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The Freshwater Zooplankton of Sri Lanka, with a Discussion of Tropical Freshwater Zooplankton Composition

By

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Introduction

At present the species composition, ecology and production of freshwater zooplankton in tropical and sub-tropical regions is poorly known. The available literature usually deals with the systematics and life histories of a few species. However the zooplankton ecology of African freshwaters is better known than that of either tropical Asia or America. For South East Asia there is the classical work of Ruttner (1952) on zooplankton ecology in Java, Sumatra and Bali. There has been in the recent past a renewed interest in zooplankton ecology and some of the work done has been in tropical countries. The present study was begun in 1968 to provide a solid base of systematics for the zooplanktonic groups Rotifera, Cladocera and Copepoda. During this work which has now been completed (Chengalath and Fernando 1973, Chengalath et al. 1973, 1975 ; Fernando 1974), I noted some consistant differences between the composition of limnetic zooplankton in tropical and temporate regions. A detailed analysis of the Sri Lanka zooplankton based on extensive samples collected from 1965–1974 from all parts of the country and all types of habitats is presented as a background to discussing differences in tropical and temperate freshwater zooplankton. Previously published data is used to substantiate these differences and an attempt is made to explain the likely reasons for these differences.

The freshwater zooplankton of tropical regions is less diverse than that of temperate regions. Data substantiating this is available in the literature and has been briefly dealt with in a recent review (Fernando 1979). However the reasons for such a difference are not yet clear. It is generally believed that fish predation is the major factor responsible for the paucity of larger zooplanktonic crustacean species. The present study indicates the reasons are probably much more complex and involve the direct and indirect effects of temperature, the type of food available and predation by fish and invertebrates. In addition toxic effects of algae and macrophytes may also influence species composition.

Review of Literature

From a historical point of view the Cladocera and Calanoida of Sri Lanka are of great interest because of the early classical work of Brady (1886), Poppe and Mrazek (1895), Daday (1898a, 1898b), Gurnes (1906, 1916, 1931) and Apstein (1907, 1910). These studies described many widely distributed speciee for the first time and the work of Apstein (1907, 1910) was the first limnological study of a sophisticated type done in a tropical country. The knowledge of the freshwater zooplankton of Sri Lanka has been

further extended by the work of Bār (1924), Mendis and Fernando (1962), Chengalath and Fernando (1973), Chengalath et al. (1973, 1975), and Fernando (1974, 1978). There are also a number of references to the zooplankton of ricefields : Weerekoon (1957), Fernando (1977) ; small lakes: Mendis (1964, 1965), Costa and de Silva (1969) and Fernando and Ellepola (1969).

The systematics of the freshwater zooplankton (exclusing Protozoa and *Chaoborus*) are better known for Sri Lanka than any other tropical country. In all 138 species of Rotifera ; 58 Cladocerans and 23 species of freeliving Cyclopoida and Calanoida are known, described and illustrated from local material. There is a considerable literature on the systematics and biology of zooplankton in tropical Africa (Proszynska 1968, Beadle 1974). In South East Asia the only areas studied in detail besides Sri Lanka are Java, Bali and Sumatra (Kiefer 1933, Brehm 1933, Hauer 1938, Ruttner 1952) and the Philippines (Mamaril 1977). There is also some data on Central and South America (Zaret 1972*b* and Brandorff 1977). Besides these papers are unpublished data from all three continents which will be presented in the present paper. Although the obvious differences between tropical and temperate freshwater zooplankton composition can be gleaned from the literature no detailed analysis of any single tropical region has been attempted and compared for the Rotifera, Cladocera and Copepoda with a temperate region.

The knowledge of zooplankton productivity in tropical freshwaters is meagre. The only detailed data comes from Lake George, Uganda where the zooplankton is dominated by a single Cyclopoida, *Thermocyclops crassus* (called *T. hyalinus*). This data is presented in a series of papers (Burgis, 1970, 1971, 1974, Burgis and Walker 1972 and Burgis et al. 1973). Predation on zooplankton by fish and invertebrates has been dealt with by Green (1967) and Zaret (1969, 1972*a*, 1972*b*, 1975) in Africa and South America respectively.

Materials and Methods

Zooplankton samples were collected with 25 #, (64 μ) and 10 # (157 μ) nets and the samples were mixed and concentrated. This method gives a wide representation of even rare species of Rotifera, Cladocera and Copepoda. An attempt was made to obtain concentrated samples by filtering a large volume of water and in deeper lakes by taking both vertical and horizontal samples. In the littoral zone the net was swept among vegetation and close to the bottom to disturb and capture Cladocera and Copepoda living on vegetation and in the fine sediment and debris. All samples were fixed immediately in 5–10% formalin. Some of the samples studied were collected by Dr. D. G. Frey, Department of Biology, Indiana University, Bloomington, U.S.A. in 1964–1965 and loaned to the author. The whole sample including a duplicate usually was examined with a M5 or M8 Wild Stereoscope and the species enumerated. Temporary preparations were made in Polyvinyl Lactophenol tinted with Lignin pink for confirming diagnoses.

The samples were collected from almost every part of Sri Lanka (Fig. 1). The names of localities and type of habitat are given in Appendix 1. A flexible numerical system has been used to designate localities and seven habitat types. A list of species identified in each sample on individual sheets of paper have been deposited in the Department of Fisheries, P.O. Box 531, Colombo 3, Sri Lanka.

The samples collected during 1965–1974 have been plotted against the dates of collection (Fig. 2). Samples have been collected in every month of the year. Typical monthly means of rainfall from representative areas of Sri Lanka have also been plotted (Fig. 2). There is some variation in rainfall from year to year but the seasonal pattern and intensity remain relatively stable. The collection

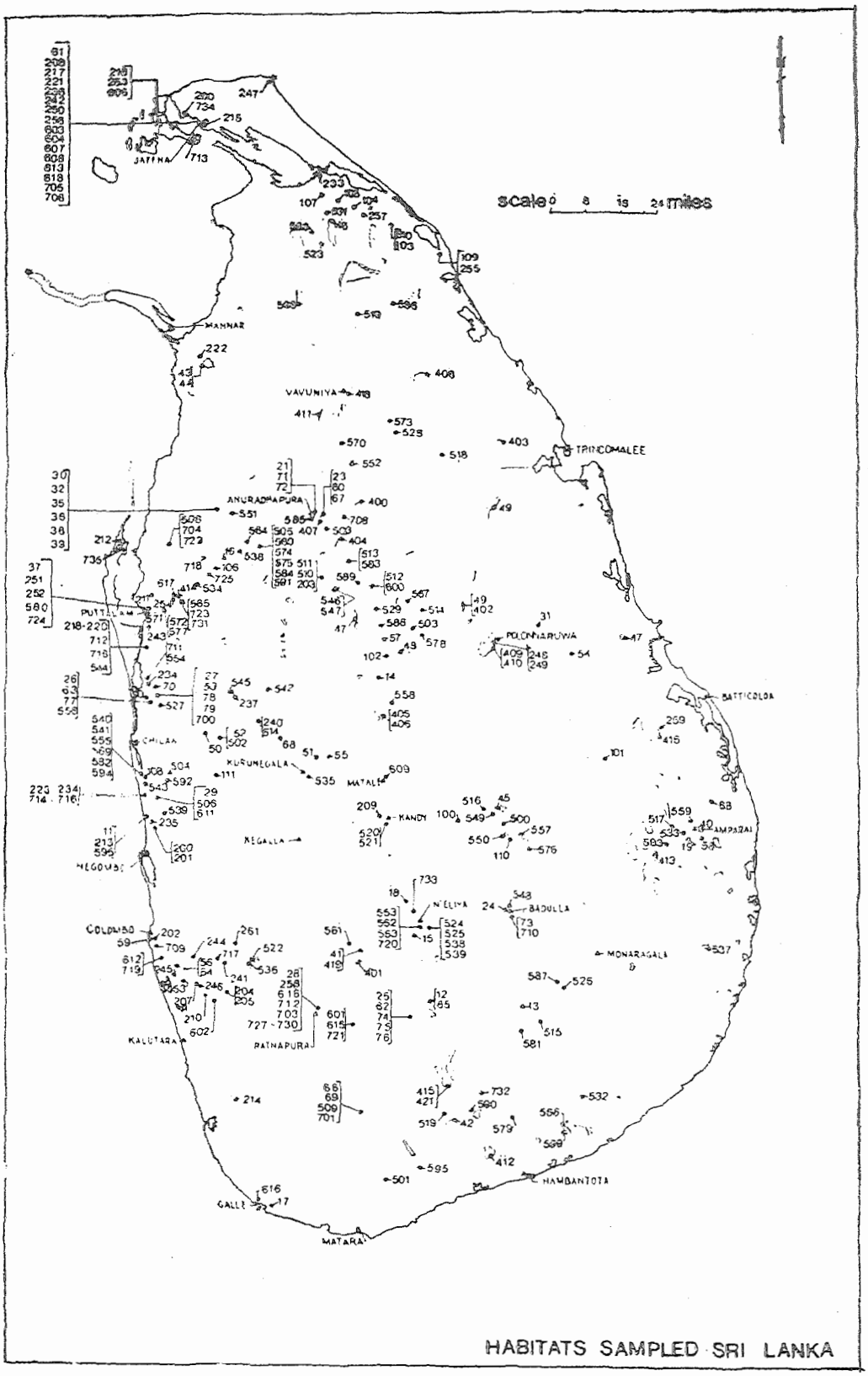

Fig. 1.—Collecting localities in Sri Lanka. Numbers designate habitat types.

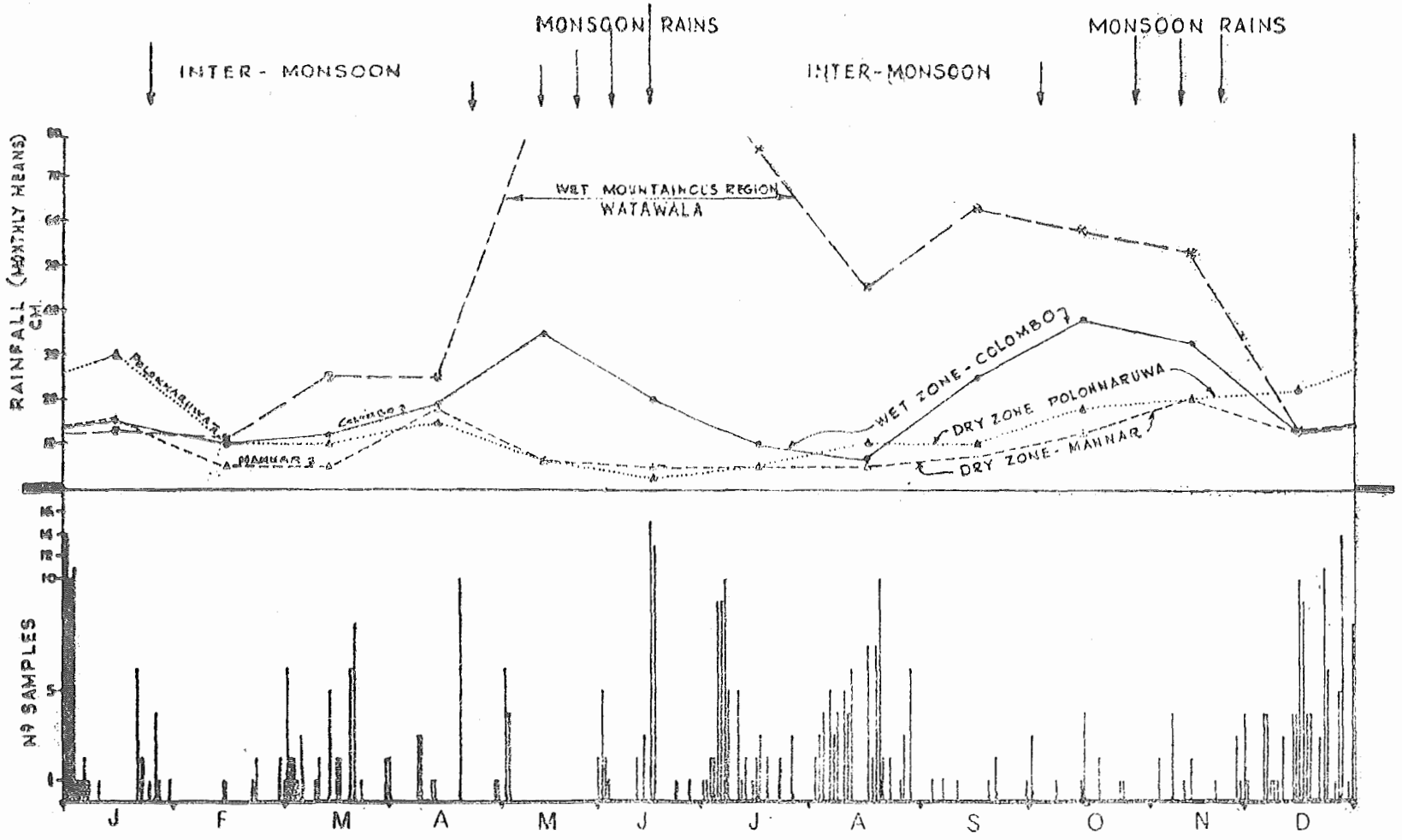

Fig. 2.—Dates of collection, number of samples collected on each date and typical rainfall patterns in Sri Lanka.

of zooplankton is most difficult during the actual monsoons (April–May and October-November) due to dilution of the fauna and the muddy water. In the dry season (January–February and September-October) there is no standing water in ponds and only the largest habitats can be sampled.

Besides the three groups of zooplankton, i.e., Rotifera, Cladocera and Copepoda the other invertebrates collected were identified to various levels from order to species. These are dealt with later, separately from the zooplankton.

Geology, Physical and Chemical Factors

The basic geological formation in most of Sri Lanka is Pre-Cambrian crystalline rock. There is some Miocene limestone in the North and Northwest and very small areas of Jurassic formations in the Northwestern region (Puttalam) and Sabaragamuwa Province (Ratnapura). A comprehensive account of the geology has been given by Cooray (1967). The elevation of the land in Sri Lanka is in the form of three peneplains. The lowest is only slightly above sea level while the highest has an average elevation of about 1,500 M. These so-called peneplains (almost plains) were first recognised by Adams (1929) and are the result of erosion of the basic rock formations.

The temperatures prevailing during the year throughout most of the country is typically tropical and varies from about 24°C–32°C. However at higher elevations much lower temperatures are recorded with lows of 1–2°C below zero in localities like Nuwara Eliya, Horton plains and Mount Pidurutalagala (elevations about 2,000 m.). Rainfall varies both in quantity and distribution during the year. Two monsoons, the Southwest (April–May) and the Northeast (October–November) bring the major portion of rainfall. Some regions (the wet zone) receive rainfall during both monsoons. Other regions receive rain only during one monsoon to all intents and purposes (Fig. 2). There are arid regions in Sri Lanka in the Northern, Northeastern, Northwestern, Eastern and Southern portions of the country.

