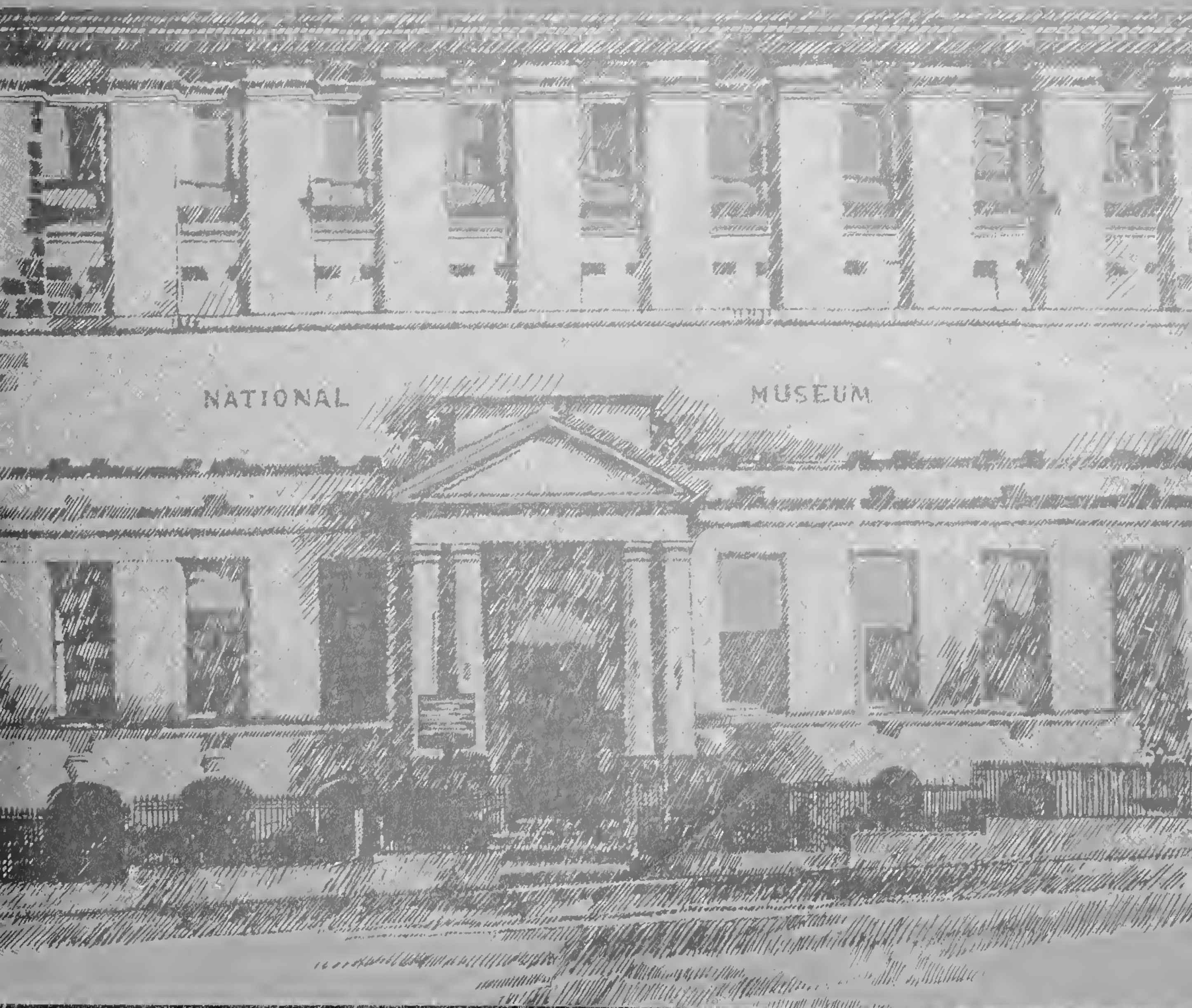
REPORTS of the NATIONAL MUSEUM of VICTORIA

No. 1 '1982'

MELBOURNE AUSTRALIA



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CONTENTS

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A QUALITATIVE STUDY OF THE MACROINVERTEBRATE FAUNA OF THE THOMSON RIVER AND ITS MAJOR TRIBUTARIES, GIPPSLAND, VICTORIA[1]

M.B. Malipatil* and J.D. Blyth

Biological Survey Department, National Museum of Victoria,
71 Victoria Crescent, Abbotsford, Victoria, 3067
(Address for reprints)

*Present address: Entomology Department, Northern Territory Museum of Arts and Sciences, P.O. Box 4646, Darwin, N.T., 5794.

ABSTRACT

The distribution and preferred habitats of aquatic invertebrates in the Thomson and Macalister River catchments were studied qualitatively over approximately 18 months, with eight collecting trips covering all seasons. Five hundred and twenty-eight taxa have been identified from within the study area. This total is made up of 410 insect taxa (excluding Chironomidae), 88 non-insect arthropods (including 70 species of Acarina, of which 75% are undescribed) and 30 non-arthropod invertebrate taxa. The maximum number of species of insects (excluding Chironomidae and Trichoptera) collected from a single station over the whole collection was 90, and from a single occasion was 42. Collections from the same station on different occasions never shared more than half of their species. Distinct differences existed between faunal assemblages of the Thomson and Macalister catchments. Physical and chemical conditions and faunal communities of rhithron and potamon were distinctly different. Normal and inverse classificatory analysis showed that rhithron stations formed three recognizable groups, and the relevance of this to a universal zonation pattern is discussed. Within the rhithron the fauna of pools was essentially made up of species preferentially occurring in riffle areas, while backwaters and banks supported a different assemblage of species including many lentic forms. Swamps and lagoons had faunae completely distinct from those of stream habitats.

INTRODUCTION

The Thomson River Study was designed to catalogue the distribution and preferred habitats of the aquatic invertebrates of the Thomson and Macalister River catchments. The work is a significant contribution to the Ministry for Conservation's Gippsland Regional Environmental Study because it provides background information on the local fauna, against which to assess the effects of the Thomson dam being built by the Melbourne and Metropolitan Board of Works.

Two impediments exist in Australia to the use of aquatic invertebrates in predicting and monitoring human impacts on aquatic systems. The first of these is the inadequacy of the taxonomy of many important freshwater groups, particularly for immature stages. However, the situation is improving rapidly, as shown by a comparison of the first and second editions of Williams (1968, 1980a), in which important references at the times of publication were reviewed. Other references to particular groups are given later in this study.

[1] This publication is number 300 in the Ministry for Conservation, Victoria, Environmental Studies Series.

Reports of the National Museum of Victoria, 1: 1-95 (1982).

The second problem is a lack of basic distributional, biological, and ecological information for aquatic populations and communities. Bayly and Williams (1973) noted only two published ecological studies on stream invertebrates in Australia. There has been considerable growth in freshwater biology in the ensuing eight years, but the ecology of stream invertebrates has still lagged behind taxonomy and zoogeography. The zoogeography and distribution of several groups has recently been summarized by various authors in Keast (1981), while Williams (1980b) has discussed biological monitoring studies in Australia, some of which have yielded useful ecological and distributional information.

Several other publications on the biology and ecology of stream macroinvertebrates in Australia are available, and the major ones are listed below:- Korboot (1963) on the larvae of five trichopteran species from south-eastern Queensland; Hynes and Hynes (1975) on plecopteran life histories; two short papers on drift during an eclipse of the sun by Cadwallader and Eden (1977) and Suter and Williams (1977); the ecology of *Paratya australiensis* (Williams, 1977); macroinvertebrate communities of a small stretch of the Mitchell and Wentworth Rivers by Ahern and Blyth (1978); Campbell (1980) on a siphlonurid mayfly; the biology of alpine planarians in Victoria (Hay and Ball, 1979); the ecology of immature Simuliidae in south-eastern Queensland by Colbo and Moorhouse (1979); and Bailey (1981a, b) on drift and activity patterns of some benthic invertebrates. The only catchment-wide survey comparable to this one was that on the Mitta Mitta catchment by Smith, Malcolm and Morison (1977, 1978). A number of other studies have been carried out, and remain as unpublished theses in various universities, or as unpublished reports. This study is only the second catchment-wide survey in Australia, and the first to be published with detailed community analysis.

Despite the gains over the last few years it remains true, as noted by Williams (1980c) that "ecological knowledge for almost all groups is grossly deficient". Not only is knowledge inadequate for monitoring and prediction, but many questions of general interest remain unanswered. This study addresses two such questions.

First, in the light of the depauperate nature of Australia's freshwater fish fauna (Williams, 1980d) and the apparent lack of diversity of the benthos of Australian lakes (Timms, 1980), is the macroinvertebrate fauna of Australian streams more or less diverse than that of northern temperate areas or tropical areas? Patrick (1961, 1964) and Patrick *et al* (1966), Bishop (1973), Stout and Vandermeer (1975), and Fox (1977) have compared the species richness of streams of tropical and temperate areas, but no assessment of the comparative richness of the Australian macroinvertebrate fauna has been made.

Secondly, can the zonation scheme of Illies (1961) and Illies and Botosaneanu (1963) be applied to Australian streams? Unpublished theses by Macmillan (1975), Bennison (1975), and Gooley (1977) suggest that at least the division into potamon and rhithron on the basis of faunal communities may be applicable in southern Australian streams.

The objectives of the study were:

(1) To provide base-line information on the invertebrates present and their distribution throughout the Thomson and Macalister catchments.

(2) To describe the main features of the fauna of particular habitat types.

(3) To compare faunae of the two major river systems in the context of abiotic characteristics.

(4) To examine communities of the main rivers and assess whether clear faunal zones exist, or whether community change results from gradual replacement of species along the length of the river.

(5) Using information gathered under objectives (2), (3) and (4), to define the major factors influencing invertebrate distribution, and to predict the likely impacts of dam construction and operation.

STUDY AREA

General Description

Vegetation, land use, geology, topography, Hydrology and water chemistry of the Thomson catchment are reviewed in Melbourne and Metropolitan Board of Works (M.M.B.W.) (1975). Figure 1 presents a map of the study area with all sampling stations marked, and Fig. 2 shows the longitudinal profiles of the Thomson and Macalister Rivers.

The Thomson River rises on the slopes of Mount Whitelaw at approximately 1220 metres elevation and along with its tributaries drains the northern and eastern sides of the Baw Baw Range. All stations above T23 are in areas of largely uncleared eucalypt forest, with typical riparian vegetation.

The Macalister River rises at an ele-

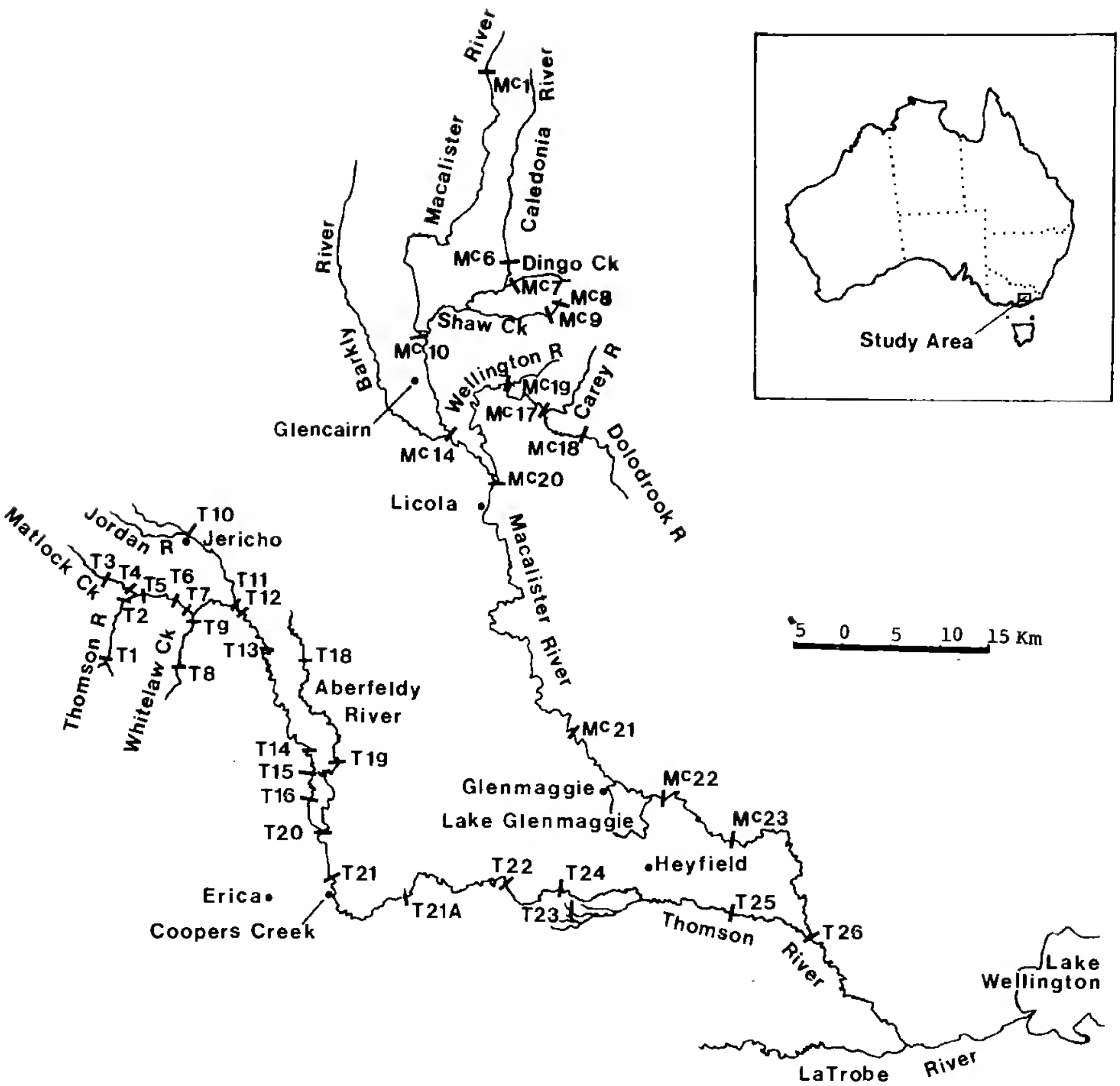


Fig. 1 Sampling stations on the Thomson and Macalister Rivers and their major tributaries.

vation of about 1600 metres on the southern side of Mount Howitt, and with its tributaries drains the western and southern slopes of the Snowy Range. Clearing of riverside vegetation commences around station Mc20.

Description of Major Aquatic Habitats

Five major habitats were recognized in the study area and are defined below. The separation of these habitats was based on current, depth, substratum, and type and abundance of food.

Riffle-rapid-runs: Usually shallow (up to 30 cm), current from moderate (70-140 cm/sec) to fast (140-280 cm/sec), occasionally swift or torrential (more than 280 cm/sec). The substratum was of eroding nature, composed of sand through to cobbles at varying proportions, depending on the current.

Patches of algae (either green filamentous or nodular) occurred on solid surfaces, and combinations of organic detritus (mainly decaying leaves and twigs), sand and silt were distributed under and among rubble and rocks. Amount and thickness of silt increased with decrease in current. Occasionally, in slower stretches, the entire substratum was covered with silt-algal carpet or algal slime.

Occasional clumps of sedge and other monocotyledonous macrophytes and floating vegetation were found at certain stations. Logs and branches of various sizes and stages of weathering occurred at several stations and supported a distinct fauna.

Pools: From 30 to 200 cm deep. Current was usually slow to moderate (14-140 cm/sec). Substratum was superficially of depositing type, with considerable accumulation of fine gravel, silt, and organic detritus, usually over solid rock, boulders or cobbles. Weathered logs, twigs and leaf litter (up to 10 cm deep) frequently occurred on pool beds.

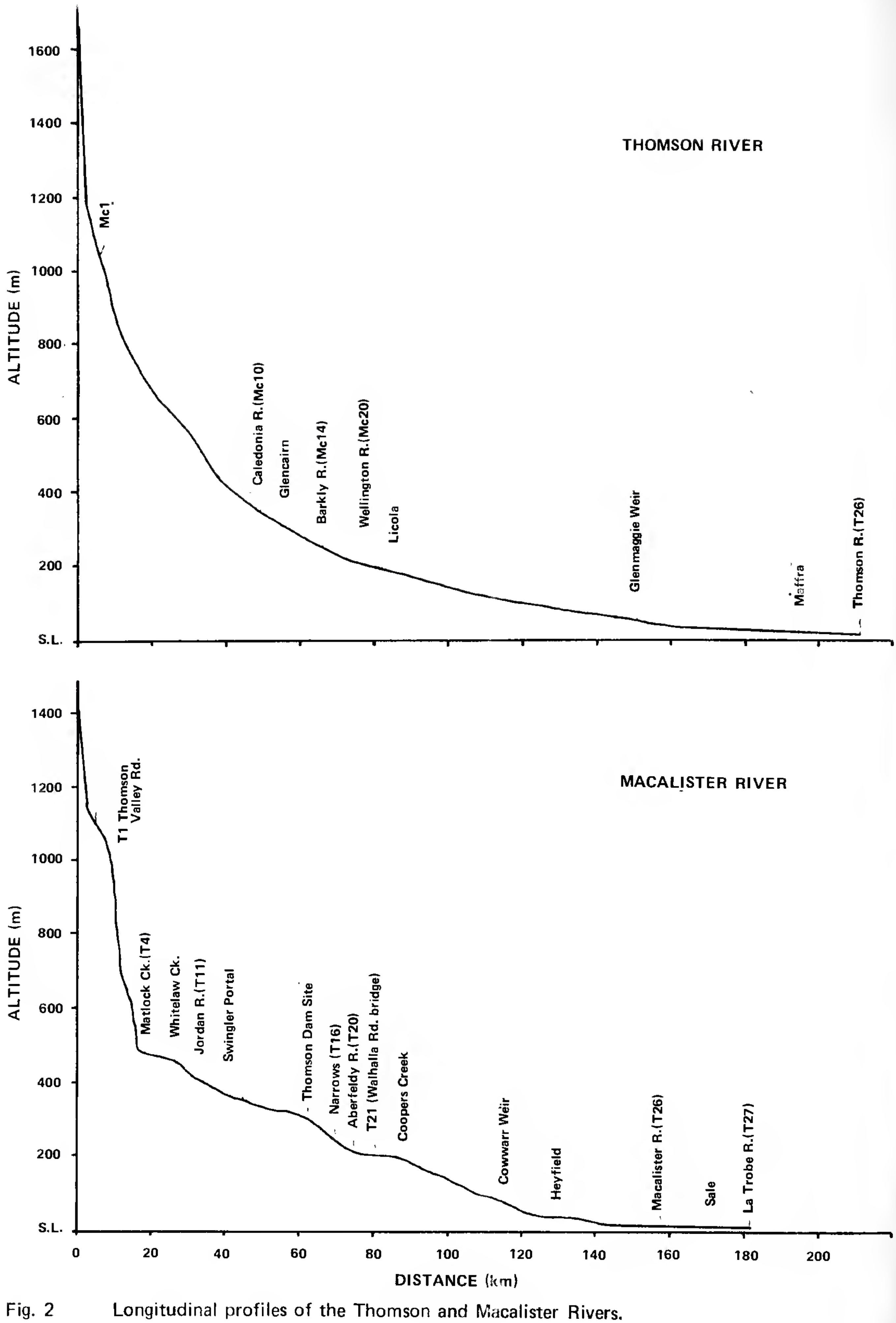


Fig. 2 Longitudinal profiles of the Thomson and Macalister Rivers.

Banks: Usually overgrown with terrestrial, semi-aquatic, and aquatic plants, or occasionally without any vegetation but with only rocky, gravelly and sandy bed. In certain stations (e.g. T26) there was some rooted vegetation, mainly sedge and aquatic macrophytes including water milfoil (*Myriophyllum* spp.) within 1 m of the water edge. Patches of organic material, including leaf packs and some filamentous algae were usually present. The current along banks was slow to moderate, and depth usually less than 30 cm, occasionally to 50 cm.

Backwaters: Still or slow flowing (less than 14 cm/sec), usually less than 30 cm, occasionally to 50 cm deep, with high silt and organic content in the substratum where aquatic plants can grow. Also there were logs, twigs and accumulations of organic litter, up to 15 cm deep.

Swamps and lagoons: Water shallow, not usually deeper than 50 cm, high in both dissolved and suspended organic matter with a dense and diverse flora of aquatic and semi-aquatic plants (see Appendices 1 and 2); substrata of clay and mud. At stations Mc8, T10, Mc17, and T26 only.

Sampling Stations

Forty-nine stations were selected, T1 to T26 on the Thomson River and Mc1 to Mc23 on the Macalister River (Fig. 1). Stations T17, Mc2 - 5, Mc11 - 13, Mc15 and Mc16 were not sampled during this phase of the study, chiefly because of difficulty of access.

The stations were divided *a priori* into three sections on the basis of altitude, topography and vegetation :-

mountain section; T1 - T10, Mc1 - Mc10;
foothill section ; T11 - T22, Mc11 - Mc21;
lowland section ; T23 - T26, Mc22 - Mc23 ;

Details on each station are given in Appendices 1 and 2. At each station the five major aquatic habitats described earlier were sampled.

PROCEDURES AND METHODS

Collecting Trips

Eight collecting trips were undertaken during the period November 1976 to March 1978 covering all seasons: 23 November - 6 December 1976; 8 - 20 February 1977; 1 - 8 May 1977; 12 - 18 August 1977; 27 September - 3 October 1977; 22 - 26 October 1977; 2 - 7 December 1977; 21 February - 2 March 1978.

Collecting Methods

Several methods were used to sample from a wide range of microhabitats including surfaces of stones, aquatic vegetation, sunken logs and accumulation of debris, over a stream length up to about 200 m at each station. Each method was applied in a consistent manner, over a standard time.

Aquatic Collecting

Kicking up the substratum (Hynes, 1961) in front of the mouth of a dip net with mesh aperture of 160 μm.

Brushing rock and log surfaces and other substrata such as algae, detritus and moss with a firm 5-cm paint brush in front of the mouth of a dip net as above.

Netting with a dip net with mesh aperture of 160 μm along banks, and in backwaters and billabongs within 1 metre of the bank. All the collecting in swamps and lagoons was done by netting.

Hand collecting along edges where the water was not deep enough for the operation of dip netting, and also on logs and rocks.

Terrestrial collecting

Adults of many aquatic insects are terrestrial or aerial. Sweeping and beating all types of vegetation, searching under stones, logs, piles of debris, etc. were used for their collection.

Light collecting

For collecting adult stages of certain aquatic insect groups such as Ephemeroptera, Trichoptera, Plecoptera and some families of Coleoptera and Diptera, light sheets illuminated by 400 watt mercury vapour bulbs powered by a generator were used for various lengths of time after sunset.

Sorting and Preservation of Specimens

Preliminary sorting of aquatic stages was done in the field, in water contained in white plastic or enamel trays. When field sorting was not possible due to lack of time the bulk samples were preserved in 5% formalin for later sorting in the laboratory.

Sorted specimens of different groups of invertebrates were fixed and preserved in their respective recommended medium, usually 75% ethanol. Water mites were preserved in GAW (100 parts glacial acetic acid with 400 parts distilled water and 500 parts glycerol). All soft-bodied specimens from terrestrial and light collecting were fixed and preserved in 75% ethanol. Sclerotized specimens such as adult Coleoptera, Hemiptera and Diptera were killed in ethyl-acetate vapour and dry mounted.

Identifications

Major invertebrate groups have been identified to species as far as possible using the literature and reference collection of the National Museum of Victoria. Several of the groups have been identified by their respective experts. Immature stages of some of the groups such as Odonata, Tipulidae, some Elmidae, and Nymphulinae could not be identified further than to family or subfamily level. In such cases presumptive species were allocated code numbers on the voucher specimen system. Voucher specimens of such species are briefly described and wherever possible figured, and deposited for future study in the working collection of the Biological Survey Department of the National Museum. Rearing immatures to adults in the laboratory enabled some species to be identified. All identified specimens have been deposited in the appropriate departmental collection of the National Museum of Victoria.

Physical and Chemical Methods

Physical and chemical measurements were determined in February 1977 and May 1977 by the M.M.B.W.

Temperatures were measured with a mercury thermometer, pH with a PYE Model 290 pH meter and glass electrode, and dissolved oxygen (D.O.) using a Yellow Springs D.O. meter. Water colour was determined with a Metrohm conductivity meter. Turbidity was measured using a Hach (Model 2100A) turbidity meter.

Suspended solids (S.S.) were determined by the increase in weight of the glass-fibre disc (Whatman GF/C) through which an appropriate portion of sample was passed and after drying at 105° C in an air oven.

Determination of hardness was by titration of the hardness producing cations, viz., calcium and magnesium with standard EDTA at a pH of 10, and alkalinity by titration with standard hydrochloric acid to pH 4.5 using a mixed indicator of methyl red and bromocresol green in alcohol (pH range 4.6 - 5.2).

PHYSICAL AND CHEMICAL ENVIRONMENT

Discharge and Current

Long-term mean daily flow, mean maximum daily flow, mean minimum daily flow and absolute historical minimum daily flow for each month of the year are presented in Appendices 3 - 5 for The Narrows and Coopers Creek stations on the Thomson River, and Glenmaggie on the Macalister River. These figures are based on continuous discharge data provided by the Hydrographics Section of the State Rivers and Water Supply Commission, Melbourne (S.R.W.S.C.).

Appendices 6 and 7 present data, also provided by the Hydrographics Section of S.R.W.S.C., relating both discharge and mean velocity to depth for The Narrows (T16) and Coopers Creek (between T21 and T21A), and for two Macalister River stations, Glencairn (between Mc10 and Mc14) and Lake Glenmaggie (Mc22).

Mean daily discharge in the Macalister at Lake Glenmaggie station is much higher for the months of April through to November than in the Thomson at Coopers Creek station. However, in December, January and February discharges at Lake Glenmaggie drop to below or almost equal to those at Coopers Creek. A sudden jump from summer levels below 400 Ml/day to over 850 Ml/day occurs in April in the Macalister, a month earlier than in the Thomson.

At discharges below about 350 Ml/day, mean velocities at Coopers Creek and Glenmaggie (the two lower sites) are similar but above 350 Ml/day the increase of velocity with discharge is much faster in the Macalister. Comparing the two more upstream gauging stations, The Narrows on the Thomson and Glencairn on the Macalister, mean velocity is slightly higher in the Thomson for similar discharges over the range of calculated velocities. Within the Thomson the ratio of velocity to discharge is generally higher at The Narrows than at Coopers Creek, especially at lower discharges. However, in the Macalister it is only at discharges over about 2,000 Ml/day that velocities at Glencairn start to become greater than those at Glenmaggie.

Depth to discharge ratio is greater at The Narrows than at Coopers Creek, while the situation is more or less reversed in the Macalister, with depth to discharge ratios actually greater at the lower site, Glenmaggie Weir, than at Glencairn.

Temperature

Temperature readings were not available for all stations and seasons. However, the temperature range in the Thomson River above Cowwarr Weir was from 6.7 to 15°C in autumn and 13 to 23°C in summer (Fig. 3), and in the Macalister River above Glenmaggie Weir the corresponding temperature ranges were 9.8 - 14.7° and 14.5 - 30° (Fig. 4). Generally, most of the stations on the Macalister River were slightly warmer than those on the Thomson River. This can be seen in Appendix 8 which was compiled from long-term records held by the S.R.W.S.C., and which gives monthly means for The Narrows and Coopers Creek (Thomson) and Lake Glenmaggie and Glencairn (Macalister). This difference is to some extent associated with the elevation, nature of beds and banks, etc. of these two rivers. Most of the Thomson River stations are at relatively high altitude, have narrow deep beds, and are situated in a deep valley. The Macalister River is wider, shallower and more exposed to the sun, so that at any Macalister station the water tends to be warmer than at Thomson stations of similar altitude. The general trend for increasing temperature with distance downstream is more obvious in the Thomson than in the Macalister. The Macalister has a number of apparently cooler tributaries joining it along much of its length.

There is evidence in the few readings taken (Fig. 4 and field observations not included herein) that at station Mc10 the Caledonia River is a cooler stream than the Macalister. The Caledonia is a narrow, steep, overshadowed stream for much of its length. Similarly, the comparative spot temperature readings throughout the survey also suggest that the Barkly is usually 1 - 2° cooler than the Macalister at their confluence.

Other Physical and Chemical Factors

Results discussed below are presented in Fig. 3 (Thomson stations) and Fig. 4 (Macalister stations).

The pH values ranged from 6.4 to 8.4 for the Thomson and 6.6 to 7.5 for the Macalister River. Swamps, with brown organically-stained water, at Mc8 and T10, had pH values of 5.5 and 6.3 respectively.

Water colour readings spanned a wide range: 7 to 110 (Pt units) in the Thomson and 10 to 36 (Pt units) in the Macalister stations. An obvious exception not included in the figures is the swamp at station Mc8 which, with dark humic brown water, had a reading of 250. Stations with colour units 50 and above were T1, T2, T6, T9, swamps at T10, T15, T25 and T26, which all had organically stained water, particularly the swamp at T10; T25 and T26 had high organic staining plus considerable suspended solids.

Levels of oxygen concentration were investigated only in summer and the data collected for the Macalister River are presented in Fig. 4. Oxygen levels in both the rivers ranged from 77 to 102% saturation, whereas in swamps at T10 they were 13-47% and at station Mc8 they ranged from 41-84% near the surface to 12.5-40% at 5-10 cm depths.

Turbidity readings ranged from 0.3 to 3.7 (Formazin turbidity units) in both these rivers but exceptions were the Thomson River at T26 (with a reading of 7.1), swamps at T10 (9.0) and Mc8 (10).

Suspended solids (S.S.) values greater than 5 (mg/l) were found at stations T6, T11 (Jordan River), T14, T15, T25, and T26 and Mc8. The swamp at T10 had an unusually high value of 94.

A big jump in hardness occurred at all sites in the May collection, while alkalinity was somewhat lower in May than in February. This is consistent with the comment by Buckney (1980) that the first flows at the beginning of the "wet season" are often chemically unusual due to accumulation and flushing out of soil chemicals. As areas of limestone are rare throughout the catchment (M.M.B.W., 1975) it may be expected that cations from the soil contributing to hardness would be in combination with anions other than carbonate and bicarbonate, so leading to an increase in hardness without a corresponding increase in alkalinity.

Conductivity readings from the Thomson ranged from 24 to 170 μmhos/cm at Thomson River stations (station T1 less than 71, the swamp at T10-75, and T25 and T26 greater than 75). The range at Macalister River stations was from 20 to 91 μmhos/cm.

Summary of Physical and Chemical Features

Figures 3 and 4 illustrate clearly the overall trend of increasing values with distance downstream for temperature, colour, turbidity, suspended solids, hardness, alkalinity and conductivity in both the Thomson and Macalister Rivers. Oxygen saturation showed the opposite trend. It is also notable that a temporary lift in conductivity, hardness, alkalinity, pH, turbidity and suspended solids occurred in the Thomson in one or both seasons at sites

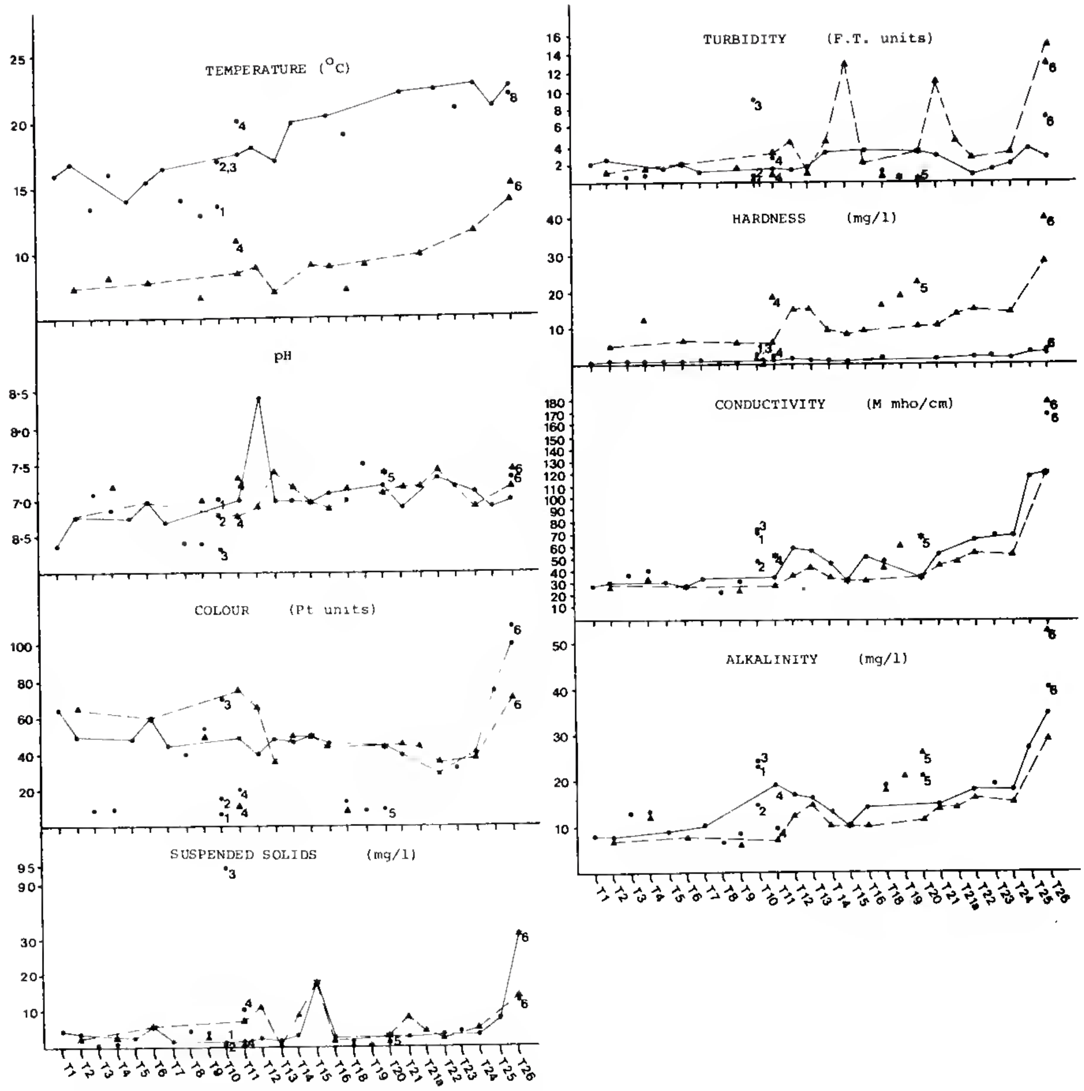


Fig. 3 Some physical and chemical features of the Thomson River. ●——●——● February 1977, ▲— — ▲— —▲ May 1977. 1 B B Creek, 2 Jordan River, 3 Swamp, 4 Jordan River, 5 Aberfeldy River, 6 Macalister River.

between T6 and T15. Construction sites at Thomson, Easton and Swingler Portals, as well as at the main dam site in May 1977, may have contributed to this result.

BIOLOGY OF SPECIES

Order Ephemeroptera

Nymphs

Nymphs of 34 species (in 13 genera) have been collected from the study area. Little literature exists on the nymphs of Australian Ephemeroptera and it has not been possible to identify further than to generic level. Species separation within each genus is presumptive, based on voucher specimens, until revisional studies on these nymphs and associated adults are attempted.

Distribution and habitats of all the species are given in Appendix 9; with station by station abundance, season of collection, and constancy in Appendix 10.

Atalonella, with 11 presumptive species, was the dominant mayfly genus in terms of species, while *Baetis, Centroptilum, Coloburiscoides* and *Tasmanocoenis* provided most individuals. Most taxa, with the exception of *Tasmanocoenis sp. 3* (common only in the Macalister) and *Atalonella spp. 3, 4, 5, 6, 7* and *8* (all of which were uncommon and occurred only in the Thomson) were widespread throughout the study area.

Twenty-two species occurred selectively in backwaters with *Tasmanocoenis* and *Atalophlebioides* being dominant genera, while ten taxa occurred selectively in riffle-rapid-runs, with *Centroptilum, Baetis* and *Coloburiscoides* being the most common.

The mean number of taxa of Ephem-

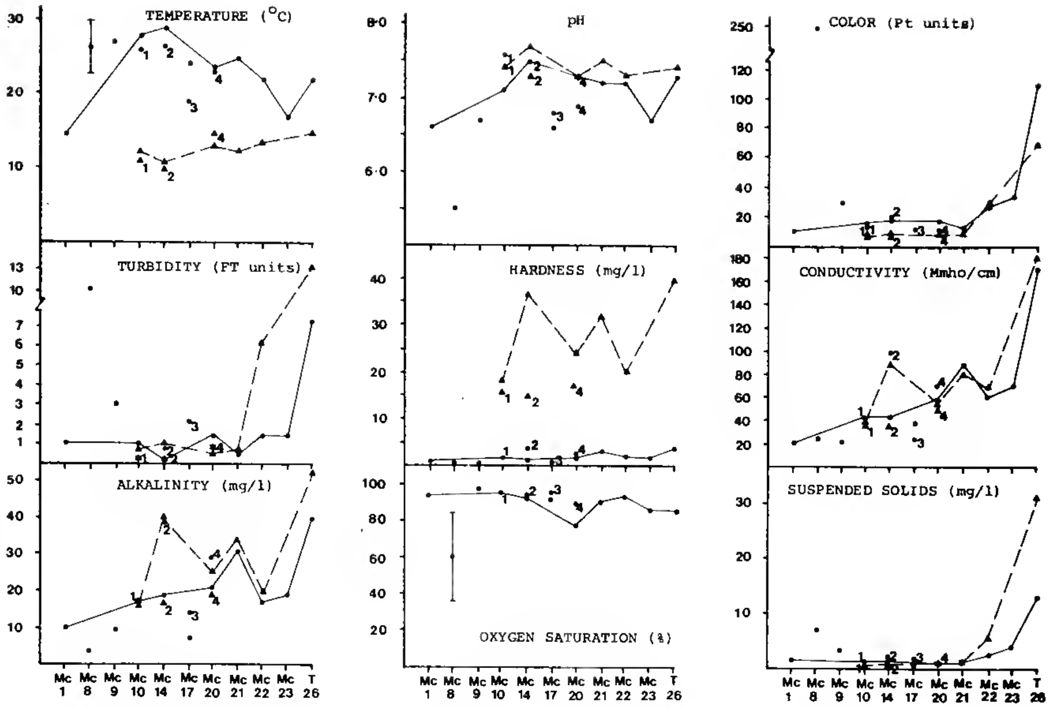


Fig. 4 Some physical and chemical features of the Macalister River. •——•——• February 1977, ▲— — ▲— —▲ May 1977. 1 Caledonia River, 2 Barkly River, 3 Wellington River, 4 Wellington River.

eroptera per station collected was 14.6, ranging from 19 at T11 and Mc20 down to 4 at Mc22.

In the Thomson River there were seven taxa with constancy values of 85 and over (Appendix 10), another eight species had values 50 to 85, while the remaining 19 species had values of less than 50. Of the respective constancy groups in the Macalister there were five, ten and 24. Constancy (C) is defined as -

$$C = \frac{a \times 100}{N}$$

where a = the number of stations collected from, and N = total number of stations.

Order Odonata

Nymphs

With the available literature it is not possible to identify most of the nymphs further than to family level. Some field-collected nymphs were reared in the laboratory to obtain the adults which are readily identifiable to species and consequently correlation of adults and nymphs was possible for some species.

Distribution and habitats of all the species are given in Appendix 11 and station by station abundance and constancy in Appendix 12.

Twelve species of Zygoptera and 19 of Anisoptera have been collected from the study area.

The anisopteran nymphs in general occur in much faster currents than the zygopteran nymphs. The latter are mostly restricted to shallow, still backwaters, billabongs, swamps and lagoons, whereas the majority of anisopteran species have normally been found in riffle-rapid-runs. However, both the Anisoptera and Zygoptera are always found attached to or sheltering among vegetation of various kinds, or under weathered logs, rocks and other solid objects where there is some entrapped organic matter.

Several species were collected only from plains stretches and/or lower foothills, and most headwater stations had particularly sparse odonate fauna.

The mean number of species per station of Odonata collected was 5.4, ranging from 11 at T26 and Mc21 to 1 at T4 and none at Mc1.

In the Thomson River, only *Aeshnidae sp. 1* and *? Synthemis eustalacta* have constancy values of 50 and over whereas in the Macalister River *Diphlebia* sp., Gomphidae sp. 1, Aeshnidae spp. 1, 2, 3, 6 and 8 have values of 50 and over (Appendix 12).

Adults

A list of species collected from the study area and their distribution are given in Appendix 13.

Order Plecoptera

Nymphs

Recently Hynes (1978) provided an annotated key to the 37 species (in 18 genera) of stonefly nymphs which are known to occur in Victoria. Of these, 28 species (*ca* 76% of the State total) in 15 genera (*ca* 83% of the State total) have been collected from the Thomson and Macalister Rivers. The stonefly fauna is dominated by the Gripopterygidae, providing 20 species, mainly wideranging in distribution and choice of habitat.

Life histories of many of the Victorian species have been studied by Hynes and Hynes (1975).

Distribution and habitat of all the species are given in Appendix 14. Distribution pattern of several of the species is shown in Figs. 5 - 12. Abundance at particular stations, seasons of collection, and constancy are shown for all species in Appendix 15.

The mean number of species of Plecoptera collected from particular stations was 11.7, ranging from 20 at T10 down to 1 at T26 and Mc22.

In the Thomson River there were two species with constancy values of 85 and over, another 13 species had values 50 to 85, while the remaining 13 had values of less than 50 (Appendix 15). In the Macalister River seven species had constancy values of 50 to 85 and the remaining 18 species had values of less than 50.

Figures 5 to 12 illustrate clearly the restriction to headwater and foothills sections of most species of Plecoptera, especially the Eustheniidae.

Order Hemiptera (Suborder Heteroptera)

A total of 36 species (in 17 genera) belonging to 10 families have been found to occur in the Thomson and Macalister Rivers.

Little is known of the biology and ecology of the Australian semi-aquatic and aquatic Heteroptera in general. In a series of papers on the taxonomy of the Australian fauna Hale (1922, 1923, 1924a, b, d, 1925, 1926) provided some bioecological data for several of the species, including some of those in the present study. General habitat information for some species of Australian Nepidae, Belastomatidae, Corixidae and Notonectidae was given by Campbell (1927) and McKeown (1943). Recently Malipatil (1980) provided some biological notes for all the species of *Microvelia* included in this paper.

Distribution and habitat data of all species are given in Appendix 16, with details of abundance, constancy and seasons of collection in Appendix 17.

Since the gerrid and veliid bugs are semi-aquatic, living on the water surface, the nature of the substratum is probably of no real importance. However, the vegetation (both overhanging and emergent) on the bank is of significance since it provides some kind of shelter against natural enemies. Distribution pattern of all the gerrid species is shown in Fig. 13.

The mean number of species of Heteroptera collected from particular stations was 7.3, ranging from 24 at T26 down to 1 at T9.

In the Thomson River there were five species with constancy values of 50 to 85, and the remaining 28 species had values of less than 50 (Appendix 17). Of the respective constancy groups in the Macalister there were 9 and 15.

As many as nine species were clearly restricted to the plains sections of the streams under study.

Order Megaloptera

Family Corydalidae

Two species, both belonging to the genus *Archichauliodes* have been collected from the study area.

Archichauliodes guttiferus guttiferus (Walker). This is the common corydalid in the Thomson and Macalister Rivers, and occurs over their entire lengths. Adults were collected only in winter and spring, and usually at light.
Distribution: T2 - 25; Mc1 - 23.
Larval Habitat:
Riffle-rapid-runs (R) ++++ (most common);
Pools & backwaters (P & Bw), ++;
Banks (B) + (least common).

Archichauliodes anagaurus Riek. Adults were collected at light in summer. No larvae were

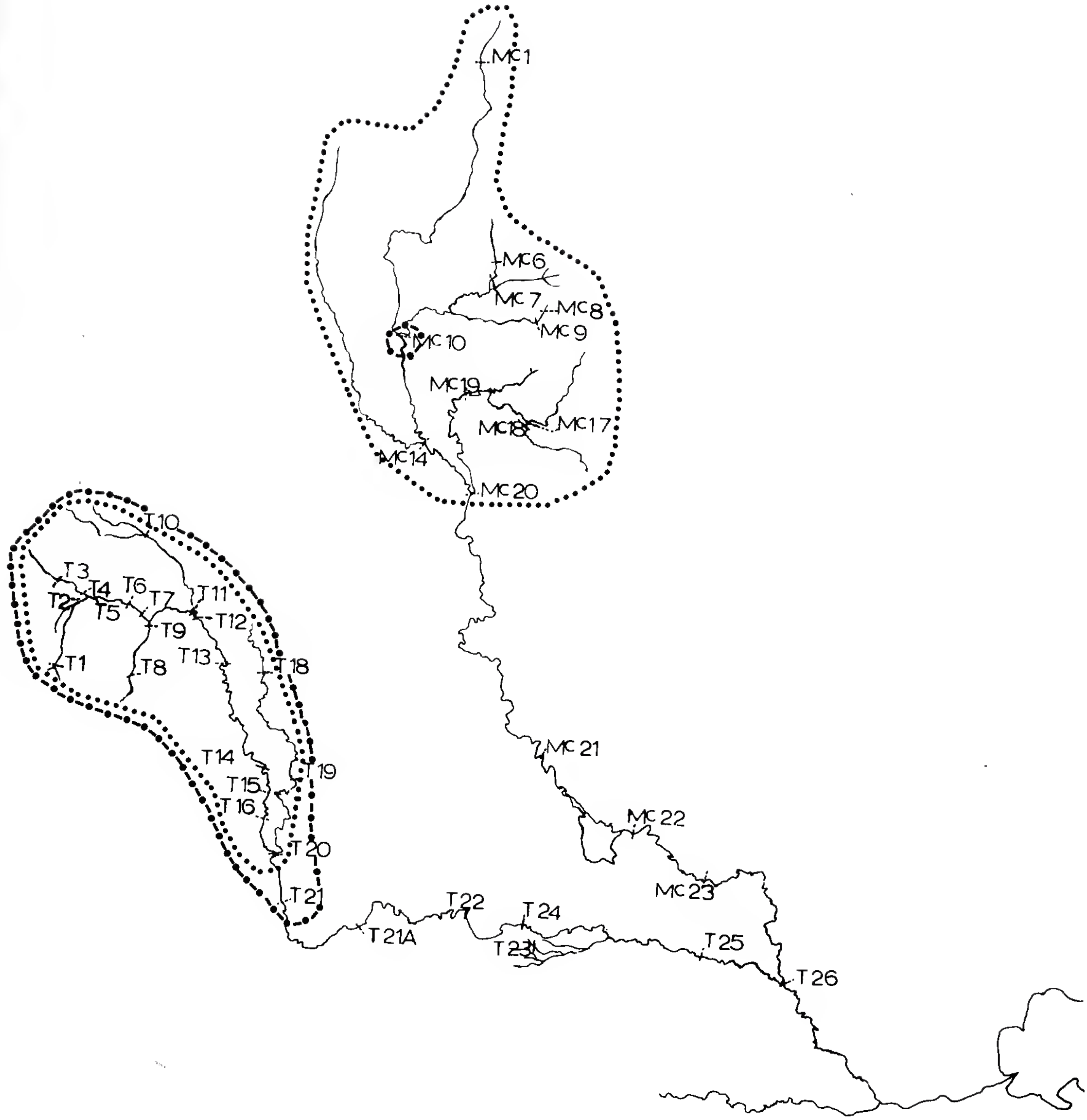


Fig. 5 Distribution of species of Eustheniidae.

collected.
Distribution: T4 & 13.

