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DEPARTMENT OF FISHERIES, CEYLON

Bulletin No. 12

A GUIDE TO THE FRESHWATER FAUNA OF CEYLON

BY

A. S. MENDIS
(Research Officer, Department of Fisheries, Ceylon)

AND

C. H. FERNANDO
(Lecturer in Zoology, University of Singapore)

Illustrations by
G. D. KARIYAWASAM
(Artist, Department of Fisheries, Ceylon)

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CONTENTS

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

2——R 19576—1,008 (9/61)

ADDITIONS AND CORRECTIONS

Page 35	*Euchlanis dilata*	should read		*Euchlanis dilatata*
	Colurus bicuspidatus Ehrb.	,,	,,	*Colurella bicuspidata* (Ehrb.)
	Colurus uncinatus Ehrb.	,,	,,	*Colurella uncinata* (Ehrb.)
	Metopidia lepadella Ehrb.	,,	,,	*Lepadella accuminata* (Ehrb.)
	Metopidia ovalis Ehrb.	,,	,,	*Lepadella ovalis* (Müller)
	Metopidia triptera	,,	,,	*Lepadella triptera* Ehrb.
	Coelopus tenuior Gosse	,,	,,	*Dilurella tenuior* (Gosse)
Page 36	*Euchlanis dilata*	,,	,,	*Euchlanis dilatata*
	Coelopus tenuior	,,	,,	*Dilurella tenuior*
	Colurus bicuspidatus	,,	,,	*Colurella bicuspidata*
	Anuraea	,,	,,	*Keratella*
Page 38	*Brachionus falcatus* Bär	,,	,,	*Brachionus falcatus* Zacharias

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 ungulata (Gosse)

Add reference : Hauer, J. 1937. Die rotatarien von Sumatra, Java und Bali nach der Ergebnissen der Deutschen Limnolagischen 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-Inselen. *Arch. Fur Hydrobiol.* 15 : 109–118.

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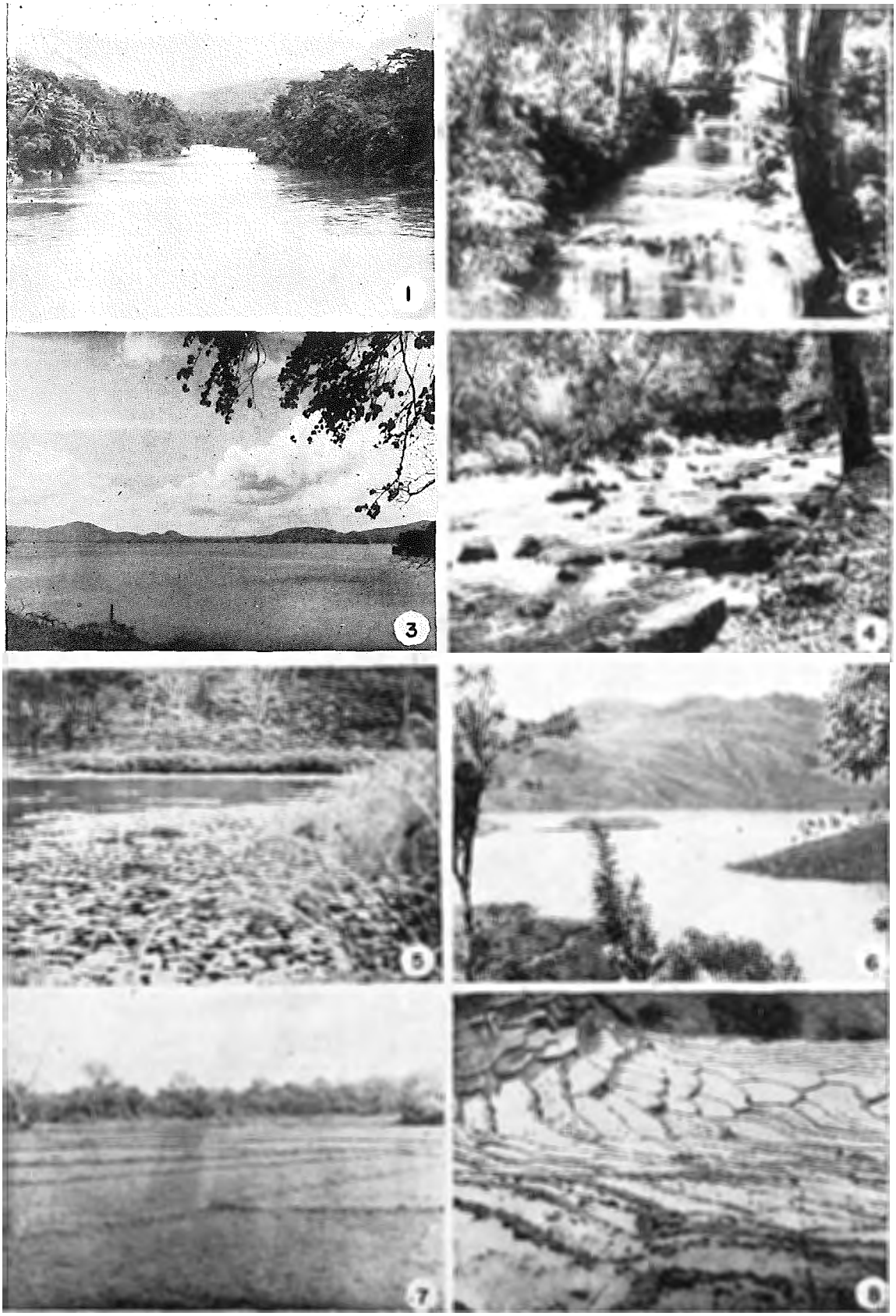
Page 71 Add to list of *Caridina*:

Caridina gracilirostris De Man

Caridina nilotica zeylanica Arud. and Costa



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.

