ASPECTS OF THE INVERTEBRATE ECOLOGY OF THE NWANEDZI TRIBUTARY OF THE LIMPOPO RIVER

BY

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SUBMITTED

IN FULFILMENT OF PART OF THE REQUIREMENTS FOR THE DEGREE

MASTER OF SCIENCE

IN THE

DEPARTMENT OF ZOOLOGY

IN THE

FACULTY OF MATHEMATICS AND NATURAL SCIENCES

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MARCH 1981

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CHAPTER 1

INTRODUCTION

Naturally occuring rivers, streams, lakes and artificial pond constructions all support their own peculiar fauna whose composition and habits vary greatly with time. The nature of faunal and floral communities in a stream is largely determined by groups of interrelated factors, namely the chemo-physical nature of the water, nature of the stream bed and current speed.

Riverine ecology in South Africa had been neglected until the late 1950's, although substantial systematic studies on individual aquatic genera and species date from as far back as 1924 when Sars studied the freshwater Entomostraca of the Cape Province. Later works include, amongst others, a study of the Notonectidae and Corixidae of South Africa (Hutchingson, 1929); Ephemeroptera (Barnard, 1932 and Crass, 1947 and 1955); Trichoptera (Scott, 1963 a and b, 1968); De Kock (1966) studied the distribution and habitat selection of Mollusca in the Mooi River; Prinsloo (1966) did a study on temperature as an ecological factor on *Lymnaea natalensis* and *Bulinus tropicus*; Noble and Eksteen (1967) worked on the production biology of larvae of *Cheumatopsyche thomasseti*; Noble and Schaefer (1967) studied the South African Cladocera, while Oberholzer and Van Eeden (1967) worked on the fresh water Mollusca of the Kruger National Park and Schoonbee (1968) revised the genus *Afronurus*.

During the 1950's scientists became increasingly aware of the general lack of ecological surveys on South African riverine fauna as well as the possible detrimental effects of industrial, agricultural and domestic pollution on aquatic habitats. The first detailed investigation on general riverine Limnology was done on the Great Berg River (Harrison and Elsworth, 1958). Subsequently a number of studies were undertaken on the qualitative and quantitative composition of the benthic communities in relation to environmental conditions (Oliff, 1960; Allanson, 1961; Hughes, 1961; Harrison and Agnew, 1962; Chutter, 1963 and 1971; Harrison, Keller and Lombard, 1963; Schoonbee, 1963 a, b, c and 1964; Kemp et al 1967; Schoonbee and Kemp, 1967; Matthew, 1968; Booyse, 1971; Potgieter, 1971; Roode, 1971; Viljoen, 1974; Wessels, 1974; Batchelor, 1977; Pretorius, 1977 and Coetzer, 1978).

To evaluate the results of surveys carried out on polluted streams, one requires, as a basis, the results of surveys carried out on unpolluted streams, the subject of this survey were to carry out a detailed study of the stream biota in comparison with the chemo-physical parameters of the habitat and to evaluate the significance of faunistic movements known to occur in running waters.

The Nwanedzi River is an unpolluted, subtropical mountain stream which originates in the Soutpansberg Mountain Range and flows north-easterly until it joins the Limpopo River (Fig. 1.1). It has only one main tributary, the Luphephe Stream.

The Luphephe-Nwanedzi water resource is a good example of what Cole (1979) had in mind when he wrote:

> "As a result of our various demands, we have created new types of lakes and streams and modified preexisting natural aquatic habitats. We have destroyed segments of the aquatic biota while husbanding others".

During 1964, upon request by the Nwanedzi Irrigation Board, the Department of Water Affairs constructed two dams, one on each of the Luphephe and the Nwanedzi Rivers. Originally water of the Luphephe tributary joined the Nwanedzi at a point below the present dam walls, but with the construction of dams on both rivers, the position changed slightly as there is now a 2,5 m deep canal joining the two water bodies approximately 100 m from the respective walls (Fig. 1.2).

The present survey seeks to extend the work of previous researchers on the ecology and zoogeography of known genera and species of riverine invertebrates in South Africa as well as accentuating the effect of damming on the ecology of a stream.

Elliott (1967) pointed out that pools and dams act as "catching basins" for invertebrate drift and may, in addition, influence the normal distribution, occurrence, incidence as well as the environmental conditions of the stream fauna.

The term drift in respect of stream invertebrates, especially insects, refers to their downstream transportation by stream currents (Hynes, 1970).

While stream invertebrates are adapted for maintaining their position in running waters, it is to be expected that the occasional individual will lose its attachment or orientation to the substrate and drift downstream (Waters, 1972).

This has for some time been recognized as an integral feature of lotic environments. Invertebrate drift has received very little attention in South Africa, and to date only one study by Chutter (1975) was ever seen on record.

The fate of animals removed from their usual surroundings by natural agencies is a matter of particular biological interest.

Ulfstrand (1968) maintains that a percentage of the drifting animals are transported out of the river to parish, others succumb to strong currents, while others still are preyed upon by other stream inhabitants. However, most decolonized individuals eventually succeed in finding suitable habitat again. To gain an insight into this aspect of riverine ecology, it was endeavoured to place Dendy type plate samplers in the Luphephe and Nwanedzi Rivers.

The results obtained are unfortunately rather too scanty and do not allow for conclusive deductions and/or comparisons. Unfortunately this aspect of riverine biology has received little attention, if any, from South African Riverine Limnologists.

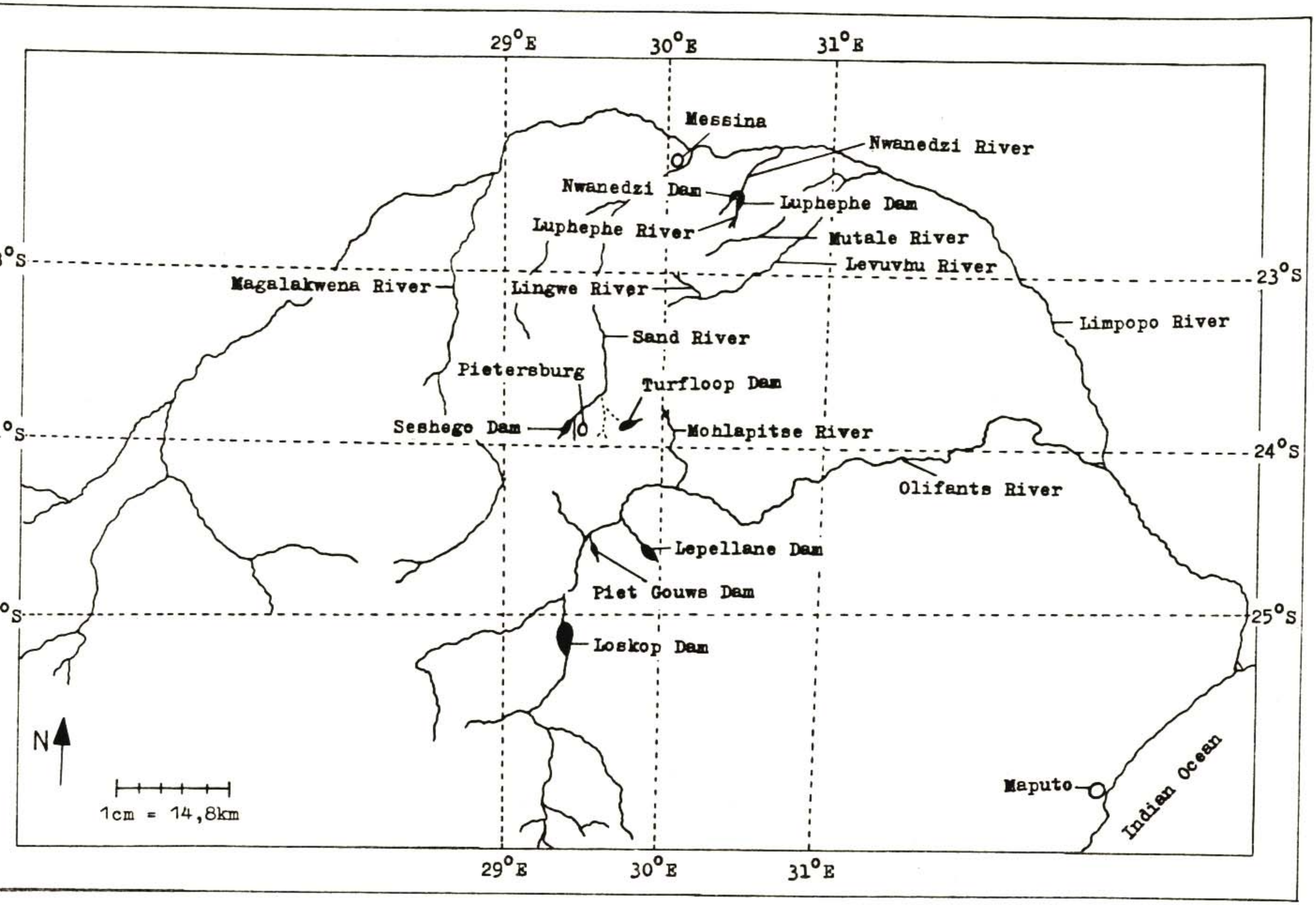


Figure 1.1 Map of the Limpopo River system showing location of the Nwanedzi River and the Luphephe Stream.

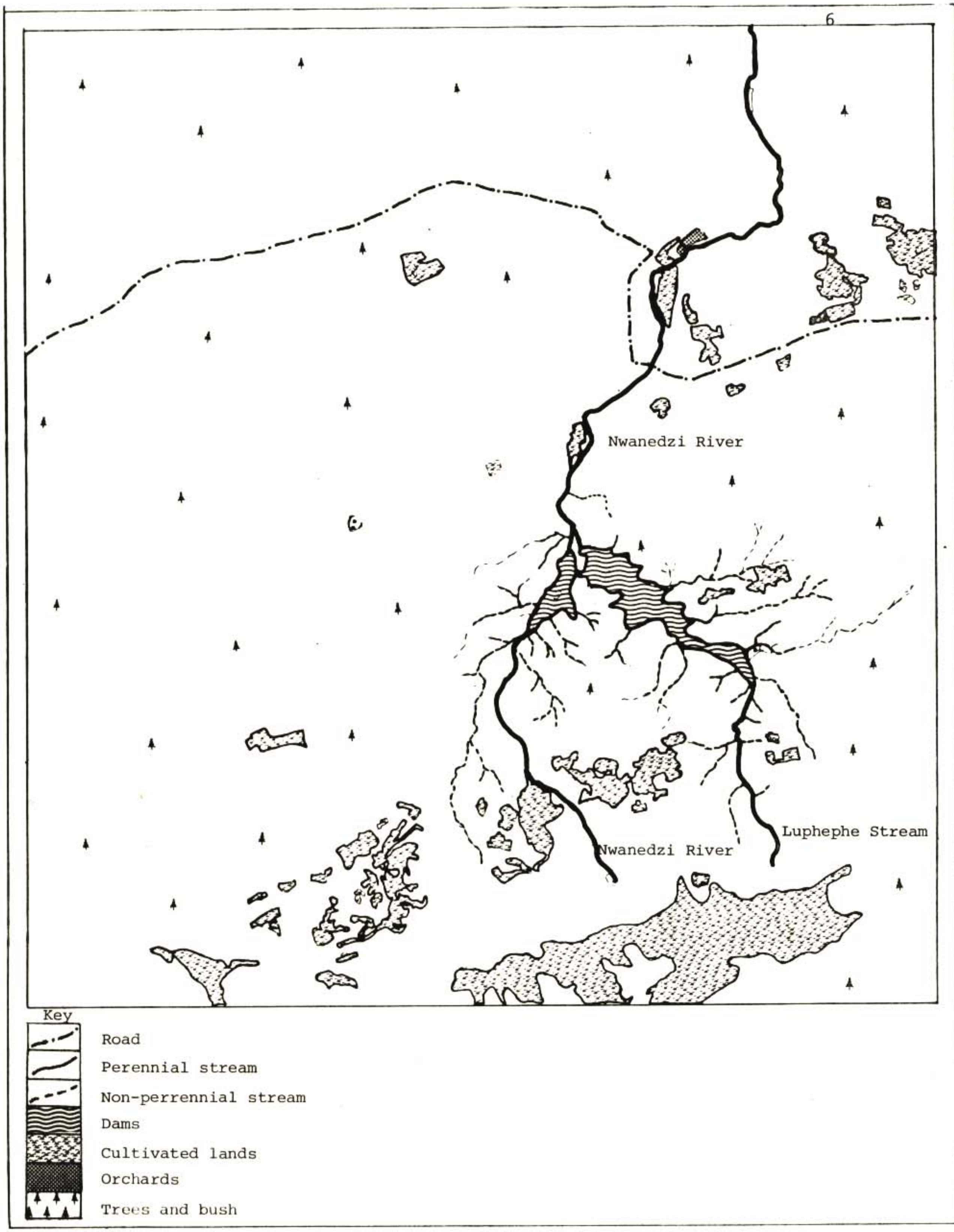


Fig. 1.2. Map showing the Nwanedzi River and the Luphephe Stream.

CHAPTER 2

DESCRIPTION OF NWANEDZI RIVER AND LUPHEPHE STREAM

2.1 Topography

The catchment area of the Nwanedzi River system occupies 746 square kilometers of the Venda Highlands on the northern slopes of the Soutpansberg Range and lies between 30° 21′ E to 30° 40′ E and 22° 21′ S to 22° 45′ S at an altitude of between 1 267 and 400 meters.

In addition to the Nwanedzi River, the plateau region is also drained, to the West, by the Njelele River and, to the East, by the Mutale River.

The Nwanedzi River catchment area falls within a subtropical and predominantly summer rainfall belt, where up to 85 percent of the annual rainfall occurs between September and April (Fig. 2.1). The vegetation types range from grassy plains to mixed Bushveld (Acocks, 1953).

From its origin the river meanders northwards for approximately 15 kilometers before it is joined by its major perennial tributary the Luphephe Stream (Fig. 1.2). Originally the Luphephe Stream merged with the Nwanedzi River at a point below the present dam walls, but the construction of the Luphephe-Nwanedzi twin impoundments changed this. The two rivers now deposit their run-off into the respective dams, which are, as was pointed out earlier (p. 3), connected by means of a joining canal. The Nwanedzi River below the impoundments is sluice fed from either or both dams.

From the impoundments this river flows north-easterly for approximately 50 kilometers before it joins the Limpopo River at a point ten kilometers north of Malaladrift.

The 15 kilometers of the Nwanedzi River, from its source to the impoundment, meanders through the foothills of the Soutpansberg and has a gradient of no less than 600 meters over this distance (Fig. 2.2). The Luphephe Stream similarly descends from an altitude of 1 067 to 667 meters over a distance of ten kilometers.

Geology

From its origin to the Limpopo River, the Nwanedzi River flows over three different geological formations, namely, the Soutpansberg Group, the Karroo Sequence and the Beit Bridge Complex.

To the north of Mavhode (Fig. 1.2), the Nwanedzi River flows for eight kilometers through a narrow, winding kloof in mountainous terrain, where Dolerite dykes and Cave Sandstone have been weathered out into narrow, straight cuttings or gullies. Along the stream, ravines with inaccessible banks have been formed. Between the dams and Gaandrik (Fig. 1.2) where the river flows over the Soutpansberg Group, as well as between Gaandrik and Trevenna where it passes over Karroo rocks, wide reed covered marshes have been formed.

2.2 Zonation of the river

Oliff (1960) subdivided the Tugela River into three main regions with eight distinct zones. These regions are: a torrential upper region; a stable middle region, where deposition balances erosion and the lower valley region, where the river traverses a flood plain.

The zonation of the Nwanedzi River, which was based on profile steepness and nature of the bottom, followed the above pattern.

Two zones were identified in the torrential upper region, viz., a Source Zone and a Waterfall to Mountain torrent Zone. The middle and lower regions were represented by one zone each, viz., a Foothill Zone and a Valley Zone respectively. The Source Zone lies between 1 598 and 1 037 meters above sea level and is about 1,5 kilometers long.

The Waterfall to Mountain torrent Zone begins where the water plunges 427 meters over the steep sided face of the mountain in a series of waterfalls and rapids. This zone covers a distance of about 11 kilometers.

The Foothill Zone is approximately 32 kilometers long and commences at an altitude of 610 meters where the valley widens slightly. The Nwanedzi impoundment is located in this zone. The substratum in the section of the zone above the impoundment is largely of a stony type, consisting of boulders and stones with intermittent gravel areas and a few small soft bottomed pools. The substratum of the section below the impoundment is, except for the occurrence of more substantial pools and sandy bottoms, more or less similar to the one described above. The Foothill Zone ends in the vicinity of Suzette (Fig. 1.2) at an altitude of 427 meters. The fourth zone, the Valley Zone, has a shallow gradual gradient of about 2,7 meters to a kilometer (Fig. 2.2).

Up to its confluence with the Limpopo River, this zone flows for approximately 22 kilometers over the shale and calcareous sediments of the Beit Bridge Complex.

The Luphephe Stream which joins the Nwanedzi River in its upper catchment area, has a relatively steep profile. Only two of the Nwanedzi River zones are present throughout the whole of this stream, namely, the Source Zone and the Waterfall to Mountain torrent Zone.

The Source Zone commences at an altitude of 976 meters and is approximately one kilometer long. The Waterfall to Mountain torrent Zone flows between 915 and 610 meters above sea level over a series of small falls and rapids. The substratum of the entire stream is predominantly of a stony nature consisting of boulders, stones and large pebbles. Occasional sand patches occur.

2.3 Habitat types (Water types)

Allen (1951) surveyed the biological productivity of the Horokiwi Stream in New Zealand and came to recognize various distinct water types in a riverine aquatic ecosystem, each with its characteristic physical, chemical and biological features.

Harrison and Elsworth (1958) and Schoonbee (1964) also used Allen's classification for the Great Berg River and Umgeni River respectively. The latter authors, however, mentioned definite ranges etc.

The following divisions and definitions of habitat types sampled in the Nwanedzi River system are based on the works mentioned above.

Pools

> "Water of considerable depth for the size of the stream, current generally slight and flow smooth apart from small turbulent areas at the head of some pools".
>
> (Allen, 1951)

> "Current under 30 cm per second; depth over 70 cm".
>
> (Harrison and Elsworth, 1958 and Schoonbee, 1964)

Only one pool was sampled in the Nwanedzi River and its average depth exceeded 250 cm.

More details of the physical characteristics of this pool appear on tables.

Flats

> "Water of slight to moderate current and generally smooth flow, but of less depth than in pools".
>
> (Allen, 1951)

> "Current under 30 cm per second; depth under 45 cm".
>
> (Harrison and Elsworth, 1958 and Schoonbee, 1964)

The average depth of flats sampled in the Nwanedzi River was 41 cm whilst the maximum current speed recorded was 43 cm per second.

For more details of the physical characteristics of the 'Nwanedzi Flats' see tables.

Runs

> "Water of moderate to rapid current and fairly deep, flow usually turbulent. In such places the stream is usually of less than average width".
>
> (Allen, 1951)

> "Current over 30 cm per second; depth over 30 cm, runs in sandy areas are shallower".
>
> (Harrison and Elsworth, 1958 and Schoonbee, 1964)

The runs sampled below the impoundments in the Nwanedzi River generally exceeded depths of 50 cm and with currents of up to 136 cm per second. For more details of the physical characteristics of the 'Nwanedzi Runs' see tables.

Stickles

> "Shallow water with a rapid current and usually a broken flow. Such conditions are often described as 'ripples', 'rapids' or 'riffles'."
>
> (Allen, 1951)

> "Current over 30 cm per second; depth under 30 cm. The same portion of the river might be a run in the wet seasons and a stickle in the dry".
>
> (Harrison and Elsworth, 1958)

The stickles encountered in the Nwanedzi River system were up to 35 cm deep and with currents ranging between 80 cm per second and 119 cm per second.

For more details of the physical characteristics of the 'Nwanedzi Stickles" see tables.

The following substrate types were found within the various habitat types sampled:

(a) Stony to gravel bottoms - in runs, flats and stickles.
(b) Sandy bottoms - in flats, pools and runs.
(c) Muddy bottoms - in pools.
(d) Flanking or Marginal Vegetation - lining runs, stickles and pools.

This survey did not include a detailed study of the aquatic vegetation because submerged vegetation was hardly present in this system. Flanking macrophytes were sampled where they dipped into the water and so formed a lodging for certain groups of aquatic invertebrates.

2.4 Sampling Stations

After an exploratory investigation of the Luphephe Stream and the Nwanedzi River, three sampling stations were selected. For the purpose of this study one sampling station was selected in the Nwanedzi River, another in the Luphephe Stream, and the third of their confluence downstream of the Luphephe-Nwanedzi twin impoundments (Fig. 1.2).

The following criteria were used in selecting the stations:

(a) For the objectives of this survey, as stipulated on page , the sampling stations had to be selected as close as possible to the Luphephe-Nwanedzi twin impoundments - hence the location of all three stations in the Foothill Zone.

(b) Accessibility of the stations.

(c) Each station was chosen in such a way that it had at least four water types represented.

Table 2.1: Some physical characteristics of the sampling stations

Station	Length*	Width*	Habitat types	Bottom types	Flanking Vegetation	Fig/Plate
	m	m				
Nwanedzi (above impoundment)	30	7	Flat	Stony/Sandy	Thelypteris totta, Panicum maximum Ishaemum arcuatum, Smilax braussiana, Maesa lanceolata, Sinecio, Peltophorum africanum, Phoenix, Ficus, Hibiscus, Cyperus, Trema orientalis.	Fig. 1.2 Plate 1
	29	4,3	Stickle	Stony		
	47	5	Run	Stony		
	6	8	Stickle	Stony		
Luphephe (above impoundment)	41	11	Run	Stony	Ficus, Maytenus senegalensis, Cyperus, Anthocleista zambesiaca, Syzygium gerrardi, Cassia abbreviata, Lonchocarpus, Sporobolus fimbriatus, Grewia flava, Adina, Rhus spinescens, Securinega virosa.	Fig. 1.2 Plate 2
	37	6	Stickle	Stony		
	71	9,5	Run	Sandy		
	29	4,3	Stickle	Stony		
Nwanedzi (below impoundments)	30	9	Flat	Stony	Ficus capensis, Thelypteris totta, Zanthocercis zambesiaca, Crinum macowanii, Securinega virosa, Ficus sonderii, Hypoxis nitidula, Zyzygium cordatum, Maytenus senegalensis.	Fig. 1.2 Plate 3
	27	6	Stickle	Stony		
	17	3	Run	Stony		
	70	13	Pool	Muddy		

* Exact length and width measurements for various habitat types changed depending on the amount of flow, therefore, approximate lengths and widths for the entire period of the survey were calculated.

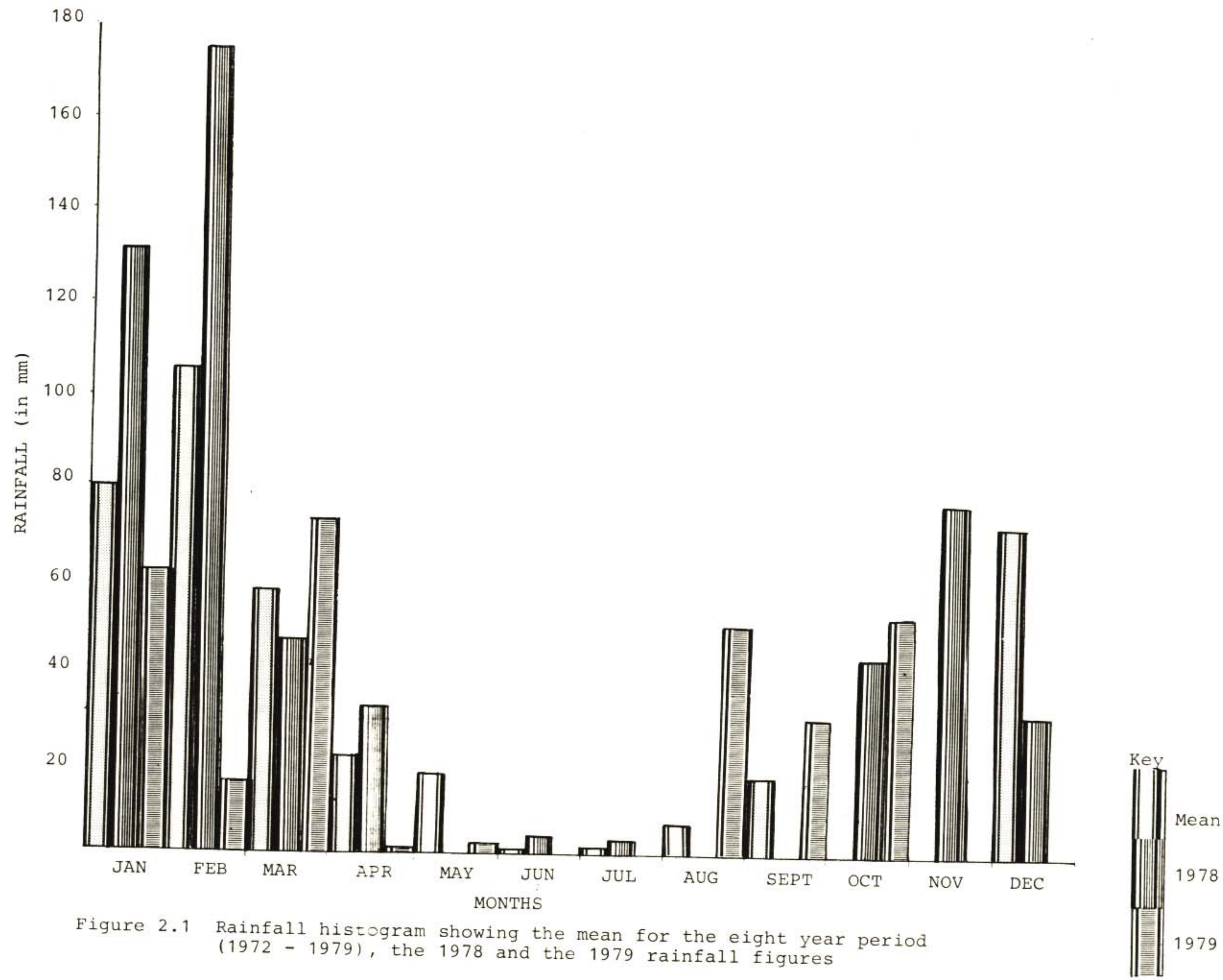


Figure 2.1 Rainfall histogram showing the mean for the eight year period (1972 - 1979), the 1978 and the 1979 rainfall figures

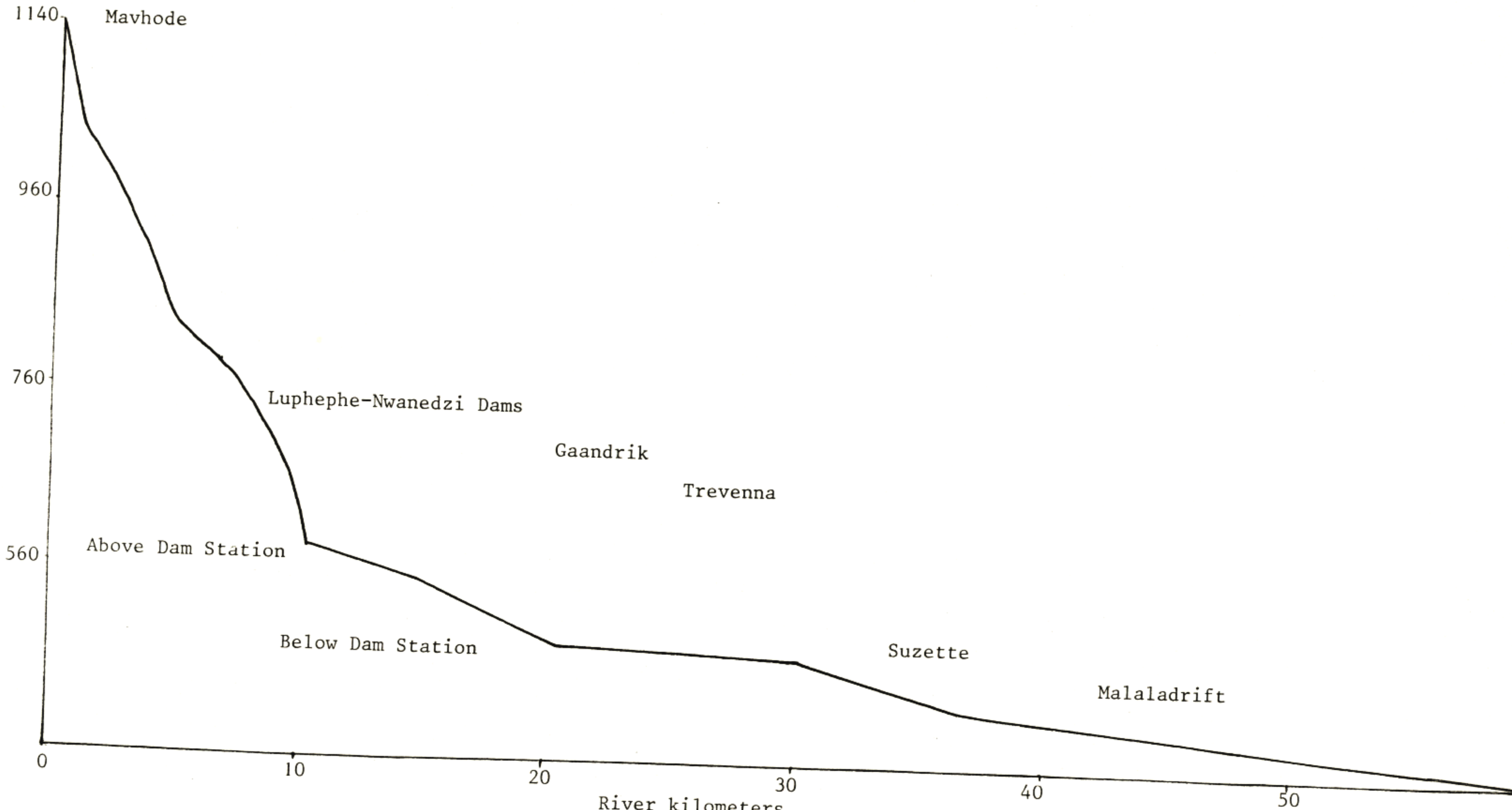


FIGURE 2.2: NWANEDZI RIVER PROFILE

Plate 1. Sampling station in the Nwanedzi River above the impoundment.

Plate 2. Sampling station in the Luphephe Stream.

Plate 3. Sampling station in the Nwanedzi River below the impoundments.

CHAPTER 3

METHODS AND APPROACH

3.1 Sampling Methods

This survey extended over a period of two years.

3.1.1 First-year Survey

During the first year each station was sampled at six-weekly intervals. The procedures and methods followed during each sampling period included:

(i) Taking care that sampling was always undertaken at the same hour of the day.

(ii) A 250 ml clear glass bottle was filled with water for chemical analyses.

(iii) A 250 ml amber glass bottle with a glass stopper was filled with surface water for the determination of the Biological Oxygen Demand (B.O.D.) for each separate habitat type. Prior to filling these bottles with water, all atmospheric Oxygen was displaced with Nitrogen gas. In the laboratory these samples were incubated for five days at 20°C with the aid of a Gram Low Temperature Incubator.

(iv) Zoobenthos in muddy areas was sampled with the aid of a 350cm² Friedlinger Type Mudgrab, while stony and sandy bottoms in shallow waters were sampled with a Surber Sampler (Surber, 1937) of 250 microns mesh size net and sampling a surface area of 0,25m². For more reliable statistical results, three samples were taken from each habitat type. The collected fauna was emptied into a marked plastic bag which was then sealed and left for later examination following the method described below.

Care was taken to sample only permanently submerged areas. This precaution was especially necessary in areas where the general water level was subject to short-term fluctuations.

Waters (1962), also pointed out that it was essential for periodic sampling programmes of bottom fauna that successive samples were not taken from locations of previous ones when the effects of such disturbances were still present.

> "Either the previous locations must be avoided, or the assumption must be made that populations have returned to normal."

This precaution was also taken into consideration during the present survey.

(v) The following chemo-physical parameters were simultaneously measured with portable field apparatus:

(a) Dissolved Oxygen with a Y.S.I. Model 54 Oxygen Meter provided with an O_2-temperature combination probe.

(b) Turbidity with a P.H.TAMM Laboratorier AB Turbidity Meter.

(c) Water conductivity ($\mu\Omega/cm$) with a Beckman Solu-Bridge Model RB_4-250 Conductivity Meter.

(e) Water temperature in °C with an ordinary Mercury Thermometer as well as with the Y.S.I. Model 54 Oxygen Meter.

(f) Current speed (revolutions per minute) with the aid of a A.OTT Kempten Model 46205 Current Meter. These readings were eventually converted to meters per second.

(vi) Length, width and depth of the various habitat types

The mean dimensions for all the habitat types per station were measured and the various habitat types classified using also current and depth as criteria.

3.1.2 Second-year Survey

During the second year, each station was visited once per season in order to sample drift and rate of colonization by stream invertebrates. Concurrent with these faunistic surveys, the various chemo-physical parameters monitored during the first-year period, were repeated. However, on these occasions the various parameters were monitored hourly over a 24 hour period in order to establish any possible cyclic changes.

Drift

To sample drift, a drift sampler of 250 microns mesh size net with a 0,0625 m^2 opening was used. This apparatus is similar to the one described by Elliott (1970) with the exception that no flow meter was built in, and that foam stabilizers were added to the outside of the frame.

The catch was emptied hourly over a period of twenty four hours, and preserved in 70% alcohol. Stream flow through, and past the sampler, was measured with an A.OTT Kempten Model 46205 Current Meter. Measurements of depth were made every 20 cm across the width of the river to provide a profile. From the current speed, width and depth profile, approximate values for the total discharge of the river and the volume of water passing through the net could be calculated. With the aid of appropriate portable field equipment, changes in water composition were also recorded on an hourly basis.

Colonization

In order to establish the rate of colonization by stream invertebrates, a modified Dendy-Type Multiple Plate Sampler with a total surface area of $1m^2$ was used.

This sampler was left in the stream for the duration of a season, after which it was carefully taken out and washed into a plastic basin. The sample was then transferred into a marked plastic bag and preserved in 70% alcohol for laboratory analysis.

3.2 Biological Parameters

3.2.1 Zoobenthos

In order to remove all possible silt contained in the faunal samples, these were transferred to a 250 microns mesh size net supported on a steel frame and washed in clean running water. The faunistic contents were then sorted out in a live conditions, counted and classified as far as possible. A stereo microscope with 20x and 40x magnifications was used to sort out the smaller organisms.

Biomass determination

The individual groups of organisms were dried in an oven at 60°C for twenty four hours and biomass determined with the aid of a five-decimal chemical balance (Mettler Model H64).

Kjeldahl Nitrogen and Phosphate Content Determination

From each group of organisms a sample of 0,25g or 0,125g dry weight was taken for digestion. A Selenium tablet (1g Na_2SO_4. 0,05g Se, BDH no. 33066) was used as a catalyst. The total Nitrogen and Phosphate present in each sample was measured with the aid of a Cenco - U.N.M.F. Automated Analyser, using the method of Basson (1977). The total Nitrogen and Phosphate contents were then expressed in mg/l. for each group as indicated in the results (Tables 4.1 - 4.7).

3.2.2 Drift and Colonization

Qualitative and quantitative analyses of the contained fauna

No further washing was required as the catch was not silt-laden. In the laboratory, the contents of the plastic bags were emptied into enamel trays. The contained faunistic components were examined under a stereo microscope with 20x and 40x magnifications. The organisms were then counted and classified into major taxonomic groups.

3.3 Chemical Parameters

Chemical analyses were done according to the methods outlined in Standard Methods for Examination of Water and Sewage (1965 and 1971).

The following procedures were followed:

(a) Biological Oxygen Demand (B.O.D.) after 5 days incubation at 20°C, using the Winkler titration Method (Standard Methods, 1965).

(b) Phosphate using the Phos Ver III Method (Standard Methods, 1971).

(c) Ammonium Nitrogen with the Nessler Calorimetric Method (Standard Methods, 1971).

(d) Nitrite Nitrogen was determined using the Diazotization Method in Standard Methods (1965).

(e) Nitrate Nitrogen using the Cadmium Reduction Method (Standard Methods, 1965).

(f) Sulphate following the Sulva Ver III Method in Standard Methods (1971).

(g) Dissolved Oxygen values were directly measured using the Y.S.I. Model 54 Oxygen Meter.

3.4 Statistical analysis of Data

Cluster and Factor analysis of both biological and chemo-physical parameters were computor analysed using the following programmes:

Cluster analyses

Programme BMDP IM Cluster Analysis on Variables, Health Science Computing Facility, University of California, Los Angeles (Dixon, 1975).

Factor analyses

Programme BMDP 4M Factor Analysis Double Precision Version, Health Science Computing Facility, University of California, Los Angeles (Dixon, 1975).

The computor printouts of the above-mentioned statistical analyses are available of the Zoology Department of the University of the North.

