## 1. INTRODUCTION.

The seminar at Nottingham in september/october 1976 was organized to achieve two objectives:

a. Comparison of the sampling methods used by each participating country
b. Comparison of methods of biological assessment of water quality

Twenty four sampling stations were selected in the River Trent Watershed with a wide range of water qualities to enable to take as many comparative samples as possible in the time available, in order to increase the total number of comparisons.

More detailed information on the River Trent Catchment can be found in the paper compiled by Goodiwiss (1976).

## 2. METHODS

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### 2.A. SAMPLING METHOD

Samples were taken with the macrofauna-net (30 cm wide, 20 cm high, 50 cm deep, with a mesh width of 0.5 mm, on a 2 m long pole) in use with the Nature Conservation Department for sampling lowlandstreams. The normal procedure is: the net is moved through the substrate with a jerky movement, over a chosen distance in upstream direction. In case a stream was too deep or the substrate too course to enable normal procedures, 'kick'-samples were taken. In addition some large stones were searched for animals.

Samples were taken through the different substrate-types present at the station in such a way that the composition of the riverbed was represented in the sample.

After taking the sample, the contents of the net were placed in a flat white tray and the macrofauna was collected om the spot, preserved in 80 % ethyl-alcohol and transported to the laboratory for identification. Very large numbers of certain species were estimated to the nearest ten (10) after picking a representative number (through all size classes) of them for detailed identification.

The minimum distance over which a sample is taken with the macrofauna-net is determined by the number of animals present at the sampling station. Samples with less than 100 animals from the water quality system (Chapter 2B) are normally not considered for water quality assessment, except in case of extremely heavy or toxic pollution.

## 2.B. ASSESSMENT METHOD.

The water quality assessment method used by the Nature Conservation Department is based on the System of Moller Pillot(1971) which was designed for lowland streams in the province of Brabant (Netherlands). It was described in our report of the EEC-seminar at Koblenz in 1975 (Tolkamp & Gardeniers, 1975). Since this report the System of Moller Pillot was further developed and extended with a number of species as described in the Dutch Manual on the Biological Assessment of Water Quality (in dutch, to be published in 1976), which is an adjustment of the System to a wider range of streams, especially streams with a higher current-velocity. This extended system is referred to as the Modified System of Moller Pillot. In Appendix I the species found during the seminar in sept./oct. 1976 are listed according to their pollutional level. Species of which the exact status (place) within a pollutional Group is not certain have a question-mark in front of them.

However, the system was devised without an index and water quality was expressed as the dominant pollutional Group of species and not as a figure (at most the Groups can be pointed out as five classes (I - V).

To be able to quantify the water quality in a figure the Quality-index (K-index) was developed by Gardeniers & Tolkamp (1976). This index was not described in the Koblenz report; afterwards we did calculate the K-index for the Main and Kahl and Dr.Tittizer did use these figures for his final report (Tittizer,1975).

The K-index is calculated in the following way:

$$K_{135} = (\%\ \text{Erist.} + \text{Chir.gr}) \times 1 + (\%\ \text{Hirud.gr}) \times 3 + (\%\ \text{Gam.} + \text{Calopt.gr}) \times 5$$

or :

$$K_{12345} = (\%\ \text{Erist.gr}) \times 1 + (\%\ \text{Chir.gr}) \times 2 + (\%\ \text{Hir.gr}) \times 3 + (\%\ \text{Gam.gr}) \times 4 + (\%\ \text{Cal.gr}) \times 5$$

Explanation of formula:

The species of the (Modified) System of Moller Pillot are arranged in five groups which are given a pollutional factor 1 to 5 (see below). The percentage of animals of each Group, regarding the total number of animals within the Modified System of Moller Pillot as 100 %, is multiplied by this factor. The results for each group are added up and the outcome (the K-index) expresses the water quality in a range from 100 (very heavily polluted) to 500 (not polluted).

Groups of the (Modified) System of Moller Pillot, with their pollutional factor:

| | pollut. Factor ↓ | | |
|---|---|---|---|
| Group: ↓ | $K_{135}$ | $K_{12345}$ | ← Index |
| Eristalis-group | 1 | 1 | ↑ increasing pollution |
| Chironomus-group | 1 | 2 | |
| Hirudinea-group | 3 | 3 | |
| Gammarus-group | 5 | 4 | |
| Calopteryx-group | 5 | 5 | |

The range from 100 to 500 can be divided into a number of classes of equal distance (e.g. 5 or 10).

To facilitate comparison with chemical or other biological classes one can calculate the percentage of the K-index within the range (formula at the bottom of Appendix II). This results in the % of Continuum which can be divided by ten to get classes 0 to 10.

The K-index and the % of Cont. can be found in Appendix II.

## Discussion of Quality-index and pollutional factors:

The System (and the Modified System) of Moller Pillot covers the whole range from very heavily polluted to not polluted water. The most polluted waters are characterized by the presence (mostly in small numbers) of animals of the Eristalis-group or by the total absence of macro-invertebrates ('dead water'). The majority of the waters in the Netherlands is (fortunately) not that excessively polluted.

The cleanest waters ;characterized by the presence (also mostly in small numbers) of animals of the Calopteryx-group, aren't much to be found in the Netherlands either. This on account of eutrophication and channelization of most running waters.

For these practical reasons the two lower and the two higher classes in the System are put together, which gives a wider range of the $K_{135}$-index for the situations mostly encountered.

Using the pollutional factors 1,3 and 5 plus the additional biological information directly from the species list can give the exact water quality in the extreme reaches of the System.

When using a different pollutional factor for each group (1,2,3,4,or 5) the Eristalis-group (extremely heavily polluted) can be distinguished from the Chironomus-group(heavily polluted). However, in the cleanest reach of the System (Gammarus- and Calopteryx-group) there is no gain of information, because of the absence of stre ms with exclusively species of the Calopteryx-group. Always (even in the cleanest situations) species of the Gammarus-group will occur also, which prevent the $K_{12345}$-index of becoming 500.

Assuming the maximum for the Calopteryx-group would be 20 % , this would reduce the upper limit of the $K_{12345}$-index to 420.

To transform $K_{135}$ to $K_{12345}$ the following formula can be used:

$$\boxed{K_{12345} - 100 = tg\,\alpha . (K_{135} - 100) + 100}$$ , in which

$tg\,\alpha$ = tg of the angle of the line giving the relationship between the K's, with $K_{135}$ on the horizontal axis and $K_{12345}$ on the vertical axis (see Appendix VI).

$tg\,\alpha$ is not exactly know but will be 0.8 at most, when Calopteryx-group is 20 % maximal and Eristalis-group is 100 % maximal ( or no macro-invertebrates at all). In Appendix VI, with our data from the River Trent Catchment, $tg\,\alpha$ = 0.5125.

## 3. DISCUSSION OF RESULTS.

Species found at the 23 sampled stations are listed on two tables: 1. The species list of the Modified System of Moller Pillot:Appendix I.
2. The list of species not on the first list: Appendix III.

The second list contains the species which are not closely associated with a certain level of pollution and species of which not enough information is available to place them in the system.

This second list can give additional information on the water quality together with the physical data observed in the field and the chemical data of the period before the samples were taken.

Explanatory remarks on the assessment results (Appendix II):

Before discussing our results some explanatory remarks should be made on some of the sampling stations:

Station 3 : The Trent Biotic Index calculated with our data comes out too high (7), probably because of the presence of 2 Ephemeroptera and 1 Gammarus ,who are very likely the result of drift during the recent flooding of the river.Calculation of the Biotic-index without these two Groups gives 4 which is more likely.(both indices were stated:4/7)

Station 6: Same remarks as for Station 3. Biotic-index of 8 should be 6. (both were stated: 6/8)

Station 11: No real sample was taken. The numbers in the list were estimated in the field from the Irish dredge-sample across the stream. The results cannot be used for comparison,although they do agree with the Median Biotic-index over jan.-aug.'76 (Appendix VII -A).

Station 13: The sample was too small (only 30 animals,while 100 is the minimum) to allow a justified calculation of the Quality-index. This station should also be left out for comparison.

Station 19: The Trent Biotic-index found in the period before the seminar is probably as low as 6 (medi-

Station 19: (cont.) an for jan.-aug.1976) because most of the samples were taken with the aid of artificial substrate. In a slowly running and rather deep stream like this, with a muddy bottom, certain groups of animals (like Ephemeroptera) avoid the netted stones under the mud layer and are thus missed in the sample. The biotic-index calculated with our data gives 9 and gives probably a more correct assessment. This is confirmed by the high K-index (476).

Station 24: This sample was also too small (only 47 animals) and can in fact not be used for comparison. Nevertheless the assessment (biotic-index or Quality-index) agrees with the Median-biotic-index. However, all these assessments are too high compared to the BOD-mean-value (App.VII).

Comparison of the Quality-index with the Chemical data:

As can be seen on the BOD-line in Appendix VII the sampling stations were indeed very well chosen over a wide range or organic pollution.

Normally we do not sample shortly after river flooding (as we had to do during the Seminar) and we need at least one or two hours per station, in stead of the hour or less we had (which influences the thoroughness of the collection). Yet we did find a pretty good range of water qualities, relatively well associated with the BOD-mean-line (Appendix VII-B,C,D).

The fact that the relationship between the biological assessment and the chemical data does not result in a correct sequence is not a surprise when we know that this relationship is very hard to determine and often even absent because of the momentary status of chemical data. Beside that a median-figure of the BOD (and of $O_2$ saturation %) will probably give a better correlation with the biological data.

It is obvious from the figures in App.VII that some of the stations are biologically in a worse state and some in a better state than the BOD-value's suggest,e.g. stations 3 and 18 respectively 10 and 24.

Station 24 puzzled us a lot, especially because of the extremely high BOD-value (135.0 mg/l).

Comparison of the Quality-index and the Biotic-index (based on the dutch data, sept./oct.1976) with the Median Biotic-index (jan.-aug.1976).

The calculation of the Median Trent Biotic-index can be found in App.IV.

We did calculate the Trent Biotic-index (Woodiwiss,1964) with our data (number of groups at the bottom line of App. III-A and B). Results of this are set in App. II,V and VII. A short comment will be given below.

