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MACROINVERTEBRATE COMMUNITIES IN THE GOULBURN RIVER AND TRIBUTARIES ABOVE LAKE EILDON, VICTORIA

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Abstract

A set of ten kick samples was collected in June 1984 at each of 17 sites in four catchments draining into the south-eastern arms of Lake Eildon, Victoria. A total of 176 macroinvertebrate taxa was identified. The majority of the taxa (153, or 85%) were insects, in 7 orders and 42 families. The high diversity and composition of the fauna compared favourably with studies of similar, relatively undisturbed sites in other Victorian river systems.

There were no significant differences between the total number of taxa collected at each site. However, ordination by Detrended Correspondence Analysis (DECORANA) and classification by Two-Way Indicator Species Analysis (TWINSPAN) detected differences between the species composition of sites in agricultural land and those in natural vegetation. The differences seemed to be due to variations in a number of taxa which may prove valuable as indicators of relatively undisturbed stream conditions (e.g. *Atalophlebioides* sp. 1, Helodidae sp. 1).

Introduction

This paper presents information on the composition and distribution of aquatic macroinvertebrate communities in rivers draining into the south-eastern arms of Lake Eildon, Victoria. Previously, little or no sampling for benthic invertebrates has been conducted in this region, although data for the La Trobe River (Metzeling *et al*., 1984; Marchant *et al*., 1984, 1985) and the Thomson River (Museum of Victoria, unpublished data) to the south, and the Mitta Mitta River (Blyth *et al*., 1984; Doeg, 1984) to the north are available.

The Study Area and Sampling Sites

The study area (Figure 1) covers the four main catchments leading into the south-eastern arms of Lake Eildon, Victoria (37°15'S, 146°5'E). The rivers draining these catchments are the Big River, the Goulburn River, the Jamieson River and the Howqua River. All four catchments are characterized by small flood plains with steep forested slopes. The rivers have similar substrata, water quality and flow regimes (State Rivers and Water Supply Commission, 1984), and are typical of the transition zone between upland streams with steep gradients and the slower flowing foothill and lowland rivers. The rivers drain catchments composed primarily of Devonian and Silurian marine sedimentary rocks, and receive an annual rainfall of 1000-1400 mm (Land Conservation Council, 1973).

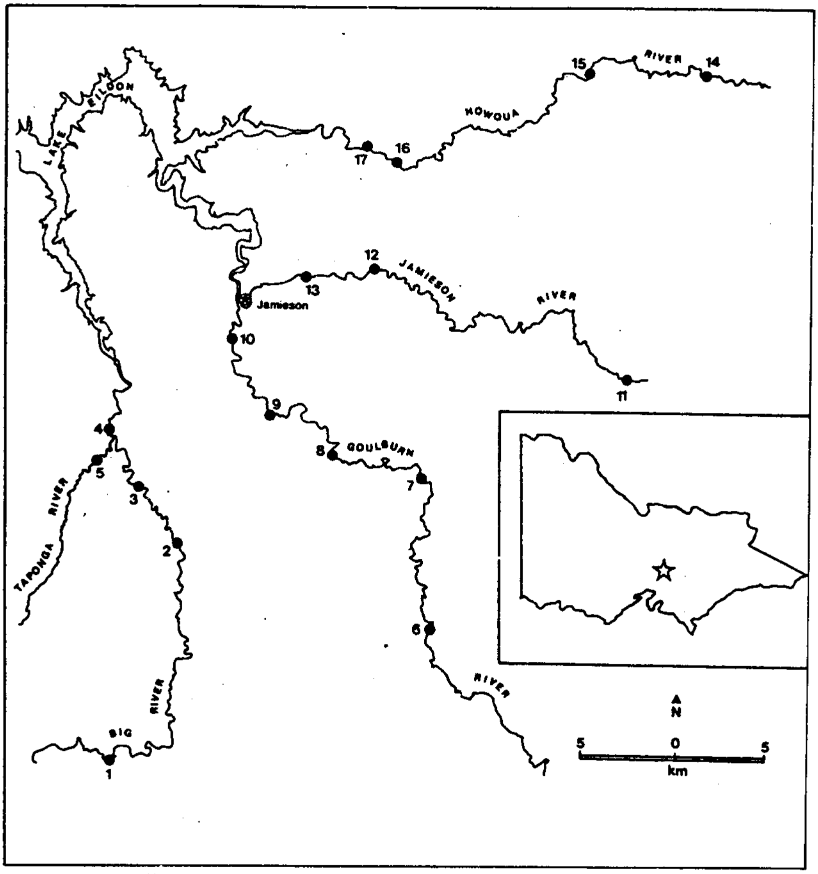

Fig. 1 Location of the study area and sampling sites.