KEY TO ABBREVIATIONS USED IN THE STATISTICAL ANALYSES

TURB NO	TURBELLARIA NUMBER	PER m^2
ANNE NO	ANNELIDA NUMBER	PER m^2
POTA NO	POTAMON NUMBER	PER m^2
EPHE NO	EPHEMEROPTERA NUMBER	PER m^2
ODON NO	ODONATA NUMBER	PER m^2
PLEC NO	PLECOPTERA NUMBER	PER m^2
COLE NO	COLEOPTERA NUMBER	PER m^2
TABA NO	TABANIDAE NUMBER	PER m^2
SIMU NO	SIMULIIDAE NUMBER	PER m^2
CHIR NO	CHIRONOMIDAE NUMBER	PER m^2
TIPU NO	TIPULIDAE NUMBER	PER m^2
TRIC NO	TRICHOPTERA NUMBER	PER m^2
GAST NO	GASTROPODA NUMBER	PER m^2
TOTA NO	TOTAL NUMBER	PER m^2
TURB BIOM	TURBELLARIA BIOMASS	IN g/m^2
ANNE BIOM	ANNELIDA BIOMASS	IN g/m^2
POTA BIOM	POTAMON BIOMASS	IN g/m^2
EPHE BIOM	EPHEMEROPTERA BIOMASS	IN g/m^2
ODON BIOM	ODONATA BIOMASS	IN g/m^2
PLEC BIOM	PLECOPTERA BIOMASS	IN g/m^2
COLE BIOM	COLEOPTERA BIOMASS	IN g/m^2
TABA BIOM	TABANIDAE BIOMASS	IN g/m^2
SIMU BIOM	SIMULIIDAE BIOMASS	IN g/m^2
CHIR BIOM	CHIRONOMIDAE BIOMASS	IN g/m^2
TIPU BIOM	TIPULIDAE BIOMASS	IN g/m^2
TRIC BIOM	TRICHOPTERA BIOMASS	IN g/m^2
GAST BIOM	GASTROPODA BIOMASS	IN g/m^2
TOTA BIOM	TOTAL BIOMASS	IN g/m^2

TURB KJN	TURBELLARIA KJELDAHL NITROGEN	mg/m^2
ANNE KJN	ANNELIDA KJELDAHL NITROGEN	mg/m^2
POTA KJN	POTAMON KJELDAHL NITROGEN	mg/m^2
EPHE KJN	EPHEMEROPTERA KJELDAHL NITROGEN	mg/m^2
ODON KJN	ODONATA KJELDAHL NITROGEN	mg/m^2
PLEC KJN	PLECOPTERA KJELDAHL NITROGEN	mg/m^2
COLE KJN	COLEOPTERA KJELDAHL NITROGEN	mg/m^2
TABA KJN	TABANIDAE KJELDAHL NITROGEN	mg/m^2
SIMU KJN	SIMULIIDAE KJELDAHL NITROGEN	mg/m^2
CHIR KJN	CHIRONOMIDAE KJELDAHL NITROGEN	mg/m^2
TIPU KJN	TIPULIDAE KJELDAHL NITROGEN	mg/m^2
TRIC KJN	TRICHOPTERA KJELDAHL NITROGEN	mg/m^2
GAST KJN	GASTROPODA KJELDAHL NITROGEN	mg/m^2
TOTA KJN	TOTAL KJELDAHL NITROGEN	mg/m^2
TURB PO_4	TURBELLARIA PHOSPHATE CONTENT	mg/m^2
ANNE PO_4	ANNELIDA PHOSPHATE CONTENT	mg/m^2
POTA PO_4	POTAMON PHOSPHATE CONTENT	mg/m^2
EPHE PO_4	EPHEMEROPTERA PHOSPHATE CONTENT	mg/m^2
ODON PO_4	ODONATA PHOSPHATE CONTENT	mg/m^2
PLEC PO_4	PLECOPTERA PHOSPHATE CONTENT	mg/m^2
COLE PO_4	COLEOPTERA PHOSPHATE CONTENT	mg/m^2
TABA PO_4	TABANIDAE PHOSPHATE CONTENT	mg/m^2
SIMU PO_4	SIMULIIDAE PHOSPHATE CONTENT	mg/m^2
CHIR PO_4	CHIRONOMIDAE PHOSPHATE CONTENT	mg/m^2
TIPU PO_4	TIPULIDAE PHOSPHATE CONTENT	mg/m^2
TRIC PO_4	TRICHOPTERA PHOSPHATE CONTENT	mg/m^2
GAST PO_4	GASTROPODA PHOSPHATE CONTENT	mg/m^2
TOTA PO_4	TOTAL PHOSPHATE CONTENT	mg/m^2
DEPT	DEPTH IN cm	
CURR	CURRENT IN m/s	
TURB	TURBIDITY EXPRESSED AS PERCENTAGE TRANSMITANCE	
TEMP	TEMRERATURE IN °C	

COND	CONDUCTIVITY IN $\mu\Omega$/cm
pH	HYDROGEN ION CONCENTRATION
O_2	DISSOLVED OXYGEN IN mg/l
B.O.D.	BIOLOGICAL OXYGEN DEMAND IN mg/l
PO_4	TOTAL PHOSPHATE IN mg/l
SO_4	TOTAL SULPHATE IN mg/l
NH_4-N	AMMONIUM NITROGEN IN mg/l
NO_3-N	NITRATE NITROGEN IN mg/l
NO_2-N	NITRATE NITROGEN IN mg/l
N1	FLAT SAMPLED IN NWANEDZI ABOVE DAM
N2	STICKLE SAMPLED IN NWANEDZI ABOVE DAM
N3	RUN SAMPLED IN NWANEDZI ABOVE DAM
N4	STICKLE SAMPLED IN NWANEDZI ABOVE DAM
L1	STICKLE SAMPLED IN THE LUPHEPHE STREAM
L2	RUN SAMPLED IN THE LUPHEPHE STREAM
L3	STICKLE SAMPLED IN THE LUPHEPHE STREAM
L4	RUN SAMPLED IN THE LUPHEPHE STREAM
C1	FLAT SAMPLED IN THE NWANEDZI BELOW DAM
C2	STICKLE SAMPLED IN NWANEDZI BELOW DAM
C3	RUN SAMPLED IN NWANEDZI BELOW DAM
C4	POOL SAMPLED IN NWANEDZI BELOW DAM

CHAPTER 4

TABULATED RESULTS FOR FIRST YEAR SURVEY

TABLE 4.1

Biotic and abiotic variables monitored during April 1978

	TURB NO.	ANNE NO.	POTA NO.	EPHE NO.	ODON NO.	PLEC NO.	COLE NO.	TABA NO.
N1	0.0	0.0	4.0	104.0	4.0	16.0	16.0	0.0
N2	0.0	0.0	4.0	52.0	4.0	8.0	12.0	0.0
N3	0.0	0.0	4.0	65.0	0.0	24.0	16.0	12.0
N4	0.0	0.0	4.0	44.0	16.0	52.0	12.0	8.0
L1	0.0	4.0	4.0	60.0	8.0	0.0	8.0	4.0
L2	0.0	8.0	0.0	56.0	4.0	40.0	0.0	4.0
L3	0.0	8.0	0.0	68.0	8.0	0.0	4.0	0.0
L4	0.0	0.0	4.0	20.0	4.0	12.0	16.0	0.0
C1	0.0	0.0	4.0	48.0	12.0	0.0	4.0	12.0
C2	0.0	0.0	0.0	32.0	0.0	16.0	0.0	4.0
C3	4.0	0.0	0.0	52.0	4.0	0.0	16.0	4.0
C4	0.0	12.0	0.0	16.0	0.0	0.0	4.0	0.0
Max	4.0	12.0	4.0	104.0	16.0	52.0	16.0	12.0
Min	0.0	0.0	0.0	16.0	0.0	0.0	0.0	0.0
Mean	0.3333	2.6666	2.3333	51.4166	5.3333	14.0	9.0	4.0
S.D.	1.1055	4.1096	1.9720	22.3698	4.7140	16.4519	6.1373	4.3204

	SIMU NO.	CHIR NO.	TIPU NO.	TRIC NO.	GAST NO.	TOTAL NO.	TURB BIOM	ANNE BIOM
N1	0.0	80.0	8.0	48.0	8.0	288.0	0.0	0.0
N2	304.0	40.0	4.0	12.0	12.0	452.0	0.0	0.0
N3	0.0	124.0	4.0	32.0	12.0	293.0	0.0	0.0
N4	40.0	120.0	0.0	12.0	12.0	332.0	0.0	0.0
L1	136.0	120.0	0.0	32.0	16.0	392.0	0.0	0.00544
L2	56.0	184.0	0.0	44.0	16.0	412.0	0.0	0.01088
L3	28.0	280.0	0.0	96.0	12.0	504.0	0.0	0.01088
L4	0.0	84.0	0.0	16.0	0.0	156.0	0.0	0.0
C1	96.0	44.0	0.0	632.0	12.0	864.0	0.0	0.0
C2	128.0	8.0	8.0	148.0	24.0	368.0	0.0	0.0
C3	24.0	32.0	0.0	212.0	24.0	372.0	0.00060	0.0
C4	0.0	12.0	0.0	40.0	0.0	84.0	0.0	0.01632
Max	304.0	280.0	8.0	632.0	24.0	864.0	0.00060	0.01632
Min	0.0	8.0	0.0	12.0	0.0	84.0	0.0	0.0
Mean	67.6666	94.0	2.0	111.3333	12.3333	376.4166	0.00005	0.01586
S.D.	85.4705	75.6218	3.055	167.235	7.2033	185.33	0.00016	0.0446

	POTA BIOM	EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM
N1	3.71756	0.20176	0.02652	0.02400	0.03360	0.0	0.0	0.00176
N2	3.71756	0.10088	0.02652	0.01200	0.02520	0.0	0.00851	0.00088
N3	3.71756	0.12610	0.0	0.03600	0.03360	0.02328	0.00851	0.00273
N4	3.71756	0.08536	0.10608	0.07800	0.02520	0.01552	0.00112	0.00264
L1	3.71756	0.11640	0.05304	0.0	0.01680	0.00776	0.00381	0.00264
L2	0.0	0.10864	0.02652	0.06000	0.0	0.00776	0.00157	0.00405
L3	0.0	0.13192	0.05304	0.0	0.00840	0.0	0.00078	0.00616
L4	3.71756	0.02910	0.02652	0.01800	0.03360	0.0	0.0	0.00185
C1	3.71756	0.09312	0.07956	0.0	0.00840	0.02328	0.00269	0.00097
C2	0.0	0.06208	0.0	0.02400	0.0	0.00776	0.00358	0.00018
C3	0.0	0.10088	0.02652	0.0	0.03360	0.00776	0.00067	0.00070
C4	0.0	0.03104	0.0	0.0	0.00840	0.0	0.0	0.00026
Max	3.71756	0.20176	0.10608	0.07800	0.03360	0.02328	0.00851	0.00616
Min	0.0	0.0291	0.0	0.0	0.0	0.0	0.0	0.00018
Mean	2.1685	0.09894	0.03536	0.021	0.0189	0.0077	0.0026	0.002
S.D.	1.8327	0.04459	0.03125	0.0246	0.0128	0.0083	0.0029	0.0016

	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTAL BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN
N1	0.01888	0.17040	0.57392	4.76840	0.0	0.0	569.520	338.936
N2	0.00944	0.04260	0.86088	4.80447	0.0	0.0	569.520	169.468
N3	0.00944	0.11360	0.86088	4.93170	0.0	0.0	569.520	211.835
N4	0.0	0.08520	0.86088	4.97756	0.0	0.0	569.520	143.396
L1	0.0	0.11360	1.14784	5.18489	0.0	4.02560	0.0	182.504
L2	0.0	0.15620	1.14784	1.52346	0.0	8.05120	0.0	182.504
L3	0.0	0.34080	0.86088	1.41286	0.0	8.05120	0.0	221.612
L4	0.0	0.05680	0.0	3.88343	0.0	0.0	569.520	65.180
C1	0.0	2.24360	0.86088	7.03006	0.0	0.0	569.520	156.432
C2	0.01888	0.52540	1.72176	2.36364	0.0	0.0	0.0	104.288
C3	0.0	0.75260	1.72176	2.64509	0.5984	0.0	0.0	169.468
C4	0.0	0.14200	0.0	0.19802	0.0	12.07680	0.0	52.144
Max	0.01888	2.24360	1.72176	7.03006	0.5984	12.07680	569.520	338.936
Min	0.0	0.04260	0.0	0.19802	0.0	0.0	0.0	52.144
Mean	0.0047	0.3952	0.8847	3.6436	0.0498	2.6837	332.22	167.5669
S.D.	0.0072	0.5936	0.5167	1.9133	0.1653	4.1359	280.7771	72.9033

Table 4.1 (cont.)

	ODON KJN	PLEC KJN	COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN
N1	39.460	36.928	48.384	0.0	0.0	2.016	21.120	222.480
N2	39.460	18.468	36.288	0.0	9.30240	1.008	10.560	55.620
N3	0.0	55.632	48.384	32.904	0.00001	3.125	10.560	148.320
N4	157.840	120.536	36.288	21.936	1.22400	3.024	0.0	111.240
L1	78.920	0.0	24.192	10.968	4.16160	3.024	0.0	148.320
L2	39.460	92.720	0.0	10.968	1.71360	4.637	0.0	203.940
L3	78.920	0.0	12.096	0.0	0.85680	7.056	0.0	444.960
L4	39.460	27.816	48.384	0.0	0.0	2.117	0.0	74.160
C1	118.380	0.0	12.096	32.904	2.93760	1.109	0.0	2929.320
C2	0.0	36.928	0.0	10.968	3.91680	0.202	21.120	685.980
C3	39.460	0.0	48.384	10.968	10.73440	0.806	0.0	982.620
C4	0.0	0.0	12.096	0.0	0.0	0.302	0.0	185.400
Max	157.84	120.536	48.384	32.904	9.3024	7.056	21.12	2929.32
Min	0.0	0.0	0.0	0.0	0.0	0.203	0.0	55.62
Mean	52.6133	32.419	27.216	10.968	2.0706	2.3688	5.28	516.03
S.D.	46.504	38.1347	18.5592	11.8467	2.6154	1.9057	8.0653	775.1343

	GAST KJN	TOTAL KJN	TURB PO_4	ANNE PO_4	POTA PO_4	EPHE PO_4	ODON PO_4	PLEC PO_4
N1	67.264	1346.108	0.0	0.0	137.96	13.447	1.918	1.738
N2	100.896	1010.590	0.0	0.0	137.96	6.724	1.918	0.869
N3	100.896	1181.176	0.0	0.0	137.96	8.405	0.0	2.606
N4	100.896	1265.900	0.0	0.0	137.96	5.689	6.672	5.647
L1	134.528	1173.199	0.0	0.41520	137.96	7.758	3.836	0.0
L2	134.528	543.994	0.0	0.83040	0.0	7.241	1.918	4.344
L3	100.896	874.448	0.0	0.83040	0.0	8.792	3.836	0.0
L4	0.0	826.637	0.0	0.0	137.96	2.586	1.918	1.3032
C1	100.896	3923.595	0.0	0.0	137.96	6.206	5.754	0.0
C2	201.792	1065.195	0.0	0.0	0.0	4.138	0.0	1.738
C3	201.792	1454.831	0.07440	0.0	0.0	6.724	1.918	0.0
C4	0.0	262.019	0.0	1.24560	0.0	2.074	0.0	0.0
Max	201.792	3923.595	0.0744	1.2456	137.96	13.447	7.672	5.647
Min	0.0	262.019	0.0	0.0	0.0	2.074	0.0	0.0
Mean	103.698	1243.9743	0.0062	0.2768	80.4767	6.6486	2.5573	1.5204
S. D.	60.5661	870.6344	0.00205	0.4265	68.0151	2.8916	2.2604	1.7866

	COLE PO_4	TABA PO_4	SIMU PO_4	CHIR PO_4	TIPU PO_4	TRIC PO_4	GAST PO_4	TOTAL PO_4
N1	3.069	0.0	0.0	0.123	1.952	8.438	20.224	188.869
N2	2.302	0.0	0.876	0.062	0.976	2.110	30.336	184.133
N3	3.069	1.680	0.0	0.191	0.976	5.626	30.336	190.849
N4	2.302	1.120	0.115	0.185	0.0	4.220	30.336	195.246
L1	1.535	0.560	0.391	0.185	0.0	5.626	40.448	198.714
L2	0.0	0.560	0.161	0.283	0.0	8.439	40.448	64.224
L3	0.768	0.0	0.081	0.431	0.0	16.525	30.336	61.599
L4	3.069	0.0	0.0	0.129	0.0	2.813	0.0	149.778
C1	0.768	1.680	0.277	0.068	0.0	111.106	30.336	294.155
C2	0.0	0.560	0.369	0.012	1.952	26.018	60.672	95.459
C3	3.069	0.560	0.069	0.049	0.0	37.270	60.672	110.405
C4	0.768	0.0	0.0	0.018	0.0	7.032	0.0	11.138
Max	3.069	1.68	0.876	0.431	1.952	111.106	60.672	294.155
Min	0.0	0.0	0.0	0.012	0.0	2.11	0.0	11.138
Mean	1.7265	0.56	0.1949	0.1446	0.488	19.6019	31.1786	145.3807
S.D.	1.177	0.6049	0.2462	0.1164	0.7454	29.3798	18.2102	75.4358

	DEPTH	CURRENT	TEMP	TURB	COND	PH	O_2	BOD	PO_4	SO_4	NH_4-N	NO_3-N	NO_2-N
N1	55.0	0.43	20.5	62.0	58.0	7.0	12.5	1.61	0.16	6.0	0.08	0.02	0.015
N2	40.0	0.91	20.6	62.0	58.0	7.0	12.2	1.61	0.15	6.0	0.08	0.02	0.016
N3	50.0	0.62	20.5	62.0	58.0	7.0	12.8	0.80	0.18	6.0	0.08	0.02	0.015
N4	28.0	1.08	20.5	62.0	58.0	7.0	12.8	1.61	0.15	5.0	0.07	0.02	0.015
L1	20.0	0.91	23.5	42.0	62.5	7.2	12.6	1.80	0.15	4.0	0.04	0.08	0.016
L2	30.0	0.59	21.9	42.0	63.0	7.3	12.1	1.62	0.15	4.0	0.09	0.02	0.016
L3	35.0	0.87	23.0	44.0	63.0	7.4	12.6	1.61	0.16	6.0	0.08	0.09	0.015
L4	20.0	0.48	22.0	37.0	71.0	7.4	12.4	1.61	0.18	4.0	0.09	2.00	0.010
C1	37.0	1.19	20.2	52.0	61.0	7.2	12.2	1.61	0.80	10.0	0.70	2.20	0.012
C2	70.0	1.36	21.0	39.0	62.0	7.0	12.8	1.61	0.80	10.0	0.67	2.20	0.017
C3	65.0	0.78	20.0	36.0	62.0	6.3	12.4	1.61	0.50	7.0	0.80	1.50	0.010
C4	250.0	0.34	17.2	40.0	58.0	7.2	8.8	1.61	0.80	12.0	0.40	2.00	0.016
Max	250.0	1.36	23.5	62.0	71.0	7.4	12.8	1.80	0.80	12.0	0.80	2.20	0.017
Min	20.0	0.34	17.2	36.0	58.0	6.3	8.8	0.80	0.15	4.0	0.04	0.02	0.010
Mean	58.33	0.79	20.91	48.33	61.21	7.08	12.18	1.56	0.35	6.67	0.26	0.85	0.0144
S. D.	59.85	0.3	1.55	10.39	3.61	0.28	1.05	0.23	0.28	2.53	0.28	0.97	2.2897

TABLE 4.2

Biotic and abiotic variables monitored during May 1978

	TURB NO.	ANNE NO.	POTA NO.	EPHE NO.	ODON NO.	PLEC NO.	COLE NO.	TABA NO.
N1	0.0	4.0	4.0	100.0	20.0	16.0	0.0	12.0
N2	0.0	0.0	12.0	32.0	32.0	48.0	12.0	8.0
N3	0.0	8.0	8.0	44.0	20.0	32.0	4.0	12.0
N4	0.0	0.0	4.0	44.0	32.0	56.0	12.0	0.0
L1	0.0	4.0	0.0	52.0	28.0	0.0	4.0	0.0
L2	0.0	4.0	4.0	112.0	92.0	24.0	4.0	8.0
L3	0.0	4.0	0.0	112.0	92.0	8.0	8.0	4.0
L4	0.0	0.0	0.0	0.0	12.0	8.0	0.0	0.0
C1	0.0	0.0	12.0	28.0	0.0	0.0	0.0	4.0
C2	0.0	0.0	4.0	24.0	4.0	20.0	0.0	8.0
C3	4.0	0.0	8.0	44.0	12.0	0.0	0.0	12.0
C4	0.0	36.0	0.0	58.0	0.0	0.0	16.0	0.0
Max	4.0	36.0	12.0	112.0	92.0	56.0	16.0	12.0
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	0.333	5.0	4.67	54.167	28.67	17.67	5.0	5.67
S.D.	1.1055	9.678	4.2687	34.326	30.28	18.436	5.4467	4.749

	SIMU NO.	CHIR NO.	TIPU NO.	TRIC NO.	GAST NO.	TOTAL NO.	TURB BIOM	ANNE BIOM
N1	0.0	0.0	4.0	88.0	0.0	248.0	0.0	0.00468
N2	236.0	40.0	0.0	56.0	12.0	488.0	0.0	0.0
N3	0.0	132.0	0.0	68.0	20.0	348.0	0.0	0.00936
N4	24.0	50.0	0.0	76.0	20.0	318.0	0.0	0.0
L1	264.0	28.0	0.0	52.0	24.0	456.0	0.0	0.00468
L2	52.0	92.0	0.0	40.0	20.0	452.0	0.0	0.00468
L3	44.0	36.0	0.0	120.0	24.0	452.0	0.0	0.00468
L4	0.0	24.0	0.0	20.0	0.0	64.0	0.0	0.0
C1	384.0	48.0	0.0	552.0	12.0	1040.0	0.0	0.0
C2	142.0	32.0	16.0	184.0	24.0	454.0	0.0	0.0
C3	36.0	76.0	4.0	176.0	32.0	404.0	0.00060	0.0
C4	0.0	80.0	0.0	120.0	0.0	310.0	0.0	0.04212
Max	384.0	132.0	16.0	552.0	32.0	1040.0	0.0006	0.04212
Min	0.0	0.0	0.0	40.0	0.0	64.0	0.0	0.0
Mean	98.5	53.167	2.0	129.33	15.67	419.5	0.00005	0.00585
S.D.	123.523	34.433	4.472	136.502	10.3869	219.428	0.00016	0.01132

	POTA BIOM	EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM
N1	1.20796	0.06100	0.19900	0.02352	0.0	0.07116	0.0	0.0
N2	3.62388	0.01952	0.31840	0.07056	0.02736	0.04744	0.02808	0.0
N3	2.41592	0.02684	0.19900	0.04704	0.00912	0.07114	0.0	0.00330
N4	1.20796	0.02684	0.31840	0.08232	0.02736	0.0	0.00029	0.00013
L1	0.0	0.03172	0.27860	0.0	0.00912	0.0	0.03142	0.00070
L2	1.20796	0.06832	0.91540	0.03528	0.00912	0.04744	0.00619	0.00230
L3	0.0	0.06832	0.91540	0.01176	0.01824	0.02372	0.00524	0.00090
L4	0.0	0.0	0.11940	0.01176	0.0	0.0	0.0	0.00060
C1	3.62388	0.01708	0.0	0.0	0.0	0.02372	0.04570	0.00120
C2	1.20796	0.01464	0.03980	0.02940	0.0	0.04744	0.01689	0.00080
C3	2.41592	0.02684	0.11940	0.0	0.0	0.07116	0.00428	0.00190
C4	0.0	0.03538	0.0	0.0	0.03648	0.0	0.0	0.00200
Max	3.62388	0.06832	0.91540	0.08232	0.03648	0.07116	0.04570	0.00330
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.40928	0.03309	0.2852	0.0259	0.0114	0.0336	0.0115	0.00125
S.D.	1.28912	0.02094	0.3013	0.0271	0.0124	0.02816	0.0148	0.00093

	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTAL BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN
N1	0.00956	0.27544	0.0	1.85232	0.0	3.46	185.04	102.40
N2	0.0	0.17528	1.07256	5.38408	0.0	0.0	555.12	32.77
N3	0.0	0.21284	1.78760	4.78216	0.0	6.93	370.08	45.06
N4	0.0	0.23788	1.78760	3.68884	0.0	0.0	185.04	45.06
L1	0.0	0.16276	2.14512	2.66412	0.0	3.46	0.0	53.25
L2	0.0	0.12520	1.78760	4.20949	0.0	3.46	185.04	114.69
L3	0.0	0.37560	2.14512	3.56898	0.0	3.46	0.0	114.69
L4	0.0	0.06260	0.0	0.19436	0.0	0.0	0.0	0.0
C1	0.0	1.72776	1.07256	6.51190	0.0	0.0	555.12	28.67
C2	0.03824	0.57040	2.14512	4.11069	0.0	0.0	185.04	24.58
C3	0.00956	0.55088	2.86016	6.06070	0.60	0.0	370.08	45.06
C4	0.0	0.37560	0.0	0.49158	0.0	31.17	0.0	59.39
Max	0.03824	1.72776	2.86016	6.51190	0.60	31.17	555.12	114.69
Min	0.0	0.1252	0.0	0.19436	0.0	0.0	0.0	0.0
Mean	0.00478	0.4044	1.4003	3.6266	0.05	4.33	215.88	55.47
S.D.	0.01068	0.4271	0.9284	1.93516	0.1658	8.38	197.47	35.15

Table 4.2 (cont.)

	ODON KJN	PLEC KJN	COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN
N1	296.12	36.35	0.0	100.56	0.0	0.0	10.69	359.66
N2	473.79	109.06	39.40	67.04	30.63	1.22	0.0	228.87
N3	296.12	72.70	13.13	100.56	0.0	4.03	0.0	277.92
N4	473.99	127.23	39.40	0.0	3.12	1.53	0.0	310.61
L1	414.57	0.0	13.13	0.0	34.27	0.85	0.0	212.52
L2	1362.15	54.53	13.13	67.04	6.75	2.81	0.0	163.48
L3	1362.15	18.18	26.26	33.52	5.71	1.10	0.0	490.44
L4	177.67	18.18	0.0	0.0	0.0	0.73	0.0	81.74
C1	0.0	0.0	0.0	33.52	49.84	1.46	0.0	2256.02
C2	59.22	45.44	0.0	67.04	18.43	0.98	42.77	752.01
C3	177.67	0.0	0.0	100.56	4.67	2.32	10.69	719.31
C4	0.0	0.0	52.53	0.0	0.0	2.44	0.0	490.44
Max	1362.15	127.23	52.53	100.56	49.84	4.03	42.77	2256.02
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.74
Mean	424.4375	40.139	16.415	47.4867	12.785	1.6225	5.3458	528.585
S.D.	448.328	41.8864	17.8826	39.7988	16.0326	1.0516	11.954	557.8841

	GAST KJN	TOTAL KJN	TURB PO_4	ANNE PO_4	POTA PO_4	EPHE PO_4	ODON PO_4	PLEC PO_4
N1	0.0	1094.28	0.0	0.357	115.928	4.880	14.398	1.720
N2	125.76	1664.02	0.0	0.0	347.784	1.562	23.037	5.107
N3	209.60	1396.13	0.0	0.714	231.856	2.147	14.398	3.440
N4	209.60	1395.38	0.0	0.0	115.928	2.147	23.037	5.958
L1	251.52	983.57	0.0	0.357	0.0	2.538	20.157	0.0
L2	209.60	2182.68	0.0	0.357	115.928	5.466	66.231	2.553
L3	251.52	2307.03	0.0	0.357	0.0	5.466	66.231	0.860
L4	0.0	278.32	0.0	0.0	0.0	0.0	8.639	0.860
C1	125.76	3050.39	0.0	0.0	347.784	1.366	0.0	0.0
C2	251.52	1447.03	0.0	0.0	115.928	1.171	2.880	2.128
C3	335.36	1766.32	0.112	0.0	231.856	2.147	8.639	0.0
C4	0.0	635.97	0.0	3.215	0.0	2.830	0.0	0.0
Max	335.36	3050.39	0.112	3.215	347.784	5.466	66.231	5.958
Min	0.0	278.32	0.0	0.0	0.0	0.0	0.0	0.0
Mean	164.19	1516.76	0.0093	0.4664	135.25	2.64	20.6373	1.885
S.D.	108.855	725.1675	0.0309	0.8643	123.72	1.675	21.7987	1.9629

	COLE PO_4	TABA PO_4	SIMU PO_4	CHIR PO_4	TIPU PO_4	TRIC PO_4	GAST PO_4	TOTAL PO_4
N1	0.0	5.147	0.0	0.0	0.988	13.631	0.0	157.049
N2	2.500	3.431	2.879	0.075	0.0	8.674	37.788	432.837
N3	0.833	5.147	0.0	0.247	0.0	10.533	62.980	332.295
N4	2.500	0.0	0.293	0.094	0.0	11.772	62.980	224.709
L1	0.833	0.0	3.221	0.052	0.0	8.055	75.576	110.789
L2	0.833	3.431	0.634	0.172	0.0	6.196	62.980	264.781
L3	1.666	1.716	0.537	0.067	0.0	18.588	75.576	171.064
L4	0.0	0.0	0.0	0.045	0.0	3.098	0.0	12.642
C1	0.0	1.716	4.685	0.090	0.0	85.505	37.788	478.934
C2	0.0	3.431	1.732	0.059	3.954	28.502	75.576	235.361
C3	0.0	5.147	0.439	0.142	0.988	27.262	100.768	377.500
C4	3.333	0.0	0.0	0.150	0.0	18.588	0.0	28.116
Max	3.333	5.147	4.685	0.247	3.954	85.505	100.768	478.934
Min	0.0	0.0	0.0	0.0	0.0	3.098	0.0	12.642
Mean	1.0415	2.4305	1.2016	0.0994	0.4942	20.034	49.3343	235.506
S.D.	1.1346	2.0369	1.507	0.06449	1.1051	21.1442	32.7085	143.5393

	DEPTH	CURRENT	TEMP	TURB	COND	PH	O_2	BOD	PO_4	SO_4	NH_4-N	NO_3-N	NO_2-N
N1	55.0	0.40	18.0	41.0	56.0	7.3	9.0	1.80	0.12	3.0	0.08	1.9	0.010
N2	35.0	0.80	18.0	37.0	56.0	7.2	8.9	1.61	0.11	3.3	0.09	1.8	0.010
N3	45.0	0.62	18.0	40.1	55.0	7.2	8.0	0.90	0.11	3.0	0.09	1.8	0.010
N4	25.0	1.03	17.0	37.0	56.0	7.2	9.0	1.80	0.10	3.2	0.08	1.8	0.010
L1	20.0	0.80	20.0	52.0	52.0	6.8	8.7	1.61	0.10	3.0	0.05	1.7	0.009
L2	30.0	0.57	20.0	43.0	51.0	6.9	8.5	1.62	0.12	3.5	0.08	1.8	0.010
L3	30.0	0.80	18.5	49.0	60.0	6.6	8.8	1.61	0.11	3.5	0.08	1.9	0.007
L4	20.0	0.42	16.0	38.0	71.0	7.3	8.9	1.61	0.16	3.5	0.10	1.8	0.007
C1	35.0	1.12	17.5	39.0	57.0	7.4	9.0	1.61	0.50	7.0	0.70	1.4	0.012
C2	65.0	1.05	17.5	38.0	57.0	7.4	9.1	1.61	0.20	7.0	0.65	1.4	0.010
C3	65.0	0.76	17.5	38.0	56.0	7.8	9.0	1.61	0.30	7.0	0.80	1.2	0.011
C4	240.0	0.32	16.0	38.0	56.0	7.2	8.8	1.61	0.50	8.0	0.70	1.4	0.012
Max	240.0	1.12	20.0	52.0	71.0	7.8	9.1	1.80	0.50	8.0	0.80	1.9	0.012
Min	20.0	0.32	16.0	37.0	51.0	6.6	8.5	0.90	0.10	3.0	0.05	1.2	0.007
Mean	55.42	0.72	17.83	40.84	56.92	7.19	8.81	1.58	0.2	4.58	0.29	1.62	0.0098
S.D.	57.68	0.25	1.21	4.67	4.78	0.29	0.29	0.22	0.14	1.91	0.3	0.29	0.0015

TABLE 4.3

Biotic and abiotic variables monitored during July 1978

	TURB NO.	ANNE NO.	POTA NO.	EPHE NO.	ODON NO.	PLEC NO.	COLE NO.	TABA NO.
N1	0.0	0.0	0.0	192.0	44.0	20.0	0.0	8.0
N2	0.0	0.0	8.0	84.0	28.0	24.0	4.0	0.0
N3	0.0	8.0	4.0	96.0	16.0	12.0	8.0	0.0
N4	0.0	0.0	8.0	72.0	12.0	56.0	24.0	4.0
L1	0.0	4.0	0.0	152.0	44.0	16.0	20.0	12.0
L2	8.0	16.0	8.0	188.0	68.0	12.0	20.0	12.0
L3	0.0	8.0	4.0	160.0	28.0	32.0	0.0	12.0
L4	0.0	0.0	8.0	16.0	0.0	4.0	4.0	4.0
C1	0.0	0.0	0.0	188.0	12.0	20.0	12.0	0.0
C2	8.0	8.0	4.0	116.0	24.0	16.0	4.0	0.0
C3	8.0	16.0	0.0	48.0	32.0	12.0	12.0	0.0
C4	0.0	32.0	0.0	34.0	0.0	0.0	0.0	0.0
Max	8.0	32.0	8.0	192.0	68.0	56.0	24.0	12.0
Min	0.0	0.0	0.0	16.0	0.0	0.0	0.0	0.0
Mean	2.0	7.67	3.67	112.167	25.67	18.67	9.0	4.33
S.D.	3.464	9.303	3.448	60.489	18.935	13.89	8.185	5.022

	SIMU NO.	CHIR NO.	TIPU NO.	TRIC NO.	GAST NO.	TOTAL NO.	TURB BIOM	ANNE BIOM
N1	0.0	12.0	8.0	68.0	24.0	376.0	0.0	0.0
N2	672.0	52.0	8.0	72.0	28.0	980.0	0.0	0.0
N3	0.0	80.0	0.0	64.0	28.0	316.0	0.0	0.00936
N4	48.0	84.0	8.0	28.0	20.0	364.0	0.0	0.0
L1	792.0	84.0	0.0	28.0	32.0	1184.0	0.0	0.00468
L2	52.0	72.0	0.0	56.0	20.0	352.0	0.00124	0.01872
L3	492.0	96.0	8.0	108.0	24.0	972.0	0.0	0.00936
L4	0.0	52.0	0.0	4.0	0.0	92.0	0.0	0.0
C1	140.0	88.0	0.0	116.0	32.0	608.0	0.0	0.0
C2	432.0	84.0	4.0	236.0	24.0	960.0	0.00124	0.00936
C3	8.0	12.0	0.0	608.0	0.0	756.0	0.00124	0.01872
C4	0.0	88.0	0.0	120.0	0.0	274.0	0.0	0.03744
Max	792.0	96.0	8.0	608.0	32.0	1184.0	0.00124	0.03744
Min	0.0	12.0	0.0	4.0	0.0	92.0	0.0	0.0
Mean	219.67	67.0	3.0	125.67	19.33	617.83	0.00031	0.00897
S.D.	281.83	27.81	3.6968	156.5244	11.7567	322.85	0.00054	0.01088

	POTA BIOM	EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM
N1	0.0	0.23424	0.91124	0.11320	0.0	0.02976	0.0	0.00071
N2	6.46984	0.10248	0.57988	0.13584	0.01240	0.0	0.09677	0.00307
N3	3.23492	0.11712	0.33136	0.06792	0.02480	0.0	0.0	0.00472
N4	6.46984	0.08784	0.24852	0.31696	0.07440	0.01488	0.00691	0.00496
L1	0.0	0.18544	0.91124	0.09056	0.06200	0.04464	0.11405	0.00496
L2	6.46984	0.22936	1.40828	0.06792	0.06200	0.04464	0.00749	0.00425
L3	3.23492	0.19520	0.57988	0.18112	0.0	0.04464	0.07085	0.00566
L4	6.46984	0.01952	0.0	0.02264	0.01240	0.01488	0.0	0.00307
C1	0.00001	0.22936	0.24852	0.11320	0.03720	0.0	0.02016	0.00519
C2	3.23492	0.14152	0.49794	0.09056	0.01240	0.0	0.06221	0.00496
C3	0.0	0.05856	0.66272	0.06792	0.03720	0.0	0.00115	0.00071
C4	0.0	0.04148	0.0	0.0	0.0	0.0	0.0	0.00519
Max	6.46984	0.23424	1.40828	0.31696	0.07440	0.04464	0.11405	0.00566
Min	0.0	0.01952	0.0	0.0	0.0	0.0	0.0	0.00071
Mean	2.9653	0.13684	0.5313	0.1056	0.0279	0.0161	0.0316	0.00395
S.D.	2.7885	0.0738	0.3923	0.0786	0.0254	0.0187	0.0406	0.0016

	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTAL BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN
N1	0.01840	0.30736	1.59528	3.21019	0.0	0.0	0.0	381.12
N2	0.01840	0.32544	1.86116	9.60528	0.0	0.0	602.96	166.74
N3	0.0	0.28928	1.86114	5.94062	0.0	6.93	301.48	190.56
N4	0.01840	0.12656	1.32940	8.69867	0.0	0.0	602.96	142.92
L1	0.0	0.12656	2.12704	3.67117	0.0	3.46	0.0	301.72
L2	0.0	0.25312	1.32940	9.89626	1.24	13.85	602.96	373.18
L3	0.01840	0.48816	1.59528	6.42347	0.0	6.93	301.48	317.60
L4	0.0	0.01808	0.0	6.56043	0.0	0.0	602.96	31.76
C1	0.0	0.52432	2.12704	3.30499	0.0	0.0	0.0	373.18
C2	0.00920	1.06672	1.59528	6.72541	1.24	6.93	301.48	230.26
C3	0.0	2.74816	0.0	3.52846	1.24	13.85	0.0	95.28
C4	0.0	0.54240	0.0	0.62651	0.0	27.70	0.0	67.49
Max	0.01840	2.74816	2.12704	9.89626	1.24	27.70	602.96	381.12
Min	0.0	0.01808	0.0	0.62651	0.0	0.0	0.0	31.76
Mean	0.0069	0.568	1.285	5.683	0.31	6.64	276.3567	222.651
S.D.	0.0085	0.7075	0.78	2.7497	0.537	8.053	259.878	120.07

	ODON KJN	PLEC KJN	COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN
N1	1397.88	185.56	0.0	42.08	0.0	0.81	20.58	466.96
N2	889.56	222.67	17.86	0.0	105.57	3.51	20.58	494.42
N3	508.32	111.34	35.71	0.0	0.0	5.40	0.0	439.49
N4	381.24	519.57	107.14	21.04	7.54	5.67	20.58	192.28
L1	1397.88	148.45	89.28	63.12	124.42	5.67	0.0	192.28
L2	2160.36	111.34	89.28	63.12	8.17	4.86	0.0	384.55
L3	889.56	296.90	0.0	63.12	77.29	6.48	20.58	741.64
L4	0.0	37.11	17.86	21.04	0.0	3.51	0.0	27.47
C1	381.24	185.56	53.57	0.0	21.99	5.94	0.0	796.57
C2	762.48	148.45	17.86	0.0	67.87	5.67	10.29	1620.61
C3	1016.64	111.34	53.57	0.0	1.26	0.81	0.0	4175.14
C4	0.0	0.0	0.0	0.0	0.0	5.94	0.0	824.04
Max	2160.36	519.57	107.14	63.12	124.42	6.48	20.58	4175.14
Min	0.0	0.0	0.0	0.0	0.0	0.81	0.0	27.47
Mean	815.43	173.1908	40.1775	22.7933	34.509	4.5225	7.7175	862.95
S.D.	601.5828	128.857	36.5396	26.4166	44.2747	1.8775	9.5101	1074.85

	GAST KJN	TOTAL KJN	TURB PO_4	ANNE PO_4	POTA PO_4	EPHE PO_4	ODON PO_4	PLEC PO_4
N1	186.96	2681.95	0.0	0.0	0.0	15.610	52.923	10.994
N2	218.12	2741.99	0.0	0.0	622.160	6.829	33.678	13.193
N3	218.12	1817.35	0.0	0.715	311.080	7.805	19.245	6.596
N4	155.80	2156.74	0.0	0.0	622.160	5.854	14.434	30.783
L1	249.28	2575.56	0.0	0.357	0.0	12.358	52.923	8.795
L2	155.80	3968.71	0.154	1.429	622.160	15.284	81.790	6.596
L3	186.96	2908.54	0.0	0.715	311.080	13.008	33.678	17.590
L4	0.0	741.71	0.0	0.0	622.160	1.301	0.0	2.199
C1	249.28	2067.33	0.0	0.0	0.0	15.284	14.434	10.994
C2	186.96	3360.10	0.154	0.715	311.080	9.431	28.867	8.795
C3	0.0	5469.13	0.154	1.429	0.0	3.902	38.490	6.596
C4	0.0	925.17	0.0	2.858	0.0	2.764	0.0	0.0
Max	249.28	5469.13	0.154	2.858	622.160	15.610	81.790	30.783
Min	0.0	741.71	0.0	0.0	0.0	1.301	0.0	0.0
Mean	150.6067	2617.8566	0.0385	0.6848	285.1567	9.1186	30.8718	10.2609
S.D.	91.5854	1229.9366	0.0667	0.831	268.153	4.9173	23.788	7.6344

	COLE PO_4	TABA PO_4	SIMU PO_4	CHIR PO_4	TIPU PO_4	TRIC PO_4	GAST PO_4	TOTAL PO_4
N1	0.0	2.152	0.0	0.050	1.902	21.658	56.208	139.839
N2	1.132	0.0	9.950	0.215	1.901	22.932	65.576	775.665
N3	2.264	0.0	0.0	0.330	0.0	20.384	65.576	433.995
N4	6.792	1.076	0.710	0.347	1.902	8.918	46.840	739.816
L1	5.660	3.228	11.722	0.347	0.0	8.918	74.944	179.252
L2	5.660	3.228	0.769	0.297	0.0	17.836	46.840	802.043
L3	0.0	3.228	7.282	0.397	1.902	34.398	56.208	479.486
L4	1.132	1.076	0.0	0.215	0.0	1.274	0.0	629.375
C1	3.396	0.0	2.072	0.363	0.0	36.946	74.944	158.433
C2	1.132	0.0	6.394	0.347	0.951	75.166	56.208	499.240
C3	3.396	0.0	0.947	0.049	0.0	193.648	0.0	248.611
C4	0.0	0.0	0.0	0.363	0.0	38.22	0.0	44.187
Max	6.792	3.228	11.722	0.397	1.902	193.648	74.944	802.043
Min	0.0	0.0	0.0	0.050	0.0	1.274	0.0	44.187
Mean	2.547	1.1656	3.3205	0.2767	0.7132	40.0248	45.2786	427.495
S.D.	2.3164	1.3509	4.1261	0.1148	0.8789	49.853	27.5344	258.745

	DEPTH	CURRENT	TEMP	TURB	COND	PH	O_2	BOD	PO_4	SO_4	NH_4-N	NO_3-N	NO_2-N
N1	45.0	0.38	16.0	42.0	63.0	6.9	11.0	1.80	0.15	4.0	0.38	1.90	0.008
N2	35.0	0.79	16.0	42.0	64.0	7.1	11.0	1.61	0.17	7.0	0.32	1.90	0.005
N3	30.0	0.55	16.0	42.0	63.0	6.9	11.0	0.80	0.16	7.0	0.40	1.90	0.004
N4	20.0	0.98	15.0	41.0	62.0	7.1	11.0	1.61	0.16	4.0	0.32	1.80	0.004
L1	20.0	0.69	19.5	42.0	63.0	7.1	10.0	1.61	0.30	4.0	0.40	1.00	0.013
L2	30.0	0.50	19.0	40.0	62.0	8.1	10.2	1.62	0.40	5.0	0.40	1.20	0.015
L3	30.0	0.74	20.0	44.0	63.0	7.9	10.0	1.61	0.30	4.0	0.35	1.00	0.011
L4	15.0	0.40	18.5	42.0	66.0	7.2	10.1	1.61	0.20	6.0	0.42	1.10	0.012
C1	30.0	0.82	13.5	39.0	62.0	7.2	11.1	1.61	0.27	3.0	0.40	1.30	0.008
C2	50.0	0.81	15.0	38.0	64.0	6.9	11.0	1.61	0.24	3.0	0.39	1.10	0.009
C3	50.0	0.69	14.5	38.0	63.0	7.1	11.2	1.61	0.26	3.0	0.39	1.10	0.010
C4	260.0	0.23	14.5	38.0	63.0	6.8	8.9	1.61	0.23	3.0	0.40	1.00	0.010
Max	260.0	0.98	20.0	44.0	66.0	8.1	11.2	1.80	0.40	7.0	0.42	1.90	0.015
Min	15.0	0.23	13.5	38.0	62.0	6.8	8.9	0.8	0.15	3.0	0.32	1.0	0.004
Mean	51.25	0.63	16.46	40.67	63.16	7.19	10.54	1.56	0.24	4.42	0.38	1.36	0.0091
S.D.	63.87	0.211	2.12	1,93	1.06	0.38	0.67	0.23	0.07	1.44	0.03	0.37	0.0033