It has to be noticed that for the calculation of the number of Groups the Odonata were considered one group and each family of the Heteroptera(Hemiptera) as a group. Pisces were left out.

The assessment reflected in the Biotic-index based on our data agrees for most stations with the assessment in the previous months - one class difference will be acceptable (App. II, VII-A and B). The stations 6,8,16,19 and 20 (11, 13 and 24 should be left out) are assessed 2 or 3 classes above the Median Biotic-index. Looking at the $K_{135}$-index (App.II and VII-C)one sees that the stations 6 and 8 are assessed much lower (2 resp. 1 class below the Median B-index); stations 16 and 20 are assessed by the same class and station 19 is still assessed too high, but this was explained before in the Explanatory remarks.

Comparing the $K_{135}$-index (Appendix II and VII-C) (expressed as % of Continuum or translated into classes 0 - 10 by dividing the % by ten) with the Median Biotic-index (Appendix II and VII-A) one sees that the stations 3 , 6 , 12 , 18 , 21 and 23 are assessed 2 or 3 classes below and stations 4,10 and 19 , 2 classes above the Median B-index. The explanation for the differences between the $K_{135}$-index and the B-index for the six stations assessed too low can be found in the use of the pollutional factors 1,3 and 5 in stead of 1, 2,3,4 and 5 ($K_{12345}$ ,see Ch.2B), which disguises the differences between 'bad' and 'worse than bad'. Looking at the % of Continuum based on $K_{12345}$ (App.IIand VII-A and D) reveals that the differences disappear (or are at most one class),except for the stations 4,10 and 19. Perhaps this is an argument for using $K_{12345}$ in spite of the disadvantages (Ch.2B).

The graphs in App.V-A,B &C,D, giving the relationship between the Median Biotic-index and the Quality-index, reveal very clear that transformation of $K_{135}$ to $K_{12345}$ reduces the range of pollutional levels from 100 - 500 to 200 - 400.

## CONCLUSIONS

The methods using the Quality-index respectively the Trent Biotic-index agree very well in final assessment, though the Quality-index using pollutional factors 1,3, and 5 ($K_{135}$) does not assess differences between 'extremely heavily polluted' and 'heavily polluted' waters. This must be explained in accompanying rema ks, although this was not the case for the stations sampled during the Seminar. Using the pollutional factors 1,2,3,4,5 ($K_{12345}$) solves the problem for the two most polluted classes, but it narrows the differences in the middle and upper range (the K-index is reduced from 100-500 to 100 - 420).

## 4. SUGGESTIONS FOR COMPARISON IN THE FINAL REPORT

Perhaps both $K_{135}$ and $K_{12345}$ could be considered. Comparison should also include comparison of the outcome of the different methods of assessment regarding type of substrate (river-type).

## 5. COMMENTS ON THE SEMINAR

The seminar was very well organized, but the number of sampling stations could have been reduced (a few less in the middle range of pollution) for time's sake. Normally we need one to two hours (average) and we only had about one hour or per station, which reduces the reliability of our sampling and collection method.

## 6. SUGGESTIONS FOR FURTHER WORK

-- Perhaps it would be useful to do a theoretical practice using all the different assessment methods on one species list for a large number of stations . Dr. Tittizer did so only for the Pantle & Buck-Saprobic-index; this was a start but all the methods should be compared with each other. For such a comparison it will be necessary to compile a species list for a large number of stations with quantitative data on it.

-- Check if the classes of all systems are of the same space ( equidistant or not).

-- Why is Biological Assessment carried out; what are the objectives, the purposes, the aims or goals of Biological Assessment? The accuracy (exactness) of the assessment will be dependent on the objectives. How large is this exactness?

The Modified System of Moller Pillot for Water Quality assessment.

| Sampling Station: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHIRONOMUS-group: subtotal: | -- | --- | 234 | 2 | 3 | 223 | 5 | 208 | 4 | 1 | -- | 7 |
| Tubificidae | | | 2 | | 3 | 221 | 4 | 60 | 4 | 1 | | 7 |
| Chironomus | | | 229 | 2 | | 2 | 1 | 112 | | | | |
| Psectrotanypus varius | | | 3 | | | | | 36 | | | | |
| HIRUDINEA-group: subtotal: | 2 | 12 | 89 | 23 | 127 | 132 | 21 | 21 | 34 | 103 | 70 | 107 |
| Erpobdella octoculata | | | 18 | 6 | 1 | 13 | 1 | | | 2 | 20 | 24 |
| Erpobd. testacea | | | | | 1 | | | | | | | |
| Asellus aquaticus | | | 71 | 1 | 125 | 119 | 19 | 6 | 34 | 100 | 50 | 77 |
| Helobdella stagnalis | 1 | | | | | | | | | | | 1 |
| Glossiphonia complanata | 1 | 4 | | 10 | | | 1 | | | | | 5 |
| Glossiph.heteroclita | | | | | | | | | | | | |
| Lumbriculidae | | | | | | | | 1 | | | | |
| Macropelopia spp. | | 8 | | | | | | | | | | |
| ?Glyptotendipes spp. | | | | | | | | | | 1 | | |
| ?Apsectrotanypus trifasc. | | | | 4 | | | | 5 | | | | |
| Conchapelopia (melanops) | | | | 2 | | | | 9 | | | | |
| GAMMARUS-group: subtotal: | 319 | 564 | 3 | 176 | 2 | 18 | 135 | 8 | 140 | -- | 3 | 9 |
| Prodiamesa olivacea | | | | 12 | | 2 | | 5 | | | | |
| Asellus meridianus | | | | | | | | | | | | |
| ?Theodoxus fluviatilis | | | | 4 | | | | | | | | |
| ?Ancylus fluviatilis | 24 | 3 | | | | | | | | | | 1 |
| Gammarus pulex | 29 | 69 | 1 | 135 | | 1 | 2 | | 13 | | 3 | 8 |
| Corixinae Larvae | | | | | | | | | 1 | | | |
| Dicranota | 1 | 5 | | | | | | | | | | |
| ?Cryptochironomus spp. | | 8 | | | | | | | | | ESTIMATION FROM IRISH DREDGE SAMPLE !!!! | |
| Platycnemis pennipes | | | | | 2 | 4 | 27 | 3 | 17 | | | |
| Coenagrionidae | | | | | | 3 | 4 | | | | | |
| ?Caenis horaria | 3 | 12 | | | | 2 | 28 | | 18 | | | |
| Cloëon dipterum | | | | | | | 50 | | 66 | | | |
| Baetis spec. | 17 | 87 | 2 | 7 | | | | | | | | |
| Baetis rhodani | 25 | 108 | | 9 | | | | | | | | |
| Phryganea obsoleta | | | | | | 1 | | | 1 | | | |
| Athripsodes cinereus | 18 | | | | | | | | | | | |
| Athrip.aterrimus | | | | | | | | | | | | |
| Plectrocnemia conspersa | | 6 | | | | | | | | | | |
| ?Polycentropus flavomacul. | 5 | 79 | | | | | | | | | | |
| Ad.Hydracarina | 53 | 79 | | 3 | | 3 | 11 | | 5 | | | |
| ?Hydropsyche siltalai | 57 | | | 1 | | | | | | | | |
| ?Hydropsyche contubernalis | | | | | | | | | | | | |
| ?Eukiefferiella gr.discolo. | 61 | 26 | | 4 | | | | | | | | |
| ?Eukiefferiella hospita | 3 | | | | | | | | | | | |
| Laccophilus hyalinus | | | | | | | | | | | | |
| Gyrinus Larvae | | | | 1 | | | | | | | | |
| Gobio gobio | | | | | | 2 | 13 | | | | | |
| Nemacheilus barbatula | | | | | | | | | 1 | | | |
| ?Ephemerella ignita | 3 | 2 | | | | | | | | | | |
| ?Ecdyonurus dispar | 2 | 59 | | | | | | | | | | |
| ?Astacus astacus | | | | | | | | | 18 | | | |
| ?Tinodes waeneri | 54 | | | | | | | | | | | |
| ?Psychomyia pusilla | | 3 | | | | | | | | | | |
| ?Rhyacophila dorsalis | 14 | 15 | | | | | | | | | | |
| ?Notidobia ciliaris | | 3 | | | | | | | | | | |
| CALOPTERYX-group: subtotal: | 16 | 57 | -- | 2 | -- | -- | -- | -- | 1 | -- | -- | -- |
| ?Agapetus fuscipes | 5 | | | | | | | | | | | |
| Cottus gobio | | 3 | | 2 | | | | | | | | |
| Elmis aenea | 2 | 14 | | | | | | | 1 | | | |
| Limnius volckmari | 1 | 32 | | | | | | | | | | |
| ?Lasiocephala basalis | 3 | 6 | | | | | | | | | | |
| Ephemera danica | 2 | 2 | | | | | | | | | | |
| Epoicocladius ephemerae | 3 | | | | | | | | | | | |
| [illegible] | 337 | 633 | 326 | 203 | 132 | 373 | 161 | 237 | 179 | 104 | 73 | 123 |

River Trent Watershed. sept./oct/'76. Appendix I,cont.