The predominant vegetation in the study area is open mixed-eucalypt woodland. Land use is primarily for tourism and agriculture, cleared and residential land being common along the lower reaches of the Goulburn, Jamieson and Howqua Rivers. Gold mining is still carried out on some tributaries of the Goulburn River, and the Big, Goulburn and Howqua Rivers have been subjected to varying intensities of gold dredging with small one-person floating suction devices (which remove patches of substratum, often to the bedrock, extract the gold and re-deposit the substratum in the stream) over the past ten years.

Seventeen sampling sites were established in the four catchments (Figure 1). Sites were chosen for their accessibility and were matched as far as possible for similarities of flow and substratum composition. The altitudes of the sites ranged from 315 to 560 m above sea level, and all were located in order 4 or 5 segments of the rivers. River width ranged between 6 and 12 m, maximum water depth in the riffles was around 50 cm and average water velocity (measured at 0.2 and 0.8 depths for each sample) was 60-70 cm sec^{-1}. Substratum composition at all sites was predominantly cobble/pebble with varying lesser quantities of sand, boulders and bedrock. Upstream sites on the Goulburn, Jamieson and Howqua Rivers, and all sites on the Big River were located in areas of undisturbed natural vegetation, while the lower sites were mainly in either cleared agricultural land or developed picnic and camping areas. Exotic vegetation (e.g. willows, blackberries) was common at many of these lower sites.

Methods

Ten kick samples were collected at each site between 17 and 21 June 1984, using a 150 µm mesh FBA net. Each sample covered an area of 0.03 m^2 to a depth of 10 cm. Sampling was conducted in riffle sections over a length of river that varied from 30-50 m at each site.

In the laboratory, organic material was separated from inorganic sediment by flotation in a saturated $CaCl_2$ solution. The organic fraction was retained, a 10% subsample taken and all macroinvertebrates in the subsample were extracted by hand under a stereomicroscope and preserved in 70% alcohol.

Where possible, macroinvertebrates were identified to species using published keys. For groups where taxonomic knowledge was inadequate (a large proportion of the taxa examined), presumptive species were identified according to the voucher collection established by the Biological Survey Department of the Museum of Victoria. The term 'species' will be used in both of the senses above throughout this paper.

Standard community variables (total number and number of species and individuals per sample) were calculated for each site and compared using common statistical procedures. The main comparative analyses between sites were carried out using ordination and classification techniques, described by Gauch (1982). The two programs employed were Detrended Correspondence Analysis (DECORANA) and Two-Way Indicator Species Analysis (TWINSPAN), supplied in the Cornell Ecology Program series and detailed by Hill (1979a,b). Programs were run using a VAX 11/780 computer in the Computer Centre, Monash University.

These techniques have been used successfully to classify macroinvertebrate communities in a large number of English streams (Furse *et al.*, 1984; Wright *et al.*, 1984), and benthic marine communities at Corner Inlet and Nooramunga in Victoria (Museum of Victoria, unpublished data), and appear to have considerable potential in analysing the results of ecological surveys.

Results

Macroinvertebrate Communities

A total of 176 macroinvertebrate taxa was collected from the 17 sampling sites, covering 5 major phyla and 8 classes. The majority (153 or 85% of the total) were insects, in 7 orders and 42 families. A list of the 30 most common taxa with the mean abundance per sample at each site is presented in Table 1. A full list of all taxa and abundances is available on request.

