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DESCRIPTION OF SAMPLING STATIONS, METHODS OF BENTHIC SAMPLING AND BIOLOGICAL WATER QUALITY ASSESSMENT; WITH SOME CONSIDERATION OF THE INFLUENCE OF SAMPLE VARIATION ON THE ASSESSMENT VALUES OBTAINED

by

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INTRODUCTION

The first bilateral study of methods of biological sampling and biological methods of water quality assessment took place during June 1977 on selected sampling sites in the catchment of the River Trent (UK).

The study was arranged in accordance with the protocol established by the joint working group responsible for the Anglo-Soviet Environmental Agreement. The programme was organised by the Nottingham Regional Laboratory of the Severn-Trent Water Authority in collaboration with the Department of the Environment and the Central Office of Information.

The main purpose of the bilateral study in Nottingham was for some of the methods of sampling and biological assessment used by UK biologists to be demonstrated to their Soviet counterparts and for the Soviet biologists to have the opportunity to test these methods at first hand in order to judge the potential of any of these methods for use within the Soviet Union.

Although the programme of work was not designed as a scientific experiment *per se,* but only as a general demonstration, the results obtained are interesting and provide a basis for discussion and some tentative conclusions.

THE SELECTION AND CHARACTERISTICS OF THE SAMPLING SITES

Six river sampling sites were originally selected and agreed upon for joint examination by the Anglo-Soviet team of experts, namely:

1. River Derwent at Baslow
2. River Dove at Mayfield
3. River Trent at Gunthorpe
4. River Soar at Normanton
5. River Derwent at Draycott
6. River Erewash at Toton.

During the course of the study it became apparent that the inclusion of one or two additional sampling stations would add considerably to the value of the exercise. Accordingly, at the request of the Soviet side, three additional river sites and two lake/reservoir sites were added to the programme as follows:

7. Mother Drain at Rossington
8. River Poulter at Crookford
9. River Idle at Bawtry

10. Blithfield Reservoir
11. Kingsmill Reservoir.

This paper is concerned with the nine river stations, the locations of which are shown in Map 1.

There are about 700 routine observation points in the Trent catchment and the limited duration of the bilateral study was a severe constraint on the choice of sampling sites. The nine stations were eventually selected to cover, as far as possible, a wide range of river types with differing water quality.

It should be mentioned that these sampling stations had been included with 15 others in connection with a similar exercise carried out during September/October 1976. This study was organised by the Nottingham Regional Laboratory of the Severn-Trent Water Authority on behalf of the Health Protection Directorate of the Directorate General for Social Affairs, in collaboration with the Environment and Consumer Protection Service, of the Commission of European Countries.

Biologists from each of the nine member countries of the EEC gathered in Nottingham to sample and make biological water quality assessments of the 24 river sites by their own methods. In a comprehensive report to members of the working party of experts[1] the methods of sampling and of biological water quality assessment currently in use in western Europe were reviewed and compared and some progress towards their harmonization was attempted by means of tables of comparability. A summary report on the Collaborative Study is in preparation[2] and may be available in 1979/80.

Some physical characteristics of the river sampling stations are given in Table 1 whilst Table 2 shows the range and mean values recorded in 1977 for a selection of chemical water quality parameters.

METHODS

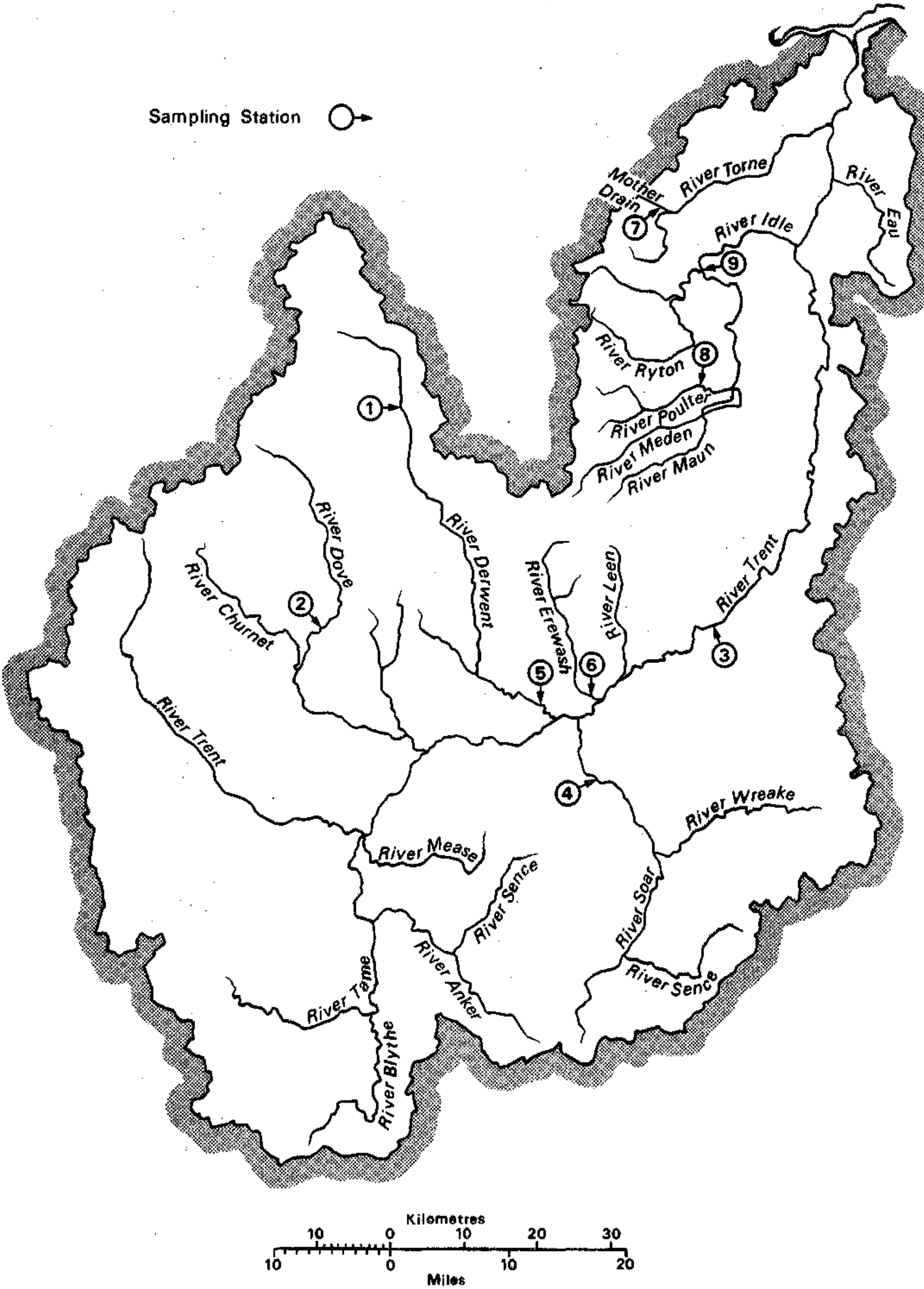
Sampling

For the purpose of this demonstration the following methods of sampling were employed, when practicable, at each site.

a. Handnet Sampling
   Handnet samples were taken by the standard technique normally used by Severn-Trent Water Authority biologists based at the Nottingham Regional Laboratory. The method is similar to that recently recommended by the Standing Committee of Analysts which is one of the joint technical committees of the Department of the Environment and the National Water Council[3].

b. Box Sampling
   The box sampler is a development of the Surber sampler in which the sides of the box circumlineate an area of one sixteenth sq m. Material from the river bed is dislodged, removed from this standard area and transferred to a net which is attached to the rear (ie downstream side) of the framework.

   This type of sampler can only be used satisfactorily in relatively shallow water — to a depth of about 30 cm.



Map 1 The Trent Catchment: Locations of the Sampling Stations

Cartographic Services MS

c. Grab Samples
A standard Eckmann Grab was used at two river sites and for sampling the two reservoirs.

This is apparently the method of sampling most frequently employed in the Soviet Union owing to the great depth of rivers and lakes in that country.

d. Artificial Substrates
Experiments on the use of artificial substrates for macroinvertebrate sampling have been taking place for sometime at the Nottingham Regional Laboratory. A number of different artificial substrates have been described, eg Scott[4], Besch and Hofmann[5], Hester and Dendy[6], Bull[7], and Anderson and Mason[8]. Similar substrates were tested in the Trent area but these were generally unsuccessful due to high losses and cost of construction.

The method developed by the Regional Laboratory, Nottingham, uses an inexpensive artificial substrate consisting of 20 pieces of clinker, each approximately 5-8 cm diameter, contained in a plastic netting bag. Each bag is placed on the river bottom and anchored by nylon cord where necessary. Three bags are placed in various habitats and colonization is allowed for the optimum period which has been found to be four weeks.

Some advantages of artificial substrates are:

i. they offer similar surface area to the colonizing organisms;

ii. they may be used in situations where other methods are impracticable, eg deep rivers;

iii. they may be used for qualitative or quantitative work;

iv. they may be planted and removed by non-biologists.

Some disadvantages are:

i. a relatively small area of the river is actually sampled;

ii. they may suffer from interference from the public;

iii. they may be lost due to abnormal environmental conditions, eg floods;

iv. there may be some loss of organisms during their removal from deep rivers.

Biological Water Quality Assessment

For this practical demonstration the following biological methods of assessment were calculated at the time of sampling:

1. Trent Biotic Index (Woodiwiss)[9]) see Table 3
2. Extended Biotic Index (Woodiwiss)[9])
3. Biotic Score (Chandler)[10]) see Table 4

4. Diversity Index (Margalef)[11])
5. Diversity Index (Shannon Weaver)[12]) see Table 5
6. Diversity Index (Wilhm and Dorris)[13])

RESULTS

The results of sampling at each river station by the methods previously described and the biological assessments derived therefrom are given in Tables 6–16.

DISCUSSION

Methods of Sampling

A comparison between the samples taken at each site has been made using Sørensen's Quotient of Similarity.

$$I = \frac{2J}{a+b}$$

where J = Number of Groups (Taxa) common to both samples.

a = Number of Taxa in Sample A.

b = Number of Taxa in Sample B.

Several such comparative indices are available for the consideration of qualitative data (14–19) whilst others, which take account of the relative abundance of taxa in the calculation, require quantitative data. The methods have been reviewed by Southwood[20].

The Sørensen Quotient is the most appropriate for the present comparison of essentially qualitative samples.

At each station, samples are compared with each other and with the background data, ie the taxa recorded for the whole years 1975 and 1976 by biologists of the Severn-Trent Water Authority. The results are tabulated in Tables 17–25A. Values of 65 and over (which indicate a reasonable degree of association) are shaded on the right hand side of each table in order to highlight similarities.

At sites where a number of handnet samples were taken there is usually fairly close similarity between them just as there is between pairs of artificial substrates. Close similarity between any handnet sample and any individual artificial substrate sample is, however, rare. An improved correlation between handnet samples and artificial substrates is often found when the three artificial substrates are combined. (The combination of three artificial substrates which have been placed in different habitats at the sampling station is normal practice in the Severn-Trent Water Authority).

At Station 8 (River Poulter at Crookford) the 4 box samples taken were individually poorly correlated with either handnet samples or artificial substrate samples. Even when the box sample results were combined they still showed a low coefficient of similarity to artificial substrate samples with but a small increase in similarity to handnet samples.

Grab samples were taken at Stations 4 and 6 and in both cases the similarity to other types of sample was very low.

The failure of these various methods of sampling to produce samples showing significant similarity to each other or with other types of sample arises mainly from the limited number of taxa found in artificial substrate, box and grab samples compared with handnet samples.

This is not really surprising since the technique of handnet sampling is deliberately designed to maximize the number of taxa found at a sampling station whereas with the other methods the area sampled in each case is relatively small.

The Tables 17–25B indicate the number of taxa recorded in each type of sample together with the percentage that this number represents of the total number of taxa found in all the samples taken at each station on that day.

This data may be summarized as follows:

TABLE 26

Type of Sample		Number of Samples/ Combinations	% of Total taxa found (all samples)	
			Mean	Range
Handnet Samples	Individual	17	68.3%	39-89%
	Combined (6o)	6	84.0%	67-100%
Artificial Substrates	Individual	24	53.7%	36-71%
	Combined (3)	8	71.4%	61-86%
Box Samples	Individual	5	36.0%	21.51%
	Combined (4)	1	64.3%	18-33%
Grab Samples	Individual	2	25.8%	18-33%

Again it is demonstrated that different methods of sampling vary in their effectiveness in terms of collecting representatives of all the taxa present at a sampling site. It is also the case that the relative abundance of organisms recorded in samples of different types and even in samples of the same type can show great variability. This is evident from an examination of the data in Tables 6–16.

These differences and variations can be understood by a consideration of the factors governing the distribution of organisms over an area of stream bed. These broadly fall into two categories.

Environmental Factors

Figure 1A is a plan of a stretch of a typical shallow stream and Figure 1B a transect across it. It is not drawn to scale but is based on one of the sampling stations examined in the bilateral study – the River Dove at Mayfield – which is typical of many such rivers in the

Trent catchment. The site is characterized by scattered large rocks 30–100 cm in diameter embedded in a matrix of stones, gravel and sand of infinitely variable dimensions and proportions. The distribution of these variably sized particles is determined by:

1. the flow pattern of the water over and through the river bed is in turn affected by;

2. changes in the depth of water, and

3. changes in the gradient of the river bed (Figure 1B).

In a river of this type it is virtually impossible to locate a quadrat sampler, either in a single position which would be truly representative of the stream bed as a whole or in a series of positions which would be identical in all physical respects. Thus, even if organisms were distributed homogenously over the area of benthos encompassed by the quadrat, the numbers of organisms found would vary from quadrat to quadrat because colonisation in each case would differ. However, the distribution of organisms is not homogenous but is influenced by biological factors.

Biological Factors

Each benthic invertebrate organism is adapted to a greater or lesser extent for the occupation of a particular niche or type of habitat. The distribution or the organism is orientated around those favoured niches but not necessarily confined to them. The niche attracts the greatest concentration of the organism(s) most suited to it but from this focus the organism extends outwards being influenced by the combined pressure of territorial expansion and the search for supplies of food. Impetus for this expansion is gained by the growth of the population within the niche. The expansion of a species from the niche may be in all directions and although it has been shown that organisms generally show a tendency to move in an upstream direction, most of the spread of a species will be in a sideways and downstream direction under the influence of the prevailing flow. Thus the orientation of various taxa on the stream bed may be regarded — for the purpose of this discussion, as a series of concentric elipses of decreasing numerical abundance radiating from an epicentre which is the ideal microhabitat for the particular organism, ie the niche.

This is shown diagrammatically in Figure 2 in relation to the occupants of five habitat types.

A. Large Rock
B. Silted Area
C. Weed Bed (Ranunculus)
D. Tree Roots/Mud
E.e. Moss covered Stones (Fontinalis).

The relative abundance of organisms within each of the areas enclosed by the intersecting eliptical lines will be significantly different. In certain areas some of the organisms may not occur at all whilst the same organisms may be quite common only a short distance away.

This point is illustrated in Figure 3 where the hypothetical distribution of ten different organisms indicated by the numbers 0–9 is shown. Again, it can be seen, that it is impossible to locate a quadrat sampler in either a single position which would be truly representative of the stream bed as a whole or in a series of positions that would necessarily reveal the same, or even remotely similar, relative abundances for the organisms present in each of the samples.

A handnet sample taken in such a way as to remove material at intervals along the transect A–B will capture a high proportion of the taxa present at the site as a whole (See Figure 4) but without any relative abundance significance.

A "quantitative" method of sampling only provides useful quantitative data when a sufficient number of replicate samples are taken at a site in order to establish that the combined data adequately represents the relative abundance of organisms at the station.

Hellawell[33] has concluded that it is apparently necessary to collect about 50 sample replicates in order to attain even an estimate of population abundance within 20% error, but for estimating the abundance of the components of a population the number of samples necessary is sometimes considerably greater.

In circumstances where the biological sampling is being undertaken for the purpose of making an investigation into a particular problem, for example to study the polluting effects of a particular discharge and its impact on the abundance of food organisms for the fish population, it might be quite reasonable to take several replicate samples.

For routine biological surveillance, however, such replication is out of the question on the grounds of cost. With a large number of sites to be examined at regular intervals and with limited manpower under pressure for other work to be carried out very significant increases in staffing levels would be required to deal with a large increase in the number of samples to be processed. It could be argued that such additional sampling effort would be more profitably applied to the more frequent, albeit qualitative, examination of the sites in order to increase the likelihood of detecting significant biological changes at an early stage.

In practice, biologists have usually had little alternative but to base their biological surveillance programmes on single handnet samples – a practice endorsed by employing authorities concerned with minimizing costs. Experience has taught those biologists the most effective ways of sampling, the limitations of their data and the types of biological assessment methods which may be applied to such data with confidence.

The danger is that others, anxious to enhance the image of biology in the field of water pollution management, will attempt to apply more and more sophisticated methods of biological assessment to this same data, without due regard to its limitations. Examples are to be found in the Saprobien System (eg methods of Pantle and Buck; Zelinka and Marvin); Diversity Indices (Shannon–Weaver; Wilhm and Dorris); and Biotic Score (Chandler). These are methods which take account of relative abundance and therefore demand strictly quantitative data but which have frequently been applied to data which is in reality only qualitative.

In the Anglo-Soviet bilateral study the biologists involved did not consider any of the samples to be quantitative. The demonstration showed that the handnet is the most versatile piece of equipment for qualitative biological sampling and can be used satisfactorily in rivers of many different types. It can be used on river beds which cannot be sampled by any other means. It must be recognised, however, that the handnet has its limitations and there are circumstances when other methods of sampling have to be employed. From the results given in Table 26 it can be seen that if artificial substate, box or grab samples are used then more than one sample is needed, in each case, for the result to be comparable with a handnet sample.

From the results obtained during the bilateral study, and bearing in mind the limitations of this data, can the number of samples of each type necessary for a reasonable comparison be estimated?

In Table 27 the cumulative number of taxa recorded by each of the methods of sampling at each sampling station is given together with the % this number represents of the total number of taxa recorded at each site in all the samples on the day. These values are plotted in Figure 5. By extrapolation it may be concluded that to equate artificial substrate, box or grab samples with the average performance of a handnet sample (in terms of the number of taxa collected) it is necessary for the following numbers of the alternative types of sample to be taken:

1 Handnet Sample	2 – 3 Artificial Substrates
	4 – 5 Box or Grab Samples

It must be realised, however, that this degree of replication is required merely to provide an equally representative list of taxa by each of the alternative methods of sampling for the sampling site under investigation. For the reasons given earlier, the samples so obtained are not to be regarded individually, or in combination, as a quantitative expression of the relative abundance of organisms at the site, or in the case of quadrat samples, within any one habitat, eg riffle.

In the EEC Collaborative Study the intensity of sampling (approximately 10 hours), at each site was such that the combined list of taxa recorded in all the participants samples could reasonably be assumed to represent the complete list of macroinvertebrate taxa present at each sampling station on the day. Each biologist used his own handnet and sampling technique and the results indicated that a 'typical' method of sampling gives a mean of only 40% (within the range 14–80%) of the taxa present at the sampling station.

The intensity of sampling in the Anglo/Soviet bilateral study was not sufficient for the same assumption to be made with confidence but, treated in the same way, the results show that a single handnet sample captures between 39–89% of the total taxa found in all the samples (68.3% mean value). In this case a number of different biologists were using the same handnet and sampling technique.

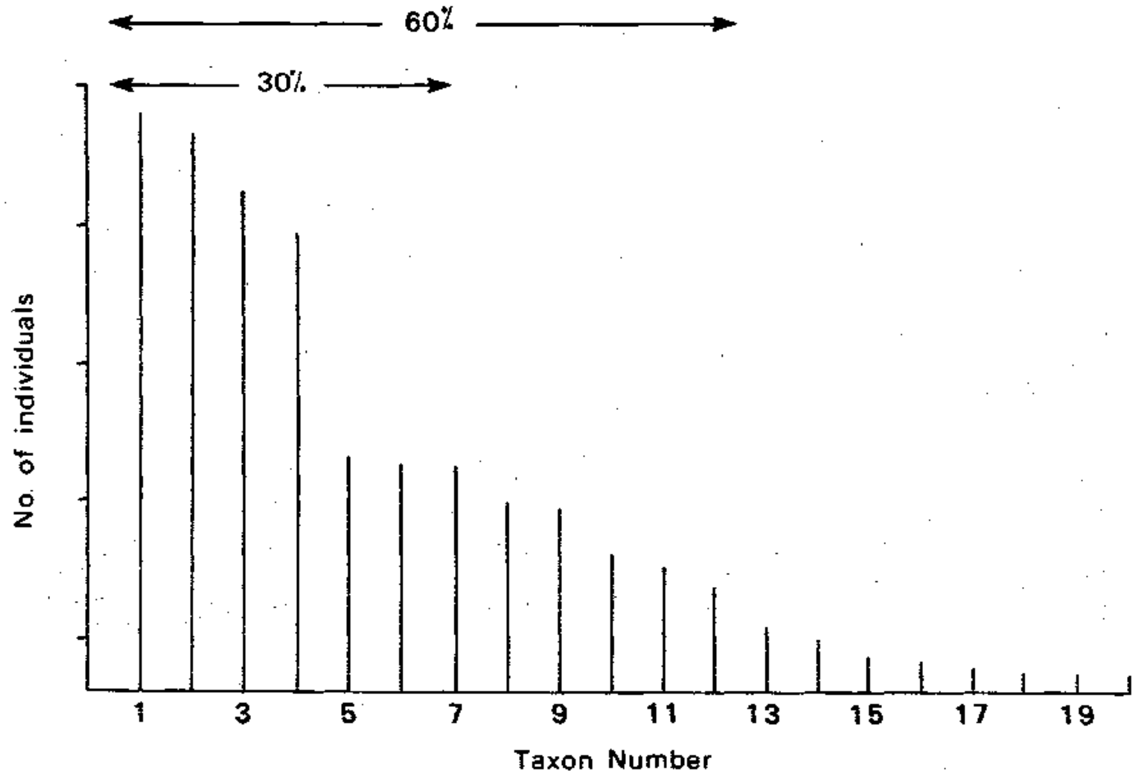
In order to ensure that the sample obtained will be at the higher end of these ranges it can be shown, by extrapolation (Figure 5) that it would be necessary to take, at each sampling station, on each sampling occasion, at least:

3–4 handnet samples, OR
5–6 artificial substrate samples, OR
8–9 box, Surber or grab samples.