The Modified System of Moller Pillot for Water Quality assessment.

| Sampling Station: | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHIRONOMUS-group: subtotal: | --- | 3 | -- | 101 | 124 | 257 | 12 | 11 | 75 | -- | 10 | 5 |
| Tubificidae | | 3 | | 101 | 7 | 94 | 3 | 2 | 75 | | 8 | 14 |
| Chironomus | | | | | 115 | 1 | 9 | 9 | | | 2 | 1 |
| Psectrotanypus varius | | | | | 2 | 162 | | | | | | |
| HIRUDINEA-group: subtotal: | 4 | 97 | 113 | 313 | 550 | 1 | 114 | 123 | -- | | 117 | 8 |
| Erpobdella octoculata | | 29 | 12 | 67 | 13 | | 21 | 2 | | | | 4 |
| Erpobd. testacea | | | 1 | | | | | | | | | |
| Asellus aquaticus | 4 | 64 | 97 | 231 | 535 | | 93 | 78 | | | 115 | 3 |
| Helobdella stagnalis | | 1 | 1 | 7 | 1 | | | 15 | | | 2 | |
| Glossiphonia complanata | | 3 | | | | | | 15 | | | | 1 |
| Glossiph.heteroclita | | | 2 | 2 | 1 | | | | | | | |
| Lumbriculidae | | | | | | | | 4 | | | | |
| Macropelopia spp. | | | | | | | | | | | | |
| !Glyptotendipes spp. | | | | 6 | | 1 | | 9 | | | | |
| ?Apsectrotanypus trifasc. | | | | | | | | | | | | |
| Conchapelopia (melanops) | | | | | | | | | | | | |
| GAMMARUS-group: subtotal: | 26 | 180 | 19 | 423 | 11 | 1 | 1032 | 132 | -- | | 7 | 34 |
| Prodiamesa olivacea | | | | | | | | | | | | |
| Asellus meridianus | | | | | | | | 84 | | | | |
| !Theodoxus fluviatilis | | 71 | | | | | | | | | | |
| ?Ancylus fluviatilis | 1 | | | | | | | | | | | |
| Gammarus pulex | | | | 1 | | | 2 | 3 | | | | |
| Corixinae Larvae | | | | | | | 35 | | | | 5 | 5 |
| Dicranota | | | | | | | | | | | | |
| ?Cryptochironomus spp. | | | | | | | 2 | | | | 2 | |
| Platycnemis pennipes | | | 9 | | 11 | | 23 | 14 | | | | 1 |
| Coenagrionidae | | 6 | 4 | 19 | | 1 | 23 | 7 | | | | |
| ?Caenis horaria | 1 | 13 | 6 | 219 | | | 109 | 1 | | | | 14 |
| Cloëon dipterum | 1 | 78 | | | | | 831 | 15 | | | | 14 |
| Baetis spec. | 11 | | | 129 | | | | | | | | |
| Baetis rhodani | | | | | | | | | | | | |
| Phryganea obsoleta | | 3 | | | | | | | | | | |
| Athripsodes cinereus | | | | 27 | | | 6 | | | | | |
| Athrip.aterrimus | | 8 | | | | | | | | | | |
| Plectrocnemia conspersa | 1 | 1 | | | | | | 7 | | | | |
| !Polycentropus flavomacul. | | | | | | | | | | | | |
| Ad.Hydracarina | | | | 28 | | | 1 | 1 | | | | |
| ?Hydropsyche siltalai | | | | | | | | | | | | |
| !Hydropsyche contubernalis | 11 | | | | | | | | | | | |
| !Eukiefferiella gr.discolo. | | | | | | | | | | | | |
| !Eukiefferiella hospita | | | | | | | | | | | | |
| Laccophilus hyalinus | | | | | | | | | | | | |
| Gyrinus Larvae | | | | | | | | | | | | |
| Gobio gobio | | | | | | | | | | | | |
| Nemacheilus barbatula | | | | | | | | | | | | |
| ?Ephemerella ignita | | | | | | | | | | | | |
| ?Ecdyonurus dispar | | | | | | | | | | | | |
| !Astacus astacus | | | | | | | | | | | | |
| ?Tinodes waeneri | | | | | | | | | | | | |
| ?Psychomyia pusilla | | | | | | | | | | | | |
| !Rhyacophila dorsalis | | | | | | | | | | | | |
| ?Notidobia ciliaris | | | | | | | | | | | | |
| CALOPTERYX-group: subtotal: | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| !Agapetus fuscipes | | | | | | | | | | | | |
| Cottus gobio | | | | | | | | | | | | |
| Elmis aenea | | | | | | | | | | | | |
| Limnius volckmari | | | | | | | | | | | | |
| ?Lasiocephala basalis | | | | | | | | | | | | |
| Ephemera danica | | | | | | | | | | | | |
| Epoicocladius ephemerae | | | | | | | | | | | | |

Station 22: NO SAMPLE TAKEN ;Riverbed not accessable because of high water level

River Trent Watershed; EEC seminar sept./oct.1976. Tolkamp & Gardeniers

Calculation of the Quality-index, and comparison with Biotic Index.

| Sampling station: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chironomus-group(%) | --- | --- | 71.8 | 1.0 | 2.3 | 59.8 | 3.1 | 87.8 | 2.2 | 1.0 | -- | 5.7 |
| Hirudinea-group (%) | 0.6 | 1.9 | 27.3 | 11.3 | 96.2 | 35.4 | 13.0 | 8.9 | 19.0 | 99.0 | 95.9 | 87.0 |
| Gammarus-group (%) | 94.7 | 89.1 | 0.9 | 86.7 | 1.5 | 4.8 | 83.9 | 3.4 | 78.2 | -- | 4.1 | 7.3 |
| Calopteryx-group(%) | 4.7 | 9.0 | --- | 1.0 | --- | --- | --- | --- | 0.6 | -- | -- | -- |
| $K_{1,2,3,4,5}$ | 404 | 407 | 229 | 387 | 299 | 245 | 381 | 216 | 374 | 299 | 304 | 302 |
| % of continuum $K_{12345}$ | 95 | 96 | 40 | 90 | 62 | 45 | 88 | 36 | 86 | 62 | 64 | 63 |
| $K_{1,3,5}$ | 499 | 496 | 158 | 473 | 295 | 190 | 462 | 132 | 453 | 298 | 308 | 303 |
| % of continuum $K_{135}$ | 100 | 99 | 15 | 93 | 49 | 23 | 91 | 8 | 88 | 50 | 52 | 51 |
| Biotic-index(based on dutch data) | 10 | 9 | 4/7 | 8 | 4 | 6/8 | 9 | 4 | 9 | 4 | 3 | 7 |
| Biotic-index(median jan.-aug.'76, STWA-data) | 10 | 10 | 4 | 7 | 4 | 4 | 8 | 2 | 8 | 3 | 5 | 7 |

(Species from the Eristalis-group (Eristalis,Culicidae,Spercheus emarginatus) were not found during this investigation).

| Sampling station: | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chironomus-group(%) | --- | 1.1 | --- | 12.1 | 18.1 | 99.2 | 1.0 | 4.1 | 100 | -- | 7.6 | 10.6 |
| Hirudinea-group (%) | 13.3 | 34.6 | 85.6 | 37.4 | 80.3 | 0.4 | 9.8 | 46.2 | --- | -- | 88.6 | 17.0 |
| Gammarus-group (%) | 86.7 | 64.3 | 14.4 | 50.5 | 1.6 | 0.4 | 89.1 | 49.6 | --- | -- | 5.3 | 72.3 |
| Calopteryx-group(%) | --- | --- | --- | --- | --- | --- | --- | --- | --- | -- | -- | -- |
| $K_{1,2,3,4,5}$ | 387 | 363 | 314 | 338 | 284 | 201 | 388 | 345 | 200 | -- | 302 | 361 |
| % of continuum $K_{12345}$ | 90 | 82 | 67 | 74 | 58 | 31 | 90 | 77 | 31 | -- | 63 | 82 |
| $K_{1,3,5,}$ | 473 | 426 | 329 | 377 | 267 | 102 | 476 | 391 | 100 | -- | 300 | 425 |
| % of continuum $K_{135}$ | 93 | 82 | 57 | 69 | 42 | 1 | 94 | 73 | 0 | -- | 50 | 81 |
| Biotic-index(based on dutch data) | 7 | 9 | 7 | 9 | 5 | 2 | 9 | 9 | 2 | -- | 5 | 8 |
| Biotic-index(median jan.-aug.'76, STWA-data) | 5 | 8 | 6 | 7 | 5 | 4 | 6 | 7 | 2 | -- | 7 | 7 |

$K_{135}$= (% Erist.+Chir.gr) x 1 + (% Hirud.gr) x 3 + (% Gam.+Cal.gr) x 5

$K_{12345}$ = (% Erist.gr) x 1 + (% Chir.gr) x 2 + (% Hir.gr) x 3 + + (% Gam.gr) x 4 + (% Cal.gr) x 5

% of C = ($K_{135}$-100)/400 . 100 % or % of C = ($K_{12345}$-100)/320 .100%

River Trent Watershed; EEC-seminar sept./oct.1976. Appendix IIIA

Species not listed in the Modified System of Moller Pillot.

| Sampling station: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polycelis spec. | | | | | | | | | | | | |
| Dugesia spec. | | 1 | | | | | | | | | | 1 |
| Lumbricidae | | 4 | | 4 | | | | | | | | |
| Stylaria lacustris | | 2 | | | | | | | | 1 | | |
| Trocheta subviridens | | | 1 | | | | | | | | | |
| Hemiclepsis marginata | | | | | | | | | | | | 1 |
| Theromyzon tessulatum | | | | | | | | | | | | 1 |
| Piscicola geometra | | 1 | | | | | | | | | | |
| Crangonyx pseudogracilis | | | | | | | 1 | 2 | 35 | | | |
| Gammarus tigrinus | | | | | | | 9 | | 3 | | | 48 |
| Plecoptera(juv.)cf Isoperla | 6 | | | | | | | | | | | |
| Leuctra inermis | 1 | 3 | | | | | | | | | | |
| Gerris spec. Larvae | | | | | | 1 | | | | | | |
| Sigara striata | | | | | | 1 | 17 | | 3 | | | |
| Sigara falleni | | | | | | | 6 | | 3 | | | |
| Sigara lateralis | | | | | | | | | | | | |
| Sigara semistriata | | | | | | | | | | | | |
| Sigara cincinna | | | | | | | | | | | | |
| Sigara spec. | | | | | | | | | | 1 | | |
| Corixa punctata | | | | | | | | | | | | |
| Corixa dorsalis | | | | | | | | 1 | | | | |
| Notonecta glauca | | | | | | | | | | | | |
| Hydropsyche angustipennis | 8 | 8 | | | | 17 | | | | | | 1 |
| Agraylea multipunctata | | | | | | | | | | | | |
| Leptoceridae spec. | 6 | | | | | | 1 | | | | | |
| Mystacides cf.azurea | 50 | 6 | | | | | | | | | | |
| Limnephilidae spec. | | | | 2 | | | | | | | | |
| Hydroptila sp.(empty) | (56) | | | | | | | | | | | |
| Sialis spec. | | | | 1 | | | 4 | | 1 | | | |
| Rhantus exsoletus | | | | | | | | | | | | |
| Ilybius sp. Larvae | 3 | 1 | 10 | | | 1 | | 7 | | | | |
| Haliplus sp.(Larv.+Ad) | | | | 1 | 1 | 28 | 11 | | | 1 | 1 | 3 |
| Stictotarsus duodecimpus. | | | | | | 1 | | | 2 | | | |
| Hygrotus (2 spp) | | | | | | | | | | | | |
| Hydroporus (2 spp) | 1 | | | 1 | | | 3 | | | | | |
| Brychius elevatus | | | | 7 | | 1 | 7 | | | | | |
| Yamatotipula spec. | | 2 | | | | | 2 | | | | | 2 |
| Limnophila spec. | | | | 1 | | | | | | | | |
| Antocha spec. | 1 | | | | | | | | | | | |
| Aphrosylus spec. | | | | | | | 1 | | | | | |
| Melanocheilia riparia | | | | 2 | | | | | | | | |
| Dixa submaculata | | | | 1 | | | | | | | | |
| Bezzia spec. | | | | | | | | | | | | |
| Palpomyia tibialis | | | | | | | | | | | | |
| Palpomyia spec. | | | | | | | | | | | | |
| Ephydridae spec. | | | | | | | | | 1 | | | |
| Chaoborus flavicans | | | | | | | | | | | | |
| Atherix variegata juv. | 1 | | | | | | | | | | | |
| Simulium equinum | | | | | | | | | | | | |
| Simulium spec. | 104 | 144 | | 11 | | | | | | | | |
| Procladius | | | | | | | | | | | | |
| Clinotanypus | | | | | | | | | 2 | | | |
| Pentaneurini spec.(juv) | 3 | | | | | | | | | | | |