Order Neuroptera

Family Neurorthidae

? Austroneurorthus. New (1978) provided some larval habitat data of this presumed *Austroneurorthus,* based on specimens from Queensland and Victoria, the latter including one (collected in November 1976) from the present study. The following habitat details have been based on additional specimens collected during 1977 and 1978. The larvae of this species is fully aquatic (cf., Williams, 1980a). All the records indicate that the larvae occur in high altitude (greater than 400 m), moderate to fast flowing streams, with the bed consisting of pebbles, cobbles and rocks at varying proportions and with some entrapped organic matter, sand and silt beneath. The

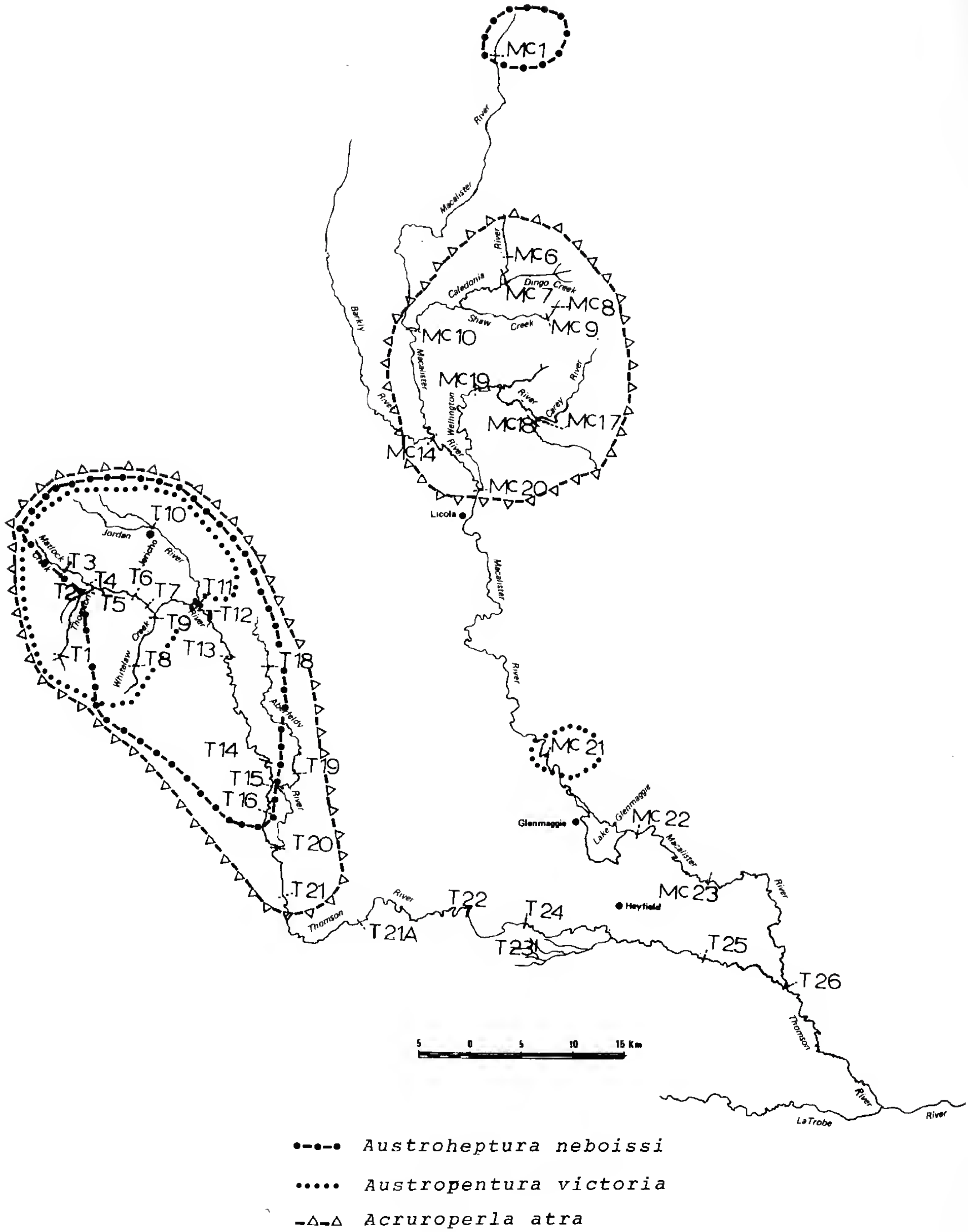


Fig. 6 Distribution of species of Austroperlidae.

larvae were also collected from organic stained water. All specimens were taken in 0-35 cm deep waters. No adults were collected.
Distribution: T2 - 9.
Habitat: (R) ++++; (P) ++.

Family Osmylidae

? Kalosmylus sp. The larvae are apparently semi-aquatic. They were taken by hand collecting under pebbles, cobbles and solid rocks, along edges and in backwater regions of streams,

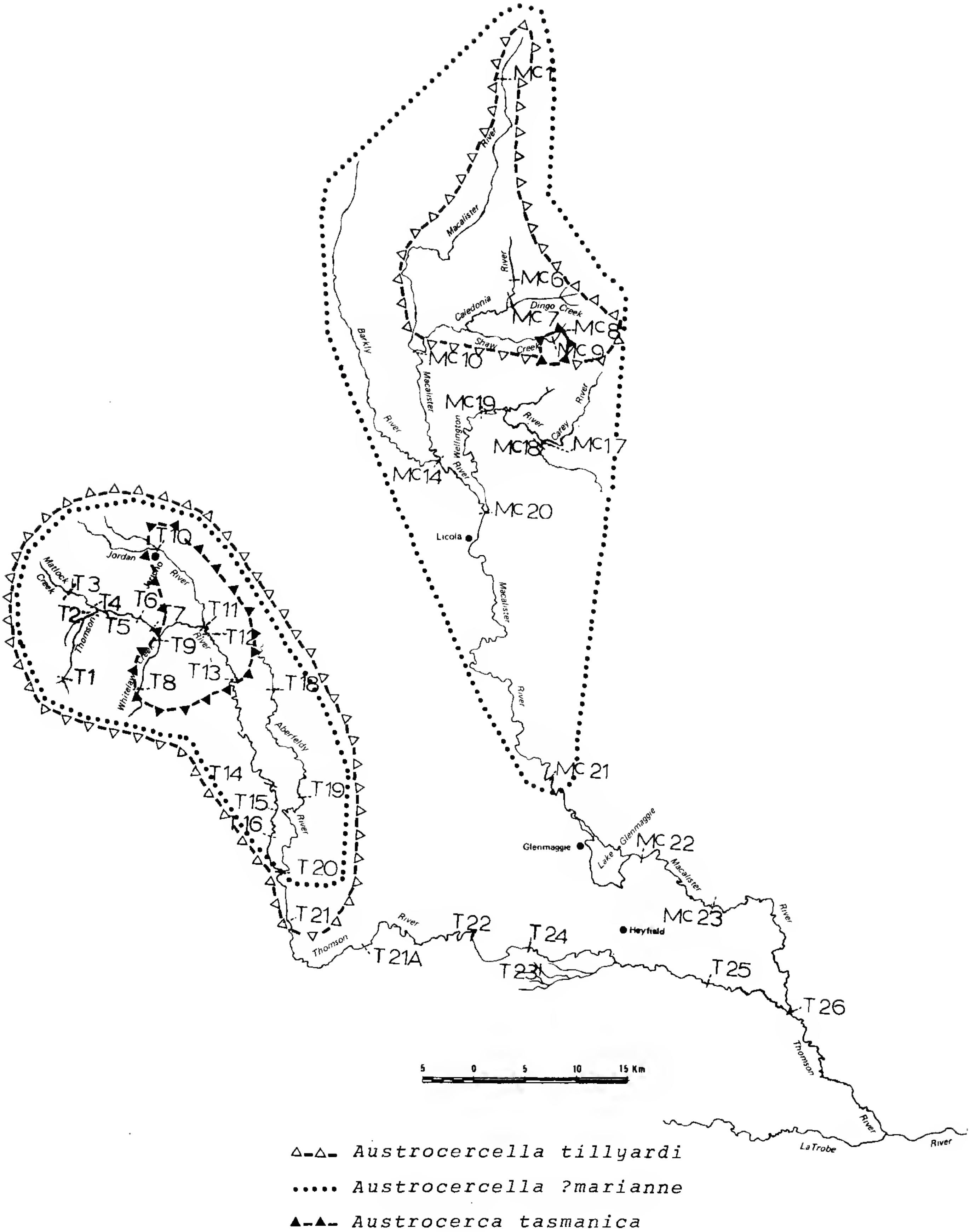


Fig. 7 Distribution of species of Notonemouridae.

in slow to fast currents.
Distribution: T9 ; Mc1.

Kempynus sp. Adults were collected at light in summer. Larvae, although presumably semi-aquatic, are unknown.

Distribution: T4 & T13.

Family Sisyridae. One species has been collected from the study area, only as adults. Larvae of this family are known to be aquatic (Riek, 1970) and associated with freshwater

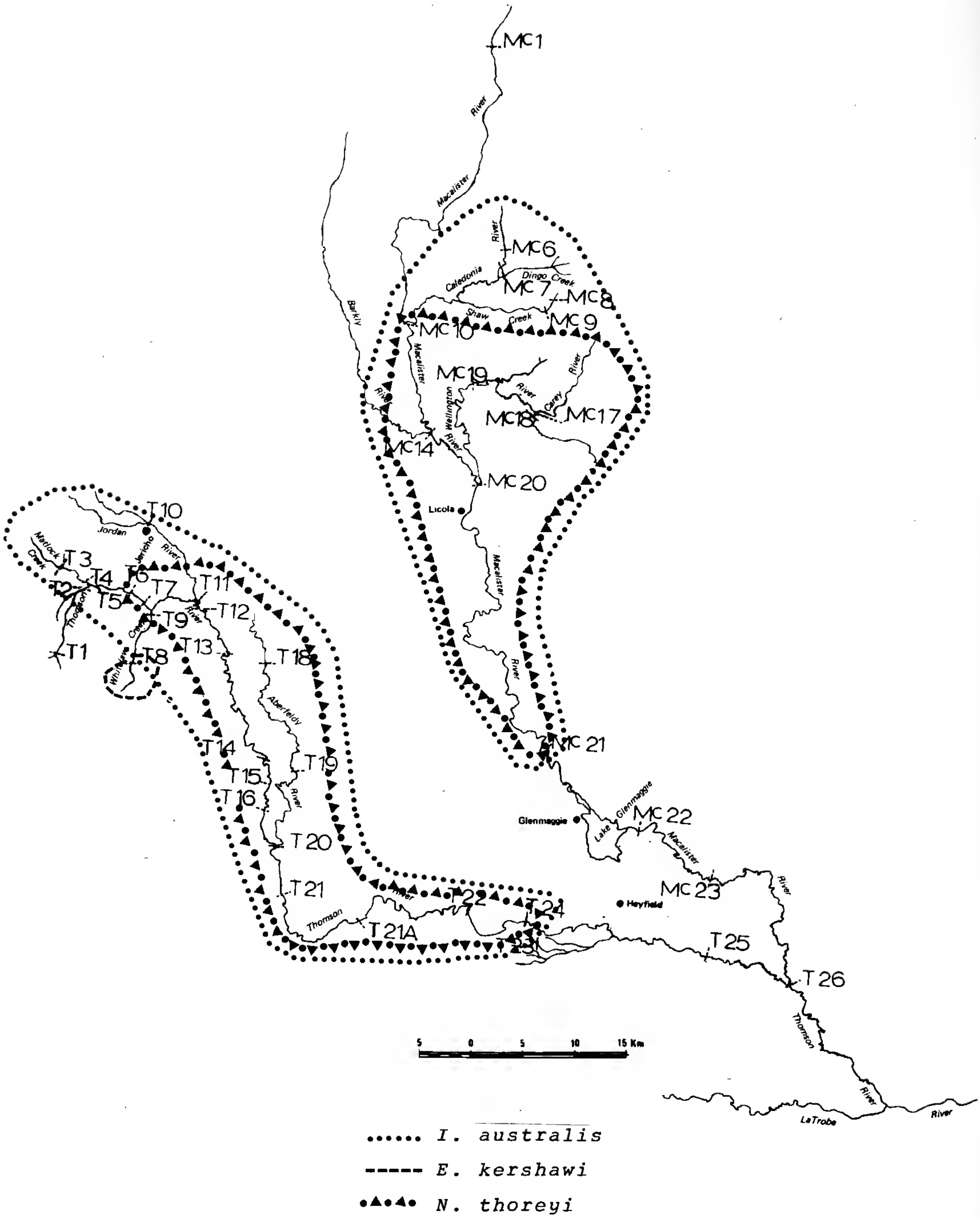


Fig. 8 Distribution of species of *Illiesoperla, Eunotoperla,* and *Newmanoperla.*

sponges (Williams, 1968).
Distribution: T4.

Order Coleoptera

Families other than Elmidae

A total of over 78 species (in 42 genera) from 12 families has been collected from the study area. The habitat data in the following pages refer to larvae and adults, only when the latter are also truly aquatic. But the distribution ranges apply to both adult and immature stages of individual species.

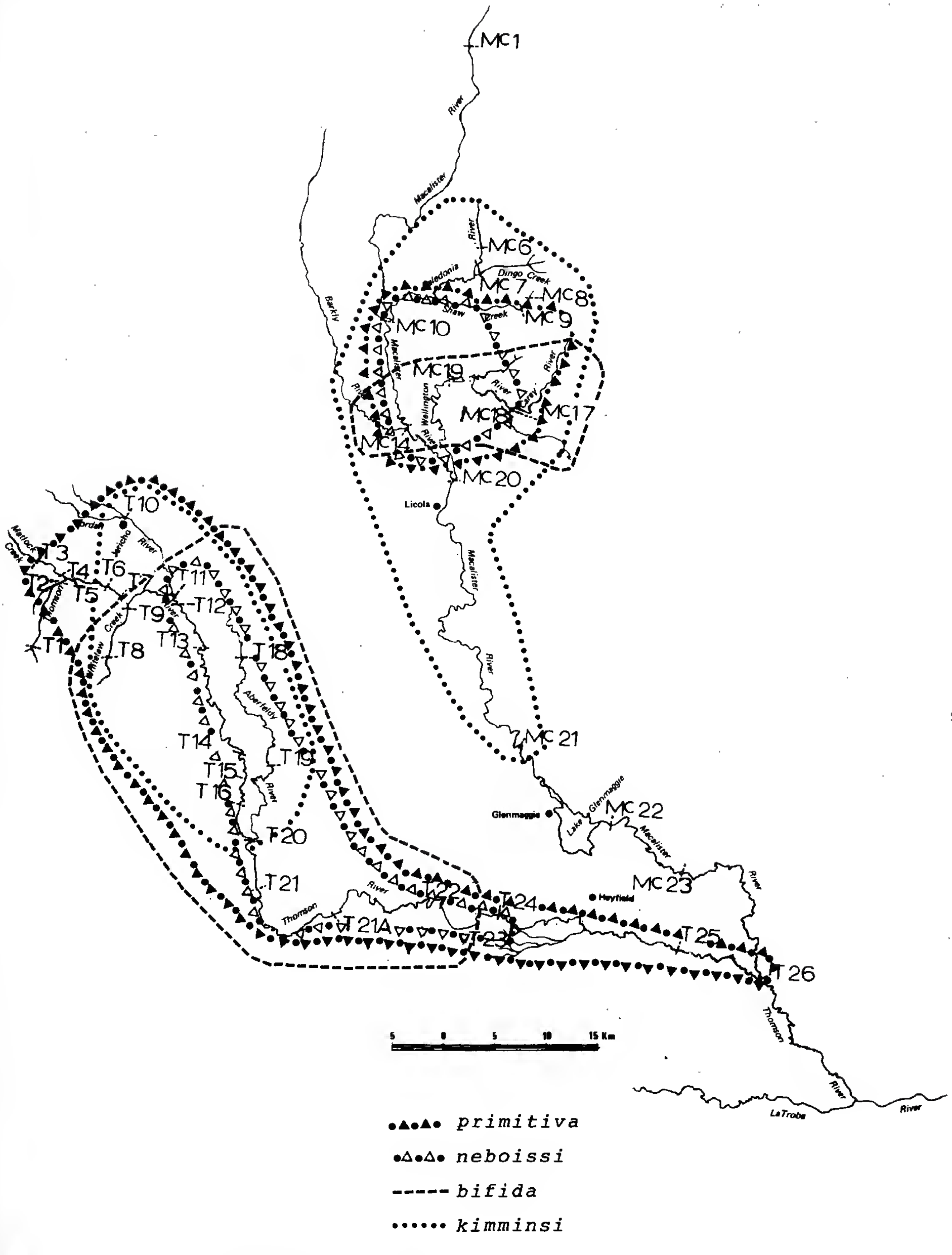


Fig. 9 Distribution of species of *Leptoperla.*

Distribution and habitat data of all the species are given in Appendix 18, with station by station abundance, season of collection, and constancy in Appendices 19-21.

Family Gyrinidae. All three species collected from the study area normally occur in still to moderate currents in backwaters and on banks, usually sheltered among overhanging and rooted aquatic vegetation, and among fallen twigs and debris along banks. The distribution of these

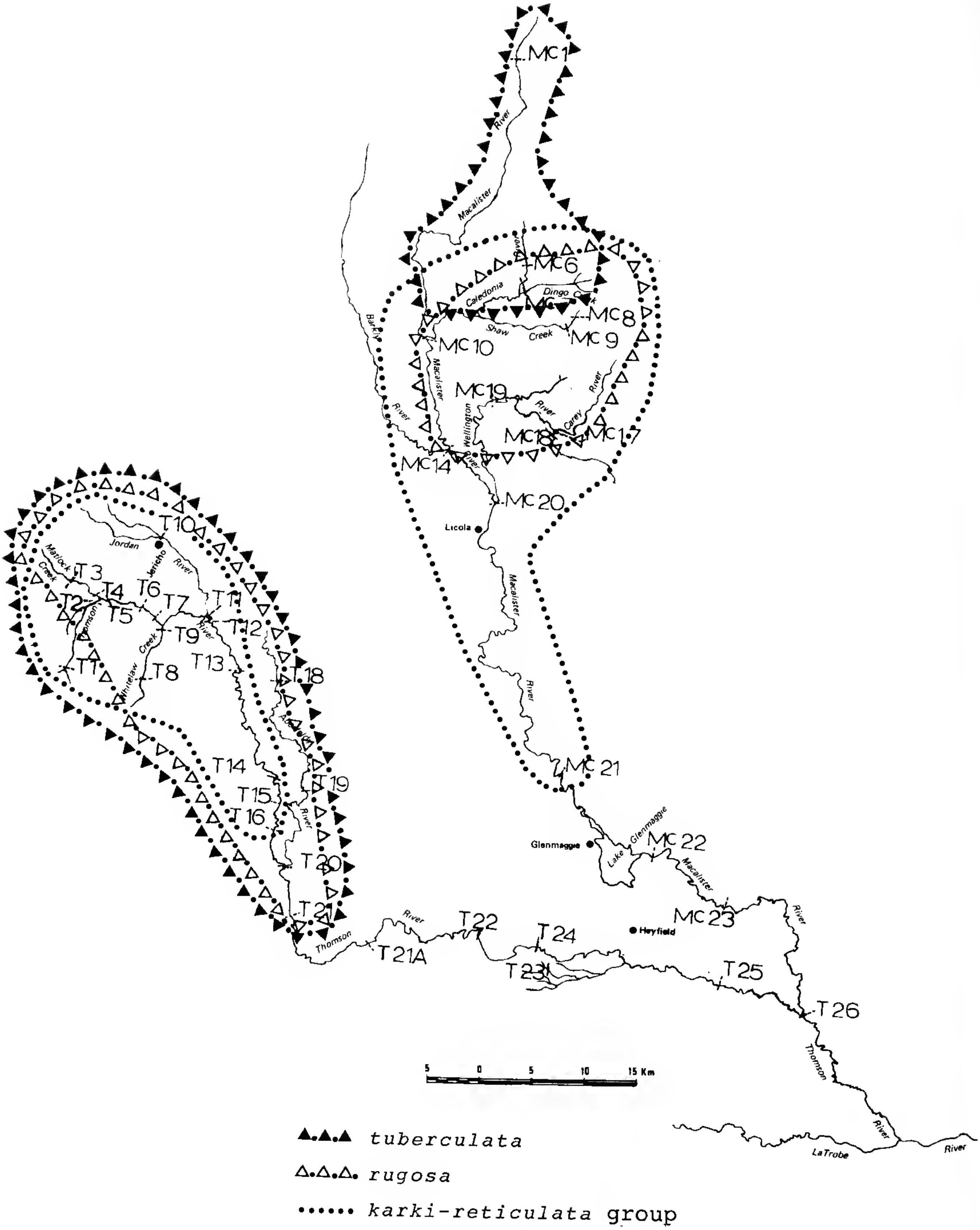


Fig. 10 Distribution of species of *Riekoperla*.

species within the Thomson and Macalister Rivers is interesting (Fig. 14). The larger *Macrogyrus oblongus* is restricted to the relatively high altitude and forest sections of these rivers and tributaries. On the other hand, the medium-sized *M. australis* and smaller *Aulonogyrus strigosus* usually co-exist, and are restricted to the lowland, grassland and 'disturbed' sections of these rivers (Appendix 19).

Family Psephenidae. Three species, all belonging to the only Australian genus *Sclerocyphon,* occur in the study area. Adults

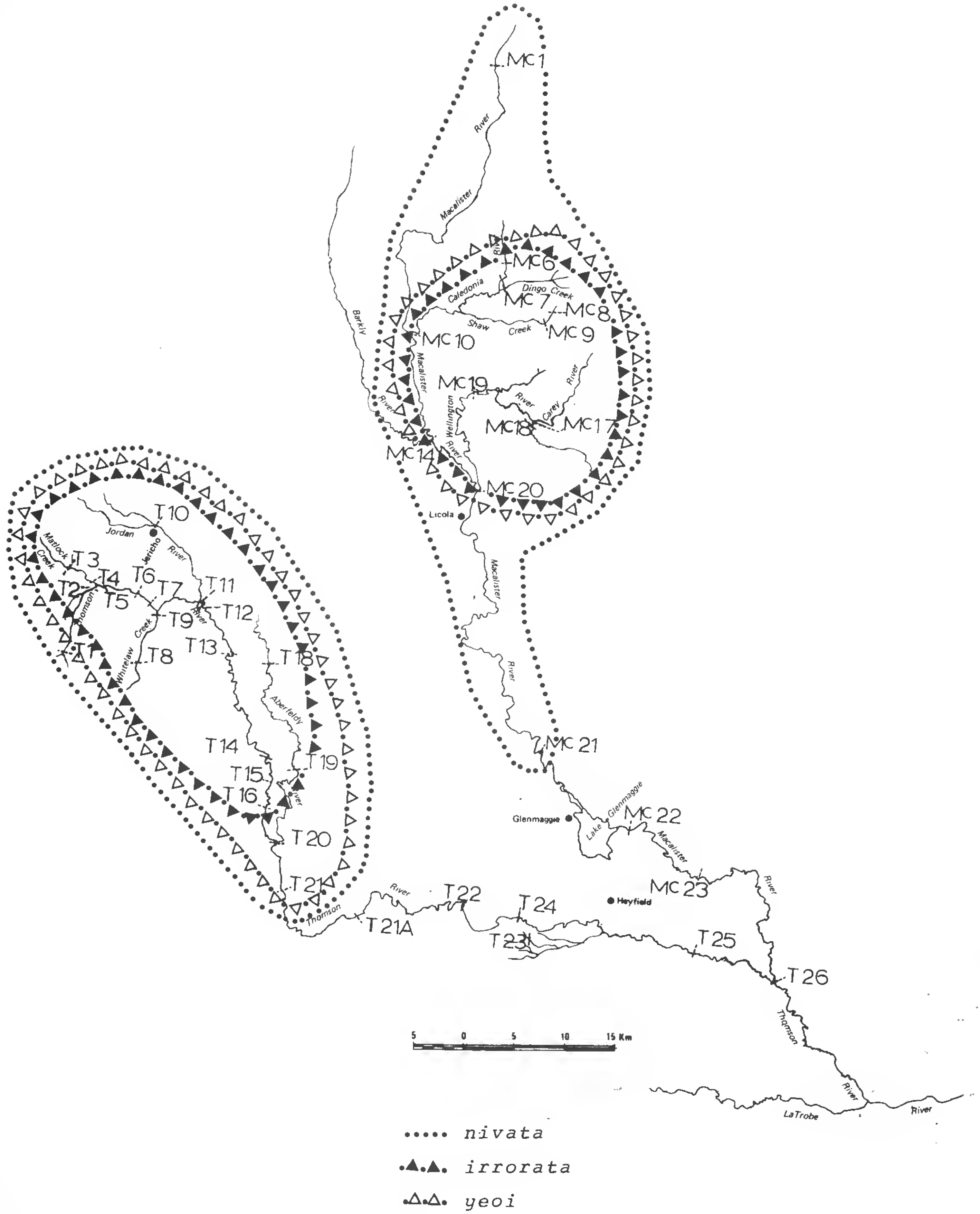
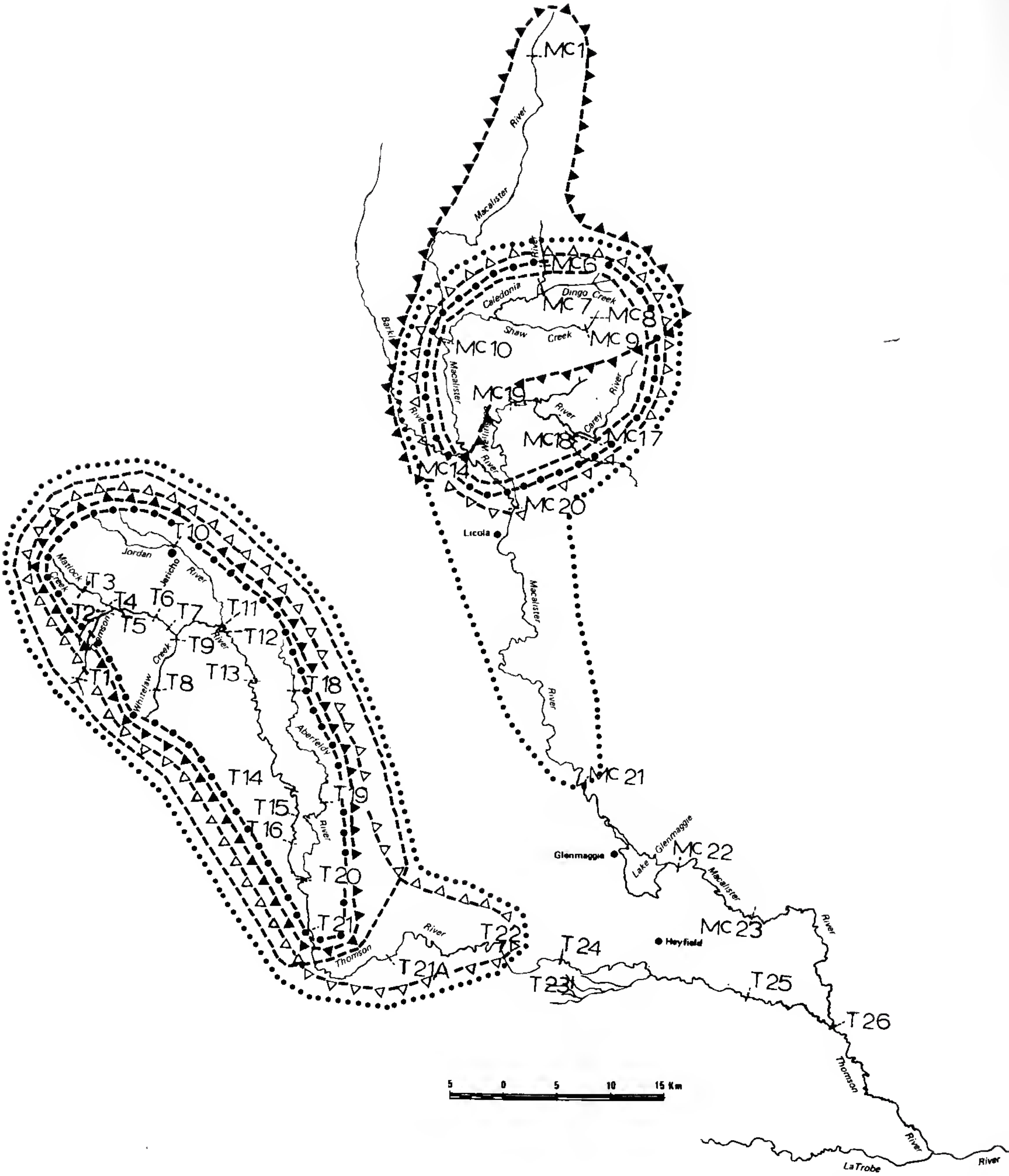


Fig. 11 Distribution of species of *Trinotoperla*.

were present in the field during spring and summer. Distribution pattern of all species is shown in Fig. 15 and abundance and constancy in Appendix 19. Larvae of all the species normally occur in riffle-rapid-run stretches and frequently in pools and on banks. According to Bertrand and Watts (1965) some species of *Sclerocyphon* have a wide habitat range, from fast flowing waters to ponds during summer, and others are restricted only to fast, stony rivers and creeks.



----- *fontana*

•••••• *serricauda*

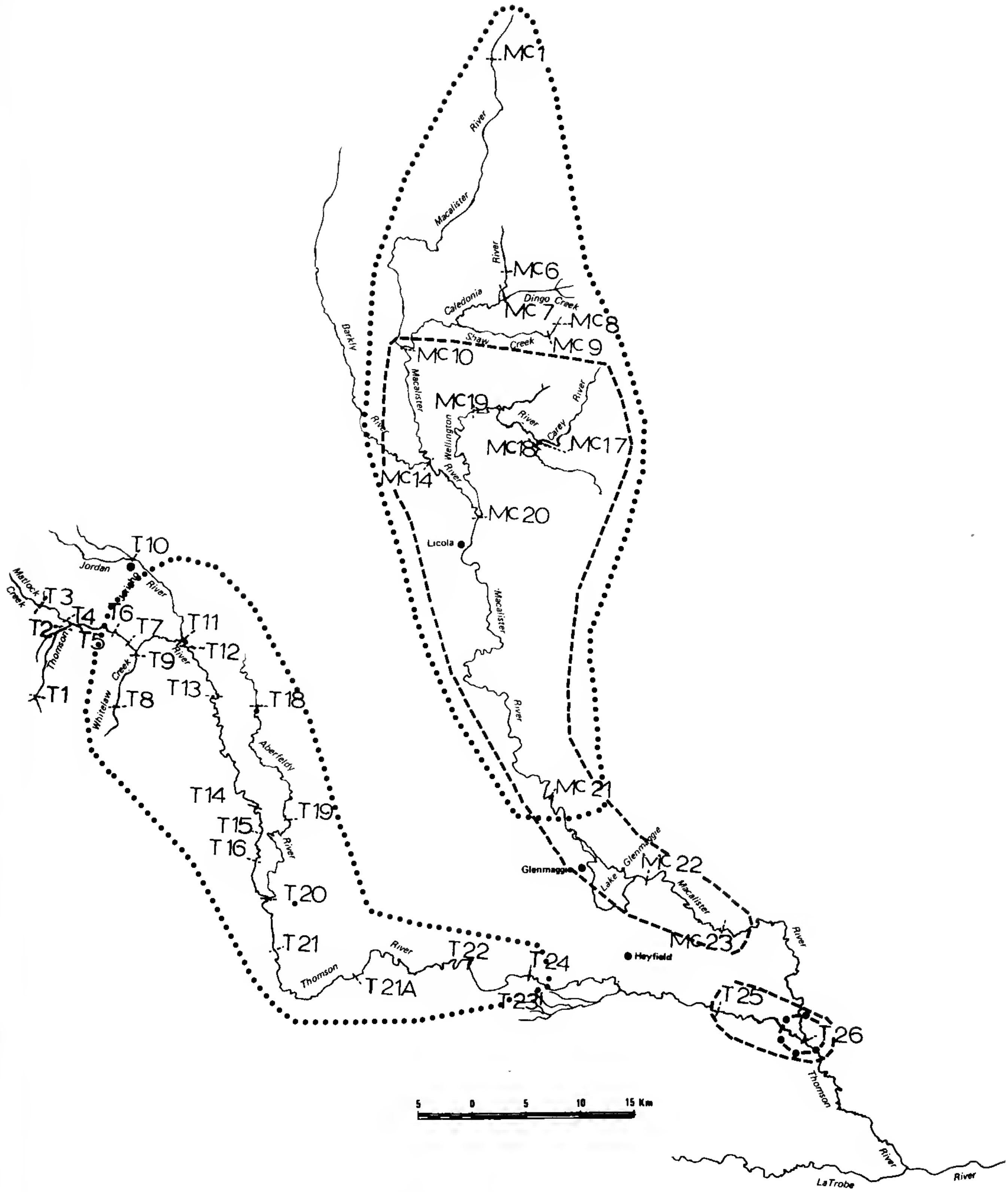
-△-△- *christinae*

-▲-▲- *arenaria*

-•-•- *brevipennis*

Fig. 12 Distribution of species of *Dinotoperla.*

Family Hydrochidae. Seven species, all of genus *Hydrochus*, have been collected from the study area, only as adults. The greatest depth of water at which these species were collected is 100 cm, although they commonly occur in shallower waters (25-50 cm).



----- *Tenagogerris euphrosyne*

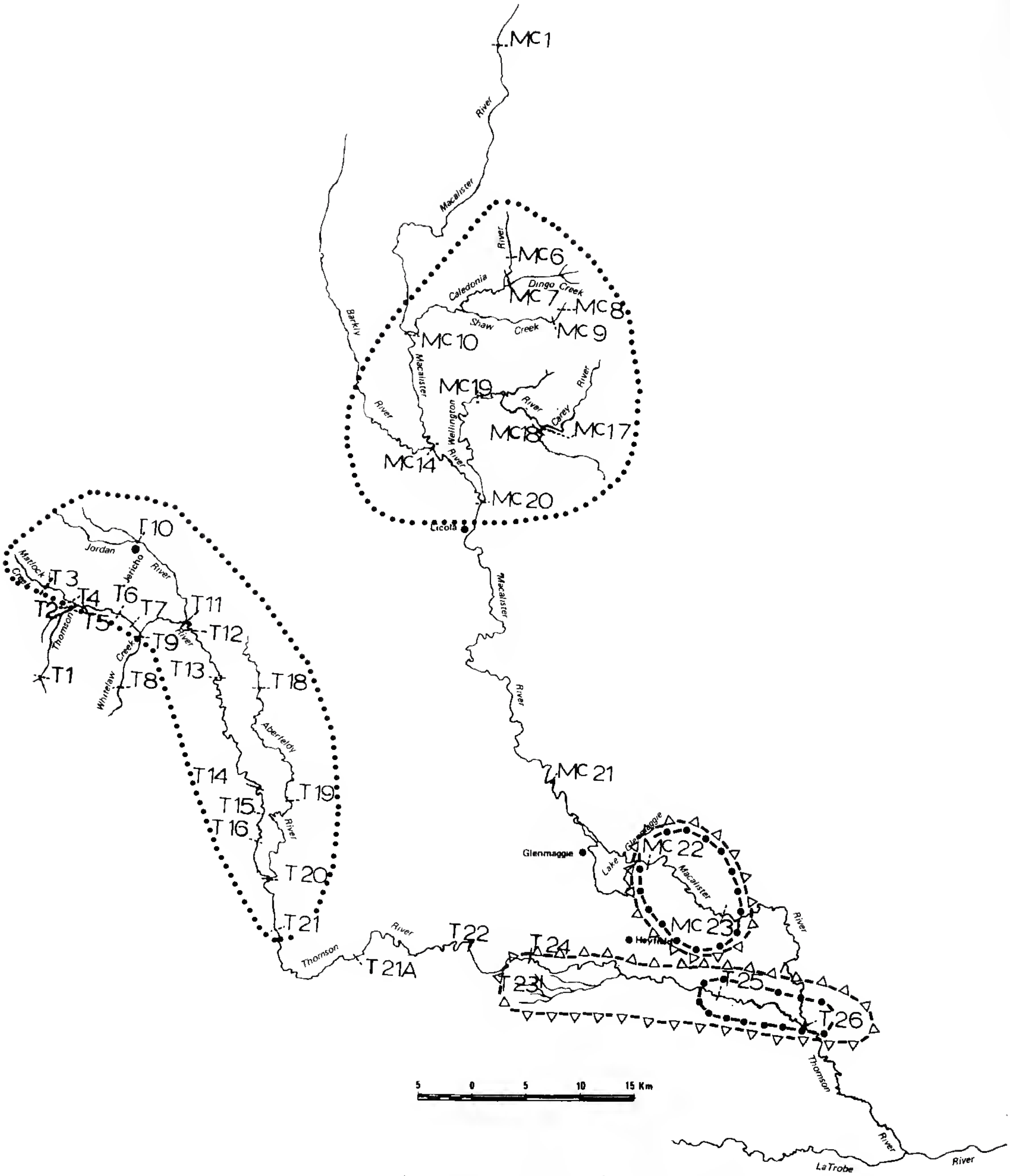
•••••• *Rheumatometra philarete*

-•-•-• *Gerris (Aquarius) antigone*

Fig. 13 Distribution of species of Gerridae.

Family Scirtidae. *Larvae.* As many as eight presumptive species have been recognized among the larvae from the study area. All the species, except Scirtidae sp. 2, were normally found in riffle-rapid-run stretches, at depths of 50-100 cm.

Adults. With the available literature it is not possible to identify all the specimens to the species level. However, Dr P. Zwick (PZ) who is currently revising the group, has examined the specimens, and provided his species code numbers which will be replaced by appro-



...... *M. (Australogyrus) oblongus*

•-•-•- *M. (Tribologyrus) australis*

-△-△- *A. strigosus*

Fig. 14 Distribution of species of *Macrogyrus* and *Aulonogyrus* (Gyrinidae).

priate names when the revision is completed. All the adults were collected in late spring and summer.

Family Hydraenidae. Seven species in two genera have been collected from the study area. They were usually found in shallow (less than 30 cm) waters. Details of distribution are given in Appendix 19.

Genus *Hydraena*. Zwick (1977a) revised this genus, and indicated that the actual habitat of the Australian adult *Hydraena* is aquatic vegetation in slowly flowing water, rather than the

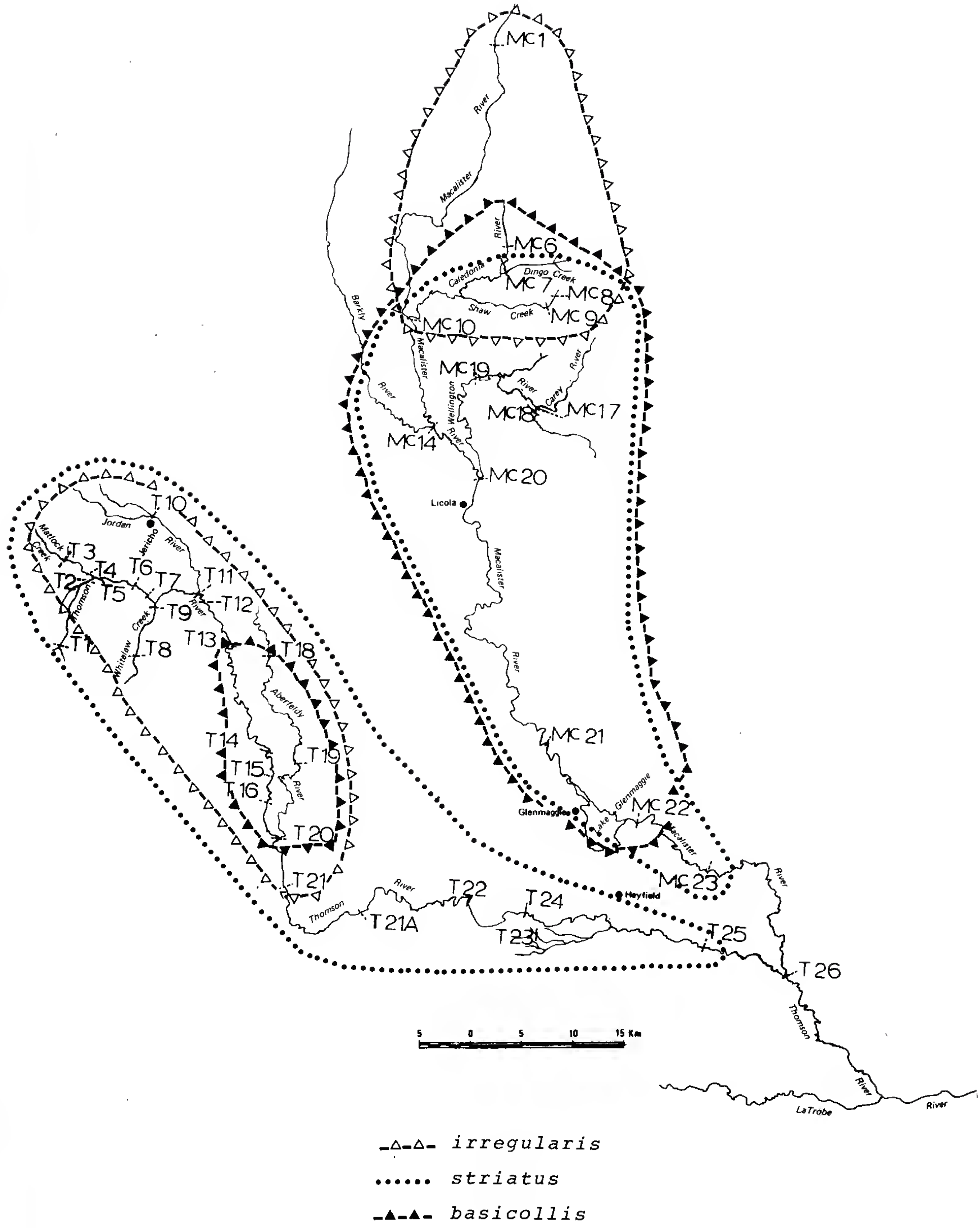


Fig. 15 Distribution of species of *Sclerocyphon* (Psephenidae).

bottom gravel of streams which the European species of this genus normally inhabit. In the present study only four species have been collected, usually at 0-50 cm depths. All the species were normally found on rooted vegetation in still or slow flowing areas of backwaters and banks.

Family Dytiscidae. Watts (1978) has recently revised the Australian Dytiscidae. Twenty-four species (in 17 genera) of dytiscids were found to occur in the Thomson and Macalister Rivers.

The species occurred in a wide variety of habitats, from riffle-rapid-runs to swamps and lagoons, although the majority of them were normally restricted to still or slow flowing areas of backwaters and banks, and swamps and lagoons, or either of these, at depths of 30 cm, rarely up to 100 cm. The mean number of species of Dytiscidae collected from particular stations was 2.9, ranging from 7 at T26 down to 1 at T16, T18 and T22, and none at all at T4 and T14 (Appendix 20).
All the species, except *Sternopriscus mundanus* in the Thomson (constancy value 50) and *Necterosoma penicillatus* in the Macalister (C value 60) had values of less than 40.

Family Hydrophilidae. A total of 21 species in 13 genera of hydrophilids have been coll-ected from the Thomson and Macalister Rivers. Some species were collected only at light, so actual habitats of these species remain unknown at present. The mean number of species of Hydrophilidae collected from particular stations was 2.5, ranging from 10 at T26 down to 1 at T11, T14, T19, T21 and Mc20, and none at all from T6, T9, T16, T20, T22 and Mc14 (Appendix 21). All the species, except *Paracymus pygmaeus* in the Thomson (constancy value 56.2) and *Berosus involutus* in the Macalister (C value 80), had values of less than 50.

Family Elmidae

At least 49 species (in 6 genera) of elmids were found in the Thomson and Macalister Rivers. Some species of *Kingolus* and *Simsonia,* in particular, cannot satisfact-orily be identified with the available literature.