TABLE 4.4

Biotic and abiotic variables monitored during August 1978

	TURB NO.	ANNE NO.	POTA NO.	EPHE NO.	ODON NO.	PLEC NO.	COLE NO.	TABA NO.
N1	0.0	0.0	8.0	94.0	16.0	20.0	4.0	4.0
N2	0.0	0.0	4.0	150.0	24.0	8.0	0.0	4.0
N3	0.0	16.0	4.0	196.0	0.0	12.0	0.0	8.0
N4	0.0	0.0	4.0	212.0	20.0	28.0	8.0	12.0
L1	0.0	8.0	4.0	240.0	44.0	8.0	4.0	4.0
L2	8.0	16.0	8.0	96.0	44.0	20.0	4.0	8.0
L3	8.0	8.0	0.0	288.0	24.0	8.0	0.0	0.0
L4	0.0	0.0	0.0	28.0	0.0	8.0	0.0	0.0
C1	0.0	0.0	8.0	60.0	0.0	0.0	0.0	0.0
C2	4.0	0.0	8.0	268.0	12.0	16.0	4.0	4.0
C3	0.0	0.0	4.0	36.0	8.0	0.0	4.0	0.0
C4	0.0	14.0	0.0	16.0	0.0	0.0	9.0	0.0
Max	8.0	16.0	8.0	288.0	44.0	28.0	9.0	12.0
Min	0.0	0.0	0.0	16.0	0.0	0.0	0.0	0.0
Mean	1.67	5.167	4.33	140.33	16.0	10.67	3.08	3.67
S.D.	3.037	6.555	3.0368	93.939	15.3188	8.537	3.04	3.815

	SIMU NO.	CHIR NO.	TIPU NO.	TRIC NO.	GAST NO.	TOTAL NO.	TURB BIOM	ANNE BIOM
N1	0.0	16.0	0.0	124.0	8.0	294.0	0.0	0.0
N2	340.0	20.0	16.0	28.0	4.0	598.0	0.0	0.0
N3	0.0	68.0	4.0	68.0	24.0	400.0	0.0	0.01872
N4	120.0	68.0	4.0	52.0	24.0	552.0	0.0	0.0
L1	72.0	84.0	0.0	48.0	0.0	516.0	0.0	0.00936
L2	48.0	28.0	0.0	48.0	16.0	344.0	0.00124	0.01872
L3	268.0	40.0	8.0	188.0	24.0	864.0	0.00124	0.00936
L4	0.0	28.0	0.0	12.0	0.0	76.0	0.0	0.0
C1	128.0	76.0	0.0	56.0	24.0	352.0	0.0	0.0
C2	508.0	68.0	0.0	68.0	8.0	968.0	0.00062	0.0
C3	100.0	24.0	4.0	312.0	24.0	516.0	0.0	0.0
C4	0.0	116.0	0.0	136.0	0.0	291.0	0.0	0.01638
Max	508.0	116.0	16.0	312.0	24.0	968.0	0.00124	0.01872
Min	0.0	16.0	0.0	12.0	0.0	76.0	0.0	0.0
Mean	132.0	53.0	3.0	95.0	13.0	480.91	0.00026	0.00604
S.D.	154.0216	30.072	4.6547	81.078	10.2144	238.41	0.00047	0.00767

	POTA BIOM	EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM
N1	5.68904	0.04747	0.53648	0.12760	0.00912	0.02372	0.0	0.00040
N2	2.84452	0.07777	0.80484	0.05104	0.0	0.02372	0.05780	0.00050
N3	2.84452	0.09898	0.0	0.07656	0.0	0.04744	0.0	0.00170
N4	2.84452	0.10706	0.67070	0.17864	0.01824	0.07116	0.02040	0.00170
L1	2.84452	0.12120	1.47554	0.05104	0.00912	0.02372	0.01224	0.00210
L2	5.68904	0.04848	1.47554	0.12760	0.00912	0.04744	0.00816	0.00070
L3	0.0	0.14544	0.804848	0.05104	0.0	0.0	0.04556	0.00100
L4	0.0	0.01414	0.0	0.05104	0.0	0.0	0.0	0.00070
C1	5.68904	0.03030	0.0	0.0	0.0	0.0	0.02176	0.00190
C2	5.68904	0.13534	0.40242	0.10208	0.00912	0.02372	0.08636	0.00170
C3	2.84452	0.01212	0.26828	0.0	0.00912	0.0	0.01700	0.00060
C4	0.0	0.00808	0.0	0.0	0.02052	0.0	0.0	0.00290
Max	5.68904	0.14544	1.47554	0.17864	0.02052	0.07116	0.08636	0.00290
Min	0.0	0.00808	0.0	0.0	0.0	0.0	0.0	0.0004
Mean	3.0816	0.0705	0.5366	0.0681	0.00703	0.024	0.02244	0.00133
S.D.	2.1595	0.0481	0.5137	0.05447	0.0069	0.02619	0.02618	0.00075

	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTAL BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN
N1	0.0	0.45012	0.79387	7.67782	0.0	0.0	530.24	77.27
N2	0.03776	0.10164	0.39694	4.39653	0.0	0.0	265.12	123.30
N3	0.00944	0.24684	2.38162	5.72582	0.0	13.85	265.12	161.11
N4	0.00944	0.18876	2.38162	6.49224	0.0	0.0	265.12	174.26
L1	0.0	0.17424	0.0	4.72308	0.0	6.93	265.12	197.28
L2	0.0	0.17424	1.58774	9.18802	1.24	13.85	530.24	78.91
L3	0.01888	0.68244	2.38162	4.14142	1.24	6.93	0.0	236.74
L4	0.0	0.04356	0.0	0.10944	0.0	0.0	0.0	23.02
C1	0.0	0.20328	2.38162	8.32790	0.0	0.0	530.24	49.32
C2	0.0	0.24684	0.79387	7.49111	0.62	0.0	530.24	220.30
C3	0.00944	1.13256	2.38162	6.67526	0.0	0.0	265.12	29.59
C4	0.0	0.49368	0.0	0.54156	0.0	12.12	0.0	13.15
Max	0.03776	1.13256	2.38162	9.18802	1.24	13.85	530.24	236.74
Min	0.0	0.04356	0.0	0.10944	0.0	0.0	0.0	13.15
Mean	0.00708	0.34485	1.29	5.4575	0.25	4.47	287.21	115.35
S.D.	0.0109	0.2943	1.0136	2.7388	0.47	5.6749	201.2798	77.2186

	ODON KJN	PLEC KJN	COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN
N1	493.92	209.20	13.13	33.54	0.0	0.49	0.0	683.86
N2	740.88	83.68	0.0	33.54	63.07	0.61	42.24	154.42
N3	0.0	125.52	0.0	67.08	0.0	2.07	10.56	375.02
N4	617.40	292.88	26.26	100.62	22.26	2.07	10.56	286.78
L1	1358.28	83.68	13.13	33.54	13.37	2.56	0.0	264.72
L2	1358.28	209.20	13.13	67.08	8.90	0.85	0.0	264.72
L3	740.88	83.68	0.0	0.0	49.71	1.22	21.12	1036.82
L4	0.0	83.68	0.0	0.0	0.0	0.85	0.0	66.18
C1	0.0	0.0	0.0	0.0	23.74	2.32	0.0	308.84
C2	370.44	167.36	13.13	33.54	94.23	2.07	0.0	375.02
C3	246.96	0.0	13.13	0.0	18.55	0.73	10.56	1720.68
C4	0.0	0.0	29.55	0.0	0.0	3.54	0.0	750.04
Max	1358.28	292.88	29.55	100.62	94.23	3.54	42.24	1720.68
Min	0.0	0.0	0.0	0.0	0.0	0.49	0.0	66.18
Mean	493.92	111.57	10.12	30.75	24.49	1.62	7.92	523.95
S. D.	472.89	89.302	9.981	31.99	28.5696	0.9175	12.2885	447.146

	GAST KJN	TOTAL KJN	TURB PO_4	ANNE PO_4	POTA PO_4	EPHE PO_4	ODON PO_4	PLEC PO_4
N1	93.04	2134.69	0.0	0.0	547.040	3.158	31.158	12.392
N2	46.52	1553.38	0.0	0.0	273.520	5.040	46.738	4.957
N3	279.12	1299.45	0.0	1.429	273.520	6.586	0.0	7.435
N4	279.12	2077.33	0.0	0.0	273.520	7.123	38.948	17.349
L1	0.0	2238.61	0.0	0.715	273.520	8.064	85.686	4.957
L2	186.08	2732.48	0.154	1.429	547.040	3.226	85.686	12.392
L3	279.12	2457.46	0.154	0.715	0.0	9.677	46.738	4.957
L4	0.0	173.73	0.0	0.0	0.0	0.941	0.0	4.957
C1	279.12	1191.26	0.0	0.0	547.040	2.016	0.0	0.0
C2	93.04	1899.99	0.077	0.0	547.040	9.005	23.369	9.914
C3	279.12	2584.44	0.0	0.0	273.520	1.210	15.579	0.0
C4	0.0	808.40	0.0	1.250	0.0	0.538	0.0	0.0
Max	279.12	2732.48	0.154	1.429	547.04	9.677	85.686	17.349
Min	0.0	173.73	0.0	0.0	0.0	0.538	0.0	0.0
Mean	151.19	1762.6016	0.0321	0.4615	296.313	4.715	31.16	6.609
S.D.	118.79	741.709	0.0584	0.5845	207.6571	3.156	29.832	5.2898

	COLE PO_4	TABA PO_4	SIMU PO_4	CHIR PO_4	TIPU PO_4	TRIC PO_4	GAST PO_4	TOTAL PO_4
N1	0.832	1.716	0.0	0.029	0.0	31.719	27.976	656.020
N2	0.0	1.716	5.950	0.037	3.904	7.162	13.988	363.012
N3	0.0	3.432	0.0	0.127	0.976	17.394	83.928	394.827
N4	1.664	5.148	2.100	0.127	0.976	13.302	83.928	444.185
L1	0.832	1.716	1.260	0.157	0.0	12.278	0.0	389.185
L2	0.832	3.432	0.840	0.052	0.0	12.278	55.952	723.313
L3	0.0	0.0	4.690	0.075	1.952	48.090	83.928	200.976
L4	0.0	0.0	0.0	0.052	0.0	3.070	0.0	9.020
C1	0.0	0.0	2.240	0.142	0.0	14.325	83.928	649.691
C2	0.832	1.716	8.890	0.127	0.0	17.384	27.976	646.340
C3	0.832	0.0	1.750	0.045	0.976	79.810	83.928	457.650
C4	1.872	0.0	0.0	0.217	0.0	34.789	0.0	38.666
Max	1.872	5.148	8.890	0.217	3.904	79.810	83.928	723.313
Min	0.0	0.0	0.0	0.029	0.0	3.070	0.0	9.020
Mean	0.6413	1.573	2.31	0.099	0.732	24.345	45.461	414.407
S.D.	0.6323	1.6367	2.6954	0.564	1.1357	20.7254	35.7196	227.3839

	DEPTH	CURRENT	TEMP	TURB	COND	PH	O_2	BOD	PO_4	SO_4	NH_4-N	NO_3-N	NO_2-N
N1	35.0	0.34	17.0	46.0	74.0	7.5	8.0	1.61	1.40	13.0	0.26	1.2	0.004
N2	30.0	0.91	17.0	48.0	74.0	7.5	8.2	1.80	0.90	12.0	0.25	1.2	0.005
N3	25.0	0.35	18.0	46.0	76.0	7.1	8.3	0.90	0.63	11.0	0.20	1.1	0.005
N4	18.0	0.98	17.5	48.0	76.0	7.1	8.3	1.61	1.10	14.0	0.25	1.2	0.005
L1	15.0	0.56	17.0	41.0	66.0	8.0	8.2	1.61	0.80	3.0	0.20	0.8	0.002
L2	30.0	0.44	17.0	41.0	80.0	8.1	8.4	1.62	1.20	4.0	0.30	0.8	0.008
L3	30.0	0.74	18.0	42.0	68.0	7.8	7.8	1.61	1.20	3.0	0.20	0.9	0.002
L4	13.0	0.31	16.0	40.0	108.0	7.8	7.9	1.80	0.62	5.0	0.20	1.0	0.005
C1	35.0	0.88	18.0	46.0	71.0	7.1	8.1	1.61	1.40	12.0	0.27	1.0	0.029
C2	50.0	0.82	17.5	43.0	70.0	7.2	8.2	1.61	1.00	12.0	0.25	1.2	0.031
C3	46.0	0.66	19.0	43.0	64.0	7.2	8.1	1.61	1.40	12.0	0.25	1.2	0.030
C4	250.0	0.23	19.0	43.0	72.0	7.1	7.5	1.61	1.10	16.0	0.38	1.2	0.030
Max	250.0	0.98	19.0	48.0	108.0	8.1	8.4	1.80	1.40	16.0	0.38	1.2	0.031
Min	13.0	0.23	16.0	40.0	64.0	7.1	7.5	0.90	0.62	3.0	0.20	0.8	0.002
Mean	48.08	0.60	17.58	43.91	74.92	7.46	8.08	1.58	1.06	9.75	0.25	1.07	0.013
S.D.	61.82	0.25	0.84	2.66	10.87	0.36	0.24	0.22	0.27	4.44	0.05	0.15	0.012

TABLE 4.5

Biotic and abiotic variables monitored during October 1978

	TURB NO.	ANNE NO.	POTA NO.	EPHE NO.	ODON NO.	PLEC NO.	COLE NO.	TABA NO.
N1	0.0	0.0	4.0	72.0	16.0	12.0	56.0	8.0
N2	0.0	0.0	8.0	196.0	36.0	12.0	24.0	8.0
N3	0.0	4.0	0.0	188.0	12.0	12.0	16.0	0.0
N4	0.0	0.0	4.0	200.0	12.0	28.0	4.0	12.0
L1	0.0	8.0	8.0	88.0	4.0	0.0	0.0	4.0
L2	4.0	4.0	4.0	160.0	20.0	16.0	8.0	4.0
L3	8.0	0.0	0.0	116.0	20.0	4.0	0.0	0.0
L4	0.0	0.0	4.0	4.0	0.0	8.0	4.0	0.0
C1	16.0	8.0	4.0	84.0	0.0	0.0	16.0	8.0
C2	8.0	0.0	0.0	36.0	0.0	4.0	0.0	8.0
C3	4.0	16.0	4.0	16.0	8.0	0.0	4.0	0.0
C4	0.0	16.0	0.0	20.0	0.0	0.0	12.0	0.0
Max	16.0	16.0	8.0	200.0	36.0	28.0	56.0	12.0
Min	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0
Mean	3.333	4.666	3.333	98.333	10.667	8.0	12.0	4.333
S.D.	4.8534	5.84997	2.7487	69.96	10.6249	8.1649	15.14375	4.15

	SIMU NO.	CHIR NO.	TIPU NO.	TRIC NO.	GAST NO.	TOTAL NO.	TURB BIOM	ANNE BIOM
N1	0.0	60.0	4.0	116.0	20.0	368.0	0.0	0.0
N2	296.0	48.0	4.0	80.0	24.0	736.0	0.0	0.0
N3	140.0	72.0	8.0	84.0	24.0	564.0	0.0	0.00468
N4	68.0	76.0	0.0	60.0	20.0	484.0	0.0	0.0
L1	144.0	16.0	0.0	24.0	32.0	328.0	0.0	0.00936
L2	60.0	20.0	0.0	200.0	20.0	520.0	0.00062	0.00468
L3	140.0	24.0	0.0	84.0	16.0	412.0	0.00124	0.0
L4	0.0	48.0	0.0	16.0	0.0	84.0	0.0	0.0
C1	80.0	84.0	4.0	32.0	16.0	352.0	0.00248	0.00936
C2	128.0	56.0	4.0	44.0	20.0	308.0	0.00124	0.0
C3	128.0	48.0	0.0	88.0	24.0	340.0	0.00062	0.01872
C4	0.0	136.0	0.0	128.0	0.0	312.0	0.0	0.01872
Max	296.0	136.0	8.0	200.0	32.0	736.0	0.00248	0.01872
Min	0.0	16.0	0.0	16.0	0.0	84.0	0.0	0.0
Mean	98.67	57.33	2.0	79.67	18.00	400.67	0.00051	0.00546
S.D.	80.685	31.5524	2.5819	49.4357	9.0185	55.339	0.00075	0.0068

	POTA BIOM	EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM
N1	0.52180	0.09288	0.82640	0.07952	0.12656	0.04760	0.0	0.00132
N2	1.04360	0.25284	1.85960	0.07952	0.05424	0.04760	0.03582	0.00106
N3	0.0	0.24252	0.61980	0.07952	0.03616	0.0	0.01694	0.00158
N4	0.52180	0.25800	0.61980	0.18564	0.00904	0.07140	0.00823	0.00167
L1	1.04360	0.11352	0.20660	0.0	0.0	0.02380	0.01742	0.00035
L2	0.52180	0.20640	1.03300	0.10608	0.01808	0.02380	0.00726	0.00044
L3	0.0	0.14964	0.03300	0.02652	0.0	0.0	0.01694	0.00053
L4	0.52180	0.00516	0.0	0.05304	0.00904	0.0	0.0	0.00106
C1	0.52180	0.10836	0.0	0.0	0.03616	0.04760	0.00968	0.00185
C2	0.0	0.04644	0.0	0.02652	0.0	0.04760	0.01549	0.00123
C3	0.52180	0.02064	0.41320	0.0	0.00904	0.0	0.01549	0.00106
C4	0.0	0.02580	0.0	0.0	0.02712	0.0	0.0	0.00299
Max	1.04360	0.25800	1.85960	0.18564	0.12656	0.07140	0.03582	0.00299
Min	0.0	0.00516	0.0	0.0	0.0	0.0	0.0	0.00035
Mean	0.4348	0.12685	0.551	0.053	0.027	0.0258	0.0119	0.0013
S.D.	0.3586	0.09025	0.5488	0.054	0.034	0.0247	0.0098	0.00069

	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTAL BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN
N1	0.00920	0.49300	1.48160	3.67988	0.0	0.0	58.44	151.13
N2	0.00920	0.34000	1.77792	5.50140	0.0	0.0	116.88	411.40
N3	0.01840	0.35700	1.77792	3.15452	0.0	3.46	0.0	394.61
N4	0.0	0.25500	1.48160	3.41218	0.0	0.0	58.44	419.80
L1	0.0	0.10200	2.37056	3.88721	0.0	6.95	116.88	184.71
L2	0.0	0.85000	1.48160	4.25376	0.62	3.46	58.44	335.84
L3	0.0	0.35700	1.18528	2.77015	1.24	0.0	0.0	243.48
L4	0.0	0.06800	0.0	0.65810	0.0	0.0	58.44	8.40
C1	0.00920	0.13600	1.18528	2.06777	2.48	6.93	58.44	176.32
C2	0.00920	0.18700	1.48160	1.81632	1.24	0.0	0.0	75.56
C3	0.00920	0.37400	1.77792	3.16169	0.62	13.86	58.44	33.58
C4	0.0	0.54400	0.0	0.61863	0.0	13.86	0.0	41.98
Max	0.01840	0.85000	2.37056	5.50140	2.48	13.86	116.88	419.80
Min	0.0	0.06800	0.0	0.61863	0.0	0.0	0.0	8.4
Mean	0.00537	0.3386	1.3334	2.915	0.5167	4.042	48.7	206.401
S.D.	0.00589	0.21	0.668	1.375	0.7523	5.0676	40.159	146.8477

	ODON KJN	PLEC KJN	COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN
N1	1267.68	91.49	180.99	67.30	0.0	1.51	10.29	722.91
N2	2858.28	91.49	78.10	67.30	39.07	1.21	10.29	498.56
N3	950.76	91.49	52.06	0.0	18.48	1.81	20.58	523.49
N4	950.76	213.47	13.02	100.96	8.98	1.92	0.0	373.92
L1	316.92	0.0	0.0	33.65	19.01	0.40	0.0	149.57
L2	1584.60	121.98	26.03	33.65	7.92	0.50	0.0	1246.40
L3	1584.60	30.50	0.0	0.0	18.48	0.61	0.0	523.49
L4	0.0	60.99	13.02	0.0	0.0	1.21	0.0	99.71
C1	0.0	0.0	52.06	67.30	10.56	2.12	10.29	199.42
C2	0.0	30.50	0.0	67.30	16.90	1.41	10.29	274.21
C3	633.84	0.0	13.02	0.0	16.90	1.21	0.0	548.42
C4	0.0	0.0	39.05	0.0	0.0	3.43	0.0	796.70
Max	2858.28	213.47	180.99	100.96	39.07	3.43	20.58	1246.40
Min	0.0	0.0	0.0	0.0	0.0	0.4	0.0	99.71
Mean	845.62	60.99	38.946	36.455	13.025	1.445	5.145	496.4
S.D.	843.0052	62.24888	48.9789	34.913	10.65	0.796	6.642	308.002

	GAST KJN	TOTAL KJN	TURB PO_4	ANNE PO_4	POTA PO_4	EPHE PO_4	ODON PO_4	PLEC PO_4
N1	165.94	2717.68	0.0	0.0	101.436	6.185	25.184	5.916
N2	199.13	4384.58	0.0	0.0	202.872	16.836	56.664	5.916
N3	199.13	2255.87	0.0	0.357	0.0	16.149	18.888	5.916
N4	165.94	2307.21	0.0	0.0	101.436	17.180	18.888	13.804
L1	265.50	1093.57	0.0	0.715	202.872	7.559	6.296	0.0
L2	165.94	3585.38	0.077	0.357	101.436	13.744	31.480	7.888
L3	132.75	2535.15	0.154	0.0	0.0	9.964	31.480	1.972
L4	0.0	241.77	0.0	0.0	101.436	0.344	0.0	3.944
C1	132.75	718.67	0.308	0.715	101.436	7.216	0.0	0.0
C2	165.94	643.35	0.154	0.0	0.0	3.092	0.0	1.972
C3	199.13	1519.02	0.077	1.429	101.436	1.374	12.592	0.0
C4	0.0	895.02	0.0	1.429	0.0	1.718	0.0	0.0
Max	265.50	4384.58	0.308	1.429	202.872	17.18	56.664	13.804
Min	0.0	241.77	0.0	0.0	0.0	0.344	0.0	0.0
Mean	149.346	1908.1058	0.0642	0.4168	84.53	8.4467	16.789	3.944
S. D.	74.826	1221.5847	0.0934	0.5225	69.71	6.0096	16.7236	4.0253

	COLE PO_4	TABA PO_4	SIMU PO_4	CHIR PO_4	TIPU PO_4	TRIC PO_4	GAST PO_4	TOTAL PO_4
N1	11.558	3.440	0.0	0.092	0.951	53.638	54.996	263.396
N2	4.954	3.440	3.700	0.074	0.951	36.992	65.995	398.394
N3	3.302	0.0	1.750	0.111	1.902	38.842	65.995	153.212
N4	0.826	5.160	0.850	0.117	0.0	27.744	54.996	241.001
L1	0.0	1.720	1.800	0.025	0.0	11.098	87.994	320.079
L2	1.651	1.720	0.750	0.031	0.0	92.480	54.996	306.610
L3	0.0	0.0	1.750	0.037	0.0	38.842	43.997	128.196
L4	0.826	0.0	0.0	0.074	0.0	7.398	0.0	114.022
C1	3.302	3.440	1.000	0.129	0.951	14.797	43.997	177.291
C2	0.0	3.440	1.600	0.086	0.951	20.346	54.996	86.637
C3	0.826	0.0	1.600	0.074	0.0	40.691	65.995	226.094
C4	2.477	0.0	0.0	0.209	0.0	59.187	0.0	65.042
Max	11.558	5.160	3.700	0.209	1.902	92.480	87.994	398.394
Min	0.0	0.0	0.0	0.025	0.0	7.398	0.0	65.042
Mean	2.4768	1.863	1.23	0.088	0.4755	36.84	49.4964	206.66
S.D.	3.1255	1.784	1.008	0.0484	0.6138	22.8589	24.799	98.87

	DEPTH	CURRENT	TEMP	TURB	COND	PH	O_2	BOD	PO_4	SO_4	NH_4-N	NO_3-N	NO_2-N
N1	30.0	0.32	21.0	42.0	66.0	6.8	8.1	1.61	0.25	6.0	0.28	1.1	0.022
N2	25.0	0.87	21.0	42.0	64.0	6.8	8.1	1.80	0.27	5.0	0.28	1.3	0.009
N3	23.0	0.35	21.0	42.0	66.0	6.8	8.1	1.80	0.24	6.0	0.28	1.2	0.012
N4	15.0	0.97	21.0	42.0	80.0	6.8	8.2	1.61	0.23	4.0	0.28	1.2	0.009
L1	15.0	0.48	23.5	44.0	65.0	7.1	8.1	1.61	0.24	4.0	0.28	1.8	0.004
L2	28.0	0.43	24.0	42.0	120.0	7.2	8.1	1.80	0.80	3.0	0.40	1.2	0.012
L3	30.0	0.68	24.5	44.0	66.0	7.1	8.3	1.80	0.35	4.0	0.21	0.9	0.008
L4	13.0	0.29	24.5	42.0	120.0	7.2	8.1	1.80	0.32	4.0	0.22	1.1	0.009
C1	35.0	0.87	18.0	42.0	68.0	6.8	8.0	1.61	0.42	3.0	0.27	1.8	0.011
C2	45.0	0.92	19.0	42.0	75.0	6.8	8.0	1.61	0.14	6.0	0.32	1.7	0.009
C3	40.0	0.62	19.0	42.0	76.0	6.8	8.0	1.61	0.14	9.0	0.28	1.8	0.012
C4	250.0	0.20	19.0	42.0	78.0	6.8	8.0	1.61	0.15	4.0	0.30	1.8	0.013
Max	250.0	0.97	24.5	44.0	120.0	7.2	8.3	1.80	0.80	9.0	0.40	1.8	0.022
Min	15.0	0.20	18.0	42.0	64.0	6.8	8.0	1.61	0.14	3.0	0.21	0.9	0.004
Mean	45.75	0.58	21.29	42.33	78.67	6.91	8.09	1.69	0.29	4.83	0.28	1.41	0.0108
S.D.	62.31	0.26	2.23	0.74	19.23	0.16	0.08	0.09	0.17	1.62	0.04	0.33	4.099

TABLE 4.6

Biotic and abiotic variables monitored during November 1978

	TURB NO.	ANNE NO.	POTA NO.	EPHE NO.	ODON NO.	PLEC NO.	COLE NO.	TABA NO.
N1	0.0	0.0	4.0	72.0	8.0	16.0	48.0	0.0
N2	0.0	0.0	4.0	100.0	8.0	12.0	24.0	8.0
N3	0.0	16.0	4.0	40.0	4.0	16.0	8.0	12.0
N4	0.0	0.0	4.0	68.0	4.0	28.0	8.0	4.0
L1	0.0	0.0	4.0	168.0	8.0	0.0	4.0	0.0
L2	8.0	16.0	8.0	140.0	8.0	16.0	16.0	4.0
L3	8.0	8.0	0.0	160.0	12.0	0.0	28.0	8.0
L4	0.0	0.0	0.0	12.0	0.0	4.0	0.0	0.0
C1	4.0	8.0	4.0	20.0	0.0	0.0	12.0	8.0
C2	0.0	0.0	4.0	36.0	8.0	16.0	0.0	8.0
C3	8.0	8.0	4.0	36.0	8.0	16.0	8.0	4.0
C4	0.0	32.0	0.0	12.0	0.0	0.0	12.0	0.0
Max	8.0	32.0	8.0	168.0	12.0	28.0	48.0	12.0
Min	0.0	0.0	0.0	12.0	0.0	0.0	0.0	0.0
Mean	2.3333	7.3333	3.3333	72.0	5.6666	10.3333	14.0	4.6666
S.D.	3.4480	9.4985	2.211	54.6991	3.8151	8.8631	13.1148	3.9440

	SIMU NO.	CHIR NO.	TIPU NO.	TRIC NO.	GAST NO.	TOTAL NO.	TURB BIOM	ANNE BIOM
N1	0.0	44.0	16.0	104.0	20.0	332.0	0.0	0.0
N2	132.0	44.0	0.0	100.0	28.0	460.0	0.0	0.0
N3	0.0	96.0	4.0	52.0	28.0	280.0	0.0	0.02448
N4	136.0	72.0	0.0	36.0	16.0	376.0	0.0	0.0
L1	174.0	30.0	0.0	40.0	48.0	476.0	0.0	0.0
L2	40.0	40.0	4.0	124.0	32.0	456.0	0.00124	0.02448
L3	128.0	44.0	8.0	64.0	48.0	516.0	0.00124	0.01224
L4	0.0	40.0	0.0	0.0	0.0	56.0	0.0	0.0
C1	112.0	56.0	4.0	144.0	0.0	372.0	0.00062	0.01224
C2	124.0	32.0	0.0	60.0	28.0	316.0	0.0	0.0
C3	28.0	60.0	0.0	88.0	40.0	308.0	0.00124	0.01224
C4	0.0	40.0	0.0	144.0	0.0	240.0	0.0	0.04896
Max	174.0	96.0	16.0	144.0	48.0	516.0	0.00124	0.04896
Min	0.0	30.0	0.0	0.0	0.0	56.0	0.0	0.0
Mean	72.8333	49.8333	3.0	79.6666	24.0	349.0	3.6166	0.01122
S.D.	64.0492	17.9528	4.6547	43.3423	16.6533	120.6219	5.3444	0.0145

	POTA BIOM	EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM
N1	1.20048	0.16848	0.25352	0.08352	0.04896	0.0	0.0	0.00356
N2	1.20048	0.23400	0.25352	0.06246	0.02448	0.06056	0.02812	0.00356
N3	1.20048	0.09360	0.12676	0.08352	0.00816	0.09084	0.0	0.00778
N4	1.20048	0.15912	0.12676	0.14616	0.00816	0.03028	0.02897	0.00853
L1	1.20048	0.39312	0.25352	0.0	0.00408	0.0	0.03706	0.00243
L2	2.40096	0.32760	0.25352	0.08352	0.01632	0.03028	0.00852	0.00324
L3	0.0	0.37440	0.38028	0.0	0.02856	0.06056	0.02726	0.00356
L4	0.0	0.02808	0.0	0.02088	0.0	0.0	0.0	0.00324
C1	1.20048	0.04680	0.0	0.0	0.01224	0.06056	0.02386	0.00454
C2	1.20048	0.08424	0.25352	0.08352	0.0	0.06056	0.02641	0.02641
C3	1.20048	0.08424	0.25352	0.08352	0.00816	0.03028	0.00596	0.00486
C4	0.0	0.02808	0.0	0.0	0.01224	0.0	0.0	0.00324
Max	2.40096	0.39312	0.38028	0.14616	0.04896	0.09084	0.03706	0.00853
Min	0.0	0.02808	0.0	0.0	0.0	0.0	0.0	0.00243
Mean	1.0004	0.16848	0.17957	0.0539	0.01428	0.03532	0.01551	0.00426
S.D.	0.6635	0.12799	0.1209	0.0462	0.01337	0.0298	0.01364	0.00186

	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTAL BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN
N1	0.03840	0.33800	1.55840	3.69332	0.0	0.0	183.88	283.03
N2	0.0	0.32500	2.18176	4.37412	0.0	0.0	183.88	393.10
N3	0.00960	0.16900	2.18176	3.99598	0.0	18.12	183.88	157.24
N4	0.0	0.11700	1.24672	3.07218	0.0	0.0	183.88	267.31
L1	0.0	0.13000	3.74016	5.76175	0.0	0.0	183.88	660.41
L2	0.00960	0.40300	2.49344	6.04718	1.24	18.12	367.76	550.34
L3	0.01920	0.20800	3.74016	4.85546	1.24	9.06	0.0	628.96
L4	0.0	0.0	0.0	0.05220	0.0	0.0	0.0	47.24
C1	0.00960	0.46800	0.0	1.83894	0.62	9.06	183.88	78.62
C2	0.0	0.19500	2.18176	4.08808	0.0	0.0	183.88	141.52
C3	0.0	0.28600	3.11680	5.08730	1.24	9.06	183.88	141.52
C4	0.0	0.46800	0.0	0.56052	0.0	36.23	0.0	47.24
Max	0.03840	0.46800	3.74016	6.04718	1.24	36.23	367.76	660.41
Min	0.0	0.0	0.0	0.05220	0.0	0.0	0.0	47.24
Mean	0.0072	0.25891	1.87008	3.61891	0.36	8.3041	153.2333	283.0442
S.D.	0.01117	0.14086	1.29762	1.8406	0.53	10.7549	101.6434	215.0099

Table 4.6 (cont.)

	ODON KJN	PLEC KJN	COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN
N1	298.64	128.11	70.51	0.0	0.0	4.09	42.94	513.45
N2	298.64	96.08	35.26	85.61	30.68	4.09	0.0	493.70
N3	149.32	128.11	11.75	128.41	0.0	8.92	10.74	256.72
N4	149.32	224.20	11.75	42.80	31.61	6.69	0.0	177.73
L1	298.64	0.0	5.88	0.0	40.44	2.79	0.0	197.48
L2	298.64	128.11	23.50	42.80	9.30	3.72	10.74	612.19
L3	447.96	0.0	41.13	85.61	29.75	4.09	21.47	315.97
L4	0.0	32.03	0.0	0.0	0.0	3.72	0.0	0.0
C1	0.0	0.0	17.63	85.61	26.03	5.20	10.74	710.93
C2	298.64	128.11	0.0	85.61	28.82	2.97	0.0	296.22
C3	298.64	128.11	11.75	42.80	6.51	5.57	0.0	434.46
C4	0.0	0.0	17.63	0.0	0.0	3.72	0.0	710.93
Max	447.96	224.2	70.51	128.41	40.44	8.92	42.94	710.93
Min	0.0	0.0	0.0	0.0	0.0	2.79	0.0	0.0
Mean	211.536	82.738	20.5658	49.9375	16.9283	4.6308	8.0525	393.315
S.D.	142.4204	70.967	19.2652	42.2057	14.8859	1.6672	12.492	213.982

	GAST KJN	TOTAL KJN	TURB PO_4	ANNE PO_4	POTA PO_4	EPHE PO_4	ODON PO_4	PLEC PO_4
N1	174.54	1699.19	0.0	0.0	115.212	13.478	18.580	8.280
N2	244.36	1865.40	0.0	0.0	115.212	18.720	18.580	6.214
N3	244.36	1297.57	0.0	1.869	115.212	7.488	9.290	8.285
N4	139.63	1234.92	0.0	0.0	115.212	12.730	9.290	14.498
L1	418.90	1208.42	0.0	0.0	115.212	31.450	18.580	0.0
L2	279.26	2345.72	0.154	1.869	230.424	26.208	18.580	8.285
L3	418.90	2004.14	0.154	0.934	0.0	29.952	27.870	0.0
L4	0.0	82.99	0.0	0.0	0.0	2.264	0.0	2.071
C1	0.0	1128.32	0.077	0.934	115.212	3.744	0.0	0.0
C2	244.36	1410.13	0.0	0.0	115.212	6.739	18.580	8.285
C3	349.08	1612.62	0.154	0.934	115.212	6.739	18.580	8.285
C4	0.0	815.75	0.0	3.738	0.0	2.264	0.0	0.0
Max	418.9	2345.72	0.154	3.738	230.424	31.450	27.87	14.498
Min	0.0	82.99	0.0	0.0	0.0	2.264	0.0	0.0
Mean	209.449	1392.09	0.0449	0.8565	96.01	13.481	13.161	5.3506
S.D.	145.3347	565.255	0.0663	1.1095	63.6858	10.2365	8.8607	4.5893

	COLE PO_4	TABA PO_4	SIMU PO_4	CHIR PO_4	TIPU PO_4	TRIC PO_4	GAST PO_4	TOTAL PO_4
N1	4.465	0.0	0.0	0.250	3.968	18.658	57.846	240.742
N2	2.233	4.380	2.891	0.250	0.0	17.940	80.984	267.404
N3	0.744	6.570	0.0	0.544	0.992	9.329	80.984	241.307
N4	0.744	2.190	2.978	0.408	0.0	6.458	46.277	210.785
L1	0.372	0.0	3.811	0.170	0.0	7.176	138.830	315.601
L2	1.488	2.190	0.876	0.227	0.992	22.246	92.554	406.093
L3	2.605	4.380	2.803	0.250	1.984	11.816	138.830	221.578
L4	0.0	0.0	0.0	0.227	0.0	0.0	0.0	4.562
C1	1.116	4.380	2.453	0.318	0.992	25.834	0.0	155.060
C2	0.0	4.380	2.716	0.181	0.0	10.764	80.984	247.841
C3	0.744	2.190	0.613	0.340	0.0	15.787	115.692	285.270
C4	1.116	0.0	0.0	0.227	0.0	25.834	0.0	33.179
Max	4.465	6.57	3.811	0.544	3.968	25.834	138.83	406.093
Min	0.0	0.0	0.0	0.170	0.0	0.0	0.0	4.562
Mean	1.3022	2.555	1.5951	0.2826	0.744	14.3201	69.4151	219.1185
S.D.	1.22	2.1593	1.4027	0.1016	1.1544	7.7662	48.1663	107.0621

	DEPTH	CURRENT	TEMP	TURB	COND	PH	O_2	BOD	PO_4	SO_4	NH_4-N	NO_3-N	NO_2-N
N1	30.0	0.34	21.0	44.0	70.0	6.5	8.1	1.61	0.38	3.0	0.17	1.3	0.009
N2	20.0	0.81	22.0	44.0	74.0	6.5	8.1	1.61	0.25	3.0	0.16	1.4	0.009
N3	25.0	0.34	22.0	44.0	76.0	6.6	8.0	1.61	0.16	3.0	0.15	1.2	0.009
N4	10.0	0.85	22.0	44.0	75.0	6.5	8.1	1.61	0.25	3.0	0.16	1.3	0.009
L1	15.0	0.46	25.0	46.0	70.0	7.1	9.0	1.61	0.25	3.0	0.10	1.4	0.011
L2	20.0	0.43	25.0	44.0	78.0	6.5	9.0	1.61	0.20	4.0	0.21	1.4	0.009
L3	25.0	0.54	25.0	46.0	74.0	6.7	8.0	1.61	0.25	3.0	0.10	1.3	0.011
L4	10.0	0.28	25.0	44.0	110.0	6.6	7.5	1.61	0.30	5.0	0.12	1.2	0.013
C1	35.0	0.87	20.0	35.0	84.0	6.1	8.1	1.61	0.35	2.0	0.54	1.5	0.018
C2	45.0	1.00	21.0	33.0	84.0	6.2	8.2	1.80	0.20	3.0	0.48	1.5	0.019
C3	45.0	0.80	20.5	34.0	84.0	6.1	8.0	1.61	0.20	2.0	0.48	1.5	0.018
C4	260.0	0.20	20.0	30.0	86.0	6.5	7.2	1.61	0.20	2.0	0.45	1.5	0.020
Max	260.0	1.00	25.0	46.0	110.0	7.1	9.0	1.80	0.38	5.0	0.54	1.5	0.020
Min	10.0	0.20	20.0	30.0	70.0	6.1	7.2	1.61	0.16	2.0	0.1	1.2	0.009
Mean	45.0	0.57	22.37	40.66	80.42	6.49	8.11	1.62	0.25	3.0	0.26	1.37	0.0129
S.D.	65.79	0.26	1.97	5.57	10.40	0.26	0.48	0.05	0.06	0.82	0.16	0.11	4.31

TABLE 4.7

Biotic and abiotic variables monitored during February 1979

	TURB NO.	ANNE NO.	POTA NO.	EPHE NO.	ODON NO.	PLEC NO.	COLE NO.	TABA NO.
N1	0.0	0.0	4.0	108.0	12.0	20.0	60.0	8.0
N2	0.0	0.0	4.0	92.0	8.0	12.0	20.0	4.0
N3	0.0	8.0	4.0	96.0	4.0	16.0	8.0	8.0
N4	0.0	0.0	4.0	60.0	0.0	0.0	8.0	8.0
L1	0.0	4.0	4.0	92.0	32.0	8.0	12.0	12.0
L2	8.0	16.0	8.0	108.0	24.0	12.0	12.0	4.0
L3	8.0	20.0	0.0	88.0	12.0	8.0	56.0	8.0
L4	0.0	0.0	4.0	16.0	0.0	4.0	8.0	0.0
C1	4.0	4.0	12.0	88.0	0.0	0.0	8.0	8.0
C2	8.0	8.0	8.0	52.0	8.0	12.0	8.0	8.0
C3	8.0	8.0	0.0	16.0	8.0	0.0	12.0	16.0
C4	0.0	16.0	0.0	44.0	0.0	0.0	24.0	0.0
Max	8.0	20.0	12.0	108.0	32.0	20.0	60.0	16.0
Min	0.0	0.0	0.0	16.0	0.0	0.0	8.0	0.0
Mean	3.0	7.0	4.3333	71.6666	9.0	7.6666	19.6667	7.0
S.D.	3.6968	6.7577	3.448	31.7262	9.6781	6.6248	17.848	4.3589

	SIMU NO.	CHIR NO.	TIPU NO.	TRIC NO.	GAST NO.	TOTAL NO.	TURB BIOM	ANNE BIOM
N1	0.0	48.0	4.0	64.0	40.0	368.0	0.0	0.0
N2	104.0	40.0	12.0	20.0	32.0	348.0	0.0	0.0
N3	0.0	84.0	0.0	16.0	32.0	276.0	0.0	0.01256
N4	68.0	172.0	0.0	20.0	40.0	380.0	0.0	0.0
L1	128.0	32.0	0.0	196.0	28.0	548.0	0.0	0.00628
L2	32.0	48.0	8.0	232.0	32.0	544.0	0.00124	0.02512
L3	124.0	84.0	4.0	132.0	28.0	572.0	0.00124	0.03140
L4	0.0	20.0	0.0	16.0	0.0	68.0	0.0	0.0
C1	108.0	52.0	4.0	20.0	40.0	348.0	0.00062	0.00628
C2	124.0	28.0	0.0	144.0	44.0	452.0	0.00124	0.01256
C3	28.0	40.0	0.0	120.0	56.0	312.0	0.00124	0.01256
C4	0.0	32.0	0.0	140.0	0.0	256.0	0.0	0.02512
Max	128.0	172.0	12.0	232.0	56.0	572.0	0.00124	0.03140
Min	0.0	20.0	0.0	16.0	0.0	68.0	0.0	0.0
Mean	59.6667	56.6667	2.6667	93.3333	31.0	372.6667	0.00046	0.0204
S.D.	52.6993	39.6933	3.7718	73.9789	15.7586	137.4999	0.00057	0.0334

	POTA BIOM	EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM
N1	0.40580	0.45144	0.26376	0.11260	0.13800	0.03424	0.0	0.00130
N2	0.40580	0.38456	0.17584	0.06756	0.04600	0.01712	0.01560	0.00108
N3	0.40580	0.40128	0.08792	0.09008	0.01840	0.03424	0.0	0.00227
N4	0.40580	0.25080	0.0	0.0	0.01840	0.03424	0.01020	0.00464
L1	0.40580	0.38456	0.70336	0.04504	0.02760	0.05136	0.01920	0.00086
L2	0.81160	0.45144	0.52752	0.06756	0.02760	0.01712	0.00480	0.00130
L3	0.0	0.36784	0.26376	0.04504	0.12880	0.03424	0.01860	0.00227
L4	0.40580	0.06688	0.0	0.02252	0.01840	0.0	0.0	0.00054
C1	1.21740	0.36784	0.0	0.0	0.01840	0.03424	0.01620	0.00140
C2	0.81160	0.21736	0.17584	0.06756	0.01840	0.03424	0.01860	0.00076
C3	0.0	0.06688	0.17584	0.0	0.02760	0.06848	0.00420	0.00108
C4	0.0	0.18392	0.0	0.0	0.05520	0.0	0.0	0.00086
Max	1.2174	0.45144	0.70336	0.11260	0.13800	0.06848	0.01920	0.00464
Min	0.0	0.06688	0.0	0.0	0.01840	0.0	0.0	0.00054
Mean	0.4396	0.2996	0.1978	0.04316	0.0452	0.0299	0.0089	0.00153
S.D.	0.3498	0.1326	0.2187	0.0372	0.041	0.0186	0.0079	0.00107

	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTAL BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN
N1	0.00888	0.20224	2.62680	4.24506	0.0	0.0	59.56	758.38
N2	0.02664	0.06320	2.10144	3.30484	0.0	0.0	59.56	646.02
N3	0.0	0.05056	2.10144	3.20455	0.0	9.29	59.56	674.11
N4	0.0	0.06320	2.62680	3.41408	0.0	0.0	59.56	421.32
L1	0.0	0.61936	1.83876	4.10218	0.0	4.65	59.56	646.02
L2	0.01776	0.73312	2.10144	4.78762	1.24	18.59	119.12	758.38
L3	0.00888	0.41712	1.83876	3.15795	1.24	23.24	0.0	617.94
L4	0.0	0.05056	0.0	0.56470	0.0	0.0	59.56	112.35
C1	0.00888	0.06320	2.62680	4.36126	0.62	4.65	178.68	617.94
C2	0.0	0.45504	2.88948	4.70268	1.24	9.29	119.12	365.14
C3	0.0	0.37920	3.67752	4.41460	1.24	9.29	0.0	112.35
C4	0.0	0.44240	0.0	0.70750	0.0	18.59	0.0	308.97
Max	0.02664	0.73312	3.67752	4.78762	1.24	23.24	178.68	758.38
Min	0.0	0.05056	0.0	0.70750	0.0	0.0	0.0	112.35
Mean	0.00592	0.29493	2.03577	3.41392	0.47	8.13	64.52	503.24
S.D.	0.00837	0.23377	1.03487	1.35939	0.57	7.85	51.34	222.78

Table 4.7 (cont.)