Species not listed in the Modified System of Moller Pillot, continued.

Appendix IIIA cont.

| Sampling station: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Corynoneura spec. | | | | | | | | | | | | |
| Microcricotopus cf bicolor | 14 | 302 | | 2 | | | | | | | | |
| Cricotopus gr.sylvestris | 3 | | 161 | | | | | 322 | 3 | | | |
| Cricotopus sp.A | 17 | 15 | 11 | 4 | | 2 | | 5 | | | | |
| Cricotopus sp.B | | | | 6 | | | | | | | | |
| Orthocladiinae sp.1 | 3 | 4 | | | | | | | | | | |
| Orthocladiinae sp.2 | 6 | | | | | | | | | | | |
| Orthocladiinae juv. | 14 | | | | | | | | | | | |
| Microtendipes spec. | | 4 | | | | | | | | | | |
| Micropsectra ge.praecox | | | | 2 | | | | 5 | | | | |
| Tanytarsus | | | | 2 | | | | | | | | |
| Paratanytarsus | | 34 | | | | | | | | | | |
| Polypedilum gr.convictum | 26 | | | | | 2 | | | 2 | | | |
| Potthastia longimanus | | 8 | | | | | | | | | | |
| Chironomidae pupae | | | | | | | | | | | | |
| Planorbis planorbis | | | | | | | | | 2 | | | 4 |
| Planorbis leucostoma | | | | | | | | | | | | |
| Planorbis vortex | | | | | | | | | 1 | | | |
| Pisidium spec. | | | | 37 | | | 1 | | 1 | | | |
| Sphaerium spec. | 1 | | | 15 | | | 1 | | 23 | | | 162 |
| Physa fontinalis | | | 3 | | 2 | | | | | | | |
| Hydrobia ulvae | 2 | 4 | | 10 | | 14 | | | 13 | | | 478 |
| Hydrobia cf.stagnorum | | | | | | | 1 | | | | | |
| Potamopyrgus Jenkinsi | 4 | 2 | | 23 | | 95 | 3 | | 6 | | | 141 |
| Potamop.Jenk.f.aculeata | | | | | | | | | | | | |
| Lymnaea peregra f.ovata | 1 | | 33 | 32 | 3 | 137 | 2 | | 23 | | | 52 |
| Lymnaea auruculavia(dead) | | | | | | | | | | | | |
| Lymnaea stagnalis | | | | | | | | | 1 | | | |
| Bithynia tentaculata | | | | | | | 4 | | | | | 1 |
| Valvata piscinalis | | | | | | | 1 | | 1 | | | 65 |
| Viviparus viviparus | | | | | | | | | | | | |
| Acroloxus lacustris | | | 19 | | | | | | | | | |
| Anodonta spec. | | | | | | | | | | | | |
| Gasterosteus aculeatus | | | | 2 | | 7 | 12 | | | | | |
| Pungitius pungitius | | | | | | | 6 | | | 1 | | |
| Eel | | | | | | | | | | | | |
| Spongillidae | | | | | | | | | | | | |
| Ostracoda | | | | | | | | | | | | |
| Number of species | 46 | 40 | 14 | 37 | 8 | 25 | 32 | 15 | 30 | 8 | 4 | 21 |
| Number of organisms | 612 | 1178 | 564 | 369 | 138 | 680 | 254 | 579 | 305 | 108 | 74 | 1083 |
| Groups of species (for calculation of Biotic-index) | 31 | 30 | 12 | 27 | 8 | 19 | 28 | 8 | 26 | 6 | 4 | 21 |

(x): does not count for totals (numbers or species or groups).

River Trent Watershed; EEC-seminar sept./oct.1976. **Appendix IIIB**

Species not listed in the Modified System of Moller Pillot.

| Sampling station: | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polycelis spec. | | | | | | | | | | | 6 | |
| Dugesia spec. | | | | | | | | 4 | | | | |
| Lumbricidae | | | | | | | | | 2 | | | |
| Stylaria lacustris | | 5 | | | 2 | | | 4 | | NO SAMPLE TAKEN | 7 | 1 |
| Trocheta subviridens | | | | | | | | | | | | |
| Hemiclepsis marginata | | | | 1 | | | | | | | | |
| Theromyzon tessulatum | | | | | | | | | | | 1 | |
| Piscicola geometra | | 1 | | | | | | | | | | |
| Crangonyx pseudogracilis | | | 7 | 39 | | | 1 | | | | | |
| Gammarus tigrinus | | | | | | | | | | | | |
| Plecoptera(juv.)cf Isoperla | | | | | | | | | | | | |
| Leuctra inermis | | | | | | | | | | | | |
| Gerris spec. Larvae | | | | | | | | | | | | |
| Sigara striata | | 6 | 41 | | 4 | | 4 | | | | | 8 |
| Sigara falleni | | 11 | 4 | | | | 28 | | | | | 1 |
| Sigara lateralis | | | | | | | | | | | 20 | |
| Sigara semistriata | | | | | | | | | | | | 1 |
| Sigara cincinna | | | | | | | | | | | 5 | |
| Sigara spec. | | | | | | | | | | | | |
| Corixa punctata | | | | | | | 1 | | | | | |
| Corixa dorsalis | | | | | | | | | | | | |
| Notonecta glauca | | | | | | | 1 | | | | | |
| Hydropsyche angustipennis | | | | 4 | | | | | | | | |
| Agraylea multipunctata | | | | 1 | | | | | | | | |
| Leptoceridae spec. | | | | | | | | | | | | |
| Mystacides cf.azurea | | | | | | | | | | | | |
| Limnephilidae spec. | | | | | | | | | | | | |
| Hydroptila sp.(empty) | | | | | | | | | | | | |
| Sialis spec. | | 12 | | | | | 4 | 6 | | | 5 | |
| Rhantus exsoletus | | | | | | | 1 | | | | | |
| Ilybius sp. Larvae | | | | | | | 1 | 1 | | | | |
| Haliplus sp.(Larv.+Ad) | | 6 | 32 | 60 | 1 | | 8 | 2 | | | 8 | |
| Stictotarsus duodecimpus. | | 14 | | | | | | 3 | | | | |
| Hygrotus (2 spp) | | | | | | | 40 | | | | | |
| Hydroporus (2 spp) | | | | | | | 16 | 1 | | | | |
| Brychius elevatus | | | | | | | | | | | | |
| Yamatotipula spec. | 1 | | | | | | | | | | | |
| Limnophila spec. | | | | | | | | | | | | |
| Antocha spec. | | | | | | | | | | | | |
| Aphrosylus spec. | | | | | | | | | | | | |
| Melanocheilia riparia | | | | | | | | | | | | |
| Dixa submaculata | | | | | | | | | | | | |
| Bezzia spec. | | | | | | | 1 | 29 | | | | |
| Palpomyia tibialis | | | | | | | | 1 | | | | |
| Palpomyia spec. | | | | | 1 | | | | | | | |
| Ephydridae spec. | | | | | | | | | | | | |
| Chaoborus flavicans | | | 7 | | | | | | | | | |
| Brachycera pupae spec | | | | | | | | | | | | 2 |
| Simulium equinum | | | | 2 | | | | | | | | |
| Simulium spec. | | | | | | | | | | | 74 | |
| Procladius | | | | | 2 | 63 | 44 | 23 | | | 4 | 1 |
| Clinotanypus | | 5 | | | | | 112 | | | | | |
| Pentaneurini spec.(juv) | | | | | | | | | | | | |

Species not listed in the Modified System of Moller Pillot, Appendix IIIB, cont. 
continued.

