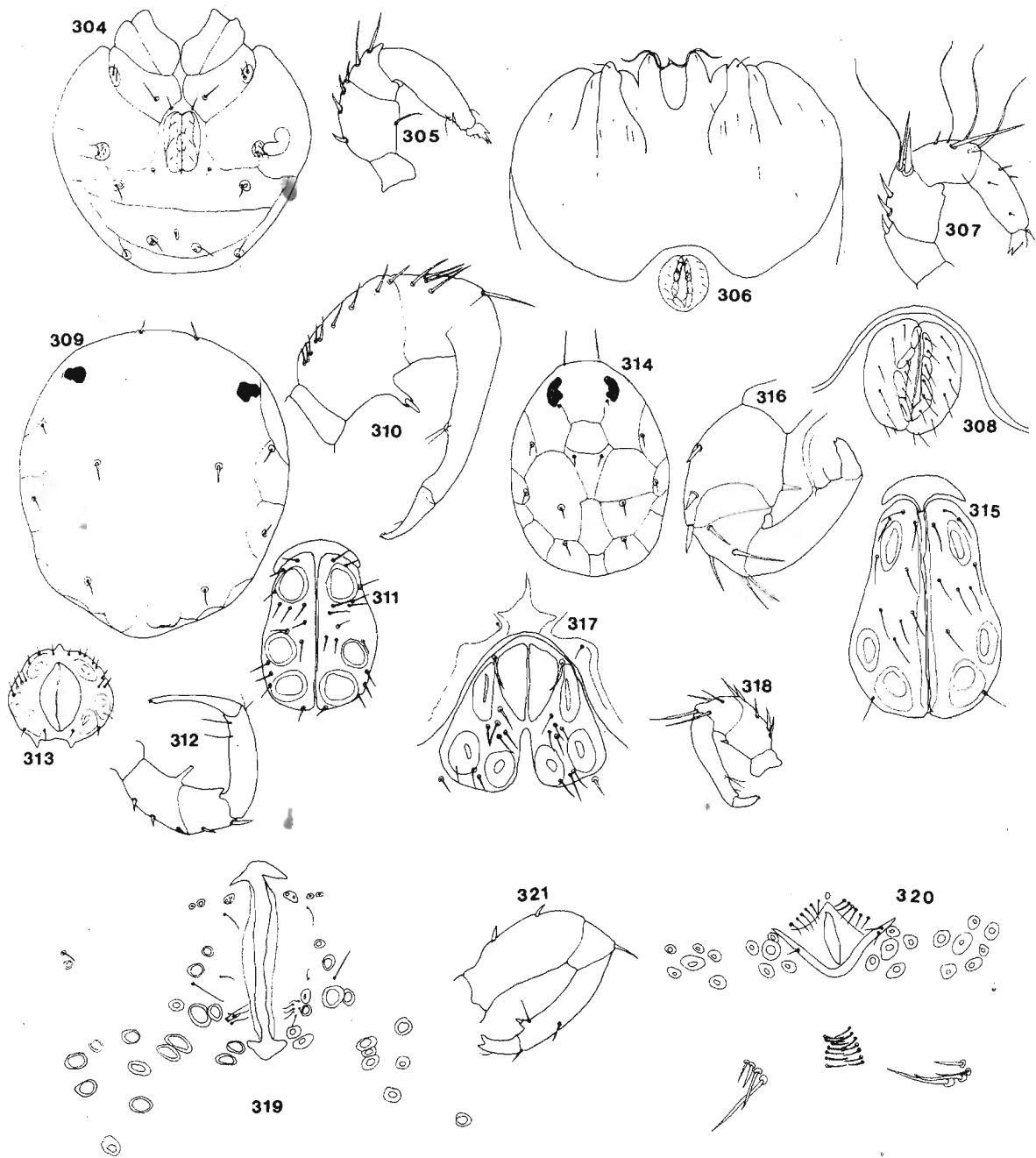
So far only two collections of Hydracarina from Sri Lanka has been studied Daday (1898) who reported on this collection recorded 14 species of which nearly all were new species. Subsequently Piersig (1900) and Walter (1929) reported on the same material and clarified some confusion in the assignment of males and females of different species to one species. This added two new species to Daday's (1898) list. A single species *Piona coccinea* var. *imminuta* (Piersig) was recorded by Apstein (1910) in his study of zooplankton in Lake Gregory. Cook (1967) doubts the presence of this sub-species in Sri Lanka. The another however found *Piona* sp. (*coccinea* group) in Sri Lanka. Lundblad (1969) recorded some species from a single collection.

The publication of Cook's (1967) monograph on water mites from India has made it possible to diagnose most Sri Lanka species. The another examined material collected with zooplankton from Sri Lanka and found twelve species hitherto unreported. These are listed together with the previous records from Sri Lanka have been illustrated. Species where material was available to the author (Figs. 304-360) have been illustrated.

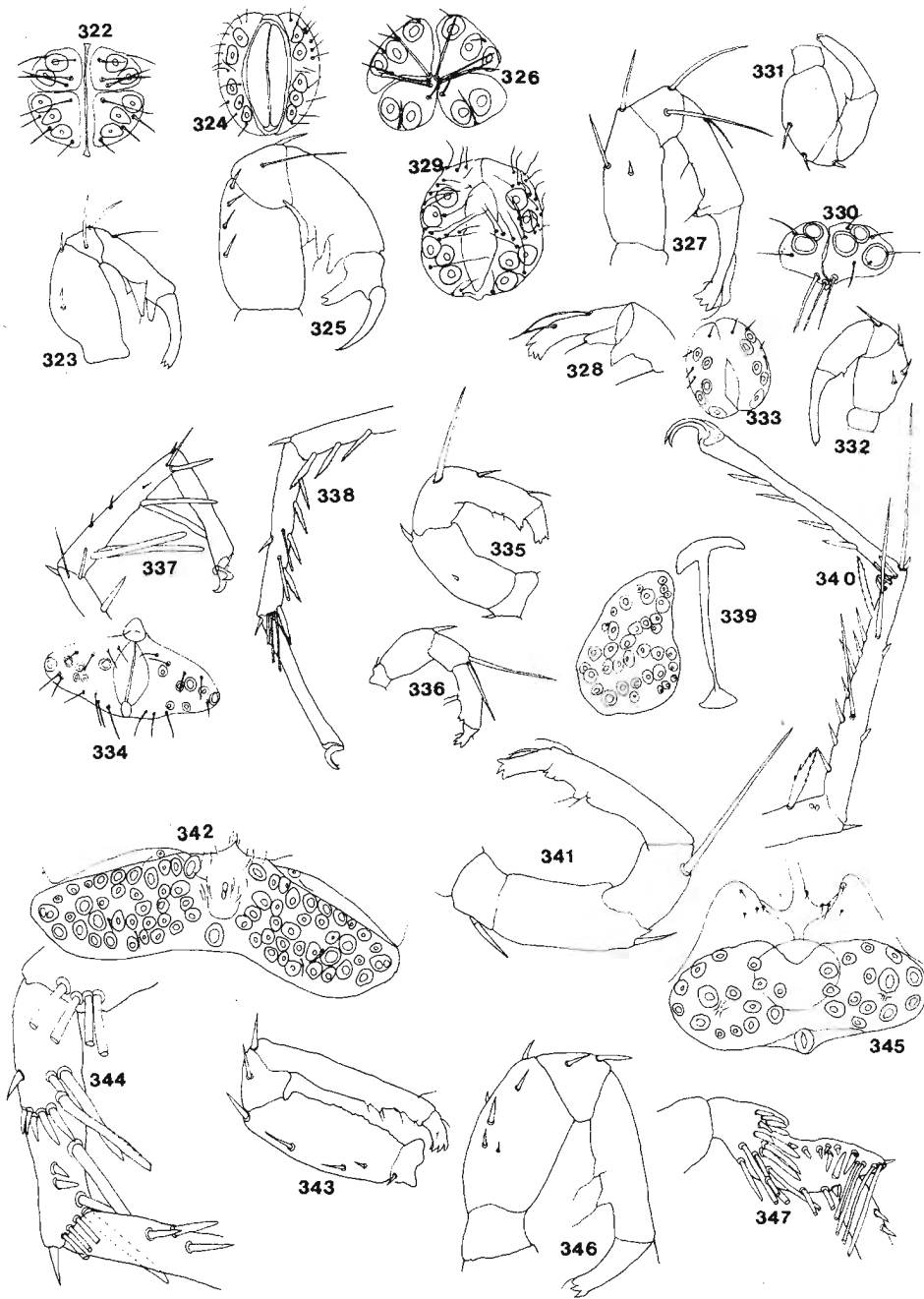
Since records of Sri Lanka Hydracarina are so few the locality data for material examined have been included.

Larval water mites are found infesting the gills and pharynx of fishes: Dubinin (1959) Tedla and Fernando (1970), Fernando et al. (1972). Hydracarina are often parasitic on freshwater mussels in their larval stages. The life history of a typical water mite has been described by Mitchell (1955). Tedla and Fernando (1970) found the non-parasitic larvae *Hydrozetes* causing tissue reaction in fish gills.

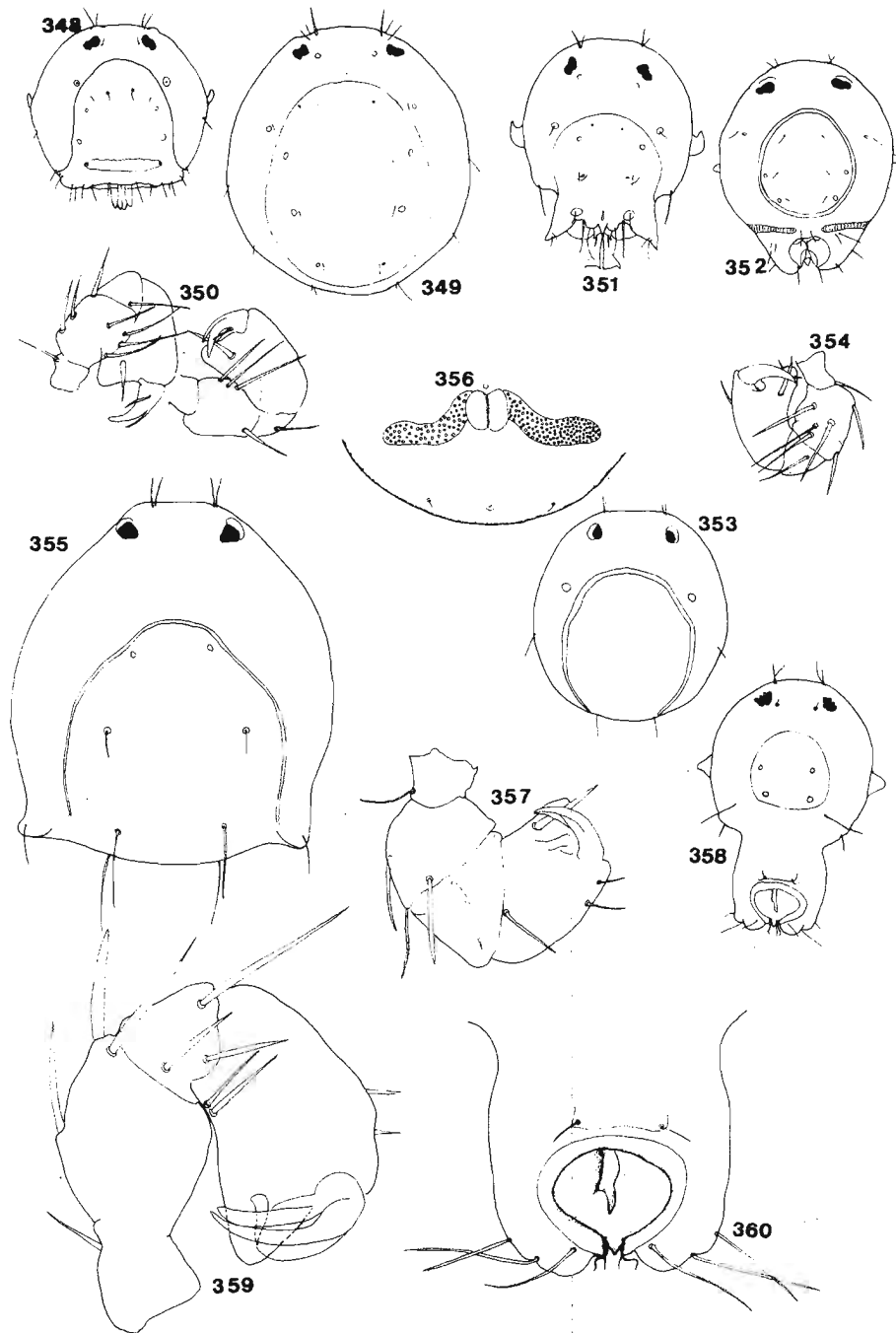
The free-living larval mites (Figs. 24 and 25) and the parasitic stages in the pharyngeal wall of a fish (Fig. 26) have been illustrated.



HYDRACARINA. Fig. 304 *Nilotonia indica*, ventral view. 305 Female palp of same. 306-308. *Oxus pictus*, 306 female, ventral view of anterior portion, 307 palp of female, 308 female genital area. 309-313 *Limnesis lembangensis*, 309 female, dorsal view, 310 female palp, 311 female, genital area, 312 male palp, 313 male genital area. 314-318 *Limnesia lucifera*, 314 female, dorsal view, 315 female, genital area, 316 female palp, 317 male, genital area, 318 male palp. 319-321 *Encendridophorus horvathi*, 319 female, genital area, 320 male, genital area, 321 female palp.



**HYDRACARINA.** Fig. 322 *Unionicola affinis*, female genital area. 323 female palp of same. 324 *Unionicola kantaka*, male genital area. 325 male palp, 326-329 *Unionicola setifera*, 326 female, genital area, 327 female palp, 328 female palp, terminal portion, 329 male, genital area. 330-333 *Unionicola similis* 330 female, genital area, 331 female palp, 332 male palp, 333 male, genital area. 334-338 *Neumania ambigua*, 334 male, genital area, 335 male palp, 336 female palp, 337 I leg 4-6, 338 IV leg 4-6 339-341 *Neumania nodosa*, 339 female, genital area, 340 IV leg 4-6 female 341, female palp, 342-344 *Piona dadayi*. 342 male, genital area. 343 male palp. 344 IV leg 4. 345-347 *Piona (coccinea group)*, 345 male, genital area, 346 male palp, 347 IV leg 4 of male.



HYDRACARINA. Fig. 348 *Arrenurus congener* male. 349 female of same. 350 female palp of same. 351 *Arrenurus liberatus* male 352-354 *Arrenurus maderaszi* 352 male 353 female, 354 female palp. 355-357 *Arrenurus orientalis* 355 female, 356 female, genital area, 357 female palp. 358-360 *Arrenurus caviger*, 358 male, 359 male palp, 360 posterior portion of male.

## Hydracarina List for Sri Lanka

## Family Hydrachnidae

*Hydrachna similis* Marsh

## Family Hydrodromidae

*Diplodontus silvestri* (Daday)

## Family Anisitsiellidae

*\*Nilotonia indica* Walter

## Family Libertiidae

*\*Oxus dahl* Piersig*Oxus pictus* (Daday)*\*Oxus longisetus* (Berl)

## Family Limnesiidae

*\*Limnesia lebangensis* Piersig*\*Limnesia lucifera* Lundbald

## Family Unionicolidae

*Encentridophorus horvarthi* (Daday)*\*Unionicola necessaria* (Koen.)*Encentridophorus spinifer* Koen*\*Unionicola setifera* Cook*Unionicola sinhalensis* Daday*\*Unionicola similis* Viets*\*Unionicola affinis* (Piersig)*\*Unionicola unguiculata* Walter*\*Unionicola chappuisi* Walter

## Family Neumaniidae

*Neumania ambigua* Piersig*Neumania nodosa* Daday

## Family Pionidae

*\*Piona caligifera* Koen*\*Piona flagellifera* Lundb.*Piona dadayi* Piersig*Piona (coccinea group)*

## Family Axonopsidae

*\*Axonopsis sp.*

## Family Arrenuridae

*Arrenurus madaraszii* Daday*\*Arrenurus caviger* Viets*Arrenurus ceylonicus* Daday*Arrenurus rostratus* Daday*Arrenurus orientalis* Daday*\*Arrenurus rouxi* Piersig*Arrenurus liberatus* Walter*Arrenurus sinhalensis* Daday*Arrenurus congener* Daday

## Locality Data of Hydracarina Collected and Studied

*Nilotonia indica* Nugegoda, rice field 1 ♀ 19.3.72.*Oxus pictus* Unichchi tank 1 ♀ 28.12.70. Nugegoda rice field 1 ♀ 27.7.71.*Limnesia lebangensis* Madurankuli, pond 1 ♀ 1.6.72. Marawila, pond 3 ♀ ♀ 22.8.72. Ratnapura, wyside pool 1 ♀ 22.8.72. Ratnapura, gem pit 1 ♂ 18.8.72. Udawalawe reservoir 1 ♀ 27.12.70.*Limnesia lucifera* Nugegoda, rice field 1 ♀ 22.7.71. Nugegoda, rice field 1 ♀ 22.6.71. Belihuloya, rice field 1 ♂ 16.8.72.

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*\*New record for SRI LANKA.*

C. H. FERNANDO

- Encentridophorus horvathi* Unichchi tank 1 ♀ 28.12.70 Marawila, pond 1 ♀ 6.12.70 Handapangala tank 1 ♀ 28.12.70  
Nugegoda, rice field 1 ♂ 1 ♀ 10.10.71 1 ♀ 22.7.71
- Unionicola affinis* Tabbowa tank 1 ♀ 6.12.70 Ambiliwewa 1 ♀ 9.8.68 Kebittigollawa Tank 1 ♀ 19.12.70
- Unionicola kantaka* Kebittigollawa tank 1 ♀ 19.12.70
- Unionicola setifera* Handapangala tank 1 ♀ 28.12.70 Kebittigollawa tank 1 ♀ 1 ♂ 19.12.70
- Unionicola similis* Kebittigollawa tank 1 ♂ 1 ♀ 19.12.70
- Neumania nodosa* Nugegoda rice field 1 ♀ 19.3.72. Ratnapura gem pit 2 ♀ ♀
- Neumania ambigua* Ratnapura gem pit 1 ♀ 18.8.72 Ratnapura, vegetated pond 1 ♂ 18.8.73
- Piona dadayi* Nugegoda, rice field 1 ♂ 1 ♀ 10.10.71
- Piona* sp. (*coccinea* group) Karapala villu 1 ♂ 7.1.72
- Axonopsis* sp. Kurunegala tank 1 ♂ 3.8.69 Nugegoda, rice field 1 ♂ 24.2.71
- Arrenurus congener* Nugegoda, rice field 1 ♂ 24.2.71 Nugegoda, rice field 2 ♀ ♀ 22.7.71 1 ♀ 19.10.71 Marawila  
pond 1 ♀ 22.8.70
- Arrenurus liberatus* Belihul-oya rice field 1 ♂ 16.8.71 Nugegoda, rice field 1 ♂ 22.7.71
- Arrenurus madaraszii* Nugegoda, rice field 1 ♂ 10.10.71 Ratnapura, pond 1 ♂ 19.8.72 Nugegoda, rice field  
1 ♂ 1 ♀ 22.7.71 1 ♀ 19.10.70,
- Arrenurus orientalis* Eppawela, pond 1 ♀ 18.8.72
- Arrenurus caviger* Nugegoda, rice field 1 ♂ 19.3.71

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## APPENDIX I

## New Species records for Sri Lanka

The following is a list of species recorded for the first time in Sri Lanka and included in the present paper.

## Phylum-Tardigrada

*Macrobotus dispar* Murray  
*Stygarctus bradypus* Schulz

*Echiniscus (E) cribosus* Murray

## Phylum Arthropoda

## Class Crustacea

## Order Conchostraca

*Caenestheriella indica* (Gurney)

*Eulimnadia michaeli* Nayar and Nair

## Order Cladocera

*Latonopsis australis* Sars  
*Bosminopsis dietersi* Richard  
*Bosmina* sp.  
*Grimaldina brazzai* Richard  
*Echinisca capensis* Sars  
*Pseudochydorus globosus* (Baird)  
*Alona monocantha* Sars

*Alona* cf. *harputaria* Sars  
*Alona pulchella* King  
*Alona setulosa* Megard  
*Alona* cf. *guttata* Sars  
*Biapetura affinis* (Leydig)  
*Pluroxus* cf. *similis* Vavra

## Order Cyclopoida

*Diacyclops* cf. *languidus* (Sars)  
*Metacyclops minutus* (Claus)

*Microcyclops moghulensis* Lindberg

Order Calanoida

*Eudiaptomus cinctus* (Gurney)  
*Tropodiptomus neilsemi* Brehm

*Tropodiptomus* cf. *doriae* (Richard)

Order Harpacticoida

*Parastenocaris* cf. *brevipes* Kessel

Class Insecta

Order Hemiptera

*Mesovelgia* sp.  
*Halovelia* sp.  
*Microvelia* 3 spp.  
*Neolardus* sp.  
*Strongylovelia* 2 spp.  
*Tetraripis* sp.  
*Velia currens* F.  
*Xiphovelia* sp.  
*Hebrus bengalensis* Dist.

*Rhagodotarsus* sp.  
*Metrobatopsis* sp.  
*Naboandelus* sp.  
*Ascelepoos annandelei* Dist.  
*Metrocoris* sp.  
*Ventidius aquarius* (Dist.)  
*Ventidius pubescens* Cheng  
*Rheumatogonus vittatus* Esaki  
*Onychotrechus* sp.

Class Arachnida

Sub-order Hydracarina

*Nilotonia indica* Walter  
*Limnesia lebangensis* Piersig  
*Limnesia lucifera* Lundblad  
*Unionicola affinis* (Piersig)  
*Unionicola kantaka* (Cook)

*Unionicola similis* Viets  
*Neumania ambigua* Piersig  
*Piona* sp. (*coccinea* group)  
*Axonopsis* sp.  
*Arrenurus caviger* Viets

# Rotifera from Sri Lanka (Ceylon) I.

## The Genus *Lecane* with Descriptions of Two New Species

by

R. CHENGALATH and C. H. FERNANDO \*

### INTRODUCTION

The Rotifera of Ceylon have received little attention in recent years. The major papers dealing with Ceylonese species are those of Daday (1898) who recorded 42 species and listed 46 species as occurring in Ceylon and Apstein (1907, 1811) who recorded a number of species in the plankton of two lakes. Mendis and Fernando (1962) gave a list of Ceylonese species. The list was revised and a few additions made by Fernando (1969). Mendis (1965) added a new generic record *Trochosphaera* to the list. Mendis (1964, 1965) and Costa and De Silva (1969) identified a number of Rotifera genera in their studies on the zooplankton of Colombo Lake and Fernando and Ellepola (1969) recorded four species in their study of two small tanks. The present study is based on collections made from a large number of lakes, ponds and paddy fields during the period 1968-1972. A large number of new records and some new species have been identified in this material. The largest number of species have been recorded in the genus *Lecane* i.e. *Lecane* (*Lecane*), *Lecane* (*Hemimonostyla*) and *Lecane* (*Monostyla*) and the present paper is restricted to this genus. In all 25 species including two new species are recorded and described. Previous records number only 8 species.

Apart from the early paper by Anderson (1889) on the Rotifera around Calcutta, India; Murray (1906) on the Rotifera of Sikkim and Stewart (1908) on the Rotifera of Tibet, there are a number of more recent papers dealing with Rotifera of adjacent areas i.e. India and the Malay Archipelago (Edmondson and Hutchinson (1934), Hauer (1936, 1937a, 1937b, 1938), Donner (1949), Brehm (1950), George (1961), Pasha (1961), Arora (1963a, 1963b, 1965, 1966), Nayar (1964, 1965a, 1965b, 1968, 1969), Wulfert (1966). Also many Rotifera have been identified in studies of zooplankton. Also recent revisions of a number of genera are available (Harring. and Myers (1926); Hauer (1929), and the comprehensive faunal works of Viogt (1957), Bartos (1959), Rudescu (1960) and Ktuikova (1970) enabling accurate diagnosis of species.

Since detailed descriptions of all previously recorded species are available only short descriptions with illustrations to enable easy diagnosis are given in the present paper. Where our material differs from that previously described this is mentioned. The two new species are described in detail. The rest of the Ceylonese species will be dealt with in a subsequent paper.

### Materials and Methods

Over 200 samples of "zooplankton" from open water and the littoral of lakes and from ponds collected during the period 1968-1972 were studied. Individual specimens of Rotifera were mounted in CMCS (Turtoxstain mountant) or Polyvinyl Lactophenol coloured dark with Lignin Pink for

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detailed study. Drawings were made with a camera lucida and all measurements are given in  $\mu$ . The material was collected with a No. 25 net; fixed in formalin and individual specimens were washed in 70% ethyl alcohol before transfer to the mountant.

#### List of species

The following is a list of species of *Lecanes* recorded in the present paper

- \**Lecane (Lecane) ceylonensis* sp. nov.
  - \**Lecane (Lecane) crepida* Haring, 1914
  - \**Lecane (Lecane) curvicornis* Murray, 1913
  - \**Lecane (Lecane) curvicornis* var. *miamiensis* Myers, 1941
  - \**Lecane (Lecane) hornemanni* (Ehrenberg, 1833)
  - Lecane (Lecane) leontina* (Turner, 1892)
  - Lecane (Lecane) ludwigi* (Eckstein, 1883)
  - Lecane (Lecane) luna* (Muller, 1776)
  - \**Lecane (Lecane) ohioensis* (Herrick, 1885)
  - Lecane (Lecane) papuana* (Murray, 1913)
  - \**Lecane (Lecane) plesioides* sp. nov.
  - \**Lecane (Lecane) ploenensis* (Vigot, 1902)
  - \**Lecane (Lecane) pusilla* Haring, 1914
  - Lecane (Lecane) unguata* (Gosse, 1887)
  - \**Lecane (Lecane) verecunda* Haring and Myers, 1926
  - \**Lecane (Hemimonostyla) sympoda* Hauer, 1929
  - Lecane (Monostyla) bulla* Gosse, 1851
  - \**Lecane (Monostyla) closterocerca* Schmarda, 1859
  - \**Lecane (Monostyla) decipiens* Murray, 1913
  - \**Lecane (Monostyla) elachis* Haring and Myers, 1926
  - Lecane (Monostyla) lunaris* (Ehrenberg, 1832)
  - \**Lecane (Monostyla) obtusa* Murray, 1913
  - Lecane (Monostyla) quadridentata* (Ehrenberg, 1832)
  - \**Lecane (Monostyla) strenuosi* (Meissner, 1908)
  - \**Lecane (Monostyla) unquitata* (Fadew, 1925)
- \* New record for Ceylon

**Description of species**

*Lecane (Lecane) ceylonensis* sp. nov. (Figs. 1 and 2)

Anterior end of lorica widest and gradually tapering towards posterior end. Anterior dorsal margins coincident and convex. Dorsal plate with elevated ridges on the sides. Ventral plate slightly larger than dorsal plate. Width of dorsal and ventral plates equal. Lateral sulci not distinct. Posterior segment short and extends only little beyond the dorsal plate. The first joint of the foot fairly large. The second joint very large, rounded posteriorly. Toes long, fairly stout and tapering into an acute point, without any claw

## MEASUREMENTS :

Length of dorsal plate ..	76	Width of anterior end ..	58
Length of ventral plate ..	80	Foot .. ..	16
Width of dorsal plate ..	48	Toe .. ..	30
Width of ventral plate ..	48		

*Lecane ceylonensis* is closely related to *Lecane nodosa* (Hauer), and *Lecane hornemanni* (Ehrenberg). In *Lecane ceylonensis* the anterior end is much broader than the middle of lorica unlike in *Lecane nodosa* or *Lecane hornemanni* where the greatest width is in the middle of the lorica. Also in both *Lecane nodosa* and *Lecane hornemanni* the width of the lorica is greater than its length. The width of the lorica of *Lecane ceylonensis* is approximately two-thirds the length. The posterior segment of *Lecane ceylonensis* is small compared to that in *Lecane nodosa* or *Lecane hornemanni*. In view of all these differences we propose that this species be designated *Lecane ceylonensis* sp. nov.

DISTRIBUTION : Palavi, pond : Chandrika wewa.

*Lecane crepida* Haring, 1914 (Figs. 3 and 4)

The specimens of *Lecane crepida* found in Ceylon agree generally with the descriptions of Haring and Myers (1926) and Hauer (1938) except that they are slightly larger. The drawings of this species by the above mentioned authors and Wulfert (1966) from Indian material shows that the ventral and dorsal plates are not coincident at the anterior end. However, most of the specimens examined from the Ceylon samples show that the anterior margin is coincident or nearly so. *Lecane crepida* has not been recorded from Ceylon previously.

## MEASUREMENTS :

Length of dorsal plate ..	73	Width of anterior end ..	58
Length of ventral plate ..	86	Foot .. ..	12
Width of dorsal plate ..	49	Toe .. ..	29
Width of ventral plate ..	56	Claw .. ..	9

DISTRIBUTION : Tabbowa, pond : Medawachchiya, tank.

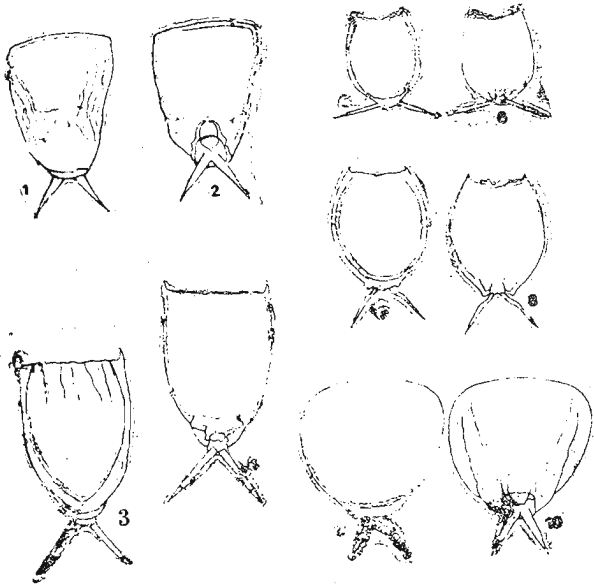
*Lecane curvicornis* Murray, 1913 (Figs. 5 and 6)

The forms found in Ceylon are typical and show no difference from the ones described by Harring and Myers (1926) in his monograph except that the Ceylonese forms are smaller. *Lecane crivicornis* is fairly common in small ponds and was abundant in some samples.

MEASUREMENTS :

Length of dorsal plate ..	111	Width of anterior end ..	66
Length of ventral plate ..	117	Foot ..	15
Width of dorsal plate ..	89	Toe ..	54
Width of ventral plate ..	96	Claw ..	9

DISTRIBUTION : Kudawewa, Madampe ; Marawila, ditch ; Tabbowa, pond ; Marawila, pond ; Ambiliwewa nr. Kurunegala.



Figs. 1 and 2.—*Lecane ceylonensis* dorsal and ventral views

Figs. 3 and 4.—*Lecane crepida* dorsal and ventral views

Figs. 5 and 6.—*Lecane curvicornis* dorsal and ventral views

Figs. 7 and 8.—*Lecane curvicornis* var. *miamiensis* dorsal and ventral views

Figs. 9 and 10.—*Lecane hornemanni* dorsal and ventral views

*Lecane curvicornis* var. *miamiensis* Myers, 1941 (Figs. 7 and 8)

*Lecane curvicornis* var. *miamiensis* was first described by Myers (1941) from Miami, Florida. It has not been reported from anywhere since. The form found in Ceylon is broader than the one described by Myers (loc. cit.). Also there are other minor differences namely that the anterior margin of Ceylonese specimens are not exactly coincident and the antero-lateral spines are a little more prominent. The shape of the posterior segment and the anterior portion of the toe, which are characteristic of this variety agrees in both the specimens from Florida, United States and from Ceylon.

MEASUREMENTS :

Length of dorsal plate ..	138	Width of anterior end ..	84
Length of ventral plate ..	153	Foot ..	15
Width of dorsal plate ..	121	Toe ..	60
Width of ventral plate ..	130	Claw ..	12

DISTRIBUTION : Recorded only from Ambiliwewa nr. Kurunegala.

*Lecane hornemanni* (Ehrenberg, 1833) (Figs. 9 and 10)

The posterior segment of Ceylonese specimens is slightly smaller compared to the specimens from the United States (Harring and Myers, 1926) and India (Wulfert, 1966) but more or less of the same size as Indonesian specimens (Hauer, 1938). *Lecane hornemanni* has not been previously recorded from Ceylon.

MEASUREMENTS :

Length of dorsal plate	72	Width of anterior end	69
Length of ventral plate	82	Foot	15
Width of dorsal plate	85	Toe	29
Width of ventral plate	72		

DISTRIBUTION : Tabbowa, pond ; Kudawewa, Madampe.

*Lecane (Lecane) leontina* Turner, 1892 (Figs. 11 and 12)

The shape of the lorica is a little different from the description of Harring and Myers (1926) which shows a wider lorica, more or less roundish. Whereas the Ceylonese forms are oval, the width of the lorica being less. Ceylonese forms of *Lecane leontina* are smaller compared to forms from other parts of the world (Harring and Myers, 1926) ; Hauer (1938) ; Voigt (1957).

MEASUREMENTS :

Length of dorsal plate	135	Width of anterior end	72
Length of ventral plate	156	Foot	15
Width of dorsal plate	97	Toe	72
Width of ventral plate	108	Claw	9

DISTRIBUTION : Nugegoda, paddy field ; Topawewa, Polonnaruwa ; Pond nr. Nikaweratiya ; Marawila, ditch ; Marawila, pond ; Morawewa ; Handapangala, tank ; Bathalagoda, tank ; Nachchaduwa, tank.

*Lecane (Lecane) ludwigi* Eckstein, 1883 (Figs. 13 and 14)

The anterior margins have a deep sinus and are not coincident. The posterior segment of *Lecane ludwigi* shows wide variation. In the specimens studied from Ceylon the posterior segment was rounded with the projection blunt and truncate.

MEASUREMENTS :

Length of dorsal plate	97	Width of anterior end	49
Length of ventral plate	138	Foot	15
Width of dorsal plate	75	Toe	44
Width of ventral plate	71		

DISTRIBUTION : Recorded only from Tabbowa, pond

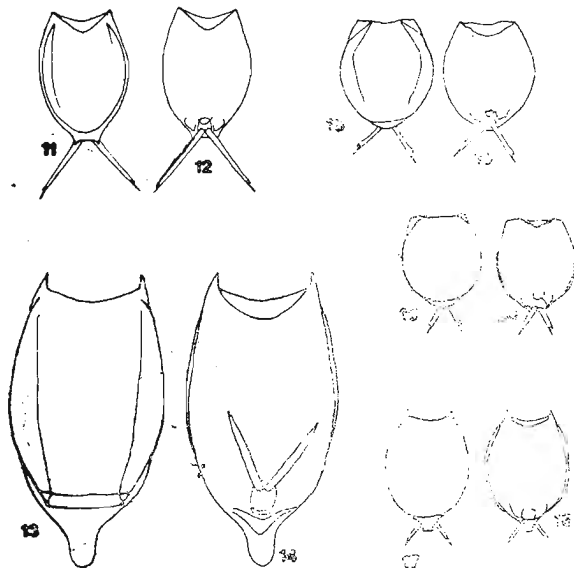
*Lecane (Lecane) luna* Müller, 1776 (Figs. 15 and 16)

The anterior margin does not have a deep, lunate sinus. The dorsal and ventral plates of the same width. The end of toes have a slight swelling and resemble those given in the drawings of Donner (1954).

MEASUREMENTS :

Length of dorsal plate	128	Width of anterior end	96
Length of ventral plate	135	Foot	18
Width of dorsal plate	111	Toe	42
Width of ventral plate	111	Claw	12

DISTRIBUTION : A common species both in tanks and ponds. Marawila, ditch ; Topawewa, Polonnaruwa ; Mandathivu, Jaffna, paddy field ; Vaddukodai, Jaffna, paddy-field ; Anabulundawa wewa ; Sigiriya tank ; Thovaramuddai, Jaffna, Giants tank ; Nachchaduwa tank ; Kalawewa ; Pavatkulam ; Kandalama tank ; Megallawewa ; Nalanda reservoir ; Moonplains reservoir ; Ambiliwewa, Nr. Kurunegala.



Figs. 11 and 12.—*Lecane leotina* dorsal and ventral views

Figs. 13 and 14.—*Lecane ludwigi* dorsal and ventral views

Figs. 15 and 16.—*Lecane luna* dorsal and ventral views

Figs. 17 and 18.—*Lecane ohioensis* dorsal and ventral views

Figs. 19 and 20.—*Lecane papuana* dorsal and ventral views

*Lecane (Lecane) ohioensis* Herrick, 1885 (Figs. 17 and 18)

The anterior margin is not coincident and the spines at the external angles are not very prominent. The posterior segment rounded and the median projection is small and truncate. Ceylonese forms are larger than the ones described by Harring and Myers (1926) from the United States. *Lecane ohioensis* has not been recorded from Ceylon previously.

MEASUREMENTS :

Length of dorsal plate	120	Width of anterior end	54
Length of ventral plate	135	Foot	15
Width of dorsal plate	99	Toe	39
Width of ventral plate	93		

DISTRIBUTION : Karainagar, Jaffna, pond ; Pond nr. Nikeweratiya ; Ambiliwewa nr. Kurunegala.

*Lecane (Lecane) papuana* Murray, 1913 (Figs. 19 and 20)

Wulfert (1966) and Pasha (1961) recorded and described *Lecane papuana* from India. They show the ventral plate as slightly broader than the dorsal plate. In contrast, in the Ceylonese specimens the dorsal plate is slightly broader than the ventral plate. In other respects the Indian and Ceylonese specimens agree. Very common in paddy fields, small ponds and lakes in Ceylon.

## MEASUREMENTS :

Length of dorsal plate	99	Width of anterior end	66
Length of ventral plate	108	Foot	15
Width of dorsal plate	87	Toe	21
Width of ventral plate	83	Claw	9

DISTRIBUTION : Negegoda paddy fields ; Thovaramuddai, Jaffna, pond ; Nedunkani, pond ; Kudawewa, Madampe ; Marawila, ditch ; Handapangala, pond ; Thinipitiwewa, Madampe ; Kantalai tank ; Kandalama tank ; Giants tank ; Ambiliwewa, nr. Kurnegala.

*Lecane (Lecane) plesiaides* sp. nov. (Figs. 21 and 22)

The lorica is sturdy and tapers gradually to the foot. Anterior dorsal and ventral margins slightly conver. External angles bear two strong triangular, more or less erect anterior spines. Dorsal plate convex, smaller than ventral plate. Surface markings limited to two pairs of convergent wavy ridges, beginning near the anterior margin. Ventral plate moderately convex. Width of dorsal and ventral plates equal. Width of lorica nearly two-third the length of body. Anterior end widest tapering posteriorly with the sides of lorica slightly undulate. A well marked transverse fold present immediately in front of foot. Lateral sulci absent. Posterior segment distincts from main body. First foot joint large, second sub-square and does not project beyond the lorica. Toes long about one-third the length of lorica and tapers into a fine point, without claws.

## MEASUREMENTS :

Length of dorsal plate	75	Width of anterior end	57
Length of ventral plate	85	Foot	8
Width of dorsal plate	50	Toe	31
Width of ventral plate	50		

*Lecane plesiaides* resembles *Lecane crepida* Haring, and *Lecane plesia* Myers, and has the general outline of these species. The lorica of *Lecane crepida* is however parallel sided in the anterior half of its length and tapers rapidly to the foot. It is also strongly gibbous posteriorly. The foot does not project beyond the lorica in *Lecane crepida* and the claws are absent. Although *Lecane crepida* and *Lecane plesiaides* are of approximately the same size, these morphological differences stand out clearly. *Lecane plesia* is also approximately the same size but differs from *Lecane plesiaides* in the following characters. The anterior spines at the external angles in *Lecane plesiaides* are more prominent and distinctly triangular whereas in *Lecane plesia* the spines are rudimentary. The lorica in *Lecane plesiaides* tapers gradually to the foot whereas in *Lecane plesia* it is more or less parallel sided for most of the length. The toes are also different in that the claws are absent in *Lecane plesiaides*. In view of all these differences and other structural characteristics different from other *Lecane* species we propose that this species be designated *Lecane plesiaides* sp. nov.

DISTRIBUTION : Recorded only from Tabbowa, pond.

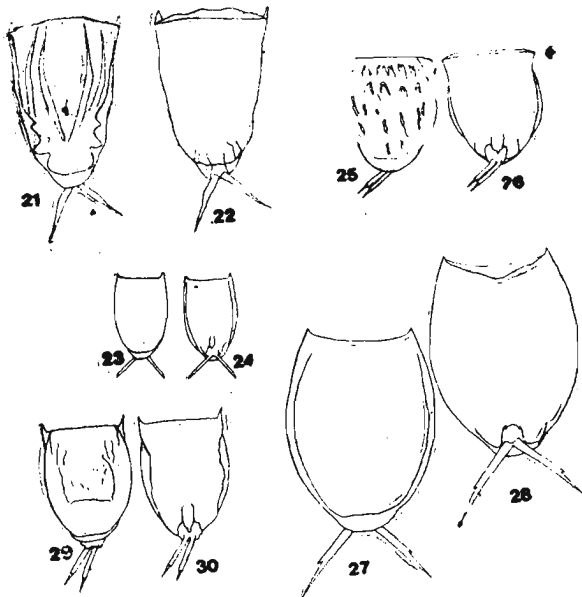
*Lecane (Lecane) ploenensis* Voigt, 1902 (Figs. 23 and 24)

The anterior margins are coincident with small triangular spines at the edges. The foot is well inside the lorica. In Wulfert's (1966) drawings of *Lecane ploenensis* from India the foot is shown as projecting outside the lorica. This may be because of the varying degree of contraction. The design on the dorsal and ventral plates were not discernible. The Ceylonese forms also are generally smaller. *Lecane ploenensis* has not been recorded from Ceylon previously.

MEASUREMENTS :

Length of dorsal plate	90	Width of anterior end	54
Length of ventral plate	99	Foot	12
Width of dorsal plate	60	Toe	36
Width of ventral plate	51		

DISTRIBUTION : Mahakandarawa wewa ; Kudawewa ; Marawila, ditch ; Waga, pond  
Poralesgamuwa tank.



Figs. 21 and 22.—*Lecane plesioides* dorsal and ventral views

Figs. 23 and 24.—*Lecane ploenensis* dorsal and ventral views

Figs. 25 and 26.—*Lecane pusilla* dorsal and ventral views

Figs. 27 and 28.—*Lecane unguolata* dorsal and ventral views

Figs. 29 and 30.—*Lecane verecunda* dorsal and ventral views

*Lecane (Lecane) pusilla* Haring, 1914 (Figs. 25 and 26)

Lorica broadly ovate. Anterior margins are not coincident, the dorsal plate projects a little over the ventral plate. The Ceylonese specimens agree in details with the description given by Haring and Myers (1926).

MEASUREMENTS :

Length of dorsal plate	53	Width of anterior end	43
Length of ventral plate	59	Foot	8
Width of dorsal plate	45	Toe	13
Width of ventral plate	40	Claw	5

DISTRIBUTION : Tabbowa, pond ; pond nr. Nikeweratiya.

*Lecane (Lecane) ungulata* Gosse, 1887 (Figs. 27 and 28)

Wulfert's (1966) drawings of *Lecane ungulata* based on material from India, shows that the dorsal plate is wider than the ventral plate in the middle portion, whereas in the Ceylonese specimens the dorsal plate is narrower than the ventral plate. The anterior end of the dorsal plate of Indian specimens have a small medium sinus unlike the Ceylonese specimens which have a more or less straight anterior end. The Ceylon specimens agree with the specimens from the United States described by Harring and Myers (1926). *Lecane ungulata* is very common in the samples from Ceylon.

MEASUREMENTS :

Length of dorsal plate	207	Width of anterior end	126
Length of ventral plate	231	Toe	27
Width of dorsal plate	162	Foot	66
Width of ventral plate	171	Claw	33

DISTRIBUTION : Tabbowa, pond ; Karainagar, Jaffna, pond ; Kayts, Jaffna, paddy field ; Punkadativu, Jaffna, pond ; Ilavalai, Jaffna, pond ; Karapola villu nr. Polonnaruwa ; Kudawewa ; Madampe ; Marawila, pond ; Nikeweratiya, pond ; Marawila, ditch.

*Lecane (Lecane) verecunda* Harring and Myers, 1926 (Figs. 29 and 30)

The anterior end coincident with two triangular spines at the external angles. Ceylonese forms closely resemble the specimens from the United States except that the Ceylonese forms are smaller in size. *Lecane verecunda* has not been recorded from Ceylon previously.

MEASUREMENTS :

Length of dorsal plate	55	Width of anterior end	41
Length of ventral plate	59	Foot	11
Width of dorsal plate	45	Toe	17
Width of ventral plate	34	Claw	6

DISTRIBUTION : Recorded only from Tabbowa, pond.

*Lecane (Hemimonstyla) sympoda* Hauer, 1929 (Figs. 31 and 32)

The specimens from Ceylon agree morphologically with the species described by Hauer (1938) from Indonesian material. However the differences between *Lecane sympoda*, *Lecane undulata*, and *Lecane inopinata*, are negligible and may be regarded as slight variations of size and due to contraction. We agree with Wulfert (1966) that all these species mentioned above can be considered as *Lecane sympoda*. *Lecane sympoda* has not been recorded from Ceylon previously. It was present in small numbers in two small ponds in Ceylon.

MEASUREMENTS :

Length of dorsal plate	60	Width of anterior end	44
Length of ventral plate	63	Foot	8
Width of dorsal plate	47	Toe	18
Width of ventral plate	42	Claw	6

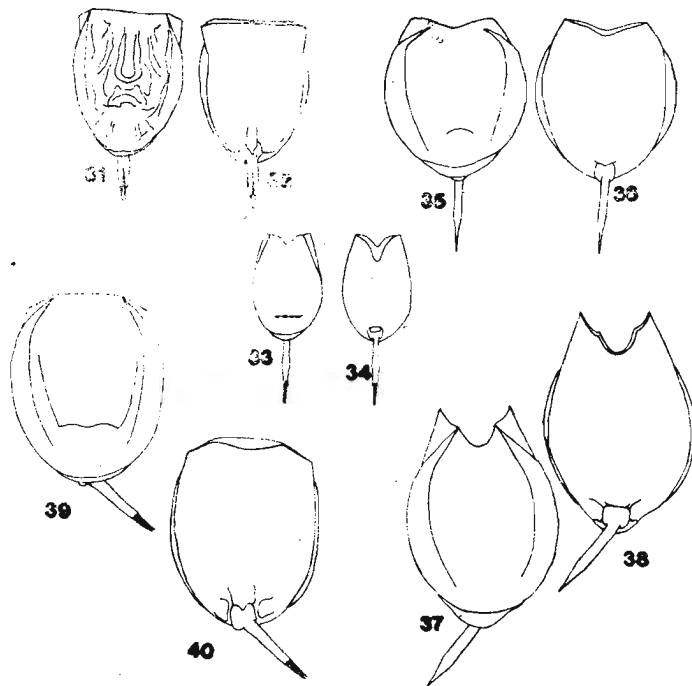
DISTRIBUTION : Marawila, pond ; Marawila, ditch.

*Lecane (Monostyla) bulla* Gosse, 1851 (Figs. 33 and 34)

The anterior end of the lorica of Ceylonese specimens is wider than in the forms reported from India (Wulfert, 1966), Indonesia (Hauer, 1938) and from the United States (Harring and Myers, 1926). The dorsal and ventral plates are of the same width.

MEASUREMENTS :

Length of dorsal plate	92	Width of anterior end	51
Length of ventral plate	97	Foot	12
Width of dorsal plate	60	Toe	42
Width of ventral plate	60	Claw	18



Figs. 31 and 32.—*Lecane sympoda* dorsal and ventral views.

Figs. 33 and 34.—*Lecane bulla* dorsal and ventral views.

Figs. 35 and 36.—*Lecane closterocerca* dorsal and ventral views.

Figs. 37 and 38.—*Lecane decipiens* dorsal and ventral views.

Figs. 39 and 40.—*Lecane elachis* dorsal and ventral views.

DISTRIBUTION : The commonest species in Ceylon. Recorded from Nugegoda, paddy field ; Karainagar, pond ; Topawewa, Polonnaruwa ; Mankumban, Jaffna ; Vaddukodai, Jaffna, paddy field ; Saravanai, Nr. Kayts, Jaffna ; Anabulundawa, wewa ; Aranaganwila tank ; Sigiriya tank ; Thovaramuddai, Jaffna, Nedunkani, pond ; Karapola villu, Nr. Polonnaruwa ; Kudawewa, Madampe ; Marawila, ditch ; Marawila pond ; Estate pond Nr. Battuluoya ; Naeliya tank ; Pitchewarnala Marawila, pond ; Unichchi pond ; Amparai tank ; Gaints tank ; Morawewa ; Kantalai tank ; Topawewa, Polonnaruwa ; Nalanda, reservoir ; Mahakandarava wewa ; Vakeneri tank ; Unichchi tank ; Pavatkulam, Udawalawe reservoir ; Beira lake ; Moonplains reservoir ; Ambiliwewa Nr. Kurunegala.