Even this number of replicates, however, would not give a complete taxa list but merely minimize sample variability at an acceptable, optimal level.

Fortunately, it is not necessary for every taxon present at a site to be recorded for an adequate biological assessment of water quality to be made. Taxa are not present at a sampling station in equal numbers, for example, there are fewer predators than prey. The population of a river reach may be shown diagrammatically as adjacent.

It can be seen that a sample containing 60% of the total taxa present at the station would most likely include Taxa 1–12 whilst a sample containing 30% of the taxa present would be most likely to include Taxa 1–7. In other words those two samples will show considerable similarity in respect of the taxa which are dominant. The differences between them will be largely in respect of the less commonly occurring taxa including perhaps a number of drift organisms. All that is necessary is for a method of biological assessment to be chosen, which, when applied to the two samples will give the same assessment value.


60%
30%
No. of individuals
1
3
5
7
9
11
13
15
17
19
Taxon Number

It is clear that the time taken in sampling as well as the ability of the person taking the sample can be principal causes of sample variation. Sampling for longer periods of time will generally produce longer lists of taxa which in turn will tend to increase biological water quality assessment values to varying degrees according to the particular rationale of each method.

For this reason a maximum time for sampling is recommended, say, 5 or 10 minutes in order to minimize this variable at an optimal level.

The third EEC Collaborative Study was carried out in Italy (9–13 October, 1978) on the Torrente Palma and Torrente Stirone which are tributaries of the River Po. One of the objectives of this study was to compare the results obtained when biologists use their own equipment and their own technique of sampling with the results obtained when all the biologists use the same type of handnet and a standard technique. The report on this study should be published in 1979.

If the standardisation of apparatus and sampling technique does lead to greater uniformity in handnet samples, it is interesting to speculate if further improvement would result from sampling being carried out by one person only. Mr Fretwell will later be describing work he has recently carried out to investigate this.

Sampling in Deep Rivers

It is not always possible to sample a transect across the river (Figure 6A) because of the limitations of water depth or dangerous flows. An equivalent sampling effort can be achieved by changing the angle of the line of sampling (AC). In very deep rivers satisfactory samples can often be obtained by sampling along the bank for an equivalent distance. Such a sample is a truer reflection of water quality than would be obtained from the deep central part of the river which frequently has a limited fauna:

a. in eroding rivers because of the unstable nature of the bed;

b. in depositing rivers because of the restricting nature of the deposits. The organisms in such a situation reflect the quality of the deposits rather than the water passing over them (see Figures 6B and C).

Biological Methods of Water Quality Assessment

Before a biological method of water quality classification is selected careful consideration should be given to:

1. the validity of the data which is available;

2. the validity of the method;

3. the purpose for which the method is to be used.

Validity of the Data

The discussion of methods of sampling in the previous section is of fundamental significance in relation to the choice of suitable methods for the biological assessment of water quality.

The limitations of the biological data available, including variations arising from natural causes and sampling differences, must be recognised.

The theoretical advantages of a sophisticated method of assessment are lost when such a method is applied to data which is not reliable in the ways demanded by such a method of assessment. It is better to underestimate the validity of such data than to over-estimate it and thereby draw false conclusions.

Whilst it may be true that generalisation can be a dangerous practice in scientific work, nevertheless, it is preferable to false precision and a broad classification, which is based on a few general principles and is only a function of the dominant characteristics of the data, may ultimately be more reliable than a supposedly "precise" classification which displays imprecision.

These remarks may be illustrated by reference to the results from the Anglo-Soviet study.

In Table 28 the maximum and minimum assessment values recorded for each assessment method at each sampling station are shown. The difference between these values (M—m) is then given as a percentage of the maximum value.

$$\frac{M-m}{M}.100$$

The samples were taken at the same time so that the spread of values at each station indicated by the percentage figure, is not related to water quality but is a direct result of the normal variation between samples as discussed earlier. The range of values $\frac{M-m}{M}.100$ obtained for the 9 sampling stations is summarised in Table 29 and shown diagrammatically in Figure 7, with the results obtained for each type of sample shown separately. It is clear, that regardless of the method of sampling, the biotic index is less influenced by normal variations in sampling efficiency than any of the other methods tested. Indeed, the biotic index shows less variation resulting from sampling differences than the data itself (— number of taxa) whereas other methods actually accentuate the differences between samples.

These findings have been confirmed by other studies including the results of the EEC Collaborative Study.

Since the biotic index was the only method of assessment among those tested which was specifically designed for use in connection with random handnet sampling these results are not surprising.

What is particularly interesting is the very poor performance of the other methods of assessment in relation to quadrat samples. On the limited data available from the Anglo-Soviet results it is evident that the Diversity Index and Biotic Score values for so-called "quantitative" quadrat samples taken at the same site at the same time show very considerable variation. This was explained in the previous section and it supports the case made there for multi-replicate sampling when such methods are employed.

VALIDITY AND APPLICATION OF THE METHODS OF ASSESSMENT

Community Diversity Index

Being a function of species abundance and equitability this method may give an approximation of the community structure and since the kind of species present are not considered it may have applications on a broad geographical basis. However, the index:

a. is very sensitive to small differences between samples which must therefore be obtained by a rigorous multi-replicate quantitative sampling method;

b. requires the determination of the numbers of individuals;

c. has high taxonomic demand, and

d. requires lengthy computation.

A particular criticism of the method is that it takes no account of the kinds of species present (ie indicator species).

The method of assessment is essentially statistical and is not a biological method of water quality assessment.

Biotic Score (Chandler)

The disadvantages of the Biotic Score include:

a. the very wide range of score value steps which individually bear little or no relation to water quality differences;

b. the apparent sensitivity of the score to water quality is overshadowed by its ultra-sensitivity to ordinary differences between samples — it therefore demands a rigorous multi-replicate quantitative sampling technique to overcome this weakness;

c. the system does not reduce data to a convenient numerical scale of values which can be interpreted easily by the non-biologist;

d. the system lacks range in moderately to heavily polluted waters;

e. the tolerance list of species and the allocation of score values is, for the most part, scientifically unfounded. For example;

   i. each species of cased caddis *(Trichoptera)* scores 75 points, each genus of *Hydracarina* scores 32 points.
   What scientific argument can be put forward to support these values?

   ii.

Tubifex *(Oligochaeta)* scores 22 points. *Asellus aquaticus* (Crustacea) scores 25 points	) 3 points) difference
Asellus aquaticus (Crustacea) scores 25 points Each species of *Ephemeroptera* scores 79 points	) 54 points) difference

In the process of natural recovery from organic pollution does the transition *Asellus* → *Ephemeroptera* represent 18 x the water quality improvement that is represented by the transition Tubifex → Asellus? Since the variety of organisms increases with recovery this imbalance is accentuated by the addition of high score values for more and more organisms as the river recovers so that the total score increases out of all proportion to any real alteration in water quality. The effect of this process is for the 'sensitivity' of the score to be low at the polluted end of the range in relation to the score range as a whole. This is inconsistent with the fact that changes in water quality, as measured by chemical parameters, tend to be greater in polluted zones than in clean zones. The pronounced fluctuations found in the scores for clean zones actually tend to result mainly from influences other than water quality, eg sampling differences and physical changes.

iii. the points allocation clearly favours those organisms adapted to life in conditions of fast flow. Organisms more suited to low current velocities and depositing substrate conditions receive fewer points.

It is usual for the pollution load of a water course to increase as it passes from source (highland, fast flowing, eroding stream) to mouth (lowland, slow-flowing, depositing river). Organisms which live in the latter conditions do so primarily because they are better adapted to the physical characteristics of that type of environment and not necessarily because they are more tolerant to higher levels of pollution. Thus it may be argued that the score for *Amphinemura* (47) is too low compared with, say, *Isoperla* (90) and that for *Planorbis* (30) too low compared with *Ancylus* (70).

f. It is claimed that the great advantage of the Biotic Score over other methods is that it takes account of the relative abundance of organisms. The effect of the abundance categories on the score values is, in reality, imaginary rather than real since they can be so easily masked by the presence of another taxa, for example:

which is of greater biological significance?

		Increase in Score Value
1.	Stoneflies <10 → Stoneflies >100	6 points
	Nais –/ occurrence	20 points
2.	Mayflies <10 → Mayflies >100	13 points
	A Leech –/ occurrence	26 points
3.	Gammarus <10 → Gammarus >100	0 points
	C. riparius –/ occurrence	21 points

In other words the abundance factor can be completely overshadowed by differences in species lists resulting from variations in sampling and/or organism sorting efficiency.

It is significant that in the new Biological Monitoring Working Party Score system relative abundance categories have been dropped.

Despite the weaknesses in detail indicated above the biotic score is based on reasonable biological presumptions and performs the functions of a biological method of assessment provided that differences in score values are interpreted with care.

Biotic Index

According to Balloch et al[21] in a paper summarizing a project carried out by students at Aston University, the Biotic Index has the following advantages:

a. classifies the main characteristics of polluted waters;

b. does not make rigorous demands on sampling technique;

c. reduces the effort involved in identification of species by the selection of key organisms;

d. possesses a simple linear scale of index values;

e. has an index value easily understood by non-biologists.

The same authors have suggested the following disadvantages:

a. the fixed-level index values render the system inflexible to moderate changes in water quality.

What this really means is that the index is relatively unaffected by minor differences in the data which might be due to water quality differences but which, as has been demonstrated, are more likely to be the result of sampling differences.

b. Narrow range of fixed-level index values.

c. lacks range in the assessment of clean to mildly polluted waters.

The objective of pollution control organisations is to minimize the effect of pollution. When a watercourse has a biotic index of 8 or higher, pollution is reasonably under control or absent. The range 0–7 is the most important since it indicates areas in which pollution control measures are inadequate or ineffective.

Further differentiation of clean waters can be achieved, if necessary, by the use of the extended biotic index.

d. does not accord "key" status to molluscs, an important group in slower moving rivers.

Molluscs are not a key group in relation to water quality.

e. takes no account of numbers of individuals.

It has been explained why this is a principal source of error in systems which take account of the numbers of individuals obtained in single qualitative samples. Hence, it is an advantage not to depend on such misleading data.

f. requires adaptation, when used outside the River Trent watershed.

The flexibility of the biotic index in this respect has permitted its adaptation for use in North America and Asia (India). Adaptability is not a disadvantage.

g. accidental presence of organisms (drift organisms) may radically alter the index value for the station.

This is equally true of other systems of classification.

h. the use of taxonomic grouping does not permit a proper analysis of the community present in relation to water quality.

Such analysis should be carried out, separately, on the biological data, not on the biological classification.

i. little recognition is made of the diversity of forms within any one grouping.

On the quality of data available this is not a fault nor is it the function of the Biotic Index to make such recognition. If this information is required, and the data is reliable, it should be obtained by the simultaneous calculation of diversity index on the same data.

j. generally not responsive to inorganic pollution by heavy metals.

All biological systems of classification are ultimately based on the classical work of Kohlkwitz and Marsson (see Figure 8) and are therefore primarily related to the effects of organic pollution. Toxic pollution, such as that due to heavy metals, is detectable when such methods are used by experienced biologists.

Validity of Methods of Assessment

A number of papers[21, 28–33] have recently been published which either review methods of biological assessment on largely theoretical grounds or give accounts of the performance of methods in relation to short-term biological investigations into the condition of particular rivers. The conclusion is often reached in these papers that the Biotic Score is the preferred method of water quality assessment because it is very sensitive to water quality changes and takes account of the abundance of organisms.

The validity of this conclusion may generally be criticised, however, on the following grounds:

1. in many of the studies methods of assessment have been applied to samples obtained in ways which are different from those for which the method of assessment was devised. For example, it is not correct to apply a biotic index to a shovel[32] or cylinder[21] sample. The biotic index should be applied to random, qualitative handnet samples[9]. Only after a satisfactory validation experiment should the Biotic Index be used on the combined results of the appropriate number of samples taken by some other method.

2. the effect of normal sample variation on the methods has not been considered adequately. This arises because the work being done, by the same team of biologists on a particular watercourse, often lends itself to a reasonable degree of standardisation. This degree of standardisation cannot be achieved on a nationwide basis when large numbers of individuals are involved in the taking of samples from a wide variety of river types.

3. the claim is made that biotic score methods are sensitive to water quality change. This is an assumption frequently made, but usually not substantiated by comparison of the score values with an adequate array of water quality data, ie chemical water quality parameters.

4. the effect of seasonality on score values, although often admitted, is frequently dismissed or ignored. In the context of an isolated biological investigation of a particular river the effects of seasonality may be irrelevant since it can be argued that on the particular day of sampling all the samples taken in a longitudinal profile of that river would be affected in the same way. The effects of seasonal variation could, however, be a very serious obstacle to the interpretation of results obtained for different rivers, possibly in different geographical regions and taken at different times of the year. It may also be an obstacle to the interpretation of results on the same river where sampling is done on an all year round basis for biological surveillance purposes.

5. no guidelines are given in any of these papers regarding the criteria used in judging the significance of change as indicated by the differences in score values and making allowance for sampling and seasonal variation.

6. the specific purposes for which a biological method of assessment may be required are either not considered or are different from the purposes underlying the Anglo-Soviet bilateral study. The success of a method in relation to one purpose does not necessarily mean that the method will automatically be successful in relation to another purpose.

7. Research groups in general tend to ignore or underestimate the importance of economic and cost-benefit considerations in the selection of methods for day to-day routine use by water management organisations funded by revenue and not by government grants.

PURPOSE OF BIOLOGICAL ASSESSMENT

Biological classification systems are not generally considered (by biologists) to be suitable for the detailed investigation of particular biological problems (such as the effects of specific polluting discharges) because all such systems have a tendancy to oversimplification. In addition, the manipulation of derived values, a characteristic of many systems, has obvious drawbacks compared with the direct examination of the biological data.

Biological systems of classification have been created to serve the following needs:

1. to assist in communication between biologists and non-biologists;

2. to facilitate the routine monitoring of natural waters for the detection of short term change in biological quality which are significant in relation to water use, fisheries development and nature conservation;

3. to provide administrators with a broad indication of long-term biological changes in natural waters in relation to the effectiveness of pollution control measures taken;

4. to reduce complex biological data to a form which allows comparison with other data including water quality analyses, and fish distribution, particularly in order to identify problem areas not revealed by the limited chemical surveillance which is normally achieved.

Given that the biological classification is to be used for one or more of these requirements what range of values is to be preferred? This is to some extent a matter of individual choice and the question is perhaps best answered by reference to the methods of assessment most widely used already, say, in western Europe. A survey of methods currently used by the EEC countries is summarised in Table 30.

Most countries utilise a 4 or 5 part system as a means of monitoring in the long term, the effectiveness of a pollution control policy, and a 10–20 part system for the other needs. The broader classification is often derived from the 10–20 part classification or, in the case of two countries, from 100 part classifications. The 100 part classifications can also be used as 10 part classifications.

Open-ended numerical assessment systems (Biotic Scores) are not favoured in any country outside the UK. It may be concluded that, in practice, systems with a range of values between 0 and 20 have proven to be the most acceptable to administrators and biologists in all these countries.

THE SELECTION OF A BIOLOGICAL ASSESSMENT METHOD

No system of biological assessment can be regarded as perfect and it may be, in part, the imperfection of existing systems which stimulates the search for new ones. However, of the systems considered by the Anglo-Soviet Group the Biotic Index is the first choice for the purposes listed in Section 5.2.3.

For other purposes, such as in the more precise investigation of the biological condition of a particular watercourse in relation to flood alleviation schemes, land drainage work and the regulation of discharges from storage reservoirs the Biotic Score system may be the most appropriate choice provided that it is applied to the results of replicate quantitative samples along the river profile. It is of less value for intercomparison between rivers owing to the very large number of ways in which any final score value can be computed.

That is not to imply that there is no place for other systems in routine biological surveillance. On the contrary, a biologist should not rely solely on one system of biological assessment any more than a chemist would rely on only one chemical parameter to consider water quality. The biologists should, in fact, choose a number of assessments appropriate to the quality of data available. He should consider the normal relationships in particular instances. For example, a low biotic index combined with a high Diversity Index or *vice versa*. Frequently, such deviations can be explained in terms of sampling difficulties or other factors not associated with water quality. Occasionally the deviations can highlight water quality problems not necessarily noticed by the use of only one method of assessment, whichever method that happened to be. The selection of suitable methods of biological assessment need not be confined to those dealt with in the Anglo-Soviet study but could be extended to include methods used in other countries. For example, the following methods have particular merits and are worthy of consideration:

1. K_{12345} (Moller Pillot)[23] Netherlands.

2. Biotic Index (Verneaux and Tuffery)[24] France.

3. Quality Q (Flanagan and Toner)[25] Ireland.

4. Relative Load (Knopp)[26] West Germany.

The system of Moller Pillot is a score-type of assessment method with the following particular advantages:

1. the system was devised primarily for use in the deep, slow, rivers found in the Netherlands;

2. only organisms which have known water quality significance are included in the assessment calculations;

3. the score range 100 (heavily polluted) to 500 (not polluted) can be adapted to give a 5 or 10 class system by banding;

4. the score allocations to organisms are less controversial than those of the Biotic Score (Chandler).

PRACTICAL APPLICATION OF METHODS IN BIOLOGICAL SURVEILLANCE

At the 1st Anglo-Soviet Seminar on "The Elaboration of the Scientific Bases for Monitoring the Quality of Surface Water by Hydrobiological indicators", held at Valdai, USSR, in 1976 I attempted to demonstrate the practical application of the Trent Biotic Index in day to day biological surveillance[27]. Examples were given of the biological record cards for a number of sampling stations in the Trent catchment. I would like to conclude this paper by showing examples of such records in terms of the Biotic Index and Biotic Score (Chandler). The examples, Tables 31/32, 33/34, 35/36, are for the River Derwent at Draycott and Baslow and the River Erewash at Toton, three of the sampling stations examined in the Anglo-Soviet bilateral study. These long term records are also shown diagrammatically in Figures 9, 10 and 11.

These examples show that the two assessment methods vary in parallel to give a similar indication of water quality change both in the short term and long term. It is equally clear that the simpler Biotic Index values are more easily interpreted than the high Biotic Score values particularly since the latter show a greater relative standard deviation.

The usefulness of the Biotic Score as a day to day management tool can be improved by utilising the square root of the actual score, thereby transforming them to the more convenient scale of 0—50 and at the same time halving the relative standard deviation.

All the values given for the three sampling stations on these record cards have been used to show the relationship between the Extended Biotic Index and Biotic Score (Chandler). It can be seen (Figure 12) that this relationship is of exponential character. The product/moment correlation coefficient is 0.981. When the Extended Biotic Index is compared with the square root of the Biotic Score the relationship is linear (Figure 13) and the correlation coefficient is 0.975.

It is suggested that this variation of the Biotic Score may enhance its general usefulness.

CONCLUSIONS

Having regard to:

1. the uses to which a system of biological assessment may be put in relation to river water quality monitoring programmes.

2. the validity of biological data normally available — as influenced by the following considerations:

a. the variability of river types and geographical regions;

b. the variability in methods of sampling which have to be adopted for practical reasons in local circumstances;

c. the variability in sampling effectiveness and level of expertise of available staff;

d. the general variability normally found between samples.

3. the validity and scientific basis of the methods of assessment under consideration.

4. Economic constraints.

It was decided by the joint Anglo-Soviet team of experts that the Trent Biotic Index has evident advantages over the other methods tested.

In particular it was felt[34] that the Trent Biotic Index:

"1. provides an adequate assessment of water quality.

2. *requires a minimum of effort and is consequently most cost-effective.*

3. does not require highly qualified staff.

4. gives the highest level of reproducibility of results of all the methods considered".

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Name of River	Name of Station	Site Number	Distance from Source	Gradient	Width of Stream	Cross-sectional area	Normal Dry Weather Flow	Depth (normal range)	Type of Bottom
			(Km)		(m)	(Sq. m)	(cumecs)	(cms)	
River Derwent	Baslow	1(1*)	37	1:550	20 (E)	13 (E)	2.0	15-30	Rocks.
River Dove	Mayfield	2(2*)	38.6	1:550	18 (E)	8 (E)	1.7	15-60	Stones, Gravel.
River Trent	Gunthorpe	3(13*)	183.4	1:3550	Not known	Not known	17.0	10-60	Stones, Gravel.
River Soar	Normanton	4(15*)	56.3	1:1770	Not known	Not known	2.0	1 m.	Mud, Silt, Gravel.
River Derwent	Draycott Ferry	5(16*)	101.4	1:1480	22.0(E)	9.0 (E)	5.0	30-60	Stones, Gravel.
River Erewash	Toton	6(17*)	37.0	1:2110	8.0(E)	1.6(E)	Not known	30-60	Stones, Gravel.
Mother Drain	Rossington Bridge	7(18*)	8.0	-	Not known	Not known	Not known	30-60	Mud, Silt, Stones.
River Poulter	Crookford	8(23*)	23.3	1:510	6.0	1.7	0.36	10-60	Stones, Gravel, Sand.
River Idle	Bawtry	9(24*)	45.1	-	Not known	Not known	Not known	20- 1m.	Sand, Silt, Mud.