Most elmid species, except *Coxelmis novemnotata* King, were normally collected in riffle-rapid-run stretches, where the majority of the species were most commonly found on weathered, grooved logs which usually had a thin silt layer, and frequently also algal and fine sand cover. The adults and larvae were found in grooves, which afford some protection against the swift currents which they usually inhabit. The other microhabitats, although less important than logs for some species, are the substratum of cobble and pebble lain on sand-gravel bed, and solid rocks, either smooth or grooved. There was light silt-algal cover and some patches of moss on rock surfaces.

In general, the larger species *Simsonia tasmanica, S. hopsoni* and *Notriolus quadriplagiatus*, seem to occur commonly in slower waters, such as banks and pools, where-as the smaller species, particularly of *Austrolimnius* and *Simsonia,* seem to prefer faster waters, such as riffle-rapid-run stretches.

Distribution and habitats of all species are given in Appendix 22 and abundance and constancy in Appendix 23.

One specimen of *Notriolus nr maculatus* Carter was collected on logs in a lagoon at the Thomson and Macalister River confluence (T26) in December 1976. It is not certain whether the lagoon was its true habitat, or the specimen was accidentally carried on the dip net used previously for sampling the stream, or was drifted or transported by the river which was in flood a couple of months prior to the collecting. Both larvae and adults of *Coxelmis v-fasciata* Lea have been collected from Lake Hindmarsh in northern Victoria (Blyth, unpub-lished data), and it is possible that *N. nr maculatus* is also capable of living in standing waters.

Austrolimnius is the largest genus of Australian Elmidae with 52 of the 99 recorded species from mainland Australia and Tasmania (Hinton, 1965). Of these, about 20 species have been collected in the present study. Hinton (1965) revised the Australian species based on about 4700 specimens collected mainly from New South Wales and Victoria. Fourteen of the species collected in the present study are new records for Victoria. All the species identifications have been made only by following Hinton's key, not by comparing with the types or his identified specimens. There-fore, the identifications may be considered only provisional.

Habitats and microhabitats of *Austrolimnius* are as for elmids as a whole except that the species *A. ochus* Hinton, *A. variabilis* Carter & Zeck, *A. nomia* Hinton, *A. messa* Hinton, and *A. sul* Hinton were not associated with logs. These species normally occurred with pebble-cobble and solid rock substratum which was lightly covered with silt, patches of algae (nodular or filamentous) and organic detritus in various combinations.

It is obvious from the distribution of elmid species given in Appendix 22 that 16 species are relatively widely distributed, from lowland grassland to highland forest section of these streams, 6 are predominantly lowland (less than 200 m) grassland species, and another 16 are predominantly moderate to high altitude (greater than 300 m) forest species. On the whole, the species of *Austrolimnius* and *Simsonia* are relatively more common in moderate-high altitude (greater than 300 m) forest sections, those of *Notriolus* and *Kingolus* in low-moderate altitude (200 -

400 m), and of *Coxelmis* in low altitude (less than 200 m) grassland sections of the streams under study.

The mean number of species of Elmidae collected from particular stations was 8.6, ranging from 24 at Mc20 down to 2 at T10 and T22, and none at all from Mc22.

In the Thomson River there were 5 species with constancy values of 50 and over, while the remaining 27 species had values of less than 50. Of the respective constancy groups in the Macalister there were 12 and 23 (Appendix 23).

Order Mecoptera

Family Bittacidae

Single adult specimens of each of *Harpobittacus tillyardi tillyardi* Esben-Petersen, *H. australis australis* (Klug) and *H. nigriceps (Selys)* were collected from Mc8 (Shaw Creek headwaters). Habitats of these species are unknown, although according to Riek (1970) the *nigriceps* group prefers moist situations bordering streams whereas the *australis* group can survive under dry situations.

Order Diptera

Larvae

Distribution and habitats of all the species are given in Appendix 24, and abundance and constancy for several families in Appendices 25 and 26.

Family Simuliidae. Mackerras and Mackerras (1948-1955) provided notes on the habitat and distribution of the immature stages of the several species of simuliids included in this study. Immature stages of 12 species of Simuliidae were found to occur in the Thomson and Macalister Rivers (Appendix 24). All the species, except *Austrosimulium (Austrosimulium) montanum,* occurred in moderate to swift flowing stretches of these rivers, attached to the substratum which usually consisted of pebbles through to cobbles at varying proportions, grooved or pitted solid rocks and logs, and occasionally macrophytes or other submersed vegetation. Surfaces were often covered with fine films of silt and algae (mainly diatoms, green filamentous and occasionally green nodular algae). There were also odd patches of moss, organic detritus and heavier algal growth. Habitats of the various species coincided with those noted by Mackerras and Mackerras (1948, 1949, 1950, 1952, 1955) and Colbo (personal communication).

The species referred to by Mackerras and Mackerras (1949) as probably the most abundant and widespread simuliid in Australia *(S. eusimulium ornatipes)* was restricted to lower reaches of the Thomson, while *A. (N.)* sp. (*furiosum* group) was the commonest and most widespread in the study area.

Distribution patterns of several species have been plotted in Figs. 16 and 17 and detailed distribution and constancy values are given in Appendix 25. The mean number of taxa of Simuliidae collected from particular stations was 2.6, ranging from 5 at T19, Mc14 and Mc20 down to none at all at T14 and T20. In the Thomson River only *A. (N.) victoriae* and *A. (N.)* sp. (*furiosum* group) had constancy values of 50 and over, and in the Macalister *A. (N.) furiosum, A. (N.)* sp. (*furiosum* group) and *A. (N.) torrentium* had similar values (Appendix 25).

Family Blephariceridae. Six species and subspecies of blephariceridae, all belonging to the only Australian genus *Edwardsina,* were collected from the study area. Zwick (1977b) revised the Australian Blephariceridae and discussed the bionomics of several of the *Edwardsina* species, including most of those in the present study. All larvae and pupae in the present study were found in riffle-rapid-run stretches with fast to very fast currents; they were usually attached to smooth surfaces of cobbles, boulders and especially solid rock, which was often deeply grooved. In some areas coarse sand, gravel and entrapped leaf litter was prevalent beneath the rocks.

Distribution patterns of several species have been plotted in Fig. 18. Occurrence, including season and constancy value, of all the species are given in Appendix 26. Habitat data and general notes are presented in Appendix 24.

Zwick (1977b) mentioned that *E. australiensis* Tillyard and *E. torrentium* Zwick occur in the upper reaches of streams in the Australian Alps where the water is permanently cool and rushes down steep slopes over rocks and boulders, often forming little cascades. Further downstream, where the streams are slower, *E. pilosa* Zwick, *E. spinosa* Zwick and *E. williamsi* Zwick occur, together with *E. polymorpha* Zwick. The last two, in particular *E. polymorpha,* are able to live further downstream than the others. Apparently similar distribution zones are observed among the species included in the present study. Only *E. polymorpha* and *E. williamsi* occur in both the Thomson and Macalister Rivers, both upper and lower regions, where there is rela-

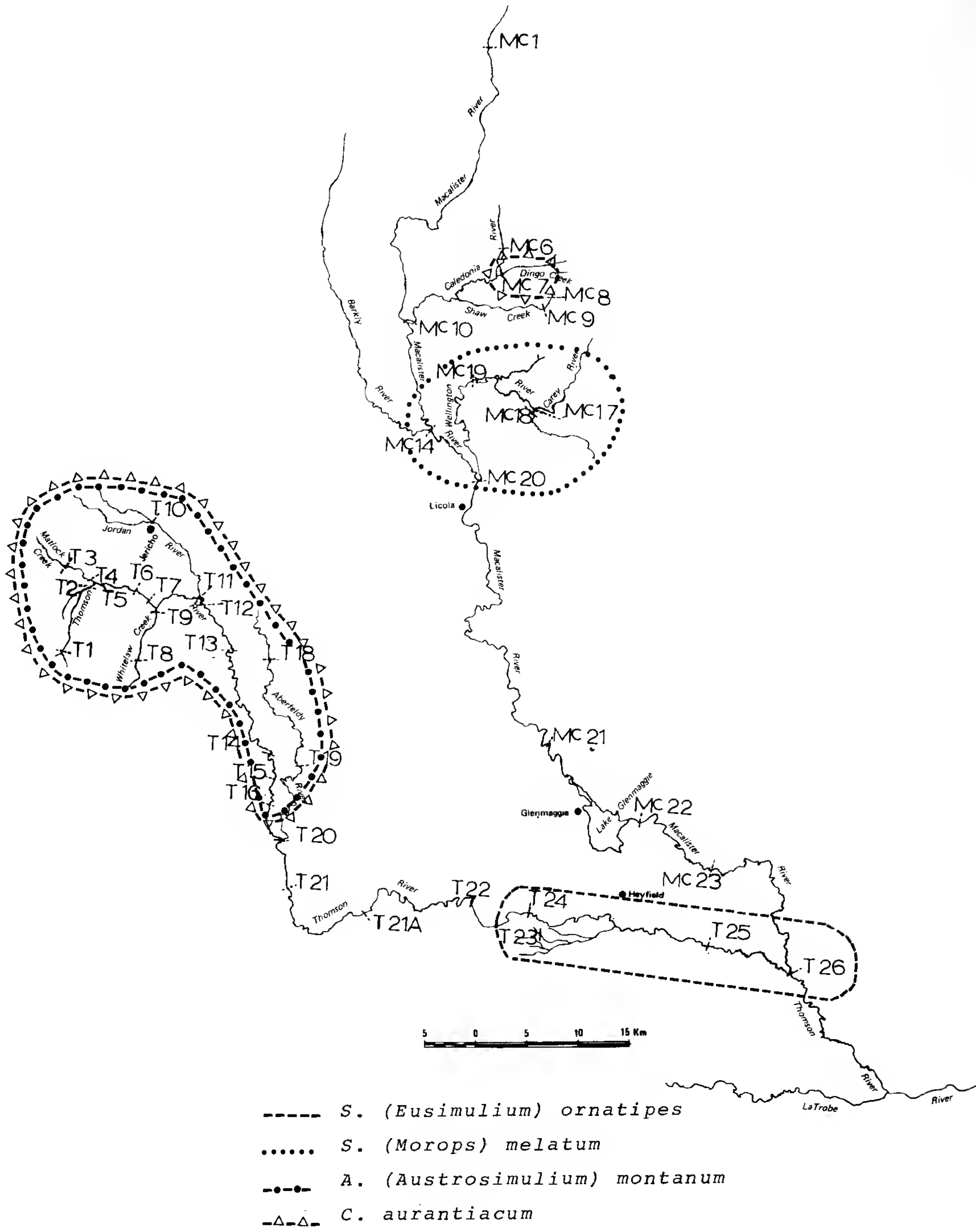


Fig. 16 Distribution of species of *Simulium, Austrosimulium* and *Cnephia.*

tively heavy algal build-up on the rock surfaces. *E. australiensis* (both the subspecies), *E. pilosa* and *E. torrentium* are found only in the Thomson River, and there mostly in the upper regions. With the distribution data available it is apparent that most of these species may co-exist, particularly *E. polymorpha* and *E. williamsi.*

In both the Thomson and Macalister Rivers none of the species had constancy values of more than 50 (Appendix 26).

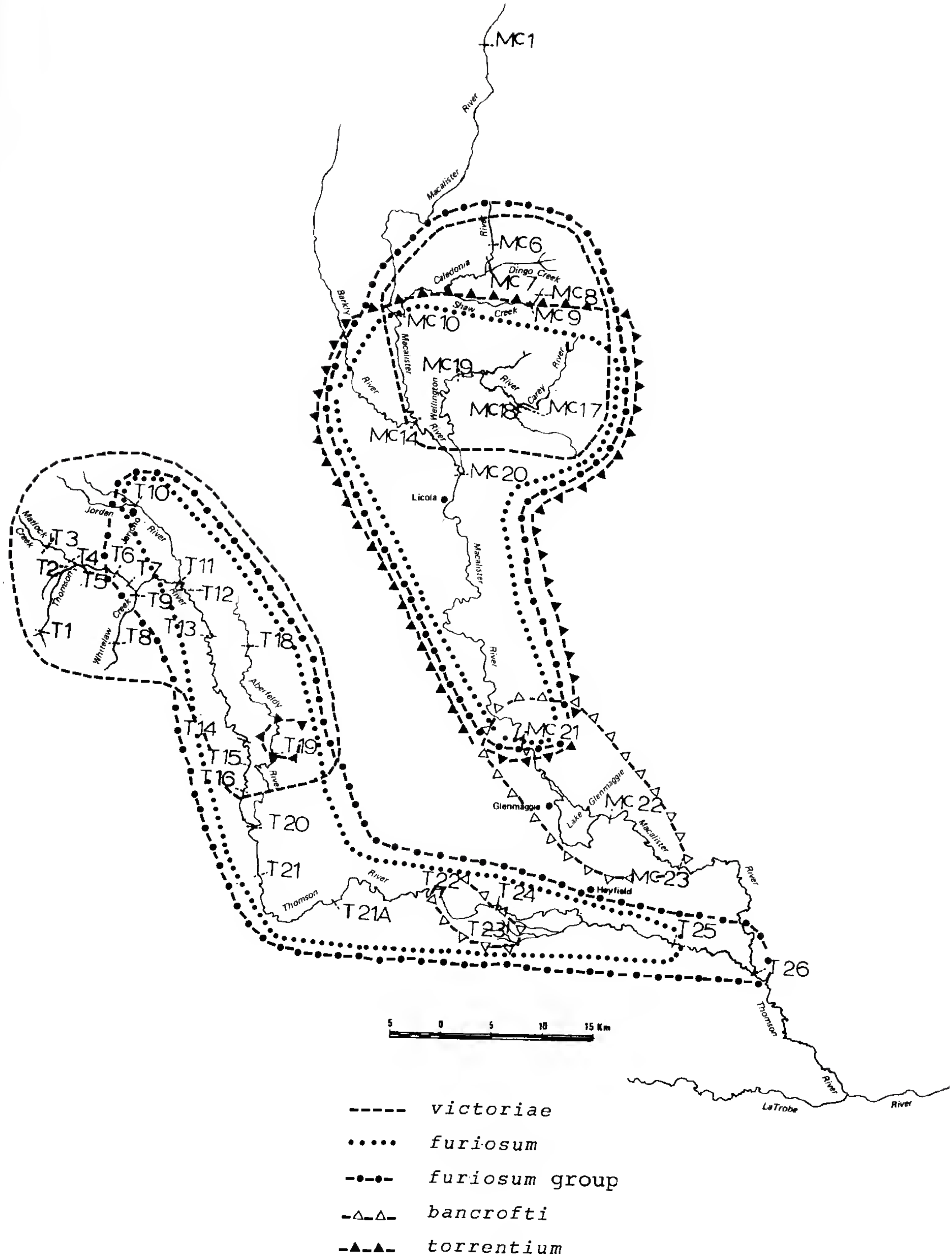


Fig. 17 Distribution of species of *Austrosimulium (Novaustrosimulium)*.

Family Culicidae. Seven species of mosquitoes have been collected from the Thomson River, three of them only from the Thomson and Macalister confluence. Two of the species were collected as adults only. The larval habitats of individual species normally occurred in swamps and lagoons, billabongs and still backwater regions, at 20-40 cm, occasionally

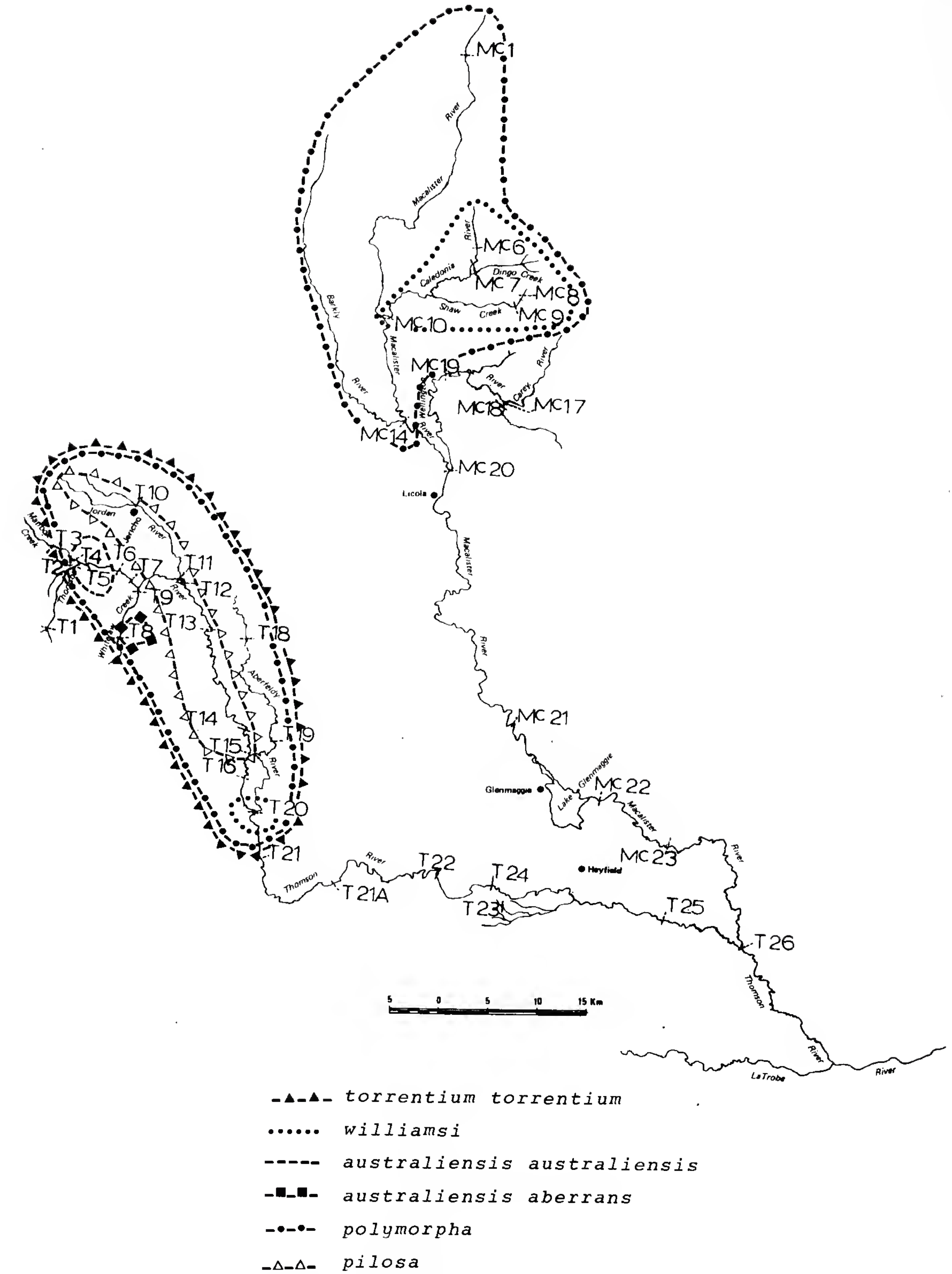


Fig. 18 Distribution of species and subspecies of *Edwardsina* (Blephariceridae).

up to 100 cm depths.

The larva of *Corethrella* was sent to Dr D.H. Colless (CSIRO Division of Entomology, Canberra), for inclusion in his forthcoming revision on the Chaoborinae. He commented (in litt.) "it's the only well-grown specimen of Australian *Corethrella* that I know of (and only the third larva!)". The first ever larva was collected in a mosquito ovitrap at Darwin (E.N. Marks, in litt.).

According to Dr E.N. Marks, this is the first time the species of Australian Culicidae (see Appendix 24 for names) were collected from underwater light traps.

Family Rhagionidae. The larvae of four species have been collected from the study area (Appendix 24). They usually occurred in moderate to fast flowing stretches, 40-100 cm deep, with the substratum of gravel through to cobbles at varying proportions, and occasional solid rocks. All surfaces were covered with light patches of green filamentous and nodular algae. Silt and heavy organic matter was trapped among and under rocks, and was often heavier in backwaters and at banks, where some larvae occurred.

Family Ceratopogonidae. Immature stages of six genera of ceratopogonids were found in the study area (Appendix 24). With the available literature, which is very sparse for the Victorian fauna, these cannot be identified to species. Most of the species normally occurred in algae, moss and silt-algal slime in a wide range of habitats, from riffle-rapid-runs to still backwaters, although with slight individual preference for any one of these. They were also commonly found in weathered, ridged logs which had thin algal or silt-algal slime cover. The larvae and pupae were usually found at depths to 25 cm. Occurrence, including season and constancy value, of several species are given in Appendix 26.

Family Tipulidae. Very little is known of the immature Tipulidae from Australia. These can not be classified even to the suprageneric level. Therefore, the National Museum Biological Survey Department has started a numbering system, based on voucher specimens, for all the freshwater species from different invertebrate surveys. There were 14 "species" of Tipulidae occurring in the study area (Appendix 24) that are truly aquatic in the larval stages.

Normally the larval stages occurred in riffle-rapid-run stretches of the streams at varying depths (20-100 cm). The larvae usually preferred a substratum of sand through to cobbles at varying proportions, covered with moderate quantities of silt, algae or silt-algal carpet or sludge, and organic matter (mainly allochthonous detritus such as leaf litter). Occurrence including season and constancy values of all the species are given in Appendix 26.

Family Empididae. The larvae of four species have been collected from the study area. All but Empididae sp. 1 occurred in similar habitats to the Rhagionidae described above; details are given in Appendix 24.

Family Dolichopodidae. Only one species has been found to occur in the study area (Appendix 24).

Order Trichoptera

Larvae

With the limited knowledge of the larvae of Australian caddisflies it has not been possible to identify the larval stages further than to the family level. Since the collecting for larvae was considerably more extensive than for the adults, there is a large amount of material collected from all the stations and seasons. When this material is identified to species, it will be possible to provide a more critical discussion on aspects such as distribution and habitat preferences of individual species.

Adults

Over 85 species (in 53 genera) belonging to 19 families of adult Trichoptera have been collected from the Thomson and Macalister Rivers. All the species have been collected during the spring and summer months at light traps. A list of species and their distributions are given in Appendix 27. Taxa indicated as new are being described by Dr. A. Neboiss (National Museum of Victoria).

General Distribution

With the limited collecting done of adults, it is not possible to provide a critical analysis of the distribution of the species. However, it is possible to recognize several main distribution patterns.

(i) Species occurring over most of the length of either or both main streams (classed M/F/L in Appendix 27). There are only five species in this group, three being more common in mountain and foothill than in lowland regions, and the other two more common in the lower regions.

(ii) Species apparently restricted to high altitude mountain areas (above 500 m; M in Appendix 27). There are 17 species in this group.

(iii) Twenty-five species are classed as M/F, occurring in mountain and foothill regions only.

(iv) Another 20 species are more or less restricted to foothill stations (F).

(v) Five species are shared between foothills and lowlands (F/L).

(vi) There are seven species predominantly collected from lowland stations only (L).

Clearly the great majority of species are primarily distributed in mountain and foothill regions of the study area.

It is obvious from Appendix 27 that the streams under study support a rich and diverse caddisfly fauna. The species diversity would probably be more obvious when all the larval material is identified and analysed. Also seen in the species list are three new genera and several new species and undoubtedly, several new records to the State of Victoria.

Order Lepidoptera

Family Pyralidae

Subfamily Nymphulinae. The larvae of three species have been collected from the study area, but those of two species cannot be identified, even to the generic level.

Nymphula prob. *nitens.* Usually collected in still or slow flowing backwaters and banks, frequently in swamps and lagoons.
Distribution: T25; Mc19 - 22.
Habitat:
Backwaters (Bw) ++++ (most common);
Banks & Swamps (B & S) ++;
Riffles & Pools (R & P) + (least common).

Nymphulinae sp. 1. Collected in 40 cm deep swamps and billabongs, with soft silt-organic substratum which was covered with a variety of aquatic vegetation including water millfoil and a considerable amount of algae.
Distribution: T26.
Habitat: (S) ++++.

Nymphulinae sp. 2. Unlike the other two species, this was collected in 30 cm deep riffle-rapid-run stretches, with gravel,pebble,and cobble bed, 20% of which was covered with patches of filamentous algae.
Distribution: Mc21
Habitat:
(R) ++++;
(P) +.

Class Turbellaria

Three species of planarians, all belonging to the family Dugesiidae, have been collected from the Thomson and Macalister Rivers (Appendix 28).

Cura pinguis (Weiss)

This, the most widespread planarian in the Australian region, was collected in a wide range of habitats, from swamps and lagoons to riffle-rapid-run stretches, although it preferred still or slow to moderate flowing backwaters and banks with considerable aquatic vegetation and logs, and silt or mud-filmed pebbles, cobbles and rocks.

Class Oligochaeta

Distribution and habitats of the species occurring in the study area are given in Appendix 29.

Phylum Mollusca

Specimens of six species of Gastropoda and two species of Bivalvia have been collected from the study area in waters up to 100 cm deep, during spring, summer and autumn (Appendix 28).

The collecting of Mollusca in the study area is far from complete and thus the distribution range of most of these species is incomplete, and so is the species list.

Family Ferrissiidae

Ferrissia (Pettancylus) tasmanicus (Tenison-Woods) has been found to occur usually in still or slow flowing backwaters and banks, occasionally in moderate to fast flowing waters. This is the commonest gastropod in the study area, occurring at depths up to 100 cm.

Family Hydrobiidae

Potamopyrgus nigra (Quoy and Gaimard) has been collected from shallow (0-5 cm), still or slow flowing backwaters of a creek running into the Thomson River.

Family Sphaeriidae

Pisidium casertanum (Poli). Like *Ferrissia (P.) tasmanicus,* this species occurs in a wide range of habitats, but commonly in still backwaters and banks.

Class Crustacea

See Appendix 30.

Order Decapoda

Paratya australiensis Riek. The species was normally found in billabongs, swamps and lagoons, still or slow to moderate flowing backwaters and banks, frequently in pools and riffle-rapid-runs. It appears that the species can tolerate muddy, turbid waters.

Subclass Copepoda. Like the next group (Parasitengona), many micro-crustacea were collected by the fine mesh nets used in this study (160 µm). Twelve species (in 9 genera) of Copepoda have been collected from the study area. All species, except *Calamoecia ampulla* and *Boeckella triarticulata,* normally occur in swamps and lagoons and still or slow flowing backwaters which are up to 50 cm deep. *C. ampulla* and *B. triarticulata* on the other hand, have been collected by brushing surfaces of concrete weir and blocks, in riffle-rapid-run stretches of streams.

Order Acarina (Parasitengona)

Although the aim of the present study has been to study macroinvertebrates, an effort has been made to collect the smaller water mites whenever possible because they are, as a group, an important constituent of the freshwater ecosystem (see below).

Dr I.M. Smith (Biosystematics Research Institute, Agriculture Canada) is currently working on the water mites from this survey, and will be publishing descriptions of the taxa with, if feasible, back references to his tentative codes of taxa included in this publication.

The 70 species (in 54 genera) of water mites belonging to 30 families collected in the Thomson and Macalister Rivers probably represent a small proportion of the total water mite fauna. However, of these, approximately 75% of the species and 30% of the genera have been found to be undescribed. In this study, only those water mites collected while sampling for macroinvertebrates, by sampling methods mainly suited for the latter, have been included. No attempt was made to examine the phreaticolous habitats or moss habitats, which are preferred by a large number of water mites.

Most of the species were found in water which was 0-50 cm deep. Generally, water mites are found in a wide range of habitats, from swamps and lagoons to riffle-rapid-run stretches of streams, and occasionally torrential waterfalls.

As seen in Appendix 31, nine species were collected only from swamps and lagoons, *Limnesia* sp. also from still backwaters, and *Oxus australicus* and *Mucronothrus* sp. which normally inhabit still or slow flowing backwaters, were also found rather frequently in swamps and lagoons, banks and pools, the latter species also in riffle-rapid-runs.

Of the 70 species collected from the study area, 31 (*ca* 44%) normally occurred in riffle-rapid-run stretches, 20 in backwaters and 6 in banks.

Some species, particularly *Albia* sp., *Eylais* sp., *Corticacarus* spp., new genus K. *Rhyncholimnochares (Paralimnochares) womersleyi* and *Trimalaconothrus* sp. have frequently been collected by brushing weathered, pitted logs.

General Distribution

Since only limited collecting has been done for water mites at present, it is not possible to discuss the distribution of individual species. However, the following generalizations may be made from the available data.

(1) Nine species were restricted to swamps and lagoons from T10 or T26, or both.

(2) Seven species were largely from the lowland region, being collected from stations downstream of T21 and Mc21.

(3) Seventeen species were widely distributed in the study area, from high altitude forest sections to the low altitude grassland sections of these streams.

(4) By far the greatest number of species (37 out of the total) are restricted to high altitude, forest sections of these streams, stations upstream of T20 and Mc20.

Habitat, distribution pattern, and season of occurrence of individual species are given in Appendix 31.

BIOLOGY OF COMMUNITIES

Composition of the Fauna

A total of 528 species of invertebrates were identified, of which 410 are insects, 88 are arthropods, and 30 other invertebrates.

The fauna of the Thomson catchment is dominated by Parasitengona (more than 70 spp), Ephemeroptera (34 spp.), Plecoptera (28 spp.), Hemiptera (36 spp.), Elmidae (49 spp.), other Coleoptera (78 spp.), Diptera (excluding Chironomidae) (48 spp.), and Trichoptera (more than 85 spp. of adults). Chironomidae, a very common family, has not been identified to species.

Table 1 presents the total number of species of insects collected at each of nine typical sites over a total of five or six collections. These totals range from 61 at T16 to 90 at Mc14. By contrast, Table 2 shows the total number of species of insects per station per single collecting trip. Well under half of the species occurring at each site over the full year were collected on a single sampling occasion. This is illustrated in another way in Table 3, where it can be seen that any two collections from the same site, whether in the same season in different years, or in different seasons, shared about half or less of their species. Patrick (1961) found a similar change through time in the suite of collectable species in various American rivers.

The whole fauna can be divided into a relatively small number of groups exhibiting particular distribution patterns illustrated by various species discussed under Biology of Species. These patterns are analysed in detail in the inverse classificatory analysis which follows.

Community Analysis Methods

The data of Appendices 10, 12, 15, 17, 19, 20, 21, 23, 25 and 26 (i.e., species distribution of nymphal Ephemeroptera, Odonata and Plecoptera, all Hemiptera and Coleoptera, and larval Diptera excluding Chironomidae) were used to carry out classification analysis of faunal relationships between stations. Taxa collected solely from lentic areas are excluded from this analysis.

The original list of 240 species (presented in the appendices listed above) was reduced to 153, by including only those species occurring at four or more stations, or if less frequently, common or abundant at one or more stations. As noted by Boesch (1973) and Stephenson, Cook and Newlands (1978), little ecological understanding is sacrificed by the elimination of very rare species from classificatory analyses, while such reduction makes for cheaper computing and easier analysis of results.

The three classificatory programs used are described below.

(1) MAGIC (Gullen, 1978): a non-hierarchical, polythetic, agglomerative strategy, yielding both a normal classification of sites with species as attributes and an inverse classification of species with sites as attributes. Minimum similarity level for a species to be grouped was set at 30, with the Jaccard similarity coefficient ranging from 0 for no shared species to 100 for total similarity. The heterogeneity parameter was set at 10%:- that is, for a station to be included in a particular group it must not be more similar to more than 10% of the stations outside that group than it is to the least similar station within the group. For inverse analysis species must occur in at least 60% of stations within the same station group(s) to be allocated to the same species group.

Some reclassifications of the resulting two-way table were performed by hand. In particular, rarer species faithful to a particular station group but not occurring at 60% of stations within the group were not clustered by the computer, and were assigned by hand. Secondly, taking abundance information into account made some reclassification desirable. Finally, any reclassification which improved the constancy for any particular species within one or more particular group(s) was carried out.

(2) DIVINF: a hierarchical, monothetic, divisive strategy (Lance and Williams, 1971) using an information statistic as the index of similarity, was also applied to give both a normal and inverse analysis.

(3) MULCLAS: a hierarchical, polythetic, agglomerative program (Dale et al., 1981) was used here for normal analysis only. MULCLAS was applied twice, once using the Canberra metric as the similarity coefficient (Fig. 20) and once using the Euclidian metric (Fig. 21) (see Clifford and Stephenson, 1973, for a discussion of the properties of different indices). In both cases the coefficient was set to the now widely used value of -0.25 for the flexible sorting strategy applied by MULCLAS.

(4) In a further attempt to clarify site and species groups, a principle co-ordinate ordination was carried out, using the ordination program, GOWER, and the diagnostic GOWECOR (Dale et al., 1981). Boesch (1973) notes that operationally this is a divisive, polythetic procedure.

Of the four approaches referred to above, DIVINF and MULCLAS with Euclidian

TABLE 1.

The number of insect species collected from selected stations over the whole survey.

Order or Family	Station Number								
	T2	T11	T13	T16	T21	T26	Mc10	Mc14	Mc20
Ephemeroptera	16	19	10	17	17	10	17	18	19
Odonata	4	4	5	4	7	11	10	9	6
Plecoptera	18	17	13	16	16	1	11	14	7
Hemiptera	2	10	10	4	11	24	12	7	15
Coleoptera excluding Elmidae	9	9	15	5	10	21	16	4	8
Elmidae	8	10	7	12	15	5	13	24	16
Diptera excluding Chironomidae	5	8	5	7	4	2	11	14	5
Totals	62	77	65	65	80	74	90	90	76

metric are symmetric, that is include double zero matches, while MULCLAS with Canberra metric, and MAGIC are asymmetric. Williams and Bunt (1980) have noted that in one instance involving mangrove communities, symmetric and asymmetric analyses gave complementary results. In the same way the different procedures used here, giving different results, act in a complementary fashion to clarify species and site relationships.

Station Groups (Normal Analysis)

The three dendrograms obtained by DIVINF and the two applications of MULCLAS (Figs. 19, 20, 21) have much in common.

First, there is an almost total division into foothill and mountain stations (T1-21 and Mc1-20) and those of the plains or lowland reaches (T23-26 and Mc21 to T26). The member stations of the two major groups are identical in all three classifications. They all place T22 and Mc21 into the group of lowland sites based on faunal characteristics, while we had, on the basis of visual appearance, placed them in the foothill group.

The lowland stations (site Group D) are also quite distinct from all other site groups derived by MAGIC (Table 4). (Note that no similarity level between groups can be assigned to the results of the non-hierarchical analysis). Site Group D is a heterogenous collection of stations not grouped by MAGIC, but still more like each other than members of the other groups, as illustrated by the dendrograms..

Secondly, Figs. 19 and 20 and Table 4 separate mountain and foothill stations into two clear groups, one (Site Group C) being essentially the middle Macalister stations (Mc10, 14 and 20) plus two lower to middle stations on the Aberfeldy and Thomson Rivers (T19 and T21 respectively). The MULCLAS dendrogram with the Canberra metric as similarity coefficient (Fig. 21) separates the same group but adds T20, the junction of the Thomson and Aberfeldy Rivers.

Thirdly, at a higher level of similarity again, the Thomson River stations above the Thomson-Aberfeldy junction show another fairly clear division into mountain stream stations (Site Group A) and upper foothill stations (Site Group B), although the membership of these two groups varies somewhat between the different classifications. The four

TABLE 2.

Number of species of insects per site per collection.

Station	Trip Number						
	1	2	3	4	6	7	8
T2	24	30	29	--	--	--	--
T6	8	21	37	17	25	--	--
T13	--	30	21	8	13	--	--
T16	11	34	38	27	21	--	--
T21	38	32	27	28	25	--	--
T26	28	44	34	16	--	--	--
Mc10	35	38	36	--	--	40	31
Mc14	35	42	34	38	--	37	29
Mc20	35	28	40	--	--	32	24

most upstream stations on the Thomson (T2, T4, T6, T9) form a "core" mountain stream group, appearing together in all four classifications. Four other stations (T11, T14, T16, T20) are "core" members of the upper foothill group in all but Fig. 21 where T20 is classed with middle and lower foothill stations. The three remaining stations in the upper foothills and mountain stream groups (T10, T13, T18) are classified differently by the three dendrograms and the two-way table.

The results of ordination were similar using either Euclidean metric or Canberra metric and Fig. 22 shows relative loadings on the first three axes for the latter only. Fig. 22 is helpful in interpreting the position of the problem stations referred to above. T10 (upper to middle Jordan River) fits reasonably neatly into the mountain stream group. T18, as might be expected, is somewhat transitional between the upper and lower foothill groups (Site Groups B and C respectively) but appears to fit best into Group B. T13, which in terms of position on the river (midway between T11 and T14) should fit neatly into the upper foothill group, appears as an aberrant station, apparently transitional between Groups B and C. This lack of conformity to Group B characteristics is reinforced by the failure of T13 to be grouped by the non-hierarchical MAGIC program. That is, T13 shows its closest affinity with more than 10% of stations outside the group it is most closely related to (Site Group B). It has been allocated to Site Group B by hand, so increasing the heterogeneity of that group.

Fig. 22 is also valuable for the graphical representation of site relationships and the indication of gradational change from station to station. In particular, T20 is seen to be more or less transitional between upper and lower foothill groups (Groups B and C), which is consistent with its intermediate physical position and a gradational change in fauna along main streams. Similarly, the heterogenous nature of Group D, lowland stations, is illustrated by the ordination of Fig. 22.

Species Groups (Inverse Analysis)

Three methods of grouping species in relation to site groups were used and gave variable results. The DIVINF inverse was not able to cope with the situation of many individuals and few attributes, and with the exception of ubiquitous species, produced largely "nonsense" groups. The GOWER ordination

TABLE 3.

Percentage of species in one collection occurring in a second collection.

A Thomson River									
Station	Trips being compared								
	1,2	1,3	1,5	1,6	2,3	2,6	2,7	3,6	3,7
T2	42	46	--	--	40	--	--	--	--
T6	50	50	--	63	52	29	43	--	24
T13	--	--	--	--	30	13	--	29	--
T16	64	52	--	52	47	29	--	37	--
T21	39	34	--	33	41	32	--	--	--
T26	50	39	25	--	41	--	--	--	--

B Macalister River						
Station	Trips being compared					
	1,2	1,3	1,7	2,3	3,7	3,8
Mc10	43	43	46	45	58	50
Mc14	49	40	51	38	41	41
Mc20	40	51	37	50	56	25

plus the diagnostic GOWECOR, and MAGIC inverse both provided species groups which can be related to particular distributions. However, the GOWECOR results associated with the ordination give no extra information and are less readily interpretable than the two-way table derived from MAGIC (Table 4). The latter is the only inverse classification presented here.

Eight recognizable groups of animals can be seen in Table 4. Species of group 1 are distributed over all site groups and are common at most stations. This group (20 species), contains seven species of Ephemeroptera of which *Baetis* sp. and *Centroptilum* sp. may contain more than one species each. Group 2 (35 species) is made up of forms widespread and common but rarely collected from lowland stations. This group is dominated by Ephemeroptera (9 species), Plecoptera (12 species) and Coleoptera (10 species) of which 5 are elmids. Group 3 (with 17 species) is the complement of group 2, being species collected only from lowland stations (Site Group D) and often only from T26, a station with many associated billabongs. Group 4 is of species mainly confined to stations on mountain streams (Site Group A), which are all on the Thomson and its tributaries. Of the eight species in this small group, four are Plecoptera (see Figs. 5 to 12). Group 5, the complement of group 4, contains 12 species generally found throughout the study area, except at stations on mountain streams. Five of these are Ephemeroptera. Group 6 (16 species) related to group 1, consists of species distributed over the whole study area and probably occurring at stations of all

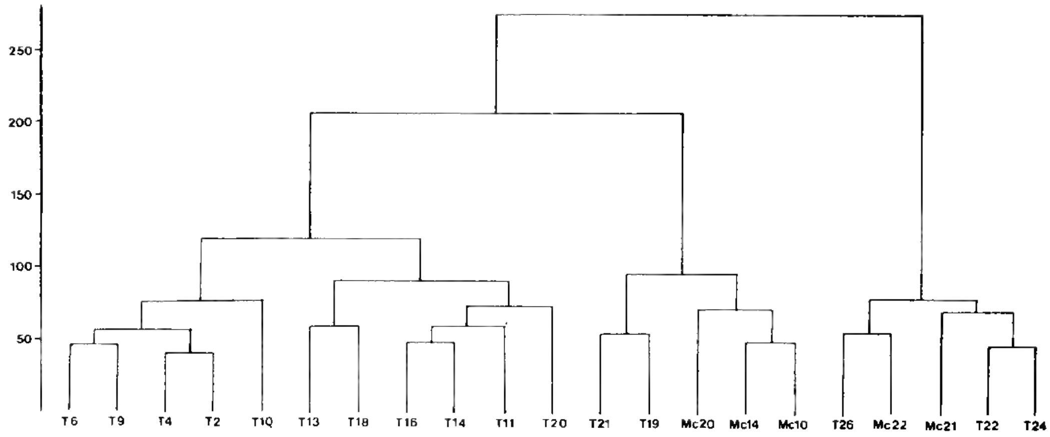


Fig. 19 Dendrogram showing DIVINF normal classification.

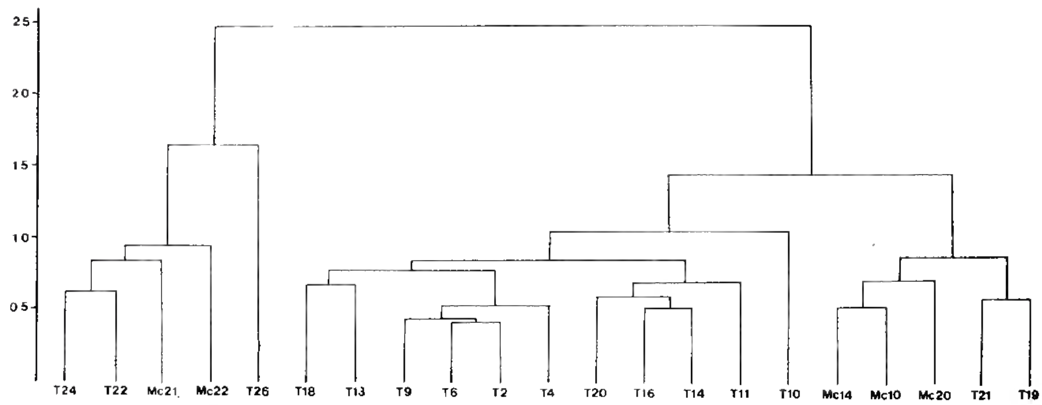


Fig. 20 Dendrogram showing MULCLAS normal classification with Canberra metric.

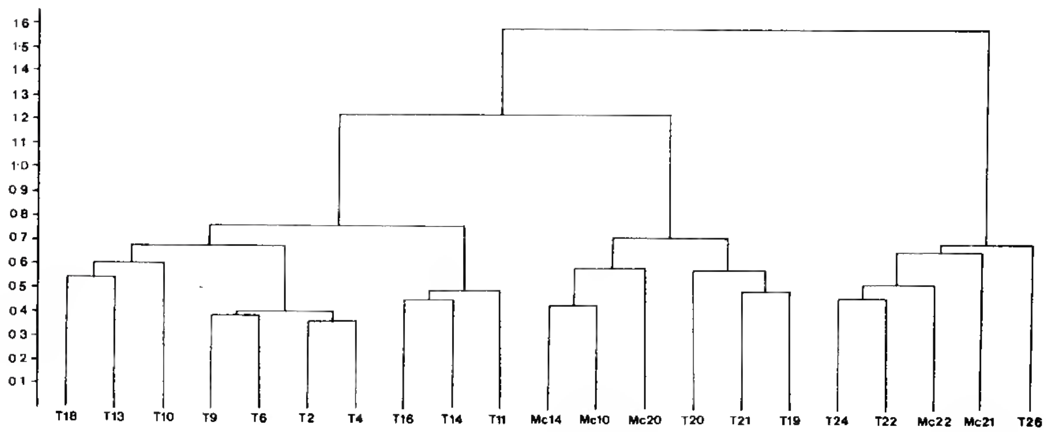


Fig. 21 Dendrogram showing MULCLAS normal classification with Euclidean metric.

TABLE 4

Non-hierarchical site and species groups (derived from MAGIC program with some hand sorting). A = abundant, C = common, R = rare. Site groups from A - D, species groups from 1 - 8.

	A					B						C					D				
Taxon	Mc 14	Mc 10	T 21	Mc 20	T 19	T 6	T 2	T 4	T 9	T 18	T 10	T 16	T 11	T 20	T 14	T 13	T 22	T 24	T 26	Mc 21	Mc 22
Group 1 "Ubiquitous" and Common Species																					
Centroptilum sp.	A	A	A	A	C	A	A	A	A	C	C	A	A	C	A	C	R	C	C	C	C
Baetis sp.	A	A	A	A	R	A	C	A	A	C	R	A	A	C	C	C	R	C	C	C	C
Coloburiscoides sp.	A	A	A	A	C	A	C	A	C	C	C	C	A	C	C	C	C	R	R	R	R
Tasmanocoenis sp. 1	C	C	C	C	C	C	C	A		C	A	A	C	C	C	C	C		A	C	C
Atalonella sp. 1	C	C	C	C	C	C	C	C	R	R	C	R	C	R	C	R	R	R	R	R	
Atalophlebioides sp. 1	C	C	C	C	C	C	C	C	R	R	C	R	C	R	C	R	R	R	R	R	
Jappa sp. 1	C	C	R	C	R	R	R	C	R	C	C	R	A		C	R	R		R		
Aeshnidae sp. 1	C	C	C	R	R	R	R		R	R	R	R	R	R		R	R	R	R	C	A
Trinotoperla nivata	A	A	A	A	A	A	R	A	A	A	A	A	A	A	A	R	R			A	
Dinotoperla serricauda	C	C	C	C	C	C	A	C	C	C	C	C	C	C	C	C	C			C	
Illiesopla australis	A	A	A	R	A	C	A	A	A	A	A	A	A	A	A	A		R		R	
Rheumotometra philarete	A	A	C	A	R	C					C	C	C	A	R			R		R	R
Microvelia peramoena	C	C	C	R	R	R				R	R		C			C		C	A		C
Microvelia fluvialis fluvialis	A	A	C	A	C	C				R	R	C	A	C							C
Notriolus quadriplagiatus	C	R	C	R	R	C	C	C	C	C	R	C	C	C	R	R	R	C			
Austrolimnius mormo	C	C	R	C	R		R	R		C		C	C	R	C	R		R	R		
Austrolimnius diemenensis	R	R	R	R	R		R			R		C	R	C	R	R		R			
Austrolimnius messa	C	C	R	R			R	R	C	C	R	C	C					R			
Austrosimulium (N) sp. (*furiosum* gp.)	A	A	R	C	C	R				C	R	C				C	R		R	R	
Microvelia dubia		C	C	R		R	R	C		R	C	C	C	C		C		C			

TABLE 4 cont.