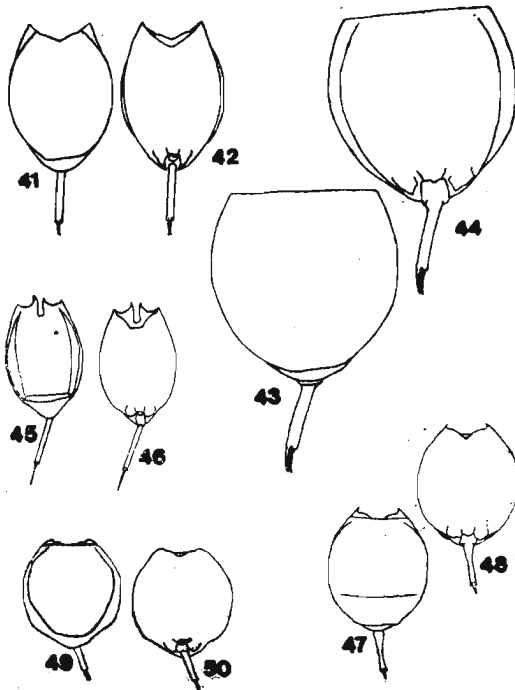
*Lecane (Monostyla) lunaris* Ehrenberg, 1932 (Figs. 41 and 42)

Ceylonese forms are larger than the Indian forms (Wulfert, 1966). Toe is long and has a single claw at the end of which are two pointed spicules. *Lecane lunaris* is very common in ponds.

MEASUREMENTS :

Length of dorsal plate ..	129	Width of anterior end ..	60
Length of ventral plate ..	144	Foot ..	15
Width of dorsal plate ..	99	Toe ..	54
Width of ventral plate ..	93	Claw ..	15

DISTRIBUTION : Recorded from Tabbowa pond ; Kudawewa, Madampe ; Naeliya tank ; Pitchewaranala Marawila, pond ; Waga, pond ; Topawewa, Polonnaruwa ; Castlereagh reservoir ; Udawalawe reservoir.



Figs. 41 and 42.—*Lecane lunaris* dorsal and ventral views.

Figs. 43 and 44.—*Lecane obtusa* dorsal and ventral views.

Figs. 45 and 46.—*Lecane quadrientata* dorsal and ventral views.

Figs. 47 and 48.—*Lecane stenroosi* dorsal and ventral views.

Figs. 49 and 50.—*Lecane unquitata* dorsal and ventral views.

*Lecane (Monostyla) Obtusa* Murray, 1913 (Figs. 43 and 44)

The drawings of Haring and Myers (1926) and Hauer (1938) show that the lorica had minute, spine-like projections at the edges of the anterior end. The Ceylonese specimens lack these spines. *Lecane Obtusa* has not been recorded from Ceylon previously.

MEASUREMENTS :

Length of dorsal plate ..	76	Width of anterior end ..	60
Length of ventral plate ..	82	Foot ..	11
Width of dorsal plate ..	76	Toe ..	26
Width of ventral plate ..	64	Claw ..	11

DISTRIBUTION : Recorded from Tabbowa, pond ; Topawewa, Polonnaruwa ; Karainagar Jaffna.

*Lecane (Monostyla) quadridentata* Ehrenberg, 1832 (Figs. 45 and 46)

The anterior margin shows differences from hitherto known specimens. The dorsal plate has a deep sinus at the anterior end and is flanked by two stout slightly out curved spines which are not of the same length. Ventral plate has a more or less 'V' shaped sinus. Posterior segment rounded and not covered by dorsal plate. Toe and claw long, claw ending in an acute point.

## MEASUREMENTS :

Length of dorsal plate	..	99	..	Width of anterior end	..	45
Length of ventral plate	..	123	..	Foot	..	18
Width of dorsal plate	..	71	..	Toe	..	45
Width of ventral plate	..	75	..	Claw	..	21

DISTRIBUTION : Tabbowa pond ; Sigiriya tank ; Kudawewa, Madampe.

*Lecane (Monostyla) stenroosi* Meissner, 1908 (Figs. 47 and 48)

The anterior dorsal margin is straight. Ventral margin has a shallow, rounded sinus and externally two stout, incurved frontal spines. Posterior segment small and rounded. Ceylonese form are slightly larger than Indian forms described by Wulfert (1966).

## MEASUREMENTS :

Length of dorsal plate	..	120	Width of anterior end	..	45
Length of ventral plate	..	126	Foot	..	12
Width of dorsal plate	..	100	Toe	..	36
Width of ventral plate	..	102	Claw	..	9

DISTRIBUTION : Recorded only from Handapangala tank.

*Lecane (Monostyla) unquitata* Fadeew, 1925 (Figs. 49 and 50)

Specimens from Ceylon are similar to those previously recorded from Asia and Africa. However, the toes are shorter when compared to the Indonesian (Hauer, 1938) African (Green, 1960) and Indian, Wulfert (1966) forms. Posterior segment prominent. The claws resemble most closely the drawing of Hauer (1938) of material from Java with two basal spicules. Ceylonese specimens are larger when compared to the Indian, Indonesian and African material

## MEASUREMENTS :

Length of dorsal plate	..	96	Width of anterior end	..	45
Length of ventral plate	..	108	Foot	..	15
Width of dorsal plate	..	89	Toe	..	27
Width of ventral plate	..	99	Claw	..	12

DISTRIBUTION : Recorded from Tabbowa, pond ; Kudawewa; Madampe ; Marawila, ditch ; Waga, pond ; Kantalai tank ; Ambiliwewa Nr., Kurunegala.

#### ACKNOWLEDGEMENTS

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## Rotifera from Sri Lanka (Ceylon) 2

### Further Studies on the Eurotatoria Including New Records

by

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#### INTRODUCTION

In the first paper of this series, Chengalath and Fernando (1973) dealt with the genus *Lecane* from Sri Lanka. In all, twenty-five species were recorded, of which seventeen species were new records. Two new species were also described. On the present paper we deal with the rest of the Eurotatoria. Again we have found many new records. In all 79 species are described in the present paper of which 47 are new records.

The present study is based on the examination of over 300 samples from 135 localities including large and small tanks, ponds of various sizes, rice fields, streams and marshes. The collections cover the whole area of Sri Lanka and were taken during different seasons of the year mainly from 1968-1972. The sampling localities are given in Fig. 1.

In the previous paper (Chengalath and Fernando 1973) the literature on the Sri Lanka species was reviewed. Also the literature on the Eurotatoria of South and South-East Asia was given. Therefore, we have omitted reference to this literature. The methods used in the present study were the same as those referred to in Chengalath and Fernando (1973).

In the present paper we have given short descriptions of the species we have recorded. Measurements are included for most species. All species are illustrated. While we have not recorded all the variation in morphological features of the species we have studied, we have given some notes on variations in a few cases. Locality data is not given for each species but its general occurrence is noted. All this material will be referred to in a detailed study on Sri Lanka Zooplankton being prepared. All localities for each species will be included in this study. In the present paper a locality for each species is given in Appendix I.

#### List of species

We have listed the species under their respective families and have used the classification of Kutikova (1970).

#### Family Asplanchnidae

*Asplanchna brightwelli* Gosse, 1850

‡ *A. priodonta* Gosse, 1850

‡ *A. sieboldi* Leydig, 1854

*Asplanchnopus multiceps* Schrank, 1783

\* Department of Biology, University of Waterloo, Waterloo, Ontario, Canada.

† D 457 Quakenbruck, W. Germany.

‡ New Records for Sri Lanka.

**ROTIFERA (EUROTATORIA)**



Fig 1. Map of Sri Lanka showing the collecting stations

**Family Brachionidae**

- \**Anuraeopsis coelata* De Beauchamp, 1932
- Anuraeopsis fissa* Gosse, 1851
- Brachionus angularis* Gosse, 1851
- B. budapestensis* Daday, 1885
- B. calyciflorus* Pallas, 1776.
- B. caudatus* Barrois and Daday, 1894
- \**B. caudatus* var. *aculeotus* Hauer, 1937
- \**B. donneri* Brehm, 1950
- B. falcatus* Zacharias, 1898
- B. forficula* Wierzejski, 1891
- \**B. leydigi* Cohn, 1862
- \**B. nilsoni* Ahlstrom, 1940
- B. quadridentatus* Herman, 1783
- B. rubens* Ehrenberg, 1838
- \**B. sessilis* Varga, 1951
- \**B. urcues* Linneaus, 1758
- \**B. urcoelaris* Muller, 1773
- B. patulus* Muller, 1786
- \**Kellicottia longispina* Kellicott, 1879
- Keratella cochlearis* Gosse, 1851
- \**K. earlinae* Ahlstrom, 1943
- \**K. lenzi* Hauer, 1953
- \**K. taurocephala* Myers, 1938
- K. tropica* Apstein, 1907
- Platylas quadricornis* Ehrenberg, 1832

**Family Euchlanidae**

- Euchlanis dilatata* Ehrenberg, 1832
- \**E. incisa* Carlin, 1939
- \**E. oropha* Gosse, 1887
- \**Dipleuchlanis macrodactyla* Hauer, 1965
- \**D. propatula* Gosse, 1887
- \**Tripleuchlanis plicata* Levander, 1894

**Family Mytilinidae**

- Mytilina mucronata* Muller, 1773
- M. ventralis* Ehrenberg, 1832

**Family Notommatidae**

- \**Cephalodella forficula* Ehrenberg, 1832
- \**C. gibba* Ehrenberg, 1832
- \**Notommatia* sp.
- Scaridium longicaudum* Muller, 1786

**Family Trichotridae**

- \**Macrochaetus collinsi* Gosse, 1867
- \**M. sericus* Thorpe, 1893
- Trichotria pocillum* Muller, 1776
- \**T. tetractis* Ehrenberg, 1832

**Family Trichocercidae**

- \**Trichocerca bicristata* Gosse, 1887
- \**T. braziliensis* Murray, 1913
- \**T. chattoni* De Beauchamp, 1907
- \**T. cylindrica* Imhoff, 1891
- \**T. dixon-nuttali* Jennings, 1903
- \**T. rattus* Muller, 1776
- \**T. similis* Wierzejski, 1893
- \**T. stylata* Gosse, 1851

**Family Colurellidae**

- \**Lepadella costata* Wulfert, 1940
- L. ovalis* Muller, 1796
- \**L. patella* Muller, 1786
- \**L. rhomboides* Gosse, 1886

**Family Dicranophoridae**

- \**Dicranophorus robustus* Harring and Myers, 1928

**Family Synchaetidae**

- \**Polyarthra dolichoptera* Idelson, 1925
- P. vulgaris* Carlin, 1943

**Family Collotheceidae**

- \**Collotheca ornata natans* Tschugunoff, 1921

**Family Filinidae**

- \**Filinia camascela* Myers, 1938
- F. longiseta* Ehrenberg, 1834
- F. opoliensis* Zacharias, 1898
- \**F. pejleri* Hutchinson, 1964
- F. terminalis* Plate, 1886

**Family Hexarthridae**

- Hexarthra intermedia* Wisniewski, 1929
- H. mira* Hudson, 1871

**Family Floscularidae**

- \**Floscularia ringens* Linnaeus, 1758
- Sinantherina semibullata* Thorpe, 1889
- \**S. spinosa* Thorpe, 1893

**Family Conochilidae**

- \**Conochilus unicornis* Rousset, 1892
- \**Conochiloides dossuarius* Hudson, 1885
- \**C. natans* Seligo, 1900

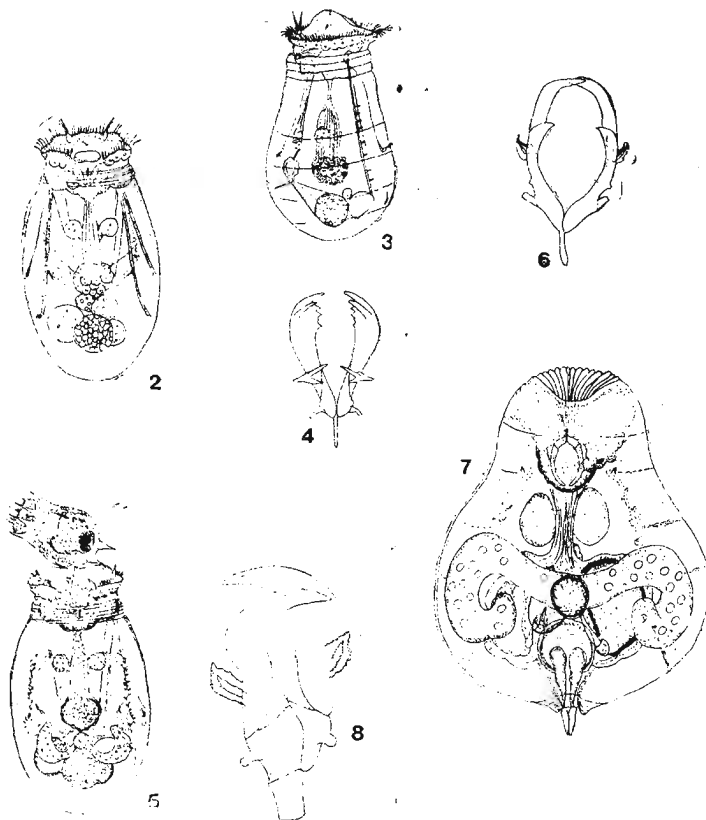
Family Testudinellidae

- \**Horealla brehmi* Donner, 1949
- Pompholyx complanata* Gosse, 1851
- \**Testudinella parva* Ternetz, 1892
- Testudinella patina* Herman, 1783
- Trochosphaera equatorialis* Semper, 1872

DESCRIPTION OF SPECIES

Genus *Asplanchna* Gosse, 1850

The transparent, sac-like *Asplanchna* is represented by 3 species in Sri Lanka. Of the 3 species *Asplanchna priodonta* and *A. brightwelli* are much more common than *A. sieboldi*. The identification of the species was done using the works of Voigt (1957), Bartos (1959) and Kutikova (1970).



Figs. 2 and 3.—*Asplanchna priodonta* ventral and lateral view respectively.

Fig. 4.—*Asplanchna priodonta* trophi.

Fig. 5.—*Asplanchna brightwelli*.

Fig. 6.—*Asplanchna sieboldi* trophi

Figs. 7 and 8.—*Asplanchnopus multiceps* contracted form and trophi respectively.

*Asplanchna brightwelli* Gosse, 1850 (Fig. 5)

Vitellarium horse-shoe shaped with more than 30 nuclei. The trophi resemble the drawings given by Kutikova (1970). Most of the specimens examined measured close to 1mm. in length even in the contracted state.

MEASUREMENTS Length of body—1250\*, Trophi—100

Very common in large and small lakes especially in eutrophic situations.

Measurements in  $\mu$  unless otherwise stated.

*Asplanchna priodonta* Gosse, 1850 (Fig. 2-4)

Vitellarium rounded. The trophi are characteristic and the inner edge of the rami has 4 to 6 teeth at the anterior end. There are also two lateral prolongations at the base of the rami. Fulcrum narrow. *A. priodonta* has not been recorded from Sri Lanka previously. However, it has been reported from India (Wulfert, 1966).

MEASUREMENTS Length of body—1200, Trophi—60.

Rare ; found in large lakes usually.

*Asplanchna sieboldi* Leydig, 1854 (Fig. 6)

Vitellarium horse-shoe shaped like in *A. brightwelli* but can be easily identified by the structure of the trophi. The trophi of the Sri Lanka specimens correspond exactly to the drawings of Hauer (1938) for material from Indonesia. The only minor difference from Hauer's drawings is in the shape of the allulae arising from the rami and in the single spine-like projection inwards in the middle of the rami. *A. sieboldi* has not been reported from Sri Lanka previously.

MEASUREMENTS Trophi—78.

Rare ; found in lakes.

Genus *Asplanchnopus* de Guerne, 1888.

This genus is represented by only a single species. The identification of this species is based on the works of Voigt (1957) and Kutikova (1970).

*Asplanchnopus multiceps* Schrank, 1783 (Fig. 7 and 8)

The foot in contracted specimens is hard to see sometimes. Trophi characteristic. The allulae on the rami differ in different specimens from little developed to well developed.

MEASUREMENTS Total length—980.

Common in ponds, rice fields and lakes.

Genus *Anuraeopsis* Lauterborn, 1900

This genus is represented by two species. The identification of species is based on Wulfert (1966).

*Anuraeopsis coelata* De Beauchamp, 1932 (Fig. 9)

The forms found in Sri Lanka are exactly like the ones found in India (Wulfert, 1966), except that the specimens found in Sri Lanka are slightly larger in size. There is a 'U' shaped sinus in the anterior end and no teeth are present inside the sinus. Small teeth are present outside the anterior sinus. Lorica pustulated. This species has not been recorded from Sri Lanka previously.

MEASUREMENTS Length of lorica—112, Width—50

Common in ponds, lakes and rice fields.

*Anuraeopsis fissa* Gosse, 1851 (Fig. 10)

Lorica made of two plates dorsal and ventral. The dorsal plate is round. The forms found in Sri Lanka resemble the Indian specimens (Wulfert, 1966). However, the Sri Lanka forms are larger.

MEASUREMENTS Length of lorica—90, Width—50.

Common in ponds and lakes.

Genus *Brachionus* Pallas, 1766

Sixteen species of *Brachionus* are recorded and this is the commonest genus in Sri Lanka. Identification of species is based on the comprehensive works of Voigt (1957), Kutikova (1970) and the monograph of Ahlstrom (1940).

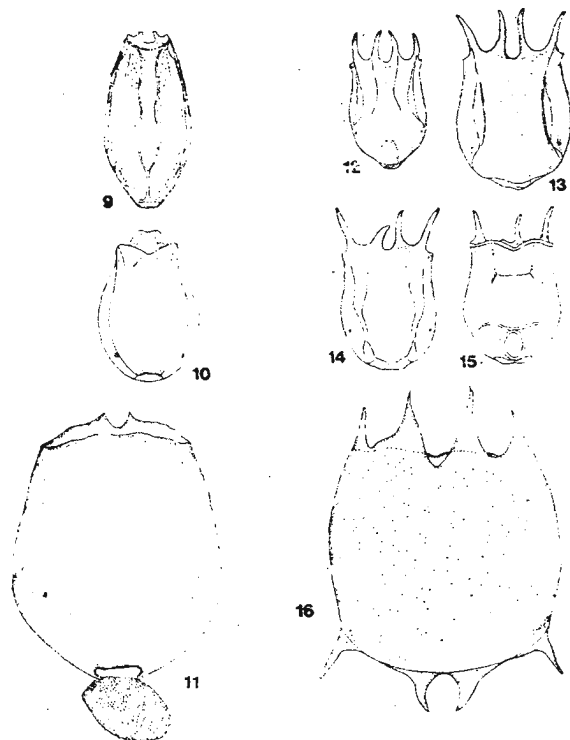


Fig. 9.—*Anuraeopsis coelata*.

Fig. 10.—*Anuraeopsis fissa*.

Fig. 11.—*Brachionus angularis*.

Figs. 12-15.—*Brachionus budapestensis*.

Fig. 16.—*Brachionus clayciflorus*.

*Brachionus angularis* Gosse, 1851 (Fig. 11)

*B. angularis* is one of the more variable species of *Brachionus*. Many forms found in Sri Lanka lack intermediate spines in which case the occipital lateral margin invariably rounds off the middle to form median spines. Most of the forms found in Sri Lanka are similar to the ones reported from Rajasthan, India (Nayar, 1968). Only the median spines are prominent and there is a deep sinus in between them. The Sri Lanka forms are smaller compared to the ones described by Nayar (1968) from North India. Ahlstrom (1940) describes a small form from Madras, S. India and the Sri Lanka forms fall in between the North and South Indian forms in size.

MEASUREMENTS :	<i>Sri Lanka</i>		<i>S. India</i>		<i>N. India</i>	
	Length	Width	Length	Width	Length	Width
	101	75	91	71	120	96

Found in large and small lakes. Not common.

*Brachionus budapestensis* Daday, 1885 (Figs. 12-15)

Lorica firm and sturdy. Foot opening more or less rounded. In some cases the lorica is lightly stippled. The forms found in Sri Lanka seems to be larger compared to the measurements given by Ahlstrom (1940) from North and South America.

Total length 150-200. Very rare, found only in a few large lakes.

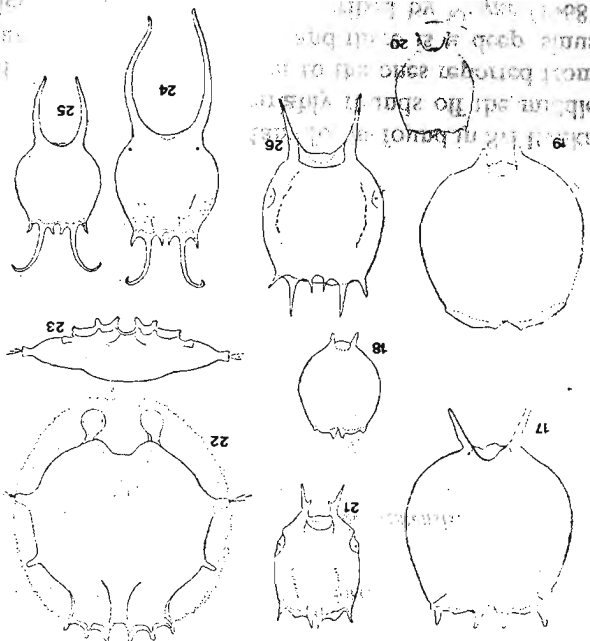
*Brachionus calyciflorus* Pallas, 1776 (Fig. 16)

A variable species especially with respect to the development of anterior and posterior spines.

The cyclomorphosis of this species has been studied by Nayyar (1963) in Northern India and he gives the variations in dimensions of *B. calyciflorus* in another paper Nayyar, (1964). Apart from the usual forms an exceptional form with a very wide lorica was encountered in some samples (Fig. 16). These large forms had well developed anterior spines but the posterior spines are relatively shorter.

MEASUREMENTS: Total length—490, width—420, Anterior median spines—65, Anterior lateral spines—47, Posterior lateral spines—25, Posterior median spines—22.

Very common in large and small lakes, also occurs in rivers. Rare in ponds.



Figs. 17-20—*Brachionus caudatus* showing variation.

Fig. 21—*Brachionus caudatus* var. *aculeatus*.

Figs. 22 and 23—*Brachionus donneri* dorsal view and lateral view from head side respectively.

Figs. 24 and 25—*Brachionus falcatulus* showing variation.

Fig. 26—*Brachionus falcatulus* short spined riverine form.

*B. caudatus* is a highly variable species. The variability has been studied in detail by Green (1960). The posterior spines vary from little developed to well developed and even asymmetrically developed. Among the anterior spines the lateral spines may or may not be present. Specimens with different degrees of development in anterior and posterior spines were found in the same sample. Ahlstrom (1940) has recorded measurements of specimens from Brazil, Argentina and Mexico and compared to these the Sri Lanka specimens are smaller and the posterior spines are much shorter.

MEASUREMENTS: Total length—153, Width—114, Anterior median spines—9, Anterior lateral spines—3, Right posterior spine—18, Left posterior spine—12.

This species is restricted to the tropical region unlike most *Brachionus* species. Fairly common in large and small lakes.

*Brachionus caudatus* var. *aculeatus* Hauer, 1937 (Fig. 21)

The specimens from Sri Lanka are typical. The anterior median and lateral spines are of the same length. The inward projection from the posterior spines are prominent. Posterior spines equal in length. This species is not common in Sri Lanka. Nayar (1968) mentions that this variety is found commonly in Rajasthan, North India. The Sri Lanka forms are a little smaller compared to the Indian forms.

MEASUREMENTS : Total length—133, Width—81, Anterior median spines—12, Anterior lateral spines—12, Posterior spines—33.

Found in only one locality namely Giants Tank, Nr. Mannar.

*Brachionus donneri* Brehm, 1950 (Figs. 22 and 23) (Plate-A)

This interesting species is usually covered with filamentous algae and other debris making it very difficult to locate in samples and thus may be easily missed. So far it has been described only from India (Brehm, 1951). The forms found in Sri Lanka differs from the original material in some respects. Forms found in Sri Lanka are much more rounded compared to the drawings given by Brehm (1951). Brehm (1951) shows 6 blunt spines at the anterior dorsal margin and 4 blunt spines at the anterior ventral margin, whereas forms found in Sri Lanka have 6 blunt spines on both the ventral and dorsal aspects. The posterior projections of the lorica are club shaped and have a deep sinus between them. The projections from the side of lorica are also prominent.

MEASUREMENTS : Length of lorica—206, Width at anterior end—170.

Rare ; recorded in two localities, Senanayake Samudra and pond near Kandy.

*Brachionus falcatus* Zacharias, 1898 (Figs. 24-26)

The anterior and posterior spines vary considerably. A form with very short spines was found in large numbers from a river (Battuluoya). This form with shorter spines may be a modification for running water existence since longer spines tend to entangle easily.

MEASUREMENTS : Total length—246, Width—96, Anterior lateral spines—12, Anterior intermediate spine—69, Anterior median spine—12.

RIVER FORM : Total length—213, Width—114, Anterior lateral spines—18, Anterior intermediate spine—33, Anterior median spine—15.

Very common in all types of habitats.

*Brachionus forficula* Wierzekski, 1891 (Fig. 27) (Plate-B)

Anterior intermediate spines missing. The antero-laterals are longer than the antero-median spines. The Sri Lanka forms resemble a new variety described from Kerala, South India (Nayar, 1969). The only difference is in the absence of anterior intermediate spines which are present in the South Indian forms. Lorica terminates posteriorly in a pair of stout more or less equal spines and have no swellings at the base of these spines. Compared to the measurements given by Nayar (1960) the Ceylonese forms seems to be a little smaller.

MEASUREMENTS : Total length—195, Width 92, Anterior median spines—10, Anterior lateral spines—20, Posterior spines—84.

Very common in large and small lakes, rivers, rice fields and ponds.

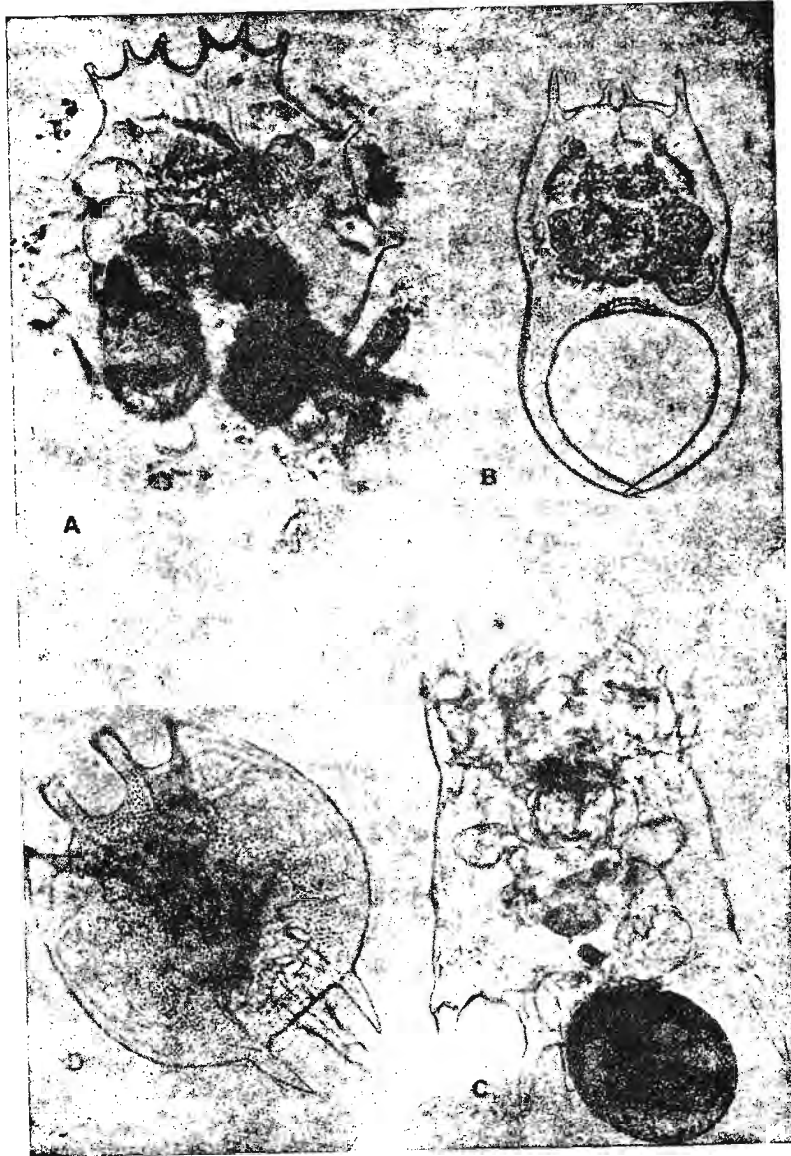


Plate : 1 A.—*Brachionus donneri*, dorsal view.  
B.—*Brachionus forficula*.  
C.—*Brachionus patulus*.  
D.—*Platytias quadricornis*.

*Brachionus leydigi* Cohn, 1862 (Fig. 28 and 29)

Anterior spines are all curved. The inner two spines curve outward, the intermediates and laterals usually curve inwards. The posterior end of the lorica usually broader than the anterior end. The three spines surrounding the foot opening are prominent. *B. leydigi* has been recorded from China and India (Ahlstrom, 1940) but was not been reported from Sri Lanka previously.

MEASUREMENTS : Total length—280.

Rare, occurs in large and small lakes.

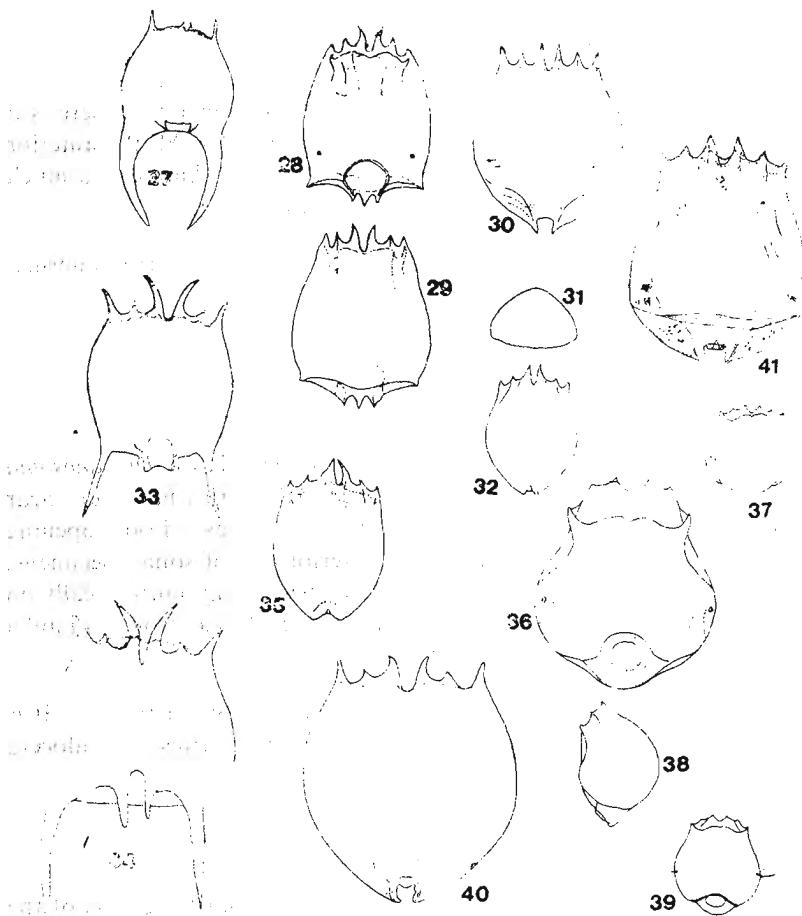


Fig. 27—*Brachionus forficula*

Figs. 28 and 29—*Brachionus leydigi*

Figs. 30-32—*Brachionus nilsoni*

Figs. 33 and 34—*Brachionus quadridentatus*

Fig. 35—*Brachionus rubens*

Figs. 36-39—*Brachionus sessilis*

Fig. 40—*Brachionus urceus*

Fig. 41—*Brachionus urceolaris*

*Brachionus nilsoni* Ahlstrom, 1940 (Fig. 30-32)

Lorica more or less rounded. Anterior spines are narrow, pointed and short with a short strengthening ridge. Median sinus prominent. Juvenile forms of *B. nilsoni* were found in some samples. They were smaller and the spines have not developed well except for the antero-medians. This species has not been recorded from Sri Lanka previously.

MEASUREMENTS : Total length—136-196.

Rare, but occurs in large and small lakes, in the littoral region.

*Brachionus quadridentatus* Herman, 1783 (Fig. 33 and 34)

A variable species. Anterior and posterior spines were well developed in all specimens examined. The lorica seemed to be longer than is usually described. Some specimens were heavily stippled while some were only lightly stippled. The foot sheath is well developed in some specimens projecting as blunt spines bounding the foot opening and is always asymmetric. This species is considered to be cosmopolitan.

MEASUREMENTS : Total length—240, width—135, Anterior lateral spines—21, Anterior intermediate spines—9, Anterior median spines—63, and posterior spine—66.

Very common in weedy ponds and rice fields.

*Brachionus rubens* Ehrenberg, 1838 (Fig. 35)

Lorica sturdy with six anterior spines of which the median spines are the longest. There is a 'V' shaped median sinus. Intermediate and lateral spines are short and pointed. All the anterior spines have a strengthening rib. Lorica not ornamented. *B. rubens*, found in Sri Lanka are much smaller than the Indian (Nayar, 1968), European or American forms (Ahlstorm, 1940).

MEASUREMENTS: Total length 144, Width—102, Anterior lateral spines—6, Anterior intermediate spines—6, Anterior median spines—12.

Rare, found in ponds and small lakes.

*Brachionus sessilis* Varga, 1951, (Fig. 36—39)

This species was first described by Varga (1951) from Lake Balaton, epizoic on *Diphanosoma bachyurum* (Lieven) and has not been reported since. The anterior end of the lorica has four clear small spine-like projections with a fairly deep sinus between the median spines. Foot opening ventral, large and more or less round. Eggs were attached to the posterior end of some specimens. In Sri Lanka *B. sessilis* was found from only one lake (Pavatkulam) and was living epizootically on *Diaphanosoma excisum* (Sars). This species of epizoic rotifera has not been recorded from Sri Lanka previously.

Only a single record so far from Sri Lanka, but probably fairly common as an epizoite. It is interesting to note that in widely different parts of the world it occurs on the same genus of Cladocera showing specificity.

*Brachionus urceus* (Linnaeus, 1758) (Fig. 40)

*B. urceus* is similar to *B. urceolaris* but differs from it in its smaller size and the shape of the anterior spines. The lorica is distinctly rounded and without ornamentation. The anterolateral and anteromedian spines are longer than intermediate spines. All the spines have a broad base. No strengthening ribs for the spines were discernible in specimens from Sri Lanka. This species has not been recorded from Sri Lanka previously.

MEASUREMENTS : Length of lorica—150, width—120, Anterior lateral spines—18, Anterior intermediate—6, Anterior median spines—18.

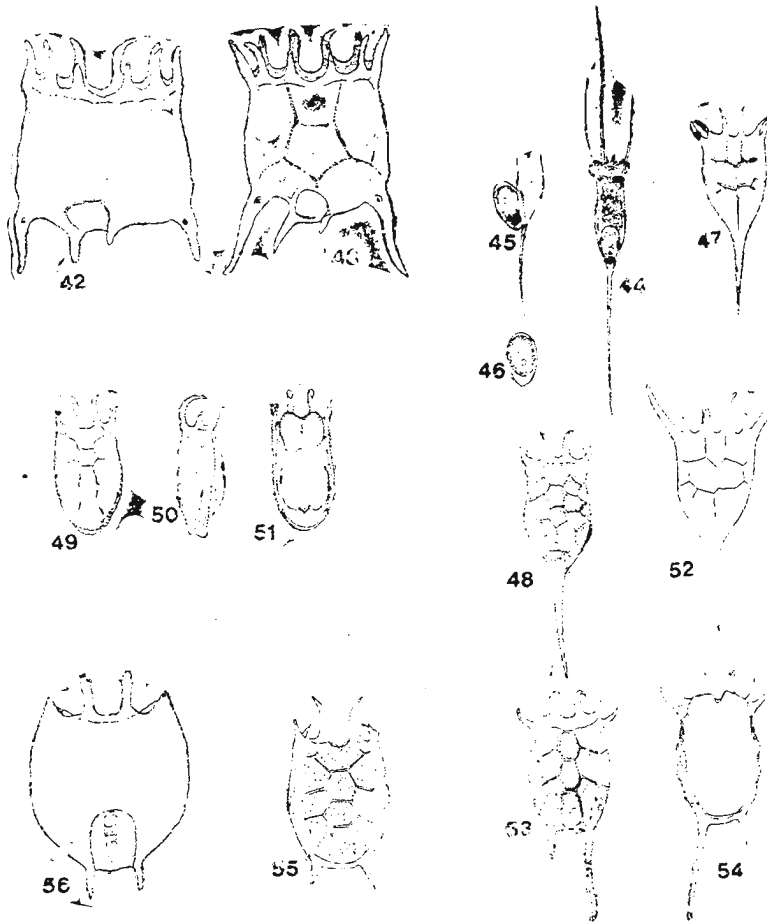
Rare, occurs in similar habitats as *B. nilsoni* and *B. urceolaris*, i.e. small and large lakes littora

*Brachionus urceolaris* Muller, 1773 (Fig. 41)

Lorica sturdy with longitudinal lines. The anterior spines have strengthening ribs. Lorica is lightly stippled especially at the edges. This species has not been reported from Sri Lanka previously.

MEASUREMENTS : Total length of lorica-245.

Rare ; occurs in similar habitats as *B. nilsoni* and *B. urceus*, i.e. small and large lakes, littoral.



Figs. 42 and 43—*Brachionus patulus*.

Figs. 44 and 45.—*Kellicottia longispina* ventral view and end of body with egg respectively.

Fig. 46—*Kellicottia longispina* egg.

Fig. 47—*Keratella cochlearis* dorsal view.

Fig. 48—*Keratella erlinae*.

Figs. 49 and 50—*Keratella lenzi* dorsal view and lateral view respectively.

Fig. 51—*Keratella lenzi* ventral view.

Fig. 52—*Keratella taurocephala*

Figs. 53 and 54—*Keratella tropica* dorsal and ventral view respectively.

Fig. 55—*Keratella tropica* small riverine form.

Fig. 56—*Platytias quadricornis* dorsal view.

*Brachionus patulus* (Muller, 1786) (Fig. 42 and 43) (Plate-C)

*B. patulus* is a very common rotifer and varies considerably in the development of spines. Some specimens have long posterior spines, both lateral and median. However, in most specimens the posterior median spines are shorter than the lateral and are asymmetrical. Sri Lanka forms agree with the description of Ahlstrom (1940). This species is considered to be cosmopolitan.

MEASUREMENTS : Total length—255-275

Very common in ponds but also occurs especially in littoral samples from lakes.

Genus *Kellicottia* Ahlstrom, 1938

This genus is a new record for Sri Lanka and is represented by a single species *K. longispina*. *Kellicottia* are long bodied, long spined rotifers with unpaired occipital spines of an equal length. Identification of species is based on Ahlstrom (1938).

*Kellicottia longispina* (Kellicott, 1879) (Fig. 44-46)

This species can be easily identified by its long thin body and long anterior and posterior spines. *K. longispina* has 6 anterior spines of varying length. Mental margin elevated with a 'U' shaped sinus. The anterior spines have short strengthening ridges and the lorica is not ornamented. Usually found entangled together in clusters because of long spines, this species has not been recorded from Sri Lanka previously.

MEASUREMENTS : Total length—780.

Rare ; only recorded from a few lakes.

Genus *Keratella* Bory de St. Vincent, 1822

This genus is represented by 5 species. However, *K. tropica* is the commonest of all species in the genus ; the other species are found only very occasionally. The identification of species is based on the revision of *Keratella* by Ahlstrom (1943).

*Keratella cochlearis* Goose, 1851 (Fig. 47)

The shape and the foundation pattern of this species is as described in Ahlstrom (1943). *K. cochlearis* has been recorded from North India (Edmondson and Hutchinson, 1934), but has not been recorded from Sri Lanka previously.

MEASUREMENTS : Total length—211, length of body—99, width—67, Anterior lateral spine—29, Anterior intermediate spine—25, Anterior median spines—32, posterior spine—80.

Rare ; recorded from a few large lakes.

*Keratella earlinae* Ahlstrom, 1943 (Fig. 48)

*K. earlinae* found in Sri Lanka agrees with the description given by Ahlstrom (1943) for material from North America. The lorica has pustules distributed along the ridges of the dorsal plate and also irregularly inside the plaques. There seems to be an extra anterolateral polygon on either side situated between the median frontal area and the accessory antero-median hexagon which is small. The posterior spine is relatively long. This species has not been recorded from outside North America so far and is a first record for Sri Lanka. Sri Lanka forms are larger compared to the North American forms.

MEASUREMENTS : Total length—256, Length of body—108, Width—89, Antero-lateral spine—29, Anterior intermediate spine—16, Anterior median spines—38, Posterior spine—106.

Rare ; found in lakes and ponds.

*Keratella lenzi* Hauer, 1953 (Fig. 49-51)

This species was first recorded from Brazil by Hauer (1953). Subsequently it has been reported from Transval, South Africa by Edmondson and Hutchinson (1934), whose identification was corrected by Berzins (1955) and by Green (1967) from lake Victoria, Lake Kyoga and Lake Albert in Africa. The forms found in Sri Lanka agree with the drawings of Berzins (1955). This species has not been recorded from Sri Lanka previously.

MEASUREMENTS : Length of lorica—148.

Rare ; occurs in large and small lakes.

*Keratella taurocephala* Myers, 1938 (Fig. 52)

The Sri Lanka specimens agrees with the description given by Ahlstrom (1943) for *materia*, from the United States. The dorsal pattern in the lorica was clearly visible. Posterior spine very long. The Sri Lanka forms are larger than those mentioned in Ahlstrom's (1943) paper but falls within the range of specimens from Ontario, Canada (Chengalath, 1971). *Keratella taurocephala* is recorded for the first time from outside North America, and is a new record for Sri Lanka.

MEASUREMENTS : Total length—285, Length of body—109, Width—83, Anterior lateral spine—54, Anterior intermediate spine—16, Anterior median spine—38, Posterior spine—125.

Rare, considered an acid water species. Found in few lakes.

*Keratella tropica* Asptein, 1907 (Fig. 53-55)

The posterior spines have varying lengths. However, the left is always shorter than the right. This species has been reported from India (Edmondson and Hutchinson, 1934), Indonesia (Hauer, 1938) and Africa (Green, 1967). The cyclomorphosis of this species have been studied by George (1966) in India and by Green (1967) in Africa. A diminutive form of this species with small lorica and small stumpy spines was found in a sample from a river (Batuluoya) (Fig. 55). This may be a special adaptation for running waters (Hynes, 1970) and was found in large numbers.

MEASUREMENTS : Total length of lorica—240.

RIVER FORM : Total length—132, Width—63, Anterior lateral spines—18, Anterior intermediate spines—12, Anterior median spines—30, Right posterior spine—18, Left posterior spine—12.

The most common species in lakes. But also occurs in rivers, ponds and rice fields.

Genus *Platyias* Haring, 1913

Wulfert (1965) revised this genus and has removed all the species except *P. quadricornis* from stand has included in the genus *Brachiomus*. Identification of species based on Ahlstrom (1940) and Wulfert (1965). This genus is represented by only one species.

*Platyias quadricornis* Ehrenberg, 1832 (Fig. 56) (Plate—D)

The material agrees with the description of Ahlstrom (1940). The tips of anterior median spines are invariably curved ventrally.

MEASUREMENTS : Total length—319, Width—156, Anterior spine—42, Posterior spine—24.

Very common in ponds. Also occurs in littoral samples from lakes.

Genus *Euchlanis* Ehrenberg, 1832 (including *Dipleuchlanis* and *Tripleuchlanis*)

The members of this genus are littoral forms and they are represented in Sri Lanka by six species. The identification of species is based on the paper of Myers (1930) and the comprehensive works of Voigt (1957), Bartos (1959) and Kutikova (1970).

*Euchlanis dilatata* Ehrenberg, 1832 (Fig. 57-60)

This species varies considerably in size and shape not only in dorsal and ventral views but also in cross sections, the dorsal arc being high or low. The anterior end and the posterior notch which is shaped like an inverted 'U' are characteristic. It is large and has a characteristic shape.

MEASUREMENTS : Length of ventral plate—120-260, Length of dorsal plate—108-205, Width of ventral plate—72-135, Width of dorsal plate—108-165, Length of toes—51-72.

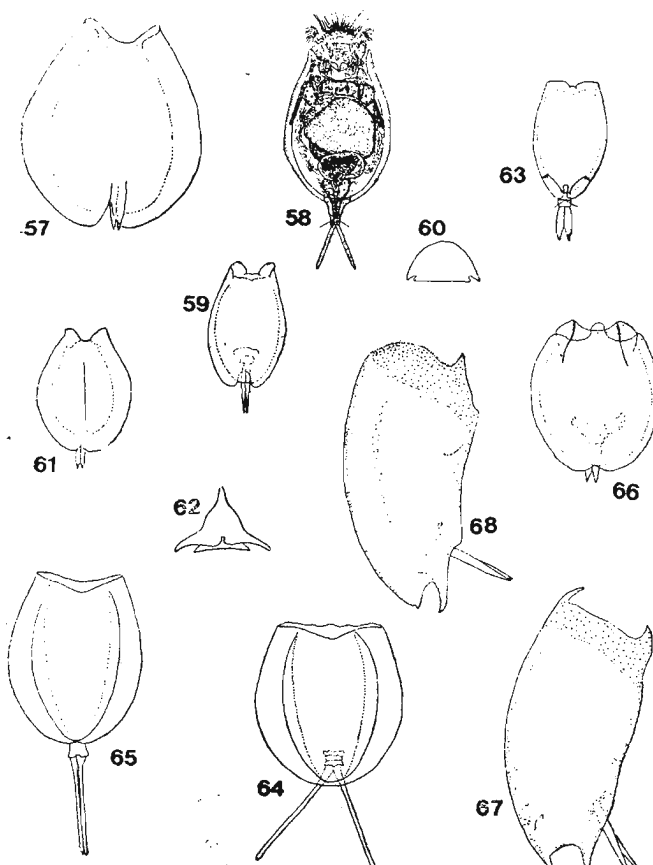
One of the commonest rotifer species occurring in all types of habitats equally frequently.

*Euchlanis incisa* Carin, 1939 (Fig. 61-62)

Body oval shaped. This species is smaller compared to most of the *Euchlanis dilatata* and *E. oropha* found in Sri Lanka. The 'V' shaped notch at the posterior end of the dorsal plate is characteristic. This species has not been recorded from Sri Lanka previously.

MEASUREMENTS : Length of ventral of plate—172, Length of dorsal plate—110, Width of lorica—80, Length of toe—66.

Rare ; found in ponds and lakes.



Figs. 57-59.—*Euchlanis dilatata*

Fig. 60.—*Euchlanis dilatata* cross section.

Figs. 61 and 62.—*Euchlanis incisa* dorsal view and cross section respectively.

Fig. 63.—*Euchlanis oropha*

Fig. 64.—*Dipleuchlanis macrodactyla*

Fig. 65.—*Dipleuchlanis propatula*

Fig. 66.—*Tripleuchlanis plicata*

Fig. 67.—*Mytilina mucronata*

Fig. 68.—*Mytilina ventralis*

*Euchlanis oropha* Goose, 1887 (Fig. 63)

Body oval, Dorsal plate has a deep notch at the posterior end. Toes wide. The anterior end is more or less straight and characteristic. This species has not been reported from Sri Lanka previously.

MEASUREMENTS : Length of lorica—190

Rare ; found in lakes.

*Dipleuchlanis macrodactyla* Hauer, 1965 (Fig. 64)

The anterior end of the ventral plate is more or less straight with a slight hump in the middle flanked by two slight depressions. Dorsal plate is much narrower than the ventral plate. Toes,

long, measures more than two-thirds the body length. *D. macrodactyla* has not been reported from Sri Lanka previously. This species was first recorded from the Amazon region by Hauer (1965) and has not been recorded since.

MEASUREMENTS : Length of ventral plate—142, Length of dorsal plate—132, Width of ventral plate—137, Width of dorsal plate—89, Toe—115.

Fairly common. Found in small ponds.

*Dipleuchlanis propatula* Goose, 1886 (Fig. 65)

Both the dorsal and ventral plates in the anterior end have median sinuses. Though at first sight *D. Propatula* can be mistaken for *D. macrodactyla* a close examination reveals differences. Toes of *D. propatula* are not as long as the toes of *D. macrodactyla* and also there are differences in the anterior margin especially of the ventral plate. In some preserved specimens the foot had not contracted into the lorica ; making the toes appear longer than they really are. This species has been reported from Kerala, India (Nayar, 1969) and from the river Sokoto, West Africa (Green, 1960) but has not been recorded from Sri Lanka previously. Compared to Indian specimens Sri Lanka specimens are smaller.

MEASUREMENTS : Length of ventral plate—165, Length of dorsal plate—151, Width of ventral plate—135, Width of dorsal plate—102, Width at anterior margin—87, Toe—99.

Fairly common in ponds.