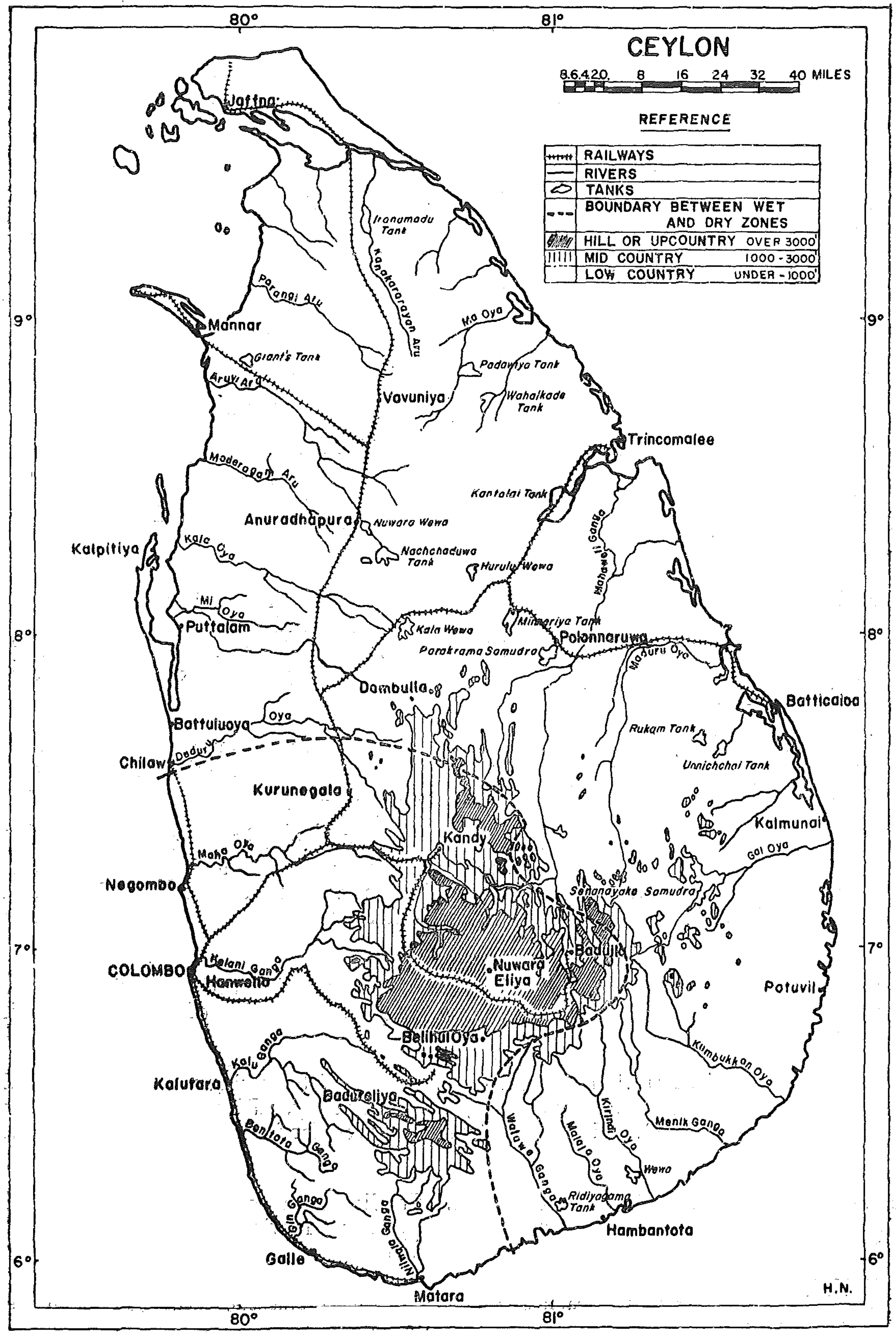
Irrigation reservoirs or lakes have been formed by damming small rivers and streams or by channelling the water from larger rivers. The larger irrigation reservoirs (or tanks as they are commonly called in Ceylon) are perennial and rarely dry up. There are hundreds of smaller reservoirs scattered throughout 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).[1] (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 Aravi) (Page 5, Fig. 4), to more or less stationary types in the low country.

[1] The Sinhalese (S) and Tamil (T) local names are given within brackets. The format will be repeated throughout this publication.



CEYLON
8 6 4 2 0 8 16 24 32 40 MILES
REFERENCE
RAILWAYS
RIVERS
TANKS
BOUNDARY BETWEEN WET AND DRY ZONES
HILL OR UPCOUNTRY OVER 3000'
MID COUNTRY 1000 - 3000'
LOW COUNTRY UNDER - 1000'
80°
81°
9°
8°
7°
6°
Jaffna
Iranamadu Tank
Kanakarayan Aru
Parangi Aru
Ma Oya
Mannar
Giant's Tank
Aruvi Aru
Vavuniya
Padaviya Tank
Wahalkada Tank
Trincomalee
Moderagam Aru
Kantalai Tank
Anuradhapura
Nuwara Wewa
Nachchaduwa Tank
Huruluwewa
Kalpitiya
Kala Oya
Mahaweli Ganga
Mi Oya
Minneriya Tank
Puttalam
Kala Wewa
Parakrama Samudra
Polonnaruwa
Maduru Oya
Dambulla
Batticaloa
Battuluoya
Deduru Oya
Rukam Tank
Chilaw
Unnichchai Tank
Kurunegala
Kandy
Kalmunai
Maha Oya
Gal Oya
Negombo
Senanayake Samudra
Badulla
COLOMBO
Kelani Ganga
Hanwella
Nuwara Eliya
Potuvil
Belihul Oya
Kalu Ganga
Kumbukkan Oya
Kalutara
Baduraliya
Menik Ganga
Bentota Ganga
Walawe Ganga
Kirindi Oya
Malala Oya
Wewa
Gin Ganga
Nilwala Ganga
Ridiyagama Tank
Hambantota
Galle
Matara
H.N.

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 testudinius* (S. Kavaiya), *Ophiocephalus* spp. (S. Loola, Mada Kanaya), *Clarias teysmanni* (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
Wallago attu (S. Valaya) ..	P	P	B		
Labeo dussumieri (S. Hiri kannaya) ..	P	P	P	B	
Ophiocephalus striatus (S. Loola) ..	P	P	P	P	P
Macrones vittatus (S. Iri ankutta) ..	P		P	P	P
Puntius vittatus (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 *Etroplus*, *Osphronemus* 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. *Opiocephalus 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 *Etroplus 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[1] on submerged stones, plants, twigs and other objects.....Porifera, page 24
Do not form such encrusting growths 5

5. With jointed (Arthropodous) limbs[2]..... 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[2].....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[3] 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

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[1] The Ectoproct colonies sometimes give the appearance of encrustations on submerged plants, &c. 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.

[2] 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.

[3] 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 unicelluar 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.