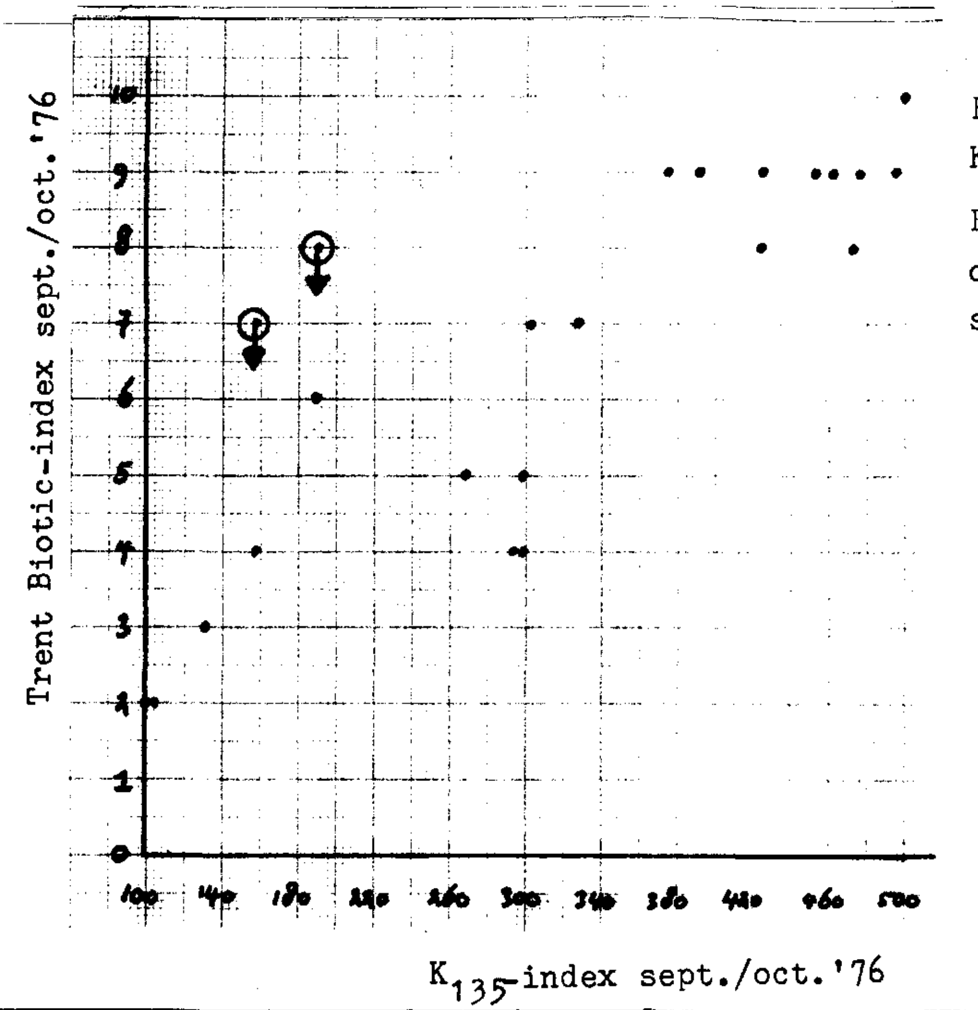
| Sampling station: | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Corynoneura spec. | | 29 | | | | | | | | NO SAMPLE TAKEN | | |
| Microcricotopus cf bicolor | | | | | | | | | | | | 1 |
| Cricotopus gr.sylvestris | | 39 | 1 | 12 | 11 | | 7 | 9 | 73 | | 2 | 1 |
| Cricotopus sp.A | 1 | 3 | | 66 | 53 | | | | | | 6 | 1 |
| Cricotopus sp.B | | 3 | | 36 | | | | | | | | |
| Orthocladiinae sp.1 | | 3 | | | | | | | | | | |
| Orthocladiinae sp.2 | | | | | | | | | | | | |
| Orthocladiinae juv. | | | | | | | | | | | | |
| Microtendipes spec. | | | | | | | | | | | | |
| Micropsectra ge.praecox | | | | | | | | | | | | |
| Tanytarsus | | | | | | | | 20 | | | | |
| Paratanytarsus | | | | | | | | | | | | 2 |
| Polypedilum gr.convictum | | 3 | | | | | 44 | 6 | | | 2 | |
| Potthastia longimanus | | | | | | | | | | | | |
| Chironomidae pupae | 1 | 1 | | | | | | | | | | |
| Planorbis planorbis | | | | | | | | | | | | |
| Planorbis leucostoma | | | | | | | | 1 | | | | |
| Planorbis vortex | | | | | | | | | | | | |
| Pisidium spec. | | | | 12 | | | | | | | | |
| Sphaerium spec. | | 28 | 1 | 50 | | | 18 | 33 | | | | |
| Physa fontinalis | | 27 | | 12 | | | | 2 | | | | |
| Hydrobia ulvae | | | | 375 | | | | 2 | | | | |
| Hydrobia cf.stagnorum | | | | | | | | | | | | |
| Potamopyrgus Jenkinsi | | 22 | | 644 | | | | 1 | | | | 1 |
| Potamop.Jenk.f.aculeata | 1 | | | | | | | | | | | |
| Lymnaea peregra f.ovata | | 57 | (1) | | | 5 | 1 | | | | | |
| Lymnaea aurucularia(dead) | | | (1) | | | | | | | | | |
| Lymnaea stagnalis | | 2 | (1) | | | | | | | | | |
| Bithynia tentaculata | | 28 | | 80 | | | 4 | 26 | | | | |
| Valvata piscinalis | | 26 | | 2 | | | 12 | | | | | |
| Viviparus viviparus | | 2 | | | | | | | | | | |
| Acroloxus lacustris | | | 1 | | | | | | | | | |
| Anodonta spec. | | 4 | | | | | | | | | | |
| Gasterosteus aculeatus | | | | | | | | | | | | |
| Pungitius pungitius | | | | | | | | | | | | |
| **Eel** | | | | | | | | | | | | (1) |
| Spongillidae | | | (1) | | | | | | | | | |
| Ostracoda | | | | | | | | | | (20,000) | | |
| Number of species | 11 | 36 | 16 | 28 | 15 | 7 | 33 | 35 | 3 | -- | 18 | 21 |
| Number of organisms | 34 | 617 | 226 | 2233 | 759 | 327 | 1506 | 440 | 150 | --- | 274 | 68 |
| Groups of species (for calculation of Biotic-index) | 10 | 27 | 14 | 25 | 11 | 5 | 26 | 28 | 2 | --- | 11 | 13 |

(x): does not count for totals (species, numbers or groups).

Calculation of the Median Trent Biotic-index over the period january - august 1976 (based on data from Woodiwiss 1976)

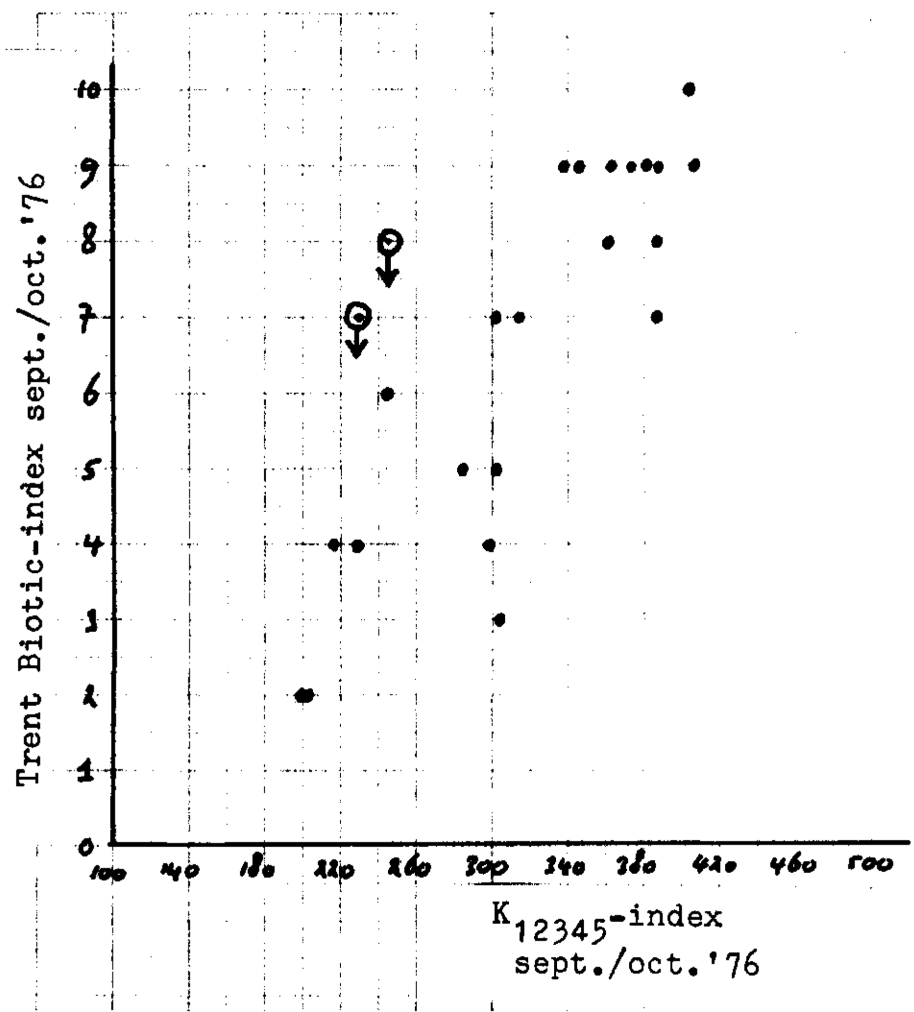
| Station | Trent Biotic-index | Median |
|---|---|---|
| 1 | 9 9 9 9 10 10 10 10 10 10 10 10 10 10 10 10 10 | 10 |
| 2 | 8 9 10 10 10 10 10 10 | 10 |
| 3 | 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4 4 4 5 5 | 4 |
| 4 | 6 6 7 7 7 8 10 | 7 |
| 5 | 3 3 3 3 4 4 4 5 5 5 | 4 |
| 6 | 4 4 4 4 4 4 4 4 5 6 | 4 |
| 7 | 6 7 7 7 7 8 8 8 8 8 8 | 8 |
| 8 | 2 2 | 2 |
| 9 | 7 7 8 8 8 8 9 9 | 8 |
| 10 | 3 3 3 3 3 3 3 3 3 3 3 3 4 4 4 | 3 |
| 11 | 4 4 4 4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 6 6 | 5 |
| 12 | 5 6 6 7 7 7 8 8 8 8 | 7 |
| 13 | 4 4 4 4 4 5 5 5 5 5 6 6 6 | 5 |
| 14 | 7 8 8 8 8 8 8 8 9 | 8 |
| 15 | 4 5 5 5 6 6 6 6 6 6 6 8 8 | 6 |
| 16 | 6 6 6 6 6 7 7 7 7 7 8 8 8 9 | 7 |
| 17 | 3 3 4 5 5 5 5 6 6 | 5 |
| 18 | 2 2 2 2 3 3 4 4 4 4 5 5 5 5 5 5 | 4 |
| 19 | 4 4 5 5 5 5 6 6 6 6 6 6 7 7 8 | 6 |
| 20 | 4 6 6 6 7 7 7 7 8 8 | 7 |
| 21 | 1 1 2 2 2 2 2 2 2 2 2 2 2 3 | 2 |
| 23 | 6 6 6 7 7 8 | 7 |
| 24 | 4 6 7 7 7 7 8 | 7 |