*Triplecuhlanis plicata* Levander, 1894 (Fig. 66)

The body ovoid in shape. Foot is wide and robust, composed of three joints. Toes are short and less than one-third the length of the body and are parallel sided ending in sharp points. This species has been reported from Indonesia (Hauer, 1938) but has not been reported from Sri Lanka previously.

MEASUREMENTS : Length of ventral plate—138, length of dorsal plate—129, Width of lorica—123, Width at anterior margin—45, Toes—42.

Rare ; found in ponds.

Genus *Mytilina* Bory de St. Vincent, 1826

This genus is represented by two species. The identification of species was based on Kutikova (1970).

*Mytilina mucronata* Muller, 1773 (Fig. 67)

Lorica consists of one piece and in cross section the dorsal sulcus is 'V' shaped. The forms found in Sri Lanka are typical. There are four spine-like projections at the anterior end which also bears very small spines.

MEASUREMENTS : Length of lorica—172, Width—83, Toe—49.

Rare ; found in the littoral of lakes and small ponds.

*Mytilina ventralis* Ehrenberg, 1832 (Fig. 68)

The anterior end of lorica with small spines along the edges and hispid to about one-fifth of the length. Posterior end narrow. Dorsal side arched. Sri Lanka specimens of *M. ventralis* are a little smaller than *M. mucronata*.

MEASUREMENTS : Length of lorica—165, Width—81, Toe—51.

Rare ; found in the littoral of lakes and small ponds.

Genus *Cephalodella* Bory de St. Vincent, 1926

This genus is new to Sri Lanka and is represented by two species. Identification of species was based on Donner (1950) and Voigt (1957).

*Cephalodella forficula* Ehernberg, 1832 (Figs. 71 and 72)

Body more or less cylindrical with a neck segment. Toes characteristic and have a small acute tooth in the middle of the dorsal side and a row of very small teeth at the end of the swollen basal part. *C. forficula* varies very much in size. The Sri Lanka specimens are larger compared to European forms (Donner, 1950 : Rriksen, 1969). This species has not been recorded from Sri Lanka previously.

MEASUREMENTS : Total length—275

Rare : found in ponds.

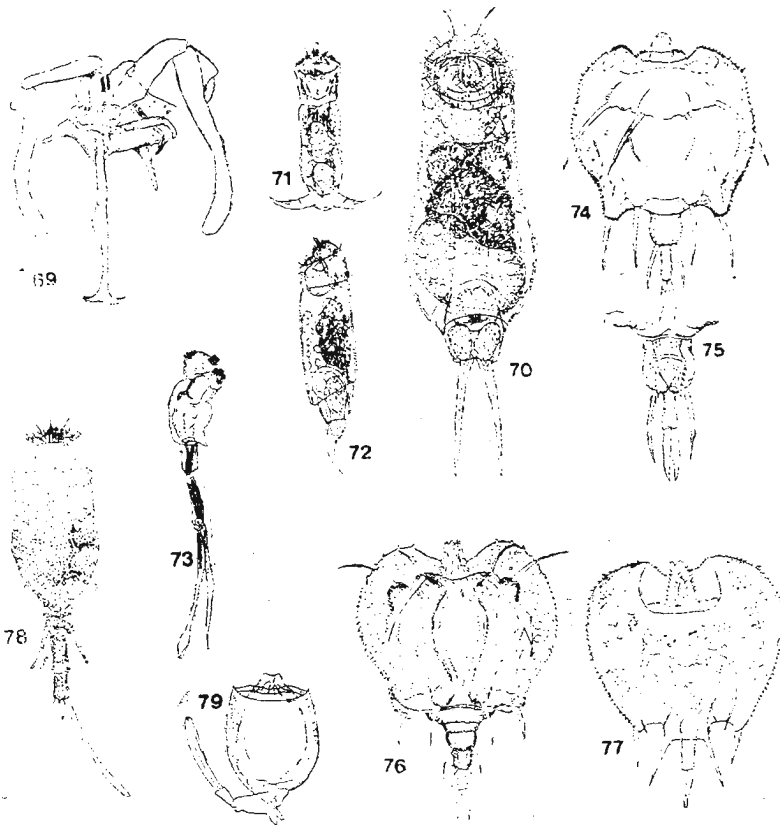


Fig. 69.—*Notommata* sp., trophi.

Fig. 70.—*Cephalodella gibba* ventral view

Figs. 71 and 72.—*Cephalodella forficula* ventral view and lateral view respectively.

Fig. 73.—*Scaridium longicaudum*.

Figs. 74 and 75.—*Macrochaetus collinsi* dorsal view and ventral view of foot respectively.

Fig. 76.—*Macrochaetus collinsi* another form.

Fig. 77.—*Macrochaetus sericus* dorsal view.

Fig. 78.—*Trichotria pocuillm* dorsal view

Fig. 79.—*Trichotria tetractis*.

*Cephalodella gibba* Ehrenberg, 1832 (Fig. 70)

Body fairly large bulging towards the posterior end. Toes long and ending in a point. *C. gibba* also varies in size of body and toes (Eriksen, 1969). This species has not been recorded from Sri Lanka previously.

MEASUREMENTS : Total length—275

Common in ponds and lakes.

Genus *Notommata* Ehrenberg, 1830 (Fig. 69)

This genus is new to Sri Lanka. Trophi diagnostic. *Notommata* sp. The species found in Sri Lanka has typical *Notommata torphi* but differs from all the drawings in the literature. Outwardly the contracted specimens looked like *Notommata coepus* Ehrenberg. However the trophi is incompatible with *N. coepus* trophi.

Rare, found in small ponds.

Genus *Scaridium* Ehrenberg, 1930

Only one species is known in this genus. Identification of this species was based on Voigt (1957).

*Scaridium longicaudum* Muller, 1786 (Fig. 73)

Lorica more or less cylindrical and very thin and transparent. Body comparatively small with a long foot. Two segmented foot. The toes are very long.

MEASUREMENTS : Total length—321, Length of body—96, Foot—90, Toe—132.

Rare, found in ponds and littoral of lakes.

Genus *Macrochaetus* Perty 1850

This genus is a new record for Sri Lanka and is represented by two species. The identification of species was based on Wulfert (1964).

*Macrochaetus collinsi* Goose, 1867 (Figs. 74-76)

The shape of the lorica is more or less rounded with spines on the margins. There are some large tooth like spines at the antero-lateral margin. The number of these spines varies from specimen to specimen but are usually one to three. The outer anterior dorsal spines are placed higher than the inner spines and their position can be variable according to the state of preservation of the animal. Like the anterior median and lateral spines, the posterior median spines also emerge from fleshy lobes. The lorica is covered with spines. Two forms of *M. collinsi* were encountered in the samples from Sri Lanka. In one form, there is only one anal segment from the base of which arise the two anal spines. Sometimes two very small spines can also be noticed ventral to this. In the other form the anal segment is composed of three or four segments and the anal spine originates from the third segment with a smaller spine arising from the fourth segment. There are also some spinules at the edges of the anal segment (Fig. 76). *M. collinsi* has been recorded from Indonesia (Hauer, 1938) and India (Nayar, 1968) but has not been recorded from Sri Lanka previously.

MEASUREMENTS : Length of lorica—100.

Commoner of the two species of *Macrochaetus*. Found in small ponds.

*Macrochaetus sericus* Thorpe, 1893 (Fig. 77)

The lorica is horse-shoe shaped with prominent spines at the edges and is wider than long. The two outer antero-dorsal spines are higher than the inner spines, all of which originated from fleshy protuberances. There is no anal segment and the posterior end of the lorica is pushed inward between the posterior outer and inner spines. Though at first glance it resembles *M. collinsi* it can

be distinguished by the aforementioned characters. This species has been reported from China (Thorpe, 1893) and from India (Arora, 1965). However, it has not been reported from Sri Lanka previously. The previous records of this species show that this may be a cosmopolitan form.

MEASUREMENTS: Length of lorica—81, Width—86, Foot—25, Claw—16.

Rare, found in small ponds.

Genus *Trichotria* Bory de St. Vincent, 1827

This genus is represented by two species. The identification was based on Voigt (1957) Wulfert (1966) and Kutikova (1970).

*Trichotria pocillum* Muller, 1776 (Fig. 78)

The lorica is comparatively long and not very wide, with a jutting edge along the dorsal surface of the lorica. The foot is 3 segmented and withdrawn in contracted specimens. Two main toes long with pointed ends. In between these two toes is a small spine which is characteristic.

MEASUREMENTS: Total length—290.

Rare, found in ponds.

*Trichotria tetractis* Ehrenberg, 1832 (Fig. 79)

Though somewhat variable most of the specimens examined had a lorica not much longer than wide. Foot with 3 segments, the first segment bearing two dorsal triangular spines. The second segment of the foot is longer than the other two, Toes long slender ending in a point. The forms from Sri Lanka agree with some forms described by Wulfert (1966) from India. This species has not been recorded from Sri Lanka previously.

MEASUREMENTS: Length of lorica—114, Width—96, Foot—69, Toe—90.

Commoner than *T. pocillum*, occurs in ponds.

Genus *Trichocerca* Lamarck, 1801

This genus is represented by eight species in Sri Lanka. The identification of species was based on Jennings (1902), Hauer (1938), Voigt (1957) and Kutikova (1970).

*Trichocerca bicristata* Gosse, 1887 (Figs. 80 and 81)

This species resembles *T. braziliensis* but differs from it in several characters. (see *T. braziliensis*). The body is long. The main toe is more than half the length of the body. The keel on the body extends for more than half the body length. Trophi large, the right manubrium larger than the left. The right manubrium seems to be wider in Sri Lanka specimens compared to the drawings given by Kutikova (1970). *T. bicristata* has not been reported from Sri Lanka previously. Green (1960) reported it from the river Sokoto, West Africa.

MEASUREMENTS: Length of body—225, Main toe—150, Width—69.

Fairly common in lakes and ponds.

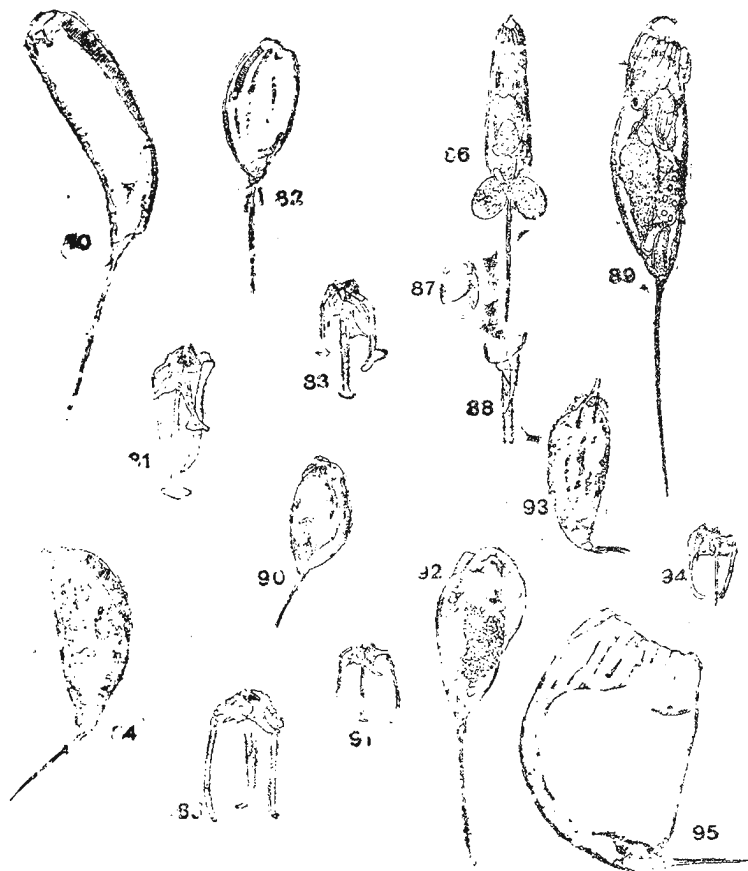
*Trichocerca braziliensis* Murray, 1913 (Figs. 82 and 83)

The body as well as the trophi resembles *T. bicristata*. However, the differences can be easily discerned by close examination. The two keels on the body extend less than one-third of the body length. Also the body is short and slightly squat. Main toe longer than the body. The shape of

the body of specimens from Sri Lanka resembles the drawings of Hauer (1965) from the Amazon. The trophi also resembles Hauer's (1965) material in general outline but there are some minor differences. The left manubrium is smaller than the right and has a small spoon shaped projection outwards which is not present in Hauer's (1965) drawing. Again there is a small spine-like extension from the right side of the rami-uncus complex. The forms found in Sri Lanka are more or less of the same size as that found in South America. So far this species has not been reported from outside the South American continent and is a new record for Sri Lanka.

MEASUREMENTS : Length of body—138, Width—69, Main toe—144, Trophi—50, Length of fulcrum 40, Right manubrium—36, Left manubrium—20.

Rare, found from only one pond, Nr. Tabbowa.



Figs. 80 and 81.—*Trichocerca bicristata* lateral view and trophi respectively.

Figs. 82 and 83.—*Trichocerca braziliensis* lateral view and trophi respectively.

Figs. 84 and 85.—*Trichocerca chattoni* lateral view and trophi respectively.

Figs. 86 and 87.—*Trichocerca cylindrica* and embryo respectively.

Figs. 88 and 89.—*Trichocerca cylindrica* enlarged portion of the proximal portion of foot and lateral view respectively.

Figs. 90 and 91.—*Trichocerca dixonuttali* and trophi respectively.

Fig. 92.—*Trichocerca rattus* lateral view.

Figs. 93 and 94.—*Trichocerca similis* and trophi respectively.

Fig. 95.—*Trichocerca stylata*

*Trichocerca chattoni* De Beauchamp, 1907 (Figs. 84 and 85)

*T. chattoni* can be easily distinguished by its anterior spine which is fairly large and curved inwards. The head opening is folded in contracted specimens. On the dorsal side of the body starting from the anterior end there is a striped area running almost to the middle. *T. chattoni* has been recorded from Indonesia (Hauer, 1938) but has not been recorded from Sri Lanka previously

MEASUREMENTS : Length of body—177, Width—72, Anterior spine—30, Main Toe—105.

Fairly common in lakes and ponds.

*Trichocerca cylindrica* Imhoff, 1891 (Figs. 86-89)

This rotifer also has an anterior spine called a mucron which is bent but it is not as prominent as in *T. chaitony*. This species differs from *T. chattoni* in having a longer toe and a much longer, cylindrical body. The forms found in Sri Lanka are typical and agrees with the description given by Jennings (1903). *T. cylindrica* has not been reported from Sri Lanka previously.

MEASUREMENTS: Total length—560.

Rare, found in lakes.

*Trichocerca dixon-nuttali* Jennings, 1903 (Figs. 90 and 91)

The body is more or less cylindrical and the anterior end has many folds which close the head opening in contracted specimens. Two toes present. The longer left toe is half the length of the body. *T. dixon-nuttali* closely resembles *T. ruttneri*, Donner. However, *T. dixon-nuttali* can be recognised by its two toes and a body which is more slender than that of *T. ruttneri*. The mastax is also diagnostic. This species has not been recorded from Sri Lanka previously.

MEASUREMENTS: Length of body—120, Width—54, Main toe—63, Trophi—34.

Found only in rice fields but in fairly large numbers.

*Trichocerca rattus* Muller, 1776 (Figs. 92)

*T. rattus* is distinguishable by its wide keel at the anterior end especially in a lateral view. The keel is usually striated. The toe is long reaching up to the total body length.

MEASUREMENTS: Total length—214.

Common in lakes and ponds.

*Trichocerca similis* Wierzejski, 1893 (Fig. 93 and 94)

The anterior end has two spines of equal length. Starting from just below the spines are two keels with a striped area running down from about one-third of the body length. Foot clearly visible. Toes unequal and short. Hauer (1965) recorded *T. similis* from the Amazon region in South America. He encountered specimens of different sizes from 166-525 which all had typical *T. similis* characteristics. Hauer (1938) also reported it from Indonesia. The Sri Lanka forms are small and agree with the West Indian form described by Wulfert (1965). *T. similis* has not been recorded from Sri Lanka previously.

MEASUREMENTS: Length of body—111, Foot—6, Toe—49, Trophi—30.

Common in ponds and lakes. The commonest species of *Trichocerca* in Sri Lanka.

*Trichocerca stylata* Gosse, 1851 (Fig. 95)

This small *Trichocerca* species has a short and wide body. The width of body is more than half the length. Toes short and emerges from a prominent foot. The anterior end has folds but is usually wide. This species has not been recorded from Sri Lanka previously.

MEASUREMENTS: Length of body—171, Width—111, Longest toe—60.

Fairly common. Found in lakes and ponds.

Genus *Lepadella* Bory de St.Vincent, 1826

This genus is represented by four species in Sri Lanka. The identification of species was based on Voigt (1957) and Kutikova (1970).

*Lepadella costata* Wulfert, 1940 (Fig. 96)

Lorica oval in shape. There are two strengthening keel-like structures running from the anterior end for about one-third of the body length. Toes long and pointed. This species has not been recorded from Sri Lanka previously.

MEASUREMENTS: Length of lorica—82, Width—77, Foot—17. Toe—27.

Rare; found only in one pond, Tabbowa.

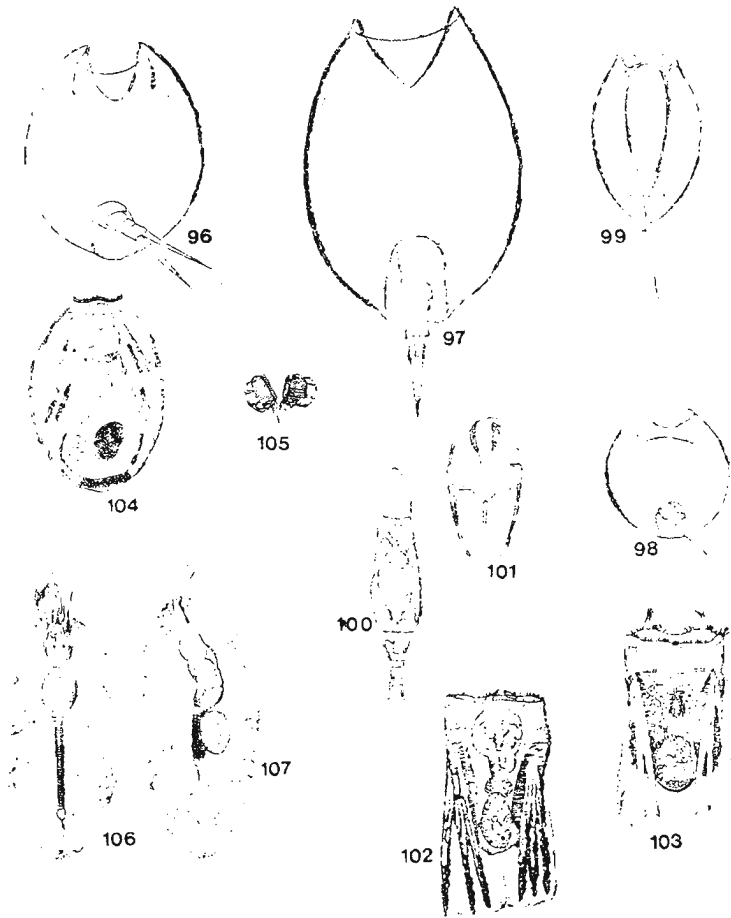


Fig. 96.—*Lepadella costata*.

Fig. 97.—*Lepadella ovalis*.

Fig. 98.—*Lepadella patella*.

Fig. 99.—*Lepadella rhomboides*.

Figs. 100 and 101.—*Dicranophorus robustus* dorsal view and trophi respectively.

Fig. 102.—*Polyarthra dolichoptera* ventral view.

Fig. 103.—*Polyarthra vulgaris* ventral view.

Figs. 104 and 105.—*Horaella brehmi* and trophi respectively.

Figs. 106 and 107.—*Collotheca ornata* ventral and view lateral view respectively.

*Lepadella ovalis* Muller, 1796 (Fig. 97)

Lorica small and oval. Foot opening board. Toes long and pointed. Lorica without any striations.

MEASUREMENTS : Length of lorica—96, Width—87, Foot opening—27, Foot—30, Toe—27.

Common ; found in ponds, littoral of lakes and rice fields.

*Lepadella patella* Müller, 1786 (Fig. 98)

Usually smaller and more rounded than *L. ovalis*, widest at the posterior part of shell. Foot opening broad. Toes short and pointed. This species has not been recorded from Sri Lanka previously.

MEASUREMENTS : Length of lorica—87, Width—79, Foot opening—22, Toe—18.

Common : found in ponds and rice fields.

*Lepadella rhomboides* Gosse, 1886 (Fig. 99)

Lorica has a keel on the dorsal side which is very tall and conspicuous and extends about half the length of the lorica. Toes long and pointed. This species has not been recorded from Sri Lanka previously.

MEASUREMENTS : Length of body—120, Toes—60.

Not common, found in ponds and littoral of lakes.

Genus *Dicranophorus* Nitzsch, 1827

This genus is represented in Sri Lanka by only one species, *Dicranophorus robustus*. The identification of species was made using the monograph of Harring and Myers (1928).

*Dicranophorus robustus* Harring and Myers, 1928 (Fig. 100 and 101)

The body is long and slender. A distinct neck segment present. Foot very short and stout. Toe short and slender. Trophi is large and elongated. Fulcrum half as long as rami. Manubrium long and slender. The Sri Lanka forms agree with the description of Harring and Myers (1928) of material from the United States of America, except in size the Sri Lanka forms being larger.

MEASUREMENTS : Total length—500, Trophi—65.

Rare ; found in ponds and lakes.

Genus *Polyarthra* Ehrenberg, 1834

This genus is represented by two species. The identification of species in this genus is based on the key of Bartos (1950).

*Polyarthra dolichoptera* Idelson, 1925 (Fig. 102)

The body more or less square with appendages narrow and longer than the body. The lateral edges of the appendages are toothed. The median rib of appendages are well developed all along the length. Vitellarium has 8 nuclei. This species has not been reported from Sri Lanka previously.

MEASUREMENTS : Length of body—102, Width—59, Length of appendage—112.

Rare ; found in lakes and ponds.

*Polyarthra vulgaris* Carlin, 1943 (Fig. 103)

Body usually larger than in *P. dolichoptera*. Lateral antennae situated at the posterior lateral end of body. Appendages as long as body, spear-shaped with lateral teeth. Vitellarium has 8 nuclei.

MEASUREMENTS : Length of body—160.

Common in lakes, ponds and rice fields.

Genus *Collotheca* Harring, 1913

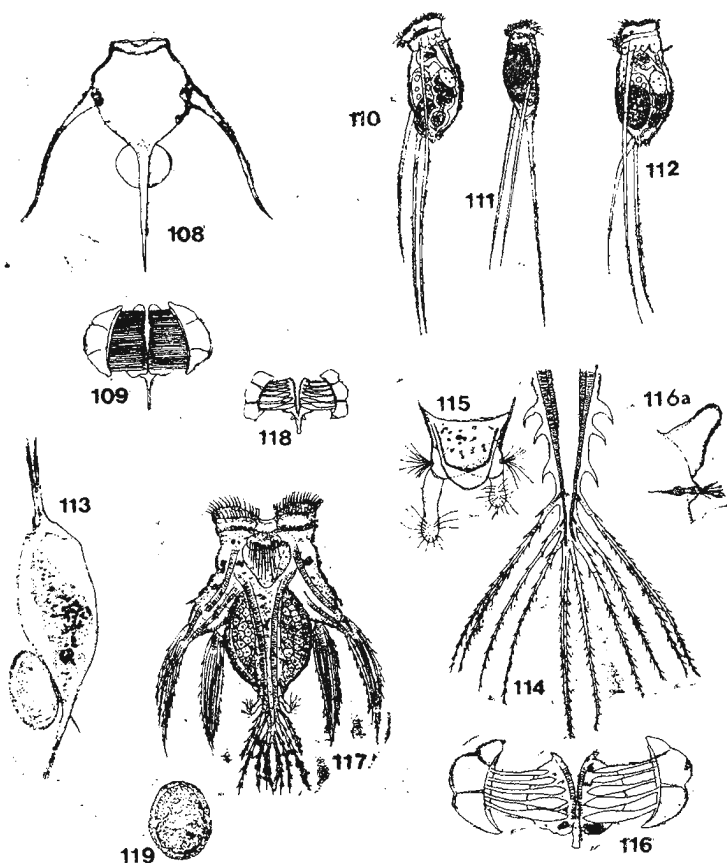
Only one species found and this is a new genus for Sri Lanka. Identification of species was done using Kutikova (1970).

*Collotheca ornata natans* Tschugunoff, 1921 (Fig. 106 and 107)

Shape of body characteristic with a slight bulge towards the posterior end. The cilia at the anterior end thick and long. Foot long and ringed. Preserved specimens highly contracted. This species has not been reported from Sri Lanka previously.

MEASUREMENTS : Total length—300, Cilia—150.

Rare, found in ponds



Figs. 108 and 109.—*Filinia camascela* with resting eggs and trophi respectively.

Fig. 110.—*Filinia longiseta*.

Fig. 111.—*Filinia pejeri*.

Fig. 112.—*Filinia terminalis*.

Fig. 113.—*Filinia opoliensis*.

Figs. 114 and 115.—*Hexarthra intermedia* ventral and arm posterior end body respectively.

Figs. 116 and 116a.—*Hexarthra intermedia* trophi and dorsal antenna respectively.

Figs. 117 and 118.—*Hexarthra mira* ventral view and trophi respectively.

Fig. 119.—*Hexarthra mira* amictic egg

Genus *Filinia* Bory de St. Vincent, 1824

This genus is represented by four species and is fairly common in Sri Lanka fresh waters. Identification of species is based on the works of Myers (1938), Voigt (1957) and Kutukova (1970).

*Filinia camascela* Myres, 1938 (Fig. 108 and 109)

The shape of the lorica is circular, truncate anteriorly. Lorica is firm. Two lateral spines have swollen bases. The terminal spines are straight and end in sharp points. Eggs were present in some specimens. This has not been recorded from anywhere since 1938 when Myers described it for the first time, from material from Panama. This is a new record for Sri Lanka.

MEASUREMENTS : Total length—240, Trophi—23, Egg—52/48.  
Rare, only recorded from a few large lakes and ponds.

*Filinia longista* (Ehrenberg, 1832) (Fig. 110)

Body fairly broad. The posterior seta is almost invariably ventrally situated.

MEASUREMENTS : Length of body—200.  
Rare, occurs in small and large lakes.

*Filinia opoliensis* (Zacharias, 1898) (Fig. 113)

Body cylindrical with two anterior spines which have broad bases. Anterior spines very long. Of the two posterior spines the longer one is as long as the anterior spines. The smaller spines in all specimens examined are very small measuring up to about one-sixth of the longer posterior spine. Because of their long spines they entangle each other and are often seen clumped together.

MEASUREMENTS : Length of body—209, Anterior spines—369 and 197, Posterior spine—221 and 36.

Common, found in lakes and large ponds.

*Filinia pejleri* Hutchinson, 1964 (Fig. 111)

Body spindle shaped. Dorsal and ventral sides are rounded. *F. pejleri* is the smallest member of this genus. This species has not been reported from Sri Lanka previously.

MEASUREMENTS : Length of body—180.  
Very common in large and small lakes.

*Filinia terminalis* (Plate, 1886) (Fig. 112)

This common rotifer found in Ceylon is typical for the species in morphology.

MEASUREMENTS : Length of body—200.  
Very common in large and small lakes.

Genus *Hexarthra* Schmarda, 1854

This genus is represented by two species. The identification of species is based on Bartos (1948, 1959).

*Hexarthra intermedia* Wisniewski, 1929 (Fig. 114–116a)

Body conical, fairly large. Ventral arm has three pairs of spines and eight filaments. Trophi characteristic with 5 teeth on either side. This species has not been reported from Sri Lanka previously.

MEASUREMENTS : Total length—220, Ventral arm—160.

Common, occurs in lakes, ponds and rice fields.

*Hexarthra mira* (Hudson, 1871) (Figs. 117 and 118)

Body large, of the same shape as that of *H. intermedia*. Ventral arm has three spines and 8 filaments. The trophi has 6 teeth on either side.

MEASUREMENTS : Total length—300, Resting egg—112.

Common, occurring in lakes, ponds and rice fields.

Genus *Floscularia* Cuvier, 1798

This genus is represented by only one species, and this is a new record for Sri Lanka. Identification of species is based on Wulfert (1939) and Voigt (1957).

*Floscularia ringens* (Linnaeus, 1758) (Fig. 120)

Body encased in a tube made of small rounded pebble like structures. Only the head is found outside the tube in living animals. Since they are usually found attached to leaves of plants or other substrata only, very rarely was it seen in plankton samples. This species has not been recorded from Sri Lanka previously.

MEASUREMENTS : Total length—900.

Rare, found in ponds.

Genus *Sinantherina* Bory de St. Vincent, 1826

This genus is represented by two species in Sri Lanka. The identification of species was done using Thorpe (1893), Voigt (1957) and Kutikova (1970).

*Sinantherina semibullata* (Thorpe, 1889) (Figs. 123 and 124)

Colonial, members of the colony attached at their foot. *S. semibullata* has two wart like structures on the anterior part of the dorsum and has nine pairs of gastric glands.

MEASUREMENTS : Contracted specimen—600, Egg—140/68.

Found in rice fields ; abundant in this habitat.

*Sinantherina spinosa* (Thorpe, 1893) (Figs. 121 and 122)

Colonial, but in preserved state most of them are detached. Young ones and adult were seen in the same colony. Fine spines are present in the dorsum which is characteristic. This species has been recorded from India (Arora, 1963) but has not been reported from Sri Lanka previously.

MEASUREMENTS : Length of contracted specimens—585, Width—81.

Found abundantly in rice fields.

Genus *Conochilus* Ehrenberg, 1834

This genus is represented in Sri Lanka by only one species which is a colonial form. The identification of the species is based on the standard works of Voigt (1957) and Bartos (1959).

*Conochilus unicornis* Rousselet, 1892 (Fig. 125)

The colonies can be seen with the naked eye as rounded bodies in fresh and preserved samples. Ventral antennae are fused with groups of cilia at the end. Foot as long as body smooth, and

appears ringed in contracted specimens. Colony entirely covered with jelly like substance with cannot be seen sometimes in preserved material. This species has not been recorded from Sri Lanka previously.

MEASUREMENTS : Contracted specimens range from 250-310.

Rare ; found in ponds.

Genus *Conochiloides* Hlava, 1904

This genus is represented by two species and is a new record for Sri Lanka. Identification of species is based on Ahlstrom (938) and Voigt (1957).

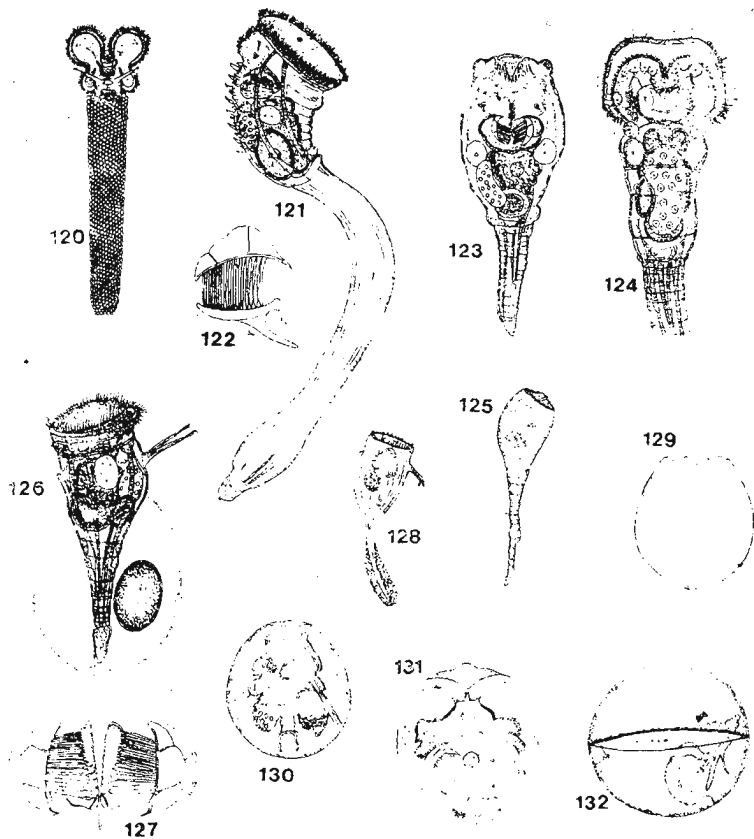


Fig. 120.—*Floscularia ringens* ventral view.

Figs. 121 and 122.—*Sinanotherina spinosa* lateral view and trophi respectively.

Figs. 123 and 124.—*Sinanotherina semibullata* contracted specimen and ventral view respectively.

Fig. 125.—*Conochilus unicornis* contracted specimen.

Figs. 126 and 127.—*Conochiloides dossuarius* lateral view and trophi respectively.

Fig. 128.— *Conochiloides natans* lateral view.

Fig. 129.—*Pompholyx complanata*

Fig. 130.—*Testudinella parva*

Fig. 131.—*Testudinella patina*

Fig. 132.—*Trochosphaera equatorialis*

*Conochiloides dossuarius* (Hudson, 1885) (Figs. 126 and 127)

The body vase shaped. Foot appears like a stalk and ringed in contracted specimens. Not colonial. Ventral antennae fused at the proximal end to about one-third the length and free at the distal end. Eggs were attached to some specimens by means of jelly-like substance. This species has been reported from India (Wulfert, 1966). However, it has not been reported from Sri Lanka previously.

Fairly common ; found in ponds.

*Conochiloides natans* (Silego, 1900) (Fig. 128)

Contracted specimens looks more or less like *C. dossuarius*. Ventral antennae are not fused and are free from proximal end. Cilia present terminally. Not colonial. This species has not been reported from Sri Lanka previously.

Fairly common ; found in ponds, lakes and rice fields.

Genus *Pompholyx* Goose, 1851

This genus is a new record for Sri Lanka and is represented by one species. The identification of this species is based on Bartos (1951).

*Pompholyx complanata* Gosse, 1851 (Fig. 129)

Lorica almost circular with the dorsal plate having a pointed protuberance in the middle. This species has not been recorded from Sri Lanka previously. *P. complanata* has been reported from India (Wulfert, 1966).

MEASUREMENTS : Length of lorica—62, Width—39.

Common in ponds, lakes and rice fields.

Genus *Horaella* Donner, 1949

Only one species is known in this genus. The identification of this species is based on Donner (1949).

*Horaella brehmi* Donner, 1949 (Figs. 104 and 105)

Body transparent and oval shaped rather than rounded with a short neck bearing the circular corona. Foot and toe absent. Trophi typical malleoramate. At the anterior end of fulcrum are two wing like projections. This species is recorded only from India before (Donner, 1949).

MEASUREMENTS : Length of body—224, Width—158.

Recorded from a pond nr. Kandy and a few small lakes.

Genus *Testudinella* Bory de St. Vincent, 1826

This genus is represented by two species. The identification of species was done using Bartos (1951).

*Testudinella parva* (Ternetz, 1892) (Fig. 130)

Body small, more or less rounded. The dorsal plate has one lobe anteriorly. Foot opening large and situated towards the posterior end and elevated. Also it is somewhat irregularly shaped. This species has not been reported from Sri Lanka Previously.

MEASUREMENTS : Length of body—96, Width—87, Foot opening 15.

Rare ; found in ponds.

*Testudinella patina* (Hermann, 1783) (Fig. 131)

Body is rounded, with one prominent lobe anteriorly. Size variable. Foot opening approximately one-third from the posterior end and circular.

MEASUREMENTS : Length of body—179, Width—160.

Very common especially in temporary ponds and rice fields. Also in the littoral of lakes.

Genus *Trochosphaera* Semper, 1872

Only two species are known in this genus of which *T. equatorialis* is found in Sri Lanka. The original description of this species was given by Semper (1972)

*Trochosphaera equatorialis* Semper, 1872 (Fig. 132)

The shape of body spherical with a band of cilia around the equator. The surface of the body is very smooth and the whole animal is extremely transparent making it possible to see all organs inside which are loosely hung inside.

MEASUREMENTS : Diameter—357.

Only a single record from Senanayake Samudra. Previously recorded in Asia from the Philippines and China from rice fields. Mendis (1965) recorded *Trochosphaerium* from Sri Lanka. We are indebted to him for a sample of his material. Although this lake was sampled many times subsequently this species was not found.

## SUMMARY AND DISCUSSION

In the present paper a total of 79 species of Eurotatoria are recorded and described from Sri Lanka. This includes 8 new generic records and 47 new specific records. In a previous paper (Chengalath and Fernando, 1973) 25 species of the genus *lecane* were recorded and described from Sri Lanka bringing the total to 104 species. A conservative estimate of Eurotatoria present in Sri Lanka is about 200 to 250. The rotifer fauna of the South East Asian region is not well known at present. From Indonesia slightly over 140 species are known, from the Indian sub-continent 130 species are on record while the fauna of Burma, Malaysia and Thailand are very poorly known.

The composition of the Eurotatoria of Sri Lanka is similar to that of India and Indonesia. Many forms are of course cosmopolitan. A few interesting records have been found, that include *Brachionus donneri*, *Brachionus nilsoni*, *Brachionus sessilis*, *Dipleuchlanis macrodactyla*, *Tripleuchlanis plicata*, *Filinia camascela*, *Horaella brehmi*, *Trichocerca braziliensis* and *Trochosphaera equatorialis*. Since there are no natural lakes in Sri Lanka no typically limnetic species of Rotifera are present. The limnetic species in man-made lakes are found in rivers and large ponds while many pond forms occur in the littoral region. The commonest genus is *Brachionus*. This is characteristic of many tropical rotifer faunas together with the absence of *Notholca* (Green, 1972). Typical tropical rotifers like *Brachionus caudatus* were recorded. Incidentally this species also shows great variability.

Some rare rotifers were recorded namely *Brachionus Donneri* previously known from only India. *Brachionus sessilis* and epizootic rotifer known only from Hungray, *Horaella brehmi* known only from India and *Trochosphaera equatorialis* which is geographically widely distributed yet uncommon. All these species were recorded in only one to three samples of the over 300 samples examined.

Five species recorded in the present paper have so far been recorded from only Southern North America and South America. These are *Brachionus nilsoni*, *Dipleuchlanis macrodactyla*, *Trichocerca braziliensis*, *Keratella taurocephala* and *Filina camascela*.

The Eurotatorian fauna of Sri Lanka is rich in species and shows considerable variety. It is typically tropical in composition and has many interesting and rare species. We consider that the 104 species so far recorded from Sri Lanka is about half the number of species present. Many of the species missing from this list are non-loricate forms and rare species which will be found with more extensive collecting and study of live material.

## ACKNOWLEDGEMENTS

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## APPENDIX I

## Examples of localities where species were collected in Sri Lanka

<i>Species</i>	<i>Locality Records</i>
Anuraeopsis coelata	Kandy Lake 13.3.1969
A. fissa	Moonplains Res. 15.11.1968
Asplanchna brightwelli	Nachchaduwa tank 6.7.1969
A. Priodonta	Marawila pond 6.9.1970
A. sieboldi	Topawewa 7.3.1969
Asplanchnopus multiceps	Nugegoda, rice field 25.3.1971
Brachionus angularis	Tabbowa tank 2.3.1969
B. budapestensis	Kandalama tank 3.8.1969
B. calyciflorus	Megalla wewa 2.3.1969
B. caudatus	Na eliya tank 8.8.1968 (Nr. Battuluoya)
B. Caudatus var. aculeatus	Giants tank 15.12.1970
B. donneri	Uduwatukelle tank 13.3.1969 (Nr. Kandy)
B. falcatus	Senanayake samudra 12.08.1968
B. forficula	Megalla wewa 2.3.1969
B. leydigi	Medawachchiya tank 4.3.1969
B. nilsoni	Handapangala tank 10.7.1969
B. patulus	Norton Bridge Res. 15.7.1969
B. quadridentias	Nugegoda, rice field 14.1.1971
B. rubens	Wirawila tank 6.7.1969
B. sessilis	Pavatkulam 4.3.1969
B. urceus	Wirawila tank 6.7.1969
B. urceolaris	Na eliya tank 8.8.1969
C. ephalodella forficula	Iranamadu tank 3.3.1969
C. gibba	Kantalai tank 6.3.1969
Collotheca oranata natans	Nachchaduwa tank 6.7.1969
Conochilus unicornis	Nugegoda, rice field 19.3.1971
Conocihloides dossuarius	Kandy Lake 13.3.1969
C. natans	Senanayake samudra 6.8.1969
Dicranophorous robustus	Aranaganwila tank 7.1.1972
Dipleuchalnis macrodactyla	Marawila pond 6.12.1970
D. propatula	Amparai wewa 6.8.1969
Euchlanis dilatata	Nugegoda, rice field 30.6.1971
E. incisa	Tabbowa tank 6.8.1969
E. oropha	Vakaneri tank 3.8.1969
Filinia camascela	Kantalai tank 6.3.1969
F. longiseta	Batalagoda tank 8.3.1969
F. opoliensis	Kandy Lake 13.3.1969
F. peileri	Vakaneri tank 7.8.1969
F. terminalis	Kcittigollawa wewa 23.3.1971
Floscularia ringnes	Medawachchiya tank 4.3.1969

<i>Species</i>	<i>Locality Records</i>
Hexarthra intermedia	Norton Bridge Res. 15.7.1969
H. mira	Sooriyawewa Nr. Embilipitiya ; 22.1.1971
Horaella brehmi	Udawatukelle tank 10.8.1968
Kellicottia longispina	Iranamadu tank 3.3.1969
Keratella cochlearis	Tabbowa tank 2.3.1969
K. earlinae	Tabbowa tank 25.1.1971
K. lenzi	Moonplains Res. 15.11.1968
K. taurocephala	Tabbowa tank 2.3.1969
K. tropica	Battuluoya river 2.6.1972
Lepadella costata	Tabbowa pond 25.7.1971
L. ovalis	Divulwewa, Anuradhapura ; edge of rice field 11.8.1972
L. patella	Sigiriya tank 3.3.1972
L. rhomboides	Tabbowa tank 25.7.1971
Macrocheatus collinsi	Kantalai tank 6.3.1969
M. sericus	Tabbowa pond 25.7.1971
Mytilina mucronata	Sigiriya tank 19.8.1969
M. ventralis	Amparai wewa 8.8.1969
Notmmata Sp.	Kantalai tank 6.3.1969
Platylas quadricornis	Tabbowa pond 25.7.1971
Polyarthra dilichoptera	Tabbowa pond 6.8.1969
P. vulgaris	Udawalawe Res. 16.7.1969
Pompholys complanata	Udawalawe Res. 16.7.1969
Scaridium longicaudum	Tabbowa pond 25.7.1971
Sinintherina semibullatta	Moonplains Res. 10.8.1968
S. spinosa	Nugegoda, rice field 19.3.1971
Testudinella parva	Waga pond 31.12.1970
T. patina	Giants tank 15.12.1970
Trichocerca bicristata	Lake Gregory 8.3.1969
T. Braziliensis	Tabbowa tank 25.1.1971
T. chattoni	Kesbewa wewa 1.8.1969
T. cylindrica	Udawalawe Res. 16.7.1969
T. dixon-nuttali	Divulwewa, edge of rice field 11.8.1972
T. rattus	Senanayake samudra 12.8.1968
T. similis	Senanayake samudra 6.8.1969
T. stylata	Mahaillupuluma 10.8.1968
Trichotria pocillum	Helanda, Ratnapura, pond 18.8.1968
T. tetractis	Tabbowa tank 25.7.1971
Tripleuchlanis plicata	Tabbowa tank, 25.7.1971
Trochosphaera equatorialis	Senanayake samudra 12.8.1968

## Rotifera from Sri Lanka (Ceylon) 3. New Species and Records with a List of Rotifera Recorded and their Distribution in Different Habitats from Sri Lanka

By

R. Chengalath\*, C. H. Fernando\* and W. Koste\*\*

### INTRODUCTION

In two previous papers (Chengalath and Fernando, 1973a and Chengalath, Fernando and Koste, 1973b) the Eurotatorian fauna of Sri Lanka has been systematically dealt with. Description of 104 species are given in the above papers. In the present study an additional twenty-two species are described. Of these two are new.

The composition of the Sri Lanka Rotifera is discussed in relation to the fauna of other parts of the world. The distribution of the species in different types of habitats is studied on the basis of samples. A complete list of all Rotifera recorded from Sri Lanka so far is given for easy reference. Examples of localities where species were collected are also given.

#### Description of species

##### 1. *Brachionus bidentata* Anderson, 1889 (Fig. 1)

The dorsal and ventral plates are closely apposed to about three-fifth of the length of the lorica, where they diverge and are united to a basal plate. Anterior dorsal margin with six spines; lateral and median spines of the same size. The lateral spines sometimes have a subspine projecting inward at about the middle. Posterior spines variable. However, most of the specimens examined had a short pair of spines as short protuberances.

This is a common rotifer in Sri Lanka with a firm lorica and is highly variable. The variants are illustrated by Ahlstrom (1940). It has been recorded from India twice, once by Anderson (1889) and then by Wulfert (1966) who described a new variety of this species called *B. bidentata* f. *adorna*. *B. bidentata* is also reported from Malaya (Russell, 1958) but he gives no drawing.

#### Measurements

Total length of lorica 192; width of lorica 156; width at anterior points 120; anterior lateral spine 40; anterior intermediate spine 20; anterior median spine 40.

Locality: Sigriya tank. 3.3.1972.

##### 2. *Brachionus plicatilis* Muller, 1786 (Fig. 2)

Lorica oval. Anterior margin with six, broadly based, acutely pointed spines more or less equal in length. No posterior spines. Foot opening is a sub-square aperture dorsally and a longer 'V' shaped aperture ventrally. This species has been recorded from India (Ahlstrom 1940).

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**Measurements**

Total length of lorica 192; width of lorica 150; width at anterior points 120; anterior lateral spines 15; anterior intermediate spines 12; anterior median spine 15.

Locality: Jaffna jetty, pond, Karamagar. 15.12.1971.

3. ***Euchlanis meneta*** Myers, 1930 (Figs. 3 and 4)

The body is oval shaped and the dorsal plate is highly arched. Posterior notch very deep. Ventral plate much narrower than the dorsal plate. Toes moderately long and slender. *E. meneta* is not common in Sri Lanka. Russell (1953) records this species from Chatham Islands near New Zealand. New for Sri Lanka.

**Measurements**

Length of body 61; width 43; width at anterior end 29; foot 19; toe 24.

Locality: Paddy field close to Ratnapura. 19.8.1972

4. ***Eudactylota eudactylota*** Gosse, 1886 (Fig. 5)

The body is spear shaped with a small head. First foot segment thick, second foot segment thin and long. Toes very long. Right toe slightly longer than the left. Eye spots visible.

**Measurements**

Total length 712; length of body 270; foot 100; toes 342.

Locality: Paddy field close to Ratnapura. 19.8.1972

5. ***Lecane bifastigata*** Hauer, 1938 (Figs. 6 and 7)

This species has been recorded from Indonesia by Hauer (1938) and by Tarnogradsky (1961) from the Russian Caucasus and has not been reported since. Specimens from the previous localities are similar. The specimens found in Sri Lanka differ slightly in that the posterior segment is not very prominent. The ornamentation on the lorica is characteristic. From the distribution of this species it seems possible that *L. bifastigata* could be a tropicopolitan form. Rare; new record for Sri Lanka.

**Measurements**

Length of dorsal plate 81; length of ventral plate 87; width of dorsal plate 56; width of ventral plate 62; width at anterior end 58; toe 25; claw 8.

Locality: Paddy field close to Ratnapura. 19.8.1972.

6. ***Lecane elsa*** Hauer, 1931 (Fig. 8)

The specimens found in Sri Lanka agree closely with the specimens described by Koste (1972) obtained from the Amazon region in South America. New record for Sri Lanka.

**Measurements**

Length of dorsal plate 123; length of ventral plate 131; width of dorsal plate 104; width of ventral plate 116; toe 71; claw 8.

Locality: Paddy field close to Ratnapura. 19.8.1972.

7. ***Lecane (Monostyla) furcata*** (Murray 1913) (Figs. 9 and 10)

Agrees in general with the description of Hauer (1938) of material from Indonesia. However, the Sri Lanka specimens are not as broad as the other forms so far described, which are more or less as wide as long (Harring and Myers 1926, Hauer, 1929; Koste, 1962). New record for Sri Lanka.

**Measurements**

Length of dorsal plate 63; length of ventral plate 63; width of dorsal plate 52; width of ventral plate 44; toe 18; claw 5.

Locality: Paddy field close to Ratnapura. 19.8.1972.

8. *Lecane hastata* (Murray 1913) (Figs 11 and 12)

*L. hastata* has been recorded and described from India by Wulfert (1966). The Sri Lanka specimens are slightly larger than the Indian forms but are of the same size as that of the United States material (Harring and Myers, 1926). Not common. New record for Sri Lanka.

**Measurements**

Length of dorsal plate 96; length of ventral plate 110; width of dorsal plate 69; width of ventral plate 91; width at anterior end 80; toe 22; claw 18.

Locality: Madurankuliya pond. 2.7.1972.