Table 1. List of the 30 most common taxa collected with the mean abundance per sample at each site.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ephemeroptera																	
Leptophlebiidae																	
Atalophlebioides sp.1	35.1	119.8	72.2	67.4	112.3	72.4	75.3	105.5	1.1	1.0	89.0	54.1	63.5	77.2	3.0		
Baetidae																	
Baetis sp.3	3.1	34.2	20.2	11.0	7.1	1.1	12.2	0.1	5.1	1.1	26.7	6.4	12.2	17.6	13.4	32.9	7.2
Caenidae																	
Tasmanocoenis sp.2	15.0	29.0	39.0	36.0	19.0	34.0	24.0	37.0	9.0	27.0	13.1	30.2	18.0	42.0	2.0	183.0	299.0
Siphlonuridae																	
Coloburiscoides sp.1	1.1	6.2	7.0	13.3	1.1	3.1	5.4	6.2	1.0	10.2		3.0	17.3		26.2	26.2	33.7
Plecoptera																	
Gripopterygidae																	
Illiesoperla australis		5.0	2.0	15.0	7.0	7.0	14.0	9.0	2.0	15.0	22.0		4.0	44.0	15.0	14.0	7.0
Trinotoperla yeoi	3.0	21.0	10.0	25.0	8.0	25.0	26.0	12.0	8.1	25.0	58.1	1.0	13.0	82.1	39.0	9.0	7.0
Riekoperla rugosa	2.0	1.0		1.0	6.0	6.0	3.0		3.0	4.0	29.0	10.0	4.0	10.0	11.0	26.0	7.0
R. karki/williamsi	9.0	1.0		1.0	2.0	14.0	26.0	18.0	68.0	40.0	2.0	23.0	35.0	13.0	50.0	73.0	28.0
Leptoperla spp.[1]	9.0	6.0	10.0	6.0	5.0	8.0	4.0	6.0	12.0	7.0		22.0	3.0	2.0	79.1	56.0	18.0
Dinotoperla fontana	9.0	43.0	12.0	6.0	5.0	20.0	2.0	3.0	19.0	14.0	5.0		3.0	26.0	25.0	11.0	9.0
D. serricauda		5.0	5.0		3.0	11.0	9.0	2.0	34.0	27.0	8.0		8.0	77.2	11.0	4.0	46.0
Trichoptera																	
Glossosomatidae																	
Agapetus sp.1	63.0	53.0	21.0	37.0	65.0	21.0	20.0	5.0	4.0	35.0	19.0	69.0	88.0	95.0	37.0	61.0	49.0
Leptoceridae																	
Notalina spp.[1]	42.0	37.0	35.0	33.0	24.0	70.1	55.0	45.0	7.0		75.1	32.0	14.0	93.0	2.0	5.0	2.0
Hydropsychidae																	
Cheumatopsyche sp.5				1.0			1.0	1.0		4.0		2.0	5.0		28.5	20.1	44.7

[1] *Notalina* spp. represents the abundance of indistinguishable immature forms of both *N. fulva* and *N. bifaria*, and *Leptoperla* spp. refers to both *L. bifida* and *L. kimminsi*.

Table 1. (cont.) List of the 30 most common taxa collected with the mean abundance per sample at each site.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Coleoptera																	
Psephenidae																	
Sclerocyphon striatus			1.0	3.0	6.0	1.0	17.0	8.2	9.0	8.1	2.1	5.1	3.1	33.1	17.1	16.7	
Helodidae																	
Helodidae sp.1	7.0	29.0	12.0	20.0	18.0	11.0	29.0	11.0						30.0	8.0	1.0	43.0
Elmidae																	
Austrolimnius spp.10E	8.0	10.0	6.0	7.0	16.0	6.0	9.0	14.0	26.0	18.0	10.0	20.0	11.0	5.0	8.0		
Diptera																	
Tipulidae																	
Tipulidae sp.4	1.0	1.0	7.0	9.0	22.0	3.0	6.1	9.0	1.0		34.0	18.2	2.0	72.0		1.0	
Chironomidae																	
Riethia sp.1	80.1	32.0	22.0	28.0	36.0	35.0	13.0	18.0	1.0	15.0	22.0	19.0	33.0	116.1	106.2	16.0	28.0
Rheotanytarsus sp.1	6.0	17.0	7.0	18.0	38.0	21.0	57.0	23.0	13.0	131.0	127.0	15.0	113.0	14.0	74.0	82.0	44.0
Rheocricotopus sp.1	5.0	12.0	2.0	2.0			3.0		2.0	12.0	8.0	13.0	19.0	6.0	37.0	3.0	9.0
nr. *Cordites* sp.1	10.0	23.0	15.0	7.0	28.0	12.0	40.0	59.0	9.0		11.0	17.0	4.0	44.0	5.0	1.0	
Cricotopus spp.12E	2.0	8.0	7.0	2.0	3.0	6.0	3.0	1.0	7.0	7.0	5.0	2.0	8.0	9.0	34.0	2.0	15.0
?*Eukiefferiella* sp.1	3.0		4.0	7.0	5.0	1.0	5.0	3.0	7.0	17.0	2.0	1.0	13.0	7.0	1.0	21.0	22.0
nr. *Eukiefferiella* sp.1	1.0	10.0	4.0		2.0	12.0	12.0	14.0	5.0	8.0	14.0	7.0	15.0	45.0	51.0	7.0	9.0
Ablabesmyia sp.1	9.0	24.0	21.0	49.0	23.0	15.0	30.0	33.0	6.0		26.0	26.0	4.0	9.0	1.0	2.0	
Podonomopsis sp.1	3.0	17.0	19.0	17.0	10.0	6.0	33.0	24.0	21.0	6.0	16.0	20.0	16.0	13.0	14.0	34.0	6.0
Aphroteniinae sp.18E	3.0	6.0	9.0	14.0	20.0	10.0	10.0	23.0	26.0	10.0	15.0	13.0	6.0	18.0	27.0	18.0	6.0
Oligochaeta	63.0	65.0	36.0	28.0	119.0	55.0	40.0	28.0	97.0	216.0	86.0	23.0	131.4	112.2	311.0	133.0	107.0
Arachnida																	
Acarina sp.		3.0	2.0	7.0	1.0	1.0	6.0	3.0	1.0	8.0	4.0	13.0	2.0	18.0	26.0	12.0	8.0