Appendix V A



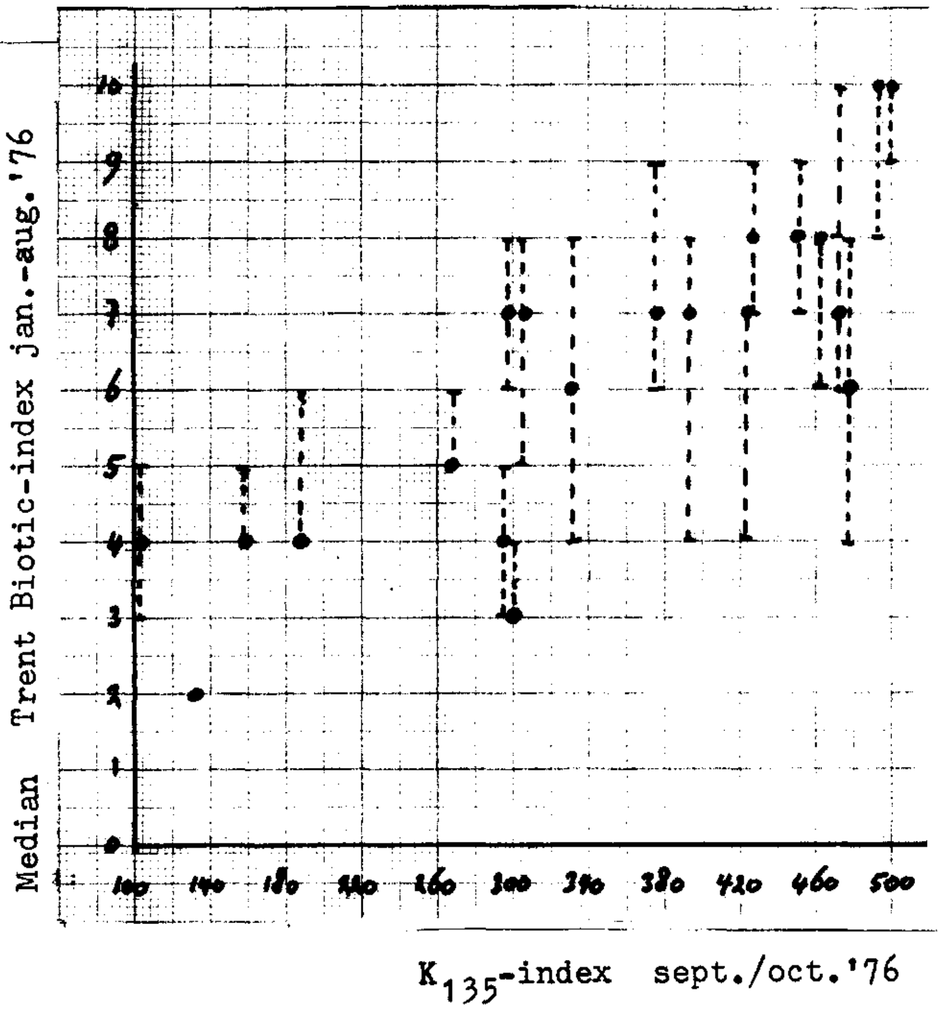

Relationship between $K_{135}$ and the Trent Biotic-index based on the dutch data, sept./oct.1976.

Appendix V-B




Relationship between $K_{12345}$ and the Trent Biotic-index based on the dutch data, sept./oct.1976

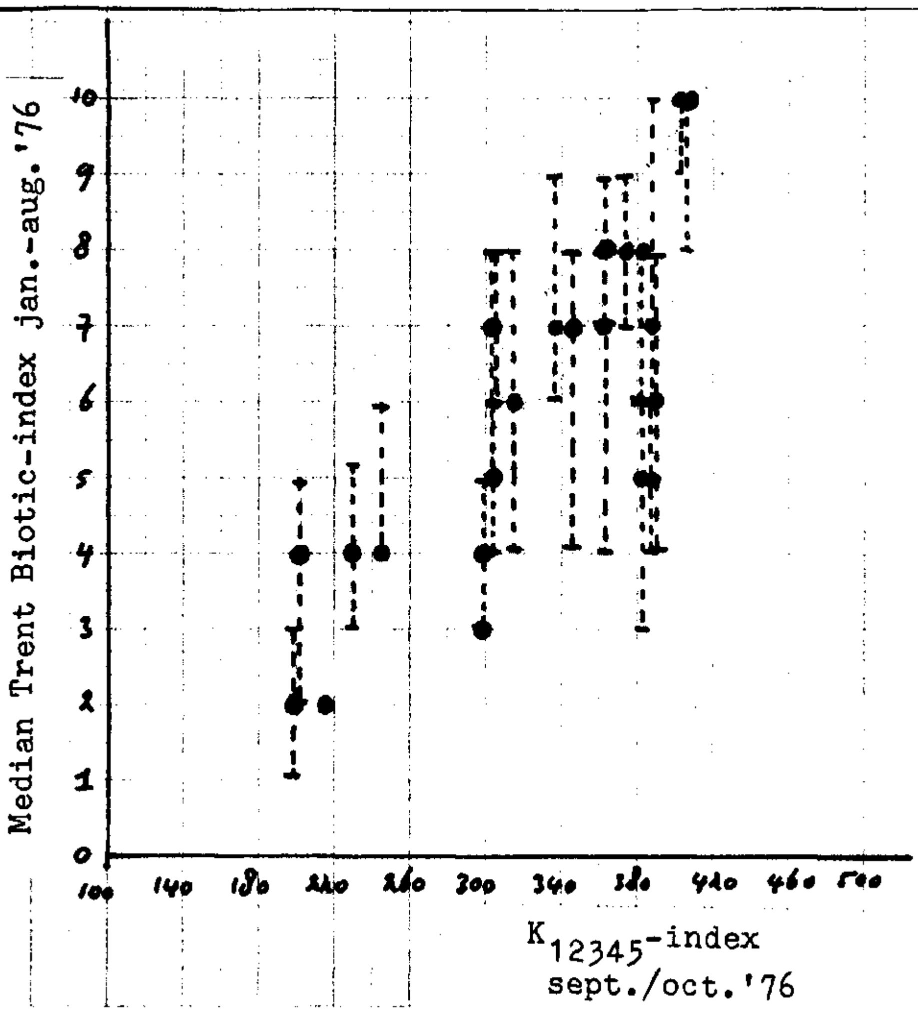
Appendix V-C




Relationship between $K_{135}$ (sept./oct.'76) and the Median Trent Biotic-index (jan.-aug.1976)

The dotted line reaches the minima and maxima

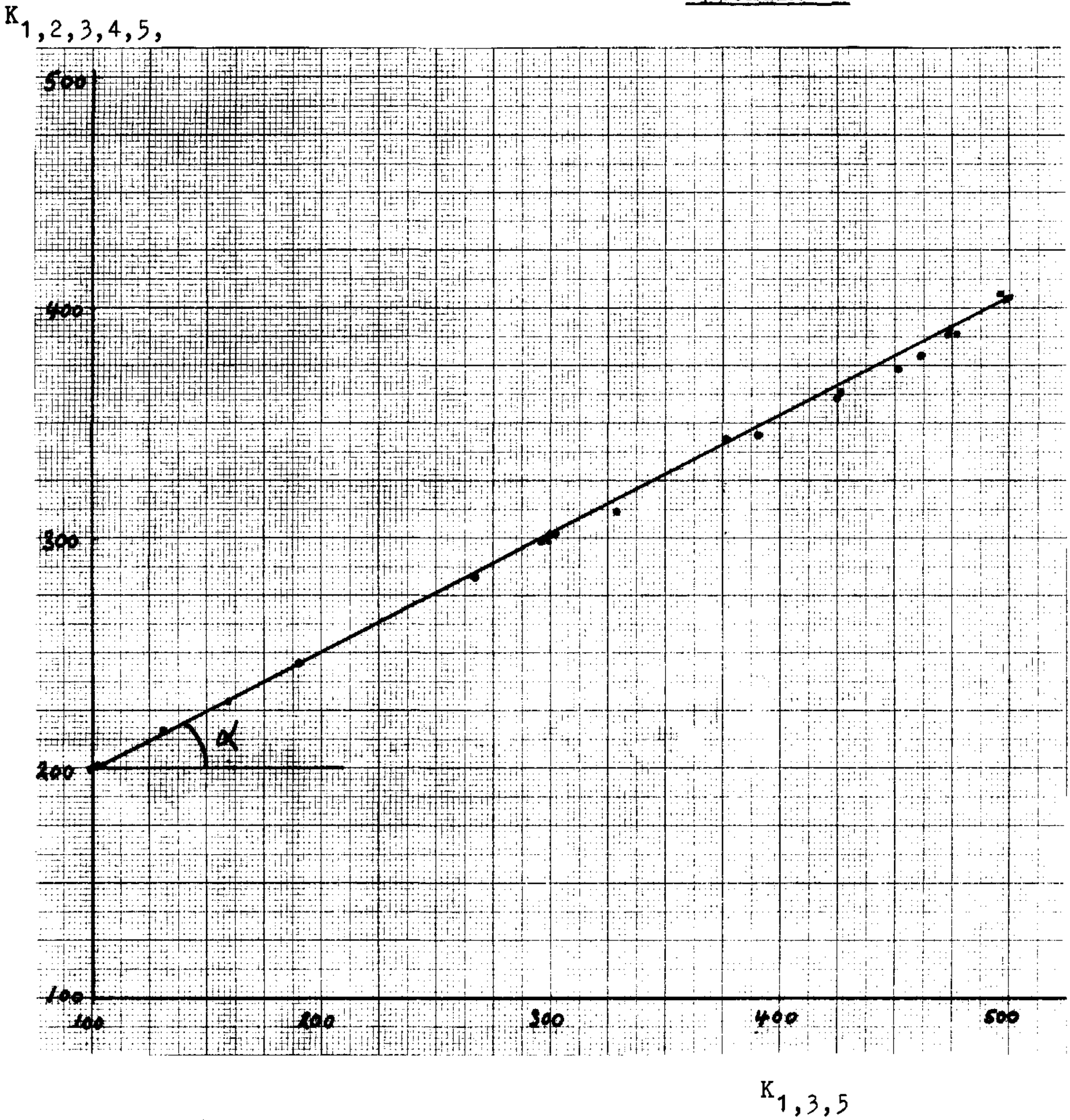
Appendix V-D




Relationship between $K_{12345}$ (sept./oct. 1976) and the Median Trent Biotic-index (jan.-aug.1976).