The water chemistry of Sri Lanka freshwaters has been investigated by a number of workers including Srimanne (1953), Giesler (1967) and Weninger (1972). There is a wide range in pH, calcium content and nitrate and phosphate levels. Slightly acid waters are common in the Southwestern and hilly regions with more alkaline waters in other regions with high calcium levels in the Miocene limestone areas. Pollution by human faeces and agricultural, industrial and household wastes is sometimes quite intense. Tidal influence is very small but the low-lying marshes near the sea-coast are infilterated by saline water and humic brackish waters are fairly widespread in these areas. The samples collected cover all types of waters in regard to size, chemistry, permanence, temperature regimes and elevation (Fig. 1, Appendix 1).

Freshwater Habitats

Sri Lanka has a wide and attractive range of freshwater habitats. In the running water category (Fig. 3) are slow-flowing, fast-flowing, temporary and perennial and low and high-elevation rivers and streams. Two recent studies, Brinck et al. (1971) and Costa and Starmuhlner (1972) give detailed descriptions of the physical, chemical and biological features of lotic waters throughout the island. The standing (lentic) habitats have been dealt with in some detail with reference to lakes, by Fernando and Indrasena (1969) and Fernando (1971, 1973, 1978) and ricefields by Fernando (1977*b*). There has been considerable human interference with both lotic and lentic waters by damming the former and extending the area of the latter type. Sri Lanka has no natural lakes and the closest approach to natural lakes are the villus or Varzea type (Reiss 1977) lakes. The extent of man-made lakes in a small area (Fig. 4) and the whole of Sri Lanka (Fig. 5) shows the extent of human interference in the natural aquatic ecosystem. Ricefields form an important component, albeit

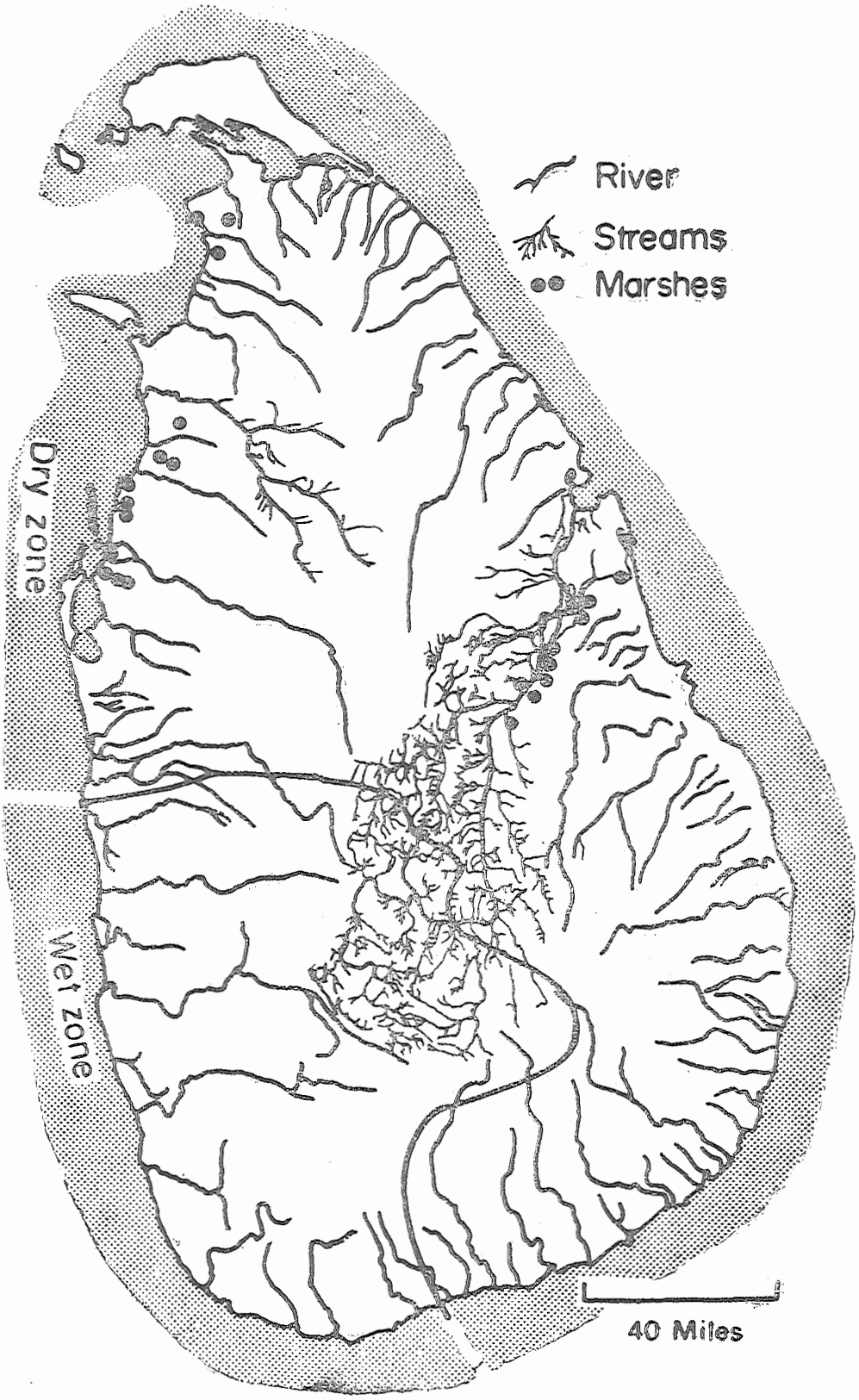

Fig. 3.—River systems in Sri Lanka. Streams are shown for only two rivers. One in the dry zone and one in the wet zone (After Fernando 1971).

temporary, of the aquatic ecosystem. There are over 10,000 small reservoirs (<300 ha) and about 60 large reservoirs (>300 ha). Together they account for about 170,000 ha (Mendis 1976). Indrasena and Fernando (1969) and Fernando (1971, 1973) have classified the reservoirs and listed the larger ones. Fernando (1971) also estimated the extent of lotic and lentic waters. One of the characteristic features of reservoirs is the great change in water level throughout the year. This has been illustrated for large and small reservoirs by Fernando (1973).

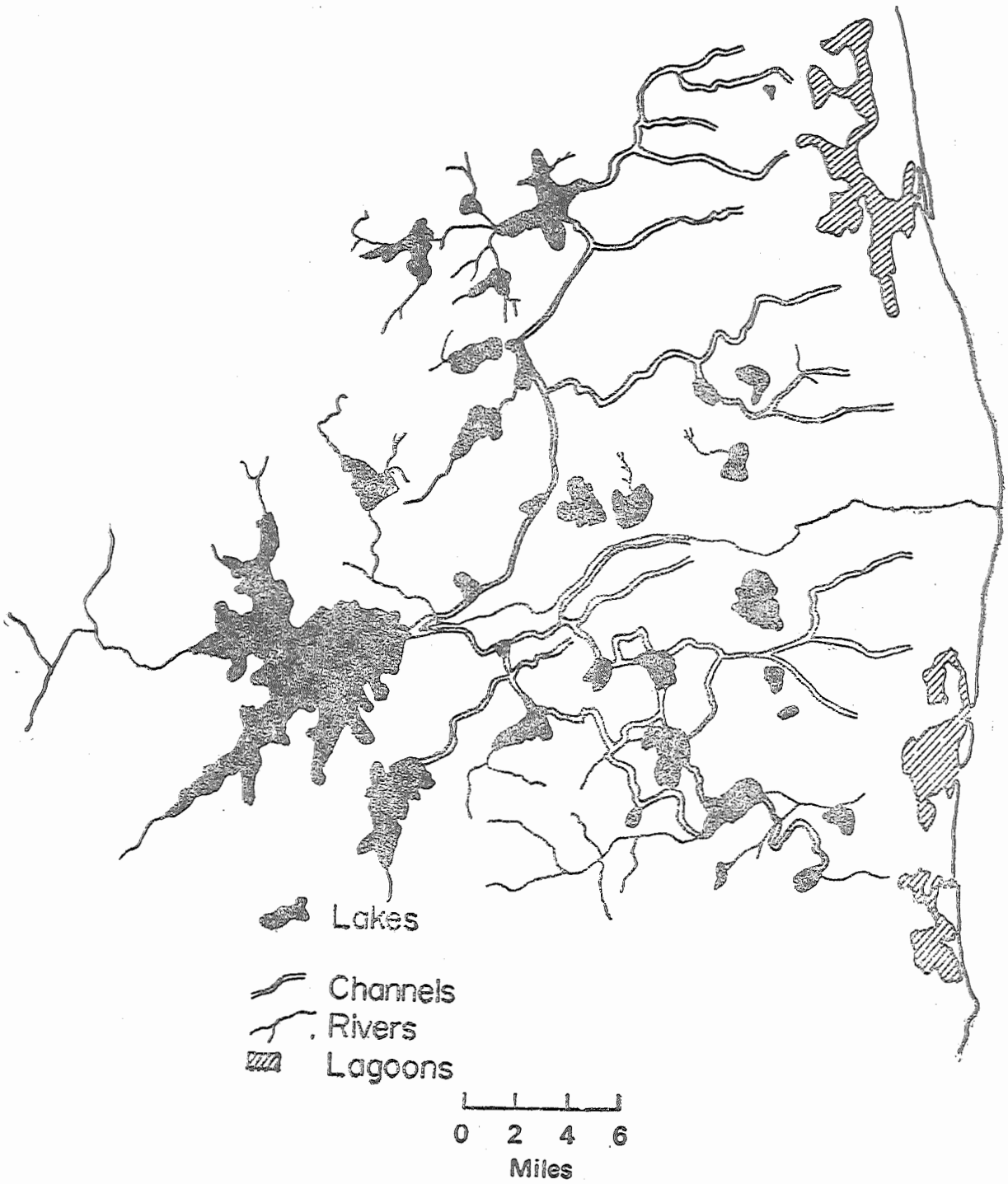

Fig. 4.—The Galoya multipurpose scheme showing the extent of human interference with the natural aquatic habitats by construction of reservoirs and channels (After Fernando 1971).

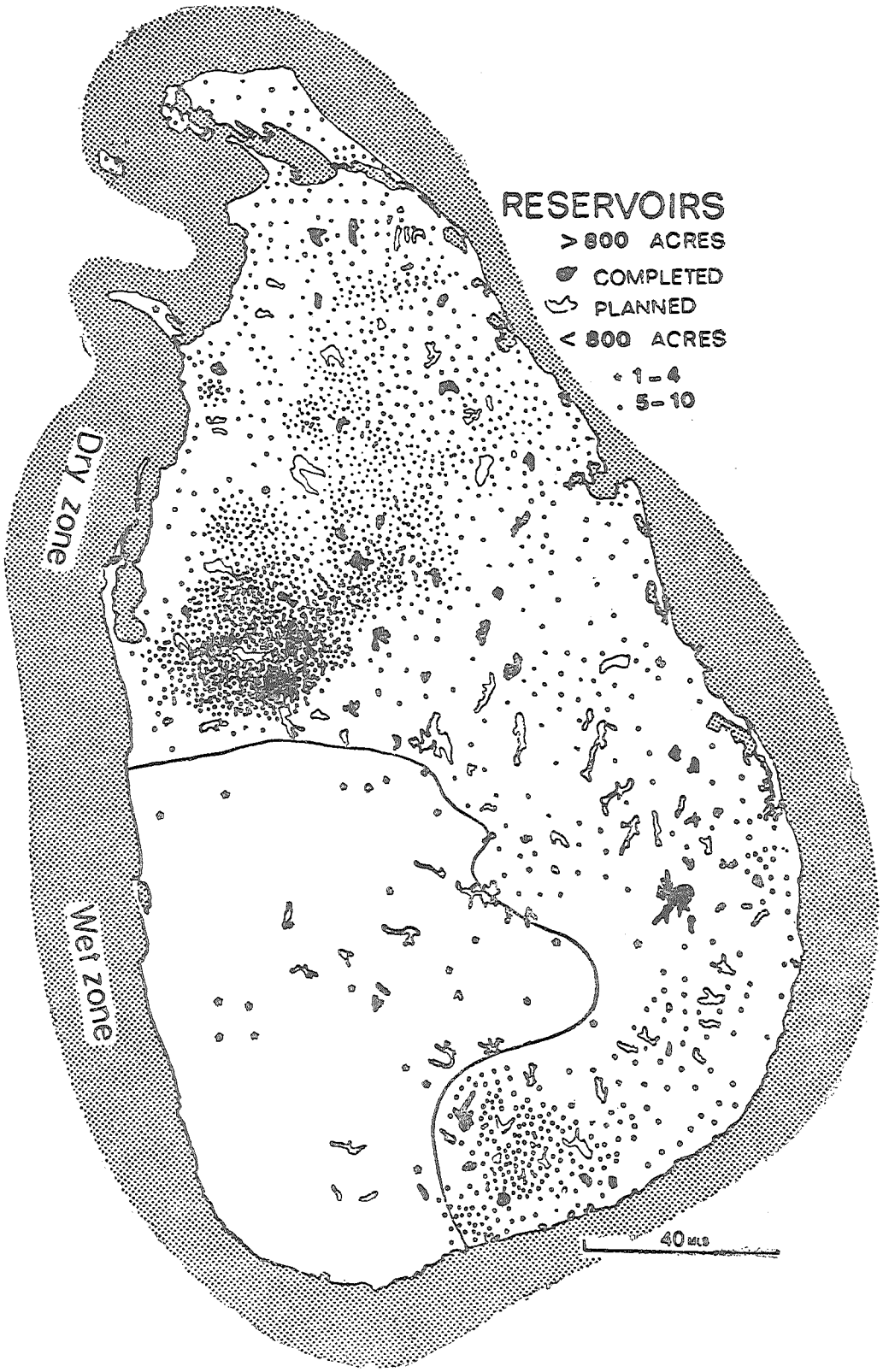

Fig. 5.—Man-made lakes in Sri Lanka (After Fernando 1971).

In Sri Lanka where rainfall is relati ly abundant there are numerous ponds of varying degrees of permanence. During the floods which follow the monsoon rains these ponds merge into extensive sheets of water. In some of the more arid areas the ponds are very temporary. These areas have characteristic faunal elements like Anostraca (no Notostraca occur in Sri Lanka), Conchostraca and large Calanoida. Few of these are recorded in the material studied because of the very short-lived nature of these ponds and their fauna.

Results

The zooplankton identified in 473 samples have been listed under seven types of habitat (Tables 1 and2). Besides the Rotifera, Cladocera and Copepoda listed in Tables 1 and 2 the other invertebrate collected with the zooplankton are listed in Table 3.

The term zooplankton is used in the present paper to include the Rotifera, Cladocera and Copepoda for purposes of detailed study and discussion. An attempt is made to separate limnetic and non-limnetic plankton. The samples from reservoirs >300 ha are considered limnetic but this is not strictly true. During the dry season these reservoirs are often quite shallow and their margins are invaded by vegetation. Although the samples were taken in open water, littoral species would predominate under these circumstances in some instances.

The percentage occurrence of all species recorded is listed under the seven types of habitats (Table 1). To separate very common species a level of 25% occurrence in any one type of habitat is considered appropriate. This species list and their percentage occurrence is given in Table 2. To show the degree (percentage) of similarity in species composition between the different types of habitats (excluding miscellaneous), a series of dendrograms was constructed using the coefficient Sj or Jacard coefficient (Jacard 1908, Sneath and Sokal 1973). Sj=NJK/NJK+NJk+NjK, where NJK=number of species present in both habitats J and K. NJk=number of species present in J but absent in K and NjK=number of species present in K but absent in J.