Within the insects, the most diverse order was the Diptera, with 50 species. The majority of these belonged to the Chironomidae (31 species), with the most common and widespread being *Rheotanytarsus* sp. 1 and *Riethia* sp. 1, the orthoclad nr. *Cordites* sp. 1 and *Ablabesmyia* sp. 1. The remaining dipteran taxa were distributed among the Tipulidae (5 species), Simuliidae (4 species), Empididae (3), Rhagionidae (3), Ceratopogonidae (2), Tabanidae and Blephariceridae (1 species each).

The second most diverse insect order was the Trichoptera (17 families, 41 species), the two most common and widespread species being *Agapetus* sp. 1 (Glossosomatidae) and *Notalina* spp. (Leptoceridae — see footnote in Table 1). All four Australian families of Plecoptera were recorded during the study, comprising 18 species dominated by the two gripopterygid species *Trinotoperla yeoi* and *Riekoperla karki/williamsi* (see Hynes, undated).

The Ephemeroptera was represented by 4 families (15 species) and contributed the two most common insect species collected: *Atalophlebioides* sp. 1 (Leptophlebiidae) and *Tasmanocoenis* sp. 2 (Caenidae). The remaining three insect orders, the Coleoptera (4 families, 24 species), Odonata (3 families, 3 species) and Megaloptera (1 species), contributed no exceptionally common taxa, although the high diversity of the Coleopteran family Elmidae (19 species) is worthy of note.

The non-insect taxa consisted of 17 species of aquatic mites (Arachnida), 3 species of Mollusca, 1 species of Collembola and the higher taxonomic groups of the hydroid Cnidaria and Turbellaria (probably only one species of each). The Oligochaeta (a taxon composed of an unknown number of species) formed the most abundant of any of the taxa collected and were present in relatively high numbers at every site.

Community Variables

Table 2 presents the total number of species and individuals, and the number of species and individuals per sample recorded at each site.

Chi-squared analysis indicated that there were no significant differences among the total number of species collected at each site, implying that the values recorded do not represent a significant deviation from the expected mean of 71.3 species. Similar analysis of the total number of individuals per site (using a logarithmic transformation) revealed significant deviations from the expected mean of 884 individuals per site ($p<0.001$). One-way analysis of variance of the number of species per sample at each site indicated that there was a significant variation between sites ($F_{16,153}=3.71$, $p<0.05$). The Student-Newman-Keuls test (Sokal and Rohlf, 1969) showed sites 11, 14 and 15 had significantly more species per sample than the remaining sites. Sites 1 and 9 had the lowest number of species per sample, and the remaining sites formed a complex set of overlapping groups. Given that each site has a similar total number of recorded taxa, this variation in the number of species per sample suggests that sites with low species density may have a more uneven distribution of taxa among

Table 2. Total number of species and individuals, and the number of species and individuals per sample (with the standard error of the mean), recorded at each site.

Catchment site	Big/Taponga Rivers					Goulburn River				Jamieson River				Howqua River			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Total no. of species	63	75	69	81	72	78	78	78	66	63	78	65	72	85	74	59	64
Total no. of individuals	554	805	587	710	822	675	758	717	597	836	1005	663	914	1434	1268	1022	1008
Mean no. of species per sample	19.5	25.4	22.9	26.2	25.4	26.5	25.8	25.9	21.1	23.1	27.8	26.3	25.9	35.6	29.9	23.1	26.1
Standard error	1.8	2.1	2.1	3.2	2.0	2.1	2.1	1.4	1.6	1.2	1.3	1.5	2.6	1.5	1.3	1.3	1.0
Mean no. of indiv. per sample	54.3	79.9	57.6	71.0	74.9	67.0	75.0	71.7	59.5	83.5	98.1	65.1	91.0	141.0	126.5	102.0	99.3
Standard error	5.4	9.8	7.6	13.5	8.3	9.7	8.4	8.3	4.8	6.8	10.2	5.7	14.8	13.1	10.0	10.2	8.2

the samples (possibly due to a more heterogeneous substratum) than sites with a higher but more homogeneous species density.

Analysis of variance of the number of individuals per sample at each site revealed significant variations between the sites ($F_{16,153}=5.79$, $p<0.005$). The Student-Newman-Keuls tests showed that sites on the Howqua River clearly had a more abundant fauna than the remaining sites, which formed a non-significant group.