9. *Lecane kahouteki* sp. nov. (Figs 13 and 14)

The outline of lorica is broadly ovate; the width is about three-fourths the length. Anterior dorsal margin is convex and narrower than the anterior ventral margin. The dorsal plate is broadly ovate and slightly truncate posteriorly with two prominent spine-like projections jutting out near the posterior end which is characteristic of this species. No clear pattern was visible on the dorsal plate. The ventral plate is somewhat elongate oval; no surface markings discernible. At the external angles of the anterior end of ventral plate are two small acute spines. Coxal plates are small. Posterior segment fairly large and semi-circular. First foot joint small, parallel sided; the second foot joint is robust and more or less square and projects about one-third of its length beyond the ventral plate. Toes short, less than one-fifth the length of the lorica and are parallel sided. Claws long and pointed.

**Measurements**

Length of dorsal plate 102; length of ventral plate 106; width of dorsal plate 75; width of ventral plate 83; width at anterior end 70; toe 20; claw 15. This species is named after the comet Kahoutek.

*L. kahouteki* sp. nov. was collected from Tabbowa tank, Puttalam on May 5, 1973. Six specimens were obtained from the sample.

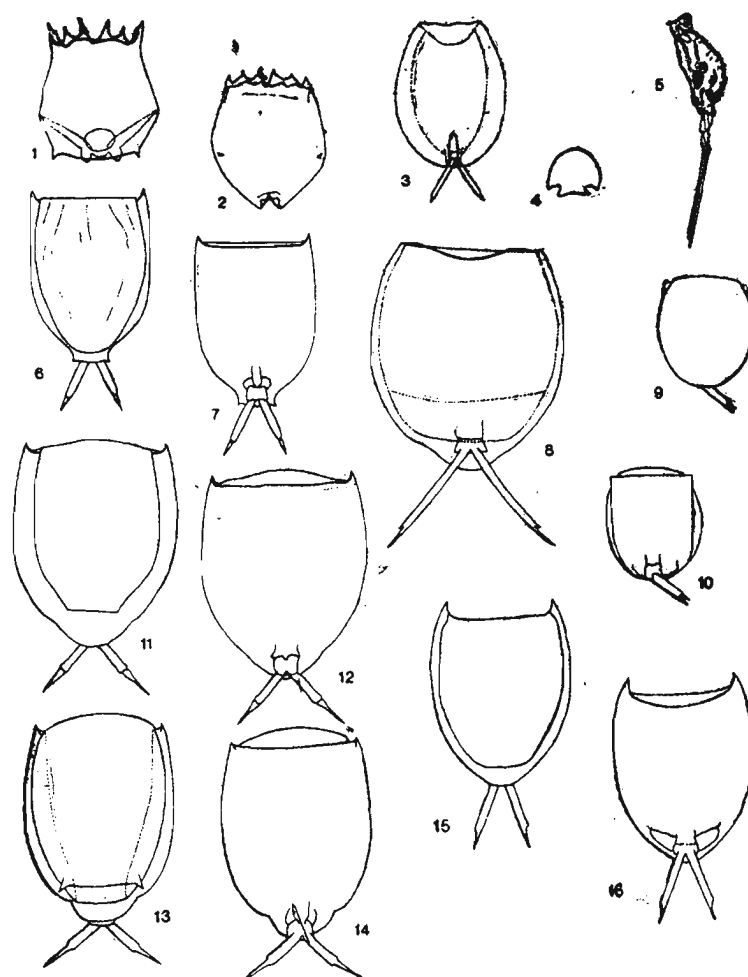
10. *Lecane lankae* sp. nov. (Figs 15 and 16)

The outline of lorica is broadly ovate; its width is more than three-fourths the length. Anterior dorsal margin more or less straight; the ventral margin has a shallow sinus. At the external angles are two stout spine-like projections. The dorsal plate is broadly ovate and broadly truncate posteriorly; it is not as wide as the ventral plate. The ventral plate is broadly ovate and larger than the dorsal and both plates are without surface markings. Posterior segment rounded and projects beyond the dorsal plate. Coxal plates are also rounded and fairly large. First foot joint of medium size; second foot joint large and does not protrude beyond the lorica. Toes long nearly two-thirds the length of lorica and are parallel sided. Claws short, prominent and ending in acute points.

**Measurements**

Length of dorsal plate 76; length of ventral plate 87; width of dorsal plate 65; width of ventral plate 72; width at anterior end 55; toe 30; claw 7.

This species is named after 'Sri Lanka'.



Figs. 1. *Brachionus bidentata* 2. *Brachionus plicatilis* 3. *Euchlanis meneta*  
 4. *Euchlanis meneta* cross-section 5. *Eudactylota eudactylota*  
 6 and 7. *Lecane bifastigata*, dorsal and ventral views  
 8. *Lecane elsa*, ventral view 9 and 10. *Lecane (Monostyla) furcata*, dorsal and ventral views  
 11 and 12. *Lecane hastata*, dorsal and ventral views  
 13 and 14. *Lecane kahouteki*, dorsal and ventral views  
 15 and 16. *Lecane lankae*, dorsal and ventral views.

*L. lankae* is related to *L. tudicola* Haring and Myers. The dorsal plate of *L. lankae* is not as wide as the ventral plate at its widest point and is completely hidden in a ventral view except for the anterior end. The ventral plate of *L. lankae* has no marginal indentations at the level of coxal plates and has a long toe with a distinct claw. In *L. tudicola* the dorsal plate is as wide as the ventral plate at its widest point and the ventral plate has marginal indentations at the level of the coxal plate and the claws are wanting. Also *L. lankae* is much smaller than *L. tudicola*. In view of all these differences we propose that this species be designated as new.

*Lecane lankae* was collected from a paddy field close to Ratnapura, Sri Lanka, on August 19, 1972.

11. ***Lecane lauterborni* Hauer, 1924** (Figs. 17 and 18)

The specimens found in Sri Lanka agree generally with the description of Hauer (1924) and Haring and Myers (1926) of material from Germany and the United States respectively. However, some differences were noted in the Sri Lanka specimens. The surface marking on the dorsal plate of Sri Lanka forms are a little different from that of the German and the United States material. The main differences are in the shape of the toes and in size. The toes of the forms found in Sri Lanka are gradually tapering to a point while in the forms described by Haring and Myers (*loc. cit.*) the toes are parallel sided for about one-third their length and then taper to an acute point. The specimens found in Sri Lanka are much smaller than the forms found in Germany (Hauer, 1924) the United States (Haring and Myers, 1926) and in Chatham Island near New Zealand (Russell, 1953). New record for Sri Lanka.

**Measurements**

Length of dorsal plate 75; length of ventral plate 81; width of dorsal plate 66; width of ventral plate 57; width at anterior end 52; toe 31.

Locality: Marawila water hold. 22.8.1972.

12. ***Lecane (Monostyla) pyriformis* Daday, 1905** (Figs. 19 and 20)

*L. pyriformis* is cosmopolitan. Hauer (1938) found this species in Indonesia and Green (1967) reports it from Lake Victoria in Africa. The forms found in Sri Lanka are fairly small. New record for Sri Lanka.

**Measurements**

Length of dorsal plate 60; length of ventral plate 64; width of dorsal plate 57; width of ventral plate 52; width at anterior end 38; toe 23.

Locality: Saravanai Nr. Kayts, Jaffna. 17.12.1971.

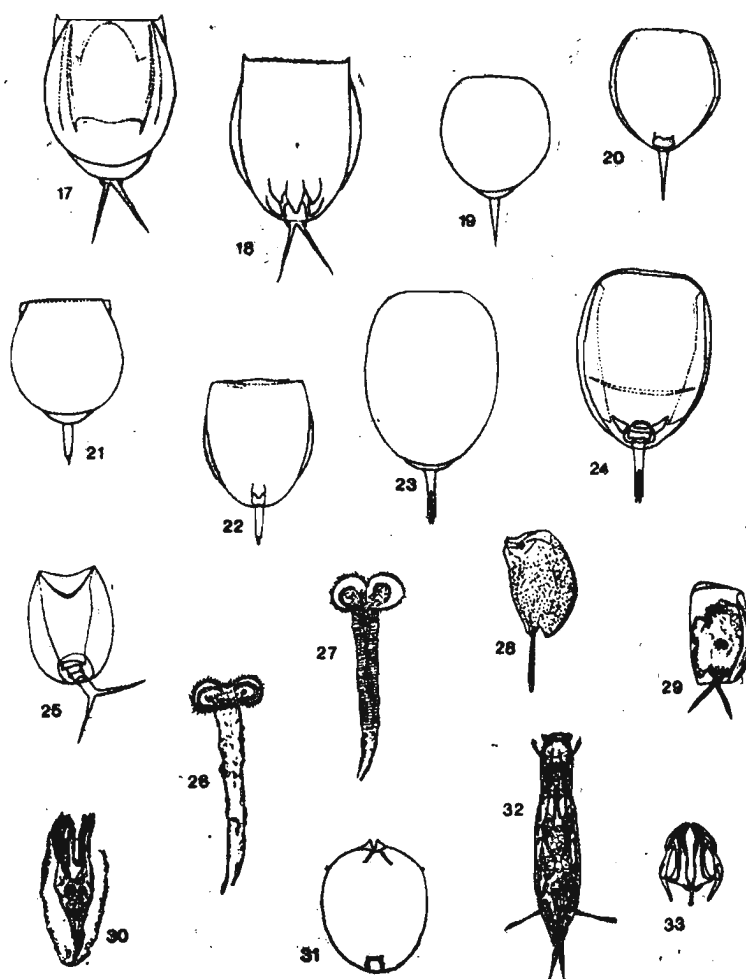
13. ***Lecane (Monostyla) scutata* Haring and Myers, 1926** (Figs. 21 and 22)

The outline of lorica is sub-circular. Posterior segment broad. The toe is long, stout and ends in a pointed claw. The specimens found in Sri Lanka resemble the form from Brazil (Koste, 1972). Rare, found only in one locality—gem-pit, Ratnapura. New record for Sri Lanka.

**Measurements**

Length of dorsal plate 90; length of ventral plate 90; width of dorsal plate 70; width of ventral plate 62; toe 28; claw 5.

Locality: Gem-pit, Ratnapura, 18.8.1972.



Figs. 17 and 18. *Lecane lauterborni*, dorsal and ventral views  
 19 and 20. *Lecane (Monostyla) pyriformis*, dorsal and ventral views  
 21 and 22. *Lecane (Monostyla) scutata*, dorsal and ventral views  
 23 and 24. *Lecane (Hemimonostyla) syngenes*, dorsal and ventral views  
 25. *Lepadella triba* 26. *Limnias ceratophylli* 27. *Limnias melicerta*  
 28. *Mytilina acanthophora* 29. *Mytilina bisulcata*  
 30. *Stephanoceros fimbriatus*  
 31. *Testudinella incisa* 32. *Tetrasisiphon hydrocora* 33. *Tetrasisiphon hydrocora—troph.*

14. *Lecane (Hemimonostyla) syngenes* Hauer, 1938 (Figs. 23 and 24)

This species was first recorded by Hauer (1938) from Indonesia and then by Koste (1972) from Brazil. The Sri Lanka material agrees with the Indonesia material described by Hauer (*loc. cit.*) but are smaller than both Indonesian and Brazilian specimens. New record for Sri Lanka.

**Measurements**

Length of dorsal plate 87; length of ventral plate 87; width of dorsal plate 69; width of ventral plate 63; toe 30; claw 5.

Locality: Tirunavakaya, Ratnapura. 18.8.1972.

15. *Lepadella triba* Myers, 1934 (Fig 25)

This small rotifer was first reported from the United States by Myers (1934) and was subsequently found in Sweden (Carlin, 1939). It does not seem to have been reported from anywhere else. The body is ovate; deep and evenly arched dorsally. Anterior margin more or less straight. Ventral sinus deep. Foot is four segmented. Toes short and pointed. This species is so very small that many rotifer workers could have missed it in their samples and is probably far more common than the published records indicate. The Sri Lanka specimens are not as large as the Swedish specimens (Carlin, 1939) but are larger than the United States specimens (Myers, 1934). Rare. New record for Sri Lanka.

**Measurements**

Length of body 61; width 43; width at anterior end 29; foot 19, toe 24.

Locality: Dothalla Mahawewa, Hettipoli. 18.12.1972.

16. *Limnias ceratophylli* Schrank, 1803 (Fig. 26)

The tube covering the body is long, cone shaped and non-transparent with a dark brown colour and attached with debris and foreign particles. The tube is transparent at the foot end.

**Measurements**

Contracted specimen—590.

Locality: Gem pit, Ratnapura. 18.8.1972.

17. *Limnias mellicerta* Weisse, 1848 (Fig. 27)

The tube enclosing the animal is long with definite striations and tapering towards the posterior end. Some debris attached to the tube. Unci with three strong teeth.

**Measurements**

Contracted specimen—660.

Locality: Gem pit, Ratnapura. 18.8.1972.

18. *Mytillina acanthophora* Hauer, 1938 (Fig. 28)

The lorica is hispid and the anterior end has two triangular projections. In the posterior end there is a deep sinus. Width of lorica more than half the length. Toes long, slender and ending in points. This species has been reported from Indonesia by Hauer (1938). New record for Sri Lanka.

**Measurements**

Length of body 135; width 84; toes 78.

Locality: Na-Eliya tank. 25.8.1972.

19. **Mytillina bisulcata** (Lucks 1912) (Fig. 29)

Lorica transparent with three keels on the back. Frontal edge smooth and curved. Width of lorica more than half the length. Toes thin and straight ending in an acute point. New record for Sri Lanka.

**Measurements**

Length of lorica 129; width 75; toe 45.

Locality: Gem pit, Ratnapura. 18.8.1972.

20. **Stephanoceros fimbriatus** (Goldfusz, 1820) (Fig. 30)

The anterior end bears five long tentacles with short alia on them. The foot in contracted specimens is highly folded, ringed and short with which they attach to the substratum. The animal is covered with a gelatinous mass.

Locality: Madulla weya, Madulla. 17.12.1972.

21. **Testudinella incisa** (Ternetz, 1892) (Fig. 31)

Lorica oval with the foot opening in the posterior extremity of ventral plate and is more or less square in shape. The anterior protuberance is divided into two by a deep cleft which is characteristic. Lateral antennae situated about one-third the length from the anterior end. This species is rare. New record for Sri Lanka.

**Measurements**

Length of body 98.

Locality: Gem pit, Ratnapura. 18.8.1972.

22. **Tetrasiphon hydrocora** Ehrenberg, 1840 (Figs. 32 and 33)

The body is elongate and fusiform. The integument is strong and hence it more or less keeps its shape, and is transparent. Two dorsal antennae present ending in a tuft of cilia. Lateral antennae is situated far back on the body and is long, tubular and carry long setae. Trophi characteristic. Ovary is very long and contains more than twenty nuclei arranged in a line. Eye spot large. The animal found from Sri Lanka appeared to have a feeble jelly covering.

*T. hydrocora* is a rare species. It has been reported from Europe (Koste, 1968) and the United States (Harring and Myers, 1922). Koste found it in swamp in Germany very rarely. Harring and Myers report it from soft and acid waters in the United States and noted that it was rare. In Sri Lanka the species was also rare. It was found only in a gem pit at Ratnapura. The specimen examined had its stomach full of desmids which suggests that it could be an acid water form. Only two specimens were found.

Locality: Gem pit, Ratnapura, 18.8.1972.

TABLE I  
Distribution of Rotifer Species from Different Habitats

Total No. of Samples/Species	Habitat					
	Rivers	Ponds	Villus	Lakes	Rice fields	Misc.
	3	60	9	101	23	32
1. <i>Anuraeopsis coelata</i> ..	1	4	—	13	—	1
2. <i>A. fissa</i> ..	—	10	1	18	1	4
3. <i>Asplanchna brightwelli</i> ..	—	6	—	37	1	2
4. <i>A. priodonta</i> ..	—	1	—	4	—	—
5. <i>A. seiboldi</i> ..	—	1	—	4	1	1
6. <i>Asplanchnopus multiceps</i> ..	—	4	1	6	3	3
7. <i>Brachionus angularis</i> ..	1	8	—	44	2	2
8. <i>B. bidentata</i> ..	—	2	—	1	—	2
9. <i>B. budapestensis</i> ..	—	—	—	1	—	—
10. <i>B. calyciflorus</i> ..	—	9	—	50	2	5
11. <i>B. caudatus</i> ..	2	5	—	32	1	—
12. <i>B. caudatus</i> var. <i>aculeatus</i> ..	—	—	—	3	—	—
13. <i>B. donneri</i> ..	—	—	—	3	—	—
14. <i>B. falcatus</i> ..	2	8	2	71	1	—
15. <i>B. forficula</i> ..	—	4	1	65	2	1
16. <i>B. leydigi</i> ..	—	—	—	—	—	1
17. <i>B. nilsoni</i> ..	—	—	1	8	—	—
18. <i>B. patulus</i> ..	1	17	2	21	10	11
19. <i>B. plicatilis</i> ..	—	1	—	—	—	1
20. <i>B. quadridentatus</i> ..	1	10	1	34	8	8
21. <i>B. rubens</i> ..	—	5	1	12	—	—
22. <i>B. sessilis</i> ..	—	—	—	2	—	—
23. <i>B. urceus</i> ..	2	3	—	12	1	2
24. <i>B. urceolaris</i> ..	—	2	1	6	—	—
25. <i>Cephalodella forficula</i> ..	—	—	—	2	—	—
26. <i>C. gibba</i> ..	—	2	—	2	—	—
27. <i>Collotheoca ornata natans</i> ..	—	—	—	7	1	—
28. <i>Conochilus unicornis</i> ..	—	3	—	4	—	2
29. <i>Conochiloides dossuarius</i> ..	—	—	—	5	1	1
30. <i>C. natans</i> ..	—	—	—	1	—	—
31. <i>Dicranophorous rubustus</i> ..	—	7	—	12	2	1
32. <i>Dipleuchlanis macrodactyla</i> ..	—	4	1	4	1	1
33. <i>D. propatula</i> ..	1	8	1	5	4	2
34. <i>Euchlanis dilatata</i> ..	3	25	3	43	15	17
35. <i>E. incisa</i> ..	—	—	—	1	—	1
36. <i>E. meneta</i> ..	—	—	—	—	1	—
37. <i>E. oropha</i> ..	—	4	1	1	—	—
38. <i>Eudactylota eudactylota</i> ..	1	1	—	3	5	1
39. <i>Filinia camascela</i> ..	—	—	—	4	—	—
40. <i>F. longiseta</i> ..	2	1	—	18	1	—

TABLE 1 (continued.)

## Distribution of Rotifer Species from Different Habitats

Total No. Samples/Species	Habitat					
	Rivers	Ponds	Villus	Lakes	Rice Fields	Misc.
41. <i>F. opoliensis</i> ..	—	2	—	33	—	—
42. <i>F. pejleri</i> ..	1	4	—	24	—	—
43. <i>F. terminalis</i> ..	1	—	—	15	1	2
44. <i>Floscularia ringens</i> ..	—	—	—	1	—	—
45. <i>Hexarthra intermedia</i> ..	2	2	—	42	—	—
46. <i>H. mira</i> ..	—	2	—	9	—	—
47. <i>Horaella brehmi</i> ..	—	2	—	7	—	—
48. <i>Kellicottia longispina</i> ..	—	—	—	3	—	—
49. <i>Keratella cochlearis</i> ..	—	—	—	11	2	—
50. <i>K. earlinae</i> ..	1	1	—	2	—	—
51. <i>K. lenzi</i> ..	—	—	1	4	—	—
52. <i>K. taurocephala</i> ..	—	—	—	1	—	—
53. <i>K. tropica</i> ..	2	5	3	90	6	1
54. <i>Lecane (Lecane) bifastigata</i> ..	—	1	—	1	—	—
55. <i>L. (L.) ceylonensis</i> ..	—	1	—	1	1	2
56. <i>L. (L.) crepida</i> ..	—	3	—	5	2	1
57. <i>L. (L.) curvicornis</i> ..	1	9	—	10	1	5
58. <i>L. (L.) curvicornis</i> var. <i>miamiensis</i> ..	—	1	—	1	—	—
59. <i>L. (L.) elsa</i> ..	1	—	—	—	1	1
60. <i>L. (L.) hastata</i> ..	—	—	1	1	—	1
61. <i>L. (L.) hornemanni</i> ..	1	7	2	4	4	2
62. <i>L. (L.) kahouteki</i> ..	—	—	—	—	—	1
63. <i>L. (L.) lankae</i> ..	1	7	2	4	4	2
64. <i>L. (L.) lauterborni</i> ..	—	—	—	—	—	1
65. <i>L. (L.) leontina</i> ..	—	9	1	31	5	8
66. <i>L. (L.) ludwigi</i> ..	—	3	—	4	—	—
67. <i>L. (L.) luna</i> ..	1	22	5	36	10	13
68. <i>L. (L.) ohioensis</i> ..	—	4	—	3	2	1
69. <i>L. (L.) papuana</i> ..	2	11	1	19	3	8
70. <i>L. (L.) plesiaides</i> ..	—	2	—	—	—	—
71. <i>L. (L.) ploenensis</i> ..	1	5	1	6	2	6
72. <i>L. (L.) pusilla</i> ..	—	—	—	—	—	1
73. <i>L. (L.) unguolata</i> ..	1	12	—	26	7	8
74. <i>L. (L.) verecunda</i> ..	—	1	—	—	1	—
75. <i>L. (Hemimonostyla) sympoda</i> ..	1	4	—	1	2	3
76. <i>L. (H.) syngenes</i> ..	—	1	—	—	—	—
77. <i>L. (Monostyla) bulla</i> ..	3	27	4	75	17	20
78. <i>L. (M.) closterocerca</i> ..	—	5	1	5	—	4
79. <i>L. (M.) decipiens</i> ..	—	6	2	7	—	2
80. <i>L. (M.) elachis</i> ..	—	5	—	3	3	3

TABLE I (continued)

## Distribution of Rotifer Species from Different Habitats

Total No. Samples/Species	Habitat					
	Rivers	Ponds	Villus	Lakes	Rice fields	Misc.
	3	60	9	101	23	32
81. <i>L. (M.) furcata</i> ..	—	—	—	—	1	—
82. <i>L. (M.) lunaris</i> ..	—	10	2	19	3	5
83. <i>L. (M.) obtusa</i> ..	—	1	—	2	2	—
84. <i>L. (M.) pyriformis</i> ..	—	3	—	4	—	3
85. <i>L. (M.) quadridentata</i> ..	1	7	1	10	4	4
86. <i>L. (M.) scutata</i> ..	—	—	—	—	—	1
87. <i>L. (M.) stenroosi</i> ..	—	—	—	6	2	1
88. <i>L. (M.) unquitata</i> ..	1	9	4	18	6	9
89. <i>Lepadella costata</i> ..	—	1	—	—	—	1
90. <i>L. ovalis</i> ..	1	5	—	4	1	3
91. <i>L. patella</i> ..	—	3	—	7	1	3
92. <i>L. rhomboides</i> ..	—	4	—	2	—	1
93. <i>L. triba</i> ..	—	—	—	—	1	—
94. <i>Limnias ceratophylli</i> ..	—	—	—	1	—	—
95. <i>L. melicerta</i> ..	—	—	—	1	—	—
96. <i>Macrochaetus collinsi</i> ..	—	2	—	1	2	—
97. <i>M. sericus</i> ..	—	1	—	4	2	1
98. <i>Mytilina acanthophora</i> ..	—	—	—	1	—	—
99. <i>M. bisulcata</i> ..	—	2	—	2	—	1
100. <i>M. mucronata</i> ..	—	—	—	5	—	—
101. <i>M. ventralis</i> ..	2	12	2	12	4	5
102. <i>Notommata sp.</i> ..	—	1	—	4	1	3
103. <i>Platylabus quadricornis</i> ..	3	19	1	23	6	4
104. <i>Polyarthra dolichoptera</i> ..	—	6	—	16	2	3
105. <i>P. vulgaris</i> ..	1	6	1	27	—	—
106. <i>Pompholyx complanata</i> ..	—	—	—	24	—	1
107. <i>Scaridium longicaudum</i> ..	—	1	—	1	—	1
108. <i>Sinantherina semibullata</i> ..	—	3	—	1	4	—
109. <i>S. spinosa</i> ..	—	2	—	3	5	1
110. <i>Stephanoceros fimbriatus</i> ..	—	—	—	1	—	—
111. <i>Testudinella incisa</i> ..	—	—	—	—	—	1
112. <i>T. parva</i> ..	—	2	—	—	1	2
113. <i>T. patina</i> ..	3	17	4	31	7	8
114. <i>Tetrasiphon hydrocora</i> ..	—	—	—	—	—	1
115. <i>Trichocerca bicristata</i> ..	—	1	—	—	—	—
116. <i>T. braziliensis</i> ..	—	1	—	—	—	—
117. <i>T. chattoni</i> ..	—	2	—	8	—	—
118. <i>T. cylindrica</i> ..	—	2	—	6	—	—
119. <i>T. dixon-nuttali</i> ..	—	—	1	—	1	—
120. <i>T. rattus</i> ..	2	2	1	16	2	4

TABLE I (continued)

## Distribution of Rotifeg from Different Habitats

Total No. of Samples/Species	Habitat					
	Rivers	Ponds	Villus	Lakes	Rice fields	Misc.
	3	60	9	101	23	32
121. <i>T. similis</i> .. .. .	—	2	—	21	—	1
122. <i>T. sylvata</i> .. .. .	—	—	—	7	1	—
123. <i>Trichotria pocillum</i> .. .. .	—	—	—	—	1	1
124. <i>T. tetractis</i> .. .. .	—	3	—	12	1	8
125. <i>Tripleuchlanis plicata</i> .. .. .	—	5	1	11	2	—
125. <i>Trochosphaera equatorialis</i> .. .. .	—	—	—	1	1	—

## Summary and Discussion

In this third paper on Rotifera from Sri Lanka twenty-two species of rotifers are recorded. This includes two new species and 14 new records for Sri Lanka. In the two previous papers a total of one hundred and four species, including new species and new generic and species records, has been described. Twelve species not described by us have been recorded by previous workers. They are: *Brachionus diversicornis* (Daday), *Epiphanes macrourus* Ehrenberg, *Lepadella triptera* Ehrenberg, *Conochilus hippocrepis* (Schrank), *Lacinularia flosculosa* (Muller), *Rotaria neptunia* Ehrenberg, *Rotaria rotaria* Pallas, *Synchaeta pectinata* Ehrenberg, *Trichocerca tenuior* Gosse, *Trichocerca elongata* (Gosse), *Trichocerca scipio* (Gosse), and *Trichocerca tigris* (Muller). This brings the total number of species of rotifers from Sri Lanka to one hundred and thirty-eight. Some species which are contracted beyond recognition and some that need to be studied when alive are omitted.

The rotifer fauna of Sri Lanka are typically cosmopolitan when compared to the lists of Hauer (1938) and Green (1972). Cosmopolitan forms (Green 1972) are also well represented. A comparison of the number of species and their composition from Sri Lanka to that of the Indian sub-continent and the Indonesian region, where the rotifer fauna has been studied at least superficially, is given in our previous paper dealing with Rotifera of Sri Lanka (Chengalath, Fernando and Koste, 1973 b). Apart from the rare and interesting species recorded earlier (loc. cit.) a few more were discovered. This includes *Lecane hastata*, *Lecane elsa*, *Lecane lauterborni*, *Lepadella triba* and *Tetrasiphon hydrocora*. All these species were recorded from only one to three samples of the over four hundred samples examined. *Lepadella triba* is so far recorded only from Sweden (Carlin, 1939) and the United States (Harring and Myers, 1922) while *Tetrasiphon hydrocora* is reported only from Europe (Koste, 1968) and the United States (Harring and Myers, 1922) and that too was very rare and found in small numbers.

Of the 228 localities sampled, 101 are lakes, 60 ponds, 32 miscellaneous habitats which include wells, gem-pits, rainpools, rockpools, waterholds, etc., 23 rice fields, 9 villus, and 3 rivers. A total of 402 samples were examined. Table I shows the distribution of each species in different habitats. Of the one hundred and twenty-six species and distinct varieties recorded, 55 are common occurring in more than twenty percent of the samples. Generally, the species which are present commonly in lakes are also present in ponds, rice fields and miscellaneous habitats.

*Asplanchna brightwelli*, *Branchionus angularis*, *B. caudatus*, *B. falcata*, *B. forficula*, *B. quadridentatus*, *B. patulus*, *Euchlanis dilatata*, *Filinia opoliensis*, *Hexarthra intermedia*, *Keratella tripoca*, *Lecane leontina*, *L. luna*, *L. papuana*, *L. unquolata*, *L. bulla*, *L. lunaris*, *Platyias quadricornis*, *Polyarthra vulgaris*, *Pompholyx complanata*, *Testudinella patina*, *Tricocerca rattus* and *Trichocerca similis* are the commonest species and these species have been located, if not in all at least in more than four types of habitats mentioned above and then in large numbers. Apart from some species like *Branchionus forficula*, *B. falcatus*, *B. caudatus*, *Filinia opoliensis*, *Keratella tropica* and *Lecane papuana*, which are cosmopolitan forms, all the above mentioned species are cosmopolitan and are found abundantly.

A total of 40 genera are represented in Sri Lanka. The genus *Lecane* has the maximum number of representatives with a total of 35 species of which four, *Lecane ceylonensis*, *L. kahouteki*, *L. lankae* and *L. plesioides* are new species. The species of the genus *Lecane* are met with in all habitats and this probably is the reason for their predominance relative to other species. *L. bulla* is the commonest species and is found in 75 lakes, 27 ponds, 20 miscellaneous habitats, 17 rice fields, 4 villus and 3 rivers. This shows again the well-known versatility of *L. bulla*. The genus *Branchionus* has 18 species including the rare species *B. donneri* and *B. sessilis*. An interesting feature noted was that almost invariably *B. falcatus* and *B. forficula* are found together in the same sample. The genus *Keratella* is represented by five species and *K. tropica* is the second commonest species found in Sri Lanka and was found in 90 lakes, 6 rice fields, 5 ponds, 3 villus, 2 rivers, and one miscellaneous habitat. This distribution clearly shows that *K. tropica* is mainly a lake species, *K. cochlearis*, *K. earlinae*, *K. lenzi* and *K. taurocephala* are very rare and all of them are found mainly in lakes which again indicate that these, like *K. tropica*, are also an open water, lake form or capable of thriving under these conditions. In Sri Lanka where no natural lakes exist (Fernando 1970) these species must have colonized man-made lakes from ponds and river oxbows. *Euchlanis dilatata* like *Lecane bulla* is widely distributed in all habitats and in fairly large numbers. *Branchionus patulus* and *Platyias quadricornis* also show a wide distribution. *Sinantharina spinosa* and *S. semibullata* although seen rarely in other habitats seem to prefer rice fields where *L. luna*, *L. bulla* and *E. dilatata* are also common.

The rotifer fauna of Sri Lanka is rich and varied and is typically tropical in composition, abounding in all kinds of habitats. This study also shows that while certain species are successful in all kinds of habitats some show a clear preference to a particular type of habitat. More extensive observation and experimental work in relation to each habitat is needed to know more about the factors affecting rotifer distribution.

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# Some Parasitic Copepoda from Sri Lanka (Ceylon) with a Synopsis of Parasitic Crustacea from Ceylonese Freshwater Fishes

by

C. H. FERNANDO and GEORGE HANEK\*

## INTRODUCTION

Material collected during 1965-1971 by one of us (C.H.F.) yielded a number of records of parasitic Copepoda. This includes three species of the family Ergasilidae, namely *Ergasilus ceylonensis* Fernando and Hanek, 1972, *E. mendisi* Fernando and Hanek, 1972 and *Paraergasilus brevidigitus* Yin, 1954; one subspecies of the family Dichelesteiidae, namely *Lamproglena chinensis sprostoni*-Kirtisinghe, 1964, and one subspecies of the family Lernaeidae, namely *Lernaea cyprinaceachackoensis* Gnanamuthu, 1951. Some of these were recovered from the fish hosts, whilst on a number of occasions *Ergasilus* spp. and on one occasion *Lernaea* sp. was recovered from zooplankton, indicating that these are quite common on fishes.

We have taken this opportunity of giving a synopsis of parasitic Crustacea collected from Ceylonese freshwater fishes. In addition to the species mentioned above, one species of Branchiura namely *Argulus foliaceus* L. and one species of Isopoda, namely *Alitropus typus* Milne Edw. have been recorded so far. It is interesting to note that some of the species, e.g. *Paraergasilus*, *Lernaea*, and *Argulus* recovered from Ceylonese fishes have been introduced with fishes imported for stocking freshwater lakes. In future introductions of foreign fish species great care should be taken that these fish are parasite free.

## MATERIALS AND METHODS

Branchial material of fishes, collected using gill nets during 1965-1971, was preserved in 10% formalin and examined at a later date. Methods as those given in Fernando and Hanek (In Press) were used for Ergasilidae. Drawings were made using a camera lucida. All species presented herein have been deposited in the collection of the Department of Biology, University of Waterloo, Waterloo, Ontario, Canada.

## RESULTS

### *Ergasilus ceylonensis* Fernando and Hanek, 1972 (Fig. 1)

Detailed description, measurements, and distribution are given in Fernando and Hanek (In Press). In addition various larval stages of this species were found in zooplankton samples collected from Magalla Wewa, Nikaweratiya and from Nuwara Wewa, Anuradhapura. This species was reported as *Ergasilus* sp. by Fernando (1969).

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*Ergasilus mendisi* Fernando and Hanek, 1972 (Fig. 2)

Detailed description, measurements, and distribution are given in Fernando and Hanek (In Press). Larval stages of this species were found in zooplankton samples collected from Nuwara Wewa, Anuradhapura.

*Paraergasilus brevidigitus* Yin, 1954 (Figs. 3-5)

This species, generally found infesting the nasal cavities and the gills, has been described from the gills of *Mylopharyngodon piceus* by Yin (1954) in China. Since then Smirnova (1962) reported this species from Amur wild carp, Amur River basin, and Hanek and Dulmaa (1970) found this species infesting the nasal cavities of *Leuciscus waleckii* in Mongolia. A single female of this species was found in zooplankton from Kantalai tank. Its morphology is the same as that described by Yin (1954), except in the structure of swimming foot V. This unisegmented appendage which Yin (1954) described as having 2 setae, bears 3 setae instead as previously reported by Smirnova (1962) and Hanek and Dulmaa (1970). Measurements of our specimen are as follows:— Total length 0.55 mm. maximum width 0.18 mm. Antennae I clearly 5-segmented, 0.081 mm. long; first segment being longest, 0.026 mm. long, second, third, and fourth 0.014 mm. long each, and fifth segment smallest, 0.013 mm. long. Antenna II. (Fig. 5) 3-segmented with three clawlike setae, 0.13 mm. long: basal segment inflated, second segment expanded centrally, two times as long as the third segment, clawlike setae 0.026 mm. long each. Swimming feet V (Fig. 4) unisegmented with three setae: segment 0.029 mm long, terminal setae 0.039 mm. long, two remaining setae 0.013 mm. long. This finding represents the first record of this genus from Ceylon. It is possible that it was introduced with imported species of Chinese carp

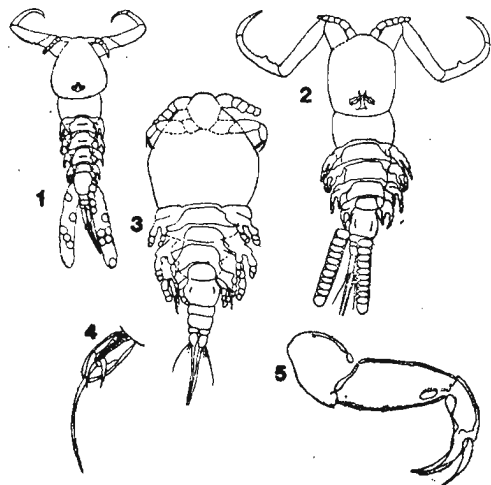


Fig. 1.—*Ergasilus ceylonensis* Fernando & Hanek.

Fig. 2.—*E. mendisi* Fernando & Hanek.

Fig. 3.—*Paraergasilus brevidigitus* Yin.

Fig. 4.—Swimming Foot V of *P. brevidigitus*.

Fig. 5.—Antenna II of *P. brevidigitus*

*Lamproglena chinensis sprostoni* Kirtisinghe, 1964 (Fig. 6)

Kirtisinghe (1964) described this subspecies from the gills of *Opiocephalus striatus* bought in Colombo market. Apparently the same subspecies was reported from the same host by Mendis and Fernando (1962). They noted; '*Lamproglena* induces a distorted growth of the tip of the gill filaments of the host causing an enlargement of the connective tissue and a degeneration of the blood capilleries in the filaments'. Our present material, collected from the gills of *Opiocephalus striatus* from Topawewa, Polonnaruwa, is in full agreement in morphological features with that of Kirtisinghe (1964).

*Lernaea cyprinacea chackoensis* Gnanamuthu, 1951, (Fig. 7)

Gnanamuthu (1951) described this subspecies from the skin of *Osphronemus goramy* and *Catla catla* in Madras, India. Since then, Mendis and Fernando (1962) have found this subspecies infesting *Cyprinus carpio*. They noted: 'From time to time there have been outbreaks of this parasite of fishes in the Fisheries Research Station ponds in Colombo. Some mirror carp brought to Colombo from Ceylon Fishing Club's hatchery in Nuwara Eliya were also found to harbour the parasite'. Kirtisinghe (1964) found this parasite on the body of *Osphronemus goramy* in freshwater ponds and lakes in Colombo. The present material consists of five females found deeply penetrated into the gill tissue of *Heteropneustes fossilis* (Bloch) collected from Parakrama Samudra, Polonnaruwa, and of three females also found deeply penetrated into the gill tissue of *Glossogobius giuris* (Hamilton-Buchanan) collected from Kiribbanare Wewa. Our material fits the original description in all respects. The measurements of eight females ranging as follows: Total length (except egg sacs) 6.0-7.2mm. width 0.5-0.7 mm. Length of unbranched anteriorly process 0.28-0.31 mm. length of branched laterally extending processes 0.69-0.72 mm., egg sacs 1.3-1.6mm. long by 0.22-0.25 mm. wide, egg size 0.07-0.08 mm. These records extend the range of hosts for this parasite to *Heteropneustes fossilis* and *Glossogobius giuris*. This species was also found in zooplankton in Nuwara Wewa, Anuradhapura.

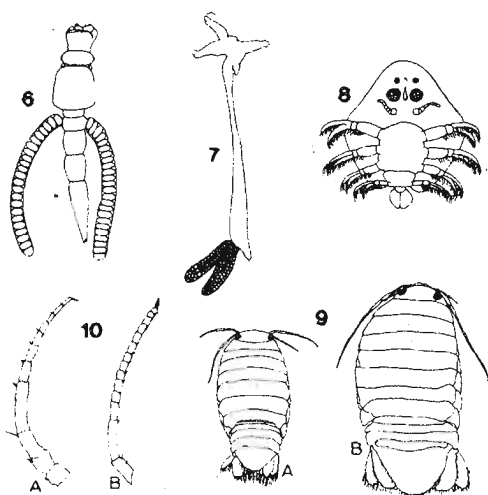


Fig. 6.—*Lamproglena chinensis sprostoni*.

Fig. 7.—*Lernaea cyprinacea chackoensis*

Fig. 8.—*Argulus foliaceus*

Fig. 9 (A & B) and 10 (A & B) *Alitropus typus*

*Argulus foliaceus* L. (Fig. 8)

Mendis and Fernando (1962) have reported this parasite from the Fisheries Research Station experimental ponds in Colombo. This parasite has been introduced to Ceylon with the mirror carp (Mendis and Fernando, 1962) and 'with the mirror carp and trout that were stocked in the lakes and streams in and around Nuwara Eliya (Kirtisinghe, 1964)'.

*Alitropus typus* Milne Edw. (Figs. 9A, 9B, 10A, 10B)

Mendis and Fernando (1962) reported this parasite from the gill chambers of *Rasbora daniconius* and *Wallago attu* collected from Angunuwila tank and from Kala-Oya respectively. They note: 'This species was also found free living in the Battulu Oya, Nedimaia (Dehiwela) and the Fisheries Department ponds at Narahenpitiya'. They also noted that 'this species is a facultative ectoparasite and lives in freshwater, close to the sea and in lagoons, from where it has probably migrated'. Ingle and Fernando (1963) recorded this species from Ceylon and discussed its systematic position.

## DISCUSSION

Of the seven species of parasitic Crustaceans recorded from Ceylon only four appear to be endemic. Three of the species, namely (*Paraergasilus brevidigitus*, *Lernaea cyprinacea chackoensis*, and *Argulus foliaceus*) have been introduced with fish imported for stocking freshwater lakes in Ceylon. Fernando (1965, 1971) has listed all the fish species introduced into Ceylonese freshwater so far. This include Chinese carps and the common carp, which seems to have been responsible for carrying the parasites into local waters. Fernando and Furtado (1963) reported another possible parasite introduction of the Cestode *Bothriocephalus gowkongensis* Yeh, 1955 with the Chinese carp *Ctenopharynydon idellus*. Fernando and Indrasena (1969) have listed many references to the introduction of this latter species to Eastern Europe.

The Ceylonese freshwater fauna is generally poor in species adapted to large water bodies, since there are no natural lakes (Fernando, 1971). There are, therefore, many niches open for species already adopted to such habitats. For these reasons it is very important that future fish introductions should be carefully screened and the fish rendered parasite free before introduction. Some methods for treating infested fish before introduction are given by Bauer and Uspenskaya (1959), Ergens (1962), and Molnar (1970).

## ACKNOWLEDGEMENTS

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## Reservoir Fishery Resources of South-East Asia\*

By

C. H. FERNANDO<sup>1</sup> AND J. I. FURTADO<sup>2</sup>

### Introduction

THERE is a long history of reservoirs (or man-made lakes) in South-East Asia, mainly for the purpose of irrigation in association with wet rice cultivation. Sophisticated reservoir systems served relatively intensive wet rice cultivation in several parts of this region such as in Sri Lanka, in the lower Mekong Basin, and in southern India. The number and size of reservoirs has increased in recent years, and is increasing rapidly, by the expansion of existing units or the construction of new multipurpose dams. This rapid increase is due to the rising demands for power and irrigation water for a growing human population and its industries. A very conservative estimate places the acreage of reservoirs by 1985 in South-East Asia at about 6 million hectares. In spite of this increase in reservoirs, the management of these resources has been delegated usually to authorities with restricted and specific goals such as irrigation, hydro-electricity or water supply. As such, the optimum utilisation of reservoir resources has not been realised fully in any part of South-East Asia.

Hitherto, reservoirs have been poorly exploited for fishery resources in South-East Asia in general. Fish yields from reservoirs vary greatly from one part to another in the region, and as expected even between individual reservoirs in the same part of the region because of ecological and edaphic differences. When considered as a whole, fish yields from reservoirs in South-East Asia have been lower than their potential. Although the comparative data available is meagre, recorded high fish yields are due either to a rich diversity of indigenous freshwater fishes, or to the introduction of "foreign" fish species. The most spectacular increases in fish yields are due to the introduction of African cichlid fishes of the genus *Tilapia*. These high yields are comparable to those observed in African reservoirs, and are much higher than that of reservoirs stocked naturally with indigenous species. The introduction of invertebrates into reservoirs to stimulate an increase in fish yield, has been considered but not implemented extensively, hitherto. The rationale for invertebrate introductions is the paucity of true limnetic species in South-East Asia. The fertilization of reservoirs or enhancing fish yield, has not yet been considered for South-East Asia, although some reservoirs have been eutrophicated by agro-industrial or other activities.

Although the management of reservoirs for optimum benefits, especially fisheries, is still to be realised fully in South-East Asia, it is more probable that an ecological basis for managing these resources for fisheries production will be more economical than other forms of comparable fish production such as pond culture. The reasons for this are that reservoir resources are becoming available primarily for other purposes, and that manipulating the reservoir ecosystem for optimum benefits requires a low energy subsidy. Such an economy is particularly important since reservoirs

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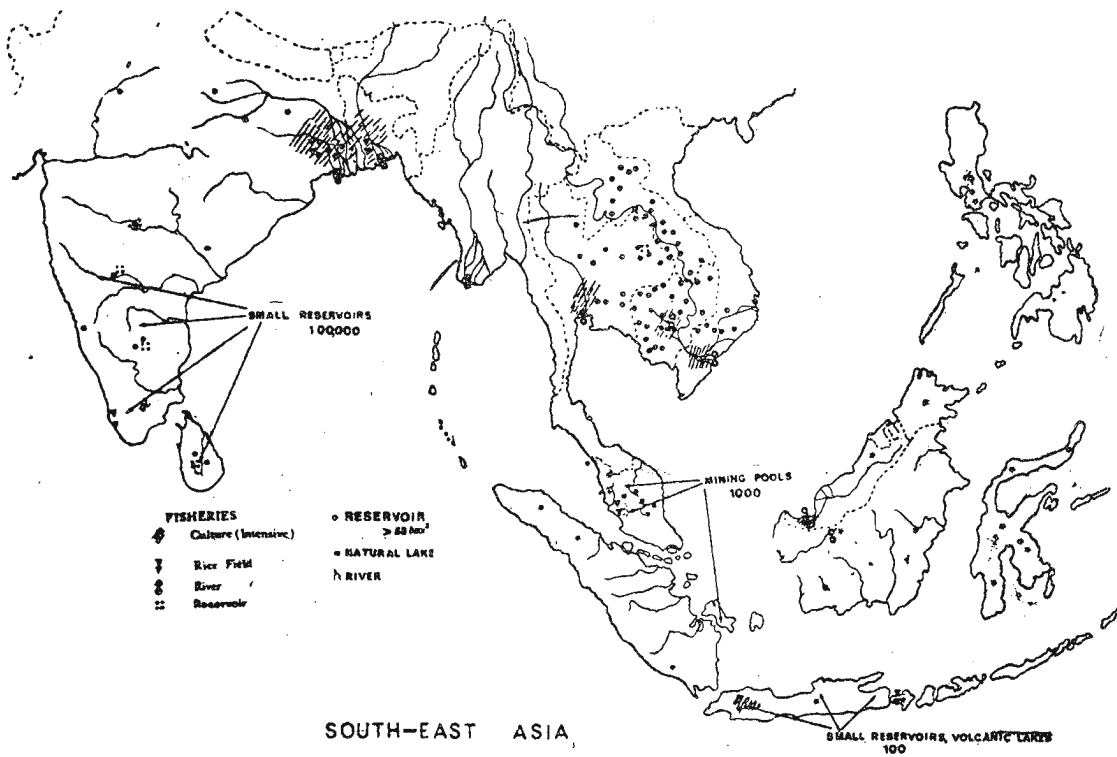


Fig. 1:— Location of major natural and man-made freshwater habitats and fisheries in South-East Asia.

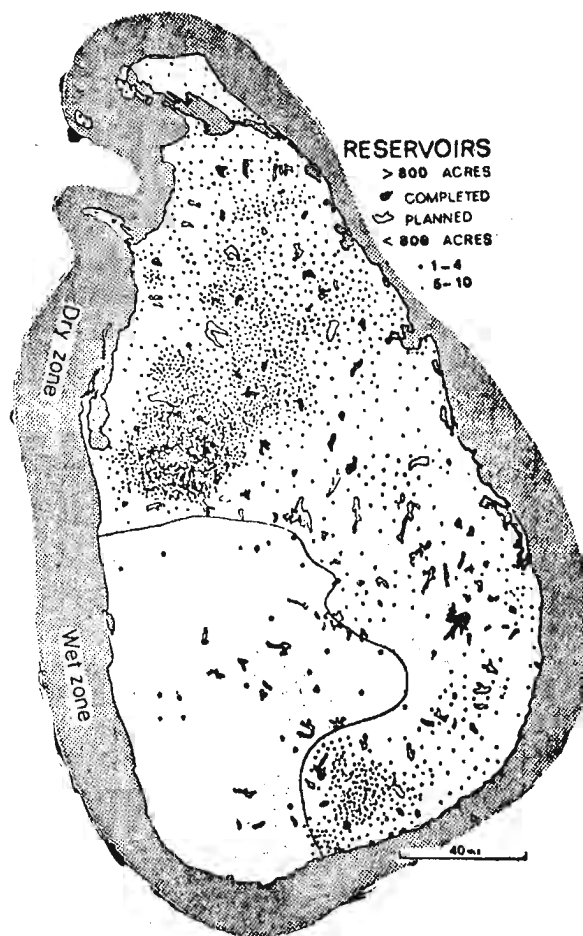


Fig. 2.—Man-made lakes in Sri Lanka. In a total area of 70,000 km<sup>2</sup> there are over 10,000 such lakes with a total area of about 125,000 hectares (Ajter Fernando 1970).

are located usually in the rural areas where the need for an abundant cheap protein source is most critical to the human population. For example, in Sri Lanka, fish introductions have stimulated a fishery industry in reservoirs with an overall average yield of about 100 kg/ha/annum. Some reservoirs have shown a sustained yield of about 200 kg/ha/annum for a period of about 20 years.

### Inland Standing Waters and Reservoirs

The available data on reservoir acreage in South-East Asia is far from reliable (Table 1) and is based on data obtained from local publications and/or from discussions with local fishery officials. Nevertheless, the reservoir acreage is quite substantial compared to rice fields and lakes.

The distribution of reservoirs in South-East Asia (Fig. 1) is very uneven both in the concentration of units and in the type of reservoir. Large (and usually deep) reservoirs are found almost exclusively in India and the Mekong region, with a few scattered in Sri Lanka and Malaysia. Small reservoirs (often referred to as "tanks") are concentrated in Southern India and Sri Lanka. Fig. 2 shows the distribution and dense concentration of small reservoirs (< 300 hectares) in Sri Lanka. In Peninsular Malaysia and Banka (Indonesia), there are numerous tin mining pools of varying size but usually only a few hectares in area. These have been and are used for fish production in Malaysia (Jothy 1968).