*(EEC Site No.) (E = Estimated)

TABLE 1. THE SAMPLING STATIONS: Some Physical Characteristics

Station Number	River	Station	B.O.D. (5 day)	Suspended Solids	Ammoniacal Nitrogen	Dissolved Oxygen (Conc.)	pH	Temperature °C	Ortho-phosphate	Water Quality Class
1	DERWENT	BASLOW - Mean Range No. of Observ'ns.	1.7 0.9-2.8 13	5 1-20 13	0.1* <0.1-0.3 13	11.2 9.5-13.2 11	7.7 7.6-8.0 13	10.0 3.5-16.5 11		1A
2	DOVE	MAYFIELD - Mean Range No. of Observ'ns.	1.6 0.8-2.8 21	12 1-102 21	0.1* <0.1-0.2 21	11.7 10.8-13.0 19	8.0 7.6-8.4 21	9.4 5-15.5 21		1A
3	TRENT	GUNTHORPE - Mean Range No. of Observ'ns.	6.4 3.8-15.8 13	26 8-74 14	0.7 0.3-1.5 14	9.0 7.3-10.6 12	7.6 7.1-8.0 14	12.0 4.2-19.2 14		2
4	SOAR	ZOUCH - Mean Range No. of Observ'ns.	4.5 3.1-8.8 24	16 5-59 24	0.5* <0.1-1.2 24	10.0 6.7-12.2 24	7.8 7.3-8.1 24	10.9 2.0-23.5 24		2
5	DERWENT	DRAYCOTT - Mean Range No. of Observ'ns.	4.0 0.6-7.5 23	13 6-31 23	0.4 <0.1-1.4 23	9.0 5.1-12 19	7.7 7.2-8.0 23	13.4 5-22.2 18		2
6	EREWASH	TOTON - Mean Range No. of Observ'ns.	9.5 3.8-16.2 12	24 6-48 12	1.9 0.4-3.4 12	6.6 3.3-9.8 12	7.4 7.2-7.6 12	11.0 4.5-19.5 12		3
7	MOTHER DRAIN	ROSSINGTON - Mean Range No. of Observ'ns.	3.4 1.2-5.6 9	19 6-43 9	0.2* <0.1-0.5 9	10.1 6.6-14.4 9	7.6 7.3-7.9 9	10.3 4.2-18.1 9		3
8	POULTER	CROOKFORD - Mean Range No. of Observ'ns.	3.5 1.2-5.6 12	13 3-29 12	0.1* <0.1-0.7 12	13.3 6.3-17.7 12	8.5 7.8-9.2 12	11.5 3.6-19.2 12		1B
9	IDLE	BAWTRY - Mean				10.1 5.8-14.1 47	7.9 7.2-8.6 49	10.3 1.8-18.2 47		2

TABLE 2. THE SAMPLING STATIONS: Some Chemical Water Quality Parameters, 1977

(All values in mg/l - except pH, Temperature.)

TABLE 3. METHODS OF ASSESSMENT - TRENT BIOTIC INDEX AND EXTENDED BIOTIC INDEX (WOODIWISS 1962, 1964

EXTENDED BIOTIC INDEX		Total number of groups present										
		0-1	2-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	.....
TRENT BIOTIC INDEX		TOTAL NUMBER OF GROUPS PRESENT										
		0-1	2-5	6-10	11-15	16+						
		BIOTIC INDICES										
Plecoptera nymphs present	More than one species.	-	7	8	9	10	11	12	13	14	15	
	One species only.	-	6	7	8	9	10	11	12	13	14	
Ephemeroptera nymphs	More than one species.*	-	6	7	8	9	10	11	12	13	14	
	One species only.*	-	5	6	7	8	9	10	11	12	13	
Trichoptera larvae present	More than one species./	-	5	6	7	8	9	10	11	12	13	
	One species only./	4	4	5	6	7	8	9	10	11	12	
Gammarus present	All above species absent.	3	4	5	6	7	8	9	10	11	12	
Asellus present	All above species absent.	2	3	4	5	6	7	8	9	10	11	
Oligochaeta/Chironomus	All above species absent.	1	2	3	4	5	6	7	8	9	10	
All above absent	May be organisms requiring no DO.	0	1	2	-	-	-	-	-	-	-	

* Baetis rhodani excluded.

/ Baetis rhodani (Ephem.) is counted in this section for the purpose of classification.

TABLE 4. METHODS OF ASSESSMENT - BIOTIC SCORE (CHANDLER, 1970)

Groups present in sample		Increasing abundance				
		Present	Few	Common	Abundant	Very abundant
		1 to 2	3 to 10	11 to 50	51 to 100	More than 100
		Points scored				
Each species of	PLANARIA ALPINA TAENOPTERYGIDAE PERLIDAE, PERLODIDAE ISOPERLIDAE, CHLOROPEDIDAE	90	94	98	99	100
Each species of	LEUCTRIDAE, CAPNIIDAE NEMOURIDAE (exd. AMPHINEMURA)	84	89	94	97	98
Each species of	EPHEMEROPTORA (exd. BAETIS)	79	84	90	94	97
Each species of	CASED CADDIS, MEGALOPTERA	75	80	86	91	94
Each species of	ANCYLUS	70	75	82	87	91
—	RHYACOPHILA (TRICHOPTORA)	65	70	77	83	88
Genera of	DICRANOTA, LIMNOPHERA	60	65	72	78	84
Genera of	SIMULIUM	56	61	67	73	75
Genera of	COLEOPTERA, NEMATODA	51	55	61	66	72
—	AMPLANEMURA (PLECOPTERA)	47	50	54	58	63
—	BAETIS (EPHEMEROPTERA)	44	46	48	50	52
—	GAMMARUS	40	40	40	40	40
Each species of	UNEASED CADDIA (exd. RHYACOPHILA)	38	36	35	33	31
Each species of	TRICLADIDA (exd. P. ALPINO)	35	33	31	29	25
Genera of	HYDRACARINA	32	30	28	25	21
Each species of	MOLLUSCA (exd. ANCYLUS)	30	28	25	22	18
—	CHIRONOMIDS (exd. C. RIPARIUS)	28	25	21	18	15
Each species of	GLOSSIPHONIA	26	23	20	16	13
Each species of	ASELLUS	25	22	18	14	10
Each species of	LEECH, exd. GLOSSIPHONIA, HAEMOPSIS	24	20	16	12	8
—	HAEMOPSIS	23	19	15	10	7
—	TUBIFEX sp.	22	18	13	12	9
—	CHIRONOMUS RIPARIUS	21	17	12	7	4
—	NAIS	20	16	10	6	2
Each species of	AIR BREATHING SPECIES	19	15	9	5	1
	NO ANIMAL LIFE			0		

TABLE 5. DIVERSITY INDICES (FORMULAE)

<table>
<tr><th>METHOD</th><th>FORMULA</th><th>NOTES</th></tr>
<tr><td>Margalef (1951)</td><td>$\bar{d} = \frac{(s - 1)}{\log_e N}$</td><td rowspan="3">$\bar{d}$ = diversity index

s = number of species or Taxa

N = Total number of individuals in the sample

n_i = number of individuals in the ith species or taxa</td></tr>
<tr><td>Shannon Weaver (1963)</td><td>$\bar{d} = -\Sigma(^{ni}/N) \ Log_e(^{ni}/)$</td></tr>
<tr><td>Wilhm & Dorris (1968)</td><td>$\bar{d} = - (^{ni}/N) \ Log_2(^{ni}/N)$</td></tr>
</table>

River Derwent at Baslow

GROUPS OF ORGANISMS	BIOTIC INDEX GROUP NUMBER	BACKGROUND DATA		HANDNET SAMPLE		ARTIFICIAL SUBSTRATES				BOX SAMPLE	GRAB SAMPLE
				S.R.	J.H.	1	2	3 →	TOTAL 1 - 3		
				U.K.	U.K.	U.K.	U.K.	U.K.	U.K.	U.K.	USSR
		1975	1976	13450	13451	13452	13453	13454	-	-	-
Porifera	1	-	-	-	-	-	-	-	-	METHOD CANNOT BE USED - ROCKY RIVER BED	METHOD CANNOT BE USED - ROCKY RIVER BED
Polycelis sp.	5	-	✓	-	-	-	-	-	-		
Dendrocoelum sp.	8	-	-	-	-	-	-	-	-		
Naididae	11	-	-	-	-	-	-	-	-		
Tubificidae	12	✓	✓	5	4	4	-	-	4		
Lumbriculidae	14	✓	-	8	2	-	-	-	-		
Lumbricidae	17	-	-	-	-	-	-	-	-		
Piscicola geometrica	20	✓	✓	1	1	-	-	1	1		
Glossiphona sp.	23/24	✓	✓	1	-	-	-	-	-		
Helobdella stagnalis	26	-	✓	2	2	-	-	-	-		
Erpobdella sp.	29/30	✓	-	-	-	-	-	-	-		
Gammarus pulex	38	✓	✓	45	16	1	-	-	1		
Asellus aquaticus	43	-	✓	-	-	-	-	-	-		
Taeniopteryx sp.	58	-	-	-	-	-	-	-	-		
Protonemura sp.	61/63	-	✓	-	-	-	-	-	-		
Amphinemura sp.	64/66	-	✓	-	-	-	-	-	-		
Nemoura sp.	67/70	-	✓	-	-	-	-	-	-		
Leuctra sp.	71/76	✓	✓	-	-	-	-	-	-		
Isoperla sp.	81/82	✓	✓	32	4	1	-	-	1		
Chloroperla sp.	87/88	-	✓	-	-	-	-	-	-		
Ephemera sp.	89	-	✓	2	1	-	1	1	2		
Caenis sp.	90	✓	✓	52	70	8	12	1	21		
Ephemerella sp.	91	-	✓	162	86	55	38	52	145		
Ecdyonurus sp.	92	✓	✓	-	-	-	-	-	-		
Rithrogena sp.	93	✓	✓	15	5	-	-	-	-		
Heptagena sp.	94	-	✓	7	-	-	-	-	-		
Paraleptophloebia sp.	97	-	-	-	-	-	-	-	-		
Chloeon sp.	100	-	-	-	-	-	-	-	-		
Baetis rhodani	101	✓	✓	64	53	12	15	10	37		
Baetis spp.	102	✓	-	-	-	6	-	-	6		
Sialis lutaria	103	-	✓	-	-	-	-	-	-		
Limnephilidae	105	✓	✓	2	1	1	-	-	1		
Sericostomatidae	106	✓	✓	14	5	-	-	-	-		
Lepidostomatinae	107	-	✓	-	-	-	2	-	2		
Beraeidae	108	-	-	-	1	-	-	-	-		
Leptoceridae	111	✓	✓	28	45	18	16	-	34		
Hydropsychidae	112	✓	✓	25	20	1	3	6	10		
Polycentropidae	113	✓	✓	9	2	-	-	-	-		
Psychomyidae	114	-	-	-	-	-	-	-	-		
Rhyacophilidae	116	✓	✓	42	17	9	12	18	39		
Glossosomatidae	117	-	✓	-	1	6	-	1	7		
Hydroptilidae	118	✓	✓	39	38	12	10	7	29		
Dytiscidae	119	-	✓	-	-	-	-	-	-		
Hydroporus	120	-	-	-	-	-	-	-	-		
Elmis sp.	130	✓	✓	16	-	-	-	-	-		
Esolus sp.	131	-	-	-	-	-	-	-	-		
Limnius sp.	132	✓	✓	18	22	5	4	16	25		
Oulimnius sp.	133	-	✓	-	-	-	-	-	-		
Riolus sp.	134	-	-	-	-	-	-	-	-		
Simulidae	135	✓	✓	24	18	6	16	12	34		
Chironomidae	136	✓	✓	40	75	38	148	46	232		
Psychodidae	140	✓	✓	-	-	-	-	-	-		
Ceratopogonidae	141	-	✓	-	-	-	-	-	-		
Tipulidae	142	✓	-	-	-	-	-	-	-		
Stratiomyidae	146	-	-	1	1	-	-	-	-		
Rhagionidae	147	-	✓	-	-	-	-	-	-		
Tabanidae	148	-	-	1	-	-	-	1	1		
Empididae	149	-	✓	-	-	-	-	-	-		
Muscidae	150	-	-	-	-	-	-	-	-		
Hydracarina	152	✓	✓	56	44	48	25	36	109		
Potamopyrgus sp.	161	✓	✓	2	-	8	-	-	8		
Hydrobia ulvae	160	-	-	-	-	-	-	-	-		
Ancylus fluviatilis	164	✓	✓	3	-	-	-	-	-		
Limnaea pereger	172	✓	✓	3	1	1	-	-	1		
Sphaerium	180	-	-	15	-	-	-	-	-		
Pisidium	181	✓	-	1	-	-	-	-	-		
TOTAL GROUPS	TOTAL	31	44	32	26	19	13	14	23		
TOTAL ORGANISMS				735	535	240	302	208	750		
TRENT BIOTIC INDEX				9	9	9	8	8	9		
EXTENDED BIOTIC INDEX				12	11	9	8	8	10		
BIOTIC SCORE				1628	1432	1078	826	730	1297		
DIVERSITY INDEX (MARGALEF) Calculated (1)				4.22	3.98	3.28	2.10	2.44	3.32		
DIVERSITY INDEX (SHANNON & WEAVER) Calculated (2)				2.72	2.55	2.33	1.80	2.05	2.18		
DIVERSITY INDEX (WILHM & DORRIS) Calculated (3)				3.93	3.68	3.37	2.60	2.95	3.15		
DIVERSITY INDEX (WILHM & DORRIS) from Tables				4.03	2.92	3.18	2.10	2.96	3.51		
LIMNOSAPROBITY				O.S	O.S	O.S	O.S	O.S	O.S		

TABLE 6. RIVER DERWENT AT BASLOW (Station 1)

River Dove at Mayfield

GROUPS OF ORGANISMS	BIOTIC INDEX GROUP NUMBER	BACKGROUND DATA		HANDNET SAMPLES 1 F.W. U.K.	HANDNET SAMPLES 2 S.R. U.K.	HANDNET SAMPLES 3 N USSR	ARTIFICIAL SUBSTRATES 1	ARTIFICIAL SUBSTRATES 2	ARTIFICIAL SUBSTRATES 3	TOTAL 1 - 3 A/S U.K.	BOX SAMPLE F.W. U.K.	GRAB SAMPLE USSR
		1975	1976	13429	13430	USSR1	13432	13433	13434		13431	-
Coelenterata - Hydra	2	-	-	-	-	-	-	-	-	-	-	METHOD COULD NOT BE USED ON THIS SUBSTRATE
Planaria/Dugesia sp.	4/6	✓	-	-	-	-	-	-	-	-	-	
Polycelis sp.	8	-	-	-	-	-	-	-	1	1	-	
Naididae	11	-	-	-	-	-	-	-	-	-	-	
Tubificidae	12	✓	✓	6	35	5	38	32	32	102	54	
Lumbriculidae	14	-	-	1	-	-	-	-	-	-	-	
Lumbricidae	17	-	-	-	-	-	-	-	-	-	-	
Piscicola sp.	20	✓	✓	1	-	-	-	-	-	-	-	
Glossiphona sp.	23/4	✓	✓	-	2	1	1	-	1	2	-	
Helobdella sp.	26	-	✓	-	-	-	1	-	-	1	-	
Erpobdella sp.	39/30	✓	-	1	-	-	-	-	-	-	-	
Crangonyx sp.	37	-	✓	-	-	-	-	-	-	-	-	
Gammarus pulex	38	✓	✓	18	22	6	20	15	56	91	10	
Asellus aquaticus	43	-	✓	-	-	-	1	-	-	1	-	
Corixidae	48	-	-	-	-	-	-	-	-	-	-	
Taeniopteryx sp.	58	-	-	-	-	-	-	-	-	-	-	
Protonemura sp.	61/63	-	✓	-	-	-	-	-	-	-	-	
Amphinemura sp.	64/66	-	✓	-	-	-	-	-	-	-	-	
Leuctra sp.	71/76	-	✓	-	-	-	-	-	-	-	-	
Isoperla sp.	81/82	✓	✓	7	3	1	-	-	2	2	-	
Dinocras sp.	85	✓	✓	5	1	-	1	-	-	1	-	
Ephemera sp.	89	-	✓	-	-	-	-	-	-	-	1	
Caenis sp.	90	✓	✓	6	19	10	3	6	12	21	20	
Ephemerella sp.	91	✓	✓	124	288	264	621	72	75	768	65	
Ecdyonurus sp.	92	-	✓	-	-	-	-	-	-	-	-	
Rithrogena sp.	93	-	-	5	24	-	2	2	-	4	3	
Heptagena sp.	94	-	-	-	-	-	-	-	-	-	-	
Paraleptophloebia sp.	97	-	✓	-	-	-	-	-	-	-	-	
Centroptilum sp.	98	-	-	-	-	-	-	-	-	-	-	
Chloeon sp.	100	-	-	-	-	-	-	-	-	-	-	
Baetis rhodani	101	✓	✓	21	32	14	7	20	9	36	24	
Baetis spp.	102	-	-	13	3	-	-	12	-	12	-	
Sialis sp.	103	-	-	-	-	-	-	-	-	-	-	
Limnephilidae	105	✓	✓	2	24	1	-	-	-	-	-	
Sericostomatidae	106	-	✓	32	4	4	-	-	-	-	-	
Lepidostomatinae	107	-	✓	-	-	-	-	-	-	-	-	
Leptoceridae	111	-	-	3	18	-	9	7	3	19	1	
Hydropsychidae	112	-	✓	69	92	18	8	6	4	18	4	
Polycentropidae	113	✓	✓	2	-	3	-	-	1	1	1	
Psychomyiidae	114	-	-	-	-	-	-	-	-	-	-	
Rhyacophilidae	116	✓	✓	22	14	16	-	3	3	6	9	
Glossosomatidae	117	-	✓	18	30	9	10	-	-	10	38	
Hydroptilidae	118	✓	✓	45	40	122	52	48	36	136	40	
Dytiscidae	119	-	-	-	1	-	-	-	-	-	-	
Platambus sp.	121	✓	✓	-	-	-	-	-	-	-	-	
Hydrobiidae	122	-	-	-	-	-	-	-	-	-	-	
Haliplidae	123	✓	✓	-	-	-	-	-	-	-	-	
Gyrinidae	125	-	-	-	-	-	-	-	-	-	-	
Hydrophilidae	129	-	-	-	-	-	-	-	-	-	-	
Elmis sp.	130	✓	✓	16	15	24	18	24	17	59	7	
Esolus sp.	131	-	-	-	-	-	-	-	-	-	-	
Limnius sp.	132	✓	✓	2	8	-	-	-	-	-	5	
Oulimnius sp.	133	-	-	-	-	-	-	-	-	-	-	
Riolus sp.	134	-	-	-	-	-	-	-				
Simulidae	135	✓	✓	34	48	57	5	10	17	32	9	
Chironomidae	138	✓	✓	28	45	368	32	28	65	125	48	
C. thummi	139	✓	-	-	-	-	-	-	-	-	-	
Psychodidae	140	✓	-	-	-	-	-	-	-	-	-	
Ceratopogonidae	141	-	✓	9	12	5	6	-	-	6	-	
Tipulidae	142	-	✓	-	-	-	-	1	-	1	-	
Ephydridae	145	✓	-	-	-	-	-	-	-	-	-	
Rhagionidae	147	✓	✓	14	1	3	-	-	1	1	1	
Tabanidae	148	✓	-	-	-	-	-	-	-	-	-	
Empididae	149	-	✓	-	-	-	1	-	-	1	1	
Muscidae/Dicranota	150	-	-	-	-	-	-	1	-	1	1	
Hydracarina	152	✓	✓	72	96	52	15	78	30	72	28	
Hydrobia sp.	160	-	-	-	-	-	-	-	-	-	-	
Potamopyrgus sp.	161	✓	✓	3	2	2	25	21	5	51	6	
Ancylus sp.	164	✓	✓	5	3	3	1	-	2	3	3	
Limnaea pereger	172	✓	✓	-	1	2	-	-	-	-	-	
Planorbis sp.	173	-	-	-	-	-	-	-	-	-	-	
Sphaerium sp.	180	✓	-	-	-	-	-	-	-	-	-	
Pisidium sp.	181	-	-	-	-	-	-	-	-	-	-	
TOTAL GROUPS	TOTAL	30	40	29	28	23	22	18	20	30	23	
TOTAL ORGANISMS				584	865	990	877	386	372	1584	378	
TRENT BIOTIC INDEX				10	10	9	9	9	9	10	9	
EXT. BIOTIC INDEX				12	12	10	10	9	9	12	10	
BIOTIC SCORE				1544	1572	1189	1077	962	1016	1439	1221	
D.I. (MARGALEF) Calc.				4.4	3.99	3.19	3.1	2.85	3.21	3.94	3.71	
D.I. (SHANNON & WEAVER) Calc.				2.72	2.43	1.88	1.33	2.40	2.14	2.00	2.52	
D.I. (WILHM & DORRIS) Calc.				3.92	2.51	2.71	1.92	3.47	3.38	2.88	3.63	
D.I. (WILHM & DORRIS) from Tables				3.92	2.52	2.71	1.90	3.68	3.30	2.9	3.7	
LIMNOSAPROBITY				O.S	O.S	O.S	O.S	O.S	O.S	O.S	O.S	

TABLE 7. RIVER DOVE AT MAYFIELD (Station 2)