Ordination

A data set, consisting of a list of species abundances at various sites can be seen as occupying an n-dimensional space, where n is the number of species. Each point in the space, representing a site, reflects the species composition at that site. Similar sites will tend to be closer together in the space than dissimilar sites, although this is very difficult to visualise from the raw data, and impossible to display on any one diagram. Ordination techniques attempt to reduce the dimensionality of the original data set so that it can be mapped onto two-dimensional diagrams with minimal loss of the relationship between the sites (Gauch, 1982; Pielou, 1984). In this context, ordination is used to explore potentially interesting patterns in the data, rather than to formally test hypotheses.

Figure 2 presents the data set collected in this study as projected onto only 2 dimensions, following analysis by DECORANA, using the mean abundance of each taxon at each site (logarithmic transformation of the data produced a similar pattern).

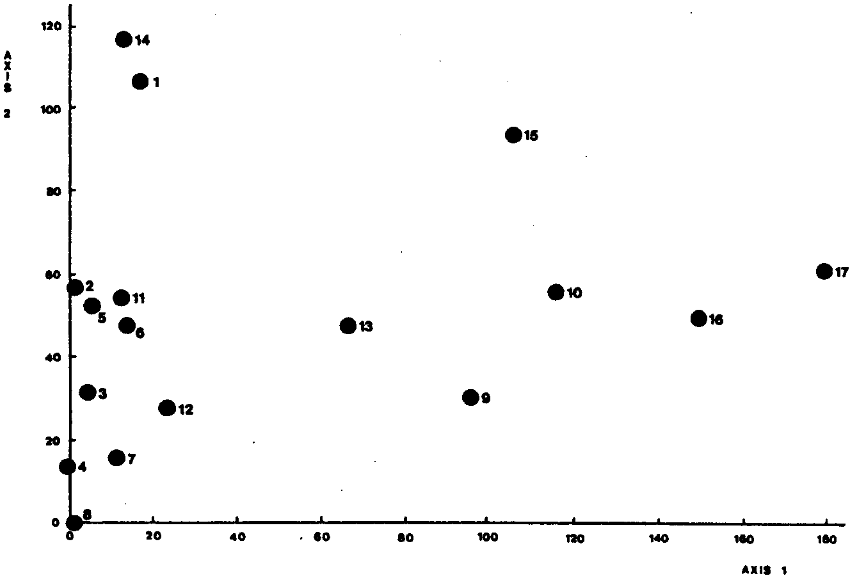

Fig. 2 DECORANA scores along the first two axes for each site.

Along the primary axis (eigenvalue = 0.27), there is a clear division between a group of 11 closely related sites with low axis 1 scores (sites 1, 2, 3, 4, 5, 6, 7, 8, 11, 12 and 14) and a group of six less closely related sites at higher axis 1 scores. The length of the gradient (1.81 units) represents a turnover of about half the community (Hill, 1979a), so that many species were distributed over the entire study area (Table 1). The group of six unrelated sites (9, 10, 13, 15, 16 and 17) represent the lower two sites on the Goulburn River, the lower site on the Jamieson River and the three lower sites on the Howqua River. This distinction between the two major groups of sites does not appear to be the result of differences in altitude, as the lower sites on the Big River are not included. As noted previously, the highest density of riparian housing and agricultural land clearing is located on the lower reaches of these rivers. The larger group of sites with similar low scores on axis 1 includes sites that are generally far less disturbed, retaining natural vegetation along the banks, and with fewer houses and less tourist access. The inclusion of site 8 in this group is somewhat anomalous as it is clearly altered, having a pine plantation along one bank and cleared land along the other. In general, however, this division along axis 1 seems to reflect closely the distribution of the sites that are affected most by human disturbance.

The dissimilarity between the group of 6 disturbed sites may be attributed to the wide range of potential disturbances in the agricultural