General Remarks

(*a*) *Rotifera.*—As expected there is a very wide range in the occurrences of the different species. Those below 2% total in all types of habitats are considered rare. There are fifteen such species. On the other hand forty species occur in six or all seven types of habitats. These can be considered eurytopic. However many rotifers can be labelled as fugitive species having a capacity to disperse rapidly. When this is combined with their ability to reproduce rapidly at the high prevailing temperatures ; it is not difficult to understand that many rotifers are wide-spread. It is difficult to draw the line between opportunistic species (McArthur 1960) which show a great propensity for increase in numbers and eurytopic species which are tolerant of a wide range of ecological conditions. Many Rotifera probably belong to both categories. Small and rare species are, of course, more likely to be missed in the enumeration. Thus the occurrence of these species has been underestimated.

The composition of the Sri Lanka Rotifera fauna is quite typical of tropical regions. There is a dominance by the genus *Brachionus* in the limnetic samples especially. Some typically temperate region genera are rare e.g. *Keratella* (except for *K. tropica*) or absent like the genera *Synchaeta*, *Notholca* and *Pleosoma*. *Trichocera* and *Testudinella* are relatively common and there is a profusion of *Lecane* species. The latitudinal variation of planktonic Rotifera and the Brachionidae have been discussed by Green (1971) and Pejler (1977) respectively. The Sri Lanka fauna fits into the tropical category in most respects but a so-called temperate species *Keratella earlinae* which according to Pejler

(1977) occurs only in the Nearctic region occurs in Sri Lanka too. Also *Kellicottia Longispina* which is supposed to occur almost exclusively in temperate regions (Pejler 1977) also occurs in Sri Lanka. However *Brachionus donneri* a species endemic to the Indian region occurs not unexpectedly in Sri Lanka; so does *Trochosphaera aequtorialis* a species with a wide but spotty world distribution.

(*b*) *Cladocera.*—The cladoceran fauna is typically tropical with some features unique to Sri Lanka. First of all, like all tropical regions the total cladoceran fauna is of the order of 60 rather than 90-100 of temperate regions (Table 4). This difference in species numbers is due to the total absence of the families Leptodoridae, Holopedidae and Polyphemidae and the very small number of *Daphnia* spp., *Pleuroxus* spp. and *Ceriodaphnia* spp. There are typically tropical species like *Chydorus barroisi*, *Ch. eurynotus*, *Dadaya macrops*, *Ceriodaphnia cornuta*, *Grimaldina brazzai*, *Indialona* spp. and some others However in Sri Lanka the genera *Acroperus* and *Camptocercus* found in neighbouring tropical countries (India, Malaysia, Indonesia) are absent. Two species *Graptoleberis testudinaria* and *Indialona macronyx* previously recorded were not found during the present study.

Cyclopoid and Calanoid Copepoda

Eleven Cyclopoida were recorded (Table 1). They are all well known and widely distributed except for *Microcyclops moghulensis*. All are cosmopolitan, tropical or widely distributed except for *Tropocyclops confinis* which was found only at high elevations. The eleven species of Calanoida recorded includes one giant calnoid *Megadiaptomus hebes* (Fernando and Hanek 1976) and a species not recorded in the present study namely *Paradiaptomus greeni*. Only one species is at all common, namely, *Phyllodiaptomus annae*.

Harpacticoida

Two widely distributed species *Elaphiodella bidens decorata* and *E. grandidiers* were found together with what appears to be the endemic *Altheyella cingalensis* (Table 1).

Introduction and Elimination of Species

Poppe and Mrazek (1958) recorded *Leptodora kindtii* (Focke) in Sri Lanka. This is very likely an introduction with temperate fish (trout) introductions. *Leptodora kindtii* has never been recorded subsequently. *Kellikottia bostonienis* and *Keratella earlinae* considered temperate species were recorded in Sri Lanka. Pejler (1977) supports the suggestion that *Kellikottia bostoniensis* (Rousselet) has been introduced into Sweden with fish (Arnemo et al. 1968). It is possible that this species and the Nearctic species *Keratella earlinae* have been introduced into Sri Lanka.

Daday (1898*a*) recorded *Graptoleberis testudinaria* and described *Indialona macronyx* from Sri Lanka. These species and *Paradiaptomus greeni* recorded by Gurney (1931) were not found in the present study in spite of extensive sampling. *Graptoleberis testudinaria* is a rare species in the tropics. *Indialona macronyx* is rare. Only two published records of this species are known (Smirnov 1972). It has been recently recorded in the Philippines (Mamaril 1977) and in Malaysia (unpublished) from marshes. Its rarity in Sri Lanka is probably due to the great reduction in area of marshes and pollution of existing ones. Fernando (1977) attributed the low diversity of zooplankton in South Indian ricefields to the elimination of marshes.

Comparison of Species Numbers and Percentage Similarity Between Different Habitats

The lowest numbers of species were recorded in villus (flood lakes) and rivers and streams. Both these types of habitats are running waters during part of the year at least and hence the paucity of planktonic species is to be expected. Also it should be noted that these habitats were sampled the least (Table 1). Ponds and small reservoirs had the richest faunas. Large reservoirs had less species than

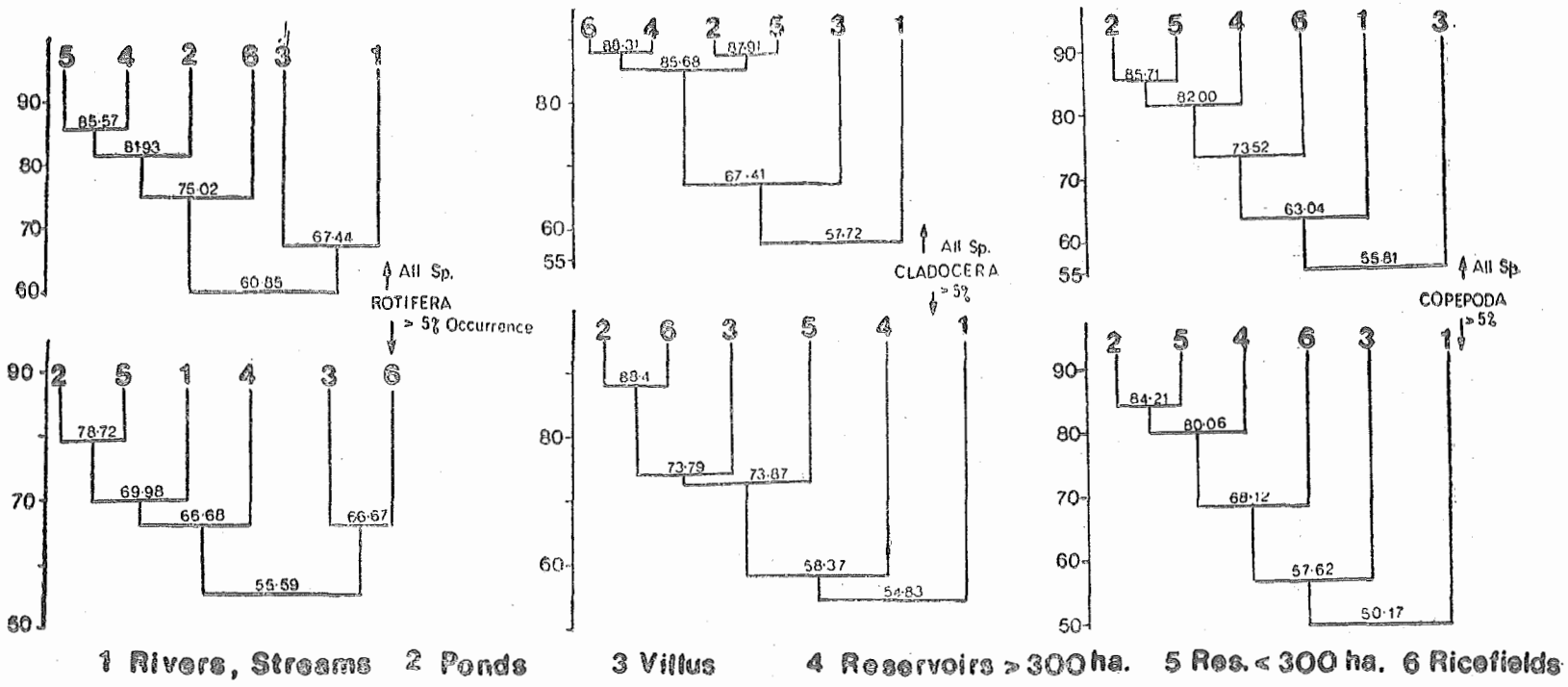

Fig. 6.—Dendrograms of percentage similarity of six types of habitats in regard to the occurrence of Rotifera, cladocera and Copepodo. Jaccard's coefficient. Sj = NJK/NJk + NJK + NJk is used (*see text*).

small reservoirs and ponds. The littoral component in the fauna is reduced and the open water components increased in large reservoirs. Small reservoirs have a combination of littoral and limnetic* species. Ponds had the highest number of species except in the Rotifera where small reservoirs which combine the features of littoral and limnetic situations had the largest number of species. Shallow water, i.e. littoral and bottom dwelling " zooplankton " seems to be far more numerous in species; hence ricefields and miscellaneous habitats, which were generally small, man-made habitats, had quite diverse faunas similar to ponds and have more species than rivers, streams and villus.

A coefficient of the percentage similarity in species composition of the different types of habitat (excluding miscellaneous) has been constructed. The three groups of zooplankton are treated independently and also one coefficient is calculated using only species occurring in $> 5\%$ of that particular habitat. This is done to exclude fugitive and rare species (Fig. 6).

In general it can be said that reservoirs and ponds are more similar than the other types of habitats (Fig. 6). However the distinction is not clearcut by any means. This is due to two factors : (1) Because in tropical freshwaters there are relatively few limnetic species (Table 2), and (2) Even the large reservoirs are often shallow and have a major littoral plankton component which is numerically dominant. There is also in Rotifera a large number of fugitive species. All these factors contribute to an eveness of the zooplankton in all types of habitats in Sri Lanka. Ruttner (1952) mentions that the zooplankton of tropical regions resembles pond plankton of temperate regions. It resembles even more tropical pond plankton. Lakes and ponds share the same species essentially as there is only a very small percentage of zooplankton species present predominantly in the limnetic region. Proszynska (1963) showed that there was a pond type and a small water body type of Copepoda and Cladocera based on temperate region records only. She defined ponds as having a uniform bottom cover of aquatic plants and no summer thermocline whereas small water bodies had a summer thermocline and a mosaic of bottom vegetation. In the tropical region a thermocline (except diurnally) is not formed in small water bodies or ponds in summer. The present results (Tables 1 and 2, Fig. 6) do not show a distinct group of Cladocera and Copepoda, one for ponds and the other for small water bodies (i.e. reservoirs < 300 ha).

Limnetic Zooplankton

Ruttner (1953) in discussing the composition of plankton mentions that the pelagial was originally colonized from the shore (littoral). He records the " advance " of littoral forms into the plankton (pelagial) in Sumatran lakes. He found *Simocephalus serrulatus* and *Latonopsis australis* comprising the major portion of the plankton in Lake Manindjau. There is no strict dividing line between littoral and pelagial zooplankton and a species may be predominantly pelagial in one region (*Moina micrura* in tropical lakes) littoral in arid areas and less often pelagial (European lakes). However most species can be designated planktonic (pelagial) or littoral *in a particular area* by considering their predominance in littoral or pelagial situations.

Limnetic zooplankton (what few species there are) can be expected to predominate in reservoirs >300 ha. There are only a very few species which are commoner in the large reservoirs than in other types of habitats (Tables 1 and 2). Using a level of 25 % occurrences as indicating " common ", eleven species of Rotifera, four of Cladocera and three of Copepoda can be considered in this category.

*The terms limnetic and littoral species are used rather loosely but designate forms found predominantly in these situations.

Of these eighteen species all except *Lecane bulla* are commoner in large reservoirs than in other types of habitats. However most of them are eurytopic except *Hexarthra intermedia* and *Filinia opoliensis*. It is clear that the so-called planktonic Rotifera, Cladocera and Copepoda in Sri Lanka lakes are largely if not wholly composed of eurytopic species commonly found also in ponds. The Rotifera show the largest number of species which can be considered predominantly limnetic.

The number of limnetic zooplankton species in Sri Lanka is thus much smaller than that of temperate regions. In Ontario, Canada, Brandlova et al. (1972) recorded eighteen species of limnetic Cladocera and more recently Smith and Fernando (1978) found 18 species of limnetic Cyclopoida and Calanoida in Ontario which rarely occur in ponds. Tonolli (1962) found more typically limnetic Rotifera in a single lake than in all the Sri Lanka samples. Changalath, Fernando and George (1972) in a study of planktonic Rotifera of Ontario listed sixty species. Of these almost half are predominantly limnetic in occurrence. Similar figures can be quoted for other temperate regions for the Cladocera, Copepoda and Rotifera.

Species Composition of Tropical Freshwater Zooplankton

The limnetic zooplankton of Sri Lanka is typical of tropical limnetic zooplankton in species composition. The Rotifera are dominated by members of the genus *Brachionus* and *Keratella tropica*. This assemblage has been noted on a worldwide scale by Green (1971) and Pejler (1977). The total number of "planktonic" Rotifera species in Sri Lanka (Circa 89 including Lecane) in reservoirs $>$ 300 ha.) is similar to figures quoted for some temperate lakes by Green (1972). In the Cladocera however there is a marked difference in the number of limnetic species in tropical as compared to temperate regions. The dominant limnetic Cladocera in the tropics consist of *Ceriodaphnia cornuta*, *Diaphanosoma* (usually *D. excisum*, less commonly *D. sarsi*, *D. modigliani*) and *Moina micrura*. All these are eurytopic species occurring in a wide range of habitats. They are referred to under many names, e.g. *Ceriodaphnia rigaudi* (see Rzoska 1956), *Moina dubia* (see Goulden 1968) and *Diaphanosoma singalense* and *D. paucispinosum* (V. Koirnek, personal communication). Also these species are the dominant species in the Potamoplankton of the Rivers Nile, Sokoto and Niger in Africa (Brook and Rzoska 1954, Green 1962 and Clarke 1978) in the Mekong (Blache 1959) and the salt lakes in Bengal, India (Seymour Swewll 1934). Brehm (1933) found these three species and very few others in the limnetic zooplankton in Indonesia. Burgis et al. (1973) found *Moina micrura*, *Ceriodaphnia cornuta* and a small *Daphnia*, *D. barbata* dominating numerically the Cladocera in Lake George, Uganda. Green (1967) found only *Diaphanosoma excisum*, *Ceriodaphnia* (2 spp.), probably including *C. cornuta*, *Moina micrura* and *Daphnia lumholtzi* in the stomach of planktivorous fish in Lake Albert, East Africa. A small species of *Daphnia*, e.g. *D. lumholtzi* or *D. barbata* and *Bosminopsis dietersi* and *Bosmina longirostris* sometimes occur in limnetic zooplankton in the tropics. Unlike the widely distributed, eurytopic forms mentioned earlier these species seem to be predominantly limnetic in occurrence. Brandorff (1977) found a slightly different mix of Cladocera cosmotropical (4 species), Cosmopolitan (1 species) and Neotropical (5 species) in an Amazon Lake. But again *Daphnia* was represented by only 1 species. In Table 5, I have compiled a list of the limnetic Cladocera occurring in South-East Asian lakes. The dominance of the few species mentioned earlier is quite evident. In Table 4, I have compared the composition of Tropical and Temperate region Cladocera faunas and the limnetic species in the two regions. There are to begin with fewer species of Cladocera in tropical regions than in temperate regions. This is not due to lack of study of tropical Cladocera since intensive collecting has been done in Indonesia (Brehm 1933), Sri Lanka (Fernando 1974), Philippines (1977), Mamaril and Malaysia and India (unpublished data). The smaller species number in tropical lakes is laregly due to the almost total absence of the genus *Daphnia* so prominent in temperate region

zooplankton. The members of the families, Holopedidae, Leptodoridae and Polyphemidae are also extremely rare in the tropics. The genera *Ceriodaphnia* and *Bosmina* are represented by more limnetic species in the temperate regions than in the tropics. On the other hand the genus *Diaphanosoma* is represented by more limnetic species in the tropics than in temperate regions where *Diaphanosoma brachyĉurum* is the only species in the zooplankton. *Moina micrura* usually a pond species in arid and temperate regions is commonly found in the limnetic region of tropical lakes (Goulden 1968).