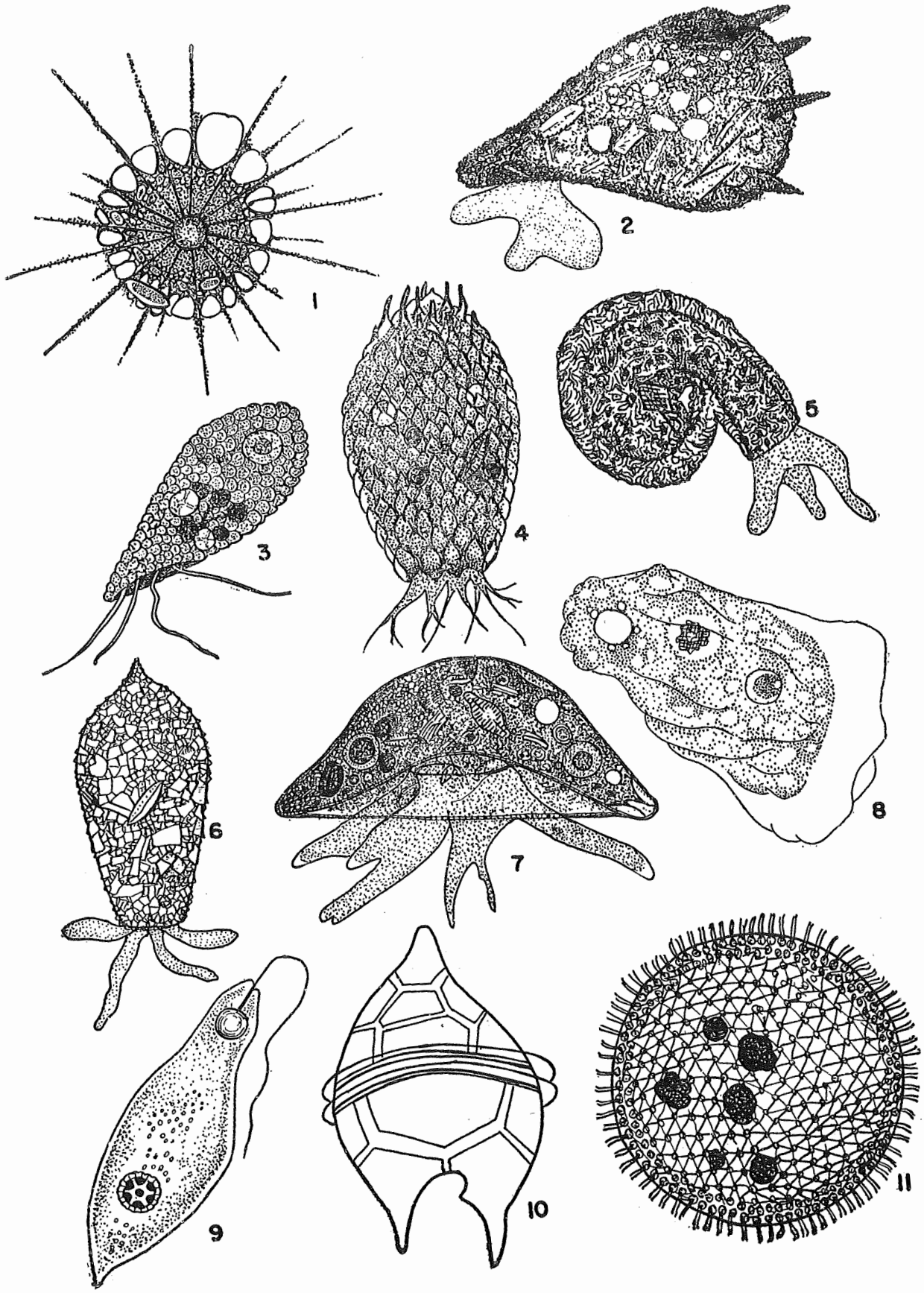
Arcella vulgaris Ehrb. (Page 19, Fig. 7)

Explanation to figures on page 19

1. *Actinophrys sol* 120 μ.[1]
2. *Centropyxis* 80 μ.
3. *Trinema* 100 μ.
4. *Euglypha* 100 μ.
5. *Lequereusia* 110 μ.
6. *Difflugia urceolata* 100 μ.
7. *Arcella vulgaris* 130 μ.
8. *Amoeba verrucosa* 60 μ.
9. *Euglena* sp. 150 μ.
10. *Peridinium tabulatum* 50 μ.
11. *Volvox aureus* 850 μ.

All the above illustrations are after various authors.

[1] 1 μ. = 1/1000th of a millimetre.



3——R 19576 (9/61)

Centropyxis aculeata (Ehrb.) (Page 19, Fig. 2)

Clathrulina elegans Cienk. (Page 23, Fig. 4)

Difflugia acuminata Ehrb.

Difflugia arcula Leidy.

Difflugia constricta (Ehrb.)

Difflugia corona Wall.

Difflugia globulosa Duj.

Difflugia lobostoma Leidy

Difflugia pyriformis Perty.

Difflugia 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.[2]

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)

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BATIA, B. L. 1936. *The Fauna of British India including Ceylon and Burma.* Protozoa : Ciliophora. London 493 pp.

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[1] 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.

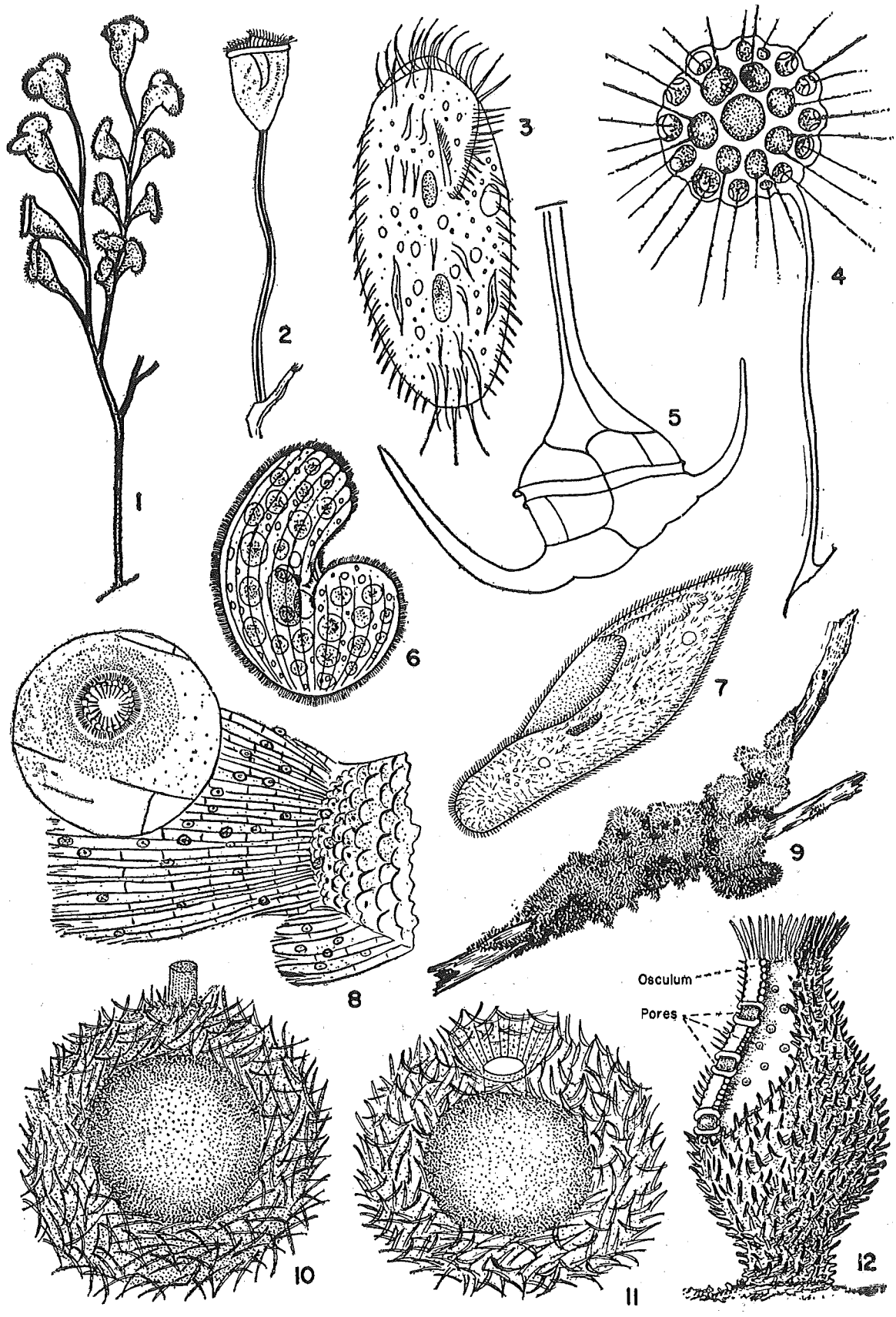
The fry, infected with *Cyclochaeta* appeared to be sluggish in their habits and did not feed well. Some of the infected fry had white blotches on the head and on the dorsal surface of the body. The fry were freed of infection by treating with a dilute solution of kitchen salt (NaCl). There were only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