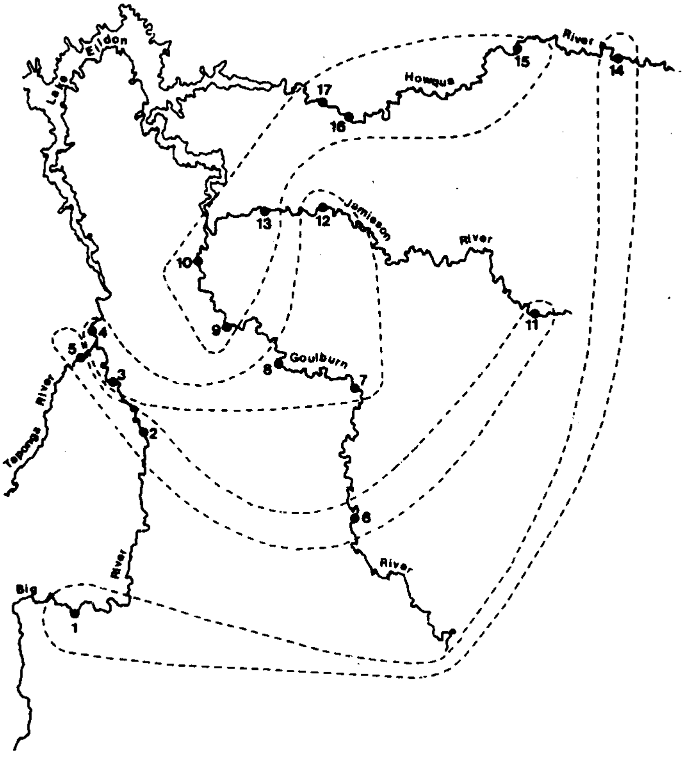

Fig. 3 Map of the study area showing site-groups by the DECORANA analysis.

and housing areas. These are likely to be unevenly distributed over the affected area, producing a detectably different community composition at each affected site.

The second axis had a much lower eigenvalue (0.08), but appears to be related to the longitudinal position of the sites in the rivers. In the group of undisturbed sites, upper sites have higher axis scores than lower sites. An arbitrary subdivision into three subgroups can be made, with site 1 and 14 in one group, sites 2, 5, 6 and 11 in a second and the five remaining sites in the third. Displaying these groups on a map of the study area (Figure 3) shows this longitudinal relationship. Further evidence for this conjecture comes from the observation that the axis 2 scores for the group of 10 undisturbed sites (not including site 5) and the distance from the most upstream confluence of first order streams (on a 1:100,000 map) on the appropriate river are highly negatively correlated, ($r= -0.92$, $df=9$, $p<0.01$), indicating that the further one samples downstream, the lower would be the equivalent axis 2 score.

No further ecological interpretation could be made from the distribution along the third (eigenvalue = 0.04) or fourth (0.03) axes. Hence, while axis 1 of the DECORANA plot appears to divide the sites on the degree of disturbance due to human activity, axis 2 possibly reflects natural longitudinal zonation in the undisturbed sections.

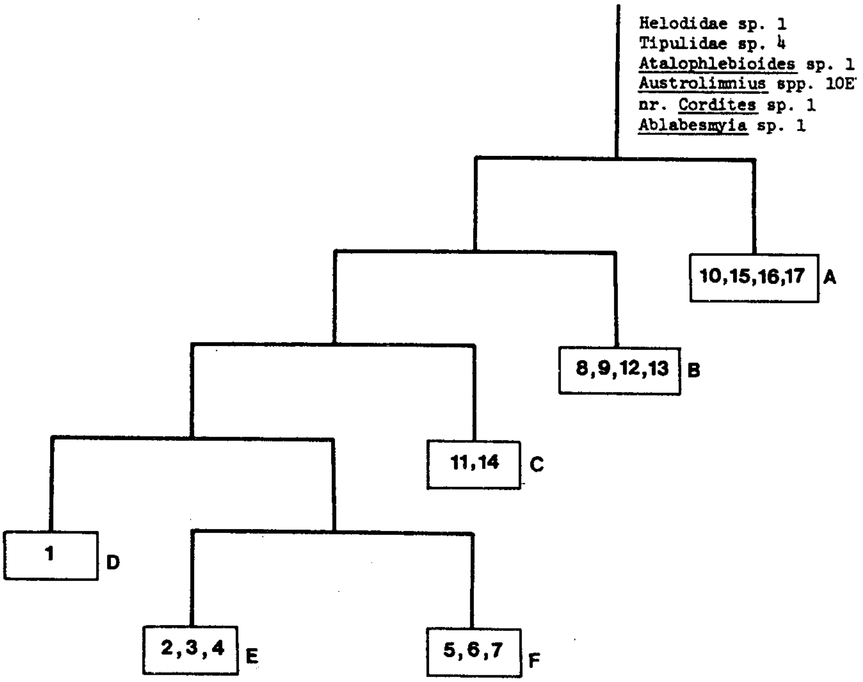

Fig. 4. Classification of sites by TWINSPAN. Major indicator species are given for the primary dichotomy.

Classification

Classification techniques assign entities (in this case, the sampling sites) into a series of groups or clusters, each member of the cluster being related by some common variable (e.g. species composition). In this way the relationship between sites, or groups of sites, can be identified, and may then possibly be related to environmental variables.