The Copepoda species commonly found in the limnetic zone of tropical lakes are also relatively limited in number as compared to temperate regions. In South-East Asia *Thermocyclops crassus* and *Mesocyclops lecukarti* are by far the commonest cyclopoids (Table 4). A similar situation has been reported for Lake George, Uganda by Burgis (1971) and Burgis et al. (1973). In tropical South America, Brandorff (1977) found only three cyclopoids in a lake. Also in general there are few calanoid species even in large lakes in South-East Asia. Lake Toba has only one species, *Tropodiaptomus doriae* (Kiefer 1933). Lake Lanao has only two species (Frey 1969, Mammaril 1977). I have compiled the occurrence of Cyclopoid Copepoda in a wide range of South East Asian lakes. The dominance of the two cyclopoids *Thermocyclops crassus* and *Mesocyclops leuckarti* and the lack of a wide species spectrum is quite evident.

Numbers of Limnetic Species and their Size

The number of zooplankton species occurring in a limnetic region in any lake varies considerably. In 27 Colorado lakes Pennak (1957) found 1-3 Copepoda, 1-5 Cladocera and 1-10 Rotifera. In 42 lakes outsides the United States but located manily in temperate regions, he states that the mean number of Copepoda is 2.7 Cladocera 2.8 and Rotifera 5.5. These figures could well apply to tropical lakes. However there is a major difference when tropical and temperate lakes are compared. The total species spectrum of tropical limnetic zooplankton is certainly much smaller in the Cladocera and Copepoda.

From the data presented it is evident that the species spectrum of limnetic Cladocera and Copepoda is much more limited in the tropics than in temperate regions. Most of the tropical data comes from South-East Asia and Africa. The South American data give essentially the same picture but the data available is much more limited. There is however a wealth of data from temperate lakes for comparison, e.g., Scourfield and Harding (1966) and Brandlova et al. (1972). The commoness of the genus *Daphnia* is accepted almost universally by temperate region limnologists. Baudouin and Scoppa (1974) mention that *Daphnia* is common everywhere in suggesting it as a suitable assay organism. Ivlev (1937) considered *Daphnia* the most important food for planktivorous fish and Galbraith (1975) used the large *Daphnia* as indices of fishing quality for rainbow trout. Yet *Daphnia* is missing or very rare in tropical countries. Only two small cyclopoid Copepoda and one or two regionally different Calanoida seem to occur in most tropical regions.

If we compare the size spectrum of limnetic Cladocera and Copepoda from tropical and temperate regions, again we see a marked difference between the two regions. The lower end of the size range is occupied in both regions by Cladocera like *Bosminopsis dietersi* and *Bosmina* spp. (Circa 0.4 mm in length). The largest tropical Cladocera are *Daphnia lumholtzi* and *Diaphanosoma* spp. (Circa 1.3 mm in length) while in temperate regions the *Daphnia* spp. often found in the zooplankton measure up to 5 mm in length and generally 2.5—3.0 mm in length. Both the common cyclopoids in tropical lakes are also $<$1.3 mm in length, much smaller than their temperate counterparts (*see*) Burgis et al. 1973). The calanoids which are rare in lakes in South-East Asia may measure upto 1.8 mm. in length including the furca.

The species size and spectrum of limnetic Cladocera and Copepoda is markedly smaller in the tropical region than in the temperate regions. The size spectrum is restricted at the upper end of the scale in tropical zooplankton communities. This applies mainly to the Cladocera and to a lesser extent perhaps to the Copepoda. An attempt will be made to explain these differences by considering the likely factors influencing species and size composition of the zooplankton.

Factors influencing Species and Size Composition

There are a number of factors which in differing combination could account for the species and size composition differences between temperate and tropical zooplankton. The most obvious factors involved are food and temperature. This includes direct and indirect effects. Predation by vertebrates and invertebrates has also been shown to have a marked impact on size and species composition of zooplankton. Also size influences predation.

Daphnia spp. differ greatly in prominence. In temperate regions they comprise one of the dominant zooplankton groups and in the tropics they are relatively insignificant. Also *Daphnia* has been studied extensively both in the field and in the laboratory. *Daphnia* spp. are filter feeders In tropical lakes there is often a predominance of large bluegreen algae. Burgis (1973) mentions that filter feeding Cladocera in Lake George, Uganda may be limited by lack of small algal particles. However this would apply to most Cladocera including the genera *Ceriodaphnia*, *Diaphanosoma* and *Moina*. Also Lewis (1974) found that in Lake Lanao, Philippines only 19.3% of the cell volume consisted of blue green algae. No *Daphnia* occur in Lake Lanao, Lake Touwiti, Lake Pozo and Lake Toba, the only large natural lakes in South-East Asia. Temperature has many direct and indirect effects on the survival and abundance of *Daphnia*. Burns and Rigler (1967) found that the feeding efficiency of *Daphnia rosea* increases with temperature up to 20°C and then fell rapidly. Hall (1964) and Bell and Ward (1970) found that *Daphnia pulex* moves to the cooler regions of the lake when the temperature rises above 20°C. The fecundity of *Daphnia pulex* was shown to peak at 15°C and fall at higher temperatures (*LeSeur* 1960). Although no generalization can be made based on evidence for all temperate regions *Daphnia* spp. it seems likely that higher temperature is an important factor limiting them to their present range. Also it has been shown that feeding efficiency in *Daphnia* increases with increasing size (Burns and Rigler 1967) but the optimum size decreases with the rise of temperature (Lynch 1977). These results of the role of temperature and size have been substantiated by other workers namely Nauwereck (1959), Hall (1964), Hall et al. (1970) and Haney (1973). In the tropics the larger *Daphnia* would be selected against by the higher prevailing temperatures throughout the lake by lowering fecundity and reducing feeding efficiency. It is a fact that the species of *Daphnia* found in limnetic regions in the tropics are of small size. Burgis et al. (1973) comments on the small size of the Cladocera in Lake George, Uganda and mentions that the *Daphnia* sp. present, *D. barbata* is only slightly over 1 mm in length. A common limnetic *Daphnia* sp. found in the tropics (and the subtropics) is *Daphnia lumholtzi*. It is about 1.3 mm long as compared to the large *Daphnia* spp. in temperate regions which measure from 2.5–5 mm in length (*see* Brooks 1957, 1963 and Scourfield and Harding 1966).

Two recent reviews by Hall et al. (1976) and Lynch (1977) discuss size selection of zooplankton by predators and the size efficiency hypothesis. Predation by fish on the larger zooplanktons has been documented by Hrbacek (1962), Brooks and Dodson (1965), Galbraith (1967) and Well (1970) besides many other workers. The predation on smaller prey in the zooplankton by invertebrates has been dealt with by Monakov (1972, 1976) and by many workers including Brandl and Fernando (1974, 1975*a*, 1975*b*, 1978). Zaret (1975) has discussed the strategies of existence of tropical zooplankton.

The effect of intensive fish predation on zooplankton is stabilization of the prey size at the lowest level where survival is possible. On the other hand invertebrate predators feed on smaller individuals increasing the premium on rapid growth to as large a size as possible. In tropical lakes small size probably has an advantage due to prevailing high tempratures adversely affecting the larger *Daphnia* spp. The situation existing in tropical lakes is certainly a complex balance between various factors. Behaviour and pigmentation play an important part in predator-prey interactions (Zaret 1972*a*, 1972*b*. 1975). Increase in size by spines, helmets and horns have been resorted to by Rotifera (Gilbert and Waage 1967, Green et al. 1976) : Cladocera (Green 1967, Zaret 1969). When two " size forms " of a species occur together there is often selective predation on one "size form " (Green 1967, Zaret 1969, Brandl and Fernando 1978). The smaller forms were shown to have a higher predation but also a higher fecundity by Green (1967) and Zaret (1969).

The smaller species spectrum of tropical zooplankton in the case of Cladocera is probably due largely to higher temperatures influencing negatively the larger *Daphnia* species which form a major component of temperate zooplankton. The uniform temperatures existing throughout the year would also not favour a diversity of zooplankton species in general. There is predation of large zooplankton species by fish and smaller zooplankton by invertebrates. In the tropics the size spectrum of prey is much smaller than in temperate zooplankton. This is generally believed to be due to intense fish predation on zooplankton in the tropics. While this may occur due to higher activity of the fish and other factors it seems to be more likely that the upper portion of the size spectrum is limited by other factors as discussed earlier. An important consequence of this limitation of size spectrum is perhaps a higher competition by fish and invertebrate predators for the prey zooplankton. Burgis (1974) found that the production of the dominant zooplankton in Lake George, Uganda, *Thermocyclops crassus* was not particularly high when compared to the production of crustacean plankton species in temperate regions. It is possible that the zooplankton production in tropical lakes is low in general compared to that of temperate lakes. It is also noteworthy that *Thermocyclops crassus* feeds on blue green algae which is not eaten by *Daphnia barbata* in Lake George, Uganda (Moriarty et al. 1973). Some blue green algae may be toxic to zooplankton (Lefevre 1950). Higher plants and blue green algae may inhibit rotifers (Hasler and Jones 1949, Edmondson 1965). Hence the ability to feed and assimilate blue green algae and withstand their toxicity are perhaps of major importance to tropical zooplankton in shallow lakes especially.

The restriction of limnetic cyclopoid copepod species in any tropical region to two or three species only may be influenced by their ability to feed on blue green algae or be carnivorous like *Mesocyclops leuckarti*. Also the even high temperatures may reduce species diversity and eliminate cold water species in the same way as in *Daphnia* spp. and crustacean zooplankton in general.

It is interesting to note that the larger *Daphnia* spp. return to the limnetic zooplankton in the subtropical region and are also present in ponds in these regions. In Lahore, Pakistan, Arora (1931) found four species of *Daphnia*. In Pokhara, Nepal *Daphnia lumholtzi* and *D. longispina* are both present in a single lake (unpublished data). In Rajasthan, India, Biswas (1971) records three species of *Daphnia* and five species in Simla hills, India (Biswas 1966). In Lake Kariba (Zambia–Rhodesia), four species of *Daphnia* were recorded and in Cuba also four species of *Daphnia* occur. Shirota (1966), records four *Daphnia* spp. in South Vietnam. In more tropical areas like Surinam and Volta Lake,) Ghana no *Daphnia* were found (data supplied by Dr. V. Korinek, Charles University, Prague). Also in sub-tropical regions " temperate " species like *Daphnia magna ; D. longispina, D. hyalina* occur concurrently with the tropical limnetic species *D. lumholtzi* as in Nepal and Northern India or only " temperate " *Daphnia* spp. occur as in Cuba. It appears from the above data that high temperatures limit the occurrence of most *Daphnia* spp. either directly or indirectly.

Other Fauna

A wide range of invertebrates were collected with the Rotifera, Cladocera and Copepoda. They are listed with the percentage occurrence in each habitat type in Table 3. The sampling method used is strongly biased towards collecting small animals in the water column and those associated with vegetation. However the large number of samples should give some measure of the commonness, rarity or absence of certain groups of animals. Besides fauna in the water column and on vegetation, forms living on the surface of the bottom sediments would be collected.

Only the testacean protozoans could be identified in the preserved samples. *Arcella* spp. were the commonest while *Centropyxis* and *Difflugia* were far less common. *Hydra*, of which two species are known from Sri Lanka, was found occasionally. Rhabdocoeles were quite common in ponds but triclads were not recorded. Triclads are quite rare in tropical freshwaters. The statoblasts of ectoprocts float readily and were often collected. *Plumutella repens* appears to be much commoner than *Lophobodella carteri* from their records in plankton samples. Nematodes were often found in the samples where the bottom sediment had been stirred up. Oligochaetes were quite common and like the nematodes, Chironomidae, *Chaoborus* and Ostracoda they come from the superficial layer of the bottom sediments. *Chaoborus* is also planktonic. Ostracoda and Chironomidae were the most commonly recorded members of these groups followed by the Oligochaeta and *Chaoborus*. Oligochaetes were absent in the limnetic samples (lakes — 300 ha.) and *Chaoborus* was most often found in limnetic samples and rare in shallow habitats. Its occurrence in large reservoirs is only slightly less than the Chironomidae. Mendis (1965) found that *Chaoborus* (*Corethra*) had a higher standing crop (numerical) than the Chironomidae in the benthos. Darlington (1977) found the same order of dominance (biomass) of *Chaoborus*, Chironomidae and Oligochaetes in the benthos of Lake George, Uganda. Ostracoda comprise a numerous and widely occurring group in benthos. They are often ignored or mentioned only in passing because of real or imagined difficulties in diagnosing them to species. In the tropical regions Ostracoda are sometimes planktonic. They have been recorded in the plankton in Sri Lanka (Apstein 1907) ; Venezuela (Brehm 1939) ; Indonesia (Klie 1933, Ruttner 1943 and Green et al., 1976) and Africa (Cameroons) by Green et al. (1974). Dr. V. Hruska (personal communication) says that they were common in the plankton of a reservoir in Cuba. Only a few species are known to be planktonic and Mr. R. Victor (personal communication) says that the systematics of the Asian planktonic species is confusing. Also planktonic species appear to be " good " benthic species quite often.

The planktonic stages of the parasitic cyclopoid Copepoda were rare and found only in samples from reservoirs. Four genera are found in Sri Lanka namely *Ergasilus*, *Paraergasilus*, *Lamprogleana* and *Lernaea* (Fernando and Hanek 1973*a*, 1973*b*). Hydracarina were relatively common and appear in all types of habitats except flowing waters with almost the same degee of frequency. These animals are usually associated with vegetation but seem to be also common in the limnetic region judging from the present records. The remaining fauna were recorded only in a few of the samples. Conchostraca and Anostraca are usually found only in arid areas except for *Cyclestheria hislopi* which occurs in ricefields and reservoirs. It is according to Junk (1977) typically associated with vegetation. It is surprisingly quite rare in the samples and it was probably discarded because of its large size. Insect larvae and the adults and larvae of Hemiptera and Coleoptera were rare in the samples. However when a large net was used more of these larger fauna were collected by Fernando (1965) in a large lake margin.

