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# River Channel Assessment - Annex B

## An Analysis of Invertebrate Records for The River Glen, 1976 - 1991

September 1992



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# ANNEX B

# AN ANALYSIS OF
# INVERTEBRATE RECORDS FOR THE RIVER GLEN, 1976-1991

**Undertaken for the National Rivers Authority, Anglian Region**

**By**


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**September 1992**

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# 1 SUMMARY

## 1.1 The data set

The data set comprises invertebrate records from 44 sites on the main River Glen and its tributaries. These can be grouped into a series of physically defined reaches. Sites and reaches are shown in Figure B1. Site codes are explained in Table B1.

Records for each site vary in frequency and distribution throughout the 1976-91 period. Taxonomic level of identification varies between records, therefore the data used in the analyses have been reduced to presence / absence family level.

## 1.2 Reach and site level differences in invertebrate fauna

TWINSPAN classification (Figures B5 and B6) and ordination using correspondence analysis (Figure B4) revealed distinct reach and site level differences in fauna which can be related to a variety of water quality, hydrological, hydraulic and other environmental variables. Figure B7 summarises the classification of sites (emboldened site codes indicate the majority of samples from this site falling in this group; plain text indicates just two or more samples). "Key taxa" are those showing strong preference for the group indicated. Classification and ordination first separated the Tham and middle West Glen sites from the rest, on the basis of their rich fauna including many taxa associated with moderate to fast flows and stable substrates. Subsequently the East Glen sites, Lower Glen/Bourne Eau sites and a group of "intermediate" sites were distinguished; the first having a very impoverished fauna (related to intermittent flow and poor water quality), the second having a fauna typical of slow-flowing, weedy habitats, and the third having an intermediate fauna, sharing taxa found in the other two. Communities associated with three major reach-types: "Upland", "lowland" and "intermediate" were identified and described are in Table B3.

## 1.3 Biological quality

Biological quality varied between sites in a way consistent with the divisions described above. The highest scoring sites were around the lower Tham and the West Glen below the Tham confluence, reflecting the diverse fauna of these sites and particularly the predominance of high-scoring insect taxa characteristic of these high-quality habitats. High scores were also obtained from the lower Glen sites around the Bourne Eau confluence - water and habitat quality is also high, but due to physical habitat differences the actual taxa present are very different from the Tham / West Glen. The interrelated factors: small size, intermittent flow and poor water quality are assumed to be responsible for the poor scores in the East and upper West Glens.

## 1.4 Temporal changes

The overall trend in biological scores during the period 1976-1991 was upwards, the majority of sites showing a steep rise in all scores from 1976 to the mid to late 1980's, followed by a slight decline in 1991. Patterns of change did vary between sites, as illustrated in Figure B10 which shows sites showing significant trends in scores. Notably the lower main Glen sites displayed constant improvement in scores, "intermediate sites" showed a slight decline in 1990-91, and some East Glen sites steadily declined.

## 1.5 Within-site temporal changes

Detailed analysis of a number of sites (section 5.6) whilst confirming the temporal trends mentioned above revealed different faunal changes associated with temporal changes in biological quality. responses to detrimental changes in habitat quality are complex, sometimes involving a reversion to a poorer fauna similar to that many years earlier, while in other cases simply a reduced version of the fauna of the previous year.

## 1.6 Seasonal changes

Evidence was present for seasonal differences in the frequency of individual taxa and biotic scores, particularly ASPT. The greater seasonality in the life-histories of higher-scoring insect taxa may account for the changes in ASPT. Variability in the frequency of sampling in each month prevent detailed investigation of seasonal changes in this data set.

## 1.7 Changes in invertebrate fauna with changing biological quality

Diversity within the higher LQI classes is high (section 5.8), with reach and site scale differences as clear within LQI classes as within the whole data set. The clear implication is that site and reach specific differences other than water quality are vital in determining the fauna. This was confirmed by examining changes in fauna associated with changes from LQI class B and C to class A-A++. The "improved" fauna associated with a change from the lower to higher class was almost invariably predictable and dependent on the initial fauna, which in turn was related to specific reaches. Table B4 summarises the dominant within-class reach groups and the taxa associated with changes from the lower to higher class.

## 1.8 Recommendations

Recommendations are made towards an improved system of biological monitoring, involving an initial detatiled survey of a river system in order to determine reach-communities, followed by coordinated invertebrate, macrophyte and hydrological monitoring. This strategy aims at enabling the magnitude, nature and causes of habitat changes to be determined and related to short and long term changes in invertebrate communities.

## 2 INTRODUCTION

The River Glen, incorporating the Rivers East and West Glen and a lower section below their confluence downstream to the confluence with the River Welland, supports a wide variety of invertebrate habitat types from fast flowing, gravel-bed reaches to slow flowing, fenland drains.

Monitoring of the invertebrate communities, both routine and in response to pollution events, has been regularly practiced on the Glen since 1976. During this time the frequency of sampling and level of invertebrate identification has varied considerably, but leading up to the 1990-91 situation where sampling at most sites was carried out at least twice a year and a substantial proportion of the fauna is identified to species level.

Despite its inconsistencies, the data set for the 1976-91 period contains a substantial amount of information, comprising some 250 records from 44 sites distributed throughout the River Glen system.

This report aims to assess:

- the nature of the invertebrate communities in different parts of the catchment;
- long-term changes in biological quality at sites with long records;
- the performance of indices of biological quality in both monitoring within-site change and comparing sites within the river system.

# 3 THE DATA SET

## 3.1 Sites

The distribution of sites on the East, West and main River Glen is shown in Figure B1. Sediment analysis of the West Glen and main Glen allow the river to be divided into a number of physically distinct reaches: The upper West Glen (reach A); the West Glen around Essendine (reach B); the West Glen around Banthorpe Lodge (reach C); the main Glen from the confluence of the East and West Glens to the confluence with Bourne Eau (reach D); the East Glen (E - lack of physical information prevents this from being further subdivided); the lower main Glen downstream of the confluence with Bourne Eau (G); Bourne Eau (B); and the River Tham (T).

The codes given to sites are listed in Table B1. Where a particular sample is refered to later in the report, the site code is followed by the month and year. In the one instance where two samples from the same site were taken in the same month, the full date follows the site code.

## 3.2 Dates

Records exist for most years in the 1976-91 period, with the exception of a gap from 1980 to 1981. The year 1988 has a particularly good site coverage due to a special survey being carried out (Extence, 1989), the results of which have been added to the NRA routine sampling data. 1990 has good seasonal coverage of the routine monitoring sites, and it is understood that current practice is to sample in spring, summer and autumn. Table B2 shows the years in which each site was sampled.

Although a few sites have regular records for the entire period (eg. WLD, GSS), the majority have a patchy record, some sampled no more recently than the early 1980's (eg. GGG), and some only in recent years (eg. ELN).

## 3.3 Taxonomic lists

Each record consists of a list of taxa found at the site, occasionally with an indication of abundance. Taxa recorded, and the level of identification, are undoubtedly influenced by the format of the recording sheet. In general the level of identification expected has tended towards the species level in later years; the earliest recording sheets are mainly to family level, ie. sufficient to allow calculation of the standard biological indices.

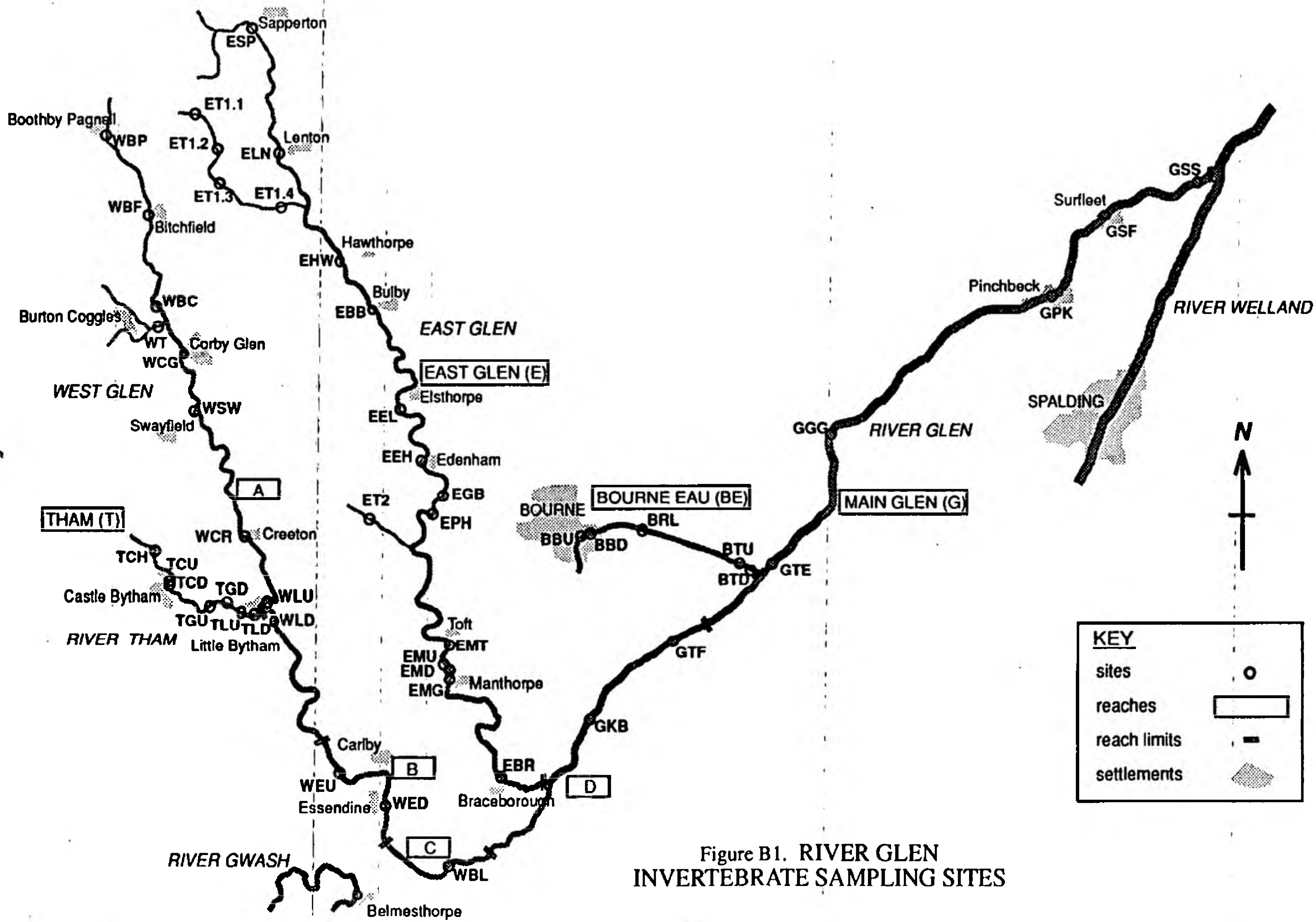



Figure B1. RIVER GLEN
INVERTEBRATE SAMPLING SITES

**Table B1.** River Glen site codes and locations

| SITE CODE | N.G.R. | LOCATION |
|---|---|---|
| ELN | TF 022302 | E. Glen at Lenton |
| EHW | TF 038272 | E. Glen at Hawthorpe Rd. |
| EBB | TF 047260 | E. Glen at Bulby - between fd. and br. |
| EEL | TF 054233 | E. Glen at Elsthorpe |
| EEH | TF 061219 | E. Glen at Edenham d/s A151 rd.br. |
| EGB | TF 067209 | E. Glen at Gravel Bridge, d/s rd.br. |
| EPH | TF 064205 | E. Glen at Pasture Hill Fm. d/s br. |
| EMT | TF 068169 | E. Glen at Manthorpe Toft, u/s STW |
| EMU | TF 066164 | E. Glen at Manthorpe, u/s STW outfall |
| EMD | TF 067163 | E. Glen at Manthorpe, d/s STW outfall |
| EMG | TF 068160 | E. Glen at Manthorpe G.S., d/s weir |
| EBR | TF 082135 | E. Glen at Braceborough, u/s & d/s rd. br. |
| ET11 | SK 998313 | Trib.of E. Glen |
| ET14 | TF 022288 | Trib.of E. Glen |
| WBP | SK 973307 | W. Glen at Boothby Pagnell |
| WBF | SK 985286 | W. Glen at Bitchfield u/s br., d/s pipe |
| WBC | SK 987261 | W. Glen, B1176, Burton Coggles G.S. |
| WCG | SK 995248 | W. Glen at Corby Glen u/s rd. br. |
| WSW | SK 998233 | W. Glen at Swayfield Rd., d/s Corby Glen STW |
| WCR | TF 011199 | W. Glen at Creeton |
| WLU | TF 019177 | W. Glen at Little Bytham, u/s confl.,d/s fd. & ft. br. |
| WLD | TF 019177 | W. Glen at Little Bytham, d/s confl.,d/s rd.br. |
| WEU | TF 038137 | W. Glen at Essendine u/s & d/s Carlby-Essendine rd.br. |
| WED | TF 050127 | W. Glen at Essendine |
| WBL | TF 068112 | Glen at Banthorpe Lodge, d/s br. |
| GKB | TF 107148 | Glen at Kates Bridge G.S., d/s weir & br. |
| GTF | TF 129170 | Glen at Thurlby Fen, end of Fen rd. |
| GTE | TF 156190 | Glen at Tongue end, d/s confl. with Bourne Eau |
| GGG | TF 173225 | Glen at Guthram Gowt |
| GPK | TF 235260 | Glen at Pinchbeck, u/s br. by sluice |
| GSF | TF 251281 | Glen at Surfleet, A16 |
| GSS | TF 277291 | Glen at Surfleet Seas End, d/s Blue Gowt Drain |
| TCH | SK 986196 | Tham at Cottage Hill, u/s bridge, d/s track |
| TCU | SK 992187 | Tham at Castle Bytham, d/s ft.br. to motte & bailey, u/s village pond |
| TCD | SK 993183 | Tham at Castle Bytham, d/s fd. in village, d/s pond |
| TGU | TF 003181 | Tham at Glebe Fm., u/s STW |
| TGD | TF 008181 | Tham, d/s STW |
| TLU | TF 012178 | Tham at Little Bytham |
| TLD | TF 015179 | Tham at Little Bytham |
| BBU | TF 102198 | Bourne Eau at Bourne, u/s confl. Car Dyke; d/s rd. br. |
| BBD | TF 105198 | Bourne Eau at Bourne, d/s rd.br., sluice +weir |
| BRL | TF 121199 | Bourne Eau, d/s railway br., d/s pylons |
| BTU | TF 148190 | Bourne Eau at Tongue End, end of farm track |
| BTD | TF 153188 | Bourne Eau at Tongue End, u/s Glen confl. |

abbreviations: u/s = upstream  rd.br. = road bridge  confl. = confluence
d/s = downstre:  ft.br. = foot bridge
br. = bridge  fd. = ford

Table B2. Dates of samples from River Glen sites

| SITE | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELN | | | | | | | | | | | | | 1 | 2 | 2 | 1 |
| EHW | | | | | | | | | | | | | 1 | | | |
| EBB | | 1 | 1 | 1 | | | 1 | 2 | | | | | 1 | | | |
| EEL | | | | | | | | | | | | | 1 | | | |
| EEH | 1 | | 1 | 1 | | | | 1 | 1 | 1 | | 1 | 1 | 2 | 3 | 1 |
| EGB | | | | | | | 1 | | | | | | | 1 | 1 | |
| EPH | | 1 | | | | | 1 | | | | | | 1 | | | |
| EMT | | | | | | | | | | | | | 1 | | | |
| EMU | | | | | | | | | | | | | 2 | | | |
| EMD | | | | | | | | | | | | | 2 | | | |
| EMG | 1 | 1 | | | | | 1 | 1 | | | | | 2 | | | |
| EBR | | | 1 | 1 | | | | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 3 | 1 |
| ET1.1 | | | | | | | | 1 | | | | | | | | |
| ET1.4 | | | | | | | | 1 | | | | | 1 | | | |
| WBP | | | | | | | | | | | | | 1 | | | |
| WBF | | | 1 | 2 | | | | 1 | | | | | 1 | | | |
| WBC | | | | | | | | | | | | | 1 | 2 | 3 | 1 |
| WCG | | | 1 | 2 | | | 1 | 1 | | | | | 1 | 1 | | |
| WSW | | | | | | | | | | | | | 1 | 1 | | |
| WCR | | | | | | | | | | | | | | 1 | | |
| WLU | | | | | | | | | | 1 | | | | | | |
| WLD | 1 | 1 | | 2 | | | | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 3 | 1 |
| WEU | 1 | 1 | 1 | 1 | | | 1 | 2 | | | | | | | | |
| WED | | | | | | | | | | | | | 1 | | | |
| WBL | 1 | | 1 | 2 | | | | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 |
| GKB | 2 | 1 | 1 | | | | | | | | | | | 1 | 3 | 1 |
| GTF | 1 | 1 | 1 | 1 | | | | 1 | | 1 | 1 | 1 | | | | |
| GTE | | | 1 | 2 | | | 1 | 1 | | 1 | 1 | 1 | | 2 | 3 | 1 |
| GGG | 2 | 1 | 1 | 1 | | | 1 | 1 | | | | | | | | |
| GPK | 2 | 1 | 1 | 2 | | | 1 | 1 | | | | | | | | |
| GSF | | | | | | | | | | | | | | 2 | 3 | 1 |
| GSS | 2 | 1 | 1 | 1 | | | | 1 | 1 | 1 | 1 | 1 | | 2 | 3 | 1 |
| TCH | | | | | | | 1 | | 1 | | | 1 | | | | |
| TCU | | | | | | | | | 1 | | | 1 | | | | |
| TCD | | | | | | | 1 | | 1 | | | 1 | | | | |
| TGU | | | | | | | 1 | | 1 | 1 | | | | | 1 | 1 |
| TGD | | | | | | | | | | 1 | | | | | | |
| TLU | | | 1 | 1 | | | | 1 | | | | | | | | |
| TLD | | 1 | | | | | 1 | | 1 | 1 | | 1 | 1 | 2 | 3 | 1 |
| BBU | 1 | | 1 | 1 | | | | | | | | | | | | |
| BBD | | 1 | | 1 | | | 1 | 1 | | | | | | | | |
| BRL | | | | 1 | | | 1 | 2 | | | | | | | | |
| BTU | | | | | | | | | | | | | | 2 | | |
| BTD | | | | | | | | | | | | | | | 2 | 1 |

## 4 METHODS

### 4.1 Sampling

All the samples were collected using a standard 1.5-minute kick-and-sweep technique with a hand net. All micro-habitats within a site were sampled in order to maximise the range of taxa recorded, except where in very deep sites sampling was restricted to the margins. Samples were sorted "live", either in the field or laboratory, and taxa identified and recorded on a standard recording form.

### 4.2 Standardisation of taxa lists

Information from the recording forms was entered in full onto a Microsoft EXCEL spreadsheet, using separate spreadsheets for different formats of recording sheets. These were then edited together to form a composite file on which every taxon name used was included. Due to differences between recording sheets the same taxa may have been refered to under different names, eg. Baetis vernus could have been recorded variously under Baetidae, Other Baetidae, *Baetis* sp., *Baetis* indet., *Baetis vernus/tenax* or *Baetis vernus*. For the purposes of comparing sites and dates it was therefore necessary to group such records to the appropriate taxonomic level: in this example, Baetidae. A "grouped" file was therefore produced for all sites. In most instances the groupings were to family level, and a further file was constructed which recorded all taxa to family level or higher.

An indication of abundance class was given on a minority of records, and for the purposes of standardisation ignored: presence / absence data were used in all the analyses.

### 4.3 Biotic indices

Using the standard formulae (Extence and Ferguson, 1989) the following biotic indices were calculated for each record, using the family data file:

Biological Monitoring Working Party Score (BMWP)
number of BMWP scoring taxa
Average Score Per Taxon (ASPT)
Lincoln Quality Index (LQI)

Calculation of the LQI required information on the type of habitat sampled: Riffle, run or pool. Such information was provided on most record sheets; where it was absent the most likely habitat type was assumed.

### 4.4 Sample classification using TWINSPAN

Two-Way Indicator Species Analysis (Hill,1979) was used to classify samples on the basis of the family level data into groups from different regions, sites, dates and seasons sharing similar invertebrate communities.

TWINSPAN uses a method of "refined ordination" to classify sites. A hierarchical pattern of divisions is produced, and with each division "preferential" taxa identified which are significantly more frequent in one sub-group or the other. Subsequently an "indicator ordination" is performed which identifies taxa on the basis of the presence or absence of which alone the same classification could be produced. For this reason the "indicator" taxa chosen are frequently the rarer taxa associated with each group, rather than more common taxa with large differences in frequency, even though these may be more ecologically significant. For this reason the discussion focuses on the preferential taxa of the main TWINSPAN ordination, although indicator taxa are shown in the dendrograms. In some instances "key" taxa are referred to - these are the most strongly preferential taxa whose presence or absence is believed to be particularly significant in group-separation.

It should be noted that TWINSPAN places greater weight on similarities in taxa present than on the absence of taxa, with the result that samples with very reduced communities tend to be grouped with others of which their faunas are subsets, at least in the earlier divisions. For this reason the TWINSPAN classifications should be viewed in conjunction with the correspondence analysis ordinations which are more effective at identifying sites with an absence of commoner taxa.

TWINSPAN sub-divides groups of samples repeatedly until the requested level of divisions has been reached. The lowest level of division which still represents ecologically meaningful end-groups, ie. there is an ecological basis for the differences in taxa between groups rather than chance sampling effects, has to be subjectively assessed. In making this assessment reference was made to the preferential taxa associated with the divisions, and to the correspondence analysis (Section 4.5) which is extremely useful in determining the actual amount of faunal variation between end-groups.

## 4.5 Sample ordination using CANOCO

Ordination was performed using the correspondence analysis option of the CANOCO package (Ter Braak, 1988). Correspondence analysis allows samples to be grouped according to similarities in their taxonomic composition. As such it is a useful tool both on its own for grouping samples and for confirming the groupings produced by complementary analyses such as TWINSPAN. Correspondence analysis was used in preference to any form of detrended correspondence analysis (eg. DECORANA). In this particular (Glen) data set where major differences in groups of samples were being investigated, rather than small between-sample changes in relation to linear environmental variables, the small benefits of detrending in eliminating some mathematical errors were considered to be outweighed by the problems that exist with the detrending process which invalidate the interpretation of the distance between points in the ordination diagram.

# 5 ANALYSIS AND DISCUSSION

## 5.1 Taxonomic diversity

From the combined list of taxa, in which the grouping of taxa under a family or higher group name was kept to the minimum necessary to standardise across the 15 year period, a total of 112 types were recorded. Lists for all the samples are given in Appendix 1.

## 5.2 Biological quality

BMWP scores, ASPTs and numbers of scoring taxa for all samples are given in Appendix 2.

Mean site scores for BMWP, no. scoring taxa and ASPT are show in Figure B2. One standard deviation error bars give an indication of the range of scores at each site over the 15 year period, although these have little true significance due to variable sample size. It is apparent that the lower West Glen and the River Tham have the most diverse and sensitive communities as indicated by all three scores. High BMWP scores are a result of both the number and "quality" of taxa. Rather surprisingly the other reaches have very similar score ranges despite the diverse nature of the habitats, with the smaller E. Glen riffle sites scoring similarly to the slow flowing lower Glen and Bourne Eau reaches, possibly due to water quality problems. Bourne Eau is notable in the steady increase in scores in progressively more downstream sites.

When reorganised and plotted against distance from the confluence with the River Welland there is a predictable relationship between scores and distance (Figure B3), with the highest scores occurring in the middle regions. The top of the tributaries have reduced communities due to their intermittent nature, and the worsening effect this has on organic pollution problems, whilst the lowest sites are deep, slow flowing and have rather specialised faunas. The middle reaches show the greatest diversity, with more predictable, moderate, flows and better water quality. LQI shows improved scores in the lower reaches due to the compensation for "restricted riffles".

## 5.3 Ordination of all samples based upon the family data

The ordination diagram constructed from the results of a correspondence analysis of the family data is shown in Figure B4. Axes one and two of the ordination accounted for the majority of the variation in the data and are therefore the only two used. Two points are omitted from the diagram: two samples from the West Glen at Corby Glen which possessed very few taxa and plotted very distantly from the rest of the points. The remainder of the sites plotted within a relatively small range on axis one of the ordination, indicating the overall similarity of their faunas. However, certain between-reach differences can be seen.

There are two noticeable trends: Along axis two, the River Tham and reach A of the (upper) West Glen overlap considerably towards the top of the diagram, with the other reaches plotting lower down. The lower West Glen (reaches B, C and D) plot slightly closer to the middle than the other sites but with no clear separation. Secondly, along axis one, the sites separated from the Tham and reach A on axis two (which overlap on axis one) are further separated into the main Glen, Bourne Eau and East Glen in a left to right direction. These trends are summarised in the inset of Figure B4. The two trends seem logical: The West Glen and Tham, being physically close and probably of similar habitat type, share a similar fauna. The lower Glen and Bourne Eau separate from the other sites being of a very different physical nature, but also possess differences from each other. The East Glen is surprisingly different from the West Glen - without knowledge of the physical nature of this reach it is difficult to explain, but pollution and/or drought may be factors. Reaches B, C and D which fall in the centre of the ordination probably possess taxa common to all the other reaches.

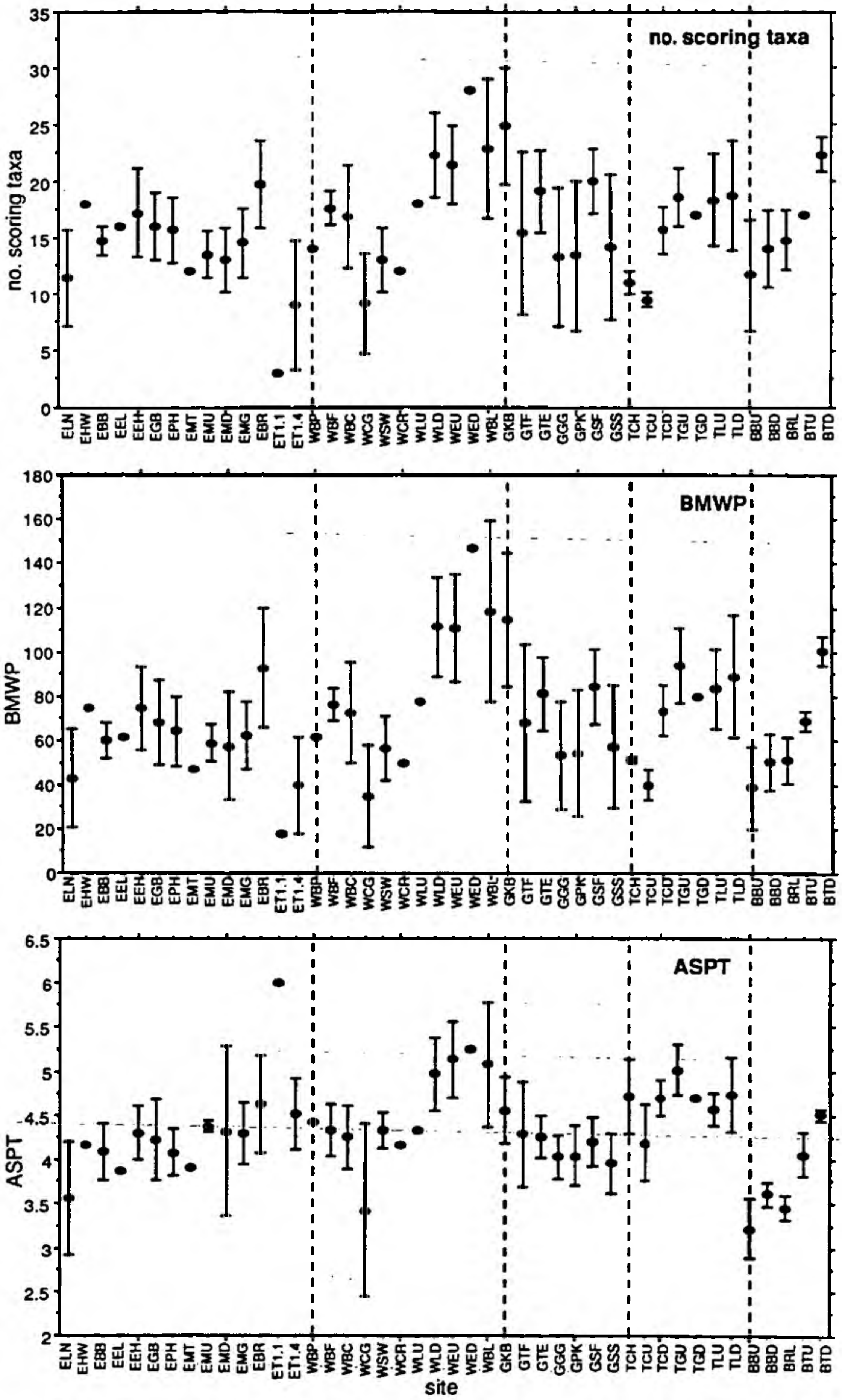



Figure B2. Mean number of scoring taxa, BMWP and ASPT for each site, with 1 S.D. error bars.

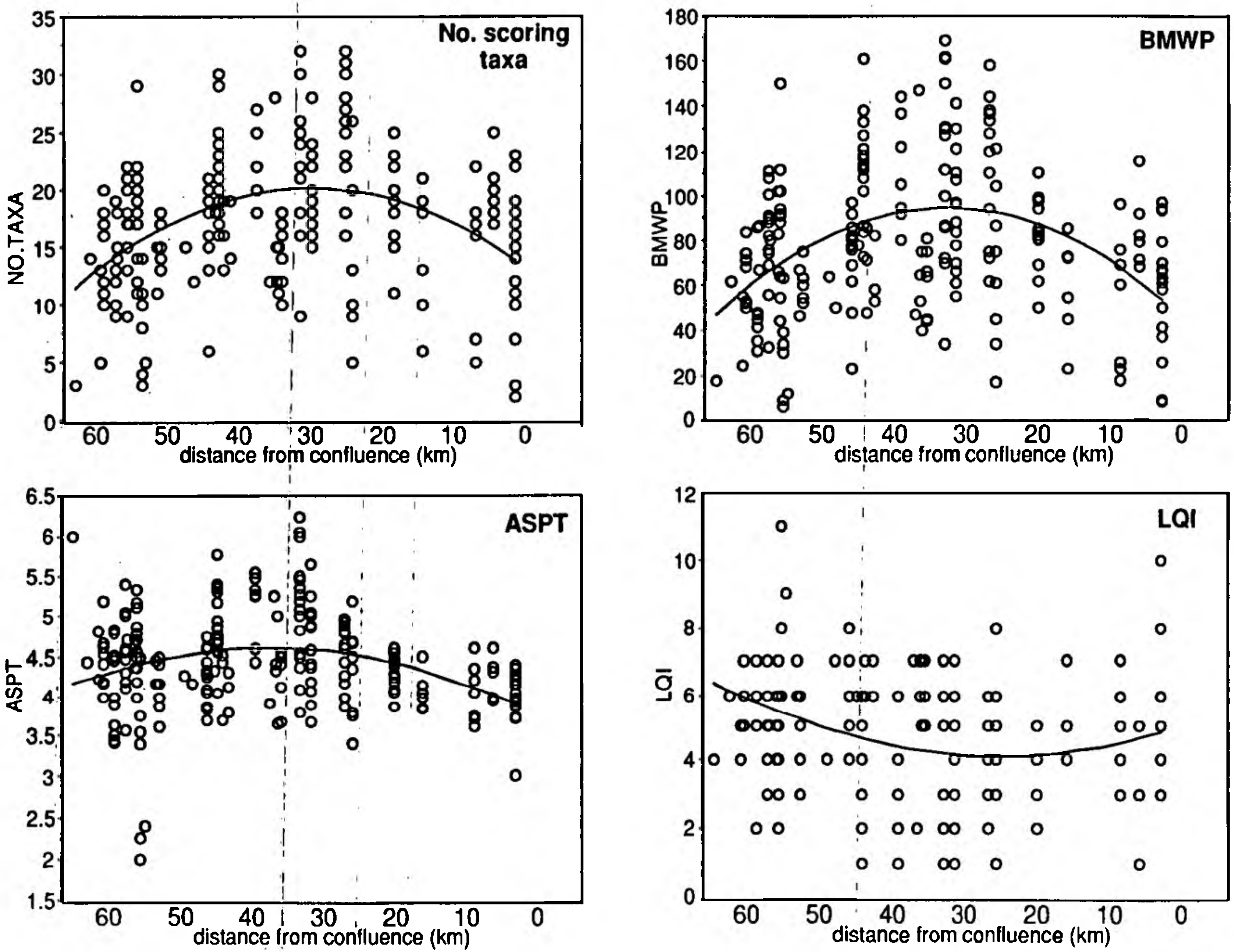



Figure B3. Number of scoring taxa, BMWP, ASPT and LQI for all samples, against distance from source

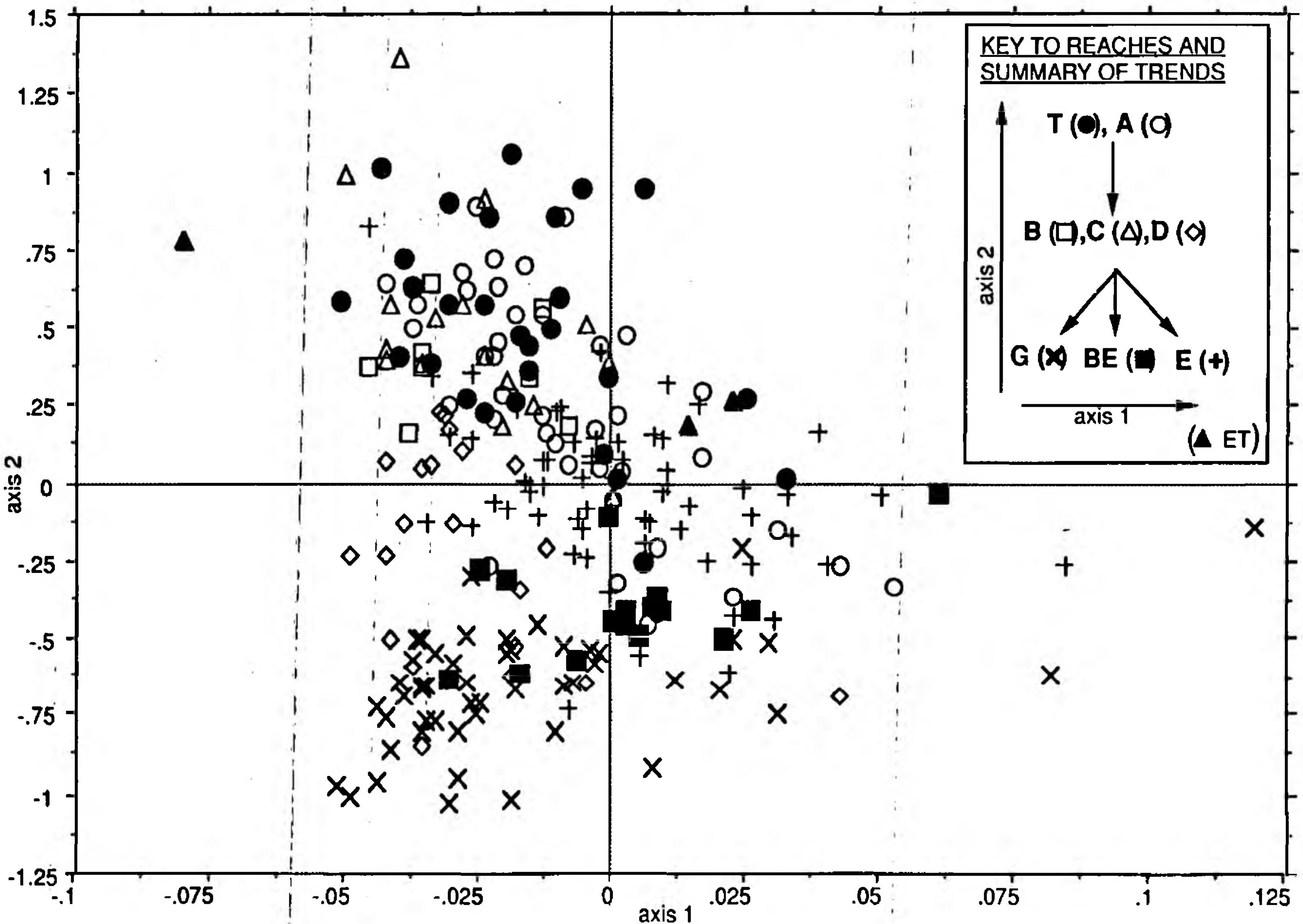



Figure B4. Correspondence analysis of River Glen family data

## 5.4 Classification of all samples based upon the family data

A classification of the whole data set was made using TWINSPAN. Figure B5 shows the dendrogram produced from the output, with taxa derived from the indicator ordination shown at each division. End group numbering is for convenient reference and and is not the same as the TWINSPAN division numbering. Figure B6 shows the diagonal samples-and-taxa matrix with groups of sites numbered at the bottom using the same notation as in the dendrogram.(Figure B5). Preferential taxa for each division are listed in Appendix 3.1. A summary of the sites, physical and biotic characteristics and key taxa associated with the eight significant divisions of the classification is illustrated in Figure B7 (emboldened site codes indicate the majority of samples from this site falling in this group; plain text indicates just two or more samples). "Key taxa" are those showing strong preference for the group indicated.

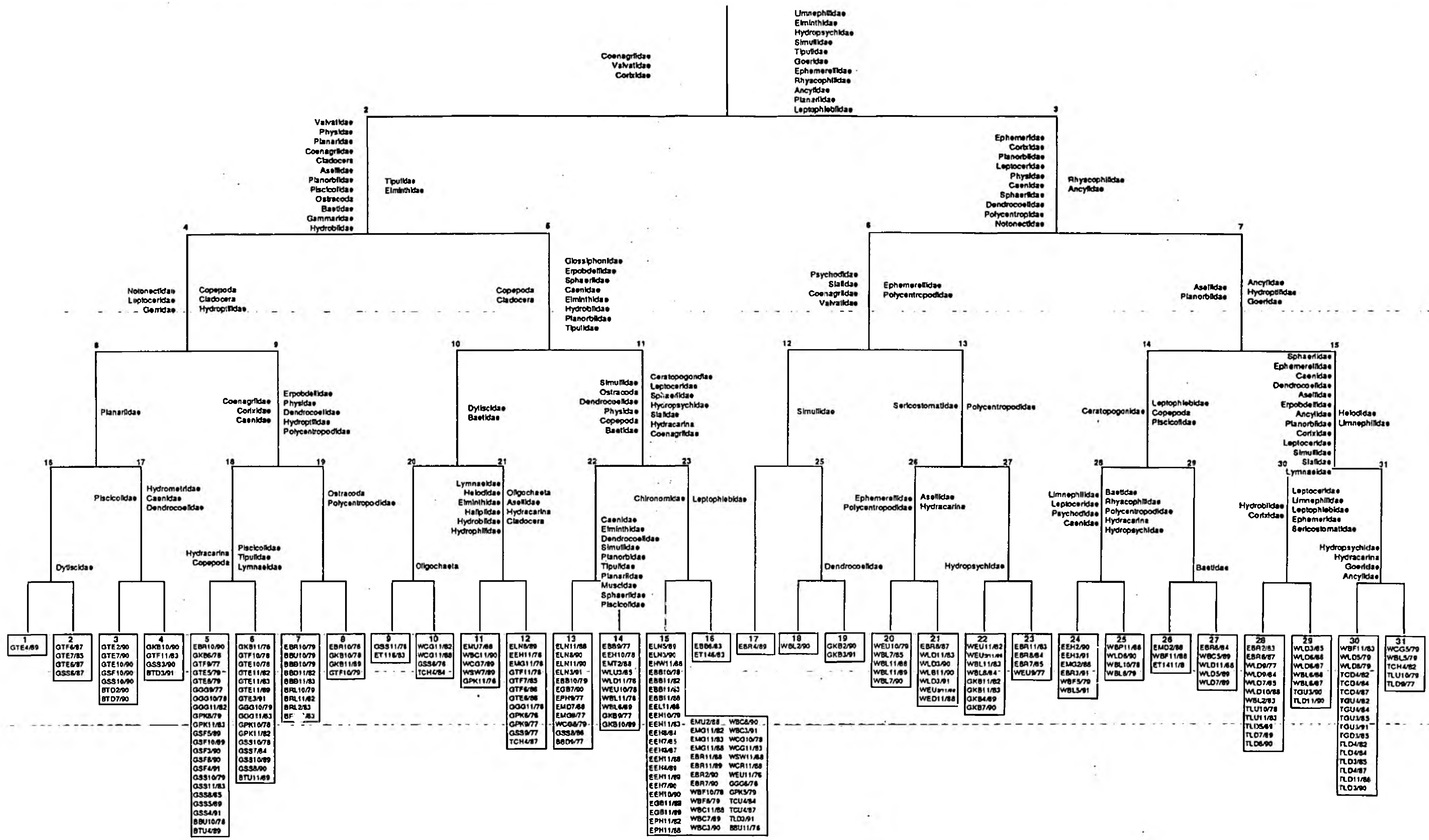
### 5.4.1 The first major division

The first major division separates (with some exceptions) the main river Glen samples, Bourne Eau and the bulk of the East Glen samples from the West Glen and Tham samples. Some sites have samples in both groups, notably GKB and EBR. These two are physically on the borderline between the two groups and so this seems logical. Taxa associated with this division suggest that the separation is based on physical rather than water quality differences: The taxa found significantly more frequently in the "East and lower Glen" group are the Ostracoda, Cladocera, Coenagriidae and Valvatidae; while those preferring the "West Glen and Tham" group include a number of Ephemeroptera: Ephemeridae, Ephemerellidae, and Leptophlebiidae; several Trichoptera: Rhyacophilidae, Polycentropodidae, Hydropsychidae, Hydroptilidae, Limnephilidae, and Goeridae; and also the Elmidae, Tipulidae, Ancylidae, Simuliidae and Dendrocoelidae. In Figure B6 these taxa are arrayed on the top left (East and lower Glen group) and bottom right (West Glen and Tham group). It is apparent from this matrix that by far the majority of taxa occur in both groups, ie. the obvious site distinctions are based on more subtle differences in frequencies of rather than the presence or absence of large groups of taxa. This might well be expected as all sites are within one catchment with many physical similarities. Also, recolonisation of any site is likely to be from others in the same catchment, which may significantly influence faunal composition of that site.

### 5.4.2 Subdivision of the main and East Glen sites: groups 1-16

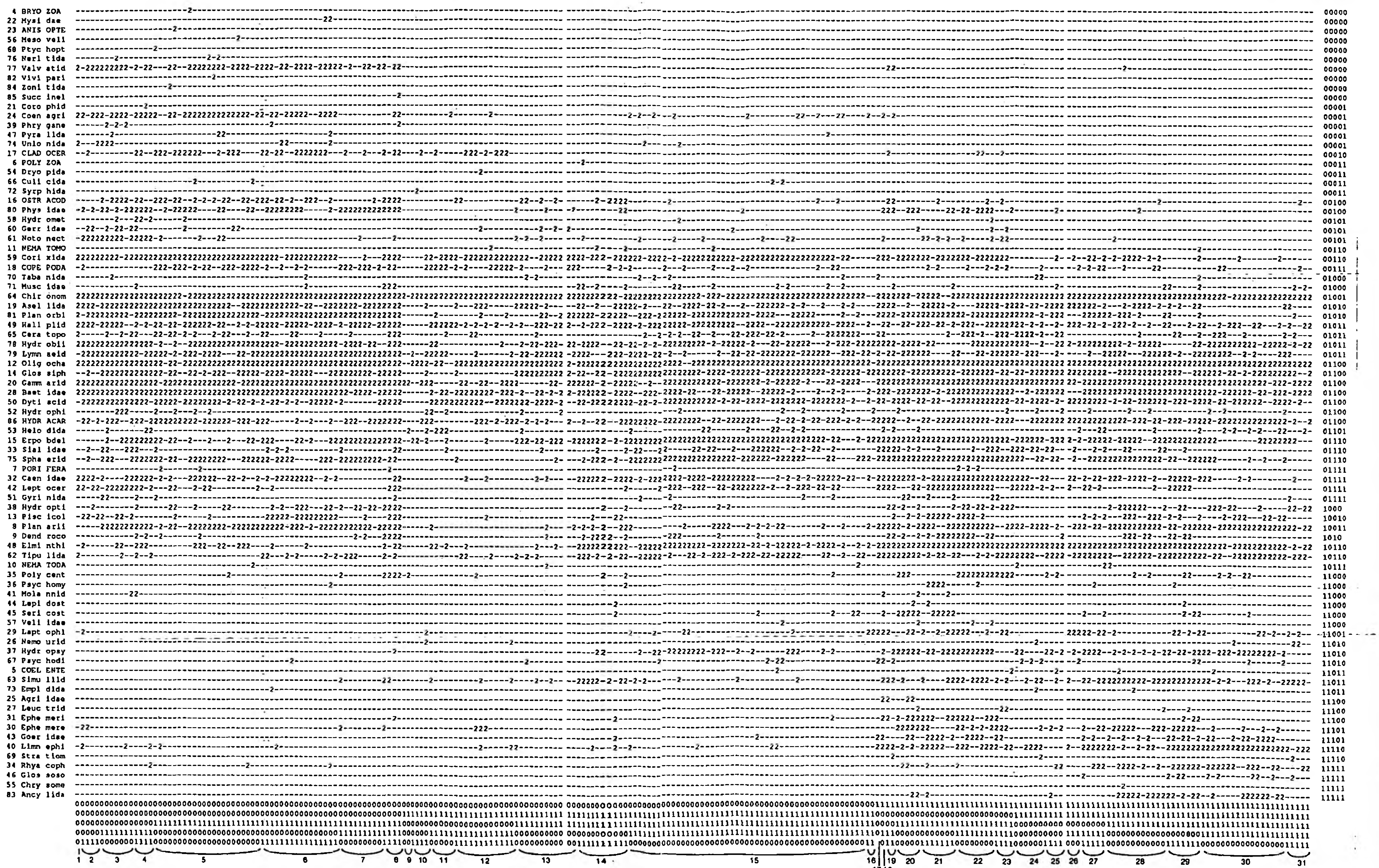
The second TWINSPAN division separates end-groups 1-8 from 9-16, within the East and lower Glen group. Groups 1-8 encompass most of the lower main Glen samples and all but two of the Bourne Eau samples. Groups 9-16 contain most of the East Glen samples but also a mixture of others from the main and West Glen and Tham. Only one family - the Hydropsychidae - is given as preferential for the groups 1-8 , while those taxa strongly preferential for the groups 9-16 include the Piscicolidae, Cladocera, Coenagriidae, Hydroptilidae, Valvatidae and Physidae. The preferential taxa probably reflect the physical difference between the smaller, faster-flowing nature of the sites in groups 9-16 as opposed to the slower-flowing lowland main Glen sites.