The dendrogram obtained from the TWINSPIN analysis is presented in Figure 4. Because of the divisive nature of the TWINSPAN algorithm, groups of sites are progressively split off on the basis of their dissimilarity from the remaining sites. Hence, the group of sites 10, 15, 16 and 17 (Group A, Figure 4) are seen as distinct from the other 13 sites. This group corresponds, in part, to the sites with high axis 1 scores in the DECORANA plot (Figure 2). The remaining sites with high axis 1 scores (sites 9 and 13) are extracted in the second dichotomy, along with the nearby sites 8 and 12 (Group B). These divisions may also be reflecting the effects of human disturbance, the inclusion of site 8 being intuitively correct, given the disturbance observed at that site. The change in affinity of site 12 from the undisturbed group in the DECORANA analysis, to the disturbed group in this TWINSPAN analysis seems strange as there is no evidence of gross disturbance at that site. It is, however, just upstream of a large area of cleared land that extends for the remaining length of the Jamieson River to Lake Eildon, and the community at this site possibly receives colonizers from both areas, making it intermediate between the disturbed and undisturbed sites in community composition.

The remaining TWINSPAN groups again seem to reflect differences between upstream and downstream macroinvertebrate communities, with the upper sites forming a distinct set of groups although the pattern of site relationships differs from the DECORANA analysis (compare Figures 3 and 5). Although the exact patterns along the second DECORANA axis and lower TWINSPAN dichotomies are somewhat different, the general conclusions are similar.

TWINSPAN also provides a list of indicator species (those which best characterise the dichotomy) for each division. These are provided for the first division in Figure 4. Hence, Helodidae sp. 1, Tipulidae sp. 4, *Atalophlebioides* sp. 1, *Austrolimnius* sp. 10E, orthoclad nr. *Cordites* sp. 1 and *Ablabesmyia* sp. 1 have the most disjunct distribution between the two halves of the dendrogram, being rare at sites 10, 15, 16 and 17, but widespread at the remaining sites (Table 1).

Discussion

Macroinvertebrate Communities of the Study Area

The total of 176 taxa and mean of around 72 species per site compares favourably with the few studies of similar sites in other Victorian river systems. Metzeling *et al.* (1984) reported totals of 178 and 172 taxa at 17 sites in the Upper LaTrobe catchment in May 1979 and 1980 respectively, using a modified Surber sampler (enclosing 0.05 m^2) with the same mesh

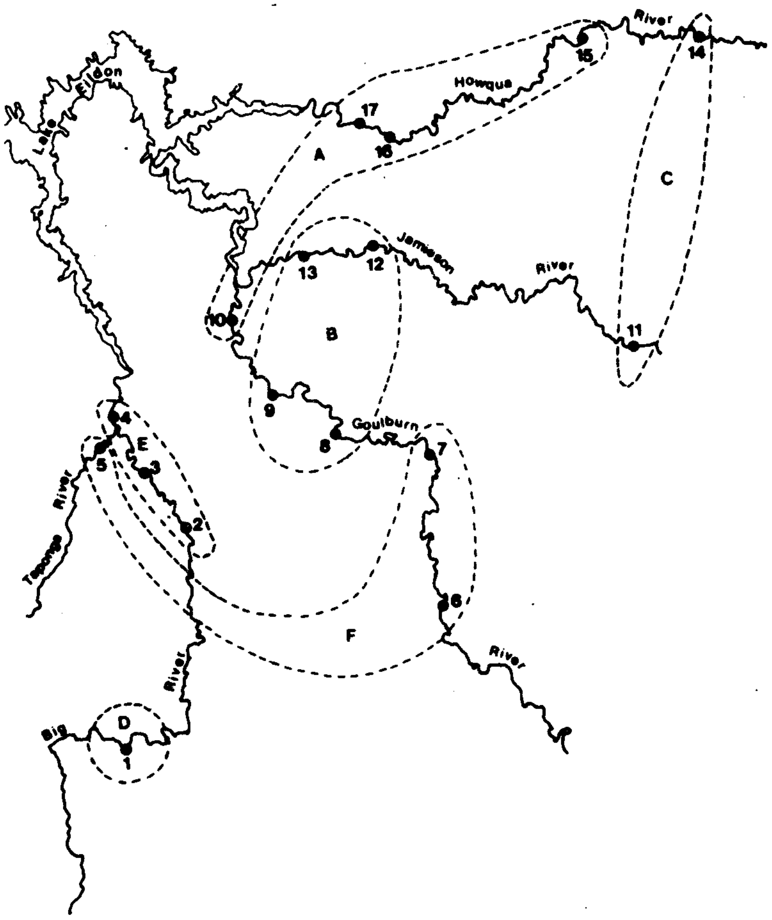

Fig. 5 Map of the study area showing site-groups indicated by the TWINSPAN analysis.

size as used here, and taking 10 samples per site. At two LaTrobe River sites with similar physical characteristics to sites used in this study, the total taxa collected were 71 and 64 (site 60), and 69 and 59 (site 52) in the two winter samples reported.

Quantitative studies in the Thomson River (Museum of Victoria, unpublished data) revealed that the total taxa collected from a set of 10 samples (using the same methods as above), taken in winter at a similar site to the majority used here, were 66 in 1979 and 68 in 1980. The mean number of species per sample at that site on each occasion were 34 and 35, which is within the range of 19.5-35.6 per sample found in this study (Table 2).