TABLE 1

Areas (in  $\times 10^6$  hectares) of some types of inland waters producing fish in South East Asia

Types/Country	Reservoirs		Ricefields	Natural lakes and flooded areas
	Present	Future		
Bangladesh	N.A.**	N.A.	10,000	N.A.**
Burma	0.010	0.150	5,000	0.050 FP
India	3,000	5,000	40,000	N.A.**
Indonesia	0.050	0.500	8,000	1,000 NL 0.100 FP
Khmer	0.080	1,000	2,000	0.400 FP
Laos	0.050	5,000	0.700	N.A.
Malaysia :				
Malaya	0.020	0.150	0.500	0.008 FS
Sabah	N.A.*	N.A.	0.050	N.A.
Sarawak	N.A.*	N.A.	0.120	0.010 FP 3.187 FS 0.006 FL
Philippines	N.A.**	N.A.	N.A.**	0.100 FP & NL
Singapore	0.000	0.000	Nil	N.A.
Sri Lanka	0.125	0.250	0.600	0.020 FP
Thailand	0.150	2,500	6,700	N.A.
Total (approximate)	3.5	13.0	70.0	1.650

N.A. = No data available

\*\* Considerable

NL = Natural lakes

\* Negligible

FP = Flood plain

FS = Freshwater swamps

TABLE 2

Inland Fish Production (1970-73) in South East Asia in metric tons per annum

Country	Capture Fisheries		Culture Fisheries
	Lakes and Reservoirs	Rivers, Marshes, etc.	
Bangladesh ..	N.A.***	N.A.***	N.A.***
Burma ..	N.A.*	N.A.***	1,500
India ..	40,000	25,000	480,000
	(Reservoirs only) ..		
Indonesia ..		300,000	140,000
Khmer ..		120,000	5,000
Laos ..	N.A.***	N.A.***	N.A.*
Philippines ..	N.A.***	N.A.*	2,000+ BRW
Sabah ..	N.A.*	5,000	300
Sarawak ..	N.A.*	N.A.***	1,000
Sri Lanka ..	8,400	N.A.*	N.A.*
	(Reservoirs only) ..		
Singapore ..		N.A.*	N.A.*
Thailand ..		52,000	63,000
West Malaysia ..		16,000	4,000
Total (Estimated)		Capture : 450,000	Culture : 700,000
		Reservoirs 60,000	
		Natural lakes (including flood fisheries) 220,000	
		Rivers, marshes, etc. 180,000	
N.A. = No data available		*** considerable	
BRW = Brackishwater fishculture 95,000 metric tons.		* negligible	

Natural lakes are few and localised in South East Asia (Fig. 1). With the exception of a few in Sulawesi, all these lakes are relatively young and the vast majority are the volcanic lakes in Indonesia. A few large flood lakes occur in the Khmer Republic and the Kapuas region in Kalimantan. Smaller flood lakes are found in Sri Lanka, Burma and Thailand. Peninsular Malaysia has two dystrophic lakes. In comparison to the reservoirs, lakes (even in the broadest sense) form only a small fraction of their acreage. Because old natural lakes are absent in many parts of South East Asia, the evolution of lake fish species and limnetic invertebrates has not occurred unlike in Africa, except for cyprinids in Lake Lanao, Philippines.

Reservoir Fisheries

Reservoir fisheries in South East Asia is of little importance at present, except in Sri Lanka where almost the total freshwater fish catch is from reservoirs and in southern India where both large and small reservoirs produce a sizeable fish catch. The location of different types of freshwater fisheries is shown in Fig. 1, and the fish catches from different types of freshwater fisheries in South East Asia is given in Table 2. Although we do not have reliable or detailed data on fish

catches, the approximate total fish catches from reservoirs is about 60,000 metric tons. It is not possible in most instances to discriminate fish catches for the different types of fishery with the available data.

TABLE 3

## Reservoirs in South East Asia having negligible fish yields

Reservoir and Location	Nature	Area(ha)	Fish Yield Kg/ha/an	Source	Remarks
Nalanda, Sri Lanka	.. Deep ..	273 ..	nil ..	.. Fernando .. 1973	.. Very little littoral fish species .. Only indigenous fish species .. Low elevation
Castlereagh, Sri Lanka	.. Deep ..	363 ..	nil ..	.. Fernando .. 1973	.. Elevation 1,500 m. .. Indigenous spp. and common carp only
Ringlet, West Malaysia	.. Deep ..	400 ..	nil ..	.. Pers. obs...	.. Elevation 0,000 m. .. Indigenous spp. and Chinese carps
Karangates, East Java	.. Deep ..	1,500 ..	nil ..	.. Pers. obs. ..	.. Indigenous spp. only .. Low elevation

Assuming that the total reservoir acreage for South East Asia is 3.5 million hectares and the fish yield is 60,000 metric tons/annum, then the overall average yield is about 20 kg/ha/an. This overall average production in reservoir fishery shows considerable variation between the component reservoirs. High production in the shallow reservoirs in south India, Sri Lanka and Indonesia account for about half the total fish catch, and very low to negligible fish yields are common in most reservoirs throughout South East Asia. Reservoirs may be classified into three broad categories on the basis of fish yield. Negligible, low and high. In addition highly eutrophic small reservoirs resemble fishponds and have similar fish yields, thus constituting a fourth category. The fish yield of some reservoirs belonging to these four categories are given in Tables 3-6.

In a large number of deep (>10m. mean depth) reservoirs in South East Asia fish yields are negligible (Table 3). Although deep reservoirs can be expected to give low fish yields, the total lack of fish production in some is surprising. Some of these lakes are at high elevations, e.g. Ringlet and Castlereagh reservoirs, while others are at low elevations, e.g. Karangates and Nalanda. In all these instances, a lack of suitable fish species seems to be the main cause for the negligible fish yields, although other factors such as low ionic concentrations and the lack of a littoral zone, are also operative.

Reservoirs with a low fish yield are usually either deeper reservoirs or dystrophic (Table 4). Their fish yields are about 10-40 kg/ha/an., and are of similar magnitude to fish yields in more temperate regions, such as 10-12 kg/ha/an., for the U. S. America (Jenkins 1967) and 18-36 kg/ha/an., for the U.S.S.R. (Frey 1967). It is worth noting that before the introduction of *Tilapia mossambica* in Sri Lanka, the yields from shallow reservoirs was less than 10 kg/ha/an., and the present yield of indigenous species in reservoirs intensively fished for *Tilapia mossambica* is 10-20 kg/ha/an.

TABLE 4

## Reservoirs in South East Asia having low fish yields

Reservoir and Location	Nature	Area (ha)	Fish Yield Kg/ha/an	Source	Remarks
Large Reservoirs in South and Central India	Deep	.. 1 million	.. 20-40	.. Anon 1969	.. Indigenous carps only
Senanayake Samudra, Sri Lanka	Deep	.. 7,700	.. 20	.. Fernando 1973	.. <i>Tilapia mossambica</i> and indigenous spp.
Djuando, Djatiluhur, West Java	Deep	.. 8,300	.. 15	.. Achmad 1970	.. <i>Tilapia mossambica</i> as indigenous spp.
Bukit Merah, West Malaysia	Shallow	.. circa 2,000	.. 35	.. Fisheries Department	.. Indigenous carps, catfish, snakeheads, <i>Trichogaster pectoralis</i> . No <i>T. mossambica</i>
Subang, West Malaysia	Shallow	.. 900	.. 90	.. Yap 1974	.. Indigenous carps
Kanjiri Duwar, S. India	Deep	.. circa 5,200	.. 84	.. Hickling 1961	.. Indigenous spp. only

TABLE 5

## Lakes and reservoirs in South East Asia having high fish yields

Habitat and Location	Status and nature	Area (ha)	Fish yield Kg/ha/an	Source	Remarks
Lake Lombotto Sulawesi	Lake Shallow	.. 4,050	.. 432	.. Hickling 1961	<i>Tilapia mossambica</i> <i>Trichogaster pectoralis</i> introduced indigenous shrimps form half of catch
Lake Tempe Sulawesi	.. Flood lake Shallow	.. 9,500 - 20,000	.. 161 800-900	.. Hickling 1961 Achmad 1975 Pers. Comm.	<i>Tilapia messambica</i> <i>Puntius javanicus</i> and <i>Trichogaster pectoralis</i> introduced
Tjiburug, West Java	.. Reservoir	.. 23-40	.. 500-600	.. Hickling 1961	After stocking with <i>Tilapia mossambica</i>
Solerojo, East Java	.. Reservoir Shallow	.. 100	.. 100	.. Pers. obs.	.. Almost entirely <i>Tilapia nilotica</i>
Parakrama Samudra, Sri Lanka	.. Reservoir Shallow	.. 2,262	.. 225	.. Fernando 1973	.. <i>Tilapia mossambica</i> about 80-90% catch
Moragaswewa, Sri Lanka	Reservoir Shallow	.. 12	.. 130	.. Fernando 1973	<i>Tilapia mossambica</i> introduced annually
Rewa Pening, central Java	Reservoir Shallow	.. 2,200	.. 250	.. Achmad 1975 Pers. Comm.	<i>Tilapia mossambica</i> major component of catch

High fish yields in reservoirs in South East Asia have been recorded almost without exception in reservoirs stocked with *Tilapia* spp. However, some South East Asian species like *Etrophus suratensis*, *Puntius javanicus*, *Trichogaster* spp. and *Labeo* spp. have contributed to these high yields. Unconfirmed reports from Thailand indicate that a newly constructed reservoir there has given a "high" fish yield. High yielding reservoirs and lakes in South East Asia show average yields of 100-900 kg/ha/an. (Table 5). All these reservoirs listed are shallow lakes, and all of them have been stocked with introduced species which now form the bulk of the fish-catch. Two of the habitats listed in Table 5 are natural lakes ; both these had very few indigenous fish and even totally lacked Cyprinidae, so that the introduction of foreign species has contributed to relatively high fish yields (Hickling 1961).

Some small reservoirs (called "tanks" in India and Sri Lanka) have many biological features in common with fishponds. They are highly eutrophic and their fish yields are very similar to those in fishponds (Table 6).

TABLE 6

## Very high fish yields in South-East Asia from different types of habitats

Habitat and Location	Status and nature	Area (ha)	Fish Yield Kg/ha/an	Source	Remarks
Temple tank, South-India	.. Pond .. .. Man-made .. .. Shallow ..	.. <1 ..	.. 2500 ..	.. Sreenivasan .. .. 1964 ..	.. Highly eutrophic .. .. <i>Tilapia mossambica</i> .. .. present as bulk of catch ..
Beira lake, Sri Lanka	.. Reservoir .. .. Man-made .. .. Ornamental ..	.. 65 ..	.. 2230 ..	.. Mendis 1969 ..	.. Highly eutrophic .. .. <i>Tilapia mossambica</i> .. .. present as bulk of catch ..
Fishponds, West Malaysia	.. Ponds .. .. Man-made ..	.. <1 ..	.. 2000 ..	.. Pers. Comm. ..	.. Chinese carps and .. .. <i>Puntius javanicus</i> ..
Fishponds, Java	.. Ponds .. .. Man-made ..	.. <1 ..	.. 2500 ..	.. Pers. Comm. ..	.. Chinese carps and .. .. <i>Puntius javanicus</i> ..
Fishponds, Calcutta	.. Ponds .. .. Man-made .. .. Experimental ..	.. <1 ..	.. 8000 ..	.. Pers. Comm. ..	.. Chinese and Indian .. .. carps ..
Fishponds, S. India.	.. Ponds .. .. Man-made ..	.. 1 ..	.. 1150-4050 ..	.. Ganapati .. .. 1972 ..	.. Indigenous carps .. .. <i>Chanos</i> ..

## Introduction of Fish and Invertebrates Species

Reservoir fisheries in South-East Asia have been influenced greatly by the introduction of "foreign" fish species. These introductions have been either within the country or region, or from Africa. The most spectacular increase due to fish introductions has been in Sri Lanka where *Tilapia mossambica* Peters was introduced in 1952. The negligible reservoir fish harvest rose to 8,400 tons per annum, and has been maintained at this level for about twenty years. This has been documented

very thoroughly by Fernando (1965, 1970 and 1973) and Fernando and Indrasena (1969). The phenomenal increase in fish yield here has been attributed to *Tilapia mossambica* occupying a vacant niche in a fauna lacking lake or pelagic species. The absence of stunting which is reported for *T. mossambica* in South-East Asia generally, is probably avoided by the high predation pressure and restriction of breeding sites. Indigenous fish species have not shown any decrease in yield through this introduction. On the contrary, the intensive exploitation of *Tilapia mossambica* has actually increased the total catch of indigenous fish.

In Indonesia, *Tilapia* spp. have been responsible for high yields in the natural lake, Lake Lombotto, Sulawesi, which previously possessed only gobies and shrimps. The introduction of *Tilapia mossambica* and *Trichogaster pectoralis* stimulated a spectacular increase in fish yield (Hickling 1961). In another Sulawesi lake, Lake Tempe, the introduction of foreign species also caused a great increase in fish yield (Hickling 1961). The effect of introduced species in stimulating fish yield in reservoirs poor in indigenous species has also been noted in Cuba by Holcik (1970). Hickling (1961) lists a number of instances in Indonesian reservoirs where introduction of *Tilapia mossambica* has increased fish yields considerably. In a recently constructed shallow reservoir in Solerojo, East Java, the fish yield is around 100/kg/ha/an., and consists entirely of *Tilapia nilotica*, while in Rewa Pening reservoir, Central Java the yield is about 250 kg/ha/an.

The impact of introduced species on Indian reservoirs has not been so spectacular, because most of the introductions have been confined to indigenous carps and *Tilapia mossambica* has been considered a pest. Sreenivasan (1967) in an excellent review points out that, where high predator pressure exists, *Tilapia mossambica* reaches a large size and produces high fish yields in South India.

It appears that the diversification of exploitable fishes in South-East Asia by introductions will enhance fish yield considerably in reservoirs. Different strategies will be required for each particular reservoir in different regions of South-East Asia, until some general principles emerge from such experimentation. It is evident that exploitable lake fish species adapted to deeper waters are lacking in South-East Asia. This has been stated specifically for Sri Lanka by Fernando (1965, 1970, 1973) and Fernando and Indrasena (1969), and is probably applicable with some reservations to other parts of the region. It is likely that the most spectacular increases in reservoir fish yields will be recorded in Sulawesi, Sri Lanka and to a lesser extent India, by the introduction of deep-water fishes. This is important because of the construction of large deep dams. The rich indigenous fish faunas of the Mekong region, Kalimantan and Malaysia may supply a greater variety of fish recruits to reservoirs in these areas stimulating high fish yields, but so far this has not occurred.

A number of South-East Asian fish species have proved valuable for introduction into reservoirs. *Etrophus suratensis* Bloch, an estuarine cichlid introduced into reservoirs in Sri Lanka, has contributed to increased fish yield. Carps belonging to the genera *Labeo*, *Puntius*, *Cirrhina* and *Catla* have provided exploitable fish stocks when introduced into reservoirs in India and Indonesia. *Trichogaster pectoralis* (Regan) has contributed significantly to the fish yield in reservoirs in Malaysia and Indonesia. *Osteochilus hasselti* (C. and V.) has contributed significantly to fish yields at Bukit Merah and Subang reservoirs, Malaysia. Clariid Catfishes and Channid Snakeheads are important predators in fish catches. However, all these species are river or marsh fish, mostly detritivores or browsers and some predators, and their yields have been much lower than that of the African cichlids introduced, which are pelagic and planktivores.

Although there has been no planned introduction of invertebrates into reservoirs in South-East Asia, this subject has been discussed with reference to Sri Lanka by Fernando (1974).

In an examination of over 1,000 samples of zooplankton from different parts of South-East Asia, from the whole spectrum of freshwater habitats, two features emerge regarding the limnetic plankton of reservoirs in South-East Asia : (1) the paucity of true limnetic zooplankters, and (2) the rarity of *Daphnia* spp. Only three species of Cladocera are at all common in the open waters in reservoirs in South-East Asia ; these species are *Diaphanosoma excisum* Sars, *Ceriodaphnia cornuta* Sars and *Moina micrura* (Kurz). . All three species are cosmopolitan and are equally common in other types of habitats besides "lakes". Two cyclopoids, *Mesocyclops leuckarti* (Claus) and *Thermocyclops crassus* (Fischer) (= *T. hyalinus*) are the only common cyclopoids in reservoirs. The Rotifera are represented however, by a large number of species of *Brachionus*, *Keratella*, *Filinia* and cosmopolitan species like *Lecane bulla* (Gosse). The taxonomy of calanoids is in a confused state. *Phylloidiaptomus annae* Apstein is the commonest calanoid form in reservoirs in Sri Lanka. It is also the commonest species found in other types of habitats, e.g., ponds, marshes. Brandlova, Brandl and Fernando (1972) listed 22 species of Cladocera alone as limnetic in lakes in Ontario, Canada in comparison.

There are only two species of *Daphnia* recorded from tropical South-East Asia. These are *Daphnia lumholtzi* Sars and *Daphnia similis* Claus (= *D. carinata* King of many authors). *D. similis* is a pond species (Brooks 1957), and *D. lumholtzi* is much commoner in reservoirs. There is a claim that a Japanese *Daphnia* species has been stocked in some reservoirs in Indonesia, e.g., Jatiluhur reservoir, West Java. Since *D. similis* is very unlikely in a reservoir and since it is not *D. lumholtzi*, the possibility remains that the *Daphnia* sp. was actually introduced from outside the area. In areas bordering tropical South-East Asia, more *Daphnia* spp. have been recorded. Shirota (1967) records 4 species in South Vietnam, and Arora (1931) found five species in Lucknow, India. The paucity of *Daphnia* throughout most of South-East Asia is rather surprising and a number of factors probably contribute to this situation : (a) High prevalent temperatures throughout the year, (b) High fish predation, and (c) Lack of natural lakes.

The rationale for considering the introduction of invertebrates into reservoirs in South-East Asia is the paucity of limnetic species. It is likely that such introductions will enable a diversification of the fish fauna and increase fish yields. Ivlev (1961) considers *Daphnia* one of the most important fish food items. Fernando (1974) has discussed invertebrate introductions into reservoirs in South-East Asia and has also reviewed Soviet work on invertebrate introductions. Other Soviet work reporting increases in fish production as a result of invertebrate introductions are Tiutenkov (1963), Gasunas (1970) and Kochalova and Ladzuya (1970).

The introduction of fish and invertebrates into reservoirs must be carefully monitored, and precautions taken to avoid the introduction of fish parasites. Fernando and Furtado (1963) and Fernando and Hanek (1973) have found fish parasites introduced into Sri Lanka with imported fish.

#### Reservoir Fertilization

Some of the shallow reservoirs in South-East Asia receive considerable quantities of organic and inorganic fertilizers. Fernando (1973) has noted the fertilization of reservoirs in Sri Lanka and lakes in Africa by large herbivorous mammals. In Singapore, one of the drinking water reservoirs (Seletar) is so highly enriched by pig faeces that the bighead carp is fattened successfully without any additional feeding, this reservoir also has a flourishing fishery of *Tilapia mossambica*.

Fertilization of reservoirs with a view to increasing fish production has however not been practiced so far in South-East Asia. Such fertilization may prove economical when suitable fish are present. Baranov, Bauet and Pokrovskii (1973) have reviewed the Soviet work on fertilization of reservoirs. Fertilizers containing Calcium, Nitrogen and Phosphorus have been used successfully to increase fish yields.

### Fish Yields in Relation to Primary Production

Primary production in most tropical reservoirs is high. Ganapati (1972) obtains values of about 3-10 gC/M<sup>2</sup>/day for Indian reservoirs, both shallow and deep. Sreenivasan (1968) reports a value of about 3 gC/M<sup>2</sup>/day for one upland reservoir and a much lower value for another in India. Sreenivasan (1969) found a conversion rate of 0.25% of primary production to fish in a South Indian Lake. McConnell (1965) found a 10% conversion of primary production by *Tilapia*.

The very high production of fishponds and highly eutrophic standing waters with suitable fish species (Table 6) indicates that present fish yields in tropical reservoirs is much lower than potential values.

### SUMMARY AND DISCUSSION

Although the reservoir area in South-East Asia is considerable, the fish production is low in the majority of reservoirs. This situation is not universal, however, and high fish production has been recorded in a number of individual reservoirs in Sri Lanka and Indonesia, and in Sri Lanka as a whole. High fish production in reservoirs (and natural lakes) in South-East Asia has with few exceptions resulted from introduction of typical lake species from Africa. It appears very likely that addition of further lake fish species especially into deeper reservoirs will increase present fish yields. Diversification of the "lake" fish fauna can be achieved by introduction of species indigenous to the region like *Etilopus suratensis* and carps in combination with African cichlids. In this introduction of fish species, three points may be noted with specific reference to *Tilapia* spp. : (a) Lakes without indigenous cyprinids and fish fauna (e.g., L., Tempe Sulawesi) show marked fluctuation in fish catch with the introduction of *Tilapia*, and this could be stabilised by the introduction of predators and more diverse species. (b) Lakes with a moderate diversity of fish fauna including cyprinids and predators (e.g., Sri Lanka) show a high stabilised production with the introduction of *Tilapia*, presumably because of the effect of predator pressure on excessive *Tilapia* breeding. (c) Lowland lakes with a rich diversity of indigenous fish species colonising lakes including cyprinids and predators (e.g., Mekong basin, Malaysia), may not require the introduction of *Tilapia*.

Introduction of invertebrates into reservoirs in South East-Asia has not been done deliberately so far. However, the experience in other parts of the world notably the Soviet Union, indicates that such introductions are likely to prove beneficial and to increase fish production. The natural paucity of the zooplankton species in typical lake forms has been noted throughout tropical South-East Asia, and careful monitoring of introductions is recommended. Perhaps a combination of invertebrate introduction and fertilization can be used especially in smaller reservoirs.

The potential for a considerable increase in fish production from reservoirs exists in South East Asia. Proper management is likely to cost less than what is required for fish culture. Rural areas are likely to benefit most from increased fish production in reservoirs, and this might be a way provide cheap protein where it is most urgently needed.

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LEGENDS TO TEXT FIGURES

Fig. 1. Location of major natural and man-made freshwater habitats and fisheries in South East Asia.

Fig. 2. Man-made lakes in Sri Lanka. In a total area of 70,000 sq. km. there are over 10,000 such lakes with a total area of about 125,000 hectares (After Fernando 1970).

# The Freshwater Fisheries of Ceylon

C. H. FERNANDO<sup>1</sup> AND H. H. A. INDRASENA<sup>2</sup>

## INTRODUCTION

THERE is no comprehensive account of the freshwater fisheries of Ceylon. The present paper is an attempt at such a treatment. Our task has been somewhat simplified by the paucity of previous work but on the other hand data relevant to the subject is scattered and not easily available in the usual abstracting journals. This paper is based on a collection of data over the last fifteen years while associated with the Fisheries Department and information gathered from other agencies concerned with water resources in Ceylon. The authors have added their own work during this period both published and unpublished.

The introduction of *Tilapia mossambica* Peters into natural waters in Ceylon in 1951 and its subsequent rapid spread and dominance of the fish catches has had a profound impact on all aspects of freshwater fisheries. The tremendous increase in fish production has been accompanied by changes in fishing methods and improved utilization. On the basis of the experience with the introduction of this species other species have been considered for introduction. The expansion of the freshwater area by the construction of irrigation and hydro electric reservoirs has increased the fish production potential considerably during the last fifteen years. The evident paucity of lake species first pointed out by Fernando (1965a) has indicated the reasons for low fish production before the advent of *Tilapia mossambica*. In the present paper this idea is developed further to cover specific types of habitats. The present work is also intended as a review of fishery practices in Ceylon's freshwaters. Such a review, we hope, will, when taken together with the new data and conclusions of this study, enable more efficient planning and use of freshwater fishery resources in the future.

Most of the data available to the authors has been from the Polonnaruwa area, namely Parakrama Samudra and Minneriya tanks and Senanayake Samudra in the Gal-Oya Valley. Studies have also been made on *Tilapia mossambica* because of its great importance to the fisheries in general.

## PREVIOUS WORK

The earliest mention of any type of freshwater fisheries in Ceylon is that of Knox (1681). His remarks although those of a layman indicate clearly that freshwater fisheries were not considered of any economic importance. He mentions that fishing was done by "boys". Willey (1910) made a detailed study of a primitive form of fish culture practiced in the Hanwella area. In a series of reports by foreign experts on fisheries development in Ceylon, passing mention is made of freshwater fisheries by Hickling (1951) and Kesteven (1951). Popular accounts on the freshwater fisheries are those of Szechowycz (1959, 1961) and Fernando (1961). Schuster (1951) and Anon (1962), the latter based on the work of Dr. S. W. Ling dealt at greater length with freshwater fisheries. Fernando (1965) discussed the remarks of Willey (1910), Amirthalingam (1949) and Schuster (1951) that the freshwater fish fauna of Ceylon was deficient in "desirable" herbivorous species. Fernando (1965a) offered an explanation for this apparent deficiency. Historical factors, according to him, made recruits of fish species for tanks from a fauna lacking typical lake species. Papers which deal directly with fisheries in the last ten years are those of Fernando and Fernando (1964), Indrasena and Ellepola (1964), Indrasena (1964, 1965a 1965b), Mendis (1964, 1965), Ellepola and Fernando (1966), Indrasena and De Silva (1964), Fernando (1967) and Fernando and Ellepola (1969). A number of papers on

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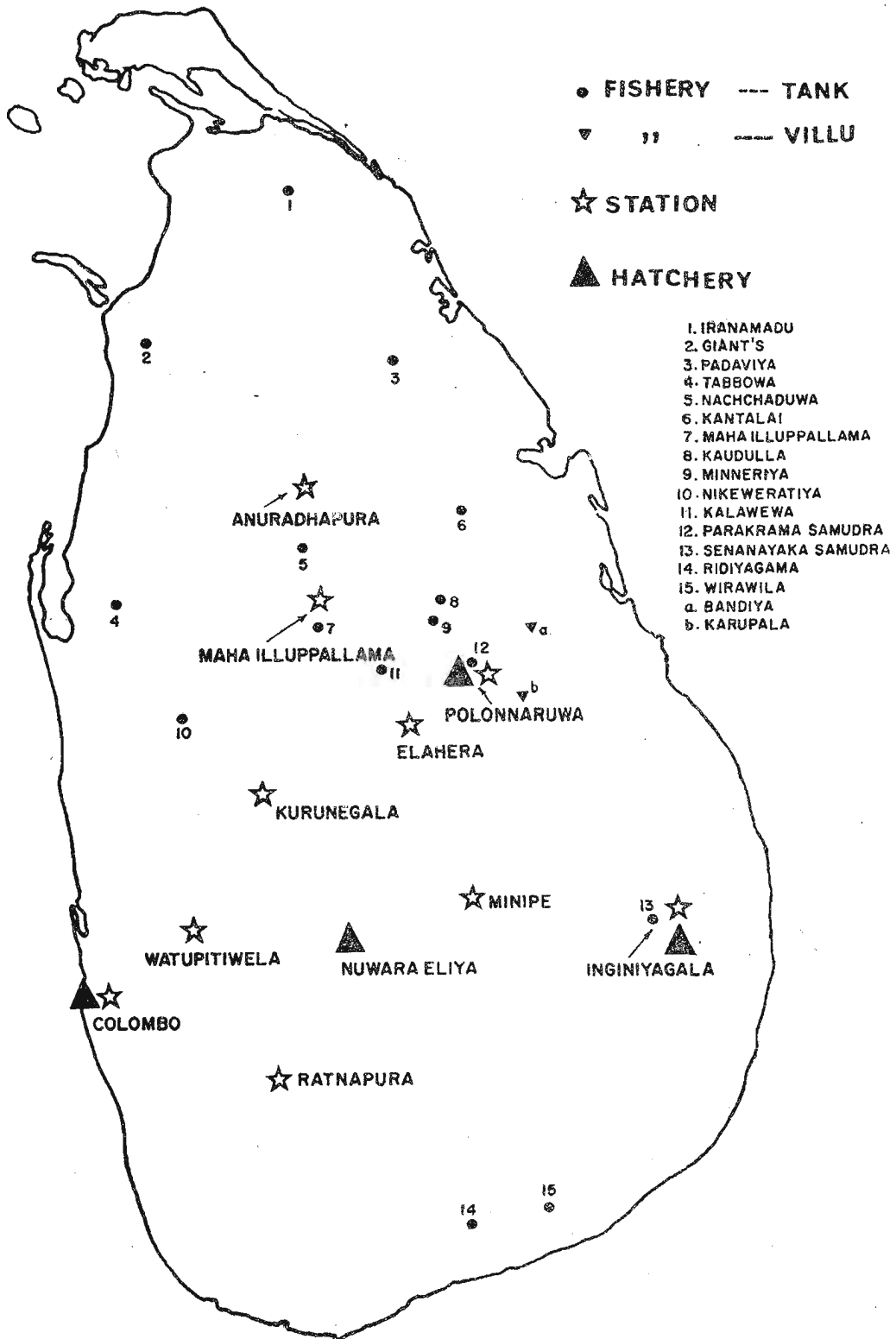


Fig. 1 — Freshwater fisheries centres.

systematics and ecology of the freshwater fauna have been published in recent years. These include works on taxonomy, limnology, distribution, food habits and parasites. All these have been listed in Mendis and Fernando (1962) and Fernando (1963, 1964 and 1969). The defensive spines of freshwater fishes were studied by Fernando and Fernando (1960).

Side by side with these scientific and semi-scientific publications there has been a gradual growth, by no means sustained at a high level however, of interest in freshwater fisheries. Comments and recommendations with some statistics of fish catches are found in the Annual Administration Reports of the Department of Fisheries from Malpas (1935) onwards. A separate section of this report was devoted to freshwater fisheries and more detailed statistics were provided in later years. Fisheries "stations" were established in a number of localities (Fig. 1). Fish hatcheries were established in Narahenpitiya (Colombo), Polonnaruwa and Inginiyagala. Besides, fisheries inspectors were posted at Kurunegala, Maha Illupuluma, Minipe, Watupitiwela, Elahara, Ratnapura and Anuradhapura. Only Polonnaruwa has survived as a viable station. Some extension work is also carried on in the Gal-Oya valley by personnel of the Gal-Oya Development Board (River Valleys Development Board). Perhaps we should mention if only in passing the fish hatchery at Nuwara Eliya where trout for stocking up-country streams are raised.

### GENERAL REMARKS ON FRESHWATER HABITATS

Ceylon has an area of 25,332 square miles and is reputed to have over 10,000 ancient irrigation reservoirs popularly called tanks (Abewickrema 1956, Anon 1955). Sixteen major rivers drain 103 river basins. The major rivers originate in the Central Highlands located in the Southern portion and flow in a more or less radial fashion through the low country. Some of the rivers produce shallow flood plains in their lower reaches. These may be very short lived lasting only during the floods or they may be permanent as in the lower reaches of the Mahaweli ganga. These latter flood plains are referred to as villus and may have a permanent connection with the river (e.g., Karapala villu) or could be formed as a lake isolated from the river when the flood waters recede (e.g., Bandiya villu). Many ponds are left by the receding flood waters and rivers themselves may be reduced to a series of ponds during the dry season.

Tanks constitute by far the largest area of permanent standing water. They vary in size from a few acres to 25 square miles (Senanayake Samudra). They comprise ancient irrigation reservoirs often restored and expanded in recent years, new reservoirs built for irrigation and some especially in the up-country mainly designed for the generation of hydro-electric power. Many of the tanks are subject to considerable changes in water levels but these changes are gradual during the year as water for irrigation is drawn or drought prevents the replenishment of water used for hydro-electric plants. The surface areas of tanks is often given at F.S.L. (Fully Supply Level) but this level may be maintained for only a few months in any year.

The extent of development of new multipurpose water conservation schemes is shown for the whole island (Fig. 2) and two river basins namely Mahaweli ganga and the Gal-Oya valley (Figs. 3-4). The last named has been completed adding 43,000 acres of tank surface and many miles of channels. The Mahaweli scheme which involves a much larger area of land will add a considerable acreage of water in the form of tanks. Three other river basin development projects namely the Deduru Oya, Uda Walawe and Kelani Ganga schemes, will together with the Mahaweli and Gal-Oya projects encompass the whole island. When completed these projects will add a vast area of freshwater habitats in the form of tanks, irrigation channels, ponds and paddy fields. The impact of these developments on the fisheries potential will be to enhance it considerably. Planning and research are urgently needed if good use is to be made of this potential.

Because of their extent paddy fields constitute an important type of freshwater habitat. Their temporary nature for fish habitation however somewhat limits their potential. They serve as nurseries for many species of fish and might under suitable conditions be used for fish culture.

### LIMNOLOGY

The major geological features of Ceylon are briefly as follows. The Island is composed almost entirely of crystalline rocks of the Pre-Cambrian age. This is overlain by Miocene limestone in the extreme North. There is a small area of Jurassic beds in the Puttalam area (Adams 1929). Water



Fig. 2.—Large reservoirs (tanks) constructed and planned.

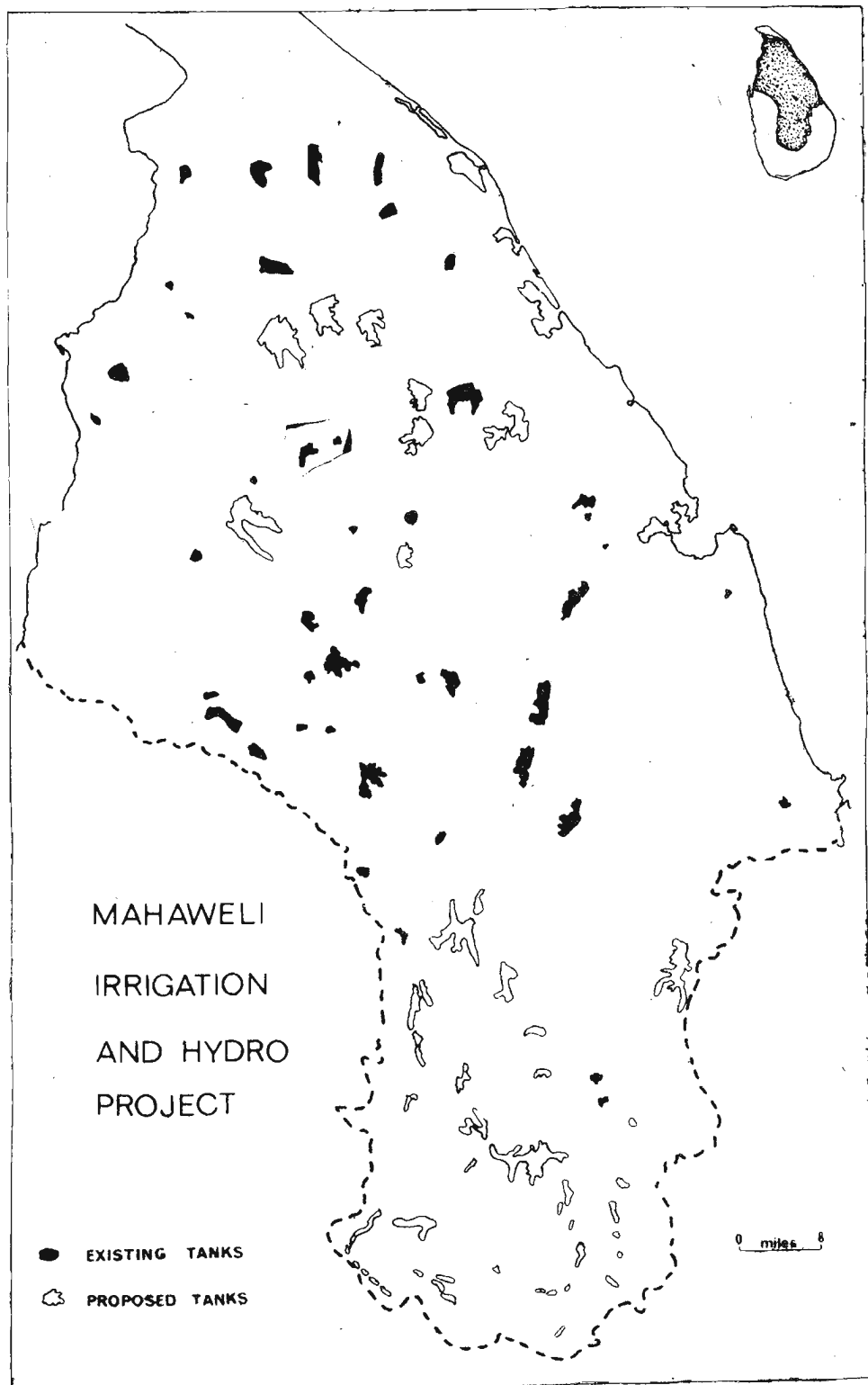


Fig. 3.—Map showing the existing and proposed reservoirs in the Mahaweli Irrigation and Hydro Project.

# THE GAL OYA VALLEY

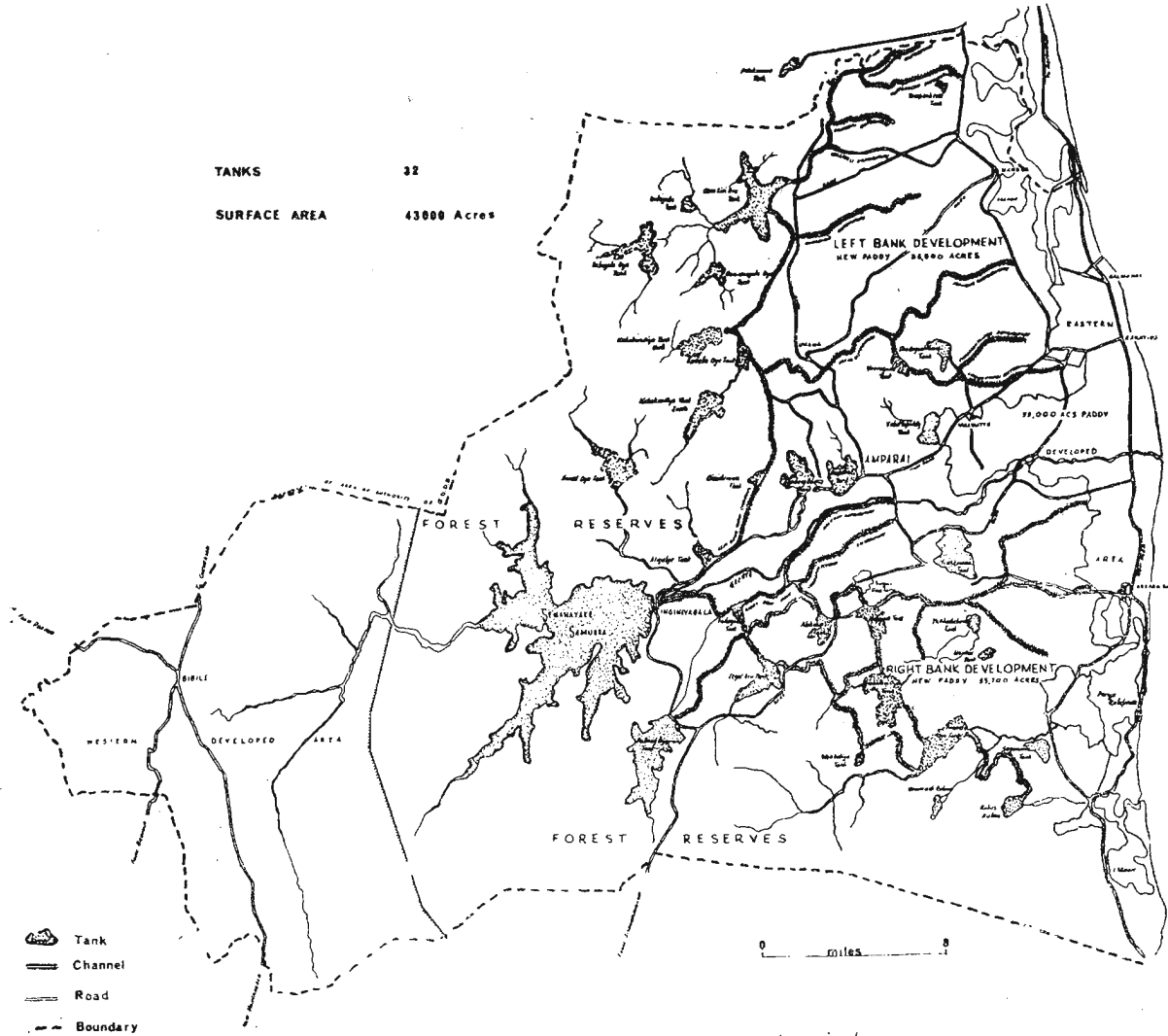


Fig. 3.—Reservoirs and irrigation channels in the Gal Oya development project.

chemistry is largely the product of the geological structure. Sirimanne (1953) provides extensive data on water analysis from all parts of the island. It is evident that in most areas the water is neutral or slightly alkaline with low to moderate amounts of dissolved solids. In the Western and Sabaragamuwa provinces the water is sometimes slightly to moderately acidic. In the coastal areas due to seepage from the sea considerable chloride concentrations are often encountered. Salt water may penetrate deeper inland in low-lying areas. Blackwater is not common but does occur in small pockets. The authors have noted it in the Nattandiya area (North Western Province) and the coastal parts of the Southern province. Mendis (1965) found darker water in some of the lakes of the Southern province. He found neutral to slightly alkaline waters in lakes in the Northern, North Central, North Western, Southern and Eastern provinces. Giesler (1967) found slightly acid waters in the localities he sampled in the Southern, Sabaragamuwa and Western provinces.

Some data on the morphometry of reservoirs (tanks) is available in the Administration Reports of the Director of Irrigation (e.g., Gunasekera 1960). The features given are water capacity, depth at sluice, surface area and capacity at full supply level (F.S.L.). Most tanks have a considerable "dead storage" which cannot be drained via the sluice. Depth contours have not been mapped for the vast majority although these could be arrived at in recently constructed reservoirs with a fair degree of accuracy from survey maps prior to impoundment. The depth contours are available for Parakrama Samudra and diagrammatic cross sections of the lake can be made (Fig. 5). Fernando and Ellepola (1969) have given the contour (F.S.L.) and area capacity curve of a small reservoir (Dalukana wewa).

There is a great deal of variation in the morphometry of reservoirs. Many of the large ancient reservoirs were built close to the foothills and have undulating bottoms. Silting of varying degrees have occurred however to alter the original condition. At the present time no classification of reservoirs based on their morphometry is available. A very tentative classification has been drawn up as follows:

1. Shallow; silted heavily; with even depth of water.  
(e.g. Giants tank, Fig. 6A)
2. Shallow; with gently sloping bottom.  
(e.g. Tabbowa tank, Fig. 6B)
3. Shallow; with undulating bottom contours.  
(e.g. Parakrama Samudra, Fig. 6C)
4. Deep; encompassing one valley.  
(e.g. Nalanda reservoir, Fig. 6D)
5. Deep; encompassing many valleys.  
(e.g. Senanayake Samudra, Fig. 6E)

Giants tank has a depth of only 10-12 ft. It has hardly any limnetic zone. Tabbowa tank has a gently sloping bottom with moderate silting and a maximum depth of about 25 ft. There is a gradation in the degree of silting and it is difficult to draw a line between category 1 and 2. However in general tanks belonging to category 1 are on relatively flat land as compared to those in category 2. Parakrama Samudra stands somewhat intermediate in category 3, but has a noticeably undulating bottom. It is not deep for the most part although a maximum depth of 37 ft. is shown on the contours. Many large tanks in the low country have bottom contours similar to that of Parakrama Samudra in general.

Nalanda reservoir consists essentially of one valley. The margins slope steeply and there is only a very small littoral zone. The slope is somewhat gentler in parts. Many reservoirs built recently fall into this category. Senanayake Samudra encompasses a number of small valleys. Therefore its bottom contours are more complicated. Categories 4 and 5 are invariably deep. Depending on the situation and height of the dam, the littoral zone may be very small or considerable. The latter is due to the intervening flat land close to the lake level at F.S.L.

The freshwater fauna is perhaps better known than in many Asian countries but the gaps in our knowledge are very considerable. Mendis and Fernando (1962) and Fernando (1963, 1964 and 1969) cover the systematics of the freshwater fauna. Freshwater algae have been dealt with by West and West (1902), Fritsch (1907), Lemmerman (1907), Crow (1923a, 1923b) and Holsinger (1955.)

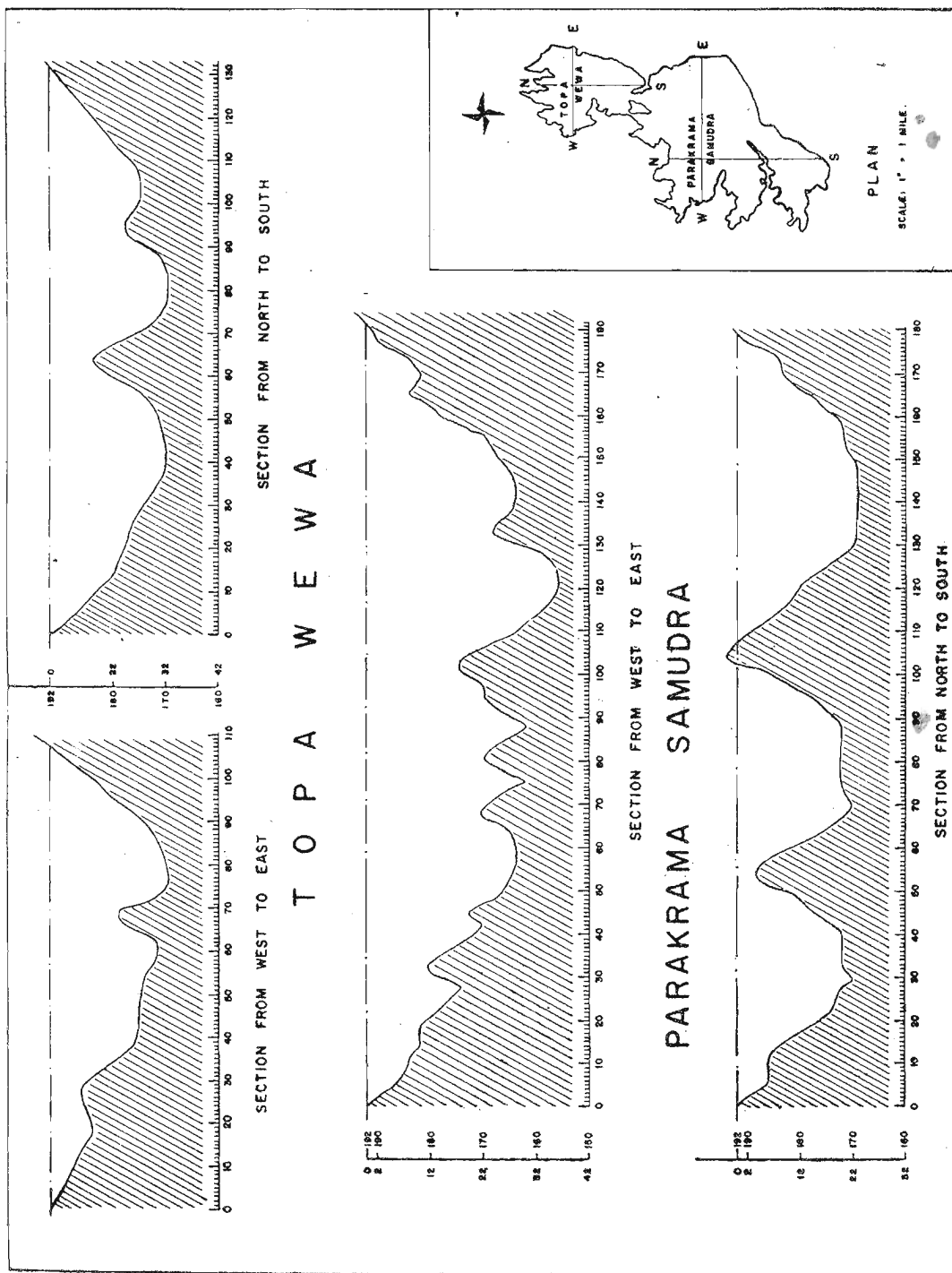


Fig. 5.—Cross sections of Parakrama Samudra a showing depth and shape of bottom (At right angles to the main dam)

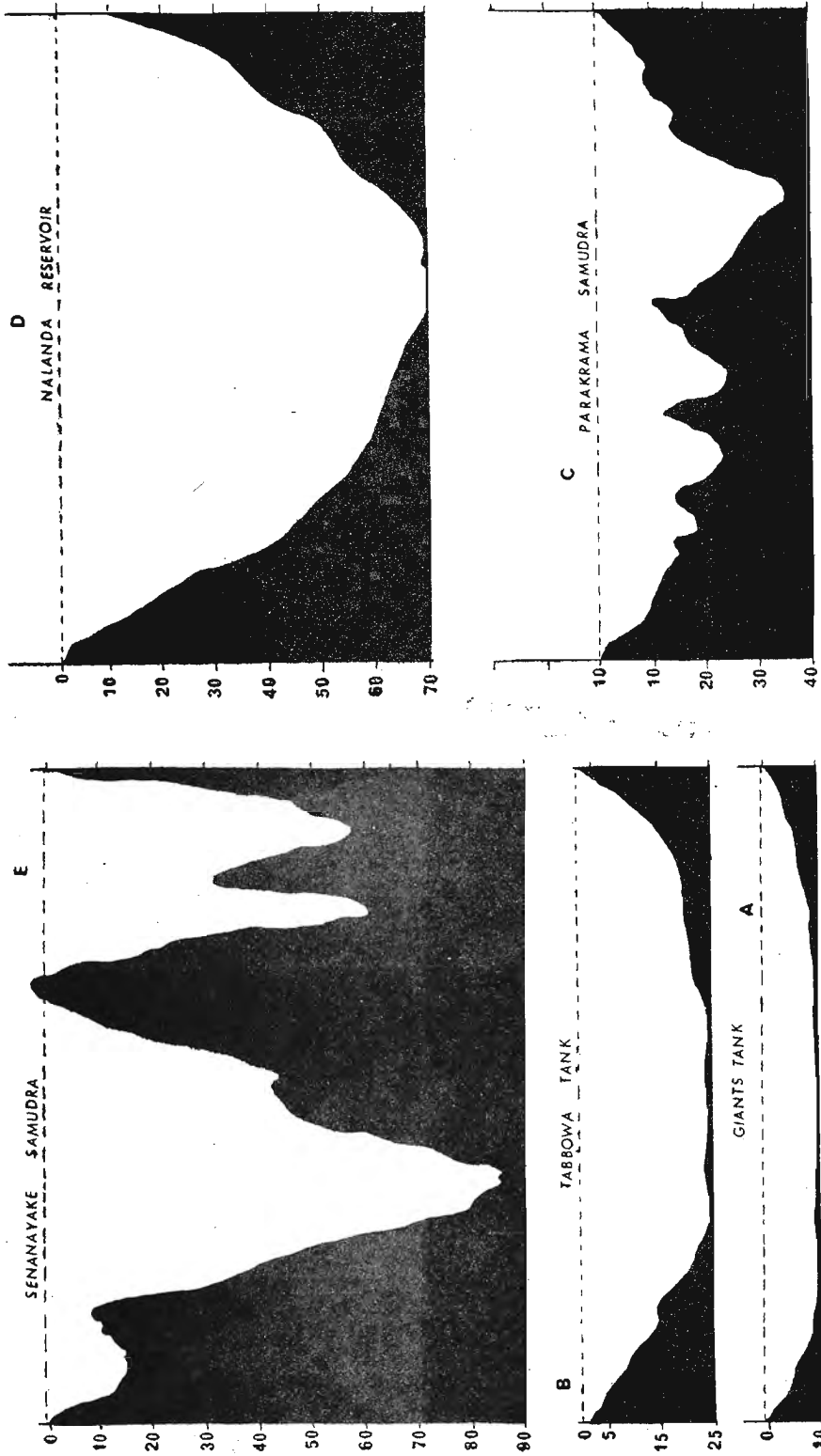


Fig. 6.— Diagrammatic representation of different reservoir types. (Parallel to the main dam Scale approximately as in Fig. 5).