[2] 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 μ.
2. *Vorticella* sp. Length of zooid 50–150 μ.
3. *Stylonchia* sp. Body length 70–150 μ.
4. *Olathurlina* sp.
5. *Ceratium* sp.
6. *Colpoda* sp. Body length 40–12 μ.
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 proliferens* ·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.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Osculum
Pores

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 bouyant 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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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 zooecium in which is enclosed a contractile portion termed the polypide. At its base each zooecium is attached to another zooecium or to some sort of supporting structure. Each zooecium 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 zooecium but when disturbed, the entire polypide withdraws into the zooecium. 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 statoblats 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 recubment. Each individual is of a dark brown or almost black colour but it has a conspicuous white marking which gives the colony a stippled appearnace. 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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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.

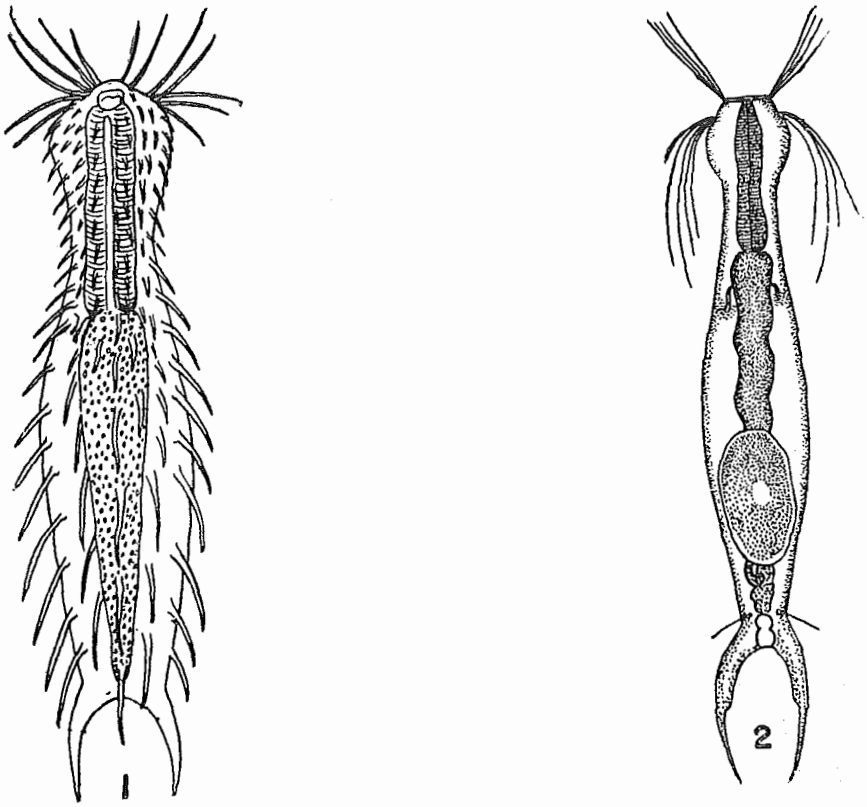


Fig. 1 *Chaetonotus* sp. after Hyman 0·5 mm.

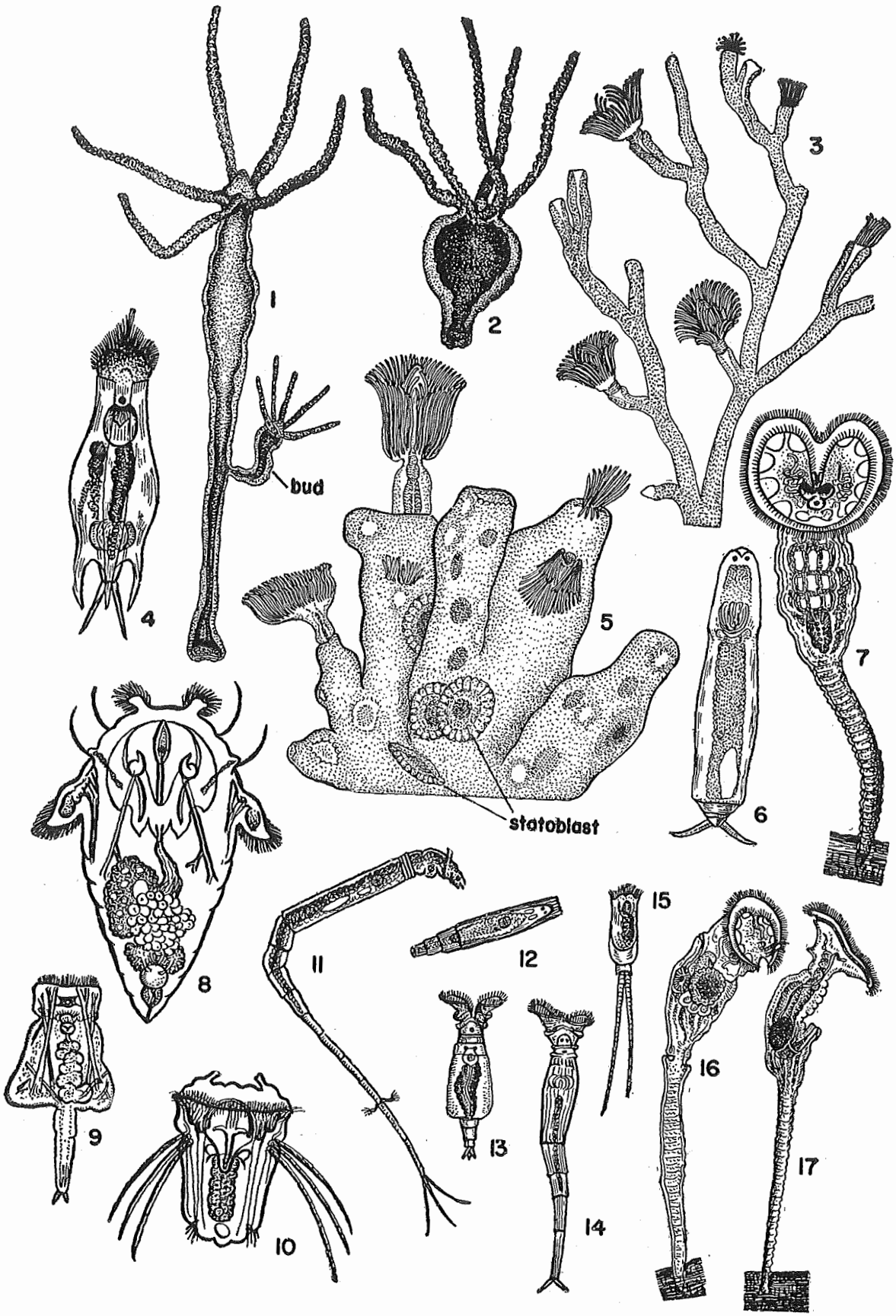
Fig. 2. *Ichthydium* sp. after Hyman 0·5 mm.