The subdivision of groups 1-8 into groups 1-4 and 5-8 does not appear to be site-based but identifies a group samples (in end groups 1-4) which possess a number of taxa including the Gerridae, Notonectidae and Unionidae at relatively high frequency but the Cladocera, Copepoda and Hydroptilidae less frequently. The subsequent division identifies groups 1 and 2 as being less diverse than groups 3 and 4, lacking a number of taxa including a number of Coleopteran families. Groups 5-8 are separated fairly clearly into groups 5-6 and 7-8 based upon the frequency of taxa which again suggest differences in flow conditions and/or possibly macrophyte development: groups 5 and 6, which mainly consist of samples from the lower main Glen sites, have higher frequencies of Coenagriidae, Caenidae and Corixidae; whereas groups 7 and 8, which include samples from Bourne Eau and the two sites close to the confluence of the East and main Glen - EBR and GKB - possess greater frequencies of taxa including Polycentropodidae and Simuliidae.



<u>Figure B5.</u> TWINSPAN groupings from an analysis of family data for all samples. End group numbers are referred to in the text; division numbers relate to those given in appendix 3.1.

<u>Figure B6.</u> TWINSPAN samples and taxa matrix. End groups numbers are as in figure 5.



| TWINSPAN division | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|
| TWINSPAN end groups | 1-4 | 5-8 | 9-12 | 13-16 | 17-19 | 20-23 | 24-27 | 28-31 |
| sites | **BTD**<br>GTE<br>GTF<br>GTE | **GTF**<br>**GTE**<br>**GGG**<br>**GPK**<br>**GSS**<br>**GSF**<br>**BBU**<br>**BBD**<br>**BRL**<br>**BTU**<br>GKB<br>EBR | **TCH**<br>GTF<br>GSS<br>GPK<br>WCG | **ELN**<br>**EBB**<br>**EEH**<br>**EGB**<br>**EPH**<br>**EMG**<br>**EBR**<br>**WBF**<br>**WBC**<br>**WCG**<br>**TCU**<br>GKB<br>WEU<br>WBL | GKB | **EBR**<br>**WEU**<br>**WBL**<br>**GKB**<br>WLD | **WBF**<br>EBR<br>EEH<br>WLD<br>WBL | **WLD**<br>**TCD**<br>**TGU**<br>**TLD**<br>**TLU**<br>EBR<br>WBL |
| group description | lowland, slow-flowing, abundant macrophytes, good water quality, rich fauna | lowland, slow-flowing, macrophytes, reasonable water quality and fauna | intermittent, or poor water quality, very reduced fauna | poor habitat, poor fauna | good,diverse habitat, rich fauna | moderate flow, some macrophytes moderate water quality, intermediate fauna | moderate flow, clean substrates, rich fauna | moderate/fast flow, stable, clean substrates, macrophytes, rich fauna |
| key taxa | Leptoceridae, Hydrometridae, Gerridae, Notonectidae, Unionidae | Cladocera, Copepoda, Hydroptilidae | Cladocera, Copepoda | Glossiphonidae, Erpobdellidae, Asellidae, Sialidae, Caenidae, Elminthidae, Hydrobiidae, Planorbiidae | Coenagriidae, Valvatidae, Helodidae, Psychodidae | Piscicolidae, Copepoda, Ephemeridae, Polycentropodidae, Psychomyidae, Gyrinidae | | Dendrocoelidae, Piscicolidae, Rhyacophilidae, Hydroptilidae, Ancylidae, Goeridae, Glossosomatidae |
| | Piscicolidae, Cladocera, Coenagriidae, Hydroptilidae, Valvatidae, Physidae | | | | Ephemerellidae, Notonectidae Physidae, Sericostomatidae, Gyrinidae | | Rhyacophilidae, Ancylidae | |
| | Ostracoda, Cladocera, Coenagriidae, Valvatidae | | | | Leptophlebidae, Ephemeridae, Ephemerellidae, Rhyacophiidae, Hydropsychidae, Limnephilidae, Goeridae, Ancylidae, Simuliidae, Polycentropodidae | | | |

Figure B7. Summary of site groupings based upon TWINSPAN classification of samples. Key taxa are those showing a strong preference for the group indicated.

Groups 9-16 are subdivided into 9-12 and 13-16 on the basis of a range of taxa absent or at very low frequency in the former group. This particularly apparent in the samples - and - taxa matrix (fig.6), where many of the common taxa located in the middle of the diagram are visibly less frequent in these groups. In particular the Hydropsychidae and Leptoceridae are absent from this group altogether. Samples comprising groups 9-12 are drawn from a wide range of sites, and appear to represent occasions when the fauna at those sites has been severely impacted (drought or pollution?). Many of these samples are from the late 70's period. Further separation of these groups (9-12) appears to reflect the severity of the faunal reduction, with group 9 the worst affected. Groups 13-16 subdivide into groups13-14: a range of samples from the upper East Glen sites, the lower East Glen sites below Manthorpe STW and a few "odd' sites from the West and main Glen; and groups 15-16: The larger East Glen sites, a significant number of upper West Glen sites and a few from the Tham and lower Glen. All of these samples appear to be from "poor quality" sites or from dates when "better" sites were under stress (eg. WEU, WLD and WBL in 1976). The taxa separating groups 13-14 from 15-16 include the Simuliidae and Physidae which are more frequent in the former group and the Coenagriidae, Sialidae, Hydropsychidae, Leptoceridae and Sphaeriidae in the latter. It could be that the former group is the more severely impacted than the latter.

### 5.4.3 Subdivision of the West Glen and Tham sites: groups 17-31

Within this set of groups the first subdivision into groups 17-23 and 24-31 separates the majority of the lower West Glen and "intermediate" sites (EBR and GKB) from the upper West Glen and Tham sites. The taxa associated with the division reflect this: the Rhyacophilidae and Ancylidae which prefer faster flow and more stable substrates show a strong preference for the West Glen and Tham sites, whereas taxa such as the Ephemeridae, Polycentropodidae, Gyrinidae, Corixidae, Notonectidae and Sericostomatidae which tolerate or prefer slower flowing conditions are more frequent in the lower West and East Glens and Kates Bridge.

Within groups 17-23 the ecological basis of further subdivisions are difficult to interpret, these being based on substitutions of taxa particularly from the Trichoptera, Coleoptera and Diptera.

Groups 24-31 subdivide into groups 24-27 and 28-31 mainly on the basis of a collection of more "sensitive" taxa which are more frequent in the latter group. Sites dominating this group are from the Tham and middle West Glen, and are those which scored highest using the various biotic indices. Taxa preferring this group include the Piscicolidae, Rhyacophilidae, Hydroptilidae, Goeridae, Glossossomatidae and Ancylidae. Taxa preferring the other group (24-27) include the Asellidae, Sialidae, Leptoceridae and Planorbiidae. Further subdivisions within groups 24-27 and 28-31 are again very difficult to interpret, being based mainly on the substitution of a few taxa at each division.

### 5.4.4 Definition of reach communites

The TWINSPAN classification produced 31 end groups between which both meaningful between-site and temporal (between-sample, within site) differences and some chance between-sample differences could be discerned (Sections 5.4.2 and 5.4.3). At the higher level of division eight major groupings based mainly upon reach-scale differences were apparent. From these it is possible to define three major reach-types:

- "lowland" - divisions 8 and 9 (end groups 1-8) contain most of the lowland-type sites, division 8 containing the most faunistically rich samples.
- "upland" - division 15 (end groups 28-31) contain the upland-type sites.
- "intermediate" - divisions 12, 13 and 14 (end groups 17-27) contain sites possessing taxa in common with both the "upland" and "lowland" sites, the three divisions representing slightly different communities, all faunistically rich.

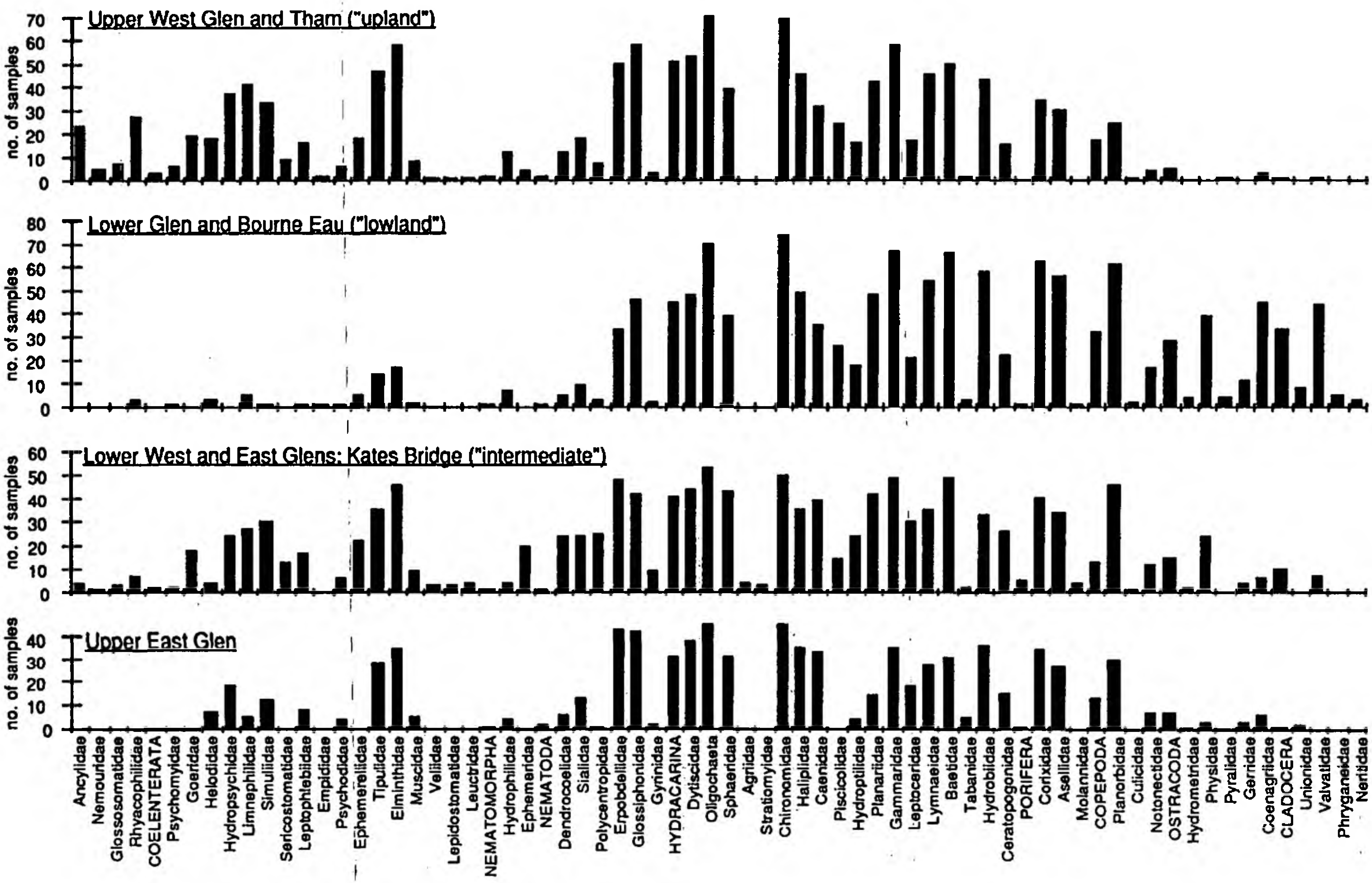



Figure B8. Frequencies of taxa within reach-types.

| "UPLAND" | "INTERMEDIATE" | "LOWLAND" |
|---|---|---|
| Chironomidae | Chironomidae | Chironomidae |
| Oligochaeta | Oligochaeta | Oligochaeta |
| Gammaridae | Gammaridae | Gammaridae |
| Baetidae | Baetidae | Baetidae |
| Corixidae | Corixidae | Corixidae |
| Planorbidae | Planorbidae | Planorbidae |
| Hydrobiidae | Hydrobiidae | Hydrobiidae |
| Asellidae | Asellidae | Asellidae |
| Lymnaeidae | Lymnaeidae | Lymnaeidae |
| Haliplidae | Haliplidae | Haliplidae |
| Dytiscidae | Dytiscidae | Dytiscidae |
| Planariidae | Planariidae | Planariidae |
| Glossiphonidae | Glossiphonidae | Glossiphonidae |
| HYDRACARINA | HYDRACARINA | HYDRACARINA |
| Coenagriidae | Coenagriidae | Coenagriidae |
| Sphaeridae | Sphaeridae | Sphaeridae |
| Caenidae | Caenidae | Caenidae |
| Erpobdellidae | Erpobdellidae | Erpobdellidae |
| COPEPODA | COPEPODA | COPEPODA |
| OSTRACODA | OSTRACODA | OSTRACODA |
| Piscicolidae | Piscicolidae | Piscicolidae |
| Ceratopogonidae | Ceratopogonidae | Ceratopogonidae |
| Leptoceridae | Leptoceridae | Leptoceridae |
| Hydroptilidae | Hydroptilidae | Hydroptilidae |
| Elminthidae | Elminthidae | Elminthidae |
| Notonectidae | Notonectidae | Notonectidae |
| Tipulidae | Tipulidae | Tipulidae |
| Sialidae | Sialidae | Sialidae |
| Hydrophilidae | Hydrophilidae | Hydrophilidae |
| Limnephilidae | Limnephilidae | Limnephilidae |
| Ephemerellidae | Ephemerellidae | Ephemerellidae |
| Dendrocoelidae | Dendrocoelidae | Dendrocoelidae |
| Rhyacophilidae | Rhyacophilidae | Rhyacophilidae |
| Helodidae | Helodidae | Helodidae |
| Polycentropidae | Polycentropidae | Polycentropidae |
| Tabanidae | Tabanidae | Tabanidae |
| Muscidae | Muscidae | Muscidae |
| Gyrinidae | Gyrinidae | Gyrinidae |
| Hydropsychidae | Hydropsychidae | |
| Simuliidae | Simuliidae | |
| Ancylidae | Ancylidae | |
| Goeridae | Goeridae | |
| Leptophlebiidae | Leptophlebiidae | |
| Sericostomatidae | Sericostomatidae | |
| Glossosomatidae | Glossosomatidae | |
| Psychodidae | Psychodidae | |
| Psychomyidae | Psychomyidae | |
| Ephemeridae | Ephemeridae | |
| COELENTERATA | COELENTERATA | |
| | Physidae | Physidae |
| | CLADOCERA | CLADOCERA |
| | Valvatidae | Valvatidae |
| | Gerridae | Gerridae |
| | Hydrometridae | Hydrometridae |
| Nemouridae | | Unionidae |
| NEMATODA | | Phryganeidae |
| NEMATOMORPHA | | Pyralidae |
| Empididae | | Neritidae |
| | | Culicidae |

Table B3. Taxa lists for the three reach-types.
Taxa occurring in less than 1% of samples in the reach omitted.

Divisions 10 and 11 (end groups 9-16), which include the East Glen sites, represent samples with impoverished faunas rather than any distinct reach community.

Figure B8 displays histograms showing the frequency of occurrence of taxa within each reach-type. The taxa have been ordered according to their proportional occurrence in the two major reach-types: Taxa occurring more frequently in the "upland" sites are ranged to the left; those more frequent in the "lowland" sites ranged to the right. It can be seen that although there are a large number of ubiquitous taxa, the majority of taxa do show a preference for one or other reach-type. The "intermediate" sites possess taxa of both community-types, plus two taxa unique to these sites (Agriidae and Stratiomyidae - at very low frequency so probably chance occurrences). Interestingly, the upper East Glen sites still record taxa from both reach-types as well as the ubiquitous ones. This suggests that the poorer faunas are due to a reduced habitat diversity at individual sites rather than a general degradation at all sites.

On the basis of the TWINSPAN divisions alone it is possible to predict the potential "best" community which each of the three major reach-types could support: For the "lowland" sites the combination of taxa associated with division 8 represents the most diverse community of this reach-type. The "upland" sites potentially possess those taxa recorded in the division 15 samples. The "intermediate" sites which fall into divisions 12-14 may possess the larger range of taxa defined by these divisions, although sites within this reach type are more variable, some tending to the "upland" and some to the "lowland" end of this intermediate spectrum. Table BB3 lists the taxa occurring in the divisions associated with the major reach types, which could potentially be found in any site within that reach. Taxa occurring in less than 1% of samples have been omitted as these may be chance rarities. It is notable that the "specialist" taxa (restricted to one or two reach-types) are not necessarily those having the highest BMWP scores, ie. specialism and sensitivity are not synonymous.

## 5.5 Long-term changes in biological quality

### 5.5.1 Changes in scores at the catchment scale

For the three indices: BMWP, ASPT and number of scoring taxa per sample, significant changes were found over the 15 year period. When all the sample scores for each year were plotted against year of sampling (Figure B9.) it was found that all three scores increased between 1976 and the late 1980's, but then declined in 1989-91. It appears that the number of invertebrate taxa have increased and then declined again, and also that the taxa which have increased and then decreased in frequency are those most sensitive to organic pollution as measured by these indices. It must be remembered, however, that the range of sites surveyed has changed during this period, and it is quite possible that the earliest samples tended to be taken in response to reported pollution incidents, whereas in later years more routine sampling of "unpolluted" sites was taking place. Such a change in sampling strategy may produce the observed increase in biological quality.

### 5.5.2 Changes in scores at the site and reach scale

A similar analysis of the records for individual sites where at least six samples had been taken over the 1976-91 period confirmed the overall trends found in the whole data set, but also revealed sites with different temporal changes in scores. Figure B10 shows those sites where a significant trend in score over time was seen when scores were regressed against year of sampling, and indicates the type of change - from steady increase, through initial increase followed by a slight decrease; slight increase followed by major decrease, to steady decrease in score. (Sites where the records only covered part of the 1976-91 period are shown overlapping the groups to which they may belong.)

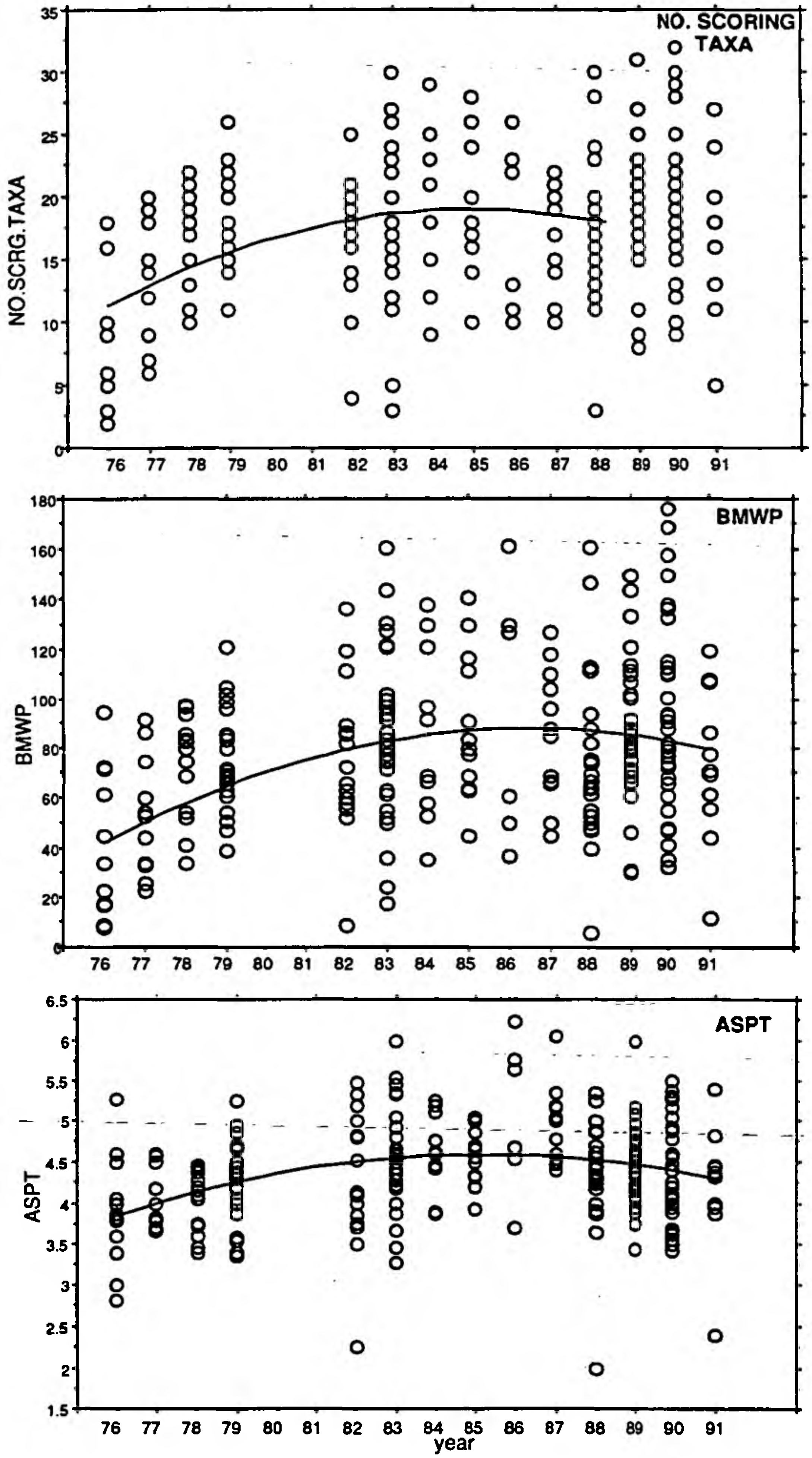



Figure B9. Regressions of number of scoring taxa, BMWP and ASPT against year of sample for all River Glen invertebrate samples.

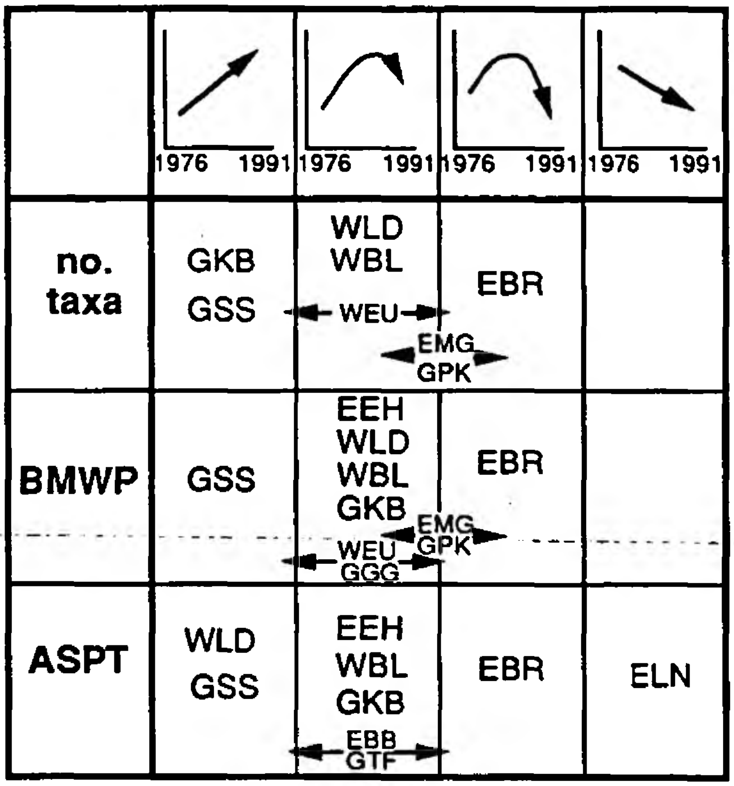



Figure B10. Patterns of 1976-1991 changes in number of scoring taxa, BMWP and ASPT for sites where the trend was significant.

The majority of sites followed the second trend, as seen in the total data set, but a few - the lower main river sites and one lower West Glen site - showed steady increases in score over the whole period. In contrast, a number of the East Glen sites showed pronounced decreases in scores. This strong regional pattern suggests an increase in quality of the main river despite major decreases in quality (due to pollution or drought?) in the East Glen.

Not all sites showed the same trend in all three scores, suggesting very different community changes. For instance, the site GSS showed a steady increase in BMWP as a result of increases in both the number and "quality" of taxa (ASPT). Sites EBR and WBL displayed similar changes but in the reverse direction, with recent decreases in BMWP, number and Average Score Per Taxon. GKB, however, showed a rise then fall in BMWP despite continually rising numbers of taxa, due to the ASPT declining. This site may in recent years be experiencing a decrease in water quality, but due to physical (perhaps hydrological?) changes is able to support a greater diversity of the more pollution-tolerant taxa. Site ELN may be responding in a similar way, as the only significant change in score was a steady decrease in ASPT.

## 5.6 Site case studies

### 5.6.1 West Glen, upstream of Essendine

Figure B11 displays the results of TWINSPAN classification, and ordination usingPP correspondence analysis of the sample data for the site WEU. TWINSPAN indicator taxa, which could be used alone to produce similar groupings, are shown on the dendrogram and ordination diagram. The dates of samples and their LQI scores are indicated. Preferential taxa associated with each TWINSPAN division are listed in Appendix 3.2.

The records for WEU span the period 1976 to 1983. During this time the BMWP scores and number of scoring taxa increased significantly, but without a corresponding increase in ASPT, suggesting that the additional taxa in later years are not significantly more pollution-sensitive. Environmental changes other than an improvement in water quality may have taken place to account for the increased diversity of taxa.

Both classification and ordination of the data identify three distinct groups of samples:

1: 9/77
2: 10/79; 11/76
3: 2/11/83; 3/11/83; 11/82; 1078

Sample 9/77 is most clearly separated from the other samples by both analyses. It is very probable that seasonal factors are responsible for this separation, as taxa absent from this September sample but frequent in the others include the mayflies Leptophlebidae, Ephemerellidae and Ephemeridae as well as a number of other insect taxa that would be absent or extremely small in this month.

Samples in group 2 - 10/79 and 11/76 possess four taxa absent from group 3: Hydroptilidae, Sialidae, Gyrinidae and Copepoda. The latter three of these in particular can tolerate, or even require, standing water conditions. This together with the fact that taxa absent from group 2 but present in samples later than 1979 include the Simuliidae and Rhyacophilidae - taxa requiring flowing water - suggest that the hydrology of the site may have changed over this period.

Sample 3/11/83 was taken in addition to the sample on 2/11/83 as dredging was in progress on the first occasion. A number of taxa are present in one sample but not the other, but with no clear pattern attributable to the disturbance. It is notable that despite recent dredging these samples score higher than previous ones.

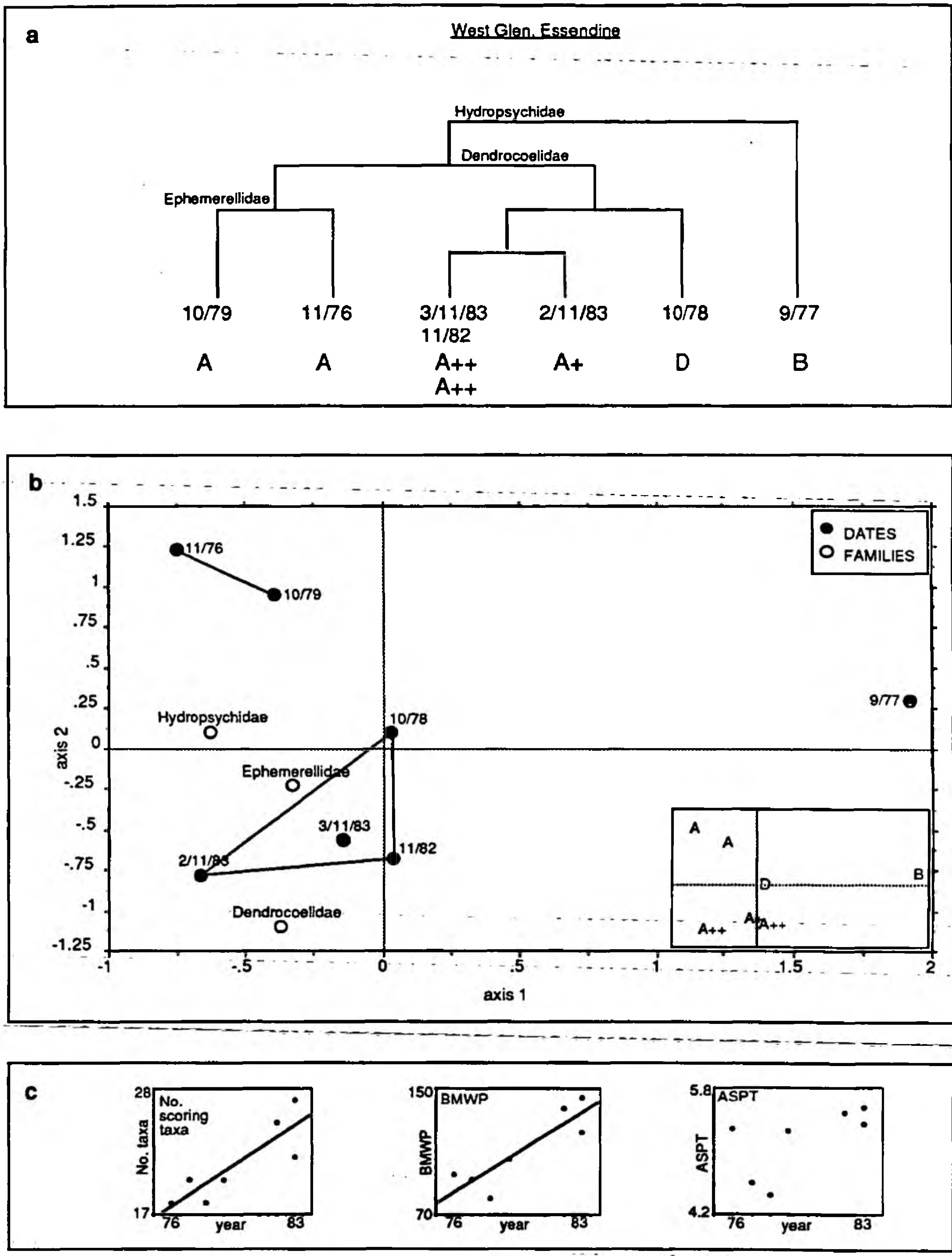



Figure B11. a) TWINSPAN classification, b) ordination and c) changes in biotic scores based on family data for the West Glen at Essendine

### 5.6.2 West Glen at Banthorpe Lodge

Summary diagrams of the analyses are shown in Figure B12, and TWINSPAN preferential taxa listed in Appendix 3.2.

Sixteen samples spanning the period 1976-91 were collected from this site. Biological quality varied considerably during this period, with a clear pattern of increasing quality until 1991, when a marked deterioration occurred.

On the basis of the TWINSPAN analysis four main groups can be distinguished:

1: 7/90, 2/83,.2/90, 11/88, 6/89, 11/89;
2: 7/85, 6/86, 6/87, 8/84, 11/83;
3: 8/79, 5/79, 5/91, 10/78;
4: 11/76.

The first division separates the low-scoring, pre-1980 samples plus the 1991 sample from the rest. The only taxa showing a preference for this group are three families of Diptera: Ceratopogonidae, Stratiomyidae and Muscidae, and Copepoda. All are tolerant of moderate pollution and stagnant conditions.

Within the low scoring groups 3 and 4, the group 4 sample, the earliest in the recorded period, has a markedly reduced fauna.and clearly separates in the classification and ordination. Preferential taxa for this sample include the Dytiscidae, Copepoda, Ostracoda, Lymnaeidae and Dendrocoelidae. These taxa, more notable as tolerant of standing water conditions rather than extreme pollution, suggest that the 1976 sample has an unusual and reduced community due to drought conditions rather than pollution, although the two may very well be acting together.

It is notable that the poor quality 1991 sample is associated with the pre-1980 samples of similar low score, both in the classification and the ordination, showing that not only has the fauna changed, but that the new community is very similar to that 12 years earlier. Presumably the taxa gained or replacing other taxa during the 1980's are the ones first lost as conditions deteriorate. It would also suggest that the physical change in habitat is towards similar conditions to those in the late '70's, which could suggest that there has been a recent deterioration in the habitat (due to drought) which has otherwise remained fairly constant.

The invertebrate communities of samples comprising TWINSPAN groups 1 and 2 are characterised by a wide variety of relatively pollution-intolerant taxa, especially Ephemeroptera and Trichoptera. The Ephemeropteran families showing preference for this group are those associated with clean, fine substrates and slow to moderate flow velocities (Caenidae, Ephemeridae and Leptophlebiidae). The presence of the Trichopteran families Hydropsychidae and Polycentropodidae, and the molluscs Ancylidae suggest more stable but again un-silted substrates. The site is probably a clean gravel and sand riffle or run under normal flow conditions, becoming silted or ponded under very low flows or organic pollution. Other taxa associated with weedy margins, such as the Corixidae and Agriidae are also associated with this group.

The samples separated by TWINSPAN into groups 1 and 2 appear to be largely overlapping in the ordination, implying that there are relatively insignificant differences in the communities of the two groups. According to the preferential taxa offered by TWINSPAN the species characterising group 2 include several associated with weedy conditions - several molluscs (Lymnaeidae, Planorbiidae, Hydrobiidae) Corixidae, Agriidae and Asellidae.

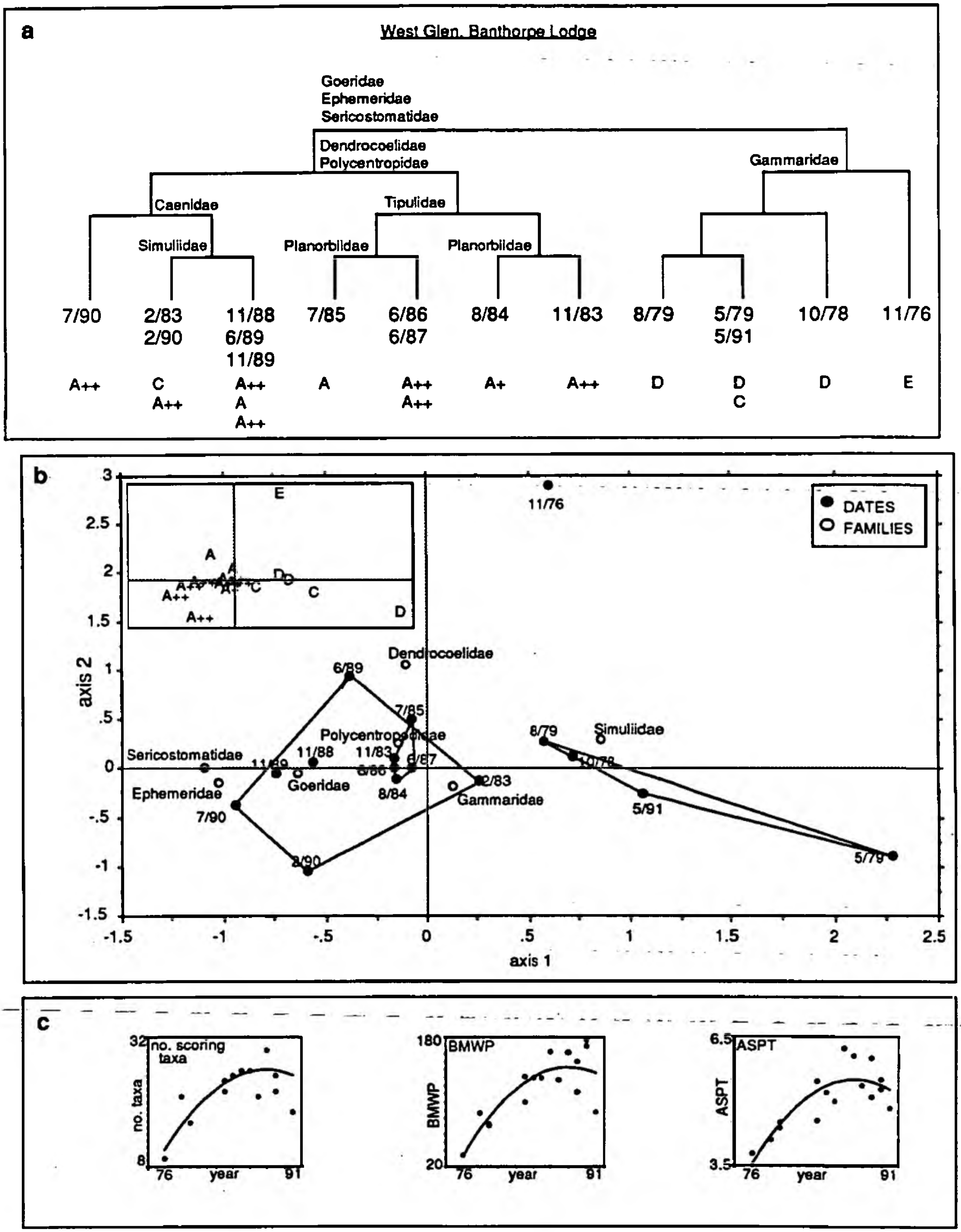



Figure B12. a) TWINSPAN classification, b) ordination and c) changes in biotic scores based on family data for the West Glen at Banthorpe Lodge

### 5.6.3 River Glen at Kates Bridge

Summary diagrams of the analyses are shown in Figure B13, and TWINSPAN preferential taxa listed in Appendix 3.2.

The changes in the invertebrate community at Kates Bridge between 1976 and 1991 are more complex than those shown for sites WEU and WBL (above). Biological quality as measured by BMWP and LQI has risen between 1976 and mid-1990 but then fallen in late-1990-91. The ASPT showed greatest change between the late 1970's and early 1980's with a quite dramatic increase. ASPT then fell in 1991. BMWP and number of scoring taxa showed greater proportional increases between the early 1980's and late1980's/1990 than did ASPT, suggesting some other habitat improvement than water quality may have been involved to account for the increasing diversity.

The four major TWINSPAN groups contain the following samples:

1: 4/89, 3/91, 10/89, 2/90;
2: 10/78, 11/82, 9/77, 11/83, 6/76, 11/76;
3: 11/89, 7/90;
4: 10/90.

The first division separates groups 3 and 4 from 1 and 2 on the basis of a large number of taxa confined to, or more frequent in, the former two groups. These include a surprisingly large number of Hemipterans: Notonectidae, Gerridae, Hydrometridae and Veliidae. These indicate slow-flowing conditions ( or at least slow-flowing margins), probably with macrophytes. Being relatively mobile these animals may indicate habitats where there has been drought and subsequent recolonisation, but the presence of other taxa such as Ephemeridae, Ephemerellidae and Coenagriidae with one or two year life-cycles makes this less likely.

Within the high-scoring groups 3 and 4, group 4 (10/90) is separated from group 3 on the presence of a number of taxa associated with more lentic conditions: Cladocera, Coenagriidae and a number of Diptera, and the absence of several taxa more associated with flowing water and/or clean substrates eg. Caenidae, Sphaeriidae. However, this distinction is not very clear with group 3 also containing several taxa which suggest slow-flowing, weedy conditions.

There is very little meaningful difference between TWINSPAN groups 1 and 2. Only the Sialidae are present in all the group 1 but none of the group 2 samples, and no taxon is present in all group 2 but no group 1 samples. A number of taxa are more frequent in one or other group, but without any obvious pattern related to habitat preference or . The ordination also shows these two groups as largely overlapping, but separated from groups 3 and 4. Only sample - 3/91 - is pulled out in the ordination as significantly different from all the others.

Reference to the ordination diagram reveals a major difference from the situation at Banthorpe Lodge: Whereas at WBL the 1991 sample showed a community with much in common with the 1970's situation, at GKB a different fauna is present in the most recent sample. With falling biological quality the community has not reverted to the earlier type but to a very different assemblage. Sample 3/91 possesses three taxa absent from all other samples: Stratiomyidae, Psychodidae and Helodidae; while lacking two taxa present in all others: Baetidae and Corixidae. It also shares with the 1990 samples several taxa absent from or infrequent in the low-scoring, pre-1980 samples eg.Sialidae, Caenidae and Leptoceridae; while lacking Copepoda which were common pre-1980 but absent in 1990. The combination of some unique features, plus similarities with temporally close samples rather than samples of similar score, leads to the 3/91 sample plotting separately in the ordination. The fact that TWINSPAN failed to separate this sample whereas the ordination did may be a due to the weight given by the latter method to unique species rather than general similarities. The similarity of the 3/91 sample to the other later samples and contrast with the early samples suggests that a permanent change in habitat has occurred at Kates Bridge.

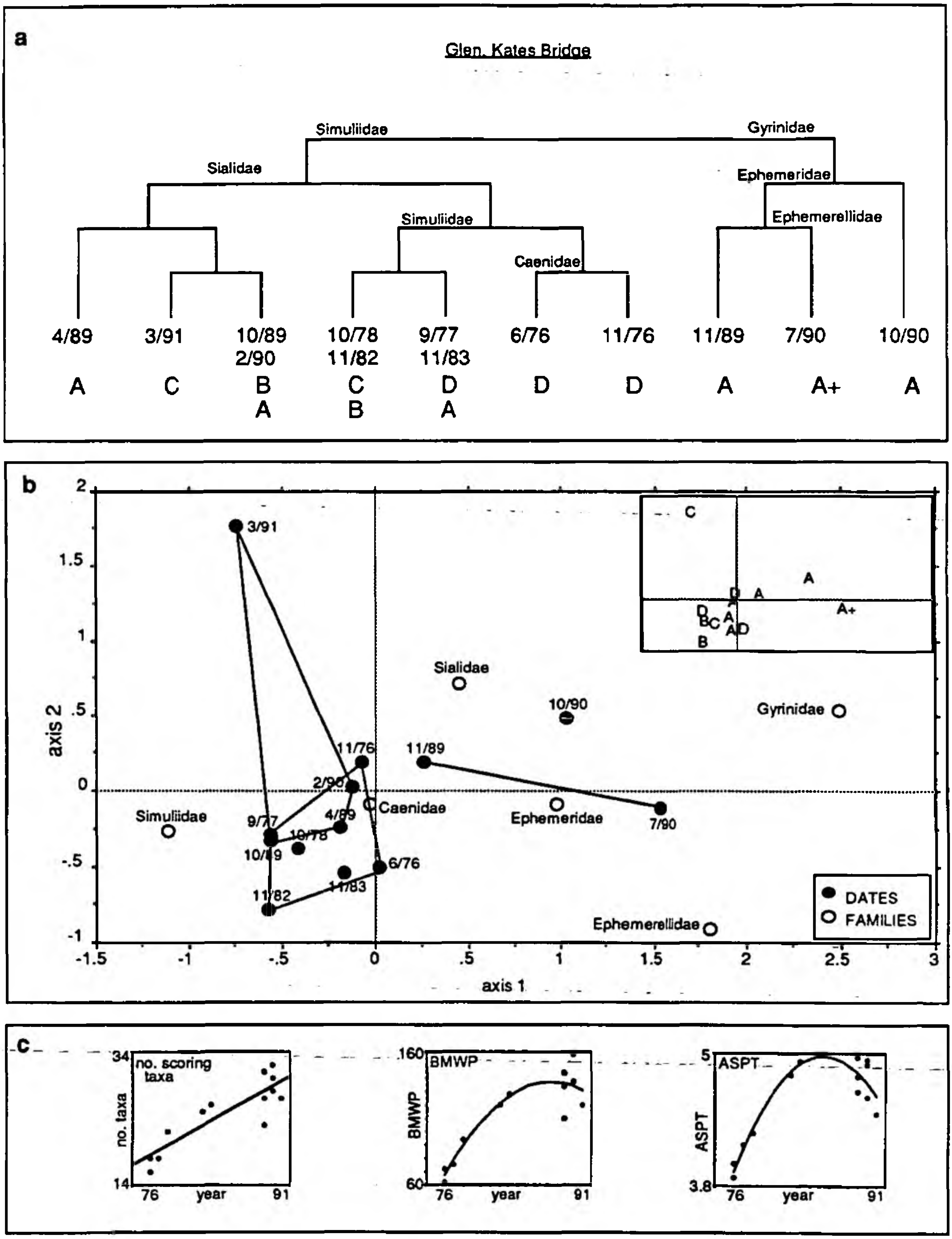



Figure B13. a) TWINSPAN classification, b) ordination and c) changes in biotic score based on family data for the River Glen at Kates Bridge.

### 5.6.4 River Glen at Surfleet Seas End

Summary diagrams of the analyses are shown in Figure B14, and TWINSPAN preferential taxa listed in Appendix 3.2.

This site, the furthest downstream in the system and close to the confluence with the River Welland, has 16 records of invertebrate samples spanning the 1976-91 period. During this time a biological quality as measured by BMWP, number of taxa, ASPT and LQI, has shown a general increase from very poor quality in 1976 to excellent (LQI A) in late 1990, with the 1991 sample being lower (LQI C - good quality) but not as significantly lower as in the previous examples. The range of biological quality from LQI H to A is notably lower than in the more upstream examples (LQI E to A++), as might be expected given the physical nature of this site.

The TWINSPAN classification produces the following four major groupings:

1: 8/90, 4/91, 5/89, 3/90;
2: 10/90, 8/85, 6/87, 7,84, 10/89;
3: 10/78, 6/76, 11/76, 9/77, 8/86;
4: 11/83, 10/79.

The first major division (groups 1 and 2 from 3 and 4) is generally supported by the ordination, although this shows a broad trend along axis 1 rather than a distinct split into two groups. This first division appears to combine differences in score and year of sampling: Groups 3 and 4 are generally the earliest and lowest scoring samples, with the exceptions of 10/79 which fits in with the temporal grouping but has a higher score (B) than other samples in the group; and 8/86, which is a more recent sample but shares a low score (D) with the other group members. Two explanations could account for this interdependency of date and score: First, the range of taxa which could possibly exist at the site, in terms of their sensitivity to pollution or other habitat degradation, could be limited by water and habitat quality, and this determines the biological score observed. The actual community present, however, as well as being limited to the range so described, must be a modification of the community previously living at that site, with gains or losses of a few taxa in response to habitat changes. Secondly, changes in one aspect of habitat quality at the site, such as water quality, could produce the observed changes in biological score, but other features of the habitat, eg. hydrology, management, which may have changed more subtly over time, determine the actual community within the limits set by (in this example) water quality. Either of these explanations would account for samples sharing more in common with other samples from a similar time period than those of similar score from a different time period.

The community differences associated with the first TWINSPAN division are largely based on a wide variety of taxa which occur in groups 1 and 2 (containing the later and higher scoring samples) which are absent from the other two groups, including many mollusc families: Unionidae, Sphaeriidae, Valvatidae, Lymnaeidae and Physidae; several beetles: Haliplidae, Dytiscidae and Elmidae; and two relatively pollution-sensitive Trichopteran families: Leptoceridae and Rhyacophilidae. There is a notable lack of Ephemeroptera - only Baetidae and Caenidae are recorded, these being present in all the groups of samples. The only taxa found more frequently in groups 3 and 4 are the Cladocera and Copepoda, suggesting fairly stagnant conditions at the time of these samples. An oddity occurring in samples 6/87 and 8/90 is the family Mysidae, suggesting some saline input at this lowland site.

The division between groups 1 and 2 is based upon a number of taxa, including the Rhyacophilidae and Physidae, which are restricted to or more frequent in group 1. Only a few taxa are limited to group 2, including the Cladocera and Gerridae. Various habitat changes such as weed cutting or dredging, could affect the distribution of the many of the taxa characterising these groups, perhaps more so than water quality.