Taxon	A					B						C					D				
	Mc 14	Mc 10	T 21	Mc 20	T 19	T 6	T 2	T 4	T 9	T 18	T 10	T 16	T 11	T 20	T 14	T 13	T 22	T 24	T 26	Mc 21	Mc 22
Group 2 Non Potamon Species																					
Atalophlebioides sp. 2		R	C	R		C	C	C	C	R	R	R	C	R	R	R					
Atalophlebioides sp. 3	R	R				R	R	R	R	R	R	R	R								
Atalonella sp. 9		R				R	R	R		R			R	R	R						
A. sp. 10	R			R		R		R	R			R	R	R							
A. sp. 3			R			R			R		R		R		R						
A. sp. 5						R		R		R			R		R						
Synlestes sp. 1	C	R	R		R		R					R	R								
Mirawara sp. 2	R		R	C	C	R	R	C	R	R		C		R	R						
Tasmanophlebia sp. 1				R			C		R	C											
T. sp. 2	C	R	R	C	R		R		R		R		R	R						R	
Dinotoperla fontana	C		C		C	C	A		C	C	A	C	C	C	C	C					
Trinotoperla yeoi	C	R	C	C	C	C	R	C	C	C	C	C	C	C	C	C					
Acruroperla atra		C			C	A	A	A	A	A	A	A	A	C	R						
Dinotoperla arenaria	R		R			A	A	A	A	A	A	A	A		R						
Austroheptura neboissi						A	A	A		A	A	R	A		R	R					
Dinotoperla brevipennis	R		C			C	C	C		C	A	C	A	A	R						
Riekoperla rugosa	R	C	C				C	C		C	C	R	C	C	R	R					
Dinotoperla christinae	R		C	R	C	C	R	R	C	C		C		C			R				
Stenoperla australis	C	C		C		C	C	C	C	C	C		A	C	C	C					
Eustheniopsis venosa			R					R			R										
Leptoperla primitiva	C	R	C			R	C			R		C	C		C	C			R		

TABLE 4 cont.

Taxon	A Mc 14	Mc 10	T 21	Mc 20	T 19	B T 6	T 2	T 4	T 9	T 18	T 10	C T 16	T 11	T 20	T 14	T 13	D T 22	T 24	T 26	Mc 21	Mc 22
Trinotoperla irrorata				R	R		R			C	C										
Epilichas nigrinus		C				C	C	C	C		R	R	R		R						
Macrogyrus (Australogyrus) oblongus	C	C	R	C		R		R		R	C	R	C	C		C					
Sclerocyphon striatus	C	C	C	C	C	C	R		R	C	C	C	R	C	R	R					
Sternopriscus mundanus		R	C	C	R	C	C				C	R	C			R					
S. multimaculatus			R			R	R		R			C		R		R					
Simsonia tasmanica	C		C			R	R	R	C			R				R					
Austrolimnius troilus	R		R		C	R				R		R	R	R							
A. anytus			R	R		R	R					C									
Kingolus nr *tinctus*	C	C	R	C				R					R		R						
Austrosimulium victoriae	C	A			R	C	R	R	C	C	C					R					
Tipulidae sp. 1	C	R	C		R	C	R	R	R		R	C	C	R	R	R					
Edwardsina polymorpha	R							C	A	C		C	R	C	C						
E. torrentium torrentium								R			C	R			R	R					
Group 3 Potamon Only Species																					
Cloeon sp.																			C		
Coenagrionidae sp. 1																			C	R	R
Coenagrionidae sp. 3																			R	R	R
Libellulidae sp. 1																			C		
Anisops gratus																			C		
Plea brunni			R																C		C
Diplonychus eques																			C		
Merragata hackeri																			C		

TABLE 4 cont.

Taxon	A					B						C					D				
	Mc 14	Mc 10	T 21	Mc 20	T 19	T 6	T 2	T 4	T 9	T 18	T 10	T 16	T 11	T 20	T 14	T 13	T 22	T 24	T 26	Mc 21	Mc 22
Mesovelia hungerfordi																			C		
Agraptocorixa eurynome																			C		
Anisops gratis																			C		
Australogyrus strigosus																		C	C		C
Octhebius lividus																		R	R		R
Rhantus prob. *suturalis*																			C		
Notriolus nr *maculatus*			R														R	C	C		
Simulium (E) *ornatipes*																			C		
Austrosimulium (N) *bancrofti*																	R			C	A
Group 4 Thomson Only Species (=mountain stream species)																					
Atalonella sp. 2					R	R	R	C	R	R	R	R	R		R						C
Austrocercella tillyardi			R			R	C	R	R		C		C								
Reikoperla tuberculata			C			C	R	C	C	R	C			C							
R. karki reticulata gp.						C	R	C			C	R	C		C						R
Austrocercella ? mariannae						R	R	C		R	R		R	R						R	
Microvelia distincta			C			A	C	C		R	C	C				A					
Sclerocyphon irregularis			R			C	C	C	R		R		R								
Austrosimulium (A) *montanum*					R	R	C	C	R	R	R										
Group 5 Species Rare or Absent in Mountain Reaches																					
Atalophlebia longicaudata	A	A	C	C	C	R	R					C	C	A	R	C	R	C			
Atalophlebia sp. 1	R	A	C	C	R					C		C	A	C	C	C	R	R	C	C	
Atalophlebia sp. 2	A	A	R	C	C					R		R	R	R			R		R	R	

TABLE 4 cont.

Taxon	A					B						C					D				
	Mc 14	Mc 10	T 21	Mc 20	T 19	T 6	T 2	T 4	T 9	T 18	T 10	T 16	T 11	T 20	T 14	T 13	T 22	T 24	T 26	Mc 21	Mc 22
Jappa sp. 2	C		C	C	C							R	R	R	C		R	R		R	
Kirrara sp.	A	A	R	C	R							C		R	R		R				
Gomphidae sp. 1	R	C	R	C								R		R			R	R		R	
Aeshnidae sp. 2	C	C	R	R	R						R				R	R	R			R	
Newmanoperla thoreyi	R	R	C		R	R						C			C	C	R	R		R	
Micronecta annae illiesi		C	A	A								A	C	A	C			A	A	A	A
Simsonia nr *leai*	C		R									R	R	R							
Notriolus allynensis	R	C	R	R										R				C	R		
Sclerocyphon basicollis	C	C		R								R		R		R					
Group 6 Widespread but Uncommon Species																					
Aeshnidae sp. 8	R	C	R		R	R			R					R	R			R			R
Synthemis eustalacta	R					R	C	R				R	R		R	R		R		R	
Leptoperla kimminsi	C	C				A				R		C		R		C			C		
Micronecta annae annae			C								A		C						A	A	A
M. oceanica				R		C			R		R					R			C	R	
Enochrus elongatulus		R					R									R			R	R	
E. maculiceps		R						R								R			R	R	
Paracymus pygmaeus		R					R	R		R	C		R		R	R		R	C		C
Necterosoma penicillatus		R	R	R					R		R		C					R		R	R
Berosus involutus	R	R	R	R		R				R	R		C			C		C	A		C
Simsonia purpurea	C									R		R		R	R				R	C	
S. wilsoni	R	R								C		R						R		R	

TABLE 4 cont.

Taxon	A					B						C					D				
	Mc 14	Mc 10	T 21	Mc 20	T 19	T 6	T 2	T 4	T 9	T 18	T 10	T 16	T 11	T 20	T 14	T 13	T 22	T 24	T 26	Mc 21	Mc 22
Austrolimnius nomia				R						R			R					R			
Austrosimulium furiosum	C	C		R							R	R	C					R		R	
Tipulidae sp. 2	C	A	R			R	R		R					R						R	C
Tipulidae sp. 3	R	R									R					C		R			
Group 7 Species Most Common in Macalister and Aberfeldy																					
Tasmanocoenis sp. 3	C	C		C										R			R			C	C
Diphlebia sp. 1	C	R		C										R							
Aeshnidae sp. 3	R	R	R		R									R						R	
Aeshnidae sp. 6	R	R	R		R						R			R						R	
Micronecta carinata	A	A		A																C	
M. nr *Carinata*	C	A	C	A	C																
M. nr *Windi*		A	C	A	R						R								C	C	
M. australiensis	C	A	A	A									C					A	A	C	C
Enithares bergrothi	R	R		C															C	R	C
Australphilus nr *saltus*	R		R		R					R						R					
Simsonia hopsoni	C	C		R																	
Kingolus quatuormaculatus	R	R		C																R	
Austrolimnius didas	C	R		R											R						
A. ochus	R	R	C		R									C		R					
A. fallax	R	R	R	R																R	
A. sp. (prob. new)	R	R	R	R	R		R		R					R							
Austrosimulium (N) *torrentium*	A	A		R	C															R	
Allaudomyia sp.	R	R			R																

TABLE 4 cont.

Taxon	A					B						C					D				
	Mc 14	Mc 10	T 21	Mc 20	T 19	T 6	T 2	T 4	T 9	T 18	T 10	T 16	T 11	T 20	T 14	T 13	T 22	T 24	T 26	Mc 21	Mc 22
Tipulidae sp. 4	C	R	R		C								R		R						
Group 8 Rare and/or Sporadically Distributed Species																					
Tasmanocoenis sp. 2	R			R				R		R											
Gomphidae sp. 2										R			R		R						
G. sp. 4				R			R											R		R	
Aeshnidae sp. 9		R																	R	R	
Leptoperla neboissi		C	R									R	R					R			
Tenagogerris euphrosyne		R		C															C		C
Sigara (T) *sublaevifrons*					R								R						C		
S. (T) *truncatipala*				C									R			R			C	R	
Micronecta robusta		C																	A		
Anisops deanei											C		C			R		R	A		
A. doris											C										
Hydrometra strigosa				R															R		R
Hydraena luridipennis											C								C		
H. tricanthi										R	C										
Liodessus gemellus		R					R						R								
Allodessus bistrigatus											R		R					R			
Antiporus femoralis				R			R												R	R	
Nothydrus australis montanus											R					R					
Kingolus yarrensis	C						R		C											R	
Austrolimnius waterhousei	R									R		R									

TABLE 4 cont.

Taxon	A					B						C					D				
	Mc 14	Mc 10	T 21	Mc 20	T 19	T 6	T 2	T 4	T 9	T 18	T 10	T 16	T 11	T 20	T 14	T 13	T 22	T 24	T 26	Mc 21	Mc 22
Cnephia aurantiacum				R	R			R													
Edwardsina pilosa											C										
E. torrentium torrentium								R			C	R			R	R					
Pellucidomyia sp.												C			R						
Tipulidae sp. 16											R	R			C						
T. sp. 10		R				R		R			R					R					
T. sp. 25	R					R							R			R					

site groups, but nowhere abundant (such as *Synthemis eustalacta*). Group 6 also contains a few sporadically abundant species such as *Micronecta annae annae*. Group 7, related to group 5, is of species found at stations on or influenced by the Macalister or Aberfeldy Rivers and is restricted to middle and lower foothills. The most common order is Coleoptera with 8 species, including 6 elmids. Finally, group 8 is of species too rare and patchily distributed to draw any conclusions about, but may contain species which correctly belong in one of groups 2-7. Group 8 contains no mayflies or stoneflies.

The relationship between results of normal and inverse analyses are generally clear. The only station group without an associated species group more or less exclusive to it is Group B, made up of upper foothill stations on the Thomson.

Communities of Major Habitats

Of the 413 species identified (aquatic stages only), 291 have been collected from backwaters, 271 from riffle-rapid-runs, 255 from banks, 217 from pools, and 109 from lagoons and swamps (Table 5). However, it is clear that many species are incidental to habitats other than their preferred ones (defined here as the habitat they are most common in). Of the 343 riverine species, 171 were collected preferentially from riffle-rapid-runs, 138 from backwaters, 29 from banks, and only 9 from pools (Table 6).

In particular, many species shared by pools and other habitats were collected only rarely from pools. None of the species occurring preferentially in pools were particularly abundant, and Table 7 lists only three taxa as being dominant in pools. (Dominant species are defined as those with a constancy value of 50% or greater in one or both rivers and abundant or common at most stations of occurrence. A species may be a dominant member of the fauna in more habitats than the one it "prefers"). The species dominant in pools are *Centroptilum* sp., *Baetis* sp. and *Coloburiscoides* sp., all very common and widespread, and collected most frequently from riffle-rapid-runs. The nine species occurring preferentially in pools were also common and widespread in other habitats. (The three elmids appeared to be associated with logs in slow flowing water and *Austrosimulium (A.) montanum* appeared able to tolerate slower flows and siltier substrata than most other simuliids.) The overall picture of the fauna of the pools is that of an "attenuated" riffle community, with only a small number of species, if any, specifically adapted to pool conditions. In fact, in rhithrons, pools can be seen to act largely as an overflow area for specifically lotic species which occur preferentially in riffles, rapids and runs. In the rhithron of the Thomson and Macalister Rivers the pools do not provide the soft substrata required by typical fauna of depositing areas.

In a similar way the fauna of banks can be seen to be related to that of backwaters. However, in this case there are a number of species which may prefer banks due to the combination of overhanging or emergent vegetation, and reasonable currents. (In particular, the three species of Gerridae, *Tenagogerris euphrosyne*, *Rheumatometra philarete* and *Gerris (Aquarius) antigone* depend upon overhanging and emergent vegetation for shade and shelter, and also lay their eggs on submerged plants.)

Species ensembles from areas of faster water are dominated by Coleoptera (especially Elmidae), Diptera, Parasitengona, Ephemeroptera, Plecoptera, and Anisoptera in that order. These groups provide 233 out of 271 species collected from riffles, rapids, and runs, and of the 171 species preferentially occurring in these areas, 140 belong to the abovenamed groups. From backwaters, the groups providing most species are. in order. Coleoptera (mainly other than Elmidae), Parasitengona, Diptera, Hemiptera, Ephemeroptera, Plecoptera, Anisoptera and Crustacea, with 265 out of 291 species. Backwaters, and to a lesser extent, banks, appear to represent the only depositing substrata in the rhithron and provided suitable habitats for some essentially lentic species.

The difference between the communities of riffle-rapid-runs and backwaters is shown clearly by the species occurring preferentially in one or the other habitat. The Ephemeroptera has 21 species collected preferentially from backwaters and only seven from riffle-rapid-runs, Hemiptera 21 species from backwaters and none from riffles, Coleoptera (excluding Elmidae) 30 from backwaters and 14 from riffles, and Crustacea eight from backwaters and only two from riffles. Conversely, 18 species of Plecoptera were most numerous in riffle-rapid-runs and only nine in backwaters, and the same pattern exists for Elmidae (34 species in riffles, one species in backwaters), Diptera (40 and three species) and Parasitengona (30 and 20 species).

The difference is even more apparent when considering the dominant taxa of these two habitats (Table 7). Of 20 taxa classified as abundant in riffle-rapid-runs and 21 in backwaters, only two were common to the two

TABLE 5.

Total number of species of each invertebrate group in major habitats.

	Riffle-rapid-runs	Pools	Banks	Backwaters	Swamps & lagoons
Ephemeroptera	30	23	28	28	6
Odonata: Zygoptera	3	3	5	7	9
Anisoptera	18	13	14	15	3
Plecoptera	27	27	25	21	
Hemiptera	12	15	24	30	23
Neuroptera	2	1	1	1	
Megaloptera	1	1	1	1	
Coleoptera: Elmidae	38	29	27	23	
All other families	29	32	42	57	32
Diptera (excluding Chironomidae)	48	33	31	33	4
Lepidoptera	2	2	1	1	2
Hydrozoa	1				
Temnocephalidea			1	1	
Turbellaria	2	1	2	3	2
Nematoda				1	
Nematomorpha		1	1	1	
Hirudinea				1	
Gastropoda					
Oligochaeta	11	8	1	9	1
Crustacea	4	1	4	14	15
Parasitengona (water mites)	43	27	43	44	12
TOTAL	271	217	251	291	180

habitat types. Of these two taxa, *Baetis* sp. may include more than a single species, while *Riekoperla tuberculata* is closely associated with patches of organic detritus either deposited in backwaters or trapped under stones. The higher taxa which provided the most species in each habitat also provided most of the dominant species. In riffle-rapid-runs five of the numerically-dominant species were Ephemeroptera, 10 were Plecoptera, five were Elmidae,

TABLE 6.

Total number of species of different invertebrate groups occurring preferentially in major habitats.

	Riffle-rapid-runs	Pools	8anks	8ackwaters	Swamps & lagoons
Ephemeroptera	7		3	21	
Odonata: Zygoptera				3	9
Anisoptera	10			7	2
Plecoptera	18	1	3	9	
Hemiptera			6	21	12
Neuroptera	1		1		
Megaloptera	1				
Coleoptera: Elmidae	34	3		1	
All other families	14		8	30	20
Diptera (excluding Chironomidae)	40	1	1	3	3
Lepidoptera	1			1	1
Hydrozoa	1				
Temnocephalidea			1		
Turbellaria	1			1	1
Nematoda				1	
Nematomorpha				1	
Hirudinea				1	
Gastropoda				5	1
Oligochaeta	11	4		5	
Crustacea	2			8	10
Parasitengona (water mites)	30		6	20	10
TOTAL	171	9	29	138	69

two were other Coleoptera and two Tipulidae. In backwaters 11 were Ephemeroptera, five Plecoptera, seven Hemiptera and two "other Coleoptera".

Riffle-rapid-runs support the largest number of common and abundant species, and also provide more rare and uncommon species than other habitats. Considering the whole range of species occurring in the middle reaches of the Thomson River, 22 species were entirely confined to riffle-rapid-runs and another 69 showed a heavy preference for them, being only

TABLE 7

Dominant taxa in major habitats.

Taxa	Riffle-rapid-runs	Pools	Banks	Backwaters	Swamps & Lagoons
Ephemeroptera	*Centroptilum* sp.	*Centroptilum* sp.	*Centroptilum* sp.		
	Baetis sp.	*Baetis* sp.	*Baetis* sp.	*Baetis* sp.	
	Coloburiscoides sp.	*Coloburiscoides* sp.			
	Kirrara sp.				
				Tasmanocoenis sp. 1	
			Tasmanocoenis sp. 3	*Tasmanocoenis* sp. 3	
				Atalophlebia sp. 1	
				Atalophlebia sp. 2	
			Atalophlebia longicaudata	*Atalophlebia longicaudata*	
			Jappa sp. 1	*Jappa* sp. 1	
				Atalophlebioides sp. 1	
				Atalonella sp. 5	
Odonata					*Coenagrionidae* sp. 1
Plecoptera	*Stenoperla australis*				
	Austroheptura neboissi				
				Acruroperla atra	
				Austrocercella tillyardi	
	Illiesoperla australis				
	Newmanoperla thoreyi		*Leptoperla primitiva*	*Leptoperla primitiva*	
	Riekoperla tuberculata		*Riekoperla tuberculata*	*Riekoperla tuberculata*	
	Riekoperla rugosa			*Dinotoperla fontana*	

TABLE 7 cont.

Taxa	Riffle-rapid-runs	Pools	Banks	Backwaters	Swamps & Lagoons
	Trinotoperla nivata			*Dinotoperla serricauda*	
	Trinotoperla yeoi		*Dinotoperla brevipennis*		
	Dinotoperla arenaria				
Hemiptera				*Rheumatometra philarete*	*Anisops deanei*
				Microvelia dubia	*Sigara (T.) sublaevifrons*
				Microvelia peramoena	*Sigara (T.) truncatipala*
				Microvelia distincta	
				Microvelia fluvialis fluvialis	
Coleoptera	*Epilichas nigrinus*		*Macrogyrus (A.) oblongus opacior*		*Hydrochus* sp. 5
	Sclerocyphon striatus			*Sternopriscus mundanus*	
	Notriolus quadriplagiatus				
	Austrolimnius victoriensis				
	Austrolimnius mormo				
	Austrolimnius messa				
	Austrolimnius (N.) victoriae				
Diptera	*Tipulidae* sp. 1				

occasionally collected from other habitat types. That is, of the approximately 300 species identified from this stretch of the river, almost one-third are closely associated with riffle-rapid-runs. The high species richness of riffle-rapid-runs is widely noted in the literature and is normally seen to be a result of greater habitat diversity than other stream areas (e.g., Sprules, 1947; Hynes, 1970; Allan, 1975a).

Swamps and lagoons had a very distinctive fauna, although with some similarities to that of backwaters and banks. Of the 109 species collected, 32 were Coleoptera (excluding Elmidae), 23 Hemiptera, 15 Crustacea, 12 Parasitengona and 9 Zygoptera. Considering the 69 species occurring preferentially in swamps and lagoons, 20 were Coleoptera, 12 Hemiptera, 10 Crustacea, 10 Parasitengona and all 9 Zygoptera species occurred in these off-river habitats. The dominant species of such areas were Coenagrionidae sp. 1., *Anisops deanei, Sigara (T.) sublaevifrons, S. (T.) truncatipala* and *Hydrochus* sp. 5, all of which were rarely collected from other habitats. Swamps and lagoons generally have higher levels of colour, turbidity and conductivity, and lower levels of dissolved oxygen and pH than any of the riverine habitats; these conditions may in some cases be as important in determining faunal distribution as the complete absence of current.

DISCUSSION

General Comments

It is reassuring as to the validity of site groups that the diverse classificatory procedures used all provided a very similar picture of station relationships. Comparing the non-hierarchical and hierarchical methods, it is clear that the internal structure (upon which MAGIC groups are recognized) is consistent with inter-group relationships (upon which the groups of Figs. 19-21 are based). The exceptions to this are the heterogenous lowland stations, Site Group D, and site 13 of Site Group B. The lowland stations group away from all others, but are not as closely related to each other as are members of the three mountain and foothill groups. Site 13, an aberrant site discussed previously, almost certainly belongs to Site Group B, but adds to the heterogeneity of that group.

Comparison of the two MULCLAS results indicates that not only do stations within a site group share common species, but joint absences also tend to be common within any particular group. One of the features of the DIVINF dendrogram (Fig. 19) is the apparently close relationship of Mc22, a very depauperate lowland station, and T26, a station unique among those of Site Group D for its species richness. The two other dendrograms show T26 as being quite dissimilar to all other stations, as a result of the large number of species collected rarely or not at all from other stations. What T26 and Mc22 have in common, however, is (i) the few species at Mc22 are largely lentic forms also occurring at T26, and (ii) these two stations have fewer obligate lotic species than any other sites, so that shared absences have counted considerably towards site similarity in the symmetric DIVINF analysis.

The proportions of total species provided by the various higher taxa are essentially similar to those reported from stony streams in other parts of the world (e.g., Jones, 1948, 1949a, b; Dittmar, 1955; Morgan and Egglishaw, 1965; Maitland, 1966; Bishop, 1973, Towns, 1979).

However, Parasitengona and Coleoptera are particularly well represented in this study, while the non-arthropod invertebrates, especially Hirudinea and Mollusca, are very poorly represented. The large number of species of Parasitengona and small Coleoptera are probably partly due to the fine collecting mesh used throughout this study.

The large differences apparent between total number of species collected for the whole study (Table 1), and for single collections from single sites (Table 2), illustrate the problems in comparing results from different studies. Bishop (1973) concluded that the numbers of insect species per site recorded by Patrick (1964) for some Peruvian streams are very low compared to his own results from a Malaysian stream. However, Patrick's figures are for one collection from each site, while Bishop's are apparently total species collected over at least three different occasions.

Bishop (1973) also indicated that his results support the conclusion that tropical streams carry a more diverse invertebrate fauna than temperate ones. As noted above, actual comparison of different surveys is extremely difficult, but the species richness reported by Bishop (1973) and that discussed herein may not be as dissimilar as they first appear. Bishop's maximum number of species per site was 184, which excluded Elmidae and Trichoptera. That reported here is 90 (see Table 1) but this figure excludes Trichoptera and Chironomidae, as well as all non-insect invertebrates including Parasitengona (with 70 species over the whole catchment) and

Oligochaeta. Further, Bishop's collecting methods were considerably more intensive than those used in this study. The results presented here suggest that considerably more careful comparison between Southern Hemisphere tropical and temperate stream communities is necessary for any worthwhile contribution to the discussion of tropical versus temperate diversity. Certainly the results herein indicate that the depauperate nature of the fish fauna of Australian inland waters (Williams, 1980d) and of the benthic fauna of Australian lakes (Timms, 1980) is not shared by the invertebrate component of the fauna of streams.

Variation between Rivers

Thomson and Macalister

Despite considerable overlap of species in the two river systems, appreciably more species were collected from the Thomson catchment, excluding the Macalister (399 taxa including adult Trichoptera), than from the Macalister (290 taxa). It is likely that this largely reflects the greater sampling effort in the Thomson catchment. Excluding species collected only from the confluence of the two rivers (T26) where they occurred mainly in billabongs, the species numbers are 373 for the Thomson and 266 for the Macalister. These totals do not include the very diverse groups, Parasitengona and Chironomidae, and indicate that the two catchments studied contain similar numbers of species to those reported for various small river systems throughout the world including: Berg (1948), over 500 species; Patrick (1949), 324 species; Jones (1949b), 191 species; Dittmar (1955), 399 species, Maitland (1966), 257 species; and Bishop (1973), 430 species. (The comparatively high numbers of species recorded here, and by Berg (1948) and Bishop (1973) are at least partly a reflection of the finer nets used in these three studies: 160, 165 and (probably) 250 µm respectively.) These results again suggest that the aquatic fauna of Australia's permanent streams is at least comparable in diversity to that of comparable streams in other parts of the world.

Examination of common species throughout the two systems yields some interesting results. Within the Plecoptera collected, three species were entirely absent from the Macalister system. These species were *Eunotoperla kershawi, Neboissoperla alpina* and *Dinotoperla eucumbene;* all known to occur in very high altitude streams (Hynes, 1978). Thirteen species were collected from half or more of the Thomson stations, and only three from half or more of the Macalister stations. Further, only seven species of Plecoptera are classed as common or abundant at three or more Macalister stations, while 18 were so classed at three or more Thomson stations. Only the three very common and widespread species, *Illiesoperla australis, Trinotoperla nivata* and *Dinotoperla serricauda,* could be considered conspicuous features of the Macalister River fauna, while 13 species of Plecoptera could be so considered in the Thomson. The small corixids (*Micronecta* spp.) were generally more common in the Macalister than in the Thomson. The psephenid beetle, *Sclerocyphon irregularis,* was absent from the Macalister, while quite widespread in the Thomson. Two species of dytiscids, *Sternopriscus mundanus* and *Necterosoma penicillatus,* were much more widespread in the Thomson than in the Macalister. The riffle beetles, family Elmidae, were also a more conspicuous part of the fauna at Thomson stations than at those on the Macalister. Station Mc14, the confluence of the Macalister and Barkly Rivers, was a notable exception yielding 23 species of elmids, more than any other station.

No analysis of the reasons for the faunal differences noted above has been attempted. However, there is at least a correlation between them and temperature regimes of the two main rivers. Temperatures in the Macalister are consistently higher than at equivalent stations on the Thomson. Long term monthly means at Glencairn on the Macalister are 1-3° C higher, and monthly maxima up to 8° C higher, than they are at The Narrows on the Thomson. It is particularly at the cooler headwater stations in the Thomson that many species occur which are not found in the Macalister system. Many workers, notably Vannote (1973), Sweeney and Vannote (1978) and Vannote and Sweeney (1980) have stressed the importance of temperature regimes in determining large scale distribution patterns of aquatic invertebrates.

Other Streams

Table 8 shows species of some major groups collected from station Mc10, classified as to whether they came from either the Caledonia or Macalister, or both. The temperature data for the Caledonia is sparse, but Figure 4 suggests that it is a few degrees cooler than the Macalister. There are considerable differences in the faunal communities of the two although at their confluence the streams are basically similar. The presence of five species of Odonata in the Macalister which were not found in the Caledonia, five species of Plecoptera exclusive to the Caledonia, and three genera of Cerato-

TABLE 8.

Species of Ephemeroptera, Odonata, Plecoptera and Diptera occurring in Macalister and Caledonia Rivers.

Macalister	*Thomson*
EPHEMEROPTERA	
Centroptilum sp.	*Centroptilum* sp.
Baetis sp.	*Baetis* sp.
Coloburiscoides sp.	*Coloburiscoides* sp.
	Tasmanophlebia sp. 2
Tasmanocoenis sp. 1	*Tasmanocoenis* sp. 1
T. sp. 3	*T.* sp. 3
Atalophlebioides spp.	*Atalophlebioides* spp.
Atalophlebia sp. 1	*Atalophlebia* sp. 1
A. sp. 2	*A.* sp. 2
Atalophlebia longicaudata	*Atalophlebia longicaudata*
Jappa sp. 1	*Jappa* sp. 1
	Jappa sp. 3
Kirrara sp.	*Kirrara* sp.
ODONATA	
Synlestes sp. 1	*Synlestes* sp. 1
Diphlebia sp. 1	
Gomphidae sp. 1	Gomphidae sp. 1
Gomphidae sp. 3	
Aeshnidae sp. 1	Aeshnidae sp. 1
Aeshnidae sp. 3	Aeshnidae sp. 2
Aeshnidae sp. 4	Aeshnidae sp. 4
	Aeshnidae sp. 5
Aeshnidae sp. 6	Aeshnidae sp. 6
Aeshnidae sp. 8	
Aeshnidae sp. 10	Aeshnidae sp. 10
Aeshnidae sp. 11	
PLECOPTERA	
Stenoperla australis	*Stenoperla australis*
	Eustheniopsis venosa
	Acruroperla atra
Illiesoperla australis	*Illiesoperla australis*
Newmanoperla thoreyi	
	Leptoperla primitiva
Leptoperla neboissi	*Leptoperla neboissi*
Riekoperla rugosa	*Riekoperla rugosa*
Trinotoperla nivata	*Trinotoperla nivata*
	T. yeoi
	Dinotoperla serricauda
DIPTERA	
Bezzia spp.	
Nilobezzia spp.	
Allaudomyia sp.	
Austrosimulium (Novaustrosimulium) victoriae	*Austrosimulium (Novaustrosimulium) victoriae*
A. (N.) furiosum	*A. (N.) furiosum*
A. (N.) sp. (*furiosum* group)	*A. (N.)* sp. (*furiosum* group)
A. (N.) torrentium	*A. (N.) torrentium*

pogonidae exclusive to the Macalister suggest again that temperature difference may be important in determining community characteristics of the two rivers. Similar faunal differences were apparent between the Barkly and the Macalister at their confluence, where the Barkly was cooler on the few occasions of temperature measurement.

Zonation of Stream Communities

General Comments

The concept of eroding and depositing zones, introduced by Moon (1939) and extended by Cummins (1972) to include substrata of intermediate type is one of many attempts to categorize stream biotopes (e.g., Illies, 1961; Illies and Botosaneanu, 1963; Cummins, 1966; Thorup, 1966; Ulfsfrand, 1968; Chutter, 1970; and Pennak, 1971). In the zonation system developed by Illies (1961) and Illies and Botosaneanu (1963), our mountain/foothills reaches and lowland reach correspond, in faunal characteristics and physical and chemical features, to the rhithron and potamon respectively. Other studies, discussed by Hynes (1970) and Bishop (1973), indicate the applicability of this basic division in streams of Southern Africa, Europe and North America, and Illies (1964) and Bishop (1973) have shown that it may also apply to tropical streams. Unpublished theses by Macmillan (1975), Bennison (1975) and Gooley (1977), suggest that the fauna and physical and chemical conditions of many Australian streams show the same division into two fairly distinct zones, and that the terms rhithron and potamon are applicable to these streams.

Cummin's (1972) terms, eroding, intermediate, and depositing areas, are used herein as referring to particular biotopes (in the sense of Ulfsfrand, 1968) which, although normally concentrated in particular longitudinal stretches may occur in either rhithron or potamon.

Rhithron vs Potamon

In this study, from T22 on the Thomson, and Mc21 on the Macalister, there are rapid increases in levels of turbidity, suspended solids, total dissolved solids, hardness, and alkalinity, and an equally clear decrease in percent saturation of oxygen. Substrata also change in the short transition zone from rhithron to potamon, with the mountain and foothill regions dominated by eroding substrata, while the lowland stretch consists mainly of depositing substrata. These comparatively rapid changes are superimposed on the gradual change along the length of both rivers of most physical and chemical factors. Coincident with this change in water quality, the overall species richness within the streams decreases appreciably at and downstream of T22 on the Thomson, and Mc21 on the Macalister. Both stations are situated approximately at the junction between rhithron and potamon. The mean number of riverine species collected from 16 rhithron stations on the two rivers was 59 ± 14, while the mean number from the five potamon stations was only 39 ± 10. The seven stations particularly rich in species were all junctions of two streams. These were, in order of total number of species collected from streams, Mc10, Mc14, T20, Mc20, T11 and T26. Numbers ranged from 84 to 62 for all but T26 which yielded only 50 species.

All methods of classificatory analysis used indicate a rapid change in community composition also occurring at the boundary of rhithron and potamon. Many species of Ephemeroptera (especially Leptophlebiidae in the Macalister), Aeshnidae, Plecoptera, Elmidae, Simuliidae, Blephariceridae, and Tipulidae were largely restricted to rhithron stations. In particular, of 31 species of Plecoptera only five were collected (and then only rarely) from stations in the potamon, and only one, *Leptoperla primitiva,* from the lowest station, T26. Within the rhithron 15 of these stoneflies were common to abundant at most stations.

Table 4 illustrates that describing particular families or higher groups as belonging to either rhithron or potamon, as in Illies and Botosaneanu (1963), may obscure the fact that "choice" of condition occurs at the species level. Some members of a nominally rhithronic family may occur throughout both zones, or even selectively in the potamon, and vice versa.

Subdivision of Rhithron

Illies, in his work on European streams, has proposed subdivisions of the two major zones into epi-, meta-, and hyporhithron, and epi-, meta-, and hypopotamon, on the basis of faunal communities (e.g., Illies, 1961; Illies and Botosaneanu, 1963). Illies and Botosaneanu also state that the point of discontinuity in faunal communities is at "principal confluences", which are junctions with streams of the same "zone". Because increased discharge is seen as the important factor (from a zonational point of view) occurring at the "principal confluences", the term "zone" above appears to be synonymous with stream order in the sense of Horton (1945) and Strahler (1957). That is, in the zonation system of Illies and Botosaneanu (1963) the boundaries within one stream of the subdivisions of rhithron and potamon occur at junctions with streams of the same order.

Macmillan (1975) and Gooley (1977) did not find any clear zonation of fauna within the rhithron or potamon in two Victorian streams, and neither did Bennison (1975) in the Coal River in Tasmania. Bennison did, however, note changes in physical and chemical factors corresponding to the subdivision of the two major zones into epi-, meta-, and hyporhithron and -potamon as suggested by Illies and Botosaneanu (1963).

In this study our limited physical and chemical data do not show anything other than a general trend with distance downstream. Further, there were too few lowland stations to allow assessment of possible subdivisions of the potamon. However, the normal classifications do identify three recognizable zones in the rhithron. Our mountain stream zone (Site Group A in Table 4) corresponds to Illies' epirhithron, our upper foothill zone (Site Group B) to the metarhithron, and our middle and lower foothill zone (Site Group C) to the hyporhithron. The boundary between Site Groups B and C is the junction of the Thomson and Aberfeldy Rivers, both streams of order 5. The boundary between Site Groups A and B appears to be the junction of the Thomson and Jordan Rivers, with stream orders 5 and 4 respectively. However, if increased discharge is the overriding factor, precise similarity in stream order is probably not necessary. Further, the Thomson is joined by Whitelaw Creek, another 4th order stream only about 5 km upstream of the Jordan junction. In fact, if a clear-cut boundary between metarhithron and hyporhithron exists, it should, according to Illies' theory, be at the Thomson River - Whitelaw Creek confluence, where two 4th order streams join.

A closer look at the data somewhat weakens the impression of clear-cut boundaries between the three subdivisions of the rhithron. First, the inverse analysis identifies faunal groups closely associated with the epirhithron (species group 4) and with the hyporhithron (species group 7) but not one associated specifically with the metarhithron. Secondly, the dendrograms of Figs. 19-21 and the ordination (Fig. 22) indicate that a degree of overlap occurs between the lower stations of one zone and the uppermost of the next. In particular T20 appears to be essentially transitional between Site Groups B and C. Thirdly, considering the Aberfeldy River, the stations T19, T20 and T21 are all in the same site group (Group C), but T19 and T21 are separated by a "principal confluence"; that is, the Thomson/Aberfeldy junction at T20. Similarly, the Macalister

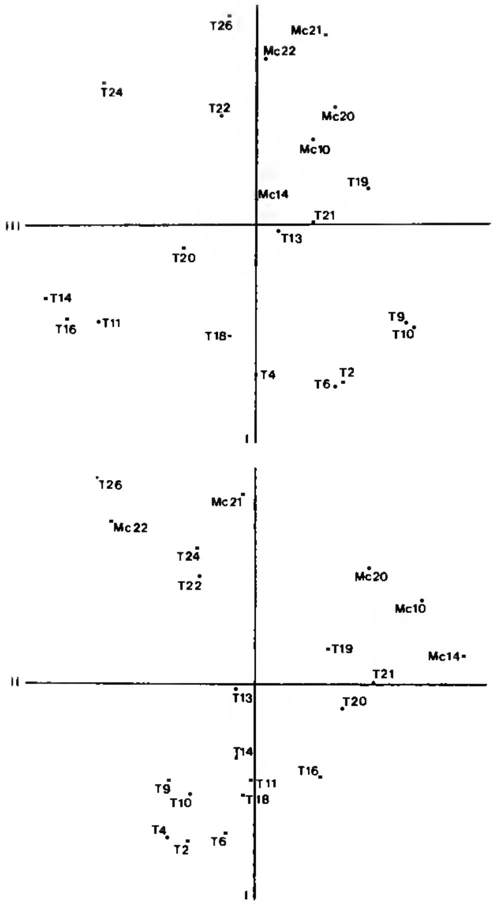


Fig. 22. GOWER principal co-ordinates ordination.

stations Mc10, Mc14 and Mc20, all belonging clearly to the same site group (Figs. 19-22) constitute three successive "principal confluences", because at each of these stations the Macalister is joined by a tributary of the same order as itself. This is not consistent with the proposal of Illies and Botosaneanu (1963) that zonal changes always occur at "principal confluences". Finally, sampling of widely separated stations, and the classificatory methods used herein, both tend to sharpen boundaries between communities, and to obscure the fact that much of the faunal replacement along the river may occur in a gradual fashion.

It would appear that in the Australian context zonation may be less predictable than suggested by the work of Illies, and that the situation may vary from stream to stream. In the present case, either the two upper rhithron zones are much further upstream on the Macalister than on the Thomson, or the subdivision into epi-, meta-, and hyporhithron may not occur at all in the Macalister. One reason for this could be the situation of the warm unshaded Macalister being joined at its "major confluences" by cooler tributaries, so that temperature does not increase as much as might be expected along its length.

While Illies' zonation scheme has potential applicability in some Australian rivers, characterisation of particular streams is still likely to require the use of consistent and detailed biotope and habitat descriptions, as recommended by Cummins (1966, 1972), Ulfstrand (1968) and Pennak (1971). The approach of Allan (1975b), which permits the testing of three models for faunal replacement along a stream, may also have value in assessing the Australian situation.

Impact of Human Activities

The anomalous position of T13 in the various classificatory analyses appears to be a result of construction activities at the site of the Swingler diversion weir, between T11 and T13. Fig. 3 indicates a big jump in some water quality factors, such as pH and conductivity at T13. The direction of faunal change is consistent with a temporary decrease in water quality, so moving the T13 communities closer to those naturally expected considerably further downstream.

The natural change from foothill conditions to those of the plains is accompanied by many results of human activities; in particular the weirs on each river, intensification of land clearing and agricultural activities, trampling of river banks by cattle and removal of stabilizing riparian vegetation. Similar effects on many of the world's rivers complicate assessment of natural zonation of stream communities. In fact, Thorup (1966) has suggested that the zonation observed by Illies on the Fulda River, and forming the basis for his general scheme, was partly a result of point sources of pollution along the river. In this study, human activities have no doubt contributed to the clearness of the division between rhithron and potamon. However, the computer grouping of site T22 and Mc21 (subjectively classed as foothill stations) with the lowland stations indicates that naturally occurring changes are probably paramount in determining the different faunae of the two zones.

The fauna of Mc22 is very reduced in number of species,and community characteristics are similar to those described from below hypolimnial release dams from other parts of the world (e.g., Ward and Stanford, 1979). Elmids were entirely absent from Mc22, and only one species of Plecoptera was collected throughout the study, although substratum and flow conditions appeared very suitable for these groups. Riverine fauna at Mc22 was dominated by the simuliid *Austrosimulium (N.) bancrofti,* very few species of chironomid larvae and one or two species of Hydropsychidae. This effect was not obvious at T26. Temperature patterns below the reservoir (Appendix 8) show reduced summer temperature. These, associated with higher than natural summer flows for irrigation purposes and rapid fluctuations in flow are probably responsible for the depauperate nature of the fauna at Mc22. Results from T23 and T24 suggest that the much smaller Cowwarr Weir has not had the same impact upon the fauna. Cowwarr is a weir with surface release, and has little impact upon flow and temperature regimes.

Discussion of the implications of construction of the Thomson Dam in relation to the invertebrate fauna has been presented elsewhere (Blyth, 1979).

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KEY TO APPENDICES

Only stations sampled at least three times over three seasons are included in the Appendices.

Habitats:-

P = Pools B = Banks
Bw = Backwaters S = Swamps

Relative abundance with respect to habitat types (not in relation to other species) is denoted by + least common to ++++ most common.

Constancy:- (C) = $\frac{a \times 100}{N}$ where

a = number of stations species collected from

N = total number of stations

constant c value	50%
accessory c value	25-50%
Accidental or Rare c value	25%

Relative abundance with respect to stations (not in relation to other species):-

A = Abundant C = Common R = Rare

Seasons of Occurrence:-

Au = Autumn W = Winter

Sp = Spring S = Summer

Distribution Categories:-

M = Mountain F = Foothill

L = Lowland

Stream Identification:-

T = Thomson River
J = Jordan River
A = Aberfeldy River
Mc = Macalister River
B = Barkly River
W = Wellington River
C = Carey River
Cal = Caledonia River

APPENDIX I.

Description of Thomson River Stations

(See Key to Appendices, page 59)

Station No.	Altitude metres	Locality	River width (m)	River depth (cm)	Stream order	Substratum	Remarks
T1	1,080	Thomson Valley Road	10–15	60	1^{o}	Predominantly cobble and pebble; heavy gravel and sand deposits	Many large logs fallen into and across stream: unshaded
T2	550	Thomson Portal Road	10–15	20	3^{o}	Generally as above, some heavy organic matter under rocks	Part of banks with thick patches of blackberries, forested
T3	580	Mt. Gregory Track	10–15	40	3^{o}	Predominantly cobble and pebble and some gravel and sand deposits	Few large logs fallen into and across stream: banks forested
T4	550	Matlock Creek off Thomson Portal Rd	5–10	30	3^{o}	Predominantly gravel, pebbles and small cobbles	Rooted Cyperaceae prevalent on small islands in middle of creek: banks forested
T5	530	Thomson Portal down-stream of confluence of east and west arms	10	50	4^{o}	Generally as T1, some heavy organic matter under rocks, little sand	Few large trees fallen into river: banks partly cleared
T6	480	Thomson-Jordan Divide Road	10–15	50	4^{o}	Extensive pebble and cobble	Small roadside clearing at bridge: banks largely forested
T7	460	0.5 km downstream of Easton Portal	10	40	4^{o}	As above	Banks heavily forested, stream shaded
T8	940	Whitelaw Creek main branch Thomson Valley Road	5	40	3^{o}	Predominantly sandy	Many fallen trees and logs across stream: banks heavily forested
T9	470	Whitelaw Creek at Whitelaw Portal	7	20	4^{o}	Small cobbles and large to medium pebbles mixed with some coarse sand	Banks mainly cleared
T10	550	Jordan River and B.B. Creek confluence, Jericho	5	20	4^{o}	Cobbles and boulders on gravel bed	All banks thickly covered with blackberries; shallow swamp near confluence, thickly covered with monocotyledonous vegetation: sparse tall timber
T11	425	Thomson-Jordan Rivers confluence, Swingler Portal	10–15 T 5 J	40 50	5^{o} T 4^{o} J	Predominantly gravel to cobble, which had considerable accumulation of organic matter in slow flow regions	All banks covered with short riparian vegetation, no trees
T12	420	0.5 km downstream of Swingler Portal on Aberfeldy Road	7–10	30–40	5^{o}	Mainly pebble	Small roadside clearing: banks mainly forested
T13	385	Bell's Clearing	20	40	5^{o}	Mainly cobble and pebble	Clearing of few hectares; banks lightly timbered
T14	295	12 km north north-west of Walhalla	10–15	50	5^{o}	Mainly pebble	Banks mainly forested
T15	270	Low Saddle Track	15–20	40	5^{o}	Sand and gravel on solid rock bed	Banks forested
T16	240	Gauging station, Narrows Road, 7 km north north-west of Walhalla	15	30–50	5^{o}	Pebble and cobble overlain on gravel and sand	River runs through steep forested gorge; river shaded for much of day throughout year

APPENDIX 1 cont.