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* 300μ
5. *Plumatella emarginata*
6. *Diglena forcipata* 280μ
7. *Megalotrocha* sp. 2 mm.
8. *Synchaeta pectinata* 350 μ
9. *Notops branchionus* 420μ
10. *Polyarthra platyptera* 125μ
11. *Actinurus neptunius* 1140μ
12. *Actinurus neptunius* with segments telescoped 350μ
13. *Philodina citrina* 500μ
14. *Rotifer vulgaris* 500μ
15. *Furcularia longiseta* 250 μ
16. *Conochilus volvox* 630μ
17. *Lacinularia socialis* 2 mm.

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

[1] 1 μ = 1/1000th of a millimet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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.....Pedaliouidae, page 35
   Foot may or may not be present but no ciliated appendages replacing foot..... 4
4. Lorica[1] present..... 5
   Lorica[1] 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

[1] 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[1] interrupted.....13
Ciliary wreath of corona[1] 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

[1] 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 ungulata Ehrb.

Euchlanis dilata 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 unicinatus 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 vestigeal. 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

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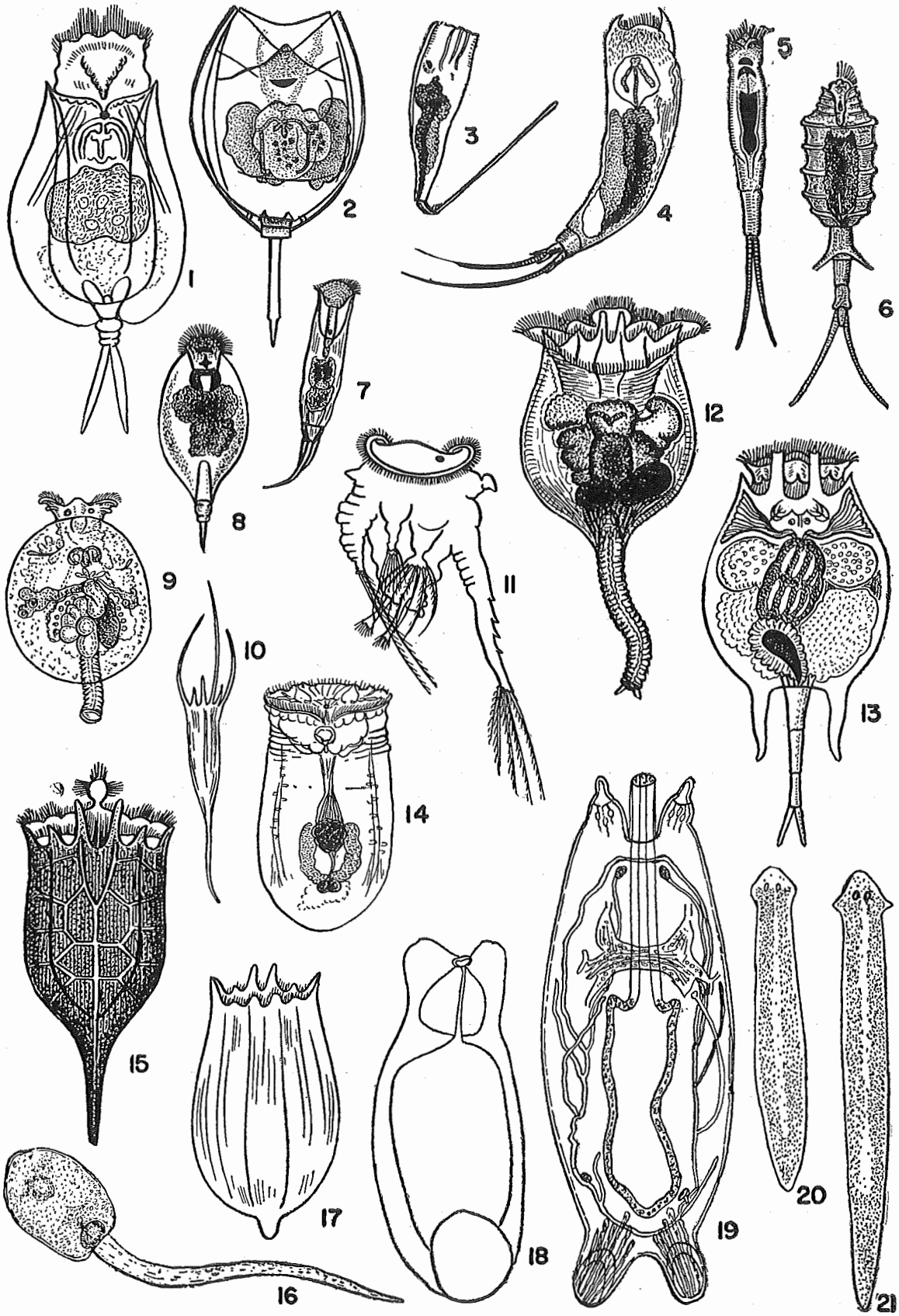
Explanation to figures on page 37

1. *Euchlanis dilata* 360μ.[1]
2. *Monostyla bulla* 230μ.
3. *Mastigocerca elongata* 500μ.
4. *Rattulus tigris* 1200μ.
5. *Scaridium longicaudum* 420μ.
6. *Dinocharis pocillum* 310μ.
7. *Coelopus tenuior* 250μ.
8. *Colurus bicuspidatus* 80μ.
9. *Pterodina elliptica* 120μ.
10. *Notholca* after various authors 210μ.
11. *Pedalion mirum* 210μ.
12. *Brachionus rubens* 280μ.
13. *Noteus quadricornis* 360μ.
14. *Asplanchna brightwelli* 500μ.
15. *Anuraea* after various authors 310μ.
16. Free living trematode larva (Cercaria).
17. *Notholca* after various authors 250μ.
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.