The dotted line reaches the minima and maxima.

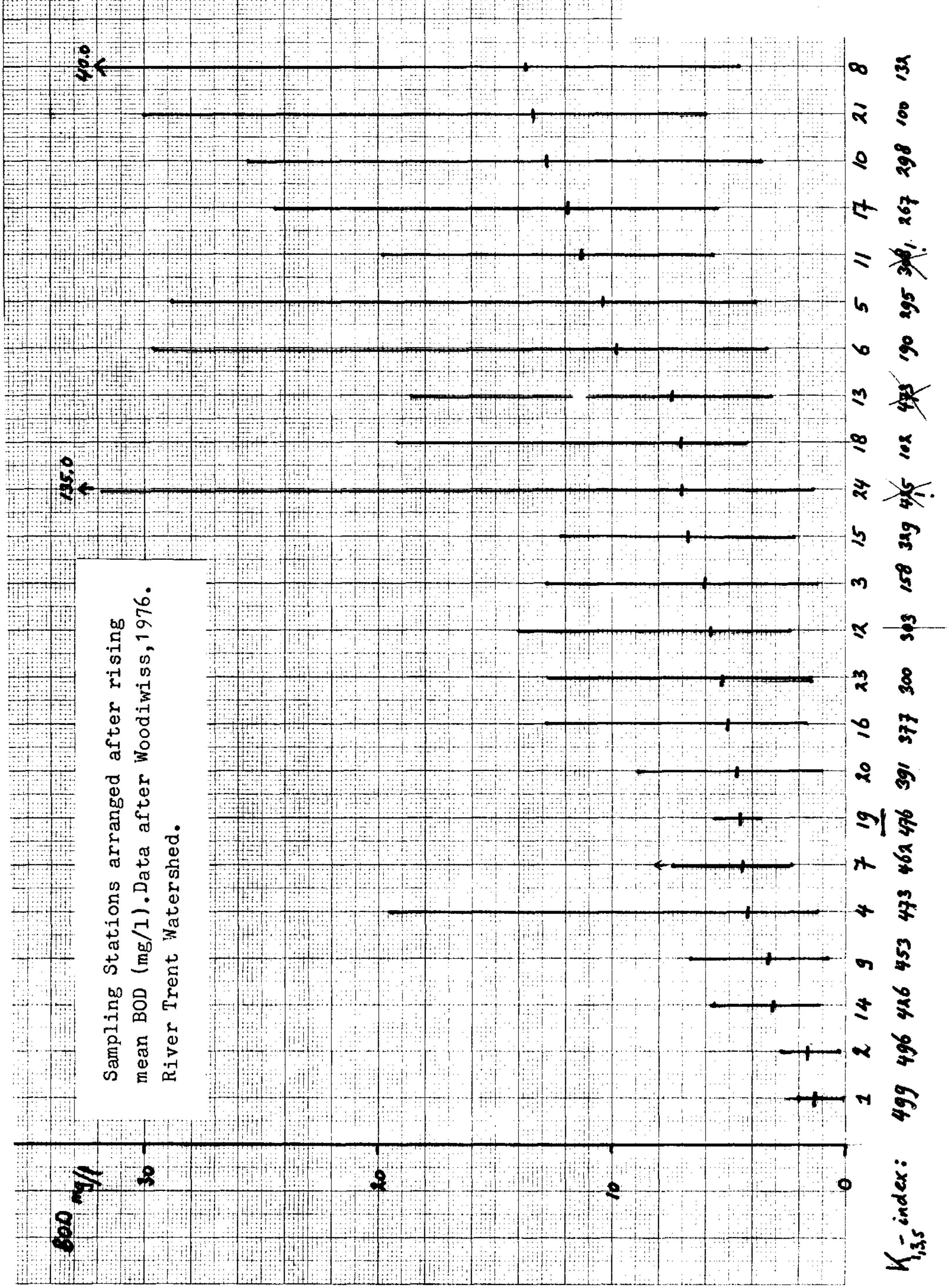
Appendix VI



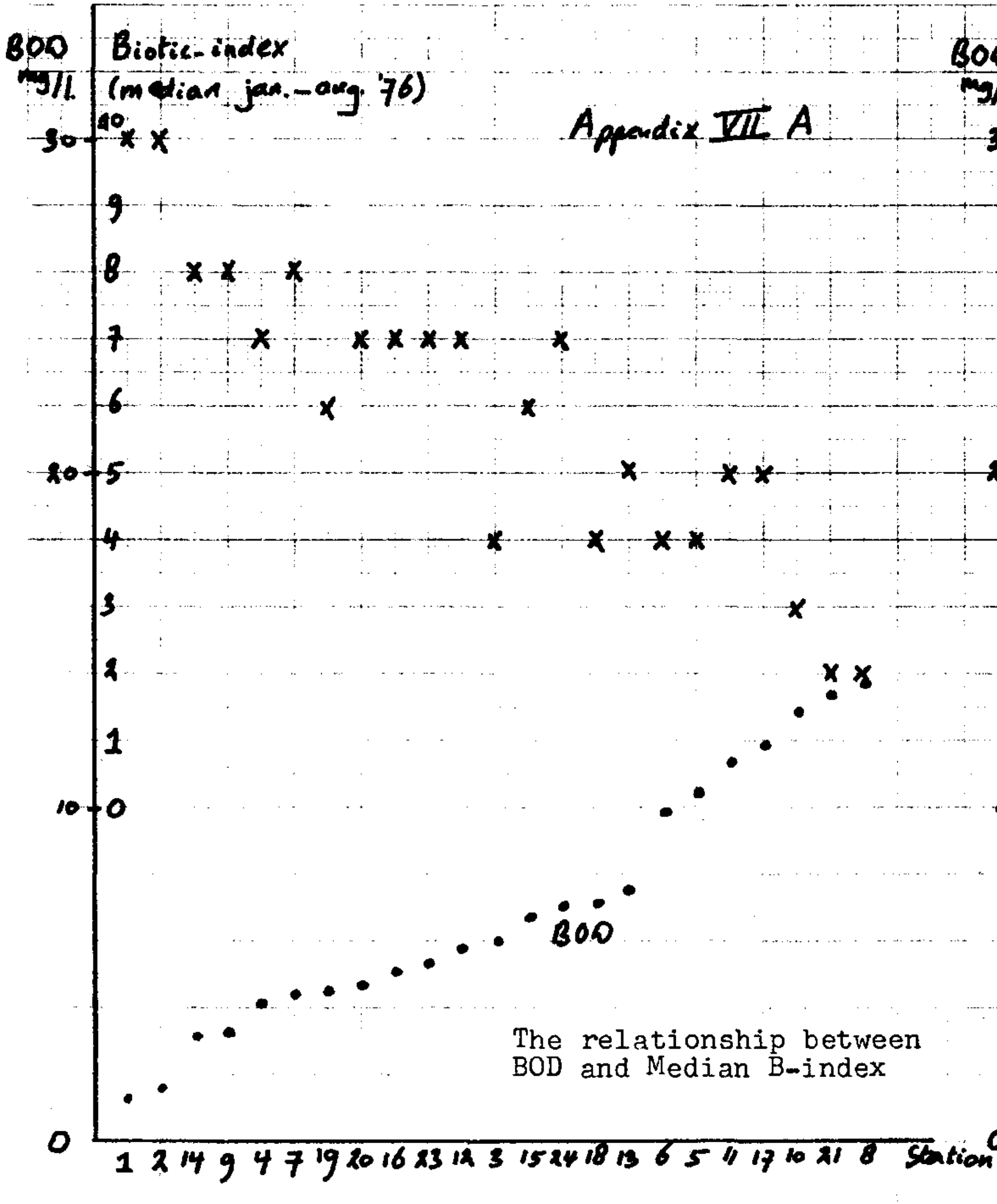

The relationship between the Quality index calculated with pollutional factors 1 , 3 and 5 and the Quality-index calculated with pollutional factors 1 , 2 , 3 , 4 and 5.
Data : EEC-seminar River Trent Watershed, sept./oct.1976.