Station No.	Altitude metres	Locality	River width (m)	River depth (cm)	Stream order	Substratum	Remarks
T18	480	Aberfeldy River at Donnelly's Creek Track crossing	10	60	4^{o}	Pebble, cobble and some solid rocks overlain on river bed	Few fallen logs in water near banks: banks lightly timbered
T19	310	Aberfeldy River on Aberfeldy-Walhalla Rd	10	60	5^{o}	Pebble, cobble and some solid rocks overlain on river bed	Banks lightly timbered
T20	230	Thomson-Aberfeldy river confluence, Finger-board Spur Track	15 T	50	5^{o}T	Mainly cobbles, pebble and gravel	Banks steep, forested: much blackberry
			7-10 A	30	5^{o}A	As in Thomson, also solid rocks	
T21	220	Moe-Walhalla Road	15-20	70	6^{o}	Pebble, cobble and solid rocks	Banks mainly forested
T21A	200	Brunton's Bridge	20-30	50	6^{o}	Pebble, gravel and sand	Banks mainly forested
T22	80	Gauging station, 4 km upstream of Cowwarr Weir	10-15	50	6^{o}	Mainly large boulders	Water slightly turbid: banks steep, forested
T23	55	Rainbow Creek on Cowwarr-Seaton Rd	5-10	30	-	Mainly sand and silt with shaley pebbles and cobbles	Water turbid: banks cleared
T24	55	Cowwarr-Seaton Rd	10-15	70	6^{o}	Mainly sand and silt	Water turbid: banks overhung with *Salix* spp.
T25	20	Tinbamba-Rosedale Rd	10-15	60	6^{o}	Mainly sand and silt	Water turbid: banks overhung with *Salix* spp.
T26*	15	Thomson-Macalister Rivers confluence	15-20 T 15-20 Mc	100 80	6^{o}T 6^{o}Mc	Sand, silt and mud As above	Shallow billabongs, which are highly silty and organic

* There were a few shallow (up to 40 cm) swamps or lagoons near (c. 100 m) the confluence, which are fed primarily by rain, occasionally by rivers in times of heavy floods, similar to those in April 1978. One of the swamps was large (c. 20 m in diameter) and rather permanent, with some quantity of water even during the driest months. All swamps were highly organic and silty, former characteristic to some extent derived from the cattle excreta since these water bodies had regularly been utilized as farm ponds; considerable amount of rooted vegetation of various kinds, such as *Triglochin procera*, *Ottelia ovalifolia*, *Alisma plantago aquatica*, *Myriophyllum*, *Callitriche stagnalis*; also some sphagnum-like moss, sedge and floating vegetation.

APPENDIX 2.

Description of Macalister River Stations
(See Key to Appendices, page 59)

Station No.	Altitude metres	Locality	River Width (m)	River depth (cm)	Stream order	Substratum	Remarks
Mc1	1,060	Upper Macalister River above Howitt Plain	5-10	40	2°	Cobbles, solid rocks and boulders	River heavily shaded by tall eucalypts and acacias
Mc6	780	Caledonia River, below junction of main branches	5-7	40	4°	As above	River shaded by a variety of small shrubs and eucalypts
Mc7	600	Dingo Creek, Caledonia River Track	5	30	3°	Mainly solid rocks and boulders	Creek completely dried out during February-March 1978: banks forested
Mc8	1,520	Shaw Creek headwaters, Snowy Plains	-	20-35	1°	This was a large swamp ('lake') surrounded by open subalpine forest (predominantly mountain gum and alpine ash), thickly covered with reeds, sphagnum moss, *Myriophyllum* (water millfoil) and other vegetation; deep organic sludge underneath	
Mc9	1,240	Shaw Creek, Bennison Plains	5-7	35	2°	Cobbles, solid rocks and boulders	Abundant green filamentous algae on rock surfaces: Completely unshaded alpine meadow
Mc10	350	Macalister and Caledonia Rivers confluence	7-12 Mc 5-10 Cal	50 Pools to 2 m	4° 4°	Mainly cobbles and pebbles As above, with some boulders and solid rocks	Most banks with cobble and pebble beaches: banks forested
Mc14	250	Macalister and Barkly Rivers confluence, Lyndon Flat	10-20 Mc 10-20 B	35 35	5°Mc 4°B	Pebbles and cobbles with some solid rocks As above	As above, or roots of living eucalypts and acacias with entrapped sand and silt: banks lightly timbered
Mc17	450	Wellington and Carey Rivers confluence	5 W 5-15 C	35 25	3°W 4°C	Pebbles and cobbles As above	Water in Wellington noticeably more turbid than that of Carey: banks forested, Wellington heavily shaded
Mc18	480	Dolodrook River at Brandy Pinch Mine	5-7	35	4°	As above	Banks lightly timbered
Mc19	360	Wellington River, 23 km north northeast of Licola, Tamboritha Rd	7-12	45	5°	Sand through to cobble, occasional large boulders	Banks forested
Mc20	230	Macalister and Wellington Rivers confluence	15-20 Mc 7-12 W	60 45	5°Mc 5°W	Pebbles and cobbles As above, and sand	Banks with light timber to forest: grazing land
Mc21	80	7 km north northwest of Glenmaggie Weir	10-15	40	6°	Pebbles and cobbles	Banks fully cleared, agricultural land
Mc22	50	0.5 km below Glenmaggie Weir	10-15	35	6°	Small pebbles to large cobbles	Water slightly turbid and muddy: banks cleared
Mc23	30	Manson's Bridge on Newry-Tinamba Road	20	50-70	6°	Gravel-pebble	Water slightly turbid and muddy: banks cleared

APPENDIX 3.
Long term average discharges and associated mean currents at The Narrows.

		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Average daily discharge	Ml/day	342	173	178	242	594	681	949	1,390	1,385	1,249	903	951
Associated mean velocity	cm/sec	45	31	31	36	64	70	85	102	101	98	83	60
No. of years of records		24	24	24	24	24	24	24	24	24	24	24	24
Average minimum daily discharge	Ml/day	208	144	125	127	228	384	428	712	798	795	467	291
Associated mean velocity	cm/sec	35	29	27	27	36	50	53	71	76	76	56	43
No. of years of records		23	23	23	23	23	22	24	24	23	23	23	24
Average maximum daily discharge	Ml/day	1,145	687	409	962	1,781	2,070	2,297	3,154	3,098	3,638	2,356	1,294
Associated mean velocity	cm/sec	92	70	52	85	114	121	126	142	141	150	126	98
No. of years of records		23	23	23	23	23	22	22	24	23	23	23	24
Absolute minimum discharge	Ml/day	71	39	34	54	83	108	127	196	335	220	132	110
Associated mean velocity	cm/sec	17	7	7	15	19	22	24	34	45	36	24	22
Year of occurrence		1968	1968	1968	1968	1967	1967	1967	1967	1967	1967	1967	1967

APPENDIX 4.
Long term average discharges and associated mean currents at Coopers Creek.

		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Average daily discharge	Ml/day	503	347	243	346	860	1,038	1,379	2,138	1,845	1,809	1,144	980
Associated mean velocity	cm/sec	34	31	29	31	40	44	50	65	59	58	46	42
No. of years of records		23	23	23	23	23	23	23	23	23	23	23	23
Average minimum daily discharge	Ml/day	210	174	176	181	281	443	524	810	964	722	482	330
Associated mean velocity	cm/day	28	26	26	26	30	33	35	40	43	38	34	30
No. of years of records		16	16	17	16	16	15	17	17	17	17	16	1
Average maximum daily discharge	Ml/day	2.515	2,226	815	1,576	2,415	3,567	2,248	4,771	3,553	4,375	2,589	2,230
Associated mean velocity	cm/day	72	67	40	54	70	90	67	110	89	104	73	66
No. of years of records		16	16	17	16	17	15	17	17	17	17	15	1
Absolute minimum discharge	Ml/day	73	42	37	54	91	117	154	330	448	223	135	100
Associated mean velocity	cm/sec	17	7	7	15	19	21	24	30	33	28	24	22
Year of occurrence		1968	1968	1968	1968	1967	1967	1967	1976	1972	1938	1938	1938

APPENDIX 5.
Long term average discharges and associated mean currents at Lake Glenmaggie.

		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Average daily discharge	Ml/day	478	351	380	877	1,142	1,984	2,246	3,991	3,220	2,862	1,660	859
Associated mean velocity	cm/sec	52	37	39	61	71	93	97	105	103	101	87	60
No. of years of records		47	47	47	47	47	47	47	47	47	47	47	47
Average minimum daily discharge	Ml/day	220	169	216	223	305	519	827	1,108	1,325	1,081	520	271
Associated mean velocity	cm/sec	30	27	30	30	34	46	59	70	79	69	45	32
No. of years of records		46	46	46	46	46	46	46	46	46	46	46	46
Average maximum daily discharge	Ml/day	639	562	880	3,302	2,226	5,529	4,721	9,517	8,196	8,660	3,963	3,963
Associated mean velocity	cm/sec	50	47	61	104	96	108	106	112	112	112	105	105
No. of years of records		46	46	46	46	46	46	46	46	46	46	46	46

APPENDIX 6.

Gauge height, discharge and mean velocity relationships at Narrows and Coopers Creek gauging stations (Thomson R.)

GAUGE HEIGHT Metres	NARROWS Discharge Ml/day	NARROWS Mean Velocity cm/sec	COOPERS Discharge Ml/day	COOPERS Mean Velocity cm/sec
0.1			50	15
0.2			123	24
0.3		7.3	221	29
0.4	50	15	350	31
0.5	136	25	515	35
0.6	253	37.1	720	38
0.7	390	50	976	43
0.8	545	61	1282	48
0.9	746	73	1633	55
1.0	988	86	2050	63
1.1	1261	97	2503	72
1.2	1566	109	2995	80
1.3	1913	118	3521	89
1.4	2290	125	4074	99
1.5	2679	133	4650	108
1.6	3060	140	5249	117
1.7	3458	147	5875	125
1.8	3886	155	6527	135
1.9	4340	162	7202	144
2.0	4828	171	7900	153
2.1	5346	177	8624	161
2.2	5880	186	9371	171
2.3	6420	194	10128	179
2.4	6980	201	10878	187
2.5	7572	209	11661	194
2.6	8195	217	12522	201
2.7	8845	224	13444	208
2.8	9510	232	14413	215
2.9	10197	239	15423	222
3.0	10905	247	16479	229
3.1	11631	254	17577	235
3.2	12372	262	18716	241
3.3	13124	269	19893	247
3.4	13888	276	21111	254
3.5	14674	283	22376	260
3.6	15490	291	23687	266
3.7	16341	298	25029	271
3.8	17222	305	26410	283
4.0	19070	319	29358	289

Values should be considered approximations only

APPENDIX 7.

Gauge height, discharge and mean velocity relationships at Glencairn and Glenmaggie gauging stations (Macalister R.)

GAUGE HEIGHT Metres	GLENCAIRN		GLENMAGGIE	
	Discharge Ml/day	Mean Velocity cm/sec	Discharge Ml/day	Mean Velocity cm/sec
0.1				
0.2		3.2		
0.3	23	10.1	20	9.0
0.4	73	19.9	66	17.4
0.5	171	31	164	27
0.6	315	41	354	38
0.7	497	51	637	50
0.8	720	61	962	64
0.9	1025	73	1324	79
1.0	1400	83	1752	90
1.1	1840	95	2260	97
1.2	2350	105	2835	101
1.3	2944	117	3346	104
1.4	3600	128	3770	105
1.5	4304	140	4191	105
1.6	5050	152	4658	105
1.7	5831	164	5153	106
1.8	6650	176	5668	108
1.9	7506	188	6194	109
2.0	8400	200	6734	110
2.1	9323	212	7289	110
2.2	10278	223	7863	111
2.3	11282	236	8458	112
2.4	12350	248	9076	112
2.5	13489	259	9720	113
2.6	14691	271	10375	115
2.7	15946	282	11048	116
2.8	17250		11751	117
2.9	18581		12496	118
3.0	20000		13298	119
3.1	21597		14150	120
3.2	23342		15002	122
3.3	25166		15858	123
3.4	27000		16723	124
3.5	28833		17602	126
3.6	30700		18500	
3.7	32600		19404	
3.8			20324	
3.9			21300	
4.0			22351	

Values should be considered approximations only

APPENDIX 8.

Long term temperature readings for four Thomson and Macalister Stations (^{0}C)

	The Narrows			Coopers Creek			Lake Glenmaggie			Glencairn		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	17.7	21	15	18.7	22	15	18.3	20	15	19.9	29	13
February	16.2	20	14	18.8	23.5	15	18	22	14	20.7	27	15
March	14.9	16.5	13	16.2	17.3	15	20.5	21	20	17.7	24	14
April	11.9	18	8	14.3	20	10	17.7	23	12	13.7	17	9
May	8.4	19	4.5	8.7	11.8	7	14.5	18	11	9.6	12	8
June	10.1	19	5	8.2	17	4	12.9	17	10	5.7	8.5	3
July	6.4	7.5	4	8.6	17	6	8.5	9	8	8	19	4
August	7.2	17	4	7.2	10	5.5	7.8	9.5	6	7.4	8.8	5
September	7.0	8.5	5	8.1	9.5	6	12.9	21	10	8.9	18.9	6
October	9.6	12.5	7	12.6	21	8	12	14.5	7	12.3	19.5	7.5
November	13.6	19.5	9	11.9	16	10	16.5	-	-	14.7	20	6
December	14.6	19.5	10	16.1	20	12	18	21	18	17	22	11.5

APPENDIX 9.
Distribution and habitats of nymphal Ephemeroptera species
(See Key to Appendices, page 59)

Taxa	Distribution	Habitat	Remarks
FAMILY BAETIDAE			
Centroptilum and *Baetis*	T1-26; Mc1-22	R++++; P, B & Bw+++	Probably more than 1 species involved in each genus; some collected on weathered logs with silt-lined furrows
Cloeon sp.	T25-26	Bw++++; S+++; B+	Collected also from underwater light trap in billabongs
FAMILY SIPHLONURIDAE			
Coloburiscoides sp.	T1-26; Mc1-21	R++++; P, B & Bw+++	Probably more than 1 species involved; specimens frequently associated with leaf litter and weathered logs
Mirawara sp. 1	T1-23; Mc14-20	Bw++++; R+++; P & B++	Frequently associated with leaf litter and weathered logs
M. sp. 2	T20 (Aberfeldy R. only)	R++++; Bw+++; B++	
Tasmanophlebia sp. 1	T2-18; Mc6-20	Bw++++; R & P+++; B++	Some specimens collected from weathered logs; occurs in shallower (0-20cm) and faster waters than sp. 2
T. sp. 2	T2-21; Mc10-21	Bw++++; R, P & B+++	Appears to tolerate heavier organic matter and sludge than sp. 1
FAMILY CAENIDAE			
Tasmanocoenis sp. 1	T2-26; Mc6-23	Bw++++; B+++; R & S++; P+	Commonest caenid in study area; frequently occurs on weathered logs
T. sp. 2	T25; Mc2-23	Bw++++; B+++; R++; P+	
T. sp. 3	T20-25; Mc10-23	B & Bw++++; R & P++	More common in Macalister than in Thomson
FAMILY LEPTOPHLEBIIDAE			
Atalophlebioides sp. 1	T1-26; Mc1-21	Bw++++; R, P & B+++	
A. sp. 2	T9 & 21; Mc9	R+++	
A. sp. 3	T4-20; Mc14-20	Bw++++; B++; R & P+	
Atalophlebia sp. 1	T3-26; Mc1-21	Bw++++; B+++; R, P & S++	
A. sp. 2	T11-26; Mc6-21	Bw++++; B+++; R, P & S++	
Atalophlebia longicaudata	T1-24; Mc7-20	Bw & B++++; R & P++	Probably more than 1 species involved; some specimens collected from weathered pitted logs; a common mayfly in the study area
Jappa sp. 1	T2-26; Mc1-20	Bw & B++++; R, P & S++	Commonest *Jappa* in the study area; occurs in habitats which are thickly covered with *Sphagnum*-like moss and heavy organic sludge
Jappa sp. 2	T11-24; Mc6-21	Bw & B++++; R, P & S++	
J. sp. 3	Mc10	R+++	
J. sp. 4	Ross Creek near T10	R+++	
Kirrara sp.	T14-22; Mc10-20	R++++; P & B++; Bw+	
Atalomicria	T15	Bw++++	Only one specimen collected
Atalonella sp. 1	T1-26; Mc1-21	Bw++++; R, P & B+++	
A. sp. 2	T2-19; Mc1-17	R++++; Bw+++; P & B++	
A. sp. 3	T3-23	Bw++++; R & B+++; P++: S+	
A. sp. 4	T9 & 14	Bw++++; B+++; R++; P+	
A. sp. 5	T2-18; Mc1	Bw++++; R & B+++	
A. sp. 6	T1-23; Mc1-20	Bw++++; R & B+++	A common leptophlebiid in Thomson
A. sp. 7	T10	R+++	
A. sp. 8	T2 & 8	Bw++++; B++	
A. sp. 9	T2-20; Mc10	Bw++++; R, P & B+	
A. sp. 10	T2-18; Mc1-14	R++++; Bw+++; B++; P+	
A. sp. 11	Mc1	R++++; P & B++	Collected in 2-10 cm deep water with considerable organic matter at edges, in spring only

APPENDIX 10.

Occurrence of nymphal Ephmeroptera at Thomson (T) and Macalister (Mc) river stations sampled over 3 seasons or more.

(See Key to Appendices, page 59)

Station	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	Mc	Mc	Mc	Mc	Mc	Season		C Value	
Species	2	4	6	9	10	11	13	14	16	18	19	20	21	22	24	26	10	14	20	21	22	T	Mc	T	Mc
F. BAETIDAE																									
Centroptilum sp.	A	A	A	A	C	A	C	A	A	C	C	C	A	R	C	C	A	A	A	C	C	All	All	100	100
Baetis sp.	C	A	A	A	R	A	C	C	A	C	R	C	A	R	C	C	A	A	A	C	C	All	All	100	100
Cloeon sp.																C						S	-	6.2	0
F. SIPHLONURIDAE																									
Coloburiscoides sp.	C	A	A	C	C	A	C	C	C	C	C	C	A	R	R	R	A	A	A	R		All	All	100	80
Mirawara sp. 1	R	C	R	R				R	C	R	C	R	R					R	C			All	All	62.5	40
M. sp. 2												R										Sp	-	6.2	0
Tasmanophlebia sp. 1	C			R						C									R			Au, Sp, S	Sp, S	18.7	20
T. sp. 2	R			R	R	R					R	R	R				R	C	C	R		Sp, S	Sp, S	43.7	80
F. CAENIDAE																									
Tasmanocoenis sp. 1	C	A	C		A	C	C	C	A	C	C	C	C	C		A	C	C	C	C	C	All	All	87.5	100
T. sp. 2		R								R								R	R			Sp, S	Sp, S	12.5	40
T. sp. 3												R		R			C	C	C	C	C	Au, Sp, S	All	12.5	100
F. LEPTOPHLEBIIDAE																									
Atalophlebia sp. 1						A	C	C	C	C	R	C	C	R	R	C	A	R	C	C		All	All	68.7	80
A. sp. 2						R			R	R	C	R	R	R		R	A	A	C	R		All	All	50	80
Atalophlebia longicaudata	R		R			C	C	R	C		C	A	C	R	C		A	A	C			All	All	68.7	60
Jappa sp. 1	R	C	R	R	C	A	R	C	R	C	R		R	R		R	C	C	C			All	All	87.5	60
J. sp. 2						R		C	R		C	R	C	R	R			C	C	R		All	All	50	60
J. sp. 3																	R					-	S	0	20
J. sp. 4					R																	W	-	6.2	0
Kirrara sp.								R	C		R	R	R	R			A	A	C			All	All	37.5	60
Atalophlebioides sp. 1	C	C	C	R	C	C	R	C	R	R	C	R	C	R	R	R	C	C	C	R		All	All	100	80
A. sp. 2	C	C	C	C	R	C	R	R	R	R		R	C				R		R			All	Sp, S	75.0	40
A. sp. 3	R	R	R	R	R	R			R	R							R	R				Au	Au, S	50	40
Atalonella sp. 1	C	C	C	R	C	C	R	C	R	R	C	R	C	R	R	R	C	C	C	R		All	All	100	80
A. sp. 2	R	C	R	R	R	R		R	R	R	R											W, Sp, S	-	62.5	0
A. sp. 3			R	R	R	R		R					R									Au, Sp, S	-	37.5	0
A. sp. 4				R				R														S	-	12.5	0
A. sp. 5		R	R			R		R		R												S	Sp, S	31.2	0
A. sp. 6				R									R									S	S	12.5	0
A. sp. 7					R																	S	-	6.2	0
A. sp. 8	R																					S	-	6.2	0
A. sp. 9	R	R	R			R		R		R		R					R					Au,	Au,	43.7	20
A. sp. 10		R	R	R		R			R			R						R	R			Au	S	37.5	40
TOTALS	16	15	16	16	14	19	10	18	17	17	15	18	17	13	8	10	17	18	19	11	4				

APPENDIX 11.
Distribution and habitats of nymphal Odonata species.
(See Key to Appendices, page)

Taxa	Distribution	Habitat	Remarks
SUBORDER ZYGOPTERA			
FAMILY COENAGRIONIDAE			
Species 1	T12 & 26; Mc 21-23	S++++; B & Bw+++; R & P+	Most common coenagrionid in the study area; some specimens collected from underwater light trap
Species 2	T26	S++++	
Species 3	T26; Mc21	S++++; Bw+++	
FAMILY MEGAPODAGRIONIDAE			
Argiolestes prob. *icteromelas*	Mc18	Bw++++; (B)++	Collected in spring only
FAMILY LESTIDAE			
Austrolestes sp. 1	T26; Mc8	S++++	
A. sp. 2	Mc17 & 22	S++++; B & Bw+++	
A. sp. 3	T10 & 26	S++++	
A. sp. 4	T10	S++++	Also collected from underwater light trap
A. sp. 5	T26	S++++	
A. sp. 6	T19	S++++; Bw+++	
FAMILY CHLOROLESTIDAE			
Synlestes sp.	T2-21; Mc6-18	Bw++++; B+++; R & P++	Relatively more common in Macalister; also occurs under weathered logs
FAMILY AMPHIPTERYGIDAE			
Diphlebia sp.	T20; Mc6-20	Bw++++; B+++	Relatively more common in Macalister
SUBORDER ANISOPTERA			
FAMILY GOMPHIDAE			
Species 1	T16-25; Mc10-23	Bw++++; R & B+++; P++	Commonest gomphid in study area
Species 2	T5-23; Mc7	As above	
Species 3	T3; Mc10 & 21	R++++; Bw+++; P & B++	
Species 4	T2 & 24; Mc21 & 22	Bw++++; P+++; B++; R+	Occurs in relatively more lentic habitats than other species
FAMILY AESHNIDAE			
Species 1	T2-26; Mc6-22	R++++; Bw+++ B++	Commonest aeshnid in study area; occasionally found in billabongs
Species 2 (*Notoaeshna sagittata)*	T13-25; Mc6-21	R++++; Bw+++; P & B+	More common in Macalister, and under boulders and solid rocks
Species 3 (*Austroaeshna pulchra)*	T10-21; Mc10-21	R++++; Bw++; P & B+	
Species 4 (*A.* prob. *pulchra)*	T14; Mc6 & 20	R++++; Bw+++;	
Species 5 (*A. brevistyla)*	T26	Bw++++; Bw+++; R & P+	
Species 6	T10-21; Mc10-21	R++++; Bw++; P & B+	
Species 7	T13	R++++	
Species 8	T6-24; Mc10-22	R++++; Bw+++; P & B+	
Species 9	T26; Mc10 & 21	Bw++++; S+++; R, P & B+	Only aeshnid collected from swamps
FAMILY SYNTHEMIDAE			
?Synthemis eustalacta	T2-24; Mc14-21	Bw++++; B+++; R++; P+	A common dragonfly in study area; some specimens found under weathered logs
FAMILY CORDULIIDAE			
Species 1	T26	S++++	
FAMILY LIBELLULIDAE			
Species 1	T26	S++++	Collected also from underwater light trap

APPENDIX 12.

Occurrence of nymphal Odonata species at Thomson (T) and Macalister (Mc) river stations sampled over 3 seasons or more.
(See Key to Appendices, page 59)

	T 2	T 4	T 6	T 9	T 10	T 11	T 13	T 14	T 16	T 18	T 19	T 20	T 21	T 22	T 24	T 26	Mc 10	Mc 14	Mc 20	Mc 21	Mc 22	Season T	Season Mc	C Value T	C Value Mc
F. COENAGRIONIDAE																									
Species 1																C				R	R	All	Au, Sp, S	6.2	40
Species 2																R						Sp	-	6.2	0
Species 3																R				R	R	Au, Sp, W	-	6.2	40
F. LESTIDAE																									
Austrolestes sp. 1																R						Sp	S	6.2	0
sp. 2																					R	-	Sp	0	20
sp. 3					R											R						Sp, S	-	12.5	0
sp. 4					R																	Sp, S	-	6.2	0
sp. 5																R						Sp	-	6.2	0
sp. 6											R											W	-	6.2	0
F. CHLOROLESTIDAE																									
Synlestes sp.	R					R			R		R		R				R	C				Au, Sp, S	Au, Sp, S	31.2	40
F. AMPHIPTERYGIDAE																									
Diphlebia sp.												R					R	C	C			Au,	Au, Sp, S	6.2	60
F. GOMPHIDAE																									
sp. 1									R			R	R	R	R		C	R	C	R		All	All	31.2	80
sp. 2						R		R		R												Sp, S	Sp,	18.7	0
sp. 3																	R			R		S	S	0	40
sp. 4	R														R				R	R		Au, S	Sp, S	12.5	40
F. AESHNIDAE																									
sp. 1	R		R	R	R	R	R		R	R	R	R	C	R	R	R	C	C	R	C	R	All,	W, Sp, S	87.5	100
sp. 2 (*Notoaeshna sagittata*)					R		R	R			R		R	R			C	C	R	R		All	All	37.5	80
sp. 3 (*Austroaeshna pulchra*)											R	R	R				R	R		R		Au, W, S	Au Sp	18.7	60
sp. 4 (*A.* prob. *pulchra*)								R											R			S	Sp, S	6.2	20
sp. 5 (*A. brevistyla*)																R						Au,	-	6.2	0
sp. 6					R						R	R	R				R	R		R		Au, W, S	Au, Sp	25	60
sp. 7							R															Sp	S	6.2	0
sp. 8			R	R				R			R	R	R		R		C	R			R	Au, S	Au, W	43.7	60
sp. 9																R	R			R		Au,	W, S	6.2	40
F. SYNTHEMIDAE																									
?Synthemis eustalacta	C	R	R			R	R	R	R						R			R		R		All,	W, Sp, S	50	40
F. CORDULIIDAE																									
sp. 1																R						W	-	6.2	0
F. LIBELLULIDAE																									
sp. 1																C						Au, Sp, S	-	6.2	0
Totals	4	1	3	2	5	4	4	5	4	2	7	6	7	3	5	11	10	9	6	11	5				

APPENDIX 13.
Distribution of adult Odonata species.
(See Key to Appendices, page 59)

Species	Distribution	
SUBORDER ZYGOPTERA		
FAMILY COENAGRIONIDAE		
Ischnura heterosticta	T24;	Mc22
I. aurora aurora	T11	
FAMILY MEGAPODAGRIONIDAE		
Argiolestes icteromelas	T2,25-26	
FAMILY LESTIDAE		
Austrolestes io		Mc8
A. analis	T26	Mc8
A. cingulatus		Mc19
FAMILY CHLOROLESTIDAE		
Synlestes weyersi		Mc10
S. tillyardi	T13	Mc6
SUBORDER ANISOPTERA		
FAMILY AESHNIDAE		
Acanthaeschna flavomaculata	T4	Mc17
Hemianax papuensis	T24-26	Mc19
Austroaeschna pulchra		Mc20
A. unicornis unicornis		Mc10
Telephlebia brevicauda		Mc1
FAMILY SYNTHEMIDAE		
Synthemis eustalacta		Mc8
Eusynthemis virgula	T2,5 & 21	
FAMILY CORDULIIDAE		
Hemicordulia australiae	T24-26	
FAMILY LIBELLULIDAE		
Diplacodes melanopsis	T11,24-26;	Mc8
Orthetrum caledonicum	T21-26;	Mc19
FAMILY GOMPHIDAE		
Austrogomphus guerini		Mc21

APPENDIX 14.
Distribution and habitats of nymphal Plecoptera species.
(See Key to Appendices, page 59)

Taxa	Distribution	Habitat	Remarks
FAMILY EUSTHENIIDAE			
Stenoperla australis	T1-20; Mc1-20	R++++; P++; B+	More common in Thomson.
Eustheniopsis venosa	T1-21; Mc10	As above	Occurs in small numbers and associated with heavier organic matter than *S. australis*
FAMILY AUSTROPERLIDAE			
Austroheptura neboissi	T2-18; Mc1	R++++; P+++; B & Bw++	Associated with heavy organic matter, mainly leaves, twigs and other woody debris
Austropentura victoria	T1-11; Mc21	R++++; P++; B+	Often occurs in company with *A. neboissi*
Acruroperla atra	T1-21; Mc6-18	Bw++++; R, P & B+++	A common stonefly throughout forested regions; found in leaf packs, weathered logs
FAMILY NOTONEMOURIDAE			
Austrocercella tillyardi	T1-21; Mc1 & 9	Bw++++; B+++; R & P++	A common notonemourid in Thomson, where it usually occurs in company with *A. atra* in heavy organic material
A. ?mariannae	T1-20; Mc1-20	P++++; R+++; B & Bw++	Occurs in slightly faster water than *A. tillyardi*
A. tasmanica	T8-13; Mc9	R++++; P++; B+	
FAMILY GRIPOPTERYGIDAE			
Illiesoperla australis	T2-24; Mc6-21	R++++; P, B & Bw++	A very common gripopterygid in study area
Eunotoperla kershawi	T8	R++++; P++	
Newmanoperla thoreyi	T6-24; Mc10-21	R++++; B & Bw+++; P++	A common stonefly species in study area
Leptoperla primitiva	T2-26; Mc9-19	B & Bw++++; P+++; R+	Commonest *Leptoperla* in study area
L. neboissi	T11-24; Mc10-19	Bw++++; P & B+++; R++	Occasionally collected from weathered solid logs
L. bifida	T8-22; Mc14-19	Bw++++; B+++; P++	As above
L. kimminsi	T6-20; Mc6-21	Bw++++; B+++ R & P++	As above
Neboissoperla alpina	Ross Creek, NE of Jericho	R++++	Only one specimen collected
Riekoperla tuberculata	T1-21; Mc1 & 7	R, B, & Bw++++; P+++	Normally found on weathered solid logs
R. rugosa	T2-21; Mc6-19	R++++; P, B & Bw+++	As above
R. karki-reticulata group	T1-16; Mc6-21	R++++; P++	Species is probably *karki*
Trinotoperla nivata	T1-21; Mc1-21	R++++; P, B & Bw+++	Commonly associated with solid surfaces and often with weathered solid logs; occurs in a wider range of habitats than other 2 species of the genus. Usually in fast currents
T. irrorata	T2-19; Mc6-20	R++++; P, B & Bw++	Commonly associated with solid surfaces as often with weathered solid logs
T. yeoi	T2-21; Mc6-20	As above	As above
Dinotoperla fontana	T1-21; Mc7-19	Bw++++; R & B+++; P+	Commonly associated with weathered logs
D. serricauda	T1-22; Mc6-21	Bw++++; R & B+++; P+	Occurs usually in company with *D. fontana*
D. christinae	T2-22; Mc6-20	R++++; Bw+++; P & B++	
D. arenaria	T2-21; Mc1-14	R++++; Bw+++; P & B++	
D. eucumbene	T3	R++++; Bw+++; P & B+	Specimens collected in a small snow-melt creek, 12 km S. of Woods Point, and from T3
D. brevipennis	T2-21; Mc6-19	B++++; R+++; P & Bw++	

APPENDIX 15.
Occurrence of nymphal Plecoptera species at Thomson (T) and Macalister (Mc) river stations sampled over 3 seasons or more.
(See Key to Appendices, page 59)

Station / Species	T 2	T 4	T 6	T 9	T 10	T 11	T 13	T 14	T 16	T 18	T 19	T 20	T 21	T 22	T 24	T 26	Mc 10	Mc 14	Mc 20	Mc 21	Mc 22	Season T	Season Mc	C Value T	C Value Mc
F. EUSTHENIIDAE																									
Stenoperla australis	C	C	C	C	C	A	C	C		C		C					C	C	C			Au,Sp,S	Au,Sp,S	62.5	60.0
Eusthenlopsis venosa		R			R								R									W,Sp,S	S	18.7	0
F. AUSTROPERLIDAE																									
Austroheptura neboissi	A	A	A		A	A	R	R	R	A			R									Au,Sp,S	Sp,S	62.5	0
Austropentura victoria						R														R		Sp,S	S	6.2	20.0
Acruroperla atra	A	A	A	A	A	A		R	A	A	C	C					C					All	S	68.7	20.0
FAMILY NOTONEMOURIDAE																									
Austrocercella tillyardi	C	R	R	R	C	C							R									Au,Sp,S	S	43.7	0
A. ?mariannae	R	C	R		R	R				R		R								R		Au,W,S	S	43.7	20.0
A. tasmanica					R		R															W,Sp,S	Sp,S	12.5	0
F. GRIPOPTERYGIDAE																									
Illiesoperla australis	A	A	C	A	A	A	A	A	A	A	A	A	A		R		A	A	R	R		All	All	87.5	80.0
Eunotoperla kershawi																						W,S	–	0	0
Newmanoperla thoreyi			R				C	C	C		R		C	R	R		R	R		R		W,Sp,S	W,Sp	50.0	60.0
Leptoperla primitiva	C		R			C	C	C	C	R			C			R	R	C				All	Au,Sp	56.2	40.0
L. neboissi						R			R				R		R		C					Au,Sp,S	S	25.0	20.0
L. bifida												R						R				Au,Sp,S	W	6.2	20.0
L. kimminsi			R				C		C	R		R					C	C		C		Au,Sp,S	All	31.2	60.0
Neboissoperla alpina					R																	W	–	6.2	0
Riekoperla tuberculata	R	C	C	C	C					R		C	C									Au,Sp,S	Sp,S	50.0	0
R. rugosa	C	C			C	C	R	R	R	C		C	C				C	R				W,Sp,S	W,Sp	62.5	40.0
R. karki-reticulata gp	R	C	C		C	C		C	R												R	All	S,Sp	43.7	20.0
Trinotoperla nivata	R	A	A	A	A	A	R	A	A	A	A	A	A	R			A	A	A	A		All	All	87.5	80.0
T. irrorata	R				C					C	R								R			Au,Sp,S	Sp,S	25.0	20.0
T. yeoi	R	C	C	C	C	C	C	C	C	C	C	C	C				R	R	C			All	W,Sp	81.2	60.0
Dinotoperla fontana	A		C	C	A	C	C	C	C	C	C	C	C					C				All	W,Sp	75.0	20.0
D. serricauda	A	C	C	C	C	C	C	C	C	C	C	C	C	C			C	C	C	C		All	All	87.5	80.0
D. christinae	R	R	C	C					C	C	C	C	C	R				R	R			All	Au,S	62.5	40.0
D. arenaria	A	A	A	A	A	A		R	A	A			R					R				All	Sp,S	62.5	20.0
D. eucumbene					R																	W,S	–	6.2	0
D. brevipennis	C	C	C		A	A		R	C	C		A	C					R				Sp	W,Sp	62.5	20.0
TOTALS	18	16	18	11	20	17	12	14	16	17	9	14	16	4	3	1	11	14	7	7	1				

APPENDIX 16.
Distribution and habitats of nymphal Hemiptera species.
(See Key to Appendices, page 59)

Taxa	Distribution	Habitat	Remarks
FAMILY GERRIDAE			
Tenagogerris euphrosyne	T25-26; Mc10-23	B++++; Bw+++; P++	Can tolerate slightly turbid and muddy water; one specimen collected from underwater light trap.
Rheumatometra philarete	T6-24; Mc1-21	B++++; Bw++++; R & P++	Commonest gerrid; can tolerate faster flows than other gerrid species.
Gerris (Aquarius) antigone	T26	B++++; Bw+++	
FAMILY VELIIDAE			
Microvelia dubia	T1-24; Mc6-20	Bw++++; B+++; P++; R+	More common in Thomson
M. peramoena	T6-26; Mc10-23	Bw++++; B+++; R, P & S+	
M. oceanica	T1-26; Mc8-21	Bw++++; S+++; B++; P+	
M. distincta	T2-21; Mc6-18	Bw++++; B+++; P++; R+	
M. fluvialis fluvialis	T6-21; Mc6-20	As above	
FAMILY CORIXIDAE			
Diaprepocoris barycephala	Mc22	Bw++++; S+	
Agraptocorixa eurynome	T26	S++++; Bw++	
A. parvipunctata	T11	B++++; Bw+++	
Sigara (Tropocorixa) sublaevifrons	T1-26; Mc8-19	S & Bw++++; B+	Some collected at light and by underwater light trap.
S. (T.) truncatipala	T13-26; Mc20-21	S & Bw++++; B+	Appears to tolerate faster waters where it occurs among patches of filamentous algae.
S. (T.) tadeuszi	T12	Bw++++; B+++; S++; P+	
Micronecta robusta	T26; Mc10-23	Bw++++; B+++; S++; P+	
M. annae annae	T10-26; Mc21-22	B++++; Bw+++; B & S++; R+	
M. a. illiesi	T11-26; Mc10-23	Bw++++; B++; R & P+	
M. carinata	Mc6-21	B & Bw++++; R & P+	
M. nr. *carinata*	T19-21; Mc6-20	Bw++++; B+++; R++; P+	Some collected at light
M. nr. *windi*	T10-26; Mc10-21	Bw++++; R,P,B & S++	Some collected from underwater light trap
M. australiensis	T11-26; Mc10-23	Bw++++; B+++; R,P & S+	As above
FAMILY NOTONECTIDAE			
Enithares bergrothi	T25-26; Mc10-22	Bw & S++++; B++	
E. hackeri	T26	S++++	
Anisops deanei	T10-26; Mc8 & 17	S++++; B+++	Some collected at light
A. thienemanni	Mc8-22	Bw++++; B & S++; R & P+	Occur in wider range of habitats than other species of *Anisops*
A. gratus	T26; Mc17	Bw++++; B+	Some collected at light
A. elstoni	T26	S++++	
A. doris	T10	S++++	
FAMILY PLEIDAE			
Plea brunni	T21-26; Mc22	S++++; Bw+++	
P. halei	T26	S++++	
FAMILY HYDROMETRIDAE			
Hydrometra strigosa	T26; Mc20-22	Bw & S++++; B+	Some collected from underwater light trap
FAMILY BELASTOMATIDAE			
Diplonychus eques	T26	S++++; Bw++	
FAMILY HEBRIDAE			
Merragata hackeri	T26	S++++	Also collected from underwater light trap
Hebrus (=Naeogeus) prob. *axillaris*	T19 & 26	Bw++++; S+++; B+	
FAMILY MESOVELIIDAE			
Mesovelia hungerfordi	T26	S++++	

APPENDIX 17.

Occurrence of Hemiptera species at Thomson (T) and Macalister (Mc) river stations sampled over 3 seasons or more.
(See Key to Appendices, page 59)

Station	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	Mc	Mc	Mc	Mc	Mc	Season		C Value	
Species	2	4	6	9	10	11	13	14	16	18	19	20	21	22	24	26	10	14	20	21	22	T	Mc	T	Mc
F. GERRIDAE																									
Tenagogerris euphrosyne																C	R		C		C	Au,Sp, S	Au,Sp, S	6.2	60
Rheumatometra philarete			C		C	C		R	C		R	A	C		R		A	A	A	R	R	S,Au, S	All	56.2	100
Gerris (Aquarius) antigone																R						A	-	6.2	0
Microvelia dubia	R	C	R		C	C	C		C	R		C	C		C		C		R			All	S	68.7	40
M. peramoena			R		R	C	C			R	R		C		C	A	C	C	R		C	All	Au,Sp, S	56.2	80
M. oceanica			C	R	R		R									C			R	R		Sp,S	Sp,S	31.2	40
M. distincta	C	C	A		C		A		C	R			C									All	-	50	0
M. fluvialis fluvialis			C		R	A			C	R	C	C	C				A	A	A		C	All	Au,Sp, S	50	80
F. CORIXIDAE																									
Diaprepocoris barycephala																					R	-	Sp	0	20
Agraptocorixa eurynome																C						Au,Sp, S	-	6.2	0
A. parvipunctata						R																Au,Sp, S	-	6.2	0
Sigara (T.) sublaevifrons						R					R					C						All		18.7	0
S. (T.) truncatipala							R									C			C	R		All	Sp,S	12.5	40
Micronecta robusta																A	C					Au,W,S	Sp,S	6.2	20
M. annae annae					A	C							C			A				A	A	All	Au,Sp, S	25	40
M. a. illiesi						C		C	A			A	A		A	A	C		A	A	A	All	Au,Sp, S	43.7	80
M carinata																	A	A	A	C		-	Au,Sp	0	80
M. nr carinata											C		C				A	C	A			W,Sp	All	12.5	60
M. nr windi					R						R		C			C	A		A	C		All	Au,Sp	25	60
M. australiensis						C							A		A	A	A	C	A	C	C	All	All	25	100
F. NOTONECTIDAE																									
Enithares bergrathi																C	R	R	C	R	C	Au,Sp, S	All	6.2	100
E. hackeri																R						Au,S	-	6.2	0
Anisops deanei					C	C	R								R	A						All		31.2	0
A. thienemanni																			R		R		Sp,S	0	40
A. gratus																C						Au		6.2	0
A. elstoni																R						Au	-	6.2	0
A. doris					C																	S	-	6.2	0
F. PLEIDAE																									
Plea brunni													R			C					C	All	Au	12.5	20

Station Species	T 2	T 4	T 6	T 9	T 10	T 11	T 13	T 14	T 16	T 18	T 19	T 20	T 21	T 22	T 24	T 26	Mc 10	Mc 14	Mc 20	Mc 21	Mc 22	Season T	 Mc	C Value T	 Mc
F. HYDROMETRIDAE																									
Hydrometra strigosa																R			R		R	Sp,S	Au,Sp	6.2	40
F. BELASTOMATIDAE																									
Diplonychus eques																C						Au,Sp, S	-	6.2	0
F. HEBRIDAE																									
Merragata hackeri																C						S	-	6.2	0
Hebrus (=Naeogeus) prob. *axillaris*																R						S	-	6.2	0
F. MESOVELIIDAE																									
Mesovelia hungerfordi																C						Au,S	-	6.2	0
F. NEPIDAE																									
Ranatra dispar																R						S	-	6.2	0
TOTALS	2	2	6	1	10	10	6	2	5	4	6	4	11	0	6	24	12	7	15	9	12				

APPENDIX 18.
Distribution and habitats of Coleoptera species (excluding Elmidae).
(See Key to Appendices, page)

Taxa	Distribution	Habitat	Remarks
FAMILY HETEROCERIDAE			
Heterocerus flindersi	T11-26; Mc10-20	B & Bw++++; P+	More common than other 2 species; adults collected at light
H. mastersi	T13; Mc20	?	No larvae found; all adults collected at light
H. debilipes	T13; Mc14	?	No larvae found; all adults collected at light
FAMILY PTILODACTYLIDAE			
Epilichas nigrinus	T2-18; Mc7-17	R++++; P++; B & Bw+	Larvae more common in Thomson; adults collected at light
FAMILY GYRINIDAE			
Macrogyrus (Australogyrus) oblongus opacior	T3-21; Mc6-20	Larva: Bw++++; B++ P & S+ Adult: B++++,P & Bw++; R+	Some collected at light
M. (Tribologyrus) australis	T25-26; Mc22-23	Bw++++; B+	Most adults collected at light
Aulonogyrus strigosus	T23-26; Mc22-23	Larva: B++++; R, P & B++ Adult: Bw++++; B+++; P+	Larvae occur in faster and deeper waters than adults
FAMILY PSEPHENIDAE			
Sclerocyphon irregularis	T2-21; Mc1-10	R++++; P, B & Bw++	Some larvae found on grooved logs; larvae present in the field all the year round
S. striatus	T1-25; Mc7-23	R++++; P & B++; Bw+	Commonest species in shady area; early instar larvae present all the year round and late instars only in May and November.
S. basicollis	T13-20; Mc6-22	R++++; P & B++	Some larvae on solid logs; late instar larvae present in February, May and August
FAMILY CARABIDAE			
Tachys striolus	T26	Bw++++; B++	Only adults collected
FAMILY GEORYSSIDAE			
Georyssus australis	T13	?	Only one adult collected, at light
FAMILY HYDROCHIDAE (Adults)			
Hydrochus victoriae	T1-26; Mc9-17	Bw++++; B+++; P & S++; R+	
H. parallelus	T26	S++++; Bw++	
H. sp. 1	Black soil Gully	S++++	Collected from a temporary swamp
H. sp. 2	T1	R++++; B+++; P & Bw+	Collected on solid logs in moderate to fast flowing waters
H. sp. 3	T21; Mc10 & 17	R++++; R+++ P & Bw++	
H. sp. 4	Mc21	data not recorded	
H. sp. 5	T26	S++++	
FAMILY SCIRTIDAE			
Larvae			
Species 1	T2-19; Mc9-20	R++++; B++; P & Bw+	Usually occur among organic litter
Species 2	T1-18; Mc14	B++++; Bw+++; R & P+	
Species 3	T10 & 19; Mc10	R++++; B+++; P & Bw+	
Species 4 and 5	Ross Creek nr T10	R++++	
Species 6	T9	R++++	
Species 7	T19	R++++	

Taxa	Distribution	Habitat	Remarks
Species 8	T6-18; Mc14	R++++; P & B++	
Adults			
Pseudomicrocara variegata (Carter)	T4	Terrestrial	One specimen collected at light
? *Pseudomicrocara* sp. 1 & 2 (PZ: H3 and H4 respectively)	T26 (?)	Terrestrial	From the larval distribution of all the scirtids it appears that these specimens were most likely collected from stations upstream of T19 or Mc20
Pseudomicrocara ? *atkinsoni* (PZ: H5)	Mc10		
Cyphon sp. (PZ: sp 6)	T2 & 19; Mc10		Two specimens laboratory reared from field collected late instar larvae
FAMILY HYDRAENIDAE			
Ochthebius lividus	T24-26; Mc22	S++++; Bw+++; B+	Normally occur on aquatic macrophytes
O. nr. *clypeatus*	T23-24; Mc22	S++++; Bw+++	
O. obcordatus	T1: Mc7	R++++; P+	Collected in spring and summer
Hydraena luridipennis	T1-26; M9-19	Bw++++; B+++; P++; S+	Can tolerate slightly muddy waters
H. tricanthi	T1-18	B++++; Bw+++; R++; P+	Some collected from solid logs
H. nr. *extorris*	Black-Soil Gully	S++++	Collected from a temporary pond
FAMILY DYTISCIDAE			
Liodessus amabilis	T13-26; Mc8-17	Bw++++; S+++	Some collected at light
L. gemellus	T1-11; Mc10	Bw++++; B+++	
L. shuckhardi	T12-22 and Wellington river below Riggall's Spur	B++++; R & Bw+++; P++	New record to Victoria
Allodessus biatrigatus	T10-24; Mc20 and Black-Soil Gully	S++++; Bw+++; B+	New record to Victoria
Limbodessus compactus	T26	S++++	Also collected from billabongs
Platynectes decempunctatus	T26; Mc17-22 and Black-Soil Gully	Bw++++; B+++; P++; R+	Some adults collected at light
Copelatus australiae	T6; Mc17 and Black-Soil Gully	Bw++++; B+++; P++	One larva collected from weathered log
Rhantus gigas	T10-26	S++++; Bw+++	
C. sharpi	Mc17	S++++; Bw++	First record from inland Victoria; spring only
Allomatus wilsoni	Mc21	Bw++++; B+	Watts (1978) recorded it from Macalister river
Rhantus nr. *suturalis*	T24-26; Mc9-23	Bw & S++++	Some adults collected at light
Hyphydrus elegans	T10 & 26	?	All adults collected at light near swamps and lagoons, presumably where they normally occur
Barretthydrus tibialis	T19; Mc18	Bw++++	
Megaporus hamatus	T10 & 26; Mc10 & 19	Bw++++; S+++	Some adults collected at light
Sternopriscus mundanus	T1-21A; Mc1-20	Bw++++; S+++; B++; R & P+	Commonest dytiscid in the study area; some adults collected from underwater light trap
S. multimaculatus	T2-21; Mc19	Bw++++; B+++ P+	
Necterosoma penicillatus	T7-24; Mc20-23	Bw++++; B+++; R & P+	
Antiporus femoralis	T2-26; Mc19-21	Bw & S++++; B+++, P+	Some adults collected at light
A. gilberti	T13-20	Bw++++	Common throughout northwestern Victoria
A. blakei	Farm pond near Glenmaggie Reservoir	S++++	
Australphilus nr. *saltus*	T13-21; Mc14	Bw++++; B+	
Homoeodytes nr. *scutellaris*	T26	S++++	
Carabhydrus niger	T10 & 15; Mc20	Bw++++; B+++; R & P+	Associated with algae and silt-algal sludge
C. sp. n.	T20	B++++; Bw+++; R++; P+	As above; species to be described by Dr. C.H.S. Watts
FAMILY HYDROPHILIDAE			
Hydrophilus albipes	T26	?	All adults collected at light

Taxa	Distribution	Habitat	Remarks
Coelostoma fabriciusi	Mc10	Bw++++; B++; P+	
Chaetarthria australis	T13; Mc10-19	?	All adults collected at light
Pseudohydrus flavus	Mc 17	?	All adults collected at light; summer only
P. floricola	T2	?	All adults collected at light
Limnoxenus zealandicus	T5-25; Mc14-22	Bw++++; S+++; B+	Some adults collected at light
L. mastersi	Mc10-19		All adults collected at light
Helochares australis	T25-26; Mc21	S++++; Bw+++; B++	
Laccobius decipiens	T23	B & Bw++++	Only one adult specimen collected; summer
Enochrus elongatulus	T4-26; Mc10 & 21	Bw++++; S+++	Most specimens collected at light
E. maculiceps	T4-26; Mc10 & 21	? S & Bw++++	All adults collected at light
Berosus involutus	T13-25; Mc6-23	Bw++++; B+++; R & P+	Some adults collected at light; a common hydrophilid in study area
B. majusculus	T26; Mc21	S++++; Bw+++	
B. australiae	T26; Mc10-17	Bw++++; S+++	
B. flindersi	T26; Mc22	S++++; Bw+++	
B. nr. *nutans*	Mc17	?	All adults collected at light; summer only
Paracymus pygmaeus	T2-26; Mc8-22	S++++; Bw+++; B+	A common hydrophilid in study area; some adults collected at light
Hydrobius sp.	T23-26	S++++; Bw+++	Only larvae collected
Nothydrus australis	T4-23; Mc1-6	B++++; R & B+++; P++	Some adults collected at light; appears to be restricted to high altitude, forest sections of streams
N. montanus	T8; Mc1 Also South Cascade Ck.	As above	Occurs in more organic substrata than *australis*
Paranacaena sp.	T13	?	Only one adult collected, at light

APPENDIX 19.