[1] 1μ=1/1000th of a millimetre.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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 militains 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* Schmarda 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.[1]

The cestodes [2] 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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[1] Dissanaike and Fernando (1960) have reported that 90 per cent. of the freshwater crabs, *Parathelphusa ceylonensis*, collected from a paddy field in Nugegoda, near Colombo, Ceylon, were infected with metacercaria of *Pleurogenoides sitapurii* (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. sitapurii*.

[2] *Senga lucknowensis* Johri (Ptychobothridae) and a protocephalid cestode were collected by the authors from *Mastacembalus armatus* and *Wallago attu* respectively.

NEMATODA [1]

(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 dessert, 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 [2] and Parasites of Vertebrates [3].

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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[1] 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.*

[2] 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.

[3] 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 developes 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 **AEOLOSOMATIDAE**

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 michaelseni Steph.

Aulophorus tonkinesis (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 Tufibicidae have been recorded from Ceylon.

Bothrioneurum iris Bedd.

Limnodrilus socialis Steph.

FAMILY **LUMBRICIDAE**

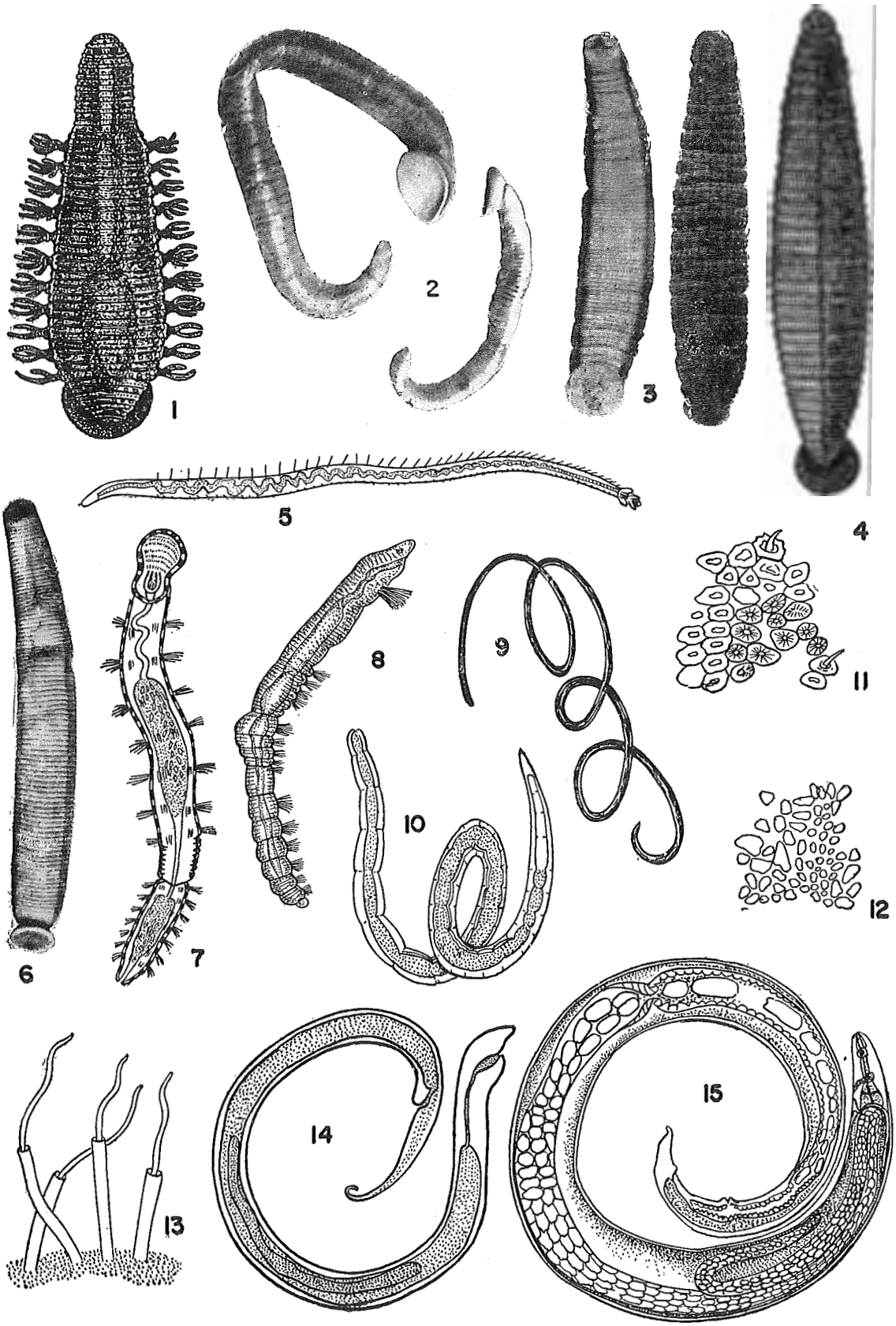
These are long worms that may measure up to 150 mm. in length. They are not truly aquatic forms, being usually found in marshy localities. They are deep red to reddish brown in colour due to the colour of their blood. Only two S-shaped chaetae are present in each of the four segmental groups (i.e., 8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

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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[1], page 52

   Shell globose or ovately fusiform.....3

3. Shell large and globose.....Pilidae, page 56

   Shell ovate or ovately fusiform.....Paludominae[1-2], page 53, Paludestrinidae[2], page 56, and Vivaparidae[2] 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)

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[1] Sub-families of the family Thiaridae.

[2] 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.