GROUPS OF ORGANISMS	BIOTIC INDEX GROUP NUMBER	BACKGROUND DATA		HAND-NET SAMPLE	ARTIFICIAL SUBSTRATES +				BOX SAMPLE	GRAB SAMPLE
				G.F. U.K.	U.K.	U.K.	U.K.	U.K.	U.K.	USSR
		1975	1976	13444	13445	13446	13447	-		
Polycelis sp.	5	-	✓	-	22	24	35	81	RIVER TOO DEEP FOR THIS METHOD	COULD NOT BE SAMPLED BY THIS METHOD
Dendrocoelum sp.	8	-	✓	-	2	3	2	7		
Naididae	11	-	-	-	-	-	-	-		
Tubificidae	12	✓	✓	23	16	10	-	26		
Theromyzon sp.	21	-	-	2	-	1	1	1		
Glossiphonia spp.	23/4	✓	✓	1	2	1 + 5	1 + 6	2 + 13		
Helobdella sp.	26	-	✓	2	-	-	-	-		
Erpobdella sp.	30	✓	✓	5	12	2	9	23		
Crangonyx sp.	37	✓	✓	4	8	2	8	18		
Orchestia sp.	36	✓	-	-	-	-	-	-		
Gammarus pulex	38	✓	-	-	-	-	-	-		
Asellus aquaticus	43	✓	✓	60	86	28	35	149		
Corixidae	49	-	-	-	-	-	-	-		
Odonata	53/7	✓	✓	-	-	-	1	1		
Caenis sp.	90	✓	-	1	-	-	-	-		
Centroptilum sp.	98	-	-	-	-	-	-	-		
Cloeon sp.	100	-	-	-	-	-	-	-		
Baetis sp.	101/2	✓	✓	-	-	-	-	-		
Leptoceridae	111	-	✓	-	-	-	-	-		
Hydropsychidae	112	✓	✓	-	-	-	-	-		
Polycentropidae	113	-	-	-	-	-	-	-		
Rhyacophilidae	116	-	-	-	-	-	-	-		
Dytiscidae	119	-	-	-	-	-	-	-		
Haliplidae	123	✓	-	-	-	-	-	-		
Simulidae	135	-	✓	-	-	-	-	-		
Chironomidae	138	✓	✓	15	21	21	18	60		
C. thummi	139	✓	✓	-	-	-	-	-		
Psychodidae	140	-	-	-	-	-	-	-		
Ceratopogonidae	141	-	-	-	-	-	-	-		
Tipulidae	142	-	✓	-	-	-	-	-		
Empididae	149	-	✓	-	-	-	-	-		
Muscidae	150	-	-	-	-	-	-	-		
Hydracarina	152	-	-	-	-	-	-	-		
Bithynia sp.	156	✓	✓	-	-	2	2	4		
Potamopyrgus sp.	161	✓	✓	3	1	4	8	13		
Ancylus sp.	163	✓	✓	1	-	-	-	-		
Limnaea pereger	172	✓	✓	1	-	-	-	-		
Planorbis sp.	173	-	✓	-	2	-	-	2		
Sphaeridae	180	-	✓	1	1	-	-	1		
Valvata	156	-	-	-	-	-	1	1		
TOTAL GROUPS	-	-	23	13	11	12	13	16		
TOTAL ORGANISMS	-	-	-	119	173	103	126	402		
TRENT BIOTIC INDEX	-	-	-	7	6	6	6	7		
EXTENDED BIOTIC INDEX	-	-	-	7	6	6	6	7		
BIOTIC SCORE	-	-	-	419	286	318	302	372		
DIVERSITY INDEX (MARGALEF)	-	-	-	2.51	1.94	2.37	2.48	2.50		
DIVERSITY INDEX (SHANNON & WEAVER)		-	-	1.60	1.63	1.94	1.95	1.91		
DIVERSITY INDEX (WILHM & DORRIS) Calculated				2.31	2.35	2.80	2.81	2.75		
DIVERSITY INDEX (WILHM & DORRIS) from Tables			-	2.3	2.35	2.84	2.77	2.73		
LIMNOSAPROBITY				B.M	B.M	B.M	B.M	B.M		

TABLE 8. RIVER TRENT AT GUNTHORPE (Station 3)

GROUPS OF ORGANISMS	BIOTIC INDEX GROUP NUMBER	BACKGROUND DATA 1975	BACKGROUND DATA 1976	HAND-NET 1 FW U.K. 13471	ARTIFICIAL SUBSTRATES 1 U.K. 13472	ARTIFICIAL SUBSTRATES 2 U.K. 13473	ARTIFICIAL SUBSTRATES 3 U.K. 13474	ARTIFICIAL SUBSTRATES 1-3 TOTAL U.K. -	BOX SAMPLE U.K. -	GRAB SAMPLE USSR -
Porifera	1	-	-	-	-	-	-	-	METHOD COULD NOT BE USED - TOO DEEP	-
Polycelis sp.	5	-	✓	2	12	22	12	46		-
Dugesia sp.	6	-	-	-	-	3	3	6		-
Dendrocoelum sp.	8	✓	✓	-	5	4	5	14		-
Tubificidae	12	✓	✓	92	7	4	6	17		274
Theromyzon sp.	21	-	✓	1	4	-	-	4		-
Hemiclepsis sp.	22	-	✓	-	-	-	-	-		-
Glossiphonia sp.	23/4	✓	✓	1	4 + 1	1 + 1	-	2 + 5		-
Helobdella sp.	26	-	✓	1	2	-	-	2		15
Erpobdella sp.	29/3	✓	✓	10	2	1	-	3		-
Crangonyx sp.	37	-	✓	59	9	8	8	25		-
Gammarus pulex	38	✓	✓	-	-	-	-	-		-
Asellus aquaticus	43	✓	✓	124	28	30	41	99		15
Corixidae	49	✓	✓	-	-	-	-	-		-
Notonectidae	52	-	-	-	-	-	-	-		-
Odonata	53/7	✓	✓	18	2	2	11	15		-
Caenis sp.	90	-	✓	16	1	-	-	1		-
Cloeon sp.	100	-	✓	-	-	-	-	-		-
Leptoceridae	111	-	-	-	-	-	-	-		-
Hydropsychidae	112	✓	✓	1	-	-	-	-		-
Dytiscidae	119	✓	✓	2	-	-	-	-		-
Platambus sp.	121	✓	✓	1	-	-	-	-		-
Haliplidae	123	✓	✓	-	-	-	-	-		-
Elmis sp.	130	-	-	-	-	-	-	-		-
Culicidae	136	-	-	-	-	-	-	-		-
Chironomidae	138	✓	✓	144	6	15	2	25		15
C. thummi	139	-	✓	-	-	-	-	-		-
Ceratopogonidae	141	-	-	5	-	-	-	-		-
Hydracarina	152	✓	✓	9	-	-	-	-		-
Valvata sp.	155	-	-	-	-	-	-	-		-
Bithynia sp.	156	-	✓	-	-	-	-	-		-
Bythinella sp.	159	-	✓	-	-	-	-	-		-
Potamopyrgus sp.	161	✓	✓	-	-	-	-	-		-
Acroloxus sp.	163	-	-	-	-	-	-	-		-
Ancylus sp.	164	-	✓	4	-	-	-	-		-
Physa sp.	166	-	✓	-	-	-	-	-		-
Limnaea stagnalis	167	-	✓	-	-	-	-	-		-
L. auricularia	171	-	-	-	-	-	-	-		-
L. pereger	172	✓	✓	6	2	1	1	4		-
Sphaerium sp.	180	-	✓	2	-	-	-	-		-
Pisidium sp.	181	-	✓	-	1	-	-	1		-
TOTAL GROUPS	-	-	32	19	15	12	9	16		4
TOTAL ORGANISMS	-	-	-	503	86	92	89	269		349
TRENT BIOTIC INDEX	-	-	-	8	7	6	5	8		3
EXTENDED BIOTIC INDEX	-	-	-	8	7	6	5	8		3
BIOTIC SCORE	-	-	-	597	421	298	231	424		64
DIVERSITY INDEX (MARGALEF) Calculated			-	2.89	3.14	2.43	1.78	2.68		0.52
DIVERSITY INDEX (SHANNON & WEAVER) Calculated				1.95	2.22	1.88	1.70	2.05		0.56
DIVERSITY INDEX (WILHM & DORRIS) Calculated				2.81	3.21	2.71	2.45	2.96		0.81
DIVERSITY INDEX (WILHM & DORRIS) from Tables				2.78	3.33	2.72	2.44	3.18		1.16
LIMNOSAPROBITY				-	-	-	-	-		-

Copepoda not included in calculations (Total of 30) *

TABLE 9. RIVER SOAR AT NORMANTON (Station 4)

GROUPS OF ORGANISMS	BIOTIC INDEX GROUP NUMBER	BACKGROUND DATA 1975	BACKGROUND DATA 1976	HANDNET SAMPLES 1 F.W. UK 13466	HANDNET SAMPLES 2 G.F. UK 13467	HANDNET SAMPLES 3 USSR -	ARTIFICIAL SUBSTRATES 1 UK 13468	ARTIFICIAL SUBSTRATES 2 UK 13469	ARTIFICIAL SUBSTRATES 3 UK 13470	ARTIFICIAL SUBSTRATES TOTAL 1 - 3 UK -	BOX SAMPLE UK -	GRAB SAMPLE USSR -
Porifera	1	-	-	-	-	-	-	-	-	-	USE OF THIS METHOD NOT POSSIBLE	USE OF THIS METHOD NOT POSSIBLE
Planaria sp.	4	-	-	-	-	-	-	-	-	-		
Polycelis sp.	5	-	✓	-	-	-	6	3	-	9		
Dugesia sp.	6	✓	✓	-	-	-	8	6	4	18		
Dendrocoelum sp.	8	-	✓	-	-	-	5	2	2	9		
Naididae	11	-	-	-	-	-	-	-	-	-		
Tubificidae	12	✓	✓	14	30	-	8	-	10	18		
Piscicola sp.	20	✓	✓	-	-	-	-	-	-	-		
Hemiclepsis sp.	22	-	✓	-	-	-	-	-	-	-		
Glossiphonia sp.	23/4	✓	✓	3	1	-	1 + 1	1	1 + 2	2 + 4		
Helobdella sp.	26	-	✓	-	-	-	-	-	1	1		
Erpobdella sp.	29/30	✓	✓	18	30	-	4	4	2	10		
Crangonyx sp.	37	-	✓	-	-	-	-	-	-	-		
Gammarus pulex	38	✓	✓	-	-	-	5	1	1	7		
Asellus aquaticus	43	✓	✓	106	122	-	82	94	85	261		
Corixidae	49	✓	✓	-	-	-	-	-	-	-		
Nepidae	50	-	✓	-	-	-	-	-	-	-		
Odonata	53/7	-	✓	-	-	-	-	-	-	-		
Caenis sp.	90	-	✓	-	-	-	-	-	-	-		
Ephemerella sp.	91	-	-	81	55	-	15	52	18	85		
Cloeon sp.	100	-	✓	-	-	-	-	-	-	-		
Baetis rhodani	101	✓	✓	8	6	-	2	1	1	4		
Beraeidae	108	-	✓	-	-	-	-	-	-	-		
Leptoceridae	111	-	✓	-	-	-	-	-	-	-		
Hydropsychidae	112	✓	✓	-	-	-	-	-	-	-		
Hydroptilidae	118	✓	-	-	1	-	-	-	-	-		
Dytiscidae	119/121	-	✓	-	-	-	-	-	-	-		
Hydrobiidae	122	-	-	-	-	-	-	-	-	-		
Haliplidae	123	✓	✓	-	-	-	-	-	-	-		
Simulidae	135	✓	-	-	-	-	-	-	-	-		
Chironomidae	138	✓	✓	70	84	-	61	48	59	168		
C. thummi	139	✓	✓	-	-	-	-	-	-	-		
Ceratopogonidae	141	-	✓	-	-	-	-	-	-	-		
Tipulidae	142	-	-	-	-	-	-	-	-	-		
Empididae	149	-	✓	-	-	-	-	-	-	-		
Hydracarina	152	✓	✓	-	2	-	-	2	-	2		
Valvata sp.	155	✓	✓	-	-	-	-	-	-	-		
Bithynia sp.	156	✓	✓	21	-	-	5	16	4	25		
Hydrobia sp.	160	-	-	-	-	-	-	-	-	-		
Potamopyrgus sp.	161	✓	✓	7	4	-	5	3	4	12		
Acroloxus sp.	163	-	-	-	-	-	-	-	-	-		
Ancylus sp.	164	✓	✓	-	2	-	-	-	-	-		
Physa sp.	166	-	✓	-	-	-	-	1	-	1		
L. stagnalis	167	✓	-	-	-	-	-	-	-	-		
L. auricularia	171	-	-	-	-	-	-	-	-	-		
L. pereger	172	✓	✓	-	-	-	3	2	2	7		
Planorbis sp.	173	✓	✓	-	-	-	-	-	-	-		
Sphaerium sp.	180	✓	✓	4	3	-	-	-	-	-		
Pisidium sp.	181	✓	✓	1	2	-	-	-	-	-		
TOTAL GROUPS	-	-	37	11	13	-	15	15	15	18		
TOTAL ORGANISMS	-	-	-	333	342	-	211	236	196	643		
TRENT BIOTIC INDEX	-	-	-	7	7	-	7	7	7	8		
EXTENDED BIOTIC INDEX	-	-	-	7	7	-	7	7	7	8		
BIOTIC SCORE	-	-	-	331	486	-	479	505	478	548		
DIVERSITY INDEX (MARGALEF) Calculated			-	1.72	2.06	-	2.62	2.56	2.65	2.63		
DIVERSITY INDEX (SHANNON-WEAVER) Calculated			-	1.79	1.72	-	1.85	1.69	1.63	1.79		
DIVERSITY INDEX (WILHM & DORRIS) Calculated			-	2.58	2.48	-	2.67	2.44	2.35	2.58		
DIVERSITY INDEX (WILHM & DORRIS) from Tables			-	2.57	2.79	-	2.65	3.08	2.34	2.58		
LIMNOSAPROBITY	-	-	-	-	-	-	-	-	-	-		

TABLE 10. RIVER DERWENT AT DRAYCOTT (Station 5)

GROUPS OF ORGANISMS	BIOTIC INDEX GROUP NUMBER	BACKGROUND DATA 1975	BACKGROUND DATA 1976	HAND-NET SR U.K. 13455	ARTIFICIAL SUBSTRATES 1 U.K. 13456	ARTIFICIAL SUBSTRATES 2 U.K. 13457	ARTIFICIAL SUBSTRATES 3 U.K. 13458	ARTIFICIAL SUBSTRATES TOTAL 1-3 U.K. -	BOX SAMPLE U.K. -	GRAB SAMPLE NK USSR -
Polycelis sp.	5	-	✓	-	-	-	-	-	RIVER UNSUITABLE FOR THIS METHOD	-
Naididae	11	-	-	-	-	-	-	-		-
Tubificidae	12	✓	✓	569	-	-	9	9		7
Lumbricidae	17	-	-	-	-	-	-	-		-
Piscicola sp.	20	-	-	-	1	-	-	1		-
Theromyzon sp.	21	✓	-	-	-	-	-	-		-
Glossiphonia sp.	23/4	✓	✓	6	8	3	6	17		-
Helobdella sp.	26	✓	✓	5	1	-	4	5		-
Batracobdella sp.	24	-	-	-	-	-	-	-		-
Erpobdella sp.	30	✓	✓	48	42	44	52	138		1
Crangonyx sp.	37	-	✓	-	-	-	-	-		-
Gammarus pulex	38	-	-	-	-	-	-	-		-
Gammarus tigrinis	42	-	✓	-	-	-	-	-		-
Asellus aquaticus	43	✓	✓	350	130	185	210	525		-
Veliidae	47	-	✓	-	-	-	-	-		-
Corixidae	49	✓	✓	-	-	-	-	-		-
Odonata	53/7	-	✓	1	-	-	-	-		-
Centroptilum sp.	98	-	-	-	-	-	-	-		-
Cloeon sp.	100	-	-	-	-	-	-	-		-
Limnephilidae	105	-	✓	-	-	-	-	-		-
Leptoceridae	111	-	✓	-	-	-	-	-		-
Hydropsychidae	112	-	-	-	-	-	-	-		-
Dytiscidae	119	-	✓	-	-	-	-	-		-
Platambus sp.	121	-	-	-	-	-	-	-		-
Haliplidae	123	✓	✓	-	-	-	-	-		-
Culicidae	136	-	✓	-	-	-	-	-		-
Chironomidae	138	✓	✓	36	86	24	14	124		48
C. thummi	139	✓	✓	-	-	-	-	-		-
Ceratopogonidae	141	-	-	-	-	-	-	-		-
Muscidae	150	✓	✓	-	-	-	-	-		-
Hydracarina	152	-	✓	-	-	-	-	-		-
P. jenkinsi	161	-	-	2	-	-	-	-		-
L. pereger	172	-	✓	-	-	-	-	-		-
Planorbis sp.	173	-	✓	-	-	-	-	-		-
Sphaeridae	180/1	-	✓	-	-	-	-	-		-
TOTAL GROUPS	-	-	23	8	6	4	6	7		3
TOTAL ORGANISMS	-	-	-	1017	268	256	295	819		56
TRENT BIOTIC INDEX	-	-	-	4	4	3	4	4		2
EXTENDED BIOTIC INDEX	-	-	-	4	4	3	4	4		2
BIOTIC SCORE	-	-	-	121	111	70	104	115		63
DIVERSITY INDEX (MARGALEF) Calculated				0.92	0.89	0.54	0.88	0.89		0.5
DIVERSITY INDEX (SHANNON-WEAVER) Calculated				1.22	1.15	0.81	0.94	1.04		0.46
DIVERSITY INDEX (WILHM & DORRIS) Calculated				1.76	1.66	1.17	1.35	1.50		0.67
DIVERSITY INDEX (WILHM & DORRIS) from Tables				1.49	1.67	1.17	1.35	1.50		0.67
LIMNOSAPROBITY				-	-	-	-	-		-

TABLE 11. RIVER EREWASH AT TOTON (Station 6)

GROUPS OF ORGANISMS	BIOTIC INDEX GROUP NUMBER	BACKGROUND DATA 1975	BACKGROUND DATA 1976	HANDNET SAMPLES FW U.K. 13512	HANDNET SAMPLES VM USSR	ARTIFICIAL SUBSTRATE SAMPLES 1 U.K. 13509	ARTIFICIAL SUBSTRATE SAMPLES 2 U.K. 13510	ARTIFICIAL SUBSTRATE SAMPLES 3 U.K. 13511	ARTIFICIAL SUBSTRATE SAMPLES TOTAL 1-3 U.K.	BOX SAMPLE	GRAB SAMPLE
Coelenterata (Hydra)	2	-	-	-	-	-	-	-	-	METHOD NOT APPLICABLE AT THIS SITE	METHOD NOT APPLICABLE AT THIS SITE
Naididae	11	-	-	-	-	-	-	-	-		
Tubificidae	12	✓	✓	39	156	6	18	-	24		
Lumbriculidae	14	✓	-	-	-	-	-	-	-		
Theromyzon sp.	21	-	-	-	-	-	-	-	-		
Glossiphonia sp.	23/4	-	✓	-	1	-	-	-	-		
Helobdella sp.	26	-	✓	-	-	-	-	-	-		
Haemopis sp.	27	-	✓	-	-	-	-	-	-		
Erpobdella sp.	29/30	-	✓	2	9	1	2	5	8		
Gammarus pulex	38	✓	✓	4	-	-	-	-	-		
Asellus aquaticus	43	✓	✓	28	24	9	15	17	41		
Veliidae	47	-	-	-	-	-	-	-	-		
Corixidae	49	✓	-	-	4	-	-	-	-		
Odonata	53/7	-	✓	1	5	1	1	3	5		
Limnephilidae	105	-	✓	16	-	1	-	2	3		
Dytiscidae	119	✓	✓	-	18	-	-	-	-		
Platambus sp.	121	-	-	2	-	-	-	-	-		
Hydrobiidae	122	-	-	-	-	-	-	-	-		
Haliplidae	123	✓	✓	3	7	8	1	2	11		
Gyrinidae	125	-	✓	-	-	-	-	-	-		
Chironomidae	138	✓	✓	30	112	10	3	5	18		
C. thummi	139	✓	✓	-	-	-	-	-	-		
Ceratopogonidae	141	-	✓	-	-	-	-	-	-		
Tipulidae	142	-	-	-	-	-	-	-	-		
Simulidae	135	-	-	-	3	-	-	-	-		
Valvata sp.	155	-	-	-	-	-	-	-	-		
Bithynia sp.	156	-	-	-	-	-	-	-	-		
Bythinella sp.	159	-	✓	-	-	-	-	-	-		
Potamopyrgus sp.	161	-	✓	-	-	-	-	2	2		
Physa sp.	166	-	-	-	-	4	-	2	6		
L. stagnalis sp.	167	-	-	-	-	-	-	-	-		
L. pereger sp.	172	✓	✓	130	63	38	25	36	99		
Planorbis sp.	173	-	✓	-	-	1	-	-	1		
Sphaeridae	180/1	-	✓	-	-	-	-	-	-		
TOTAL GROUPS	-	-	20	10	11	10	7	9	11		
TOTAL ORGANISMS	-	-	-	245	402	79	65	74	218		
TRENT BIOTIC INDEX	-	-	-	5	5	5	4	5	6		
EXTENDED BIOTIC INDEX	-	-	-	5	5	5	4	5	6		
BIOTIC SCORE	-	-	-	326	302	302	156	274	311		
DIVERSITY INDEX (MARGALEF) Calculated			-	1.64	1.67	2.06	1.44	1.86	1.86		
DIVERSITY INDEX (SHANNON & WEAVER) Calculated				1.49	1.63	1.66	1.44	1.57	1.71		
DIVERSITY INDEX (WILHM & DORRIS) Calculated				2.16	2.35	2.40	2.08	2.27	2.46		
DIVERSITY INDEX (WILHM & DORRIS) from Tables											
LIMNOSAPROBITY											

TABLE 12. MOTHER DRAIN AT ROSSINGTON BRIDGE (Station 7)