	ODON KJN	PLEC KJN	COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN
N1	409.34	172.72	198.72	45.40	0.0	1.49	9.93	307.26
N2	272.90	103.63	66.24	24.20	17.03	1.24	29.80	96.02
N3	136.45	138.18	26.50	45.40	0.0	2.60	0.0	76.82
N4	0.0	0.0	26.50	45.40	11.13	5.33	0.0	96.02
L1	1091.58	69.09	39.74	72.60	20.95	0.99	0.0	940.99
L2	818.69	103.63	39.74	24.20	5.24	1.49	19.87	1113.83
L3	409.34	69.09	185.47	45.40	20.30	2.60	9.93	633.73
L4	0.0	34.54	26.50	0.0	0.0	0.62	0.0	76.02
C1	0.0	0.0	26.50	45.40	17.68	1.61	9.93	96.02
C2	272.90	103.63	26.50	45.40	20.30	0.87	0.0	691.34
C3	272.90	0.0	39.74	90.80	4.58	1.24	0.0	576.12
C4	0.0	0.0	79.49	0.0	0.0	0.99	0.0	672.14
Max	1091.58	172.72	198.72	90.80	20.95	5.33	29.80	1113.83
Min	0.0	0.0	26.50	0.0	0.0	0.62	0.0	76.82
Mean	307.008	66.209	65.1367	40.35	9.7675	1.7558	6.6217	448.026
S. D.	330.14	57.213	59.112	25.0269	8.6272	1.2296	9.3653	355.241

	GAST KJN	TOTAL KJN	TURB PO4	ANNE PO_4	POTA PO4	EPHE PO_4	ODON PO4	PLEC PO4
N1	294.20	2257.00	0.0	0.0	35.240	36.115	22.541	11.170
N2	235.36	1492.44	0.0	0.0	35.240	30.765	15.027	6.702
N3	235.36	1404.27	0.0	0.958	35.240	32.102	7.514	8.936
N4	294.20	959.46	0.0	0.0	35.240	20.064	0.0	0.0
L1	205.94	3152.11	0.0	0.479	35.240	30.765	60.109	4.468
L2	235.36	3259.38	0.154	1.917	70.480	36.115	45.082	6.702
L3	205.94	2224.22	0.154	2.396	0.0	29.427	22.541	4.468
L4	0.0	309.59	0.0	0.0	35.240	5.350	0.0	2.234
C1	294.20	1293.23	0.077	0.479	105.721	29.427	0.0	0.0
C2	323.62	1979.35	0.154	0.958	70.480	17.389	15.027	6.702
C3	411.88	1520.14	0.154	0.958	0.0	5.350	15.027	0.0
C4	0.0	1080.18	0.0	1.917	0.0	14.714	0.0	0.0
Max	411.88	3259.38	0.154	2.396	105.721	36.115	60.109	11.17
Min	0.0	309.59	0.0	0.0	0.0	5.35	0.0	0.0
Mean	228.005	1744.28	0.05775	0.8385	38.177	23.965	16.9057	4.2818
S.D.	115.904	835.365	0.07116	0.8096	30.377	10.609	18.1795	3.7

	COLE PO_4	TABA PO_4	SIMU PO_4	CHIR PO_4	TIPU PO_4	TRIC PO4	GAST PO4	TOTAL PO4
N1	12.600	2.476	0.0	0.091	0.918	11.162	97.508	229.821
N2	4.200	1.238	1.606	0.076	2.754	3.488	78.006	179.102
N3	1.680	2.476	0.0	0.159	0.0	2.790	78.006	169.861
N4	1.680	2.476	1.050	0.325	0.0	3.488	97.508	161.831
L1	2.520	3.714	1.976	0.061	0.0	34.182	68.256	241.771
L2	2.250	1.238	0.494	0.091	1.836	40.461	78.006	285.096
L3	11.760	2.476	1.915	0.159	0.918	23.021	68.256	167.491
L4	1.680	0.0	0.0	0.038	0.0	2.790	0.0	47.332
C1	1.680	2.476	1.668	0.098	0.918	3.488	97.508	243.540
C2	1.680	2.476	1.915	0.053	0.0	25.114	107.259	249.207
C3	2.520	4.952	0.432	0.076	0.0	20.928	136.511	186.908
C4	5.040	0.0	0.0	0.061	0.0	24.416	0.0	46.148
Max	12.600	4.952	1.976	0.325	1.836	40.461	136.511	285.096
Min	1.68	0.0	0.0	0.038	0.0	2.79	0.0	46.148
Mean	4.13	2.1665	0.92	0.1073	0.612	16.2773	75.5686	184.009
S. D.	3.748	1.349	0.814	0.0749	0.8655	12.902	38.41469	71.956

	DEPTH	CURRENT	TEMP	TURB	COND	PH	O_2	BOD	PO_4	SO4	NH_4-N	NO_3-N	NO_2-N
N1	35.0	0.39	23.0	42.0	64.0	6.4	7.8	1.61	0.35	3.0	0.18	1.20	0.009
N2	20.0	0.84	23.0	42.0	64.0	6.3	8.3	1.61	0.24	3.0	0.22	1.50	0.009
N3	25.0	0.67	23.0	44.0	64.0	6.3	8.3	1.61	0.20	3.0	0.31	2.00	0.011
N4	10.0	0.92	23.0	40.0	60.0	6.2	7.8	1.80	0.22	3.0	0.22	1.80	0.009
L1	20.0	0.63	24.0	34.0	58.0	6.6	8.0	1.61	0.14	3.0	0.31	1.50	0.008
L2	25.0	0.48	24.0	34.0	56.0	6.7	8.0	1.61	0.45	3.0	0.31	1.10	0.006
L3	30.0	0.57	25.0	44.0	60.0	6.1	8.0	1.61	0.33	4.0	0.31	1.50	0.004
L4	10.0	0.43	24.0	40.0	62.0	6.1	7.9	1.61	0.35	3.0	0.33	1.20	0.007
C1	35.0	1.01	22.0	30.0	88.0	6.6	8.2	1.61	0.50	2.0	0.44	2.10	0.018
C2	45.0	1.06	23.0	34.0	90.0	6.3	8.0	1.80	0.20	3.0	0.50	1.80	0.020
C3	45.0	0.85	22.0	30.0	90.0	6.4	8.1	1.61	0.30	2.0	0.44	1.50	0.018
C4	300.0	0.23	24.0	32.0	90.0	6.5	7.9	1.61	0.25	3.0	0.45	1.80	0.025
Max	300.0	1.06	25.0	44.0	90.0	6.7	8.3	1.80	0.50	4.0	0.50	2.10	0.025
Min	10.0	0.23	22.0	30.0	56.0	6.1	7.8	1.61	0.14	2.0	0.18	1.1	0.0004
Mean	50.0	0.67	23.33	37.16	70.5	6.38	8.03	1.64	0.29	2.92	0.34	1.58	0.012
S.D.	76.18	0.25	0.85	5.13	13.64	0.19	0.16	0.07	0.1	0.49	0.09	0.31	0.0063

TABLES 4.8 - 4.15

Correlation matrices

TABLE 4.8

Correlation matrix of biological and chemo-physical parameters monitored in the Nwanedzi River System during April 1978

EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTA BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN	ODON KJN	PLEC KJN
100																
12	100															
6	26	100														
25	-0	3	100													
5	33	30	0	100												
12	-22	2	12	37	100											
40	31	24	-15	-4	-10	100										
39	-46	8	11	-10	32	-32	100									
-3	34	-35	-27	53	-8	-25	-15	100								
24	3	6	-22	30	24	-2	21	23	100							
30	60	7	72	56	40	-17	12	39	3	100						
1	-9	-26	34	0	-20	-25	-20	18	-49	-16	100					
18	-18	-16	-58	-38	-34	36	-43	-22	30	-74	-36	100				
-23	38	14	58	31	37	-10	11	2	-34	89	-36	-60	100			
100	12	6	28	3	11	40	39	-4	22	31	1	-20	25	100		
12	100	26	0	33	-22	31	-46	34	3	50	-9	-18	38	11	100	
7	24	98	7	24	16	19	12	-39	6	11	-28	-20	20	7	24	100
25	0	3	100	0	12	-15	11	-27	-22	42	34	-58	58	29	0	7
5	33	30	0	100	37	-4	-10	5	30	56	-0	-38	31	3	33	24
-3	6	-15	-19	-9	63	-24	20	5	31	29	-15	-23	20	-4	6	3
40	31	24	-15	-4	-10	100	-32	-25	-2	-17	-25	36	10	40	31	19
39	-46	8	11	-10	32	-32	100	-15	21	12	-20	-43	11	39	-46	12
-3	34	-35	-27	53	-8	-25	-15	100	23	39	18	-22	2	-4	34	39
24	3	6	-22	30	24	-2	21	23	100	3	49	-30	34	22	3	6
16	50	-21	-1	63	8	-22	-6	92	18	72	7	-48	39	16	50	-23
1	-9	-26	34	0	-20	-25	-20	18	49	-16	100	-20	-36	1	-9	-28
-18	-18	-16	-58	-38	-34	36	-42	-22	-30	-74	-20	100	-60	-20	-18	-20
23	38	14	58	31	37	-10	11	2	-34	89	-36	-60	100	25	38	20
100	12	6	28	3	11	40	39	-4	22	31	1	-20	25	100	12	7
12	100	26	0	33	-22	31	-46	34	3	50	-9	-18	38	12	100	24
6	26	100	3	30	2	24	8	-35	6	7	-26	-16	14	6	26	98
25	0	3	100	0	12	-15	11	-27	-22	42	34	-58	58	28	0	7
5	33	30	0	100	37	-4	-10	53	30	56	-100	-38	31	3	33	24
-3	6	-15	-19	-9	63	-24	20	5	31	29	-15	-23	20	-5	6	3
40	31	24	-14	-4	-10	100	-32	-25	-2	-16	-25	35	-10	41	31	19
39	-46	8	11	-10	32	-32	100	-15	21	12	-20	43	11	39	-46	12
-3	34	-34	-27	53	-8	-25	-15	100	23	39	18	-22	2	-4	34	-38
24	3	6	-22	30	24	-2	21	23	100	3	49	-30	34	22	3	6
30	52	5	39	58	37	17	10	46	4	100	-14	-73	86	31	52	8
-39	-46	-29	-23	-26	-23	-43	-2	-8	-36	-57	3	-59	-45	-41	-46	-31
-9	44	4	-37	43	28	-10	12	48	65	35	-2	-41	2	-11	44	7
30	28	5	-6	-7	8	65	-9	-15	28	19	-18	-12	16	32	28	3
53	28	40	39	33	49	5	38	-7	-14	60	-36	-41	66	53	28	49
-40	-3	-17	-2	-26	-36	19	-34	1	-11	-13	7	-3	-9	-36	-3	-22
16	12	5	-44	-17	-10	47	-20	-11	-58	-7	-85	45	13	-15	12	3
45	33	30	27	32	28	34	26	6	53	53	6	-70	36	47	33	30
-15	36	-23	-34	-53	55	-9	-23	10	5	-14	7	21	-19	-15	36	-21
-48	-21	-40	-46	18	-17	-64	6	62	13	-19	17	11	41	-50	-21	-44
-35	-27	-41	-41	9	-18	-58	17	49	-3	-24	4	21	-38	-38	-27	-43
-31	-12	-39	-24	25	-17	-60	3	70	45	-9	58	-16	-43	-33	-12	-43
-69	-28	-42	-23	3	-32	-63	-7	53	-8	-15	20	-4	-27	-69	-22	-48
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	TURB NO	ANNE NO	POTA NO	EPHE NO	ODON NO	PLEC NO	COLE NO	TABA NO	SIMU NO	CHIR NO	TIPU NO	TRIC NO	GAST NO	TOTA NO	TURB BIOM	ANNE BIOM	POTA BIOM
TURB NO	100																
ANNE NO	-20	100															
POTA NO	-36	-60	100														
EPHE NO	1	-20	25	100													
ODON NO	-9	-18	38	12	100												
PLEC NO	-26	-16	14	6	26	100											
COLE NO	34	-58	58	28	0	3	100										
TABA NO	0	-38	31	4	33	30	0	100									
SIMU NO	-15	-23	20	-5	6	15	-19	-9	100								
CHIR NO	-25	36	-10	40	31	24	-15	-4	-24	100							
TIPU NO	-20	-43	11	39	-46	8	11	-10	26	-32	100						
TRIC NO	18	-22	2	-4	34	35	-27	53	5	-25	-15	100					
GAST NO	49	-30	-34	21	3	6	-22	30	31	-2	21	23	100				
TOTA NO	-1	-23	13	26	53	-18	-33	48	39	14	-12	80	41	100			
TURB BIOM	100	-20	-36	1	-9	-26	34	0	-15	-25	-20	18	49	-1	100		
ANNE BIOM	-20	100	-60	-20	-18	-16	-58	-38	-23	36	-43	22	-30	-23	-20	100	
POTA BIOM	-36	-60	100	25	38	14	58	31	20	-10	11	2	-34	13	-36	-60	100
EPHE BIOM	1	-18	23	100	12	6	25	5	-3	40	39	3	24	27	1	-18	23
ODON BIOM	-9	-18	38	12	100	26	0	33	6	31	-46	34	3	52	-9	-18	38
PLEC BIOM	-26	-16	14	6	26	100	3	30	-15	24	8	35	7	-18	-26	-16	14
COLE BIOM	34	-58	58	28	0	3	100	0	-19	-15	11	27	-22	-33	34	-58	58
TABA BIOM	0	-36	31	4	33	30	0	100	-9	-4	-10	52	30	48	0	-38	31
SIMU BIOM	-20	-34	37	11	-22	2	12	38	63	-10	32	8	25	21	-20	-34	37
CHIR BIOM	-25	36	-10	40	31	24	-15	-4	-24	100	-32	25	-2	14	-25	36	-10
TIPU BIOM	-20	-43	11	39	-46	8	11	-10	20	-32	100	15	21	-12	-20	-43	11
TRIC BIOM	18	-22	2	-4	34	-35	-27	53	5	-25	-15	100	23	80	18	-22	2
GAST BIOM	49	-30	-34	22	3	6	-22	30	31	-2	12	23	100	41	49	-30	-34
TOTA BIOM	-16	-74	89	31	50	7	43	56	29	-17	12	39	3	50	-16	-74	89
TURB KJN	100	-20	-36	1	-9	-26	34	0	-15	-25	-20	18	49	-1	100	-20	-36
ANNE KJN	-20	100	-60	-20	-18	-16	-58	-38	-23	36	-43	22	-30	-23	-20	100	-60
POTA KJN	-36	-60	100	25	38	14	58	31	20	-10	11	2	-34	13	-36	-60	100
EPHE KJN	1	-20	25	100	12	6	28	4	-5	40	39	4	22	26	1	-20	25
ODON KJN	-9	-18	38	12	100	26	0	33	6	31	-46	34	3	52	-9	-18	38
PLEC KJN	-28	-20	20	7	24	98	7	24	3	19	12	39	6	-15	-28	-20	20
COLE KJN	34	-58	58	28	0	3	100	0	-19	-15	11	27	-22	-33	34	-58	58
TABA KJN	0	-38	31	4	33	30	0	100	-9	-4	-10	52	30	48	0	-38	31
SIMU KJN	-15	-23	20	-5	6	-15	-19	-9	100	-24	20	5	31	39	-15	-23	20
CHIR KJN	-25	36	-10	40	31	24	-15	-4	-24	100	-32	25	-2	14	-25	36	-10
TIPU KJN	-20	-43	11	39	-46	8	11	-10	20	-32	100	15	21	-12	-20	-43	11
TRIC KJN	18	-22	2	-4	34	-35	-27	53	5	-25	-15	100	23	80	18	-22	2
GAST KJN	49	-30	-34	22	3	6	-22	30	31	-2	21	23	100	41	49	-30	-34
TOTA KJN	7	-48	39	16	50	-21	-7	63	12	-22	-6	92	18	82	7	-48	39
TURB PO_4	100	-20	-36	1	-9	-26	34	0	-15	-25	-20	18	49	-1	100	-20	-36
ANNE PO_4	-20	100	-60	-20	-18	-16	-58	-38	-23	36	-42	22	-30	-23	-20	100	-60
POTA PO_4	-36	-60	100	25	38	14	58	31	20	-10	11	2	-34	13	-36	-60	100
EPHE PO_4	1	-20	25	100	12	6	28	3	-5	40	39	4	22	26	1	-20	25
ODON PO_4	-9	-18	38	12	100	26	0	33	6	31	-46	34	3	52	-9	-18	38
PLEC PO_4	-26	-16	14	6	26	100	3	30	-15	24	8	35	6	-18	-26	-16	14
COLE PO_4	34	-58	58	28	0	3	100	0	-19	-15	11	27	-22	-33	34	-58	48
TABA PO_4	0	-38	31	4	33	30	0	100	-9	-4	-10	53	30	48	0	-38	31
SIMU PO_4	15	-23	20	-5	6	-15	-19	-9	100	-24	20	5	31	39	-15	-23	20
CHIR PO_4	25	35	-10	41	31	24	-14	-4	-24	100	-32	25	-2	15	-25	35	-10
TIPU PO_4	-20	-43	11	39	46	8	11	-10	20	-32	100	15	21	-12	-20	-42	11
TRIC PO_4	18	-22	2	-4	34	-35	-27	53	5	-25	-15	100	23	80	18	-22	2
GAST PO_4	49	-30	-34	22	3	6	-22	30	31	-2	21	23	100	41	49	-30	-34
TOTA PO_4	-14	-73	86	31	52	5	39	58	27	-17	10	46	4	55	-14	-73	86
DEPT	-3	59	-45	-41	46	-29	-23	-26	-24	-43	-2	8	-36	-46	3	59	-45
CURRENT	-2	-41	2	-11	44	4	-39	43	52	-10	12	48	65	65	-2	-41	2
TEMP	-18	12	16	32	28	5	-6	-7	18	65	-9	-15	28	26	-18	-12	16
TURB	-36	-41	66	53	28	40	39	33	21	5	38	-7	-14	18	-36	-41	66
COND	-7	-3	-9	-36	3	-17	-2	-26	-18	19	-34	1	-11	-7	7	-3	9
PH	-85	45	13	-15	12	5	-43	-17	-4	47	-20	-11	-58	3	-85	45	13
O_2	6	-70	36	47	33	30	27	32	17	34	26	6	53	39	6	-70	36
B.O.D.	7	21	-19	-15	36	-21	-34	-53	28	-9	-23	10	5	14	7	21	19
PO_4	17	11	41	-51	21	-40	-46	18	-2	-64	6	62	13	18	17	11	41
SO_4	4	21	-38	-38	-27	-41	-41	9	-2	-58	17	49	-3	10	4	21	-38
NH_4-N	58	-16	-43	-33	12	-39	-24	25	-1	-60	3	70	45	32	58	-16	43
NO_3-N	20	-4	-27	-69	22	-42	-23	3	-14	-63	-7	53	-8	2	20	-4	27
NO_2-N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	TIPU PO4	TRIC PO4	GAST PO4	TOTA PO4	DEPT	B.O.D.	CURRENT	TEMP	TURB	COND	PH	O_2	PO_4	SO_4	NH_4-N	NO_3-N
0																
2	100															
5	15	100														
2	21	23	100													
6	10	46	4	100												
4	-2	-8	-36	-56	100											
0	12	-48	65	37	39	100										
7	-9	-15	28	17	-80	26	100									
5	38	-7	-14	58	-23	5	-14	100								
9	-34	1	-11	-13	-35	-7	53	-68	100							
7	-20	-11	-58	-7	-6	-14	35	25	25	100						
1	26	5	54	51	-93	49	71	27	21	-15	100					
9	-23	10	5	-13	0	19	19	-42	-28	12	-14	100				
4	6	62	13	-14	60	30	60	-38	-10	-18	-48	12	100			
9	17	49	3	-20	75	17	-73	-16	-35	-14	-81	0	93	100		
0	3	70	45	-3	30	40	-44	-42	0	-53	-16	13	87	71	100	
3	-7	53	-8	-11	41	15	-42	-58	37	-6	-37	19	85	68	77	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN	GAST KJN	TOTA KJN	TURB PO4	ANNE PO4	POTA PO4	EPHE PO4	ODON PO4	PLEC PO4	COLE PO4	TABA PO4	SIMU PO4	CHIR PO4
100																	
0	100																
-19	-9	100															
-15	-4	-24	100														
11	-10	20	-32	100													
-27	53	5	-25	-15	100												
-22	30	31	-2	21	23	100											
-1	63	12	-22	-6	91	18	100										
34	-0	-15	-25	-20	18	49	7	100									
-58	-38	-23	36	-4	-22	-30	-48	-20	100								
58	31	20	-10	-11	2	-34	39	-36	-60	100							
28	4	-5	40	39	-4	22	16	1	-20	25	100						
-0	33	6	31	-46	34	3	50	-9	-18	38	12	100					
3	30	-15	24	8	-35	6	-21	-26	-16	14	6	26	100				
100	0	-19	-15	11	-27	-22	-1	34	-58	58	28	0	3	100			
0	100	-9	-4	-10	53	30	63	0	-38	31	3	33	30	0	100		
-19	-9	100	-24	20	5	31	12	-15	-23	20	-5	6	-15	-19	-10	100	
-14	-4	-24	100	-32	-25	-2	-21	-25	35	-10	41	31	24	-14	-4	24	10
11	-10	20	-32	100	15	21	-6	-20	-42	11	39	-46	8	11	-10	20	3
-27	53	5	-25	15	100	23	91	18	-22	2	-4	34	-34	-27	53	5	2
-22	30	31	-2	-21	23	100	18	49	-30	-34	22	3	6	-22	30	31	
39	58	27	-17	10	46	4	77	-14	-73	87	31	52	5	-39	58	27	1
-23	-26	-24	-43	-2	-8	-36	-31	3	59	-45	-41	-46	29	-23	-26	-24	4
-37	43	52	-10	12	48	65	50	-2	-41	2	-11	44	4	-37	43	52	-1
-6	-7	17	65	-9	-15	28	-3	-18	-12	16	32	28	5	-6	-7	17	
39	33	21	5	38	-7	-14	24	-36	-41	66	53	28	40	39	33	21	
-2	-26	-18	19	-34	1	-11	-8	7	-3	-9	-36	-3	-17	-2	-26	-18	1
-44	-17	-4	47	-20	-11	-58	-12	-8	45	13	-15	12	5	-44	-17	-4	4
27	32	17	34	26	6	53	28	6	-70	36	47	33	30	-27	32	17	3
-34	-53	28	-9	-23	10	5	1	7	21	-20	-15	36	23	-34	-53	28	
-46	18	-2	-64	6	63	13	36	17	11	-41	-50	-21	-40	-46	18	2	-6
-41	9	-2	-58	17	49	3	25	4	21	-38	-38	-27	-41	-41	10	-2	-5
-24	25	-1	-60	3	70	45	47	58	-16	-43	-33	12	-39	-24	25	-1	-6
-23	3	-14	-63	-7	53	8	29	20	-4	27	-69	22	-42	-23	3	-14	-6
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

TABLE 4.9

Correlation matrix of biological and chemo-physical parameters monitored in the Nwanedzi River System during May 1978

[illegible] BIOM	EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTA BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN	ODON KJN	PLEC KJN
00																	
28	100																
24	75	100															
33	-5	20	100														
4	14	17	40	100													
54	24	4	14	-43	100												
49	-29	-19	-17	-16	-14	100											
25	7	7	-9	6	37	-15	100										
0	-19	-31	-4	-41	35	1	-19	100									
51	-21	-36	-37	-30	2	63	0	12	100								
16	11	33	7	-16	26	15	23	24	5	100							
33	-5	8	22	-20	51	50	30	10	52	65	100						
24	-9	-17	-29	-28	40	-15	22	14	10	47	38	100					
37	17	-18	-29	59	-27	-30	37	-20	-11	-42	-50	-16	100				
00	-28	-24	33	-14	54	49	25	0	51	16	83	24	-37	100			
28	100	75	-5	14	24	-29	7	-19	-21	11	-5	-9	17	-29	100		
24	75	100	20	17	4	-19	7	-31	-36	33	8	-17	-18	-24	75	100	
33	-5	20	100	40	14	-17	-9	-4	-37	7	21	-29	-29	33	-5	20	100
14	14	17	40	100	-43	-16	6	-41	-30	-16	-20	-28	59	-14	14	17	40
54	24	4	14	-43	100	-14	37	35	2	26	51	40	-27	54	24	4	14
19	-30	-19	-14	-15	-16	100	-17	1	63	16	51	-15	-31	49	-30	-19	-14
25	4	9	13	21	27	-25	94	-25	-4	30	32	20	34	25	4	9	13
0	-19	-31	-4	-41	35	1	-19	100	12	24	100	14	-20	0	-19	-31	-4
51	-21	-36	-37	-30	2	63	0	12	100	5	52	10	-11	51	-21	-36	-37
16	11	33	7	-16	26	15	23	24	5	100	65	47	-42	16	11	33	7
55	37	43	-1	-5	21	43	21	-38	58	34	73	13	-28	55	38	43	-1
24	-9	-17	-29	-28	40	-15	22	15	10	47	38	100	-16	24	-9	-17	-29
37	17	-18	-29	59	-27	-30	37	-20	-11	-42	-50	-16	100	-37	17	-18	-29
00	-28	-24	33	-14	54	49	25	0	51	16	83	24	-37	100	-28	-24	33
28	100	75	-5	14	24	-29	7	-19	-21	11	-5	-9	17	-29	100	75	-5
24	75	100	20	17	4	-19	7	-31	-36	33	8	-17	-18	-24	75	100	20
33	-5	20	100	39	14	-17	-9	-4	-37	7	22	-29	-29	33	-5	20	100
14	14	17	40	100	-43	-16	6	-41	-30	-16	-20	-28	59	-14	14	17	40
54	24	4	14	-43	100	-14	37	35	2	26	51	40	-27	54	24	4	14
49	-30	-19	-14	-15	-16	100	-17	1	63	16	51	-15	-31	49	-30	-19	-14
43	2	25	29	-14	46	-11	77	-17	-3	54	59	24	-21	43	-2	25	29
0	-19	-31	-4	-41	35	1	-19	100	12	24	10	14	-20	0	-19	-31	-4
51	-21	-36	-37	-30	2	63	0	12	100	5	52	10	-11	51	-21	-36	-37
16	11	33	7	-16	26	15	23	24	5	100	65	47	-42	16	11	33	7
95	-12	-3	29	-17	54	52	28	3	54	43	96	30	-46	95	-12	-3	29
23	3	-37	-31	49	-15	-26	29	6	4	-38	-40	5	93	-23	4	-37	-31
44	-28	-4	24	-12	-6	62	-23	30	55	61	70	4	-57	44	-28	-4	24
1	64	59	1	-23	33	25	3	-6	-17	39	26	-10	-31	1	64	59	1
48	53	55	-37	-7	-20	18	-8	-22	-17	32	-12	-18	-4	-48	53	55	-37
26	-46	-20	-17	-20	-32	-23	-31	-2	-5	-43	-44	-6	-15	-26	-46	-20	-17
50	-56	-74	-6	-36	39	-3	7	39	35	-6	27	62	-12	50	-56	-74	-6
-2	-8	-12	-11	-11	-20	21	-71	38	29	-10	-2	18	-25	-2	-8	-12	-11
24	16	7	-7	8	-35	10	-79	12	7	-19	-23	4	-13	-24	16	7	-7
19	-25	-54	-55	6	-19	28	22	0	72	-26	7	20	51	19	-25	-54	-55
14	-29	-53	-50	-2	-3	19	21	41	61	2	15	38	40	14	-29	-53	-50
25	-32	-57	-49	-14	9	21	21	43	65	11	27	51	28	25	-32	-57	-49
24	40	58	48	17	-6	-26	-24	-41	-57	-24	-31	-60	-21	-24	40	58	48
63	-1	-29	39	10	53	-3	32	26	28	-2	44	17	14	63	-1	-29	39

	TURB NO	ANNE NO	POTA NO	EPHE NO	ODON NO	PLEC NO	COLE NO	TABA NO	SIMU NO	CHIR NO	TIPU NO	TRIC NO	GAST NO	TOTA NO	TURB BIOM	ANNE BIOM
TURB NO	100															
ANNE NO	-16	100														
POTA NO	24	37	100													
EPHE NO	-9	17	-28	100												
ODON NO	-17	-18	-24	75	100											
PLEC NO	-29	-29	33	-5	20	100										
COLE NO	-29	59	-14	14	17	40	100									
TABA NO	40	-27	54	24	4	14	-43	100								
SIMU NO	-15	-31	18	-32	-16	4	-15	-2	100							
CHIR NO	20	34	18	4	10	17	21	30	-25	100						
TIPU NO	14	-20	56	-15	-35	-36	-41	9	1	-25	100					
TRIC NO	10	-11	9	-24	-33	-13	-30	20	64	-4	12	100				
GAST NO	47	-42	34	12	31	-3	-16	17	16	30	24	5	100			
TOTA NO	-2	-19	18	-5	-1	7	-13	24	83	6	-2	86	27	100		
TURB BIOM	100	-16	24	-9	-17	-29	-28	40	-15	20	14	10	47	-2	100	
ANNE BIOM	-16	100	-37	17	-18	-29	59	-27	-31	34	-20	-11	-42	-19	-16	100
POTA BIOM	24	-37	71	-30	-22	49	-14	67	49	25	0	51	16	60	24	-37
EPHE BIOM	-9	17	-30	100	75	-4	14	25	-30	4	-19	-21	11	-2	-9	17
ODON BIOM	-17	-18	-22	75	100	19	17	3	-19	9	-31	-36	33	-4	-17	-18
PLEC BIOM	-29	-29	49	-4	19	90	40	6	-14	13	-4	-37	7	-18	-29	-29
COLE BIOM	-28	59	-14	14	17	40	100	-43	-15	21	-41	-30	16	-13	-28	59
TABA BIOM	40	-27	67	25	3	6	-43	94	-16	27	35	2	26	5	40	-27
SIMU BIOM	-15	-30	18	-31	-16	1	-16	0	100	-25	1	63	15	83	-15	-30
CHIR BIOM	22	37	18	7	8	-5	6	40	-17	94	-19	0	23	11	22	37
TIPU BIOM	14	-20	56	-15	-35	-36	-41	9	1	-25	100	12	24	-2	14	-20
TRIC BIOM	10	-11	9	-24	-33	-12	-30	21	63	-4	12	100	5	86	10	-11
GAST BIOM	47	-42	34	12	31	-3	-16	17	16	30	24	5	100	27	47	-42
TOTA BIOM	38	-50	63	-6	10	33	-20	59	51	32	10	52	65	72	38	-50
TURB KJN	100	-16	24	-9	-17	-29	-28	40	-15	20	14	10	47	-2	100	-16
ANNE KJN	-16	100	-37	17	-18	-29	59	-27	-31	34	-20	-11	-42	-19	-16	100
POTA KJN	24	-37	71	-30	-22	49	-14	67	49	25	0	51	16	60	24	-37
EPHE KJN	-9	17	-30	100	75	-4	14	25	-30	4	-19	-21	11	-2	-9	17
ODON KJN	-17	-18	-22	75	100	19	17	3	-19	9	-31	-36	33	-4	-17	-18
PLEC KJN	-29	-29	49	-4	19	90	40	6	-14	13	-4	-37	7	-18	-29	-29
COLE KJN	-28	59	-14	14	17	40	100	-43	-16	21	-41	-30	-16	-13	-28	59
TABA KJN	40	-27	67	25	3	6	-43	94	-16	27	36	2	26	5	40	-27
SIMU KJN	-15	-31	18	-32	-16	4	-15	-2	100	-25	1	63	16	83	-15	-31
CHIR KJN	20	34	18	4	10	17	21	30	-25	100	-25	-4	30	6	20	34
TIPU KJN	14	-20	56	-15	-35	-39	-41	9	1	-25	100	12	24	-2	14	-20
TRIC KJN	10	-11	9	-24	-33	-12	-30	20	63	-4	12	100	5	86	10	-11
GAST KJN	47	-42	34	12	31	-3	-16	17	16	30	24	5	100	27	47	-42
TOTA KJN	13	-28	3	34	46	29	-5	44	44	22	-38	58	34	77	13	-28
TURB PO_4	100	-16	24	-9	-17	-29	-28	40	-15	20	14	10	47	-2	100	-16
ANNE PO_4	-16	100	-37	17	-18	-29	59	-27	-31	34	-20	-11	-42	-19	-16	100
POTA PO_4	24	-37	71	-30	-22	49	-14	67	49	25	0	51	16	60	24	-37
EPHE PO_4	-9	17	-30	100	75	-4	14	25	-30	4	-19	-21	11	-3	-9	17
ODON PO_4	-17	-18	-22	75	100	19	17	3	-19	9	-31	-36	33	-4	-17	-18
PLEC PO_4	-29	-29	49	-4	19	90	39	6	-14	13	-4	-37	7	-18	-29	-29
COLE PO_4	-28	59	-14	14	17	40	100	-43	-15	21	-41	-30	-16	-13	-28	59
TABA PO_4	40	-27	67	25	3	6	-43	94	-16	27	35	2	26	5	40	-27
SIMU PO_4	-15	-31	18	-32	-16	4	-15	-2	100	-25	1	63	16	83	-15	-31
CHIR PO_4	24	-21	35	2	25	33	-14	50	-11	84	-17	-3	54	15	24	-21
TIPU PO_4	14	-20	56	-15	-35	-36	-41	9	1	-25	100	12	24	-2	14	-20
TRIC PO_4	10	-11	9	-24	-33	-13	-30	20	63	-4	12	100	5	86	10	-11
GAST PO_4	47	-42	34	12	31	-3	-16	17	16	30	24	5	100	27	47	-42
TOTA PO_4	30	-46	68	-14	-1	44	-17	66	52	30	3	54	43	70	30	-46
DEPT	5	93	-15	4	-38	-36	49	-19	-28	26	6	4	-38	-14	5	93
CURRENT	4	-57	40	-28	-3	26	-12	-4	64	-12	30	55	61	67	4	-57
TEMP	-10	-31	1	64	59	1	-23	33	24	-5	-6	-17	39	21	-10	-31
TURB	-18	-4	-51	53	55	-35	-7	-18	17	-17	-22	-18	32	8	-18	-4
COND	-6	-15	-26	-46	-20	-17	-20	-32	-24	-36	-2	-5	-43	-38	-6	-15
PH	62	-12	50	-56	-74	-6	-36	39	-3	7	39	35	-6	3	62	-12
O2	18	-25	4	-7	-12	-14	-11	-22	22	-69	38	29	-10	14	18	-25
B.O.D.	4	-13	-24	16	7	-7	8	-35	11	-74	12	7	-19	0	4	-13
PO_4	20	51	-13	-27	-51	-36	6	-4	27	16	0	72	-26	48	20	51
SO_4	38	40	14	-29	-53	-50	-2	-3	18	14	41	61	2	38	38	40
NH_4	51	28	22	-32	-57	-48	-14	10	20	15	43	65	10	40	51	28
NO_3	-60	-21	-24	40	58	48	17	-6	-26	-19	-41	-57	-24	-38	-60	-21
NO_2	17	14	63	-1	-29	39	11	53	-2	40	26	28	-2	25	17	14

COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN	GAST KJN	TOTA KJN	TURB PO_4	ANNE PO_4	POTA PO_4	EPHE PO_4	ODON PO_4	PLEC PO_4	COLE PO_4	TABA PO_4	SIMU PO_4	CHIR PO_4
100																	
-43	100																
-15	-16	100															
21	27	-25	100														
-41	35	1	-25	100													
-30	2	63	-4	12	100												
-16	26	16	30	24	5	100											
-5	21	44	22	-38	58	34	100										
-28	40	-15	20	14	10	47	13	100									
59	-27	-31	34	-20	-11	-42	-28	-16	100								
-14	54	49	25	0	51	16	55	24	-37	100							
14	24	-30	4	-19	-21	11	37	-9	17	-28	100						
17	4	-19	9	-31	-36	33	43	-17	-18	-24	75	100					
39	14	-14	14	-4	-37	7	-1	-29	-29	33	-5	20	100				
100	-43	-15	21	-41	-30	-16	-5	-28	59	-14	14	17	39	100			
-43	100	-16	27	35	2	26	21	40	-27	54	24	4	14	-43	100		
-15	-16	100	-25	1	63	16	44	-15	-31	49	-30	-19	-14	-15	-16	100	
-14	46	-11	84	-17	-3	54	38	24	-21	43	2	25	29	-14	46	-11	100
-41	35	1	-25	100	12	24	-38	13	-20	0	-19	-31	-4	-41	35	1	-17
-30	2	63	-4	12	100	5	58	10	-11	51	-21	-36	-37	-30	2	63	-3
-16	26	16	30	24	4	100	34	47	-42	16	11	33	7	-16	26	16	54
-17	54	52	30	3	54	43	71	30	-46	95	-12	-3	29	-17	54	52	53
49	-15	-28	25	6	4	-38	-32	5	93	-23	3	-37	-31	49	-15	-27	-30
-12	-6	64	-12	30	55	61	44	4	-57	44	-28	-4	23	-12	-6	64	16
-23	33	24	-5	-6	-17	39	35	-10	-31	1	64	59	1	-23	33	24	21
-7	-20	17	-17	-22	-18	32	17	-18	-4	-48	53	55	-37	-7	-20	17	-7
-20	-32	-24	-36	-2	-5	-43	-34	-6	-15	-26	-46	-20	-16	-20	-32	-24	-31
-36	39	-3	7	39	35	-6	-14	62	-12	50	-56	-74	-6	-36	39	-3	7
-11	-20	22	-69	38	29	-10	0	18	-25	-2	-8	-12	-11	-11	-20	22	-7
8	-35	11	-74	12	7	-19	-2	4	-13	-24	16	7	-7	8	-35	11	-74
6	-19	27	16	0	72	-26	18	20	51	19	-25	-54	-55	6	-19	27	-19
-2	-3	18	14	41	61	2	1	38	40	14	-29	-53	-50	-2	-3	18	-17
-14	9	20	15	43	65	11	6	51	28	25	-32	-57	-49	-14	9	20	-9
17	-6	-26	-19	-41	-57	-24	-2	-60	-21	-24	40	58	48	17	-6	-26	0
11	53	-2	40	26	28	-2	18	17	14	63	-1	-29	39	11	53	-2	29

TIPU PO4	TRIC PO4	GAST PO4	TOTA PO4	DEPTH	CURRENT	TEMP	TURB	COND	PH	O_2	B.O.D.	PO_4	SO_4	NH_4-N	NO_3-N	NO_2-N
100																
12	100															
24	5	100														
3	54	43	100													
6	4	-38	-34	100												
30	55	61	60	-45	100											
-6	-17	39	17	-46	8	100										
-22	-18	32	-28	-28	0	71	100									
-2	-5	-43	-38	-11	-20	-64	-26	100								
39	35	-6	36	18	8	-51	-77	16	100							
38	29	-10	-2	0	28	-17	-24	18	30	100						
12	7	-19	-23	1	10	0	-1	8	2	91	100					
0	72	-26	12	66	2	-51	-35	3	44	24	8	100				
41	61	2	13	65	16	-50	-40	-2	55	36	11	88	100			
43	65	11	25	55	22	-46	-42	-4	66	36	8	85	98	100		
-41	-57	-24	-26	-47	-26	38	35	12	-66	-31	-4	77	93	96	100	
26	28	-2	55	32	12	-12	-68	-49	56	7	-7	32	38	42	-36	100

TABLE 4.10

Correlation matrix of biological and chemo-physical parameters monitored in the Nwanedzi River System during July 1978

EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTA BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN	ODON KJN	PLEC KJN
100																
67	100															
-14	-26	100														
15	33	26	100													
56	65	16	25	100												
24	25	1	2	28	100											
13	-26	7	18	11	30	100										
18	8	54	-23	16	28	-10	100									
-24	6	-34	-5	-38	-15	-46	-20	100								
74	36	6	21	25	55	35	32	-42	100							
6	30	50	32	19	20	11	38	-28	27	100						
5	48	-34	21	-4	-11	-23	-26		-23	22	100					
-28	-2	-67	-15	-11	-28	13	-44	36	-55	-39	35	100				
-23	0	58	20	8	2	15	29	-40	-1	92	6	-29	100			
100	67	-14	15	56	24	13	18	-24	74	6	5	-28	-23	100		
67	100	-26	33	65	25	-26	8	6	36	30	48	-2	1	67	100	
20	2	75	40	18	18	19	73	-18	42	45	-22	-51	32	20	3	100
15	33	26	100	25	2	18	-23	-5	21	32	21	-15	20	15	33	40
56	65	16	25	100	28	11	16	-38	25	19	-4	-11	8	56	65	18
24	25	1	2	28	100	30	28	-15	55	20	-11	-28	2	24	25	18
13	-26	7	18	11	30	100	-10	-47	35	12	-23	13	15	13	-26	19
18	8	54	-23	16	28	-10	100	-20	32	38	-26	-44	29	18	8	73
-24	6	-34	-5	-38	-15	-46	-20	100	-42	-28	64	36	-40	-24	6	-18
74	36	6	21	25	55	35	32	-42	100	27	-23	-55	-1	74	36	42
27	67	-23	27	14	12	-42	6	73	4	19	77	11	-12	27	67	10
5	48	-34	21	-4	-11	-23	-26	64	-23	22	100	35	6	5	48	-22
-28	-2	-67	-15	-11	-28	13	-44	36	-55	-39	35	100	-29	-28	-2	-51
-23	0	58	20	8	2	15	29	-40	-1	92	6	-29	100	-23	1	32
100	67	-14	15	56	24	13	18	-24	74	6	5	-28	-23	100	67	20
67	100	-26	33	65	25	-26	8	6	36	30	48	-2	1	67	100	3
13	3	70	30	8	32	12	79	-20	45	55	-26	-54	42	13	4	95
15	33	26	100	25	2	18	-23	-5	-21	32	21	-15	20	15	33	40
56	65	16	25	100	28	11	16	-38	25	19	-4	-11	8	56	65	18
23	26	0	2	27	100	27	27	-10	53	19	-9	-26	0	23	26	17
13	-26	7	18	11	31	100	-10	-46	35	12	-23	13	15	13	-26	19
8	-0	59	-15	11	38	7	96	-18	31	49	-23	-40	41	8	-0	78
-24	6	-34	-5	-38	-15	-46	-20	100	-42	-28	64	36	-40	-24	6	-18
74	36	6	21	25	55	35	32	-42	100	27	-23	-55	-1	74	36	42
-12	17	54	28	12	10	11	32	-28	9	98	20	-31	97	-12	17	39
-36	-36	-54	-39	-31	-24	14	-21	11	-50	-58	-7	82	-38	-36	-36	-43
16	3	50	46	-9.	45	26	39	14	51	45	10	-52	23	16	3	75
18	44	18	-0	71	56	10	19	-43	20	48	-14	-21	44	18	44	1
22	13	48	-11	56	33	6	47	-58	39	34	-60	-54	33	22	13	34
13	24	-10	34	43	63	15	-25	-20	27	-21	-19	-14	-28	13	24	-11
44	53	15	25	68	10	21	4	-13	11	51	26	2	40	44	53	15
20	15	26		-33	-5	-40	29	31	40	32	22	-62	9	20	15	41
17	22	18	-3	30	17	-27	32	9	-19	-8	13	-6	-10	17	22	14
43	56	-33	34	54	20	30	-42	13	3	8	51	37	-6	43	56	-23
-18	1	18	-6	-2	8	-8	8	-46	17	57	-30	-34	63	-18	1	-6
23	-15	-39	1	-16	-29	11	-74	6	-1	-50	5	7	-47	23	-15	-55
16	-3	26	5	-29	-18	-23	44	-29	46	27	-38	-53	20	16	-3	43
-21	16	-21	4	46	2	1	-45	18	-57	-21	19	54	-10	-21	16	-43

	TURB NO	ANNE NO	POTA NO	EPHE NO	ODON NO	PLEC NO	COLE NO	TABA NO	SIMU NO	CHIR NO	TIPU NO	TRIC NO	GAST NO	TOTA NO	TURB BIOM	ANNE BIOM	POTA BIOM
TURB NO	100																
ANNE NO	35	100															
POTA NO	6	-29	100														
EPHE NO	5	-28	-23	100													
ODON NO	48	-0	0	67	100												
PLEC NO	-22	-51	32	20	3	100											
COLE NO	21	-15	20	15	33	40	100										
TABA NO	-4	-11	8	56	65	18	25	100									
SIMU NO	-11	-28	0	24	25	18	2	28	100								
CHIR NO	-23	13	15	13	-26	19	18	11	30	100							
TIPU NO	-26	-44	29	18	8	73	-23	16	28	-10	100						
TRIC NO	64	36	-40	-24	6	-18	-5	-38	-15	-46	20	100					
GAST NO	-23	-55	-0	74	36	42	21	25	55	35	32	-42	100				
TOTA NO	23	-13	-18	36	44	18	10	25	89	16	21	24	50	100			
TURB BIOM	100	35	6	5	48	-22	21	-4	-11	-23	-26	64	-23	23	100		
ANNE BIOM	35	100	-29	-28	-2	-51	-15	-11	-28	13	-44	36	-55	-13	35	100	
POTA BIOM	-27	-48	82	-48	-41	43	-4	-20	13	12	46	-34	-2	-14	-27	-48	100
EPHE BIOM	5	-28	-23	100	67	20	15	56	24	13	18	-24	74	36	5	-28	-48
ODON BIOM	48	-0	0	67	100	3	33	65	25	-26	8	6	36	44	48	-2	41
PLEC BIOM	-34	-67	58	-14	-26	75	26	16	1	7	54	-34	6	-15	-34	-67	73
COLE BIOM	21	-15	20	15	33	40	100	25	2	18	-23	-5	21	10	21	-15	-4
TABA BIOM	-4	-11	8	56	65	18	25	100	28	11	16	-38	25	25	-4	-11	-20
SIMU BIOM	-11	-28	0	24	25	18	2	28	100	30	28	-15	55	89	-11	-28	13
CHIR BIOM	-23	13	15	13	-26	19	18	11	30	100	-10	-46	35	16	-23	13	12
TIPU BIOM	-26	-44	29	18	8	73	-23	16	28	10	100	-20	32	21	-26	44	46
TRIC BIOM	64	36	-40	-24	6	-18	-5	-37	-15	-46	-20	100	-42	24	64	36	-34
GAST BIOM	-23	-55	-0	74	36	42	21	25	55	35	32	-42	100	50	-23	-55	-2
TOTA BIOM	22	-39	92	6	30	43	32	19	20	12	38	-28	27	12	22	-39	68
TURB KJN	100	35	6	5	48	-22	21	-4	11	-23	-26	64	-23	23	100	35	-27
ANNE KJN	35	100	-29	-28	2	-51	-15	-11	28	13	-44	36	-55	-13	35	100	-48
POTA KJN	6	-29	100	-23	0	32	20	8	2	15	29	-40	-0	-18	6	-29	82
EPHE KJN	5	-28	-23	100	67	20	15	56	24	13	18	-24	74	36	5	-28	-48
ODON KJN	48	-0	0	67	100	3	33	65	25	-26	8	6	36	44	48	-2	-4
PLEC KJN	-22	-51	32	20	3	100	40	18	18	19	73	-18	42	18	-21	-51	4
COLE KJN	21	-15	20	15	33	40	100	25	2	18	-23	-5	21	10	21	-15	-
TABA KJN	-4	11	8	56	65	18	25	100	28	11	16	-38	25	25	-4	-11	-20
SIMU KJN	-11	-28	0	24		18	2	28	100	30	28	-15	55	89	-11	-28	1
CHIR KJN	-23	13	15	13	-26	19	18	11	30	100	-10	-46	35	16	-23	13	1
TIPU KJN	-26	-44	29	18	8	73	-23	16	28	-10	100	-20	32	21	-26	-44	46
TRIC KJN	64	36	-40	-24	6	-18	-5	38	-15	-46	-20	100	-42	24	64	50	-34
GAST KJN	-23	-55	-0	74	36	42	21	25	55	35	32	-42	100	50	-23	-55	-
TOTA KJN	8	11	-12	27	67	10	27	14	12	-42	6	73	4	52	77	11	-3
TURB PO_4	100	35	6	5	48	-22	21	-4	-11	-23	-26	64	-23	23	100	35	2
ANNE PO_4	35	100	-29	-28	-2	-51	-15	-11	-28	13	-44	36	-55	-13	35	100	-4
POTA PO_4	6	-29	100	-23	0	32	20	8	2	15	29	-40	-0	-18	6	29	8
EPHE PO_4	5	-28	-23	100	67	20	15	56	24	13	18	-24	74	36	5	-28	-4
ODON PO_4	48	-0	0	67	100	3	33	65	25	-26	8	6	36	44	48	-2	-4
PLEC PO_4	-26	-54	42	13	4	95	30	8	32	12	79	-20	45	27	-26	-54	5
COLE PO_4	21	-15	20	15	33	40	100	25	2	18	-23	-5	21	10	21	-15	-
TABA PO_4	-4	-11	8	56	65	18	25	100	28	11	16	-38	25	25	-4	-11	-2
SIMU PO_4	-9	-26	0	23	26	17	2	27	100	27	27	-10	53	90	-9	-26	1
CHIR PO_4	-23	13	15	13	-26	19	18	11	31	100	-10	-46	35	16	-23	13	1
TIPU PO_4	-23	40	41	8	-0	78	-15	12	38	7	96	-18	31	30	-23	-40	5
TRIC PO_4	64	36	-40	-24	6	-18	-5	-38	-15	-46	-20	100	-42	24	64	36	-3
GAST PO_4	-23	-55	-0	74	36	42	21	25	55	35	32	-42	100	50	-23	-55	-
TOTA PO_4	20	-31	97	-12	17	39	28	12	10	10	32	-28	9	-1	20	-31	7
DEPTH	-7	82	-38	-36	-36	-43	-39	-31	-24	14	-21	11	-50	-26	-7	82	-3
CURRENT	10	-52	23	16	3	75	49	-9	45	26	39	14	51	55	10	-52	3
TEMP	-14	-21	44	18	44	0	0	71	56	10	19	-43	20	36	-14	-21	2
TURB	-60	-54	33	22	13	34	-11	56	32	6	47	-58	39	8	-60	-54	4
COND	-19	-14	-28	13	24	-11	34	43	63	15	-25	-20	29	50	-19	-14	-2
PH	26	3	40	44	53	15	25	68	10	21	4	-13	11	19	26	3	-
O_2	22	-62	9	20	15	41	21	-33	-4	-40	29	31	40	14	22	-62	1
B.O.D.	13	-6	-10	17	22	14	-3	30	17	-27	32	9	-19	21	13	-6	-1
PO_4	51	37	-6	43	56	-23	34	54	20	30	-42	13	3	38	51	37	-4
SO_4	-30	-34	63	-18	1	-6	-6	-2	8	-7	8	-46	17	-19	-30	-34	5
NH_4-N	5	7	-48	23	-15	-55	1	-16	-29	11	-74	6	-1	-21	5	7	-5
NO_3-N	-38	-53	20	16	-3	42	5	-29	-18	-23	44	-29	46	-26	-38	-53	3
NO_2-N	19	54	-10	-21	16	-43	4	46	2	1	-45	18	57	5	19	54	-2

TIPU PO_4	TRIC PO4	GAST PO4	TOTA PO4	DEPTH	CURRENT	TEMP	TURB	COND	PH	O2	B.O.D.	PO4	SO_4	NH4-N	NO_3-N	NO_2-N
100																
-18	100															
31	-42	100														
45	-28	8	100													
-22	11	-50	-49	100												
53	14	51	36	-56	100											
23	-43	20	46	-37	-6	100										
44	-58	39	30	-49	5	74	100									
-24	-20	27	-27	-16	5	42	23	100								
11	-13	11	48	-34	11	59	31	-10	100							
25	31	40	22	-66	60	-32	-3	-26	-18	100						
26	9	-19	-8	9	3	7	-15	7	18	-15	100					
-34	13	3	4	-4	0	33	-18	23	75	-35	23	100				
11	-45	17	58	-35	-11	52	59	-4	8	13	-53	-32	100			
-78	5	-1	-51	6	-25	-36	-39	7	-5	-5	-8	32	-29	100		
35	-29	46	20	-29	22	-22	26	-33	-30	63	-30	-66	47	-21	100	
-40	18	-57	-12	25	-43	43	0	32	46	-71	22	63	-17	9	-83	100

COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN	GAST KJN	TOTA KJN	TURB PO_4	ANNE PO_4	POTA PO_4	EPHE PO_4	ODON PO_4	PLEC PO_4	COLE PO_4	TABA PO_4	SIMU PO_4	CHIR PO_4
100																	
25	100																
2	28	100															
18	11	30	100														
-23	16	28	-10	100													
-5	-17	-15	-46	-20	100												
21	25	55	35	32	-42	100											
27	14	12	-42	6	73	4	100										
21	-4	-11	-23	-26	64	-23	77	100									
-15	-11	-28	13	-44	36	-55	11	35	100								
20	8	2	15	29	-40	-1	-12	6	-29	100							
15	56	24	13	18	-24	74	27	5	-28	-23	100						
33	65	25	-26	9	6	36	67	48	-2	1	67	100					
30	8	32	12	79	-20	45	10	-26	-54	42	13	4	100				
100	25	2	18	-23	-5	21	27	21	-15	20	15	33	30	100			
25	100	28	11	16	-38	25	14	-4	-11	8	56	65	8	25	100		
2	27	100	27	27	-10	53	16	-9	-26	0	23	26	32	2	27	100	
18	11	31	100	-10	-46	35	-42	-23	13	15	13	-26	12	18	11	28	100
-15	11	38	7	-96	-18	31	6	-23	-40	41	8	0	86	-15	11	37	7
-5	-38	-15	-46	-20	100	-42	73	64	36	-40	-24	6	-20	-5	-38	-10	-47
21	25	55	35	32	-42	100	4	-23	-55	-1	74	36	45	21	25	53	35
28	12	10	11	32	-28	9	10	20	-31	97	-12	17	49	28	12	9	11
-39	-31	-25	14	-21	11	-50	-30	-7	82	-38	-36	-36	-41	-39	-31	-24	14
46	-9	45	26	39	14	51	34	10	-52	23	17	3	76	46	-9	46	26
-0	71	56	10	19	-43	20	0	-14	-21	44	18	44	11	0	71	55	10
-11	56	33	6	47	-58	39	-27	-60	-54	33	22	13	38	-11	56	31	6
34	43	63	15	-25	-20	27	-5	-19	-14	-28	13	24	-12	34	43	63	15
25	68	10	21	4	-13	11	32	29	3	40	44	53	12	25	68	10	22
21	-33	-4	-40	29	31	40	45	22	-62	9	20	15	44	21	-33	-3	-40
-4	30	17	-27	32	9	-19	19	13	-6	-10	17	22	15	-3	30	17	-27
34	54	20	30	-42	13	3	43	51	37	-6	43	56	-30	34	54	20	30
-6	-2	-8	-7	8	-46	17	-27	-30	-34	63	-18	1	13	-6	-2	6	-7
1	-16	-29	-11	-74	6	-1	-17	5	1	-47	23	-15	-65	1	-16	-29	11
5	-23	-18	-23	44	-29	46	-14	-38	-53	20	16	-3	52	5	-29	-19	-23
4	46	2	1	-45	18	-57	12	19	54	-10	-21	16	-49	4	46	3	1

TABLE 4.11

Correlation matrix of biological and chemo-physical parameters monitored in the Nwanedzi River System during August 1978

EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTA BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN	ODON KJN	PLEC KJN
100																
44	100															
43	41	100														
-13	11	27	100													
40	39	85	29	100												
58	14	6	-18	-4	100											
11	-21	-23	46	0	-8	100										
28	13	-7	-37	6	43	-37	100									
-18	-17	-38	18	42	-4	-15	6	100								
17	-12	12	-17	25	2	-12	13	38	100							
20	33	41	-2	43	21	-24	-11	6	56	100						
39	49	24	-12	5	34	-22	2	9	25	28	100					
6	21	-3	13	20	39	-37	-16	-4	3	-10	37	100				
5	23	38	0	35	20	-18	-26	-18	20	90	8	-19	100			
100	44	42	-12	40	58	11	27	-16	19	21	39	6	5	100		
44	100	41	11	39	13	-21	13	-17	-12	33	49	21	23	44	100	
43	41	10	27	85	6	23	-7	-38	12	41	24	-3	38	42	41	100
-13	11	2	100	29	-18	46	-37	18	-17	-2	-12	13	0	-12	11	27
40	39	8	29	100	43	0	6	-42	25	43	5	20	35	40	39	85
58	14	6	-18	-4	100	-8	43	-4	2	21	34	-39	20	58	14	6
11	-21	-23	46	0	-8	100	-37	-15	-12	-24	-22	37	18	11	-21	-23
28	13	-7	-37	6	43	-37	100	6	13	-11	2	-16	-26	27	13	-7
-18	-17	-38	18	-42	-4	-15	6	100	38	6	9	-4	-18	-16	-17	-38
17	-12	12	-17	25	2	-12	13	38	100	56	25	3	20	19	-12	12
21	55	-8	-15	-14	21	-36	6	47	15	50	54	21	37	22	55	-8
39	49	24	-12	5	34	-22	2	9	25	28	100	37	8	39	49	24
6	21	-3	13	20	-39	37	-16	-4	3	-10	37	100	-19	6	21	3
5	23	38	0	35	20	-18	-26	-18	20	90	8	19	100	5	23	38
100	43	42	-12	39	58	11	27	-15	19	21	38	5	5	100	43	42
44	100	41	11	39	14	21	13	-17	-12	33	49	21	23	44	100	41
44	43	99	24	85	12	28	4	-41	9	40	22	-6	37	43	43	99
-13	11	27	100	29	-18	46	-37	18	-17	-2	-12	-13	0	-12	11	27
40	39	85	29	100	-4	0	6	-42	25	43	5	20	35	40	39	85
58	14	6	-18	-4	100	-S	43	-4	2	21	34	-39	20	58	14	6
11	-21	-24	46	0	-7	100	-37	-15	12	-24	-22	37	-18	11	-21	-24
28	13	-7	37	6	43	-37	100	6	13	-11	2	-16	-26	27	13	-7
-18	-17	-38	18	-42	-4	-15	6	100	38	6	9	-4	-18	-16	-17	-38
17	-12	12	-17	25	2	-12	13	28	100	56	25	3	20	19	-12	12
15	33	42	0	41	22	-23	-18	-5	37	97	20	-14	97	16	33	42
-39	-35	-40	58	-33	16	60	-19	24	-33	-45	-13	36	-34	-40	35	-40
45	18	14	-12	18	70	-6	48	-4	41	40	7	-55	26	46	18	14
-15	-36	-47	34	-25	0	44	2	73	44	5	-5	24	-14	-13	-36	-47
10	-22	26	2	42	15	-1	48	-12	33	31	-44	-31	29	9	-22	26
-35	-25	16	-25	0	-32	-27	-17	-52	-33	-45	-9	-8	-28	-37	-25	16
15	74	14	-25	-3	-10	-40	-2	-22	-34	-7	52	23	-8	14	74	14
34	44	54	-18	72	-17	-29	10	35	-35	71	8	-5	65	34	44	54
-24	25	-8	13	-37	27	-28	10	-5	-45	-19	8	-56	-8	-24	25	-8
-27	4	-6	27	-21	4	-16	-12	57	41	54	20	-24	41	25	4	-6
-31	-58	-2	44	9	4	28	5	16	7	7	-56	-27	18	-31	-58	-2
-53	-13	-14	65	-9	-14	37	-23	12	-19	-1	0	25	11	-53	-13	-14
-20	-59	4	31	-4	20	0	23	24	0	-7	-52	-44	2	-19	-59	4
-33	-48	-51	35	-47	26	41	-28	48	0	2	-13	-14	9	-31	-48	-51

	TURB NO	ANNE NO	POTA NO	EPHE NO	ODON NO	PLEC NO	COLE NO	TABA NO	SIMU NO	CHIR NO	TIPU NO	TRIC NO	GAST NO	TOTA NO	TURB BIOM	ANNE BIOM	POTA BIOM
TURB NO	100																
ANNE NO	37	100															
POTA NO	84	-19	100														
EPHE NO	39	6	5	100													
ODON NO	49	21	23	44	100												
PLEC NO	24	-3	38	42	41	100											
COLE NO	-12	13	0	-12	11	27	100										
TABA NO	48	20	35	40	39	85	29	100									
SIMU NO	34	-39	20	58	14	6	-18	-4	100								
CHIR NO	-22	36	-18	10	-21	-23	46	0	-6	100							
TIPU NO	23	-16	-26	27	13	-7	-37	6	43	-37	100						
TRIC NO	8	-4	-18	-16	-17	-38	18	-42	-4	-15	6	100					
GAST NO	25	3	20	19	-12	12	-17	25	2	-12	13	38	100				
TOTA NO	45	-15	11	80	28	14	-2	8	87	4	38	22	25	100			
TURB BIOM	100	39	8	39	49	24	-12	5	34	-22	2	9	25	45	100		
ANNE BIOM	37	100	-19	6	21	-3	13	20	-39	37	-16	-4	3	-15	37	100	
POTA BIOM	11	-16	10	8	24	35	-2	37	24	-14	-24	-20	23	15	11	-16	100
EPHE BIOM	39	6	5	100	44	43	-13	40	58	11	28	-18	17	79	39	6	7
ODON BIOM	49	21	23	44	100	41	11	39	13	-21	13	-17	-12	28	49	21	24
PLEC BIOM	24	-3	38	42	41	100	27	85	6	-23	-7	-38	12	14	24	-3	35
COLE BIOM	-12	13	0	-12	11	27	100	29	-18	46	-37	18	-17	-2	-12	13	-2
TABA BIOM	5	20	35	40	39	85	29	100	-4	0	6	-42	25	8	5	20	37
SIMU BIOM	34	-39	20	58	14	6	-18	-4	100	-8	43	-4	2	87	34	-39	25
CHIR BIOM	-22	37	-18	11	-21	-23	46	0	-8	100	-37	-15	-12	5	-22	37	-14
TIPU BIOM	2	-16	-26	27	13	-7	-37	6	43	-37	100	6	13	38	2	-16	-24
TRIC BIOM	8	-4	-18	-16	-17	-38	18	-42	-4	-15	6	100	38	22	9	-4	-20
GAST BIOM	25	3	20	19	-12	12	-17	25	2	-12	13	38	100	25	25	3	23
TOTA BIOM	28	-10	90	21	33	41	-2	43	21	-24	-11	6	56	29	27	-10	90
TURB KJN	100	37	8	39	49	24	-12	5	34	-22	2	9	25	45	100	37	11
ANNE KJN	37	100	-18	5	21	-3	13	20	-39	37	-16	-4	3	-15	37	100	-16
POTA KJN	8	-19	100	5	23	38	0	35	20	-18	-26	-18	20	11	8	-19	99
EPHE KJN	39	6	5	100	44	42	-12	40	58	11	27	-16	19	80	39	6	8
ODON KJN	49	21	23	44	100	41	11	39	13	-21	13	-17	-12	28	49	21	24
PLEC KJN	2	3	38	42	41	100	27	85	6	-23	-7	-38	12	14	24	-3	35
COLE KJN	-12	13	0	-12	11	27	100	29	-18	46	-37	18	-17	-2	-12	13	-2
TABA KJN	5	20	35	40	39	85	29	100	-4	0	6	-42	25	8	5	20	37
SIMU KJN	34	-39	20	58	14	6	-18	-4	100	-8	43	-4	2	87	34	-39	25
CHIR KJN	-22	37	-18	11	-21	-23	46	0	-8	100	37	-15	-12	5	-22	37	-14
TIPU KJN	2	-16	-26	27	13	-7	-37	5	43	-37	100	6	13	38	2	-16	-24
TRIC KJN	9	-4	-18	-16	-17	-38	18	-42	-4	-15	6	100	38	22	9	-4	-20
GAST KJN	25	3	20	19	-12	12	-17	25	2	-12	13	38	100	25	25	-3	23
TOTA KJN	54	21	37	22	55	-8	-15	-14	21	-36	6	47	15	39	54	21	36
TURB PO_4	100	37	8	39	49	24	-12	5	34	-22	2	9	25	45	100	37	11
ANNE PO_4	37	100	-19	6	21	-3	13	20	39	37	-16	-4	3	-15	37	100	-16
POTA PO_4	8	-19	100	5	23	38	0	35	20	-18	-26	-18	20	11	8	-19	99
EPHE PO_4	38	5	5	100	43	42	-12	39	58	11	27	-15	19	80	38	5	7
ODON PO_4	49	21	23	44	100	41	11	39	14	-21	13	-17	12	28	49	21	24
PLEC PO_4	22	-6	37	43	43	99	24	85	12	-28	4	-41	9	16	22	-6	35
COLE PO_4	-12	13	0	-12	11	27	100	29	-18	46	-37	18	17	-2	-12	13	-2
TABA PO_4	5	20	35	40	39	85	29	100	-4	0	6	-42	25	8	5	20	37
SIMU PO_4	34	-39	20	58	14	6	-18	-4	100	-8	43	-4	2	87	34	-39	25
CHIR PO_4	-22	37	-18	11	21	-24	46	0	-7	100	-37	-15	12	5	-22	37	-14
TIPU PO_4	2	-16	-26	27	13	-7	-37	6	43	-37	100	6	13	38	2	-16	-24
TRIC PO_4	9	-4	-18	-16	-17	-38	18	-42	-5	-15	6	100	38	22	8	-4	-20
GAST PO_4	25	3	20	19	-12	12	-17	25	2	-12	13	38	100	25	25	3	23
TOTA PO_4	20	-14	97	16	33	42	0	41	22	-23	-18	-5	37	23	20	-14	97
DEPT	-13	36	-34	-40	-35	-40	58	-33	-16	60	-19	24	-33	15	-13	36	-34
CURRENT	7	-55	26	46	18	14	-12	18	70	-6	48	-4	41	65	7	-55	31
TEMP	-5	24	-14	-13	-36	-47	34	-25	0	44	2	73	44	23	-5	24	-12
TURB	-44	-31	29	9	-22	26	0	42	15	-1	48	-12	33	10	-44	-31	27
COND	-9	-8	-28	-37	-25	16	-25	0	-32	-27	-17	-52	-33	-60	-9	-8	-29
PH	52	23	-8	14	74	14	-25	-3	-10	-40	-2	-22	-34	-9	52	23	-9
O_2	8	-5	64	34	44	54	-18	72	17	-29	10	-35	35	17	8	-5	69
B.O.D.	7	-56	-8	-24	25	-8	13	-37	27	-28	10	-5	-45	0	8	-56	-8
PO_4	20	-24	41	-25	4	-6	27	-21	4	-16	-12	57	41	11	20	-24	38
SO_4	-56	-27	18	-31	-58	-2	44	9	4	28	5	16	7	-4	-56	-26	16
NH_4-N	0	25	11	-53	-13	-14	65	-9	-14	37	-23	12	-19	-23	0	25	11
NO_3-N	-52	-44	2	-19	-59	4	31	4	20	0	23	24	0	9	-52	-44	-1
NO_2-N	-13	-14	9	-31	-48	-51	35	-47	26	41	-28	48	0	20	-13	-14	12

TIPU PO4	TRIC PO4	GAST PO4	TOTA PO4	DEPT	CURRENT	TEMP	TURB	COND	PH	O2	B.O.D.	PO4	SO4	NH_4-N	NO_3-N	NO_2-N
100																
6	100															
13	38	100														
-18	-5	37	100													
-19	24	-33	-40	100												
48	4	41	34	-39	100											
2	7	44	-6	59	5	100										
48	-12	33	29	-8	48	15	100									
-17	-52	-33	-40	-17	-38	-66	-27	100								
-2	-22	-34	-4	-36	-24	-62	-63	28	100							
10	-35	35	69	-72	40	-34	27	-7	12	100						
10	-5	-45	12	4	27	-33	-21	19	35	-26	100					
-12	57	41	49	16	25	46	18	-51	-19	-13	28	100				
5	16	7	11	49	13	49	70	-24	-89	-15	-12	29	100			
-23	12	-19	5	8	-21	45	8	-17	-30	-37	21	46	55	100		
23	24	0	-3	33	14	34	62	-12	-80	-17	-3	15	90	30	100	
28	48	0	5	59	7	68	-10	-37	-58	-34	8	38	52	53	44	100

COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN	GAST KJN	TOTA KJN	TURB PO4	ANNE PO4	POTA PO4	EPHE PO4	ODON PO4	PLEC PO4	COLE PO4	TABA PO4	SIMU PO4	CHIR PO4
100																	
29	100																
-18	-4	100															
46	0	-8	100														
-37	6	43	-37	100													
18	-42	-4	-15	6	100												
-17	25	2	-12	13	38	100											
-15	-14	21	-36	6	47	15	100										
-12	5	34	-22	2	9	25	54	100									
13	20	39	37	-16	-38	3	21	37	100								
0	35	20	-18	-26	-18	20	37	8	-19	100							
-12	39	58	11	27	15	19	22	38	5	5	100						
11	39	14	21	13	-16	-12	55	49	21	23	43	100					
24	85	12	-28	4	-41	9	-8	22	-6	37	42	43	100				
100	29	-18	46	-37	-18	17	-15	-12	13	0	-12	11	24	100			
29	100	-4	0	6	-42	25	-14	5	20	35	39	39	85	29	100		
-18	-4	100	-8	43	-4	2	21	34	-39	20	58	14	12	-18	-4	100	
46	0	-7	100	37	-15	-12	-36	-22	37	-18	11	-21	-28	46	0	-7	100
-37	6	43	37	100	6	13	6	2	-16	-26	27	13	4	-37	6	43	-37
18	-42	-4	-15	6	100	38	47	8	-4	-18	-15	-17	-41	18	42	-4	-15
-17	25	2	-12	13	38	100	15	25	3	20	19	12	9	-17	25	2	-12
0	41	22	-23	18	-5	37	48	20	-14	97	15	33	41	1	41	22	-23
58	-33	-16	60	19	24	-33	-18	-13	36	34	-40	-35	-42	58	-33	-16	60
-12	-18	70	-6	48	-4	41	-1	7	55	26	46	18	-18	12	18	70	-6
34	-25	0	44	2	73	44	16	-5	24	-14	-13	-37	-50	34	-25	0	44
2	42	15	-1	48	12	33	-31	-44	-31	29	9	-22	32	2	42	15	-1
-25	0	-32	-27	-17	-52	-33	-56	-9	-8	-28	-37	-25	16	-25	0	-32	-28
-25	-3	10	-40	-2	-22	-34	44	52	23	-7	14	74	15	-25	-3	-10	-40
-18	72	17	-29	10	-35	35	20	8	-5	65	34	44	56	-18	72	17	-29
13	-37	27	-28	10	-5	-45	-3	7	-56	-8	-24	25	-5	13	37	27	-28
27	-21	4	-16	-12	57	41	41	20	-24	41	-26	4	-8	27	21	4	-16
44	9	4	28	5	16	7	-39	-56	-27	18	-30	-58	0	44	9	4	28
65	-9	-14	37	-23	12	-19	-7	0	25	11	-53	-13	-14	65	9	-14	37
31	4	20	0	23	24	0	-36	-52	-44	2	-19	-59	8	31	4	-20	1
35	-47	26	41	-28	48	1	-5	-13	-14	9	-31	-48	-54	35	-47	26	-41

TABLE 4.12

Correlation matrix of biological and chemo-physical parameters monitored in the Nwanedzi River System during October 1978

	EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTA BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN	ODON KJN	PLEC KJN
0																	
1	100																
3	70	100															
2	70	46	100														
6	10	34	18	100													
7	40	19	51	30	100												
4	49	60	-4	-16	13	100											
2	-19	-38	-6	22	4	-38	100										
6	17	11	-6	41	5	36	16	100									
9	24	44	25	29	-14	-17	3	-8	100								
3	49	39	13	5	34	63	-55	38	-3	100							
0	72	82	41	29	39	64	-53	20	29	80	100						
23	-16	-25	-40	-20	14	5	-2	13	-17	-0	-21	100					
6	-44	-41	-59	-18	-45	-16	41	-2	17	-10	-26	6	100				
0	21	34	12	16	37	34	-42	-16	-19	43	61	-23	-6	100			
1	100	70	70	10	40	49	-19	17	24	49	72	-16	-44	21	100		
4	70	100	46	34	19	60	-38	-11	44	39	82	-25	-41	34	70	100	
2	70	46	100	18	51	-4	-6	-6	25	13	41	-40	-59	12	70	46	100
6	11	34	18	100	30	-16	22	41	29	5	29	-20	-18	16	11	34	18
7	40	19	51	30	100	13	4	5	-14	34	39	14	-45	37	40	19	51
4	50	60	-3	-15	14	100	-38	35	17	62	64	5	-17	34	50	60	-3
2	-19	-38	-6	21	4	-38	100	16	3	-55	-53	-2	41	-42	-20	-39	-6
9	32	15	6	48	19	31	20	91	-10	29	18	11	-26	-19	32	15	6
4	23	44	28	30	-13	-18	8	-4	99	-8	25	-14	14	-24	23	44	28
3	55	41	17	7	38	62	-55	36	-3	99	81	-1	-18	43	55	41	17
9	76	97	55	39	24	48	-32	12	59	42	85	-27	-35	29	76	97	55
3	-16	-25	-40	-20	14	5	-2	13	-17	-0	-21	100	6	-23	-16	-25	-40
-6	-44	-41	-59	-18	-45	-16	41	-1	17	-10	-26	6	100	-6	-44	-41	-59
0	21	33	12	16	37	34	-42	-16	-19	43	60	-23	-6	100	21	34	12
1	100	70	70	10	40	49	-19	17	24	49	72	-16	-44	21	100	70	70
3	70	100	46	34	19	60	-38	11	44	39	82	-25	-41	34	70	100	46
2	70	46	100	18	51	-4	-6	-6	25	13	41	-40	-59	12	70	46	100
6	10	34	18	100	30	-16	22	41	29	5	29	-20	-18	16	10	34	18
7	40	19	51	30	100	13	4	5	-14	34	39	14	-45	37	40	19	51
4	49	60	-4	-16	13	100	-38	36	-17	63	64	5	-16	34	49	60	-4
2	-19	-38	-6	21	4	-38	100	16	3	-55	-53	-2	41	-42	-19	-38	-6
9	32	15	6	48	19	31	20	91	-10	29	18	11	-26	-19	32	15	6
9	24	44	25	29	-14	-17	3	-8	100	-3	29	-17	17	-19	24	44	25
3	49	39	13	5	34	63	-55	38	8	100	80	0	-10	43	49	39	13
6	55	68	35	30	42	50	-50	1	20	66	92	-27	-16	86	55	68	35
2	-38	-31	-36	1	-31	34	76	-21	32	-58	51	-11	61	-42	-38	-31	-36
7	34	20	20	-26	67	54	-13	11	-36	39	30	50	-30	17	35	20	20
9	20	30	25	-21	-30	-3	-69	-53	9	-1	19	-34	-46	19	20	30	25
11	2	6	-33	-35	-25	24	-53	-41	-23	30	13	6	-5	11	2	6	-33
1	-18	-/5	26	-27	-22	-48	-18	-47	27	-48	-27	-13	-10	1	-18	-15	26
7	-8	1	-2	-39	-39	-18	-65	-63	7	-15	-4	-7	-22	17	-8	1	-2
-2	52	50	47	-10	-1	13	-44	-36	3	11	30	-17	-59	-2	52	50	47
-4	42	55	25	-9	-39	30	-40	2	22	-11	22	-16	-44	-4	42	55	25
16	34	30	27	-2	2	-12	-41	-18	52	1	27	26	-21	16	34	30	27
10	-26	3	-18	15	-19	22	-2	57	-2	32	12	-18	26	-10	-26	3	-18
4	21	10	22	4	24	-5	-2	2	67	24	30	-2	17	4	21	10	22
12	-46	-56	-62	-24	2	5	34	10	-23	11	-23	28	74	12	-46	-56	-62
16	-14	-3	-6	72	-7	-46	32	39	54	-3	2	2	34	-16	-14	-3	-6