If we compare these fauna with what would be axpected in a temperate region certain obvious differences are seen. There is an absence of triclads in the samples whereas in temperate regions this group would certainly have been recorded. There are also no Isopoda and Amphipoda in the

samples. These two groups are not common in the tropics as noted by Beadle (1976). However *Caridina* (Crustacea : Atyidae) not found in temperate waters occur in all types of habitats.

DISCUSSION AND SUMMARY

About 500 samples of freshwater zooplankton collected during 1965-1974 from Sri Lanka were studied in detail. The samples came from all parts of the island, include all types of freshwater habitat and cover all seasons of the year. Seven habitat types were disignated, namely ponds, reservoirs<300 and>300 ha, ricefields, villus (flood lakes), rivers and streams and miscellaneous habitats (usually small in extent and man-made). All the Rotifera, Cladocera and Copepoda were enumerated and the results analysed.

The zooplankton consists of a typical tropical assemblage. The Rotifera are characterised by the dominance of the genus *Brachionus* and *Keratella tropica*. However, unexpected species like *Kellicottia longispina* and *Keratella earlinae* considered temperate species were found. *Brachionus donneri* endemic to the Indian region was also found. The Cladocera species are fewer in number than in temperate regions and have three distinctly dominant species in the limnetic region, namely *Ceriodaphnia cornuta*, *Diaphanosoma excisum* and *Moina micrura*. These species are tropicopolitan and eurytopic occurring in lakes throughout the tropics and often dominating in the limnetic zooplankton. A few other Cladocera occur fairly commonly in the limnetic region. These are *Daphnia lumholtzi*, *Bosminopsis dietersi*, *Pseudosida bidentata*, *Chydorus eurynotus* and *Chydorus barroisi*. *Daphnia lumholtzi* and *Bosminopsis dietersi* seem to be truly limnetic. *Chydorus barroisi* and *Ch. eurynotus* probably occupy the same niche as *Chydorus sphaericus* which is occasionally found in the limnetic region of temperate lakes.

Two cyclopoid copepods dominate in the limnetic zooplankton. These are the herbivorvous *Thermocyclops crassus* and the carnivorous *Mesocyclops leuckarti*. Again these are tropicopolitan and occur in limnetic situations where they are the dominant cyclopoids. They are also eurytopic.

Only one calanoid was at all common, namely *Phyllodiaptomus annae*, a eurytopic species found in all types of habitats in Sri Lanka.

There are no clear-cut differences between the species compositon of the different habitats though ponds, small reservoirs and large reservoirs resemble one another more closely than the other habitats. The richest zooplankton fauna seems to be in ponds and small reservoirs.

The limnetic zooplankton of Sri Lanka is typical of the tropical region in species composition. This has been demonstrated by reference to previous work from Asia, Africa and South America. An attempt has also been made to explain the differences between tropical and temperate region zooplankton. The larger limnetic Cladocera which dominate the plankton in temperate regions and belong to the genus *Daphnia* are rare or absent in the tropics. The uniform high temperatures probably reduce species diversity and certainly select for smaller cladocerans. Fecundity is lowered in some *Daphnia* spp. by high temperatures (>20°C). Perhaps this applies to all large *Daphnia* spp. The uniform high temperatures of the habitats probably is partly responsible for the lack of diversity in the Copepoda too. But there appears to be a reasonably large number of Rotifera, although the number of " good " limnetic species given by Tonolli (1962) for a typical temperate lake has a much higher number than in Sir Lanka reservoirs>300 ha. Fish which feed on larger zooplarkters have a smaller size to deal with than in temperate zooplankton. Since invertebrate predators feed on smaller

zooplankton the size spectrum available to fish and invertebrates may overlap to a considerable degree causing competition to be severe. The elimination of larger zooplanktonic Crustacea in tropical lakes seems to be due largely to temperature effects. Predation by fish may play a subsidiary role.

The small number of typically limnetic zooplankton in tropical lakes is due certainly to the action of many factors including temperature and predator pressure. To this list must be added the food which is dominated by blue-green algae in the tropics and also the zooplanktons must be resistant to toxins produced by these algae. The interaction of algae, higher plants, zooplankton predators, zooplankton herbivores and fish predators cause the species composition to be in a state of dynamic balance. Individual species may show escape behaviour, searching ability, varying modes of predation, change in pigmentation and many other adaptations.

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TABLE I

Percentage Occurrence of Zooplankton Species in Different Water Bodies in Sri Lanka

Habitat	Ponds	Villus	Ricefields	Reservoirs < 300 ha	Reservoirs > 300 ha	Rivers and Streams	Miscellaneous Habitats
Number of Samples	85	10	54	159	98	24	43
Species							
Rotifera :							
**Anuræopsis coelata De Beauchamp ..	2.35	10.00		4.40	7.14	4.17	2.32
**A. fissa (Gosse)	20.00		3.70	14.47	12.24	8.33	16.28
**Asplanchna brightwelli Gosse ..	5.88	10.00	7.41	27.04	29.59		9.30
A. priodonta Gosse	2.35		1.85	1.89	2.04		
A. sieboldi (Leydig)	1.18		1.85	1.89	2.04		
Asplanchnopus multiceps (Schrank) ..	12.94	10.00	16.67	6.92			9.30
**Brachionus angularis Gosse ..	9.41		7.41	22.01	33.68	16.67	6.98
B. bidentata Anderson	1.18			1.89			4.65
*B. budapestensis Daday				0.63	1.02		
**B. calyciflorus Pallas	9.41	10.00	9.26	27.67	51.02	4.17	16.28
**B. caudatus Hauer	9.41		1.83	14.47	25.51	12.50	2.32
B. donneri Brehm				1.89	1.02		
B. falcatus Zacharias	9.41		5.56	38.36	69.39	16.67	4.65
**B. forficula Wierzejski	3.53	10.00	7.41	26.41	71.43	8.33	6.98
B. leydigi Cohn				2.52	1.02		4.65
B. nilsoni Ahlstrom		10.00		2.52	5.10		
**B. patulus Muller	34.12	40.00	27.78	10.69	6.12	8.33	30.23
B. plicatilis Muller	1.18						2.32
**B. quadridentatus Hermann ..	15.29	30.00	20.37	16.98	16.33	8.33	18.60
**B. rubens Ehrenberg	4.71		3.70	7.55	6.12	8.33	2.32
*B. sessilis Varga				0.63	1.02		
**B. urceus (L.)	7.06		1.85	7.55	5.10	8.33	4.65
B. urceolaris Muller	2.35			3.77	4.08		
Cephalodella forficula Ehrenberg ..	1.18		1.85	0.63			
C. gibba Ehrenberg	2.35			1.89	2.04		
Collotheca ornata	2.35		3.70	2.52	8.16		2.32
Colurella sp. Tschugunoff ..					8.33	2.32	
Conochilus unicornis Rousselet ..	7.00		14.67	2.32	3.06		9.30
Conochiloides dossuarius (Hudson) ..	1.18		1.85		3.06		2.32
*C. natans (Seligo)					1.02		
**Dicranophorus robustus Harring and Myers	12.94	10.00	3.70	11.32	2.04	4.17	2.32
**Diphenchlanis macrodactyla Hauer ..	3.53	10.00	3.70	2.52	2.04		6.98
**D. propatula (Gosse)	11.76	20.00	9.26	3.77	1.02	8.33	9.30
Epiphanes macroura (Barrois and Jaday) ..	1.18		1.85	1.26	13.26		
**Euchlanis dilatata Ehrenberg ..	37.65	40.00	48.15	32.70	1.02	25.00	44.19
E. incisa Carlin	1.18		5.56	0.63	3.06		4.65

Values below 0.5 are not included.
*Rare = < 2% (Total occurrence).
**Eurytopic = occur in at least six of the seven habitat types.
X = previous records only, not recorded in present study.

TABLE 1 (*Contd.*)

Percentage Occurrence of Zooplankton Species in Different Water Bodies in Sri Lanka

Habitat	Ponds	Villus	Ricefields	Reservoirs < 300 ha	Reservoirs > 300 ha	Rivers and Streams	Miscellaneous habitats
Number of Samples	85	10	54	159	98	24	43
Species							
E. meneta Myers			1.85				
E. oropha Gosse	4.71			1.26	1.02		
Eudactylota eudactylota (Gosse) ..	1.18		9.26	1.26	1.02	4.17	2.32
Filina camascela Myers				0.63	4.08		
F. longiseta (Ehrenberg)	1.18		1.85	8.80	11.22	8.33	2.32
F. opoliensis (Zacharias)	3.53			10.69	26.53		
F. pejleri Hutchinson	5.88			5.66	22.44	12.50	
F. terminalis (Plate)	1.18		1.85	8.18	9.18	4.17	4.65
* Floscularia ringens L.				0.63	1.02		
Hexarthra intermedia Wiszniewski ..	2.35			22.64	30.61	12.50	
H. mira Hudson	2 35			3.77	3.06		
Horaella brehmi Donner				3.14	5.10		
Kellicottia longispina Kellicot ..				1.26	2.04		
Keratella cochlearis (Gosse) ..			1.85	4.40	8.16		
K. earlinæ Ahlstrom	2.35				2.04	4.17	
K. lenzi Hauer				2.52			
K. taurocephala Myers					2.04		
**K. tropica Apstein	11.76	40.00	14.81	41.51	80.61	20.83	6.30
Lecane bifastigata Hauer	1.18			1.26			2.32
L. ceylonensis Chengalath and Fernando ..	4.71		3.70	3.14			4.65
L. crepida Harring	4.71		3.70	3.14			4.65
L. curvicornis Murray	12.94		7.41	8.18		4.17	23.26
*L. curvicornis var miamiensis Myers ..	1.18			0.63			
L. elsa						4.17	4.65
L. hastata Murray		20.00		1.89			4.65
**L. hornemanni Ehrenberg.. ..	10.59	30.00	7.41	5.66	2.04	4.17	9.30
**L. leontina (Turner)	20.00	20.00	12.96	12.96	6.12	16.67	18.60
L. Ludwigi (Eckstein)	3.53	10.00		1.89			
**L. luna (Muller)	32.94	60.00	22.22	23.27	14.29	16.67	39.53
L. ohioensis Herrick	7.06		3.70	1.89			4.65
**L. papuana Murray	20.00	10.00	14.81	13.21	6.12	16.67	20.93
*L. plesiaides Chengalath and Fernando ..			1.85				
**L. pleonensis Vigot	9.41	20.00	5.56	6.92	1.02	8.33	20.93
*L. pusilla Harring	1.18						
**L. ungulata (Gosse)	23.53	10.00	27.78	14.72	5.10	8.33	23.26
L. verecunda Harring and Myers ..	2.35	10.00	1.85	0.63		4.17	

Values below 0.5 are not included.
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TABLE 1—(*Contd.*)

Percentage Occurrence of Zooplankton Species in Different Water Bodies in Sri Lanka

Habitat	Ponds	Villus	Rice fields	Reservoirs < 300 ha	Reservoirs > 300 ha	Rivers and Streams	Miscellaneous habitats
Number of Samples	85	10	54	159	98	24	43
Species							
L. sympoda Hauer	5.88		1.85				11.63
*L. syngenes Hauer	1.18						
**L. bulla (Gosse)	50.59	60.00	42.59	44.65	40.82	58.33	58.14
**L. closterocerca (Schmarda) ..	7.06	10.00		6.92	1.02	12.50	4.65
**L. decipiens (Murray)	9.41	10.00	1.85	4.40	2.04	4.17	6.98
**L. elachis Harring and Myers ..	4.71	10.00	7.41	1.26	1.02		11.63
L. furcata Murray	1.18		3.70				
L. hastata (Murray)	1.18						
**L. lunaris (Ehrenberg)	16.47	30.00	7.41	9.43	9.18	4.17	13.95
*L. lanka Chengalath and Fernando ..			1.85				
L. obtusa (Murray)	1.18			1.89	3.06		
L. pyriformis (Daday)	5.88			1.89			6.98
**L. quadrindentata (Ehrenberg) ..	8.24	20.00	7.41	6.29		12.50	13.95
L. stenroosi (Meissner)			3.70	3.14	2.04		2.32
**L. unquitata Fadeew	12.94	40.00	11.11	13.21	5.10	12.50	32.56
Lepadella costata Wulfert ..	1.18						2.32
**Lepadella ovalis (Muller)	8.24		1.85	1.89	1.02	8.33	6.98
**Lepadella patella (Muller)	9.41	20.00	1.85	1.89	1.02	4.17	6.98
Lepadella rhomboides (Gosse) ..	4.71			0.63	1.02		2.32
*Lepadella triba Myers			1.85				
Macrochaetus collinsi (Gosse) ..	2.35	1.85	1.26	1.02			
M. sericus (Thorpe)	2.35		3.70	1.89	1.02		
Monommata sp.	2.35			1.26	1.02		2.32
Mytilina acanthophora Hauer ..						8.33	
M. bisulcata (Lucks)	3.53			1.26			
M. mucronata (Muller)	1.18			2.52	1.02		
**M. ventralis (Ehrenberg)	17.65	20.00	7.41	6.92	5.10	4.17	13.95
Notommata sp.	3.53		5.56	1.89	2.04		4.65
**Platyias quadricornis Ehrenberg ..	35.29		29.63	13.84	10.20	25.00	13.95
**Polyarthra dolichoptera Idelson ..	10.59		3.70	7.55	5.10	4.17	9.30
**P. vulgaris Carlin	8.24	20.00	1.85	16.35	20.41	16.67	4.65
**Pompholyx complanata Gosse ..	25.88	10.00	12.96	27.04	33.67	37.50	34.88
Scaridium longicaudum Muller ..	2.35		1.85	0.63			2.32
Sinantherina semibullata (Thorpe) ..	5.88		5.56	1.89	1.02		2.32
S. spinosa (Thorpe)	4.71		20.37	1.26	1.02		2.32
*Stephanocerus fimbriatus Goldfuss ..				1.26			
*Squatinella sp.				1.26			

Values below 0.5 are not included.