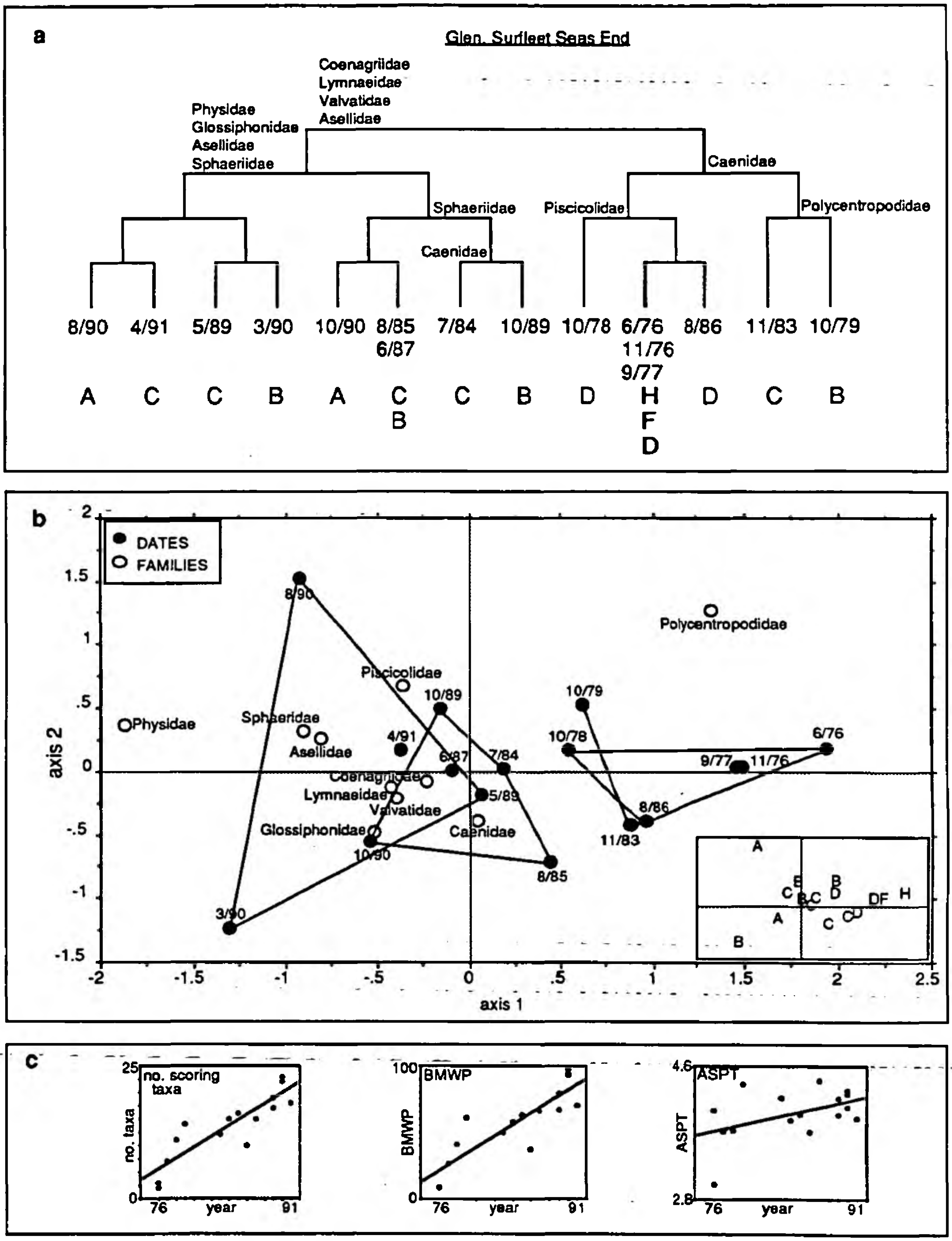



Figure B14. a) TWINSPAN classification, b) ordination and changes in biotic score based on family data for the River Glen at Surfleet Seas End.

The ordination separates samples 8/90 and 3/90 far more clearly than the classification. Sample 3/90 possesses three taxa absent from all other: Dendrocoelidae, Helodidae and Corophidae; and lacks three taxa common in the majority of other higher-scoring samples: Piscicolidae, Hydracarina and Ostracoda. Sample 8/90 again has a few unique taxa: Psychomyidae, Pyralidae; a few relatively rare ones: Unionidae, Mysidae; and lacks the beetles Elmidae which occur in the other high scoring samples. Thus the ordination again appears more sensitive to unique taxa than the classification.

Within the TWINSPAN groups 3 and 4 there is considerable variation in the numbers of taxa within samples rather than type. Samples 6/76 and 11/76 are have severely restricted fauna, containing only Oligochaetes, Gammaridae, Chironomidae, Hydracarina and Cladocera. Saline intrusion is the probable cause, due to drought. Because they share all of the taxa present in the 1976 samples TWINSPAN groups these and the 1977 sample together. However, this later sample has a considerably improved fauna with the addition of Dytiscidae, Baetidae, Planorbiidae, Corixidae and Copepoda. The other two samples in group 3 possess taxa including Haliplidae and Hydrobiidae, in addition to those in the other samples of the group.

Group 4 samples share most of the taxa present in group 3, but in addition have a number of others including two families of Trichoptera (Hydroptilidae and Polycentropodidae) - an Order completely absent from group 3. It is the presence of taxa such as the Cladocera, Gerridae and Copepoda in these group 4 samples in common with group 3 which places them on this side of the first classification division rather than with the other samples of similar score.

It seems probable that there has been an overall gradual improvement in habitat at this site, subsequent to (but not related to) a dramatic improvement following the drought of 1976 which resulted in a period of saline intrusion.

### 5.6.5 East Glen at Braceborough

Summary diagrams of the analyses are shown in Figure B15, and TWINSPAN preferential taxa listed in Appendix 3.2.

The River East Glen at Braceborough differs from the previous examples in that biological quality peaked in 1986 and declined subsequently, whereas in the majority of sites the peak was in 1989-90. Sixteen biological records exist for Braceborough, over the period 1978-91.

The TWINSPAN classification produces the following main groups:

1: 2/83, 6/86, 6/87, 8/87;
2: 4/89, 2/90, 3/91, 11/88, 11/89, 7/90;
3: 8/84, 7/85, 11/83, 10/90;
4: 10/78, 10/79.

These groups coincide with differences in both biological quality of samples and years of sampling. The first TWINSPAN division separates the later samples (groups 1 and 2) from the earlier ones (groups 3 and 4), with two exceptions (see later). Within each of these two major groups the second split appears to divide samples of high (groups 1 and 3) from low (groups 2 and 4) biological quality.

The first TWINSPAN division shows the "early" samples (groups 3 and 4) to have a number of taxa absent or less frequent in the "late" group, including relatively "sensitive" families such as the Leuctridae, Ephemerellidae, Hydroptilidae and Polycentropodidae; the molluscs Physidae and Valvatidae; a number of Coleopteran families: Haliplidae, Hydrophilidae and Gyrinidae; and the micro-crustaceans Copepoda, Cladocera and Ostracoda The "late" group has relatively few preferential taxa: Limnephilidae, Hydropsychidae, Leptoceridae, Sericostomatidae and Psychodidae. Bearing in mind that this first split seems to be based on

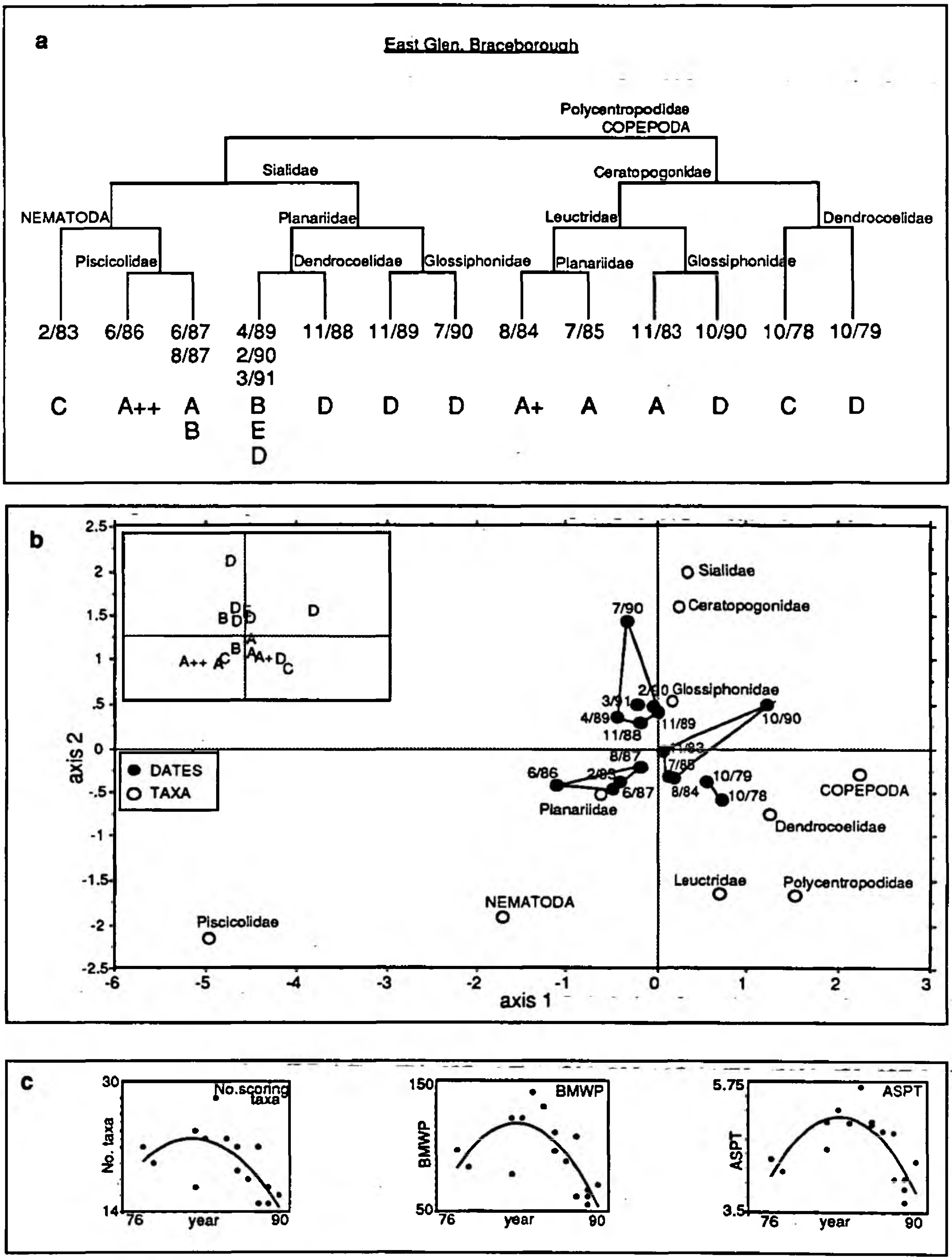



Figure B15. a) TWINSPAN classification, b) ordination and c) changes in biotic scores based on family data for the East Glen at Braceborough.

temporal rather than water quality differences a possible explanation for the community changes seen might be that there has been a reduction in macrophyte cover or marginal habitat in more recent years.

Within the "late" group, the high-scoring group 1 separates from group 2 on the basis of a number of Ephemeroptera: Leptophlebidae, Ephemerellidae, Ephemeridae and Caenidae; and Trichoptera: Hydropsychidae, Hydroptilidae, Limnephilidae and Glossosomatidae. Similarly, within the "early" group, high-scoring group 3 separates from group 4 because of the preference of several Ephemeroptera and Trichoptera: Leptophlebidae, Ephemeridae, Caenidae, Limnephilidae and Goeridae; but also other insect orders: Odonata (Coenagriidae), Plecoptera (Leuctridae) and a large number of Coleoptera and Hemiptera: Gyrinidae, Hydrophilidae, Corixidae, Notonectidae and Gerridae. These reinforce the idea that good marginal habitat may be sustaining these rich communities.

Two samples do not appear to fit in with the early/late, high-scoring/low-scoring pattern outlined above. Sample 2/83 has a low score for group 1. It lacks many taxa present in the other members of this group, but has more in common with it than with group 4. Sample 10/90 also has a low score compared to the rest of its group, but most of those taxa it has it shares with other members that group. However, these are not all the most common taxa in the group, which may account for the ordination separating this sample more clearly than the classification. In other respects the ordination confirms the TWINSPAN classification.

Disregarding the two "odd" samples that could be due to short-term events, the pattern suggests that there has been a permanent habitat change, possibly linked to improved marginal habitat, superimposed upon which are short term changes due to a range of stresses such as pollution or drought.

## 5.7 Seasonality

The life history patterns of many invertebrates, particularly univoltine insect species, create seasonal peaks and troughs in abundance of many taxa. It might therefore be expected that this element of seasonality in individual taxon abundance may lead to changes in numbers of taxa collected at a site and biotic scores depending on the time of year, particularly where a large proportion of the fauna share similar life histories. Insect dominated sites may show fewer taxa in early autumn, for instance, between emergence of one generation and hatching of the next.

Comparison of samples collected during different months using classification or ordination of the whole data set proved unsuitable for examining seasonal differences due to the overwhelming influence of site-specific variation. Applying similar methods to individual sites was also inappropriate as no single site had sufficient number of records.

Investigating the seasonal distribution of individual taxa was problematical due to the uneven distribution of samples between months. In an attempt to overcome this "weighted frequencies" were calculated for the commoner taxa by first separating the samples into the three major reach types ("upland", "intermediate" and "lowland" - see Section 5.4.4 ), then dividing the number of occurrences of each taxon within each month by the proportion of samples taken in each month within the reach type. The results for the three reach types were then totalled to give a single "weighted frequency" for each taxon for each month. These were then plotted against months to reveal any seasonal differences. It should be noted that the above procedure is not statistically reliable and was used only to look for general patterns. For several taxa seasonal patterns were apparent. Figure B16 shows the distribution of the Caenidae and Ephemerellidae and relates these to the known life-history curves for the common species in these families (Elliott et al 1988). The species chosen as representative of the families (*Ephemerella ignita* and *Caenis luctuosa* and *C. horaria*) have been found to be common in the River Glen (Milan, pers. comm.). For the Caenidae, a sharp decrease in frequency of collection occurs in July, corresponding to the emergence of the adults, followed by an increase during the period when

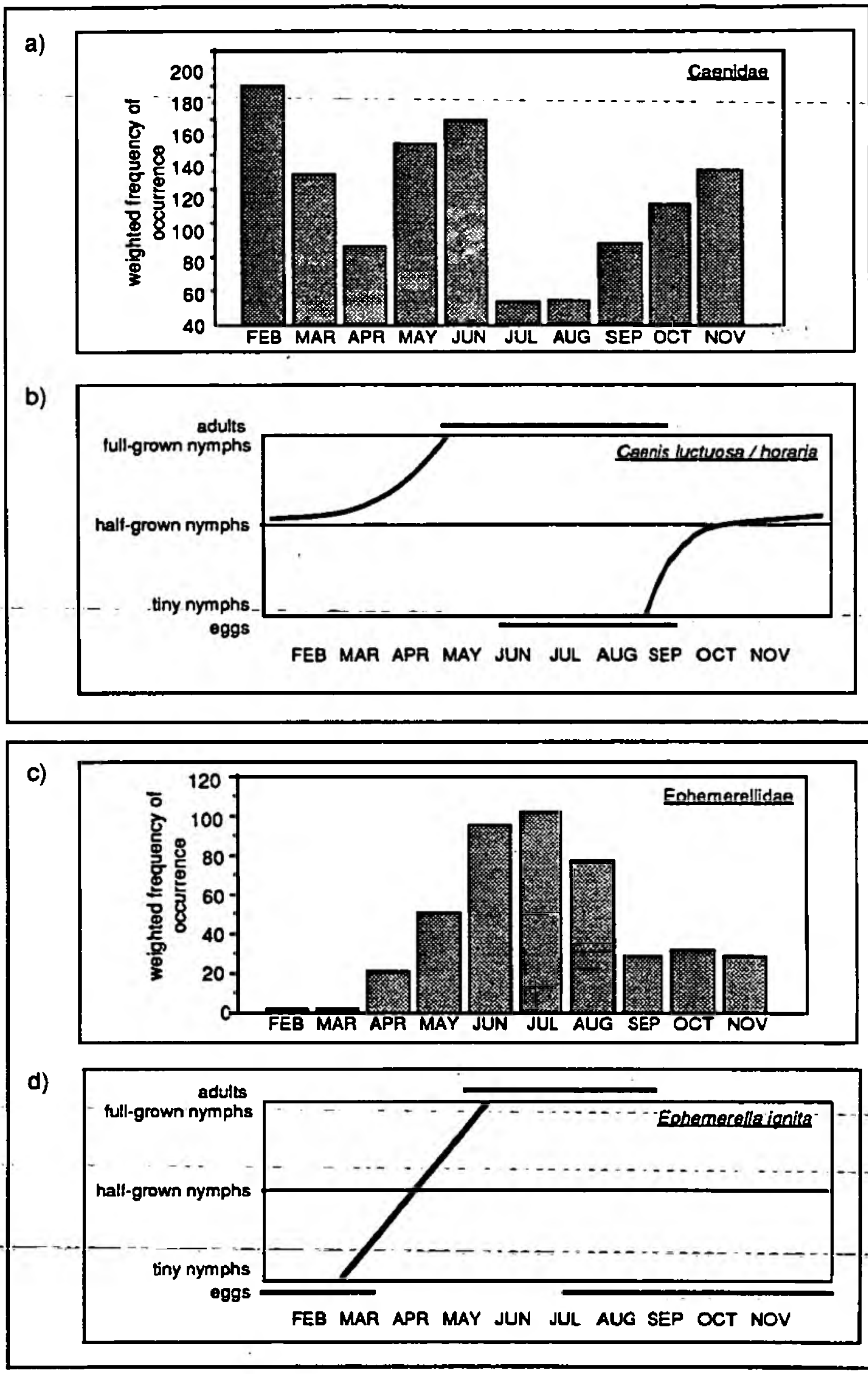



Figure 16. Frequency of occurrence of the families Ephemerellidae and Caenidae in each month. Frequencies are weighted to compensate for unequal sampling intensity within each month and reach type (units are arbitary). Observed weighted frequencies: a) Caenidae and c) Ephemerellidae; temporal distribution of life-stages: b) *Caenis luctuosa* and *C.horaria* and d) *Ephemerella ignita* (adapted from Elliott *et al* 1988).

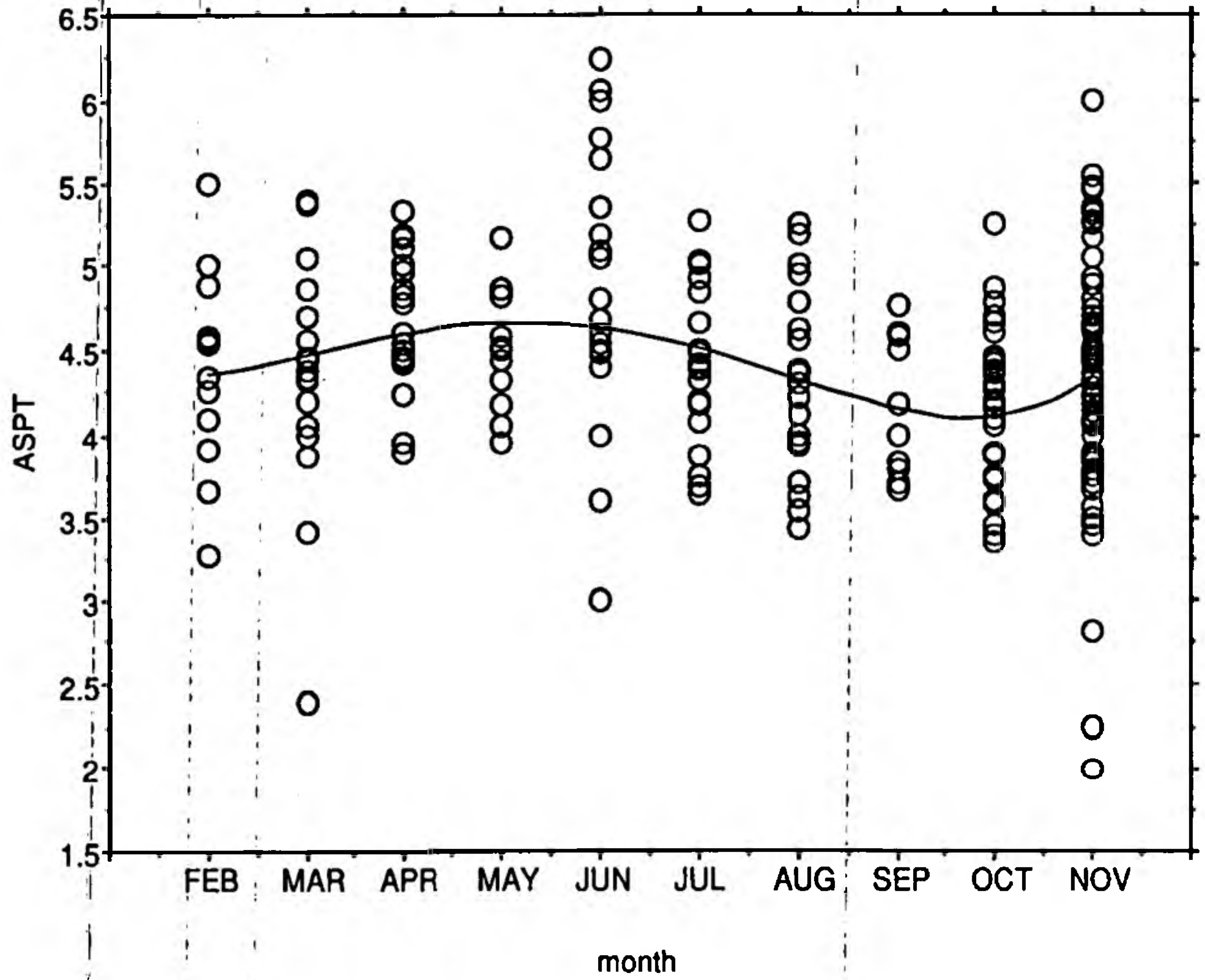



Figure B17. Regression of ASPT against month, all samples

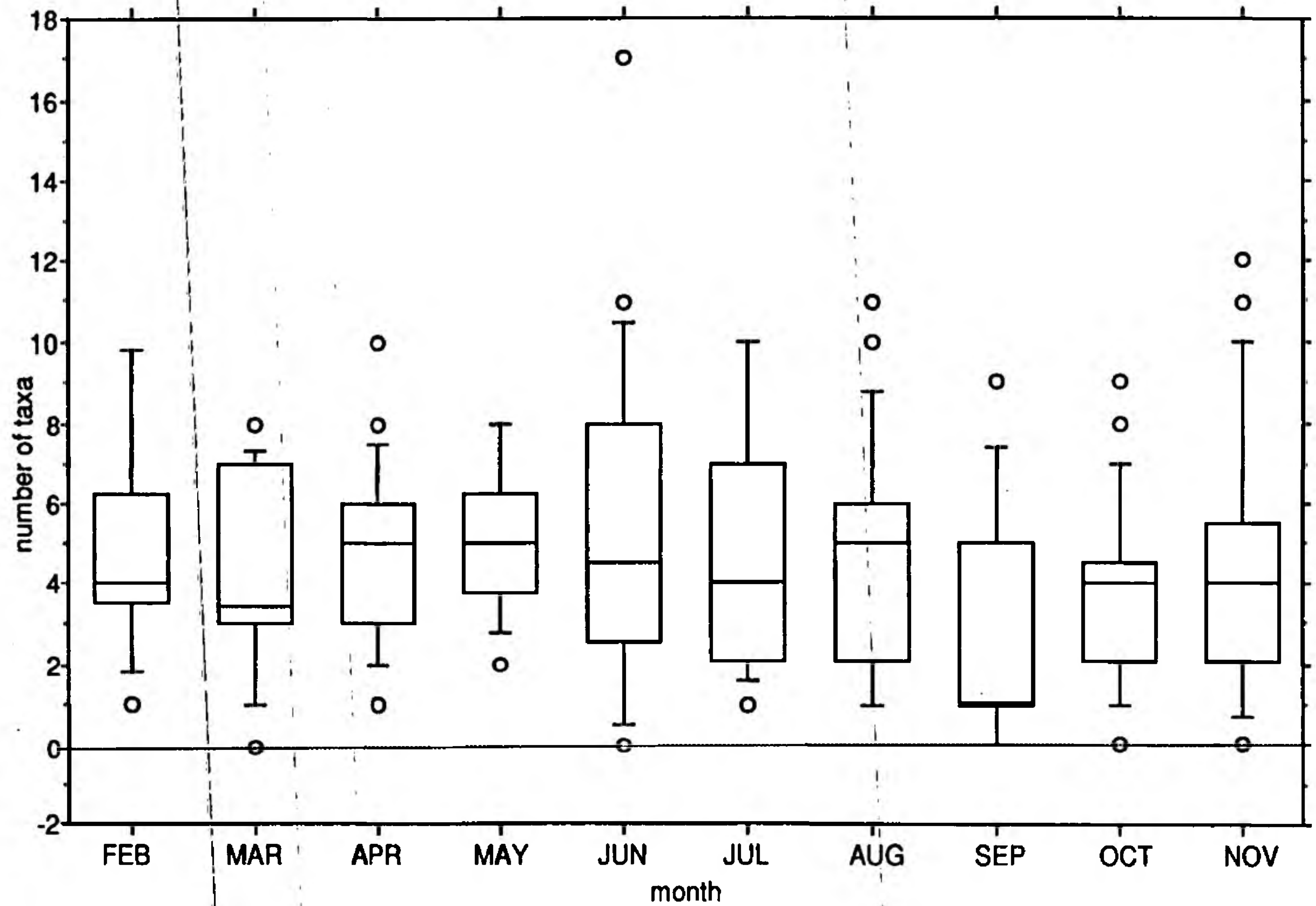



Figure B18. Numbers of Ephemeroptera, Plecoptera and Trichoptera taxa collected each month. Box plots indicate means, one standard deviation error and 95% confidence limits.

the next generation of nymphs would be hatching from eggs. In the Ephemerellidae the decrease in frequency of collection (which occurs during August-September) is later than that predicted from the known life-cycle - possibly due to a regional difference in the time of emergence.

No significant seasonal differences were found in the total number of taxa or BMWP. However, a significant relationship (NB Again the problem of the uneven distribution of samples between months makes this analysis unreliable) was found between ASPT and month of collection (Figure B17). Lowest scores were found in autumn, as might be predicted as high scoring taxa are predominantly insects with aquatic larvae and nymphs, the majority of which emerge in summer. Other explanations may be possible, linked to this season being the one of lowest flows.

Based on the assumption that the taxa contributing to the seasonality of ASPT scores would be predominantly the Ephemeroptera, Trichoptera and Plecoptera, numbers of these taxa alone were plotted against month (Figure B18). Contrary to expectations no significant seasonality was found in numbers of these taxa recorded, although the seasonal trends coincided with those of ASPT (Figure B17).

## 5.8 Performance of biotic indices

The use of biotic scores to evaluate the diversity and quality of invertebrate fauna at a site potentially masks differences in communities due to the grouping of taxa with quite varied behaviours, life histories and other ecological traits into score groups using the sole criterion of sensitivity to organic pollution. Classification and ordination of samples based on individual taxa can be used to look at variability within score groups, in order to identify how much between-sample variation is being ignored by consideration of biotic scores alone.

### 5.8.1 Variation within LQI classes

Figure B19 shows the correspondence analysis ordination of the family data from all sites with the area of the plot covered by samples from each LQI class shaded. This demonstrates that the area covered by samples within the A classes (A, A+ and A++) is greater, ie. the variety of communities is greater, than that of the lower classes. Thus grouping sites as "A" class disguises a greater range of faunas than E or F classes. Samples in the lower score classes have a greater proportion of taxa in common than those in the highest classes.

### 5.8.2 Classification and Ordination of samples within LQI classes

#### LQI A, A+ and A++ class samples

Classification of the samples which scored A, A+ or A++ on the LQI scale using TWINSPAN revealed that the within class diversity could be accounted for largely by between site differences (Figures B20 and B21). A very distinct split was apparent between the lower main Glen and Bourne Eau sites on the left, and the Tham and West Glen on the right. The few East Glen samples achieving A class status split between the two main groups, with the more upstream sites on the left and downstream ones (EBR) on the right. This division mirrors that observed for the whole data set. Preferential taxa associated with this division in the A class samples (listed in Appendix 3.3) are the same as for the whole set, with the exceptions that the families Hydrophilidae, Gerridae and Physidae are also preferential for the left-hand group, and Sericostomatidae for the right-hand group in the A class samples, whereas the

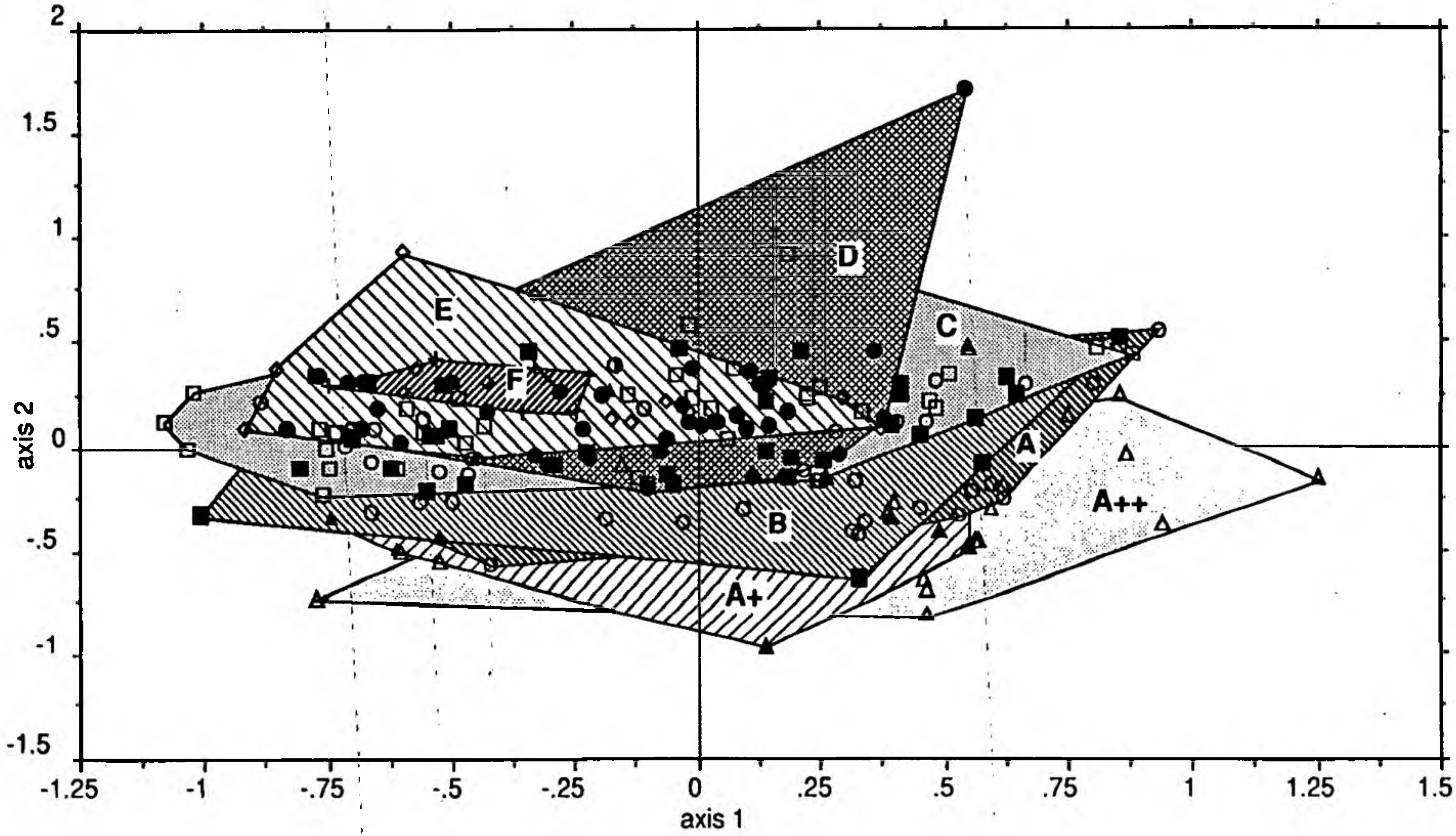



Figure B19. Ordination based on a correspondence analysis of family data for all samples; LQI classes are highlighted.

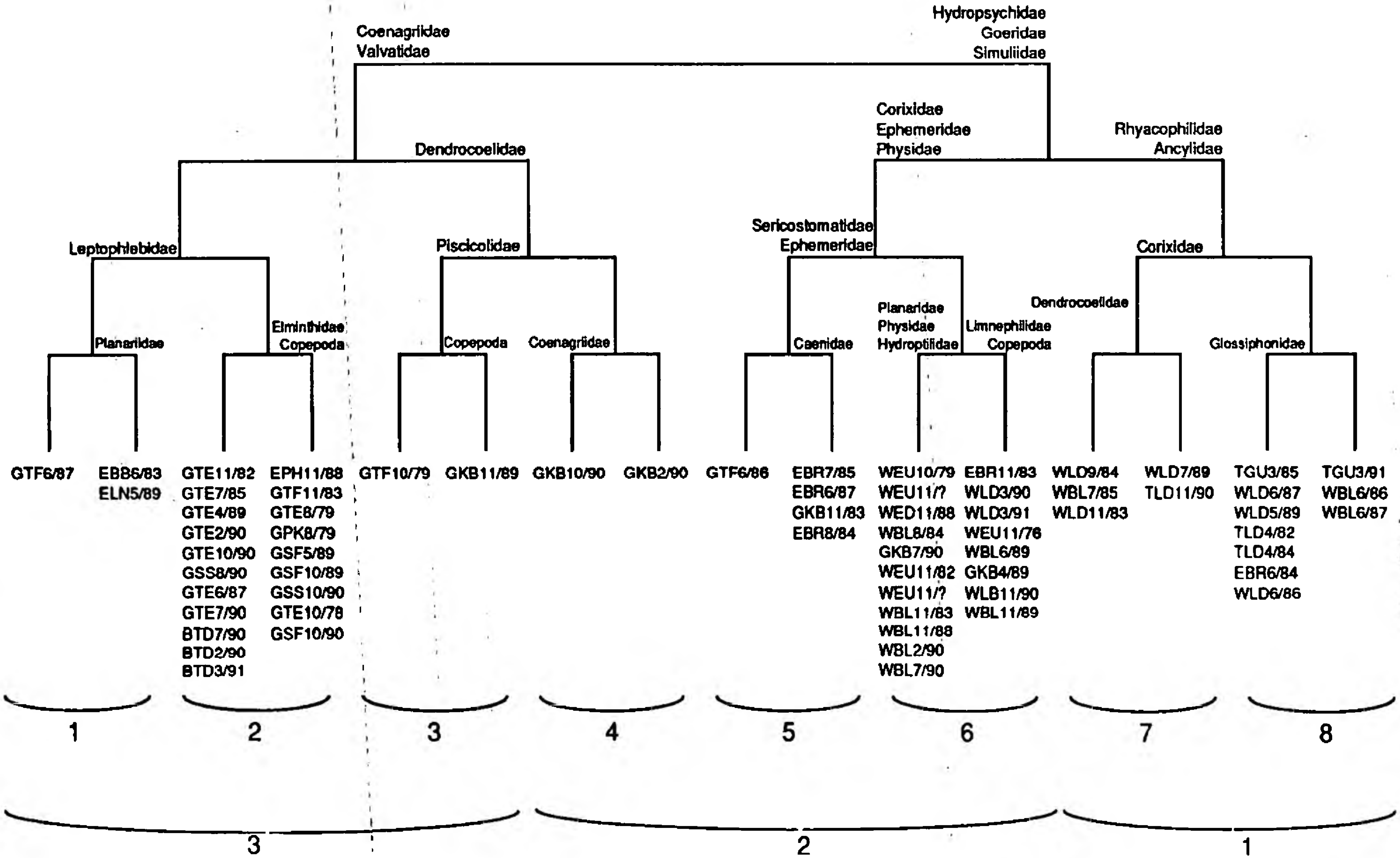



Figure B20. TWINSPAN classification of LQI class A, A+ and A++ samples. Groups 1-8 are referred to in figures 20 and 21, and groups 1-3 in figure 26.

Figure B21. TWINSPAN samples and taxa matrix for LQI class A-A++ samples

```
77 Valv atid ----2222222-22--22222222222-----------------------2-------------- 1111
76 Neri tida ------------------2--2--------------------------------------------- 1111
74 Unio nida -----2222-2------------------------------------------------------- 1111
73 Empi dida -------------------2---------------------------------------------- 1111
66 Culi cida ----------------2------------------------------------------------- 1111
52 Hydr ophi ------------2---22-22-2-----2---2--------------------------------- 1111
47 Pyra lida -------22---------------------------------------------------------- 1111
39 Phry gane ----------2-2--------222------------------------------------------ 1111
24 Coen agri 2222-22222--22-22222222222---------------2------------------------ 1111
23 ANIS OPTE ----------------2------------------------------------------------- 1111
22 Mysi dae  --------2--------------------------------------------------------- 1111
85 Succ inei -----------------------2------------------------------------------- 1110
58 Hydr omet -------------2-2------2--2----------2----------------------------- 1110
17 CLAD OCER ---22-----------222-----2222---22---------------------------------- 1110
80 Phys idae 2--2--2-222222-222---222222---2--22-2-22222-----2-2--------------- 1101
70 Taba nida -------2-----------------------------------------------2---------- 1101
61 Noto nect 2---2-22-222-2-2----2-2-22--22-2-2--2-2--2-------2---2------------ 1101
60 Gerr idae ----2----222--2-----2-2--2-22-------2-----2----------------------- 1101
16 OSTR ACOD ---2--222---2--2222-2-22222----2---------------222---------------- 1101
79 Lymn aeid 22222-22222222-22222222222-2222--2-22--2-22---2--22222222--------- 1100
19 Asel lida 2-22222222222-22222222222222-2---2-2---22-222-222-2-222-2---2---- 1100
71 Musc idae ---------------------------22--------2-------------------2---------- 1011
81 Plan orbi ---22222222-2222222222222222-22-222222-222222-22222222--2--2---- 1010
78 Hydr obii 2222222222222222222222222222-2222---22---22222--22-2-22222-2-22-2-- 1010
59 Cori xida 2-222222222222222222-22222222222222-22222222-2222222222---------- 1010
49 Hali plid 22222222222---2-2222222222-22-2-2222--22222-2-222-22222---2-----2 1010
42 Lept ocer 2----2-2-2222222222222222---2--2222222-22-222-222--2---22--22-22 1010
33 Sial idae ---22-2---222-2---------2222------2--22---2222--2-22-2--2----------2- 1010
65 Cera topo -----2----22--2-22--2--222--2-22-2-2--22-2--2---------222----2--- 1001
32 Caen idae 2222222--2-22222-222---2222-22222222222222-22222222-2--2-22--22222 1001
75 Spha erid -2222-222-22-2222222----222-2222222222222222222222222--2-2-22-2 1000
64 Chir onom 2-2222222222222222222222222222222222222-222222-2222-22222222222222 1000
14 Glos siph -2222-222-22222222-2222222-2-2222222-22-22-22222222222222222222--- 1000
8 Plan arii -222--222-2222-22222222222-222-22222222222-2---2--2-2-22-2222222 1000
53 Helo dida --2-------2--2-----------------------------22-----------22--22---2-- 0111
86 HYDR ACAR 2-2-2--22-22-2222222--2222222222-222-22222-2-22-22-2-22222222222-2 0110
50 Dyti scid 22222-2222222-22222222222-22222222222-222222-2222-22-222222-2222- 0110
28 Baet idae 2222222222222222222222222222222222222222222--2222222222222222222222 0110
20 Gamm arid 2-22222222222222222222222222222222222222222222222222222222222222222 0110
18 COPE PODA 2-2-----------2-2222----2---2-----------2---2--2-22-2-22---2-------- 0110
13 Pisc icol 2--22-2-2--2----2--222222-----2--2-2-2222-2-22-2-2-2-22222--22---- 0110
12 Olig ocha 2222222222222222222222222222222222222222222222222222222222222222222 0110
2          2222222222222222222222222222222222222222222222222222222222222222222 0110
48 Elmi nthi 22------------22-22-2222222-22222222222222222222222222222222222222 0101
15 Erpo bdel -22-----2-2222222--222-2222-2-22222222222222222222222222-2222-2-22 0101
51 Gyri nida ------2---2------------22---------2-2---2--2--2------22----------- 0100
41 Mola nnid ----------2-------------2------------2--22------------------------ 0100
38 Hydr opti --------22-------22---2-2222-2-22-22-2--2--2---------22-----2-2-----2- 0100
62 Tipu lida -----2--------22------2---222-2--22-2--2---2222-2--22222222222222222 0011
40 Limn ephi 2-22---------22-------------22222--2--22-2-2-222-22222222222222222 0011
36 Psyc homy --------2--------------------------------------22---2---2---------2--- 0011
34 Rhya coph --------2----2----------------------2--2-------------22222-222--2222 0011
29 Lept ophl 222----------------------2-22-2-22--22222------222---22-222222--2 0011
83 Ancy lida ---------------------------------------2--------22-2-22--22-222- 0010
67 Psyc hodi --------------------------------------2--------------2--------2-- 0010
63 Simu liid --------------------------22222--222-22--2-2-----2--22-22-222-22222 0010
55 Chry some ----------------------------------------------------2-------------- 0010
46 Glos soso ----------------------------------------------------------2-2-2--2- 0010
44 Lepi dost -----------------------------------------------2--2--2----------2-- 0010
43 Goer idae ------------------------------22--22---222-222-2-222-2-22--2222222 0010
30 Ephe mere 2---2----------------------2222222-222--2-22------22222-222-222-22 0010
11 NEMA TOMO ------------------------------------------------------2----------- 0010
10 NEMA TODA ------------------------------------------------------2----------- 0010
35 Poly cent -----------------------22---2-2222-222-22--2--2-2---2---2-------222 0001
25 Agri idae --------------------------2--------------22--------2--------------- 0001
9 Dend roco -----------------------2222------2222222--2--2--22-222---------2-22 0001
57 Veli idae ------------------------------------22-----2---------------------- 0000
54 Dryo pida ---------------------------2------------------------------------- 0000
45 Seri cost -----------------------------2-2---2-222-2222-22-2-22-----2-22- 0000
37 Hydr opsy --------------------------2----22-22222222222-222-2-2222-2222222-22- 0000
31 Ephe meri --------------------------2-2----222222222222-222-2--2-2---------2- 0000
27 Leuc trid ------------------------------2--2-------------2--------------------2 0000
7 PORI FERA ------------------------------------2-2------------------------------ 0000
          00000000000000000000000000011111111111111111111111111111111111111
          00000000000000000000000011110000000000000000000000011111111111111
          00011111111111111111111110011000001111111111111111110000011111111
          01100000000000011111111101010111100000000000111111110001100000000111
           1        2          3 4   5         6          7     8
                    1                          2                 3
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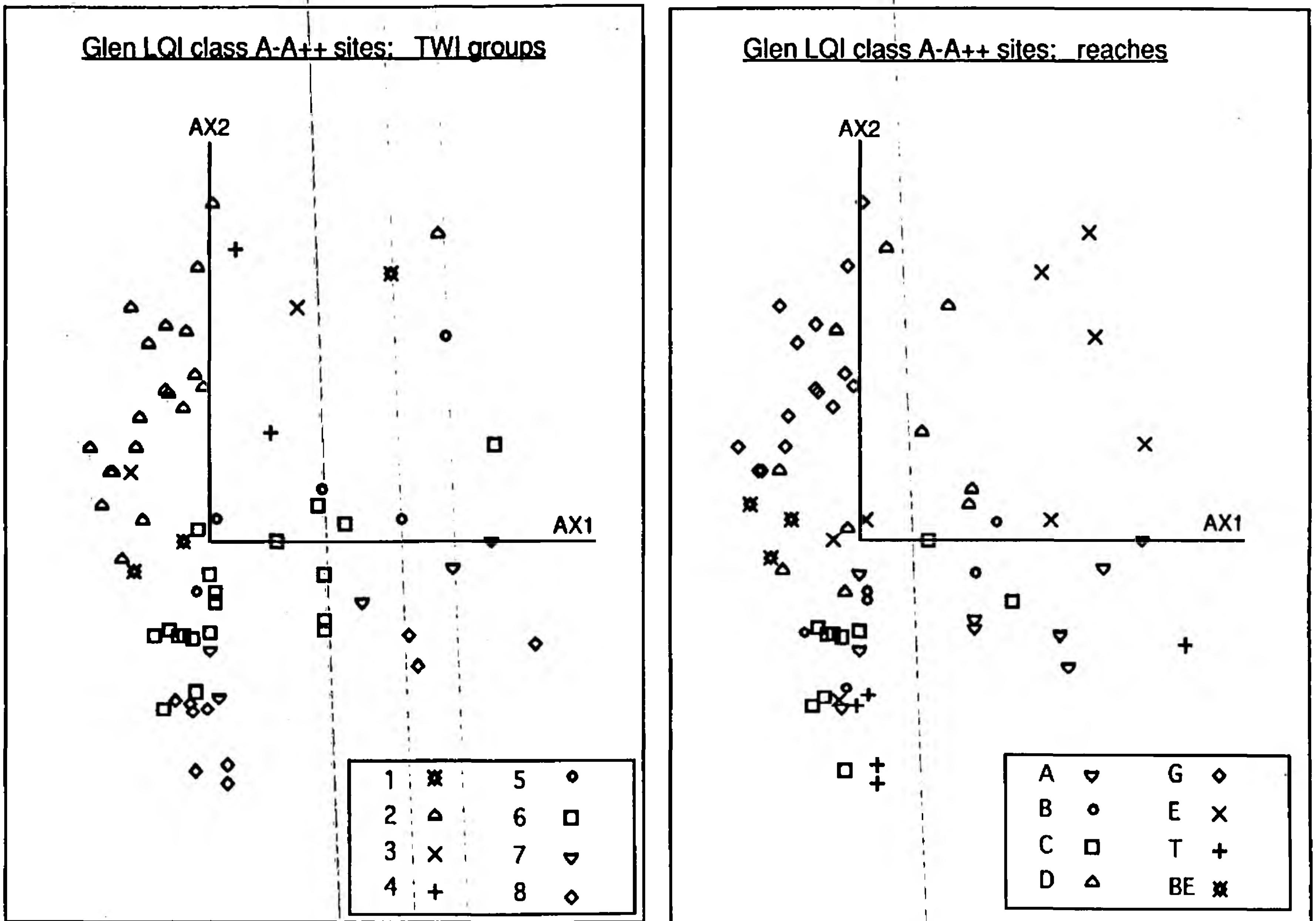


Figure B22. Ordination based on correspondence analysis of family data for samples in classes A-A++, with reaches and TWINSPAN end groups (see Figure 20) highlighted.

Hydroptilidae are no longer more frequent in the right-hand group in this classification. Thus the site-based division is generally sharper in the A class group alone.

The next division within the lower Glen samples separates a small number which are relatively taxa-rich (one GTF and three GKB samples) from the rest, while in the West Glen and Tham samples split roughly between the lower West Glen and the few East and main Glen samples on the left, and the upper West Glen and Tham samples on the right. This again mirrors the classification of the whole data set.

Ordination of the A class data (see Figure B22, which shows the same ordination with reaches and TWINSPAN groups separately highlighted) confirmed the higher groupings produced by TWINSPAN, but showed the lower divisions to be somewhat arbitrary. Highlighting the samples by reach showed again that the TWINSPAN groups broadly coincided with the different reaches The implications of the classification and ordination are that class A - A++ samples from different reaches contain communities characteristic of those reaches, with particular characteristic taxa, not just a greater diversity.

### Classification and Ordination of LQI B and C class samples

Repeating the TWINSPAN classification (Figures B23 and B24) and correspondence analysis (Figure B23 - axis 3 appears to be as significant as axis 2 in this analysis, so plots using axes 1 and 2 and 1 and 3 are shown) on the samples scoring either B or C on the LQI scale produced as, if not more, positive a reach-separation as for the A class data. This was rather unexpected, as a greater diversity was predicted between the higher scoring samples. Again the lower, main river and Bourne Eau sites are separated from the rest on the basis of a rich mollusc fauna and certain other taxa characteristic of slow flowing or still-water sites with abundant macrophytes, eg. Cladocera, Coenagriidae and Notonectidae. (Preferential species for this classification are listed in Appendix 3.3.)

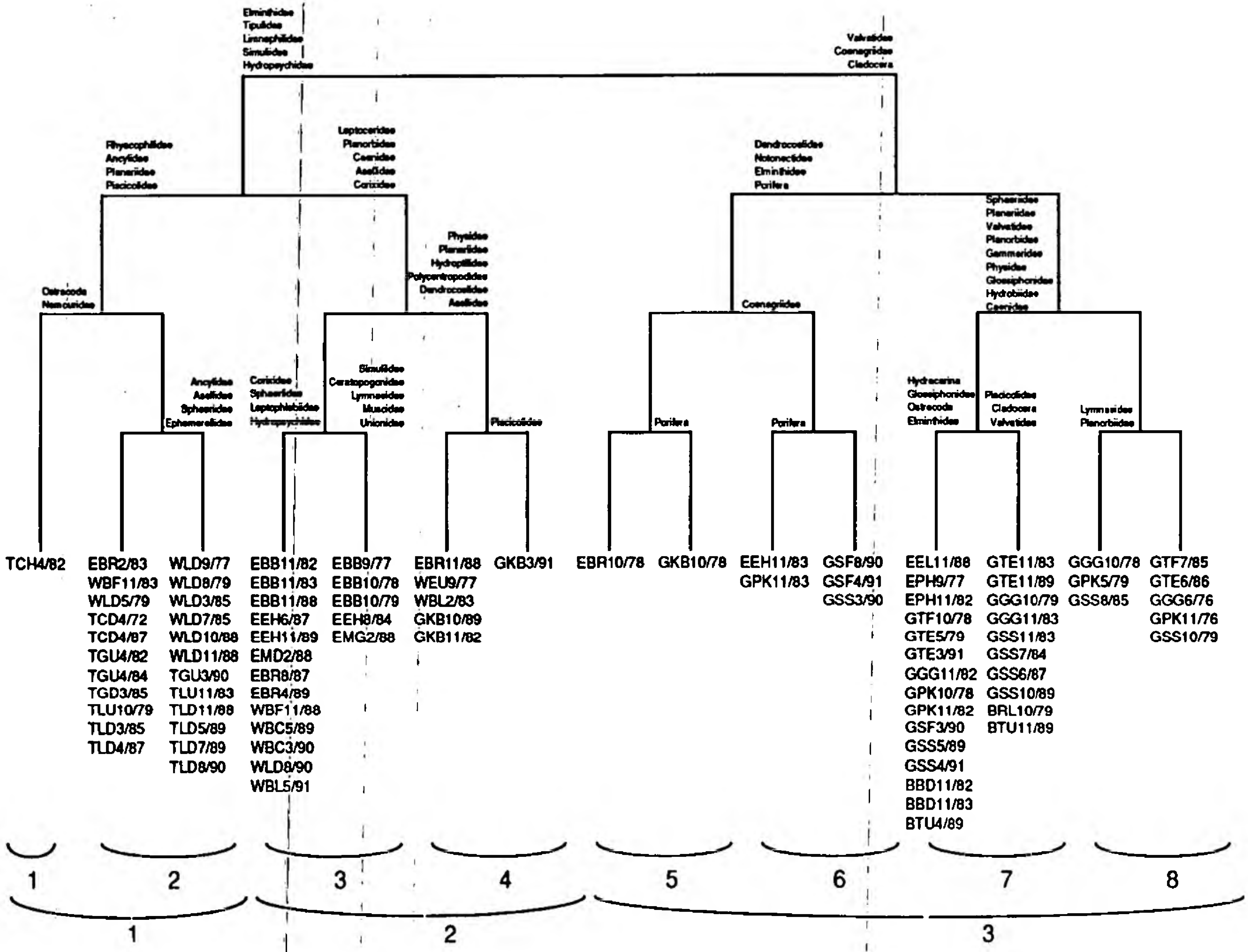


Figure B23. TWINSPAN classification of LQI class B and C samples. Groups 1-8 are referred to in figures 23 and 24, and groups 1-3 in figure 26.

Figure B24. TWINSPAN samples and taxa matrix for LQI class B and C samples