	TURB NO	ANNE NO	POTA NO	EPHE NO	ODON NO	PLEC NO	COLE NO	TABA NO	SIMU NO	CHIR NO	TIPU NO	TRIC NO	GAST NO	TOTA NO	TURB BIOM	ANNE BIOM	POTA BIOM
TURB NO	100																
ANNE NO	6	10															
POTA NO	-23	-6	100														
EPHE NO	-16	-44	21	100													
ODON NO	25	-42	33	70	100												
PLEC NO	-40	-59	12	70	46	100											
COLE NO	-20	-18	16	10	34	18	100										
TABA NO	14	-45	37	40	19	51	30	100									
SIMU NO	5	-16	34	49	60	-4	-16	13	100								
CHIR NO	-2	41	-42	-19	-39	-6	21	4	-38	100							
TIPU NO	11	-26	-19	32	15	6	48	19	31	20	100						
TRIC NO	-17	17	-19	24	44	25	29	-14	-17	3	-10	100					
GAST NO	0	-10	43	49	39	13	5	34	63	-55	29	-3	100				
TOTA NO	-13	-20	21	87	83	46	24	32	68	-10	41	41	54	100			
TURB BIOM	100	6	-23	-16	-25	-40	-20	14	5	-2	11	-18	-0	-13	100		
ANNE BIOM	6	100	-6	-44	-41	-59	-18	-45	-16	41	-27	-17	-10	-20	6	100	
POTA BIOM	-23	-6	100	21	33	12	16	37	34	-42	-19	-19	43	21	-23	-6	10
EPHE BIOM	-16	-44	21	100	70	70	10	40	49	-19	32	24	49	87	-16	-44	2
ODON BIOM	-25	-41	33	70	100	46	34	19	60	-39	15	-44	39	83	-25	-41	3
PLEC BIOM	-40	-59	12	70	46	100	18	51	-4	-6	6	-25	13	46	-40	-59	1
COLE BIOM	-20	-18	16	10	34	18	100	30	-16	21	48	29	5	24	-20	-18	1
TABA BIOM	14	-45	37	40	19	51	30	100	13	4	19	-14	34	32	14	-45	3
SIMU BIOM	5	-16	35	39	60	-4	-16	13	100	-38	31	-17	63	68	5	-16	3
CHIR BIOM	-2	41	-42	-19	-38	-6	22	4	-38	100	20	3	-55	-10	-2	41	-4
TIPU BIOM	13	-2	-16	17	1143	-6	41	5	36	16	91	-8	38	36	13	-2	-1
TRIC BIOM	-17	17	-19	24	44	25	29	14	-17	3	-10	100	-3	41	-18	17	-1
GAST BIOM	0	-10	43	49	39	13	5	34	63	-55	29	-3	100	54	-0	-10	4
TOTA BIOM	-21	-26	60	72	82	41	29	39	64	-53	18	29	80	80	-22	-26	6
TURB KJN	100	6	-23	-16	-25	-40	-20	14	5	-2	11	-17	0	-13	100	6	-2
ANNE KJN	6	100	-6	-44	-41	-59	-18	-45	-16	41	-26	17	-10	-20	6	100	-
POTA KJN	-23	-6	100	21	34	12	16	37	34	-42	-19	-19	43	21	-23	-6	10
EPHE KJN	-16	-44	21	100	70	70	10	40	49	-19	32	24	49	87	-16	-44	2
ODON KJN	-25	-41	34	70	100	46	34	19	60	-39	15	44	39	83	-25	-41	3
PLEC KJN	-40	-59	12	70	46	100	18	51	-4	-6	6	25	13	46	-40	-59	1
COLE KJN	-20	-18	16	11	34	18	100	30	-16	22	48	29	5	24	-20	-18	1
TABA KJN	14	-45	37	40	19	51	30	100	13	4	19	-14	34	32	14	-45	3
SIMU KJN	5	-17	34	50	60	-3	-15	14	100	38	31	-17	62	69	5	-17	3
CHIR KJN	-2	41	-42	-19	-38	-6	21	4	-38	100	19	3	-55	-10	-2	41	-4
TIPU KJN	11	-26	-19	32	15	6	48	19	31	20	100	-10	29	41	11	-27	-1
TRIC KJN	-14	14	-24	23	44	28	30	-13	-18	8	-6	99	-8	40	-14	14	-2
GAST KJN	0	-18	43	55	41	17	7	38	62	-55	32	-3	99	57	-1	-18	4
TOTA KJN	-27	-35	29	76	97	55	39	24	48	-32	16	59	42	87	-27	-35	2
TURB PO_4	100	6	-23	-15	-25	-40	-20	14	5	-2	11	-17	-0	-13	100	6	-2
ANNE PO_4	6	100	-6	-44	-41	-59	-18	-45	-16	41	-26	17	-10	-20	6	100	-
POTA PO_4	23	-6	100	21	33	12	16	37	34	-40	-19	-19	43	21	-23	-6	10
EPHE PO_4	-16	-44	21	100	70	70	10	40	49	-19	32	24	49	87	-16	-44	2
ODON PO_4	25	-41	33	70	100	46	34	19	60	-39	15	44	39	83	-25	-41	3
PLEC PO_4	-40	-59	12	70	46	100	18	51	-4	-6	6	25	13	43	-40	-59	1
COLE PO_4	-20	-18	16	10	34	18	100	30	-16	21	48	29	5	24	-20	-18	1
TABA PO_4	14	-45	37	40	19	51	30	100	13	4	19	-14	34	32	14	-45	3
SIMU PO_4	5	-16	34	49	60	-4	-16	13	100	-38	31	-17	63	68	5	-16	3
CHIR PO_4	-2	41	-42	-19	-38	-6	21	-4	-38	100	20	3	-55	-10	-2	41	-4
TIPU PO_4	11	-26	-19	32	15	6	48	19	31	20	100	-10	29	41	11	-27	-1
TRIC PO_4	-17	17	19	24	44	25	29	-14	-17	3	-10	100	-3	41	-18	17	-1
GAST PO_4	0	-10	3	49	39	13	5	34	63	-55	29	-3	100	54	-0	-10	4
TOTA PO_4	-27	16	6	55	68	35	30	42	50	-50	-1	20	66	61	-27	-16	8
DEPT	-11	61	-42	-38	-31	-36	1	-31	-34	76	-19	32	-58	-17	-11	61	-4
CURRENT	50	-31	17	35	20	20	-26	67	54	-14	9	-36	39	34	50	-30	[illegible]
TEMP	-34	-46	19	20	30	25	-21	-30	-3	-69	-39	9	-1	-6	-34	-46	[illegible]
TURB	6	-5	11	2	6	-33	-35	-25	24	-53	-35	-23	30	-9	6	-5	[illegible]
COND	-13	-10	1	-18	-15	26	-27	-22	-48	-18	-45	27	-48	-35	-13	-10	
PH	-7	-22	17	-8	1	-2	-39	-39	-18	-65	-54	7	-15	-31	-7	-22	1
O_2	17	-58	2	52	50	47	-10	1	13	-44	-22	3	11	25	-17	-58	-
B.O.D.	16	-44	-4	42	55	25	-9	-39	30	-40	13	22	-11	34	-16	-44	-
PO_4	26	-21	16	34	30	27	-2	2	-12	-41	-16	52	1	21	25	-21	[illegible]
SO_4	-18	26	-10	-26	3	-18	15	-19	22	-2	23	-2	32	1	-18	26	[illegible]
NH_4-N	2	17	4	21	10	22	4	24	-5	-2	3	67	24	32	-2	17	
NO_3-N	28	74	12	-46	-56	-62	-24	2	5	34	5	-23	11	-24	28	74	[illegible]
NO_2-N	2	34	-16	-14	-3	-6	72	-7	-46	32	30	54	-3	2	2	34	[illegible]

TIPU PO4	TRIC PO4	GAST PO4	TOTA PO4	DEPT	CURRENT	TEMP	TURB	COND	PH	O_2	B.O.D.	PO4	SO4	NH4-N	NO3-N	NO_2-N
100																
-10	100															
29	-3	100														
-1	20	66	100													
-19	32	-58	-58	100												
9	36	39	21	-39	100											
-39	9	1	21	40	-32	100										
-35	-23	30	8	-17	-1	54	100									
-45	27	-48	-10	-5	-33	46	-31	100								
-54	7	-15	7	27	-34	89	49	65	100							
-22	3	11	15	39	11	71	56	-3	41	100						
13	22	-11	11	-30	-19	65	8	38	52	47	100					
-16	52	1	31	-27	-9	47	0	58	61	21	49	100				
24	-2	32	-1	-8	0	-39	-23	-31	-48	-31	-23	58	100			
3	67	24	29	15	-3	-16	-38	32	-2	-40	-10	48	-7	100		
-6	-23	11	-9	41	12	-66	-8	-25	-39	-79	-69	-35	19	25	100	
30	54	-3	1	24	-48	-35	-41	-7	-32	-37	-24	14	25	31	6	100

COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN	GAST KJN	TOTA KJN	TURB PO4	ANNE PO4	POTA PO4	EPHE PO4	ODON PO4	PLEC PO4	COLE PO4	TABA PO4	SIMU PO4	CHIR PO4
100																	
30	100																
-15	14	100															
21	4	-38	100														
48	19	31	19	100													
30	-13	-18	8	-6	100												
7	38	62	-55	32	-9	100											
39	24	49	-32	16	59	44	100										
-20	14	5	-2	11	-14	-1	-27	100									
-19	-45	-17	41	-26	-14	-18	-35	6	100								
16	37	34	-42	-19	-24	43	29	-23	-6	100							
11	40	50	-19	32	23	55	76	-16	-44	21	100						
34	19	60	39	15	44	41	97	-25	-41	33	70	100					
18	51	-3	-6	6	28	17	55	-40	-60	12	70	46	100				
100	30	-15	21	48	30	7	39	-20	-18	16	10	34	18	100			
30	100	14	4	19	-13	32	24	14	-45	37	40	19	51	30	100		
-16	13	100	-38	31	-18	62	48	5	-16	34	49	60	-4	-16	13	100	
21	4	-38	100	20	8	-55	-32	-2	41	-42	-19	-39	-6	21	4	-38	100
48	19	31	19	100	-6	32	16	11	-26	-19	32	15	6	48	19	31	20
29	-14	-17	3	-10	99	-3	59	-17	17	-19	24	44	25	29	-14	-17	3
5	34	62	-55	29	-8	99	42	0	-10	43	49	39	13	5	34	63	-55
30	42	50	-50	-1	14	67	70	-27	-16	86	55	68	35	30	42	50	-50
1	-31	-35	76	-19	32	-58	26	-11	61	42	-38	-31	-36	1	-31	-34	76
-26	67	55	-13	9	-32	39	14	50	-30	17	35	20	20	-26	67	54	-14
-21	-30	-2	-67	-39	4	3	25	-34	-46	19	20	30	25	-21	-30	-3	-69
-36	-25	24	-53	-35	-31	32	-3	-6	-5	11	2	6	-33	-35	-25	24	-53
-27	-22	-48	-18	-45	28	-49	-10	-13	-10	1	-18	-15	26	-27	-22	-48	-18
-40	-39	-17	-65	-54	3	-13	-2	-7	-22	17	-8	1	-2	-39	-39	-18	-65
-10	1	14	-44	-22	3	15	44	-17	-58	-2	52	50	47	-10	1	13	-44
-9	-39	31	-40	13	25	-8	48	-16	-44	-4	42	55	25	-9	-39	30	-40
-2	2	-11	-41	-16	51	4	39	26	-21	16	34	30	27	-2	2	-12	-41
15	-19	20	-2	24	-0	23	-1	-18	26	-10	-26	3	-18	15	-19	22	-2
4	24	-5	-2	3	63	25	30	-2	17	4	21	10	22	4	24	-5	-2
24	2	4	34	6	-26	6	-53	28	74	12	-46	-56	-62	-24	2	5	34
72	-7	-46	32	30	55	-5	11	2	34	-16	-14	-3	-6	72	-7	-46	32

TABLE 4.13

Correlation matrix of biological and chemo-physical parameters monitored in the Nwanedzi River System during February 1979

EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTA BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN	ODON KJN	PLEC KJN
100																
75	100															
-10	20	100														
31	41	4	100													
-2	19	18	-8	100												
54	38	-8	-15	23	100											
-25	-23	60	-12	40	-8	100										
21	32	2	86	-4	-28	-5	100									
-9	-9	-18	41	5	-16	-21	24	100								
77	90	10	12	22	41	-12	9	-22	100							
75	89	35	19	18	31	-7	12	-10	93	100						
-29	-45	-35	-5	25	18	5	6	45	-43	-51	100					
-29	-45	-35	-5	25	18	5	6	45	-43	-51	100	100				
-29	-45	-35	-5	25	18	5	6	45	-43	-51	100	100	100			
-29	-45	-35	-5	25	18	5	6	45	-43	-51	100	100	100	100		
75	100	20	41	19	38	-23	32	-9	90	89	45	45	-45	-45	100	
-10	20	100	4	18	-8	60	2	-18	10	35	-35	-35	-35	-35	20	100
31	41	4	100	-8	-15	-12	86	41	12	19	-5	-5	-5	-5	41	4
-2	19	18	-8	100	23	40	-4	5	22	18	25	25	25	25	19	18
54	38	-8	-15	23	100	-8	-28	-16	41	31	18	18	18	18	38	-8
-28	14	31	-36	39	19	-6	-20	-17	6	8	-7	-7	-7	-7	14	31
21	32	2	86	-4	-28	-5	100	24	9	12	6	6	6	6	32	2
-9	-9	-18	41	5	-16	-21	24	100	-22	-10	45	45	45	45	-9	-18
77	90	10	12	22	41	-12	9	-22	100	13	-43	-43	-43	-43	90	10
64	80	31	53	36	24	-5	39	40	66	78	-14	-14	-14	-14	80	31
33	41	-9	13	18	-1	-10	15	31	42	36	15	15	15	15	41	-9
-22	-34	-27	-5	1	-50	4	-8	56	-24	-20	2	2	2	2	-34	-27
28	29	56	5	20	14	14	6	26	29	55	9	9	9	9	29	56
100	75	-10	31	-2	54	-25	21	-9	77	75	-29	-29	-29	-29	75	-10
75	100	20	41	19	38	-23	32	-9	90	80	-45	-45	-45	-45	100	20
-10	20	100	4	18	-8	60	2	-18	10	35	-3	-35	-35	-35	20	100
31	41	4	100	-8	-15	-12	86	41	12	19	-5	-5	-5	-5	41	4
-2	19	18	-8	100	23	40	-4	5	22	18	25	25	25	29	19	18
54	38	-8	-15	23	100	-8	-28	-16	41	31	18	18	18	18	38	-8
-31	-23	46	-8	54	-26	93	3	-11	-8	-5	10	10	10	10	-23	46
21	32	2	86	-4	-28	-5	100	24	9	12	6	6	6	6	32	2
-8	-8	18	42	5	-16	-21	25	100	-21	-10	45	45	45	45	-8	-18
77	90	10	12	22	41	-12	9	-22	100	93	-43	-43	-43	-43	90	10
67	75	41	19	27	34	0	16	12	77	91	-18	-18	-18	-18	75	41
-37	-41	-34	-4	-30	-36	-19	-17	51	-40	-41	-5	-5	-5	-5	-41	-34
-6	23	35	-21	47	64	16	-30	3	16	15	34	-34	34	34	23	35
68	34	-20	-9	-16	20	-24	-1	-53	43	37	36	-36	-36	36	34	-20
66	39	13	31	1	20	15	32	-50	40	41	-31	-31	-31	31	39	13
-63	-62	-25	-53	-23	-42	-17	-40	-26	-60	66	-10	-10	-10	-10	-62	-25
65	21	-29	5	-32	22	-14	5	-45	37	30	-45	-45	-45	45	21	-29
73	55	18	2	7	49	-14	8	-2	63	73	21	-1	1	1	55	18
-20	18	19	-32	25	24	-27	-19	-14	7	9	-9	-9	-9	-9	18	19
-5	-16	-22	51	-35	5	-20	56	10	-32	-41	48	48	48	48	-16	-22
18	-0	9	-12	-21	-16	-16	-0	-59	-5	3	-37	-37	-37	37	-0	9
-60	-32	-9	-27	11	-10	-12	-24	57	-34	-35	51	51	51	-51	-32	-9
-12	2	-18	-15	-4	26	-40	-31	65	-0	2	35	35	35	35	2	-18
-29	-33	-70	-37	-32	-3	-46	-34	14	-22	44	16	16	-16	-16	-33	-70

	TURB NO	ANNE NO	POTA NO	EPHE NO	ODON NO	PLEC NO	COLE NO	TABA NO	SIMU NO	CHIR NO	TIPU NO	TRIC NO	GAST NO	TOTA NO	TURB BIOM	ANNE BIOM	POTA BIOM
TURB NO	100																
ANNE NO	60	100															
POTA NO	13	21	100														
EPHE NO	-8	8	35	100													
ODON NO	21	20	3	50	100												
PLEC NO	-7	-7	12	65	40	100											
COLE NO	4	24	41	36	14	41	100										
TABA NO	35	-8	6	5	34	-1	0	100									
SIMU NO	32	3	29	24	32	-8	-4	33	100								
CHIR NO	-13	-8	-8	16	-25	-16	0	17	6	100							
TIPU NO	10	0	24	56	22	36	25	-24	22	-12	100						
TRIC NO	53	64	-9	12	75	7	8	16	19	-33	0	100					
GAST NO	46	16	25	21	17	16	-2	82	33	27	11	2	100				
TOTA NO	49	43	13	60	73	26	28	42	64	17	28	66	43	100			
TURB BIOM	100	60	13	-8	22	-7	4	35	32	-13	10	53	46	49	100		
ANNE BIOM	60	100	27	8	20	-7	24	-8	3	-8	0	64	-16	43	60	100	
POTA BIOM	13	-27	100	35	3	12	-41	-7	30	-8	24	-9	25	13	-13	-27	10
EPHE BIOM	-8	8	35	100	49	65	36	5	24	16	56	12	21	60	-8	8	2
ODON BIOM	-15	-22	-2	48	43	65	66	18	-20	-15	17	15	22	24	-15	-22	2
PLEC BIOM	-7	-7	12	65	40	100	40	-1	-8	-16	36	7	16	26	-7	-7	5
COLE BIOM	8	30	-40	32	14	-36	98	4	-9	3	10	14	-2	29	8	30	[illegible]
TABA BIOM	50	0	-5	-6	-4	-2	7	85	13	29	-14	-7	89	22	50	0	2
SIMU BIOM	32	3	29	24	32	-8	-4	33	100	6	22	19	32	64	32	3	14
CHIR BIOM	-13	-8	-8	16	-25	-16	0	17	6	100	-12	-3	27	17	-13	-8	1
TIPU BIOM	10	0	24	56	22	36	25	-24	22	-12	100	0	11	28	10	0	[illegible]
TRIC BIOM	53	64	-9	12	75	7	8	16	19	-33	0	100	2	66	53	64	2
GAST BIOM	46	-16	25	21	17	16	-2	82	32	27	11	2	100	43	46	-16	2
TOTA BIOM	51	-3	46	48	50	33	0	71	44	10	26	30	89	68	51	-3	5
TURB KJN	100	60	13	-8	21	-7	4	35	32	-13	10	53	46	49	100	60	[illegible]
ANNE KJN	60	100	-27	8	20	-7	24	-8	32	-8	0	64	-16	43	60	100	[illegible]
POTA KJN	13	-27	100	35	3	12	-41	-7	29	-8	24	-9	25	13	13	27	[illegible]
EPHE KJN	-8	8	35	100	49	65	-37	-5	24	16	56	12	21	60	-8	8	[illegible]
ODON KJN	21	20	3	49	100	40	14	34	32	-25	22	75	17	73	22	20	2
PLEC KJN	-7	-7	12	65	40	100	41	-1	-8	-16	36	7	16	26	-7	-7	5
COLE KJN	4	24	-41	36	14	41	100	0	-4	0	25	8	-2	28	4	24	[illegible]
TABA KJN	34	-8	-6	6	38	0	-2	100	35	16	-23	18	81	44	34	-8	2
SIMU KJN	32	3	29	24	32	-8	-4	33	100	6	22	19	33	64	32	3	1
CHIR KJN	-13	8	-8	16	-25	-16	0	17	6	100	-12	-33	27	17	-13	-8	1
TIPU KJN	10	0	24	56	22	36	25	-24	22	-12	100	0	11	28	10	0	[illegible]
TRIC KJN	53	64	-9	12	75	7	8	16	19	-33	0	100	2	66	53	64	2
GAST KJN	46	16	25	21	17	16	-2	82	33	27	11	2	100	43	46	-16	2
TOTA KJN	38	36	15	64	93	48	26	36	35	-17	30	78	32	86	38	36	5
TURB PO_4	100	60	13	-8	21	-7	4	35	32	-13	10	53	46	49	100	60	2
ANNE PO_4	60	100	-27	8	20	-7	24	-8	3	-8	0	64	16	43	60	100	-1
POTA PO_4	13	-27	100	35	3	12	-41	-7	30	-8	24	-9	25	13	13	-27	10
EPHE PO_4	-8	8	35	100	49	65	36	5	25	16	56	12	21	60	8	8	2
ODON PO_4	21	20	3	49	100	40	14	34	32	-25	22	75	17	73	22	20	2
PLEC PO_4	-7	-7	12	65	40	100	41	-1	-8	-16	36	7	16	26	-7	-7	5
COLE PO_4	35	24	-41	36	14	41	100	0	-4	0	25	8	-2	28	4	24	[illegible]
TABA PO_4	35	-8	-6	5	34	1	0	100	33	17	-24	16	82	42	35	-8	2
SIMU PO_4	32	3	29	24	32	-8	-4	33	100	6	22	19	33	64	32	3	1
CHIR PO_4	-13	-7	-8	16	-25	-16	0	17	6	100	-12	-33	27	17	-13	-8	1
TIPU PO_4	10	0	-24	56	22	36	25	-24	22	-12	100	-0	11	28	10	0	[illegible]
TRIC PO_4	53	64	-9	12	75	7	8	16	19	-33	0	100	2	66	53	64	2
GAST PO_4	46	-16	25	21	17	16	-2	82	33	27	11	1	100	43	46	-16	2
POTA PO_4	46	0	59	62	61	42	0	55	46	0	34	38	75	73	46	0	8
DEPT	-15	44	-37	-27	-27	-33	10	-41	-32	-24	-22	23	50	-22	-15	44	-
CURRENT	31	-32	47	-6	-16	-18	-46	52	62	27	2	-26	70	18	31	-32	3
TEMP	0	52	-38	14	36	14	38	-45	6	-5	3	-44	-65	29	0	52	-
TURB	-36	-16	-29	34	-9	56	46	-22	-10	39	22	-44	-15	-5	-36	-16	1
COND	30	14	8	-50	-45	-43	-22	14	1	-34	-31	0	17	-26	30	14	-4
PH	11	16	43	38	49	0	-21	13	0	-33	19	53	15	34	11	16	-1
O_2	9	2	22	23	-4	13	-33	17	23	-19	38	-23	24	-2	10	2	7
B.O.D.	12	-20	22	-22	-23	-11	-29	10	31	49	-32	-7	31	14	12	-20	[illegible]
PO_4	36	15	45	14	-14	-13	15	-20	-16	-14	39	-4	3	-5	36	15	-1
SO_4	-5	38	-38	30	23	40	53	-35	15	21	12	20	-40	35	-4	38	[illegible]
NH_4-N	50	40	15	-52	-21	-46	-41	8	13	-43	-42	29	0	-10	50	40	[illegible]
NO_3-N	-10	0	23	-4	-50	-33	-36	16	26	32	-34	-36	16	-9	-10	0	2
NO_2-N	21	31	5	-38	-40	-23	-28	-3	-7	-28	-43	10	0	-20	21	31	-6

TIPU PO_4	TRIC PO_4	GAST PO_4	TOTA PO_4	DEPTH	CURRENT	TEMP	TURB	COND	PH	O_2	B.O.D.	PO_4	SO_4	NH_4-N	NO_3-N	NO_2-N
100																
25	100															
9	-21	100														
16	12	77	100													
-17	51	-40	-49	100												
-30	3	16	30	-35	100											
-1	-53	43	22	-47	-35	100										
32	-50	40	34	-69	-26	75	100									
-40	-27	-60	-70	15	-16	6	-32	100								
5	-44	37	9	-11	-56	71	70	-27	100							
8	-2	63	87	-57	21	45	44	-55	30	100						
-19	-14	7	8	0	49	-21	-41	10	-33	6	100					
55	10	-37	-26	-25	-1	-7	19	5	-5	-6	-24	100				
-0	-59	-5	-6	-47	-34	75	60	43	39	15	0	8	100			
-24	57	-34	-17	48	43	-75	-95	24	-81	-26	40	-8	-63	100		
-31	65	0	15	45	48	-52	-77	-9	-50	10	35	-12	-66	82	100	
-34	15	-22	-57	68	-13	-17	-66	45	-7	-46	16	-9	-33	52	49	100

COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN	GAST KJN	TOTA KJN	TURB PO_4	ANNE PO_4	POTA PO_4	EPHE PO_4	ODON PO_4	PLEC PO_4	COLE PO_4	TABA PO_4	SIMU PO_4	CHIR PO_4
100																	
-8	100																
-15	23	100															
-36	39	19	100														
86	-4	-28	-20	100													
41	5	-16	-17	24	100												
12	22	41	6	9	-22	100											
53	36	24	1	39	40	66	100										
13	18	-1	-22	15	31	42	57	100									
-5	1	-50	-20	-8	59	-24	-0	21	100								
5	20	14	13	6	26	29	59	20	-15	100							
31	-2	54	-28	21	-9	77	64	33	-22	28	100						
41	19	38	14	32	-9	90	80	41	-34	29	75	100					
4	18	-8	31	2	-18	10	31	-9	-27	56	-10	20	100				
100	-8	-15	-36	86	41	12	53	13	-5	5	31	41	4	100			
-8	100	23	39	-4	5	22	36	18	1	20	-2	19	18	-8	100		
-15	23	100	19	-28	-16	41	24	-1	-50	14	54	38	-8	-15	23	100	
-8	54	-26	-8	3	-11	-8	-2	-3	17	13	-31	-23	46	-8	54	-26	100
86	-4	-28	-20	100	24	9	39	15	-8	6	21	32	2	86	-4	-28	3
42	5	-16	-17	25	100	-21	41	31	59	26	-8	8	-18	42	5	-16	-12
12	22	41	6	9	-22	100	66	42	-24	29	77	90	10	12	22	41	-8
19	27	34	9	16	12	77	84	40	-21	82	67	5	41	20	27	34	2
-4	-30	-36	-4	-17	51	-44	-26	15	79	42	-38	-41	-34	-4	-30	-36	-17
-21	47	64	52	-30	3	16	26	14	-48	32	-6	23	35	-21	47	64	4
-9	-16	20	-29	-1	-53	43	9	21	-24	-2	69	34	-20	-9	-16	20	-28
31	1	20	-41	32	-50	40	24	-3	-46	14	66	39	13	31	1	20	11
-52	-23	-42	8	-40	-26	-60	-73	-6	6	-45	63	-62	-25	-52	-24	-42	-14
5	-32	22	-39	5	-45	37	-7	-27	-8	-18	65	21	-29	5	-32	22	-19
2	7	49	2	8	-2	63	58	27	-33	78	73	55	18	2	7	49	-18
-32	25	24	97	-19	-14	7	1	-20	-23	9	-20	18	19	-32	25	24	-30
51	-35	5	-31	56	10	-37	17	-14	-47	-12	-5	16	22	51	-35	5	-25
-12	-21	-16	-5	0	-59	-5	19	-12	-34	0	18	0	9	-12	-21	-16	-20
-27	11	-10	41	-24	57	-34	-10	18	33	6	-60	-32	-9	-27	11	-10	-6
-15	-4	26	27	-31	65	-0	20	24	24	21	-12	-2	-18	-15	-4	26	-40
-37	-32	-3	7	-35	14	-22	-49	5	41	-64	-29	-33	-70	-37	-32	-3	-42

TABLE 4.14

Correlation matrix of biological and chemo-physical parameters monitored in the Nwanedzi River System during November 1978

	EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTA BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN	ODON KJN	PLEC KJN
	100																
	48	100															
	65	65	100														
	32	67	36	100													
	-6	10	-2	10	100												
	24	-20	-8	-9	-13	100											
	16	-15	-16	3	29	6	100										
	56	17	36	10	-14	22	-12	100									
	12	15	7	14	-7	19	-33	0	100								
	21	22	16	-2	89	33	27	11	1	100							
	48	34	33	0	65	44	10	26	30	89	100						
	-8	-15	-7	8	50	32	-13	10	53	46	51	100					
	8	-22	-7	30	0	3	-8	0	64	-16	-9	6	100				
	35	-1	12	-40	-5	29	-8	24	-9	25	46	13	-27	100			
	100	48	65	32	-6	24	16	56	12	21	48	-8	8	35	100		
	49	43	40	14	-4	32	-25	22	75	17	50	21	20	3	49	100	
	65	65	100	36	-2	-8	-16	36	7	16	33	-7	-7	12	65	40	100
	36	66	41	98	7	-4	0	25	8	-2	0	4	24	-41	36	14	40
	6	-19	0	3	83	35	16	-23	18	81	71	34	-8	-6	6	38	0
	24	-20	-8	-9	13	100	6	22	19	33	44	32	3	29	24	32	-8
	16	-15	-16	3	29	6	100	12	-33	27	100	-13	-8	-8	16	-25	-16
	56	17	36	10	-14	22	-12	100	0	11	26	10	0	24	56	22	36
	12	15	7	14	-7	19	-33	0	100	2	30	53	64	9	12	75	7
	21	22	16	-2	89	33	27	11	2	100	89	46	-16	25	21	17	16
	64	49	48	27	9	35	-17	30	78	32	66	38	36	15	64	93	48
	-8	-15	-7	8	50	32	-13	10	53	46	51	100	60	13	-8	21	-7
	8	-22	-7	30	0	3	-8	0	64	-16	-3	60	100	-28	8	20	-7
	35	-1	12	-40	-5	29	-8	24	-9	25	46	13	-27	100	35	3	12
	100	48	65	32	-6	24	16	56	12	21	48	-8	8	35	100	49	65
	49	43	40	14	-4	32	-25	22	75	17	50	21	20	3	49	100	40
	65	65	100	36	-2	-8	-16	36	7	16	33	-7	-7	12	65	40	100
	36	66	41	98	7	-4	0	25	8	-2	0	4	24	-41	36	14	40
	5	18	1	4	85	33	17	-24	16	82	71	35	-8	-7	5	34	-1
	24	-20	8	-9	13	100	6	22	19	33	44	32	3	29	24	32	-8
	16	-15	16	3	29	6	100	-12	33	27	10	-13	-8	-8	16	-25	-17
	56	17	36	10	-14	22	-12	100	0	11	26	10	0	24	56	22	36
	12	15	7	14	-7	19	-33	0	100	2	30	53	64	-9	12	75	7
	21	22	16	-2	89	33	27	11	2	100	89	46	-16	25	21	17	16
	62	39	42	0	44	47	0	34	38	75	96	46	0	59	62	61	42
	-27	-15	-33	12	-36	-32	-24	-22	23	-50	-52	-15	44	-36	-27	-27	-33
	-6	-36	-18	-49	57	62	27	2	-26	71	57	31	-32	47	-6	-16	-18
	14	0	14	40	-60	6	-5	3	-44	-65	-43	0	53	-38	14	36	14
	34	22	56	39	-12	-10	39	22	-44	-15	-22	-36	-16	29	34	-9	56
	-50	-29	-43	-19	-30	1	-94	-31	0	17	2	30	14	8	-50	-45	-43
	38	21	0	-18	-6	0	-33	19	53	15	43	11	16	42	38	49	0
	23	-39	13	-42	21	23	-19	38	-23	24	22	10	2	22	23	-4	13
	-22	-20	-11	-26	18	31	49	-92	-7	31	21	12	-20	22	-22	-23	-11
	14	10	-13	18	4	-16	-13	38	-4	3	13	36	15	45	14	-14	-13
	30	12	40	51	-39	15	21	12	20	-40	-27	-5	38	-38	30	23	40
	-52	-50	-46	-33	13	13	-43	-42	29	0	-2	50	40	15	-52	-21	-46
	-4	-51	-33	-34	21	26	32	-34	-36	16	2	-10	0	23	-4	-50	-33
	-38	-35	-23	-23	10	7	-28	-43	10	0	9	21	31	5	-38	-40	-23

	TURB NO	ANNE NO	POTA NO	EPHE NO	ODON NO	PLEC NO	COLE NO	TABA NO	SIMU NO	CHIR NO	TIPU NO	TRIC NO	GAST NO	TOTA NO	TURB BIOM	ANNE BIOM	POTA BIOM
TURB NO	100																
ANNE NO	21	100															
POTA NO	20	-15	100														
EPHE NO	33	-22	28	100													
ODON NO	41	-34	29	75	100												
PLEC NO	-9	-27	56	-10	20	100											
COLE NO	13	-5	5	31	41	4	100										
TABA NO	18	1	20	-2	19	18	-8	100									
SIMU NO	-1	-50	14	54	38	-8	-15	23	100								
CHIR NO	-3	17	13	-31	-23	41	-8	54	-26	100							
TIPU NO	15	-8	6	21	32	2	86	-4	-28	3	100						
TRIC NO	31	56	26	-9	-9	-18	41	5	-16	-12	24	100					
GAST NO	42	-24	29	77	90	10	12	22	41	-8	9	22	100				
TOTA NO	39	-12	43	82	70	1	37	30	-68	-13	19	28	67	100			
TURB BIOM	100	21	20	33	42	-9	13	18	-1	-3	15	31	42	39	100		
ANNE BIOM	21	100	-15	-22	-34	-27	-5	1	-50	17	-8	56	-24	-12	21	100	
POTA BIOM	20	-15	100	28	29	56	5	20	13	13	6	26	29	43	20	-15	100
EPHE BIOM	33	-22	28	100	75	-10	31	-2	54	-31	21	-9	77	82	33	-22	35
ODON BIOM	41	-34	29	75	100	20	41	19	38	-23	32	-9	90	70	42	-34	-1
PLEC BIOM	-9	-27	56	-10	20	100	4	18	-8	46	2	-18	10	1	-9	-27	12
COLE BIOM	13	-5	5	31	41	4	100	-8	-15	-8	86	41	12	37	13	-5	-40
TABA BIOM	18	1	20	-2	19	18	-8	100	23	54	4	5	22	30	18	1	5
SIMU BIOM	-1	-50	14	54	38	-8	-15	23	100	-26	-28	-16	41	68	-1	-50	29
CHIR BIOM	-10	4	14	-25	-23	60	-12	40	8	93	-5	-21	-12	-8	-10	4	-8
TIPU BIOM	15	-8	6	21	32	2	86	-4	-28	3	100	24	9	19	15	-8	24
TRIC BIOM	31	56	26	-9	-9	-18	41	5	-16	-12	24	100	-22	28	31	56	-9
GAST BIOM	42	-24	29	77	90	10	12	22	41	-8	9	-22	100	67	42	-24	25
TOTA BIOM	36	-20	55	75	89	35	19	18	31	-5	12	-10	93	67	37	-20	46
TURB KJN	15	2	9	-29	-45	-35	-5	25	18	10	6	45	-43	6	14	2	13
ANNE KJN	15	2	9	-29	-45	-35	-5	25	18	10	6	45	-43	6	14	2	-27
POTA KJN	15	2	9	-29	-45	-35	-5	25	18	10	6	45	-43	6	14	2	100
EPHE KJN	15	2	9	-29	-45	-35	-5	25	18	10	6	45	-43	6	14	2	35
ODON KJN	41	-34	29	75	100	20	41	19	40	-23	32	-9	90	70	42	-34	3
PLEC KJN	-9	-27	56	-10	20	100	4	18	-8	46	2	-18	10	1	-9	-27	12
COLE KJN	13	-5	5	31	41	4	100	8	-15	-8	86	41	12	37	13	-5	-41
TABA KJN	18	1	20	-2	19	18	-8	100	23	54	-4	5	22	30	18	1	-6
SIMU KJN	-1	-50	14	54	38	-8	-15	23	100	-26	-28	-16	41	68	-9	-50	29
CHIR KJN	-22	-20	13	-28	14	31	-36	39	19	-8	-20	-17	6	-12	-22	-20	-8
TIPU KJN	15	-8	6	21	32	2	86	-4	-28	3	100	24	9	19	15	-8	24
TRIC KJN	31	56	26	-9	-9	-18	41	5	-16	-12	24	100	-22	28	31	56	-9
GAST KJN	42	-24	29	77	90	10	12	22	41	-8	9	-22	100	67	42	-24	25
TOTA KJN	57	-0	59	64	80	31	53	36	24	-2	39	40	66	81	57	-0	15
TURB PO_4	100	21	20	33	41	-9	13	18	-1	-3	15	31	42	39	100	21	13
ANNE PO_4	21	100	-15	-22	-34	-27	-5	1	-50	17	-8	56	-24	-12	21	100	-27
POTA PO_4	20	-15	100	28	29	56	5	20	14	13	6	26	29	43	20	-15	100
EPHE PO_4	33	-22	28	100	75	-10	31	-2	54	-31	21	-9	77	82	33	-22	35
ODON PO_4	41	-34	29	75	100	20	41	19	38	-23	32	-9	90	70	42	-34	3
PLEC PO_4	-9	-27	56	-10	20	100	4	18	-8	46	2	-18	10	1	-9	-27	12
COLE PO_4	13	-5	5	31	41	4	100	-8	-15	-9	86	41	12	37	13	-5	-41
TABA PO_4	18	1	20	-2	19	8	-8	100	-23	54	-4	5	22	30	18	1	-7
SIMU PO_4	-1	-50	14	54	38	-8	-15	23	100	-26	-28	-16	41	68	-9	-50	29
CHIR PO_4	-0	17	13	-31	-23	45	-8	54	-26	100	3	-11	-8	-13	-3	17	-8
TIPU PO_4	15	-8	6	21	32	2	86	-4	-28	3	100	24	9	19	15	-8	24
TRIC PO_4	31	56	26	-8	-8	-18	42	5	-16	-12	25	100	-21	29	31	56	-9
GAST PO_4	42	-24	29	77	90	10	12	22	41	-8	9	-22	100	69	42	-24	25
TOTA PO_4	40	-21	82	67	75	41	19	27	34	2	16	12	77	74	40	-21	59
DEPT	-15	79	-42	-38	-40	-34	-4	-30	-36	-17	-17	51	-40	-27	-15	79	-36
CURRENT	14	-48	32	-6	23	35	-21	47	64	4	-30	3	16	34	14	-48	47
TEMP	21	-24	-2	69	34	-20	-9	-16	20	-28	-1	-53	43	21	22	-24	-38
TURB	-3	-45	14	66	39	13	31	1	20	10	32	-50	40	33	-3	-46	-29
COND	-6	6	-45	-63	-6	-25	-52	-23	-42	-14	-40	-26	-60	-83	-6	6	8
PH	-27	-8	-18	65	21	-29	5	-32	22	-19	5	-45	37	24	-27	-8	43
O_2	27	-33	78	73	55	18	2	7	49	-18	8	-2	63	68	27	-33	22
B.O.D.	-20	-23	9	-20	18	19	-32	-25	29	-30	-19	-14	7	-8	-20	-23	22
PO_4	-14	-47	-12	-5	16	-22	51	-35	5	-25	55	10	-37	-5	-15	-47	45
SO_4	-12	-34	0	18	-0	9	-12	-21	-16	-20	-0	-59	-5	-30	-12	-3	-38
NH_4-N	18	33	1	-60	-32	-9	-27	11	-10	-6	-24	57	-34	-20	18	33	15
NO_3-N	24	24	21	-12	0	-18	-15	-4	26	-40	-31	65	-0	25	24	24	23
NO_2-N	5	41	-64	-29	-33	-70	-37	-32	-3	-42	-34	14	-22	-30	5	41	5