Some quantitative data on plankton and bottom fauna is available in Holsinger (1955b) and Mendis (1964, 1965). Seasonal fluctuations in plankton organisms have been studied by Apstein (1907, 1910). The only quantitative data on the bottom fauna of lakes are those of Mendis (1964, 1965). Holsinger (1955b) on the basis of phytoplankton counts found that Gregory's lake at Nuwara Eliya was intermediate in productivity as compared to the higher Beira Lake and the lower Nuwara wewa. This is of some interest because plankton feeders are not numerous in the up-country lakes. For that matter the fish fauna in these lakes is poor. Fernando and Ellepola (1969) give some data on the plankton and littoral fauna of two small tanks in the Polonnaruwa area. Except for water chemistry where some broad generalizations can be made the data on plankton and bottom fauna of tanks in Ceylon is very meagre indeed. Limnological studies can be considered to be in their infancy in Ceylon.

### FISH FAUNA

Fifty nine species of fish are found in freshwaters of Ceylon (Table 1). Five of these have been introduced into the country. At least seven other species have been introduced but have failed to establish themselves. Fernando (1965a) has discussed these introductions. Half the fish species are cyprinids. Most of these carps and carplets are herbivorous. The Cyprinidae include small very abundant species like *Puntius vittatus*, *Rasbora daniconius* and *Danio aequipinnatus*. These species serve no doubt as important forage for carnivorous fishes. Many of the carplets and medium sized carps are not very abundant as compared to the three species mentioned. Some of them however may be locally abundant. Of the larger carps *Labeo dussumieri* (Fig. 7), *Puntius dorsalis* and *Puntius sarana* are important food fishes but only *Labeo dussumieri* can be considered to be of major economic importance. This species is abundant and has an acceptable flavour. The common carp *Cyprinus carpio* has recently established itself in the Southern Province. However, together with the crucian carp it is a sport fish in up-country tanks. All the catfishes have an acceptable flavour but only *Wallago attu*, *Ompok bimaculatus*, *Heteropneustes fossilis* and *Macrones vittatus* are abundant. Of the snakeheads only *Ophiocephalus striatus* can be considered of economic value. The others are small or rare. The Cichlidae although few in species number constitute today the most important group of food fishes. *Etroplus suratensis*, a species indigenous to Ceylon, was introduced into tanks from its native haunts which were estuaries and coastal ponds. Today it is of considerable importance as a food fish, 20 years after this introduction. *Tilapia mossambica* (Fig. 8) constitutes from 50-90% of the catch by weight from large tanks. It is certainly the most important food fish. Of the anabantids *Osphronemus goramy* is of some importance as a food fish. *Anabas testudineus* although a coarse fish is eaten in some areas where other fish are not available or are expensive. *Glossogobius giuris* is a favoured fish but is by no means as abundant as the other large carnivores. *Macrognathus aculeatus* is abundant in some areas and is of some economic importance.

It has been the view of a number of fishery biologists that the Ceylonese freshwater fish fauna is poor in herbivorous species which are of economic importance. Fernando (1965a) discussed these views and showed that they were not entirely warranted. Fernando (1965a) showed that the paucity of "Lake" species was real and this was due to the absence of natural lakes. Fish recruits for irrigation reservoirs did not fill the niches in these efficiently.

Studies on the food habits of Ceylonese freshwater fishes by Fernando (1956, 1965b), Costa and Fernando (1967) and Giesler (1967) in Ceylon and by Indian workers has been used to compile the data for Table 1. Strict carnivores are few as is to be expected. Strict herbivores include small forage fishes and some large carps. Many species however have a varied diet including insects as a major component. *Heteropneustes fossilis* and *Mystus vittatus* have been shown to feed on molluscs (Fernando, 1965b). *Etroplus suratensis* was also found to feed extensively on one species of mollusc, *Bellamya ceylonica* (Dohrn) in Parakrama Samudra during the period when the fish comes into shallow water to lay its eggs. A number of siluroids and cichlids have been reported to feed on molluscs in Africa (De Bont and De Bont 1952, McMahon 1960). Perhaps the mollusc eating habit is more widespread among indigenous Ceylonese species of freshwater fish than has hitherto been suspected. Carnivorous species seem to be abundant in low-country tanks but there appears to be a paucity of species feeding on plankton and soft macrophytes. It is also likely that bottom feeders and insectivorous species could profitably be added to the present complement of freshwater fish species in the large tanks.

TABLE 1

Freshwater Fishes of Ceylon — Maximum Sizes and Food Habits

O = Omnivore	C = Carnivore	H = Herbivore	
Species	Maximum Length cms.	Food Habits	Remarks
<i>Chela labuca</i>	5.75	H	
<i>Rasbora vaterifloris</i>	3.75	O	.. Aquarium fish
<i>Rasbora daniconius</i>	10.0	O	.. Very abundant
<i>Amblypharyngodon melittinus</i>	7.5	H	
<i>Horadandiya atukorali</i>	2.5	H	
<i>Esomus danrica</i>	6.25	H	
<i>Danio aequipinnatus</i>	7.5	H	.. Aquarium fish; Abundant
<i>Cyprinus carpio</i>	60	O	.. Introduced
<i>Carassius carassius</i>	45	O	.. do.
Tor khudree	75	O	.. Game fish
<i>Puntius melanampyx</i>	2.25	H	
<i>Puntius dorsalis</i>	23.5	H	.. Food fish
<i>Puntius filamentosus</i>	11.75	H	
<i>Puntius chola</i>	8.75	H	
<i>Puntius amphibius</i>	7.5	H	
<i>Puntius bimaculatus</i>	5.75	H	
<i>Puntius nigrofasciatus</i>	5.75	H	.. Aquarium fish
<i>Puntius pleurotaenia</i>	15.0	H	.. do.
<i>Puntius sarana</i>	30	O	.. Food fish
<i>Puntius vittatus</i>	5.0	H	.. Very abundant
<i>Puntius titteya</i>	4.75	O	.. Aquarium fish
<i>Puntius cumingi</i>	5.0	H	.. do.
<i>Puntius tietoi</i>	5.0	H	.. do.
<i>Labeo dussumieri</i>	35	H	.. Important food fish
<i>Labeo porcellus</i>	37	—	.. Food fish
<i>Labeo fisheri</i>	37	H	.. Rare
<i>Garra ceylonensis</i>	15	H	.. Torrent stream dweller
<i>Lepidocephalus thermalis</i>	5.0	H	.. Bottom feeder
<i>Noemacheilus notostigma</i>	6.25	H	.. do.
<i>Noemacheilus botia</i>	3.25	H	.. do.
<i>Wallago attu</i>	150	C	.. Food fish
<i>Ompok bimaculatus</i>	38	C	.. do.
<i>Clarias teysmanni</i>	30	O	.. do.
<i>Heteropneustes fossilis</i>	25	O	.. Food fish; Feeds on Molluscs
<i>Macrones gulio</i>	25	O	
<i>Macrones keletius</i>	12.5	O	
<i>Macrones vittatus</i>	10.0	O	.. Food fish
<i>Anguilla bicolor</i>	60	O	
<i>Anguilla nebulosa</i>	100	O	
<i>Panchax melastigma</i>	3.75	O	} Surface feeders Feed on mosquito Larvae
<i>Panchax lineatus</i>	5.75	O	
<i>Panchax panchax</i>	3.75	O	
<i>Channa orientalis</i>	10.0	C	
<i>Ophiocephalus marulius</i>	80	C	.. Food fish
<i>Ophiocephalus striatus</i>	68	C	.. do.
<i>Ophiocephalus punctatus</i>	20	C	
<i>Ophiocephalus gachua</i>	15	C	
<i>Tilapia mossambica</i>	38	H	.. Introduced
<i>Etroplus suratensis</i>	30	O	.. Food fish; Feeds on Molluscs
<i>Etroplus maculatus</i>	7.5	O	.. Ornamental fish
<i>Anabas testudineus</i>	15	O	
<i>Trichogaster pectoralis</i>	25	H	.. Introduced
<i>Belontia signata</i>	11.5	O	
<i>Osphronemus geramy</i>	30	H	.. Introduced
<i>Macropodus cupanus</i>	4.75	O	.. Ornamental
<i>Malpulutta kretseri</i>	4.5	O	.. Rare; Aquarium fish
<i>Glossogobius giuris</i>	35	C	.. Food fish
<i>Macrogathus aculeatus</i>	25	C	.. do.
<i>Mastacembelus armatus</i>	62	C	

Naming and maximum size of fishes according to Munro (1955). Subspecific names have been omitted.

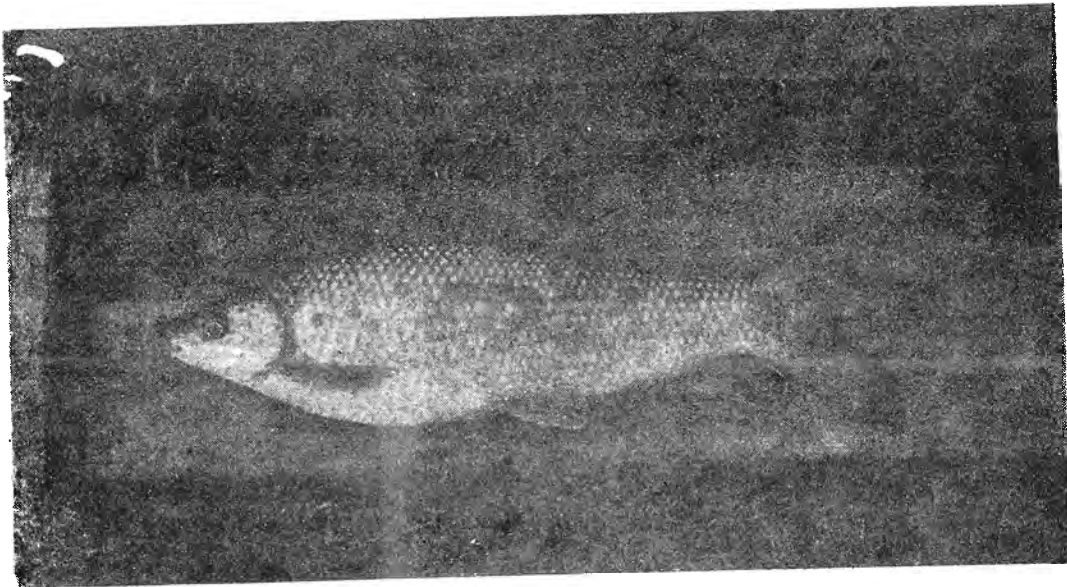


Fig.—7. *Labeo dussumieri*,

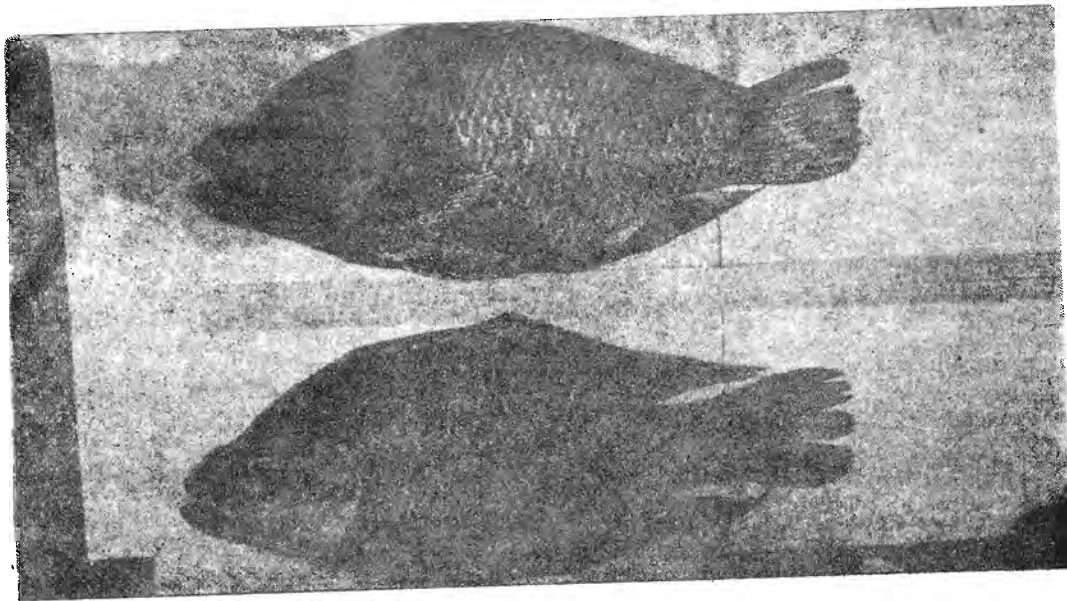


Fig. 8.—*Tilapia mossambica*. The male (upper) recognisable by its darker colour and more pointed anterior end.

THE ROLE OF INTRODUCED SPECIES

Fernando (1965a) gave a short account of fish introductions and discussed their importance in inland fisheries. It is clear that *Tilapia mossambica* is the most important commercial food fish forming as much as 90% of the catch by weight in some of the low country tanks. Its importance seems less in the Gal Oya valley but this may be due to inefficient fishing for this species.

A study of the status of *Tilapia mossambica* was undertaken to answer some questions that had arisen in regard to this species. The stunting of *T. mossambica* reported in many parts of S. E. Asia in small lakes and ponds seems to be less marked in some of the lakes with flourishing fisheries for this species. However stunting was common in other habitats, e.g., lagoons, some tanks and in ponds. It has been claimed from time to time that *Tilapia mossambica* was affecting "adversely" local species by predation or competition. However the fish is not carnivorous (Fernando 1965a and unpublished data).

The ubiquity of *Tilapia mossambica* enables it to be studied in a wide variety of habitats. 8 such habitats were chosen for a comparison of the coefficient of condition (K) and mean length and weight of fish caught in gill nets with 3"-5" mesh. There is perhaps a slight bias towards larger fish where they are proportionately more numerous, since the smaller mesh sizes are not used. However the results of this study are indicative of a wide size range of the fish (Table 2). The coefficient of condition is also very variable. It is not necessarily correlated with the size attained by the fish in a particular habitat. The lowest value of K was found in Batticaloa lagoon which is by no means as productive of fish as shallow lakes. In fish ponds without artificial feeding and where overcrowding was most marked and K very low, the production per acre was very high. Beira Lake a highly polluted habitat where K is high, had a very high production of *Tilapia mossambica* (Mendis 1964).

TABLE 2  
The Status of *Tilapia mossambica* in some Habitats in Ceylon  
All Samples taken in 1964-65. Fish Production Values for 1963

HABITAT				FISH			
Name of Habitat	Max. Depth Ft.	Area (acres)	Description	Mean length cms.	Mean weight gms.	Coefficient of condition (K)	Fish catch lb./acre/annum
Beira lake Colombo	20	150	Brackish, highly fertilized	15.9	93	2.25	2,000
Batticaloa lagoon	15	29,500	Brackish	20.41	144	1.70	no data, low
Fish ponds	4	0.25	Freshwater	17.6	90	1.79	1,600
Karapala villu	30	1,500	Freshwater marsh connected to river	26.8	443	2.10	75
Tabbowa tank	30	1,140	Freshwater Lake (shallow)	24.8	338	1.95	no data, probably about 100
Parakrama Samudra	40	5,590	Freshwater Lake	28.4 (34.2 in 1957)	443	1.88	160
Minneriya tank	60	6,300	Freshwater Lake (deep)	29.4	598	2.00	105
Kandalama tank	70	2,430	Freshwater Lake (deep)	31.40	651	2.02	no data, probably about 100

$$K = \frac{W \times 10^6}{L^3} \quad W = \text{wt. in gms.} \quad L = \text{length in mm.}$$

A factor which could cause stunting and a low K would be overcrowding due to excessive breeding. Three lakes were chosen to check this namely Parakrama Samudra, Minneriya tank and Tabbowa tank. *Tilapia mossambica* makes prominent nests (Fig. 9) which can be located very easily. During the dry season the areas occupied by freshly made nests were plotted on maps of the lakes (Fig. 10). It is quite evident that in Minneriya the nests or breeding sites are restricted while in Tabbowa tank and Parakrama Samudra they are more extensive in proportion to the total area.



Fig. 9.—Nests of *Tilapia mossambica* in the shallow margin of Parakrama Samudra.

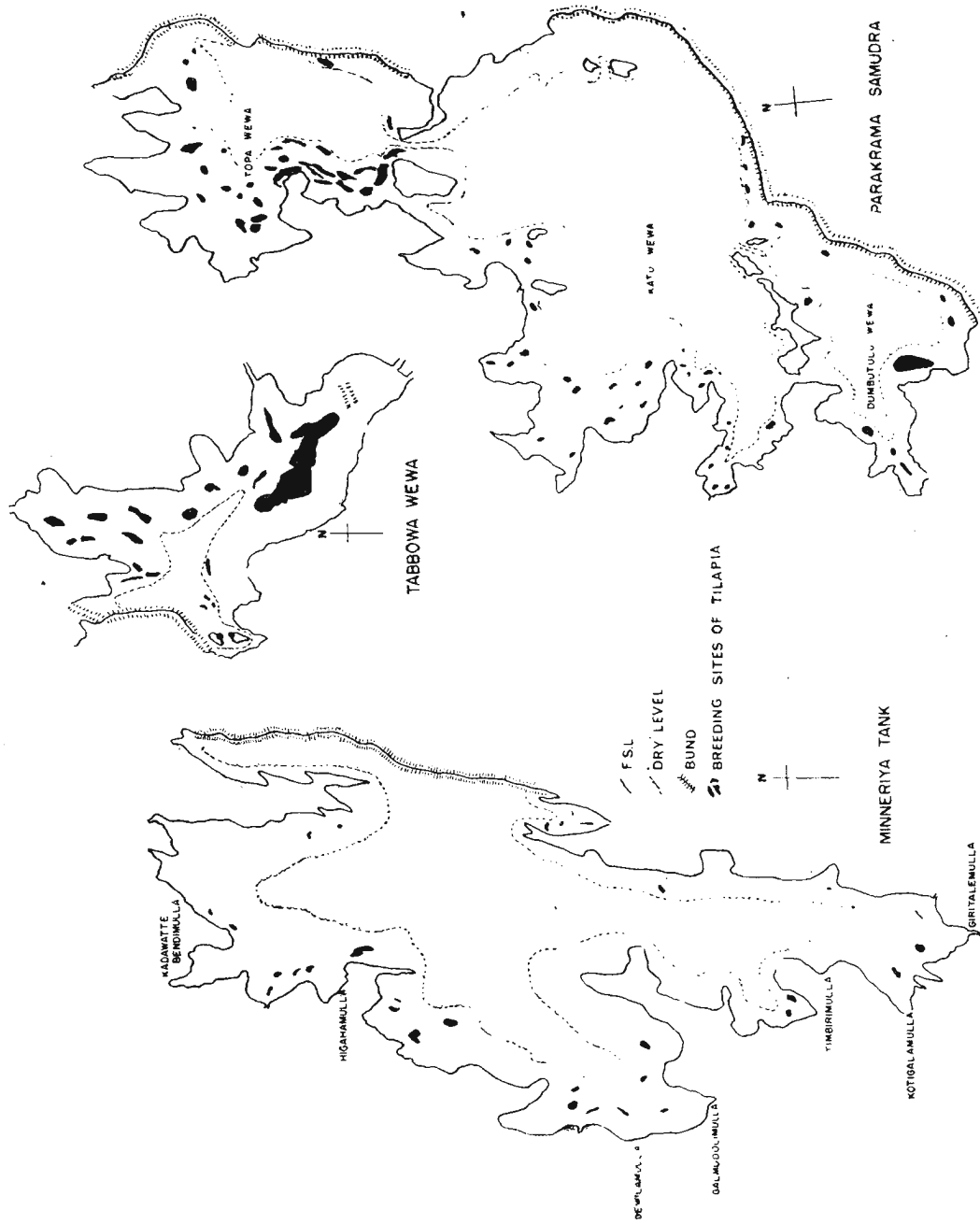


Fig. 10.— Breeding areas of *Tilapia mossambica* in three selected tanks

The slightly higher K value for Tabbowa tank fish is difficult to explain since the mean size and weight of fish from this tank is lower than in Parakrama Samudra. However exploitation of the fish stocks is very intense in Parakrama Samudra. But, on the other hand, it is a deeper tank than Tabbowa. It is likely that the deeper water with consequent spacing allows for better growth under normal conditions, but the K is lower due to some unknown factors. The small size of the fish from shallow water's like Batticaloa lagoon, Tabbowa tank and Beira Lake and the larger size of fish in deeper tanks like Minneriya, Kandalama and Parakrama Samudra is at least partly due to the restriction of breeding sites in the latter. Mendis (1964) found that the mean size of *T. mossambica* had increased from 18.3 cms in 1957 to 20.5 cms in 1963 in Beiralake. Calculation of K gives the values 2.10 and 1.99 respectively. This is interesting since the K value in 1964 from the present study is higher but the mean size is lower than the value for 1963. A steep gradient in the bottom does not allow *Tilapia mossambica* to build stable nests. An even or gently sloping mud-sand bottom is most suitable for nest building. Soft mud resulting from silting is not suitable either. Beauchamp (1958), Lowe-McConnell (1959) and Welcome (1966) found that the availability of suitable breeding sites may restrict the numbers of *Tilapia* spp.

It is evident from this study that *Tilapia mossambica* in Ceylon's "natural" waters shows a wide range of sizes and coefficient of condition (K). Further studies should elucidate the causes of these differences.

Canagaratnam (1968) found that *Tilapia mossambica* grows faster in salt water than in freshwater. However under natural conditions the fish is usually of smaller size in saline habitats because of the abundant breeding areas.

Of the other introduced species *Osphronemus goramy* is of some importance. The common carp *Cyprinus carpio* which has recently established itself in the tanks of the Southern Province has been considered undesirable as it damages breeding sites of *Tilapia* sp. (Pruginin 1967). But Maar (1960) considers it suitable for introduction into natural waters or for culture.

#### INTRODUCTION OF ADDITIONAL SPECIES

Two extreme views on the introduction of "foreign" species of fish can be taken namely total prohibition and indiscriminate introductions. Fernando (1956a) discussed views current before the introduction of *Tilapia mossambica*, a species which subsequently enhanced the fishery immensely. Fernando (1965a) pointed out the reasons for the success of *Tilapia mossambica* and the low productivity of our natural waters in indigenous species. In the same paper he pointed out that introductions had been somewhat haphazard. With the data we have on *Tilapia mossambica* which is discussed in the present paper and experience in other countries where fish introductions have been carried out it is, in our opinion, possible to obtain a relatively balanced species group capable of a high production of economic sized fishes. Fast growing species with a high fecundity are abundant in the genus *Tilapia* (Lowe 1955a, 1955b). This genus also offers a range of species as regards tolerance to the low temperatures prevailing in our up-country reservoirs (Chimits 1955, 1957). The two norms which should be aimed at are a balance of plankton, bottom feeding and higher plant feeding forms and a sufficient predator pressure to crop excess fish. Predator species are abundant in the low-country but may be needed in up-country reservoirs. Lowe-McConnell (1969) points out that high predator pressure may help more prey species to co-exist. Plankton and higher plant feeding indigenous species are not sufficient to crop efficiently these food items produced in artificial lakes. There are niches to be filled and the fish chosen should be selected for desirable qualities. The insect feeding fish fauna is prominent in our freshwaters (Fernando 1956, 1965b, Costa and Fernando 1967). Perhaps omnivorous species should also be introduced into both rivers and lakes. In 1969 *Tilapia zilli* Gervais, *T. melanopleura* Dum. and *T. hornorum* Trewavas were imported for stocking local waters.

Some specific introductions are discussed in subsequent sections of the present paper but continuing research both on indigenous species and introduced species in regard to their biology should be a top priority for the freshwater division of the Fisheries Research Station.

#### PARASITES AND PREDATORS

The first paper dealing with freshwater fish parasites of Ceylon was that of Kulasiri and Fernando (1956). Subsequent papers are Crusz and Sathanathan (1960), Yeh (1960), Fernando and Furtado (1963a, 1963b), Ingle and Fernando (1963), Gussev (1963), Crusz, Ratnayake and Sathanathan (1964), Fernando (1965b) and Costa and Wijekoon (1966). A list of fish parasites recorded from Ceylon and the likely genera to be found are given in Fernando (1964).

Our present knowledge of the parasites of freshwater fishes of Ceylon is meagre although some ground has been covered by work published since 1956. No published data is available on the Myxosporidea and Microsporidia—important protozoan parasites. One record of a digenetic trematode is available from freshwater fishes. We have no data at all on the incidence and intensity of infestation. Seasonal cycles of infestation have not been studied. However a number of findings have some relevance to fisheries. Fernando and Furtado (1963a) reported the possible introduction of the cestode *Bothriocephalus gowkonensis* Yeh with Chinese carp imported for stocking. This parasite was found in an indigenous carp and was known previously from Canton. Professor O. N. Bauer (personal communication) says that this parasite was introduced with Chinese carp into the Ukraine. Fernando (1965b) attributed mortality of *Glossogobius giurus* to heavy infestation with larvae of the nematode *Hedruris* sp. Fernando (Loc. cit.) also noted heavy infestation of other carnivorous species with larval nematodes of *Hedruris* sp. and *Eustrongylides* sp. Increased mortality of carnivorous species could adversely affect the predator pressure so important in “controlling” the population of *Tilapia mossambica*. One of us (C. H. F.) in an examination of over 200 specimens of *Tilapia mossambica* found no metazoan parasites. Other workers have reported similar results with *Tilapia* spp. where few or no parasites were recorded in their “natural habitats” (Schuster 1952a, 1952b; Worthington 1932). Chimits (1957) comments on this finding and a contrary view based on records by Du Plessis (1954). Chimits (Loc. cit.) states that in the latter case the Tilapias were living at the uttermost limits of their natural range. Parasites have however been reported from a number of *Tilapia* spp. including *T. mossambica*. Baker (1958) recorded protozoans including Myxosporidia. Fryer (1960) found *Lernaea* on *Tilapia* spp. Paperna (1963, 1964) reported many monogeneans from *Tilapia* spp. and found the interesting phenomenon of intestinal Monogenea in *Tilapia* spp. One of us (C. H. F.) has found an unidentified Monogenea in the stomach of *Etroplus suratensis*. Awachie (1965) and Ukoli (1965) recorded many species of helminth parasites from *Tilapia* spp. in West Africa. A factor that must be taken into account in the case of *Tilapia mossambica* in Ceylon is that since a small number of specimens were imported the chances of infested fish being among them was small. However it is surprising that the many non-specific parasites do not seem to occur in or on *Tilapia mossambica* in Ceylon. Ky (1969) found only a few protozoan parasites but no adult metazoan parasites in *Tilapia mossambica* in Vietnam.

Fernando (1965b) dealt with the predators of freshwater fishes in Ceylon. There is little to add to this account at the present time. The possible introduction of predatory fish species is discussed elsewhere in the present paper.

## FISHERIES

Freshwater fisheries in Ceylon can be classified in various ways. For the present study we have drawn up the following categories:—

- (a) Large tanks in the low and mid-country.
- (b) Small tanks.
- (c) Up-country reservoirs and lakes.
- (d) Low and mid-country reservoirs.
- (e) Rivers and streams.
- (f) Villus.
- (g) Paddy fields.
- (h) Fish culture in ponds.
- (i) Trout and other sport fishing.
- (j) Miscellaneous fisheries.

**(A) Large Tanks In The Low And Mid-Country**

This fishery is concentrated in the North Central, Northern, North Western, Eastern and Southern provinces. The tanks which fall into this category are mostly ancient irrigation reservoirs. A few recently constructed tanks e.g., Huruluwewa, Nachchaduwa and Mahakanadarawa fall into this category. The major fisheries of this type are shown in Fig. 1.

Intermittent fishing with gill net has been carried out in large tanks for about 20–25 years. The authors noted as early as 1952 a beach seine being used in Nuwara Wewa. Subsistence fishing using rod and line, traps, cast nets, small seines and with lights at night dates back to a period where no records exist. During severe droughts parts of large tanks became muddy pools choked with fish. The local inhabitants often took the opportunity of collecting fish at such times.

With the introduction of *Tilapia mossambica* in 1951, fisheries in large tanks became established on a firmer footing. Migrant fishermen from the sea coast started spending a few weeks to a few months each year fishing the rapidly expanding stocks of *Tilapia mossambica*. Some of the indigenous species like *Labeo dussumieri*, *Etroplus suratensis* and *Wallago attu* were also exploited to a greater and greater extent concomitantly. Some fishermen became permanent settlers near these tanks. These sites are shown in Fig. 1. All these localities have been visited by the authors. It is likely, however, that such fishing sites are more numerous.

Parakrama Samudra can be taken as a representative of large, relatively shallow, low country tank. It is the only tank where statistics of fish catches are available for any length of time (1949–1966). Catches for this period are shown in Fig. 14. From fragmentary data of fish catches in other large tanks it appears that Parakrama Samudra has the highest fish production/acre/annum. This figure is of the order of 160 lbs. The abundant aquatic bird population (Table 3) is also an indication of the high fish production.

TABLE 3

List of birds observed feeding in the water in Parakrama Samudra between 13–25th January, 1965

<i>Podiceps ruficollis capensis</i> Salvadori	<i>Haliastur indus indus</i> (Boddaert)
<i>Pelicanus roseus</i> Gmelin	<i>Haliaeetus leucogaster</i> (Gmelin)
<i>Phalacrocorax fuscicollis</i> Stephens	<i>Ichthyophaga ichthyaeetus plumbiceps</i> Baker
<i>Phalacrocorax carbo sinensis</i> (Blum)	<i>Amaurornis phoenicurus phoenicurus</i> (Pennant)
<i>Phalacrocorax niger</i> (Vieillot)	<i>Lobioamellus indicus lankae</i> Koelz
<i>Anhinga melanogaster</i> Pennant	<i>Pluvialis dominica fulva</i> (Gmelin)
<i>Ardea cinerea rectirostris</i> Gould	<i>Tringa stagnalis</i> (Bechstein)
<i>Ardeola grayii</i> (Sykes)	<i>Tringa nebularia</i> (Gunnerus)
<i>Ardeola ibis coromanda</i> (Boddaert)	<i>Tringa glareola</i> L.
<i>Egretta alba modesta</i> (Gray)	<i>Tringa ochropus</i> L.
<i>Egretta intermedia intermedia</i> (Wagler)	<i>Actitis hypoleucos</i> (L.)
<i>Egretta garzetta garzetta</i> (L.)	<i>Himantopus himantopus ceylonensis</i> Whistler
<i>Nycticorax n. nycticorax</i> (L.)	<i>Burhinus oedinenus indicus</i> (Salvadori)
<i>Ibis leucocephalus leucocephalus</i> (Pennant)	<i>Sterna albifrons sinica</i> (Gmelin)
<i>Dissouraepiscopus episcopus</i> (Boddaert)	<i>Alcedo althris taprobana</i> Kleinschmidt
<i>Dendrocygna javanica</i> (Horsfall)	<i>Pelargopsis capedsis gurali</i> (Pearson)

Commercial fishing in Parakeama Samudra is carried on throughout the year with gill nets (Fig. 11). Beach seines are used for six months at most. Fernando (1967) has given a detailed account of the latter fishery. In addition there is a cast net fishery specifically for *Heteropneustes fossilis*. Thirty boats were used of which 18 were rafts (Fig. 12) and the rest outrigger canoes. In 1964, about 50 active fishermen were resident in Parakrama Samudra. The distribution of fishermen's huts is shown in Fig. 13. Gill netting was done mainly at night and the catch per fisherman per fishing day was about 75 lbs.

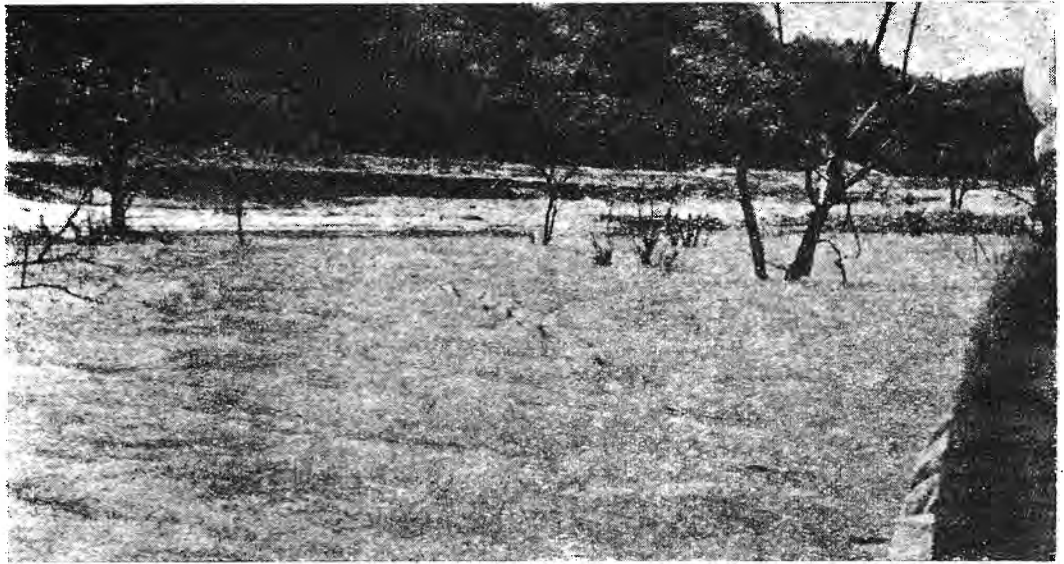


Fig. 11.—A gill net set in a tank.

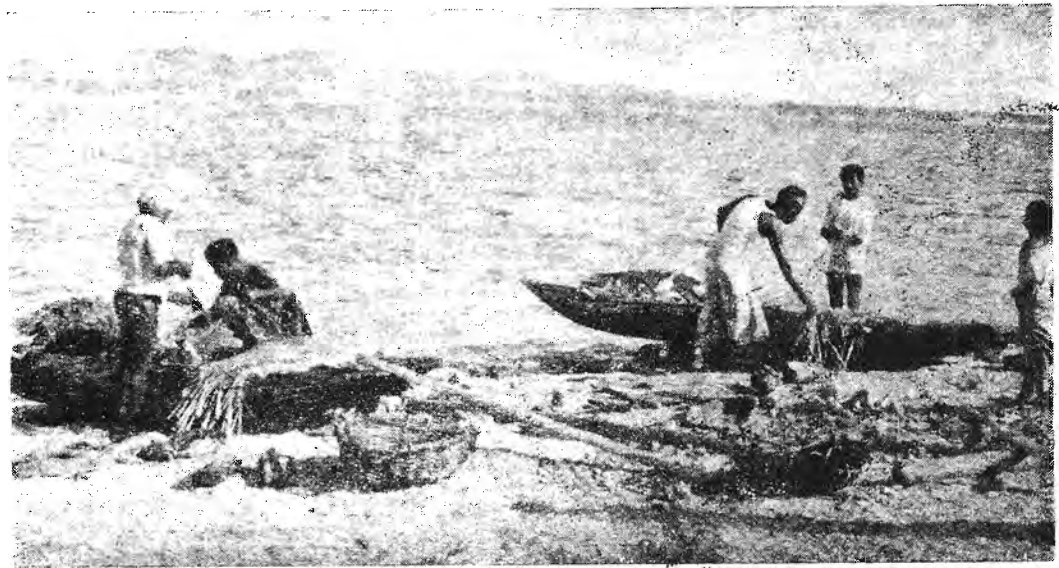


Fig. 12.—Sorting gill net catches. Note the type of boat used—Rafts (Teppam).

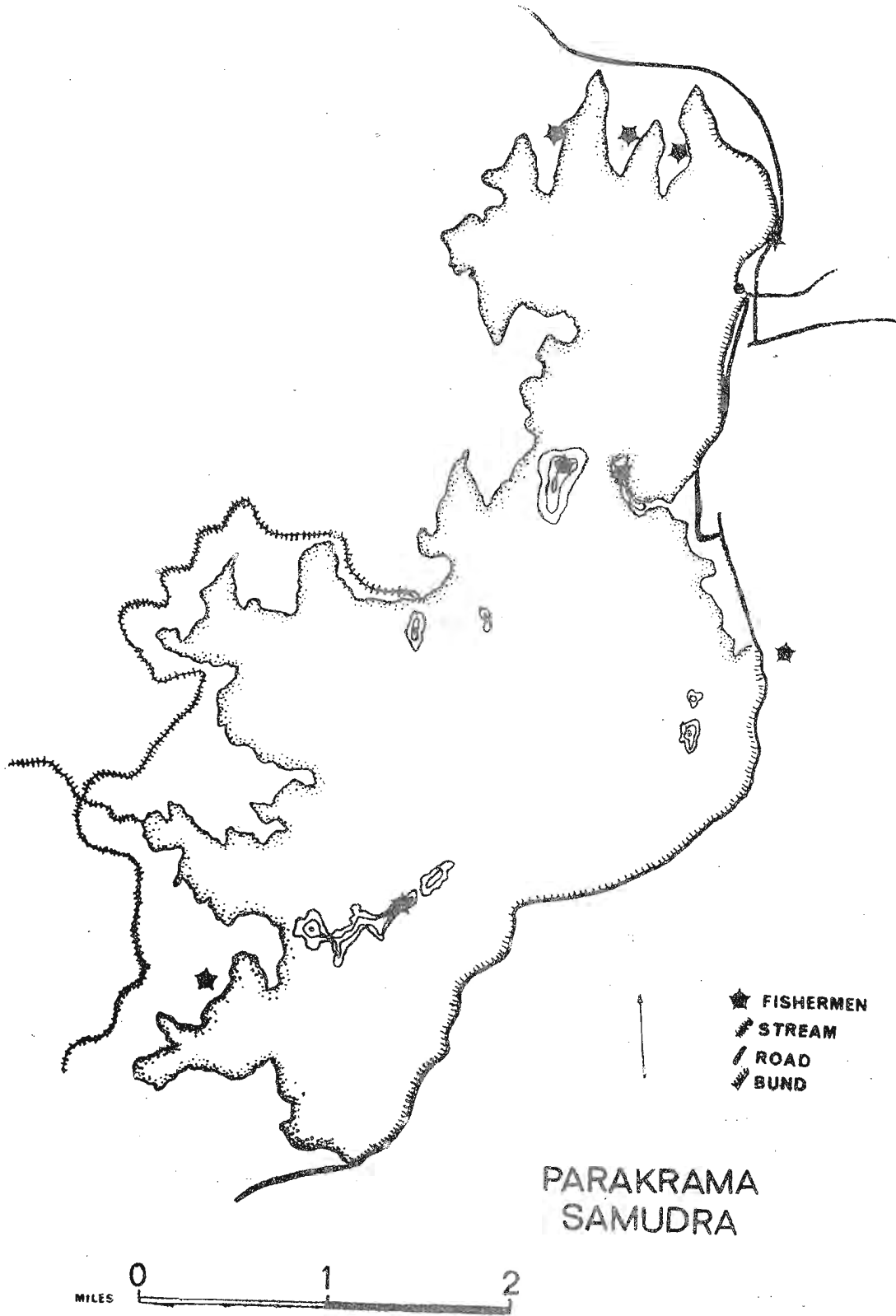


Fig. 13.—Parakrama Samudra showing fishing sites and fishermen's dwellings.

In addition to total fish catches from Parakrama Samudra for the period 1949-1966, data is available on the species composition of the catches. Some of this latter data is available in the Administration Reports of the Director of Fisheries and also in Fernando (1965b). The fish catches from Parakrama Samudra for the years 1949-1966 are shown in Fig. 14. Prior to the introduction of *Tilapia mossambica* in 1952 fish catches were very low. *Tilapia mossambica* started entering the fishery in 1954. Unfortunately no data is available for fish catches during this year. In 1955 considerable numbers of *Tilapia mossambica* were being caught according to reports by the Fisheries Officers stationed at Polonnaruwa but no separate statistics were kept of this species. In 1956 the percentage of *Tilapia mossambica* by weight was 21.9 of the total catch. The percentage increased rapidly reaching 90% in 1958. This figure has remained unchanged substantially although the percentage of *Tilapia mossambica* has shown decreases in 1960 and again beginning in 1964. The total fish catch has gone up tremendously since 1949. In 1963 it hit 1 million lbs. and has remained around that figure until 1966. Besides *Tilapia mossambica* a number of other species are caught in some numbers. They are *Labeo dussumieri*, *Eetroplus suratensis*, *Wallago attu*, *Ompok bimaculatus*, *Puntius sarana* and *P. dorsalis*. Also small quantities of *Osphronemus goramy* and *Heteropneustes fossilis* are caught. It is evident that the fishery in Parakrama Samudra is maintained by *Tilapia mossambica*. The indigenous species are exploited only because of the high catches of *Tilapia mossambica*. It is also evident that the catches of indigenous species have not fallen. From data on species composition of catches it is clear that the large indigenous species are not being progressively reduced in quantity in the catches. Indrasena (1965a) and Fernando (1967) pointed out that the beach seine fishery in Parakrama Samudra diversifies the fish catch. Fernando (1967) also mentioned the possibility of using small meshed beach seines for catching small coarse fish. In all, 25 species of indigenous fishes were recorded by the authors in 1964. Their numbers did not seem to have diminished from pre-*Tilapia* days.

Mendis (1965) used the fish catches from Parakrama Samudra as a baseline to calculate fish production in other tanks. He used a figure of 100 lbs./acre/annum for this purpose. The figure in 1964 was closer to 150 lbs./acre/annum. It is likely that further increases in the fish production of Parakrama Samudra are possible. Perhaps the introduction of complementary species of *Tilapia* will accomplish this. Also if uses are found for small coarse fish a considerable quantity of this category is available for exploitation.

Some data is available of fish catches from other large tanks in the low country. The species composition of the fish catches from these is essentially the same as for Parakrama Samudra. Although no reliable statistics are available of total fish catches it appears that where exploitation is heavy fish catches of 100-200 lbs./acre/annum can be obtained from these large tanks.

#### (B) Small Tanks Fig. (15)

Fisheries in small tanks consist usually of subsistence fishing. However in recent years more intensive fisheries have been noted in a few small tanks. Fernando and Ellepola (1969) give two such instances. In a small tank near Wirawila one of us (C. H. F.) noted in 1968 a fishery using gill nets. The catch in this case consisted almost entirely of *Tilapia mossambica*. Perhaps similar fisheries exist in many other small tanks.

During the dry season many small tanks dry up. This provides the local population with the opportunity of collecting fish without any specialized fishing apparatus. This type of mud fishing (Hora 1932) is very prevalent.

It is possible to use small tanks as fish ponds with annual stocking of desirable species. *Tilapia mossambica*, *Eetroplus suratensis*, *Labeo dussumieri*, and macrophytic plant feeding *Tilapia* spp. might well be used for this purpose. A preliminary study by Fernando and Ellepola (1969) showed the feasibility of such a fishery.

On a very conservative estimate there is at the present time about 50,000 acres of small tanks (each less than 100 acres in area). The figures of fish production given by Fernando and Ellepola (loc. cit.) for two tanks are 100 and 70 lbs./acre/annum. Using a very conservative estimate of 50 lbs./acre/annum this is a total production of 2.5 million lbs./annum. This figure is, we must stress, a very low estimate. Stocking with fast growing species could easily double this figure. Also the use of *Tilapia* hybrids giving monosex progeny (Hickling 1960, Pruginin 1967) may prove useful for small tanks as they have done in pond culture.

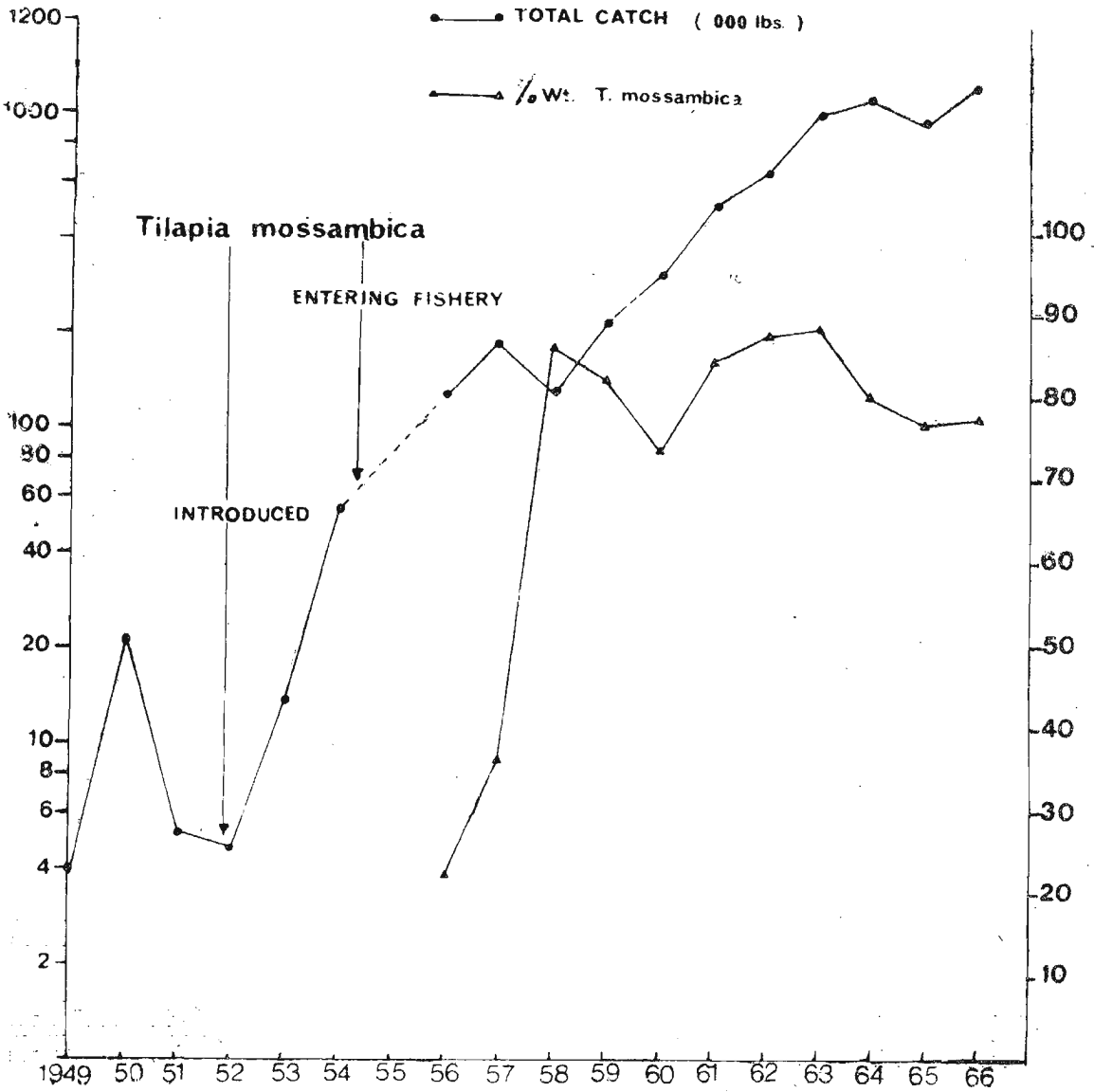


Fig. 14.—Fish catches from Parakrama Samudra, 1949-66.