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TABLE I—(*Contd.*)

Percentage Occurrence of Zooplankton Species in Different Water Bodies in Sri Lanka

Habitat	Ponds	Villus	Riccfields	Reservoirs < 300 ha	Reservoirs > 300 ha	Rivers and Streams	Miscellaneous habitats
Number of Samples	85	10	54	159	98	24	43
Species							
Testudinella incisa (Ternetz)							2.32
T. parva (Ternetz)	4.71			1.26			4.65
**T. patina (Hermann)	29.41	30.00	24.07	18.24	9.18	20.83	25.58
*Trichocerca bicristata (Gosse)	1.18						
*T. braziliensis Murray	1.18						
T. chattoni (De Beauchamp)	1.18			1.26	4.08		
T. cylindrica (Imhoff)	3.53			4.40	5.10		
T. dixon-nuttali (Jennings)			1.85	0.63			
**T. rattus (Muller)	7.06	20.00	3.70	8.80	5.10	8.33	9.30
**T. similis (Wierzejski)	5.88	10.00		11.32	21.43	4.17	2.32
T. stylata (Gosse)			1.85	3.14	3.06		
*Tetrasiphon hydrochera Ehrenberg							2.32
Limnias ceratophylli Schrank							2.32
Limnias mellicerta Wiesse							2.32
Trichotria pocillum (Muller)				0.63			2.32
Trichotria tetractis (Ehrenberg)	7.06		5.56	8.18	3.06		11.63
**Tripleuchlanis plicata (Levander)	10.59	10.00	5.56	3.77	2.04		6.98
*Trochosphaera equatorialis Semper							
Totals (Species) ..	98	37	71	105	89	49	73
Cladocera							
Sididae							
**Diaphanosoma excisum Sars	10.59	20.00	7.41	33.96	59.18		6.98
**D. sarsi Richard	35.29	10.00	11.11	15.09	9.18	16.67	18.60
**Pseudosida bidentata Herrick	18.82	30.00	18.52	11.92	22.45		18.60
Latonopsis australis Sars	2.35		7.41	1.26			11.63
Daphniidae							
**Ceriodaphnia cornuta Sars	34.12	30.00	37.04	33.33	72.45	29.17	20.93
Ceriodaphnia dubia Richard			1.85		5.10		2.32
Daphnia carinata King	2.35						
D. Lumholtzi Sars	1.18			6.29	21.42		
Scapholeberis kingi Sars	14.12	10.00	11.11	3.77			6.98

Values below 0.5 are not included.

*Rare = < 2% (Total occurrence).

**Eurytopic = occur in at least six of the seven habitat types.

X = previous records only, not recorded in present study.

TABLE I—(*Condt.*)

Percentage Occurrence of Zooplankton Species in Different Water Bodies in Sri Lanka

Habitat	Ponds	Villus	Ricefields	Reservoirs < 300 ha	Reservoirs > 300 ha	Rivers and Streams	Miscellaneous Habitats
Number of Samples	85	10	54	159	98	24	43
Species							
*Simocephalus acutirostratus King	1.18			0.63			
**S. vetulus Muller	12.94	20.00	18.52	10.06	3.06		13.95
Moinidae							
**Moina micrura Kurz	23.53	10.00	24.07	28.93	60.20	4.17	23.26
**Moinodaphnia mcleayi King	12.94		33.33	10.06	1.02	4.17	16.28
Bosminidae							
*Bosmina longirostris Muller	1.18						
*Bosmina sp.	1.18						
Bosminopsis dietersi Richard	1.18			13.21	12.24	4.17	
Macrothricidae							
Echinisca capensis Sars	1.18		3.70	5.66		4.17	6.98
**E. triserialis (Brady)	37.65	50.00	46.30	21.38	12.24	8.33	32.56
Grimaldina brazzai Richard							4.65
Gurnella raphaelis Richard	7.06						2.32
Gurneyella odiosa (Gurney)	7.06		11.11				
**Ilyocryptus spinifer Herrick	21.18	20.00	14.81	3.77	2.04	8.33	18.60
Macrothrix shadini Mukhamediev	2.35						
**M. spinosa King	15.29		24.07	5.66	1.02	16.67	13.95
Chydoridae							
*Alona costata Sars			1.85				
**A. davidi Richard	12.77	30.00	12.96	7.01	2.04	4.17	9.30
**A. guttata Sars	7.06		14.81	6.29	1.02	4.17	4.65
A. harpularia Sars	4.71		7.41	2.52	1.02		4.65
**A. monocantha Sars	9.41	10.00	5.56	3.77	3.06		4.65
**A. pulchella King	10.59	20.00	5.56	5.66	3.06		6.98
*A. setulosa Megard			1.85				
Alonella excisa Fischer	1.18		11.11	1.89	1.02		6.98
*Biapertura affinis (Leydig)				0.63			2.32
B. intermedia (Stingelin)	3.53		3.70	2.52	11.22		
**B. karua (King)	55.29	60.00	37.04	30.82	11.22	37.50	37.21
**B. verrucosa (Sars)	20.00	60.00	18.52	18.87	16.33	12.50	16.28

Values below 0.5 are not included.

* Rare = < 2% (Total occurrence).

** Eurytopic = occur in at least six of the seven habitat types.

X=previous records only, not recorded in present study.

TABLE I—(*Contd.*)

Percentage Occurrence of Zooplankton Species in Different Water Bodies in Sri Lanka

Habitat	Ponds	Villus	Ricefields	Reservoirs <300 ha	Reservoirs >300 ha	Rivers and Streams	Miscellaneous Habitats
Number of Samples	85	10	54	159	98	24	43
Species							
**Chydorus barriosi Richard	29.41	40.00	42.59	27.04	28.57	37.50	34.88
**Ch. eurynotus Sars	32.94	20.00	27.78	27.67	10.20	48.83	39.53
**Ch. parvus Daday	17.65	10.00	27.78	11.32	1.02	4.17	13.95
**Ch. sphaericus Muller	7.06		7.41	6.29	7.14	4.17	2.32
**Ch. ventricosus Daday	11.76	10.00	7.41	10.69	4.08		6.98
**Dadaya macrops (Daday)	10.59	10.00	11.11	3.77	1.02		6.98
**Dunhevedia crassa King	9.41		5.56	1.26	2.04	4.17	4.65
D. serrata Daday	4.88		1.85	1.89		4.17	6.98
Euryalona orientalis (Daday)	2.35		3.70	2.52			2.32
*Graptoleberis testudinaria (Fischer)	X						
**Indialona globulosa (Daday)	3.53	20.00	3.70	6.92	1.02	20.83	4.65
*Indialona macronyx (Daday)	X						
Kurzia longirostris (Daday)	10.59		1.85	3.77	2.04		
Leydigia australis Sars	4.71	30.00	3.70	8.80	4.08		6.98
L. acanthocercoides (Fischer)	3.53		1.85	1.26	2.04		2.32
Oxyurella sinhalensis (Daday)	2.35	10.00	16.67	5.03	1.02		
**Pleuroxus similis Vavra				1.26			
Pseudochydorus globosus (Baird)			1.85	0.63	1.02		
Total (Species)	48	22	41	43	36	20	38
COPEPODA							
Cyclopoda							
Ectocyclops phaleratus (Koch)	1.18		16.67		1.02		9.30
Eucyclops serrulatus (Fischer)	3.53		3.70	1.89		4.17	4.65
Macrocyclops distinctus (Richard)	2.35		5.56				2.32
**Mesocyclops leuckarti (Claus)	77.65	70.00	72.22	77.36	89.80	75.00	86.05
*Metacyclops minutus (Claus)			1.85				
*Microcyclops moghulensis Lindberg			1.85				
**Microcyclops varicans Sars	51.76	50.00	61.11	27.04	5.10	25.00	60.47
Paracyclops fimbriatus (Fischer)	1.18		5.56	0.63		4.17	4.65
**Thermocyclops crassus (Fischer)	25.88		16.67	20.13	48.98	16.67	44.19
**Tropocyclops prasinus (Fischer)	12.94	10.00	16.67	5.03	4.08	4.17	23.26
Tropocyclops confinis (Kiefer)				5.03			

Values below 0.5 are not included.

*Rare = < 2% Total occurrence.

**Eurytopic = occur in at least six of the seven habitat types.

X = previous records only, not recorded in present study.

TABLE I—(*Contd.*)

Percentage Occurrence of Zooplankton Species in Different Water Bodies in Sri Lanka

Habitat	Ponds	Villus	Ricefields	Reservoirs < 300 ha	Reservoirs > 300 ha	Rivers and Streams	Miscellaneous Habitats
Number of Samples	85	10	54	159	98	24	43
Species							
Harpacticoida							
Attheyella cigalensis Brady			3.70	0.63			
Elaphiodella bidens decorata (Schmeil)	1.18					8.33	
**E. grandidieri Guerne and Richard	7.06	10.00	14.81	4.40	7.14	4.17	2.32
Calanoida							
Eudiaptomus cinctus (Gurney)	1.18	10.00		2.52	1.02		2.32
E. drieschi (Poppe and Mrazek)	5.88		7.41	7.55	2.04		4.65
Heliodiaptomus viduus (Gurney)	2.35	10.00		6.92	13.26		
*Megadiaptomus hebes (Kiefer)	1.18						
Paradiaptomus greeni Gurney	X						
Neodiaptomus schmackeri (Poppe and Richard) ..	11.76		1.85	12.56	24.48		4.65
**Phyllodiaptomus annae Apstein	35.29	50.00	16.67	51.57	68.37	20.83	27.91
Rhinediaptomus indicus Kiefer	3.53						
Tropodiaptomus australis Kiefer	8.24		5.56	5.03	17.35		4.65
**T. nielseni (Brehm)	12.94	40.00	1.85	3.77	4.08		13.95
T. doriae (Richard)	1.18			1.89			
Total (Species) ..	20	8	18	16	13	10	15

Values below 0.5 are not included.

*Rare = < 2 per cent (Total occurrence).

**Eurytopic occur in at least six of the seven habitat types.

X = previous records only, not recorded in present study.

TABLE II

Occurrences > 25 per cent of Zooplankton Species in Sri Lanka Freshwaters of Different Types

(Numbers rounded off to nearest whole number)

Habitat	Ponds	Villus	Ricefields	Reservoirs < 300 ha	Reservoirs > 300 ha	Rivers and Streams	Miscellaneous Habitats
Number of Samples	85	10	54	159	89	24	43
Species							
Rotifera							
Asplanchna brightwelli				27	30		
Brachionus angularis					34		
B. calyciflorus				28	51		
B. caudatus					26		
B. falcatus				38	69		
B. forficula				26	71		
B. patulus	34	40	28				30
B. quadridentatus		30					
Euchlanis dilatata	38	40	48	33		25	44
Filinia opopliensis					27		
Hexarthra intermedia					31		
Keratella tropica		40		42	81		
Lecane hornemanni		30					
L. luna	33	60					39
L. ungulata			28				
L. bulla	51	60	43	45	41	58	58
L. lunaris		30					
L. unquitata		40					33
Platyias quadricornis	35		30			25	
Pompholyx complanata	26			27	34	38	35
Testudinella elliptica	29	30					26
Cladocera							
Diaphanosoma excisum				34	59		
D. Sarsi	35						
Pseudosida bidentata		30					
Ceriodaphnia cornuta	34	30	37	33	72	29	
Moina micrura				29	60		
Moinodaphnia mcleayi			33				
Macrothrix triserialis	38	50	46				
Alona punctata		30					
Biapetura karua	55	60	37	31		38	37
B. verrucosa		60					
Chydorus barriosi	29	40	41	27	29	38	35
Ch. eurynotus	33		28	28		49	
Ch. parvus			28				
Leydigia australis		30					
Copepoda							
Mesocyclops leuckarti	78	70	72	77	90	75	86
Microcyclops varicans	52	50	61	27		25	60
Thermocyclops crassus	26				49		44
Calanoida							
Phyllodiaptomus annae	35	50		52	68		28

TABLE III

Percentage Occurrence of Some Genera, Species and Groups of Fauna in the Plankton Samples collected in Sri Lanka, 1965–1974

(The occurrence of more than one member of a group is listed as a single occurrence.)

Habitats	Rivers and streams	Ponds	Villus	Reservoirs < 300 ha	Reservoirs > 300 ha	Ricefields	Miscellaneous Habitats
Number of Samples	24	85	10	89	159	54	43
Genera, Species and Groups							
Protozoa							
*Difflugia	12	02	—	—	02	—	—
*Arcella	58	44	03	23	37	31	44
*Centropyxis	50	01	—	02	08	05	14
Coelenterata							
Hydra	—	04	—	02	04	—	07
Platyhelminthes							
Rhabdocoela	—	82	—	02	04	10	14
Tricladida	—	—	—	—	—	—	—
Ectoprocta							
*Plumatella repens L.	25	14	60	14	14	07	16
*Lophobodella carteri (Hyatt) ..	—	—	—	01	.06	—	—
Nematoda	25	16	40	01	15	15	14
Hirudinea	—	01	—	—	—	—	—
Oligochaeta	25	24	—	—	15	22	32
Mollusca	—	03	10	01	03	02	07
Conchostraca..	—	03	—	—	—	—	—
Cyclestheria hislopi (Baird) ..	—	02	—	—	.06	05	—
Anostraca	—	02	—	—	—	—	—
Ostracoda	20	55	60	.06	20	57	44
Decapoda (Caridina)	08	04	30	05	02	05	02
Insecta							
Ephemeroptera	—	11	30	03	08	24	14
Odonata	—	13	20	02	.06	12	20
Hemiptera	25	25	—	03	.06	06	20
Diptera							
Culicidae	12	09	—	01	02	20	23
*Chaoborus	—	03	—	17	04	—	02
*Chironomidae	58	37	—	20	23	44	37
Heleidae	04	03	—	01	02	12	07
Strationyidae	—	—	—	—	—	—	02
Coleoptera							
Hydrophilidae	—	06	—	—	—	—	—
Noteridae	—	03	—	01	.06	02	02
Dytiscidae	—	—	—	—	.06	15	02
Arachnida							
Hydracarina	20	20	20	22	23	20	18
Tardigrada	—	01	—	—	.06	—	02
Parasites							
*Paraergasilus brevidigitus Yin ..	—	—	—	01	01	—	—
*Ergasilus sp.	—	—	—	01	.06	—	—
*Lernaea cyprinacea L.	—	—	—	—	.06	—	—
*Lamproglena sinensis Yu.	—	—	—	—	.06	—	—

*Planktonic at some stage of life or throughout life cycle.

TABLE IV

Composition of the Cladoceran Fauna of Some South-East Asian Countries and Temperate Regions

(A comparison is also given of the limnetic species in tropical Asian and Holarctic regions. Tropical "India" is compared with Northern India. India = Indian sub-continent. The total number of Cladocera species in Indonesia is about 65 and in the Philippines 49 are known with a probable total of about 55.)

Area and Type	Tropical		Temperate		Planktonic Species		India	
	Sri Lanka	Malaysia	Britain	Ontario, Canada	Planktonic Species, Trop. Asia	Planktonic Species, Holarctic	Tropical	Temperate
Total No. of Species	56	58	88	92	10	36	62	52*
Families, Genera								
Holopedidae	0	0	1	1	0	1	0	0
Polyphemidae	0	0	3	1	0	3	0	1
Leptodoridae	0	0	1	1	0	1	0	1
Daphniidae								
Daphnia	2	1	10	12	1	18*	2	6
Ceriodaphnia	2	2	8	8	2	4	2	4
Others	4	3	5	5	0	0	3	1
Sididae								
Diaphanosoma	2	4	1	1	3	1	4	1
Others	2	2	2	6	0	0	3	1
Bosminidae	2	1	2	4	2	7*	2	2
Moinidae	3	3	3	1	1	0	4	2
Chydoridae	31	35	41	41	1‡	1‡	34	26
Macrothricidae	8	8	11	11	0	0	8	6

* Fauna poorly studied.

‡ In temperate regions, *Chydorus sphaericus* is often found in numbers in the plankton. In tropical South-East Asia *Ch. barroisi* is found instead.

TABLE V

The Occurrence of 10 Species of Cladocera and 2 Species of Cyclopoid Copepoda in Plankton Samples from a Variety of South-East Asian Lakes and Reservoirs

(All other species and the number of times they occur in samples are given similar numbers for the species listed are also given. Numbers in parentheses refer to the total number of species involved in the occurrences listed. The high values for Malaysian and Sri Lankan reservoirs indicate that littoral species were involved.)