GROUPS OF ORGANISMS	BIOTIC INDEX GROUP NUMBER	BACKGROUND DATA 1975	BACKGROUND DATA 1976	HANDNET SAMPLES 1 F.W. U.K. 13500	HANDNET SAMPLES 2 V.M. USSR -	HANDNET SAMPLES 3 N.K. USSR -	ARTIFICIAL SUBSTRATE SAMPLES 1 U.K. 13498	ARTIFICIAL SUBSTRATE SAMPLES 2 U.K. 13499	ARTIFICIAL SUBSTRATE SAMPLES 3 U.K. 13497	ARTIFICIAL SUBSTRATE SAMPLES TOTAL 1-3 -	BOX SAMPLES 1 F.W. U.K. 13496	BOX SAMPLES 2 F.W. U.K. 13513	BOX SAMPLES 1 N.K. USSR -	BOX SAMPLES 2 V.M. USSR -
Planaria sp.	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Polycelis sp.	5	-	✓	-	-	-	3	-	5	8	1	-	2	-
Dugesia sp.	6	✓	-	-	-	-	7	7	1	15	-	-	-	-
Naididae	11	-	-	-	-	-	-	-	-	-	-	-	-	-
Tubificidae	12	✓	✓	18	81	135	8	8	-	16	260	310	48	89
Enchytraeidae	13	-	-	-	-	-	-	-	-	-	-	-	-	-
Lumbriculidae	14	-	-	-	-	-	-	-	-	-	-	-	-	-
Theromyzon sp.	21	-	✓	-	-	-	2	1	-	3	1	-	-	-
Hemiclepsis sp.	22	-	✓	-	-	-	-	-	-	-	-	-	-	-
Glossiphonia sp.	23/4	✓	✓	-	2	-	-	-	-	-	-	-	-	-
Helobdella sp.	26	-	✓	2	-	-	-	-	1	1	1	-	-	1
Erpobdella sp.	29/30	-	✓	-	-	-	-	-	-	-	-	-	-	-
Gammarus pulex	38	-	✓	-	-	-	-	-	-	-	-	-	-	-
Asellus aquaticus	43	✓	✓	29	108	108	36	28	28	92	5	16	7	18
Corixidae	49	✓	✓	-	3	2	1	-	-	1	-	-	-	-
Odonata	53/7	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenis sp.	90	-	✓	5	8	4	-	1	1	2	1	6	2	-
Rithrogena/Heptagena	93/4	-	-	-	-	-	-	-	-	-	1	-	-	-
Cloeon sp.	100	-	-	-	-	-	-	-	-	-	-	-	-	-
Baetis sp.	101/2	-	-	-	-	-	-	-	-	-	-	-	-	-
Sialis sp.	103	✓	✓	-	-	-	-	-	-	-	-	-	-	-
Limnephilidae	105	✓	✓	-	-	-	-	1	-	1	-	-	-	-
Leptoceridae	111	-	✓	-	15	18	1	-	2	3	-	-	5	8
Hydropsychidae	112	✓	✓	-	-	-	-	-	-	-	-	-	-	-
Psychomyidae	114	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydroptilidae	118	-	✓	-	1	-	1	-	-	1	-	-	1	-
Dytiscidae	119	✓	✓	-	2	2	-	3	2	5	-	-	-	1
Platambus sp.	121	✓	✓	6	1	1	-	-	-	-	-	-	-	-
Haliplidae	123	✓	✓	1	4	2	2	2	2	6	-	-	1	-
Gyrinidae	125	✓	✓	-	-	-	-	-	-	-	-	-	-	-
Elmis sp.	130	-	-	-	-	-	-	-	-	-	-	-	-	-
Oulimnius sp.	133	-	-	-	-	1	-	-	-	-	-	-	-	-
Simuliidae	135	✓	✓	2	-	4	-	-	-	-	1	-	-	6
Chironomidae	138	✓	✓	47	108	189	30	39	60	129	22	25	15	60
C. thummi	139	✓	✓	-	2	-	-	2	1	3	-	-	-	-
Ceratopogonidae	141	-	-	1	5	-	-	-	-	-	-	-	-	-
Tipulidae	142	-	✓	-	-	-	-	-	-	-	-	-	-	-
Muscidae/Dicranota	143	✓	-	-	-	-	-	-	-	-	-	2	2	1
Hydracarina	152	✓	✓	-	3	-	-	-	-	-	-	1	-	-
Potamopyrgus sp.	161	✓	✓	1	18	18	-	-	-	-	-	-	1	1
Limnaea pereger	172	✓	-	1	1	4	8	4	4	16	-	-	-	-
Planorbis sp.	173	-	✓	-	-	1	5	-	3	8	-	-	-	-
Sphaerium sp.	180	✓	✓	-	5	3	-	-	-	-	-	-	1	-
Pisidium sp.	181	-	✓	-	9	-	-	-	-	-	-	-	1	-
TOTAL GROUPS	-	-	29	11	18	15	12	11	12	17	9	6	12	9
TOTAL ORGANISMS	-	-	-	113	376	492	104	96	110	310	293	360	86	185
TRENT BIOTIC INDEX	-	-	-	7	8	7	7	7	7	8	7	6	7	5
EXTENDED BIOTIC INDEX	-	-	-	7	8	7	7	7	7	8	7	6	7	5
BIOTIC SCORE	-	-	-	382	649	599	423	423	461	658	349	224	526	354
DIVERSITY INDEX (MARGALEF) Calculated			-	2.12	2.86	2.26	2.37	2.19	2.34	2.79	1.41	0.85	2.47	1.53
DIVERSITY INDEX (SHANNON & WEAVER) Calculated				1.61	1.86	1.55	1.84	1.67	1.43	1.75	0.49	0.57	1.52	1.30
DIVERSITY INDEX (WILHM & DORRIS) Calculated				2.32	2.69	2.24	2.65	2.41	2.06	2.53	0.70	0.82	2.19	1.88
DIVERSITY INDEX (WILHM & DORRIS) from Tables														
LIMNOSAPROBITY				B.M.										

TABLE 13. RIVER POULTER AT CONFLUENCE (Station 8)

River Idle at Bawtry

GROUPS OF ORGANISMS	BIOTIC INDEX GROUP NUMBER	BACKGROUND DATA 1975	BACKGROUND DATA 1976	HANDNET SAMPLES FW U.K. 13515	HANDNET SAMPLES VM USSR	HANDNET SAMPLES NK USSR	ARTIFICIAL SUBSTRATE SAMPLES 1 U.K.	2 U.K.	3 U.K.	TOTAL 1-3	BOX SAMPLE	GRAB SAMPLE
Planaria sp.	4	-	-	-	-	-	ALL ARTIFICIAL SUBSTRATE SAMPLES LOST				METHOD NOT APPLICABLE TO THIS SITE	METHOD NOT APPLICABLE TO THIS SITE
Polycelis sp.	5	✓	✓	-	-	1						
Dugesia sp.	6	✓	-	-	-	-						
Dendrocoelum	8	✓	-	-	-	-						
Naididae	11	-	-	-	-	-						
Tubificidae	12	✓	✓	32	103	144						
Piscicola sp.	20	✓	-	-	-	-						
Theromyzon sp.	21	-	-	-	-	-						
Glossiphonia sp.	23/4	✓	✓	1	-	-						
Helobdella sp.	26	✓	-	-	-	-						
Erpobdella sp.	29/30	✓	✓	-	-	-						
Crangonyx sp.	37	-	✓	-	-	-						
Gammarus pulex	38	✓	✓	-	-	-						
Asellus aquaticus	43	✓	✓	10	36	24						
Corixidae	49	✓	✓	4	15	7						
Notonectidae	52	-	-	-	-	-						
Odonata	53/7	-	✓	-	-	1						
Caenis	90	✓	✓	45	9	18						
Ephemerella sp.	91	-	-	1	1	-						
Procloeon sp.	99	-	-	-	-	-						
Cloeon sp.	100	✓	-	2	1	1						
Baetis sp.	101/2	✓	-	-	-	-						
Sialis	103	✓	✓	-	-	-						
Leptoceridae	111	✓	✓	-	-	-						
Polycentropidae	113	✓	✓	-	-	-						
Hydroptilidae	118	-	✓	-	-	-						
Dytiscidae	119	✓	✓	6	32	30						
Platambus sp.	121	✓	✓	18	2	3						
Haliplidae	123	✓	✓	3	6	5						
Hydrophilidae	129	-	-	-	-	-						
Elmis sp.	130	-	✓	-	-	-						
Simuliidae	135	✓	✓	-	-	-						
Chironomidae	138	✓	✓	20	135	99						
C. thummi	139	✓	-	-	-	2						
Psychodidae	140	-	-	-	-	-						
Ceratopogonidae	141	-	✓	-	8	-						
Tipulidae	142	✓	-	-	-	-						
Syrphidae	144	-	-	-	1	-						
Stratiomyidae	146	-	-	-	-	-						
Rhagionidae	147	-	-	-	-	-						
Hydracarina	152	✓	✓	1 + 6	18	9						
Viviparus sp.	154	-	✓	6	-	-						
Valvata sp.	155	✓	✓	-	-	-						
Bithynia sp.	156	✓	✓	16	-	2						
Potamopyrgus sp.	161	-	✓	11	-	17						
Physa sp.	166	-	✓	-	-	-						
Limnaea stagnalis	167	-	-	-	-	-						
L. pereger	172	✓	-	18	30	27						
Planorbis sp.	173	✓	-	-	-	-						
Anodonta sp.	179	✓	✓	-	-	-						
Sphaerium sp.	180	✓	✓	-	-	-						
Pisidium sp.	181	✓	✓	-	-	-						
TOTAL GROUPS	-	-	30	17	14	16						
TOTAL ORGANISMS	-	-	-	200	402	390						
TRENT BIOTIC INDEX	-	-	-	9	8	9						
EXTENDED BIOTIC INDEX	-	-	-	9	8	9						
BIOTIC SCORE	-	-	-	681	513	566						
DIVERSITY INDEX (MARGALEF) Calculated			-	3.02	2.17	2.51						
DIVERSITY INDEX (SHANNON & WEAVER) Calculated				2.39	1.89	1.90						
DIVERSITY INDEX (WILHM & DORRIS) Calculated				3.44	2.73	2.74						
DIVERSITY INDEX (WILHM & DORRIS) from Tables												
LIMNOSAPROBITY												

TABLE 14. RIVER IDLE AT BAWTRY (Station 9)

Blithfield Reservoir

GROUPS OF ORGANISMS	BIOTIC INDEX GROUP NUMBER	BACKGROUND DATA 1975	BACKGROUND DATA 1976	HAND -NET SAMPLE 1 FW U.K. 13439	GRAB SAMPLE 1 NK USSR1
Tubificidae	12	-	-	5	17
Lumbriculidae	14	-	-	1	-
Corixidae	49	-	-	600 + 2	-
Caenis sp.	90	-	-	10	2
Trichoptera	104 to 118	-	-	-	1
Chironomidae	138	-	-	120	91
Ceratopogonidae	141	-	-	-	2
Hydracarina	152	-	-	200 + 200	-
NUMBER OF GROUPS	-	-	-	7	5
NUMBER OF ORGANISMS	-	-	-	1138	113
TRENT BIOTIC INDEX	-	-	-	6	5
EXTENDED BIOTIC INDEX	-	-	-	6	5
BIOTIC SCORE	-	-	-	179	174
DIVERSITY INDEX (MARGALEF) Calculated				0.85	0.85
DIVERSITY INDEX (SHANNON & WEAVER) Calculated				1.03	0.64
DIVERSITY INDEX (WILHM & DORRIS) Calculated				1.48	0.93
DIVERSITY INDEX (WILHM & DORRIS) from Tables					0.93
LIMNOSAPROBITY				-	-

TABLE 15. RESULTS: Blithfield Reservoir (Station 10)

GROUPS OF ORGANISMS	BIOTIC INDEX GROUP NUMBER	BACKGROUND DATA 1975	BACKGROUND DATA 1976	HANDNET SAMPLES FW U.K. END OF JETTY	HANDNET SAMPLES FW U.K. MARGIN	BOX SAMPLE	GRAB SAMPLE USSR
Polycelis tenuis	5	-	-	-	1	METHOD CANNOT BE USED IN LAKES	-
Tubificidae	12	-	-	25	7		220
Glossiphonia sp. Erpobdella sp.	23/4 30	- -	- -	- 3	1 8		- 1
Asellus aquaticus	43	-	-	-	380		-
Dytiscidae	119	-	-	-	1		-
Chironomidae C. thummi	138 139	- -	- -	149 61	30 -		63 29
Hydracarina	152	-	-	35	2		-
Potamopyrgus sp.	161	-	-	-	-		1
TOTAL GROUPS	-	-	-	5	8		5
TOTAL ORGANISMS	-	-	-	273	430		313
TRENT BIOTIC INDEX	-	-	-	3	4		2
EXTENDED BIOTIC INDEX	-	-	-	3	4		2
BIOTIC SCORE	-	-	-	111	213		63
DIVERSITY INDEX (MARGALEF) Calculated				0.71	1.15		0.70
DIVERSITY INDEX (SHANNON & WEAVER) Calculated				1.2	0.50		0.83
DIVERSITY INDEX (WILHM & DORRIS) Calculated				1.73	0.73		1.19
DIVERSITY INDEX (WILHM & DORRIS) from Tables				1.73	0.72		1.19
LIMNOSAPROBITY				-	-		-

TABLE 16. RESULTS: Kings Mill Reservoir (Station 11)

Key: A. Sorensen Quotients of Similarity
B. Sampling Effectiveness

A / B

		75	76	1	2	T	1	2	3	T	Number of Taxa in Sample	% of Total Number Taxa found
Background Data (1975)	75											
Background Data (1976)	76	69										
Handnet Samples S.R. (UK)	1	79	71								32	88.9
Handnet Samples J.H. (UK)	2	70	66	83							26	72.2
Combined Total	T	65	72	97	87						34	94.4
Artificial Substrates UK	1	68	54	63	76	64					19	52.8
Artificial Substrates UK	2	47	59	53	62	51	69				13	36.1
Artificial Substrates UK	3	44	58	57	60	54	67	81			14	38.9
Combined Total	T	67	70	73	78	74	90	72	76		23	63.9

(Total taxa found 31)

TABLE 17. RIVER DERWENT AT BASLOW

A / B

		75	76	1	2	3	T	1	2	3	T	B	Number of Taxa in Sample	% of Total Number Taxa found
Background Data (1975)	75													
Background Data (1976)	76	69												
Handnet Samples F.W. (UK)	1	71	70										29	75.5
Handnet Samples S.R. (UK)	2	69	71	88									28	71.8
Handnet Samples N.K. USSR	3	66	73	81	86								23	59.0
Combined Total	T	74	72	95	93	84							32	82.1
Artificial Substrates UK	1	54	65	78	75	71	75						19	48.7
Artificial Substrates UK	2	50	55	68	70	63	67	70					16	41.0
Artificial Substrates UK	3	68	60	73	71	94	73	71	74				19	48.7
Combined Total	T	60	71	78	79	75	36	85	75	80			30	76.9
Box Sample F.W. (UK)	B	60	63	77	75	74	77	71	78	79	79		20	51.3

(Total taxa found 39)

TABLE 18. RIVER DOVE AT MAYFIELD

A / B

		75	76	1	1	2	3	T	Number of Taxa in Sample	% of Total Number Taxa found
Background Data (1975)	75									
Background Data (1976)	76	68								
Handnet Sample	1	65	61						13	68.4
Artificial Substrate (UK)	1	48	65	67					11	57.9
Artificial Substrate (UK)	2	53	57	64	78				12	63.2
Artificial Substrate (UK)	3	53	56	54	67	80			13	68.4
Combined Total	T	58	67	62	81	86	83		16	84.2

(Total taxa found 19)

TABLE 19. RIVER TRENT AT GUNTHORPE

Key: A. Sorensen Quotients of Similarity
B. Sampling Effectiveness

		A								B	
		75	76	1	1	2	3	T	G	Number of Taxa in Sample	% of Total Number Taxa found
Background Data (1975)	75										
Background Data (1976)	76	67									
Handnet Sample F.W. (UK)	1	63	47							19	86.4
Artificial Substrate (UK)	1	52	60	71						15	68.2
Artificial Substrate (UK)	2	57	45	58	74					12	54.5
Artificial Substrate (UK)	3	48	39	50	67	86				9	40.9
Combined Total	T	50	58	59	97	86	72			16	72.7
Grab Sample (USSR)	1	30	22	35	42	50	46	40		4	18.2

(Total taxa found 22)

TABLE 20. RIVER SOAR AT NORMANTON

		A									B	
		75	76	1	2	T	1	2	3	T	Number of Taxa in Sample	% of Total Number Taxa found
Background Data (1975)	75											
Background Data (1976)	76	71										
Handnet Samples F.W. (UK)	1	56	42								11	52.4
Handnet Samples G.F. (UK)	2	63	58	83							13	61.9
Combined Total	T	67	43	89	96						14	66.7
Artificial Substrates UK	1	60	50	69	57	62					15	71.4
Artificial Substrates UK	2	55	54	62	57	62	87				15	71.4
Artificial Substrates UK	3	55	50	69	57	62	87	80			15	71.4
Combined Total	T	56	58	62	58	63	91	91	91		18	85.7

(Total taxa found 21)

TABLE 21. RIVER DERWENT AT DRAYCOTT

		A								B	
		75	76	1	1	2	3	T	G	Number of Taxa in Sample	% of Total Number Taxa found
Background Data (1975)	75										
Background Data (1976)	76	59									
Handnet Sample S.R. (UK)	1	63	45							8	88.9
Artificial Substrate UK	1	59	34	71						6	66.7
Artificial Substrate UK	2	53	30	67	80					4	44.4
Artificial Substrate UK	3	70	41	86	83	80				6	66.7
Combined Total	T	67	40	80	92	73	92			7	77.8
Grab Sample (USSR)	G	43	23	55	44	57	67	60		3	33.3

(Total taxa found 9)

TABLE 22. RIVER EREWASH AT TOTON

Key: A. Sorensen Quotients of Similarity
B. Sampling Effectiveness

		A: 75	76	1	2	T	1	2	3	T	B: Number of Taxa in Sample	% of Total Number Taxa found
Background Data (1975)	75											
Background Data (1976)	76	53										
Handnet Sampling F.W. (UK)	1	60	60								10	58.8
Handnet Sampling V.M. USSR	2	67	58	67							11	64.7
Combined Total	T	67	65	83	98						14	82.4
Artificial Substrates UK	1	50	60	80	67	67					10	58.8
Artificial Substrates UK	2	59	52	82	78	67	82				7	41.2
Artificial Substrates UK	3	42	55	74	60	61	84	75			9	52.9
Combined Total	T	50	65	76	64	64	95	78	90		11	64.7

(Total taxa found 17)

TABLE 23. MOTHER DRAIN AT ROSSINGTON BRIDGE

		A: 75	76	1	2	3	T	1	2	3	T	1	2	3	4	T	B: Number of Taxa in Sample	% of Total Number Taxa found
Background Data (1975)	75																	
Background Data (1976)	76	69																
Handnet Samples F.W. (UK)	1	52	45														11	39.3
Handnet Samples V.M. USSR	2	63	68	62													18	64.3
Handnet Samples N.K. USSR	3	63	59	69	73												15	53.4
Combined Total	T	78	93	67	90	81											22	78.6
Artificial Substrates UK	1	44	49	43	53	59	58										12	42.9
Artificial Substrates UK	2	58	45	55	55	54	53	61									11	39.3
Artificial Substrates UK	3	44	49	52	53	59	63	67	73								12	42.9
Combined Total	T	64	65	60	63	63	74	83	79	83							17	60.71
Box Samples F.W. (UK)	1	28	42	60	30	42	43	48	50	49	54						9	32.14
Box Samples F.W. (UK)	2	30	29	47	42	38	37	33	47	33	35	53					6	21.42
Box Samples N.K. USSR	3	44	54	52	67	59	63	58	43	50	55	48	56				12	42.86
Box Samples V.M. USSR	4	48	42	60	44	58	53	38	40	48	46	56	53	57			9	32.14
Combined Total	T	53	68	62	67	41	78	53	48	59	63	67	50	80	67		18	64.28

(Total taxa found 28)

TABLE 24. RIVER POULTER AT CROOKFORD

		A: 75	76	1	2	3	T	B: Number of Taxa in Sample	% of Total Number Taxa found
Background Data (1975)	75								
Background Data (1976)	76	71							
Handnet Samples F.W. (UK)	1	53	55					17	81.0
Handnet Samples V.M. USSR	2	48	45	77				14	66.7
Handnet Samples N.K. USSR	3	58	57	79	73			16	76.2
Combined Total	T	57	60	59	80	86		21	100.0

(Total taxa found 21)

TABLE 25. RIVER IDLE AT BAWTRY

TABLE 26. SUMMARY OF DATA IN TABLES 17 - 25

Type of Sample		Number of Samples/ Combinations	% of Total taxa found (all samples)	
			Mean	Range
Handnet Samples	Individual	17	68.3%	39-89%
	Combined (60)	6	84.0%	67-100%
Artificial Substrates	Individual	24	53.7%	36-71%
	Combined (3)	8	71.4%	61-86%
Box Samples	Individual	5	36.0%	21.51%
	Combined (4)	1	64.3%	18-33%
Grab Samples	Individual	2	25.8%	18-33%

STATION NUMBER:		1		2		3		4		5		6		7		8		9	
TOTAL NUMBER OF TAXA IN ALL SAMPLES:		36		39		19		22		21		9		17		28		21	
		No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
HANDNET SAMPLES	1	26	72	23	59	13	68	19	86	11	52	8	89	10	59	11	39	14	67
	2	34	94	29	74	-	-	-	-	14	67	-	-	14	82	17	61	19	90
	3	-	-	32	82	-	-	-	-	-	-	-	-	-	-	22	79	21	100
ARTIFICIAL SUBSTRATE SAMPLES	1	13	36	18	46	11	58	9	41	15	71	4	44	7	41	11	39	-	-
	2	16	44	24	62	15	79	12	55	17	81	6	67	10	59	16	57	-	-
	3	23	64	30	77	16	84	16	73	18	86	7	78	11	65	17	61	-	-
BOX SAMPLES	1	-	-	23	59	-	-	-	-	-	-	-	-	-	-	6	21	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	39	-	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	50	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	64	-	-
GRAB SAMPLES	1	-	-	-	-	-	-	4	18	-	-	3	33	-	-	-	-	-	-