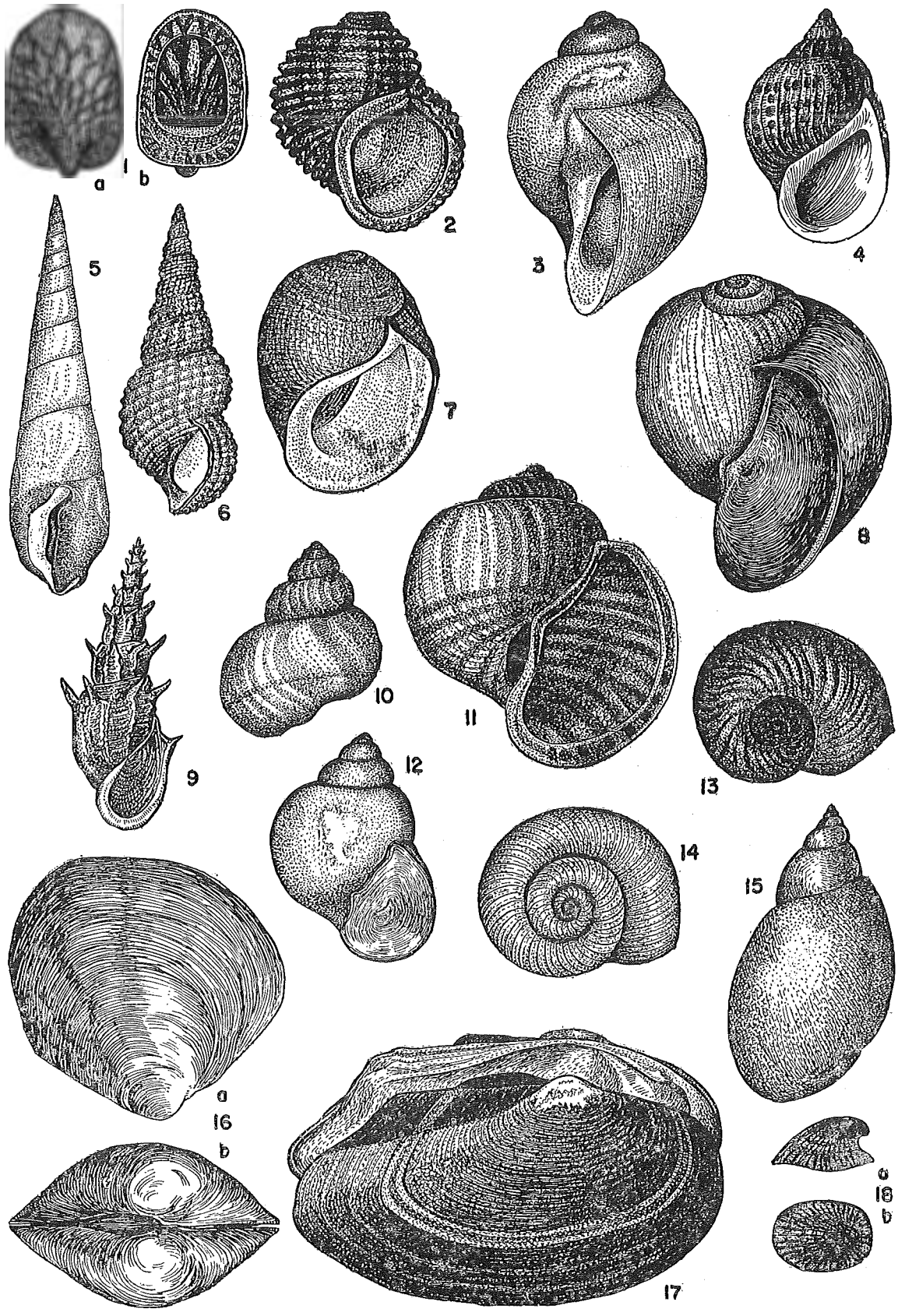
Melanoides crenulata (Deshayes)
Melanoides crenulata confusa (Dohrn)
Melanoides lineata (Gray)
Melanoides tuberculata (Müller), (Page 55, Fig. 6)
Melanoides tuberculata layardi (Dohrn)
Melanoides tuberculata subcreba (Nevill)
Thiara acanthica (Lea) (Page 55, Fig. 9)
Thiara datura (Dohrn)
Thiara rudis (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 chilinoides* 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. *Bellamya ceylonica* 2 cms. high.
11. *Pila layardi*, from Han. & Theo. 5 cms. high.
12. *Bithynia 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.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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 **PALUDESTRINIDAE**

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 [1] (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.

Bellamya ceylonica (Dohrn) (Page 55, Fig. 10)
Bellamya 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

[1] 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 [1] (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) Ancylidae,, 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 sh[illegible] 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 [1] Gray
Lymnaea pinguis [2] (Dohrn) (Page 55, Fig. 15)

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[1] New Record for Ceylon.
[2] Hubendick, B. (1951) states that *Lymnaea luteola* Lamark 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 hypticyclos 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 (Lamarck) (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 claws.....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

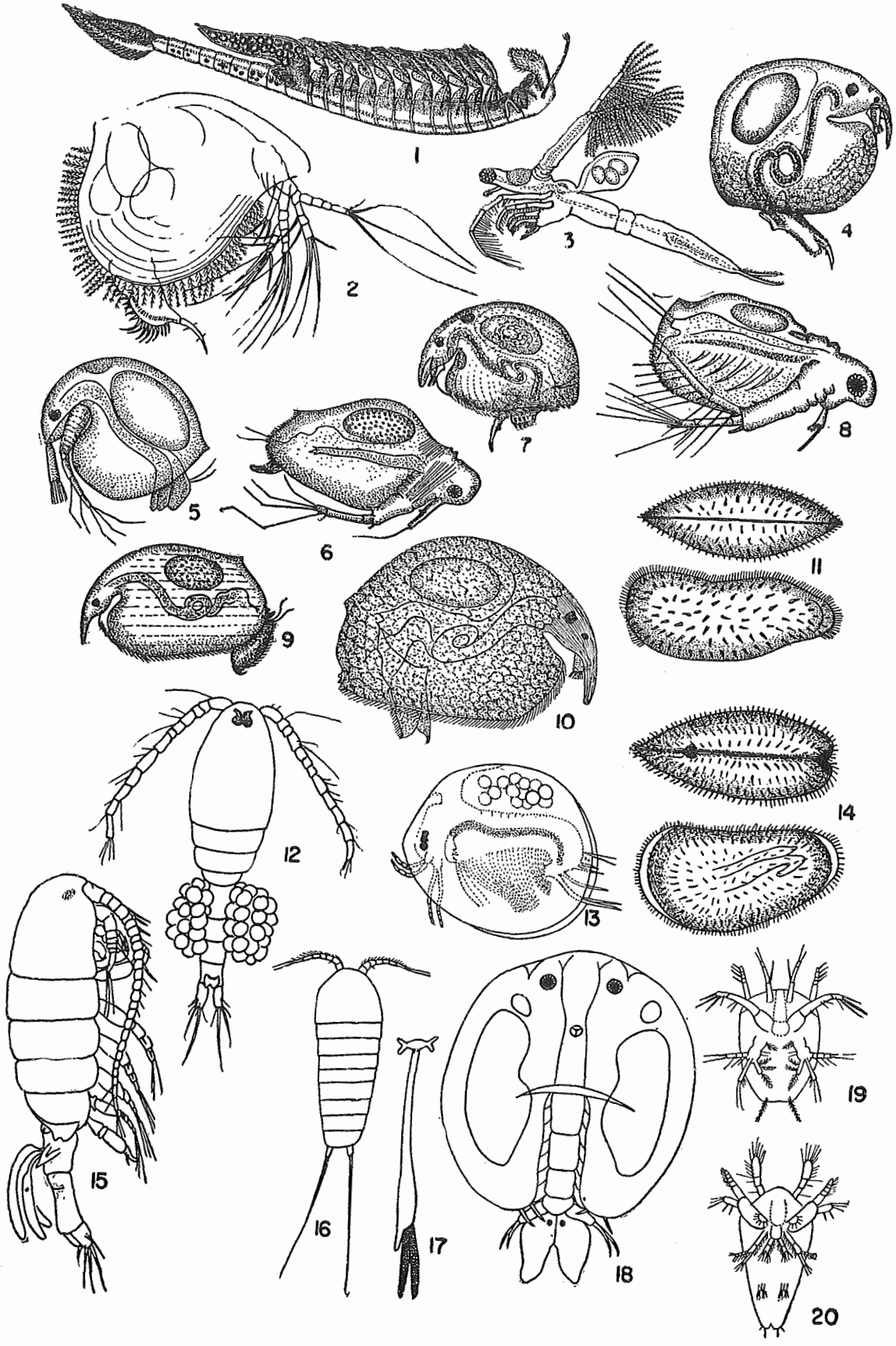
(Water Fleas)