```
 5 COEL ENTE  ------------22----------------------------2-----------------------------------------------  0000
26 Nemo urid  2-----2-------------------------------------------------------------------------------------  0000
27 Leuc trid  ------------------------2-------------------------------------------------------------------  0000
34 Rhya coph  ---2222-22-222-2222-2-2----------------------------------------------2-------------------  0000
43 Goer idae  -2-2--2---22-22--2-2-----------2----------2-2-2------------------------------------------  0000
46 Glos soso  ---22---2--2--2--------------------------------------------------------------------------  0000
73 Empi dida  ----------------2------------------------------------------------------------------------  0000
83 Ancy lida  --------2-2-22222-222222-----------2--------2--------------------------------------------  0000
30 Ephe mere  ------------22-22-2-2222------2----22-----------2------------------------------------22---  0001
53 Helo dida  ------2--2----------22------2-------------------2------2----------------------------------  0001
31 Ephe meri  ------------------2-----------2-------------------------------------------------------------  0010
37 Hydr opsy  --2222-22-22--2-222--2-2-2222---2222----2-----22--2---------------------------------------  0010
40 Limn ephi  222222222222-22--22222-------222-2--2----2-22--2-----------------------------------------  0010
45 Seri cost  ------------------2-----------------------2----------------------------------------------  0010
52 Hydr ophi  ---2-----------2---2-------------2------2---------------------------------------2------  0010
63 Simu liid  222222--222-2-222-2--222-----22--22-222222--222222--------------------------------------  0010
11 NEMA TOMO  ---------------------------------------------2-------------------------------------------  0011
29 Lept ophl  2-2--------2-------------2-2-22222-----------------------------------------------------  0011
36 Psyc homy  -----------------2---------------------------22-----------------------------------------  0011
69 Stra tiom  ------------------------------------2----------2----------------------------------------  0011
33 Sial idae  ---------------2-2----22--2----22--2------22-2-2-------2--2------------2---------------  0100
42 Lept ocer  --------------2------2----2-22-2-2222---2222-222-22--------2---------2------2--------2--  0100
48 Elmi nthi  -2222-222222222222222222222222222222222222222222-222222-2----2--22--------------22-----  0100
62 Tipu lida  222-2-222222-22222222-2222222--22222-222-2-222222---------2--------2---22----2-2-2------  0100
67 Psyc hodi  ------------------2-------2----2----2----------2------------2--------------------------  0100
70 Taba nida  -------------------------2-----2----2--2------------------------2-----------------2------  0101
15 Erpo bdel  -222------222222222-22222222222-2222222222-2222222---22-222-2-2--222---22----22----22-2  0110
35 Poly cent  ----22----------2--2-----------------------2-22-22--------------------------------2---2  0111
71 Musc idae  ---------2----2--------2------------2--2----2-2222------------2-----------------2------  0111
10 NEMA TODA  -2--------------------------------------------------2-----------------------------------  1000
13 Pisc icol  ------22--2---2222-2222------------------------2-2---------2---22------2222-22222----2---  1000
74 Unio nida  ------------------------------------2-2------------------------------22----2-----------  1000
 8 Plan arii  -222222222222-222222222-------222---2-----22222222-2222-222222-22222222-2222-222-22-----  1001
 9 Dend roco  --------------222--2-----------------------2-2--2-22222--2-2-----------2----------2---------  1001
12 Olig ocha  222222222222222222222222222-222222222222222222222222222222222222222222222222222222222222-2  1001
14 Glos siph  --22222-2-2222222222222222222-222222222222-2-2222222-22222-222222222222-22----22-22--2--  1001
20 Gamm arid  2222222222-22222222222222--22222222222--2222222222222222-222222222222222222222222222--2--2  1001
28 Baet idae  2222-222-2-22222222222222-2--22-2-2222222-2222-2222222-22222222222222222222222222222--2  1001
32 Caen idae  -222---2----2-2222---2--222222222-2-22-222-22222--22--222222222222---222222--2-2----22-2  1001
38 Hydr opti  -2-2222--2--22-22------2---------------2--2222222--2---2-2--2----22-2-22---2---------2  1001
49 Hali plid  --2-222222--2-2-22-22--2222-222-222-2--22-22-2--22222222222222---2222-222-2-22-2222222-  1001
50 Dyti scid  2-222-222--2---2-2222222-2-22222222-22222-2-222222222-222--2-2-222-----22--222--2222-222  1001
58 Hydr omet  ----------------------------------------2--------------------------------------2-------  1001
64 Chir onom  22222-2222222222222222222222-22222222222222222222222222222222222222222222222222222-2222222  1001
75 Spha erid  -222--------2222222-22-22222-2222222-2-2-222-22-2222222-22222--22222222---2-22---------  1001
78 Hydr obii  -2-2222222222-2-222222--2-222-2-22-2-2222-22-22-222222222-222222222-2222222-2-22--2-2  1001
79 Lymn aeid  -22222--2---222---222222-22---22-2---222-2-2--2222--2-2-2-2-222222-2222222-22222222----  1001
86 HYDR ACAR  -22222222-222-2-222-222-22-2-22222-22-222-222222222-22-22222-2-22222-2--2---2---2-2222-2  1001
19 Asel lida  ---------------2-2222--2----2-22222-2-222--22222222-222222-222222222-2222----22222-22--2  1010
65 Cera topo  ----2---------2------------2----2----2-22222-2----2---2----222---2-2-----2--2----22-2-2-2  1010
81 Plan orbi  -2----------2-22-2-----22-2-2-22-222222-222222222222222222222222222222222222222222----2  1010
59 Cori xida  -------2-------222-22-2-22222-22222--2----2-222-22222222222222222222--2-2222222222222222-22  1011
 7 PORI FERA  ----------------------------------------------2--222-------------------------------------  1100
61 Noto nect  --------------------------2-2-------------------22222-------------2-------2-----------  1100
16 OSTR ACOD  2-------------------2-----------------------2-222---2----2-2-22222--22--------------2-2  1101
18 COPE PODA  2---2------------------22-----------2--22-----------2---2-22-2---2--22-222-2-2---2-2----2-2  1101
80 Phys idae  ------------------------------------------2222222--222-2-2-22----222-2222----2-2-------  1101
17 CLAD OCER  ---------------------------------------------2-2--22-----2--222------2-2222-22-2-222--2  1110
21 Coro phid  ----------------------------------------------------2-----------------------------------  1110
24 Coen agri  -------------------------2--------2------------2--22222----2222-222--2-2222222-2222--222  1110
47 Pyra lida  -----------------------------------------------------22------------------------------------  1110
56 Meso veli  ---------------------------------------------------------------------------------2-----  1110
60 Gerr idae  ----------------------------------------------------------------------------2-----2-2-----  1110
76 Neri tida  -----------------------------------------------------2-----------------------------------  1110
 4 BRYO ZOA   ------------------------------------------------------------2------------------------  1111
22 Mysi dae   ----------------------------------------------------------------------------2---------  1111
77 Valv atid  ----------------------------------------------22--2222---22-222222--22222222222--2-----  1111
82 Vivi pari  ---------------------------------------------------------------2---------------------  1111
84 Zoni tida  ----------------------------------------------------------2-----------------------------  1111
              0000000000000000000000000000000000000000000000011111111111111111111111111111111111111111
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              1      2                  3                4    5  6             7               8
                     1                              2                              3
```

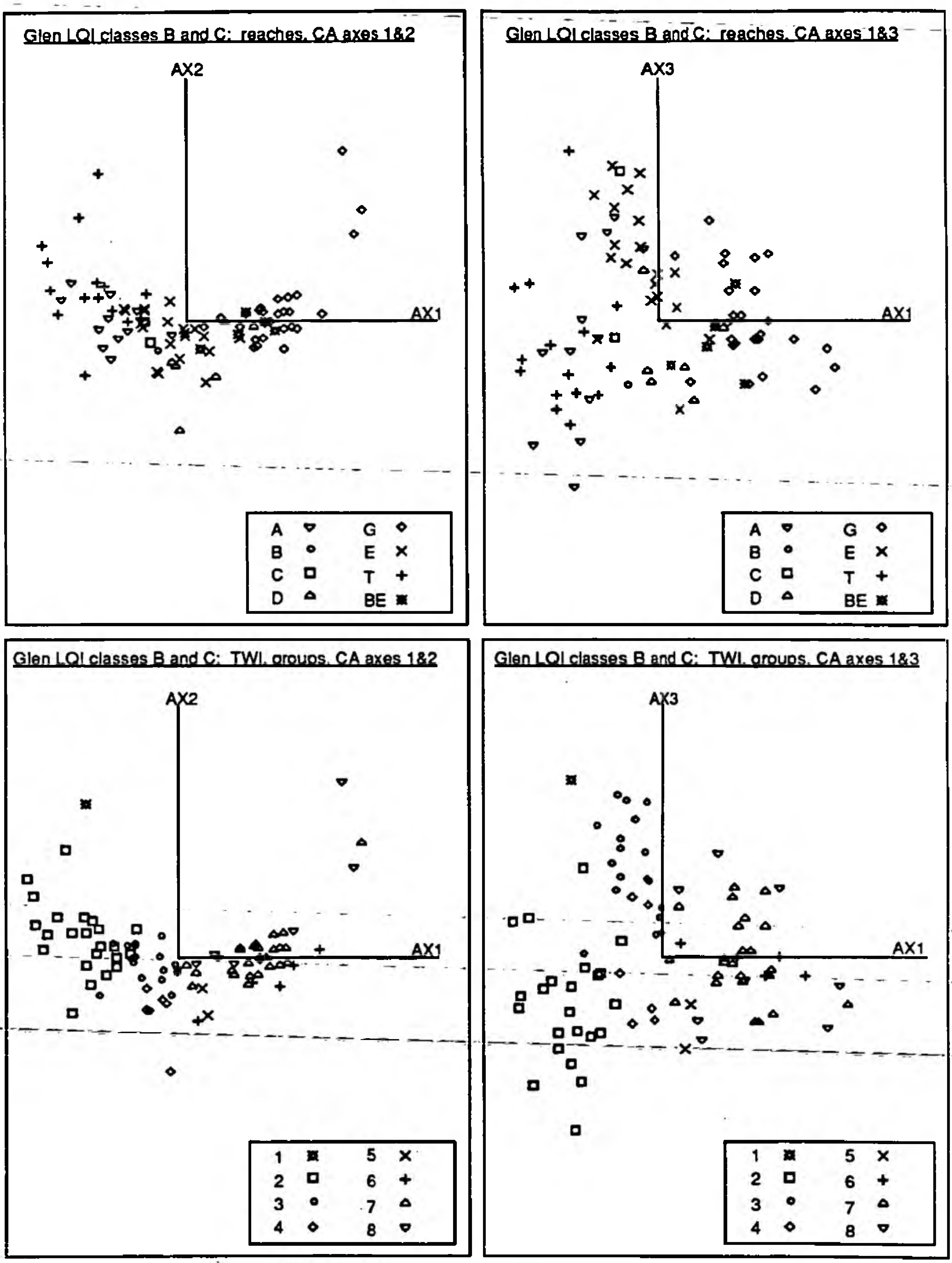


Figure B25. Ordination based on correspondence analysis of family data for samples in LQI classes B and C, axes 1&2 and 1&3, with reaches and TWINSPAN end groups (see figure 21) highlighted.

### 5.8.3 Implications of within LQI class differences

On the evidence of the within-LQI class classifications above it appears that several different types of community can be defined within each class. It may be predicted that a class B site owes it's characteristic fauna to a range of environmental conditions, and that were such a site to improve to class A status, due to, for example, an improvement in water quality, the other environmental constraints at that site would determine what type of class A community would develop.

By extracting from the data those class B and C samples from sites which at the next sampling occasion were class A or above, and comparing the TWINSPAN groups into which these fell with the TWINSPAN group of the subsequent class A sample, it was possible to assess whether class B and C communities of one TWINSPAN group always developed into the same type of class A community. The eight original TWINSPAN end groups were re-grouped into three, these being based on the most significant divisions (subjectively defined from the previous classifications - see Sub-sections 5.8.1 and 5.8.2) which broadly represent the "upper", "lower" and "intermediate" type faunas. Figure B26 shows the frequency with which each transition took place. It is clear that there is a strong link between the nature of the communities from the two bands of LQI class. The taxa associated with the transitions are listed in Table B4.

The variability within LQI classes and the reach-determined nature of this variation has clear implications where conservation measures are undertaken not only to improve biological quality but also to encourage a particular kind of invertebrate community or even specific (perhaps rare) taxa. Water quality improvement alone at a class B site may ensure improvement to class A status, but does not guarantee that, for instance, damselflies, which occur frequently in class A sites, will be present. Reference to the fauna of other class A sites within that reach, however, may enable an accurate prediction of the kind of community to be expected (see section 5.4.4).

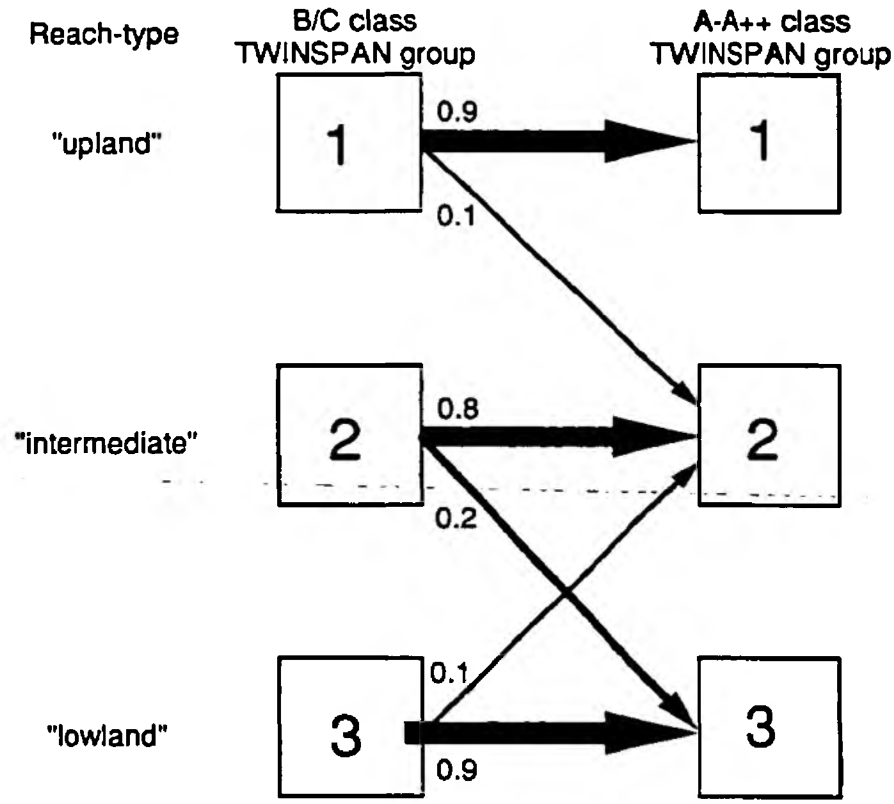


Figure B26. Frequency (numbers by arrows) of transition of LQI class B and C samples of TWINSPAN groups 1-3 to LQI class A-A++ samples of TWINSPAN groups 1-3.

Table B4. Taxa associated with changes from LQI class B/C to A-A++

| Tham and middle West Glen (B/C gp.1 > A-A++ gp.3) | | East Glen and "intermediate" sites (B/C gp.2 > A-A++ gp.2) | | lower main Glen and Bourne Eau (B/C gp.3 > A-A++ gp.1) | |
|---|---|---|---|---|---|
| **taxa gained** | **% samples** | **taxa gained** | **% samples** | **taxa gained** | **% samples** |
| HYDRACARINA | 50 | Piscicolidae | 80 | Leptoceridae | 60 |
| Helodidae | 50 | Dendrocoelidae | 50 | Dytiscidae | 40 |
| Leptoceridae | 50 | COPEPODA | 50 | Gerridae | 40 |
| Leptophlebiidae | 50 | Leptophlebiidae | 50 | Hydrobiidae | 30 |
| Planariidae | 30 | Ephemeridae | 50 | Lymnaeidae | 30 |
| COPEPODA | 30 | Sericostomatidae | 50 | | |
| Polycentropidae | 30 | Dytiscidae | 50 | | |
| Limnephilidae | 30 | Corixidae | 50 | | |
| **taxa lost** | | **taxa lost** | | **taxa lost** | |
| Sialidae | 50 | Asellidae | 50 | | |
| Hydroptilidae | 50 | Tipulidae | 50 | | |
| | | Hydrobiidae | 50 | | |
| | | Planorbidae | 50 | | |
| | | Ancylidae | 50 | | |

# 6 CONCLUSIONS

## 6.1 Biological records

The data set of biological records for the River Glen system is probably a good representative of many for similar systems with a history of water quality, and quantity, problems and general conservation interest. It reflects not only changes in the invertebrate communities of the system, but the development of biological monitoring itself. The records begin in the mid-1970's when biological indices were first widely used, and when the severe drought of 1976 caused particular concerns about damage to,and recovery of, biological communities. The most widely used Biological index at the time was the Trent Biotic Index, and the level of identification used in invertebrate monitoring was that needed to derive TBI scores and little more. The later development of the BMWP system, the LQI system and later still the recognition of the importance of seasonally consistent, routine sampling and species level differences demanded improvements in the level of identification and frequency of sampling: all reflected in the detail of the data set.

These long-term changes in the nature of the invertebrate records inevitably effect their interpretation, particularly in two ways: First, where the level of identification varies, for comparisons to be valid only the highest taxonomic groups can be used, and much detail in "better" records is wasted. Secondly, as the motivation for monitoring has changed from response to particular incidents to routine quality assessment, the average quality observed and the sites targeted will have changed.

If long term assessments of biological records are considered of value, then the above problems should be considered especially carefully when either planning a new or altering an old monitoring program.

## 6.2 Site and reach level differences in Invertebrate communities

The invertebrate fauna of the Glen system is typical of lowland-type rivers, being rich in a range of taxa including many insect orders, molluscs and crustaceans. This invertebrate diversity reflects the water chemistry and diversity of substrate, flow characteristics and macrophytes. Classification and ordination of the family level data revealed distinct reach and site level differences in communities, but also great similarities. Representatives of the Trichoptera, Coleoptera, Mollusca and Crustacea were found in the majority of samples, with changes at the family level distinguishing sites as opposed to whole orders or classes as can be found in comparisons between rivers. Reach-scale differences in community were clear, with "upland", "lowland" reaches and an "intermediate" zone around the confluence of the West and East Glens being clearly distinguished. These reach-types defined on the basis of the invertebrate fauna corresponded closely to known physical differences at this scale, for examples sedimentological differences. By the nature of the faunal differences it appeared that water quality was only one of a number of physical attributes varying between sites and reaches.

The analytical tools used to investigate site and reach differences - TWINSPAN and correspondence analysis - proved successful in combination. TWINSPAN is very useful for identifying assemblages of taxa characterising groups of samples and reaches, but is less helpful in assessing the magnitude of between-group differences, especially where these are principally differences relating to presence or absence of taxa. Ordination is essential for comparing the separation of groups and identifying aberrant samples.

From the classification of the three reach-types, lists of taxa associated with each could be produced, which may be regarded as the total communities which any site within those reaches could potentially possess.

## 6.3 Biological scores

Biological scores including LQI proved efficient at identifying within site differences in fauna: In the site case-studies samples of similar score were consistently grouped together; only occasionally did temporal differences override score differences, and on these occasions long term changes in habitat were inferred. At the site and reach level, however, differences were greater between sites and reaches than between score groups, indicating that factors other than water quality were structuring the communities. Within LQI classes, for instance, site and reach differences were as clear as within the whole data set. Also, these between site and reach differences were as great within the lower LQI classes (B and C) as between the highest (A - A++). This is rather surprising as it was assumed that there would be greater uniformity in the lower-quality sites, with a limited range of common taxa. What may in fact be happening is that where the fauna is reduced it is a more specialised community which remains, being more highly adapted to the particular site-type, ie. it implies that specialism and sensitivity to water quality are not necessarily linked.

The diversity within sites of high and moderate quality (as defined by LQI) emphasises the importance of between-site differences in factors other than water quality: Hydrology, hydraulics, substrate, macrophytes and other biotic and abiotic characteristics, in determining the composition of invertebrate communities, and has clear implications for river management.

## 6.4 Long-term changes

Examination of changes in biological scores over the 1976-91 period for the whole data set indicated that biological quality rose from 1976 to the late 1980's, with a slight fall in 1991. More detailed analysis of individual sites proved that these did not all show the same pattern of changes. Whilst most sites followed the pattern described for the whole data set, some showed a continuous increase in scores, some no change and a few a progressive decrease. In addition, changes in BMWP were a result of either changes in the quality (ASPT) or number of taxa, or both. The implication of this is that changes in invertebrate diversity are occuring as a result of factors in addition to changes in water quality. Some long term changes are likely to be due to "structural" changes in the habitat, perhaps related to weed-cutting and dredging regimes, whereas other, shorter-term changes reflect more variable influences, the most significant of these is likely to be hydrology. A further examination of the biological data in conjunction with the hydrological records could therefore be very enlightening.

The five "case-studies" revealed interesting relationships between temporal changes in invertebrate community and biological score. In the case of Banthorpe Lodge on the West Glen the fauna of the 1991 sample closely resembled that of the late 1970's samples, with which it also shared a low score, suggesting that the community responded to drought in a similar manner on both occasions. However, at Surfleet Seas End on the main Glen the relatively high scoring 1979 sample showed more faunal similarities with the other 1970's samples, despite their low scores, than with the high scoring 1980's samples; while the low scoring 1991 sample resembled the other later samples rather than low scoring 1970's ones. This could be due to saline intrusion during the 1970's period. The Glen at Kates Bridge showed a different pattern again, with the low-scoring 1991 sample resembling faunistically neither the 1980's samples it was close to temporally, nor the 1970's samples it was close to in score. It therefore appears that the fauna of different sites behave differently under stress: Either changing to a new, adapted and quite different community (if, for example, the management regime changes or there is a permanent change in discharge due to abstraction or augmentation), or to a reduced form of their normal community, with only the most sensitive taxa eliminated. Such differences may depend on the nature of the stress, its duration (whether it results in a permanent change in habitat), and also on the nature and source of recolonisation after such a stress event.

## 6.5 Seasonal differences

Evidence for seasonal changes in frequency of collection was found for a number of taxa, predictably families of univoltine insects. Although no significant seasonal changes in BMWP or number of taxa were observed in the whole data set, small but significant changes were observed in ASPT: a distinct trough was observed in September / October. This could be a result of the fact that most high-scoring taxa are insect nymphs and larvae, which do have seasonal peaks and troughs of abundance related to growth, emergence, and egg- or later-stage diapause. However, an attempt to relate numbers of the three orders of insects containing most of these taxa (Plecoptera, Ephemeroptera and Trichoptera) failed to show any significant pattern similar to that of ASPT. The trough in ASPT was later than that expected if the predominance of these taxa were indeed the cause. An alternative possibility is that annual lowest flows, which frequently coincide with this September / October period, are influencing the taxa present and / or collected.

## 7 RECOMMENDATIONS

Analysis of the existing invertebrate records for the River Glen system has revealed that the invertebrate community is responsive to:

- reach-scale habitat conditions, and
- physical and biotic, as well as chemical, variations at sites within the reach-scale constraints.

These findings suggest that there is great potential for expanding the use of biological monitoring beyond the setting and monitoring of water quality objectives (for which it was designed and appears to perform satisfactorily) to assess the potential "best" invertebrate community on a reach-specific basis and set targets if required based on this potential, and by improved and coordinated measurement of a range of habitat factors to monitor the effects of these on the invertebrate community and its ability to achieve the predicted potential. The following strategy (illustrated in Figure B27) is designed to provide the necessary information for such an expanded use of biological monitoring:

### 7.1 Preliminary reach assessment

An initial biological survey of the river system incorporating the maximum number of sites possible and at least three seasonal collections should be carried out in order to identify reach types. Existing invertebrate records could be included in this initial assessment. The choice of sampling sites should aim to include as many habitat types as possible, particularly those subjectively identified as "habitat rich". From this preliminary survey reaches would be defined on the basis of the fauna using a combination of analytical techniques including classification and ordination of sites as described in section 4. For each reach a list of taxa which could potentially be supported in that reach would be compiled.

### 7.2 Selection of routine monitoring sites

Within each reach a number of routine sites should be selected, including those which fulfil the following criteria (within the normal limits eg. accessibility):

- sites of the highest habitat quality
- sites susceptible to ecological damage (pollution, low flows, any other locally important factors)
- sites reflecting the range of management regimes in the reach

Routine monitoring of these sites should provide a continually-updated picture of the maximum and minimum biological quality of the reach, reflecting natural and anthropogenic influences on the invertebrate community.

### 7.3 Biological monitoring - frequency

Sampling carried out in spring, summer and autumn (as at present) appears to provide adequate seasonal coverage. Emergence of some insect taxa can take place within a few days, making it preferable for all sites within a reach to be sampled over the same few days each year, thus allowing accurate between-site and between-year comparisons.

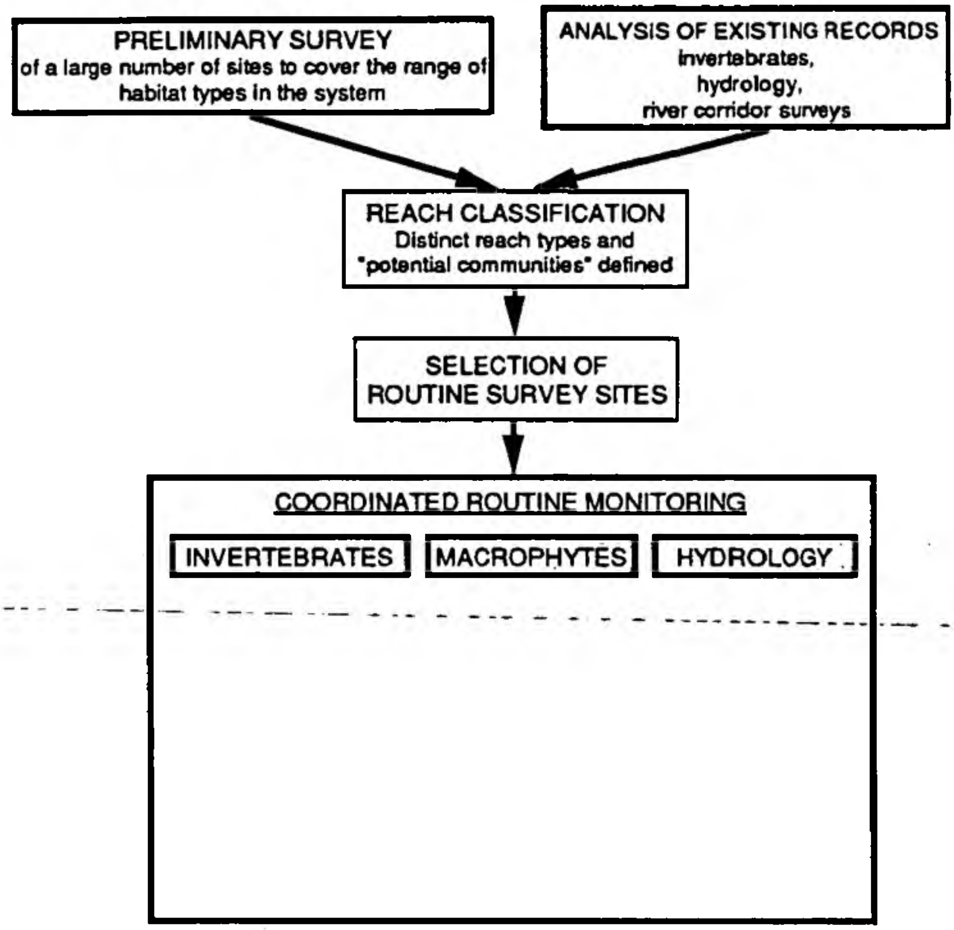


Figure B27 Strategy for reach assessment, coordinated biological and hydrological recording and integration of additional information to allow the monitoring of short- and long-term change.

## 7.4 Biological monitoring - field procedure

### 7.4.1 Invertebrate sampling

The upstream and downstream limits of each site should be clearly defined, and sampling using the kick and sweep method carried out between these limits on each occasion, with the effect that a reduction in wet width will result in a smaller area being sampled. Sampling effort should be divided between micro-habitats in proportion to their area within the site.

### 7.4.2 Invertebrate identification

If identification to species level is considered desirable and practicable for some taxa then this should be consistently used for these taxa. Varying identification between family and species level necessitates that the species level information be wasted when between-sample comparisons are made. For some taxa, species level identification is easy during one season but impossible during others, in which case separate recording forms might be considered for the spring, summer and autumn samples which would allow between-year if not between season comparisons for these groups.

## 7.5 Associated routine monitoring

In order to relate between-site and between sample changes to the physical and other biotic site characteristics, the assessment of a suite of variables should be performed at the same time as the invertebrate sampling:

- macrophyte cover and type - a record of the **percentage cover of the site and dominant species** would be more informative than a list of all species presence / absence alone.

- substrate composition - an index of **dominant substrate type** and amount of surface **siltation.**

- hydraulic characteristics - coordinating **routine current metering surveys** with the invertebrate monitoring would provide vital information on site depth and flow velocity distributions, which could be related to discharge and / or water level information from continuous monitoring stations.

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# APPENDICES

# APPENDIX B1. TAXA LISTS FOR ALL SAMPLES

Appendix 1.

| | E.GB. | | | | | E.PH | E.MT | E.MU | | E.MD | | E.MG | | | | | | E.BR. | | | | | | | | | | | | | | | | ET1.1 | ET1.4 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAXON | 11/82 | 11/89 | 07/90 | 09/77 | 11/82 | 11/88 | 02/88 | 02/88 | 07/88 | 02/88 | 07/88 | 11/76 | 09/77 | 11/82 | 11/83 | 02/88 | 11/88 | 10/78 | 10/79 | 02/83 | 11/83 | 08/84 | 07/85 | 06/84 | 06/87 | 08/87 | 11/88 | 04/89 | 11/89 | 02/90 | 07/90 | 10/90 | 03/91 | 06/83 | 06/83 | 11/88 |
| BRYOZOA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COELENTERATA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| POLYZOA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PORIFERA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Dugesia polychroa/lugubris* | | | | | | | | | | | | | | | | | | |1|1| | | | | | | | | | | | | | | | |
| *Dugesia tigrina* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Polycelis sp.* |1|1| |1|1| | | |1| | | | | |1| | |1|1| | | |1|1|1|1|1|1| |1| | |1| | |1|
| *Dendrocoelum lacteum* |1| | |1| | | | | | | | | | | | | |1| | | | | | | | |1| | | | | | | | | |
| NEMATODA | | | |1| | | | | | | | | | | | | | | |1| | | | | | | | | | | | | | | | |
| NEMATOMORPHA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| OLIGOCHAETA |1|1|1|1|1|1|1|1| |1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1| | |1|
| Piscicolidae | | | | | | | | | | | | | | | | | | | | | | | |1| | | | | | | | | | | | |
| *Glossiphonia complanata* |1|1|1|1| |1| |1| |1| | | | |1| |1| | | | |1|1|1| |1|1|1| |1|1| |1| |1|1|
| *Glossiphonia heteroclita* | | | | | | | | | | | | | | | | | | |1| | | | | | | | | | | | | | | | | |
| *Helobdella stagnalis* | | |1|1| |1| | | | |1| |1| | | | |1| | | |1|1| | | | | | |1| |1|1| | | |
| *Hemiclepsis marginata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Theromyzon tessulatum* |1| |1| | | | | | | | | | |1| | | | | | | | | | | | | | | | | | | | | | |
| Erpobdellidae |1|1|1| |1|1|1|1| |1|1| |1|1|1|1|1|1|1|1|1|1|1| | |1|1|1|1|1|1|1|1| |1|1|
| OSTRACODA | | |1| | | | | | | | | |1| | | | |1| | | |1| | | | | | | | | |1| | | | |
| CLADOCERA | | | | | | | | | | | |1| | | | | |1| | | |1| | | | | | | | | |1| | | | |
| COPEPODA | | | |1| |1| | |1| | |1| | |1| | | |1| |1| |1| | | | | | | | |1| | | |1|
| *Asellus aquaticus* | |1| |1| | | | | | | | | |1| | | | | | |1| |1|1| |1|1|1|1|1|1|1|1| | |1|
| *Asellus meridianus* | | | |1| | | | | |1| | | | | | | |1|1| | | | | | | |1| | | | | | | | |1|
| *Crangonyx sp.* | | | | | | | | | | | |1| | | | | |1| |1| | | | | | | | | | | | | | | | |
| *Gammarus sp.* |1| | | |1|1|1|1|1|1|1| |1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1| |1| |1|1|1| | |
| *Gammarus zaddachi* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Corophidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Neomysis integer* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ANISOPTERA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Coenagridae | | | | | | | | | | | | | |1| | | | | | | | | | | | | | | |1| | | | | | |
| *Calopteryx splendens* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nemouridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Leuctridae | | | | | | | | | | | | | | | | | | | | | |1|1| | | | | | | | | | | | | |
| *Baetis sp.* | | |1| | | |1|1|1| |1|1| |1|1|1| |1|1|1|1|1|1|1|1|1| | | | |1|1| | | | |
| *Centroptilum sp.* |1| | | |1|1| | |1| |1| | | |1|1| | | |1|1|1|1| | |1| |1| | | | | | | | |
| *Cloeon sp.* | | |1| | | | | | | | | | | |1| | | | | |1|1|1| | | | | |1|1| | | | | | |
| Leptophlebiidae | | | | | | | | | |1| | | | | | | | | | | |1|1|1|1|1| |1| | | | | | |1|1|
| *Ephemerella ignita* | | | | | | | | | | | | | | | | | | | | | |1|1|1|1|1| | | | | | | | | | |
| Ephemeridae | | | | | | | | | | | | | | | | | | | | |1| | | | |1| | | | | | | | | | |
| Caenidae |1|1| |1|1|1|1|1| |1| |1| |1|1|1|1| | |1|1|1|1|1|1|1| |1| | | | | | | | |
| *Sialis lutaria* | | |1| | |1| | | | | | | | | | |1| |1| |1| | | | | |1|1|1|1|1|1|1| | | |
| Rhyacophilidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Polycentropidae | | | | | | | | | | | | | | | | | |1|1| |1|1|1| | | | | | | | | | |1| | |
| Psychomyidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydropsychidae |1|1| | | | | |1| | | | | | | | |1| | | | | | |1|1| | | | | | | | | | | |
| Hydroptilidae |1| | | |1| | | | | | | | | | | | |1|1|1| |1|1| | | | | | | | | | | | | |
| Phryganeidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Limnephilidae | | | | | | | | | |1| | | | | |1| | | |1|1| |1|1|1|1| |1| | |1| |1| | | |
| Molannidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Leptoceridae |1|1| | | |1| |1| |1| | | |1|1|1|1| | | | | | |1| | |1|1|1| |1| |1| | | |
| Goeridae | | | | | | | | | | | | | | | | | | | |1|1|1| |1| | |1|1| | | | | | | | |
| *Lepidostoma hirtum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lepidostomatidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sericostomatidae | | | | | | | | | | | | | | | | | | | | | | | |1| | |1| | | | | | | | | |
| *Agapetus sp.* | | | | | | | | | | | | | | | | | | | | | | | |1| | | | | | | | | | | | |
| *Glossosoma sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nymphula nymphaeta* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Elmis aenea* |1|1| | |1| |1|1| |1| |1|1|1| |1|1|1| | |1|1|1|1|1|1|1|1| |1| | |1| | |1|
| *Limnius volkmari* | | | | | |1| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Oulimnius sp.* |1|1| | |1| | |1|1| | | | | | |1|1|1| |1| |1|1| | | | |1| | | | | | | | |
| *Riolus sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Haliplidae |1|1|1|1|1|1| | |1|1| |1|1| |1| |1|1|1| |1|1|1| |1|1|1| |1| | |1|1| | |1|
| Dytiscidae | |1|1|1| |1| |1|1|1|1|1| | |1| |1|1|1| |1|1|1|1|1|1|1|1|1| |1|1|1| | |1|
| Gyrinidae | | | | | | | | | | | | | | | | | | | | |1| | | | | | | | | | |1| | | | |
| Hydrophilidae | | | | | | | | |1| | | | | | | | | | | | |1| | | | | | | | |1| | |1| |
| Helodidae | | | | | | | | | | | | | |1| | | | | | | | | | | | | | | | |1| | |1| |1|
| Dryopidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chrysomelidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mesoveliidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Veliidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydrometridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Corixidae |1|1|1|1|1|1| | |1| |1|1|1|1|1| |1|1| | |1|1|1| |1|1|1|1|1|1|1|1| | | | |
| Gerridae | | |1| | |1| | | | | | |1| | | | | | | | | |1| | | | | | | | | | | | | |
| Notonectidae | | |1| | | | | | | | | | | | | | | | | | |1|1| |1|1| | |1| | | | | | | |
| Dicranota l. | | | | | | | | | | | | | | | |1| | | | |1|1|1|1| | | | | | | | | | | | |
| Tipulidae l. |1|1| | | |1|1| | | | |1| |1|1| |1|1| |1| | | | | | | | |1|1| | |1| | |1|
| Pedicia l. | | | | | | | | | | | | | | | | | | | | | | | | | | |1| | | | | | | | | |
| Simuliidae | | | | | | |1|1|1|1|1| | | | |1| |1|1|1|1| |1|1|1|1| | | | | | | | | | |
| Chironomidae |1| |1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1| | |1|
| Ceratopogonidae | | | | | |1| |1| | | | | | |1|1|1| | | |1|1|1| | | |1|1| |1|1|1|1| | | |
| *Culex sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |1| | | | | | |
| Dixidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pericoma sp. l.* | | | | | | | | | | | | | | | | | | | | | | | | | | | |1| |1| | |1| | |1|
| *Psychoda sp. l.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ptychopteridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |1| | | | |
| Stratiomyidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tabanidae | | | | | | | | | | | | | | | | | | | | | | | | | | | |1| | | | | | | | |
| Muscidae | | | | | | | | | | | | | | | | | |1| | | | | | | | | | | | | | | | | | |
| *Eristalis sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Empididae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Unionidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sphaeridae |1|1| | |1|1| | | | | | |1|1|1| |1| |1|1|1|1|1| |1|1|1|1|1|1| |1| | | | |
| Neritidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Valvatidae | | | | | | | | | | | | | | | | | |1|1| | | | | | | | | | | | | | | | | |
| *Potamopyrgus jenkinsi* | |1| | | |1|1|1|1|1|1| | | | |1|1| | | |1|1|1|1|1| | |1| | |1| | | | |1|
| *Hydrobia sp.* | | | | | | | | | | | | | |1| | | | | |1| | | | | | | | | | | | | | |1| |
| *Bythinea leachi* | | | | |1| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Bythinea tentaculata* | |1| |1| | | | | | | | |1| | | | | | | | | | | |1| | | | | | | | | | | |
| *Lymnea auricularia* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea glabra* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea palustris* | | | | | | | | | | | | | | | | | | | | |1| | | | | | | | | | | |1| | | |
| *Lymnea peregra* |1| |1|1| |1|1|1|1| |1| |1| |1|1|1|1|1|1|1|1|1| |1|1| |1|1|1|1|1|1| | | |
| *Lymnea stagnalis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea truncatula* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Physidae | | | |1| | | | | | | | | |1| | | |1|1| | | | | | | | | | | | | | | | | |
| Planorbidae |1|1|1|1|1|1|1|1| | | | | |1|1|1| |1|1|1|1|1|1|1| |1|1|1|1|1|1|1|1| | | |
| Viviparidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Ancylus fluviatilis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Acroloxus lacustris* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Zonitidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Succineidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| HYDRACARINA |1| | |1|1|1| |1|1|1| | | |1|1| |1|1| |1|1|1|1|1|1|1|1|1| | | | |1|1| |1|1|

Appendix 1.

| | W.BP. | W.BF. | | | | | W.BC. | | | | | | | W.CG. | | | | | | | W.SW. | | W.CR. | W.LU. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAXON | 11/88 | 10/78 | 05/79 | 08/79 | 11/83 | 11/88 | 11/88 | 05/89 | 07/89 | 03/90 | 08/90 | 11/90 | 03/91 | 10/78 | 05/79 | 08/79 | 11/82 | 11/83 | 11/88 | 07/89 | 11/88 | 07/89 | 11/88 | 03/85 |
| BRYOZOA | | | | | | | | | | | | | | | | | | | | | | | | |
| COELENTERATA | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| POLYZOA | | | | | | | | | | | | | | | | | | | | | | | | |
| PORIFERA | | | | | | | | | | | | | | | | | | | | | | | | |
| *Dugesia polychroa/lugubris* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Dugesia tigrina* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Polycelis sp.* | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | 1 | | | | | | 1 | | | 1 |
| *Dendrocoelum lacteum* | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| NEMATODA | | | | | | | | | | | | | | | | | | | | | | | | |
| NEMATOMORPHA | | | | | | | | | | | | | | | | | | | | | | | | |
| OLIGOCHAETA | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 |
| Piscicolidae | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Glossiphonia complanata* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | | | | 1 | | | |
| *Glossiphonia heteroclita* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Helobdella stagnalis* | | | 1 | | 1 | 1 | | | | 1 | 1 | | | | | | | 1 | | | | | | |
| *Hemiclepsis marginata* | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| *Theromyzon tessulatum* | | | | | | | 1 | | | 1 | 1 | | | | | | | 1 | | | | | | |
| Erpobdellidae | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 |
| OSTRACODA | | | | | | | | | | | | | | | | | | 1 | | | | | | |
| CLADOCERA | | | | | | | | | | | | 1 | | | | | | | | | | | | |
| COPEPODA | | | | | | | | 1 | | | | 1 | | | | | | 1 | | 1 | | 1 | | |
| *Asellus aquaticus* | | | | | | | | | | | | | | | | | | | | | 1 | | | |
| *Asellus meridianus* | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | | 1 | | | | 1 | | | | | | | | | |
| *Crangonyx sp.* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gammarus sp.* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | | | | | | | | 1 | | 1 | 1 |
| *Gammarus zaddachi* | | | | | | | | | | | | | | | | | | | | | | | | |
| Corophidae | | | | | | | | | | | | | | | | | | | | | | | | |
| *Neomysis integer* | | | | | | | | | | | | | | | | | | | | | | | | |
| ANISOPTERA | | | | | | | | | | | | | | | | | | | | | | | | |
| Coenagriidae | | | | | | | | | | 1 | 1 | | | | | | | 1 | | | | | | |
| *Calopteryx splendens* | | | | | | | | | | | | | | | | | | | | | | | | |
| Nemouridae | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| Leuctridae | | | | | | | | | | | | | | | | | | | | | | | | |
| *Baetis sp.* | 1 | 1 | 1 | | 1 | | | 1 | 1 | | | | | | | | | | | | | | | |
| *Centroptilum sp.* | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| *Cloeon sp.* | | | | | | | | | 1 | | | | | | | 1 | | 1 | | 1 | | 1 | | 1 |
| Leptophlebiidae | | | | | 1 | 1 | | 1 | 1 | | | | | | 1 | | | | | | | | | |
| *Ephemerella ignita* | | | | | | | | | | | | | | | | | | | | | | | | |
| Ephemeridae | | | | | | | | | | | | | | | | | | | | | | | | |
| Caenidae | 1 | 1 | | | 1 | 1 | 1 | | | 1 | | | 1 | | | | | 1 | | | 1 | | 1 | 1 |
| *Sialis lutaria* | 1 | 1 | 1 | | | 1 | | | 1 | | 1 | | | 1 | | | | 1 | | | | 1 | | |
| Rhyacophilidae | | | | | | | | | | | | | | | | | | | | | | | | |
| Polycentropidae | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| Psychomyiidae | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydropsychidae | 1 | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | 1 | | | |
| Hydroptilidae | | | | | | | | | | | | | | | 1 | | | | | | | | | |
| Phryganeidae | | | | | | | | | | | | | | | | | | | | | | | | |
| Limnephilidae | | 1 | 1 | | 1 | | | 1 | | | | | | | 1 | | | | | | | | | 1 |
| Molannidae | | | | | | | | | | | | | | | | | | | | | | | | |
| Leptoceridae | | | | | | | 1 | 1 | | 1 | 1 | | 1 | | | | | 1 | | | 1 | | | |
| Goeridae | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lepidostoma hirtum* | | | | | | | | | | | | | | | | | | | | | | | | |
| Lepidostomatidae | | | | | | | | | | | | | | | | | | | | | | | | |
| Sericostomatidae | | | | | | | | | | | | | | | | | | | | | | | | |
| *Agapetus sp.* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Glossosoma sp.* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nymphula nymphaeta* | | | | | | | | | | | | | | | | | | | | | | | 1 | |
| *Elmis aenea* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | | | | | 1 | | | 1 | | 1 | 1 |
| *Limnius volkmari* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Oulimnius sp.* | | 1 | | 1 | 1 | | 1 | 1 | 1 | | | 1 | 1 | | | | | | | | | 1 | | 1 |
| *Riolus sp.* | | | | | | | | | | | | | | | | | | | | | | | | |
| Haliplidae | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 |
| Dytiscidae | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 |
| Gyrinidae | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | |
| Hydrophilidae | | | 1 | 1 | | | | 1 | | | 1 | | | | | 1 | | | | | | 1 | | |
| Helodidae | | 1 | | | | | | | 1 | | 1 | 1 | | | | | | | | 1 | | 1 | | |
| Dryopidae | | | | | | | | | | | | | | | | | | | | | | | | |
| Chrysomelidae | | | | | | | | | | | | | | | | | | | | | | | | |
| Mesoveliidae | | | | | | | | | | | | | | | | | | | | | | | | |
| Veliidae | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| Hydrometridae | | | | | | | | | | | | | | | | | | | | | | | | |
| Corixidae | | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 |
| Gerridae | | | | | | | | | | | | | | | | | | | | | | | | |
| Notonectidae | | | | | | | 1 | | 1 | | | | | | | | | | | | | | | |
| Dicranota l. | 1 | | | | 1 | | | 1 | | | | | | | | | | | | | | | | |
| Tipulidae l. | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | 1 | | 1 | |
| Pedicia l. | | | | | | | | | | | | | | | | | | | | | | | | |
| Simuliidae | | | 1 | | 1 | | | 1 | | 1 | | | | | 1 | | | | | | | | | 1 |
| Chironomidae | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Ceratopogonidae | | | | 1 | | | | | | | | | | 1 | | | | | | | | 1 | 1 | |
| *Culex sp.* | | | | | | | | | | | | | | | | | | | | | | | | |
| Dixidae | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| *Pericoma sp. l.* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psychoda sp. l.* | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | |
| Ptychopteridae | | | | | | | | | | | | | | | | | | | | | | | | |
| Stratiomyidae | | | | | | | | | | | | | | | | | | | | | | | | |
| Tabanidae | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| Muscidae | | 1 | | | | | 1 | | | | | | | | | | | | | | | | 1 | |
| *Eristalis sp.* | | | | | | | | | | | | | | | | | | | 1 | | | | | |
| Empididae | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| Unionidae | | | | | | | | | | | | | | | | | | | | | | | | |
| Sphaeriidae | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | 1 | 1 |
| Neritidae | | | | | | | | | | | | | | | | | | | | | | | | |
| Valvatidae | | | | | | | | | | | | | | | | | | | | | | | | |
| *Potamopyrgus jenkinsi* | | 1 | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | 1 | |
| *Hydrobia sp.* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Bythinea leachi* | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Bythinea tentaculata* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea auricularia* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea glabra* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea palustris* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea peregra* | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | |
| *Lymnea stagnalis* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea truncatula* | | | | | | | | | | | | | | | 1 | | | | | | | | | |
| Physidae | | | | | | | | | | | | | | | | | | | | | | | | |
| Planorbidae | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | | | | | | 1 |
| Viviparidae | | | | | | | | | | | | | | | | | | | | | | | | |
| *Ancylus fluviatilis* | | | | | | | | | | | | | | | | | | | | | | | | |
| *Acroloxus lacustris* | | | | | | | | | | | | | | | | | | | | | | | | |
| Zonitidae | | | | | | | | | | | | | | | | | | | | | | | | |
| Succineidae | | | | | | | | | | | | | | | | | | | | | | | | |
| HYDRACARINA | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | 1 | | | 1 | | | | 1 | | | | | 1 | |

Appendix 1.

| TAXON | W.LD. | | | | | | | | | | | | | | | | | | W.EU. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAXON | 11/76 | 09/77 | 05/79 | 08/79 | 11/83 | 09/84 | 03/85 | 07/85 | 06/86 | 06/87 | 10/88 | 11/88 | 05/89 | 07/89 | 03/90 | 08/90 | 11/90 | 03/91 | 11/76 | 10/78 | 09/77 | 10/79 | 11/82 | 11/83 | 11/83 |
| BRYOZOA | | | | | | | | | | | | | | | | | | | | | | | | | |
| COELENTERATA | | 1 | | 1 | | | | | | | | | | | | | | | | | 1 | | | | |
| POLYZOA | | | | | | | | | | | | | | | | | | | | | | | | | |
| PORIFERA | | | | | | | | | | | | | | | | | | | | | | | 1 | | |
| *Dugesia polychroa/lugubris* | | | | | | 1 | | 1 | | | | | | | | | | | | | | | 1 | | 1 |
| *Dugesia tigrina* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Polycelis sp.* | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | | 1 | | | | | 1 | 1 | 1 | | 1 | 1 |
| *Dendrocoelum lacteum* | 1 | | | | 1 | 1 | 1 | 1 | 1 | | 1 | | | | | | 1 | 1 | | 1 | | | 1 | 1 | 1 |
| NEMATODA | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| NEMATOMORPHA | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| OLIGOCHAETA | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Piscicolidae | | | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | | 1 | 1 | | 1 | 1 | | | | | 1 | 1 | 1 |
| *Glossiphonia complanata* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | 1 | | | | | 1 |
| *Glossiphonia heteroclita* | | | | | | | | | | | | | | | | | | | | 1 | | | | | |
| *Helobdella stagnalis* | 1 | | | | 1 | 1 | 1 | 1 | | 1 | | 1 | | | | | 1 | | 1 | | | 1 | | 1 | 1 |
| *Hemiclepsis marginata* | | | | | | | | | 1 | | | | | | | | | | | | | | | | |
| *Theromyzon tessulatum* | | | | | | | | | | | | | 1 | | | | | | | | | 1 | | | |
| Erpobdellidae | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| OSTRACODA | 1 | | | | | | | | | | | | | | | | 1 | | | | | | | | |
| CLADOCERA | | | | | | | | | | | | | | | | | | | | | | | | | |
| COPEPODA | | | | | 1 | 1 | | | | | | | 1 | 1 | | | 1 | | 1 | | | | | | |
| *Asellus aquaticus* | 1 | | | | | 1 | 1 | | | 1 | | | | 1 | 1 | 1 | | 1 | | | 1 | | | | |
| *Asellus meridianus* | | | | | 1 | | | | | | 1 | 1 | | 1 | | | 1 | | | | | | | | |
| *Crangonyx sp.* | | | | | | 1 | | | | | | | | | | | | | | | | | | | |
| *Gammarus sp.* | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Gammarus zaddachi* | | | | | | | | | | | | | | | | | | | | | | | | | |
| Corophiidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Neomysis integer* | | | | | | | | | | | | | | | | | | | | | | | | | |
| ANISOPTERA | | | | | | | | | | | | | | | | | | | | | | | | | |
| Coenagriidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Calopteryx splendens* | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nemouridae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Leuctridae | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Baetis sp.* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Centroptilum sp.* | | | | | | 1 | | 1 | | | | | | | | | | | | | | | | | 1 |
| *Cloeon sp.* | | | | | | | | | | 1 | | | | | | | 1 | | | | | | | | |
| Leptophlebiidae | | | | | | | | | 1 | 1 | | | 1 | 1 | | | 1 | | | | | | 1 | 1 | 1 |
| *Ephemerella ignita* | | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | | | | | | 1 | 1 | | 1 |
| Ephemeridae | | | | | 1 | | | | | | | | | | 1 | | | | 1 | | | 1 | 1 | 1 | 1 |
| Caenidae | 1 | 1 | 1 | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Sialis lutaria* | 1 | | | | | 1 | | 1 | | | | 1 | | 1 | | 1 | 1 | | 1 | | 1 | 1 | | | |
| Rhyacophilidae | | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | 1 | | |
| Polycentropidae | | | | | | | | | | | 1 | | | | | | | | 1 | 1 | 1 | 1 | 1 | | 1 |
| Psychomyiidae | | | | | 1 | | | | 1 | | | 1 | | | 1 | | 1 | 1 | | | | | | | |
| Hydropsychidae | 1 | | 1 | | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| Hydroptilidae | | 1 | 1 | 1 | | 1 | | 1 | | 1 | 1 | | | | | | | | | 1 | 1 | | | | 1 |
| Phryganeidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Limnephilidae | | | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | 1 | 1 | 1 | | 1 | 1 | | | 1 | | 1 | | 1 |
| Molannidae | | | | | | | | | | | | | | | | | | | | | | | | 1 | |
| Leptoceridae | | | | | 1 | | 1 | | 1 | 1 | | | 1 | | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 |
| Goeridae | | | 1 | 1 | 1 | 1 | 1 | | 1 | | | 1 | | | 1 | | 1 | 1 | | | | | | | |
| *Lepidostoma hirtum* | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lepidostomatidae | | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| Sericostomatidae | | | | | | | | | | | | | | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | |
| *Agapetus sp.* | | | 1 | | | | 1 | | | 1 | | | | | | | | | | | | | | | |
| *Glossosoma sp.* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nymphula nymphaeata* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Elmis aenea* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Limnius volkmari* | | | | | | | | | | | | | | | | | | 1 | | | | 1 | | | 1 |
| *Oulimnius sp.* | | 1 | | 1 | | | 1 | | | | 1 | | | | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 |
| *Riolus sp.* | | | | | | | | | | | | | | | | | | | | | | 1 | | | |
| Haliplidae | 1 | 1 | | | 1 | 1 | 1 | | | | 1 | 1 | | 1 | | | 1 | 1 | | 1 | 1 | | | | 1 |
| Dytiscidae | 1 | | 1 | | | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | | 1 | 1 | | 1 |
| Gyrinidae | | | | | 1 | | | | | | | | | | | | | | 1 | | | | | | |
| Hydrophilidae | | | 1 | | | | | 1 | | | | | | | | | | | | | | 1 | | | |
| Helodidae | | | | | | | | | | | | | 1 | 1 | | | | | | | | | | | |
| Dryopidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chrysomelidae | | | | | | 1 | | | | | | | | | | | | | | | | | | | |
| Mesoveliidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Veliidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydrometridae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Corixidae | 1 | | | | 1 | 1 | | 1 | | | 1 | 1 | | 1 | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| Gerridae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Notonectidae | | | | | 1 | | | | | | | | | | | | 1 | | | | | | | 1 | 1 |
| Dicranota l. | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | | | 1 | | 1 | | |
| Tipulidae l. | 1 | | | | | | | | | | | 1 | | | | | | 1 | | | 1 | 1 | 1 | | |
| Pedicia l. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Simuliidae | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | | | | | | | | 1 | 1 | 1 |
| Chironomidae | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | 1 |
| Ceratopogonidae | | | | 1 | | | | | 1 | 1 | | | | | | | | | 1 | | | | | 1 | 1 |
| *Culex sp.* | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dixidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pericoma sp. l.* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psychoda sp. l.* | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ptychopteridae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stratiomyidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tabanidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Muscidae | 1 | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| *Eristalis sp.* | | | | | | | | | | | | | | | | | | | | | | | | | |
| Empididae | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| Unionidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sphaeriidae | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Neritidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Valvatidae | | | | | | 1 | | | | | | | | | | | | | | | | | | | |
| *Potamopyrgus jenkinsi* | | | | 1 | 1 | | | 1 | | | | 1 | 1 | 1 | 1 | | | | | | | | | | |
| *Hydrobia sp.* | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | 1 | | | | |
| *Bythinea leachi* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Bythinea tentaculata* | | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea auricularia* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea glabra* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea palustris* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea peregra* | | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | | | | 1 | | | | | | | 1 | | 1 | | |
| *Lymnea stagnalis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea truncatula* | | | | | | | | | | | | | | | | | | | | | | | | | |
| Physidae | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 | 1 |
| Planorbidae | | 1 | | | 1 | 1 | 1 | 1 | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | 1 | 1 |
| Viviparidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Ancylus fluviatilis* | | 1 | | 1 | 1 | | 1 | | 1 | | 1 | | | | | 1 | | | | | | | | | |
| *Acroloxus lacustris* | | | | | | 1 | | 1 | | | | | | | | | | | | | | | | | |
| Zonitidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Succineidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| HYDRACARINA | 1 | 1 | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 |

Appendix 1.

| | W.ED. | W.BL. | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAXON | 11/88 | 11/76 | 10/78 | 05/79 | 08/79 | 02/83 | 11/83 | 08/84 | 07/85 | 05/86 | 06/87 | 11/88 | 06/89 | 11/89 | 02/90 | 07/90 | 05/91 |
| BRYOZOA | | | | | | | | | | | | | | | | | |
| COELENTERATA | | | 1 | | | | | | | | | | | | | | |
| POLYZOA | | | | | | | | | | | | | | | | | |
| PORIFERA | | | | | | | 1 | | | | | | | | | | |
| *Dugesia polychroa/lugubris* | | | | | | 1 | | | | | | | | | | | |