Occurrence of Ptilodactylidae, Gyrinidae, Psephenidae and Hydraenidae species at Thomson (T) and Macalister (Mc) river stations sampled over 3 seasons or more.

(See Key to Appendices, page 59)

Station / Species	T 2	T 4	T 6	T 9	T 10	T 11	T 13	T 14	T 16	T 18	T 19	T 20	T 21	T 22	T 24	T 26	Mc 10	Mc 14	Mc 20	Mc 21	Mc 22	Season T	Season Mc	C Value T	C Value Mc
F. PTILODACTYLIDAE																									
Epilichas nigrinus	C	C	C	C	R	R		R	R								C					Au,Sp	Sp,S S	50	20
F. GYRINIDAE																									
Macrogyrus (Australogyrus) oblongus opacior		R	R		C	C	C		R	R		C	R				C	C	C			Au,Sp, S	Au,Sp, S	56.2	60
M. (Tribologyrus) australis																R					R	Au,S	Au,S	6.2	20
Australogyrus strigosus															C	C					C	Au,Sp, S	Au,Sp, S	12.5	20
F. PSEPHENIDAE																									
Sclerocyphon irregularis	C	C	C	R	R	R							R									All	-	43.7	-
S. striatus	R		C	R	C	R	R	R	C	C	C	C	C				C	C	C		C	All	All	75	80
S. basicollis							R		R			R					C	C	R			Au,Sp	All	18.7	60
F. HYDRAENIDAE																									
Ochthebius lividus															R	R					R	Au,Sp S	Au,Sp, S	12.5	20
O. nr. clypeatus															R						R	Au,Sp, S	Au,Sp, S	6.2	20
Hydraena luridipennis					C											C						Sp,S	Sp,S	12.5	0
H. tricanthi					C					R												Sp	-	12.5	0
TOTALS	3	3	4	3	6	4	3	2	4	3	1	3	3	-	3	4	4	3	3		5				

APPENDIX 20.

Occurrence of Dytiscidae species at Thomson (T) and Macalister (Mc) river stations sampled over 3 seasons or more.

(See Key to Appendices, page 59)

Station	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	Mc	Mc	Mc	Mc	Mc	Season		C Value	
Species	2	4	6	9	10	11	13	14	16	18	19	20	21	22	24	26	10	14	20	21	22	T	Mc	T	Mc
Liodessus amabilis							R										R					Au,Sp	Sp,S	6.2	20
L. gemellus	R					R											R					Sp,S	S	12.5	20
L. shuckhardi														R								Au,Sp, S	-	6.2	0
Allodessus bistrigatus					R	R									R							Sp,S	-	18.7	0
Limbodessus compactus																R						S	-	6.2	0
Platynectes decempuntatus																R					R	S	Sp,S	6.2	20
Copelatus australiae			R																			W	Sp	6.2	0
Chostonectes gigas					R								R									Au,Sp, S	-	12.5	0
Allomatus wilsoni																				R		-	Sp,S	0	20
Rhantus prob. *suturalis*																C						Au,Sp	-	6.2	0
Hyphydrus elegans					R											R						Au,Sp	-	12.5	0
Barretthydrus nr. *tibialis*											R											Au	Sp	6.2	0
Megaporus hamatus																R	R					Au	Sp	6.2	20
Sternopriscus mundanus	C		C		C	C	R		R		R		C				R		C			All	Au, Sp S	50	40
S. multimaculatus	R		R	R			R					R	R									Sp,S	S	37.5	0
Necterosoma penicillatus				R	R	C					R		R		R				R	R	R	All	Sp,S	37.5	60
Antiporus femoralis	R															R			R	R		Sp	W,Sp, S	12.5	40
A. gilberti							R						R									Au,S	-	12.5	0
Austrolphilus nr. *saltus*							R			R	R		R				R					Au,Sp, S	-	25	20
Homoeodytes nr. *scutellaris*																R						Sp,S	-	6.2	0
Carabhydrus niger					R														R			Au,S	Sp,S	6.2	20
C. sp. n.												R										Au	-	6.2	0
TOTALS	4	0	3	2	6	4	5	0	1	1	4	2	6	1	2	7	4	1	4	3	2				

APPENDIX 21.
Occurrence of Hydrophilidae species at Thomson (T) and Macalister (Mc) river stations sampled over 3 seasons or more.
(See Key to Appendices, page 59)

Station	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	Mc	Mc	Mc	Mc	Mc	Season		C Value	
Species	2	4	6	9	10	11	13	14	16	18	19	20	21	22	24	26	10	14	20	21	22	T	Mc	T	Mc
Hydrophilus albipes																R						Sp	-	6.2	0
Coelostoma fabriciusi																	R					-	S	0	20
Chaetarthria australis							R										R					S	S	6.2	20
P. floricola	R																					S	-	6.2	0
Limnoxenus zealandicus																R					R	Sp,S	Sp	6.2	20
L. nr. *mastersi*																	R					-	S	0	20
Helochares australis																R				R		Sp,S	Sp,S	6.2	20
Enochrus elongatulus		R					R									R	R			R		Sp,S	Sp,S	18.7	40
E. maculiceps		R					R									R	R			R		Sp,S	S	18.7	40
Berosus involutus							R			R	R		R		R		R		R	C	C	Au,Sp,S	All	31.2	80
B. australiae																R	R					Au,Sp	S	6.2	20
B. majusculus																R				R		Au,Sp	Sp	6.2	20
B. flindersi																R					R	Sp	Sp	6.2	20
Paracymus pygmaeus	R	R			C	R	R	R		R					R	C	R				R	All	Sp,S	56.2	40
Hydrobius sp.															R	R						W,Sp,S	-	12.5	0
Nothydrus australis		R			R		R															S	S	18.7	0
Paranacaena sp.							R															Sp,	S	6.2	0
TOTALS	2	4	0	0	2	1	7	1	0	2	1	0	1	0	3	10	8	0	1	5	4				

APPENDIX 22.
Distribution and habitats of Elmidae species.
(See Key to Appendices, page 59)

Taxa	Distribution	Habitat	Remarks
Simsonia tasmanica	(Adult) T1-25; Mc14 (Larva) T1-22; Mc1-19	R++++; P+++; B++; Bw+ As for adult	
S. hopsoni	(Adult) Mc10-21 (Larva) T10-26; Mc10-20	R++++; B+++; P++; Bw+	Occurs in shallower waters (30 cm) than *tasmanica*
S. purpurea	T14-20; Mc7-21	R++++; P & B++; Bw+	Usually collected by brushing solid rocks covered with silt and algae
S. wilsoni	T1-25; Mc9-21	R++++	Prefers relatively more silt algal cover
S. nr. *leai*	T11-21; Mc1-14	R++++; P & B++; Bw+	Prefers logs which are heavily weathered and without any silt cover
S. sp. 1	T1-18; Mc1-21	R++++; B++; Bw+	Another common *Simsonia* in study area
S. sp. 2	T9 & 16; Mc14	R++++; B++; Bw+	
Notriolus quadriplagiatus	(Adult) T2-25; Mc1-20 (Larva) T2-26; Mc7-20	R++++; B+++; Bw++; P+	One of the commonest elmids in Thomson
N. allynensis	(Adult) T20-26; Mc1-20 (Larva) Mc10-20	R++++; P+ As for adult	
N. nr. *maculatus*	(Adult) T21-26 (Larva) T1-26; Mc10-23	R++++; B+++; Bw+	Some specimens collected by netting rooted aquatic macrophytes on banks
Coxelmis novemnotata	(Adult) T25-26 (Larva) T26	Bw++++; B+++; R & P+	Only elmid to occur normally in still or slow flowing backwaters and banks
Kingolus quatuormaculatus	Mc10-21	R++++; Bw+++; B++	Can tolerate considerably turbid waters
K. yarrensis	T1-9; Mc1-21	R++++; B & Bw+	
K. nr. *tinctus*	T4-25; Mc1-20	R++++; P, B & Bw+	
K. flavosignatus	Mc14 & 20	R++++; P++	
K. sp. 1	Mc20 & 21	R++++; B & Bw++; P+	
K. spp.	T1-25; Mc1-20		At least 3 species may be involved, but cannot be separated at present
Austrolimnius victoriensis	T1-20 & 26; Mc1-21	R++++; P, B & Bw+	
A. troilus	T1-21; Mc1-14	As above	New record to Victoria
A. metasternalis	T1-13 and Wellington River below Rigall's Spur	R++++; P+	
A. anytus	T2-21; Mc9 & 20	R++++; P+++ B & Bw+	Not collected from very fast waters
A. keyi	T8 & 13	R++++; P+	New record to Victoria
A. mormo	T2-26; Mc1-20	R++++; P++; B+	New record to Victoria
A. diemenensis	T6-24; Mc10-20	R++++; P+++; B++; Bw+	
A. waterhousei	T16-18; Mc14A	R++++; P+	New record to Victoria
A. prob. *montanus*	T21; Mc18;	R++++	
A. didas	T14 & 23; Mc7-20	R++++; P+	
A. ochus	T13-21; Mc6-14	R++++; P++; B+	New record to Victoria; normally found associated with filamentous algae
A. dayi	T11-25	R++++; P+++; B & Bw++	
A. codrus	T15	P++++; R+++; B++; Bw+	New record to Victoria; spring only
A. fallax	T15-25; Mc10-21	P++++; R+++; B & Bw++	New record to Victoria
A. oblongus	Mc9	R++++; P++; B+	New record to Victoria; summer only
A. nomia	T11-24; Mc18-20	As for *fallax*	New record to Victoria
A. messa	T1-24; Mc6-20	R++++; P+++; B++	New record to Victoria
A. sul	T18; Mc14	R++++; P+	New record to Victoria
A. nr. *nicon*	Mc14	R++++	
A. nr. *medon*	Mc14 & 20	R++++	
A. variabilis	Mc18-20	P++++; R+++; B & Bw++	New record to Victoria
A. prob. new sp. (*mila-messa* grp.)	T4-21; Mc10-20	R++++; P & B++; Bw+	

APPENDIX 23.

Occurrence of Elmidae species at Thomson (T) and Macalister (Mc) river stations sampled over 3 seasons or more.
(See Key to Appendices, page 59)

Station	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	Mc	Mc	Mc	Mc	Mc	Season		C Value	
Species	2	4	6	9	10	11	13	14	16	18	19	20	21	22	24	26	10	14	20	21	22	T	Mc	T	Mc
Simsonia tasmanica	R	R	R	C			R		R				C					C				All	S	43.7	20
S. hopsoni																	C	C	R			-	Sp,S	0	60
S. purpurea								R	R	R		R						C		R		Au,Sp	Au,Sp, S	25	40
S. wilsoni									R	C					R		R	R		R		Sp,S	S	18.7	60
S. nr. *leai*						R			R			R	R					C				Au,S	S	25	20
Notriolus quadriplagiatus	C	C	C	C	R	C	R	R	C	C	R	C	C	R	C		R	C	R			All	Au,Sp, S	93.7	60
N. allynensis												R	R		C	R	C	R	R			Au,Sp, S	Au,Sp, S	25	60
N. nr. *maculatus*													R	R	C	C						Au,Sp, S	-	25	0
Coxelmis novemnotata																R						Sp,S	-	6.2	0
Kingolus quatuormaculatus																	R	R	C	R		-	Sp,S	0	80
K. yarrensis	R			C														C		R		Au,Sp, S	Au,Sp	12.5	40
K. nr. *tinctus*		R				R		R					R				C	C	C			Au,Sp, S	Au,Sp, S	25	60
K. nr. *flavosignatus*																		R	R			-	Sp,S	0	40
Austrolimnius victoriensis	C	C	R	C		C		R	R			R				R				C		All	Sp,S	56.2	20
A. troilus			R			R			R	R	C	R	R					R				All	Sp,S	43.7	20
A. metasternalis	R						R															Au,Sp, S	-	12.5	0
A. anytus	R		R						C				R						R			Au,Sp, S	Sp,S	25	20
A. keyi							R															S	-	6.2	0
A. mormo	R	R				C	R	C	C	C	R	R	R		R	R	C	C	C			All	Au,Sp, S	75	60
A. diemenensis			R			R	R	R	C	R	R	C	R		R		R	R	R			All	Au,Sp, S	62.5	60
A. waterhousei									R	R								R				Au,S	Sp	12.5	20
A. prob. *montanus*													R					R				Sp	Sp	6.2	20
A. didas								R									R	C	R			Sp,S	Au,Sp, S	6.2	60
A. ochus							R				R	C	C				R	R				Au,Sp, S	Sp	25	40
A. dayi						R									R							Au,Sp, S	-	12.5	0
A. fallax													R				R	R	R	R		Au,S	Au,Sp, S	6.2	80
A. variabilis																			R			-	Sp	0	20
A. nomia						R				R					R				R			Au,S	S	18.7	20
A. messa	R	R		C	R	C			C	C			R		R		C	C	R			Au,Sp, S	Au,Sp, S	56.2	60
A. sul										R								R				Sp	Sp	6.2	20
A. nr. *nicon*																		R				-	Au,Sp,S	0	20
A. nr. *medon*																		R	R			-	Sp	0	40
A. sp. (prob. new)		R	R								R	C	R				R	R	R			Au,Sp, S	Au,Sp, S	31.2	60
TOTALS	8	7	7	5	2	10	7	7	12	10	6	10	15	2	9	5	13	24	16	6	0				

APPENDIX 24.
Distribution and habitats of larval Diptera species.
(See Key to Appendices, page 59)

Taxa	Distribution	Habitat	Remarks
FAMILY SIMULIIDAE			
Simulium (Eusimulium) ornatipes	T23 & 26	R++++; B++; P+	Habitat as for simuliids in general; also grooved logs, submerged grass, lower reaches only
S. (Morops) melatum	M14 & 20	R++++; P & B+	Mainly from cobbles in shallow, fast flowing water
Austrosimulium (Austrosimulium) montanum	T1-19	P & Bw++++; R & B+++	Common in Thomson; wide range of current; areas of slower current with silty substrata somewhat preferred
A. (A.) sp.	T1 & 2	R++++	Rare; Upper Thomson only
Cnephia aurantiacum	T1-19; Mc7 Goulburn river nr. Woods Point	R++++	High altitude sites only (above 400m); cascades and very fast flowing riffle areas
C. sp.	T5	R++++	Collected in similar habitats to *aurantiacum*; summer only
Austrosimulium (Novaustrosimulium) victoriae	T1-19; Mc6-19 Goulburn river nr. Woods Point	R++++; P, B & Bw++	Common in study area above 400 m; from plants and cobbles in slow to fast current
A. (N.) furiosum	T10-25; Mc10-21	R++++; P, B & Bw++	Similar habitats to *victoriae* but wider range; often associated leaves and twigs, and grooved logs
A. (N.) sp. (*furiosum* group)	T6-26; Mc6-21	R++++; P, B & Bw++	Commonest simuliid in study area. Often on solid rocks and boulders.
A. (N.) bancrofti	T22-23; Mc21-23	R++++	Restricted to lower reaches; from solid surfaces, often with silt and algae, turbid water
A. (N.) torrentium	T19; Mc10-21	R++++	Aberfeldy and Macalister only; medium elevation stations; fast water; common over restricted range
A. (N.) sp.	Mc19A	R+++	Found in similar habitats to *torrentium*
FAMILY BLEPHARICERIDAE			
Edwardsina australiensis australiensis	T5; Coulburn river nr. Woods point	R++++	Also in cascades and snow melt water - falls; summer only
E. a. aberrans	T8	R++++	Collected in similar habitats to *australiensis*
E. polymorpha	T4-20; Mc1-14	R++++; P, B & Bw++	Commonest blephariceriid in Thomson; all adults collected at light in October
E. pilosa	T10 & 15; Coulburn river nr. Woods Point	R++++; P+	Adults collected at light in summer
E. torrentium torrentium	T4-20; Goulburn river nr. Woods Point	R++++; P, B & Bw++	Collected in similar habitats to *polymorpha* and *pilosa*
E. williamsi	T20: Mc6-10	R++++	As above
FAMILY RHAGIONIDAE			
Species 1	T8-16; Mc20	R++++; Bw++; P & B+	
Species 2	T7; Mc10 & 18	R++++	
Species 3	T16	R++++	
Species 4	T2-11; Mc1-20	R++++; B & Bw++; P+	Some specimens were associated with weathered logs
FAMILY TIPULIDAE			
Species 1	T1-21; Mc10-21	R++++; B & Bw+++; P+	A common tipulid in study area
Species 2	T2-23; Mc6-22	R++++; P+	Commonest species in study area; some collected under weathered logs
Species 3	T10-24; Mc1-14	R++++	
Species 4	T1-21; Mc10-20	R++++; Bw++; P & B+	
Species 5	T6 & 20	R++++; Bw+++; P& B++	Some found under grooved logs
Species 6	T1; Mc17	R++++; B++ P+	Some found under overhanging vegetation on banks; collected in spring and summer

Taxa	Distribution	Habitat	Remarks
Species 10	T1-13; Mc1-10	R++++; P++; Bw++	
Species 12	T11	R++++	
Species 16	T5-16	R++++; Bw++; P & B+	
Species 23	T9	R++++; P & Bw++; B+	
Species 24	T10	R++++	Collected under fallen weathered logs and in vegetation trapped among rocks
Species 27	T11 & 25; Mc14 & 19	R++++; P & Bw++	
Species 28	T8	R++++; P & Bw+	Collected in summer only
FAMILY CULICIDAE			
Aedeomyia (Aedeomyia) venustipes	T26	S++++	Pupae collected from underwater light trap
Anopheles (Cellia) annulipes	T26	S++++	Larvae collected from underwater light trap
Culex (Neoculex) fergusoni	T10-11	S++++; Bw+++	As for *A. (C.) annulipes*
Culiseta (Neotheobaldia) hilli	T4	?	One newly emerged adult female taken from an exposed log in middle of stream during Autumn
Aedes (Ochlerotatus) camptorhynchus	T26	?	Two adult males collected at light during spring
A. (D.) flavifrons	T6	Bw+++; P+++	
Corethrella sp.	T10	Bw++++;	Only one larva collected
FAMILY CERATOPOGONIDAE			
Pellucidomyia sp.	T14-16	R++++; B+++; P & Bw++	
Bezzia spp.	T4-16 & 26; Mc6-23	R,B,P & Bw++++	Several species occur in study area but cannot be separated at present
Nilobezzia spp.	T6-21; Mc6-19	As above	At least 3 species occur in study area
Dasyhelea sp.	T4 & Mc14	R++++; B & Bw++; P++	
Allaudomyia sp.	T19; Mc10 & 14	R++++; B & Bw+++; P++	
FAMILY EMPIDIDAE			
Species 1	T21	B++++; Bw++	All specimens collected by sieving through fine sand and silt (*c*.50:50) mixed with eucalypt litter
Species 2	T2-23; Mc6-20	R++++; P,B & Bw++	Commonest empidid in study area
Species 3	T6-26; Mc10 & 22	R++++; B & Bw+	
Species 4	T4-23; Mc14	R++++; B & Bw++	
FAMILY DIXIDAE			
Species 1	T10-26; Mc6-20	Bw++++; R+++; B++; P+	Common dixid in study area; backwaters and banks
Species 2	T4-14; Mc6	Bw++++; B++	Collected by searching through organic debris and leaf litter
FAMILY DOLICHOPODIDAE			
Species 1	T4 & 11	R++++; B+	
FAMILY TABANIDAE			
Species 1	T6 & 11; Mc14 & 20	Bw++++; R++; P & B+	

APPENDIX 25.

Occurrence of Simuliidae species at Thomson (T) and Macalister (Mc) river stations over 3 seasons or more.

(See Key to Appendices, page 59)

Station / Species	T 2	T 4	T 6	T 9	T 10	T 11	T 13	T 14	T 16	T 18	T 19	T 20	T 21	T 22	T 24	T 26	Mc 10	Mc 14	Mc 20	Mc 21	Mc 22	Season T	Season Mc	C Value T	C Value Mc
Simulium (E.) ornatipes																C						S	-	6.2	0
S. (M.) melatum																		R	R			-	S	0	40
Austrosimulium (A.) montanum	C	C	R	R	R					R	R											All	-	43.7	0
A. (A.) sp.	R																					Sp,S	-	6.2	0
Cnephia aurantiacum			R	R							R											Sp,S	Sp	18.7	0
A. (N.) victoriae	R	R	C	C	C		R			C	R						A	C				All	Au,W,	50.0	40
A. (N.) furiosum					R	C			R						R		C	C	R	R		All	All	25.0	80
A. (N.) sp. (*furiosum* group)			R		R		C		C	C	C		R	R		R	A	A	C	R		All	All	56.2	80
A. (N.) bancrofti														R						C	A	Sp,S	Au,Sp, S	6.2	40
A. (N.) torrentium											C						A	A	R	R		W	All	6.2	80
A. (N.) sp.																			R			–	W	0	20
TOTALS	3	2	4	3	4	1	2	0	2	3	5	0	1	2	1	2	4	5	5	4	1				

APPENDIX 26.

Occurrence of Blephariceridae, Ceratopogonidae and Tipulidae species at Thomson (T) and Macalister (Mc) river stations sampled over 3 seasons or more.
(See Key to Appendices, page 59)

Station	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	Mc	Mc	Mc	Mc	Mc	Season		C Value	
Species	2	4	6	9	10	11	13	14	16	18	19	20	21	22	24	26	10	14	20	21	22	T	Mc	T	Mc
FAMILY BLEPHARICERIDAE																									
E. a. aberrans										R												Sp	–	6.2	0
E. polymorpha		C		A		R		C	C	C		C						R				Au,Sp, S	Sp,S	43.7	20
E. pilosa					C																	All	–	6.2	0
E. torrentium torrentium		R			C			R	R			R										Au,Sp, S	–	31.2	0
E. williamsi												R					R					Sp	Sp,S	6.2	20
FAMILY CERATOPOGONIDAE																									
Pellucidomyia sp.								R	C													Sp,S	–	12.5	0
Dasyhelea sp.		R																R				Sp,	s	6.2	20
Monohelea sp.		R																				Sp,S	–	6.2	0
Allaudomyia sp.																	R	R				Au	Au,S	6.2	40
FAMILY TIPULIDAE																									
Species 1	R	R	C	R	R	C	R	R	C		R	R	C				R	C		R		All	W,Sp, S	75.0	60
Species 2	R		R	R								R	R				A	C		R	C	Au,Sp, S	Au,Sp, S	31.2	80
Species 3					R			C							R		R	R				Sp	Sp,	18.7	40
Species 4						R		R			C		R				R	C				All	All	25.0	40
Species 5			R									R										W,Sp, S	–	12.5	0
Species 10		R	R		R	R	R										R					Au,Sp, S	Sp,S	31.2	20
Species 12						R																W	–	6.2	0
Species 16					R			C	R													W,Sp, S	-	18.7	0
Species 23				R																		S	–	6.2	0
Species 24					R																	W	–	6.2	0
Species 25			R			R	R											R				All	Au	18.7	20
Species 27						R												R				W,S	W	6.2	20
TOTALS	2	6	5	4	7	7	3	7	5	2	3	6	3	0	1	0	7	9	0	2	1				

APPENDIX 27.
Distribution of adult Trichoptera species.
(See Key to Appendices, page 59)

Taxa	Station collected	Distribution Category
FAMILY ATRIPLECTIDIDAE		
Atriplectides dubius Mosely	T4-13; Mc10-19	M/F
FAMILY CALOCIDAE		
Tamasia sp.	T4-24	M/F/L
Caenota plicata Mosely	T1-15. Also from junction of Thomson river and Newlands creek	M/F
FAMILY CONOESUCIDAE		
Coenoria (?) sp. n.	T3-10	M
Conoesucus sp. 1	T10 & 13	M/F
Hampa patona Mosely	T13-15; Mc1	M/F
Costora sp. 1	T1 & 13; Mc14	M/F
Lingora aurata Mosely	T24; Mc10-19	F/L
FAMILY CALAMOCERATIDAE		
Anisocentropus bicoloratus Mart.	T13; Mc10-20	F
Anisocentropus valgus Neboiss	T13	F
FAMILY ECNOMIDAE		
Ecnomina irrorata Kimmins	T10 & 13; Mc14	M/F
Ecnomina batyle Neboiss	T13; Mc19	F
Ecnomina sp. n.	T13; Mc14-20	F
Ecnomus continentalis Ulmer	T26; Mc14-20	F/L
Ecnomus tillyardi Mosely	T15; Mc10-20	F
Ecnomus sp. n.	T10-13; Mc14-19	F
FAMILY GLOSSOSOMATIDAE		
Agapetus spp.	T3-15; Mc1-20	M/F
FAMILY HELICOPHIDAE		
Alloecella grisea Banks	T3-10; Mc1-14	M/F
FAMILY HELICOPSYCHIDAE		
Helicopsyche murrumba Kimmins	T10; Mc14-20	M/F
Helicopsyche heacota Kimmins	T10; Mc14-20	M/F
FAMILY HYDROPSYCHIDAE		
Asmicridea edwardsi (McLachlan)	T4-26; Mc1-19	M/F/L
Cheumatopsyche modica (McLachlan)	T11-26; Mc10-20	F/L
Austropsyche sp. n.	T4-10	M
Macronema dubia (Ulmer)	Mc14	F
FAMILY HYDROPTILIDAE		
Hellyethira exserta Wells	T24	L
Hellyethira simplex Neboiss	T10	M
Maydenoptila pseudorupina Wells	T4-13	M/F
Hydroptila sp. 1	T13	F
Oxyethira columba (Neboiss)	Mc10-22	F/L
Orthotrichia aberrans Wells	Mc14	F
FAMILY LIMNEPHILIDAE		
Archaeophylax ochreus Mosely	Junction of Thomson river and Newlands creek	M
FAMILY ODONTOCERIDAE		
Marilia sp. 1	T13; Mc10-20	F
FAMILY PHILOPOTAMIDAE		
Hydrobiosella waddama Mosely	T1-13; Mc1-17	M/F
Hydrobiosella sp. n.	T1	M
Chimarra monticola Kimmins	T15; Mc10-20	M/F
Chimarra sp. 1	T10-13; Mc6-19	F
FAMILY PHILORHEITHRIDAE		
Kosrheithrus tillyardi Mosely & Kimmins	T1-16; Mc7-20	M/F
Aphilorheithrus stepheni Mosely	T4-15; Mc1-19	M/F
Austrheithrus dubitans Mosely	T1-10; Mc17	M
Austrheithrus nr. *ronewa* Mosely	T15-16; Mc1	M/F
FAMILY STENOPSYCHIDAE		
Stenopsychodes aureoniger Schmid	T13; Mc14-17	F

Taxa	Station collected	Distribution Category
FAMILY POLYCENTROPODIDAE		
Plectrocnemia australica Banks	T4-15; Mc1-17	M/F
Gen *et* sp. n.	T13-24; Mc14-19	L
Nyctiophylax sp. n.	T13; Mc14-21	F
FAMILY TASIMIIDAE		
Tasimia sp.1	?	M/F
FAMILY HYDROBIOSIDAE		
Ethochorema turbidum Neboiss	T1-16; Mc1-20	M/F
Taschorema evansi Mosely	T10-16	M/F
Ulmerochorema membrum Neboiss	T13-15; Mc10-20	F
Ulmerochorema rubiconum Neboiss	T1-16; Mc22	M/F/L
Ulmerochorema seona Mosely	T1-15	M/F
Ulmerochorema stigma (Ulmer)	Mc22	L
Ulmerochorema onychion Neboiss	Mc22	L
Apsilochorema obliquum Mosely	T1-16; Mc1-19	M/F
Apsilochorema gisbum (Mosely)	T11-16; Mc17	F
Psyllobetina locula Neboiss	T4-15	M/F
Psyllobetina cumberlandica Neboiss	T1	M
Psyllobetina attunga Neboiss	Mc1	M
Ptychobiosis nigrita (Banks)	T1-10	M
Koetonga clivicola Neboiss	T1-10	M
Austrochorema alpinum Neboiss	T1	M
Megogata neocopina Neboiss	T1	M
Tanjilana akroreia Neboiss	T1	M
FAMILY LEPTOCERIDAE		
Notalina fulva Kimmins	T10-13 & 26	F/L
Notalina bifaria Neboiss	T1-13	M/F
Notalina sp. 1	T13-26; Mc1-20	M/F/L
Condocerus paludosus Neboiss	T1-13	M/F
Triplectidina nigricornis Mosely	T4	M
Notoperata maculata (Mosely)	T10	M
Leptocerus sp. (prob. 2 species)	T25; Mc1	?
Triaenodes sp. n. "PT-743" *	T13; Mc10-19	F
Lectrides varians Mosely	T10-13	M/F
Triplectides nr *proximus* Neboiss	T4-10; Mc1	M
Triplectides elongatus Banks	T10	M
Triplectides australis Navas	Mc10-19	F
Triplectides ciuskus Mosely	T13; Mc17-20	F
Triplectides nr *similis* Mosely	T4-13; Mc10-20	M/F
Oecetis australis Banks	T1-26; Mc10-19	M/F/L
Oecetis inscripta Kimmins	T24-26	L
Oecetis nr *laustra* Mosely	T24-26	L
Oecetis nr *pechana* Mosely	T26	L
Oecetis nr *aeoloptera* Kimmins	T13	F
Oecetis nr *arcada* Mosely	Mc19	F

*Neboiss note book no.

APPENDIX 28.
Distribution and habitats of Coelenterata, Temnocephalidae, Turbellaria, Nematoda, Nematomorpha, Gastropoda and Hirudinea.
(See Key to Appendices, page 59)

Taxa	Distribution	Habitat	Remarks
ORDER HYDROZOA			
species 1	Mc22	R++++	
CLASS TEMNOCEPHALIDEA			
Temnocephala sp.	Mc6-7	B++++; Bw+++	Data on hosts unavailable
CLASS TURBELLARIA			
FAMILY DUGESIIDAE			
Cura pinguis	T1-26; Mc1-23	Bw++++; B+++; R, P & S++	
DUGESIIDAE sp. 1	T26	S++++	
DUGESIIDAE sp. 2	Mc20-23	R++++; Bw+++; B++	
CLASS NEMATODA			
species 1	T1-10	Bw++++; B+++; R & P++	Normally with heavy organic matter and patches of algae
CLASS NEMATOMORPHA			
Gordius sp.	T2-18; Mc10 & 17	Bw++++; B+++; P+	Normally occurs where there is heavy accumulation of leaf litter and organic matter or detritus
CLASS GASTROPODA			
FAMILY FERRISSIIDAE			
Ferrissia (Pettancylus) tasmanicus	T3-23; Mc17 & 21	Bw++++; B+++; R, P & ?S+	
FAMILY HYDROBIIDAE			
Potamopyrgus nigra	T21	Bw++++; B++	
FAMILY PLANORBIDAE			
Physastra gibbosa	T26; Mc23	Bw++++; B+++	Collected from still or slow flowing backwaters and banks
CLASS BIVALVIA			
Segnitila victoriae	T26	S++++; Bw++	Collected from billabongs
FAMILY SPHAERIIDAE			
Pisidium casertanum	T14 & 19; Mc9-20	Bw++++; B+++; R & P+	
Sphaerium tasmanica	T4; Mc8	Bw++++	Collected from still backwaters
CLASS HIRUDINEA			
species 1	T26	S++++	

APPENDIX 29.
Distribution and habitats of Oligochaeta species.
(See Key to Appendices, page 59)

Taxa	Distribution	Habitat	Remarks
FAMILY TUBIFICIDAE			
Tubifex tubifex	T1-13; Mc14A	R & P++++; Bw++	Collected all the year round to 80 cm deep water
Branchiura sowerbyi	T26	P & Bw++++	Collected during autumn; to 40 cm deep water
?Rhyacodrilus (or Telmatodrilus) sp.	T3	not recorded	Collected during spring and summer
?Limnodrilus sp.	T4	Bw++++	Collected during spring and summer
FAMILY PHREODRILIDAE			
Phreodrilus (Antarctodrilus) sp. n.	T2	P & Bw++++; R++	Collected during spring and summer
P. proboscidea	T4	P & Bw++++; R++	Collected during autumn
P. ?campbellianus	T16	R++++; P & Bw+++	Collected during spring and summer; to 100 cm deep water
P. sp.	T10-14	P & Bw++++	Collected during spring and summer
P. nudus	T16	R++++	Collected during spring and summer
FAMILY NAIDIDAE			
Nais communis/variabilis	T3-16; Mc10	R++++; P, S & Bw++	Collected during spring and summer
N. elonguis	T13; Mc10	R++++	Collected during spring and summer; to 30 cm deep water
N. sp.	T10-21	R++++	Collected during spring and summer; to 40 cm deep water
Pristina sp.	T12	R++++	Collected during spring and summer; to 30 cm deep water
FAMILY LUMBRICULIDAE			
Lumbriculus variegatus	T9-23	R++++; B, P & Bw++	Collected all the year round; to 50 cm deep water
Megadrile (non-haplotaxid)	T6-13	R++++	Collected during spring and summer
Megadrile (perichaetine)	T16	R++++	Collected during spring and summer
FAMILY ENCHYTRAEIDAE spp.	T6-21	R++++	Collected all the year round

APPENDIX 30.
Distribution and habitats of Crustacea species.
(See Key to Appendices, page 59)

Taxa	Distribution	Habitats	Remarks
ORDER DECAPODA			
Paratya australiensis	T19-26; Mc21-22	Bw++++; B & S+++; R & P++	
Euastacus sp.	T6	P & Bw++++	Only one specimen collected
SUBCLASS OSTRACODA			
Cypretta sp.	T10 & 26; Mc9 & 21	Bw++++; S+++	
Candonocypris sp.	T19; Mc21	Bw++++; S+++	
SUBORDER CLADOCERA			
Chydorus sphaericus	T26	S++++; Bw+++	
Ceriodaphnia laticaudata	T26	S++++; Bw+++	
SUBCLASS COPEPODA			
Acanthocyclops vernalis	T1-26	Bw & S++++; B+	Some collected by brushing log surfaces
Macrocyclops albidus	T10 & 26	S++++; Bw++	
Eucyclops agilis	T2-26; Mc17-21	Bw & S++++; B+	
Ectocyclops medius	T10	S++++	
Mesocyclops leuckarti	T26; Mc22	Bw++++; S+++	
Tropocyclops sp.	T1 & 26	Bw++++; B++; S+	
Calamoecia ampulla	T23; Mc22	R++++	
Boeckella triarticulata	T23	R++++	
B. saycei	T26	S++++; Bw+++	
B. fluvialis	T26	S++++; Bw+++	Collected from underwater light trap
B. minuta	T26	S++++; Bw+++	Collected from underwater light trap
Microcyclops varicans	T26	B & S++++	

APPENDIX 31.
Habitat and season of occurrence of water mite species.
(See Key to Appendices, page 59)

Taxa	Habitat	Season	Distribution Category
FAMILY ANYSTIDAE			
Tencateia sp.	B++++; Bw+++	S	M/F
FAMILY ARRENURIDAE			
Arrenurus sp	S++++	A, S	
FAMILY ASCIDAE			
Protolaelaps sp.	B & Bw++++	S	M/F
FAMILY ATHIENEMANNIIDAE			
Gretacarus sp.	R, P, B & Bw++++	Sp, S	M/F
FAMILY ATURIDAE			
Frontipodopsis sp.	R++++; P & B++	Sp	M/F
Notoaturus sp.	R++++; P, B & Bw++	All	W
Tryssaturus n. sp.	R++++	S	M/F
Axonopsella sp.	Bw++++; B+++; R++; P+	Sp	W
Albia (Anchistalbia) sp.	Bw++++; B++	A, Sp	M/F
FAMILY ? ATURIDAE			
New genus M, n. sp.	R++++; B+++; P++	Sp	M/F
FAMILY CERATOZETIDAE			
Edwardzetes sp.	Bw++++; B++	Sp	M/F
FAMILY EUTEGEIDAE			
New genus, n. sp.	R++++	Sp	M/F
FAMILY EYLAIDAE			
Eylais sp.	S++++	W, Sp	
FAMILY HYDRACHNIDAE			
Hydrachna (Rhabdohydrachna) nr. *hamata*	S++++	Sp	
Hydrachna (s.s.) *bilobata*	S++++	Sp	
FAMILY HYDRODROMIDAE			
Hydrodroma sp.	Bw++++; R & P+++; B++	Sp, S	M/F
FAMILY HYDROZETIDAE			
Hydrozetes sp.	B++++: Bw+++; R & P++	S	L
FAMILY HYDRYPHANTIDAE			
Diplodontus sp.	S++++	Sp, S	
Wandesia (New subgenus) sp.	R++++	Sp	M/F
Thyas (Todothyas) sp.	R++++; P & B++; Bw+	A, Sp, S	M/F
FAMILY HYGROBATIDAE			
? *Aspidiobates* sp. 1	S++++	S	
Australorivacarus multiscutatus	B++++; P++; R+	W	M/F
? *Aspidiobates* sp. 2	Bw++++; B+	Sp	M/F
? *Aspidiobates* sp. 3	R++++	W	M/F
? *Atractidella* sp.	R++++	S	M/F
Australiobates (s.s.) sp.	B++++; R, P & B+++	All	W
Australiobates (? New subgenus) sp.	R++++	S	L
Australiobates (Coaustraliobates) longipalpis	Bw++++	Sp	L
Corticacarus (?Corticacarellus) sp.1	R++++; B++; Bw+	A, Sp, S	W
Corticacarus (?Corticacarellus) sp.2	R++++; Bw+++; B++	A, Sp, S	W
Corticacarus (Paracorticacarus) sp.	R++++; B & Bw+++; P+	All	W
Corticacarus (s.s.) sp. 1	R++++; P & B+	A, Sp, S	M/F
Corticacarus (s.s.) sp. 2	Bw++++	S	M/F
Corticacarus (s.s.) sp. 3	R++++; B+++; Bw++	S	W
Corticacarus (s.s.) sp. 4	R++++	A, Sp	M/F
Hygrobatella (Tetrahygrobatella	R++++	S	M/F
New genus A, n. sp.	R++++; B+++; Bw++	All	W
New genus B, n. sp.	R++++; P, B & Bw++	All	W
New genus C, n. sp.	R++++; B & B+++; P+	All	W
Caenobates acheronius	Bw++++; R & B+++	All	W
New genus E., n. sp.	R++++; B++; P & Bw+	A, S	M/F
New genus F, n. sp.	S?	Sp	
New genus H, n. sp.	R++++; B++; P & Bw+	A, S	M/F

Taxa	Habitat	Season	Distribution Category
FAMILY NEOTRICHOZETIDAE			
New genus, n. sp.	Bw++++	S	M/F
FAMILY OPPIIDAE			
Lanceoppia sp.	R++++; P+	Sp	M/F
FAMILY ORIBATULIDAE			
Scheloribates sp. 1	Bw++++	Sp	M/F
Scheloribates sp. 2	B++++; R & P++	sp	M/F
Sellnickia nr. *caudata*	B++++; Bw++; P+	S	L
Zygoribatula sp.	B & Bw++++	S	M/F
FAMILY OXIOAE			
Frontipoda (Flabellifrontipoda) pectinata	Bw++++; R & B++; P+	A, Sp, S	W
Frontipoda sp.	Bw++++; R & B++; P+	A, Sp	M/F
Oxus australicus	Bw++++; B+++; S++; P+	Sp	M/F
FAMILY PIONIDAE			
Piona uncatiformis	S++++	A, W	
FAMILY RHODACARIDAE			
Ologamasinae discutatus complex	R++++; P & B+	S	M/F
FAMILY TRHYPOCHTHONIIDAE			
Mucronothrus sp.	Bw++++; R, B & S++; P+	sp, S	W
FAMILY TORRENTICOLIDAE			
Torrenticola sp.	R++++; B+++; Bw++; P+	Sp, S	M/F
FAMILY TROMBIDIIDAE			
Microtrombidium sp.	P & R++++	S	M/F
Trombidium (s. lat) sp.	B++++; Bw+++	A	M/F
FAMILY UNIONICOLIDAE			
Koenikea nr. *australica*	Bw++++; B+++	A, Sp	L
Unionicola (s.s.) sp.	Bw++++	W	L
New genus I, n. sp.	R++++; P, B & Bw+	A, S	W
New genus J, n. sp.		S	
New genus Q, n. sp.		S	
FAMILY JOHNSTONIANIDAE			
Diplotrombium sp.	R++++	W	M/F
FAMILY LAELAPIDAE			
Ololaelaps sp.	Bw++++; B+++; R++	W, sp	M/F
FAMILY LIMNESIIDAE			
Limnesia nr. *australica*	S++++	W	
Limnesia sp.	S++++; B+++	Sp, S	L
Limnesia nr. *solida*	Bw++++; B++	A	
New genus K, n. sp.	R++++; B++; Bw+	Sp, S	M/F
Tubophorella sp. nr. *amoena*	R++++; B & Bw+	W, Sp, S	M/F
FAMILY LIMNOCHARIDAE			
Rhyncholimnochares (Paralimnochares) womersleyi	R++++; B & Bw+	All	W
Limnochares (Cyclothrix) sp.	S++++	S	
FAMILY MALACONOTHRIDAE			
Trimalaconothrus sp.	R++++; B & Bw+	A, S	M/F
FAMILY MOMONIIDAE			
? *Momoniella* sp.	Bw++++	S	M/F
FAMILY MYCOBATIDAE			
Punctoribates sp.	B++++; Bw+++; R & P+	Sp, S	W

CATALOGUE OF TYPES OF SPONGE SPECIES FROM SOUTHERN AUSTRALIA DESCRIBED BY ARTHUR DENDY

Avril L. Ayling[1], S. Stone[2] and Brian J. Smith[3]

[1] Marine Research Foundation, P.M.B.1, Daintree, North Queensland, Australia
[2] British Museum (Natural History), London, England
[3] National Museum of Victoria, Melbourne, Victoria, Australia

ABSTRACT

Arthur Dendy D.Sc., F.R.S., one of the leading authorities on sponge taxonomy, made one of his first major solo contributions to this field by describing the large southern Australian sponge fauna based on survey work off the Victorian coast. Specimen details are given of the types of the 87 new species and subspecies described by Dendy in this study held in the British Museum (Natural History) and the National Museum of Victoria. These include the RN numbers (Dendy's reference numbers), the registered numbers of the two institutions and comments on the status of the material.