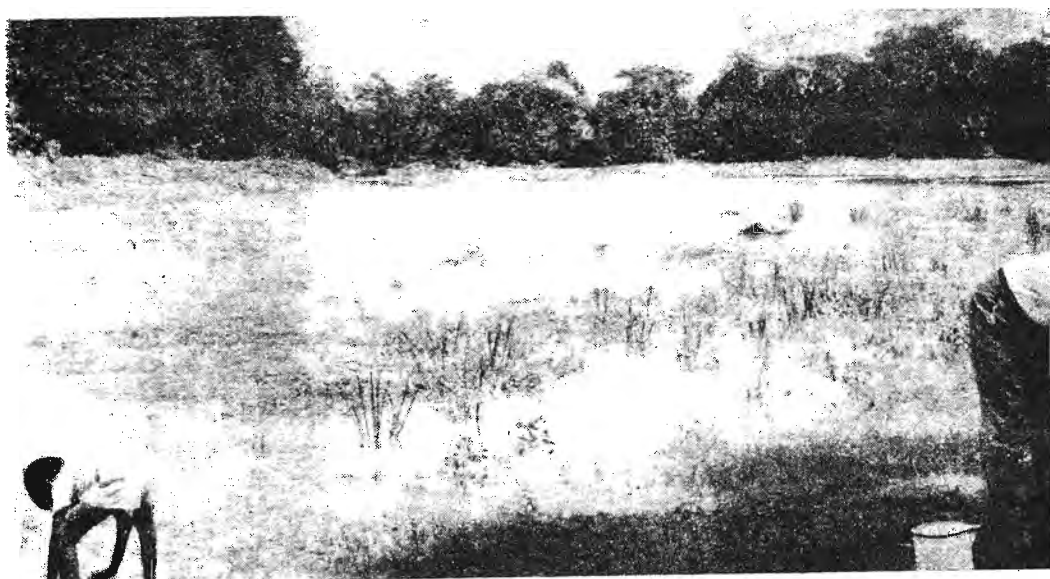


Fig. 15.—A small tank near Habarana.



Fig. 16.—Nalanda reservoir, showing the steep gradient of the margin.

**(C) Up-Country Reservoirs And Lakes**

These are the least productive of fish at the present time. They include the hydro-electric reservoirs, Norton Bridge and Castlereagh and the deep lakes, Kande-ela and Moonplains and the shallower Gregory's lake. Only in Gregory's lake is there any fishery at all and in this case it is a sport fishery. Common carp and crucian carp are taken by rod and line in Gregory's lake. No data is available on the total catch. Little if at all in the way of fish is taken from any of the other up country lakes.

Apstein (1910) and Holsinger (1955b) have studied the plankton of Gregory's lake. From the data of the latter's study it appears that Gregory's lake has a high phytoplankton productivity.

It seems likely that introduction of suitable species into up-country lakes will increase fish productivity. Species worth considering are *Tilapia sparmanni* (Castelnau) and *Tilapia galilaea* (Ardeti) both of which can withstand low temperatures. The former species has been used as a forage fish, (Hey 1953). *Tilapia sparmanni* is phytophagous and omnivorous and *T. galilaea* feeds on phytoplankton (Chimits 1955, 1957). Chimits (1955, 1957) states that *Tilapia sparmanni* can withstand temperatures as low as 7°C and *T. galilaea* 9°C. The absence of large predatory species might prove a disadvantage. *Notopterus chitala* (Ham.) a native of North India might prove a suitable introduction. Alikunhi (1957) states that it grows to over 4 ft. in length and is predatory and breeds in confined waters.

**(D) Low And Mid Country Reservoirs**

This category of lakes is somewhat varied in size but all of them are of recent construction. Many new reservoirs are planned (Fig. 2). They all have some features in common. They have a considerable portion of their area relatively deep and the margins have steep gradients (Fig. 16).

TABLE 4  
Fish catches (lbs.) from Senanayaka Samudra 1961-64

	1961	%	1962	%	1963	%	1964	%
	Catch		Catch		Catch		Catch	
<i>Tilapia mossambica</i>	122,564 ..	36.75 ..	128,614 ..	32.74 ..	62,036 ..	41.27 ..	111,440 ..	50.84
<i>Labeo dussumieri</i>	197,198 ..	59.13 ..	165,290 ..	42.08 ..	65,359 ..	43.48 ..	75,479 ..	34.43
Total catch	333,510 ..	—	392,783 ..	—	150,329 ..	—	219,214 ..	—

Some data is available for fish catches from the largest reservoir in Ceylon, Senanayake, Samudra (Fig. 17 & 18). These fish catches are summarised in Table 4. The catch seems to be divided into a major portion consisting of 75-95% of the weight and consisting of *Tilapia mossambica* and *Labeo dussumieri* and a small portion 5-25% consisting of *Wallago attu*, *Etiropus suratensis*, *Puntius* spp., *Ophiocephalus striatus* and *Ompok bimaculatus*. Unlike in the large low-country tanks *Tilapia mossambica* constitutes only 50% by weight at most. *Labeo dussumieri* is equally important in the catch. The lower percentage of *Tilapia mossambica* as compared to the large low-country tanks is interesting. However it has become the most important fish in the catch displacing *Labeo dussumieri* from this role (Table 4). The steep gradients of the margins unsuitable for *Tilapia mossambica* breeding sites may be one of the causes of this differences. According to Mendis (1965) using 100 lbs. per acre per annum for Parakrama Samudra as a baseline, Senanayake Samudra should produce over one million lbs. of fish per annum. The actual production was of the order of a third of this figure. It is possible, in fact likely, that the fishing could be intensified considerably. One of the features of the fishery is that actual fishing is restricted to the shallower margin away from the bund (Fig. 17). The distances between the fishing sites and the fishermen's habitations are great thus reducing the efficiency of fishing.

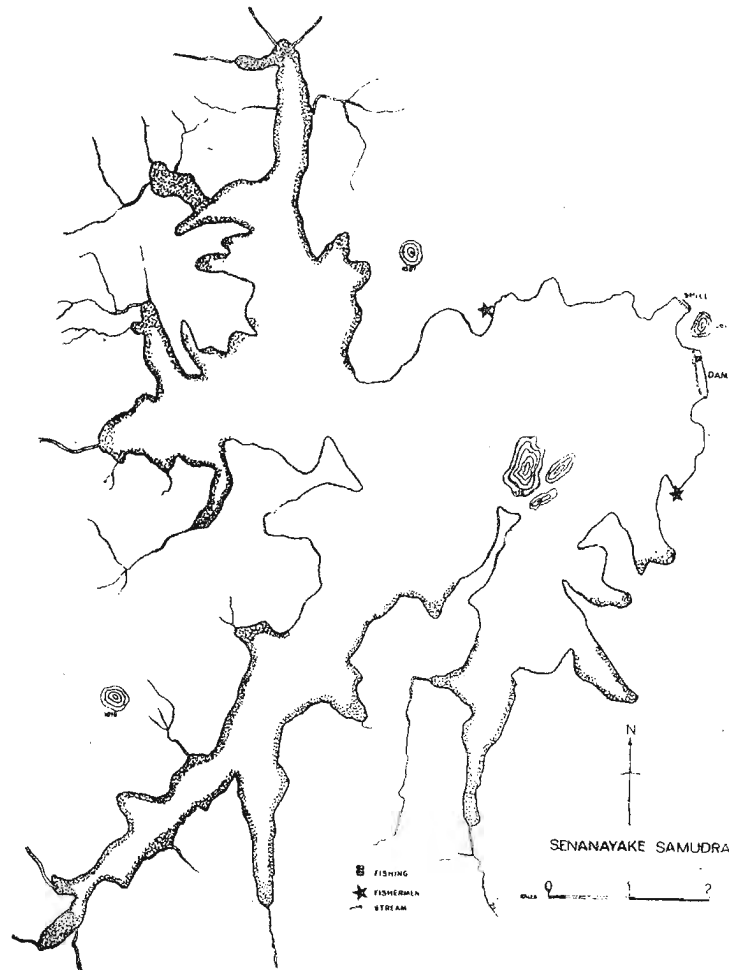


Fig. 17.—Senanayake Samudra showing fishing sites and fishermen's dwellings  
Fishing is done only in the stippled areas.

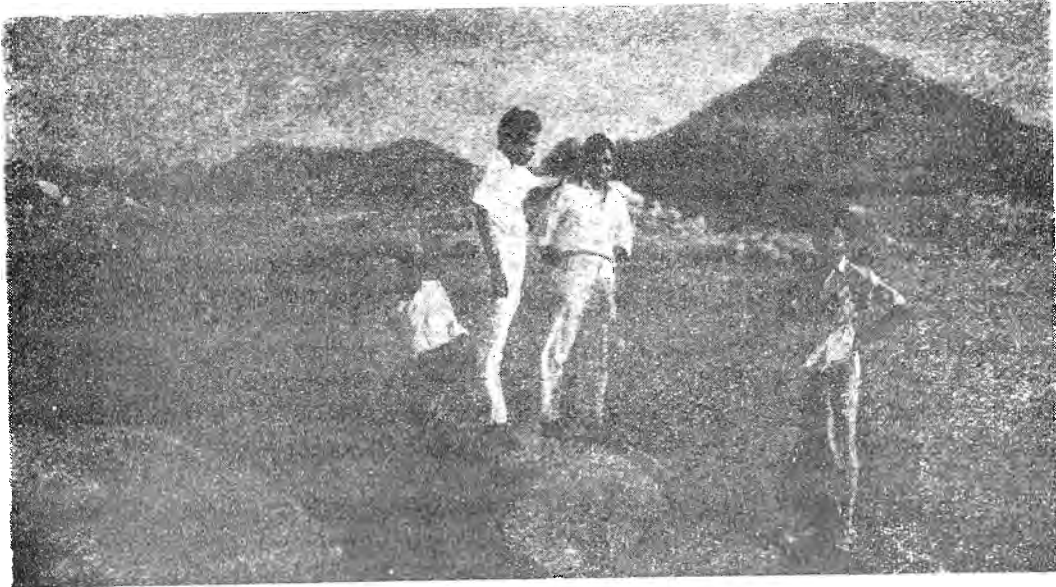


Fig. 18.—A view of Senanayake Samudra at low water level.

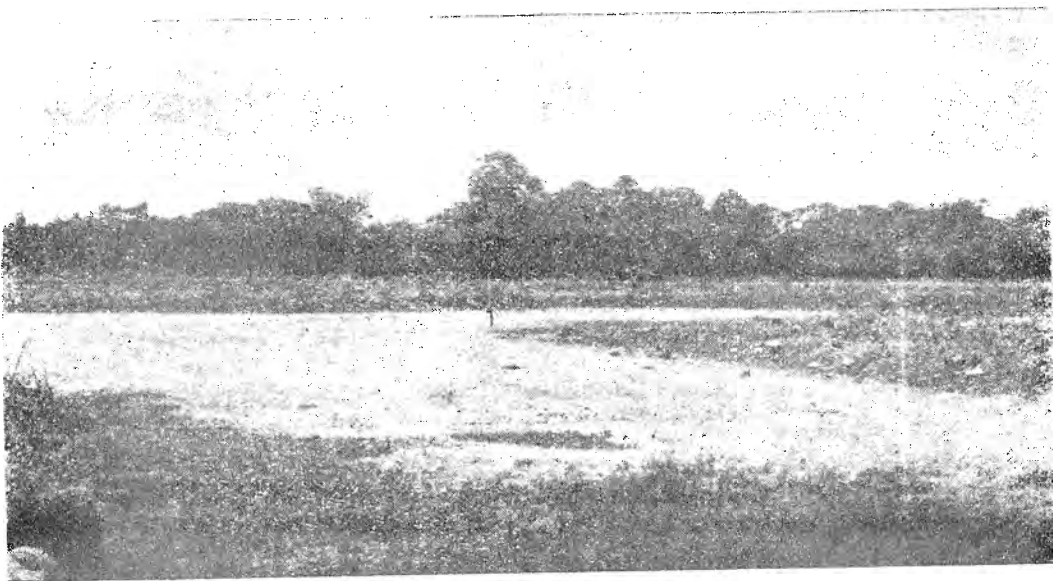


Fig. 19.—Bandiya villu.

The authors feel that the fish stocks could be enhanced by the introduction of complementary species of *Tilapia*. A plankton feeding species like *T. galilaea* or *T. macrochir* might prove suitable. If the fishable stocks are increased it might become economic to use motorised craft on large reservoirs

(E) **Rivers And Streams**

The sixteen major rivers have a vast number of streams criss crossing the river basins they drain. Some up-country streams provide suitable habitats for trout while many are torrential and flow by a rapid gradient into the low-country. Many low-country streams provide breeding sites for fish during the flood season. Important food species like *Labeo dussumieri* move upstream from tanks to breed. Rivers and streams are therefore an important part of the complex of freshwater habitats and though they do not yield the same amount of fish per acre as shallow tanks they nevertheless fulfill an essential role in the life-histories of some fish species. They also bring into lakes large quantities of nutrients and of course water.

A number of valuable indigenous species inhabit rivers for longer or shorter periods of time and fisheries have been developed to catch these using various legal and illegal (dynamiting, poisoning) methods. During floods spawners moving upstream are caught in traps and nets.

No records are available of the fish catches from rivers and streams. Nevertheless the extent of their area offers an important source of fish. Sport fishing is of some importance in rivers. Important river and stream species are *Labeo dussumieri*, *Wallago attu*, *Osphronemus goramy*, *Tox khudree* and large *Puntius* spp.

The mouths of rivers have a valuable fish and crustacean fauna. Many marine and freshwater species intermingle to varying degrees. Prawns (*Macrobrachium* spp.) are of some importance in certain areas like Madampe and Kalutara. Sited in many river mouths are fisheries for a variety of species both freshwater and marine. Again we have no data at present of the extent, the species composition or the size of the fish catches of these fisheries.

(F) **Villus**

The closest approach to natural lakes in Ceylon are the villus. They are of two kinds. Those connected permanently to a river (e.g., Karapala villu) and those formed as a result of the contraction of flooded areas (e.g., Bandiya villu, Fig. 19). Villus are common in the lower reaches of the Mahaweli ganga, the Wilpattu and in the Yala areas.

The villus in the lower reaches of the Mahaweli ganga seem to be ideal nurseries for fishes. The giant gouramy, *Osphronemus goramy* which was accidentally introduced into the Mahaweli ganga around 1909 appeared in numbers first in the villus (De Zylva 1960). Malpas (1937) suggested using the villus for rearing gouramy.

It is unfortunate that no study has been undertaken on the biology of this interesting habitat, the villu in its various forms. Conservationists and freshwater biologists should join in preserving this unique habitat.

Data of fish catches from villus is meagre. Regular fishing has only been reported from villus in the Polonnaruwa area. Perhaps this is due to the fact that in other areas the villus are remote and there are no fisheries personnel to report such fisheries. We have some data from Karapala villu for the years 1961-1966 (Table 5). The annual catch seems to have varied between 50-100,000lbs.

TABLE 5  
Fish Catches (lbs.) from Karapala Villu 1960-66  
Catches are from October 1st to September 30th

Year	Total catch	<i>T. mossambica</i>
1960-61	107,200	4,560
1961-62	106,475	no data
1962-63	86,500	no data
1963-64	55,580	no data
1964-65	65,680	41,523
1965-66	64,650	41,900
1966-67	55,550	37,550

The percentage of *Tilapia mossambica* by weight was only about 3% in 1961 and the records for 1964 have a value of about 75%, a figure repeated in 1965 and 1966. However, the total fish catch had fallen considerably from 1961-1966. Whether this is due to selective fishing for *Tilapia mossambica* it is difficult to state. It is true however that only one group of fishermen were involved in the fishing and the range of gear used was not as varied as in the large tanks. The authors visited Karapala villu on a number of occasions during the height of the fishing season. The species caught were more diverse than that of large tank fisheries on any one day. *Labeo dussumieri*, *Wallago attu*, *Ompok bimaculatus*, *Etroplus suratensis*, *Ophiocephalus striatus*, *Osphronemus goramy* and *Puntius* spp. all figured regularly in the catches although in much smaller numbers than *Tilapia mossambica*.

#### (G) Paddy Fields

During the floods paddy fields serve as vast areas of open water where many species of fish breed. They act as natural nurseries for most of the smaller species. However, the period during which sufficient water is available for fish is short and many of the species have high mortalities during the dry season. The survivors which are usually those which find their way into irrigation channels, streams and large ponds often suffer further decimation before the next monsoon rains set in.

Weerekoon (1957) gave a popular account of some invertebrate animals in paddy fields in Ceylon. Considerable quantities of small sized fish are caught in paddy fields and irrigation ditches. Fernando (1956b) found 24 species of fish in paddy fields in the Western lowlands. Notable absentees were the large species like *Labeo dussumieri*, *Wallago attu*, *Ompok bimaculatus* but 11 others including *Labeo dussumieri* and *Ompok bimaculatus* were found in irrigation ditches. The presence of 35 out of 54 indigenous species in paddy fields and irrigation ditches shows that this is perhaps the most favourable habitat for indigenous freshwater fishes. The abundant food and a refuge during the drought in irrigation ditches perhaps enables many species to reach considerable numbers in this habitat.

Attempts were made to use paddy fields for fish culture (De Zylva 1953). *Trichogaster pectoralis* and later *Tilapia mossambica* were used. This project was abandoned a few years later.

#### (H) Fish Culture In Ponds

De Zylva (1952) and Anon (1962) give detailed instructions regarding fish culture in ponds. A number of attempts to raise various species of fish in ponds have been made from time to time in the last fifteen years. At the fisheries stations some measure of success has been achieved in spawning common carp, gouramy and *Trichogaster pectoralis*. These have been used mainly for stocking 'natural' waters, i.e., tanks. The breeding of carp and gouramy have been dealt with by Indrasena and Ellepola (1964) Indrasena and de Silva (1964) and Ellepola and Fernando (1968).

Fernando (1965a) attributed the failure of pond culture to the lack of a practical tradition among the indigenous people. The prospects for fish culture are not very promising, but with sustained efforts it could become an important source of fish.

The use of indigenous carp fry captured in natural waters could form an important source of fast growing species for culture in ponds. This type of culture is widely practiced in India (Alikunki 1957). Fry of *Labeo dussumieri* have been collected and successfully reared by the authors.

#### (I) Trout And Other Sport Fishing

The recreational aspect of fishing might be considered as inherent in some of the rod and line fishing done especially by young people. Most rod and line fishing is however more subsistence fishing rather than recreational. True sport fishing is not widespread in Ceylon for a variety of reasons. The religious sentiments of many people prevent them from engaging in such a pastime and the search for outdoor activities of this kind is still restricted to only a few enthusiasts.

Trout are introduced into up-country streams annually by the Fishing Club at Nuwara Eliya. A trout hatchery is maintained for this purpose. Common carp, crucian carp and trout fishing is controlled by licence. An account of trout culture is given by Fowke (1938).

A number of indigenous species are caught in sport fishing in various parts of the island. *Tor-khudree* is perhaps the most sought after sport fish. *Ophiocephalus striatus*, *Wallago attu*, and *Labeo dussumieri* are taken by sportsman besides the introduced *Osphronemus goramy*.

Sport fishing has considerable potential for development as a tourist attraction and for recreational purposes of the local population. Sport fisheries are useful means of getting non-professionals interested in biology and fisheries. Many articles on sport fishing can be found in *Loris*, the journal of Ceylon wild life.

#### (J) Miscellaneous Fisheries

Ceylon is fortunate in having a large number of aquarium fishes among its indigenous fauna (Table 1). A number of these species are however rare and are found only in very restricted localities. Studies on their population and breeding habits should be undertaken with a view to exploitation and conservation.

### FISHING GEAR

Pearson (1923) described the various kinds of fishing gear in use at that time. Since then new materials have been used in the construction of some of the gear he describes but basically the gear has not changed where freshwater fisheries are concerned. Some marine gear has been introduced to fish the large stocks of *Tilapia mossambica*. The traditional gear used in freshwaters were traps, rod and line, cast nets and small seines.

Gill nets are the most widely used type of gear at the present time (Fig. 11). Stretched mesh sizes 3"-6" are used. The nets are set from the bottom, in midwater or at the surface. Mendis (1965) on the basis of fishing trials suggested 3"-4" mesh sizes during the day for *Labeo* and *Puntius* and 5"-6" mesh at night for *Tilapia mossambica*. Most of the gill net fishing at present is done at night. Gill nets are subject to damage by crocodiles in many of the tanks. Also gill netted *Tilapia mossambica* have their gills eaten by *Heteropneustes fossilis* and *Anguilla* in some localities according to Fernando and Fernando (1965). Gill netting is done from rafts (teppams) or outriggers (orus). The quality of boats used is not high. Very often boats unfit for use in the sea are transferred to freshwater fishing.

Beach seines have been used in a number of large tanks on a regular basis. Fernando (1967) made a detailed study of this fishery in the Polonnaruwa area. Beach seines account for only a small portion of the catch but it diversifies the species composition.

The authors have used long lines for fishing in Parakrama Samudra, Nalanda reservoir and Senanayake Samudra. The species caught were *Wallago attu*, *Ompok bimaculatus* and *Anguilla nebulosa*. As a commercial venture this method does not seem to have prospects. Trammel nets were also used on an experimental basis. The catches were similar in species composition and weight to that of gill nets. Fishermen are however unwilling to use them because of the novelty, cost and the difficulty of disentangling the fish caught.

### UTILIZATION

Fernando (1965a) pointed out that though the fish production was low in the "pre *Tilapia*" period this small fish production provided much needed protein for the villager. In many areas subsistence fishing with cast nets, traps, rod and line etc. provided at least some fish for the villagers. There was also a prejudice against freshwater fish as compared to marine fish. One reason for this was perhaps the paucity of desirable species. Religious sentiments too played an important part in the aversion to eating freshwater fish, many of which remained alive at the time of selling to the householder.

At the present time freshwater fish reaches a wider area and are eaten by a greater percentage of the people especially in towns far away from the site of the fishery. *Tilapia mossambica* is by far the largest contributor to the fish catch. This species has an agreeable flavour. It is sold fresh, iced, dried with salt or smoked. The price is low compared to marine fish of "equivalent" standards in size and taste. Since it is likely that the production of *Tilapia* spp. will be increased considerably in the near future, other methods of utilization should be considered. De Silva (1963) worked out a

process for canning *Tilapia mossambica* in curry sauce. This and other methods of utilization, e.g., fish meal, sauces, etc., should be explored in Ceylon. Hess (1968, 1969) investigated in Uganda the canning of *Haplochromis* spp. which are smaller than *Tilapia mossambica*. He found a tomato sauce base most acceptable. However canning of freshwater fish on a commercial scale has not been done so far.

### SOCIO-ECONOMIC PROBLEMS

Fernando (1965a) and Indrasena (1965) have commented on some socio-economic problems. Commercial fishing in freshwaters is a recent phenomenon. Legislation may be necessary to prevent abuses but we feel that no laws are better than ill-conceived ones. On no account should legislation be introduced without consulting fishermen and Fisheries Officers. An effort should be made to help economically fishermen on similar terms as those employed in marine fisheries. These fishermen are contributing a vast quantity of protein to the country at very little cost in foreign exchange. A tank like Parakrama Samudra produces a catch by weight equivalent to half that of a large trawler's catch (Weerekoon 1965). We need hardly stress the difference in cost of the two operations.

### SUMMARY

Based on our present knowledge a comprehensive account of the freshwater fisheries of Ceylon is given. The material for the present paper comes from data gathered by the authors over a period of fifteen years on the general setup of the fisheries and specific research carried out on a few major aspects of the fisheries. All the previous published work is gathered together.

The fish production from freshwaters has increased immensely since the introduction of *Tilapia mossambica* in 1951. The introduction of complementary species of *Tilapia* is suggested to enhance further the fish production. For up-country reservoirs a predator is suggested in addition because of the lack in the Ceylon fish fauna of a large lake dwelling predator tolerant to low temperatures.

A study of the "status" of *Tilapia mossambica* has shown that it has a wide size range and coefficient of condition in different habitats. Restriction of breeding sites and living space may account partly for these differences.

Fish catches from different types of habitats show differences in fish production, species composition of catches and the relative proportions of the fish caught. In Parakrama Samudra the fishery is dominated by *Tilapia mossambica* which forms about 90% of the catch by weight. A similar situation exists in most if not all the large low-country tanks. In Senanayake Samudra the fishery is maintained by *Tilapia mossambica* and *Labeo dissumieri* and in Karapala villu *Tilapia mossambica* dominated the fish catch comprising about 75% by weight in 1966. The species caught are most diverse in Karapala villu and least so in Senanayake Samudra. Figures available on fish production show a catch of about 150 lbs./acre/annum for Parakrama Samudra. In comparison the catches for Senanayake Samudra and Karapala villu are low.

The extension of freshwater areas by construction of tanks for irrigation and reservoirs for hydro-electric power will increase considerably the fish production potential. Planned introductions of selected species could well increase the fish stocks considerably. A relatively unexploited source is the small tank of which there are many thousands in the country. A fry fish industry and annual introduction of fingerlings for harvesting in a few months could utilize these habitats for fish production.

A review of the literature on the freshwater fauna and limnology shows clearly that our knowledge in these areas is meagre. We also know little regarding fish parasites and their dynamics. No fisheries development programme could be successful in the long run if research on these vital subjects is neglected.

The prospects for increasing the fish production from freshwaters are good. The spectacular success of *Tilapia mossambica* may not be repeated but the fish production can most certainly be enhanced, the catch better utilized and the fishermen's lot improved.

## ACKNOWLEDGEMENTS

We wish to thank the many fishermen who supplied us with valuable information on fish catches, fishing methods, etc., The two Sub-Inspectors of Fisheries Messrs. M. T. T. Fernando and W. B. Ellepola were responsible for gathering some of the data. They also took an active part in the field research. Mr. David Perera, the lorry driver, Mr. W. P. Silva, boatman, Mr. W. John Fernando net mender and at times cook, and Mr. W. K. T. Perera, laboratory assistant trained in gear technology went beyond the call of duty to help in this work. Data of fish catches from Senanayake Samudra was provided by Messrs. D. K. de Alwis and T. Poopalapillai of the Gal-Oya Development Board. Mr. P. B. Karunaratne, Entomology section, Ceylon National Museum provided the data on water birds in Parakrama Samudra. Professor O. N. Bauer, Institute of Fish Diseases, Academy of Science, Leningrad provided information re parasite infestation of carp. Dr. Ernest Hess, formerly F. A. O., Rome discussed canning of freshwater fish and Mr. R. C. K. Pieries, formerly of the Irrigation Department, Ceylon, supplied some of the data on reservoirs.

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#### ADDENDUM

Since this paper was written we received from Professor O. N. Bauer a list of references to the occurrence of the very pathogenic cestode *Bothriocephalus gowkonensis* which was recorded in Ceylon by Fernando and Fernando (1963). Since this species will certainly be of considerable importance to the freshwater fisheries of Ceylon and the references are not cited in English journals we have included the references mentioned below. *Bothriocephalus gowkonensis* has spread into the U.S.S.R. and Rumania. Although unrecorded in many parts of Asia and Europe it has probably invaded both cultured and wild cyprinid fishes. The senior author certainly saw this species in Malaysia and it is likely to spread into Africa and North America with imported fish. It is relatively non-specific and seems to be restricted to the Cyprinidae.

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## THE FRESHWATER INVERTEBRATE FAUNA OF SRI LANKA

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### INTRODUCTION

A continental island of 70,000 sq. km. in total area, Sri Lanka has a wide range of altitudes varying from sea level to over 2,000 metres. 103 river systems (9 of them large rivers) flow almost diagonally. The rivers arise mainly in the hills of the central part of Sri Lanka. There are no natural lakes but over 10,000 man-made lakes are listed. These lakes (tanks, reservoirs; Sinhala. *wāwa*, Tam'il. *kulam*) are part of a sophisticated irrigation network whose construction began over 1000 years ago. There is a high rainfall associated with two monsoons. The central highlands have the highest rainfall and during the monsoons rivers are swollen and often flood considerable areas of lowland. Many collections of waters in the form of large and small ponds result from each monsoonal period. During the intervening dry season many of these ponds are eliminated and even some of the rivers dry up leaving only pools of water in their beds.

The freshwater invertebrate fauna of Sri Lanka is rich, varied and typical of a continental tropical island. The freshwater habitats of varying degrees of permanence are dominated by running waters in the form of torrential, fast flowing and slow flowing streams and rivers. Apart from the man-made lakes, man's agricultural and other activities have created many ponds channels and miscellaneous habitats like wells, gem pits, etc. Practically every freshwater habitat in Sri Lanka is either man-made or man-influenced. A few flood lakes (Sinhala. *villus*) are found in the lower reaches of the Mahaweli ganga and Kalā oya. These are the only natural large bodies of standing water in Sri Lanka.

In the whole Oriental Region (South East Asia), Sri Lanka can claim to be the best known as regards to freshwater invertebrate fauna. Its strategic position, relatively small size, mild climate by and large and the natural beauty of the landscape has attracted many naturalists to collect material in the Island. The earlier general works of Kelaart (1852), Tennent (1861) and Haeckel (1883) provided a good introduction to the Natural History of the island. Many naturalists from Europe and North America collected faunal material from Sri Lanka. Some of these collections included freshwater material and was reported on subsequently. The papers of Brady (1886) and Daday (1898) dealt extensively with the freshwater fauna. These two papers also established many new species which were subsequently found to be widely distributed like many other freshwater invertebrates. A small number of papers were also published on freshwater invertebrates based on one or two samples. The volumes of the Fauna of British India dealing with aquatic invertebrates included some Sri Lankan material but in all cases the coverage of the Sri Lankan fauna was superficial. Also this series is incomplete and does not deal with the Oligochaeta and the Crustacea.

The publication of "*A guide to the freshwater fauna of Ceylon*" by Mendis and Fernando (1962) and the supplements 1-4 (Fernando 1963a, 1964, 1969, 1974) provide a comprehensive coverage of the freshwater invertebrate fauna. Sri Lanka is the only country in South East Asia where such a comprehensive coverage has been attempted. Recent expeditions by the University of Lund (1962) and the University of Vienna (1970) collected intensively in the running

water habitats especially. Some of the material collected has already been reported on. Other faunal collections have recently been made by the Smithsonian Institution and by me. However, many groups of freshwater invertebrates have been poorly studied even at the taxonomic level. Fernando (1974) listed only five groups among the fifty he listed as being well known taxonomically (see also Table 1). Twenty-five groups were listed as poorly known and the rest as fairly well known. The low level of our knowledge of the freshwater invertebrate fauna of Sri Lanka can be attributed to (a), the general low level of knowledge of tropical faunas and (b), the lack of economic incentives, due to low fish production from freshwaters. Recently, however, the fish yield has increased dramatically (Fernando, 1971). The exploitation of the freshwater fishery potential of Sri Lanka will require a sound knowledge of limnology and fisheries. Basic systematic studies will aid greatly these fields of study.

In the present paper some background information on geology, water chemistry and the freshwater habitats are given. The present knowledge of the freshwater faunal groups is briefly commented upon. Some remarks are made concerning noteworthy features of faunal composition. A very brief account of the biogeography of the Sri Lanka freshwater fauna is given. Some aspects of the ecology of the freshwater fauna are discussed. My own investigations on the zooplankton and ricefield ecology are briefly discussed together with a short comment on freshwater fish parasites.

#### Geology

The physiography of Sri Lanka can best be described as consisting of three peneplains (almost Plains) as shown by Adams (1929). These peneplains are (1), slightly above sea level (2), 300-800 metres and (3), 1,000-2,000 metres above sea level. Nine-tenths of the total area of Sri Lanka is made up of highly crystalline non-fossiliferous rock of the Pre-Cambrian era. A small area in the North Western portion of the island is formed of Miocene limestone. Almost insignificant areas are of Jurassic age. Cooray (1967) has given a detail account of the Geology of Sri Lanka. Erb (1966-70) has dealt with landforms and drainage in Sri Lanka.

#### Water Chemistry

There has been no systematic or detailed study of the water chemistry of Sri Lanka freshwaters. Sirimanne (1953) recorded low to moderate amounts of dissolved solids and acidic waters in the Western and Sabaragamuwa Provinces and slightly alkaline waters in the other provinces. Mendis (1965) recorded slightly alkaline waters in the Northern, North Central North Western, Southern and Eastern Provinces in his study of lakes. He also noted slightly darker humic waters in the Southern province. Geisler (1967) and Weninger (1972) who examined mainly samples from the south and southwest found these waters extremely poor in electrolytes, very soft and slightly acidic. There is some intrusion of salt water in regions where the coastal areas are almost at sea-level elevations. There is hardly any tidal influence in Lanka and hence saline water does not intrude upstream unless the land is almost at sea level. There are no data on the extent of organic or inorganic pollution of Sri Lanka waters. However, Colombo lake is highly eutrophic as a result of industrial and domestic pollution. Many reservoirs in the North Western and North Central Province are also eutrophic if one is to judge

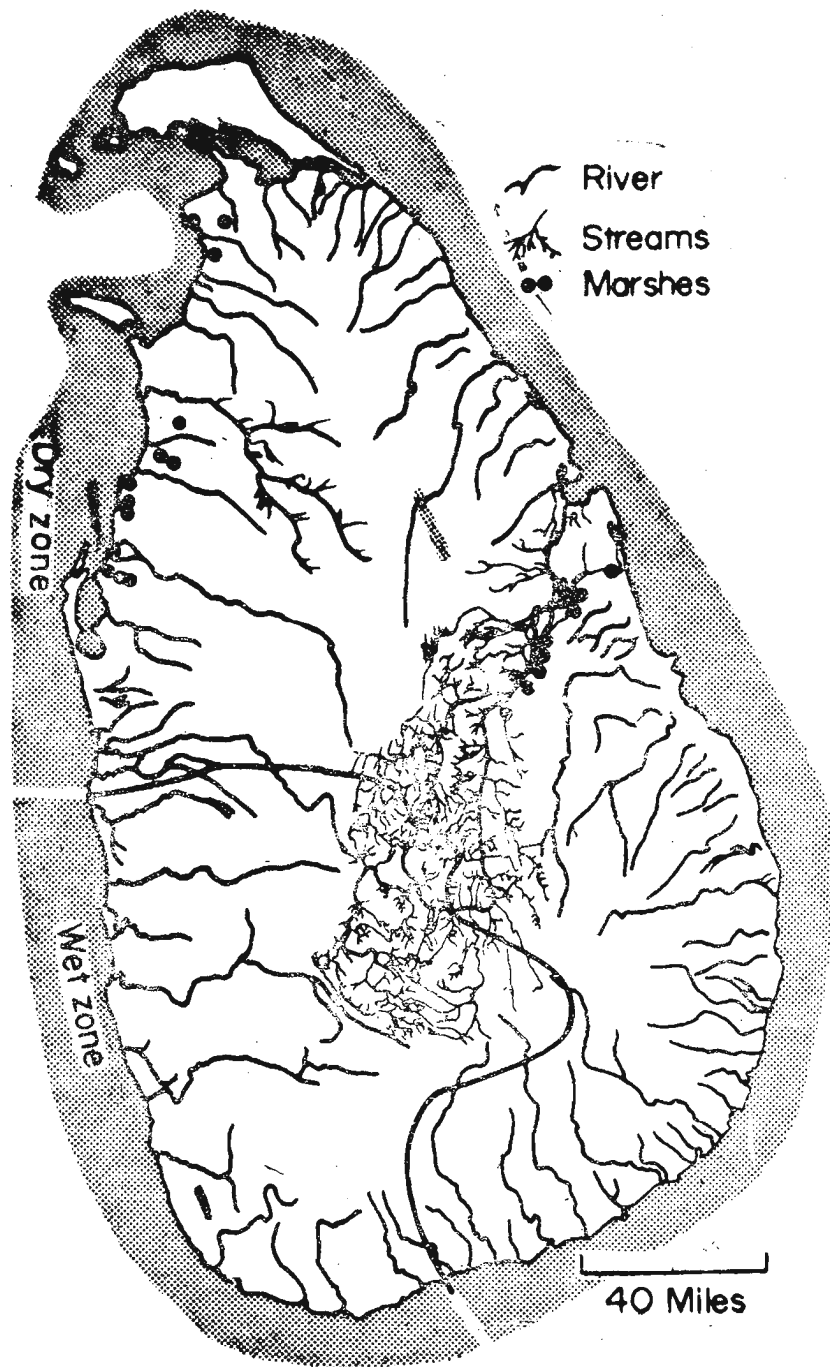


Fig. 1.— The major natural freshwater habitats in Sri Lanka. The marshes are flood lakes or "villus." Only two stream systems of rivers are shown (After Fernando, 1971).

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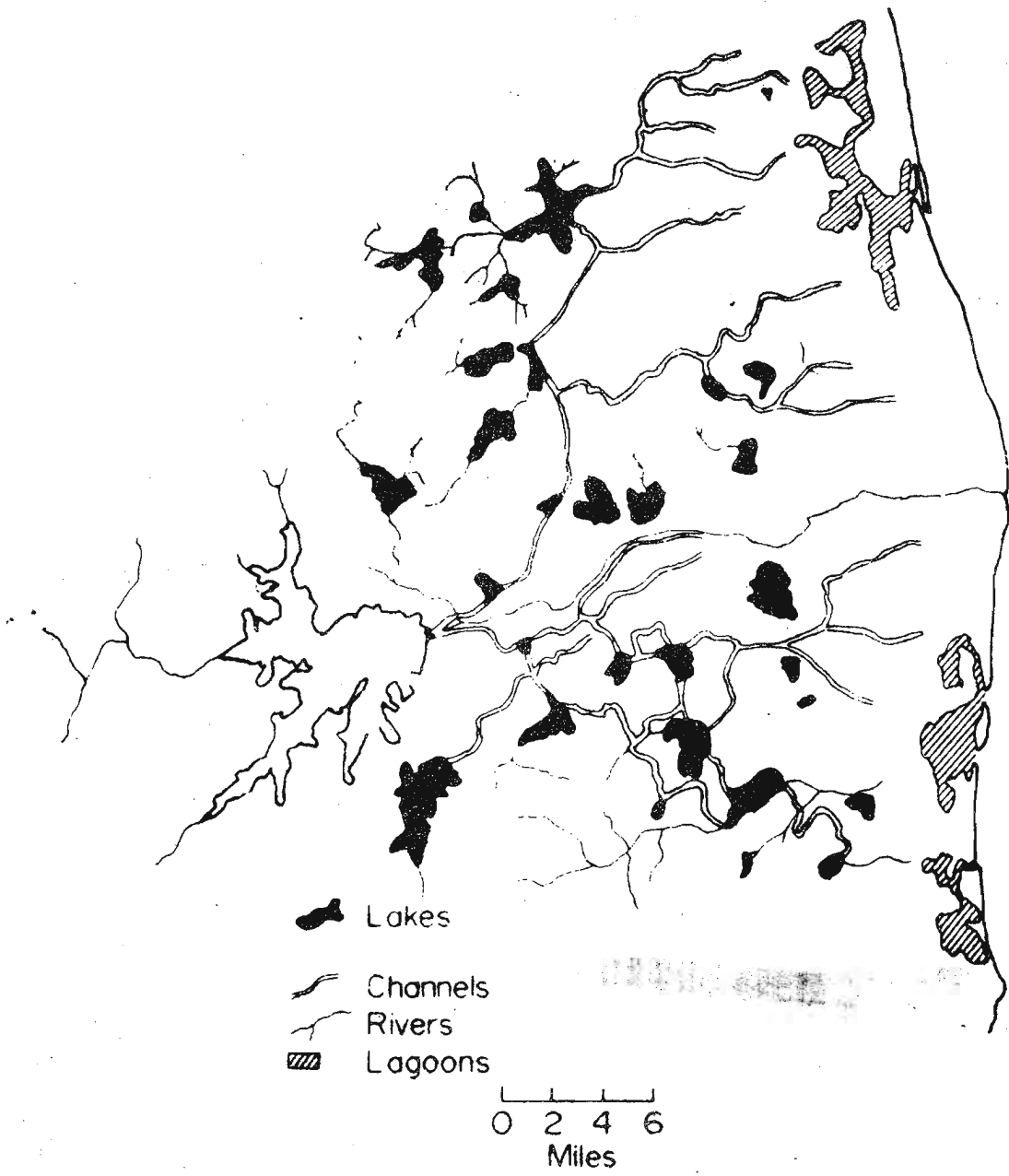


Fig. 2.— Man-made channels connecting irrigation reservoirs in the Gal-Oya multipurpose scheme. A numerous and dense network of small channels lead water in to ricefields (After Fernando, 1971).

from their fish yields. Fernando (1973) attributed the high fish yields in Parakrama Samudra (225 kg. hec. per annum) partly to cattle droppings fertilizing these waters. With the increasing use of fertilizers, both organic and inorganic, and the increase of domestic and industrial pollution, eutrophication will be accelerated. The use of biocides will have marked effects especially in ricefields.

#### Freshwater Habitats

The running waters in Sri Lanka are quite extensive (Fig. 1). Brinck et al. (1971) and Costa and Starmühlner (1972) have given accounts of the streams in some parts of the country supported by photographs. They have also given some physical characteristics of running water habitats. Fernando (1971) estimated the length of the rivers as 4,563 km. No estimate can be made of the length of streams, irrigation channels and other running waters of small size. The agricultural activities associated with irrigating rice alone accounts for a vast extent of channels. Fig. 2 gives some idea of the extent of the major channels in a multi-purpose irrigation and hydroelectric scheme.

Standing waters in Sri Lanka are man-made by and large. Fernando (1971) states that there are 10,000 man-made lakes (tanks) for irrigation of ricefields. These lakes are situated mainly in the dry zone (Fig. 3). Fernando and Indrasena (1969) have classified these lakes into five types : shallow, heavily silted ; shallow, gently sloping bottom ; shallow, undulating bottom ; deep, encompassing one valley ; and deep, encompassing several valleys. Ricefields comprise an extensive area of freshwaters albeit for limited periods of the year. Ponds of varying size and degree of permanence occur throughout the island. Some are semi-natural (natural but man influenced), others are ornamental or created by such activities as road buildings, plantations or landscaping, habitats of small surface area but deep and created by quarrying, gemming and well construction. The only standing freshwaters of any size which can be considered natural are the "villus." These are similar to the Varzea lakes described by Fittkau *et al* (1968-69) and the Reiss (1977). Brinck *et al.* (1971), Erb (1970), Costa and Starmühlner (1972) have given some background information on freshwater habitats in Sri Lanka. Fernando and Indrasena (1969) and Fernando and Ellepola (1969) have made some comments mainly on standing waters. Fernando and Indrasena (1969) have given a bibliography of previous limnological studies in Sri Lanka.

#### Freshwater Invertebrate Fauna

A comprehensive coverage of the literature on the freshwater invertebrates of Sri Lanka is given in Mendis and Fernando (1962), and Fernando (1963 a, 1964, 1969, 1974). Species lists for all groups are included. More recent records are referred to in the present paper. Table 1 summarises the status of our knowledge of the freshwater fauna of Sri Lanka. Brief notes are given for each group for invertebrates listed in Table 1.

## Protozoa

Both free-living and parasitic Protozoa have been poorly studied and many new records and new species will be added and nomenclatural changes made when detailed studies of this group are undertaken. The Sporozoa which are parasitic have gone unrecorded. There is no doubt that *Eimeria*, Myxosporidia and Microsporidia are common in freshwater fishes in Sri Lanka. Many ciliate parasites are also likely to be found.

## Porifera

This group is poorly represented in freshwaters and only two species have been recorded. It is likely that the actual number of species present is only slightly more than the present records show.

TABLE 1

Present knowledge of the freshwater invertebrates of Sri Lanka as shown by numbers of species recorded and estimated. The level of knowledge is given by categories: a. well known, b. fairly well known, c. poorly known. Some species numbers recorded are given for Malaya and Britain for comparison (Modified from Fernando 1974).

FAUNAL GROUPS	SPECIES NUMBERS					Remarks
	Category	Recorded				
		Sri Lanka Recorded	Sri Lanka Estimated	Malaya	Britain	
<b>Protozoa</b>						
Free living	.. C	.. 40	.. 150	.. —	.. —	—
Parasitic	.. C	.. 5	.. 50	.. —	.. —	No Sporozoa recorded
<b>Porifera</b>	.. B	.. 2	.. 2	.. —	.. —	—
<b>Coelenterata</b>	.. B	.. 2	.. 4	.. —	.. —	—
<b>Platyhelminthes</b>						
Rhabdocoela	.. C	.. 4	.. 10	.. 0	.. —	—
Temnocephalida	.. B	.. 4	.. 6	.. 1	.. 0	—
Tricladida	.. B	.. 2	.. 5	.. 1	.. 10	—
Monogenea	.. B	.. 21	.. 50	.. —	.. —	—
Digenea	.. C	.. 1	.. 20	.. 0	.. —	Very poorly studied in Sri Lanka
Aspidobothrea	.. —	.. 0	.. 3	.. 0	.. —	—
Cestoda	.. B	.. 3	.. 5	.. 4	.. —	—
<b>Minor Phyla</b>						
Ectoprocta	.. B	.. 4	.. 10	.. —	.. —	—
Gastrotricha	.. C	.. 2	.. 5	.. —	.. —	—
Tardigrada	.. C	.. 3	.. 20	.. —	.. —	Poorly known except in W. Europe
<b>Nematomorpha</b>	.. B	.. 3	.. 5	.. —	.. —	Few species anywhere
<b>Rotifera</b>						
Monogononta	.. A	.. 126	.. 250	.. —	.. —	—
Bdelloida	.. C	.. 3	.. 75	.. —	.. —	—
<b>Nematoda</b>						
Parasitic	.. B	.. 9	.. 30	.. —	.. —	—
Free living	.. C	.. 3	.. 300	.. —	.. —	—

Category	Sri Lanka	Recorded			Remarks	
		Sri Lanka	Sri Lanka	Malaya		
		Recorded	Estimated	Britain		
<b>Acanthocephala</b>	.. B ..	2 ..	5 ..	4 ..	— ..	—
<b>Annelida</b>						
Oligochaeta	.. B ..	31 ..	60 ..	— ..	84 ..	—
Hirudinea	.. B ..	9 ..	12 ..	10 ..	— ..	—
Branchiobdellidae	.. — ..	0 ..	0 ..	— ..	1 ..	North American in distribution
<b>Mollusca</b>						
Gastropoda	.. A ..	50 ..	55 ..	— ..	— ..	Personal communication
Pelecypoda	.. A ..	10 ..	12 ..	— ..	— ..	F. Starmühlner
<b>Crustacea</b>						
Notostraca	.. — ..	0 ..	1 ..	0 ..	— ..	—
Anostraca	.. B ..	1 ..	1 ..	0 ..	— ..	—
Conchostraca	.. B ..	3 ..	5 ..	1 ..	— ..	—
Branchiura	.. A ..	1 ..	1 ..	2 ..	— ..	—
Cladocera	.. A ..	55 ..	65 ..	60 ..	90 ..	Malaya, unpublished data.
Ostracoda	.. B ..	25 ..	45 ..	— ..	— ..	<i>Daphnia</i> spp. rare in Sri Lanka
Copepoda	.. A ..	29 ..	35 ..	— ..	— ..	—
Amphipoda	.. B ..	2 ..	4 ..	0 ..	15 ..	—
Isopoda	.. B ..	2 ..	4 ..	2 ..	5 ..	Few free-living Isopoda and Amphipoda found in tropics
Macrura	.. B ..	18 ..	22 ..	— ..	1 ..	—
Brachyura	.. A ..	8 ..	8 ..	12 ..	0 ..	—
Ripicol insects (Orthoptera)	.. B ..	5 ..	8 ..	— ..	— ..	—
<b>Insecta (larvae aquatic)</b>						
Odonata	.. A ..	112 ..	115 ..	— ..	40 ..	—
Ephemeroptera	.. C ..	18 ..	170 ..	— ..	47 ..	—
Plecoptera	.. C ..	4 ..	10 ..	— ..	30 ..	Few spp. in tropics
Neuroptera	.. C ..	0 ..	4 ..	— ..	6 ..	—
Lepidoptera	.. C ..	4 ..	6 ..	— ..	— ..	—
Trichoptera	.. B ..	184 ..	250 ..	— ..	195 ..	—
<b>Diptera</b>						
Chironomidae	.. C ..	22 ..	400 ..	— ..	380 ..	Tropical larvae very poorly known
Ceratopogonidae	.. C ..	22 ..	75 ..	— ..	— ..	—
Culicidae	.. A ..	122 ..	122 ..	— ..	— ..	—
Dixidae	.. C ..	1 ..	2 ..	— ..	— ..	—
Psychodidae	.. C ..	6 ..	10 ..	— ..	— ..	—
Simuliidae	.. C ..	5 ..	10 ..	— ..	35 ..	—
Rhagionidae	.. C ..	1 ..	2 ..	— ..	— ..	—
Blepharoceridae	.. C ..	1 ..	2 ..	— ..	— ..	Torrential larvae
Sciomyzidae	.. C ..	0 ..	2 ..	— ..	— ..	Larvae parasitic in molluscs
<b>Insecta (all stages, aquatic)</b>						
Hemiptera	.. B ..	120 ..	135 ..	110 ..	62 ..	<i>Micronecta</i> spp. 21 known
Coleoptera	.. B ..	150 ..	220 ..	160 ..	— ..	—
Hydracarina	.. C ..	39 ..	125 ..	— ..	— ..	—

### Coelenterata

Only two species of *Hydra* have been recorded. Like the Porifera, few freshwater species occur in this group. It is likely though that the rare *Craspedacusta sowerbyi* Lankester which has a dominant medusa phase occurs in Sri Lanka. This species has a rare but widespread occurrence in widely separated parts of the world. Berry and Dhaliwal (1961) recorded this species from Malaya. In India a related freshwater medusa, *Limnocnida*, has been recorded.