| *Dugesia tigrina* | | | | | | | | | | | | | | | | | |
| *Polycelis sp.* | 1 | | 1 | 1 | | | 1 | 1 | | 1 | 1 | 1 | | | 1 | 1 | 1 |
| *Dendrocoelum lacteum* | 1 | 1 | | | 1 | | 1 | 1 | 1 | 1 | 1 | | | | | 1 | |
| NEMATODA | | | | | | | | | | | | | | | | | |
| NEMATOMORPHA | | | | | | | | | | | | | | | | | |
| OLIGOCHAETA | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Piscicolidae | | | | | | | 1 | 1 | | | | 1 | 1 | | | 1 | |
| *Glossiphonia complanata* | 1 | | | 1 | 1 | 1 | | 1 | | | | | | 1 | 1 | 1 | 1 |
| *Glossiphonia heteroclita* | | | | | | | | | | | | | 1 | | | | |
| *Helobdella stagnalis* | | | 1 | 1 | | | 1 | 1 | 1 | | | | | 1 | | 1 | 1 |
| *Hemiclepsis marginata* | | | | | | | | | | | | | | | | | |
| *Theromyzon tessulatum* | | | | | | | 1 | 1 | 1 | | | | | | | | |
| Erpobdellidae | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| OSTRACODA | | 1 | | | | | | | | | | | 1 | | | | |
| CLADOCERA | | | | | | | | | | | | | | | | | |
| COPEPODA | | 1 | | | | | 1 | | | | | | | | | | 1 |
| *Asellus aquaticus* | 1 | | | | | | | | | | | 1 | 1 | | 1 | | |
| *Asellus meridianus* | | | 1 | | 1 | 1 | | | | | | | | | | | |
| *Crangonyx sp.* | | | | | | | | | | | | | | | 1 | | |
| *Gammarus sp.* | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Gammarus zaddachi* | | | | | | | | | | | | | | | | | |
| Corophidae | | | | | | | | | | | | | | | | | |
| *Neomysis integer* | | | | | | | | | | | | | | | | | |
| ANISOPTERA | | | | | | | | | | | | | | | | | |
| Coenagriidae | | | | | | | | | | | | | | | 1 | | |
| *Calopteryx splendens* | | | | | | | | | | | | 1 | | 1 | 1 | | |
| Nemouridae | | | | 1 | | | | | | | | | | | | | |
| Leuctridae | | | | | | | | | | | 1 | | | | | 1 | |
| *Baetis sp.* | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| *Centroptilum sp.* | 1 | | | | | 1 | 1 | 1 | 1 | 1 | | | | | | | 1 |
| *Cloeon sp.* | | | | | | | | 1 | | | | | 1 | | | | |
| Leptophlebiidae | 1 | | | | | | 1 | | | | 1 | 1 | | 1 | 1 | | |
| *Ephemerella ignita* | | | | | 1 | | | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 |
| Ephemeridae | 1 | | | | | | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | |
| Caenidae | 1 | | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| *Sialis lutaria* | | | | | | | | 1 | | 1 | | 1 | | | 1 | 1 | |
| Rhyacophilidae | | | 1 | | 1 | | | | 1 | 1 | 1 | 1 | | | | | |
| Polycentropidae | | | 1 | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | | | |
| Psychomyidae | | | | | | | | | | | | | | | | | |
| Hydropsychidae | 1 | | | | 1 | | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | |
| Hydroptilidae | 1 | | | 1 | | 1 | 1 | | 1 | 1 | | | | | | 1 | |
| Phryganeidae | | | | | | | | | | | | | | | | | |
| Limnephilidae | | | | | | 1 | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | | 1 |
| Molannidae | | | | | | | | | | | | | | | 1 | 1 | |
| Leptoceridae | 1 | | | | | | 1 | 1 | | 1 | 1 | | | 1 | 1 | 1 | 1 |
| Goeridae | 1 | | | | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | |
| *Lepidostoma hirtum* | | | | | | | | | | 1 | | | | | | | |
| Lepidostomatidae | | | | | | | | | | | | | 1 | 1 | | | |
| Sericostomatidae | 1 | | | | | | | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | |
| *Agapetus sp.* | | | | | | | | | | 1 | | | | | | | |
| *Glossosoma sp.* | | | | 1 | | | | | | 1 | | | | | | | |
| *Nymphula nymphaeta* | | | | | | | | | | | | | | | | | |
| *Elmis aenea* | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Limnius volkmari* | 1 | | | | 1 | | 1 | | 1 | | 1 | | | | 1 | 1 | 1 |
| *Oulimnius sp.* | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | | | 1 | 1 | 1 | 1 |
| *Riolus sp.* | | | 1 | | 1 | | | | | | | | | | | | |
| Haliplidae | 1 | | 1 | | | | 1 | 1 | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 |
| Dytiscidae | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | 1 | 1 |
| Gyrinidae | 1 | | | | | | | | 1 | | | 1 | | | | | |
| Hydrophilidae | | | | | 1 | | | | | | | | | | | | |
| Helodidae | | | | | | | | | | | | | | | 1 | 1 | |
| Dryopidae | | | | | | | | | | | | | | | | | |
| Chrysomelidae | | | | | | | | | | | | | | | | | |
| Mesoveliidae | | | | | | | | | | | | | | | | | |
| Veliidae | | | | | | | | 1 | | | | | | | | 1 | |
| Hydrometridae | | | | | | | | | | | | | | | | | |
| Corixidae | 1 | | 1 | | | 1 | 1 | | 1 | | | 1 | 1 | 1 | 1 | 1 | |
| Gerridae | | | | | | | | | | | | | | | | 1 | |
| Notonectidae | | | | | | | | | | | | | | | 1 | | |
| Dicranota l. | | | 1 | | | | | | 1 | 1 | 1 | | | | | 1 | |
| Tipulidae l. | 1 | 1 | | 1 | 1 | 1 | | | | | | 1 | | 1 | 1 | 1 | |
| Pedicia l. | | | | | | | | | | | | | | | | | |
| Simuliidae | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | | | | 1 | | 1 |
| Chironomidae | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 |
| Ceratopogonidae | | | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | 1 | | 1 |
| *Culex sp.* | | | | | | | | | | | | | | | | | |
| Dixidae | | | | | | | | | | | | | | | | | |
| *Pericoma sp. l.* | | | | | | | | | | | | | | | 1 | | 1 |
| *Psychoda sp. l.* | | | | | | | | | | | | | | | | | |
| Ptychopteridae | | | | | | | | | | | | | | | | | |
| Stratiomyidae | | | | 1 | | | | | | | | | | | | | 1 |
| Tabanidae | | | | | | | | | | | | | | | | | 1 |
| Muscidae | 1 | | 1 | 1 | | | | | | | | | | | | | |
| *Eristalis sp.* | | | | | | | | | | | | | | | | | |
| Empididae | | | | | | | | | | | | | | | | | |
| Unionidae | | | | | | | | | | | | | | | | | |
| Sphaeriidae | 1 | | 1 | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Neritidae | | | | | | | | | | | | | | | | | |
| Valvatidae | | | | | | | | | | | | | | | | | |
| *Potamopyrgus jenkinsi* | | | | | 1 | | | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| *Hydrobia sp.* | | | 1 | 1 | | 1 | | | | | | | | | | | |
| *Bythinea leachi* | | | | | | | | | | | | | | | | | |
| *Bythinea tentaculata* | | | | | | | | | 1 | | | | 1 | | | | 1 |
| *Lymnea auricularia* | | | | | | | | | | | | | | | | | |
| *Lymnea glabra* | | | | | | | | | | | | | | | | | |
| *Lymnea palustris* | | | | | | | | | | | | | | | | | |
| *Lymnea peregra* | 1 | 1 | 1 | | | | | | 1 | | | 1 | 1 | 1 | | 1 | |
| *Lymnea stagnalis* | | | | | | | | | | | | | | | | | |
| *Lymnea truncatula* | | | | | | | | | | | | | | | | | |
| Physidae | 1 | | 1 | | | 1 | 1 | | | | | 1 | | 1 | 1 | 1 | |
| Planorbidae | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| Viviparidae | | | | | | | | | | | | | | | | | |
| *Ancylus fluviatilis* | | | | | | 1 | | | | 1 | | | | | | 1 | |
| *Acroloxus lacustris* | | | | | | | | | | | | | | 1 | | | |
| Zonitidae | | | | | | | | | | | | | | | | | |
| Succineidae | | | | | | | | | | | | | | | | | |
| HYDRACARINA | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | | | 1 | | 1 |

Appendix 1.

| TAXON | G.KB. | | | | | | | | | | | | | G.TF. | | | | | | | | G.TE. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 05/76 | 11/76 | 09/77 | 10/78 | 10/89 | 11/82 | 11/83 | 04/89 | 11/89 | 02/90 | 07/90 | 10/90 | 03/91 | 11/76 | 09/77 | 10/78 | 10/79 | 11/83 | 07/85 | 06/86 | 06/87 | 10/78 | 05/79 | 08/79 | 11/82 | 11/83 | 07/85 | 06/86 | 06/87 | 04/89 | 11/89 | 02/90 | 07/90 | 10/90 | 03/91 |
| BRYOZOA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COELENTERATA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| POLYZOA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PORIFERA | 1 | | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Dugesia polychroa/lugubris* | | 1 | 1 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | | | | | | 1 | | 1 | | | | | | | | 1 | | 1 | |
| *Dugesia tigrina* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | |
| *Polycelis sp.* | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | | 1 | 1 | 1 | | | | 1 | 1 | 1 | 1 | 1 | | | | | | 1 | 1 | 1 | 1 |
| *Dendrocoelum lacteum* | 1 | | | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | | | | 1 | | | | | | | | | | | | | | | | | | |
| NEMATODA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NEMATOMORPHA | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| OLIGOCHAETA | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Piscicolidae | | | 1 | 1 | | | 1 | | 1 | | | | 1 | | | 1 | 1 | | | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | | | |
| *Glossiphonia complanata* | 1 | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | | | | | | | | 1 | | | | | | | 1 | 1 | 1 | |
| *Glossiphonia heteroclita* | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | |
| *Helobdella stagnalis* | 1 | | 1 | 1 | 1 | | | 1 | | 1 | 1 | 1 | 1 | | | 1 | | 1 | | | | 1 | 1 | 1 | 1 | | 1 | | | | | 1 | 1 | 1 | 1 |
| *Hemiclepsis marginata* | | | | | | | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| *Theromyzon tessulatum* | | | | 1 | 1 | | 1 | | | | | | 1 | | | | 1 | 1 | | | | | 1 | 1 | | 1 | | | | | | | 1 | | |
| Erpobdellidae | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | | | | 1 | 1 | 1 | | | | 1 | | | | | 1 | | |
| OSTRACODA | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | | 1 | 1 | | 1 | 1 | 1 | 1 | | | | | | 1 | 1 | 1 | | | | | | 1 | | 1 | 1 |
| CLADOCERA | 1 | 1 | | | | 1 | 1 | | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | | | | 1 | 1 | 1 | 1 | 1 | | | | | | | |
| COPEPODA | 1 | | 1 | 1 | | | | 1 | 1 | | | | | | 1 | 1 | | | | | 1 | | | 1 | | 1 | | | | | | | | | |
| *Asellus aquaticus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Asellus meridianus* | | | 1 | | | | 1 | 1 | | | | | | | 1 | | | | 1 | | | 1 | 1 | 1 | | 1 | | | | | | | | | |
| *Crangonyx sp.* | | | | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Gammarus sp.* | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | 1 | 1 | | 1 | | | | 1 | 1 | | | 1 | 1 | 1 | | 1 | | | |
| *Gammarus zaddachi* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Corophiidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Neomysis integer* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ANISOPTERA | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| Coenagrionidae | | 1 | | | | | | | 1 | | | 1 | 1 | | | | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | | | | 1 | 1 | 1 | 1 | | 1 | 1 |
| *Calopteryx splendens* | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nemouridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Leuctridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Baetis sp.* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | | | | 1 | 1 |
| *Centroptilum sp.* | | | | | | 1 | 1 | 1 | | | | | | | | | 1 | | 1 | 1 | | | 1 | | | | | | 1 | | | | | | |
| *Cloeon sp.* | | | | | | 1 | 1 | | 1 | | | | | | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
| Leptophlebiidae | | | | | | | | 1 | | 1 | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| *Ephemerella ignita* | | | | | | | 1 | | | | 1 | | | | | | | | 1 | 1 | 1 | | | | | | | | | | | | | | |
| Ephemeridae | | | | | | | | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| Caenidae | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 |
| *Sialis lutaria* | | | | | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | | | | | | | | 1 | | 1 | | | | 1 | 1 | 1 | | |
| Rhyacophilidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Polycentropidae | | | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | | | | 1 | | 1 | | | | | | | | | | | | | | | | |
| Psychomyidae | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydropsychidae | | | | | | 1 | 1 | 1 | 1 | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| Hydroptilidae | | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | | | 1 | | | | | 1 | 1 | 1 | | 1 | | | 1 | | | | | | |
| Phryganeidae | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | | | | | | | | | 1 | | |
| Limnephilidae | 1 | | | | | | 1 | 1 | | 1 | 1 | | 1 | | | | | | | 1 | 1 | | | | 1 | | | | | | | | | | |
| Molannidae | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| Leptoceridae | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | 1 | 1 | | | 1 | 1 | 1 | 1 | | | | | 1 | 1 | | | 1 | 1 | |
| Goeridae | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lepidostoma hirtum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lepidostomatidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sericostomatidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Agapetus sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Glossosoma sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nymphula nymphaeta* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | |
| *Elmis aenea* | | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | 1 | | | 1 | | | | | | | | | | | | | | |
| *Limnius volkmari* | | | | | | | 1 | | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| *Oulimnius sp.* | | | | | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | | | | 1 | | | | | 1 | | | | | | | | | | | | | |
| *Riolus sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Haliplidae | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | | | | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Dytiscidae | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | | 1 | 1 | 1 | 1 | |
| Gyrinidae | | | | | | | | | 1 | | 1 | 1 | | | | | | | | | | | | | | | | | | | | 1 | 1 | | |
| Hydrophilidae | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| Helodidae | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | 1 | | |
| Dryopidae | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | |
| Chrysomelidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mesoveliidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Veliidae | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydrometridae | | | | | | | | | | | 1 | 1 | | | | | | 1 | | | | | | | | | | | | | | | | | |
| Corixidae | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Gerridae | | | | | | | | | | | 1 | 1 | | | | | | | | 1 | | | | | | | 1 | | 1 | | | | 1 | | |
| Notonectidae | 1 | | | | | | | | 1 | | 1 | 1 | | | | | | 1 | | | 1 | | | | | | 1 | | 1 | | | 1 | 1 | 1 | |
| *Dicranota l.* | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| Tipulidae l. | | 1 | 1 | | 1 | | | 1 | 1 | 1 | | 1 | 1 | | | 1 | | | | | | | | | | | | | | 1 | | | | | |
| *Pedicia l.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Simuliidae | | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | 1 | | | | | | | 1 | | | | | | | | | | | | | | | |
| Chironomidae | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Ceratopogonidae | 1 | 1 | | 1 | | | 1 | | 1 | | | 1 | | 1 | | 1 | 1 | | 1 | | | | 1 | 1 | | | | | | 1 | | | 1 | | 1 |
| *Culex sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dixidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pericoma sp. l.* | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Psychoda sp. l.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ptychopteridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stratiomyidae | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| Tabanidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | |
| Muscidae | | | | 1 | 1 | | | | 1 | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| *Eristalis sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Empididae | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | |
| Unionidae | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 | 1 | 1 | 1 | 1 | |
| Sphaeriidae | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | | 1 | | | | | 1 | 1 | 1 | 1 | 1 | | | | 1 | 1 | 1 | 1 | 1 |
| Neritidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Valvatidae | | 1 | | | | | | | 1 | 1 | | 1 | 1 | | | 1 | 1 | | | | | 1 | 1 | 1 | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | |
| *Potamopyrgus jenkinsi* | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | 1 | | 1 | | 1 | | 1 | 1 | 1 |
| *Hydrobia sp.* | 1 | 1 | 1 | 1 | | 1 | | | | | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | |
| *Bythinea leachi* | | | | | | | | 1 | | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | |
| *Bythinea tentaculata* | 1 | 1 | 1 | 1 | | | | 1 | | 1 | 1 | 1 | 1 | | | 1 | | 1 | | | 1 | 1 | | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Lymnea auricularia* | | | | | | | | | | | | | | | | 1 | | | | | | | | 1 | | | | | | | | | 1 | 1 | |
| *Lymnea glabra* | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | |
| *Lymnea palustris* | | | | | | | | | | | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Lymnea peregra* | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | | 1 | | 1 | 1 | | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | | |
| *Lymnea stagnalis* | | | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | | |
| *Lymnea truncatula* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Physidae | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | 1 | 1 | | 1 |
| Planorbidae | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Viviparidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Ancylus fluviatilis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Acroloxus lacustris* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Zonitidae | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | |
| Succineidae | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| HYDRACARINA | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | | 1 | 1 | | | | | 1 | 1 | |

Appendix 1.

| | G.GG. | | | | | | | G.PK. | | | | | | | | G.SF. | | | | | | G.SS. | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAXON |06/76|11/76|09/77|10/78|10/79|11/82|11/83|06/76|11/76|09/77|10/78|05/79|08/79|11/82|11/83|05/89|10/89|03/90|08/90|10/90|04/91|06/76|11/76|09/77|10/78|10/79|11/83|07/84|08/85|08/86|06/87|05/89|10/89|03/90|08/90|10/90|04/91|
| BRYOZOA | | | | | |1| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COELENTERATA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| POLYZOA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PORIFERA | | | | | | | | | | | | | | |1| | | | | | | | | | | | | | | | | | | | | | |
| *Dugesia polychroa/lugubris* | | | | |1|1| | | | | | |1|1| | |1|1|1|1|1| | | | | | | | | | |1| | |1| |1|
| *Dugesia tigrina* | | | | | | | | | | | | | | | |1| |1|1| |1| | | | | | |1|1| | |1|1|1|1| |1|
| *Polycelis sp.* | | | | | |1|1| | | | |1|1| |1| | | |1| |1| | | | | |1| | | | | |1|1|1|1| |
| *Dendrocoelum lacteum* | | | | | | | | | | | | | | |1| | | | | | | | | | | | | | | | | | |1| | | |
| NEMATODA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NEMATOMORPHA | |1| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| OLIGOCHAETA |1|1| |1|1|1|1|1| |1|1|1|1|1|1|1|1|1|1|1|1|1| |1|1|1|1|1|1|1|1|1|1|1|1|1|1|
| Piscicolidae | | | | |1| |1| | | |1| | |1| | |1| | |1| | | | |1| | |1| | |1| |1| |1|1| |
| *Glossiphonia complanata* |1| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |1| |
| *Glossiphonia heteroclita* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Helobdella stagnalis* |1| | | |1|1|1| | | |1|1|1|1| |1| |1|1|1|1| | | | | | | | | | |1| |1|1|1|1|
| *Hemiclepsis marginata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Theromyzon tessulatum* |1| | | |1| | | | | | | | | | |1| | | | | | | | | | | | |1|1| | | | | | | |
| Erpobdellidae |1| | | |1|1|1| | | | | | |1| | |1| | | | | | | | |1| | | | | | | |1|1|1|1|
| OSTRACODA |1| |1| | | | | | | |1| |1|1| |1| |1| |1|1| | | |1|1| | | | | |1| | |1|1|1|
| CLADOCERA | | |1|1|1|1|1|1| |1|1| |1|1|1| | | |1| | |1| |1|1|1|1|1|1| | | |1| | | | |
| COPEPODA |1|1|1|1|1| | |1| |1|1| |1| | |1|1| | | |1| | |1| |1|1| | |1| |1| | | | |1|
| *Asellus aquaticus* | | | |1|1|1| | | | |1|1|1|1|1|1|1|1|1|1|1| | | | |1| | | | | |1|1|1|1|1|1|
| *Asellus meridianus* | | |1| | | | | | | |1| | | | |1| | | | | | | | | | | | | | | | | | | | | |
| *Crangonyx sp.* | | |1| |1| |1| | |1|1|1|1| |1|1|1|1|1|1|1| | | |1|1|1|1| | | | |1|1|1|1|1|
| *Gammarus sp.* | | | |1| |1| | | | | | | |1|1|1| | | | | | |1| | | | | | | | | | | |1|1|1|
| *Gammarus zaddachi* | | | | | | | | | | | | | | | | | | | | | |1| |1| | |1|1| |1|1|1| | |1| | |
| Corophidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |1| | | |
| *Neomysis integer* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |1| |1| | |
| ANISOPTERA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Coenagridae |1|1| |1|1|1|1| |1| |1|1|1| |1|1|1|1|1|1|1| | | | |1|1|1|1| |1|1|1|1|1|1|1|
| *Calopteryx splendens* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nemouridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Leuctridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Baetis sp.* | |1| |1| |1| | | |1| | | | | | | | |1|1| | | | |1| | | | | | | | | |1| | |
| *Centroptilum sp.* | | | | | | | | | | | | | |1| | | | | | | | | | | | | |1|1|1|1| | | | | | |
| *Cloeon sp.* | | |1| |1|1|1| | | |1|1|1|1|1|1|1|1| | |1| | |1| |1|1|1|1|1|1|1|1|1| |1|1|
| Leptophlebiidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Ephemerella ignita* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ephemeridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Caenidae |1| | | |1|1|1| | | |1| |1|1|1|1|1|1| | | | | | | |1|1| | | | |1|1|1| | | |
| *Sialis lutaria* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rhyacophilidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |1| |1|
| Polycentropidae | | | | | | | | | | | | | | | | | | | | | | | | | |1| | | | | | | | | | | |
| Psychomyidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |1| | |
| Hydropsychidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydroptilidae | | | | |1| |1| | | |1| |1| | | | | | | |1| | | | |1| | | | | | |1| |1| | |
| Phryganeidae | | | | | | | | | | | | | | | | | | | |1| | | | | | | | | | | | | | | | | |
| Limnephilidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Molannidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Leptoceridae |1| | | | | | | | | | | |1| | |1|1| | |1| | | | | | | | | | |1| | | | |1| |
| Goeridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lepidostoma hirtum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lepidostomatidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sericostomatidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Agapetus sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Glossosoma sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nymphula nymphaeta* | | | | | | | | | | | | | | | | | | |1| |1| | | | | | | | | | | | | |1| | |
| *Elmis aenea* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Limnius volkmari* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Oulimnius sp.* | | | | | | | | | | |1|1|1| |1|1| | |1|1|1| | | | | | | |1| | |1| |1| |1|1|
| *Riolus sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Haliplidae |1| | |1|1|1|1|1|1| |1|1|1| |1|1|1| |1|1|1| | | |1| | |1|1|1| | |1|1|1|1|1|
| Dytiscidae |1| | |1|1|1| |1|1|1| |1|1|1|1|1|1|1|1|1| | | |1|1|1| |1|1| |1|1|1|1|1|1| |
| Gyrinidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydrophilidae | | | | | | | | | | | |1|1| | | |1| | |1| | | | | | | | | | | | | | | |1| |
| Helodidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |1| | | |
| Dryopidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chrysomelidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mesoveliidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | |1| | | | | | | | |
| Veliidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydrometridae | | | |1| | | | | | | | | | | | | | | |1| | | | | | | | | | | | | | | | | |
| Corixidae | |1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1| | |1|1|1|1|1|1|1|1|1|1|1|1| |1|
| Gerridae | | | |1| | | | | | | | | | | | | | | |1| | | | | | |1| |1|1| | | | | |1| |
| Notonectidae | | | | | | | | | | | | | | |1| | | |1|1|1| | | | | | | | | |1| | |1| |1| |
| Dicranota l. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tipulidae l. | |1| | |1| | | | | | |1| | | | | | | | | | | | | | | | | | | | |1| | |1| |
| Pedicia l. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Simuliidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chironomidae |1|1|1| |1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|1|
| Ceratopogonidae |1| | |1|1| | | | | | |1|1| | | | |1| | |1| | | | |1| |1| | | | | | | |1|1|
| *Culex sp.* | | | | | | | | | | | | |1| | | | | | | | | | | | | | | | | | | | | | | | |
| Dixidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pericoma sp. l.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psychoda sp. l.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ptychopteridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stratiomyidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tabanidae | | | | | | | | | | |1|1| | | | | | | | | | | | | | | | | | | | | | | | | |
| Muscidae | | | | | | | | | | |1|1| | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eristalis sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Empididae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Unionidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |1| | | | | | |
| Sphaeriidae | | | | | |1| | | | | | |1| |1|1|1|1|1| |1| | | | | | |1| | | |1|1|1|1| |1|
| Neritidae | | | | | | | | | | | | | | | | |1| |1|1| | | | | | | | | | | | | | | | | |
| Valvatidae | | | | |1|1|1| | | |1| |1|1|1|1|1|1|1|1|1| | | | | |1|1|1| |1|1|1|1|1|1|1|
| *Potamopyrgus jenkinsi* | | | | | | |1| | | |1| |1| |1|1|1|1|1|1| | | | | | | | | | | |1|1| |1| | |
| *Hydrobia sp.* | | | | | |1| | | | | |1| |1| | | | | | | | | | |1|1| | | | | | | | | | | |
| *Bythinea leachi* | | | | | | |1| | | | | | | |1| | |1| | | | | | | | |1| | | | | | | | | | |
| *Bythinea tentaculata* |1| | | |1|1|1| | |1|1|1|1|1| |1|1|1|1|1|1| | | | |1| |1|1|1|1|1|1|1|1|1|1|
| *Lymnea auricularia* | | | | | | | | | | | | | |1| |1| | |1| | | | | | | | | | | | |1|1| |1| | |
| *Lymnea glabra* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea palustris* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea peregra* | | | |1|1|1|1| | | |1|1|1| | |1|1|1|1|1| | | | |1| | |1|1| |1|1|1|1|1|1| |
| *Lymnea stagnalis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea truncatula* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Physidae | | |1|1|1|1|1| | | | | |1| | | | | |1|1|1| | | | | | | | | | | | |1|1| |1|
| Planorbidae | | | |1|1|1|1| | | |1|1|1|1|1|1|1|1|1|1|1| | |1|1|1| | | | | | | |1|1|1|1|
| Viviparidae | | | | | | | | | | | | | | | | | |1| | | | | | | | | | | | | | | | | | | |
| *Ancylus fluviatilis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Acroloxus lacustris* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Zonitidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Succineidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| HYDRACARINA |1| |1|1|1|1| |1| | | | |1|1| |1|1|1|1|1|1|1| |1| |1| | |1|1|1|1| | |1| |1|

Appendix 1.

| TAXON | B.BU. | | | B.BD. | | | | B.RL. | | | | B.TU. | | B.TD. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 11/76 | 10/78 | 10/79 | 09/77 | 10/79 | 11/82 | 11/83 | 10/79 | 11/82 | 02/83 | 11/83 | 04/89 | 11/89 | 02/90 | 07/90 | 03/91 |
| BRYOZOA | | | | | | | | | | | | | | | | |
| COELENTERATA | | | | | | | | | | | | | | | | |
| POLYZOA | | | | | | | | | | | | | | | | |
| PORIFERA | | | | | | | | | | | | | | | | |
| *Dugesia polychroa/lugubris* | | 1 | | | 1 | | | 1 | 1 | | 1 | 1 | | | | |
| *Dugesia tigrina* | | | | | | | | | | | | | | | | |
| *Polycelis sp.* | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | | 1 | 1 | 1 | 1 |
| *Dendrocoelum lacteum* | | | | | | 1 | | 1 | | | | | | | | |
| NEMATODA | | 1 | | | | | | | | | | | | | | |
| NEMATOMORPHA | | | | | | | | | | | | | | | | |
| OLIGOCHAETA | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Piscicolidae | | | | | | | | 1 | | | | | 1 | | 1 | |
| *Glossiphonia complanata* | | 1 | 1 | | 1 | 1 | 1 | 1 | | | | | | | | |
| *Glossiphonia heteroclita* | | | | | | | | | | | | | | | | |
| *Helobdella stagnalis* | | 1 | | | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | | 1 | 1 |
| *Hemiclepsis marginata* | | | | | | | | | | | | | | | | |
| *Theromyzon tessulatum* | | | | | 1 | | | | | | | | | 1 | 1 | |
| Erpobdellidae | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| OSTRACODA | | | | | | | | | | 1 | | 1 | | 1 | | |
| CLADOCERA | | | 1 | | | | | 1 | | | | | | | | |
| COPEPODA | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | | 1 | 1 | | | | |
| *Asellus aquaticus* | | 1 | 1 | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Asellus meridianus* | | | | | | | | | | | | | | | | |
| *Crangonyx sp.* | | | 1 | | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Gammarus sp.* | | 1 | 1 | 1 | 1 | 1 | 1 | | | | 1 | | | | | |
| *Gammarus zaddachi* | | | | | | | | | | | | | | | | |
| Corophidae | | | | | | | | | | | | | | | | |
| *Neomysis integer* | | | | | | | | | | | | | | | | |
| ANISOPTERA | | | | | | | | | | | | | | | | |
| Coenagrionidae | | | | | | | | | | | | 1 | 1 | 1 | | 1 |
| *Calopteryx splendens* | | | | | | | | | | | | | | | | |
| Nemouridae | | | | | | | | | | | | | | | | |
| Leuctridae | | | | | | | | | | | | | | | | |
| *Baetis sp.* | | 1 | 1 | | | | 1 | 1 | | | | | | | 1 | 1 |
| *Centroptilum sp.* | | | | | | 1 | | | | | | | | | | |
| *Cloeon sp.* | | | | | | | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | |
| Leptophlebiidae | | | | | | | | | | | | | | | | |
| *Ephemerella ignita* | | | | | | | | | | | | | | | | |
| Ephemeridae | | | | | | | | | | | | | | | | |
| Caenidae | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 |
| *Sialis lutaria* | | | | | | | | | | | | | | 1 | 1 | |
| Rhyacophilidae | | | | | | | | | | | | | | | | 1 |
| Polycentropidae | | | | | | | | | | | | | | | | |
| Psychomyidae | | | | | | | | | | | | | | | | |
| Hydropsychidae | | | | | | | | | | | | | | | | |
| Hydroptilidae | | | | | | 1 | 1 | | 1 | 1 | | | | | | |
| Phryganeidae | | | | | | | | | | | | | | 1 | | |
| Limnephilidae | | | | | | | | | | | | | | 1 | | 1 |
| Molannidae | | | | | | | | | | | | | | | 1 | |
| Leptoceridae | | | | | | | | | | | | 1 | | 1 | 1 | 1 |
| Goeridae | | | | | | | | | | | | | | | | |
| *Lepidostoma hirtum* | | | | | | | | | | | | | | | | |
| Lepidostomatidae | | | | | | | | | | | | | | | | |
| Sericostomatidae | | | | | | | | | | | | | | | | |
| *Agapetus sp.* | | | | | | | | | | | | | | | | |
| *Glossosoma sp.* | | | | | | | | | | | | | | | | |
| *Nymphula nymphaeta* | | | | | | | | | | | | | | | | |
| *Elmis aenea* | | | | | | | | | | | | | | | | |
| *Limnius volkmari* | | | | | | | | | | | | | | | | |
| *Oulimnius sp.* | | | | | | | | | | | | | | | | |
| *Riolus sp.* | | | | | | | | | | | | | | | | |
| Haliplidae | | | | | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | | | |
| Dytiscidae | | 1 | | | | | | | | | 1 | | | 1 | 1 | |
| Gyrinidae | | | | | | | | | | | | | | | | |
| Hydrophilidae | | | | | | | | | | | | | | 1 | | |
| Helodidae | | | | | | | | | | | | | | | | 1 |
| Dryopidae | | | | | | | | | | | | | | | | |
| Chrysomelidae | | | | | | | | | | | | | | | | |
| Mesovelidae | | | | | | | | | | | | | | | | |
| Veliidae | | | | | | | | | | | | | | | | |
| Hydrometridae | | | | | | | | | | | | | | | | 1 |
| Corixidae | | 1 | | 1 | | | | 1 | | | | 1 | 1 | 1 | 1 | 1 |
| Gerridae | | | | | | | | | | | | | | | 1 | |
| Notonectidae | | | | | | | 1 | | | | | | | | 1 | 1 |
| Dicranota l. | 1 | | | | | | | | | | | | | | | |
| Tipulidae l. | 1 | | 1 | | 1 | 1 | | | | | | | 1 | | | 1 |
| Pedicia l. | | | | | | | | | | | | | | | | |
| Simuliidae | | | | | | | | | | | | | | | | |
| Chironomidae | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Ceratopogonidae | | | | | 1 | | | | | | | | | | 1 | |
| *Culex sp.* | | 1 | | | | | | | | | | | | | | |
| Dixidae | | | | | | | | | | | | | | | | |
| *Pericoma sp. l.* | | | | | | | | | | | | | | | | |
| *Psychoda sp. l.* | | | | | | | | | | | | | | | | |
| Ptychopteridae | | | | | | | | | | | | | | | | |
| Stratiomyidae | | | | | | | | | | | | | | | | |
| Tabanidae | | | | | | | | | | | | | | | | |
| Muscidae | | | | | | | | | | | | | | | | |
| *Eristalis sp.* | | | | | | | | | | | | | | | | |
| Empididae | | | | | | | | | | | | | | | | |
| Unionidae | | | | | | | | | | | | | | | | |
| Sphaeriidae | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 |
| Neritidae | | | | | | | | | | | | | | | | |
| Valvatidae | | | | | 1 | | | 1 | 1 | | 1 | 1 | 1 | 1 | | 1 |
| *Potamopyrgus jenkinsi* | | | | | | | 1 | | | | | 1 | | | | |
| *Hydrobia sp.* | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | |
| *Bythinea leachi* | | | | | | | | | | | | | | | | |
| *Bythinea tentaculata* | | | | | | | | | 1 | 1 | | | 1 | 1 | 1 | 1 |
| *Lymnea auricularia* | | | | | | | | | | | | 1 | | | | 1 |
| *Lymnea glabra* | | | | | | | | | | | | | | | | |
| *Lymnea palustris* | | | | | | | | | | | | | | 1 | | |
| *Lymnea peregra* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 |
| *Lymnea stagnalis* | | | | | | | | 1 | | 1 | | | | | | |
| *Lymnea truncatula* | | | | | | | | | | | | | | | | |
| Physidae | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 |
| Planorbidae | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| Viviparidae | | | | | | | | | | | | | | | | |
| *Ancylus fluviatilis* | | | | | | | | | | | | | | | | |
| *Acroloxus lacustris* | | | | | | | | | | | | | | | | |
| Zonitidae | | | | | | | | | | | | | | | | |
| Succineidae | | | | | | | | | | | | | | | | |
| HYDRACARINA | | | 1 | | 1 | 1 | | | 1 | 1 | 1 | 1 | | | 1 | 1 |

Appendix 1.

| TAXON | T.CH. | | | T.CU. | | T.CD. | | | T.GU. | | | | | T.GD. | T.LU. | | | T.LD. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 04/82 | 04/84 | 04/87 | 04/84 | 04/87 | 04/82 | 04/84 | 04/87 | 04/82 | 04/84 | 03/85 | 03/90 | 03/91 | 03/85 | 10/78 | 10/79 | 11/83 | 09/77 | 04/82 | 04/84 | 03/85 | 04/87 | 11/88 | 05/89 | 07/89 | 03/90 | 08/90 | 11/90 | 03/91 |
| BRYOZOA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COELENTERATA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| POLYZOA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PORIFERA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Dugesia polychroa/lugubris* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Dugesia tigrina* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Polycelis sp.* | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | |
| *Dendrocoelum lacteum* | | | | | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | | |
| NEMATODA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| NEMATOMORPHA | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | |
| OLIGOCHAETA | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Piscicolidae | | | | | | | 1 | | 1 | 1 | 1 | | | | | | 1 | | | 1 | 1 | | 1 | 1 | 1 | 1 | | 1 | |
| *Glossiphonia complanata* | | 1 | | 1 | 1 | 1 | | | 1 | | 1 | 1 | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Glossiphonia heteroclita* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Helobdella stagnalis* | | | | | | | | | | | | 1 | | | | | | | | | | | | | | 1 | | | |
| *Hemiclepsis marginata* | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| *Theromyzon tessulatum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | |
| Erpobdellidae | | 1 | | | | | | | | | | 1 | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| OSTRACODA | 1 | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| CLADOCERA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COPEPODA | 1 | 1 | 1 | | | 1 | 1 | | | | | | | | | | | | | | | | | 1 | 1 | | | | |
| *Asellus aquaticus* | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| *Asellus meridianus* | | | | | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | 1 | |
| *Crangonyx sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gammarus sp.* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Gammarus zaddachi* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Corophiidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Neomysis integer* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ANISOPTERA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Coenagriidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Calopteryx splendens* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nemouridae | 1 | 1 | 1 | | | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| Leuctridae | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | |
| *Baetis sp.* | | | | | | | 1 | 1 | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| *Centroptilum sp.* | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | |
| *Cloeon sp.* | 1 | | 1 | | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| Leptophlebiidae | 1 | 1 | | | | | | | | | | | | | | | | | 1 | 1 | | 1 | | | | | | 1 | |
| *Ephemerella ignita* | | | | | | | | | | | 1 | 1 | | | | | | | | 1 | | | 1 | 1 | 1 | | 1 | | |
| Ephemeridae | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | 1 | |
| Caenidae | | | | 1 | 1 | | | | | 1 | | | 1 | | 1 | | | | | | | | | 1 | | | | 1 | |
| *Sialis lutaria* | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| Rhyacophilidae | | | | | | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | | 1 | 1 | | 1 | | | 1 | |
| Polycentropidae | | | | | | 1 | | 1 | | | 1 | | 1 | | | | 1 | | | | | | | | | | | | |
| Psychomyidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydropsychidae | | | | | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | | | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | |
| Hydroptilidae | | | | | | 1 | | 1 | 1 | | | | | | 1 | 1 | | 1 | 1 | | | | | | | | 1 | | |
| Phryganeidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Limnephilidae | 3 | | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | |
| Molannidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Leptoceridae | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | |
| Goeridae | | | | | | | | | 1 | | 1 | | 1 | | | | 1 | | 1 | 1 | 1 | 1 | | | | | | | |
| *Lepidostoma hirtum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lepidostomatidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sericostomatidae | | | | | 1 | | | | | | | 1 | 1 | | | | | | | | | | | | | | | 1 | 1 |
| *Agapetus sp.* | | | | | | 1 | | | | | | | | 1 | | | | | 1 | | | 1 | | | | | | | |
| *Glossosoma sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nymphula nymphaeta* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Elmis aenea* | | | | | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Limnius volkmari* | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | |
| *Oulimnius sp.* | | | | | | | 1 | | | | 1 | 1 | | | | | | | | | 1 | 1 | | | | | | 1 | 1 |
| *Riolus sp.* | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | |
| Haliplidae | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | | | | 1 | | 1 | 1 | 1 | 1 | | | | 1 | | | | 1 | 1 | |
| Dytiscidae | 1 | | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| Gyrinidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydrophilidae | | 1 | | | | | 1 | | | | | | | | | | 1 | | | | | | | | | 1 | | | |
| Helodidae | | 1 | | | | | 1 | | 1 | | | | 1 | | | 1 | | | 1 | | | | 1 | 1 | | 1 | | 1 | |
| Dryopidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chrysomelidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mesoveliidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Veliidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydrometridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Corixidae | | 1 | 1 | 1 | | | | | | 1 | | | | | | | 1 | | | | | | 1 | | 1 | | | 1 | |
| Gerridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Notonectidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dicranota l. | 1 | | | | | 1 | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | | | 1 | | |
| Tipulidae l. | | | | | | | | | | | | 1 | 1 | | 1 | 1 | | | | | | | 1 | | 1 | 1 | 1 | 1 | 1 |
| Pedicia l. | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | |
| Simuliidae | 1 | | 1 | | | 1 | | 1 | | | | 1 | 1 | 1 | 1 | 1 | | | 1 | | 1 | | | 1 | 1 | 1 | 1 | 1 | |
| Chironomidae | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Ceratopogonidae | | | | 1 | 1 | 1 | 1 | | | | 1 | | | | | | | | | | | | | | | 1 | | 1 | 1 |
| *Culex sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dixidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pericoma sp. l.* | | | | | | | | | | | | 1 | 1 | | | | | | | | | | | | | 1 | | 1 | |
| *Psychoda sp. l.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ptychopteridae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stratiomyidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tabanidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | |
| Muscidae | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | 1 | 1 | |
| *Eristalis sp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Empididae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Unionidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sphaeriidae | | | | | | | | | | | | 1 | 1 | | 1 | | 1 | | | 1 | | | | 1 | 1 | 1 | | 1 | 1 |
| Neritidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Valvatidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Potamopyrgus jenkinsi* | | | | 1 | | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 |
| *Hydrobia sp.* | | | | | | 1 | | | 1 | | | | | | 1 | 1 | | 1 | | | | | | | | | | | |
| *Bythinea leachi* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Bythinea tentaculata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea auricularia* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea glabra* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea palustris* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea peregra* | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | | 1 | 1 | | 1 | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | |
| *Lymnea stagnalis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lymnea truncatula* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Physidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Planorbidae | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 |
| Viviparidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Ancylus fluviatilis* | | | | | | | | | | | 1 | 1 | 1 | 1 | | | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | |
| *Acroloxus lacustris* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Zonitidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Succineidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| HYDRACARINA | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 |

## APPENDIX B2. BIOTIC SCORES FOR ALL SAMPLES

Appendix 2. **RIVER GLEN BIOLOGICAL SCORES**

| SAMPLE | BMWP | NO.SCRG.TAXA | ASPT | HABITAT TYPE | LQI |
|---|---|---|---|---|---|
| E.LN.11/88 | 48 | 12 | 4.0 | RR | D |
| E.LN.5/89 | 86 | 19 | 4.5 | RR | A+ |
| E.LN.8/89 | 31 | 9 | 3.4 | RR | E |
| E.LN.3/90 | 41 | 12 | 3.4 | RR | E |
| E.LN.8/90 | 47 | 13 | 3.6 | RR | D |
| E.LN.11/90 | 35 | 10 | 3.5 | RR | E |
| E.LN.3/91 | 12 | 5 | 2.4 | RR | G |
| E.HW.11/88 | 75 | 18 | 4.2 | R | D |
| E.BB.9/77 | 60 | 15 | 4.0 | RR | C |
| E.BB.10/78 | 54 | 15 | 3.6 | RR | C |
| E.BB.10/79 | 54 | 14 | 3.9 | RR | C |
| E.BB.11/82 | 52 | 13 | 4.0 | RR | C |
| E.BB.6/83 | 63 | 14 | 4.5 | RR | A |
| E.BB.11/83 | 75 | 17 | 4.4 | RR | B |
| E.BB.11/88 | 64 | 15 | 4.3 | RR | B |
| E.EL.11/88 | 62 | 16 | 3.9 | RR | C |
| E.EH.11/76 | 23 | 6 | 3.8 | R | F |
| E.EH.10/78 | 86 | 21 | 4.1 | R | D |
| E.EH.10/79 | 86 | 20 | 4.3 | R | D |
| E.EH.11/83 | 92 | 20 | 4.6 | R | B |
| E.EH.8/84 | 97 | 21 | 4.6 | R | B |
| E.EH.7/85 | 69 | 16 | 4.3 | R | D |
| E.EH.6/87 | 69 | 15 | 4.6 | R | C |
| E.EH.11/88 | 82 | 19 | 4.3 | R | D |
| E.EH.4/89 | 80 | 18 | 4.4 | R | D |
| E.EH.11/89 | 76 | 16 | 4.8 | R | C |
| E.EH.2/90 | 81 | 19 | 4.3 | R | D |
| E.EH.7/90 | 48 | 13 | 3.7 | R | E |
| E.EH.10/90 | 77 | 19 | 4.1 | R | D |
| E.EH.3/91 | 78 | 18 | 4.3 | R | D |
| E.GB.11/82 | 86 | 19 | 4.5 | R | D |
| E.GB.11/89 | 71 | 16 | 4.4 | R | D |
| E.GB.7/90 | 48 | 13 | 3.7 | R | E |
| E.PH.9/77 | 53 | 14 | 3.8 | RR | C |
| E.PH.11/82 | 58 | 14 | 4.1 | RR | B |
| E.PH.11/88 | 82 | 19 | 4.3 | RR | A |
| E.MT.2/88 | 47 | 12 | 3.9 | R | E |
| E.MU.2/88 | 65 | 15 | 4.3 | R | D |
| E.MU.7/88 | 53 | 12 | 4.4 | R | E |
| E.MD.2/88 | 75 | 15 | 5.0 | R | C |
| E.MD.7/88 | 40 | 11 | 3.6 | R | E |
| E.MG.11/76 | 45 | 10 | 4.5 | R | E |
| E.MG.9/77 | 44 | 12 | 3.7 | R | E |
| E.MG.11/82 | 66 | 16 | 4.1 | R | D |
| E.MG.11/83 | 81 | 18 | 4.5 | R | D |
| E.MG.2/88 | 64 | 14 | 4.6 | R | C |
| E.MG.11/88 | 75 | 17 | 4.4 | R | D |
| E.BR.10/78 | 97 | 22 | 4.4 | R | C |
| E.BR.10/79 | 84 | 20 | 4.2 | R | D |
| E.BR.2/83 | 78 | 17 | 4.6 | R | C |
| E.BR.11/83 | 121 | 24 | 5.0 | R | A |
| E.BR.8/84 | 121 | 23 | 5.3 | R | A+ |
| E.BR.7/85 | 141 | 28 | 5.0 | R | A |
| E.BR.6/86 | 130 | 23 | 5.7 | R | A++ |
| E.BR.6/87 | 96 | 19 | 5.1 | R | A |
| E.BR.8/87 | 110 | 22 | 5.0 | R | B |
| E.BR.11/88 | 88 | 18 | 4.9 | R | C |
| E.BR.4/89 | 107 | 22 | 4.9 | R | B |
| E.BR.11/89 | 61 | 15 | 4.1 | R | D |
| E.BR.2/90 | 55 | 15 | 3.7 | R | E |
| E.BR.7/90 | 61 | 15 | 4.1 | R | D |
| E.BR.10/90 | 66 | 17 | 3.9 | R | D |
| E.BR.3/91 | 70 | 16 | 4.4 | R | D |

| | | | | | |
|---|---|---|---|---|---|
| ET1.1.6/83 | 18 | 3 | 6.0 | R | B |
| ET1.4.6/83 | 24 | 5 | 4.8 | R | E |
| ET1.4.11/88 | 55 | 13 | 4.2 | R | E |

Appendix 2. **RIVER GLEN BIOLOGICAL SCORES**

| SAMPLE | BMWP | NO.SCRG.TAXA | ASPT | HABITAT TYPE | LQI |
|---|---|---|---|---|---|
| W.BP.11/88 | 62 | 14 | 4.4 | R | D |
| W.BF.10/78 | 84 | 20 | 4.2 | R | D |
| W.BF.5/79 | 71 | 17 | 4.2 | R | D |
| W.BF.8/79 | 68 | 17 | 4.0 | R | D |
| W.BF.11/83 | 84 | 18 | 4.7 | R | C |
| W.BF.11/88 | 74 | 16 | 4.6 | R | C |
| W.BC.11/88 | 76 | 17 | 4.5 | R | D |
| W.BC.5/89 | 101 | 22 | 4.6 | R | B |
| W.BC.7/89 | 88 | 21 | 4.2 | R | D |
| W.BC.3/90 | 82 | 18 | 4.6 | R | C |
| W.BC.8/90 | 74 | 18 | 4.1 | R | D |
| W.BC.11/90 | 32 | 9 | 3.6 | R | E |
| W.BC.3/91 | 56 | 13 | 4.3 | R | E |
| W.CG.10/78 | 34 | 10 | 3.4 | R | F |
| W.CG.5/79 | 63 | 14 | 4.5 | R | D |
| W.CG.8/79 | 39 | 11 | 3.5 | R | F |
| W.CG.11/82 | 9 | 4 | 2.3 | R | I |
| W.CG.11/83 | 63 | 14 | 4.5 | R | D |
| W.CG.11/88 | 6 | 3 | 2.0 | R | I |
| W.CG.7/89 | 30 | 8 | 3.8 | R | F |
| W.SW.11/88 | 67 | 15 | 4.5 | R | D |
| W.SW.7/89 | 46 | 11 | 4.2 | R | E |
| W.CR.11/88 | 50 | 12 | 4.2 | R | E |
| W.LU.3/85 | 78 | 18 | 4.3 | R | D |
| W.LD.11/76 | 73 | 18 | 4.1 | R | D |
| W.LD.9/77 | 87 | 19 | 4.6 | R | C |
| W.LD.5/79 | 102 | 21 | 4.9 | R | B |
| W.LD.8/79 | 84 | 17 | 4.8 | R | C |
| W.LD.11/83 | 161 | 30 | 5.4 | R | A++ |
| W.LD.9/84 | 138 | 29 | 4.8 | R | A |
| W.LD.3/85 | 117 | 24 | 4.9 | R | B |
| W.LD.7/85 | 112 | 24 | 4.7 | R | B |
| W.LD.6/86 | 127 | 22 | 5.8 | R | A++ |
| W.LD.6/87 | 118 | 22 | 5.4 | R | A |
| W.LD.10/88 | 112 | 23 | 4.9 | R | B |
| W.LD.11/88 | 113 | 24 | 4.7 | R | B |
| W.LD.5/89 | 114 | 22 | 5.2 | R | A |
| W.LD.7/89 | 121 | 25 | 4.8 | R | A |
| W.LD.3/90 | 113 | 21 | 5.4 | R | A |
| W.LD.8/90 | 73 | 16 | 4.6 | R | C |
| W.LD.11/90 | 133 | 25 | 5.3 | R | A+ |
| W.LD.3/91 | 108 | 20 | 5.4 | R | A |
| W.EU.11/76 | 95 | 18 | 5.3 | R | A |
| W.EU.10/78 | 80 | 18 | 4.4 | R | D |
| W.EU.9/77 | 92 | 20 | 4.6 | R | B |
| W.EU.10/79 | 105 | 20 | 5.3 | R | A |
| W.EU.11/82 | 137 | 25 | 5.5 | R | A++ |
| W.EU.2/11/83 | 122 | 22 | 5.5 | R | A++ |
| W.EU.3/11/83 | 144 | 27 | 5.3 | R | A+ |
| W.ED.11/88 | 147 | 28 | 5.3 | R | A+ |
| W.BL.11/76 | 34 | 9 | 3.8 | R | E |
| W.BL.10/78 | 86 | 21 | 4.1 | R | D |
| W.BL.5/79 | 72 | 16 | 4.5 | R | D |
| W.BL.8/79 | 70 | 16 | 4.4 | R | D |
| W.BL.2/83 | 100 | 22 | 4.5 | R | C |
| W.BL.11/83 | 131 | 24 | 5.5 | R | A++ |
| W.BL.6/84 | 130 | 25 | 5.2 | R | A+ |
| W.BL.7/85 | 130 | 26 | 5.0 | R | A |
| W.BL.6/86 | 162 | 26 | 6.2 | R | A++ |
| W.BL.6/87 | 127 | 21 | 6.0 | R | A++ |
| W.BL.11/88 | 161 | 30 | 5.4 | R | A++ |
| W.BL.6/89 | 112 | 22 | 5.1 | R | A |
| W.BL.11/89 | 150 | 25 | 6.0 | R | A++ |
| W.BL.2/90 | 176 | 32 | 5.5 | R | A++ |
| W.BL.7/90 | 169 | 32 | 5.3 | R | A++ |
| W.BL.5/91 | 87 | 18 | 4.8 | R | C |

Appendix 2. **RIVER GLEN BIOLOGICAL SCORES**

| SAMPLE | BMWP | NO.SCRG.TAXA | ASPT | HABITAT TYPE | LQI |
|---|---|---|---|---|---|
| G.KB.6/76 | 72 | 18 | 4.0 | R | D |
| G.KB.11/76 | 62 | 16 | 3.9 | R | D |
| G.KB.9/77 | 75 | 18 | 4.2 | R | D |
| G.KB.10/78 | 94 | 22 | 4.3 | R | C |
| G.KB.10/89 | 110 | 23 | 4.8 | R | B |
| G.KB.11/82 | 120 | 25 | 4.8 | R | B |
| G.KB.11/83 | 128 | 26 | 4.9 | R | A |
| G.KB.4/89 | 134 | 27 | 5.0 | R | A |
| G.KB.11/89 | 144 | 31 | 4.6 | R | A |
| G.KB.2/90 | 137 | 28 | 4.9 | R | A |
| G.KB.7/90 | 158 | 32 | 4.9 | R | A+ |
| G.KB.10/90 | 138 | 30 | 4.6 | R | A |
| G.KB.3/91 | 120 | 27 | 4.4 | R | C |
| G.TF.11/76 | 17 | 5 | 3.4 | RR | F |
| G.TF.9/77 | 34 | 9 | 3.8 | RR | D |
| G.TF.10/78 | 75 | 20 | 3.8 | RR | C |
| G.TF.10/79 | 121 | 26 | 4.7 | RR | A++ |
| G.TF.11/83 | 67 | 20 | 4.4 | RR | A |
| G.TF.7/85 | 45 | 10 | 4.5 | RR | B |
| G.TF.6/86 | 61 | 13 | 4.7 | RR | A |
| G.TF.6/87 | 104 | 20 | 5.2 | RR | A++ |
| G.TE.10/78 | 98 | 22 | 4.5 | RR | A+ |
| G.TE.5/79 | 80 | 18 | 4.4 | RR | B |
| G.TE.8/79 | 99 | 23 | 4.3 | RR | A |
| G.TE.11/82 | 82 | 20 | 4.1 | RR | A |
| G.TE.11/83 | 62 | 16 | 3.9 | RR | C |
| G.TE.7/85 | 84 | 20 | 4.2 | RR | A |
| G.TE.6/86 | 50 | 11 | 4.5 | RR | B |
| G.TE.6/87 | 85 | 19 | 4.5 | RR | A+ |
| G.TE.4/89 | 69 | 15 | 4.6 | RR | A |
| G.TE.11/89 | 81 | 20 | 4.1 | RR | B |
| G.TE.2/90 | 94 | 23 | 4.1 | RR | A |
| G.TE.7/90 | 110 | 25 | 4.4 | RR | A+ |
| G.TE.10/90 | 81 | 19 | 4.3 | RR | A |
| G.TE.3/91 | 82 | 16 | 3.9 | RR | C |
| G.GG.6/76 | 45 | 10 | 4.5 | RR | B |
| G.GG.11/76 | 23 | 6 | 3.8 | RR | E |
| G.GG.9/77 | 23 | 6 | 3.8 | RR | E |
| G.GG.10/78 | 54 | 13 | 4.2 | RR | B |
| G.GG.10/79 | 85 | 21 | 4.0 | RR | B |
| G.GG.11/82 | 73 | 19 | 3.8 | RR | C |
| G.GG.11/83 | 72 | 18 | 4.0 | RR | C |
| G.PK.6/76 | 18 | 5 | 3.6 | RR | E |
| G.PK.11/76 | 23 | 5 | 4.6 | RR | C |
| G.PK.9/77 | 26 | 7 | 3.7 | RR | D |
| G.PK.10/78 | 69 | 17 | 4.1 | RR | B |
| G.PK.5/79 | 69 | 17 | 4.1 | RR | B |
| G.PK.8/79 | 96 | 22 | 4.4 | RR | A |
| G.PK.11/82 | 60 | 16 | 3.6 | RR | C |
| G.PK.11/83 | 76 | 18 | 4.2 | RR | B |
| G.SF.5/89 | 82 | 19 | 4.3 | RR | A |
| G.SF.10/89 | 92 | 21 | 4.4 | RR | A |
| G.SF.3/90 | 68 | 17 | 4.0 | RR | C |
| G.SF.8/90 | 79 | 20 | 4.0 | RR | C |
| G.SF.10/90 | 115 | 25 | 4.6 | RR | A++ |
| G.SF.4/91 | 71 | 18 | 3.9 | RR | C |
| G.SS.6/76 | 9 | 3 | 3.0 | RR | H |
| G.SS.11/76 | 8 | 2 | 4.0 | RR | F |
| G.SS.9/77 | 26 | 7 | 3.7 | RR | D |
| G.SS.10/78 | 41 | 11 | 3.7 | RR | D |
| G.SS.10/79 | 61 | 14 | 4.4 | RR | B |
| G.SS.11/83 | 50 | 12 | 4.2 | RR | C |
| G.SS.7/84 | 58 | 15 | 3.9 | RR | C |
| G.SS.8/85 | 63 | 16 | 3.9 | RR | C |
| G.SS.8/86 | 37 | 10 | 3.7 | RR | D |
| G.SS.6/87 | 66 | 15 | 4.4 | RR | B |
| G.SS.5/89 | 67 | 17 | 3.9 | RR | C |
| G.SS.10/89 | 79 | 19 | 4.2 | RR | B |
| G.SS.3/90 | 93 | 23 | 4.0 | RR | B |
| G.SS.8/90 | 97 | 23 | 4.2 | RR | A |
| G.SS.10/90 | 94 | 22 | 4.3 | RR | A |
| G.SS.4/91 | 70 | 18 | 3.9 | RR | C |

Appendix 2. **RIVER GLEN BIOLOGICAL SCORES**

| SAMPLE | BMWP | NO.SCRG.TAXA | ASPT | HABITAT TYPE | LQI |
|---|---|---|---|---|---|
| T.CH.4/82 | 52 | 10 | 5.2 | R | C |
| T.CH.4/84 | 53 | 12 | 4.4 | R | E |
| T.CH.4/87 | 50 | 11 | 4.5 | R | E |
| T.CU.4/84 | 35 | 9 | 3.9 | R | E |
| T.CU.4/87 | 45 | 10 | 4.5 | R | E |
| T.CD.4/82 | 87 | 18 | 4.8 | R | C |
| T.CD.4/84 | 67 | 15 | 4.5 | R | D |
| T.CD.4/87 | 67 | 14 | 4.8 | R | C |
| T.GU.4/82 | 90 | 18 | 5.0 | R | C |
| T.GU.4/84 | 69 | 15 | 4.6 | R | C |
| T.GU.3/85 | 91 | 18 | 5.1 | R | 5 |
| T.GU.3/90 | 111 | 22 | 5.0 | R | B |
| T.GU.3/91 | 108 | 20 | 5.4 | R | A |
| T.GD.3/85 | 80 | 17 | 4.7 | R | C |
| T.LU.10/78 | 83 | 19 | 4.4 | R | D |
| T.LU.10/79 | 66 | 14 | 4.7 | R | C |
| T.LU.11/83 | 102 | 22 | 4.6 | R | B |
| T.LD.9/77 | 54 | 12 | 4.5 | R | E |
| T.LD.4/82 | 112 | 21 | 5.3 | R | A |
| T.LD.4/84 | 92 | 18 | 5.1 | R | A |
| T.LD.3/85 | 64 | 14 | 4.6 | R | C |
| T.LD.4/87 | 88 | 17 | 5.2 | R | B |
| T.LD.11/88 | 94 | 20 | 4.7 | R | B |
| T.LD.5/89 | 102 | 21 | 4.9 | R | B |
| T.LD.7/89 | 92 | 21 | 4.4 | R | C |
| T.LD.3/90 | 88 | 21 | 4.2 | R | D |
| T.LD.8/90 | 91 | 19 | 4.8 | R | B |
| T.LD.11/90 | 150 | 29 | 5.2 | R | A+ |
| T.LD.3/91 | 44 | 11 | 4.0 | R | E |

| | | | | | |
|---|---|---|---|---|---|
| B.BU.11/76 | 17 | 6 | 2.8 | RR | G |
| B.BU.10/78 | 52 | 15 | 3.5 | RR | D |
| B.BU.10/79 | 47 | 14 | 3.4 | RR | E |
| B.BD.9/77 | 33 | 9 | 3.7 | RR | D |
| B.BD.10/79 | 51 | 15 | 3.4 | RR | D |
| B.BD.11/82 | 63 | 17 | 3.7 | RR | C |
| B.BD.11/83 | 55 | 15 | 3.7 | RR | C |
| B.RL.10/79 | 61 | 17 | 3.6 | RR | C |
| B.RL.11/82 | 56 | 16 | 3.5 | RR | D |
| B.RL.2/83 | 36 | 11 | 3.3 | RR | E |
| B.RL.11/83 | 52 | 15 | 3.5 | RR | D |
| B.TU.4/89 | 72 | 17 | 4.2 | RR | B |
| B.TU.11/89 | 66 | 17 | 3.9 | RR | C |
| B.TD.2/90 | 101 | 22 | 4.6 | RR | A++ |
| B.TD.7/90 | 94 | 21 | 4.5 | RR | A+ |
| B.TD.3/91 | 107 | 24 | 4.5 | RR | A++ |

# APPENDIX 3 TWINSPAN PREFERENTIAL TAXA

## APPENDIX 3.1

TWINSPAN PREFERENTIAL TAXA FOR THE CLASSIFICATION OF ALL SAMPLES

## Appendix 3.1

TWINSPAN "indicator" taxa and negative (left-hand groups) and positive (right-hand groups) preferential taxa from the classification of all samples (Section 5.4, Figures 5 and 6). N = the number of samples in the division; numbers after preferential taxa indicate the number of samples in the negative and positive groups in which these taxa occur.