$$K_{12345} - 100 = tg\,\alpha \cdot (K_{135} - 100) + 100$$

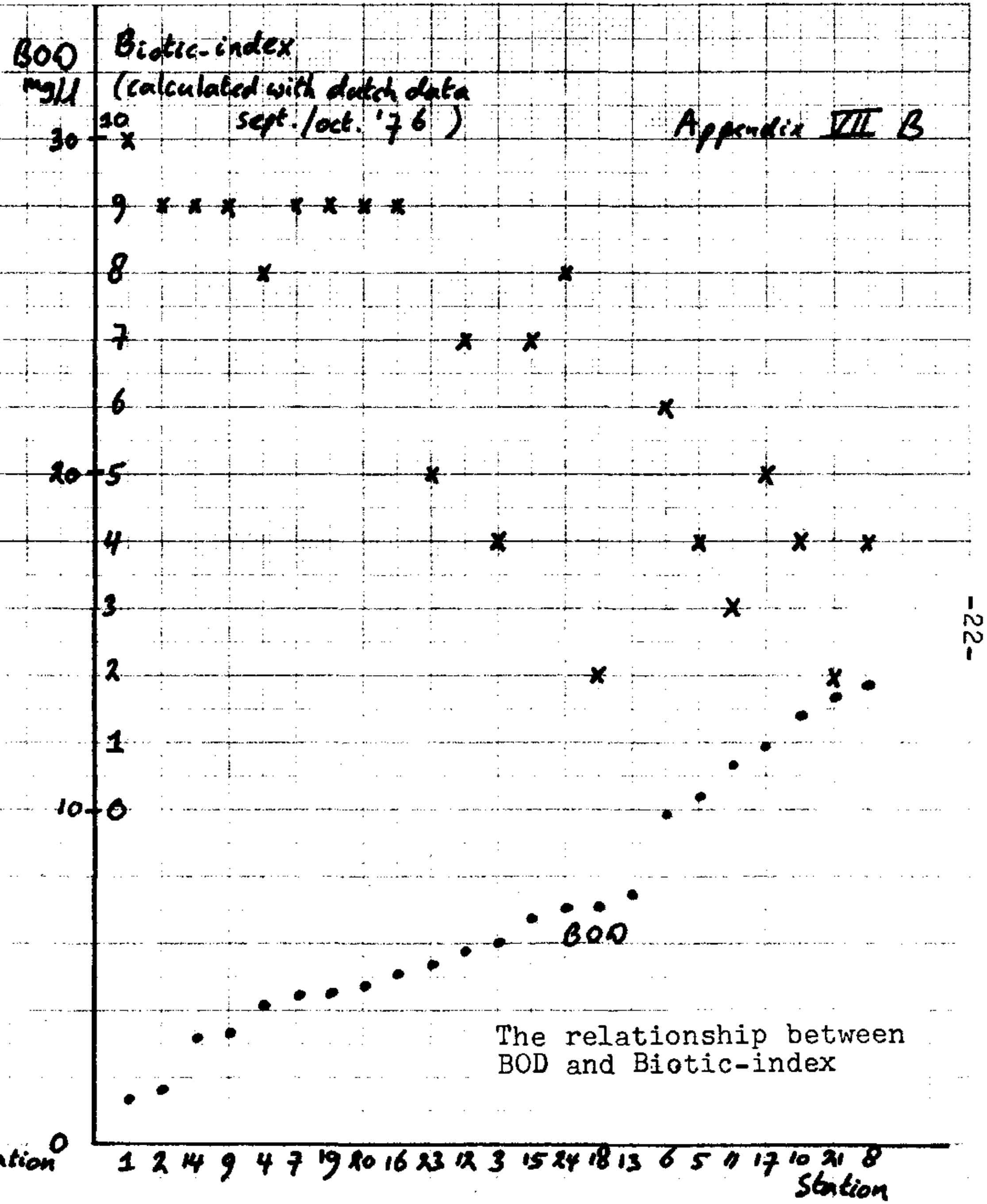
## Appendix VII




Sampling Stations arranged after rising mean BOD (mg/l).Data after Woodiwiss,1976. River Trent Watershed.

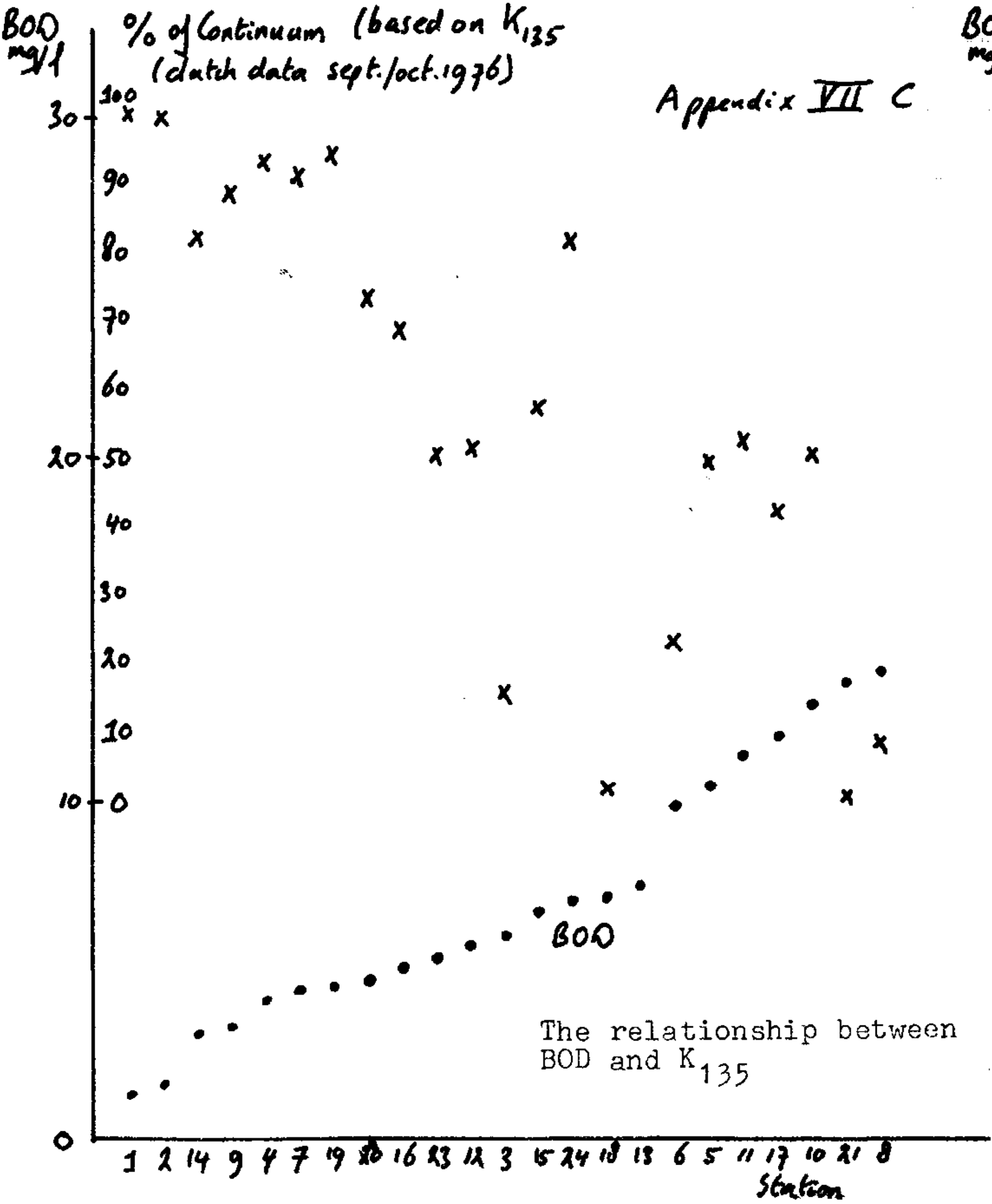



The relationship between BOD and Median B-index



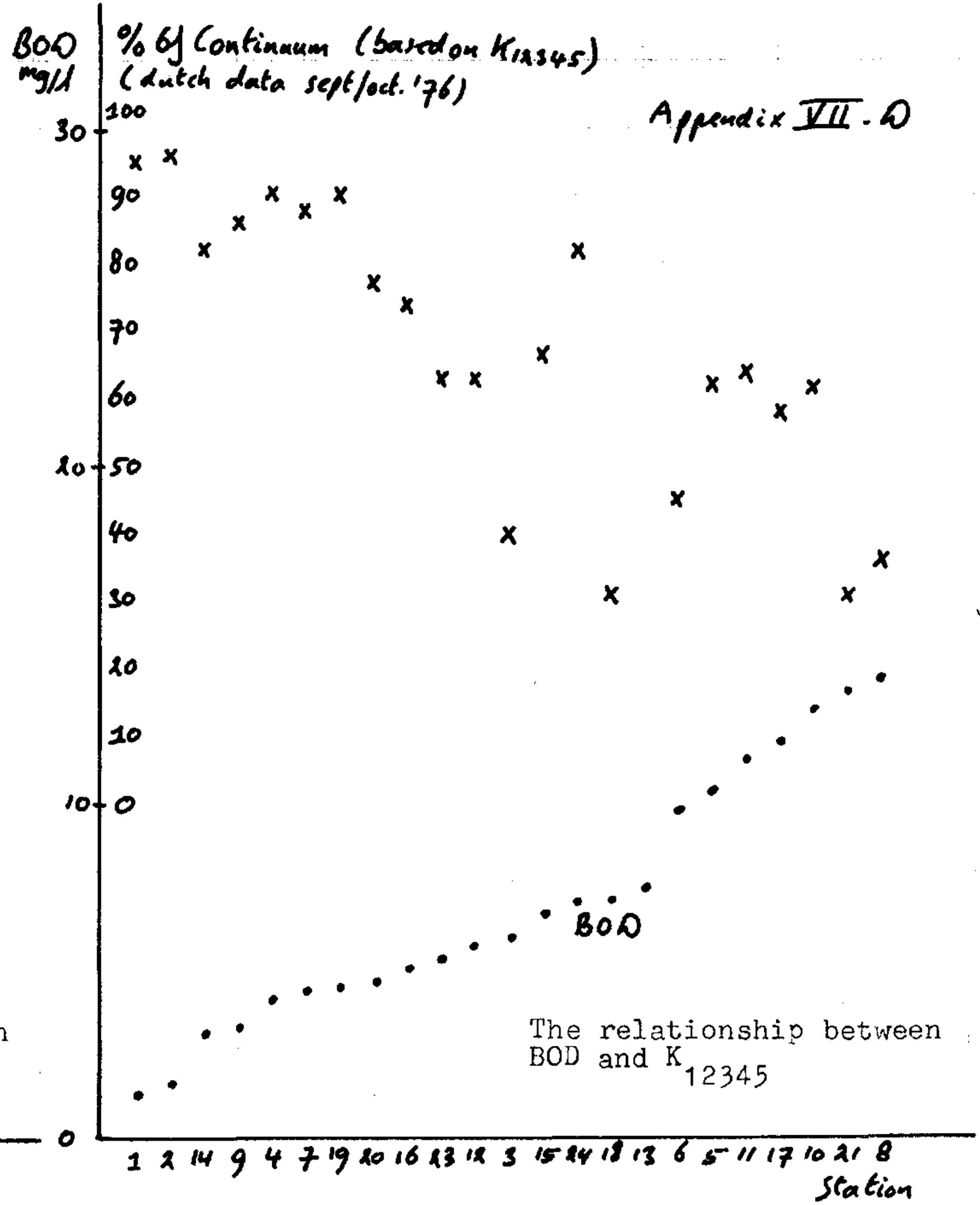

The relationship between BOD and Biotic-index

Appendix VII C




The relationship between BOD and $K_{135}$

Appendix VII . D




The relationship between BOD and $K_{12345}$

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