Lakes, Reservoirs, Plankton	Individual Lakes						Groups of Lakes					
	Lake Toba, Sumatra, Kiefer (1933)	Lake Toba, Sumatra, Brehm (1933)	Lake Lanao, Philippines. Frey (1939), Lewis (1974)	Grand Lac, Kampuchea, Mizuno and Mori (1970)	Bhopal Lake, India	Lake Parakrama, Sri Lanka	Bhumipol Reservoir, Thailand	2 Malaysian Reservoirs, Lai and Chua 1976	Malaysian Reservoirs	Sri Lanka Reservoirs	Indonesian Lakes, Kiefer (1933)	Indonesian Lakes, Brehm (1933)
Number of Samples	3	?	?	?	28	7	5	?	33	98	16	12
Species												
Cladocera												
Diaphanosoma sarsi ..	—	+	—	—	—	+	+	+	+	+	—	+
D. excisum ..	—	—	—	+	+	+	+	+	+	+	—	+
D. modigliani ..	—	—	+	—	—	—	—	—	—	—	—	+
Ceriodaphnia cornuta	—	—	—	+	+	+	+	+	+	+	—	+
Ceriodaphnia dubia ..	—	—	—	—	—	—	—	—	—	+	—	+
Moina micrura ..	—	—	+	+	+	+	—	+	+	+	—	+
Bosmina longirostris ..	—	—	+	—	+	—	—	—	—	+	—	+
Bominopsis dietersi ..	—	—	+	+	—	—	—	—	+	+	—	+
Daphnia lumholtzi ..	—	—	—	—	+	+	—	—	+	+	—	—
Other Daphnia sp. ..	—	—	—	—	—	—	—	—	+	—	—	—
Total Occurrences												
Species × Occurrences	Only Copepoda				68	20	13		53	235	Only Copepoda	21
Other Species than above												
Species × Occurrences		1	0		16	6	1	2	97	154		4
					(7)	(5)	(1)	(2)	(32)	(29)		(3)
Cyclopoid Copepoda												
Thermocyclops crassus	+		+	+?	+	+	+	+	+	+	+	
Mesocyclops leuckarti	+		+?	+	+	+	+	+	+	+	+	
Total Occurrences												
Species × Occurrences	6	Only Cladocera	?	2	54	9	9	?	127	138	28	Only Cladocera
Others Species than above												
Species × Occurrences	1		?	?	0	1	0	0	36	10	6	
	(1)					(1)			(4)	(3)	(3)	

APPENDIX I

Sampling Localities in Sri Lanka 1968–1975

The type of habitat is indicated as follows : 1. Rivers and Streams ; 2. Ponds ; 3. Villus (Natural habitats) ; 4. Lakes > 300 ha ; 5. Lakes < 300 ha ; 6. Ricefields (Manmade habitats) ; 7. Miscellaneous habitats :— Wells, Gem pits, Rainpools, etc. Provinces : Central (C) ; Sabaragamuwa (Sab) ; Eastern (E); Southern (S); Western (W); North Western (NWP) ; North Central (NCP) ; Northern (N) ; Uva (Uva). 1965 samples collected by Dr. D. G. Frey. Includes also miscellaneous samples collected before 1968.

1. Rivers and Streams

10. Battulu Oya (NWP) : 2. VI. 72, 15. X. 72, 25. VII. 72
11. Bolawalana, Wennappuwa (NWP), 16. III. 73
12. Belihuloya, (Sab) 16. VIII. 72
13. Buduruwagala aru, Baddelandeniyaya (Uva) 5. VII. 74
14. Dambullu Oya, Dambulla (C) 16. VI. 74
15. Hingulu Oya, Hingula (C) 4. VII. 74
16. Kala Oya (NCP) 15. VI. 74
17. Kottawa Nr. Galle (S) 9. XII. 73
18. Kubal Oya, Diyanawatte Kumbura (C) 22. XII. 73
19. Maha Oya, Amparai (E) 4. VII. 74
100. Madugoda, N.R. Mahiyannganne (C) 5. VII. 74
101. Maya Oya, Dambadeniya–Padiyatalawa Road (E) 5. VII. 74
102. Mirisgama Oya Dambulla—Anuradhapura Road. (C) 16. VI. 74
103. Moongal aru Nr. Mullativu (N) 22. IV. 74
103.1 Mullativu, Nandi Kadel Freshwater Entering Lagoon (N) 22. IV. 74
104. Mullativu-Paranthan Road Culvert 7/3 (N) 22. IV. 74
105. Mullativa–Paranthan Road before 4/9 Culvert (N) 22. IV. 74
106. Nochchiyagama (NCP) 15. VI. 73
107. Paranthan–Jaffna Road 26/1 (N) 22. IV. 74
108. Ratmaloya Nr. Madampe (Chilaw) (NWP) 28. XI. 73
109. Thanniyootu, Mullativu (N) 22. IV. 74
110. Uheliya Oya, Dumbara (Uva) 15. IV. 74
111. Yaticalan Oya, Bogahakumbura Near Kurunegala (NWP) 30. XI. 73

2. Ponds

20. Agampitiya (NWP) 16. III. 73
21. Anuradhapura, Lotus pond (NCP) 4. I. 65
22. Anuradhapura, pond in Moat (NCP) 5. V. 73
23. Anuradhapura, Pond Near Archaeological Museum (NCP) 5. V. 73
24. Badulla, Shannon Estate (Uva) 1. I. 65
25. Balangoda (Sab) 16. VIII. 72
26. Battulu Oya (NWP) 24. XII. 70
27. Battulu Oya, Coconut estate (NWP) 24. XII. 70
28. Batugedera Near Ratnapura (Sab) 19. VIII. 72
29. Bibilideniya Near Nattandiya (NWP) 18. VIII. 71
200. Bolawalana Panchchankuliya, (NWP) 16. III. 73
201. Bolawalana Panchchankuliya Pond 2 (NWP) 16. III. 73
201.1 Chavakachcheri–Karativu Road Jaffna (N) 26. XII. 73
202. Colombo, Queen Victoria Park (W) 31. XII. 64
202.1 Dothalla, Mahawewa, Hettipola (NWP) 16. XII. 72
203. Eppawela (NCP) 11. VIII. 72
203.1 Ensalwatte, Deniyaya (Sab)
204. Gurugoda, Millewa–Padukka Road (W) 23. XII. 72
205. Gurugoda Nr. Horana (W) 23. XII. 72

5—A 45286 (80/03)

206. Handapangala (Uva) 28. XII. 70
207. Horana Nr. Piliyandala (W) 23. XII. 72=210
207.1 Hunnelama, Mahawewa (NWP) 7. XII. 72
208. Ilavalai, Jaffna Peninsula (N) 17. XII. 71
208.1 "Jaffna" 1974 ; Pond 3 1974 ; Decemher 1975
209. Kahalla, Near Katugastota (C) 26. X. 72
210. Kahataduwa, Near Horana (W) 23. XII. 72
211. Kalpitiya, Near Paraidi (NWP) 15. X. 72
212. Kalpitiya (NWP) 25. VII. 71
213. Kammala, Near Wennappuwa (NWP) 6. III. 73
214. Kanneliya, Near Udugama (S) 14. VII. 72
215. Karainagar, Jaffna Near Jetty (N) 15. XII. 71
216. Kayts, Jaffna (N) 17. XII. 72
217. Kodikamam, Jaffna (N) 16. XII. 72
218. Madurankuliya Near Hindu temple (NWP) 15. X. 72
219. Madurankuliya, Lotus pond (NWP) 1. VI. 72
220. Madurankuliya, Pond 2 (NWP) 2. VI. 72
221. Mankumban, Near Mandativu, Jaffna (N) 17. XII. 71
222. Mannar (N) 18. XII. 70
223 to 225. Marawila, small ponds (NWP) 29. XI. 72 ; 6. XII. 72 ; 1. VII. 73
226. Marawila, Pitchchawarnala (NWP) 7. XII. 70
227 to 232. Marawila ponds (NWP) 6. XII. 70 ; 6. XII. 70 and 6. IX. 70 (2 samples) ; 22. VII. 72 ; 1. VI 73 ; 18. III. 73 ; 5. V. 73 ; 11. I. 74
233. Mullativu, on Jaffna road (N) 22. IV. 74
234. Mundel (NWP) 15. X. 72
235. Nainamadama Near Wennappuwa (NWP) 16. III. 73
236. Navakuli, Jaffna (N) 16. XII. 71
237. Nikeweratiya (NWP) 16. XII. 70
238. Nuwara Eliya, Park (C) 21. XII. 73
239. Nuwara Eliya (C) 27. VII. 71
240. Padeniya (NWP) 17. XII. 72
241. Padukka (W) 23. XII. 72
242. Palai, Jaffna (N) 22. IV. 74 ; 1974
243. Palavi (NWP) 25. VII. 71
244. Panagoda (W) 23. XII. 72
245. Piliyandala (W) 23. XII. 72
246. Piliyandala Near Horana (W) 23. XII. 72
247. Point Pedro, Jaffna (N) 16. XII. 71
247.1 Polgaswita-Piliyandala Road (W) 23. XII. 72
248. Polonnaruwa, Freshwater Fisheries Station (NCP) 13. III. 62 ; 3. 1. 65
249. Polonnaruwa Near Gal Vihare (NCP) 1. I. 65
250. Punkudativu, Jaffna (N) 17. XII. 71
251. Puttalam, small pond (NWP) 12. VII. 73
252. Puttalam, pond (NW) 12. VI. 73
253. Saranavai, Jaffna (N) 17. XII. 71
254. Tabbowa Near Puttalam (NWP) 25. VII. 71
255. Thanniyootu, Near Mullativu (N) 22. IV. 74
256. Thavady, Jaffna (N) 16. XII. 71
257. Theravai Near Mullativu (N) 22. IV. 74
258. Thiruwanaketiya Near Ratnapura (Sab) 19. VIII. 72

259. Unichchi (E) 28. 12. 70
259.1 Vaddukoddai, Jaffna ; (N) 26. VI. 74
260. Vaddukoddai, Jaffna ; temple pond (N) 15. XII. 71
260.1 Vaddukoddai ; Jaffna, (N) 3. I. 74
261. Waga (W) 31. XII. 70

3. Villus

30. Kale villu, Wilpattu (NWP) 10. IV. 73 (Saline ; no freshwater zooplankton)
31. Karapola villu, Near Polonnaruwa (NCP) 7.I.72
32. Kokkare villu, Wilpattu (NCP) 10. IV. 73
33. Marawila, smalll villu near sea (NWP) 24. II. 73
34. Marawila, Kudawatuwela villu (NWP) 1.I.74
35. Perybandi villu Wilpattu (NCP) 14. IV. 73
36. Nelunvillu, Wilpattu (NCP) 10. IV. 73
37. Panikkar villu Wilpattu (NWP) 11. IV. 73
38. Puttalam (Mahavillu) (NWP) 6. V. 73
39. Talawila villu, Wilpattu (NWP) 11. IV. 73

4. Reservoirs > 300 ha

40. Amparai tank (E) 3. VII. 68 ; 6. VIII. 69 ; 28. XII. 70 ; 5. VII. 74
41. Castlereagh reservoir (C) 10. VII. 68 ; 16. VII. 69
42. Chandrika wewa (Sab) 5. VIII. 68 ; 16. VII. 69 ; 27. XII. 70 ; 22. I. 71
43 to 44. Giants tank (Yodawewa), Mannar (N) 18. VIII. 68 ; 5. VII. 69 ; 18. XII. 70
45. Horaborawewa (Soraborawewa) (Uva) 10. XI. 72 ; 4. VII. 74
46. Iranamadu tank (N) 16. VII. 68 ; 3. III. 69 ; 22. III. 71
47. Kalawewa (NCP) 3. I. 65 ; 18. XII. 70 ; 3. VIII. 68 ; 6. VII. 69
48. Kandalama tank (C) 3. VIII. 68 ; 8. III. 69 ; 28. XII. 70 ; 16. VI. 74
49. Kantalai tank (E) 20. VIII. 68 ; 6. III. 69 ; 20. XII. 70
400. Mahakandarawa tank (NCP) 19. VII. 68 ; 20. XII. 70 ; 15. VI. 74
401. Maskeliya reservoir (C) 24. XII. 70
402. Minneriya tank (NCP) 3. VII. 68 ; 20. X. 69 ; 28. XII. 70
403. Morawewa (E) 19. VIII. 68 ; 5. VII. 69 ; 20. XII. 70
404. Nachchaduwa tank (NCP) 2. VIII. 68 ; 6. VII. 69 ; 18. XII. 70
404.1 Nagadeepa wewa (NCP) 1. X. 72 ; 10. XI. 72
405. Nalanda reservoir (C) 3. VIII. 68 ; 20. X. 69 ; 28. XII. 70 ; 15. VI. 74
406. Nalanda reservoir (littoral), little vegetation (C) 27. XII. 73
407. Nuwarawewa, Anuradhapura (NCP) 2. VII. 68 ; 6. VII. 69 ; 19. XII. 70 ; 12. VII. 72
408. Padaviya tank (NCP) 17. VIII. 68 ; 5. III. 69 ; 23. II. 71 ; 23. III. 71
409. Parakrama Samudra (NCP) 2. VIII. 68 ; 7. III. 69 ; 28. XII. 70 ; 6. I. 72 ; 4. III. 72
410. Parakrama Samudra (NCP) 27. X. 57
411. Pavatkulam (N) 17. VIII. 68 ; 4. III. 69
412. Ridiyagama tank (S) 28. I. 71
413. Senanayake Samudra (Uva) 3. VIII. 68 ; 6. VIII. 69 ; 28. XII. 70 ; 27. I. 71 ; 5. VII. 74
414. Tabbowa tank (NWP) 15. VIII. 68 ; 2. III. 69 ; 16. XII. 70 ; 22. III. 71 ; 31. V. 72 ; 5. V. 73
415. Udawalawe reservoir (Uva-Sab) 5. VIII. 68 ; 16. VII. 69 ; 22. XII. 70 ; 22. I. 71 ; 7. VII. 74
416. Unichchi tank (E) 4. VII. 68 ; 7. VIII. 69 ; 28. XII. 70
417. Vakeneri tank (E) 3. VII. 68 ; 7. VIII. 69 ; 28. XII. 70
418. Vavunikulam (N) 22. III. 71
418.1 Wirawila tank (S) 5. VIII. 68 ; 6. VII. 69 ; 27. XII. 70

Littoral Samples

419. Castlereagh reservoir (C) 23. XII. 70
420. Tabbowa tank (NWP) 31. V. 72
421. Udawalawe Reservoir (Uva-Sab) 27. XII. 70 ; 7. VII. 74