TIPU PO4	TRIC PO4	GAST PO4	TOTA PO4	DEPT	CURRENT	TEMP	TURB	COND	PH	O_2	B.O.D.	PO4	SO4	NH4-N	NO3-N	NO2-N
100																
0	100															
11	2	100														
34	38	75	100													
-22	23	-50	-51	100												
2	-26	71	46	-48	100											
34	44	-64	-29	17	-64	100										
22	-44	-15	-20	-36	-20	37	100									
-31	0	17	-9	53	31	-53	-68	100								
19	53	15	53	24	-8	-21	-68	19	100							
38	-23	24	21	-20	42	36	6	14	13	100						
-32	-7	31	13	-13	56	-18	-1	15	30	-34	100					
39	-4	3	-19	-10	-10	-12	23	7	28	0	-37	100				
12	20	-40	-19	0	-41	86	70	-59	-47	-28	8	-29	100			
-42	29	0	-6	43	24	-20	-74	84	22	17	11	7	-40	100		
-34	-36	16	-5	24	53	-42	-19	52	0	40	31	-22	28	44	100	
-43	10	0	-15	64	17	-30	-52	87	16	15	25	-17	-32	83	61	100

COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN	GAST KJN	TOTA KJN	TURB PO_4	ANNE PO_4	POTA PO_4	EPHE PO_4	ODON PO_4	PLEC PO_4	COLE PO_4	TABA PO_4	SIMU PO_4	CHIR PO_4
100																	
-1	100																
-4	35	100															
0	16	6	100														
25	-23	22	-12	100													
8	18	19	-33	-0	100												
-2	81	33	27	11	2	100											
26	39	35	-17	30	78	32	100										
4	34	32	-13	10	53	46	38	100									
24	-8	3	-8	0	64	-16	36	60	100								
-41	-6	29	-8	24	-9	25	15	13	27	100							
36	6	24	16	56	12	21	64	-8	8	35	100						
14	38	32	-25	22	75	17	93	21	20	3	49	100					
41	0	-8	-16	36	7	16	48	-7	-7	12	65	40	100				
100	-1	-4	0	25	8	-2	26	4	24	-41	36	14	41	100			
0	100	33	17	-24	16	82	36	35	-8	-7	5	34	-1	0	100		
-4	35	100	6	22	19	33	35	32	3	29	24	32	-8	-4	33	100	
0	16	6	100	-12	-33	27	-17	-13	-8	-8	16	-25	-16	0	17	6	100
25	-23	22	-12	100	0	11	30	10	0	24	56	22	36	25	-24	22	-12
8	18	19	-33	0	100	2	78	53	64	-9	12	75	7	8	16	19	-33
-2	81	33	27	11	2	100	32	46	-16	25	21	17	16	-2	82	33	27
0	56	46	0	34	38	75	76	46	-0	59	62	-61	42	0	55	46	0
10	-41	-32	-24	-22	23	-50	-20	-15	44	36	-27	-27	-33	10	-41	-32	-24
-46	51	62	27	2	-26	71	-9	31	-32	47	-6	-16	-18	-46	52	62	27
38	-43	6	-5	3	-44	-65	29	0	52	-38	14	36	14	38	45	6	-4
46	-22	-10	39	22	-44	-15	-11	-36	-16	-29	34	-9	56	46	-22	-10	39
-22	12	1	-34	-31	0	17	-32	30	14	8	-50	-45	-43	-22	14	1	-34
-21	16	0	-33	19	53	15	56	11	16	43	38	49	0	-21	13	0	-33
-33	18	23	-19	38	-23	24	-2	10	2	22	23	-4	13	-33	17	23	-19
-29	9	31	49	-32	-7	31	15	12	-20	22	22	-23	-11	-29	10	31	49
15	-21	-16	-13	39	-4	3	0	36	15	45	14	-14	-13	15	20	-16	-14
53	-34	15	21	-12	19	-40	23	-5	38	-38	30	23	40	53	-35	15	21
-41	7	13	-43	-42	-29	0	14	50	40	15	-52	-21	-46	-41	8	13	-43
-37	15	26	32	-34	-36	16	-37	-10	0	23	-4	50	-33	-37	16	26	32
-28	-4	-7	-28	-43	11	0	-25	21	31	5	-38	-40	-23	-28	-3	-7	-28

TABLE 4.15

Correlation matrix (Total) of biological and chemo-physical parameters monitored in the Nwanedzi River system during all the sampling periods

POTA BIOM	EPHE BIOM	ODON BIOM	PLEC BIOM	COLE BIOM	TABA BIOM	SIMU BIOM	CHIR BIOM	TIPU BIOM	TRIC BIOM	GAST BIOM	TOTA BIOM	TURB KJN	ANNE KJN	POTA KJN	EPHE KJN	ODON KJN	PLEC KJN
00																	
21	100																
-1	33	100															
42	16	33	100														
11	38	37	19	100													
2	13	20	20	5	100												
25	13	22	20	-6	8	100											
6	9	-14	27	3	14	17	100										
8	20	7	16	7	8	19	-6	100									
-2	-8	4	-12	0	-12	3	-14	-3	100								
-7	48	19	7	8	39	23	7	18	-7	100							
75	15	35	46	6	23	35	6	14	13	44	100						
-2	-8	-9	-10	4	17	4	14	4	2	-16	-19	100					
-2	-8	-9	-10	4	17	4	14	4	2	-16	-19	100	100				
-2	-8	-9	-10	4	17	4	14	4	2	-16	-19	100	100	100			
-2	-8	-9	-10	4	17	4	14	4	2	-16	-19	100	100	100	100		
-6	25	85	3	22	19	28	-11	4	10	16	34	-9	-9	-9	-9	100	
38	19	35	92	20	20	26	29	20	-9	14	46	-10	-10	-10	-10	31	100
-11	41	36	19	99	5	-6	2	10	-1	8	6	-4	-4	-4	-4	22	20
1	16	21	20	5	99	8	13	7	-11	38	23	17	17	17	17	21	20
24	13	23	20	-6	8	100	17	19	3	23	35	4	4	4	4	28	26
2	0	-10	18	-5	21	14	56	-9	-12	11	4	7	7	7	7	-8	20
8	21	7	17	7	9	19	-5	99	-3	18	14	4	4	4	4	4	21
-3	-6	6	-9	2	-13	4	-13	-2	100	-6	13	3	3	3	3	12	-6
-4	47	19	8	7	38	23	7	18	-6	100	45	-16	-16	-16	-16	16	15
11	35	63	27	27	11	29	-4	6	63	23	53	-6	-6	-6	-6	72	30
13	18	12	-9	8	19	6	-6	4	20	27	13	7	7	7	7	15	-6
28	4	-9	-21	9	-4	-19	21	-14	13	-14	-24	5	5	5	5	-7	-18
86	-17	19	50	-5	13	29	10	5	-5	1	81	-2	-2	-2	-2	18	45
23	99	29	13	38	14	10	8	19	-9	49	13	-7	-7	-7	-7	20	15
5	25	83	30	13	21	29	-9	7	6	20	43	-10	-10	-10	-10	86	35
38	21	36	90	19	18	33	29	24	-8	15	48	-10	-10	-10	-10	32	98
11	41	36	19	99	5	-6	2	10	-1	8	6	-4	-4	-4	-4	22	20
1	17	21	20	5	99	8	12	7	-11	39	23	16	16	16	16	21	20
24	13	23	20	-6	7	100	17	18	6	22	35	4	4	4	4	29	26
8	9	-13	27	3	15	17	98	-5	-14	10	10	15	15	15	15	-9	29
9	20	6	16	8	9	20	-4	99	-3	16	15	5	5	5	5	2	20
-8	-7	14	-5	5	-15	4	-16	3	95	-8	10	1	1	0	0	23	-4
-7	50	19	7	8	39	22	7	18	-7	100	43	-16	-16	-16	-16	16	13
77	2	35	5	3	22	37	9	10	9	25	93	-6	-6	-6	-6	35	51
24	-24	-25	-32	1	-27	-20	-1	-14	11	-41	-42	-3	-3	-3	-3	-26	-31
21	1	-7	8	-15	21	32	-3	12	17	35	32	9	9	9	9	-2	13
28	52	-4	-20	16	7	-9	0	-4	-22	26	-16	0	0	0	0	-5	-24
31	1	0	4	1	-10	2	1	15	-12	-6	20	-12	-12	-12	-12	-2	6
18	-5	-4	6	-11	4	2	2	-16	-13	-7	-23	11	11	11	11	-5	3
36	35	22	12	-26	-9	13	-13	2	9	-24	33	-20	-10	-20	-20	24	13
31	-10	-16	6	0	-28	-3	13	2	16	-16	20	-7	-7	-7	-7	-9	7
22	7	16	1	-2	-8	10	-20	4	3	-7	-16	0	0	0	0	19	-2
26	-16	15	0	-16	-9	11	-28	3	19	-4	26	-1	-1	-1	-1	3	4
33	-34	-10	-3	-15	-14	7	-23	11	12	-14	21	-11	-11	-11	-11	-13	-2
-8	-10	-12	-5	-2	5	5	-7	2	46	3	2	15	15	15	15	-7	-8
19	0	-7	-5	-1	13	-1	-19	-2	9	16	-9	4	4	4	4	-2	-4
6	-25	-3	-3	1	-11	1	-6	-2	17	-13	-4	4	4	4	4	-23	-33

	TURB NO	ANNE NO	POTA NO	EPHE NO	ODON NO	PLEC NO	COLE NO	TABA NO	SIMU NO	CHIR NO	TIPU NO	TRIC NO	GAST NO	TOTA NO	TURB BIOM	ANNE BIOM
TURB NO	100															
ANNE NO	25	100														
POTA NO	3	-23	100													
EPHE NO	13	-7	6	100												
ODON NO	6	-4	6	42	100											
PLEC NO	-19	-26	25	15	28	100										
COLE NO	9	6	-4	5	0	7	100									
TABA NO	14	-11	27	18	22	22	11	100								
SIMU NO	3	-21	13	34	21	11	-11	8	100							
CHIR NO	-13	13	-9	-1	-9	14	3	7	-4	100						
TIPU NO	3	-17	16	22	-4	5	21	1	18	-16	100					
TRIC NO	17	13	-8	-9	4	-13	-3	4	6	-18	-2	100				
GAST NO	28	-16	20	27	11	4	19	38	20	-2	17	-5	100			
TOTA NO	16	-6	9	53	37	16	1	21	81	7	18	47	28	100		
TURB BIOM	100	25	3	13	6	-19	9	14	3	-13	3	17	28	16	100	
ANNE BIOM	27	99	-22	-9	-7	-26	10	-9	-22	12	-15	12	-12	-8	27	100
POTA BIOM	-14	-27	61	6	2	34	-15	6	26	4	8	-1	-11	20	-14	-28
EPHE BIOM	19	-2	9	49	7	1	44	23	8	13	22	-8	58	24	19	4
ODON BIOM	12	-7	11	58	67	18	29	21	20	-18	8	0	19	36	12	-9
PLEC BIOM	-8	-21	31	35	18	66	12	19	16	-1	17	-17	9	19	-8	-21
COLE BIOM	9	7	-3	7	9	13	93	13	-6	7	8	-1	16	7	9	9
TABA BIOM	18	-7	33	19	18	17	8	87	2	-0	9	-9	36	10	18	-4
SIMU BIOM	6	-19	14	41	21	10	9	9	96	-5	19	2	23	79	6	-19
CHIR BIOM	-6	20	-5	1	-8	17	7	8	11	60	-5	-17	11	13	-6	21
TIPU BIOM	4	-16	16	21	-5	4	20	0	18	-17	99	-2	17	17	4	-14
TRIC BIOM	20	14	-11	-6	6	-12	-3	-1	7	-17	-3	98	-8	48	20	13
GAST BIOM	26	-18	23	30	14	4	13	36	19	-5	18	-3	97	28	26	-14
TOTA BIOM	13	-24	64	38	33	33	1	30	35	-5	14	14	39	48	13	-24
TURB KJN	7	3	1	-11	-9	-11	2	8	0	-1	4	4	-16	-3	7	5
ANNE KJN	7	3	1	-11	-9	-11	2	8	0	-1	4	4	-16	-3	7	5
POTA KJN	7	3	1	-11	-9	-11	2	8	0	-1	4	4	-16	-3	7	5
EPHE KJN	7	3	1	-11	-9	-11	2	8	0	-1	4	4	-16	-3	7	5
ODON KJN	16	-5	10	58	77	17	14	21	28	-17	4	4	17	43	16	-7
PLEC KJN	-6	-18	26	40	23	72	13	20	22	0	22	-14	15	27	-6	-18
COLE KJN	8	6	-3	7	8	13	94	13	-5	6	11	-2	17	7	8	8
TABA KJN	16	-7	33	20	20	16	7	89	3	-1	8	-7	36	11	16	-5
SIMU KJN	6	-18	14	41	21	10	-9	9	96	-6	19	2	23	79	7	-19
CHIR KJN	-8	6	-2	-6	-7	13	-4	11	7	29	9	-13	12	3	-8	6
TIPU KJN	3	-17	16	22	-4	5	20	1	18	-16	100	-2	17	18	3	-15
TRIC KJN	22	16	-12	-4	7	-11	-2	-3	6	-17	-3	97	-7	48	22	15
GAST KJN	25	-19	23	31	15	5	12	36	20	-4	18	-3	97	29	25	-15
TOTA KJN	29	2	16	43	54	16	21	24	30	-18	7	58	25	67	29	1
TURB PO_4	100	24	4	13	6	-19	8	15	2	-13	3	17	28	16	100	26
ANNE PO_4	27	99	-22	-9	-7	-26	10	-9	-22	12	-15	12	-12	-8	27	100
POTA PO_4	-1	-16	68	19	18	31	-13	12	27	-3	5	-5	-4	23	-1	-19
EPHE PO_4	18	0	10	43	5	-1	45	23	5	-1	21	-7	59	19	18	6
ODON PO_4	19	1	12	60	87	20	8	25	25	-18	8	3	18	43	19	-2
PLEC PO_4	-5	-18	27	39	22	66	13	16	28	-2	26	-13	18	31	-5	-17
COLE PO_4	8	6	-3	7	8	13	94	13	-5	6	11	-2	17	7	8	8
TABA PO_4	17	-7	32	19	19	16	8	89	3	-1	8	-7	37	11	17	-4
SIMU PO_4	7	-18	13	41	22	10	-9	8	96	-6	18	4	22	79	7	-18
CHIR PO_4	-5	17	-3	2	-5	20	7	9	12	63	-4	-17	14	14	-5	18
TIPU PO_4	4	-17	18	21	-6	4	21	1	19	-15	99	-2	16	18	4	-15
TRIC PO_4	24	16	-14	2	8	-12	-1	-8	6	-17	-4	89	-9	46	24	13
GAST PO_4	27	-17	22	29	12	3	14	36	18	-5	18	-4	98	27	27	-13
POTA PO_4	12	-16	68	34	31	32	-4	22	34	-8	11	8	20	41	12	-18
DEPT	-11	63	-33	-29	-24	-29	1	-29	-20	4	-14	12	-40	-20	-11	61
CURRENT	-12	-45	24	4	-5	24	-19	29	39	6	12	21	35	41	12	-44
TEMP	7	-9	-1	6	-19	-20	28	12	-9	4	-3	17	32	-15	7	-1
TURB	-23	-28	-5	18	5	17	3	-2	8	17	14	-14	-11	6	-23	-31
COND	13	2	-11	-6	-24	-18	-7	-5	-5	-19	-17	-14	-5	-19	13	5
PH	-8	-5	15	26	27	15	-37	-5	17	7	2	6	-32	22	-8	-12
O_2	-16	-19	-8	-7	3	25	-8	-6	9	31	3	13	-11	16	-16	-22
B.O.D.	9	-14	-9	0	9	-10	-1	-14	14	-23	4	3	-3	5	9	-11
PO_4	7	-2	8	25	-5	-17	-17	-9	6	-20	4	20	-14	14	7	-5
SO_4	-22	-9	5	4	-16	-12	-20	-12	9	-20	9	13	-22	8	-22	-13
NH_4-N	17	19	3	-16	-20	-28	-9	12	6	-23	2	50	7	18	16	19
NO_3-N	4	2	7	-14	8	-10	-2	7	-5	-39	-3	12	18	-7	4	3
NO_2-N	-2	14	1	-23	-20	-16	-2	-8	1	10	-20	19	-16	2	-2	15

TIPU PO4	TRIC PO4	GAST PO4	TOTA PO4	DEPT	CURRENT	TEMP	TURB	COND	PH	O_2	B.O.D.	PO_4	SC_4	NH4-N	NC3-N	NO2-N
100																
-4	100															
17	-8	100														
11	9	24	100													
-14	12	-41	-34	100												
13	7	34	19	-39	100											
-2	-22	28	-27	-19	-7	100										
15	-12	-7	6	-23	5	4	100									
-17	-3	-5	-13	0	-23	26	-24	100								
2	10	-27	38	-6	-5	-48	17	-11	100							
1	8	-17	4	-11	30	-16	38	-37	25	100						
3	6	-6	-13	-2	10	17	-22	20	-3	-17	100					
5	10	-5	32	8	0	-23	5	17	38	-22	6	100				
10	9	-15	25	19	5	-30	29	-10	32	7	-14	66	100			
2	38	3	6	32	21	-23	-47	5	-5	2	7	18	18	100		
-5	5	16	-2	12	8	-9	-49	0	-27	-32	5	-9	-6	33	100	
-18	17	-13	-3	43	-2	0	-10	5	2	2	2	21	32	19	-6	100

COLE KJN	TABA KJN	SIMU KJN	CHIR KJN	TIPU KJN	TRIC KJN	GAST KJN	TOTA KJN	TURB PO4	ANNE PC4	POTA PO4	EPHE PO4	ODON PC4	PLEC PO4	COLE PO4	TABA PO4	SIMU PO4	CHIR PO4
100																	
4	100																
-6	8	100															
-7	20	14	100														
10	8	19	-8	100													
1	-12	4	-10	-3	100												
8	38	24	11	18	-6	100											
27	14	29	-5	7	64	23	100										
7	17	6	-8	3	22	26	29	100									
8	-5	-19	6	-16	15	-15	0	26	100								
-6	12	29	4	5	-5	3	24	0	-19	100							
40	17	10	0	20	-7	48	31	18	6	-19	100						
13	25	-30	-4	7	8	21	63	19	-1	26	22	100					
19	18	33	20	25	-5	16	32	-6	-17	47	17	36	100				
100	5	-6	-6	10	1	8	27	7	8	-6	40	13	19	100			
5	100	8	20	8	-12	39	14	18	-4	11	18	25	18	5	100		
-5	8	100	13	18	7	23	31	7	-18	27	10	30	34	-5	7	100	
2	14	17	56	-4	-12	10	-3	-5	18	12	8	-6	28	2	13	17	100
11	8	19	-8	100	-2	18	6	4	-15	6	19	5	24	11	8	19	-3
4	-14	4	-13	-4	96	-8	67	24	13	-6	-9	11	-3	4	-14	7	-15
9	38	22	12	17	-7	96	22	28	-13	0	51	19	14	9	39	21	10
2	22	37	5	11	9	26	47	12	-18	95	0	43	54	2	21	37	12
0	-27	-20	0	-14	12	-41	-24	-11	61	-25	-23	-28	-30	0	-27	-20	-3
-14	21	32	10	12	15	36	15	12	-44	12	0	0	12	-14	21	32	-1
17	9	-9	1	-4	-23	24	-7	6	0	-32	55	-13	-20	17	10	-10	-1
0	-11	0	-13	15	-14	-5	-5	-23	-31	11	-4	-2	3	0	-12	0	0
-11	2	2	9	-17	-11	-8	-16	12	5	-12	-5	-11	6	-11	2	2	2
-27	-9	13	-21	2	7	-22	14	-7	-12	43	-39	31	10	-27	-10	13	-11
0	-29	-4	3	3	14	-14	9	-16	-22	9	-14	-12	6	0	-29	-3	14
-2	-8	13	-2	4	3	-8	7	9	-11	-16	7	13	0	-2	-8	13	-21
-16	-10	11	-21	4	19	-2	8	7	-5	32	-17	16	4	-16	-10	11	-29
-16	-14	7	-19	9	10	-13	-12	-22	-13	32	-35	-12	0	-16	-15	7	-24
-3	5	5	5	3	44	3	18	18	19	2	-11	-14	5	-3	6	5	-10
0	13	0	-7	-3	7	15	2	4	3	-6	4	-2	0	-1	14	0	-19
0	-12	0	1	-19	18	-13	-8	-1	15	2	-24	-29	-35	0	-12	0	-5

TABLE 4.16

Factor analysis of biological and chemo-physical parameters monitored in the Nwanedzi River System during April 1978

	POTAMON, COLEOPTERA AND ANNELIDA FACTOR	TRICHOPTERA FACTOR	TURBELLARIA AND GASTROPODA FACTOR	TIPULIDAE AND ODONATA FACTOR	EPHEMEROPTERA FACTOR	PLECOPTERA FACTOR	CHIRONOMIDAE FACTOR	SIMILIIDAE FACTOR	TABINIDAE FACTOR
POTA PO_4	88								
POTA KJN	88								
POTA BIOM	88								
POTA NO	88								
COLE PO_4	85								
COLE KJN	85								
COLE NO	85								
COLE BIOM	85								
TOTA BIOM	79	47							
ANNE BIOM	-78								
ANNE PO_4	-78								
ANNE NO	-78								
ANNE KJN	-78								
TOTA PO_4	76	54							
TRIC KJN		95							
TRIC NO		95							
TRIC BIOM		95							
TRIC PO_4		95							
TOTA KJN	34	92							
TOTA NO		82			26			36	
CURR		62				27		56	
NH_4		59	54		-38		-28		
PO_4	-36	55			-47		-48		
TURB NO			95						
TURB PO_4			95						
TURB BIOM			95						
TURB KJN			95						
PH			-90				32		
GAST BIOM			70						
GAST NO			70						
GAST PO_4			70						
GAST KJN			70						
TIPU BIOM				95					
TIPU PO_4				95					
TIPU NO				95					
TIPU KJN				95					
ODON KJN				59					
ODON NO				59					
ODON PO_4				59					
ODON BIOM				59					
EPHE BIOM					94				
EPHE PO_4					93				
EPHE KJN					93				
EPHE NO					93				
NO_3		41			-76	-31			
TURB	51		-29		55	37	-28		
PLEC BIOM						95			
PLEC PO_4						95			
PLEC NO						95			
PLEC KJN						92			
TEMP							93		
DEPT	-43						-78		
O_2	41					28	73		
COND					-53	-26	70	-25	
SO_4	-38	42		26	-27		-66		
CHIR PO_4							63		
CHIR BIOM							62		
CHIR KJN							62		
CHIR NO							62		
SIMU NO								97	
SIMU KJN								97	
SIMU PO_4								97	
B.O.D.									-87
TABA BIOM									67
TABA PO_4									67
TABA NO									67
TABA KJN									67
SIMU BIOM								65	67
NO_2									
V.P. Values	12,004	10,863	8,411	7,077	6,984	6,052	5,891	5,506	3,760

TABLE 4.17

Factor analysis of biological and chemo-physical parameters monitored in the Nwanedzi River System during May 1978

	TRICHOPTERA AND SIMULIIDAE FACTOR	EPHEMEROPTERA AND ODONATA FACTOR	ANNELIDA AND COLEOPTERA FACTOR	TABANIDAE AND POTAMON FACTOR	PLECOPTERA FACTOR	TURBELLARIA AND GASTROPODA FACTOR	CHIRONOMIDAE FACTOR	TIPULIDAE FACTOR
TOTA NO	96							
TRIC BIOM	94							
TRIC NO	94							
TRIC PO_4	94							
TRIC KJN	94							
SIMU PO_4	74							
SIMU NO	74							
SIMU KJN	74							
SIMU BIOM	73							
TOTA KJN	73	48						-34
CURR	65		-41		36			33
TOTA PO_4	64		-27	49	37	25		
TOTA BIOM	64		-32	34	31	39	29	
PO_4	62		58		-31			
NH_4	51		41		-26	44		36
EPHE PO_4		94						
EPHE KJN		94						
EPHE BIOM		94						
EPHE NO		94						
ODON NO		90						
ODON BIOM		90						
ODON KJN		90						
ODON PO_4		90						
PH		-67		46		42		
TEMP		67	-29	25				
TURB		60		-33	-43			
DEPT			96					
ANNE BIOM			95					
ANNE PO_4			95					
ANNE NO			95					
ANNE KJN			95					
COLE PO_4			64					
COLE BIOM			64					
COLE NO			64					
COLE KJN			64					
SO_4	50	-33	52			34		37
TABA NO				91				
TABA BIOM				89				
TABA KJN				89				
TABA PO_4				89				
NO_2			35	63	44			
POTA PO_4				60				
POTA KJN				60				
POTA BIOM				60				
POTA NO				54				
PLEC BIOM					93			
PLEC KJN					93			
PLEC PO_4					93			
PLEC NO					87			
TURB BIOM						93		
TURB NO						93		
TURB KJN						93		
TURB PO_4						93		
GAST BIOM						62		
GAST KJN						62		
GAST NO						62		
GAST PO_4						62		
NO_3	-45	42			26	-56		
B.O.D.							-92	
CHIR NO							88	
CHIR KJN							88	
CHIR BIOM							86	
CHIR PO_4							86	
O_2	26						-85	
TIPU BIOM								95
TIPU PO_4								95
TIPU KJN								95
TIPU NO								95
COND		-42	-31	-31				
V.P. Values	11,182	10,260	9,478	7,365	7,280	6,860	5,977	5,895

TABLE 4.18

Factor analysis of biological and chemo-physical parameters monitored in the Nwanedzi River System during July 1978

	TURBELLARIA AND TRICHOPTERA FACTOR	EPHEMEROPTERA, GASTROPODA AND ODONATA FACTOR	TIPULIDAE AND PLECOPTERA FACTOR	TABANIDAE FACTOR	POTAMON FACTOR	SIMULIIDAE FACTOR	ANNELIDA FACTOR	CHIRONOMIDAE FACTOR	COLEOPTERA FACTOR
TURB KJN	89								
TURB PO_4	89								
TURB NO	89								
TURB BIOM	89								
TOTA KJN	86							-30	
TRIC NO	84								
TRIC BIOM	84								
TRIC KJN	84								
TRIC PO_4	84								
TURB	-54		28	49			-33		
EPHE BIOM		89							
EPHE NO		89							
EPHE KJN		89							
EPHE PO_4		89							
GAST PO_4		80							
GAST KJN		80							
GAST NO		80							
GAST BIOM		80							
ODON KJN		60							
ODON PO_4		60							
ODON NO		60							
ODON BIOM		60							
TIPU PO_4			91						
TIPU BIOM			90						
TIPU NO			90						
TIPU KJN			90						
PLEC PO_4			86						
PLEC NO			85						
PLEC KJN			85						
NH_4			-76		-38	-26			
TABA BIOM				92					
TABA NO				92					
TABA PO_4				92					
TABA KJN				92					
PH	27			77	35			28	
NO_2		-50	-36	70					
TEMP				69	45	48			
PO_4	44		-36	62				35	
POTA PO_4					95				
POTA NO					95				
POTA KJN					95				
TOTA PO_4					93				
TOTA BIOM			28		89				
SO_4	-38				70				
POTA BIOM					69				
SIMU PO_4						96			
SIMU KJN						95			
SIMU BIOM						95			
SIMU NO						95			
TOTA NO	37	26				84			
COND	-28		-29	28	-26	70			38
ANNE BIOM							84		
ANNE NO							84		
ANNE PO_4							84		
ANNE KJN							84		
DEPT		-28			-32		79		
PLEC BIOM			55				-60		
O_2	35	35	26	-43			-58	-30	
CHIR NO								92	
CHIR KJN								92	
CHIR BIOM								92	
CHIR PO_4								92	
COLE BIOM									97
COLE PO_4									97
COLE NO									97
COLE KJN									97
B.O.D.			27	31					
NO_3	-35	42	37	-48				-33	
CURR	31		50			33	-48	32	38
V.P. Values	9,660	9,451	8,371	8,359	7,494	6,495	5,981	5,502	5,376

TABLE 4.19

Factor analysis of biological and chemo-physical parameters monitored in the Nwanedzi River System during August 1978

	PLECOPTERA AND TABANIDAE FACTOR	EPHEMEROPTERA AND SIMULIIDAE FACTOR	COLEOPTERA AND CHIRONOMIDAE FACTOR	POTAMON FACTOR	ODONATA FACTOR	ANNELIDA FACTOR	TRICHOPTERA FACTOR	TIPULIDAE FACTOR	GASTROPODA FACTOR	TURBELLARIA FACTOR
PLEC BIOM	94									
PLEC KJN	94									
PLEC NO	94									
PLEC PO_4	94									
TABA BIOM	88									
TABA PO_4	88									
TABA KJN	88									
TABA NO	88									
NO_2	-53		50		-45		27			
TOTA NO		90								
EPHE PO_4		88								
EPHE KJN		88								
EPHE NO		88								
EPHE BIOM		88								
SIMU KJN		79								
SIMU BIOM		79								
SIMU PO_4		79								
SIMU NO		79								
COLE BIOM			89							
COLE KJN			89							
COLE PO_4			89							
COLE NO			89							
NH_4		-39	79							25
DEPT	-34		72		-32	30			-26	
CHIR KJN			64							
CHIR NO			64							
CHIR BIOM			64							
CHIR PO_4			64							
POTA BIOM				96						
POTA PO_4				96						
POTA KJN				96						
POTA NO				96						
TOTA PO_4				92						
TOTA BIOM	26			85					38	
O_2	50		-29	57	25					
ODON BIOM					89					
ODON KJN					89					
ODON NO					89					
ODON PO_4					89					
PH			-36		78				-30	35
NO_3			29		-73	-29	27	32		-26
SO_4			51		-69			25		-31
ANNE BIOM						94				
ANNE NO						94				
ANNE PO_4						94				
ANNE KJN						94				
B.O.D.					33	-75			-32	29
CURR		52				-53		38	45	
TRIC NO							91			
TRIC BIOM							91			
TRIC KJN							91			
TRIC PO_4							91			
TOTA KJN				46	47		57			28
TIPU BIOM								93		
TIPU PO_4								93		
TIPU NO								93		
TIPU KJN								93		
TURB	31			28	-35			57		-40
GAST BIOM									92	
GAST KJN									92	
GAST NO									92	
GAST PO_4									92	
TURB NO										87
TURB KJN										87
TURB PO_4										87
TURB BIOM										87
PO_4			35	44		-32	46		35	26
COND		-46	-39	-38			-46			
TEMP	-39		50		-30	30	49		40	

TABLE 4.20

Factor analysis of biological and chemo-physical parameters monitored in the Nwanedzi River system during October 1978

	ODONATA, SIMULIIDAE AND EPHEMEROPTERA FACTOR	TABANIDAE AND PLECOPTERA FACTOR	ANNELIDA AND CHIRONOMIDAE FACTOR	TRICHOPTERA FACTOR	GASTROPODA FACTOR	POTAMON FACTOR	COLEOPTERA FACTOR	TURBELLARIA FACTOR	TIPULIDAE FACTOR
ODON KJN	84								
ODON BIOM	84								
ODON PO_4	84								
ODON NO	84								
SIMU KJN	84								
SIMU BIOM	83								
SIMU PO_4	83								
SIMU NO	83								
TOTA NO	81	28		30	26				
TOTA KJN	75	27		44			27		
TOTA BIOM	62				51	39			
EPHE NO	60								
EPHE BIOM	60								
EPHE KJN	60								
EPHE PO_4	60								
TABA BIOM		84							
TABA KJN		84							
TABA PO_4		84							
TABA NO		84							
PLEC BIOM		83							
PLEC KJN		83							
PLEC PO_4		83							
PLEC NO		83							
ANNE PO_4			62						
ANNE NO			62						
ANNE KJN			62						
ANNE BIOM			62						
CURR	48	55					-29	52	
CHIR NO			85						
CHIR PO_4			85						
CHIR KJN			85						
CHIR BIOM			85						
TEMP			-81					-32	-31
PH			-75				-28		-32
DEPT		-34	71						
NO_3	-27	-35	64			33	-26	28	
B.O.D.	49		-60		-41				
O_2	36	28	-52			-33			-43
TRIC NO				93					
TRIC BIOM				93					
TRIC PO_4				93					
TRIC KJN				92					
NH_4				81					
PO_4			-48	64				31	
GAST BIOM					88				
GAST NO					88				
GAST PO_4					88				
GAST KJN					86				
COND	-39		-40	46	-54		-35		
POTA KJN						93			
POTA PO_4						93			
POTA NO						93			
POTA BIOM						93			
TOTA PO_4	45				40	71			
COLE BIOM							94		
COLE NO							94		
COLE PO_4							94		
COLE KJN							94		
NO_2	-28			52			68		
TURB BIOM								97	
TURB PO_4								97	
TURB KJN								97	
TURB NO								97	
TIPU PO_4									86
TIPU NO									86
TIPU KJN									86
TIPU BIOM									84
TURB		-35	-37	-37	40				-51
SO_4					36			-25	
V.P. Values	11,000	9,857	8,712	6,970	6,209	6,043	5,972	5,801	4,776

TABLE 4.21

Factor analysis of biological and chemo-physical parameters monitored in the Nwanedzi River system during November 1978

	GASTROPODA, ODONATA AND EPHEMEROPTERA FACTOR	TIPULIDAE AND COLEOPTERA FACTOR	TRICHOPTERA AND ANNELIDA FACTOR	SIMULIIDAE FACTOR	PLECOPTERA FACTOR	TABANIDAE AND CHIRONOMIDAE FACTOR	POTAMON FACTOR	TURBELLARIA FACTOR
GAST PO_4	96							
GAST NO	96							
GAST BIOM	96							
GAST KJN	96							
TOTA BIOM	92						30	
ODON PO_4	90							
ODON KJN	90							
ODON NO	90							
ODON BIOM	90							
EPHE NO	78							
EPHE BIOM	78							
EPHE PO_4	78							
TOTA PO_4	72				26		60	
TOTA KJN	68	36					29	
TOTA NO	67			52				
COND	-63	-38	-30					
ANNE KJN	-58							
TURB KJN	-58							
EPHE KJN	-58							
POTA KJN	-58							
TIPU BIOM		95						
TIPU NO		95						
TIPU KJN		95						
TIPU PO4		95						
COLE BIOM		93						
COLE NO		93						
COLE KJN		93						
COLE PO_4		93						
PO_4	-45	68		39		-31		
TRIC NO			90					
TRIC KJN			90					
TRIC BIOM			90					
TRIC PO_4			90					
NO_3		-26	76	30				39
SO4			-74					
DEPT			71	-34			-41	
ANNE BIOM			66					
ANNE NO			66					
ANNE PO_4			66					
TURB	34	30	-65					
NH_4			63					51
TEMP	41		-61		-32			
SIMU BIOM				89				
SIMU NO				89				
SIMU KJN				89				
SIMU PO_4				89				
CURR				72	35	28		
PLEC KJN					95			
PLEC BIOM					95			
PLEC NO					95			
PLEC PO4					95			
CHIR BIOM					60	47		
NO_2		-36	31		-59	-28	-46	
TABA PO_4						97		
TABA BIOM						97		
TABA KJN						97		
TABA NO						97		
CHIR PO_4						63		
CHIR NO						63		
POTA BIOM							87	
POTA NO							87	
POTA PO_4							87	
O2	55			27			78	
B.O.D.								90
CHIR KJN						30		85
TURB NO								88
TURB PO_4								88
TURB BIOM								88
PH	43		-39		-36			-49
V.P. Values	15,325	9,485	8,813	7,005	6,843	5,957	5,000	4,173

TABLE 4.22

Factor analysis of biological and chemo-physical parameters monitored in the Nwanedzi River System during February 1979

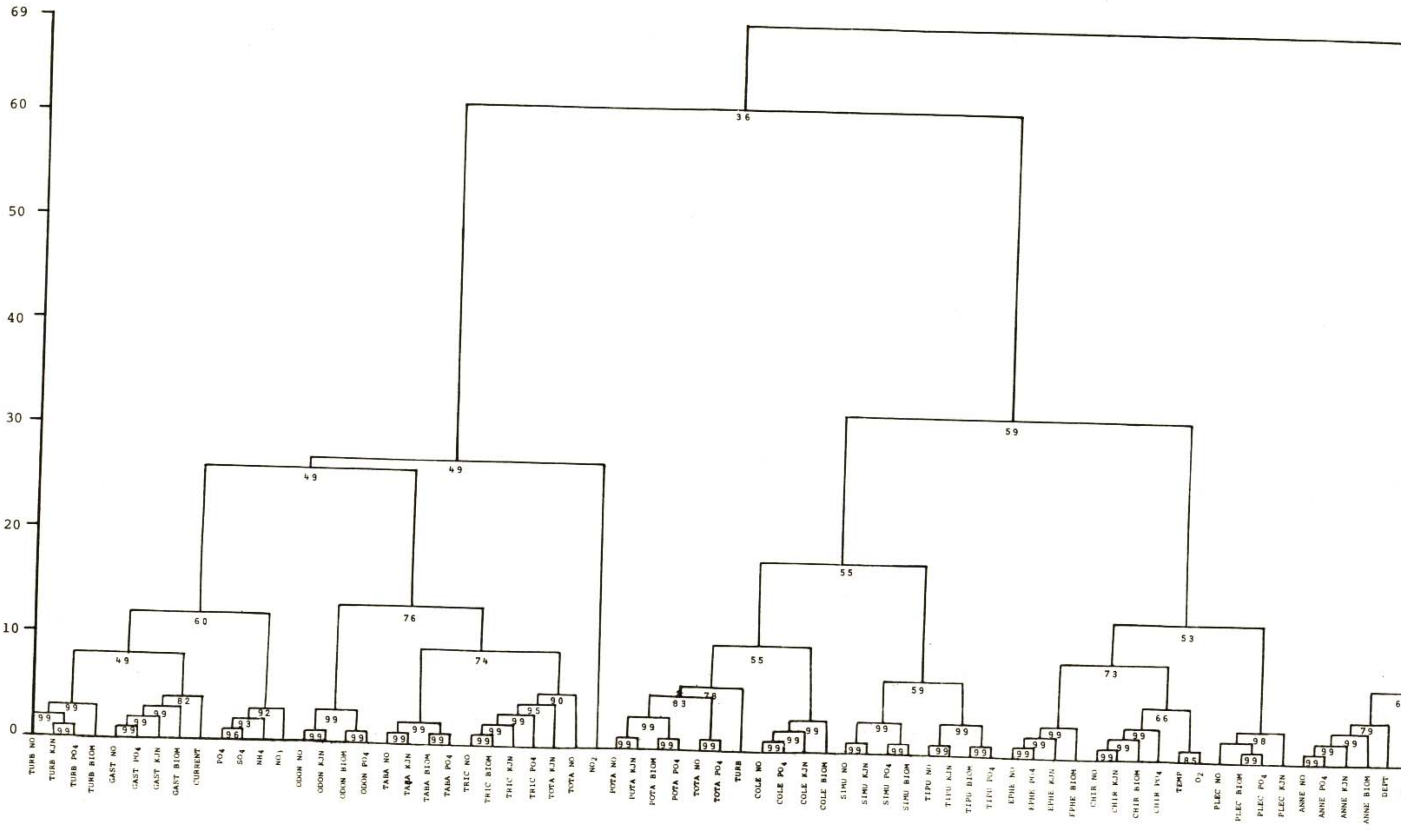
	GASTROPODA AND TABANIDAE FACTOR	ODONATA AND TRICHOPTERA FACTOR	ANNELIDA AND TURBELLARIA FACTOR	PLECOPTERA AND EPHEMEROPTERA FACTOR	TIPULIDAE FACTOR	POTAMON FACTOR	CHIRONOMIDAE FACTOR	COLEOPTERA FACTOR	SIMULIIDAE FACTOR
GAST BIOM	95								
GAST PO_4	95								
GAST NO	95								
GAST KJN	95								
TABA BIOM	95								
TABA NO	90								
TABA PO_4	90								
TABA KJN	89								
TOTA BIOM	79	34				38			
TEMP	-70	-30	29			-31			
CURR	62					29		-38	53
TOTA PO_4	61	45		29		50			
ODON PO_4		92						30	30
ODON NO		92							
ODON KJN		92							
TOTA KJN		83		33					
TRIC NO		81							
TRIC BIOM		81							
TRIC PO_4		81							
TRIC KJN		81							
TOTA NO		63	36				26		47
PH		62				44			
ANNE NO			90						
ANNE BIOM			90						
ANNE PO_4			90						
ANNE KJN			90						
TURB BIOM			82						
TURB PO_4			82						
TURB KJN			82						
TURB NO			82						
NH_4			52	-35	-41		-49	-27	
PLEC KJN				94					
PLEC NO				94					
PLEC PO_4				94					
PLEC BIOM				94					
TURB				64		-34	42		
EPHE BIOM				54					
EPHE NO				54					
EPHE PO_4				54					
EPHE KJN				54					
TIPU NO					92				
TIPU PO_4					92				
TIPU KJN					92				
TIPU BIOM					92				
B.O.D.					-54	28	38		36
POTA KJN						93			
POTA BIOM						93			
POTA NO						93			
POTA PO_4						93			
PO_4			27	-30	47	55		28	-31
CHIR PO_4							96		
CHIR BIOM							96		
CHIR NO							96		
CHIR KJN							96		
COND	26	-38	28	-39	-33		-51		
COLE BIOM								93	
COLE KJN								91	
COLE PO_4								91	
COLE NO								91	
ODON BIOM								69	
O_2					50			-54	
SIMU PO_4									95
SIMU KJN									95
SIMU NO									95
SUMU BIOM									95
NO_3		-44			-28			-28	30
DEPT	-44		26	-31					
NO_2		-31	40		-50		-38		
SO_4	-51			48			34		
V.P. Values	10,892	9,299	8,320	7,091	6,491	6,195	5,826	5,454	5,362