INTRODUCTION

Arthur Dendy D.Sc., F.R.S., recognised as one of the world's leading authorities on sponge systematics, commenced his work on the group working with Mr S. O. Ridley on the sponges of the 'Challenger' Expedition and later joined the staff of the British Museum (Natural History). He was then appointed to the staff of the Biology Department of the University of Melbourne, Victoria, Australia in 1888 where he quickly became involved in a survey of the marine fauna of the area around Port Phillip Heads being carried out by Mr J. Bracebridge Wilson under the auspices of the Royal Society of Victoria. In the 6 years that Dendy was in Melbourne (1888-1894) 8 papers resulted from his studies on the anatomy and systematics of southern Australian sponges in which he described 84 new species and 3 new subspecies. During this study he also established his rigorous methodology which stands today as a model for sponge taxonomical investigation.

The object of this paper is to draw together the information on the type holdings of these species and subspecies described by Dendy from southern Australia. The type series are divided between the British Museum (Natural History) and the National Museum of Victoria but it is not clear from the publications how the specimen allocations were made. This paper arose out of work by one of us (A.L.A.) on the sponge type holdings of the National Museum of Victoria. Many previously unrecognised types specimens were brought to light and enquiries revealed that type holdings from the same collection were also present in London. Because of the importance of this material to sponge systematics in general and also to correct

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mistakes and assumptions about the type status of some specimens already made and their effect on future taxonomic studies, it was decided to compile a comprehensive catalogue of all the types in this series.

The survey work was carried out on a shallow water marine fauna, the sponges including both Demospongiae and Calcarea. The original plan, agreed between the Council of the Royal Society of Victoria and Dendy, was to publish a series of papers, which would then be published as a special volume 'devoted to the Monograph on Victorian sponges...' thereby 'making the work more accessible to students...' (Dendy, 1891:2-3). Dendy decided on this approach because of the large number of specimens in the collection. This plan had to be modified almost immediately because of the 'reduction of Govt. grant to the Royal Society' (Dendy, 1893:69). Dendy decided on the compromise of continuing the work by producing abridged descriptions, fully realising that the scientific value of such work was seriously impaired without the all-important and costly illustrations, as he expected that the financial situation would only be a temporary one. This is why he was able to widen the scope of the work to include material from areas outside the Port Phillip Heads. However, this treatment had to be modified in turn when he came to deal with the first of the families in the Monaxonida (Dendy 1895) because of the sheer bulk of material which had to be processed, forcing him to concentrate solely on the Port Phillip Heads specimens. He says (Dendy 1895:232) '...the amount of material is so large that it certainly seems desirable to publish a systematic epitome without waiting for the possibility of publishing complete and final descriptions accompanied by the (very) necessary illustrations.'

The number of species treated in each of the five main papers is as follows:- the 1891 paper deals with 18 calcareous species of which 10 were new; the 1893 paper, 78 calcareous species of which 17 were new; the 1895 paper, 37 demosponge species of which 17 were new; the 1896 paper, 58 demosponge species of which 28 were new; and the 1897 papers, 42 demosponge species of which 12 were new.

In the 1891 monograph he stated in the introduction that the material, including type specimens, used in the study would be divided into three and lodged in the British Museum (Natural History), London, the National Museum of Victoria, Melbourne, and the Zoology Department, University of Melbourne, but without specifying details. Thus the calcareous sponges were divided into three parts and slides, spirit and dry material lodged accordingly. Many of the types lodged in the University of Melbourne were subsequently transferred to the National Museum. All this material was without RN numbers (see below).

Dendy implemented a simple but effective specimen registration system by giving a sequential number to individual specimens on initial sorting of the collection. This was the RN numbering system which enables sectioned or fragmented material to be easily referred back to the original specimen (Dendy, 1895). He had already commenced work on the survey material before he initiated the system and thus all the Calcarea described in his early work were divided and lodged without receiving numbers. Some of these calcareous specimens received numbers in later publications. Where the RN numbers are available they have enabled many of the previously unrecognized types in this present study to be established beyond all doubt.

The early idea of lodging type specimens equally in Britain and in Melbourne seems to have been modified or abandoned for his later work on the non-calcareous sponges. The National Museum of Victoria holds the primary set of type specimens of these species. However the British Museum (Natural History) also has significant holdings from most type series. From the Calcarea the British Museum has either a spirit or dry specimen from nearly every species. It also has a slide from every specimen identified by an RN number held in the National Museum of Victoria. The two exceptions to this general statement are that the British Museum (Natural History) collections do not contain a slide for *Sycon giganteum* (RN 458) and have the only specimen of *Sycon minutum* (RN 90). Of the non-Calcarea the only specimen held by the British Museum (Natural History) is *Spirastrella areolata*. It holds representative slides from all specimens except *Raspailia vestigifera* (RN 655). The National Museum of Victoria has no specimens or slides for the 27 individual specimens listed in Appendix 1.

Wilson's early survey work in Port Phillip Bay was commenced before Dendy arrived in Australia. In the beginning he sent his early sponge collection to Mr. H.J. Carter in England who described a number of species (Dendy, 1889:36). These specimens were then lodged in the British Museum (Natural History) and it was Dendy, working as an assistant in that institution in 1886, who received, registered and labelled much of this material.

Carter's contribution to the study of this fauna was considerable. Between 1885 and 1887 he published 15 papers on Wilson's material, dealing with about 211 species and varieties of which 182 were new to science. Systematic groups covered included both Calcarea and Demospongiae. In all, 93 Carter species were listed and thus considered valid by Dendy in his eight papers. On his arrival in Australia Dendy began work on the accumulated Wilson specimens of 'nearly 2000 specimens...' He also accompanied Wilson on dredging trips to obtain further material. This was probably the first time a major systematic study of one fauna of sponges was undertaken where the worker participating in the collecting (Dendy, 1891) saw the material alive and became familiar with the prevailing ecological conditions. Through his contacts at the British Museum Dendy obtained fragments of over 200 specimens identified by Carter for comparative purposes and with the assistance of firstly Rev. Walter Fielder and then Mr Fryett, who cut sections of the specimens, used them to aid in this identifications. In fact he included some of these British Museum specimens in the type series of three of his new species (*Reniera longimanus, Spirastrella papillosa* var. *porosa, Myxilla victoriana*).

The catalogue of the type holdings of Dendy's southern Australian species given below shows that most of the material has survived the three quarters of a century since its lodgement. Only two species, *Esperella rara* (RN 1108) and *Collosclerophora arenacea* (RN 923), out of the 87 species and subspecies described, could not be located in the type holdings of either institution. Five species are represented by a microscope slide only, with no macro-specimen found in either institution (Appendix 1 - asterisked). For 25 species, certain macro-specimens in their type series could not be found (Appendix 1). However slides are available of all of these missing specimens and other spirit and dry material is available for study. Five species have type series where a type lot (macro-specimen and slide of a particular RN number) is completely missing (Appendix 2). In all, the British Museum holds 276 parts of type lots (42 specimens and 234 slides) while the National Museum of Victoria holds 212 parts of type lots (192 specimens and 20 slides).

Both museums hold large non-type collections of Wilson's survey material identified by Dendy and it was on the basic assumption that we had control of the bulk of his material that the compilation of the catalogue was thought feasible. However it is not impossible that further duplicate material, particularly extra microscope slides, may come to light in other museums, especially those of New Zealand and South Africa to which Dendy travelled between his time in Melbourne and his return to London.

SCOPE OF THE CATALOGUE

The catalogue contains the data on the types of the southern Australian sponge species described by Dendy from 1891 to 1916 held in the British Museum (Natural History) and the National Museum of Victoria. Statements made about the status of the types are based on the assumption that types of these species are held exclusively by the two institutions. This annotated catalogue is intended to preclude errors such as those by Burton (1963) who made statements on the status of calcareous types in the British Museum without being aware of complementary and in some cases superior type holdings in Melbourne. The erection of lectotypes based on microscope slides was particularly unfortunate since macro-material of the same species was available. Because of the lack of RN registration numbering, these slides cannot now be positively related to macro-syntype holdings. The species involved are *Leucosolenia dubia, L. proxima, L. pulcherrima, L. stipitata, L. stolonifer,* and *Ute spenceri.*

The compilation of this catalogue has revealed the damage that unsatisfactory numbering of specimens, coupled with incomplete curatorial procedures can do to the information content of type material. It is known that both institutions had small curatorial staffs who were overworked. This, together with the fact that the RN numbers of the material used in the early work were unpublished at the time of lodgement and that no clear indication was given of the status of the material, resulted in a confused picture regarding the collection.

ARRANGEMENT OF THE CATALOGUE

The listings are alphabetical by species irrespective of their taxonomic groupings, with the original generic combination given followed by the year of description and the page number in that paper. The year refers to a Dendy paper listed in the bibliography. (For a full Dendy bibliography see Smith et al., *in press*). The list was not arranged by genera as it was felt that users of the catalogue were more likely to seek information about a particular species under its original combination. No reference was made to present-day synonymies owing to the still highly fluid nature of sponge systematics.

The type status of the holdings of each

species is given by an initial letter as follows: H - holotype; S - syntype.

Dendy did not designate a holotype for his new taxa. Therefore where there is evidence of a type series of more than one specimen the entire suite of types is automatically considered to be syntypes. On the other hand where there is positive evidence that a single specimen only was used for the original description, this specimen is termed the holotype. Inclusion of material as type in the catalogue was only made after all relevant evidence was considered. There is positive evidence that the material included was donated either directly or indirectly to the respective institution by Dendy and in most cases labels in Dendy's hand are attached to the material giving RN numbers, localities and other clues helping to establish their authenticity. Microscope slides also bear a printed label with the name ARTHUR DENDY.

All specimens given published RN numbers are listed in the catalogue. Also included are a number of specimens and slides of Calcarea which bear unpublished RN numbers (denoted by brackets in the catalogue). In addition, it will be seen that a number of specimens of Calcarea have been listed without RN numbers. Their authenticity can be verified by the labels, written by Dendy, giving data which correlate with the descriptions.

Many of the entries consist of pairs of the same RN number, usually referring to a macro-specimen in the National Museum of Victoria and a slide in the British Museum. These slides were prepared from the respective macro-specimen to facilitate identification and description. This is a special feature of sponge systematic research technique, since the internal skeleton provides many of the diagnostic characters upon which the modern classification is based.

Material held in the National Museum of Victoria is denoted by a registration number with the prefix G (between G2279 and G2491), while the British Museum (Natural History) material bears a composite registration number prefixed by a four-digit number denoting the year of registration. A general description of the preservation of each specimen is given: sl - micro-scope slide preparation; alc. - specimen in 75% alcohol; dry - preserved dry.

Comments on the type status of the material or points of special interest are given for particular specimens. Opinions by other sponge experts (Bergquist, Burton and Kirkpatrick) on the status of this material are given where these differ from those of the present authors.

No station data are given for this material as this is available in the original description. A key to the Port Phillip station numbers was published by Wilson (1895).

CATALOGUE

For each specimen its RN number, registration number and method of presentation is given.

acerata, Iotrochota. 1896:24 (H)

434	G2279	dry
434	1902:10:18:283	sl

alata, Clathria. 1896:34 (S)

752	G2280	alc
752	1902:10:18:330	sl
763	G2281	alc
792	G2282	alc
792	1902:10:18:331	sl
801	G2283	alc
801	1902:10:18:49	sl
842	G2284	alc
842	1902:10:18:332	sl
843	G2285	alc
843	1902:10:18:333	sl

angulifera, Clathria. 1896:32 (H)

1160	G2286	alc
1160	1902:10:18:328	sl

arenacea, Collosclerophora. 1916:321 (H)

923	---	--

The single specimen is not present in either collection.

arenacea, Halichondria. 1895:239 (H)

629	G2287	alc
629	1902:10:18:88	sl

arenifibrosa, Desmacidon. (?) 1896:21 (H)

979	G2288	alc
979	1902:10:18:280	sl

arenosum, Echinodictyum. 1896:46 (H)

925	G2289	alc
925	1902:10:18:366	ı

areolata, Spirastrella. 1897:255 (S)

---	1907:8:7:3	dry

In BM(NH) register entry in Kirkpatrick's hand "Presented Prof. A. Dendy" "Type dry".

---	1902:10:18:84	sl
	Labelled "From large, dry specimen" in Dendy's hand.	
479	1902:10:18:470	sl
1187	G2290	dry
1187	1902:10:18:471	sl

australiana, Sigmaxinella. 1897:240 (S)

352	G2291	dry
352	1902:10:18:405	sl
388	G2292	alc
388	1902:10:18:406	sl
616	1902:10:18:73	sl
	Labelled "larger specimen" in Dendy's hand.	
654	G2293	alc
654	1902:10:18:407	sl
812	G2294	alc
1063	G2295	alc
1063	1902:10:18:408	sl

australiensis, Damiria. 1896:28 (S)

361	G2296	alc
361	1902:10:18:292	sl
451	G2297	alc
451	1902:10:18:293	sl
662	G2298	alc
662	1902:10:18:294	sl
673	G2299	alc
717	G2300	alc
717	1902:10:18:42	sl
718	G2301	alc
718	1902:10:18:295	sl
719	G2302	alc
718	1902:10:18:296	sl
722	G2303	alc
722	1902:10:18:297	sl
836	G2304	alc
836	1902:10:18:298	sl
837	G2305	alc
837	1902:10:18:299	sl
838	G2306	alc
838	1902:10:18:300	sl
845	G2307	alc
845	1902:10:18:301	sl
861	G2308	alc
861	1902:10:18:302	sl
903	G2309	alc
903	1902:10:18:303	sl
919	G2310	alc
919	1902:10:18:304	sl
997	G2311	alc
997	1902:10:18:305	sl

australis, Desmacidon. 1896:19 (S)

303	G2312	dry
303	1902:10:18:266	sl
351	G2313	alc
351	1902:10:18:267	sl
532	G2314	alc
532	1902:10:18:268	sl
762	G2315	alc
762	1902:10:18:37	sl
929	1902:10:18:269	sl
951	G2316	alc
999	G2317	alc
999	1902:10:18:270	sl

axinelloides, Ophlitaspongia. 1896:39 (H)

329	G2318	dry
329	1902:10:18:342	sl

bispiculata, Siphonochalina. 1895:246 (S)

1055	G2319	alc
1055	1902:10:18:14	sl
1079	G2320	alc
1079	1902:10:18:110	sl

boomerang, Sycon. 1893a:82 (H)

---	G2321	alc
	Size of specimen similar to description. No RN number in description, therefore status questionable.	
(255)	1925:11:1:1677	sl

carteri, Chondropsis. 1895:256 (H)

978	G2322	alc
978	1902:10:18:166	sl

carteri, Forcepia. 1896:25 (H)

607	G2323	alc
607	1902:10:18:286	sl

carteri, Sycon. 1893a:79 (S)

---	1893:6:9:3	alc
	Specimens may be from a single colony or many; therefore treated here as syntypes.	
---	1893:6:9:3a	sl
---	G2324	alc
---	G2325	alc
---	1925:11:1:56	alc
(67)	1925:11:1:1745	sl

ciocalyptoides, Sigmaxinella. 1897:242 (S)

338	G2326	alc
338	1902:10:18:413	sl
442	G2327	alc
882	G2328	alc
882	1902:10:18:75	sl
1092	G2329	alc
1092	1902:10:18:414	sl

clathrata, Axinella. 1897:233 (H)

1006	G2330	alc
1006	1902:10:18:380	sl

clathrata, Reniera. 1895:237 (S)

920	1902:10:18:86	sl
1185	G2331	alc

1185	1902:10:18:3	sl

clavatus, Leucascus. 1893a:78 (S)

---	1893:6:9:2	alc
	Burton (1963) considered this specimen to be the holotype. However, it must be a syntype as a type series of two specimens was described by Dendy.	
---	G2332	alc
---	1924:2:6:53	sl
(196)	G2333	alc
	Labelled in Dendy's hand "part of type". RN No. not quoted in original description.	
(196)	1925:11:1:1726	sl
(240)	1925:11:1:1727	sl
(241)	G2334	alc
	Probably second specimen of description as numerous embryos present.	
(241)	1925:11:1:1728	sl

columnifer, Chondropsis. 1895:254 (H)

445	1902:10:18:163	sl
	See Appendix 1.	

crassa, Esperella. 1896:17 (S)

521	1902:10:18:260	sl
939	G2335	alc
939	1902:10:18:32	sl

cylindrica, Grantiopsis. 1893a:90 (S)

---	G2336	alc
---	G2337	alc
---	1893:6:9:14A	dry
	Burton (1963) considered this specimen to be the holotype, but there is some doubt as to whether one or more specimens were used; therefore they are treated here as syntypes.	
(190)	1893:6:9:14a	sl
(190)	G2338	sl

depressa, Leucosolenia. 1891:65 (H)

---	G2340	alc
---	G2341	alc
	These two specimens fit together to form the specimen figured: 1891 pl. 3, fig. 4.	
(55)	1891:9:19:11	alc
	Labelled "pt of figured specimen" in Dendy's hand.	
(55)	1891:9:19:11a	sl
(55)	G2339	sl

depressa, Vosmaeropsis. 1893a:110 (H)

(228)	G2342	alc
(228)	1925:11:1:1072	sl
---	1924:2:6:102	sl

difficilis, Suberites. 1897:248 (S)

? 394	G2344	dry
? 394	1902:10:18:445	sl
	Question mark before the RN number appears in the original description.	
1129	G2343	alc
1129	1902:10:18:444	sl

dubia, Leucosolenia. 1891:50 (S)

---	G2345	alc
---	G2346	alc
	Labelled "pt of specimen figured in *Mon. Vict. Spong.* pl. 1, fig. 3" in Dendy's hand.	
---	G2347	alc
---	1891:9:19:3	alc
	This specimen selected cotype by Burton (1963). Labelled "part of figured spec." in Dendy's hand.	
---	1924:2:6:9	sl
(10)	G2349	sl
(10)	1925:11:1:1682	sl
(11)	1891:9:19:2	alc
	This specimen selected as lectotype by Burton (1963). Labelled "part of one of types" in Dendy's hand.	
(11)	1891:9:19:2a	sl
(11)	G2348	sl
(12)	1925:11:1:1684	sl
(19)	1925:11:1:1683	sl
(57a)	1925:11:1:1685	sl

ensiferum, Sycon. 1893a:81 (S)

---	G2351	alc
---	1893:6:9:6	alc
	Burton (1963) considered this specimen to be the holotype. However, it must be considered a syntype as there was a type series of two specimens in the original description. Labelled "portion of type" in Dendy's hand.	
---	1893:6:9:6a	sl
(144)	1925:11:1:1747	sl
(145)	G2350	alc
(145)	1925:11:1:1746	sl

fibrosa, Spirastrella. 1897:254 (S)

319	G2352	alc
319	1902:10:18:468	sl
475	G2353	alc
642	G2354	dry
642	1902:10:18:469	sl
1179	G2355	alc
1179	1902:10:18:83	sl

fistulatus, Fusifer. 1896:49 (S)

6	1902:10:18:373	sl
501	1902:10:18:374	sl
683	G2356	alc
683	1902:10:18:61	sl

1045 --- --
No material with this RN number in either collection.

fryetti, Reniera. 1895:238 (S)

1141	G2357	alc
1141	1932:1:25:16	sl
1183	G2358	alc
1183	1902:10:18:6	sl

gabrieli, Ophlitaspongia. 1896:38 (H)

915	G2359	alc
915	1902:10:18:341	sl

giganteum, Sycon. 1893a:84 (S)

---	G2360 Labelled "portion" in Dendy's hand.	alc
(192)	1893:6:9:7 Burton (1963) considered this specimen as a paratype. However, the material should be considered as a syntype as two specimens were mentioned in the original description. Labelled "upper half of specimen" in Dendy's hand.	alc
(192)	1893:6:9:7a	sl
(458)	G2361	alc

gladiator, Leucandra. 1893a:101 (H)

---	G2363	alc
(212)	G2362	alc
(212)	1893:6:9:21	alc
(212)	1893:6:9:21a	sl

gravida, Plumohalichondria. 1896:42 (S)

716	G2364	alc
716	1902:10:18:353	sl
881	G2365	alc
881	1902:10:18:55	sl

guntheri, Microtylotella. 1896:26 (S)

473	G2366	alc
473	1902:10:18:287	sl
757	1902:10:18:40	sl

hispida, Grantessa. 1893a:106 (S)

---	1893:6:9:25 Burton (1963) considered this specimen to be the holotype. However, it should be considered syntype as more than one specimen was mentioned in the original description.	alc
---	1893:6:9:25a	sl
---	G2367	alc
(132)	1925:11:1:1778	sl
(136)	G2368	alc
(136)	1925:11:1:1779	sl
(142)	1925:11:1:1780	sl

imperfecta, Clathria. 1896:35 (H)

376	G2369	alc
376	1902:10:18:335	sl

imperfecta, Oceanapia. 1895:249 (H)

1181	1902:10:18:116 See Appendix 1.	sl

intermedia, Desmacidon. 1896:20 (H)

1163	1902:10:18:274 See Appendix 1.	sl

kirkii, Axinella. 1897:235 (S)

686	G2370	alc
686	1902:10:18:387	sl
884	G2371	alc
884	1902:10:18:67	sl

longimanus, Reniera. 1895:237 (S)

576	1902:10:18:87	sl
609	G2372	alc
609	1902:10:18:5	sl
---	1886:12:15:172 Dendy listed "? BMd68 (*"Chalina polychotoma"*, Reg. 86-12-15-172)" in the original description as a type. This is one of the fragments determined by Carter sent to Dendy by the British Museum. The specimen listed here as a syntype is the original specimen from which the fragment was taken.	dry

lucasi, Leucosolenia. 1891:45 (S)

---	1891:9:19:1 Labelled "part of type" in Dendy's hand.	alc
---	1925:11:1:1839	sl
(45)	1925:11:1:19 Burton (1963) designated this specimen mounted on a slide as holotype.	sl
---	G2373 Labelled "part of type" in Dendy's hand but doubtful as locality is given as St. Vincents Gulf, S.A., which is not the type locality.	alc
(89)	1925:11:1:20 Locality with specimen given as St. Vincents Gulf, S.A., - not type locality. However, listed here as may be associated with specimen above.	alc

minutum, Sycon. 1893a:80 (S)

(90)	1893:6:9:4 Burton (1963) considered this specimen as a paratype, though Dendy did not give this designation. May be considered a holotype as syntype series is only inferred in the description.	alc
(90)	1893:6:9:4a	sl

mollis, Oceanapia. 1895:248 (S)

1167	G2374	alc
1167	1902:10:18:17	sl
1193	G2375	alc
1193	1902:10:18:115	sl

myxilloides, Clathria. 1896:35 (H)

729	G2376	alc.
729	1902:10:18:334	sl.

pallida, Rhaphisia. 1897:257 (S)

314	G2377	alc
314	1925:11:1:1372	sl
? 527	G2382	alc
	Question mark before the RN no. appears in the original description.	
? 527	1925:11:1:1371	sl
621	G2378	alc
621	1902:10:18:24	sl
737	G2379	alc
879	G2380	alc
879	1925:11:1:1374	sl
982	G2381	alc
982	1925:11:1:1370	sl
? 1015	G2383	alc
	Question mark before the RN no. appears in the original description.	
? 1015	1925:11:1:1373	sl

pelliculata, Leucosolenia. 1891:54 (S)

---	1891:9:19:8	alc
	Burton (1963) considered this specimen to be the holotype. However, it should be considered as a syntype as more than one specimen was mentioned in the original description. Labelled "part of figured specimen" in Dendy's hand.	
---	1891:9:19:5	alc
---	G2385	alc
	Labelled "Specimen figured in *Mon. Vict. Sponges*" in Dendy's hand.	
---	G2386	alc
---	G2387	alc
---	1924:2:6:13	sl
(13)	G2384	alc
(13)	G2389	sl
(13)	1925:11:1:1694	sl
(14)	1925:11:1:1695	sl
(15)	1925:11:1:1696	sl
(16)	G2388	alc
(16)	1925:11:1:1693	sl
(17)	1925:11:1:1697	sl
(38)	1925:11:1:1698	sl

phillipensis, Esperella. 1896:15 (H)

827	G2390	alc
827	1902:10:18:239	sl

phillipensis, Gellius. 1895:247 (S)

334	G2391	alc
334	1902:10:18:111	sl
702	G2392	alc
723	1902:10:18:112	sl
794	G2393	alc
794	1902:10:18:113	sl
973	G2394	dry
973	1902:10:18:15	sl

phillipensis, Leucandra. 1893a:100 (H)

(185)	G2395	alc
(185)	1925:11:1:1681	sl

phillipensis, Oceanapia. 1895:249 (S)

321	G2397	alc
321	1902:10:18:16	sl
1184	1902:10:18:117	sl

var. porosa, Spirastrella papillosa. 1897:253 (S)

290	G2398	dry
290	1902:10:18:466	sl
301	1902:10:18:82	sl
562	G2399	alc
---	1886:12:15:250	dry
	Dendy listed "BM?d120 (*"Spirastrella cuctatrix"*, Reg. 86-12-15-250)" in the original description as a type. This is one of the fragments determined by Carter and sent to Dendy by the British Museum. The specimen listed here as a syntype is the original specimen from which the fragment was taken.	
---	1886:12:15:250a	sl
	Slide made from the fragment sent to Dendy. Labelled with the name and reg. no. in Dendy's hand.	

proxima, Leucosolenia. 1891:62 (S)

---	1891:9:19:6	alc
	This specimen was selected as a lectotype by Burton (1963).	
---	1891:9:19:10	alc
---	1925:11:1:14	alc
(24)	1925:11:1:27	alc
(28)	1925:11:1:1706	sl
(31)	G2401	alc
(31)	1925:11:1:1705	sl
(48)	G2400	sl
(48)	1925:11:1:1704	sl
(49)	1925:11:1:1703	sl

proxima, Reniera. 1895:237 (S)

288	G2402	alc
288	1902:10:18:4	sl
594	1932:1:25:18	sl
1191	G2403	alc

pulchella, Synute. 1892:2 (H)

---	G2404	alc
---	G2405	sl
---	G2406	sl
---	1925:11:1:1680	sl.

pulcherrima, Leucosolenia. 1891:52 (S)

---	1924:2:6:22	sl
(20abc)	1891:9:19:7	alc
(20abc)	1891:9:19:7a	sl
(20abc)	G2407	sl
(21)	1925:11:1:1691	sl
(22)	1925:11:1:1690	sl
(23)	G2408	alc
(23)	1925:11:1:1689	sl

rara, Esperella. 1896:18 (H)

1108	----	--
	This single specimen is not present in either collection.	

ridleyi, Echinodictyum. 1896:44 (S)

269	G2409	alc
269	1902:10:18:363	sl
633	1902:10:18:364	sl
928	G2410	alc
928	1902:10:18:57	sl
1033	----	--
	No material with this RN number in either collection.	

rubra, Stylotrichophora. 1895:259 (H)

478	1902:10:18:233	sl
	See Appendix 1.	
510	G2411	alc
510	1902:10:18:28	sl
561	G2412	alc
1043	G2413	alc
1043	1902:10:18:234	sl
	The original description in 1895 was based on a single specimen. Dendy (1897:258) referred these additional specimens (RN 510, 561, 1043) to this species in such a way as to suggest they be treated as types. While this is not possible, this material is valuable reference material, particularly as the type material is represented by a slide only.	

schmidtii, Eumastia. 1895:240 (H)

390	G2414	alc
390	1902:10:18:90	sl

simplex, Leucascus. 1893a:77 (S)

---	G2415	alc
---	G2416	alc
	Labelled "portion" in Dendy's hand.	
---	1893:6:9:1	alc
---	1924:2:6:55	sl.
(217)	G2418	alc
	"Appears to have grown on a crab's back" in description. Specimen corresponds.	
(217)	1925:11:1:1703	sl
(226)	G2419	alc
(226)	1925:11:1:1731	sl
(229)	1925:11:1:1729	sl
(230)	1925:11:1:34	alc
(230)	1925:11:1:34a	sl
(230)	G2417	sl

var solida, Leucosolenia ventricosa. 1891:62 (S)

---	G2420	alc
---	G2422	alc
	Labelled "specimen figured in *Mon. Vict. Spong.*" in Dendy's hand.	
---	1925:11:1:1712	sl
	Burton (1963) considered this slide to be the holotype. However, it should be considered a syntype as more than one specimen is mentioned in the original description.	
---	1925:11:1:1716	sl
---	1925:11:1:1718	sl
(51)	1925:11:1:1715	sl
(51)	G2421	sl

spenceri, Ute. 1893a:94 (S)

(195)	G2423	alc
(195)	G2424	sl
(195)	1925:11:1:1678	sl
	This slide selected as lectotype by Burton (1963). At that time he was unaware of the existence of spirit type material.	
(224)	G2425	alc
	Labelled "attached to a crab's back" in Dendy's hand - mentioned in description. Still attached to crab.	
(224)	1925:11:1:1679	sl
	Burton (1963) designated this slide cotype.	

spiculosa, Ute. 1893a:92 (H)

---	G2428	alc
(84)	G2426	alc
(84)	1893:6:19:16	alc
(84)	1893:6:19:16a	sl
(84)	G2427	sl
	Probably all part of the same colony.	

spirastrelloides, Suberites. 1897:247 (H)

1128	G2429	alc
1128	1902:10:18:443	sl

spongiosa, Esperella. 1896:15 (S)

280	G2430	alc
280	1902:10:18:240	sl
292	G2431	alc
292	1902:10:18:31	sl
350	G2432	alc
350	1902:10:18:241	sl

363	G2433	alc
372	G2434	alc
372	1902:10:18:242	sl
396	G2435	alc
396	1902:10:18:243	sl
408	G2436	alc
472	G2347	dry
472	1902:10:18:244	sl
525	G2438	alc
525	1902:10:18:245	sl
578	G2439	alc
578	1902:10:18:30	sl
579	G2440	alc
579	1902:10:18:246	sl
581	G2441	alc
581	1902:10:18:247	sl
588	G2442	alc
588	1902:10:18:248	sl
603	G2443	alc
603	1902:10:18:249	sl
648	G2444	alc
648	1902:10:18:250	sl
749	G2445	alc
749	1902:10:18:251	sl
805	G2446	alc
805	1902:10:18:252	sl
941	1902:10:18:253	sl
968	G2447	alc
968	1902:10:18:254	sl
990	G2448	alc
990	1902:10:18:255	sl
1152	G2449	alc
1152	1902:10:18:256	sl
1190	G2450	dry
1194	G2451	dry
1194	1902:10:18:257	sl

spongiosum, Echinodictyum. 1896:45 (S)

790	G2452	alc
790	1902:10:18:365	sl
946	1902:10:18:58	sl

stipitata, Leucosolenia. 1891:51 (S)

---	G2453 Probably specimen figured.	alc
(29)	1925:11:1:1673 This slide selected as lectotype by Burton (1963). At that time he was unaware of the existence of alcohol type material.	sl
(33)	1925:11:1:1675	sl
(34)	1925:11:1:1674	sl

stolonifer, Leucosolenia. 1891:46 (S)

---	1891:9:19:4 This specimen selected as lectotype by Burton (1963).	alc
---	G2454	alc
---	G2455	alc
(41)	1925:11:1:1707	sl
(42 or 43)	1925:11:1:28	alc
(42)	1925:11:1:28a	sl
(42 or 43 or part)	1925:11:1:13	alc
(43)	1925:11:1:13a	sl
(56)	1925:11:1:1709	sl
(57)	1925:11:1:1708	sl

tenuis, Acarnus. 1896:50 (S)

from 974	G2456	alc
from 974	1902:10:18:62 Labelled "encrusting *Plumohalichondria arenacea*".	sl
from 991	G2457	alc
from 991	1902:10:18:375 Labelled "encrusting *Tedania digitata*".	sl
from 1072	1902:10:18:323 Labelled "encrusting *Clathria typica*".	sl

tenuispiculata, Acanthella. 1897:238 (S)

542	G2458	alc
542	1902:10:18:397	sl
1188	G2459 Label on outside of box in P.R. Bergquist's handwriting reads "RN(?) 1188 not id. by Dendy". It is a dried specimen, with a string-attached label with "15" written on it. Unsure whether it is a type or not. However, it is definitely *Ac. tenuispiculata* although no such descriptive label exists.	dry
1188	1902:10:18:70	sl

tenuispiculata, Plumohalichondria. 1896:44 (H)

1024	1902:10:18:362 See Appendix 1.	sl

topsentii, Chondropsis. 1895:254 (S)

487	G2460	dry
487	1902:10:18:164	sl
499	G2461	alc
499	1902:10:18:21	sl
1071	G2462	dry

toxifer, Esperella. 1896:16 (H)

779	G2463	alc
779	1902:10:18:259	sl

tumida, Phakellia. 1897:236 (H)

1155	G2464	alc
1155	1902:10:18:389	sl

uncifer, Plumohalichondria. 1896:41 (H)

1047	G2465	alc
1047	1902:10:18:352	sl

uteoides, Leucosolenia. 1893b:178 (H)

---	1893:6:9:33	alc
	"Single specimen" in original description. All specimens mentioned here thought to be fragments of that specimen.	
---	G2466	alc
---	1925:11:1:1725	sl
(258)	G2467	alc
(258)	1925:11:1:1724	sl

vestigifera, Raspailia. 1896:47 (H)

655	G2468	alc

victoriana, Myxilla. 1896:30 (S)

492	G2469	alc
492	1902:10:18:313	sl
835	G2470	alc
835	1902:10:18:314	sl
844	G2471	alc
895	1902:10:18:43	sl
922	1902:10:18:315	sl
---	1887:7:11:26	dry
	Dendy listed "BMd97 (*"Halichondria pustulata"*, Reg. 87-7-11-26)" in the original description as a type. This is one of the fragments determined by Carter and sent to Dendy by the British Museum. The specimen listed here as a syntype is the original specimen from which the fragment was taken.	
---	1887:7:11:26a	sl
	This slide was made from the fragment sent to Dendy. Slide labelled with name and reg. no. in Dendy's hand.	

viridis, Chalina. 1895:244 (S)

333	----	--
	No material with this RN number exists in either collection.	
572	1902:10:18:12	sl
744	G2472	alc
744	1902:10:18:103	sl

vosmaeri, Grantia. 1893a:88 (H)

(193A)	G2473	alc
(193A)	1925:11:1:104	alc
	There is probably only a single original specimen in the type series, though this is not clear from the original description. There is a label, written by Dendy, with this specimen reading "smaller specimen".	
(193A)	1925:11:1:104a	sl

var. whiteleggii, Sycon gelatinosum. 1893a:84 (S)

---	G2475	alc
---	1925:11:1:1509	alc
---	1925:11:1:1509a	sl
(153)	G2474	alc
(153)	1893:6:9:13	alc
	Burton (1963) considered this specimen to be the holotype. However, it must be considered a syntype as there was a type series of 9 specimens mentioned in the original description. This number of types is accounted for in the holdings of the two institutions.	
(153)	1893:6:9:13a	sl

wilsoni, Chondropsis. 1895:252 (S)

540	1902:10:18:154	sl
613	G2476	alc
613	1902:10:18:20	sl
658	G2477	alc
? 663	G2480	alc
	Question mark before the RN number appears in the original description.	
? 663	1902:10:18:158	sl
? 711	G2481	alc
? 711	1902:10:18:159	sl
735	G2478	alc
735	1902:10:18:155	sl
817	G2479	alc
817	1902:10:18:156	sl
1054	G2396	alc
1054	1902:10:18:157	sl

wilsoni, Leucosolenia. 1891:63 (S)

(32)	1891:9:19:12	alc
	Labelled "part of figured specimen" in Dendy's hand.	
(32)	1891:9:19:12a	sl
(32)	G2488	alc
	Labelled "part of specimen figured in *Mon. Vict. Spong."* in Dendy's hand.	
(32)	G2487	sl
(32)	G2485	sl
(32/5)	G2482	sl
(32/6a)	G2483	sl
(32/8a)	G2486	sl
(32/9a)	G2484	sl
(50)	1925:11:1:1670	sl

wilsoni, Vosmaeropsis. 1893a:111 (S)

---	1893:6:9:29	alc
	Burton (1963) considered this specimen to be the holotype. However, it must be considered a syntype as more than one specimen was mentioned in the original description.	
---	1893:6:9:29a	sl
---	G2490	alc
---	1955:11:2:96	dry
	Labelled "dried from spirit. To be used for dissection. Duplicate material" in Dendy's hand.	
---	1955:11:2:96a	sl
(71)	1925:11:1:1539	alc
(71)	1925:11:1:1539a	sl
(175)	1925:11:1:1797	sl
(176)	G2489	alc
(177)	G2491	sl

(177)	1925:11:1:1795	sl
(178)	1925:11:1:60	alc
(178)	1925:11:1:60a	sl
(179)	1925:11:1:1495	alc
(179)	1925:11:1:1495a	sl
(180)	1925:11:1:74	alc
(180)	1925:11:1:74a	sl
(184)	1925:11:1:1796	sl

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ADDENDUM

Since the paper was prepared it has come to our notice that 79 slides of 74 species were lodged by Dendy in the Australian Museum, Sydney, while he was in New Zealand. These were duplicate slides, many of which were of southern Australian species (Whitelegge, 1901).

Dendy also lodged some material in the Zoology Museum, Victoria University College, Wellington, New Zealand (Fell, 1950). These were mainly blocked specimens from which Dendy had already cut sections. This collection includes types of nine southern Australian species described by Dendy (Fell, 1950):

carteri, Sycon 1893a:79
cylindrica, Grantiopsis 1893a:90
giganteum, Sycon 1893a:84
gladiator, Leucandra 1893a:101
phillipensis, Leucandra 1893a:100
pulcella, Synute 1892:2
simplex, Leucascus 1893a:77, RN 226
spiculosa, Ute 1893a:92, RN 84
wilsoni, Vosmaeropsis 1893a:111

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APPENDIX 1.

List of demosponge macro-specimens missing from the species type series. In each case a slide exists of the missing specimen and except for those species marked with an asterisk (*), other spirit or dry material exists.

areolata, Spirastrella	1897:255	RN 479
australiana, Sigmaxinella	1897:240	RN 616
australis, Desmacidon	1896:19	RN 929
clathrata, Reniera	1895:237	RN 920
*columnifer, Chondropsis**	1895:254	RN 445
crassa, Esperella	1896:17	RN 521
fibrosa, Spirastrella	1897:254	RN 1171
fistulatus, Fusifer	1896:49	RN 6
fistulatus, Fusifer	1896:49	RN 501
guntheri, Microtylotella	1896:26	RN 757
*imperfecta, Oceanapia**	1895:249	RN 1181
*intermedia, Desmacidon**	1896:20	RN 1163
longimanus, Reniera	1895:237	RN 576
phillipensis, Gellius	1895:247	RN 723
phillipensis, Oceanapia	1895:249	RN 1184
var porosa, Spirastrella papillosa	1897:253	RN 301
proxima, Reniera	1895:237	RN 594
ridleyi, Echinodictyum	1896:44	RN 633
rubra, Stylotrichophora *	1895:259	RN 478
spongiosa, Esperella	1896:15	RN 941
spongiosum, Echinodictyum	1896:45	RN 946
tenuis, Acarnus	1896:50	RN 1072 (encrusting)
*tenuispiculata, Plumohalichondria**	1896:44	RN 1024
victoriana, Myxilla	1896:30	RN 895
victoriana, Myxilla	1896:30	RN 922
viridis, Chalina	1895:244	RN 572
wilsoni, Chondropsis	1895:252	RN 540

APPENDIX 2.

List of demosponge species of which a type lot (both specimen and slide) from the type series is missing. All type material has been lost where the species is marked with an asterisk (*).

arenacea, Collosclerophora *	1916:321	RN 923
fistulatus, Fusifer	1896:49	RN 1045
*rara, Esperella**	1896:18	RN 1108
ridleyi, Echinodictyum	1896:44	RN 1033
viridis, Chalina	1895:244	RN 333

A CATALOGUE OF THE BLEEKER COLLECTION OF FISHES IN THE NATIONAL MUSEUM OF VICTORIA

Joan M. Dixon and Linda M. Huxley
Department of Mammalogy, National Museum of Victoria, Melbourne

ABSTRACT

The National Museum of Victoria has a collection of approximately 870 specimens of fishes from the East Indian Archipelago, originally belonging to the Dutch ichthyologist Pieter Bleeker. Bleeker's collection was auctioned in 1879 and the C and D series purchased by Edward Gerrard jr. The National Museum of Victoria purchased a collection from Gerrard in 1881 which seems to be derived mainly from the C series. The collection includes six genera of elasmobranchs in five families, 265 genera of teleosts in 100 families and is a good representation of fishes from the East Indian Archipelago. A list of this material is presented to bring this generally unknown and valuable collection to the notice of ichthyologists.

INTRODUCTION

Pieter Bleeker (1819-1878) collected extensively while stationed in Batavia as an Army surgeon from 1842 to 1860. Between 1852 and 1860 he forwarded 12 shipments of more than 11000 specimens of fishes to the Rijksmuseum van Natuurlijke Historie in Leiden. This material, a part of his enormous personal collection of some 26000 specimens, did not contain types which he apparently retained in his personal collection. Before his return to Holland he shipped specimens to other European museums. Between 1858 and 1880, nine lots containing 1786 specimens including some types were sold to the British Museum. The remainder of his personal collection was kept intact until his death in 1878. The Bleeker Collection has been discussed in depth by Boeseman (1973) and Whitehead *et al.* (1966).

In 1879, Bleeker's private collection was auctioned. It was divided by Hubrecht, curator at the Leiden Museum and author of the sale catalogue, into 15 approximately systematic groups in five main series, A to E, of diminishing importance. All 15 groups of series A, those believed to contain types, were purchased by the Leiden Museum. Groups VI, XIV and XV of series B were bought by W. Berlin, Professor of Comparative Anatomy at Amsterdam. The C and D series were bought by Edward Gerrard, ostensibly for resale to the British Museum. The remaining 12 groups of series B and all of series E were unsold. These specimens may have been sent to the Leiden Museum or they may have been sold at a later date.

At the time, the Director of the National Museum was Professor Frederick McCoy. From the correspondence between McCoy and Edward Gerrard jr it is clear that the National Museum of Victoria (NMV) had regular business dealings with Gerrard. On 6 January 1881, Gerrard forwarded a bill of lading for eight cases containing a collection of 677 spirit specimens of Bleeker's fishes which were purchased from Gerrard for £151.7.6. The fishes alone cost £71.7.6, the balance being for glass jars, spirit, shipping and other expenses. Gerrard indicated that the labels on the bottles were the original ones which were tied on the fishes and that he

Reports of the National Museum of Victoria, 1: 111-123 (1982).

had also sent a good number not in bottles, because of the difficulty in getting spirit shipped. 'None of the steamers would take them unless the spirit was taken out of the bottles and put into iron jars so I was obliged to get them sent by a sailing vessel'. (Letter to McCoy 6 January 1881.)

In the Director's Progress Report of the NMV for the year 1881, McCoy referred to 'great additions to the general series of fish, including Bleeker's famous collection from the seas of the Netherlands-India'. At this time, McCoy was the only scientist in the NMV although there were taxidermists and assistants. W.E.G. Simmons, clerk, accessioned the Bleeker collection. By 1884, 202 specimens from the collection appeared in Schedule D of the Director's Progress Report of the NMV where McCoy presented the contents of the register. The remaining 495 specimens of the collection appeared in Schedule E of a similar report in 1885.