TABLE 27. CUMULATIVE TOTAL OF TAXA RECORDED BY EACH SAMPLING METHOD

TABLE 28. THE RANGE OF EACH BIOLOGICAL ASSESSMENT VALUE AT EACH SAMPLING STATION

The difference between the maximum and minimum is shown (M - m) together with the percentage of the maximum ($\frac{M-m}{M}$ .100)

LOCATION OF SAMPLING SITE	TYPE OF SAMPLE	Number of Samples	BIOTIC INDEX (Woodiwiss)				EXTENDED BIOTIC INDEX (Woodiwiss)				BIOTIC SCORE ——	
			Min (m)	Max (M)	M - m	$\frac{M-m}{M}$ .100	Min (m)	Max (M)	M - m	$\frac{M-m}{M}$ .100	Min (m)	Max (M)
DERWENT AT BASLOW	Handnet	2	9	9	0	0%	11	12	1	8.3%	1432	1628
	Art. Sub.	3	8	9	1	11%	8	9	1	11.1%	730	1078
	Box	0	-	-	-	-	-	-	-	-	-	-
	Grab	0	-	-	-	-	-	-	-	-	-	-
DOVE AT MAYFIELD	Handnet	3	9	10	1	10%	10	12	2	16.7%	1189	1572
	Art. Sub.	3	9	9	0	0%	9	10	1	10%	962	1077
	Box	1	(9)	-	-	-	(10)	-	-	-	(1221)	-
	Grab	0	-	-	-	-	-	-	-	-	-	-
DERWENT AT DRAYCOTT	Handnet	2	7	7	0	0%	7	7	0	0%	331	486
	Art. Sub.	3	7	7	0	0%	7	7	0	0%	478	505
	Box	0	-	-	-	-	-	-	-	-	-	-
	Grab	0	-	-	-	-	-	-	-	-	-	-
EREWASH AT TOTON	Handnet	1	(4)	-	-	-	(4)	-	-	-	(121)	-
	Art. Sub.	3	3	4	1	25%	3	4	1	25%	70	111
	Box	0	-	-	-	-	-	-	-	-	-	-
	Grab	1	(2)	-	-	-	(2)	-	-	-	(63)	-
SOAR AT NORMANTON	Handnet	1	(8)	-	-	-	(8)	-	-	-	(597)	-
	Art. Sub.	3	5	7	2	28.6%	5	7	2	28.6%	231	421
	Box	0	-	-	-	-	-	-	-	-	-	-
	Grab	1	(3)	-	-	-	(3)	-	-	-	(64)	-
TRENT AT GUNTHORPE	Handnet	1	(7)	-	-	-	(7)	-	-	-	(419)	-
	Art. Sub.	3	6	6	0	0%	6	5	0	0%	286	318
	Box	0	-	-	-	-	-	-	-	-	-	-
	Grab	0	-	-	-	-	-	-	-	-	-	-
POULTER AT CROOKFORD	Handnet	3	7	8	1	12.5%	7	8	1	12.5%	382	649
	Art. Sub.	3	7	7	0	0%	7	7	0	0%	423	461
	Box	4	5	7	2	28.6%	5	7	2	28.6%	224	526
	Grab	0	-	-	-	-	-	-	-	-	-	-
IDLE AT BAWTRY	Handnet	3	8	9	1	11.1%	8	9	1	11.1%	533	681
	Art. Sub.	0	-	-	-	-	-	-	-	-	-	-
	Box	0	-	-	-	-	-	-	-	-	-	-
	Grab	0	-	-	-	-	-	-	-	-	-	-
MOTHER DRAIN AT ROSSINGTON BR.	Handnet	2	5	5	0	0%	5	5	0	0%	202	326
	Art. Sub.	3	4	5	1	20%	4	5	1	20%	156	302
	Box	0	-	-	-	-	-	-	-	-	-	-
	Grab	0	-	-	-	-	-	-	-	-	-	-

TABLE 28. - continued

—— (Chandler)		DIVERSITY INDEX (Wilhm and Dorris)				DIVERSITY INDEX (Margalef)				NUMBER OF TAXA			
M - m	$\frac{M - m}{M}$ .100	Min (m)	Max (M)	M - m	$\frac{M - m}{M}$ .100	Min (m)	Max (M)	M - m	$\frac{M - m}{M}$ .100	Min (m)	Max (M)	M - m	$\frac{M - m}{M}$ .100
196	12%	3.68	3.93	0.25	6.4%	3.98	4.22	0.24	5.7%	26	32	6	18.8%
348	32.3%	2.60	3.37	0.77	22.8%	2.10	3.28	1.18	3.6%	13	19	6	31.6%
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
383	24.4%	2.71	3.92	1.21	30.9%	3.19	4.4	1.21	27.5%	23	29	6	20.7%
115	10.7%	1.92	3.47	1.55	44.7%	2.85	3.21	0.36	11.2%	18	22	4	18.2%
-	-	(3.63)	-	-	-	(3.71)	-	-	-	(23)	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
155	31.9%	2.48	2.58	0.10	3.9%	1.72	2.06	0.34	16.5%	11	13	2	15.4%
27	5.3%	2.35	2.67	0.32	12.0%	2.56	2.65	0.09	3.4%	15	15	0	0%
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	(1.76)	-	-	-	(0.92)	-	-	-	(8)	-	-	-
41	36.9%	1.17	1.66	0.49	29.5%	0.54	0.89	0.35	39%	4	6	2	33.3%
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	(0.67)	-	-	-	(0.5)	-	-	-	(3)	-	-	-
-	-	(2.78)	-	-	-	(2.89)	-	-	-	(19)	-	-	-
190	45.1%	2.45	3.21	0.76	23.7%	1.78	3.14	1.36	43.3%	3	9	15	40%
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	(0.81)	-	-	-	(0.52)	-	-	-	(4)	-	-	-
-	-	(2.31)	-	-	-	2.51	-	-	-	(13)	-	-	-
32	10.1%	2.35	2.81	0.46	16.4%	1.94	2.48	0.54	21.8%	11	13	2	15.4%
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
267	41.1%	2.24	2.69	0.45	16.7%	2.12	2.86	0.74	25.9%	11	18	7	38.9%
38	8.2%	2.06	2.65	0.59	22.3%	2.19	2.37	0.18	7.6%	11	12	1	8.3%
302	57.4%	0.70	2.19	1.49	68.0%	0.85	2.47	1.62	65.6%	6	12	6	50%
-	-	-	-	-	-	-	-	-	-	-	-	-	-
148	21.7%	2.74	3.44	0.7	20.3%	2.17	3.02	0.85	28.1%	14	17	3	17.6%
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
124	38%	2.16	2.35	0.19	8.1%	1.64	1.67	0.03	1.8%	10	11	1	9.1%
146	48%	2.08	2.40	0.32	13.3%	1.44	2.06	0.62	30.1%	7	10	3	30%
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-

BIOLOGICAL ASSESSMENT METHOD	SAMPLING METHODS			
	Handnet Samples	Artificial Substrates	Box Samples	Grab Samples
	%	%	%	%
BIOTIC INDEX (Woodiwiss)	5.6 (0.0-12.5)	10.6 (0-28.6)	28.6 (-)	-
EXTENDED BIOTIC INDEX (Woodiwiss)	8.1 (0-16.7)	11.8 (0-28.6)	28.6 (-)	-
BIOTIC SCORE (Chandler)	28.2 (12-41.1)	24.6 (5.3-48)	57.4 (-)	-
DIVERSITY INDEX (Wilhm & Dorris)	14.4 (3.9-30.9)	23.1 (12-44.7)	68.0 (-)	-
DIVERSITY INDEX (Margalef)	17.6 (1.8-28.1)	20.0 (3.4-43.3)	65.6 (-)	-
NUMBER OF TAXA	20.1 (9.1-38.9)	25.4	50.0 (-)	-

TABLE 29. VARIATIONS IN SCORE AND VARIOUS INDEX VALUES DUE TO SAMPLING DIFFERENCES

TABLE 30. METHODS OF BIOLOGICAL ASSESSMENT QUALITY IN USE IN EUROPE

COUNTRY (Participant)	RANGE OF QUALITY CLASSES			
Macroinvertebrates:	0/1 → 4/5	0 → 10/20	0 → 100	>100
BELGIUM (VD)	Quality Class (I-V)	Biotic Index (Tuffery and Verneaux) 0-10		
DENMARK (ID)	Degree of Pollution (I-IV)			
FRANCE (FS)	Water Quality Class (1-5)	Biotic Index (Tuffery and Verneaux) 0-10 Pollution Index 0-10 I.Q.B.G. 0-20		
IRELAND (BHC)	Quality (1-5)			
ITALY (GB)	Saprobic Index (1-4)*	Biotic Index (Tuffery and Verneaux) 0-10 Biotic Index (Woodiwiss) 0-10		
LUXEMBOURG	Degree of Pollution (I-IV)	Biotic Index (Tuffery and Davaine) 0-10		
NETHERLANDS (TG)	Quality Class (I-V)	Quality Class 1-10	K_{12345} % C (0-100) K_{135} % C (0-100)	K_{12345} (100-500) K_{135} (100-500)
UK (W) (R)	DOE Classification (A-D) Diversity Index (Margalef)* Diversity Index (W & D)*	Biotic Index (Woodiwiss) 0-10 Extended Biotic Index 0-15		Biotic Score 0-2500+
WEST GERMANY (B)	Coupling Analysis (I-IV)			
WEST GERMANY (T)			BEOL (0-100)	
FRANCE (BT)	Diversity Index (Shannon and Weaver)*	Coefficient of Stability 0-10 Biotic Index (Verneaux and Tuffery) 0-10 Biotic Index (Woodiwiss) 0-10		
Periphyton				
FRANCE (C)	Saprobic Index 1-4 * Diversity Index (W & D)*	Diatomic Index (Coste) 0-10		
BELGIUM (DU)	Saprobic Index 1-4 *	Sequential Comparison Index (Cairns et al)		Autotrophic Index 0-1000+

* These systems have decimal sub-divisions.

TABLE 31. BIOTIC SCORE (CHANDLER) AND SCORE VALUES FOR THE PERIOD 1956–1978

RIVER : DERWENT AT BASLOW

METHOD OF ASSESSMENT : BIOTIC SCORE - Chandler

Month / Year	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	ANNUAL Mean Median	5 YEAR STATISTICS	
1956														Mean (Median)	Range 1084–1974
1957															
1958												1974	-/1974		S.D. 381
1959					1491					1292			-/1391	1460	
1960		1084											-/1084	(1391)	Relative S.D. % 26.1%
1961							902						-/902	Mean (Median)	Range 902–11014
1962							904						-/904		
1963		1014											-/1014	903	S.D. 91
1964		791											-/791	(903)	
1965															Relative S.D. % 10%
1966														Mean (Median)	Range 581–1242
1967															
1968		1242		1123									-/1187	970	S.D. 289
1969		581											-/581	(1029)	
1970									935				-/935		Relative S.D. % 30%
1971														Mean (Median)	Range 531–1348
1972					899		531						-/715		
1973				1000						1269			-/1135	1038	S.D. 265
1974				1256						1083			-/1169	(1041)	
1975				1348						921			-/1135		Relative S.D. % 25.5%
1976				1059		929			1456	770			1053/994	Mean (Median)	Range 770–1632
1977					1613	1628				1232			1491/1613		
1978				~~1347~~ 1412						1632			1453/1412	1305	S.D. 304
1979														(1364)	
1980															Relative S.D. % 23%

TABLE 32. BIOTIC INDEX VALUES FOR THE PERIOD 1956–1978

RIVER : DERWENT AT BASLOW

METHOD OF ASSESSMENT : EXTENDED BIOTIC INDEX

Month / Year	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	ANNUAL Mean / Median	5 YEAR STATISTICS Mean (Median)	5 YEAR STATISTICS
1956														12 (12)	Range 11–13; S.D. 0.82; Relative S.D. % 6.8%
1957															
1958												13	–/13		
1959					12					12			–/12		
1960				11									–/11		
1961							10						–/10	10.3 (10)	Range 10–11; S.D. 0.5; Relative S.D. % 4.9%
1962							10						–/10		
1963		11											–/11		
1964		10											–/10		
1965															
1966														9.25 (9.5)	Range 8–10; S.D. 0.96; Relative S.D. % 10.37%
1967															
1968		10		10									–/10		
1969		8											–/8		
1970									9				–/9		
1971														10.25 (10)	Range 9–12; S.D. 1.16; Relative S.D. % 11.3%
1972					10		9						–/9.5		
1973				10						10			–/10		
1974				12						10			–/11		
1975				12						9			–/10.5		
1976				10		10			12	9			10/10	11.1 (11.5)	Range 9–12; S.D. 1.1; Relative S.D. % 9.9%
1977					12	12				11			12/12		
1978				12/11						12			12/12		
1979															
1980															

TABLE 33. BIOTIC SCORE (CHANDLER) AND VALUES FOR THE PERIOD 1956–1978

RIVER : DERWENT AT DRAYCOTT

METHOD OF ASSESSMENT : BIOTIC SCORE √Chandler

Month / Year	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	ANNUAL Mean / Median	5 YEAR STATISTICS Mean (Median)	5 YEAR STATISTICS
1956										5			-/5	13.8 (15)	Range 5–20; S.D. 4.8; Relative S.D. % 34.8%
1957											11		-/11		
1958			7						20	18			15/18		
1959			16				16		17		14		16/16		
1960					14								-/14		
1961			17			12				16			15/16	11.5 (13)	Range 9–17; S.D. 5.1; Relative S.D. % 44.3%
1962			15			13							-/14		
1963	14					11							-/12		
1964															
1965				9				13					-/11		
1966													-	17 (17)	Range 16–18; S.D. 1.4; Relative S.D. % 8.3%
1967									18				-/18		
1968													-		
1969													-		
1970								16					-/16		
1971	16							13	13	15			14/14	18.7 (19)	Range 13–25; S.D. 3.6; Relative S.D. % 19.4%
1972		16		22		17		25/19					20/19		
1973			19	19					23				20/19		
1974			17									16	-/16		
1975					19		24	20	24	19			21/20		
1976		21					24	19	30				23/23	22.7 (22.5)	Range 18–30; S.D. 4.2; Relative S.D. %
1977			19	17	18	18/22	25	23	27	29			22/22		
1978										25			-/25		
1979															
1980															

TABLE 34. BIOTIC INDEX AND EXTENDED BIOTIC INDEX VALUES 1956–1978

RIVER : DERWENT AT DRAYCOTT

METHOD OF ASSESSMENT : BIOTIC INDEX

Month / Year	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	ANNUAL Mean Median	5 YEAR STATISTICS Mean (Median)	5 YEAR STATISTICS
1956										2			-/2	4.5 (5)	Range 2-7; S.D. 1.6; Relative S.D. % 36.7%
1957										5			-/5		
1958			2						7	6			5/6		
1959			5				5		5			5	5/5		
1960					3								-/3		
1961			5			2				5			4/5	3.8 (4)	Range 2-5; S.D. 1.0; Relative S.D. % 25.7%
1962			4			4							-/4		
1963															
1964	4					3							-/3.5		
1965				3				4					-/3.5		
1966														5 (5)	Range 4-6; S.D. 1.4; Relative S.D. % 28.3%
1967									6				-/6		
1968															
1969															
1970								4					-/4		
1971	4							4	4	4			4/4	5.8 (6)	Range 4-8; S.D. 1.3; Relative S.D. % 23.0%
1972		5		7		7			7/6				6/7		
1973			6	5					8				6/6		
1974			6									6	-/6		
1975					6		7	5	8	5			6/6		
1976		6					8	7	9				8/7.5	7.1 (7.5)	Range 6-9; S.D. 1.2; Relative S.D. % 16.8%
1977			6	6	7	7/7	9	8	8	8			7/7		
1978										8			-/8		
1979															
1980															

TABLE 35. BIOTIC SCORE (CHANDLER) AND SCORE VALUES 1956-1978

RIVER : EREWASH AT TOTON

METHOD OF ASSESSMENT : BIOTIC SCORE - Chandler

Month / Year	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	ANNUAL Mean / Median	5 YEAR STATISTICS	
1956										134			-/134	Mean (Median)	Range 9-134
1957								80				9	-/44.5	52	S.D. 39
1958				30									-/30	(43.5)	Relative S.D. % 75%
1959					49						45		-/47		
1960					27				42				-/34.5		
1961					59					9			-/34	Mean (Median)	Range 9-59
1962								30				41	-/35.5	39.6	S.D. 20.7
1963				12									-/12	(44.5)	Relative S.D. % 52.3%
1964		59						48		59			53/59		
1965															
1966														Méan (Median)	Range 106-137
1967														121.5	S.D. 21.9
1968														(121.5)	Relative S.D. % 18%
1969								106					-/106		
1970						137							-/137		
1971						127							-/127	Mean (Median)	Range 98-307
1972				154		164		145					154/154	157.4	S.D. 70.2
1973		98											-/98	(145)	Relative S.D. % 44.6%
1974															
1975	107							367					-/207		
1976	71	96		119			261		227				155/119	Mean (Median)	Range 71-342
1977					110/89		194	181	185	250			168/183	171.9	S.D. 77.7
1978		342						153					-/209	(181)	Relative S.D. % 45.2%
1979															
1980															

TABLE 36. BIOTIC INDEX VALUES 1956–1978

RIVER: EREWASH AT TOTON

METHOD OF ASSESSMENT: BIOTIC INDEX/EXTENDED BIOTIC INDEX

Month / Year	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	ANNUAL Mean/Median	5 YEAR STATISTICS Mean (Median)	5 YEAR STATISTICS
1956										4			-/4	2.4 (2)	Range 1-4; S.D. 0.92; Relative S.D. % 38.3%
1957								3				1	-/2		
1958				2									-/2		
1959					3						2		-/2.5		
1960					2				2				-/2		
1961					2					1			-/1.5	1.9 (2)	Range 1-2; S.D. 0.35; Relative S.D. % 18.4%
1962								2				2	-/2		
1963				2									-/2		
1964		2						2		2			2/2		
1965															
1966														4 (4)	Range 4-4; S.D. 0.0; Relative S.D. % 0%
1967															
1968															
1969								4					-/4		
1970						4							-/4		
1971						4							-/4	4.1 (4)	Range 3-5; S.D. 0.69; Relative S.D. % 16.7%
1972				5		4		4					4.3/4		
1973		4											-/4		
1974															
1975	3							5					-/4		
1976	3	3	5				5		4				4/4	4.3 (4)	Range 3-6; S.D. 0.83; Relative S.D. % 19.3%
1977					4/4		4	5	4	5			4.3/4		
1978		6						4					-/5		
1979															
1980															

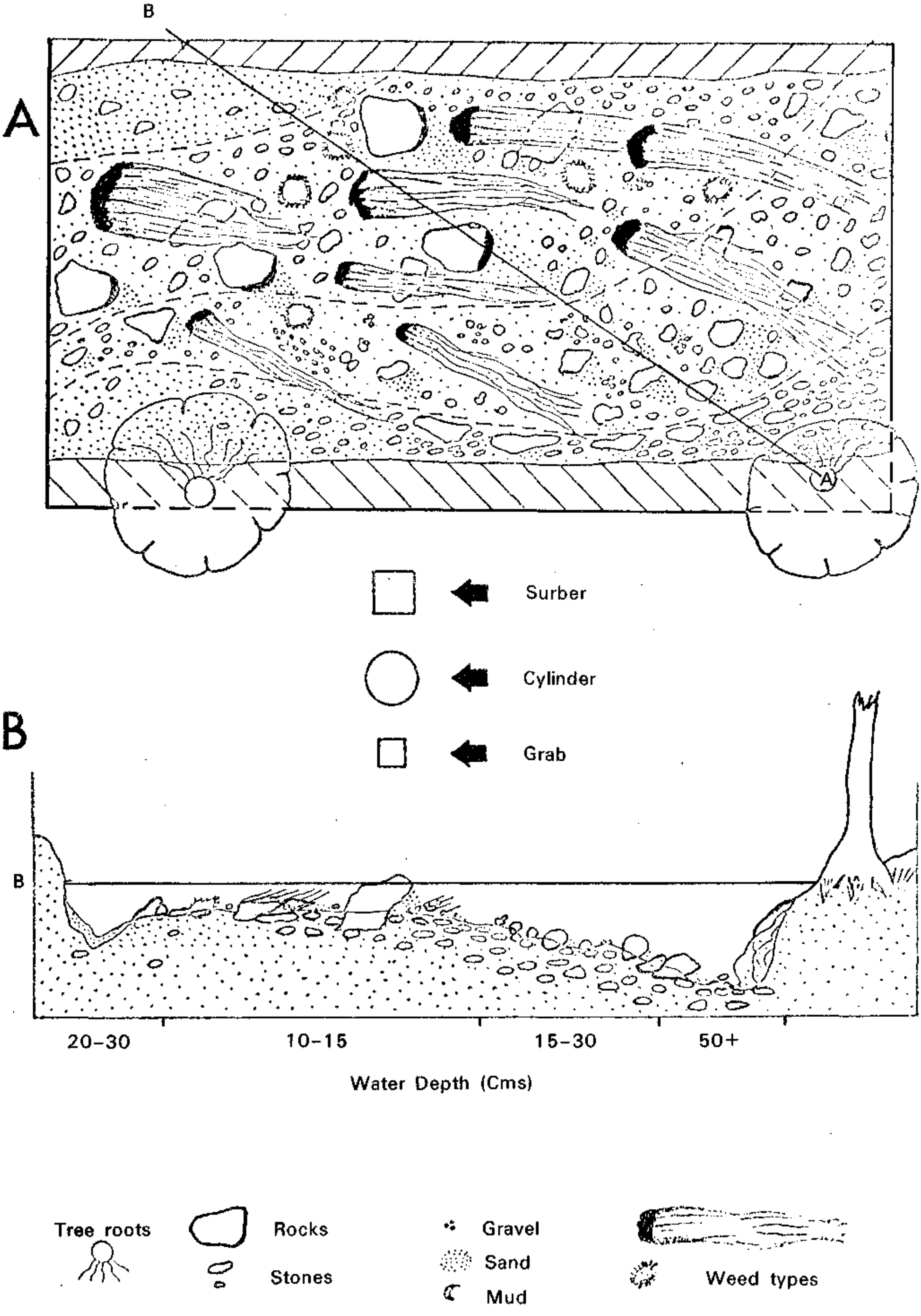

FIG 1 Environmental characteristics of a typical shallow stream

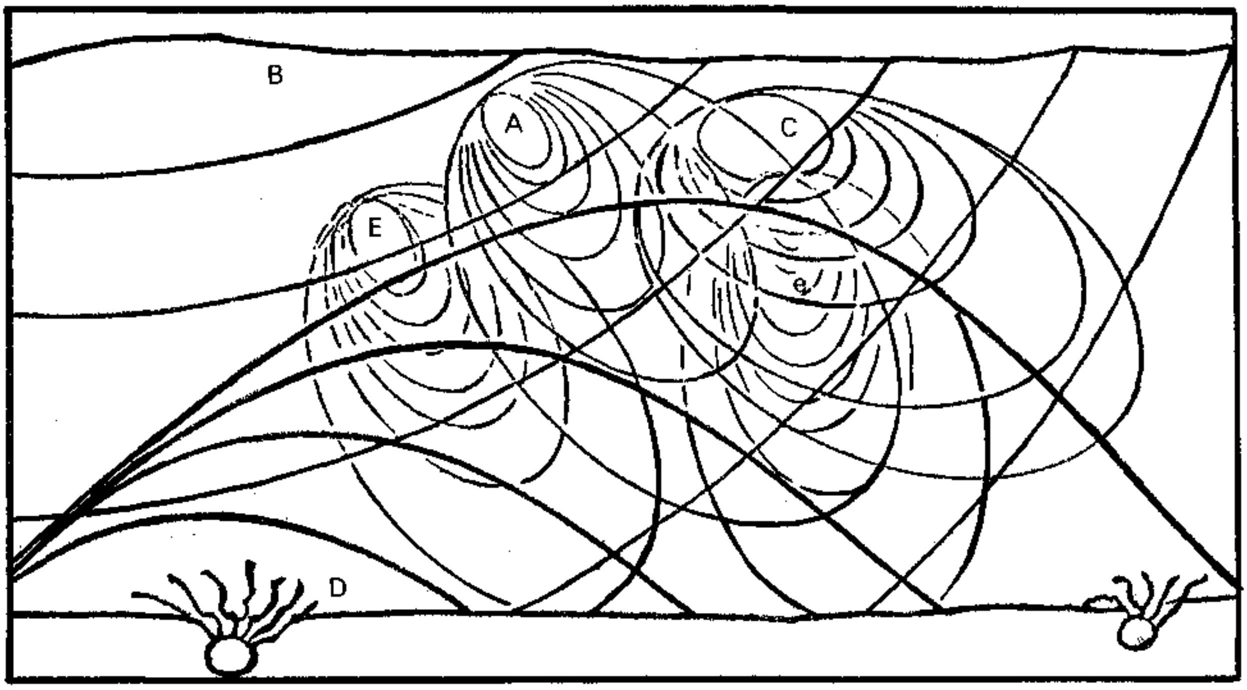

FIG 2 The influence of environmental niches on the distribution of organisms on the stream bed (c.f. FIG 1)