Although differences in the sampling methods and programs tend to obscure the comparisons, the numbers and density of taxa collected in this study can be seen to be of the same order as that reported from fairly undisturbed sites with similar physical characteristics in the foothill sections of other Victorian rivers.

Certainly, the number of taxa is greater than that found in severely disturbed rivers. Doeg (1984) collected less than 30 species at a site on the Mitta Mitta River (site 3A) just downstream of Dartmouth Dam. Similarly, the Museum of Victoria (unpublished data) found fewer than 40 species at a site disturbed by reservoir construction on the Thomson River during winter. Both of these sites were located in areas topographically similar to most of the sites used here.

The species composition recorded at most of the sites appears to be typical of relatively undisturbed sites in the foothill-upland transition zones. The taxa collected are generally similar to those found in qualitative studies by Blyth *et al.* (1984) in sections of the Mitta Mitta River before the construction of Dartmouth Dam, and in the Mitchell River by Ahern and Blyth (1978). Of the 34 most abundant species recorded in the upper LaTrobe catchment (Metzeling *et al.*, 1984), 17 were represented in the 34 most abundant taxa collected here. Of the 48 most common species collected at an undisturbed site on the Thomson River (Museum of Victoria, unpublished data), 26 were among the 48 most common taxa recorded here. The main areas of species overlap between these studies tend to be in the leptophlebiid Ephemeroptera, some of the Plecoptera, glossosomatid and leptocerid Trichoptera and many of the Chironomidae (Diptera) and Elmidae (Coleoptera).

Effects of Agricultural Disturbance

The clearing of land for agricultural purposes may have several effects on a stream which could influence the macroinvertebrate communities, although the problem has received little attention in Australia. These influences may include increases in soil erosion, solar radiation and nutrient run-off from fertilizers, or a decrease in organic input through leaf-fall. In this specific case, housing and high intensity tourist activity may also have some effect on the river communities.

Species which characterise the main dichotomy of the TWINSPAN analysis (Figure 4) may have been restricted in their distribution by one or more of these influences. Although the status of species that are indicative of clean water and undisturbed substrata in Victoria is presently unclear, previous work (e.g. Marchant *et al.*, 1985; Museum of Victoria, unpublished data) suggests that some of the taxa collected in this study may prove useful as sensitive indicators of relatively undisturbed upland sections of Victorian rivers. Those included in Figure 4 which appear to have the most potential as sensitive indicators are *Atalophlebioides* sp. 1 and Helodidae sp. 1. Both of these species were reduced in abundance at sites disturbed by construction of the Thomson Dam (Museum of Victoria, unpublished data). The low numbers of these taxa at sites 9, 10, 15, 16 and 17 (Table 1) suggests that some impact from human disturbance has occurred at those sites. This agrees well with the observation that these sites do seem to be the most heavily altered by human activity. Further work on the remaining taxa noted in Figure 4 would be required to establish their environmental requirements.

However, the high diversity, even at the disturbed sites, suggests that the levels of aquatic disruption are not as serious as found in other, more disturbed rivers in Victoria, where the total species diversity is severely depressed and the faunal composition is totally different to that found at undisturbed sites. That many of the taxa seem to be evenly distributed over the study area, at both disturbed and undisturbed sites, implies that the above mentioned indicator species, which are reduced in abundance at the disturbed sites, are sensitive to fairly minor disturbances.

Conclusions

The macroinvertebrate communities at sites flowing through relatively undisturbed natural vegetation in rivers draining into Lake Eildon seem to be typical of the fauna of the upland-foothill transition zone in Victorian rivers. Diversity was high and the fauna was dominated by many species from the leptophlebiid Ephemeroptera, the Plecoptera, Trichoptera, elmid beetles, Chironomidae (Diptera) and Oligochaeta. Some of these taxa may prove to be useful as indicators of clean water quality and undisturbed substratum conditions.

Other sites in the study area appeared to be somewhat affected by the influences of human activity, including agricultural clearing, bankside housing and tourist use. Although similar numbers of taxa were collected at each site, there was a clear distinction between the sites on the lower reaches of the Goulburn, Jamieson and Howqua Rivers in both the DECORANA and TWINSPAN results (Figures 2 and 4), although the affinities of sites 8 and 12 were somewhat obscure. These distinct sites (9, 10, 13, 15, 16 and 17) were located in areas that had the highest density of housing and agricultural clearing, and the species composition at most of these sites was characterised by reductions in the abundance of species that previous work in this department has suggested may be deleteriously affected by the influences of human disturbance (e.g. *Atalophlebioides* sp. 1, Helodidae sp. 1).

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