5. Reservoirs <300 ha

50. Agampitiya wewa (NWP) 16. III. 73
51. Ambiliwewa, Near Kurunegala (NWP) 9. VIII. 68
52. Anabulundawa tank, Near Hettipola (NWP) 11. VII. 71 ; 8. I. 72
53. Angunuwila tank (NWP) 12. VII. 71
54. Aranaganwila tank (NWP) 7. I. 72
55. Batalagoda tank (NWP) 2. VIII. 68 ; 8. III. 69
55.1 Batticaloa lagoon, Saline (E) 7. VIII. 69
56. Boralesgamuwa tank (W) 1. VIII. 68 ; 30. I. 70 ; 31. XII. 70 ; 3. XII. 72
57. Bulugala tank (C) 16. VI. 74
58. Chadiyantalawa tank (E) 27. I. 71
59. Colombo lake (Beira) (W) 31. XII. 64
500. Dambarawa tank (Uva) 4. VII. 74
501. Denagama tank (S) 23. I. 71
502. Dothalla tank (Mahawewa) (NWP) 16. XII. 72
503. Drassastraweliya tank (NCP) 3. I. 65
504. Dummaladeniya tank (NWP) 16. VII. 71
505. Dundambuwewa, Near Nochchiyagama (NWP) 16. VI. 74
506. Dunnage wewa, Near Narawila (NWP) 28. XI. 73
507. Eliya Divulwewa (NCP) 11. VIII. 72
508. Eluvankulam tank (NWP) 13. VI. 73
509. Ensalwatte, Near Deniyaya small catchment (Sab) 11. XII. 73
510. Eppawela tank ; littoral (NCP) 11. VIII. 72
511. Eppawela tank (NCP) 11. VIII. 72
512. Galwewa (NCP) 6. XI. 72
513. Gnanakulama, Near Maradankadawela (NCP) 16. VI. 74
514. Habarana tank (NCP) 2. I. 65
515. Handapangala (Uva) 5. VIII. 68 ; 10. VII. 69 ; 28. XII. 70
516. Hasalaka tank (C) 4. VII. 74
517. Hinidurawa tank (E) 27. I. 71
518. Horowapotana tank (NCP) 20. XII. 70
519. Kanakarasen tank (N) 23. III. 71
520. Kande ela reservoir (C) 23. III. 73
521. Kande ela reservoir, littoral (C) 23. III. 73
522. Kalatuwewa reservoir (W) 9. VIII. 68.
523. Kalluvil kulam (N) 22. IV. 74
524. Kandy Lake (C) 10. VII. 68 ; 13. III. 69 ; 24. XII. 70 ; 4. VII. 73
525. Kandy (Uduwatakelle tank) (C) 10. VIII. 68 ; 13. III. 69 ; 24. XII. 70 ; 4. III. 72 ; 28. XII. 72 ; 4. VII. 74
526. Katugahagalge tank, Near Buttala (Uva) 6. VII. 74
527. Katupotha tank, Near Battuluoya (NWP) 26. VIII. 68 ; 9. VIII. 71 ; 28. VIII. 72 ; 15. VI. 74
528. Kebittigollawa tank (NCP) 19. XII. 70 ; 23. III. 71
529. Kekirawa tank (NCP) 16. VI. 74
530. Kesbewa wewa (W) 1. VIII. 68 ; 31. XII. 70
531. Kilinochchi tank (N) 19. XII. 70
532. Kiribbanare wewa (Uva) 22. I. 71
533. Kondavattavam kulam (E) 5. VII. 74

534. Kumbukkan wewa (NWP) 15. VI. 74
535. Kurunegala wewa (NWP) 9. VIII. 68 ; 8. III. 69
536. Labugama reservoir (W) 9. VIII. 68 ; 31. XII. 70
537. Lahugala tank (E) 28. VIII. 72
538. Lindawewa, Near Nochchiyagama (NCP) 16. VI. 73
539. Lunuwila tank (NWP) 16. VIII. 71
540. Madampe, Near Chilaw (Kudawewa) (NWP) 8. VIII. 68 ; 26. VIII. 69
541. Madampe. Near Chilaw (Kudawewa) (NWP) 6. XII. 70
542. Madulla wewa (Uva) 17. XII. 72
543. Madampe, Near Chilaw (Mahawewa) (NWP) 16. VIII. 71
544. Madurankuliya tank (NWP) 2. VII. 72
545. Magalla wewa (NWP) 15. VIII. 68 ; 2. III. 69 ; 17. XII. 70
546. Mahaillupulama tank, littoral (NCP) 10. VIII. 72
547. Mahaillupulama tank (NCP) 10. VIII. 72
548. Maha Oya tank, Near Badulla (Uva) 5. VII. 74
549. Mahiyanganne tank (Uva) 5. VII. 74
550. Mapakada tank (Uva) 10. XI. 72 ; 4. VII. 74
551. Maradanmaduwa tank, Wilpattu (NWP) 11. IV. 73
552. Medawachchiya tank (NCP) 18. VII. 68 ; 4. III. 69 ; 19. XII. 70
553. Moonplains reservoir (C) 10. VII. 68 ; 15. XI. 68
554. Mundel wewa (NWP) 4. I. 65
555. Mylawa wewa (NWP) 30. XI. 73
556. Na-eliya tank, Near Battuluoya (NWP) 8. VIII. 68 ; 26. VIII. 68 ; 28. VIII. 70 ; 5. VIII. 72 ; 25. VIII. 72 ; April 1973
558. Naula tank (C) 15. VI. 74
559. Navagiriyawa wewa (E) 22. I. 71
560. Nochchiyagama wewa (NCP) 16. VI. 74
561. Norton Bridge reservoir (C) 11. VIII. 68 ; 15. VII. 69 ; 23. XII. 70
562. Nuwara Eliya lake, littoral (C) 23. XII. 70
563. Nuwara Eliya lake (C) 1. I. 65 ; 10. VII. 68 ; 15. XI. 68 ; 23. XII. 70 ; 1. X. 72
564. Pahalamaharagaswewa (NCP) 22. III. 71
565. Pahariya tank, Near Puttalam (NWP) 15. VI. 74
566. Pannegamuwa tank (S) 5. VIII. 68
567. Pelvehera tank (NCP) 2. I. 65
568. Pikulam, Near Mullativu (N) 22. IV. 74
569. Pinkattiya tank, Near Chilaw (NWP) 17. VII. 71 ; 11. VII. 71
570. Punewa tank (NCP) 22. III. 71
571. Punchivillu tank, littoral (NWP) 1. VI. 72
572. Punchivillu tank (NWP) 1. VI. 72
573. Punchuttuwa tank (NCP) 23. III. 71
574. to 575. Rambewa, (=Rambewewa) Near Nochchiyogama (NCP) 6. V. 73 ; 22. III. 71 : 15. VI. 74
576. Rotawewa, Keselpotha (Uva) 10. XI. 72
577. Sellakandel tank, Near Puttalam (NWP) 15. VI. 74
578. Sigiriya tank (C) 3. III. 72
579. Sooriya wewa (S) 22. I. 71
580. Tammana wewa, Near Puttalam (NWP) 5. V. 73
581. Tellula tank (Uva) 7. VII. 74
582. Thinipitiwewa, Near Chilaw (NWP) 22. VIII. 70 ; 16. VIII. 71 ; 15. X. 72 ; 3. IX. 73

583. Tirippane tank (NCP) 16. VI. 74
584. Timbiri wewa, Near Nochchiyagama (NCP) 376. V.
585. Tissawewa (NCP) 22. III. 71 ; 15. VI. 74
586. Thovaramudai, Near Nedunkeni (N) 2. V. 72
587. Udagamuwa tank, Near Buttala (Uva) 7. VII. 74
588. Udaliyagama tank, Near Kekirawa (NCP) 16. VI. 74
589. Ulankulama, Maradankadawela (NCP) 16. VI. 74
590. Urusita tank (S) 22. I. 71
591. Valiwewa, Near Nochchiyagama (NCP) 10. VI. 73
592. Walahapitiya wewa, Near Nattandiya (NWP) 30. XI. 73
593. Walagama tank (Uva) 27. I. 71
594. Watugahamulla tank, Near Chilaw (NWP) 30. XI. 73
595. Weeraketiya tank (S) 23. III. 71
596. Wennappuwa tank (NWP) 23. III. 71 ; 16. VIII. 71

6. Ricefields

60. Alankulama, Near Anuradhapura (NCP) 12. VIII. 72
61. Allipiddy, Near Mandativu (N) 17. XII. 71
62. Balangoda (Sab) 16. XII. 73
63. Battuluoya (NWP) 28. VIII. 72
64. Bellanwila, Near Ratmalana (W) 23. XII. 72
65. Belihuloya (Sab) 16. VIII. 72
66. Chavakachcheri Jaffna (N) 5. I . 75
66.1 Deniyaya (S) 13. XI. 73
67. Divulwewa, Near Anuradhapura 11. VIII. 72
68. Dothalla (NWP) 16. XII. 72
69. Ensalwatte, Deniyaya (S) 11. XII. 73
600. Galwewa (NCP) 6. XI. 72
601. Ganegama, Pelmadulla (Sab) 18. VII. 72
602. Horana (W) 23. XII. 72
603. Kaitadi, Jaffna (N) 16. XII. 71
604. Karainagar, Jaffna (N) 15. XII. 71
605. Kayts (N) 17. XII. 71
606. Kottawa, Near Galle (S) 9. XII. 73
607. Mandativu (N) 17. XII. 71
608. Manipay (N) 17. XII. 71
609. Matale (C) 2. I. 65
610. Mullativu-Paranthan Road (N) 22. IV. 74
611. Narawila, Near Nattandiya (NWP) 28. XI. 73
612. Nugegoda, Gangodawila (W) 22. XII. 70 ; 25. I. 71 ; 14. II. 71 ; 24. II. 71 ; 4. III. 71 ; 12. III. 71 ; 19. III. 71 ; 25. III. 71 ; 2. IV. 71 ; 1. VI. 71 ; 22. VI. 71 ; 30. VI. 71 ; 15. VII. 71 ; 22. VII. 71 ; 10. X. 71 ; 19. X. 71 ; 30. X. 71 ; 7. VIII. 72 ; 21. IX. 72
613. Pandeteruppu, Jaffna (N) 16. XII. 72
614. Padeniya (NWP) 17. XII. 72
614.1 Palai, Jaffna (N)
615. Pelmadulla, Ganegama (Sab) 19. VII. 72
616. Ratnapura (Sab) 19. XIII. 72
616.1 Ratnapura, Helanda, disused well in ricefield (Sab) 18. VIII. 72
617. Tabbowa (NWP) 3. V. 72
618. Vaddukoddai (N) 14. XII. 71

7. Miscellaneous Habitats

70. Angunuwila, Culvert (NWP) 15. VI. 74

71. to 72. Anuradhapura, Roadside ditches (NCP) 3. I. 65 ; 4. I. 65

73. Badulla (Legawatte estate), small water collection (Uva) 18. VIII. 72
74. Balangoda, disused well (Uva) 18. VIII. 72

75. Balangoda, drinking well (Uva) 16. XII. 73
76. Balangoda, small water collection (Uva) 15. VIII. 72

77. Battuluoya (Near Na-Eliya) well (MWP) 25. VII. 72
78. Battuluoya, deep well (NWP) 28. VIII. 72

79. Battuluoya, disused shallow well (NWP) 28. XII. 72
700. Battuluoya, disused well (NWP) 28. VIII. 72

701. Ensalwatte, Deniyaya, pool (S) 11. XII. 73
702. Helanda, Ratnapura, stagnant ditch (Sab) 18. VIII. 72

703. Helanda, Ratnapura, disused well (Sab) 18. VIII. 72
704. Iluvankulam, small water collection (NWP) 13. VI. 73

705. Kallundai, Jaffna, flood waters (N) 14. XII. 71
706. Kallundai, Jaffna, flood waters among plants (N) 14. XII. 71

707. Kalpitiya, slightly saline pool (NWP) 15. VI. 74
708. Kaludiyapokuna (Mihintale) rockpool (NCP) 16. VI. 74

709. Kirillipone Near Colombo, Quarry for road metal (W) 23. XII. 72
710. Legawatte (Badulla), well (Uva) 8. X. 72

711. Mundel, roadside pools (NWP) 4. I. 65
712. Madurankuliya, roadside pools (NWP) 15. X. 72

713. Mandativu, temple bath (N) 17. XII. 71

714. 715. 716. Marawila, ditches (NWP) 7. XII. 70 ; 8. XII. 70 ; 22. VIII. 72 ; 29. XII. 72

717. Meegoda, roadside pool (W) 23. XII. 72
718. Nochchiyagama, Lunic water hole (NCP) 15. VI. 73

719. Nugegoda, deep well (W) 21. IX. 72
720. Nuwara Eliya (Hakgala road), wayside pool (C) 1. X. 72

721. Pelmadulla, small water collection (Sab.) 17. VIII. 72
722. Puttalam, small water collection (NWP) 13. VI. 74

723. Puttalam (Anuradhapura road) small wayside pool (NWP) 15. VI. 74
724. Puttalam, burrow pit (NWP) 4. I. 65

725. Puttalam (Anuradhapura road) culvert (NWP) 6. V. 73
726. Puttalam (Colombo road) roadside ditch (NWP) 15. VI. 74

727. Ratnapura, disused gem pit (Sab) 18. VIII. 72
728. Ratnapura, wayside ditch (Sab) 22. VIII. 72

729. Ratnapura, gem pit in use (Sab) 18. VIII. 72
730. Ratnapura, small water collection (Sab) 18. VIII. 72

730.1 Seruvil, Velanai, Jaffna, Rainpool (N) 1974
731. Tabbowa (Puttalam), culvert (NWP) 5. V. 73

732. Timbolketiya, near Thanamalwila, wayside pool (Uva) 7. VII. 74
733. Totapola, Near Punduloya, well (C) 22. XI. 73

733.1 Ullankulama (Kalpitiya) very small water hole (NWP) 15. VI. 74
734. Vaddukoddai, wayside ditch (N) 14. XII. 71

735. Vellankadu (Kalpitiya) wayside ditch (NWP) 14. XII. 71

ADDENDUM

These samples collected by Dr. D. G. Frey were examined after the analysis for species composition was completed Repeats of previous localities mean additional samples :

1. Rivers and Streams

   14.1 Habarana-Polonnaruwa Road, Clear Stream (NCP) 3.I.65

2. Ponds

   244.1 Peradeniya, Botanical Gardens (C) 2.I.65
   244.2 Peradeniya, University Park (C) 2.I.65
   249.1 Polonnaruwa Near Parakrama Samudra (NCP) 3.I.65

4. Reservoirs $\geq$ 300 ha

   41. Castlereagh reservoir (C) 1.I.65
   402. Minneriya tank (NCP) 3.I.65
   405. Nalanda reservoir (C) 2.I.65
   407. Nuwarawewa, Anuradhapura (NCP) 3.I.65
   409. Parakrama Samudra (NCP) 3.I.65 (2 samples)
   420. Tabbowa tank (NWP) 4.I.65

5. Reservoirs $\leq$ 300 ha.

   59. Colombo lake (Beira) (W) 31.×I.64
   524. Kandy lake (C) 2.I.65 (2 samples)
   561. Norton Bridge Reservoir (C) 1.I.65
   563. Nuwara Eliya lake (C) 1.I.65 (5 samples)
   582. Thinipitiwewa, Near Chilaw (NWP) 4.I.65
   585. Tissawewa (NCP) 4.I.65

6. Ricefields

   609. Matale (C) 2.I.65

7. Miscellaneous Habitats

   71. Anuradhapura, Roadside ditches (NCP) 3.I.65