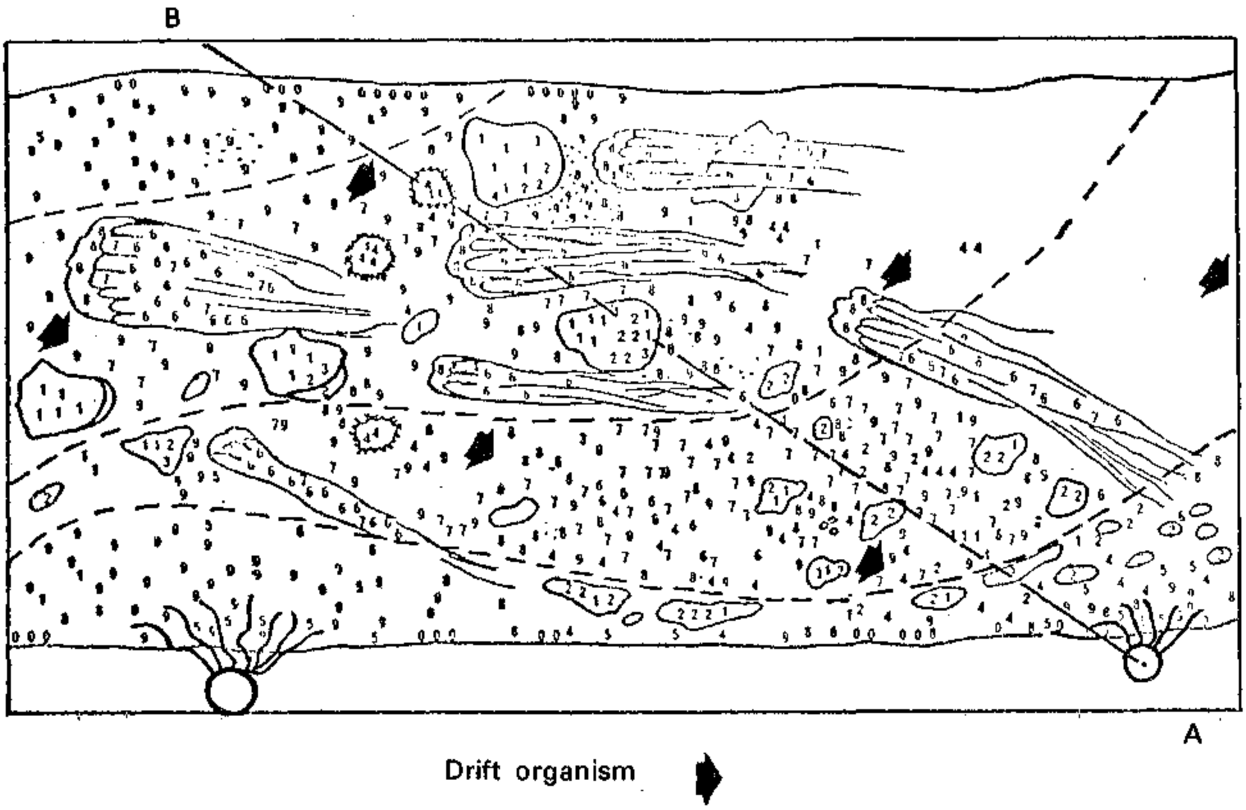

FIG.3 The hypothetical distribution of ten different organisms in a typical shallow stony stream (c.f. FIG.1 and 2)

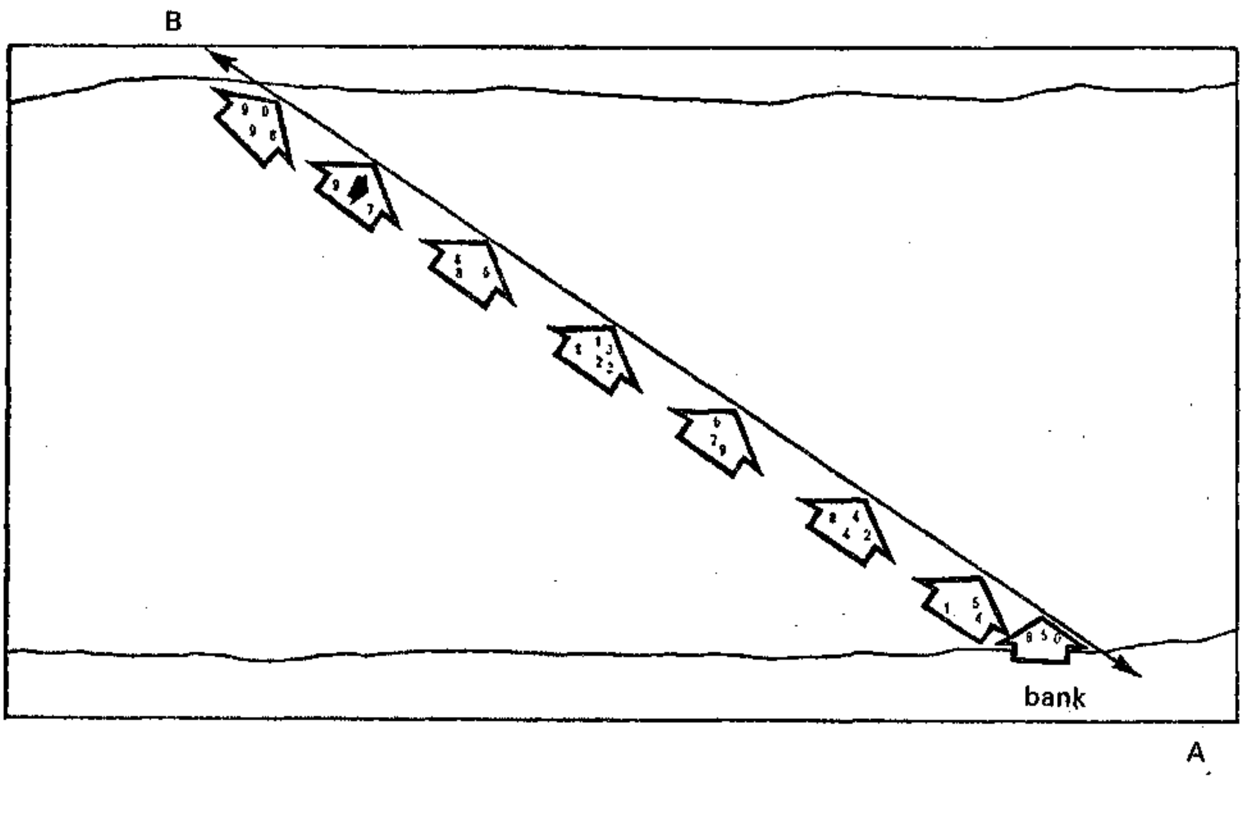

FIG 4 The effect of handnet sampling along the transect AB (c.f. FIGS.1 2 and 3)

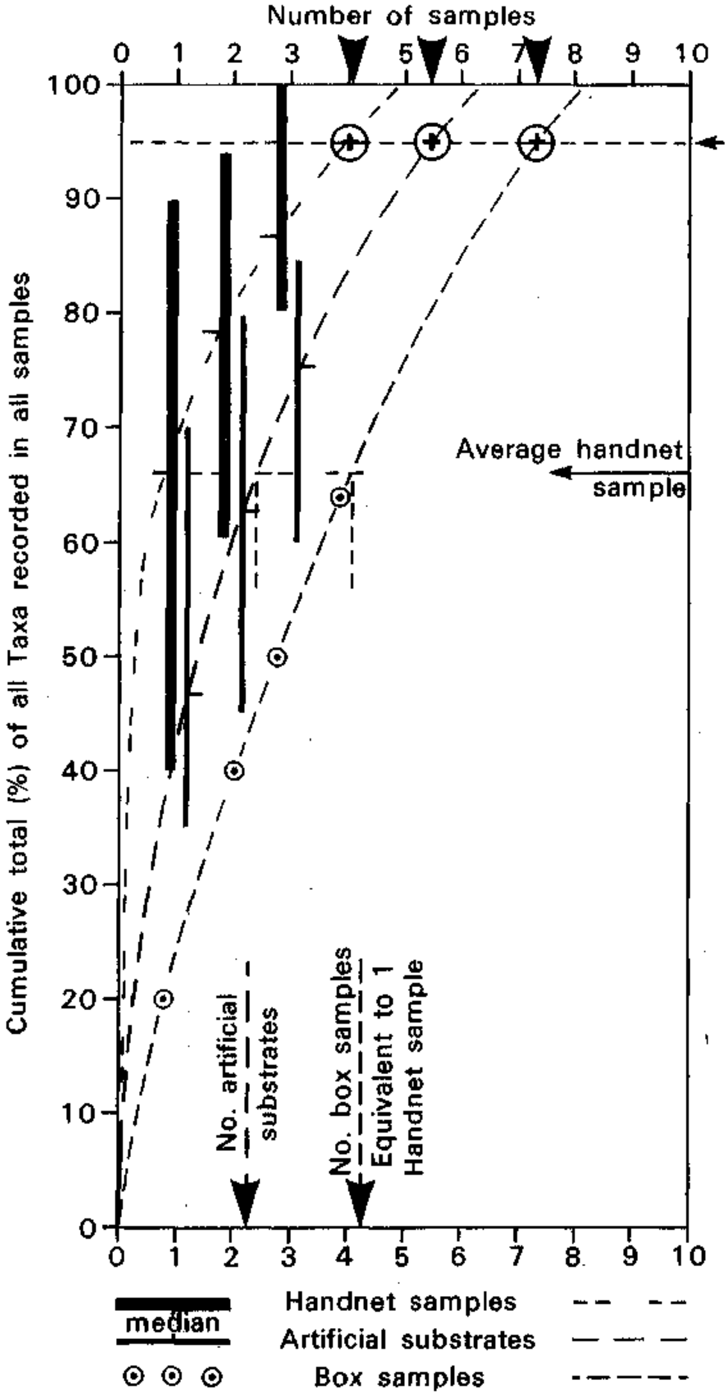

FIG.5 Cumulative total (%) of taxa recorded by each sampling method. The equivalent of three methods of sampling

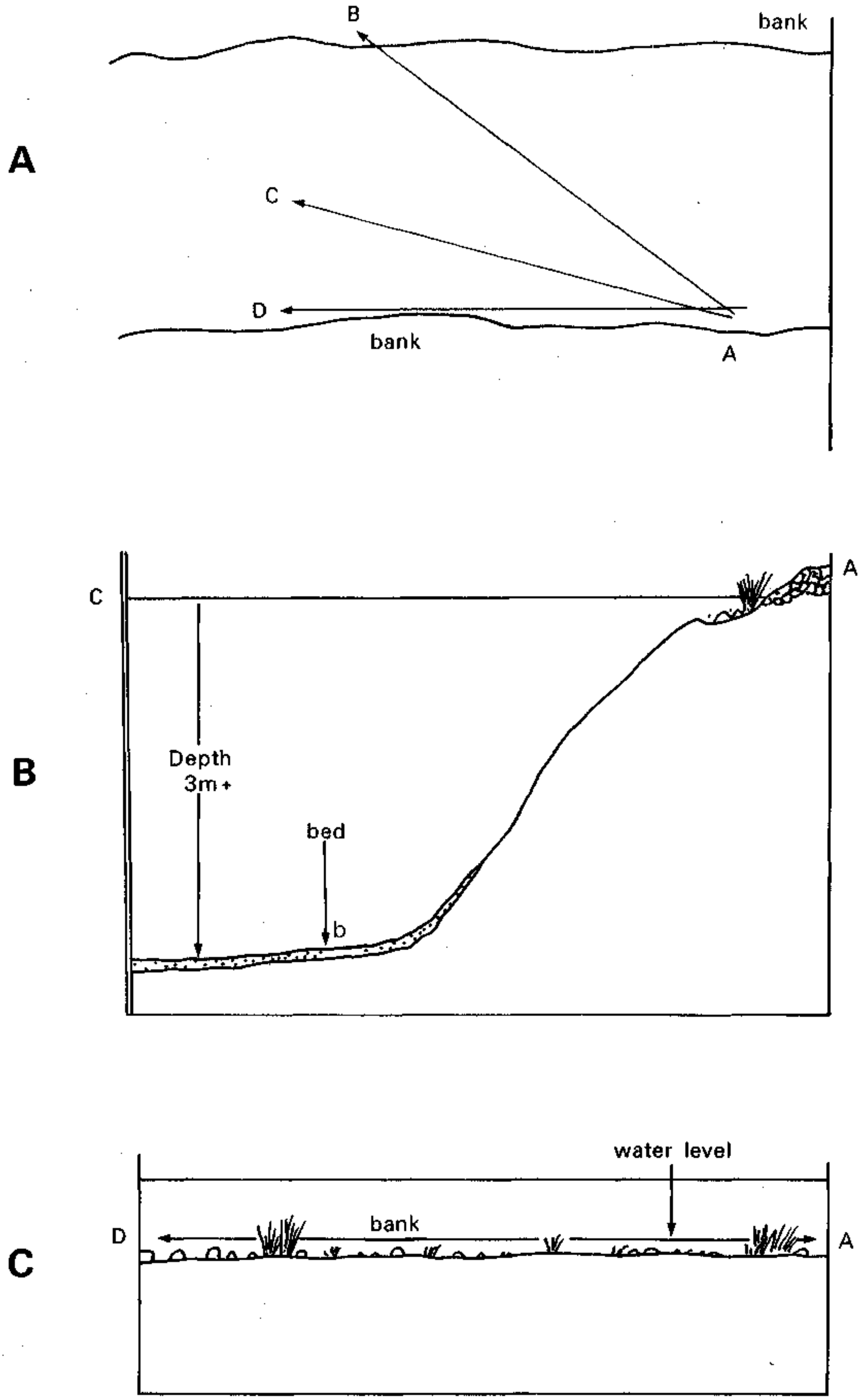

FIG 6 The problem of sampling in deep rivers

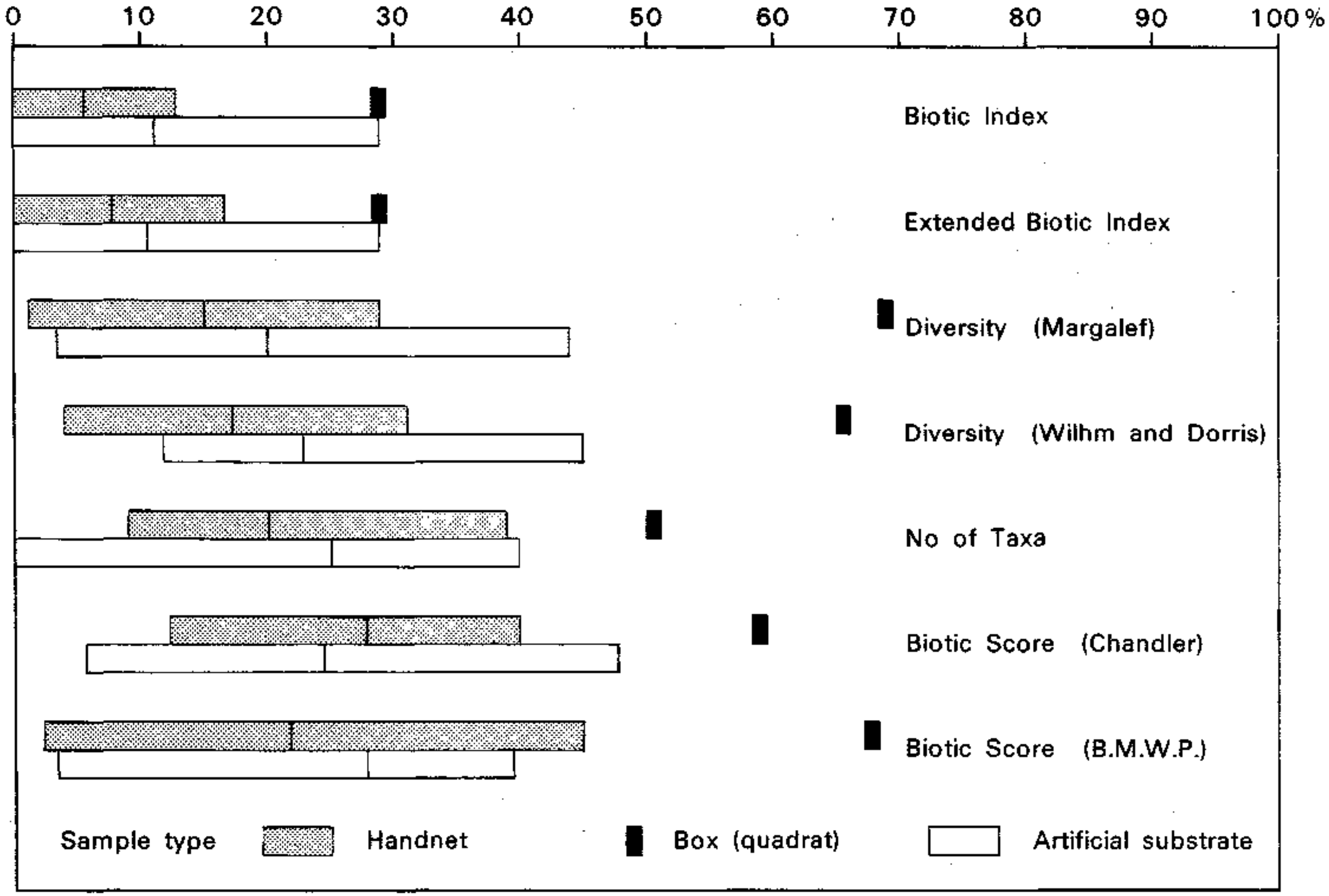

FIG.7 The influence of sampling differences on various biological assessment methods (drawn from table 29)