```
DIVISION    1  (N= 249)          I.E. GROUP *
Eigenvalue  .170  at iteration   2
INDICATORS, together with their SIGN
Limn ephil(+)   Elmi nthil(+)   Hydr opsyl(+)   Simu liidl(+)   Tipu lidal(+)   Goer idael(+)   Ephe merel(+)
Coen agril(-)   Rhya cophl(+)   Valv atidl(-)   Ancy lidal(+)   Plan arill(+)   Cori xidal(-)   Lept ophll(+)

NEGATIVE PREFERENTIALS
OSTR ACOD1( 48,  7) CLAD OCER1( 41,  4) Coen agril( 58,  2) Valv atidl( 49,  3)

POSITIVE PREFERENTIALS
Dend rocol( 22, 25) Lept ophll(  9, 33) Ephe merel(  7, 38) Epne meril(  3, 21) Rhya cophl(  3, 34) Poly centl( 11, 25)
Hydr opsyl( 24, 55) Hydr optil( 29, 33) Limn ephil( 14, 64) Goer idael(  2, 35) Elmi nthil( 72, 84) Tipu lidal( 56, 68)
Simu liidl( 21, 55) Ancy lidal(  0, 27)
**************************************************************************************************

DIVISION    2  (N= 162)          I.E. GROUP *0
Eigenvalue  .132  at iteration   1
INDICATORS, together with their SIGN
Valv atidl(-)   Phys idael(-)   Plan arill(-)   Coen agril(-)   CLAD OCER1(-)   Asel lidal(-)   Plan orbil(-)
Pisc icoll(-)   OSTR ACOD1(-)   Baet idael(-)   Elmi nthil(-)   Gamm aridl(-)   Tipu lidal(+)   Hydr obill(-)

NEGATIVE PREFERENTIALS
Plan arill( 53, 22) Pisc icoll( 27,  4) OSTR ACOD1( 34, 14) CLAD OCER1( 32,  9) Asel lidal( 60, 41) Coen agril( 45, 13)
Hydr optil( 23,  6) Noto nectl( 20, 10) Valv atidl( 49,  0) Phys idael( 43,  6)
**************************************************************************************************

DIVISION    3  (N=  87)          I.E. GROUP *1
Eigenvalue  .108  at iteration   2
INDICATORS, together with their SIGN
Ephe meril(-)   Cori xidal(-)   Plan orbil(-)   Lept ocerl(-)   Phys idael(-)   Caen idael(-)   Spha eridl(-)
Dend rocol(-)   Poly centl(-)   Rhya cophl(+)   Ancy lidal(+)   Noto nectl(-)

NEGATIVE PREFERENTIALS
Dend rocol( 15, 10) Ephe meril( 18,  3) Poly centl( 15, 10) Lept ocerl( 21, 16) Seri costl( 11,  6) Gyri nidal(  6,  1)
Cori xidal( 24, 15) Noto nectl(  9,  1) Phys idael( 15,  2) Plan orbil( 26, 22)

POSITIVE PREFERENTIALS
Rhya cophl(  4, 30) Ancy lidal(  3, 24)
NON-PREFERENTIALS
Plan arill( 22, 49) Olig ochal( 28, 59) Pisc icoll( 13, 20) Glos siphl( 24, 49) Erpo bdell( 27, 42) COPE PODA1(  6, 11)
Asel lidal( 18, 27) Gamm aridl( 28, 56) Baet idael( 25, 49) Lept ophll( 15, 18) Ephe merel( 15, 23) Caen idael( 26, 29)
Sial idael( 13, 14) Hydr opsyl( 20, 35) Hydr optil( 13, 20) Limn ephil( 20, 44) Goer idael( 15, 20) Elmi nthil( 28, 56)
Hall plidl( 19, 31) Dyti scidl( 22, 44) Helo didal(  3, 12) Tipu lidal( 20, 48) Simu liidl( 15, 40) Chir onoml( 25, 58)
Cera topol( 10, 17) Spha eridl( 28, 33) Hydr obill( 19, 42) Lymn aeidl( 18, 31) HYDR ACAR1( 22, 48)
**************************************************************************************************

DIVISION    4  (N=  67)          I.E. GROUP *00
Eigenvalue  .086  at iteration   3
INDICATORS, together with their SIGN
Noto nectl(-)   COPE PODA1(+)   Lept ocerl(-)   CLAD OCER1(+)   Gerr idael(-)   Hydr optil(+)

NEGATIVE PREFERENTIALS
Sial idael(  6,  7) Lept ocerl( 13, 10) Hydr ometl(  4,  1) Gerr idael(  7,  3) Noto nectl( 14,  6) Unio nidal(  5,  3)

POSITIVE PREFERENTIALS
CLAD OCER1(  3, 29) COPE PODA1(  1, 29) Hydr optil(  2, 21)
**************************************************************************************************

DIVISION    5  (N=  95)          I.E. GROUP *01
Eigenvalue  .142  at iteration   2
INDICATORS, together with their SIGN
Glos siphl(+)   Erpo bdell(+)   Spha eridl(+)   Caen idael(+)   Elmi nthil(+)   Hydr obill(+)   Plan orbil(+)
Tipu lidal(+)   COPE PODA1(-)   CLAD OCER1(-)

NEGATIVE PREFERENTIALS
CLAD OCER1(  9,  0) COPE PODA1( 12, 16)

POSITIVE PREFERENTIALS
Plan arill(  1, 21) Glos siphl(  2, 63) Erpo bdell(  5, 62) Asel lidal(  5, 36) Caen idael(  2, 45) Sial idael(  1, 23)
Hydr opsyl(  0, 23) Lept ocerl(  0, 26) Elmi nthil(  4, 49) Tipu lidal(  3, 38) Cera topol(  3, 24) Spha eridl(  1, 45)
Hydr obill(  3, 49) Plan orbil(  3, 46)
**************************************************************************************************

DIVISION    6  (N=  28)          I.E. GROUP *10
Eigenvalue  .084  at iteration   2
INDICATORS, together with their SIGN
Psyc hodil(-)   Ephe merel(+)   Poly centl(+)   Sial idael(-)   Coen agril(-)   Valv atidl(-)

NEGATIVE PREFERENTIALS
OSTR ACOD1(  2,  3) CLAD OCER1(  1,  3) Coen agril(  2,  0) Agri idael(  2,  2) Sial idael(  4,  9) Mola nnidl(  1,  2)
Helo didal(  2,  1) Psyc hodil(  3,  0) Stra tioml(  1,  0) Taba nidal(  1,  0) Musc idael(  1,  1) Valv atidl(  2,  0)

POSITIVE PREFERENTIALS
Pisc icoll(  1, 12) COPE PODA1(  0,  6) Ephe merel(  0, 15) Poly centl(  0, 15) Psyc homyl(  0,  5) Gyri nidal(  0,  6)
**************************************************************************************************
```

## Appendix 3.1

```
DIVISION     7  (N=  59)          I.E. GROUP *11
Eigenvalue  -.097  at iteration   2
INDICATORS, together with their SIGN
Ancy lidal(+)   Hydr optil(+)   Asel lidal(-)   Goer idael(+)   Plan orbil(-)

NEGATIVE PREFERENTIALS
Asel lidal( 15, 12) Sial idael(  9,  5) Lept ocerl( 10,  6) Psyc nodil(  4,  4) Plan orbil( 13,  9)

POSITIVE PREFERENTIALS
Dend rocol(  1,  9) Pisc icoll(  3, 17) Rhya cophl(  5, 25) Hydr optil(  0, 20) Goer idael(  2, 18) Glos aosol(  1,  9)
Ancy lidal(  1, 23)
*******************************************************************************************************

DIVISION     8  (N=  16)          I.E. GROUP *000
Eigenvalue  .108  at iteration   3
INDICATORS, together with their SIGN
Plan ariil(+)
NEGATIVE PREFERENTIALS
Ephe merel(  2,  0)

POSITIVE PREFERENTIALS
Plan ariil(  0, 11) Glos siphl(  1, 11) Erpo bdell(  0,  8) OSTR ACOD1(  0,  7) Sial idael(  1,  5) Phry ganel(  0,  3)
Elmi nthil(  1,  5) Gyri nidal(  0,  3) Hydr ophil(  0,  3) Helo didal(  0,  3) Hydr ometl(  0,  4) Spha eridl(  1,  8)
Phya idael(  2,  9)
*******************************************************************************************************

DIVISION     9  (N=  51)          I.E. GROUP *001
Eigenvalue  .081  at iteration   2
INDICATORS, together with their SIGN
Coen agril(-)   Erpo bdell(+)   Cori xidal(-)   Phys idael(-)   Caen idael(-)   Dend rocol(+)   Hydr optil(+)
Poly centl(+)

NEGATIVE PREFERENTIALS
Coen agril( 30,  2) Caen idael( 23,  2) Cori xidal( 37,  5)

POSITIVE PREFERENTIALS
Dend rocol(  2,  6) Erpo bdell( 17, 13) Sial idael(  4,  3) Poly centl(  1,  5) Hydr optil( 12,  9) Tipu lidal(  6,  5)
Simu liidl(  0,  3) Musc idael(  1,  3) Phys idael( 19, 13)
*******************************************************************************************************

DIVISION    10  (N=  23)          I.E. GROUP *010
Eigenvalue  .260  at iteration   3
INDICATORS, together with their SIGN
Dyti scidl(+)   Baet idael(+)

NEGATIVE PREFERENTIALS
Erpo bdell(  3,  2)

POSITIVE PREFERENTIALS
CLAD OCER1(  1,  8)
*******************************************************************************************************

DIVISION    11  (N=  72)          I.E. GROUP *011
Eigenvalue  .096  at iteration   2
INDICATORS, together with their SIGN
Cera topol(+)   Lept ocerl(+)   Spha eridl(+)   Simu liidl(-)   OSTR ACOD1(-)   Hydr opsyl(+)   Dend rocol(-)
Phya idael(-)   Sial idael(+)   HYDR ACAR1(+)   Coen agril(+)   COPE PODA1(-)   Baet idael(-)

NEGATIVE PREFERENTIALS
Dend rocol(  7,  5) OSTR ACOD1(  9,  3) Simu liidl( 10,  5) Phys idael(  5,  1)

POSITIVE PREFERENTIALS
Coen agril(  0, 11) Sial idael(  3, 20) Hydr opsyl(  2, 21) Lept ocerl(  1, 25) Cera topol(  1, 23) Spha eridl(  6, 39)
*******************************************************************************************************

DIVISION    12  (N=   4)          I.E. GROUP *100
Eigenvalue  .120  at iteration   4
INDICATORS, together with their SIGN
Simu liidl(+)

NEGATIVE PREFERENTIALS
Goer idael(  1,  1) Cera topol(  1,  1) Taba nidal(  1,  0)

POSITIVE PREFERENTIALS
Dend rocol(  0,  2) Pisc icoll(  0,  1) OSTR ACOD1(  0,  2) CLAD OCER1(  0,  1) Coen agril(  0,  2) Agri idael(  0,  2)
Ephe meril(  0,  2) Hydr opsyl(  0,  2) Hydr optil(  0,  2) Mola nnidl(  0,  1) Seri costl(  0,  1) Hali plidl(  0,  2)
Helo didal(  0,  2) Noto nectl(  0,  1) Simu liidl(  0,  3) Stra tioml(  0,  1) Musc idael(  0,  1) Valv atidl(  0,  2)
Phya idael(  0,  3)
*******************************************************************************************************

DIVISION    13  (N=  24)          I.E. GROUP *101
Eigenvalue  .093  at iteration   3
INDICATORS, together with their SIGN
Seri costl(-)   Poly centl(+)

NEGATIVE PREFERENTIALS
Rhya cophl(  3,  1) Psyc homyl(  4,  1) Seri costl( 10,  0) Gyri nidal(  4,  2) Ancy lidal(  3,  0)

POSITIVE PREFERENTIALS
PORI FERA1(  0,  3) CLAD OCER1(  0,  3) COPE PODA1(  2,  4) Poly centl(  3, 12) Hydr optil(  3,  8) Simu liidl(  4,  8)
Cera topol(  1,  7)
```

## Appendix 3.1

```
DIVISION   14  (N=  18)          I.E. GROUP *110
Eigenvalue  .120  at iteration  2
INDICATORS, together with their SIGN
Lept ophl1(+)   COPE PODA1(+)   Cera topo1(-)   Pisc icol1(+)

NEGATIVE PREFERENTIALS
Poly cent1(  2,  0) Cera topo1(  7,  0) Psyc hodi1(  3,  1) Taba nica1(  2,  0) Lymn aeid1(  5,  2)

POSITIVE PREFERENTIALS
Pisc icol1(  0,  3) COPE PODA1(  1,  4) Lept ophl1(  0,  7) Goer idae1(  0,  2) Seri cost1(  0,  2) Helo dida1(  0,  3)
Cori xida1(  1,  4)
*******************************************************************************************************************

DIVISION   15  (N=  41)          I.E. GROUP *111
Eigenvalue  .101  at iteration  2
INDICATORS, together with their SIGN
Spha erid1(-)   Ephe mere1(-)   Caen idae1(-)   Dend roco1(-)   Asel lida1(-)   Erpo bdel1(-)   Ancy lida1(-)
Plan orbi1(-)   Cori xida1(-)   Lept ocer1(-)   Simu liid1(-)   Sial idae1(-)   Limn ephi1(+)   Helo dida1(+)
Lymn aeid1(-)

NEGATIVE PREFERENTIALS
Dend roco1(  9,  0) Asel lida1( 10,  2) Ephe mere1( 13,  4) Caen idae1( 14,  5) Sial idae1(  5,  0) Lept ocer1(  6,  0)
Cori xida1(  8,  2) Spha erid1( 16,  6) Plan orbi1(  8,  1)

POSITIVE PREFERENTIALS
Helo dida1(  2,  7)
*******************************************************************************************************************
```

# APPENDIX 3.2

## TWINSPAN PREFERENTIAL TAXA FOR THE CLASSIFICATIONS OF THE CASE-STUDY SITES

**3.2.1 West Glen at Essendine**

**3.2.2 West Glen at Banthorpe Lodge**

**3.2.3 Glen at Kates Bridge**

**3.2.4 Glen at Surfleet Seas End**

**3.2.4 East Glen at Braceborough**

## Appendix 3.2.1 Indicator and preferential taxa for WEU.

TWINSPAN "indicator" taxa and negative (left-hand groups) and positive (right-hand groups) preferential taxa from the classification of WEU samples (Section 5.6.1, Figure 11). N = the number of samples in the division; numbers after preferential taxa indicate the number of samples in the negative and positive groups in which these taxa occur.