### Platyhelminthes

Few records of free-living Platyhelminthes are available for Sri Lanka (Table 1). Mendis and Fernando (1962) mentioned that there were no records of freshwater triclad. Ball (1970) described a new species, *Dugesia nannophallus* and revised the Oriental species. There appear to be other freshwater triclad in Sri Lanka (Ball—personal communication). De Beauchamp (1973) gives many records of *D. nannophallus* from up-country streams. Rhabdocoelae are also poorly known but in my studies of zooplankton I have noted that they are relatively common.

The ectoparasitic temnocephalids are common in freshwater macrurans. Four species are known at present. However, the genus *Temnocephala* which occurs in freshwater crabs (Potamonidae) has so far not been recorded.

Parasitic platyhelminths have received little attention so far (Table 1). However, the Monogenea are relatively well known due to the work of Gussev (1963) and Gussev and Fernando (1973). Two unusual monogeneans living in the stomach of *Etroplus suratensis* (Bloch) and belonging to the genus *Enterogyrus* were recorded by Gussev and Fernando (1973). Digenea are practically unknown from freshwater fishes in Sri Lanka. This is due to lack of studies on this group. These parasites are well represented in India. Few cestodes occur in freshwater fishes. Of the few Sri Lanka species known *Bothriocephalus gowkonensis* Yeh has probably been introduced with Chinese carp imported for culture. Many larval platyhelminths occur in or on freshwater fishes (fig. 17). There is practically no data on these organisms at present in Sri Lanka.

### Minor Phyla

Only three species of the sessile group Ectoprocta have been recorded. I have found another species, *Lophopodella carteri* (Hyatt). The Indian fauna is rich consisting of sixteen species (Wiebach, 1974). These animals because of their sedentary habit are often not recognized by zoologists. It is likely that the Sri Lanka fauna is much richer than the present records show (Table 1).

Relatively few gastrotrichs, tardigrades and Nematomorpha are on record (Table 1). Of these three groups only the Tardigrada comprise a species rich group. However, these unusual, moss dwelling forms are found mainly in the mountainous regions of the tropics. The Sri Lanka records are also largely confined to higher elevations.

The Rotifera comprise a prominent group among zooplankton, in the littoral zone of freshwater habitats and in moss. Recently, a study of Eurotatoria based on an extensive collection in Sri Lanka yielded about 140 species (Chengalath and Fernando, 1973; Chengalath *et al*, 1973; 1975). All the species recorded were illustrated and described briefly. The Bdelloidea are however poorly known (Table 1).

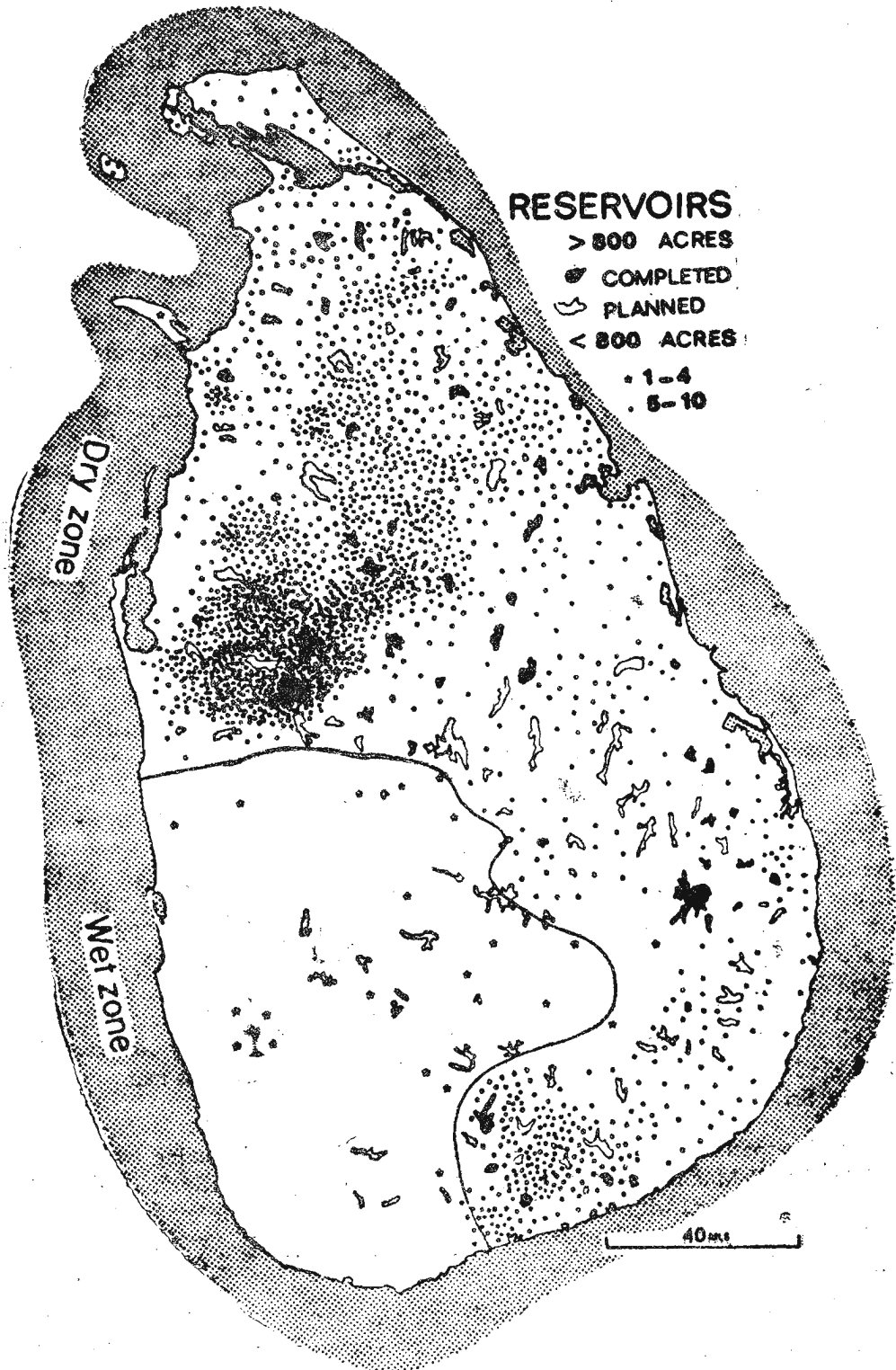


Fig. 3.—Man-made lakes in Sri Lanka (After Fernando, 1971)

### Nematoda

Both free-living and parasitic nematodes are poorly known (Table 1). It is certain that many parasitic species are unrecorded. Free-living forms are much more numerous but practically uninvestigated in Sri Lanka.

### Acanthocephala

Only two species of this aberrant group of parasites are known. They occur commonly in fishes.

### Annelida

Oligochaetes are common and numerous in the benthos. Together with the Chironomidae they form the bulk of the benthic biomass. Oligochaetes also occur sometimes in enormous numbers in polluted habitats. Although the fauna is fairly well known (Table 1), this important group deserves detailed study. Aquatic Hirudinea are common in a variety of habitats but especially in ricefields. They include *Paraclepsis vulnifera* Harding, parasitic on the gills of freshwater crabs. Surprisingly the only record of a piscicolid leech parasite in fish is that of De Silva (1963) who found a new genus *Zeylanicobdella*.

### Mollusca

Fernando (1974) predicted that the number of valid freshwater mollusc species will be reduced when more detailed studies using up to date criteria was done. This has in fact occurred (Starmühlner, 1975). Presently only 60 or so valid species comprise the indigenous freshwater fauna. One interesting find is the genus *Pisidium*. Three species have been recorded by Starmühlner (personal communication). The freshwater mollusc fauna is not very rich especially in the lowlands. The low calcium content of most freshwaters in Sri Lanka is not favourable to most Mollusca.

### Crustacea

The Crustacea comprise an important and numerous component of the freshwater fauna. The free-living forms which are by far the most numerous are mainly planktonic (Cladocera and Copepoda). Ostracoda are benthic but in the tropics planktonic forms occur too. Macrocrustaceans belonging to the families Palaemonidae, Atyidae and Potamonidae are typical of tropical freshwaters. Among the Branchiopoda, the Cladocera are relatively numerous in species (Table 1). Few species of Anostraca and Conchostraca have been recorded and no Notostraca (tadpole shrimps) are known from Sri Lanka. The Conchostraca and Anostraca are inhabitants of very temporary habitats and are commoner in the dry Northern Province especially the Jaffna Peninsula. The adjoining region of South India has many of the species recorded in Sri Lanka.

Fifty-five species of Cladocera are known from Sri Lanka including two new records, *Macrothrix shadini* Mukhamediev and *Simocephalus acutirostratus* (King). The Cladoceran fauna is typically tropical with relatively few species belonging to the genus *Daphnia* and the family Bosminidae, which dominate the zooplankton in the temperate zone. Fernando (1974) has illustrated all the species recorded up to that time and given diagnostic notes.

The Ostracoda which comprise 19 valid recorded species are quite common in ponds with vegetation. Detailed studies on material I have collected is in progress and about 45 species have been provisionally identified.

Copepoda have both free-living and parasitic representatives. In all 29 species have been recorded. This includes four parasites (Fernando and Hanek 1973). The free-living forms belong to the Cyclopoida, Calanoida, and Harpacticoida. A new genus of calanoid, *Zeylanodiaptomus* was described by Fernando and Hanek (1976). This is a very large calanoid (about 4 mm. long). Similar large calanoids are known from India and other parts of the world especially the U.S.A. *Rhinediaptomus indicus* Kiefer is a new record. This species has been well described by Rajendran (1973). Incidentally *Paradiaptomus greeni* Gurney which was described from Sri Lanka was not found in any of the numerous samples I examined. A rich fauna of *Parastenocaris* has been described by Enckell (1970).

The Branchiura, Isopoda and Amphipoda are poorly represented in the Sri Lanka fauna. The Branchiura (fish lice) are parasitic and comprise few species. In tropical freshwaters both Amphipoda and Isopoda are poorly represented. These two groups are well represented in the temperate zone both in running and standing waters. A single ectoparasitic isopod, *Alitropus typus* Milne Edw., occurs on fish.

#### Ripicol Insects (Orthoptera)

Although not considered as strictly aquatic, some "grasshoppers" and cockroaches are found in rivers and streams. They can remain submerged for considerable periods. Kaltenbahe (1973) has recorded three species from Sri Lanka, namely *Euscelimena gavialis* (Sauss.) and *Paranemobius pictus* (Sauss.) (Orthoptera), and *Rhabdoblatta* sp. (Dictyoptera). Previous records include *Rhabdoblatta terranea* Walk. and *R. subsarsa* Walk.

#### Insects with aquatic larvae

The Culicidae and the Odonata are the best studied groups as in other countries. These groups are numerous in species. Some groups are represented by few species in the tropics (Table 1). These include the Plecoptera (stoneflies), Neuroptera, Dixidae and Simuliidae. Others are represented by few species anywhere—Lepidoptera, Rhagionidae, Blepharoceridae and Sciomyzidae. Recently Reichhoff (1973) has recorded a number of larval types of aquatic moths from torrential streams. A rich ephemeropteran fauna occurs in Sri Lanka but so far their systematics is poorly documented. A large collection of larvae and adults taken by the Lund University and Vienna University expeditions is under study. A rich Trichoptera fauna is known mainly from adults. Malicky (1973) has described some larvae and larval cases.

#### True Aquatic insects

Some members of two major insect orders the Hemiptera and Coleoptera are aquatic during all stages of their life-history. The aquatic Hemiptera (Heteroptera) are represented by over 120 species (Table 1) comprising a rich and varied fauna. Four families are unusually well represented namely the Nepidae, Corixidae, Veliidae and Gerridae. The Corixidae belong almost entirely to the genus *Micronecta*. Wroblewski (1972) states that this richness of *Micronecta*

is unmatched in any other land and attributes it to intensive collecting and favourable conditions. A number of *Micronecta* species occur exclusively in running waters, others occur commonly in pools in river and stream beds. It is likely that the small stream has been a favourable and stable habitat in Sri Lanka over a long period. Other evidence for this hypothesis is the unusual richness of the interstitial harpacticoid genus *Parastanocaris* studied by Enckell (1970). The numerous weedy ponds probably serve also as a very favourable habitat for *Micronecta* and the Nepidae. The Gerridae are not as rich in species as in Malaya. Cheng and Fernando (1969) found many forest stream forms in Malaya. This habitat is much more extensive and varied in Malaya than in Sri Lanka.

Aquatic Coleoptera belong to a number of wholly aquatic groups like Dytiscidae, Hydrophilidae, Haliplidae, Gyrinidae and Elminthidae. Haliplidae are poorly represented as in all tropical regions. The Dytiscidae and Hydrophilidae are rich in species. The Elminthidae were poorly known but Deleve (1973) has recorded nine species bringing the total to 12 species records for Sri Lanka. Bertrand (1973) has described many larvae of aquatic Coleoptera including those of the semiaquatic groups Helodidae, Dryopidae, Dascillidae and Lampyridae.

#### Hydracarina (water mites)

Although water mites are very common in both standing and running waters only a small proportion of the species present in Sri Lanka have been recorded so far. The larvae of Hydracarina are parasitic on and in many aquatic invertebrates. The free-living adults are usually predatory. I found an unidentified Hydracarina larva in the oesophageal muscles of fish, *Etrophus suratensis*. This unusual location of mite larvae although probably accidental has been noted previously in the Soviet Union and U.S.A.

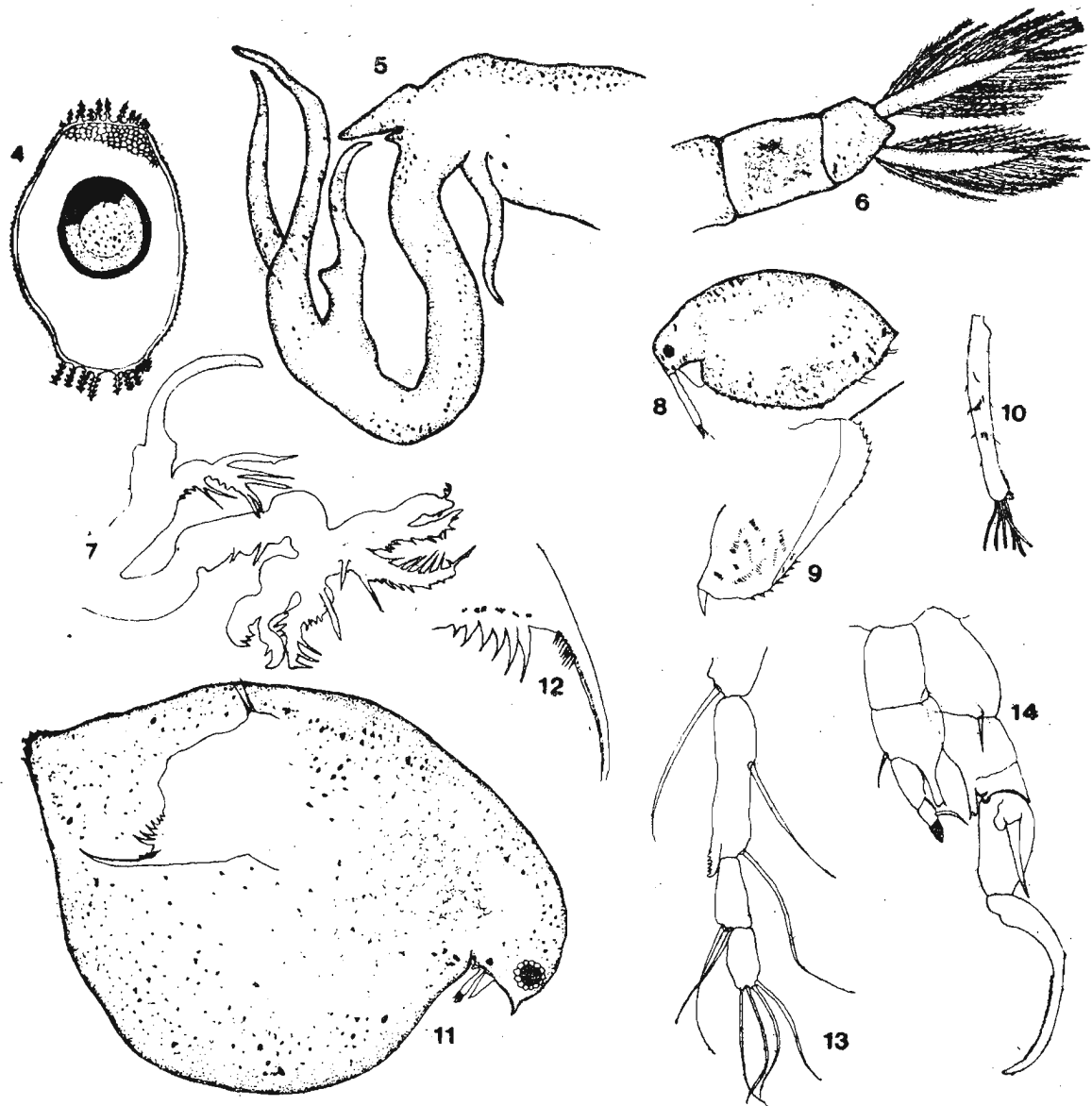
The number of recorded Hydracarina is about 40 species (Table 1). It is difficult to estimate the number of species actually present in Sri Lanka. But considering the wide variety of weedy habitats of both standing and running water types the number of species must be quite large.

#### New Records of Species

Although the freshwater fauna of Sri Lanka is relatively well known as compared to other countries in South East Asia, many species have yet to be recorded and described. This is evidenced by the numerous new species and records unearthed by the Lund and Vienna University expeditions. Fernando (1974) listed 56 new records ranging from Tardigrada to Hydracarina.

When studying collections of freshwater fauna, I came across six species hitherto unrecorded ; — *Lophopodella carteri* (Hyatt) (Ectoprocta), *Branchinella kugenumaensis* Ishikawa and *Streptocephalus dichotomus simplex* Gurney (Anostraca), *Simocephalus acutirostratus* (King) and *Macrothrix shadini* Mukhamediev (Cladocera) and *Rhinedioptomus indicus* Kiefer (Copepoda).

*Lophopodella carteri* (Fig. 4) is a widely distributed ectoproct. It has a characteristic spinoblast. *Branchinella kugenumaensis* is easily recognized by its much branched second antenna and characteristic frontal appendage (Fig. 7). *Streptocephalus dichotomus simplex* differs from the other *Streptocephalus* species known from Sri Lanka, *S. spinifer* Gurney, in that the posterior segments of the male do not bear spines and the second antenna has its main finger branched (Figs. 5 and 6). Both these Anostracans are described by Bernice (1973). *Simocephalus acutirostratus* can be separated from all other species of the genus by its acutely



Figs. 4-14—New records of freshwater invertebrates from Sri Lanka. 4, Spinoblast of *Lophopedolla careri* from drawing by M. Wiebach; 5, 6, *Streptocephalus simplex*, 5, Antenna 2 of male; 8, Posterior portion of male; 7, *Branchinella kugenumaensis*, Antenna 2 and dorsal appendage of male; 8-10, *Macrothrix shadini*; 8, Parthenogenetic female; 9, Postabdomen of same; 10, Antennule of same (After Mukhamediev 1963); 11-12 *Simocephalus acutirostratus* 11, Parthenogenetic female; 12, Part of postabdomen showing claw and basal pecten; 13-14, *Rhinediaptomus indicus*; 13, Terminal portion of male Griefantenna; 14, Leg 5 of male.

pointed head (Fig. 11). It also has a basal pecten in the postabdominal claw (Fig. 12). This species has been well described by Sars (1896). *Macrothrix shadini* was described from the Soviet Union by Mukhamediev (1963). It can be diagnosed by the structure of the antennule and the postabdomen. *Rhinediaptomus indicus* a common species in South India has been described adequately by Rajendran (1973). The diagnostic fifth leg of the male and the terminal portion of the "Griefantenna" are illustrated (Figs. 13 and 14).

Locality data for these new records are as follows : *Lophopodella carteri*, Udawalawe Reservoir, 7. VII. 74. Collector P. B. Fernando : *Branchinella kugenumaensis*, Vaddukoddai, pond 1974. Collector R. Selvarajah : *Streptocephalus dichotomus simplex*, Nochchiyagama (Rambewa) Nr. Anuradhapura 15. VI. 74. Collector P. B. Fernando : *Simocephalus acutirostratus*, Kekirawatank, Kekirawa. 16. VI. 74 : *Macrothrix shadini*, Pond, Marawila 1. VIII. 73. Collector P. B. Fernando for both samples. *Rhinediaptomus indicus*, "Jaffna" 1974. Collector R. Selvarajah.

### BIOGEOGRAPHY

Two recent papers deal with the broad aspects of the biogeography of the Indian Region. Croizat (1968) has given a rather unorthodox account which is nevertheless very penetrating and pertinent. He considers form-making and combination important factors and dispersal in the traditional sense as unimportant in analysing faunal distributions. Mani (1974) considers the fauna as consisting of Gondwana elements and intrusive elements of Tertiary and later ages of Malaysian, Indo-Chinese and Palaearctic origin. Freshwater fauna by and large belongs to groups which were prominent and widely distributed before the Tertiary. Hence a high proportion of Gondwana forms are to be expected.

The role of birds in the transport of resistant stages of freshwater fauna has been reviewed by Theinemann (1950) and Löffler (1963). Recent faunal introductions in historical times have occurred with rice seeds (Fernando 1977). Fish parasites have been introduced with foreign fishes to Sri Lanka (Fernando and Hanek 1973). Fox (1965) and Ghetti (1973) have recorded over twenty species of extra-European Ostracoda introduced into Italian ricefields.

Gondwana distributed forms found in Sri Lanka, Africa and South America are quite common among freshwater species, eg., *Lophopodella carteri* (Ectoprocta), *Cyclestheria hislopi* (Baird) (Conchostraca), *Ilyocypris* (Ostracoda). Also many species are common to Africa and Sri Lanka, e.g., *Paradiaptomus greeni* (Copepoda) and *Oncocypris* (Ostracoda). Edmunds (1972) cites the genus *Kimminsula* found in Sri Lanka as a Gondwanaland genus.

No detailed analysis of the biogeography of the freshwater fauna of the Oriental region has been undertaken so far. With the rapid accumulation of systematic data this task is now possible.

Endemism of freshwater forms has been commented upon by some recent workers in groups where the systematics is well worked out. Lieftinck (1965) found no generic endemism and a low species endemism in the dragonfly fauna of Sri Lanka. The work of Wroblewski (1972) shows a high endemism in the genus *Micronecta* in Sri Lanka. Of the 55 freshwater fishes 9 are endemic to Sri Lanka. These like the *Micronecta* are inhabitants of small streams.

Mani (1974) commented on the massive destruction of natural habitats brought about by deforestation in India. Fernando (1977) on the basis of evidence of faunal diversity in ricefields in South India and Sri Lanka concluded that the elimination of marshes in South India could account for the lower faunal diversity in South Indian ricefields. In Sri Lanka, man has

created a large number of new types of natural habitats (Lakes). Also man activities have altered the existing natural habitats. The small stream habitat in Sri Lanka seems to have been the most favourable for evolution of small stream fishes, stream dwelling *Micronecta* spp. and interstitial *Parastamoacaris*. The streams however do not reflect a high degree of suitability for the forest stream Gerridae. Cheng and Fernando (1969) found a richer gerrid fauna in forest streams in Malaysia. It is possible that the recent destruction of forests can account partly for this difference but the Malayan rain forest may be a more suitable situation for these gerrid species. The new niches created by man-made lakes have already been demonstrated for fishes (Fernando 1971, 1973). Perhaps invertebrate introductions will also "take" in these habitats.

## ECOLOGY OF THE FRESHWATER FAUNA

Although there is now a considerable accumulation of data on the systematics of the freshwater invertebrate fauna ecological studies are still very meagre. I shall review the literature on the ecology of running waters and discuss standing water based on previous work and my own investigations. I shall also deal specifically with the aquatic fauna of ricefields and freshwater fish parasites.

### Running Waters

Rivers and streams comprise the major portion of natural freshwaters in Sri Lanka (Fig. 1). In addition, man-made channels for irrigation are quite common and extensive in most parts of the country (Fig. 2). Running waters of very diverse type are found. These include torrential, fast flowing and slow flowing streams. Temporary streams are quite common. Rivers of varying size and discharge characteristics occur. Some rivers are quite shallow and sandy. Others are deep and muddy. Many rivers dry up during the intermonsoonal period leaving only small collections of water on their beds. Some details of the physical and chemical characteristics and the fauna in running water are given in Brinck *et al.* (1971), Costa and Satrmühlner (1972) and Weninger (1972). Faunal studies which include ecological notes have been based on the material collected by the Lund University in 1962 and the Austrian—Ceylonese hydrobiological mission in 1970. Most of these papers are referred to earlier in the section on the freshwater fauna. Costa and Fernando (1967) studied the feeding relationships of the meso— and macrofauna of a small mountainous stream. The Sri Lanka running water fauna is rich and varied. Flood and drought affect many running waters dramatically and faunal recolonization must play an important part in maintaining the fauna. There is at present a considerable amount of literature on the ecology of running waters in the tropics. The comprehensive work of Hynes (1970) covers this subject on a worldwide basis. Fittkau *et al.* (1968-69) deal with Amazonian freshwaters and Bishop (1973) has done a monograph on the ecology of a small Malaysian river. The running waters of Sri Lanka offer a wide scope for research in ecology now that a fair proportion of the fauna has been worked out taxonomically.

### Standing Waters

Practically all the standing freshwaters in Sri Lanka are man-made or man-influenced to a high degree. Irrigation reservoirs of which there are about 10,000 listed (Fig. 3) form the major area of standing waters. These "reservoirs" vary in surface area from a few to about 7500 hectares. About 50 of these reservoirs have a surface area of over 300 hectares. The few flood lakes or villus are shallow expanses of water connected to rivers. Their levels vary with river level and they are similar to the Varzea lakes in the Amazon basin. Fittkau *et al.*

1968-69 have described these Amazonian lakes. There is some saline intrusion into coastal standing waters but since tides are small this influence is not great. Ponds of varying permanence are a feature of almost any Sri Lankan landscape. Some of these are semi-natural. Others have been formed by man's agricultural or road building activities. Fernando and Indrasena (1969) have given an account of standing waters and a bibliography of biological studies on these habitats in Sri Lanka. These include the earliest limnological studies by Apstein (1907, 1910) and more recent investigations by Holsinger (1955a, 1955b), Mendis (1964, 1965), Costa and De Silva (1969), Fernando (1965) and Fernando and Ellepola (1969). The ricefield fauna has been studied by Weerakoon (1957), Weerakoon and Samarasinghe (1958), Fernando (1977). Fernando and Furtado (1975) have compiled a bibliography of references to ricefield fauna. The fauna of temporary habitats have been investigated by Fernando (1959, 1960, 1963b) with special reference to colonization.

During the period 1968-1976 I collected and studied over 450 samples from 319 freshwater habitats in different localities in Sri Lanka. The localities and types of habitats are shown in Fig. 15. Samples were taken in the small habitats with 20 cm. mouth diameter plankton nets and with 25 cm mouth diameter plankton nets in the larger habitats. Two mesh sizes 25 ( $64\mu\text{m}$ ) and 10 ( $157\mu\text{m}$ ) were used in each habitat usually and the collections pooled and preserved in 10 % formalin.

In all about 140 Rotifera, 55 Cladocera and 29 Copepoda species were identified. They have all been described and illustrated in Chengalath and Fernando (1973), Chengalath et al. 1973, 1975 and Fernando (1974). 379 of the samples (those collected upto 1973) were analysed in detail. This analysis is presented in Table 2. Besides the species of zooplankton (Rotifera, Cladocera and Copepoda), I have analysed the non-arthropod groups, e.g., Protozoa, Ectoprocta, Oligochaeta and the other arthropod groups, e.g. Decapoda, Ephemeroptera. Each occurrence of a group is considered a single record irrespective of the number of individual species.

Rivers and streams have the lowest percentage of the total fauna. Small lakes have the highest percentage followed by ponds. Ricefields and miscellaneous man-made habitats are poorer in species and groups, while larger lakes and villus have poorer faunas than small lakes and ponds. These results refer mainly to fauna in the water column, among vegetation and on the surface of the bottom. The poor plankton fauna in streams and rivers is to be expected. Ricefields are subjected to mechanical interference and induced drying and flooding. These activities retard the orderly development of the fauna. Villus are subjected to sudden changes in the water level. This causes exposure and flooding with consequent interference with animal life especially in the littoral zone. Large lakes have less littoral area and consequently are poor in littoral fauna. Ponds and small lakes offer the widest range of niches for the fauna.

Certain general features in the species composition of the zooplankton stand out clearly. Limnetic plankton is poor in species and only three Cladocera, *Ceriodaphnia cornuta* Sars, *Moina micrura* Kurz and *Diaphanosoma excisum* Sars are at all common. *Diaphanosoma sarsi* Richard and *Chydorus barroisi* Richard are also found but less commonly. Only two Cyclopoids, *Mesocyclops leuckarti* (Claus) and *Thermocyclops crassus* (Fischer) (= *hyalinus*) occur regularly. No calanoid can be considered as common but *Phyllodiaptomus annae* (Apstein) occurs most often. All the limnetic zooplankton are among the commoner species in the littoral and in ponds. *Daphnia* spp. are very rare indeed. Of the two species in Sri Lanka one, *Daphnia cephalata* King, was found only in two very small ponds. The other *D. humholtzi* Sars occurred in less than 5% of the samples examined in very small numbers. *Daphnia* spp. form a dominant group in zooplankton in temperate regions. A more detailed analysis of the zooplankton is in that of Fernando (1980).



Fig.15.— Localities in Sri Lanka where zooplankton samples were collected during 1968—1974 (After Fernando 1979).

In any programme of fish culture or introduction, the relative paucity of zooplankton must be taken into account. However, till studies on secondary production are done, no estimate of the biomass of zooplankton available is possible. Zooplanktonivorous fish are not common in tropical freshwaters. Phytoplankton and macrophyte feeding fishes are much commoner together with insectivorous forms.

Some general comments can be made on faunal groups and particular habitats. Rhabdocoeles are relatively common, while ectoproct resting stages are rare. Temporary habitats especially in the Northern dry zone are rich in Conchostraca and Anostraca.

#### **Ricefield ecology**

Ricefields cover extensive areas in Sri Lanka (0.65 million hectares). They serve as habitats for a wide range of aquatic invertebrates which are planktonic, nektonic and benthic in habit. Ricefields besides producing the staple cereal crop in Sri Lanka have a potential for fish culture. Also the aquatic invertebrates play an important role in influencing the yield of rice directly by acting as pests or indirectly by positive or negative effects on the yield through their biological activities. Fernando (1977) has discussed the ecology of ricefields in South East Asia, and Fernando and Furtado (1975) have compiled a bibliography of references to the aquatic fauna of ricefields in the world. A diagrammatic representation of the ricefield eco-system is shown in Fig. 16.

The ecology of Sri Lanka ricefields has not been investigated to any great extent as is the case elsewhere, but Weerekoon (1957) and Weerekoon and Samarasinghe (1958) studied the fauna and the population dynamics and density of the aquatic benthic fauna. From data collected in South East Asian rice-fields, I compiled Table 3. It gives the relative diversities of ricefield faunas in some South East Asian countries. The Sri Lankan ricefield fauna is diverse as compared to that of South Indian ricefields. This is attributable partly at least to the lack of refuges in the form of marshes in South India. Marshes constitute an integral part of the natural ecosystem where many aquatic species can survive and recolonize areas where the fauna has been eliminated by adverse conditions. Table 2 gives the faunal diversity of ricefields as compared with other freshwater habitats. The diversity is lower than that of small lakes and ponds. This is due to the temporary nature of the ricefield habitat and the interference caused by ploughing and irrigation.

The biological activities of the aquatic invertebrates in ricefields have been shown to have beneficial effects on the yield of rice through weed control and organic enrichment. Biological control of some pests may also be possible using aquatic invertebrates. The study of the ecology of the ricefield may, therefore, have some important practical benefits.

#### **Freshwater fish parasites**

A wide spectrum of invertebrates parasitise freshwater fishes. Some of them cause epizootics both in wild and cultured fishes. The role of fish parasites in tropical freshwaters has, however, been poorly investigated. With the growing importance of freshwater fish as human food in South East Asia, fish parasitology will no doubt assume an important role. Fig. 17 shows the types of parasites and their location in fish. Fernando *et al.* (1972) have produced a manual on the methods used in the study of fish parasites. Some common parasites are also illustrated.

The introduction of foreign fish species for culture or into open waters often results in the introduction of fish parasites too. Fernando and Furtado (1963) and Fernando and Hanek (1973) have shown that cestodes and parasitic copepods have been introduced into Sri Lanka freshwaters with imported fish. Strict quarantine measures can prevent further parasite introductions.

**DIAGRAM OF RICEFIELD ECOSYSTEM**

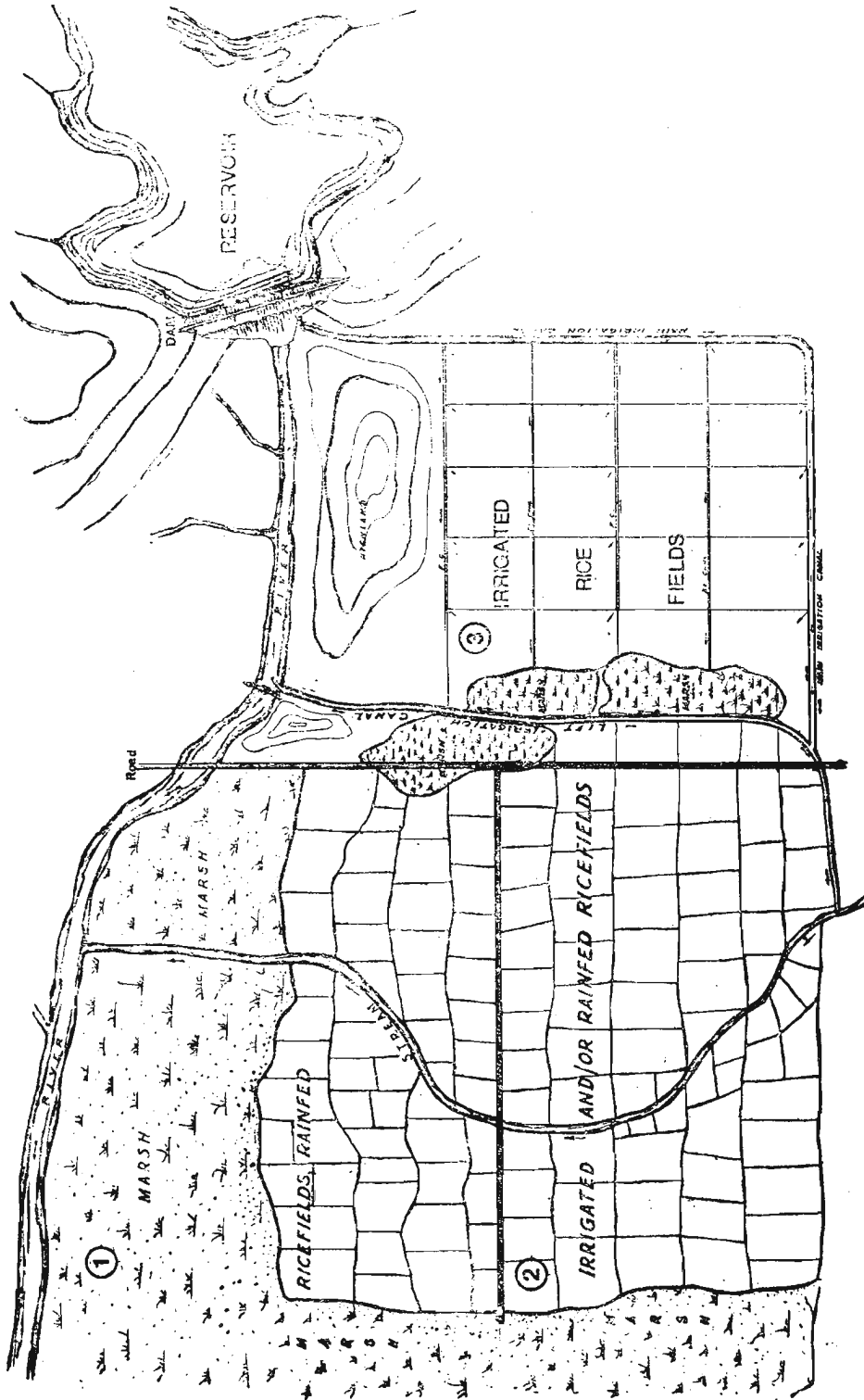


Fig. 16. — Diagram of the ricefield ecosystem (After Fernando, 1977).

**Table 2.—Aquatic faunal composition of ricefields and other habitats in Sri Lanka  
—(Data 1968–1973)**

Habitat		No. Species and Groups						Samples Examined	% Species and Groups	
		Rotifera	Cladocera	Cyclopoida Harpacticoida	Calanoida	Non-Arthropod Phyla (Groups)	Arthropods: other Crustacea and Orders		Habitat	Sample
Villus (Marshes)	Total	35	23	4	4	5	6	9	33	10.1
	Av. Range	9.6 4–21	7.2 4–11	1.5 1–2	1.2 0–3	2.2 0–4	2.0 1–4			
Ponds	Total	86	46	10	7	5	7	71	68	8.7
	Av. Range	9.4 0–30	5.5 0–13	2.1 0–5	0.7 0–3	1.2 0–5	1.6 0–6			
Rice Fields	Total	67	38	14	3	4	6	49	56	9.0
	Av. Range	8.0 0–36	6.6 1–15	2.6 0–8	0.3 0–2	1.2 0–4	2.2 0–5			
Lakes > 300h	Total	56	25	8	7	5	7	90	46	7.1
	Av. Range	8.8 0–25	4.1 0–13	1.6 0–4	1.3 0–3	0.4 0–4	0.6 0–5			
Lakes < 300h	Total	107	41	8	8	6	7	122	76	7.1
	Av. Range	8.9 0–29	3.9 0–16	1.4 0–4	0.9 0–4	0.9 0–6	0.6 0–4			
Misc.Habitats (Man Made)	Total	72	34	10	3	5	6	32	55	8.1
	Av. Range	8.8 1–21	4.6 0–14	2.4 0–6	0.4 0–2	1.3 0–5	1.5 0–3			
Rivers, Streams	Total	37	12	4	1	3	6	6	27	7.3
	Av. Range	9.8 2–19	2.8 0–6	1.7 0–2	0.5 0–1	1.0 0–2	1.3 0–5			
								Total	Average	
Total No. Spp./Group Sri Lanka		136	51	15	9	12	11	379	52	8.1

Occurrence of species of Rotifera, Cladocera and Copepoda and groups (Phyla) of non-Arthropoda eg. Protozoa, Annelida and Arthropoda groups : other Crustacea eg. Conchostraca, Palaemonidae, and Arthropoda orders eg. a Coleoptera, Hydracarina (from Fernando, 1977).

**Table 3.—Faunal composition of rice fields in South-East Asia (Data 1968-1974)**

No. Species and Groups		Rotifera	Cladocera	Cyclopoida Harpacticoida	Calanoida	Non-Arthropod Phyla (Groups)	Arthropoda : Other Crustacea and Orders	No. Samples Examined	Remarks
<b>Area</b>									
<b>Philippines</b>									
(a) Insecticide	Total	2	2	2	0	3	3	13	Fauna poor, Ostracoda dominant
	Av.	0.3	0.1	0.5	0	0.5	1.1		
(b) No Insecticide	Total	39	11	6	1	3	8	20	Cladocera few
	Av.	10.1	1.8	1.7	0.1	1.2	2.7		
<b>Burma (Rangoon)</b>									
	Total	9	14	5	1	3	5	2	Fauna diverse
	Av.	6.5	10.5	2.5	1.0	2.0	4.0		
<b>Indonesia N. Borneo</b>									
	Total	24	20	6	2	7	6	11	Fauna average
	Av.	6.6	3.9	1.7	0.5	2.4	1.8		
<b>S. India</b>									
	Total	14	11	4	2	4	5	8	Fauna not diverse
	Av.	3.0	2.9	1.7	0.3	2.3	2.3		
<b>W. Malaysia</b>									
	Total	56	40	10	3	6	7	45	Fauna diverse
	Av.	7.6	8.1	2.8	0.1	2.2	2.5		
<b>Sri Lanka</b>									
	Total	67	38	14	3	4	6	49	Fauna diverse
	Av.	8.0	6.6	2.6	0.3	1.2	2.2		

Occurrence of species of Rotifera, Cladocera and Copepoda and groups (Phyla) of non-Arthropoda eg Protozoa, Annelida and Arthropoda groups : other Crustacea eg. Conchostraca, Palaemonidae and Arthropoda orders eg. Coleoptera, Hydracarina (From Fernando, 1977).

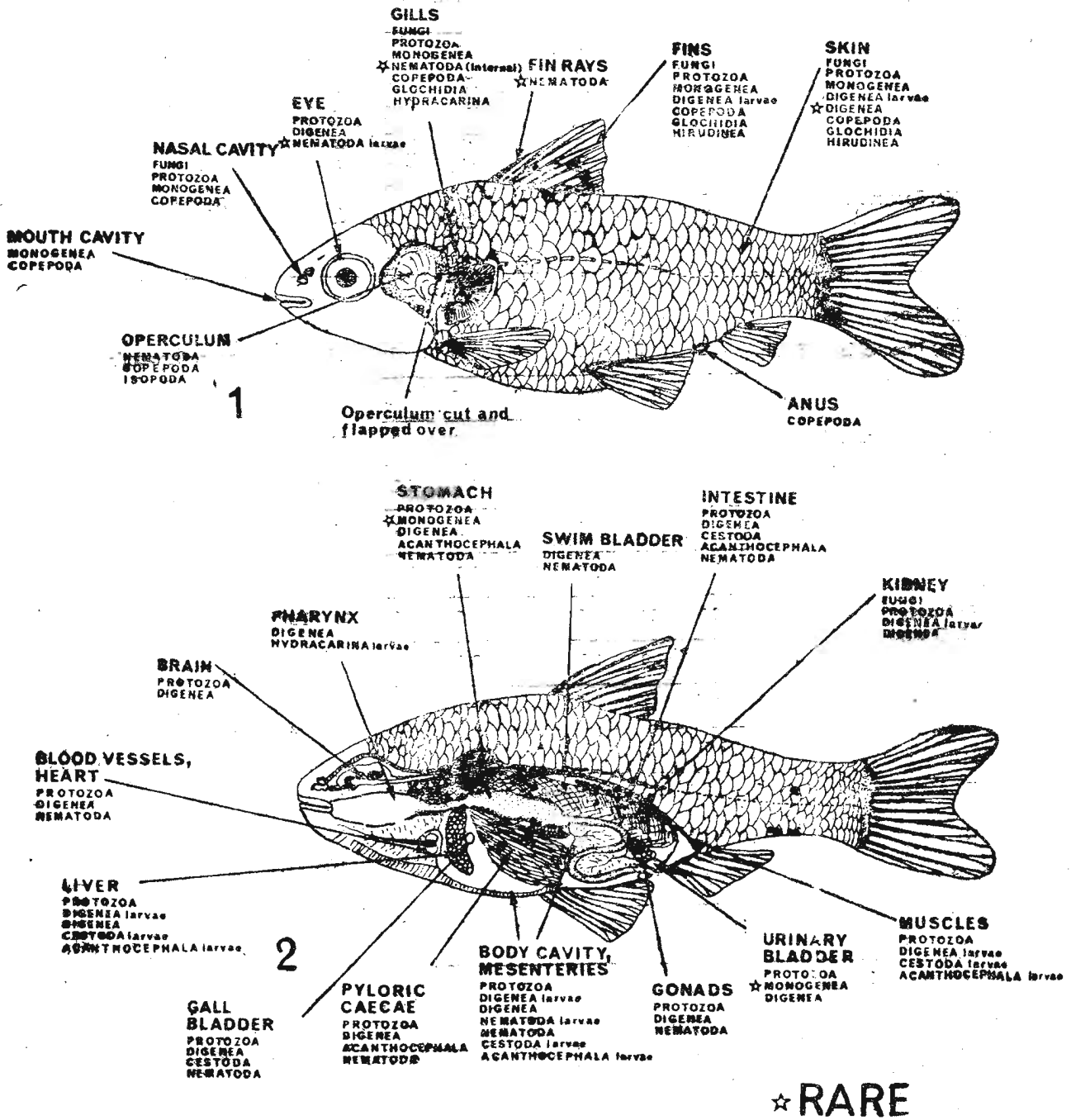


Fig. 17—Diagram showing location of the different groups of parasites in a freshwater fish. (After Fernando, *et al* 1972).

### Summary and Discussion

The freshwater fauna of Sri Lanka is better known taxonomically than that of any other country in South East Asia. Perhaps it is better known than that in any other tropical country in the world at present. There is available a comprehensive coverage of the fauna in "*A guide to the freshwater fauna of Ceylon*" and its four supplements. Many recent papers on freshwater invertebrates have been based on material collected by the Lund University and the Austrian-Ceylonese hydrobiological expeditions to Sri Lanka and my own collections. However, many freshwater invertebrates remain unrecorded and undescribed. The ecology of the freshwater invertebrates in the various aquatic ecosystems is still in its infancy in Sri Lanka. With increasing knowledge of the fauna, such investigations will become more and more feasible.

The freshwater invertebrate fauna of Sri Lanka is rich and varied. It is typical in composition for a tropical continental island. Biogeographically there is a strong Gwondwana component with affinities mainly with South India, Africa and Malaysia. The mountain stream fauna is similar to that of the fauna in similar situations in India. A detailed biogeographic analysis of the fauna is now possible. This should give some interesting results of the distribution of individual species and groups of invertebrates.

Freshwater habitats are varied and numerous. Although most habitats are either man-made or man influenced there is still a relatively rich invertebrate fauna. The small stream habitat seems to have been the most favourable. It has many endemics. Man-made lakes are now of considerable economic importance for fish production. The study of their limnology is, therefore, of practical value. Limnological studies are now more feasible with the increased knowledge especially of the zooplankton. Benthic animals, however, remain poorly known. Two other areas of study having practical implications are the ecology of ricefields and the role of fish parasites. With the increase of population, human influence on freshwater habitats has increased dramatically. The effects of pollution on the freshwater fauna is an added hazard. The result of these cumulative influences will be to reduce the diversity of the fauna. Attempts must be made to keep these destructive effects as low as possible.

Sri Lanka is perhaps ripe for the establishment of a centre for the study of tropical limnology and fisheries. The freshwater fauna is relatively well known and there is an abundance of different types of running and standing waters. Because of its small size and good system of roads, access to most parts of the country is easy. Much of the past work on systematics and ecology of the freshwater fauna has resulted from the exertions of scientists outside the country. While sophisticated systematics might still be limited due to lack of local expertise and facilities, ecological work can only be done thoroughly in the local setting. Sri Lanka possesses an abundance of freshwater resources. The potential for food production and recreation of these resources can be exploited by sound ecological work and scientific management.

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#### Addendum

Dr. D. M. Davies, McMaster University, Hamilton, Ontario brought to my notice two papers on Simuliidae which are relevant to this paper :

Croskey, R. W. (1974) — "Family Simuliidae in A catalogue of Diptera of the Oriental region." Vol. 1. Suborder Nematocera by Delfinado M. D. and Hardy, D. E., pp. 1-618. Univ. Hawaii. Press.

Davies, L. (1968) — A key to the British species of Simuliidae (Diptera) in the larval, pupal and adult stages. F.B.A. Scientific Publications 24, 125 pp.

Dussart (1974) has reviewed the ecology of inland waters of South East Asia. The Sri Lanka fauna is mentioned a number of times. Unfortunately the more recent work has not been incorporated. The review nevertheless is a useful addition to the meagre contributions at present to the freshwater ecology of this region :

Dussart, B. H. (1974) — "Biology of inland waters in humid tropical Asian Natural Resources Research " UNESCO 12, 331-353.

One of the papers inadvertently omitted is Fernando, C. H. (1960), "The freshwater crabs (Potamonidae)," *Ceylon J. Sci. (Bio. Sci.)*, 3, 191-222. This paper deals with the ecology of the Sri Lanka species. There are relatively few papers on the ecology of this group anywhere in the world. In Sri Lanka ecological studies on freshwater fauna are still very meagre, hence this paper is worth noting.

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