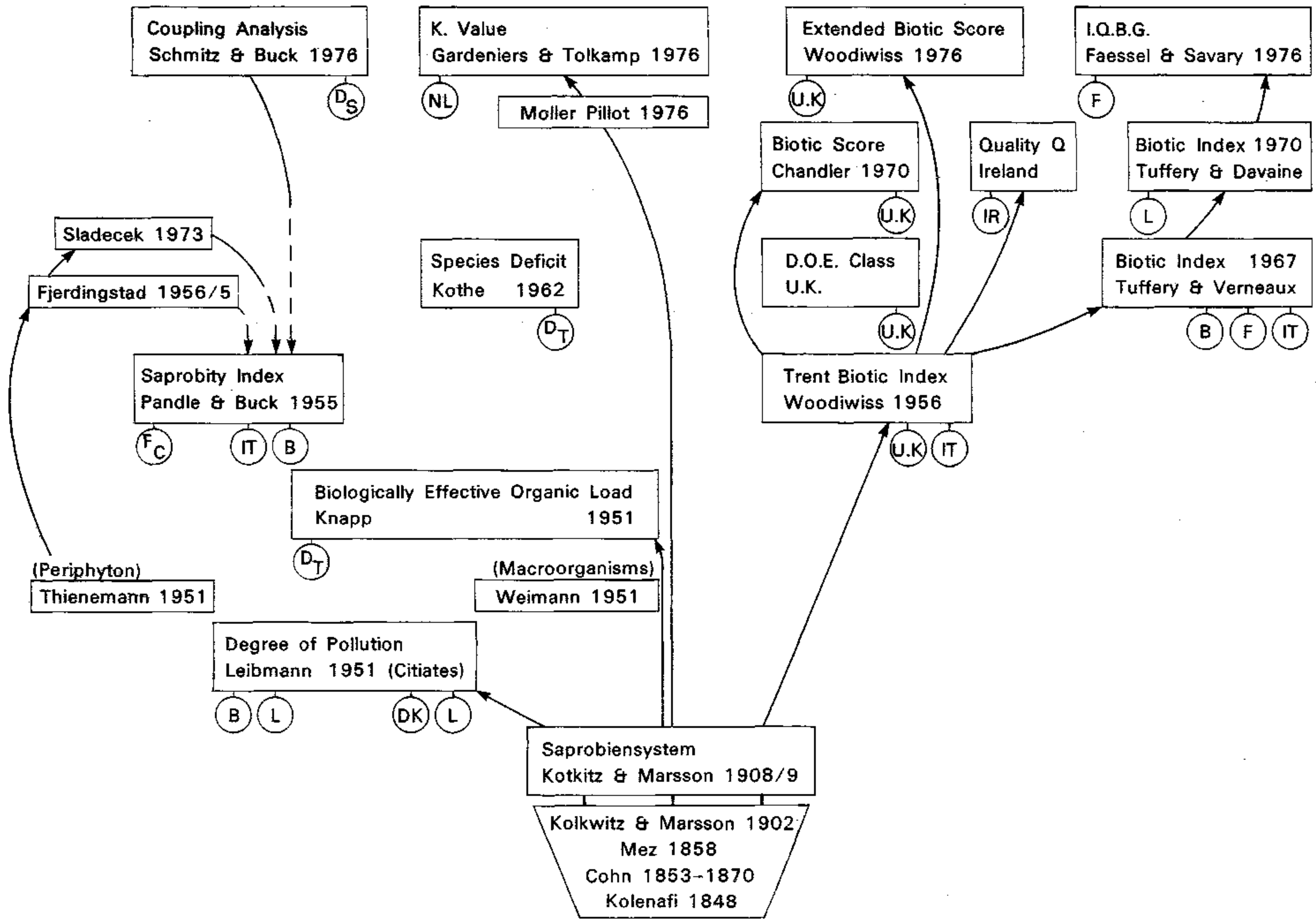

FIG.8 The Relationships between biological methods of assessment

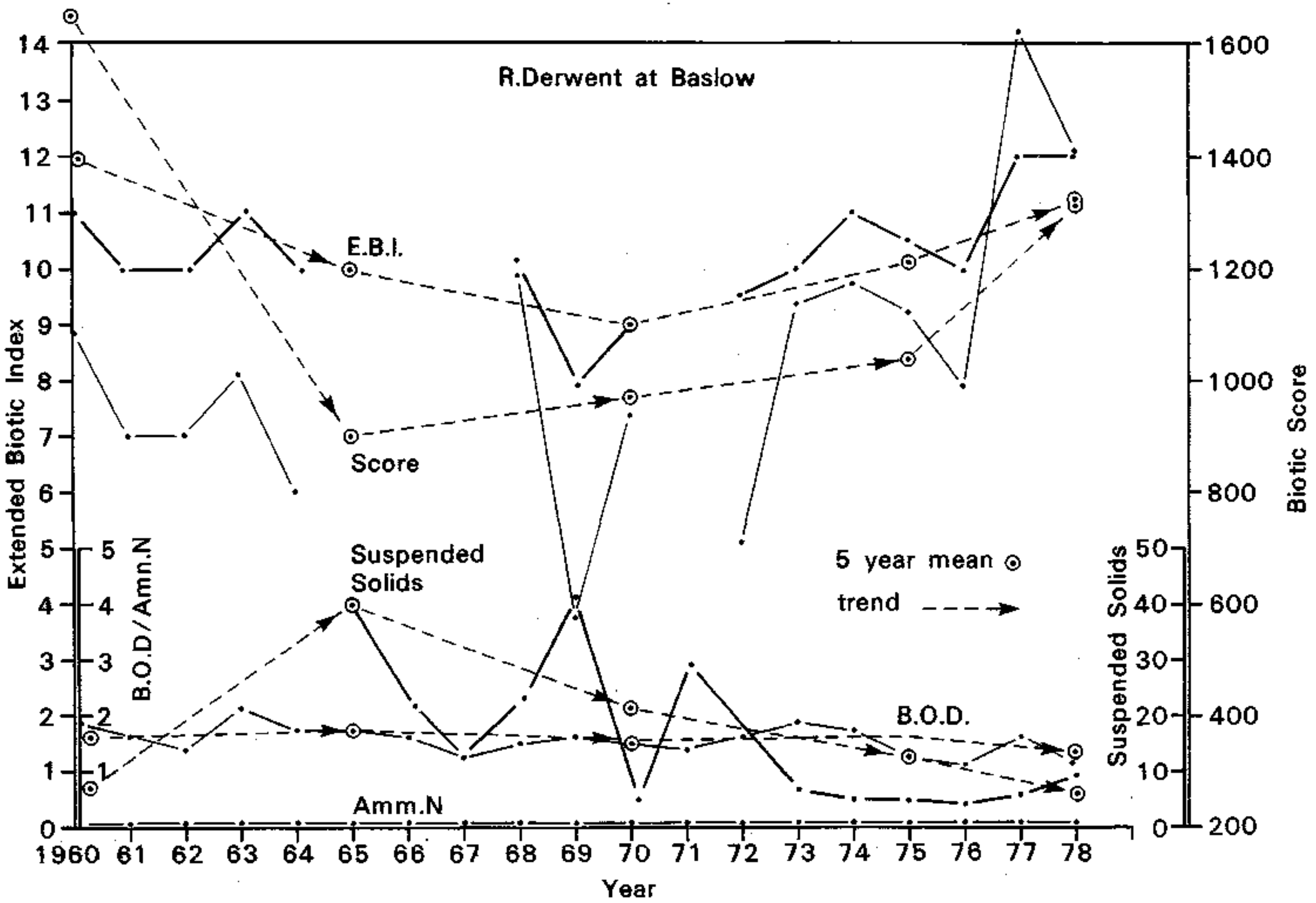

FIG.9 Long-term biological record of R.Derwent at Baslow (Station 1)

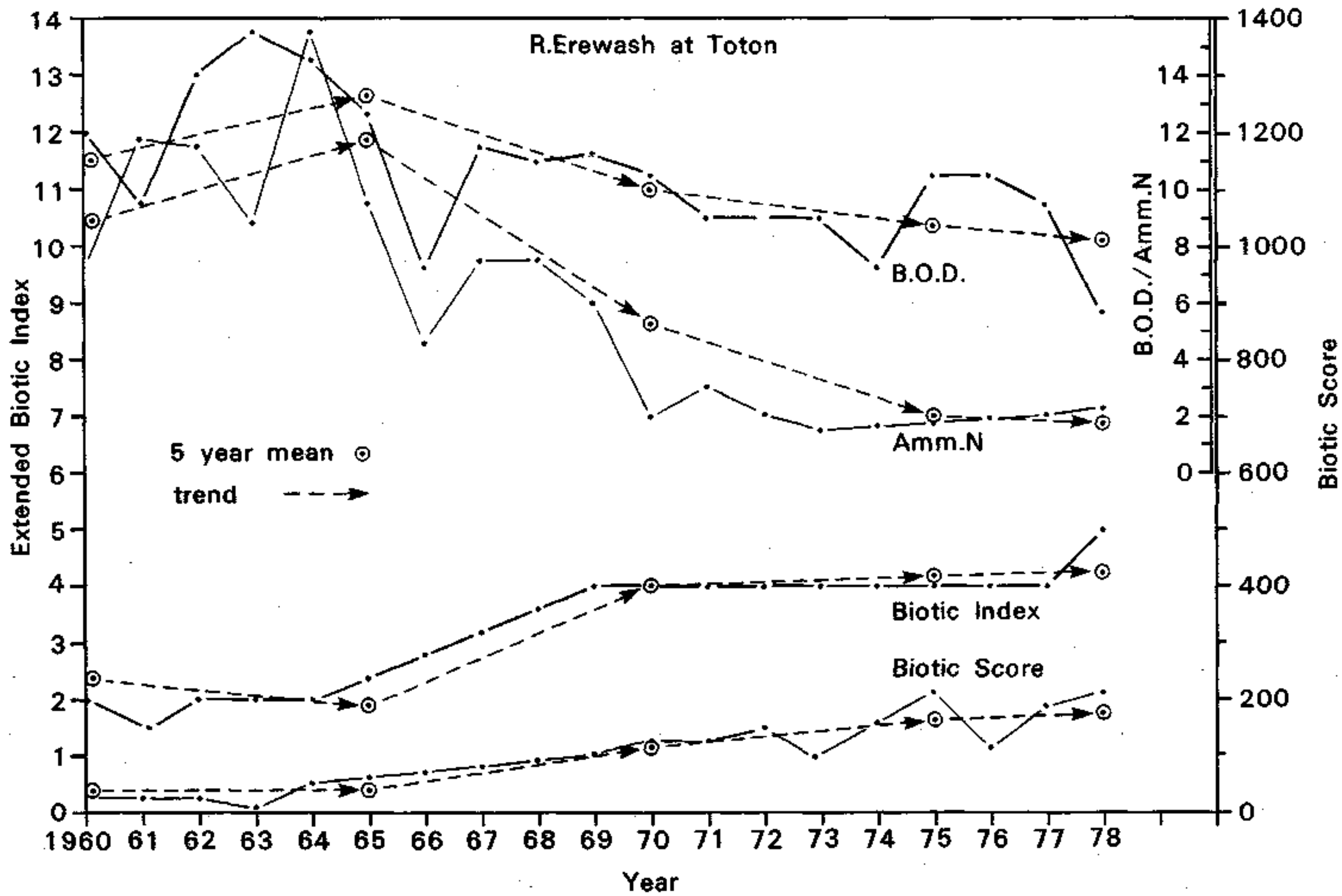

FIG.10 Long-term biological record of R.Erewash at Toton (Station 6)

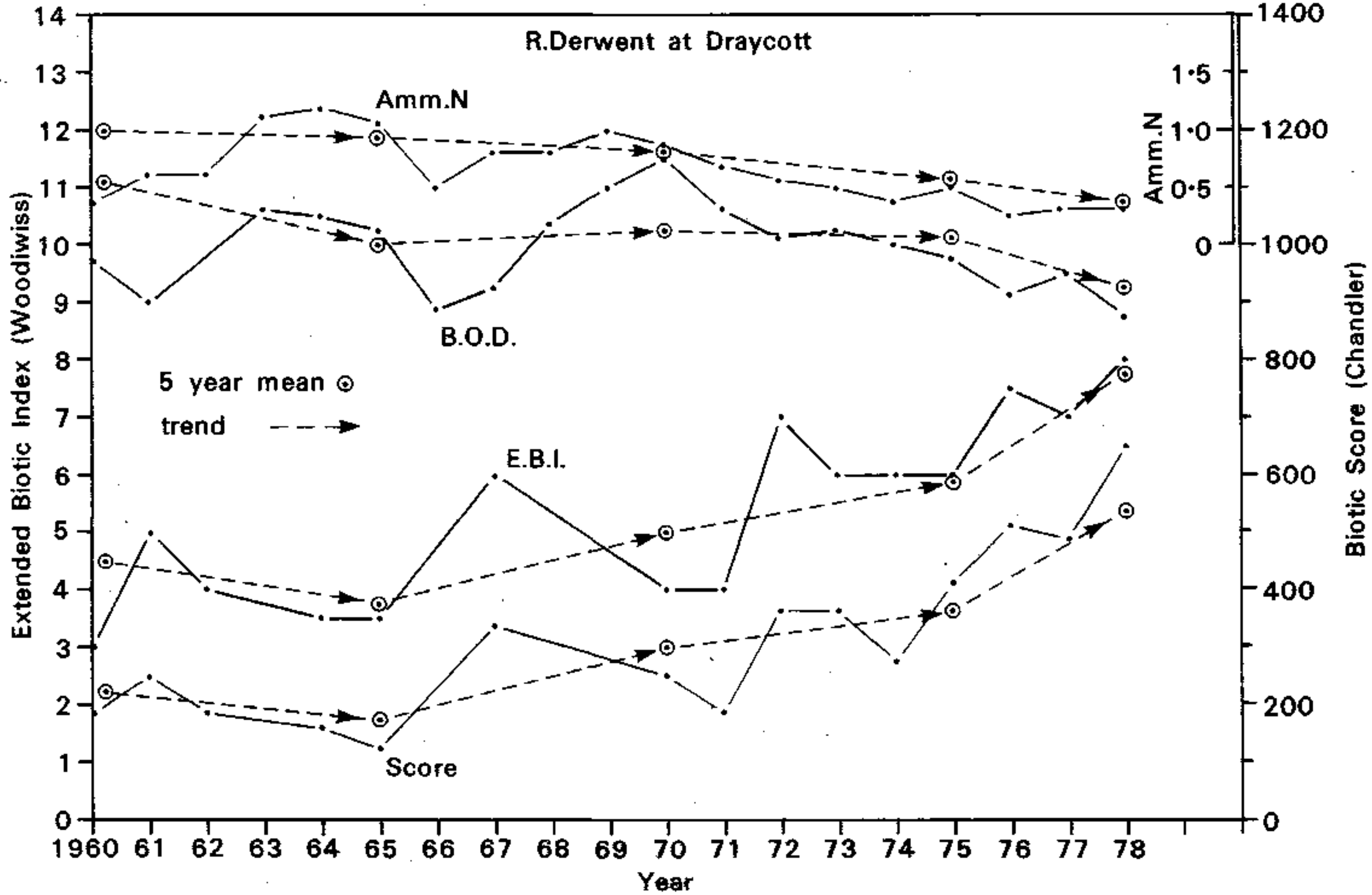

FIG.11 R.Derwent at Draycott (Station 5)

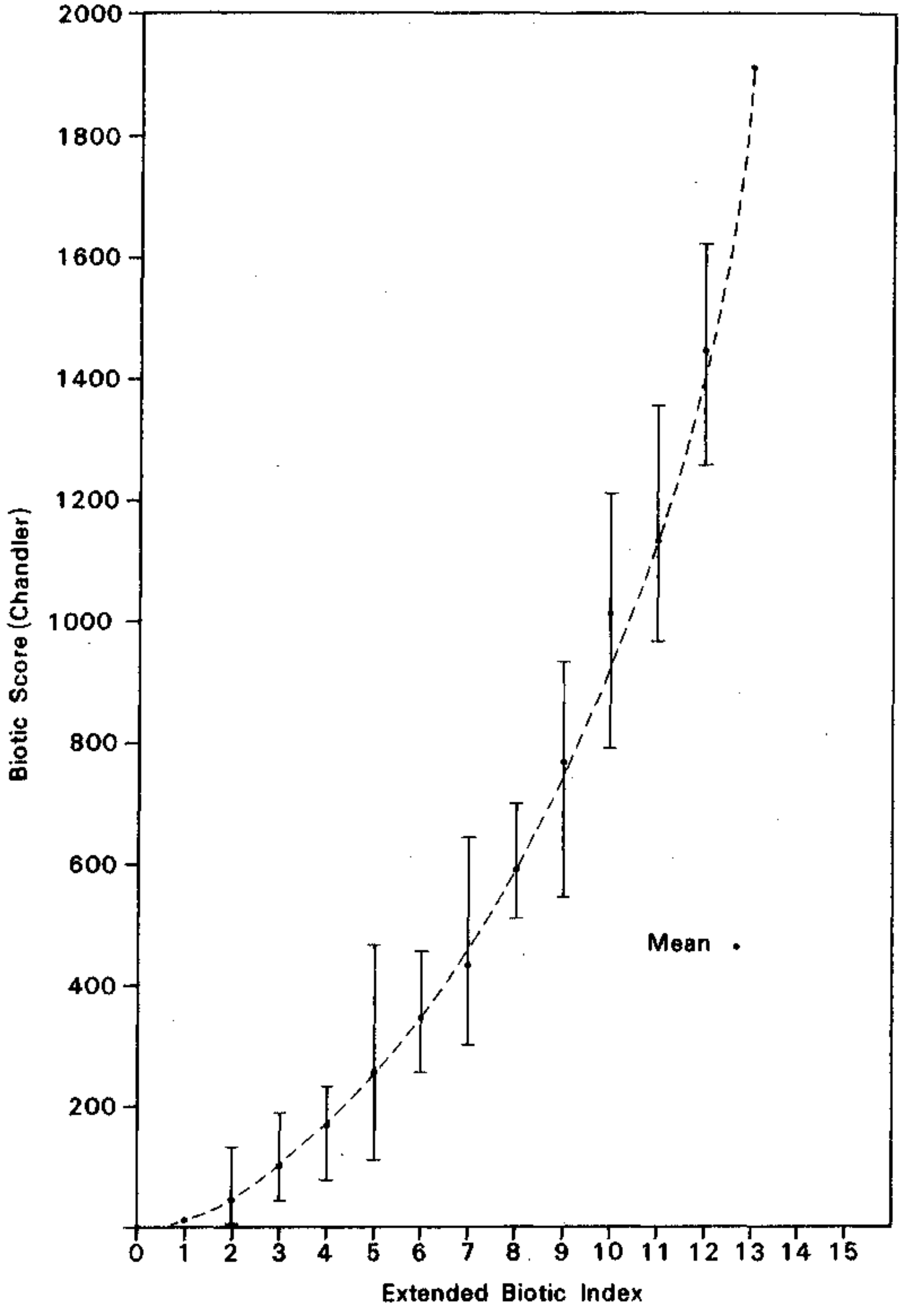

FIG.12 Relationship between E.B.I. and Biotic Score

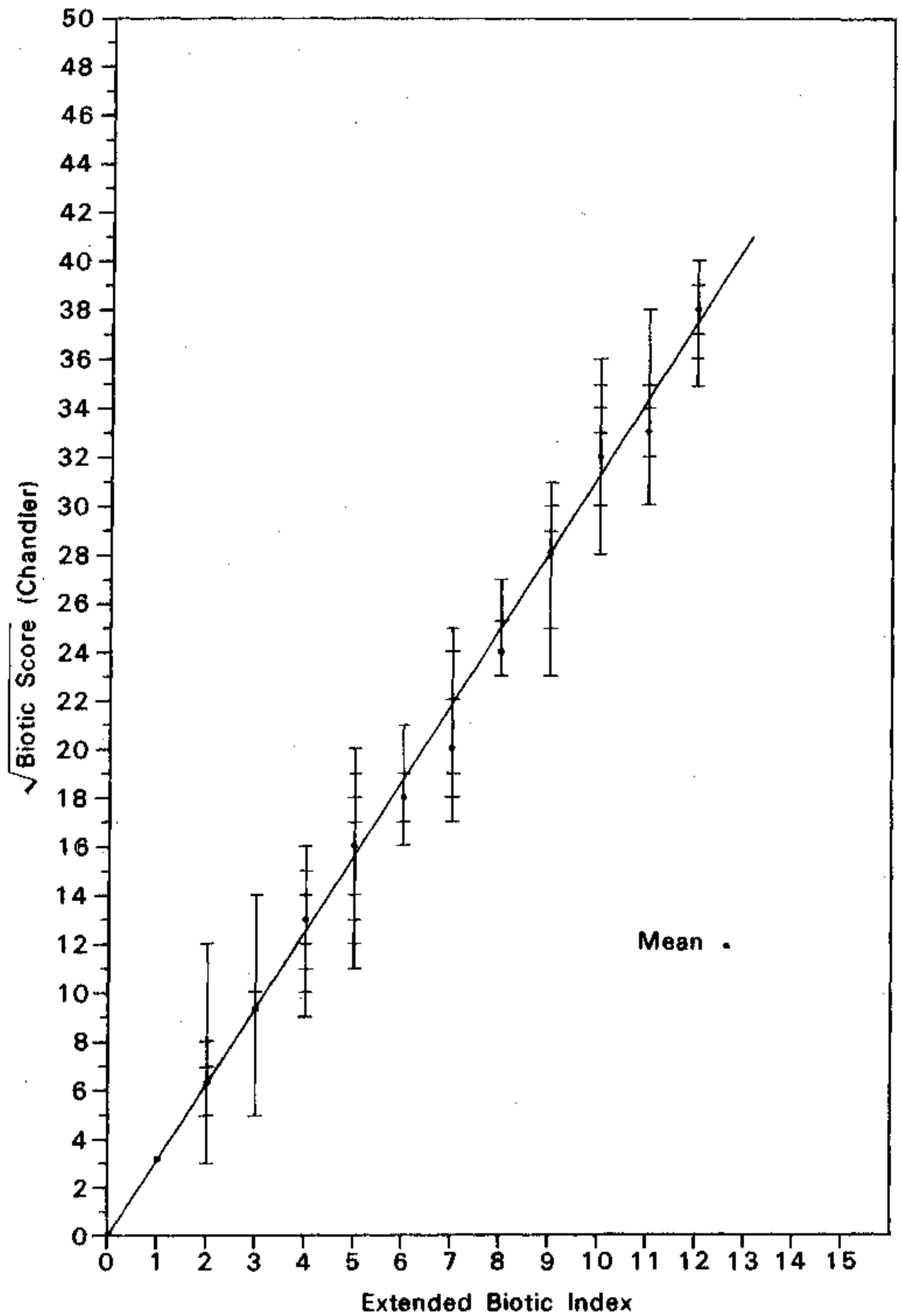

FIG.13 Relationship between E.B.I. and Biotic Score