```
DIVISION    1  (N=   7)          I.E. GROUP *
Eigenvalue  .222  at iteration   2
INDICATORS, together with their SIGN
Hydr opsyl(-)

NEGATIVE PREFERENTIALS
Lept ophl1(  3,   0) Ephe merel(  3,   0) Ephe meril(  5,   0) Seri costl(  3,   0) Dend rocol(  4,   0) Hydr opsyl(  6,   0)
Dyti scidl(  5,   0) Cori xidal(  6,   0) Noto nectl(  2,   0) Simu liidl(  3,   0) Pisc icoll(  3,   0) Glos siphl(  5,   0)
Erpo bdell(  6,   0) Cera topol(  3,   0)

POSITIVE PREFERENTIALS
Limn ephil(  2,   1) Hydr optil(  2,   1) Hali plidl(  2,   1) Tipu lidal(  2,   1) Sial idael(  2,   1) Asel lidal(  0,   1)
Hydr obill(  0,   1) Lymn aeidl(  1,   1) Phys idael(  2,   1) COEL ENTEl(  0,   1)
*****************************************************************************************************************

DIVISION    2  (N=   6)          I.E. GROUP *0
Eigenvalue  .211  at iteration   1
INDICATORS, together with their SIGN
Dend rocol(+)

NEGATIVE PREFERENTIALS
Seri costl(  2,   1) Gyri nidal(  1,   0) Hydr ophil(  1,   0) Tipu lidal(  1,   1) Sial idael(  2,   0) COPE PODA1(  1,   0)

POSITIVE PREFERENTIALS
Lept ophl1(  0,   3) Mola nnidl(  0,   1) Rhya cophl(  0,   1) Limn ephil(  0,   2) Hydr optil(  0,   2) Plan ariil(  1,   4)
Dend rocol(  0,   4) Hali plidl(  0,   2) Noto nectl(  0,   2) Simu liidl(  0,   3) Pisc icoll(  0,   3) Lymn aeidl(  0,   1)
Phys idael(  0,   2) Plan orbil(  0,   4) PORI FERA1(  0,   1) HYDR ACAR1(  1,   4)
*****************************************************************************************************************

DIVISION    4  (N=   2)          I.E. GROUP *00
Eigenvalue  .219  at iteration   0
INDICATORS, together with their SIGN
Ephe merel(-)

NEGATIVE PREFERENTIALS
Ephe merel(  1,   0) Plan ariil(  1,   0) Hydr ophil(  1,   0) Tipu lidal(  1,   0)

POSITIVE PREFERENTIALS
Lept ocerl(  0,   1) Gyri nidal(  0,   1) COPE PODA1(  0,   1) Cera topol(  0,   1) HYDR ACAR1(  0,   1)
*****************************************************************************************************************

DIVISION    5  (N=   4)          I.E. GROUP *01
Eigenvalue  .145  at iteration   6
RA TROUBLE    6 ITERATIONS, AND RESIDUAL IS STILL    .026  INSTEAD OF   .003 (THE TOLERANCE)
INDICATORS, together with their SIGN
Lept ophl1(-)

NEGATIVE PREFERENTIALS
Lept ophl1(  3,   0) Ephe merel(  2,   0) Ephe meril(  3,   0) Mola nnidl(  1,   0) Lept ocerl(  3,   0) Seri costl(  1,   0)
Rhya cophl(  1,   0) Limn ephil(  2,   0) Noto nectl(  2,   0) Tipu lidal(  1,   0) Simu liidl(  3,   0) Pisc icoll(  3,   0)
Lymn aeidl(  1,   0) Phys idael(  2,   0) PORI FERA1(  1,   0) Cera topol(  2,   0)

POSITIVE PREFERENTIALS
Hydr optil(  1,   1) Hali plidl(  1,   1)
*****************************************************************************************************************
DIVISION   10  (N=   3)          I.E. GROUP *010
Eigenvalue  .178  at iteration   6
RA TROUBLE    6 ITERATIONS, AND RESIDUAL IS STILL    .045  INSTEAD OF   .003 (THE TOLERANCE)
INDICATORS, together with their SIGN
Ephe merel(+)

NEGATIVE PREFERENTIALS
Mola nnidl(  1,   0) Seri costl(  1,   0) Noto nectl(  1,   1) Glos siphl(  1,   1) Phys idael(  1,   1) Cera topol(  1,   1)

POSITIVE PREFERENTIALS
Ephe merel(  0,   2) Rhya cophl(  0,   1) Poly centl(  0,   2) Limn ephil(  0,   2) Hydr optil(  0,   1) Hali plidl(  0,   1)
Dyti scidl(  0,   2) Tipu lidal(  0,   1) Lymn aeidl(  0,   1) Chir onoml(  0,   2) PORI FERA1(  0,   1)
*****************************************************************************************************************
```

## Appendix 3.2.2 Indicator and preferential taxa for WBL.

TWINSPAN "indicator" taxa and negative (left-hand groups) and positive (right-hand groups) preferential taxa from the classification of WBL samples (Section 5.6.2, Figure 11). N = the number of samples in the division; numbers after preferential taxa indicate the number of samples in the negative and positive groups in which these taxa occur.

```
DIVISION    1  (N=  16)          I.E. GROUP *
Eigenvalue  .164  at iteration  1
INDICATORS, together with their SIGN
Goer idael(-)   Ephe meril(-)   Seri costl(-)

NEGATIVE PREFERENTIALS
Caen idael( 10,  2) Spha eridl( 10,  2) Goer idael(  9,  0) Limn ephil(  6,  1) Hydr opsyl(  8,  1) Cori xidal(  8,  1)
Ephe meril(  8,  0) Lept ocerl(  7,  1) Seri costl(  7,  0) Poly centl(  6,  1) Phya idael(  6,  1) Hydr optil(  5,  1)
Lept ophl1(  5,  0) Pisc icoll(  5,  0) Sial idael(  5,  0) Ancy lidal(  4,  0) Lepi dostl(  3,  0) Agri idael(  3,  0)

POSITIVE PREFERENTIALS
Cera topol(  4,  4) COPE PODA1(  1,  2) Stra tioml(  0,  2) Musc idael(  0,  2)
**********************************************************************************************************************

DIVISION    2  (N=  11)          I.E. GROUP *0
Eigenvalue  .132  at iteration  1
INDICATORS, together with their SIGN
Dend rocol(+)   Poly centl(+)

NEGATIVE PREFERENTIALS
Plan orbil(  6,  2) Hydr obiil(  6,  2) Cori xidal(  6,  2) Seri costl(  5,  2) Lymn aeidl(  4,  1) Phya idael(  5,  1)
Asel lidal(  4,  0) Ancy lidal(  3,  1) Agri idael(  3,  0) Mola nnidl(  2,  0) Helo didal(  2,  0)

POSITIVE PREFERENTIALS
Simu liidl(  2,  4) Dend rocol(  1,  5) Poly centl(  1,  5) Rhya cophl(  1,  3)
**********************************************************************************************************************

DIVISION    3  (N=   5)          I.E. GROUP *1
Eigenvalue  .308  at iteration  1
INDICATORS, together with their SIGN
Gamm aridl(-)

NEGATIVE PREFERENTIALS
Gamm aridl(  4,  0) Baet idael(  4,  0) Erpo bdell(  4,  0) Caen idael(  2,  0) Glos siphl(  4,  0) Spha eridl(  2,  0)
Hydr obiil(  4,  0) Plan ariil(  3,  0) HYDR ACAR1(  4,  0) Hali plidl(  2,  0) Ephe merel(  2,  0) Limn ephil(  1,  0)
Hydr opsyl(  1,  0) Cori xidal(  1,  0) Cera topol(  4,  0) Lept ocerl(  1,  0) Poly centl(  1,  0) Phya idael(  1,  0)
Rhya cophl(  2,  0) Hydr optil(  1,  0) Asel lidal(  2,  0) Psyc hodil(  1,  0) Stra tioml(  2,  0) Musc idael(  2,  0)
Glos sosol(  1,  0) COEL ENTE1(  1,  0) Taba nidal(  1,  0) Nemo uridl(  1,  0) Hydr ophil(  1,  0)

POSITIVE PREFERENTIALS
Dyti scidl(  2,  1) Dend rocol(  1,  1) Lymn aeidl(  1,  1) COPE PODA1(  1,  1) OSTR ACOD1(  0,  1)
**********************************************************************************************************************

DIVISION    4  (N=   6)          I.E. GROUP *00
Eigenvalue  .181  at iteration  1
INDICATORS, together with their SIGN
Caen idael(+)

NEGATIVE PREFERENTIALS
Ephe merel(  1,  2) Lept ocerl(  1,  2) Dend rocol(  1,  0) Hydr optil(  1,  1) Pisc icoll(  1,  2) Sial idael(  1,  2)
Ancy lidal(  1,  2) Leuc tridl(  1,  0) Mola nnidl(  1,  1) Helo didal(  1,  1) Veli idael(  1,  0) Gerr idael(  1,  0)

POSITIVE PREFERENTIALS
Caen idael(  0,  5) HYDR ACAR1(  0,  3) Simu liidl(  0,  2) Goer idael(  0,  5) Limn ephil(  0,  4) Cera topol(  0,  2)
Asel lidal(  0,  4) Lept ophl1(  0,  3) Lepi dostl(  0,  2) Agri idael(  0,  3)
**********************************************************************************************************************

DIVISION    5  (N=   5)          I.E. GROUP *01
Eigenvalue  .221  at iteration  1
INDICATORS, together with their SIGN
Tipu lidal(-)

NEGATIVE PREFERENTIALS
Tipu lidal(  3,  0) Simu liidl(  3,  1) Ephe merel(  3,  1) Limn ephil(  3,  1) Seri costl(  2,  0) Lymn aeidl(  1,  0)
Rhya cophl(  3,  0) Ancy lidal(  1,  0) Lepi dostl(  1,  0) Leuc tridl(  1,  0) Glos sosol(  1,  0) Gyri nidal(  1,  0)

POSITIVE PREFERENTIALS
Glos siphl(  1,  2) HYDR ACAR1(  1,  2) Cera topol(  0,  2) Ephe meril(  1,  2) Phya idael(  0,  1) Pisc icoll(  0,  2)
COPE PODA1(  0,  1) Veli idael(  0,  1) PORI FERA1(  0,  1)
**********************************************************************************************************************

DIVISION    6  (N=   4)          I.E. GROUP *10
Eigenvalue  .248  at iteration  6
RA TROUBLE   6 ITERATIONS, AND RESIDUAL IS STILL   .007  INSTEAD OF   .003 (THE TOLERANCE)
INDICATORS, together with their SIGN
Cori xidal(+)

NEGATIVE PREFERENTIALS
Caen idael(  2,  0) Ephe merel(  2,  0) Limn ephil(  1,  0) Hydr opsyl(  1,  0) Lept ocerl(  1,  0) Dend rocol(  1,  0)
Hydr optil(  1,  0) COPE PODA1(  1,  0) Psyc hodil(  1,  0) Stra tioml(  2,  0) Glos sosol(  1,  0) Taba nidal(  1,  0)
Nemo uridl(  1,  0) Hydr ophil(  1,  0)

POSITIVE PREFERENTIALS
Dyti scidl(  1,  1) Spha eridl(  1,  1) Hali plidl(  1,  1) Cori xidal(  0,  1) Poly centl(  0,  1) Lymn aeidl(  0,  1)
Phya idael(  0,  1) Rhya cophl(  1,  1) Asel lidal(  1,  1) Musc idael(  1,  1) COEL ENTE1(  0,  1)
**********************************************************************************************************************
```

## Appendix 3.2.2

```
DIVISION     9  (N=    5)           I.E. GROUP *001
Eigenvalue   .198  at iteration   1
INDICATORS, together with their SIGN
Simu liidl(-)

NEGATIVE PREFERENTIALS
Plan ariil(  2,   1) HYDR ACAR1(  2,   1) Simu liidl(  2,   0) Cera topol(  2,   0) Hydr optil(  1,   0) Psyc hodil(  1,   0)
Mola nnidl(  1,   0) Helo didal(  1,   0) Coen agril(  1,   0) Noto nectl(  1,   0)

POSITIVE PREFERENTIALS
Ephe merel(  0,   2) Ephe meril(  1,   3) Seri costl(  1,   3) Poly centl(  0,   1) Lymn aeidl(  0,   3) Rhya cophi(  0,   1)
Pisc icoll(  0,   2) Lepi dostl(  0,   2) OSTR ACOD1(  0,   1) Gyri nidal(  0,   1)
**************************************************************************************************************************

DIVISION    10  (N=    3)           I.E. GROUP *010
Eigenvalue   .269  at iteration   2
INDICATORS, together with their SIGN
Plan orbil(-)

NEGATIVE PREFERENTIALS
Plan orbil(  1,   0) Dyti scidl(  1,   1) Glos siphl(  1,   0) Spha eridl(  1,   1) Hydr obiil(  1,   0) Hali plidl(  1,   1)
Hydr opsyl(  1,   1) Cori xidal(  1,   0) Seri costl(  1,   1) Lymn aeidl(  1,   0) Hydr optil(  1,   1) Gyri nidal(  1,   0)

POSITIVE PREFERENTIALS
Plan ariil(  0,   2) HYDR ACAR1(  0,   1) Goer idael(  0,   2) Ephe meril(  0,   1) Lept oceri(  0,   2) Lept ophll(  0,   1)
Sial idael(  0,   1) Ancy lidal(  0,   1) Lepi dostl(  0,   1) Leuc tridl(  0,   1) Glos sosol(  0,   1)
**************************************************************************************************************************

DIVISION    11  (N=    2)           I.E. GROUP *011
Eigenvalue   .236  at iteration   0
INDICATORS, together with their SIGN
Plan orbil(-)

NEGATIVE PREFERENTIALS
Plan orbil(  1,   0) Hydr obiil(  1,   0) Simu liidl(  1,   0) Ephe merel(  1,   0) Sial idael(  1,   0) Veli idael(  1,   0)

POSITIVE PREFERENTIALS
Limn ephil(  0,   1) Cori xidal(  0,   1) Phys idael(  0,   1) Hydr optil(  0,   1) Lept ophll(  0,   1) COPE PODA1(  0,   1)
PORI FERA1(  0,   1)
**************************************************************************************************************************

DIVISION    12  (N=    3)           I.E. GROUP *100
Eigenvalue   .362  at iteration   2
INDICATORS, together with their SIGN
Caen idael(+)

NEGATIVE PREFERENTIALS
Tipu lidal(  1,   1) Ephe merel(  1,   1) Hydr opsyl(  1,   0) Dend rocol(  1,   0) Rhya cophl(  1,   0) Asel lidal(  1,   0)
Hydr ophil(  1,   0)

POSITIVE PREFERENTIALS
Caen idael(  0,   2) Dyti scidl(  0,   1) Spha eridl(  0,   1) Plan ariil(  0,   2) Hali plidl(  0,   1) Simu liidl(  0,   2)
Limn ephil(  0,   1) Lept oceri(  0,   1) Hydr optil(  0,   1) COPE PODA1(  0,   1) Psyc hodil(  0,   1) Stra tioml(  0,   2)
Musc idael(  0,   1) Glos sosol(  0,   1) Taba nidal(  0,   1) Nemo uridl(  0,   1)
**************************************************************************************************************************
```

## Appendix 3.2.3 Indicator and preferential taxa for GKB.

TWINSPAN "indicator" taxa and negative (left-hand groups) and positive (right-hand groups) preferential taxa from the classification of GKB samples (Section 5.6.3, Figure 13). N = the number of samples in the division; numbers after preferential taxa indicate the number of samples in the negative and positive groups in which these taxa occur.

```
DIVISION    1  (N=  13)          I.E. GROUP *
Eigenvalue  .118  at iteration   2
INDICATORS, together with their SIGN
Simu liidl(-)    Gyri nidal(+)

NEGATIVE PREFERENTIALS
Lept ophll(  2,   0) Goer idael(  2,   0) Psyc homyl(  2,   0) Simu liidl(  8,   0) PORI FERA1(  3,   0)

POSITIVE PREFERENTIALS
Ephe merel(  1,   1) Ephe meril(  2,   2) Mola nnidl(  0,   1) Coen agril(  2,   2) Gyri nidal(  0,   3) Veli idael(  0,   1)
Hydr ometl(  0,   2) Gerr idael(  0,   2) Noto nectl(  1,   3) Sial idael(  4,   3) Valv atidl(  3,   2) Musc idael(  3,   2)
*****************************************************************************************************************************

DIVISION    2  (N=  10)          I.E. GROUP *0
Eigenvalue  .129  at iteration   1
INDICATORS, together with their SIGN
Sial idael(-)

NEGATIVE PREFERENTIALS
Lept ophll(  2,   0) Ephe meril(  2,   0) Lept ocerl(  4,   3) Agri idael(  1,   0) Limn ephil(  3,   2) Dend rocol(  4,   2)
Elmi nthil(  4,   3) Helo didal(  1,   0) Tipu lidal(  4,   3) Sial idael(  4,   0) Valv atidl(  2,   1) NEMA TOMO1(  1,   0)
Psyc hodil(  1,   0) Stra tioml(  1,   0) Musc idael(  2,   1)

POSITIVE PREFERENTIALS
Goer idael(  0,   2) Pisc icoll(  1,   3) Lymn aeidl(  2,   6) PORI FERA1(  0,   3) CLAD OCER1(  1,   4) COPE PODA1(  1,   3)
Cera topol(  0,   4)
*****************************************************************************************************************************

DIVISION    3  (N=   3)          I.E. GROUP *1
Eigenvalue  .076  at iteration   0
INDICATORS, together with their SIGN
Ephe meril(-)

NEGATIVE PREFERENTIALS
Ephe merel(  1,   0) Ephe meril(  2,   0) Poly centl(  2,   0) Limn ephil(  1,   0) Hydr opsyl(  2,   0) Veli idael(  1,   0)
Pisc icoll(  1,   0) COPE PODA1(  1,   0)

POSITIVE PREFERENTIALS
Mola nnidl(  0,   1) Coen agril(  1,   1) Hydr ometl(  1,   1) Gerr idael(  1,   1) Tipu lidal(  1,   1) Valv atidl(  1,   1)
OSTR ACOD1(  1,   1) CLAD OCER1(  1,   1) Cera topol(  1,   1) Musc idael(  1,   1) HYDR ACAR1(  1,   1)
*****************************************************************************************************************************

DIVISION    4  (N=   4)          I.E. GROUP *00
Eigenvalue  .093  at iteration   6
RA TROUBLE    6 ITERATIONS, AND RESIDUAL IS STILL    .026  INSTEAD OF    .003 (THE TOLERANCE)
INDICATORS, together with their SIGN
Hydr optil(+)

NEGATIVE PREFERENTIALS
Lept ophll(  1,   1) Ephe meril(  1,   1) Poly centl(  1,   1) Hydr opsyl(  1,   1) COPE PODA1(  1,   0)

POSITIVE PREFERENTIALS
Agri idael(  0,   1) Psyc homyl(  0,   1) Coen agril(  0,   1) Hydr optil(  0,   3) Helo didal(  0,   1) Pisc icoll(  0,   1)
Valv atidl(  0,   2) Lymn aeidl(  0,   2) NEMA TOMO1(  0,   1) CLAD OCER1(  0,   1) Psyc hodil(  0,   1) Stra tioml(  0,   1)
Musc idael(  0,   2)
*****************************************************************************************************************************

DIVISION    5  (N=   6)          I.E. GROUP *01
Eigenvalue  .191  at iteration   1
INDICATORS, together with their SIGN
Simu liidl(-)

NEGATIVE PREFERENTIALS
Ephe merel(  1,   0) Lept ocerl(  3,   0) Goer idael(  2,   0) Psyc homyl(  1,   0) Poly centl(  3,   0) Gamm aridl(  4,   1)
Hydr optil(  3,   0) Hydr opsyl(  2,   0) Elmi nthil(  3,   0) Simu liidl(  4,   0) Pisc icoll(  3,   0) Glos siphl(  4,   1)
Phys idael(  4,   0) Plan orbil(  4,   1) Musc idael(  1,   0)

POSITIVE PREFERENTIALS
Limn ephil(  1,   1) Coen agril(  0,   1) Dend rocol(  1,   1) Hali plidl(  2,   2) Noto nectl(  0,   1) Valv atidl(  0,   1)
OSTR ACOD1(  2,   2) CLAD OCER1(  2,   2) Cera topol(  2,   2)
*****************************************************************************************************************************

DIVISION    6  (N=   2)          I.E. GROUP *10
Eigenvalue  .213  at iteration   0
INDICATORS, together with their SIGN
Ephe merel(+)

NEGATIVE PREFERENTIALS
Coen agril(  1,   0) Tipu lidal(  1,   0) Pisc icoll(  1,   0) Valv atidl(  1,   0) OSTR ACOD1(  1,   0) CLAD OCER1(  1,   0)
COPE PODA1(  1,   0) Cera topol(  1,   0) Musc idael(  1,   0) HYDR ACAR1(  1,   0)

POSITIVE PREFERENTIALS
Ephe merel(  0,   1) Limn ephil(  0,   1) Veli idael(  0,   1) Hydr ometl(  0,   1) Gerr idael(  0,   1)
*****************************************************************************************************************************
```

## Appendix 3.2.3

```
DIVISION     9  (N=    3)           I.E. GROUP *001
Eigenvalue  .212  at iteration   6
RA TROUBLE    6 ITERATIONS, AND RESIDUAL IS STILL    .016  INSTEAD OF    .003 (THE TOLERANCE)
INDICATORS, together with their SIGN
Coen agril(-)

NEGATIVE PREFERENTIALS
Limn ephil(  1,  1) Coen agril(  1,  0) Hydr opsyl(  1,  0) Dyti acidl(  1,  1) Helo didal(  1,  0) Plac lcoll(  1,  0)
Spha eridl(  1,  1) Valv atidl(  1,  1) Hydr obiil(  1,  1) Lymn aeidl(  1,  1) Psyc hodil(  1,  0) Stra tioml(  1,  0)
Musc idael(  1,  1)

POSITIVE PREFERENTIALS
Lept ophll(  0,  1) Ephe meril(  0,  1) Agri idael(  0,  1) Psyc homyl(  0,  1) Poly centl(  0,  1) Hali plidl(  0,  2)
Cori xidal(  0,  2) Baet idael(  0,  2) NEMA TOMO1(  0,  1) CLAD OCER1(  0,  1)
****************************************************************************************************************************

DIVISION    10  (N=    4)           I.E. GROUP *010
Eigenvalue  .092  at iteration   6
RA TROUBLE    6 ITERATIONS, AND RESIDUAL IS STILL    .019  INSTEAD OF    .003 (THE TOLERANCE)
INDICATORS, together with their SIGN
PORI FERA1(-)

NEGATIVE PREFERENTIALS
Lept ocerl(  2,  1) Psyc homyl(  1,  0) Poly centl(  2,  1) Hydr optil(  2,  1) Dend rocol(  1,  0) Erpo bdell(  2,  1)
Spha eridl(  2,  1) Chir onoml(  2,  1) PORI FERA1(  2,  0) Musc idael(  1,  0)

POSITIVE PREFERENTIALS
Ephe merel(  0,  1) Caen idael(  1,  2) Limn ephil(  0,  1) Elmi nthil(  1,  2) Pisc icoll(  1,  2)
****************************************************************************************************************************

DIVISION    11  (N=    2)           I.E. GROUP *011
Eigenvalue  .267  at iteration   0
INDICATORS, together with their SIGN
Caen idael(-)

NEGATIVE PREFERENTIALS
Caen idael(  1,  0) Limn ephil(  1,  0) Dend rocol(  1,  0) Noto nectl(  1,  0) Glos siphl(  1,  0) Plan orbil(  1,  0)
PORI FERA1(  1,  0) COPE PODA1(  1,  0)

POSITIVE PREFERENTIALS
Gamm aridl(  0,  1) Coen agril(  0,  1) Tipu lidal(  0,  1) Valv atidl(  0,  1)
****************************************************************************************************************************
```

## Appendix 3.2.4 Indicator and preferential taxa for GSS.

TWINSPAN "indicator" taxa and negative (left-hand groups) and positive (right-hand groups) preferential taxa from the classification of GSS samples (Section 5.6.4, Figure 14). N = the number of samples in the division; numbers after preferential taxa indicate the number of samples in the negative and positive groups in which these taxa occur.

```
DIVISION    1  (N=   16)         I.E. GROUP *
Eigenvalue  .187  at iteration   1
INDICATORS, together with their SIGN
Coen agril(-)   Lymn aeidl(-)   Valv atidl(-)   Asel lidal(-)

NEGATIVE PREFERENTIALS
Lept ocer1(  2,  0) Rhya cophl(  2,  0) Coen agril(  9,  2) Unio nidal(  2,  0) Plan arii1(  8,  1) Elmi nthi1(  5,  0)
Hali plid1(  7,  2) Dyti acid1(  8,  3) Noto nect1(  3,  0) Tipu lidal(  2,  0) Pisc icol1(  5,  1) Glos siph1(  6,  1)
Erpo bdel1(  4,  1) Asel lidal(  6,  1) Spha erid1(  6,  0) Valv atid1(  9,  1) Lymn aeid1(  8,  1) Phys idae1(  3,  0)
Mysi dae 1(  2,  0) Cera topo1(  3,  1) Lept ocer2(  2,  0) Rhya coph2(  2,  0) Coen agri2(  9,  2) Unio nida2(  2,  0)
Plan arii2(  8,  1) Elmi nthi2(  5,  0) Hali plid2(  7,  2) Dyti acid2(  8,  3) Noto nect2(  3,  0) Tipu lida2(  2,  0)
Pisc icol2(  5,  1) Glos siph2(  6,  1) Erpo bdel2(  4,  1) Asel lida2(  6,  1) Spha erid2(  6,  0) Valv atid2(  9,  1)
Lymn aeid2(  8,  1) Phys idae2(  3,  0) Mysi dae 2(  2,  0) Cera topo2(  3,  1)

POSITIVE PREFERENTIALS
CLAD OCER1(  3,  5) COPE PODA1(  2,  4) CLAD OCER2(  3,  5) COPE PODA2(  2,  4)
*************************************************************************************************************************

DIVISION    2  (N=    9)         I.E. GROUP *0
Eigenvalue  .163  at iteration   2
INDICATORS, together with their SIGN
Phys idae1(-)   Glos siph1(-)   Asel lida1(-)   Spha erid1(-)

NEGATIVE PREFERENTIALS
Psyc homy1(  1,  0) Caen idae1(  2,  1) Rhya coph1(  2,  0) Dend roco1(  1,  0) Helo dida1(  1,  0) Glos siph1(  4,  2)
Erpo bdel1(  3,  1) Asel lida1(  4,  2) Spha erid1(  4,  2) Phys idae1(  3,  0) OSTR ACOD1(  3,  1) COPE PODA1(  2,  0)
Coro phid1(  1,  0) Pyra lida1(  1,  0) Psyc homy2(  1,  0) Caen idae2(  2,  1) Rhya coph2(  2,  0) Dend roco2(  1,  0)
Helo dida2(  1,  0) Glos siph2(  4,  2) Erpo bdel2(  3,  1) Asel lida2(  4,  2) Spha erid2(  4,  2) Phys idae2(  3,  0)
OSTR ACOD2(  3,  1) COPE PODA2(  2,  0) Coro phid2(  1,  0) Pyra lida2(  1,  0)

POSITIVE PREFERENTIALS
Lept ocer1(  0,  2) Gerr idae1(  0,  2) Tipu lida1(  0,  2) Pisc icol1(  1,  4) CLAD OCER1(  0,  3) Lept ocer2(  0,  2)
Gerr idae2(  0,  2) Tipu lida2(  0,  2) Pisc icol2(  1,  4) CLAD OCER2(  0,  3)
*************************************************************************************************************************

DIVISION    3  (N=    7)         I.E. GROUP *1
Eigenvalue  .255  at iteration   3
INDICATORS, together with their SIGN
Caen idae1(+)

NEGATIVE PREFERENTIALS
Hali plid1(  2,  0) Hali plid2(  2,  0)

POSITIVE PREFERENTIALS
Caen idae1(  0,  2) Poly cent1(  0,  1) Coen agri1(  0,  2) Hydr opti1(  0,  1) Plan arii1(  0,  1) Gerr idae1(  1,  1)
Erpo bdel1(  0,  1) Asel lida1(  0,  1) Valv atid1(  0,  1) Hydr obii1(  2,  2) OSTR ACOD1(  1,  1) COPE PODA1(  2,  2)
Cera topo1(  0,  1) Caen idae2(  0,  2) Poly cent2(  0,  1) Coen agri2(  0,  2) Hydr opti2(  0,  1) Plan arii2(  0,  1)
Gerr idae2(  1,  1) Erpo bdel2(  0,  1) Asel lida2(  0,  1) Valv atid2(  0,  1) Hydr obii2(  2,  2) OSTR ACOD2(  1,  1)
COPE PODA2(  2,  2) Cera topo2(  0,  1)
*************************************************************************************************************************

DIVISION    4  (N=    4)         I.E. GROUP *00
Eigenvalue  .120  at iteration   6
RA TROUBLE   6 ITERATIONS, AND RESIDUAL IS STILL    .043  INSTEAD OF    .003 (THE TOLERANCE)
INDICATORS, together with their SIGN
Hali plid1(+)

NEGATIVE PREFERENTIALS
Caen idae1(  1,  1) COPE PODA1(  1,  1) Caen idae2(  1,  1) COPE PODA2(  1,  1)

POSITIVE PREFERENTIALS
Psyc homy1(  0,  1) Rhya coph1(  0,  2) Hydr opti1(  0,  1) Unio nida1(  0,  1) Dend roco1(  0,  1) Hali plid1(  0,  3)
Helo dida1(  0,  1) Noto nect1(  0,  1) Pisc icol1(  0,  1) Erpo bdel1(  0,  3) Phys idae1(  0,  3) Coro phid1(  0,  1)
Mysi dae 1(  0,  1) Pyra lida1(  0,  1) Cera topo1(  0,  1) Psyc homy2(  0,  1) Rhya coph2(  0,  2) Hydr opti2(  0,  1)
Unio nida2(  0,  1) Dend roco2(  0,  1) Hali plid2(  0,  3) Helo dida2(  0,  1) Noto nect2(  0,  1) Pisc icol2(  0,  1)
Erpo bdel2(  0,  3) Phys idae2(  0,  3) Coro phid2(  0,  1) Mysi dae 2(  0,  1) Pyra lida2(  0,  1) Cera topo2(  0,  1)
*************************************************************************************************************************

DIVISION    5  (N=    5)         I.E. GROUP *01
Eigenvalue  .238  at iteration   1
INDICATORS, together with their SIGN
Spha erid1(+)

NEGATIVE PREFERENTIALS
Lept ocer1(  2,  0) Unio nida1(  1,  0) Elmi nthi1(  2,  0) Hydr ophi1(  1,  0) Meso veli1(  1,  0) Gerr idae1(  2,  0)
Noto nect1(  2,  0) Glos siph1(  2,  0) Erpo bdel1(  1,  0) OSTR ACOD1(  1,  0) HYDR ACAR1(  2,  0) Lept ocer2(  2,  0)
Unio nida2(  1,  0) Elmi nthi2(  2,  0) Hydr ophi2(  1,  0) Meso veli2(  1,  0) Gerr idae2(  2,  0) Noto nect2(  2,  0)
Glos siph2(  2,  0) Erpo bdel2(  1,  0) OSTR ACOD2(  1,  0) HYDR ACAR2(  2,  0)

POSITIVE PREFERENTIALS
Caen idae1(  0,  1) Hydr opti1(  0,  1) Spha erid1(  0,  2) CLAD OCER1(  1,  2) Mysi dae 1(  0,  1) Caen idae2(  0,  1)
Hydr opti2(  0,  1) Spha erid2(  0,  2) CLAD OCER2(  1,  2) Mysi dae 2(  0,  1)
*************************************************************************************************************************
```

## Appendix 3.2.4

```
DIVISION    6  (N=   5)          I.E. GROUP *10
Eigenvalue  .285  at iteration   1
INDICATORS, together with their SIGN
Pisc icoll(-)

NEGATIVE PREFERENTIALS
Hali plidl(  1,  1) Dyti acidl(  1,  1) Cori xidal(  1,  2) Pisc icoll(  1,  0) Baet idael(  1,  2) Hydr obill(  1,  1)
Lymn aeidl(  1,  0) Plan orbil(  1,  2) OSTR ACOD1(  1,  0) CLAD OCER1(  1,  2) Hali plid2(  1,  1) Dyti acid2(  1,  1)
Cori xida2(  1,  2) Pisc icol2(  1,  0) Baet idae2(  1,  2) Hydr obil2(  1,  1) Lymn aeid2(  1,  0) Plan orbi2(  1,  2)
OSTR ACOD2(  1,  0) CLAD OCER2(  1,  2)

POSITIVE PREFERENTIALS
Gerr idael(  0,  1) Glos siphl(  0,  1) COPE PODA1(  0,  2) HYDR ACAR1(  0,  3) Gerr idae2(  0,  1) Glos siph2(  0,  1)
COPE PODA2(  0,  2) HYDR ACAR2(  0,  3)
**************************************************************************************************************************

DIVISION    7  (N=   2)          I.E. GROUP *11
Eigenvalue  .318  at iteration   0
INDICATORS, together with their SIGN
Poly centl(+)

NEGATIVE PREFERENTIALS
Plan ariil(  1,  0) Gerr idael(  1,  0) Valv atidl(  1,  0) Plan arii2(  1,  0) Gerr idae2(  1,  0) Valv atid2(  1,  0)

POSITIVE PREFERENTIALS
Poly centl(  0,  1) Hydr optil(  0,  1) Dyti acidl(  0,  1) Erpo bdell(  0,  1) Asel lidal(  0,  1) OSTR ACOD1(  0,  1)
Cera topol(  0,  1) HYDR ACAR1(  0,  1) Poly cent2(  0,  1) Hydr opti2(  0,  1) Dyti acid2(  0,  1) Erpo bdel2(  0,  1)
Asel lida2(  0,  1) OSTR ACOD2(  0,  1) Cera topo2(  0,  1) HYDR ACAR2(  0,  1)
**************************************************************************************************************************

DIVISION    9  (N=   3)          I.E. GROUP *001
Eigenvalue  .255  at iteration   4
INDICATORS, together with their SIGN
Caen idael(-)

NEGATIVE PREFERENTIALS
Caen idael(  1,  0) Dend rocol(  1,  0) Elmi nthil(  1,  1) Dyti acidl(  1,  1) Helo didal(  1,  0) Noto nectl(  1,  0)
Lymn aeidl(  1,  1) Coro phidl(  1,  0) Caen idae2(  1,  0) Dend roco2(  1,  0) Elmi nthi2(  1,  1) Dyti acid2(  1,  1)
Helo dida2(  1,  0) Noto nect2(  1,  0) Lymn aeid2(  1,  1) Coro phid2(  1,  0)

POSITIVE PREFERENTIALS
Psyc homyl(  0,  1) Rhya cophl(  0,  2) Hydr optil(  0,  1) Unio nidal(  0,  1) Pisc icoll(  0,  1) OSTR ACOD1(  0,  2)
COPE PODA1(  0,  1) Mysi dae 1(  0,  1) Pyra lidal(  0,  1) Cera topol(  0,  1) HYDR ACAR1(  0,  2) Psyc homy2(  0,  1)
Rhya coph2(  0,  2) Hydr opti2(  0,  1) Unio nida2(  0,  1) Pisc icol2(  0,  1) OSTR ACOD2(  0,  2) COPE PODA2(  0,  1)
Mysi dae 2(  0,  1) Pyra lida2(  0,  1) Cera topo2(  0,  1) HYDR ACAR2(  0,  2)
**************************************************************************************************************************

DIVISION   10  (N=   3)          I.E. GROUP *010
Eigenvalue  .254  at iteration   4
INDICATORS, together with their SIGN
Hydr ophil(-)

NEGATIVE PREFERENTIALS
Lept ocerl(  1,  1) Gamm aridl(  1,  1) Plan ariil(  1,  1) Elmi nthil(  1,  1) Hali plidl(  1,  1) Hydr ophil(  1,  0)
Gerr idael(  1,  1) Noto nectl(  1,  1) Tipu lidal(  1,  0) Pisc icoll(  1,  1) Glos siphl(  1,  1) Erpo bdell(  1,  0)
Asel lidal(  1,  0) OSTR ACOD1(  1,  0) Cera topol(  1,  0) Lept ocer2(  1,  1) Gamm arid2(  1,  1) Plan arii2(  1,  1)
Elmi nthi2(  1,  1) Hali plid2(  1,  1) Hydr ophi2(  1,  0) Gerr idae2(  1,  1) Noto nect2(  1,  1) Tipu lida2(  1,  0)
Pisc icol2(  1,  1) Glos siph2(  1,  1) Erpo bdel2(  1,  0) Asel lida2(  1,  0) OSTR ACOD2(  1,  0) Cera topo2(  1,  0)

POSITIVE PREFERENTIALS
Unio nidal(  0,  1) Meso velil(  0,  1) Cori xidal(  0,  2) CLAD OCER1(  0,  1) HYDR ACAR1(  0,  2) Unio nida2(  0,  1)
Meso veli2(  0,  1) Cori xida2(  0,  2) CLAD OCER2(  0,  1) HYDR ACAR2(  0,  2)
**************************************************************************************************************************

DIVISION   11  (N=   2)          I.E. GROUP *011
Eigenvalue  .148  at iteration   0
INDICATORS, together with their SIGN
Caen idael(+)

NEGATIVE PREFERENTIALS
Cera topol(  1,  0) Cera topo2(  1,  0)

POSITIVE PREFERENTIALS
Caen idael(  0,  1) Hydr optil(  0,  1) Tipu lidal(  0,  1) Asel lidal(  0,  1) Mysi dae 1(  0,  1) Caen idae2(  0,  1)
Hydr opti2(  0,  1) Tipu lida2(  0,  1) Asel lida2(  0,  1) Mysi dae 2(  0,  1)
**************************************************************************************************************************

DIVISION   13  (N=   4)          I.E. GROUP *101
Eigenvalue  .334  at iteration   6
RA TROUBLE   6 ITERATIONS, AND RESIDUAL IS STILL   .036  INSTEAD OF   .003 (THE TOLERANCE)
INDICATORS, together with their SIGN
Cori xidal(+)
NEGATIVE PREFERENTIALS

POSITIVE PREFERENTIALS
Hali plidl(  0,  1) Dyti acidl(  0,  1) Cori xidal(  0,  2) Gerr idael(  0,  1) Baet idael(  0,  2) Glos siphl(  0,  1)
Hydr obill(  0,  1) Plan orbil(  0,  2) Olig ochal(  1,  2) COPE PODA1(  0,  2) HYDR ACAR1(  1,  2) Hali plid2(  0,  1)
Dyti acid2(  0,  1) Cori xida2(  0,  2) Gerr idae2(  0,  1) Baet idae2(  0,  2) Glos siph2(  0,  1) Hydr obil2(  0,  1)
Plan orbi2(  0,  2) Olig ocha2(  1,  2) COPE PODA2(  0,  2) HYDR ACAR2(  1,  2)
**************************************************************************************************************************
```

## Appendix 3.2.5 Indicator and preferential taxa for EBR.

TWINSPAN "indicator" taxa and negative (left-hand groups) and positive (right-hand groups) preferential taxa from the classification of EBR samples (Section 5.6.5, Figure 15). N = the number of samples in the division; numbers after preferential taxa indicate the number of samples in the negative and positive groups in which these taxa occur.

```
DIVISION     1  (N=  16)           I.E. GROUP *
Eigenvalue  .174  at iteration   3
INDICATORS, together with their SIGN
Poly cent1(+)    COPE PODA1(+)

NEGATIVE PREFERENTIALS
Hydr opsy1(  2,   0) Limn ephi1(  7,   2) Lept ocer1(  6,   0) Seri cost1(  2,   0) Psyc hodi1(  3,   0) Hydr opsy2(  2,   0)
Limn ephi2(  7,   2) Lept ocer2(  6,   0) Seri cost2(  2,   0) Psyc hodi2(, 3,   0)

POSITIVE PREFERENTIALS
OSTR ACOD1(  0,   3) CLAD OCER1(  0,   3) COPE PODA1(  0,   4) Leuc trid1(  0,   2) Ephe mere1(  3,   5) Poly cent1(  0,   5)
Hydr opti1(  1,   4) Hali plid1(  5,   6) Gyri nida1(  0,   2) Hydr ophi1(  0,   2) Valv atid1(  0,   2) Phys idae1(  0,   2)
OSTR ACOD2(  0,   3) CLAD OCER2(  0,   3) COPE PODA2(  0,   4) Leuc trid2(  0,   2) Ephe mere2(  3,   5) Poly cent2(  0,   5)
Hydr opti2(  1,   4) Hali plid2(  5,   6) Gyri nida2(  0,   2) Hydr ophi2(  0,   2) Valv atid2(  0,   2) Phys idae2(  0,   2)
*****************************************************************************************************************************

DIVISION     2  (N=  10)           I.E. GROUP *0
Eigenvalue  .227  at iteration   1
INDICATORS, together with their SIGN
Sial idae1(+)

NEGATIVE PREFERENTIALS
NEMA TODA1(  1,   0) Pisc icol1(  1,   0) Lept ophl1(  3,   1) Ephe mere1(  3,   0) Ephe meri1(  1,   0) Caen idae1(  4,   1)
Hydr opsy1(  2,   0) Hydr opti1(  1,   0) Limn ephi1(  4,   3) Glos soso1(  1,   0) Noto nect1(  2,   1) Simu liid1(  4,   0)
Hydr obii1(  3,   2) HYDR ACAR1(  4,   3) NEMA TODA2(  1,   0) Pisc icol2(  1,   0) Lept ophl2(  3,   1) Ephe mere2(  3,   0)
Ephe meri2(  1,   0) Caen idae2(  4,   1) Hydr opsy2(  2,   0) Hydr opti2(  1,   0) Limn ephi2(  4,   3) Glos soso2(  1,   0)
Noto nect2(  2,   1) Simu liid2(  4,   0) Hydr obii2(  3,   2) HYDR ACAR2(  4,   3)

POSITIVE PREFERENTIALS
Erpo bdel1(  2,   6) Asel lida1(  2,   6) Sial idae1(  0,   6) Lept ocer1(  1,   5) Cera topo1(  0,   5) Psyc hodi1(  0,   3)
Erpo bdel2(  2,   6) Asel lida2(  2,   6) Sial idae2(  0,   6) Lept ocer2(  1,   5) Cera topo2(  0,   5) Psyc hodi2(  0,   3)
*****************************************************************************************************************************

DIVISION     3  (N=   6)           I.E. GROUP *1
Eigenvalue  .199  at iteration   2
INDICATORS, together with their SIGN
Cera topo1(-)

NEGATIVE PREFERENTIALS
Coen agri1(  1,   0) Leuc trid1(  2,   0) Lept ophl1(  2,   0) Ephe meri1(  1,   0) Caen idae1(  3,   0) Limn ephi1(  2,   0)
Goer idae1(  2,   0) Gyri nida1(  2,   0) Hydr ophi1(  2,   0) Cori xida1(  4,   1) Gerr idae1(  1,   0) Noto nect1(  2,   0)
Cera topo1(  4,   0) Ptyc hopt1(  1,   0) Spha erid1(  4,   1) Hydr obii1(  3,   0) HYDR ACAR1(  4,   1) Coen agri2(  1,   0)
Leuc trid2(  2,   0) Lept ophl2(  2,   0) Ephe meri2(  1,   0) Caen idae2(  3,   0) Limn ephi2(  2,   0) Goer idae2(  2,   0)
Gyri nida2(  2,   0) Hydr ophi2(  2,   0) Cori xida2(  4,   1) Gerr idae2(  1,   0) Noto nect2(  2,   0) Cera topo2(  4,   0)
Ptyc hopt2(  1,   0) Spha erid2(  4,   1) Hydr obii2(  3,   0) HYDR ACAR2(  4,   1)

POSITIVE PREFERENTIALS
Plan arii1(  1,   2) Dend roco1(  0,   1) Hydr opti1(  2,   2) Simu liid1(  2,   2) Musc idae1(  0,   1) Valv atid1(  0,   2)
Phys idae1(  0,   2) Plan arii2(  1,   2) Dend roco2(  0,   1) Hydr opti2(  2,   2) Simu liid2(  2,   2) Musc idae2(  0,   1)
Valv atid2(  0,   2) Phys idae2(  0,   2)
*****************************************************************************************************************************

DIVISION     4  (N=   4)           I.E. GROUP *00
Eigenvalue  .194  at iteration   6
RA TROUBLE   6 ITERATIONS, AND RESIDUAL IS STILL   .045  INSTEAD OF   .003 (THE TOLERANCE)
INDICATORS, together with their SIGN
NEMA TODA1(-)

NEGATIVE PREFERENTIALS
NEMA TODA1(  1,   0) Erpo bdel1(  1,   1) Hydr opti1(  1,   0) Goer idae1(  1,   1) Tipu lida1(  1,   1) NEMA TODA2(  1,   0)
Erpo bdel2(  1,   1) Hydr opti2(  1,   0) Goer idae2(  1,   1) Tipu lida2(  1,   1)

POSITIVE PREFERENTIALS
Pisc icol1(  0,   1) Glos siph1(  0,   2) Asel lida1(  0,   2) Lept ophl1(  0,   3) Ephe mere1(  0,   3) Ephe meri1(  0,   1)
Hydr opsy1(  0,   2) Lept ocer1(  0,   1) Seri cost1(  0,   1) Glos soso1(  0,   1) Hali plid1(  0,   2) Dyti scid1(  0,   3)
Cori xida1(  0,   2) Noto nect1(  0,   2) Pisc icol2(  0,   1) Glos siph2(  0,   2) Asel lida2(  0,   2) Lept ophl2(  0,   3)
Ephe mere2(  0,   3) Ephe meri2(  0,   1) Hydr opsy2(  0,   2) Lept ocer2(  0,   1) Seri cost2(  0,   1) Glos soso2(  0,   1)
Hali plid2(  0,   2) Dyti scid2(  0,   3) Cori xida2(  0,   2) Noto nect2(  0,   2)
*****************************************************************************************************************************

DIVISION     5  (N=   6)           I.E. GROUP *01
Eigenvalue  .193  at iteration   1
INDICATORS, together with their SIGN
Plan arii1(-)

NEGATIVE PREFERENTIALS
Plan arii1(  4,   0) Dend roco1(  1,   0) Glos siph1(  4,   1) Gamm arid1(  4,   0) Lept ophl1(  1,   0) Caen idae1(  1,   0)
Goer idae1(  2,   0) Seri cost1(  1,   0) Elmi nthi1(  4,   0) Cera topo1(  4,   1) Psyc hodi1(  3,   0) Taba nida1(  1,   0)
HYDR ACAR1(  3,   0) Plan arii2(  4,   0) Dend roco2(  1,   0) Glos siph2(  4,   1) Gamm arid2(  4,   0) Lept ophl2(  1,   0)
Caen idae2(  1,   0) Goer idae2(  2,   0) Seri cost2(  1,   0) Elmi nthi2(  4,   0) Cera topo2(  4,   1) Psyc hodi2(  3,   0)
Taba nida2(  1,   0) HYDR ACAR2(  3,   0)