In summary, the collection of Bleeker fishes now housed in the NMV was purchased from E. Gerrard jr who had purchased series C and D at the auction. There are more than 50 species represented in the NMV collection which are not listed in the D series of the auction catalogue. It seems most likely that the NMV collection is part of the C series and generally the number of specimens in the NMV collection is equal to or less than the number listed in the auction catalogue. In the cases where the specimen numbers do not match, addition of the numbers in the C and D series usually makes up the number in the NMV collection. Since Gerrard had both series, it is not inconceivable that he mixed them occasionally. Boeseman (pers. comm.) also advised that the numbers of specimens listed in the auction catalogue may not always be correct.

There are approximately 960 species listed in the C series of the auction catalogue, about two-thirds of these, approximately 640 species, are held in the NMV collection. Several of these do not appear in the auction catalogue or are not listed in the C series. Species not listed at all in the auction catalogue are :-

46107. *Dangila leptocheilos.* This may be a mis-spelling of *D. lipocheilos* listed in Group XI.

45840. *Ophiocephalus mystax. O. melanosoma,* a senior synonym, is listed in Group VI.

46362. *Monacanthus broekii. Paramonacanthus broekii* is listed in Group XIV.

A963. *Gymnothorax islingteena.* There is some doubt that this specimen is from the Bleeker collection. The locality, East of Africa, and the label do not match those of the rest of the collection.

46022. *Carangoides (Gymnostethus) ciliaris. C. armatus* is a junior synonym listed in Group V although this species occurs elsewhere in the collection.

Species listed in the auction catalogue but not in the C series are :-

46457. *Holacanthus nox* is listed in the A and B series only.

A961. *Tetraodon richei* is listed in the A series only.

A877. *Tetragonoptrus triangul* is listed in the A series only.

In his letter to McCoy of 6 January 1888, Gerrard wrote 'besides those charged, I have sent a good number which I did not put in bottles'. The account charged the NMV for 677 specimens but 697 were registered, so as Gerrard stated, it seems that he included some extra specimens which may account for the problematic ones. It is most likely that they are Bleeker specimens. The jars and labels are similar but the possibility that Gerrard included specimens from another collection cannot be discounted.

The specimens in the NMV collection are preserved in alcohol and for the most part are in their original glass bottles. In the 1880s fishes were usually wrapped in cloth and sent in large containers of alcohol. A few specimens were still in this condition when this paper was prepared. In most cases the specimens in the collection had a label wired to the jar when the specimens were registered. In some cases, the original label with the scientific name only is inside, in others it is tied to the top of the jar. Often an additional label with the name of the fish was glued to the outside base of the bottle, but these have deteriorated with time. The specimens with unprefixed registration numbers have an 'A' designation in the registers and on the labels, which is thought to be a reference to storage and should not be confused with the A series in the auction catalogue. The generic and specific names listed here follow the NMV labels and register and for the most part agree with the spellings used in the auction catalogue. Where possible we have corrected spelling mistakes which were introduced during registration, for example, *Labes* was corrected to *Labeo*, *Epinephelus coelang* to *E. boelang* and *Choerops vittatus* to *Ctenops vittatus*.

Classification at family and ordinal levels follows Compagno (1973) for elasmobranchs and Greenwood *et al.* (1966) for teleost species.

The NMV registration numbers are listed in arabic numerals with specimens registered recently having an A prefix. These precede the scientific name of each species and the auction groupings which are in roman numerals. When there is more than one specimen the number is listed in brackets.

Specimens marked by an asterisk have not been located but it is possible that further specimens may be located.

Authors' names are abbreviated as follows : Blkr - Bleeker, Bl Schn - Bloch & Schneider, Cant - Cantor, Cuv - Cuvier, CV - Cuvier & Valenciennes, Ehr - Ehrenberg, Forsk - Forskal, Forst - Forster, Frem - Freminville, Gill - Gill, Gr - Gray, Gthr - Gunther, HB - Hamilton-Buchanan, Heck - Heckel, Jen - Jenyns, Kp - Kaup, Kittl - Kittlitz, K v H - Kuhl & van Hasselt, Lac - Lacepede, Less - Lesson, L - Linnaeus, MH - Muller & Henle, Pet - Peters, QG - Quoy & Gaimard, Rich - Richardson, Rupp - Ruppell, Schl - Schlegel, Swns - Swainson, v Hass - van Hasselt, Val - Valenciennes.

CLASS ELASMOBRANCHII

ORDER ORECTOLOBIFORMES

Family Hemiscyllidae

46398-9	*Chiloscyllium plagiosum*	MH XV
46400-1	*Chiloscyllium plagiosum*	MH XV

ORDER CARCHARHINIFORMES

Family Carcharhinidae

46406	*Carcharias (Prionodon) menisorrah*	Val XV
46586	*Carcharias (Prionodon) sorrah*	Val XV

ORDER RAJIFORMES

Family Rhinobatidae

A2104	*Rhinobatis ligonifer*	Cant I

ORDER MYLIOBATIFORMES

Family Dasyatidae

46555	*Raja akajei*	MH XV
A949	*Trygon macrurus*	Blkr XV
A915	*Trygon uarnakoides*	Blkr XV
*46692	*Trygon walga*	MH XV

Family Myliobatidae

46378	*Myliobatis maculatus*	Gr XV

CLASS TELEOSTEI

ORDER ELOPIFORMES

Family Elopidae

46587	*Elops saurus*	L XII

Family Albulidae

46021	*Conorhynchus glossodon*	Blkr XII

ORDER ANGUILLIFORMES

Family Moringuidae

46483-5	*Moringua raitaborua*	Cant XIII

Family Muraenidae

46130	*Echidna polyzona*	Blkr XIII
46132	*Echidna variegata*	Forst XIII
*46131	*Echidna zebra*	Blkr XIII
46149	*Gymnothorax cancellatus*	Blkr XIII
46150-1	*Gymnothorax ceramensis*	Blkr XIII
46152	*Gymnothorax flavimarginatus*	Blkr XIII
46444	*Gymnothorax isingleenoides*	Blkr XIII
A963	*Gymnothorax islingteena* (East of Africa, one specimen)	Blkr ----
46147	*Gymnothorax pictus*	Blkr XIII
46445	*Gymnothorax prosopeion*	Blkr XIII
46146	*Gymnothorax reticulatus*	Blkr XIII
46148	*Gymnothorax tessellatus*	Blkr XIII
46446	*Gymnothorax tile*	Blkr XIII
46372	*Muraena maculata*	HB XIII
A947	*Muraena sidat* (2 specimens)	Blkr XIII

Family Muraenesocidae

46589 *Muraenesox bagio* Pet XIII
46373 *Muraenesox singapurensis* Blkr XIII
46509 *Muraenesox talabon* 8lkr XIII

Family Congridae (including Leptocephalidae)

46387 *Ophisoma anago* Blkr XIII

Family Ophichthidae (including Myrophidae)

*46388-9 *Ophichthys boro* Cuv XIII
46390 *Ophisurus fasciatus* Rich XIII

ORDER CLUPEIFORMES

Family Clupeidae (including Dorosomatidae and Dussumieridae)

A945 *Alosa indica* Blkr XII
46003 *Alosa kanagurta* Blkr XII
A2049 *Alosa malayana* Blkr XII
46582 *Alosa toli* Val XII
A936 *Clupea (Clupeoides) argyrotaenia* Blkr XII (3 specimens)
46044-5 *Clupea (Harengula) brachysoma* Blkr XII
A935 *Clupea (Amblygaster) clupeoides* Blkr XII
46041-2 *Clupea (Harengula) gibbosa* Blkr XII
A938 *Clupea (Amblygaster) leiogaster* Blkr XII
A2051 *Clupea (Harengula) lemuru* Blkr XII
46043 *Clupea (Harengula) melanosticta* Blkr XII
A937 *Clupea (Harengula) melanurus* Blkr XII
A939 *Clupea (Harengula) moluccensis* 8lkr XII (3 specimens)
46410 *Clupea (Harengula) perforata* Blkr XII
46419-20 *Dorosoma chacunda* Blkr XII
A944 *Dussumieria acuta* Val XII (3 specimens)
A2050 *Ilisha amblyuropterus* Blkr XII
A942 *Ilisha elongata* Blkr XII
A940 *Ilisha hoevenii* Blkr XII (2 specimens)
A943 *Ilisha indica* Blkr XII
A941 *Ilisha megalopterus* Blkr XII
45838 *Opisthopterus macrognathus* Blkr XII
45839 *Opisthopterus tartoor* Gill XII
46618-9 *Spratelloides gracilis* Gthr XII

Family Engraulidae

46074-8 *Coila borneensis* Blkr XII
46049-50 *Coila dussumieri* Val XII
46046 *Coila macrognathus* 8lkr XII
A2052 *Engraulis dussumieri* Val XII (2 specimens)
46120-2 *Engraulis encrasicholoides* Blkr XII
A2047 *Engraulis encrasicholus* Cuv XII
46128-9 *Engraulis kammalensis* 8lkr XII
A955 *Engraulis mystax* Val XII
46127 *Engraulis poorawah* Blkr XII
46123-4 *Engraulis setirostris* Val XII
46125-6 *Engraulis valenciennesii* 8lkr XII
A946 *Setipinna breviceps* 8lkr XII
46627-9 *Setipinna melanochir* 8lkr XII
46626 *Setipinna tali* 8lkr XII
46688-9 *Stolephorus commersonianus* Lac XII
46690 *Stolephorus heterolobus* Blkr XII
A2048 *Stolephorus indicus* Blkr XII (3 specimens)
A2063 *Stolephorus tri* 8lkr XII

ORDER OSTEOGLOSSIFORMES

Family Osteoglossidae

45846 *Osteoglossum formosum* Schl XII

Family Notopteridae

46385 *Notopterus borneensis* Blkr XII
46382 *Notopterus chitala* Gthr XII
46591-2 *Notopterus chitala* Gthr XII
46386 *Notopterus kapirat* Lac XII

ORDER GONORYNCHIFORMES

Family Chanidae

46405 *Chanos salmoneus* Val XII
46584 *Chanos salmoneus* Val XII

ORDER CYPRINIFORMES

Family Cyprinidae

A931 *Amblyrhynchichthys truncatus* 8lkr XI
A930 *Balantiocheilus melanopterus* Blkr XI
46016-7 *Barbichthys laevis* Blkr XI
46103-4 *Carpio flavipinna* Blkr XI
46105 *Chela oxygastroides* 8lkr XI
46402 *Crossochilus oblongus* v Hass XI
46096 *Cyclocheilichthys (Anemat.) apogon* 8lkr XI
46095 *Cyclocheilichthys (Anemat.) apogonide* Blkr XI
46106 *Cyclocheilichthys armatus* 8lkr XI
46585 *Cyclocheilichthys enoplus* Blkr XI
46094 *Cyclocheilichthys (Siaja) siaja* 8lkr XI
46107 *Dangila leptocheilos* CV ----
46434 *Epalzeorhynchus callopterus* Blkr XI

A932 *Hampala macrolepidota* K v H XI (2 specimens)
46478-9 *Labeo (Diplocheilus) lucas* Blkr XI
46322 *Labeobarbus douronensis* Blkr XI
46321 *Labeobarbus soro* Blkr XI
46588 *Labeobarbus tambra* Blkr XI
46320 *Labeobarbus tambroides* Blkr XI
46304 *Leptobarbus hoevenii* Blkr XI
46467 *Lobocheilus falcifer* Blkr XI
46468-73 *Lobocheilus lipocheilus* Blkr XI
46465-6 *Lobocheilus (Lobocheilus) schwanefeldi* Blkr XI
46513-4 *Morulius chrysophekadion* Blkr XI
45938 *Puntius (Barbodes) belinka* Blkr XI
45894 *Puntius (Barbodes) bramoides* Blkr XI
45893 *Puntius bulu* Blkr XI
45895 *Puntius (Barbodes) erythropterus* Blkr XI
45903 *Puntius javanicus* Blkr XI
45897 *Puntius (Barbodes) lateristriga* Blkr XI
45902 *Puntius (Capoeta) leiacanthus* Blkr XI
45900-1 *Puntius (Barbodes) maculatus* Blkr XI
A933 *Puntius (Barbodes) marginatus* Blkr XI
45899 *Puntius (Capoeta) padangensis* Blkr XI
45896 *Puntius (Barbodes) rubripinna* Blkr XI
45898 *Puntius sophare* Blkr XI
46548-53 *Rasbora argyrotaenia* Blkr XI
A934 *Rasbora cephalotaenia* Blkr XI
A965 *Rasbora dusonensis* Blkr XI
46546-7 *Rasbora einthovenii* Blkr XI
46545 *Rasbora kallochroma* Blkr XI
46554 *Rasbora lateristriata* Blkr XI
46268-70 *Rohita hasseltii* Val XI
46271-2 *Rohita (Rohita) melanopleura* Blkr XI
46274 *Rohita schlegelii* Blkr XI
46273 *Rohita vittata* Val XI
46679 *Schismatorhynchus heterorhynchus* Blkr XI

Family Homalopteridae

46224 *Homaloptera fasciata* v Hass XI
46223 *Homaloptera javanica* v Hass XI
46221-2 *Homaloptera ocellata* v Hass XI

Family Cobitidae (including Acanthopsidae)

45969-70 *Acanthophthalmus javanicus* v Hass XI
A2062 *Botia macracanthus* Blkr XI (3 specimens)
*46306-7 *Lepidocephalichthys hasseltii* Blkr XI
46380-1 *Nemacheilus fasciatus* K v H XI

ORDER SILURIFORMES

Family Bagridae

46011 *Bagroides melanopterus* Blkr IX
46173 *Hemibagrus hoevenii* Blkr IX
46454 *Hemibagrus nemurus* Blkr IX
46172 *Hemibagrus planiceps* Blkr IX
46226 *Hypselobagrus keletius* Blkr IX
46463 *Hypselobagrus micracanthus* Blkr IX
46225 *Hypselobagrus wolffi* Blkr IX

Family Siluridae

46018 *Belodontichthys macrochir* Blkr IX
46072 *Cryptopterichthys palembangensis* Blkr IX
46071 *Cryptopterus limpok* Blkr IX
46069-70 *Cryptopterus micropus* Blkr IX
46415 *Callichrous bimaculatus* Swns IX
46511 *Micronema hexapterus* Blkr IX
46257 *Phalacronotus micropogon* Blkr IX
A929 *Silurodes hypophthalmus* Blkr IX (2 specimens)

Family Pangasiidae

A928 *Lais hexanema* Blkr IX
*46599 *Pangasius djambal* Blkr IX
45892 *Pangasius macronema* Blkr IX
46540 *Pseudopangasius polyuranodon* Blkr IX

Family Amblycipitidae

45993 *Acrochordonichthys pleurostigma* Blkr IX
45992 *Acrochordonichthys zonatus* Blkr IX

Family Akysidae

46004 *Akysis variegatus* Blkr IX

Family Sisoridae (Bagariidae)

46015 *Bagarius buchanani* Blkr IX
46162-3 *Glyptothorax platypogon* Blkr IX

Family Clariidae

46083-5 *Clarias batrachus* Val IX
46086 *Clarias leiacanthus* Blkr IX
46087 *Clarias melanoderma* Blkr IX

Family Ariidae

46581 *Arioides argyropleuron* Blkr IX
45964 *Arioides leiocephalus* Blkr IX
45986 *Arius coelatus* Val IX
45987 *Arius utik* Blkr IX
46019 *Batrachocephalus micropogon* Blkr IX
46464 *Hemipimelodus borneensis* Blkr IX
46559 *Hexanematichthys sundaicus* Blkr IX
46234 *Ketengus typus* Blkr IX
46590 *Netuma thalassina* Blkr IX
45847 *Osteogeneiosus macrocephalus* Blkr IX

46593-4	*Osteogeneiosus valenciennesii*	Blkr IX
45949	*Pseudarius arius*	Blkr IX
45948	*Pseudarius pidada*	Blkr IX

Family Plotosidae

46538-9	*Plotosus arab*	Blkr IX
46595	*Plotosus canius*	HB IX

Family Callichthyidae

A2070	*Callichthys tamoata*	L IX

ORDER GADIFORMES

Family Gadidae (including Gaidropsaridae)

46093	*Ciliata mustela*	Blkr VIII

Family Carapidae

46134	*Fierasfer gracilis*	Blkr VIII
46135	*Fierasfer homei*	Kp VIII

ORDER ATHERINIFORMES

Family Cyprinodontidae

46530-5	*Panchax buchanani*	Val XI

Family Anablepidae

A2061	*Anableps tetrophthalmus*	Val XI

Family Atherinidae

45966	*Atherina duodecimalis*	CV VI
45965	*Atherina presbyter*	CV VI
45967-8	*Atherina valenciennesii*	Blkr VI
45971-3	*Atherina valenciennesii*	Blkr VI

ORDER BERYCIFORMES

Family Monocentridae

46374	*Monocentris japonicus*	CV II

Family Holocentridae

46486-7	*Myripristis macrolepis*	Blkr II

ORDER GASTEROSTEIFORMES

Family Centriscidae (Amphisilidae)

45995	*Amphisile strigata*	Gthr VI

Family Syngnathidae (including Hippocampidae)

A851	*Doryichthys boaja*	Blkr XIV
46422	*Doryichthys brachyurus*	Blkr XIV
46447-8	*Gasterotokeus biaculeatus*	Heck XIV
46227-8	*Hippocampus kuda*	Blkr XIV
46622-3	*Syngnathus conspicillatus*	Jen XIV
46620-1	*Syngnathus pelagicus*	L XIV
46624-5	*Syngnathus retzii*	Blkr XIV

ORDER CHANNIFORMES

Family Channidae (including Ophicephalidae)

45844-5	*Ophiocephalus gachua*	HB VI
45843	*Ophiocephalus lucius*	K v H VI
45840	*Ophiocephalus mystax*	Blkr ---
45841-2	*Ophiocephalus striatus*	Blkr VI

ORDER SYNBRANCHIFORMES

Family Synbranchidae (Symbranchidae including Flutidae)

46376-7	*Monopterus javanensis*	Lac XIII
A948	*Symbranchus bengalensis*	Blkr XIII

ORDER SCORPAENIFORMES

Family Scorpaenidae

45963	*Apistus alatus*	CV II
A902	*Gymnapistus barbatus* (2 specimens)	Swns II
A901	*Paracentropogon longispinis* (3 specimens)	Blkr II
46560	*Prosopodasys trachinoides*	Cant II
A905	*Pseudomonopterus (Dendroch.) brachypt.* (2 specimens)	Blkr II
A904	*Pseudomonopterus (Dendroch.) zebra* (2 specimens)	Blkr II
A903	*Scorpaenopsis gibbosus*	Blkr II

Family Synancejidae

46557	*Leptosynanceia asteroblepa*	Blkr II
A2053	*Polycaulus elongatus* (3 specimens)	Gthr II

Family Platycephalidae

46598	*Platycephalus indicus*	Blkr II
46254	*Platycephalus pristiger*	CV II

Family Cyclopteridae (including Liparidae)

46355-8	*Liparis vulgaris*	Cuv III

ORDER PEGASIFORMES

Family Pegasidae

46259 *Pegasus natans* L XIV

ORDER PERCIFORMES

Family Centropomidae (including Latidae and Ambassidae)

45996-7 *Ambassis gymnocephalus* Blkr III
45998-9 *Ambassis nalua* Blkr III
A2072 *Plectropoma calcarifer* Cuv I
46515 *Psammoperca waigioensis* Blkr I

Family Serranidae (including Epinephelidae and Anthiidae)

45994 *Anyperodon leucogrammicus* Gthr I
46414 *Centrogenys waigiensis* Blkr I
46617 *Cromileptes altivelis* Swns I
A886 *Diploprion bifasciatum* K v H I
46210 *Epinephelus argus* Bl Schn I
46423-4 *Epinephelus boelang* Blkr I
46427 *Epinephelus angularis* Blkr (=*celebicus* Blkr) I
46212 *Epinephelus cyanostigma* Blkr I
A2105 *Epinephelus cyanostigma* Blkr I
46214 *Epinephelus fasciatus* Blkr I
46218 *Epinephelus formosus* Blkr I
46217 *Epinephelus fuscoguttatus* Blkr I
46211 *Epinephelus gilberti* Blkr I
46209 *Epinephelus lanceolatus* Blkr I
A895 *Epinephelus leopardus* Blkr (=*spiluris* Blkr) I
46213 *Epinephelus merra* Blkr I
46425 *Epinephelus miniatus* Blkr I
46215 *Epinephelus sexfasciatus* Blkr I
46426 *Epinephelus summana* Blkr I
46428-9 *Epinephelus urodelus* Blkr I
46216 *Epinephelus variolosus* Blkr I
45958 *Paracanthistius maculatus* Blkr I
A896 *Paracanthistius maculatus* Blkr I
46523 *Pseudanthias huchtii* Blkr I

Family Grammistidae

46167-8 *Grammistes orientalis* Bl Schn I

Family Theraponidae

46651 *Therapon (Datnia) argenteus* Blkr I
46647-8 *Therapon (Datnia) therops* Blkr I
46649-50 *Therapon (Datnia) yarbua* Blkr I

Family Kuhliidae

A868 *Moronopsis ciliatus* Blkr I
46489 *Moronopsis rupestris* Blkr I
46488 *Moronopsis taeniurus* Gill I

Family Priacanthidae

46521 *Priacanthus benmebari* Schl I
45953 *Priacanthus carolinus* CV I
46596-7 *Priacanthus hamrur* CV I
45955-6 *Priacanthus tayenus* Rich I

Family Apogonidae

45974-5 *Amia aurea* Blkr I
46393-4 *Amia endekataenia* Blkr I
45977 *Amia frenata* Blkr I
45978-9 *Amia frenata* Blkr I
45980 *Amia hoevenii* Blkr I
45976 *Amia orbicularis* Blkr I
46392 *Amia quadrifasciata* Blkr I
A2058 *Paramia quinquelineata* Blkr I

Family Sillaginidae

46630-1 *Sillago maculata* QG III
46691 *Sillago sihama* Rupp III

Family Lactariidae

46308 *Lactarius delicatulus* CV V

Family Echeneidae

A918 *Echeneis naucrates* L V (2 specimens)

Family Carangidae

46023 *Carangoides armatus* Blkr V
46616 *Carangoides aureoguttatus* Blkr V
46022 *Carangoides (Gymnostethus) ciliaris* Blkr ---
46024 *Carangoides fulvoguttatus* Blkr V
A888 *Carangoides gallichthys* Blkr V
46025 *Carangoides malabaricus* Blkr V
46026 *Carangoides oblongus* Blkr V
46028-9 *Caranx (Caranga) ekala* CV V
46030 *Caranx melampygus* CV V
A864 *Dekapterus kurra* Blkr V
A853 *Gnathanodon speciosus* Blkr V
46319 *Leioglossus carangoides* Blkr V
46371 *Megalaspis rottleri* Blkr V
46678 *Scomberoides sanctipetri* Blkr V
A962 *Scomberoides toloo* Blkr V
A2060 *Selar boops* Blkr V
A2074 *Selar hasseltii* Blkr V
A916 *Selar kuhlii* Blkr V
A915 *Selaroides leptolepis* Blkr V
A2106 *Seriola purpurascens* Schl V
46640 *Trachinotus baillonii* CV V

Family Formionidae

46000 *Apolectus niger* Blkr III

Family Menidae

46510 *Mene annacarolina* Lac V

Family Leiognathidae

46170-1 *Gazza argentaria* Gthr V
46452-3 *Gazza equulaeformis* Rupp V
46169 *Gazza minuta* Blkr V
46475-6 *Leiognathus dacer* Blkr V
A863 *Leiognathus edentulus* Blkr (=*ensifera* CV) V
A917 *Leiognathus fasciatus* Blkr (=*filigera* Cuv) V
46325-6 *Leiognathus gomorah* Blkr V
46327 *Leiognathus insidiator* Blkr V
46323-4 *Leiognathus lineolatus* Blkr V
*46474 *Leiognathus nuchalus* Blkr V

Family Bramidae

46014 *Brama brama* L XI

Family Lutjanidae

46407 *Caesio chrysozona* Blkr I
46067-8 *Caesio coerulaureus* Blkr I
46413 *Caesio erythrogaster* K v H I
A957 *Caesio pisang* Blkr I (4 specimens)
46450-1 *Gymnocaesio gymnopterus* Blkr I
46315 *Lutjanus amboinensis* Blkr I
46312 *Lujanus argentimaculatus* Blkr I
46313-4 *Lutjanus biguttatus* Blkr I
46506 *Lutjanus bohar* Bl Schn I
46507 *Lutjanus butonensis* Blkr I
A897 *Lutjanus butonensis* Blkr I
46430-3 *Lutjanus chirtah* Blkr I
46508 *Lutjanus chrysotaenia* Blkr I
46241-2 *Lutjanus decussatus* Blkr I
A2071 *Lutjanus erythropterus* Blkr I
46240 *Lutjanus fulviflamma* Blkr I
46239 *Lutjanus johnii* Lac I
46310-1 *Lutjanus lutjanus* Blkr I
46505 *Lutjanus macolor* Blkr I
A2075 *Lutjanus marginatus* Blkr I (2 specimens)
46316 *Lutjanus quinquelineatus* Blkr I
46237 *Lutjanus rivulatus* Blkr I
46318 *Lutjanus russellii* Blkr I
46238 *Lutjanus sebae* Blkr I
46317 *Lutjanus vitta* Blkr I

Family Nemipteridae

46282-3 *Scolopsis bilineatus* CV I
46284 *Scolopsis bimaculatus* Rupp I
46285 *Scolopsis bimaculatus* Rupp I
46275-7 *Scolopsis cancellatus* CV I
A899 *Scolopsis cancellatus* CV I (3 specimens)
46278-9 *Scolopsis ciliatus* Gthr I
46281 *Scolopsis margaritifer* CV I
46280 *Scolopsis torquatus* CV I
46286 *Scolopsis vosmeri* CV I

Family Lobotidae

46421 *Datnioides pulota quadrifasciatus* Blkr I
A2108 *Lobotes surinamensis* CV I

Family Gerridae

46119 *Diapterus abbreviatus* Blkr I
46118 *Diapterus filamentosus* Blkr I
46117 *Diapterus kapas* Blkr I
46418 *Diapterus macracanthus* Blkr I
A900 *Diapterus macrosoma* Blkr I
46417 *Diapterus oyena* Blkr I
A898 *Diapterus poetie* Blkr I
46528 *Pentaprion longimana* Blkr I

Family Pomadasyidae

45961 *Plectorhynchus chaetodonoides* Lac I
45959 *Plectorhynchus crassispina* Blkr I
46250 *Plectorhynchus lineatus* Blkr I
46249 *Plectorhynchus orientalis* Swns I
46251-2 *Plectorhynchus pictus* Blkr I
45960 *Plectorhynchus radja* Blkr I
A2064 *Pomadasys argyreus* Blkr I
A885 *Pomadasys hasta* Blkr I
46542 *Pomadasys maculatus* Blkr I

Family Lethrinidae

46328 *Lethrinus haematopterus* Schl I
46333 *Lethrinus miniatus* CV I
46330-1 *Lethrinus ornatus* CV I
46334 *Lethrinus ornatus* CV I
46332 *Lethrinus reticulatus* CV I
46329 *Lethrinus variegatus* Ehr I

Family Pentapodidae

45851-2 *Pentapus caninus* Blkr I
45848-50 *Pentapus setosus* CV I

Family Sparidae (including Denticidae and Pimelepteridae)

46108 *Dentex taeniopterus* CV I
46109-10 *Dentex tolu* CV I
46449 *Gymnocranius lethrinoides* Blkr I
46601 *Sparus datnia* Blkr I
46600 *Sparus hasta* Bl Schn I

Family Sciaenidae

46229-30 *Johnius belangeri* Cant II
A2107 *Pseudosciaena aneus* Blkr II (3 specimens)
46522 *Pseudosciaena diacanthus* Blkr II

A859 *Pseudosciaena miles* Blkr II (2 specimens)
A964 *Sciaena dussumieri* Blkr II

Family Mullidae

45911-2 *Parupeneus indicus* Blkr II
45915 *Parupeneus janseni* Blkr II
45913-4 *Parupeneus pleurostigma* Blkr II
A908 *Upeneus sundaicus* Blkr II (2 specimens)
*46675-7 *Upeneus tragula* Rich II
46673-4 *Upeneus vittatus* CV II

Family Pempheridae

45890 *Pempheris vanicolensis* CV III

Family Toxotidae

46657-8 *Toxotes microlepis* Gthr III

Family Kyphosidae

46541 *Pimelepterus tahmel* Forsk II

Family Ephippidae (including Platacidae)

A887 *Ilarchis orbis* Cant II
46260 *Platax batavianus* CV II

Family Chaetodontidae (including Pomacanthidae)

45962 *Acanthochaetodon annularis* Blkr II
A880 *Acanthochaetodon imperator* Blkr II
46391 *Acanthochaetodon semicirculatus* Blkr II
A874 *Chaetodontoplus dimidiatus* Blkr II
A874 *Chaetodontoplus mesoleucus* Blkr II
A881 *Coradion chrysozonus* Kp II
46175 *Holacanthus bicolor* Lac II
46174 *Holacanthus diacanthus* Gthr II
46457 *Holacanthus nox* Blkr II
A857 *Holacanthus sextriatus* K v H II
46456 *Holacanthus vrolikii* Blkr II
A873 *Taurichthys macrolepidotus* Blkr II (2 specimens)
A879 *Taurichthys varius* CV II
A871 *Tetragonoptrus (Chaetodont.) collaris* Blkr II
46634 *Tetragonoptrus (Rhabd.) ephippium* Blkr II
A856 *Tetragonoptrus (Lepidoch.) kleinii* Blkr II
A855 *Tetragonoptrus (Cithar.) meyeri* Blkr II
A872 *Tetragonoptrus (Tetrag.) miliaris* Blkr II
A854 *Tetragonoptrus (Tetrag.) octofasciat.* Blkr II
A876 *Tetragonoptrus (Linoph.) rafflesii* Blkr II
A858 *Tetragonoptrus (Chaetodont.) selene* Blkr II
A877 *Tetragonoptrus (Gonoch.) triangul.* Blkr II
A909 *Tetragonoptrus (Rhabd.) trifasc.* Blkr II
A878 *Tetragonoptrus (Lepidoch.) unimac.* Blkr II

Family Pomacentridae (including Glyphiodontidae, Chromidae and Premnidae)

46001-2 *Amblypomacentrus breviceps* Blkr VII
46060 *Chromis analis* Blkr VII
46059 *Chromis cinerascens* Blkr VII
46397 *Chromis lepisurus* Blkr VII
46061 *Chromis ternatensis* Blkr VII
46062 *Chromis xanthochir* Blkr VII
46113 *Distichodus chrysopoecilus* Blkr VII
46112 *Distichodus fasciatus* Gill VII
46116 *Distichodus notophthalmus* Blkr VII
46111 *Distichodus prosopotaenia* Blkr VII
46516 *Distichodus trimaculatus* Blkr VII
46140-1 *Glyphidodon (Glyphidodontops) albifasciatus* Blkr VII
46441-3 *Glyphidodon (Glyphidodontops) antjerius* Blkr VII
46137 *Glyphidodon (Amblygliphidodon) aureus* Blkr VII
46440 *Glyphidodon (Glyphidodon) bengalensis* Blkr VII
46438-9 *Glyphidodon (Glyphidodon) coelestinus* Blkr VII
46138 *Glyphidodon (Amblygliphidodon) leucogaster* Blkr VII
46437 *Glyphidodon (Stegastes) leucozona* Blkr VII
46139 *Glyphidodon (Glyphidodontops) modestus* Blkr VII
46136 *Glyphidodon (Glyphidodon) septemfasciatus* CV VII
46142-3 *Glyphidodon (Glyphidodontops) unimaculatus* CV VII
46144 *Glyphidodon (Glyphidodontops) uniocellatus* Blkr VII
46145 *Glyphidodon (Glyphidodontops) zonatus* Blkr VII
46481-2 *Lepidozygus tapeinosoma* Blkr VII
45854 *Paraglyphidodon melas* Blkr VII
45853 *Paraglyphidodon xanthurus* Blkr VII
45891 *Parapomacentrus bankieri* Blkr VII
45906 *Pomacentrus (Pomacentrus) anabatoides* Blkr VII
45908 *Pomacentrus (Pseudop.) littoralis* Blkr VII
45907 *Pomacentrus (Pseudop.) melanopterus* Blkr VII
45909-10 *Pomacentrus (Pseudop.) moluccensis* Blkr VII
45904-5 *Pomacentrus (Pomacentrus) pavo* Lac VII
46258 *Premnas biaculeatus* Blkr VII

45935-6 *Prochilus bifasciatus* Blkr VII
45917 *Prochilus ephippium* Blkr VII
45934 *Prochilus percula* Blkr VII
45916 *Prochilus perideraion* Blkr VII
4591B *Prochilus polymnus* Blkr VII
45937 *Prochilus sebae* Blkr VII
A927 *Tetradrachma arcuatum* Blkr VII
46659-61 *Tetradrachma reticulatum* Blkr VII
46662-3 *Tetradrachma trimaculatum* Blkr VII

Family Mugilidae

4640B *Agonostomus oxyrhynchus* Gthr VI
46367-8 *Mugil borneensis* Blkr VI
46369-70 *Mugil ceramensis* Blkr VI
46512 *Mugil cunnesius* Blkr VI
46366 *Mugil engeli* Blkr VI
A919 *Mugil vaigiensis* QG VI

Family Sphyraenidae

A910 *Sphyraena commersonii* CV III
46602 *Sphryaena forsteri* CV III
46603 *Sphryaena jello* CV III
46632-3 *Sphryaena obtusata* CV III

Family Polynemidae

46435 *Eleutheronema tetradactyla* Blkr III
A911 *Trichidion heptadactylus* Blkr III
46671-2 *Trichidion hexanemus* Blkr III
46669 *Trichidion indicum* Blkr III
46666 *Trichidion melanochir* Blkr III
46667-B *Trichidion plebejus* Blkr III
46670 *Trichidion sextarius* Blkr III

Family Labridae (including Coridae)

45991 *Anampses meleagrides* Val VII
A922 *Anampses twistii* Blkr VII
46032 *Cheilinus ceramensis* Blkr VII
46035 *Cheilinus chlorurus* Cuv VII
46033 *Cheilinus fasciatus* Cuv VII
46034 *Cheilinus radiatus* Cuv VII
46031 *Cheilinus trilobatus* Lac VII
4609B-9 *Cheilio inermis* Rich VII
46063 *Choerops macrodon* Blkr VII
46066 *Choerops oligacanthus* Blkr VII
46065 *Choerops schoenleini* Blkr VII
46092 *Coricus rostratus* CV VII
46073 *Coris formosa* Blkr VII
46403 *Coris giofredi* Gthr VII
46074 *Coris greenoughii* Gthr VII
A2045 *Cossyphus diana* Val VII
46097 *Cossyphys mesothorax* Val VII
46416 *Crenilabrus cottae* CV VII
46102 *Crenilabrus mediterraneus* CV VII
46020 *Cymolutes praetextatus* Gthr VII
46436 *Epibulus insidiator* Cuv VII
46164-5 *Guntheria coeruleovittata* Blkr VII
46166 *Guntheria trimaculata* Blkr VII
46187-B *Halichoeres bicolor* Blkr VII
46181-3 *Halichoeres binotopsis* Blkr VII
A892 *Halichoeres chloropterus* Blkr VII
4617B-9 *Halichoeres guttatus* Blkr VII
46184 *Halichoeres hartzfeldi* Blkr VII
46185 *Halichoeres kneri* Blkr VII
46176-7 *Halichoeres miniatus* Blkr VII
46189-90 *Halichoeres modestus* Blkr VII
46186 *Halichoeres nigrescens* Blkr VII
461B0 *Halichoeres podostigma* Blkr VII
46191-3 *Halichoeres poecila* Blkr VII
A2057 *Halichoeres reichei* Blkr VII
46460-1 *Halichoeres schwarzii* Blkr VII
A926 *Hemigymnus melanopterus* Gthr VII (2 specimens)
46462 *Hemipteronotus pentadactylus* Blkr VII
46459 *Hemipteronotus punctulatus* Blkr VII
A893 *Hemitautoga centriquadra* Blkr VII
A960 *Julis dorsalis* QG VII
46232 *Julis janseni* Blkr VII
46233 *Julis lunaris* Val VII
46231 *Julis quadricolor* Less VII
A923 *Julis umbrostigma* Rupp VII
46309 *Leptojulis cyanopleura* Blkr VII
463B4 *Novaculichthys macrolepidotus* Blkr VII
463B3 *Novaculicthys taeniurus* Blkr VII
45951-2 *Platyglossus melanurus* Blkr VII
A925 *Platyglossus melanurus* Blkr VII
A2046 *Platyglossus purpurescens* Blkr VII
45950 *Platyglossus vrolikii* Blkr VII
45957 *Pseudodax moluccensis* Blkr VII
46607-10 *Stethojulis albovittata* Gthr VII
466B4-5 *Stethojulis axillaris* Blkr VII
46605-6 *Stethojulis interrupta* Gthr VII
A2056 *Stethojulis kallosoma* Blkr VII (2 specimens)
466B0-2 *Stethojulis phekadopleura* Blkr VII
4645B *Stethojulis strigiventer* Gthr VII
A924 *Stethojulis trilineata* Blkr VII
A2055 *Stethojulis trilineata* Gthr VII

Family Scaridae (including Callyodontidae)

AB66 *Callyodon brachysoma* Blkr VII
460B2 *Callyodon moluccensis* Blkr VII
A2054 *Callyodon spinidens* Cuv VII (2 specimens)
45943 *Pseudoscarus aeruginosus* Blkr VII
45945 *Pseudoscarus cantori* Blkr VII
45942 *Pseudoscarus frenatus* Blkr VII
45939 *Pseudoscarus nuchipunctatus* Blkr VII
45941 *Pseudoscarus pyrrhostethus* Blkr VII
45940 *Pseudoscarus rivulatus* Blkr VII
45944 *Pseudoscarus viridis* Blkr VII
A921 *Scarichthys auritus* Blkr VII

Family Mugiloididae (including Parapercidae)

46261-2 *Parapercis cylindrica* Blkr III
46263-4 *Parapercis xanthozona* Blkr III
46536 *Percis pulchella* Schl III

Family Uranoscopidae

A860 *Uranoscopus asper* Schl II

Family Ammodytidae

45985 *Ammodytes tobianus* L VIII

Family Callionymidae

A906 *Parascorpaena picta* Blkr II
46686-7 *Synchiropus opercularoides* Blkr II
A907 *Synchiropus opercularoides* Blkr II ((3 specimens)

Family Kurtidae

46235-6 *Kurtus indicus* Blkr V

Family Acanthuridae (including Acronuridae and Teuthididae)

45983-4 *Acronurus melanurus* Gthr V
46517 *Harpurus scopas* Blkr (=*rhombeus* Kittl) V
46518-9 *Naseus amboinensis* Blkr V
46379 *Naseus annulatus* Blkr V
A865 *Naseus lituratus* CV V
46543 *Rhombotides glaucopareus* Blkr V
A884 *Rhombotides humeralis* Blkr V
46267 *Rhombotides lineatus* Blkr V
A956 *Rhombotides mata* 8lkr (=*bleekeri* Gthr) V
46544 *Rhombotides matoides* CV V
46265-6 *Rhombotides triostegus* Blkr V

Family Siganidae

46638-9 *Teuthis corralinus* Gthr V
46645-6 *Teuthis dorsalis* Gthr V
46637 *Teuthis guttatus* Gthr V
A2109 *Teuthis hexagonatus* Gthr V
46643-4 *Teuthis java* Gthr V
46635-6 *Teuthis margaritifera* Gthr V
A862 *Teuthis marmorata* Gthr V
A889 *Teuthis puella* Gthr V
46641-2 *Teuthis vermiculata* Gthr V

Family Trichiuridae

A913 *Trichiurus glossodon* 8lkr V (2 specimens)
46693 *Trichiurus haumela* CV V

Family Scombridae (including Thunnidae)

46080 *Cybium guttatus* CV V
46404 *Cybium konam* Blkr V
46081 *Cybium lineolatum* CV V
A912 *Thynnus thunnina* CV V

Family Stromateidae

46604 *Stromateoides cinereus* Blkr III

Family Anabantidae

45988 *Anabas oligolepis* 8lkr VI
45989-90 *Anabas testudineus* Cuv VI

Family Belontiidae (including Polyacanthidae)

46524 *Polyacanthus hasseltii* CV VI

Family Helostomatidae (Helostomidae)

46455 *Helostoma temminckii* K v H VI

Family Osphronemidae

46012-3 *Betta picta* Blkr VI
46064 *Ctenops vittatus* 8lkr VI (3 specimens)
A891 *Osphronemus olfax* CV VI
46664-5 *Trichopus trichopterus* Lac VI

Family Luciocephalidae

46359 *Luciocephalus pulcher* Blkr VI

Family Mastacembelidae

A920 *Macrognathus aculeatus* Lac VI
46526-7 *Pararhynchobdella armata* Blkr VI
46525 *Pararhynchobdella maculata* Blkr VI
46556 *Rhynchobdella unicolor* Blkr VI

ORDER PLEURONECTIFORMES

Family Psettodidae

45887 *Psettodes erumei* Blkr VIII

Family Bothidae (including Paralichthyidae)

45888-9 *Platophrys (Arnogloss.) mogki* Blkr VIII
A867 *Platophrys (Platoph.) pantherinus* Blkr VIII
45946 *Pseudorhombus polyspilos* Blkr VIII
45947 *Pseudorhombus russelli* Gthr VIII

Family Soleidae (including Achiridae and Synapturidae)

46409 *Achiroides melanorhychus* Blkr VIII
A894 *Achirus pavoninus* Lac VIII
46009 *Brachirus pan* Swns VIII
46010 *Brachirus zebra* Swns VIII
46611-2 *Solea humilis* Cant VIII
44613-5 *Solea humilis* Cant VIII

Family Cynoglossidae

46054 *Cynoglossus macrolepidotus* Gthr VIII
46055 *Cynoglossus melanopterus* Gthr VIII
46058 *Cynoglossus oxyrhynchus* Gthr VIII
46412 *Cynoglossus potous* Blkr VIII
46056-7 *Cynoglossus puncticeps* Gthr VIII
46411 *Cynoglossus quadrilineatus* Gthr VIII
46287 *Paraplagusia bilineata* Blkr (=*blochii* Blkr) VIII
46253 *Paraplagusia marmorata* Blkr VIII

ORDER TETRAODONTIFORMES

Family Triacanthidae

A958 *Triacanthus blochii* Blkr XIV
A959 *Triacanthus brevirostris* Val XIV
A882 *Triacanthus nieuhofii* Blkr XIV
A953 *Triacanthus oxycephalus* Blkr XIV

Family Balistidae (including Monacanthidae, Aluteridae and Psilocephalidae)

45982 *Aluteres monoceros* Blkr XIV
45981 *Aluteres scriptus* Blkr XIV
A954 *Balistes (Balistapus) armatus* Blkr XIV
A875 *Balistes (Pseudobal.) flavomarginatus* Blkr XIV
46005 *Balistes (Balistapus) frenatus* Blkr XIV
46006-7 *Balistes (Balistapus) verrucosus* Blkr XIV
46008 *Balistes (Pseudobal.) viridescens* Blkr XIV
46133 *Erythrodon niger* Rupp XIV
46305 *Leiurus stellatus* Blkr XIV
46477 *Liomonacanthus pardalis* Blkr XIV
46375 *Melichthys vidua* Blkr XIV
46362 *Monacanthus broekii* Blkr ---
46360-1 *Monacanthus chinensis* Cuv XIV
46365 *Monacanthus melanocephalus* Blkr XIV
46363-4 *Monacanthus tomentosus* Cuv XIV
46537 *Paramonacanthus choirocephalus* (2 specimens) Blkr XIV
46256 *Pseudomonacanthus macrurus* Blkr XIV
46529 *Pseudaluteres nasicornis* Blkr XIV
46520 *Psilocephalus barbatus* Swns XIV

Family Ostraciontidae

A883 *Ostracion (Acanthostr.) arcus* Blkr XIV
46536 *Ostracion (Acanthostr.) cornutus* Blkr XIV
46535 *Ostracion (Acanthostr.) punctatus* Lac XIV
A861 *Ostracion (Acanthostr.) rhinorhynchus* Blkr XIV
46537 *Ostracion (Acanthostr.) sebae* Blkr XIV
A870 *Ostracion (Acanthostr.) tetragonus* L XIV
A869 *Ostracion (Tetrosomus) turritus* Swns XIV

Family Tetraodontidae (including Chonarhinidae and Canthigasteridae)

46079 *Canthogaster margaritatus* Blkr XIV
46076-7 *Canthogaster ocellatus* Blkr XIV
46078 *Canthogaster striolatus* Blkr XIV
46075 *Canthogaster valentini* Blkr XIV
46100 *Chonerhinus modestus* Blkr XIV
46101 *Chonerhinus naritus* Blkr XIV
A2059 *Crayracion fluviatilis* Blkr XIV
46053 *Crayracion immaculatus* Blkr XIV
46395 *Crayracion implutus* Blkr XIV
46396 *Crayracion leiurus* Blkr XIV
46052 *Crayracion manillensis* Blkr XIV
46051 *Crayracion mappa* Blkr XIV
A951 *Crayracion nigropunctatus* Blkr XIV
46583 *Crayracion stellatus* Blkr XIV
46558 *Leiodon patoca* Blkr XIV
46655 *Tetraodon hypselogeneion* Blkr XIV
46656 *Tetraodon lunaris* Bl Schn XIV
46652 *Tetraodon oblongus* Blkr XIV
A952 *Tetraodon psittacus* Bl Schn XIV
A961 *Tetraodon richei* Frem XIV (2 specimens)
46653-4 *Tetraodon spadiceus* Rich XIV

Family Diodontidae

A950 *Paradiodon novemmaculatus* Blkr XIV

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