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. *Illiocryptus halyi* after Brady 0·7 mm.
3. *Leptodora kindti* after various authors 1 cm.
4. *Chydorus sphaericus* after Ward and Whipple 0·3 mm.
5. *Guernella ceylonica.*
6. *Pseudosida szalayi* 2 mm.
7. *Alonella karua* 0·7 mm.
8. *Diaphanosoma singalense* 2·8 mm.
9. *Dunhevedia serrata* 0·9 mm.
10. *Pleuroxus laevis* 0·7 mm.
11. *Stenocypris ceylonica.*
12. *Cyclops prasinus* after Gurney up to 3 mm.
13. *Cyclestheria hislopi* 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.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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)
Illiocryptus halyi Brady (Page 63, Fig. 2)
Leptodora kindti (Focke) (Page 63, Fig. 3)
Leydigia acanthocercoides (Fisch.)
Macronynx spinosa King
Macrothrix triserialis Brady
Moinodaphnia macropa Straus
Moinodaphnia submucronata Brady
Pleuroxus laevis Sars
Pseudalona longirostris (Daday)
Pseudosida szalayi 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 [1]

Cyclops [1] *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.

[1] 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)

P arasitic 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 dentatomarginatus 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 divisable 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[1] ")

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.

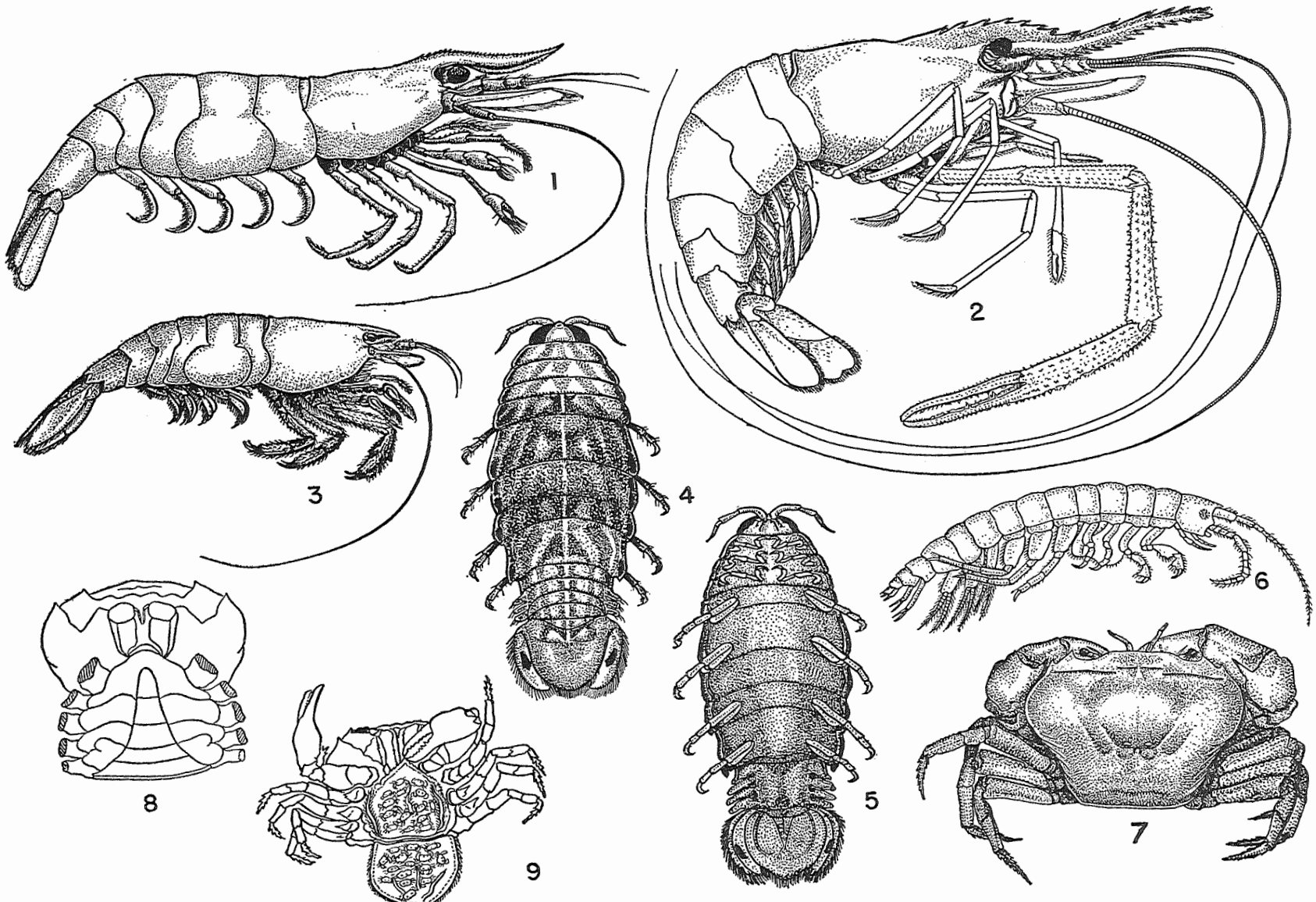
In 1958 a new species, *Paracallipe fernandoi* Wignarajah, obtained from tap water was described. Amphipods obtained from the Colombo (Beira) lake were indentified as *Grandidierella megnae* (Page 69, Fig. 6). A specimen of *Parorchistia* sp. was found in a tank at Angunuwila.

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

6——R 19576 (9/61)

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.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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[1] " 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 locomotary 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[1] ")

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.

[1] 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 pereiopods is very greatly enlarged and in mature specimens is often longer than the body.

Only one genus, *Macrobrachium* (*Palaemon*) is represented in Ceylon. *M. rosenbergi* 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. latemanus* 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 [1].

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.

[1] 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 [1] —Springtails.

Of the above orders only the aquatic Hemiptera, Coleoptera and Collembola [1] 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.[2] 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[2], 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

[1] 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.

[2] 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.....Pleiidae, page 78
   Antennae two segmented.....Helotrephidae, 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.