POSITIVE PREFERENTIALS
Baet idae1(  2,   2) Helo dida1(  0,   1) Noto nect1(  0,   1) Culi cida1(  0,   1) Hydr obii1(  1,   1) Baet idae2(  2,   2)
Helo dida2(  0,   1) Noto nect2(  0,   1) Culi cida2(  0,   1) Hydr obii2(  1,   1)
*****************************************************************************************************************************
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## Appendix 3.2.5

```
DIVISION    6  (N=    4)          I.E. GROUP *10
Eigenvalue  .134  at iteration    6
RA TROUBLE   6 ITERATIONS, AND RESIDUAL IS STILL   .025  INSTEAD OF   .003 (THE TOLERANCE)
INDICATORS, together with their SIGN
Leuc tridl(-)

NEGATIVE PREFERENTIALS
Plan arill( 1, 0) Glos siphl( 2, 1) Leuc tridl( 2, 0) Lept ophll( 2, 0) Ephe merel( 2, 1) Caen idael( 2, 1)
Poly centl( 2, 1) Hydr optil( 2, 0) Elmi nthil( 2, 1) Gerr idael( 1, 0) Noto nectl( 2, 0) Tipu lidal( 2, 1)
Hydr obiil( 2, 1) Plan erii2( 1, 0) Glos siph2( 2, 1) Leuc trid2( 2, 0) Lept ophl2( 2, 0) Ephe mere2( 2, 1)
Caen idae2( 2, 1) Poly cent2( 2, 1) Hydr opti2( 2, 0) Elmi nthi2( 2, 1) Gerr idae2( 1, 0) Noto nect2( 2, 0)
Tipu lida2( 2, 1) Hydr obii2( 2, 1)

POSITIVE PREFERENTIALS
COPE PODA1( 1, 2) Asel lidal( 1, 2) Coen agril( 0, 1) Ephe meril( 0, 1) Sial idael( 0, 2) Gyri nidal( 0, 2)
Ptyc hoptl( 0, 1) COPE PODA2( 1, 2) Asel lida2( 1, 2) Coen agri2( 0, 1) Ephe meri2( 0, 1) Sial idae2( 0, 2)
Gyri nida2( 0, 2) Ptyc hopt2( 0, 1)
**************************************************************************************************************

DIVISION    7  (N=    2)          I.E. GROUP *11
Eigenvalue  .225  at iteration    0
INDICATORS, together with their SIGN
Dend rocol(-)

NEGATIVE PREFERENTIALS
Dend rocol( 1, 0) OSTR ACOD1( 1, 0) CLAD OCER1( 1, 0) Elmi nthil( 1, 0) Cori xidal( 1, 0) Tipu lidal( 1, 0)
Musc idael( 1, 0) HYDR ACAR1( 1, 0) Dend roco2( 1, 0) OSTR ACOD2( 1, 0) CLAD OCER2( 1, 0) Elmi nthi2( 1, 0)
Cori xida2( 1, 0) Tipu lida2( 1, 0) Musc idae2( 1, 0) HYDR ACAR2( 1, 0)

POSITIVE PREFERENTIALS
COPE PODA1( 0, 1) Sial idael( 0, 1) Spha eridl( 0, 1) COPE PODA2( 0, 1) Sial idae2( 0, 1) Spha erid2( 0, 1)
**************************************************************************************************************

DIVISION    9  (N=    3)          I.E. GROUP *001
Eigenvalue  .276  at iteration    2
INDICATORS, together with their SIGN
Pisc icoll(-)

NEGATIVE PREFERENTIALS
Pisc icoll( 1, 0) Glos siphl( 1, 1) Asel lidal( 1, 1) Hydr opsyl( 1, 1) Lept ocerl( 1, 0) Goer idael( 1, 0)
Seri costl( 1, 0) Glos sosol( 1, 0) Tipu lidal( 1, 0) Hydr obiil( 1, 1) Plan orbil( 1, 1) Pisc icol2( 1, 0)
Glos siph2( 1, 1) Asel lida2( 1, 1) Hydr opsy2( 1, 1) Lept ocer2( 1, 0) Goer idae2( 1, 0) Seri cost2( 1, 0)
Glos soso2( 1, 0) Tipu lida2( 1, 0) Hydr obii2( 1, 1) Plan orbi2( 1, 1)

POSITIVE PREFERENTIALS
Erpo bdell( 0, 1) Ephe meril( 0, 1) Hali plidl( 0, 2) Cori xidal( 0, 2) Noto nectl( 0, 2) Spha eridl( 0, 2)
Lymn aeidl( 0, 2) Erpo bdel2( 0, 1) Ephe meri2( 0, 1) Hali plid2( 0, 2) Cori xida2( 0, 2) Noto nect2( 0, 2)
Spha erid2( 0, 2) Lymn aeid2( 0, 2)
**************************************************************************************************************

DIVISION   10  (N=    4)          I.E. GROUP *010
Eigenvalue  .181  at iteration    6
RA TROUBLE   6 ITERATIONS, AND RESIDUAL IS STILL   .009  INSTEAD OF   .003 (THE TOLERANCE)
INDICATORS, together with their SIGN
Dend rocol(+)

NEGATIVE PREFERENTIALS
Baet idael( 2, 0) Lept ophll( 1, 0) Caen idael( 1, 0) Limn ephil( 2, 0) Tipu lidal( 3, 0) Psyc hodil( 3, 0)
Taba nidal( 1, 0) Hydr obiil( 1, 0) Lymn aeidl( 3, 0) Baet idae2( 2, 0) Lept ophl2( 1, 0) Caen idae2( 1, 0)
Limn ephi2( 2, 0) Tipu lida2( 3, 0) Psyc hodi2( 3, 0) Taba nida2( 1, 0) Hydr obii2( 1, 0) Lymn aeid2( 3, 0)

POSITIVE PREFERENTIALS
Dend rocol( 0, 1) Goer idael( 1, 1) Seri costl( 0, 1) Hali plidl( 1, 1) Dend roco2( 0, 1) Goer idae2( 1, 1)
Seri cost2( 0, 1) Hali plid2( 1, 1)
**************************************************************************************************************

DIVISION   11  (N=    2)          I.E. GROUP *011
Eigenvalue  .310  at iteration    0
INDICATORS, together with their SIGN
Glos siphl(+)

NEGATIVE PREFERENTIALS
Hali plidl( 1, 0) Noto nectl( 1, 0) Tipu lidal( 1, 0) Spha eridl( 1, 0) Hali plid2( 1, 0) Noto nect2( 1, 0)
Tipu lida2( 1, 0) Spha erid2( 1, 0)

POSITIVE PREFERENTIALS
Glos siphl( 0, 1) Limn ephil( 0, 1) Helo didal( 0, 1) Cera topol( 0, 1) Culi cidal( 0, 1) Hydr obiil( 0, 1)
Glos siph2( 0, 1) Limn ephi2( 0, 1) Helo dida2( 0, 1) Cera topo2( 0, 1) Culi cida2( 0, 1) Hydr obii2( 0, 1)
**************************************************************************************************************
```

## Appendix 3.2.5

```
DIVISION   12  (N=   2)          I.E. GROUP *100
Eigenvalue  .168  at iteration   0
INDICATORS, together with their SIGN
Plan ariil(+)

NEGATIVE PREFERENTIALS
OSTR ACOD1(  1,   0) CLAD OCER1(  1,   0) Goer idae1(  1,   0) OSTR ACOD2(  1,   0) CLAD OCER2(  1,   0) Goer idae2(  1,   0)

POSITIVE PREFERENTIALS
Plan ariil(  0,   1) COPE PODA1(  0,   1) Asel lida1(  0,   1) Limn ephi1(  0,   1) Hydr ophi1(  0,   1) Gerr idae1(  0,   1)
Simu liid1(  0,   1) Plan arii2(  0,   1) COPE PODA2(  0,   1) Asel lida2(  0,   1) Limn ephi2(  0,   1) Hydr ophi2(  0,   1)
Gerr idae2(  0,   1) Simu liid2(  0,   1)
**********************************************************************************************************************

DIVISION   13  (N=   2)          I.E. GROUP *101
Eigenvalue  .316  at iteration   0
INDICATORS, together with their SIGN
Glos siph1(+)

NEGATIVE PREFERENTIALS
Ephe mere1(  1,   0) Ephe meri1(  1,   0) Caen idae1(  1,   0) Poly cent1(  1,   0) Limn ephi1(  1,   0) Goer idae1(  1,   0)
Elmi nthi1(  1,   0) Tipu lida1(  1,   0) Simu liid1(  1,   0) Hydr obli1(  1,   0) Ephe mere2(  1,   0) Ephe meri2(  1,   0)
Caen idae2(  1,   0) Poly cent2(  1,   0) Limn ephi2(  1,   0) Goer idae2(  1,   0) Elmi nthi2(  1,   0) Tipu lida2(  1,   0)
Simu liid2(  1,   0) Hydr obli2(  1,   0)

POSITIVE PREFERENTIALS
Glos siph1(  0,   1) OSTR ACOD1(  0,   1) CLAD OCER1(  0,   1) Coen agri1(  0,   1) Hydr ophi1(  0,   1) Ptyc hopt1(  0,   1)
Glos siph2(  0,   1) OSTR ACOD2(  0,   1) CLAD OCER2(  0,   1) Coen agri2(  0,   1) Hydr ophi2(  0,   1) Ptyc hopt2(  0,   1)
**********************************************************************************************************************
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# APPENDIX 3.3

## TWINSPAN PREFERENTIAL TAXA FOR THE CLASSIFICATION OF SAMPLES WITHIN LQI CLASSES A - A++ AND B &C.

**3.3.1 LQI classes A - A++**

**3.3.2 LQI classes B & C**

## Appendix 3.3.1 LOI classes A-A++

TWINSPAN "indicator" taxa and negative (left-hand groups) and positive (right-hand groups) preferential taxa from the classification of A-A++ class samples (Section 5.8.2, Figures 20 and 21). N = the number of samples in the division; numbers after preferential taxa indicate the number of samples in the negative and positive groups in which these taxa occur.

```
DIVISION    1  (N=   66)          I.E. GROUP *
Eigenvalue  .188  at iteration   2
INDICATORS, together with their SIGN
Coen agril(-)   Hydr opsyl(+)   Valv atidl(-)   Goer idael(+)   Simu liidl(+)

NEGATIVE PREFERENTIALS
OSTR ACOD1( 15,  4) CLAD OCER1(  9,  2) Coen agril( 22,  1) Hydr ophil(  6,  2) Gerr idael(  8,  4) Noto nectl( 13,  9)
Valv atidl( 20,  1) Phys idael( 18, 11)

POSITIVE PREFERENTIALS
Dend rocol(  4, 17) Lept ophil(  4, 22) Ephe merel(  2, 26) Ephe meril(  2, 20) Rhya cophl(  2, 14) Poly centl(  2, 18)
Hydr opsyl(  1, 30) Limn ephil(  6, 31) Goer idael(  0, 24) Seri costl(  0, 18) Elmi nthil( 13, 38) Tipu lidal(  7, 28)
Simu liidl(  1, 24) Ancy lidal(  0, 11)
****************************************************************************************************************************

DIVISION    2  (N=   27)          I.E. GROUP *0
Eigenvalue  .090  at iteration   1
INDICATORS, together with their SIGN
Dend rocol(+)

NEGATIVE PREFERENTIALS
Hydr ophil(  6,  0) Unio nidal(  5,  0) Hydr ophi2(  6,  0) Unio nida2(  5,  0)

POSITIVE PREFERENTIALS
Dend rocol(  0,  4) OSTR ACOD1( 11,  4) CLAD OCER1(  5,  4) Agri idael(  0,  1) Ephe meril(  0,  2) Sial idael(  7,  4)
Poly centl(  0,  2) Hydr opsyl(  0,  1) Hydr optil(  5,  4) Mola nnidl(  1,  1) Elmi nthil(  9,  4) Gyri nidal(  2,  2)
Tipu lidal(  4,  3) Simu liidl(  0,  1) Cere topol(  7,  3) Musc idael(  0,  2) Succ ineil(  0,  1) Dend roco2(  0,  4)
OSTR ACOD2( 11,  4) CLAD OCER2(  5,  4) Agri idae2(  0,  1) Ephe meri2(  0,  2) Sial idae2(  7,  4) Poly cent2(  0,  2)
Hydr opsy2(  0,  1) Hydr opti2(  5,  4) Mola nnid2(  1,  1) Elmi nthi2(  9,  4) Gyri nida2(  2,  2) Tipu lida2(  4,  3)
Simu liid2(  0,  1) Cera topo2(  7,  3) Musc idae2(  0,  2) Succ inei2(  0,  1)
****************************************************************************************************************************

DIVISION    3  (N=   39)          I.E. GROUP *1
Eigenvalue  .093  at iteration   2
INDICATORS, together with their SIGN
Cori xidal(-)   Rhya cophl(+)   Ephe meril(-)   Phys idael(-)   Ancy lidal(+)

NEGATIVE PREFERENTIALS
Ephe meril( 17,  3) Sial idael( 10,  3) Cori xidal( 22,  5) Noto nectl(  8,  1) Phys idael( 11,  0) Ephe meri2( 17,  3)
Sial idae2( 10,  3) Cori xida2( 22,  5) Noto nect2(  8,  1) Phys idae2( 11,  0)

POSITIVE PREFERENTIALS
Rhya cophl(  2, 12) Glos aosol(  0,  4) Helo didal(  2,  5) Ancy lidal(  2,  9) Rhya coph2(  2, 12) Glos soso2(  0,  4)
Helo dida2(  2,  5) Ancy lida2(  2,  9)
****************************************************************************************************************************

DIVISION    4  (N=   23)          I.E. GROUP *00
Eigenvalue  .100  at iteration   3
INDICATORS, together with their SIGN
Lept ophl1(-)

NEGATIVE PREFERENTIALS
COPE PODA1(  2,  5) Lept ophil(  3,  0) Ephe merel(  1,  1) Limn ephil(  2,  3) Helo didal(  1,  2) COPE PODA2(  2,  5)
Lept ophl2(  3,  0) Ephe mere2(  1,  1) Limn ephi2(  2,  3) Helo dida2(  1,  2)

POSITIVE PREFERENTIALS
OSTR ACOD1(  0, 11) CLAD OCER1(  0,  5) Sial idael(  0,  7) Hydr optil(  0,  5) Phry ganel(  0,  4) Lept ocerl(  1, 16)
Hydr ophil(  0,  6) Gerr idael(  0,  7) Tipu lidal(  0,  4) Cera topol(  0,  7) Unio nidal(  0,  5) Valv atidl(  0, 16)
Plan orbil(  0, 19) OSTR ACOD2(  0, 11) CLAD OCER2(  0,  5) Sial idae2(  0,  7) Hydr opti2(  0,  5) Phry gane2(  0,  4)
Lept ocer2(  1, 16) Hydr ophi2(  0,  6) Gerr idae2(  0,  7) Tipu lida2(  0,  4) Cera topo2(  0,  7) Unio nida2(  0,  5)
Valv atid2(  0, 16) Plan orbi2(  0, 19)
****************************************************************************************************************************

DIVISION    5  (N=    4)          I.E. GROUP *01
Eigenvalue  .098  at iteration   6
RA TROUBLE   6 ITERATIONS, AND RESIDUAL IS STILL   .023  INSTEAD OF   .003 (THE TOLERANCE)
INDICATORS, together with their SIGN
Pisc icoll(-)

NEGATIVE PREFERENTIALS
Pisc icoll(  2,  0) COPE PODA1(  1,  0) Coen agril(  2,  1) Poly centl(  2,  0) Hydr opsyl(  1,  0) Phry ganel(  1,  0)
Dyti scidl(  2,  1) Cera topol(  2,  1) Succ ineil(  1,  0) Pisc icol2(  2,  0) COPE PODA2(  1,  0) Coen agri2(  2,  1)
Poly cent2(  2,  0) Hydr opsy2(  1,  0) Phry gane2(  1,  0) Dyti scid2(  2,  1) Cera topo2(  2,  1) Succ inei2(  1,  0)

POSITIVE PREFERENTIALS
Agri idael(  0,  1) Lept ophil(  0,  1) Limn ephil(  0,  1) Mola nnidl(  0,  1) Hydr ometl(  0,  1) Gerr idael(  0,  1)
Tipu lidal(  1,  2) Simu liidl(  0,  1) Spha eridl(  1,  2) Agri idae2(  0,  1) Lept ophl2(  0,  1) Limn ephi2(  0,  1)
Mola nnid2(  0,  1) Hydr omet2(  0,  1) Gerr idae2(  0,  1) Tipu lida2(  1,  2) Simu liid2(  0,  1) Spha erid2(  1,  2)
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## Appendix 3.3.1

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DIVISION    6  (N=  24)           I.E. GROUP *10
Eigenvalue  .097  at iteration   2
INDICATORS, together with their SIGN
Seri costl(+)   Ephe meril(+)

NEGATIVE PREFERENTIALS
CLAD OCER1(  2,  0) Leuc tridl(  2,  1) Ephe merel(  5,  9) Hydr optil(  3,  5) Gerr idael(  2,  2) Noto nectl(  3,  5)
CLAD OCER2(  2,  0) Leuc trid2(  2,  1) Ephe mere2(  5,  9) Hydr opti2(  3,  5) Gerr idae2(  2,  2) Noto nect2(  3,  5)

POSITIVE PREFERENTIALS
Dend rocol(  0, 11) Pisc icoll(  1, 11) Ephe meril(  0, 17) Sial idael(  0, 10) Hydr opsyl(  2, 16) Lept ocerl(  1, 15)
Seri costl(  0, 12) Gyri nidal(  0,  5) Phys idael(  1, 10) Dend roco2(  0, 11) Pisc icol2(  1, 11) Ephe meri2(  0, 17)
Sial idae2(  0, 10) Hydr opsy2(  2, 16) Lept ocer2(  1, 15) Seri cost2(  0, 12) Gyri nida2(  0,  5) Phys idae2(  1, 10)
**********************************************************************************************************************

DIVISION    7  (N=  15)           I.E. GROUP *11
Eigenvalue  .119  at iteration   2
INDICATORS, together with their SIGN
Cori xidal(-)

NEGATIVE PREFERENTIALS
Dend rocol(  3,  3) Pisc icoll(  4,  4) COPE PODA1(  3,  1) Asel lidal(  4,  2) Ephe meril(  2,  1) Sial idael(  2,  1)
Seri costl(  3,  3) Hali plidl(  5,  2) Gyri nidal(  2,  0) Cori xidal(  5,  0) Spha eridl(  5,  5) Lymn aeidl(  5,  2)
Plan orbil(  5,  2) Dend roco2(  3,  3) Pisc icol2(  4,  4) COPE PODA2(  3,  1) Asel lida2(  4,  2) Ephe meri2(  2,  1)
Sial idae2(  2,  1) Seri cost2(  3,  3) Hali plid2(  5,  2) Gyri nida2(  2,  0) Cori xida2(  5,  0) Spha erid2(  5,  5)
Lymn aeid2(  5,  2) Plan orbi2(  5,  2)

POSITIVE PREFERENTIALS
Poly centl(  1,  4) Lept ocerl(  1,  6) Glos sosol(  0,  4) Poly cent2(  1,  4) Lept ocer2(  1,  6) Glos soso2(  0,  4)
**********************************************************************************************************************

DIVISION    8  (N=   3)           I.E. GROUP *000
Eigenvalue  .262  at iteration   2
INDICATORS, together with their SIGN
Plan ariil(+)

NEGATIVE PREFERENTIALS
Pisc icoll(  1,  0) COPE PODA1(  1,  1) Asel lidal(  1,  1) Gamm aridl(  1,  1) Ephe merel(  1,  0) Limn ephil(  1,  1)
Lept ocerl(  1,  0) Elmi nthil(  1,  1) Cori xidal(  1,  1) Noto nectl(  1,  0) Chir onoml(  1,  1) Phys idael(  1,  0)
HYDR ACAR1(  1,  1) Pisc icol2(  1,  0) COPE PODA2(  1,  1) Asel lida2(  1,  1) Gamm arid2(  1,  1) Ephe mere2(  1,  0)
Limn ephi2(  1,  1) Lept ocer2(  1,  0) Elmi nthi2(  1,  1) Cori xida2(  1,  1) Noto nect2(  1,  0) Chir onom2(  1,  1)
Phys idae2(  1,  0) HYDR ACAR2(  1,  1)

POSITIVE PREFERENTIALS
Plan ariil(  0,  2) Glos siphl(  0,  2) Erpo bdell(  0,  2) Helo didal(  0,  1) Spha eridl(  0,  2) Plan arii2(  0,  2)
Glos siph2(  0,  2) Erpo bdel2(  0,  2) Helo dida2(  0,  1) Spha erid2(  0,  2)
**********************************************************************************************************************

DIVISION    9  (N=  20)           I.E. GROUP *001
Eigenvalue  .093  at iteration   2
INDICATORS, together with their SIGN
Elmi nthil(+)    COPE PODA1(+)

NEGATIVE PREFERENTIALS
Sial idael(  6,  1) Limn ephil(  3,  0) Unio nidal(  5,  0) Sial idae2(  6,  1) Limn ephi2(  3,  0) Unio nida2(  5,  0)

POSITIVE PREFERENTIALS
COPE PODA1(  0,  5) Elmi nthil(  0,  7) Hydr ophil(  1,  5) Hydr ometl(  1,  2) Neri tidal(  0,  2) COPE PODA2(  0,  5)
Elmi nthi2(  0,  7) Hydr ophi2(  1,  5) Hydr omet2(  1,  2) Neri tida2(  0,  2)
**********************************************************************************************************************

DIVISION   10  (N=   2)           I.E. GROUP *010
Eigenvalue  .137  at iteration   0
INDICATORS, together with their SIGN
COPE PODA1(+)

NEGATIVE PREFERENTIALS
Phry ganel(  1,  0) Succ ineil(  1,  0) Phry gane2(  1,  0) Succ inei2(  1,  0)

POSITIVE PREFERENTIALS
COPE PODA1(  0,  1) Ephe meril(  0,  1) Hydr opsyl(  0,  1) Gyri nidal(  0,  1) Noto nectl(  0,  1) Tipu lidal(  0,  1)
Musc idael(  0,  1) Spha eridl(  0,  1) COPE PODA2(  0,  1) Ephe meri2(  0,  1) Hydr opsy2(  0,  1) Gyri nida2(  0,  1)
Noto nect2(  0,  1) Tipu lida2(  0,  1) Musc idae2(  0,  1) Spha erid2(  0,  1)
**********************************************************************************************************************

DIVISION   11  (N=   2)           I.E. GROUP *011
Eigenvalue  .203  at iteration   0
INDICATORS, together with their SIGN
Coen agril(-)

NEGATIVE PREFERENTIALS
Coen agril(  1,  0) Mola nnidl(  1,  0) Dyti scidl(  1,  0) Gyri nidal(  1,  0) Hydr ometl(  1,  0) Gerr idael(  1,  0)
Noto nectl(  1,  0) Cera topol(  1,  0) Musc idael(  1,  0) Coen agri2(  1,  0) Mola nnid2(  1,  0) Dyti scid2(  1,  0)
Gyri nida2(  1,  0) Hydr omet2(  1,  0) Gerr idae2(  1,  0) Noto nect2(  1,  0) Cera topo2(  1,  0) Musc idae2(  1,  0)

POSITIVE PREFERENTIALS
Agri idael(  0,  1) Lept ophll(  0,  1) Ephe meril(  0,  1) Limn ephil(  0,  1) Simu liidl(  0,  1) Agri idae2(  0,  1)
Lept ophl2(  0,  1) Ephe meri2(  0,  1) Limn ephi2(  0,  1) Simu liid2(  0,  1)
**********************************************************************************************************************
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DIVISION   12  (N=   5)          I.E. GROUP *100
Eigenvalue  .212  at iteration   1
INDICATORS, together with their SIGN
Caen idae1(+)

NEGATIVE PREFERENTIALS
Asel lida1(  1,  2) Dryo pida1(  1,  0) Gerr idae1(  1,  1) Asel lida2(  1,  2) Dryo pida2(  1,  0) Gerr idae2(  1,  1)

POSITIVE PREFERENTIALS
Plan arii1(  0,  3) Pisc icol1(  0,  1) Glos siph1(  0,  3) Erpo bdel1(  0,  3) OSTR ACOD1(  0,  1) CLAD OCER1(  0,  2)
COPE PODA1(  0,  1) Leuc trid1(  0,  2) Lept oph11(  0,  3) Caen idae1(  0,  4) Poly cent1(  0,  3) Hydr opsy1(  0,  2)
Hydr opti1(  0,  3) Lept ocer1(  0,  1) Goer idae1(  0,  2) Elmi nthi1(  0,  4) Hali plid1(  0,  3) Hydr ophi1(  0,  1)
Noto nect1(  0,  3) Tipu lida1(  0,  2) Cera topo1(  0,  3) Spha erid1(  0,  4) Hydr obii1(  0,  4) Lymn aeid1(  0,  4)
Phys idae1(  0,  1) Plan arii2(  0,  3) Pisc icol2(  0,  1) Glos siph2(  0,  3) Erpo bdel2(  0,  3) OSTR ACOD2(  0,  1)
CLAD OCER2(  0,  2) COPE PODA2(  0,  1) Leuc trid2(  0,  2) Lept oph12(  0,  3) Caen idae2(  0,  4) Poly cent2(  0,  3)
Hydr opsy2(  0,  2) Hydr opti2(  0,  3) Lept ocer2(  0,  1) Goer idae2(  0,  2) Elmi nthi2(  0,  4) Hali plid2(  0,  3)
Hydr ophi2(  0,  1) Noto nect2(  0,  3) Tipu lida2(  0,  2) Cera topo2(  0,  3) Spha erid2(  0,  4) Hydr obii2(  0,  4)
Lymn aeid2(  0,  4) Phys idae2(  0,  1)
**************************************************************************************************************

DIVISION   13  (N=  19)          I.E. GROUP *101
Eigenvalue  .104  at iteration   2
INDICATORS, together with their SIGN
Plan arii1(-)   Phys idae1(-)   Hydr opti1(-)   Limn ephi1(+)   COPE PODA1(+)

NEGATIVE PREFERENTIALS
Plan arii1( 11,  2) Ephe mere1(  7,  2) Hydr opti1(  5,  0) Mola nnid1(  3,  0) Veli idae1(  3,  0) Noto nect1(  4,  1)
Simu liid1(  6,  2) Phys idae1(  8,  2) Plan arii2( 11,  2) Ephe mere2(  7,  2) Hydr opti2(  5,  0) Mola nnid2(  3,  0)
Veli idae2(  3,  0) Noto nect2(  4,  1) Simu liid2(  6,  2) Phys idae2(  8,  2)

POSITIVE PREFERENTIALS
OSTR ACOD1(  0,  3) COPE PODA1(  1,  4) Asel lida1(  4,  6) Psyc homy1(  0,  3) Lepi dost1(  0,  2) OSTR ACOD2(  0,  3)
COPE PODA2(  1,  4) Asel lida2(  4,  6) Psyc homy2(  0,  3) Lepi dost2(  0,  2)
**************************************************************************************************************

DIVISION   14  (N=   5)          I.E. GROUP *110
Eigenvalue  .194  at iteration   1
INDICATORS, together with their SIGN
Dend roco1(-)

NEGATIVE PREFERENTIALS
Dend roco1(  3,  0) Ephe mere1(  3,  1) Poly cent1(  1,  0) Psyc homy1(  1,  0) Hydr opsy1(  3,  1) Hydr opti1(  2,  0)
Lept ocer1(  1,  0) Lepi dost1(  1,  0) Gyri nida1(  2,  0) Chry some1(  1,  0) Noto nect1(  1,  0) Valv atid1(  1,  0)
Dend roco2(  3,  0) Ephe mere2(  3,  1) Poly cent2(  1,  0) Psyc homy2(  1,  0) Hydr opsy2(  3,  1) Hydr opti2(  2,  0)
Lept ocer2(  1,  0) Lepi dost2(  1,  0) Gyri nida2(  2,  0) Chry some2(  1,  0) Noto nect2(  1,  0) Valv atid2(  1,  0)

POSITIVE PREFERENTIALS
NEMA TODA1(  0,  1) NEMA TOMO1(  0,  1) Lept oph11(  0,  2) Seri cost1(  1,  2) Helo dida1(  0,  2) Cera topo1(  0,  1)
Psyc hodi1(  0,  1) Taba nida1(  0,  1) Musc idae1(  0,  1) NEMA TODA2(  0,  1) NEMA TOMO2(  0,  1) Lept oph12(  0,  2)
Seri cost2(  1,  2) Helo dida2(  0,  2) Cera topo2(  0,  1) Psyc hodi2(  0,  1) Taba nida2(  0,  1) Musc idae2(  0,  1)
**************************************************************************************************************

DIVISION   15  (N=  10)          I.E. GROUP *111
Eigenvalue  .142  at iteration   1
INDICATORS, together with their SIGN
Glos siph1(-)

NEGATIVE PREFERENTIALS
Pisc icol1(  4,  0) Glos siph1(  7,  0) Asel lida1(  2,  0) Lept oph11(  6,  1) Cera topo1(  3,  0) Lymn aeid1(  2,  0)
Plan orbi1(  2,  0) Pisc icol2(  4,  0) Glos siph2(  7,  0) Asel lida2(  2,  0) Lept oph12(  6,  1) Cera topo2(  3,  0)
Lymn aeid2(  2,  0) Plan orbi2(  2,  0)

POSITIVE PREFERENTIALS
Dend roco1(  1,  2) Leuc trid1(  0,  1) Ephe meri1(  0,  1) Sial idae1(  0,  1) Poly cent1(  1,  3) Lepi dost1(  0,  1)
Seri cost1(  1,  2) Hali plid1(  1,  1) Psyc hodi1(  0,  1) Dend roco2(  1,  2) Leuc trid2(  0,  1) Ephe meri2(  0,  1)
Sial idae2(  0,  1) Poly cent2(  1,  3) Lepi dost2(  0,  1) Seri cost2(  1,  2) Hali plid2(  1,  1) Psyc hodi2(  0,  1)
```

# Appendix 3.3.2 LOI classes B and C

TWINSPAN "indicator" taxa and negative (left-hand groups) and positive (right-hand groups) preferential taxa from the classification of B and C class samples (Section 5.8.2, Figures 23 and 24). N = the number of samples in the division; numbers after preferential taxa indicate the number of samples in the negative and positive groups in which these taxa occur.

```
DIVISION    1  (N=  88)          I.E. GROUP *
Eigenvalue  .197  at iteration   2
INDICATORS, together with their SIGN
Elmi nthil(-)    Tipu lidal(-)    Valv atidl(+)    Coen agril(+)    Limn ephil(-)    Simu liidl(-)    Hydr opsyl(-)
CLAD OCER1(+)

NEGATIVE PREFERENTIALS
Lept ophl1( 10,  0) Ephe merel( 12,  3) Sial idael( 12,  3) Rhya cophl( 15,  1) Hydr opsyl( 25,  1) Limn ephil( 28,  0)
Lept ocerl( 17,  6) Goer idael( 13,  0) Elmi nthil( 46, 13) Tipu lidal( 39,  8) Simu liidl( 31,  2) Ancy lidal( 15,  0)

POSITIVE PREFERENTIALS
OSTR ACOD1(  4, 14) CLAD OCER1(  1, 19) COPE PODA1(  7, 17) Coen agril(  3, 27) Valv atidl(  1, 25) Phys idael(  5, 18)
************************************************************************************************************************

DIVISION    2  (N=  48)          I.E. GROUP *0
Eigenvalue  .129  at iteration   1
INDICATORS, together with their SIGN
Rhya cophl(-)    Lept ocerl(+)    Plan orbil(+)    Ancy lidal(-)    Plan ariil(-)    Pisc icoll(-)    Caen idael(+)
Limn ephil(-)    Asel lidal(+)    Cori xidal(+)

NEGATIVE PREFERENTIALS
Plan ariil( 21, 10) Pisc icoll( 11,  1) Ephe merel(  9,  3) Rhya cophl( 15,  0) Limn ephil( 19,  9) Goer idael(  9,  4)
Glos sosol(  5,  0) Ancy lidal( 13,  2) Plan arii2( 21, 10) Pisc icol2( 11,  1) Ephe mere2(  9,  3) Rhya coph2( 15,  0)
Limn ephi2( 19,  9) Goer idae2(  9,  4) Glos soso2(  5,  0) Ancy lida2( 13,  2)

POSITIVE PREFERENTIALS
Asel lidal(  6, 16) Lept ophl1(  3,  7) Caen idael( 10, 20) Sial idael(  4,  8) Lept ocerl(  2, 15) Cori xidal(  7, 15)
Cera topol(  2,  9) Phys idael(  0,  5) Plan orbil(  6, 19) Asel lida2(  6, 16) Lept ophl2(  3,  7) Caen idae2( 10, 20)
Sial idae2(  4,  8) Lept ocer2(  2, 15) Cori xida2(  7, 15) Cera topo2(  2,  9) Phys idae2(  0,  5) Plan orbi2(  6, 19)
************************************************************************************************************************

DIVISION    3  (N=  40)          I.E. GROUP *1
Eigenvalue  .097  at iteration   3
INDICATORS, together with their SIGN
Dend rocol(-)    Noto nectl(-)    Elmi nthil(-)    PORI FERA1(-)

NEGATIVE PREFERENTIALS
PORI FERA1(  3,  0) Dend rocol(  5,  3) Poly centl(  2,  2) Lept ocerl(  2,  4) Pyra lidal(  2,  0) Elmi nthil(  6,  7)
Noto nectl(  5,  2) Simu liidl(  2,  0) Musc idael(  3,  2) PORI FERA2(  3,  0) Dend roco2(  5,  3) Poly cent2(  2,  2)
Lept ocer2(  2,  4) Pyra lida2(  2,  0) Elmi nthi2(  6,  7) Noto nect2(  5,  2) Simu liid2(  2,  0) Musc idae2(  3,  2)

POSITIVE PREFERENTIALS
Pisc icoll(  1, 13) Pisc icol2(  1, 13)
************************************************************************************************************************

DIVISION    4  (N=  24)          I.E. GROUP *00
Eigenvalue  .140  at iteration   2
INDICATORS, together with their SIGN
OSTR ACOD1(-)    Nemo uridl(-)

NEGATIVE PREFERENTIALS
OSTR ACOD1(  1,  1) COPE PODA1(  1,  3) Nemo uridl(  1,  1) Lept ophl1(  1,  2) OSTR ACOD2(  1,  1) COPE PODA2(  1,  3)
Nemo urid2(  1,  1) Lept ophl2(  1,  2)

POSITIVE PREFERENTIALS
Plan ariil(  0, 21) Pisc icoll(  0, 11) Glos siphl(  0, 20) Erpo bdell(  0, 16) Asel lidal(  0,  6) Ephe merel(  0,  9)
Caen idael(  0, 10) Rhya cophl(  0, 15) Hydr opsyl(  0, 14) Hydr optil(  0, 11) Goer idael(  0,  9) Glos sosol(  0,  5)
Elmi nthil(  0, 22) Hali plidl(  0, 14) Cori xidal(  0,  7) Spha eridl(  0, 13) Hydr obiil(  0, 19) Lymn aeidl(  0, 15)
Plan orbil(  0,  6) Ancy lidal(  0, 13) HYDR ACAR1(  0, 18) Plan arii2(  0, 21) Pisc icol2(  0, 11) Glos siph2(  0, 20)
Erpo bdel2(  0, 16) Asel lida2(  0,  6) Ephe mere2(  0,  9) Caen idae2(  0, 10) Rhya coph2(  0, 15) Hydr opsy2(  0, 14)
Hydr opti2(  0, 11) Goer idae2(  0,  9) Glos soso2(  0,  5) Elmi nthi2(  0, 22) Hali plid2(  0, 14) Cori xida2(  0,  7)
Spha erid2(  0, 13) Hydr obii2(  0, 19) Lymn aeid2(  0, 15) Plan orbi2(  0,  6) Ancy lida2(  0, 13) HYDR ACAR2(  0, 18)
************************************************************************************************************************

DIVISION    5  (N=  24)          I.E. GROUP *01
Eigenvalue  .144  at iteration   1
INDICATORS, together with their SIGN
Phys idael(+)    Plan ariil(+)    Hydr optil(+)    Poly centl(+)    Dend rocol(+)    Asel lidal(+)

NEGATIVE PREFERENTIALS
Lept ophl1(  7,  0) Taba nidal(  4,  0) Lept ophl2(  7,  0) Taba nida2(  4,  0)

POSITIVE PREFERENTIALS
Plan ariil(  4,  6) Dend rocol(  1,  3) OSTR ACOD1(  0,  2) Sial idael(  4,  4) Poly centl(  0,  3) Psyc homyl(  0,  2)
Hydr optil(  1,  5) Goer idael(  1,  3) Musc idael(  2,  2) Phys idael(  0,  5) Plan arii2(  4,  6) Dend roco2(  1,  3)
OSTR ACOD2(  0,  2) Sial idae2(  4,  4) Poly cent2(  0,  3) Psyc homy2(  0,  2) Hydr opti2(  1,  5) Goer idae2(  1,  3)
Musc idae2(  2,  2) Phys idae2(  0,  5)
************************************************************************************************************************
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## Appendix 3.3.2

```
DIVISION    6  (N=    7)          I.E. GROUP *10
Eigenvalue  .197  at iteration   1
INDICATORS, together with their SIGN
Coen agri1(+)

NEGATIVE PREFERENTIALS
Pisc icol1(  1,  0) Erpo bdel1(  2,  2) OSTR ACOD1(  2,  1) COPE PODA1(  1,  1) Ephe mere1(  1,  0) Poly cent1(  2,  0)
Hydr opti1(  2,  2) Lept ocer1(  1,  1) Tipu lida1(  1,  0) Simu liid1(  2,  0) Cera topo1(  1,  1) Musc idae1(  2,  1)
Lymn aeid1(  2,  2) Pisc icol2(  1,  0) Erpo bdel2(  2,  2) OSTR ACOD2(  2,  1) COPE PODA2(  1,  1) Ephe mere2(  1,  0)
Poly cent2(  2,  0) Hydr opti2(  2,  2) Lept ocer2(  1,  1) Tipu lida2(  1,  0) Simu liid2(  2,  0) Cera topo2(  1,  1)
Musc idae2(  2,  1) Lymn aeid2(  2,  2)

POSITIVE PREFERENTIALS
Coen agri1(  0,  5) Caen idae1(  0,  3) Pyra lida1(  0,  2) Elmi nthi1(  1,  5) Noto nect1(  0,  5) Spha erid1(  1,  5)
Hydr obii1(  1,  5) Coen agri2(  0,  5) Caen idae2(  0,  3) Pyra lida2(  0,  2) Elmi nthi2(  1,  5) Noto nect2(  0,  5)
Spha erid2(  1,  5) Hydr obii2(  1,  5)
*******************************************************************************************************************

DIVISION    7  (N=   33)          I.E. GROUP *11
Eigenvalue  .105  at iteration   2
INDICATORS, together with their SIGN
Spha erid1(-)    Plan arii1(-)    Valv atid1(-)    Plan orbi1(-)    Gamm erid1(-)    Phys idae1(-)    Glos siph1(-)
Hydr obii1(-)    Caen idae1(-)

NEGATIVE PREFERENTIALS
Plan arii1( 21,  2) Pisc icol1( 12,  1) Glos siph1( 19,  3) Caen idae1( 19,  3) Hydr opti1(  9,  1) Spha erid1( 17,  0)
Valv atid1( 19,  1) Phys idae1( 12,  1) Plan orbi1( 25,  4) Plan arii2( 21,  2) Pisc icol2( 12,  1) Glos siph2( 19,  3)
Caen idae2( 19,  3) Hydr opti2(  9,  1) Spha erid2( 17,  0) Valv atid2( 19,  1) Phys idae2( 12,  1) Plan orbi2( 25,  4)

POSITIVE PREFERENTIALS
Ephe mere1(  0,  2) Poly cent1(  0,  2) Gerr idae1(  1,  2) Cera topo1(  7,  5) Ephe mere2(  0,  2) Poly cent2(  0,  2)
Gerr idae2(  1,  2) Cera topo2(  7,  5)
*******************************************************************************************************************

DIVISION    8  (N=    1)          I.E. GROUP *000
DIVISION FAILS - There are too few items
*******************************************************************************************************************

DIVISION    9  (N=   23)          I.E. GROUP *001
Eigenvalue  .125  at iteration   3
INDICATORS, together with their SIGN
Ancy lida1(+)    Asel lida1(+)    Spha erid1(+)    Ephe mere1(+)

NEGATIVE PREFERENTIALS
Glos soso1(  4,  1) Glos soso2(  4,  1)

POSITIVE PREFERENTIALS
Dend roco1(  0,  4) Pisc icol1(  3,  8) Erpo bdel1(  5, 11) Asel lida1(  0,  6) Ephe mere1(  0,  9) Sial idae1(  0,  4)
Cori xida1(  1,  6) Spha erid1(  3, 10) Plan orbi1(  1,  5) Ancy lida1(  2, 11) Dend roco2(  0,  4) Pisc icol2(  3,  8)
Erpo bdel2(  5, 11) Asel lida2(  0,  6) Ephe mere2(  0,  9) Sial idae2(  0,  4) Cori xida2(  1,  6) Spha erid2(  3, 10)
Plan orbi2(  1,  5) Ancy lida2(  2, 11)
*******************************************************************************************************************

DIVISION   10  (N=   18)          I.E. GROUP *010
Eigenvalue  .126  at iteration   2
INDICATORS, together with their SIGN
Simu liid1(+)    Cori xida1(-)    Cera topo1(+)    Spha erid1(-)    Lept ophi1(-)    Hydr opsy1(-)    Lymn aeid1(+)
Musc idae1(+)    Unio nida1(+)

NEGATIVE PREFERENTIALS
Plan arii1(  4,  0) Lept ophi1(  7,  0) Ephe mere1(  3,  0) Sial idae1(  4,  0) Hydr opsy1(  8,  1) Cori xida1( 10,  1)
Psyc hodi1(  3,  0) Spha erid1( 12,  2) Plan arii2(  4,  0) Lept ophi2(  7,  0) Ephe mere2(  3,  0) Sial idae2(  4,  0)
Hydr opsy2(  8,  1) Cori xida2( 10,  1) Psyc hodi2(  3,  0) Spha erid2( 12,  2)

POSITIVE PREFERENTIALS
Simu liid1(  5,  5) Cera topo1(  3,  4) Musc idae1(  0,  2) Unio nida1(  0,  2) Lymn aeid1(  5,  4) Simu liid2(  5,  5)
Cera topo2(  3,  4) Musc idae2(  0,  2) Unio nida2(  0,  2) Lymn aeid2(  5,  4)
*******************************************************************************************************************

DIVISION   11  (N=    6)          I.E. GROUP *011
Eigenvalue  .211  at iteration   1
INDICATORS, together with their SIGN
Pisc icol1(+)

NEGATIVE PREFERENTIALS
Baet idae1(  4,  0) Poly cent1(  3,  0) Psyc homy1(  2,  0) Goer idae1(  3,  0) Hali plid1(  3,  0) Cori xida1(  4,  0)
Cera topo1(  2,  0) Baet idae2(  4,  0) Poly cent2(  3,  0) Psyc homy2(  2,  0) Goer idae2(  3,  0) Hali plid2(  3,  0)
Cori xida2(  4,  0) Cera topo2(  2,  0)

POSITIVE PREFERENTIALS
Dend roco1(  2,  1) Pisc icol1(  0,  1) OSTR ACOD1(  1,  1) Coen agri1(  0,  1) Hydr opsy1(  1,  1) Limn ephi1(  2,  1)
Helo dida1(  0,  1) Psyc hodi1(  0,  1) Stra tiom1(  0,  1) Musc idae1(  1,  1) Valv atid1(  0,  1) Lymn aeid1(  2,  1)
Dend roco2(  2,  1) Pisc icol2(  0,  1) OSTR ACOD2(  1,  1) Coen agri2(  0,  1) Hydr opsy2(  1,  1) Limn ephi2(  2,  1)
Helo dida2(  0,  1) Psyc hodi2(  0,  1) Stra tiom2(  0,  1) Musc idae2(  1,  1) Valv atid2(  0,  1) Lymn aeid2(  2,  1)
*******************************************************************************************************************
```

## Appendix 3.3.2

```
DIVISION   12  (N=   2)          I.E. GROUP *100
Eigenvalue  .221  at iteration   0
INDICATORS, together with their SIGN
PORI FERA1(+)
NEGATIVE PREFERENTIALS
CLAD OCER1(  1,  0) Ephe merel(  1,  0) Elmi nthi1(  1,  0) Tipu lida1(  1,  0) Valv atid1(  1,  0) CLAD OCER2(  1,  0)
Ephe mere2(  1,  0) Elmi nthi2(  1,  0) Tipu lida2(  1,  0) Valv atid2(  1,  0)

POSITIVE PREFERENTIALS
PORI FERA1(  0,  1) Pisc icol1(  0,  1) COPE PODA1(  0,  1) Lept ocer1(  0,  1) Cera topo1(  0,  1) Spha erid1(  0,  1)
Hydr obii1(  0,  1) PORI FERA2(  0,  1) Pisc icol2(  0,  1) COPE PODA2(  0,  1) Lept ocer2(  0,  1) Cera topo2(  0,  1)
Spha erid2(  0,  1) Hydr obii2(  0,  1)
********************************************************************************************************************

DIVISION   13  (N=   5)          I.E. GROUP *101
Eigenvalue  .226  at iteration   1
INDICATORS, together with their SIGN
PORI FERA1(-)

NEGATIVE PREFERENTIALS
PORI FERA1(  2,  0) Dend roco1(  2,  1) Caen idae1(  2,  1) Hydr opsy1(  1,  0) Lept ocer1(  1,  0) Musc idae1(  1,  0)
PORI FERA2(  2,  0) Dend roco2(  2,  1) Caen idae2(  2,  1) Hydr opsy2(  1,  0) Lept ocer2(  1,  0) Musc idae2(  1,  0)

POSITIVE PREFERENTIALS
Plan arii1(  1,  3) Glos siph1(  1,  3) OSTR ACOD1(  0,  1) COPE PODA1(  0,  1) Asel lida1(  1,  3) Coro phid1(  0,  1)
Pyra lida1(  0,  2) Helo dida1(  0,  1) Cera topo1(  0,  1) Neri tida1(  0,  1) Valv atid1(  1,  3) Lymn aeid1(  0,  2)
Phys idae1(  0,  3) Plan arii2(  1,  3) Glos siph2(  1,  3) OSTR ACOD2(  0,  1) COPE PODA2(  0,  1) Asel lida2(  1,  3)
Coro phid2(  0,  1) Pyra lida2(  0,  2) Helo dida2(  0,  1) Cera topo2(  0,  1) Neri tida2(  0,  1) Valv atid2(  1,  3)
Lymn aeid2(  0,  2) Phys idae2(  0,  3)
********************************************************************************************************************

DIVISION   14  (N=  25)          I.E. GROUP *110
Eigenvalue  .096  at iteration   2
INDICATORS, together with their SIGN
Pisc icol1(+)    HYDR ACAR1(-)    Glos siph1(-)    CLAD OCER1(+)    Valv atid1(+)    OSTR ACOD1(-)    Elmi nthi1(-)

NEGATIVE PREFERENTIALS
OSTR ACOD1(  8,  1) Elmi nthi1(  5,  0) HYDR ACAR1( 12,  2) OSTR ACOD2(  8,  1) Elmi nthi2(  5,  0) HYDR ACAR2( 12,  2)

POSITIVE PREFERENTIALS
Pisc icol1(  3,  9) CLAD OCER1(  4,  7) Tipu lida1(  2,  4) Unio nida1(  0,  3) Pisc icol2(  3,  9) CLAD OCER2(  4,  7)
Tipu lida2(  2,  4) Unio nida2(  0,  3)
********************************************************************************************************************

DIVISION   15  (N=   8)          I.E. GROUP *111
Eigenvalue  .298  at iteration   2
INDICATORS, together with their SIGN
Lymn aeid1(-)    Plan orbi1(-)

NEGATIVE PREFERENTIALS
Plan arii1(  2,  0) Glos siph1(  2,  1) Elmi nthi1(  2,  0) Hydr ophi1(  1,  0) Meso veli1(  1,  0) Hydr omet1(  1,  0)
Gerr idae1(  2,  0) Tipu lida1(  1,  0) Taba nida1(  1,  0) Musc idae1(  1,  0) Valv atid1(  1,  0) Lymn aeid1(  3,  1)
Phys idae1(  1,  0) Plan orbi1(  3,  1) Plan arii2(  2,  0) Glos siph2(  2,  1) Elmi nthi2(  2,  0) Hydr ophi2(  1,  0)
Meso veli2(  1,  0) Hydr omet2(  1,  0) Gerr idae2(  2,  0) Tipu lida2(  1,  0) Taba nida2(  1,  0) Musc idae2(  1,  0)
Valv atid2(  1,  0) Lymn aeid2(  3,  1) Phys idae2(  1,  0) Plan orbi2(  3,  1)

POSITIVE PREFERENTIALS
Erpo bdel1(  0,  3) OSTR ACOD1(  0,  2) Ephe mere1(  0,  2) Caen idae1(  0,  3) Poly cent1(  0,  2) Erpo bdel2(  0,  3)
OSTR ACOD2(  0,  2) Ephe mere2(  0,  2) Caen idae2(  0,  3) Poly cent2(  0,  2)
```