TABLE 4.23

Factor analysis (Total) of all biological and chemo-physical parameters monitored in the Nwanedzi River System during all the sampling periods

	GASTROPODA AND TABANIDAE FACTOR	ODONATA FACTOR	POTAMON FACTOR	SIMULIIDAE FACTOR	TRICHOPTERA FACTOR	COLEOPTERA AND EPHEMEROPTERA FACTOR	ANNELIDA AND TURBELLARIA FACTOR	TIPULIDAE FACTOR	CHIRONOMIDAE FACTOR
GAST PO_4	87								
GAST BIOM	86								
GAST NO	86								
GAST KJN	85								
TABA PO_4	69								
TABA KJN	68								
TABA BIOM	67								
TABA NO	65								
ODON PO_4		86							
ODON KJN		84							
ODON BIOM		80							
ODON NO		80							
EPHE NO		58							
POTA PO_4			93						
TOTA PO_4			87						
POTA BIOM			85						
TOTA BIOM	34		77						
POTA NO			68						
PLEC BIOM			51						
SIMU KJN				91					
SIMU PO_4				91					
SIMU BIOM				91					
SIMU NO				89					
TOTA NO		30		72	50				
TRIC BIOM					97				
TRIC KJN					96				
TRIC NO					95				
TRIC PO_4					90				
TOTA KJN		55			63				
COLE KJN						95			
COLE PO_4						95			
COLE BIOM						94			
COLE NO						93			
EPHE PO_4						54			
EPHE BIOM						53			
ANNE PO_4							86		
ANNE BIOM							86		
ANNE NO							85		
TURB BIOM							57		
TURB NO							57		
TURB PO_4							57		
DEPT	-46	-28					51		
POTA KJN			95						
TURB KJN							95		
ANNE KJN							95		
EPHE KJN						95			
TIPU KJN								97	
TIPU NO								97	
TIPU BIOM								97	
TIPU PO_4								97	
CHIR PO_4									87
CHIR BIOM									87
CHIR NO									68
CHIR KJN									60
PLEC KJN			48						
PLEC PO_4			47						
PLEC NO			34						
CURR	44			36	30		-42		
TEMP	35		-34		-28	34			
TURB							46		
COND					-30				
PH	-33	31	41			-38			
O_2					-32		-45		32
B.O.D.									-32
PO_4			44						-44
SO_4	-26	-26	45						
NH_4					50		28		
NO_3									
NO_2		-45							
V.P. Values	7,077	5,586	5,584	5,212	5,204	4,941	4,715	4,635	4,314

FIGURE 4.1
Cluster analysis of biological and chemo-physical parameters monitored in the Nwanedzi River system during April 1978



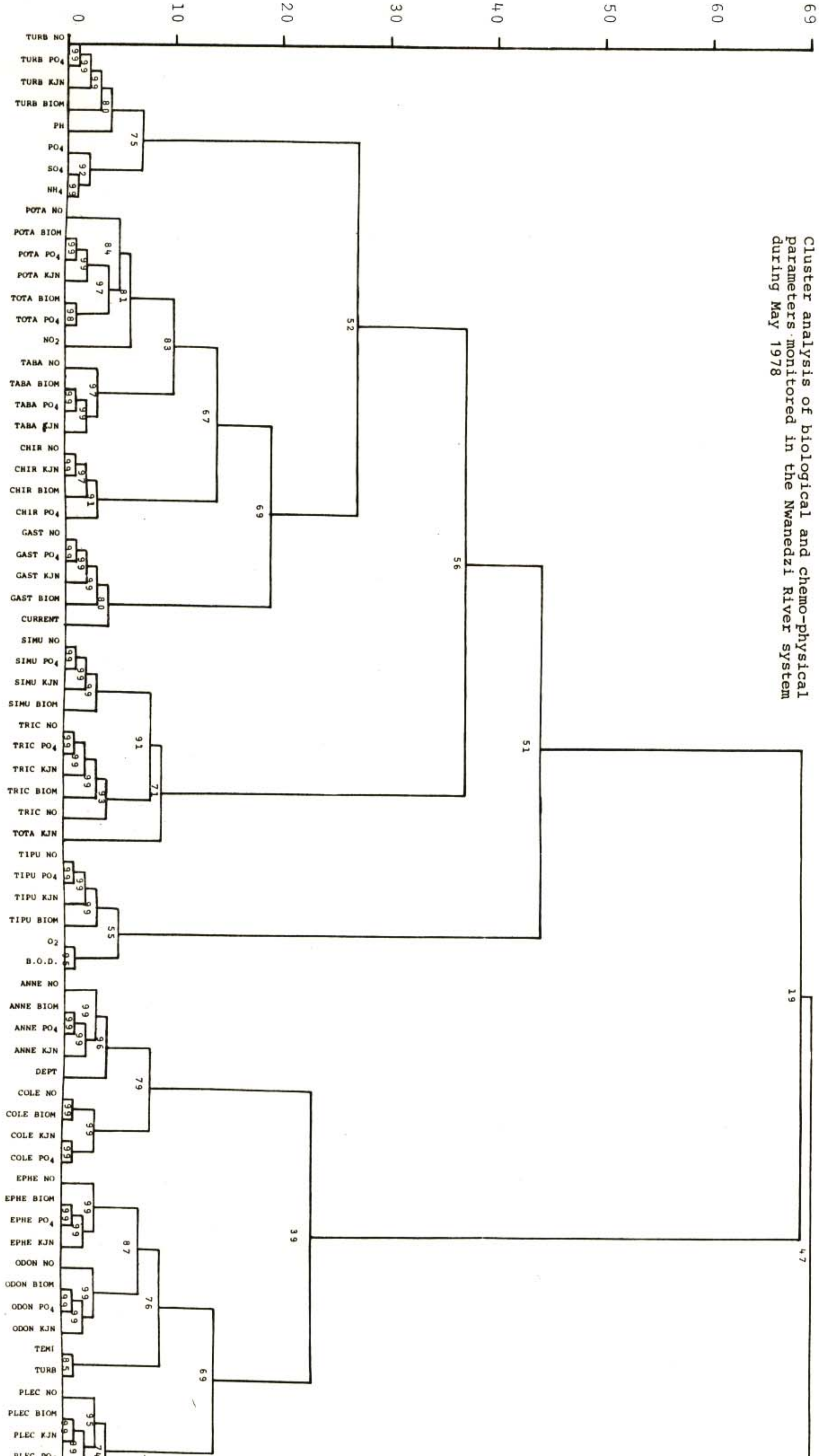


FIGURE 4.2
Cluster analysis of biological and chemo-physical parameters monitored in the Nwanedzi River system during May 1978

FIGURE 4.3

Cluster analysis of biological and chemo-physical parameters monitored in the Nwanedzi River system during July 1978

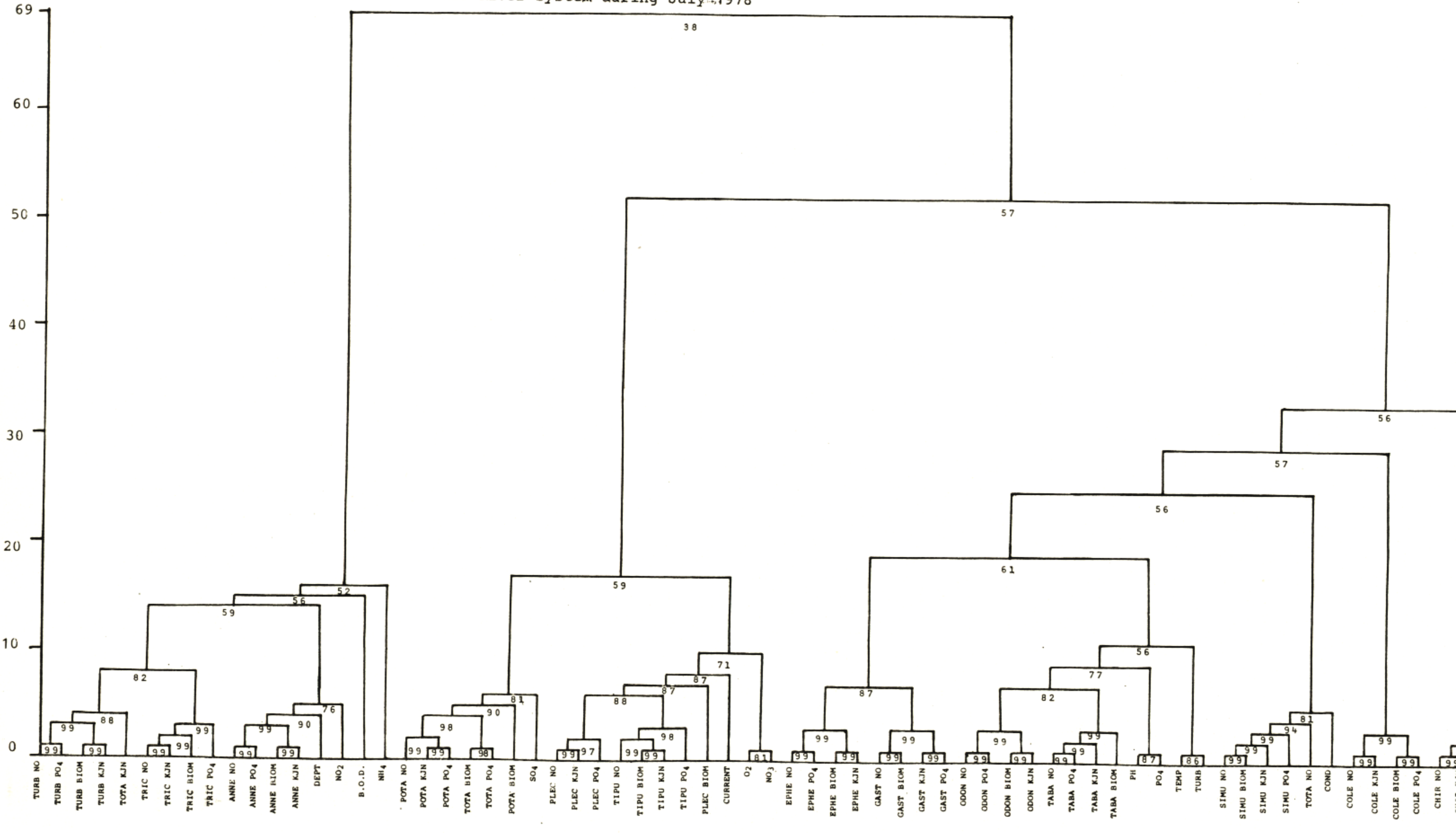


FIGURE 4.4

Cluster analysis of biological and chemo-physical parameters monitored in the Nwanedzi River system during August 1978

FIGURE 4.5

Cluster analysis of biological and chemo-physical parameters monitored in the Nwanedzi River system during October 1978

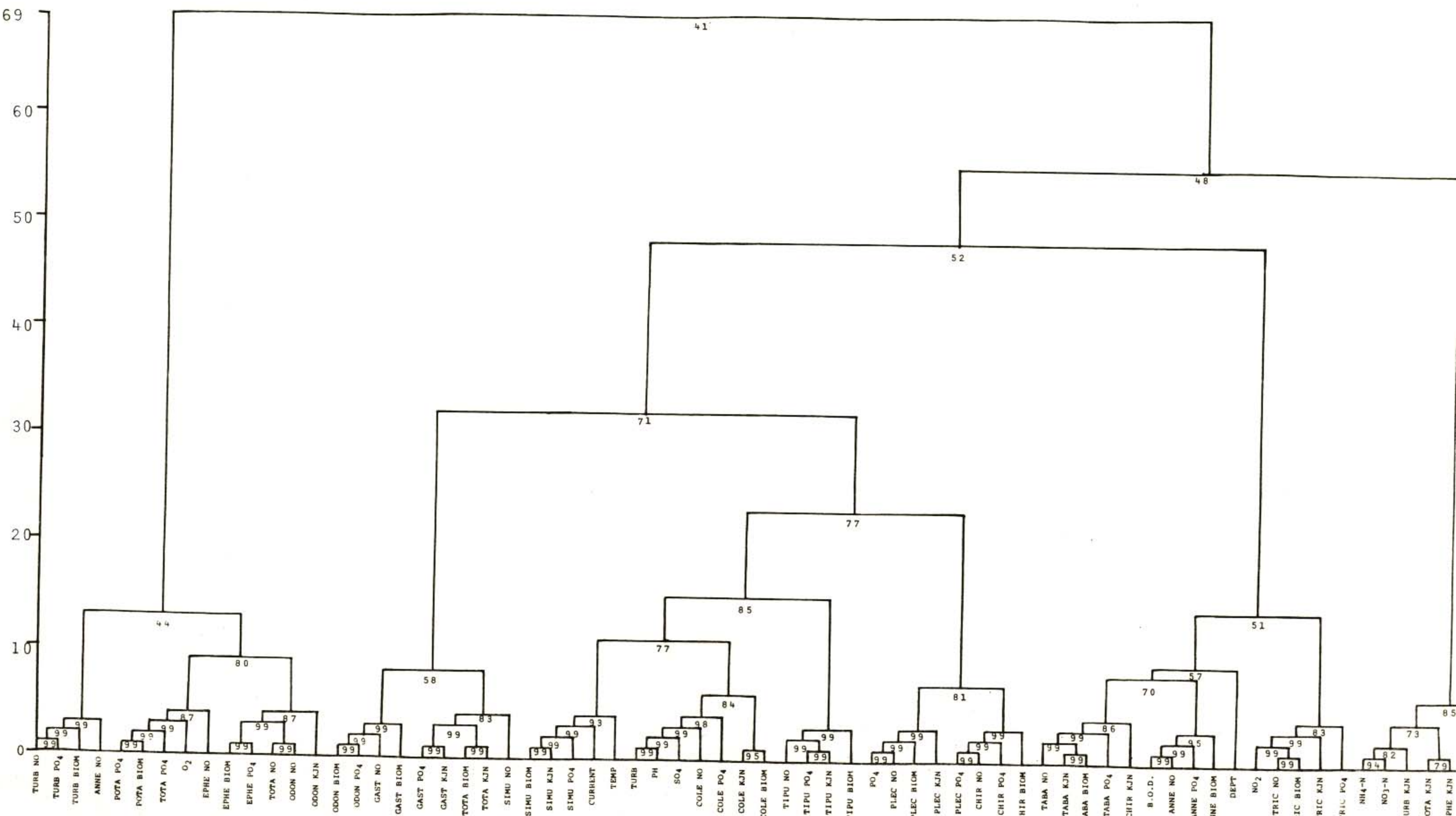


FIGURE 4.6

Cluster analysis of biological and chemo-physical parameters monitored in the Nwanedzi River system during November 1978

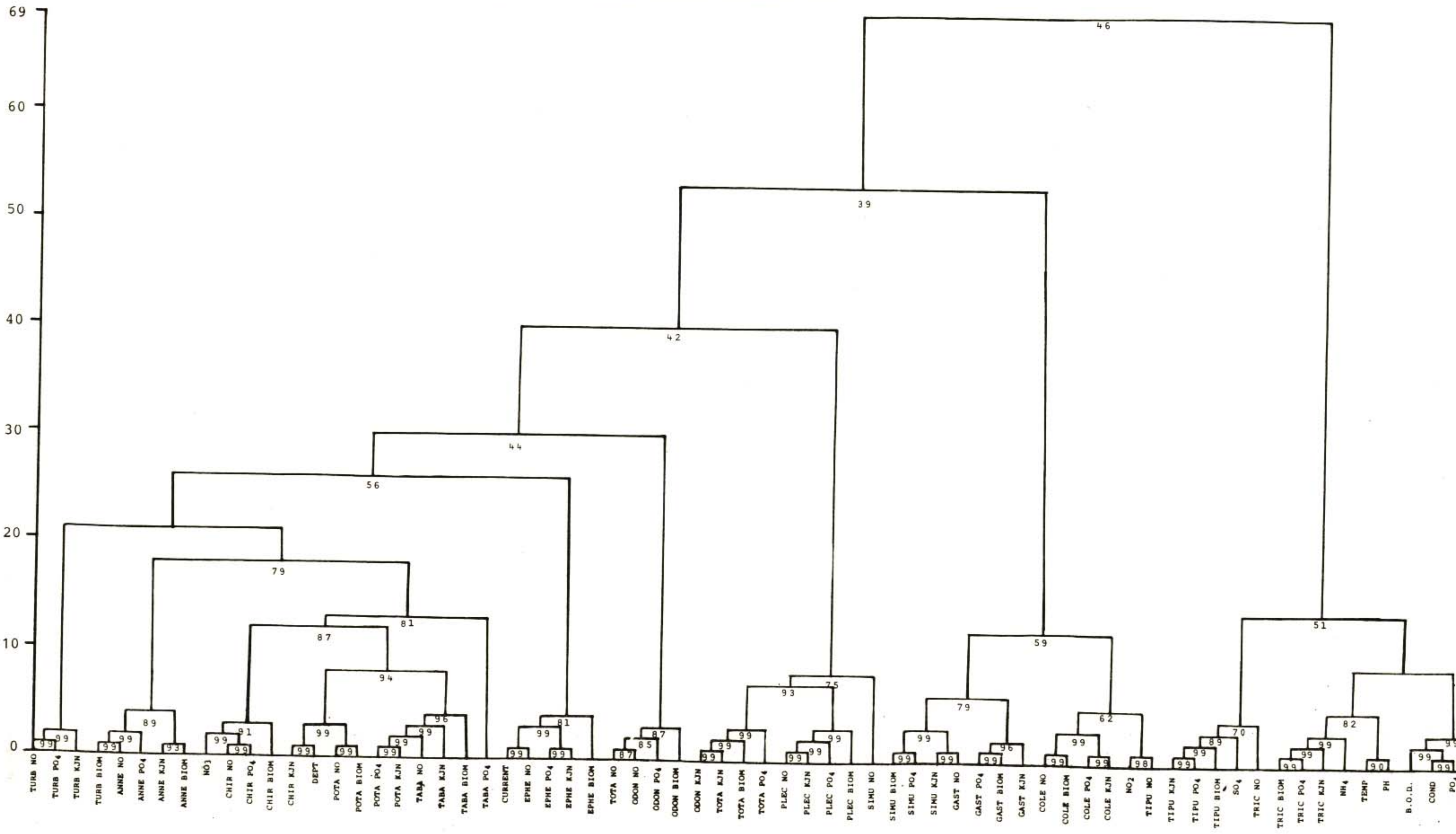


FIGURE 4.7

Cluster analysis of biological and chemo-physical parameters monitored in the Nwanedzi River system during February 1979

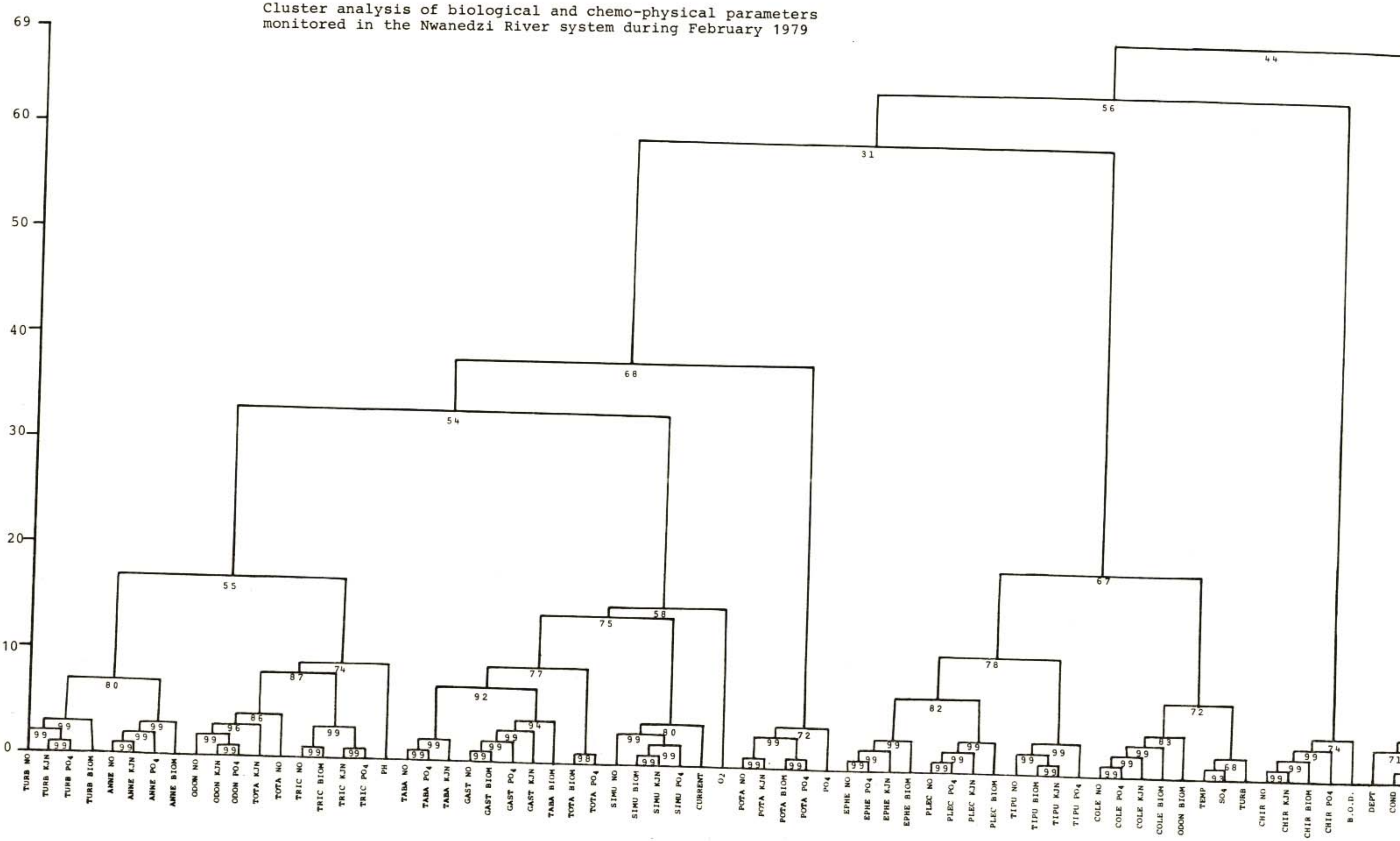
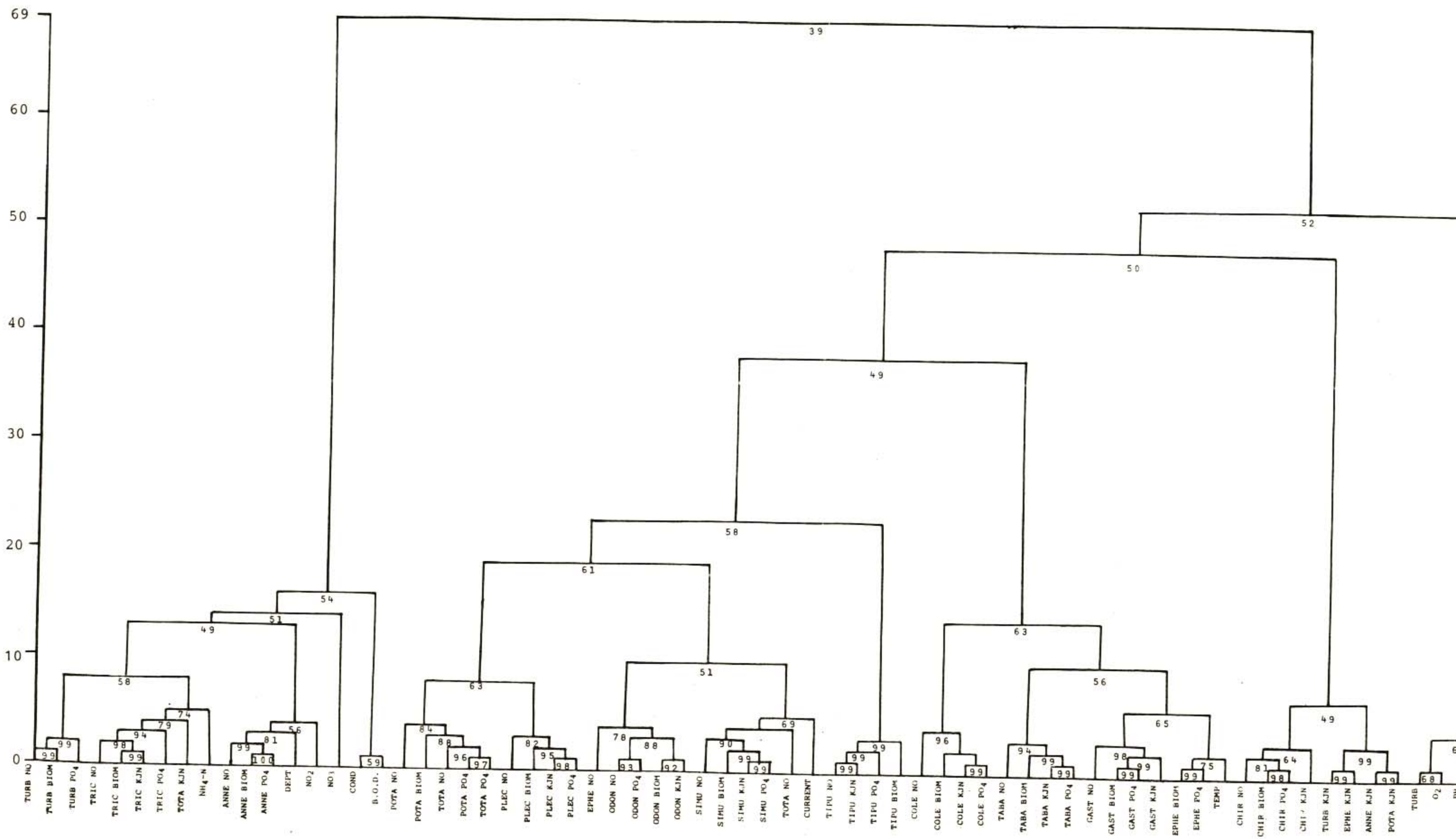


FIGURE 4.8

Cluster analysis (Total) of all biological and chemo-physical parameters monitored in the Nwanedzi River system during all the sampling periods



CHAPTER 4

RESULTS AND DISCUSSION

4.1 Zoobenthos and chemo-physical parameters monitored during the First-Year.

The following organisms were collected from the Nwanedzi River and the Luphephe Stream during the present survey. Hutchinson (1929), Barnard (1932), Crass (1947), Pennak (1953), Ward and Whipple (1959), Scott (1963 and 1963a), Schoonbee (1968) and Quigley (1977) were consulted for the identification of the organisms. Prof. H.J. Schoonbee of the Rand Afrikaans University helped with most of the identifications.

Coelenterata	*Hydra* sp.
Platyhelminthes	Turbellaria
Annelida	*Limnodrilus* sp.
Arthropoda	
Crustacea	*Potamon warreni*
Ephemeroptera	*Baetis harrison*
	Centroptilum sp. I.
	Centroptilum sp. II.
	Centroptilum sp. III.
	Centroptilum sp. IV.
	Euthraulus bugandensis
	Afronurus scotti
	Oligoneuropis lawrencei
	Neurocaenis discolor
	Caenis sp.
Odonata	Libellulidae
	Aeshna sp.

Plecoptera	*Neoperla spio*
Coleoptera	Dytiscidae
	Aulonogyrus sp.
	Eubrianax sp.
	Elmidae sp. I
	Elmidae sp. II
	Hydrophilidae
	Helodidae
Diptera	Tabanidae
	Simulium adersi
	Simulium nigritarsus
	Chironomus sp.
	Ceratopogonidae
	Tendipedidae
	Forcipomyia sp.
	Tipulidae
	Culicidae
Hemiptera	*Micronecta* sp.
	Plea pullula
	Nepa apiculata
	Notonecta sp.
Trichoptera	*Cheumatopsyche thomasseti*
	Macronema capense
Mollusca	*Bulinus (Bulinus) tropicus*
	Lymnaea sp.
	Melanoides tuberculata

The numerically dominant organisms were grouped into major taxomonic categories, counted, weighed and their Kjeldahl nitrogen and phosphate contents determined (Tables 4.1 to 4.7).

General distribution of the fauna

COELENTERATA

Hydra sp. were collected in very low numbers in the Nwanedzi River below the impoundments. As these organisms were collected from this locality only, their occurrence here can be associated with the relatively high zooplankton densities observed during the course of this study.

PLATYHELMINTHES

The Turbellaria were collected from the Luphephe Stream and the Nwanedzi River below the impoundments. They preferred flats and runs with moderate current speeds. The occurrence of the Turbellaria in higher concentrations below the impoundments suggests that there is some degree of organic enrichment at this site (Cole, 1979).

ANNELIDA

Although in smaller numbers, Limnodrilus sp. were found at all sampling localities. This group prefered soft bottoms with low current speeds such as in pools and flats.

The Crustacea, Odonata and Plecoptera were collected from all sampling stations where the current was moderate and the bottom stony as in runs and flats. Some Odonata and Plecoptera were even collected from stickles.

EPHEMEROPTERA

All Centroptilum species, E. bugandensis, A. scotti and O. lawrenceiwere abundant in flats, runs and stickles at all the sampling stations while Caenis sp. was collected only from the pool below the impoundments. *B. harrison* and *N. discolor* were rare in the Luphephe and the Nwanedzi above dam stations, whereas in the Nwanedzi River below the impoundments they were collected in large numbers. *N. discolor* was found to prefer stony bottoms covered with algae and slight currents with water of low turbidity. Harrison (1958) found that this species prefered muddy waters, while Schoonbee (1964) collected it from localities with clear waters.

The numbers of Hemiptera were very low. *Micronecta* sp., *Nepa apiculata* and *Plea pullula* were collected from stony bottom habitats in the Luphephe Stream. *Notonecta* was encountered only once from the Nwanedzi River below the impoundments. The Hemiptera prefer quiet waters where they can swim freely.

COLEOPTERA

Eubrianax sp. and *Aulonogyrus* sp. were numerically the most dominant members of this order. They were found together with the Elmidae and Hydrophilidae at all sampling localities. The Dytiscidae and the Helodidae were scarcely collected from the Luphephe Stream and the Nwanedzi River above the impoundment, while none of them was ever encountered below the dams. The Coleoptera generally prefered flats and runs with stony bottoms though *Eubrianax* sp. was from time to time collected from stickles.

DIPTERA

The Diptera were collected from all sampling stations. The Simuliidae were numerically dominant in all stickles, while the Chironomidae, Ceratopogonidae, Tendipedidae, Forcipomyidae, Tabanidae and Tipulidae were collected from flats and runs. *Chironomus* sp. was collected from the pool in the Nwanedzi River below the impoundments.

TRICHOPTERA

This group was represented mainly by Cheumatopsyche thomasseti at all sampling stations. They prefered stony bottoms with moderate to fast currents. The Trichoptera were collected in high numbers from the station below the impoundments when the water was muddy and with high nutrient contents.

The Mollusca, which dominated in biomass values were collected from habitats with stony and muddy bottoms. This group was represented at all sampling stations throughout this investigation.

Judging from the species composition and the numerical values, the Nwanedzi River above the impoundment has no signs of organic enrichment; whilst in the Luphephe Stream slight traces of eutrophication resulting from local inhabitants could be detected. The Nwanedzi River below the impoundments was characterised by community types such as Trichoptera and Turbellaria which are associated with organic enrichment (Schoonbee, 1963 and Batchelor, 1977).

Statistical analyses of data

Computer analyses were conducted in order to quantify the relationships between the biological-invertebrate communities and chemo-physical parameters that were recorded. The correlation matrix was used to detect relationships between all the different parameters, while the factor and cluster analyses were conducted to determine whether the different parameters acted in groups as well as identifying the different factors themselves.

These methods have similarly and successfully been used by Jooste (1977) as water samples from Seshego Dam - Pietersburg, Batchelor (1977) when investigating the effects of fish farming practices on water quality of some Transvaal rivers and Pretorius (1978) on water samples from the Vaal River Barrage.

During this study, the dominant invertebrate groups in the two rivers above the impoundments, in order of importance, were found to be the Simuliidae, Ephemeroptera and Chironomidae (Tables 4.1 - 4.7). This fauna is typical of unpolluted conditions with water of good quality (Batchelor, 1977).

The Trichoptera was the dominant group in the Nwanedzi River below the dams. This, together with an abundance of Turbellaria and Gastropoda, is characteristic of community types associated with organic enrichment (Allanson, 1961, Schoonbee, 1963 a, b and c and Batchelor, 1977).

The high faunal quantities collected from the Nwanedzi River downstream of the impoundments were to be expected as this secion of the river receives all its water from the Luphephe-Nwanedzi twin impoundments. Water released from a dam, especially from below the thermoclone is rich in nutrients (Hynes, 1970). This fact is substantiated by the biological and chemophysical data collected from the station below the impoundments (Tables 4.1 - 4.7). During the dry winter seasons, the sluices of either one or both dams are opened to feed the river below the impoundments. As this water has a high nutrient content (Jooste, pers. comm.), a higher rate of primary productivity followed by an increase in invertebrate numbers would be expected. Such a situation becomes evident on analysing the results of this survey (Tables 4.1 - 4.7). The two rivers above the impoundments yielded the highest number of organisms during Spring. This season was however characterised by minimum water flow as no rain fell during this period. A decrease in nutrient concentrations occured, indicating a higher rate of photosynthesis, resulting in an increased oxygen content of the water (Tables 4.2 - 4.5).

The river below the impoundments usually had higher current velocities as a result of water released from the two dams or by overflowing. The maximum flow recorded at this locality was 1,36 m/s whilst the maximum flow upstream of the impoundments was 1,08 m/s. In the correlation matrices current has positive correlations with rheophilic forms like the Odonata, Plecoptera, Tabanidae, Simuliidae and Trichoptera, whilst negative correlations with the Annelida, Coleoptera and Chironomidae were indicated (Tables 4.8 - 4.15). Current again appeared strongly in the Simuliidae and Trichoptera factors (Tables 4.16 - 4.23), which was verified by the cluster analyses (Figures 4.1 - 4-8).

It is a known fact that currents increase turbidity of the water which results in particles being in suspension which are resultingly ingested by filter feeders - hence the high correlation of current with forms like the Simuliidae.

The water temperature in the two rivers above the impoundments ranged between 16°C and 25,5°C, whilst in the river below the impoundments the recorded range was 13,5° to 20°C. The low temperatures recorded below the impoundments were as a result of water flowing into the stream by overflow as well as water from below the thermocline which fed the stream during the dry season.

Therefore, the dominant fauna below the impoundments should have positive correlations with low temperature values. In the correlation matrices, the low temperatures recorded during winter and early spring correlated positively with the Odonata, Plecoptera, Tabanidae and Trichoptera (Tables 4.9 - 4.12 and 4.24). The Ephemeroptera, Simuliidae and Chironomidae correlated positively with the high summer water temperatures (Tables 4.13 - 4.15 and 4.24). Temperature is further included in the Ephemeroptera, Simuliidae and Chironomidae factors and in the Cluster diagrams (Figures 4.1 - 4.8) temperature is found with these organisms in the same groups.

Light transmittance in the two rivers above the impoundments ranged between 40% and 62%, whilst the river below the dams had light transmittance values ranging from 30% to 52%. The river below the impoundments had high flow rates even during the dry winter months as a result of water released from the dams for irrigation purposes. This water had low turbidity values probably as a result of the high density of suspended particles below the thermocline. As turbidity is related to current strength and substrate, the low turbidity values are ascribed to the stirring up effect of the substrate by the strong water currents. Decomposition of vegetable matter can be another possible source of lower turbidity values at this locality. Turbidity limits the penetration of light and thereby the rate of photosynthesis.

As it was the case with temperature, the fauna of the streams above the dams was expected to correlate with high turbidity values more so than with the dominant fauna in the river below the impoundments. In the correlation matrices, Potamon, Ephemeroptera, Odonata, Plecoptera and Simuliidae were indeed found to have high positive correlations with turbidity (Tables 4.8 - 4.15 and 4.24), whilst the Turbellaria and Trichoptera indicated low correlations with this parameter. A negative correlation between turbidity and Annelida was found during all surveys. The factor and cluster analyses support these correlations

(Tables 4.16 - 4.23 and Figures 4.1 - 4.8).

Conductivity values remained remarkably constant both above and below the impoundments during the first three surveys, indicating no nett gain or loss of dissolved salts in the impoundments during these surveys (Tables 4.1 - 4.3). However, during the subsequent surveys, an increase in conductivity as well as differences in conductivity above and below the dams were recorded.

Conductivity did not decrease with temperature as was expected. The low flow rates experienced later in the year in the streams above the impoundments resulted in higher salt concentrations and this together with evaporation and an insufficient inflow of freshwater, probably resulted in higher conductivity values in the dams. Sulfate is ranked second to carbonate as the principal anion in freshwater (Clark, 1954). The increased sulfate concentrations below the dams, contributed somewhat to the higher conductivity values at that locality (Tables 4.4 - 4.7). Conductivity correlated positively with the Simuliidae and Tabanidae (Table 4.24).

The hydrogen ion concentration appeared to be related to conductivity and dissolved oxygen. pH values did not vary during the first three surveys, while a decrease from 7,5 to 6,5 was experienced in the subsequent surveys. The dissolved oxygen content remained the same both above and below the impoundments, though a slight difference between surveys was experienced. As the river below the impoundment receives all its water from the two dams which have lower dissolved oxygen contents (Jooste, pers. comm.), the oxygen content below the impoundments was expected to be lower than that of the stream above. However, as a result of the high solubility of oxygen, the velocity of the stream and the lower water temperatures in the river below the impoundments, oxygen saturation is quickly attained an hence the virtually equal oxygen values at the sampling localities within surveys.

The differences in dissolved oxygen concentrations between surveys, can possibly be ascribed to improved invertebrate numbers and metabolic rates (Tables 4.1 - 4.7). With the reduction of dissolved oxygen as a result of respiration, and presumably an increase in carbon dioxide a decline in the pH values would be expected. Oxygen had positive correlations with all the faunal groups (Table 4.24), indicating that oxygen is an important limiting factor in aquatic systems (Clark, 1954).

The B.O.D. values were constant at all sampling localities as well as between the different sampling periods (Tables 4.1 - 4.7). This was not according to expectations. The stream below the impoundments aught to have had higher B.O.D. values as a result of higher microbial and plankton densities at this locality (as will be seen later). Therefore, the accuracy of the method followed for B.O.D. determinations may be questioned. As it was the case with dissolved oxygen, the Y.S.I. model B.O.D. probe would probably have yielded more reliable results. The Winkler titration method appears to be sensitive to temperature fluctuations and possibly to other environmental factors such as atmospheric pressure and humidity. That the similarity in B.O.D. values may also be due to experimental error may not be excluded. The B.O.D. values recorded during this study are considered to be unreliable and will therefore not be included in the discussion.

The maximum ammonium concentration recorded in both the Luphephe Stream and the Nwanedzi River above the impoundment was 0,31 mg/l as compared to 0,9 mg/l recorded below the impoundments was full of dead foliage, higher concentrations of ammonia resulting from bacterial mineralization would be expected. Secondly, aquatic organisms excrete ammonia as a by-product of metabolism (Clark, 1954), and with a higher number of organisms below the impoundments, more ammonia would be excreted into the water system. The Luphephe-Nwanedzi twin impoundments serve as yet another source of NH_4-N, NO_3-N, NO_2-N, PO_4 and SO_4 (Jooste, pers. comm.).

On reviewing the results of the NO_2-N determinations, it is noted from Tables 4.1 - 4.7 that there is hardly any difference between the values recorded in the stream above and below the impoundments ($t = 0{,}4074$, $dF = 10$, $P<0{,}01$).

The NO_3-N above the impoundment ranged from 0,02 mg/l to 1,9 mg/l whereas below the dam the values ranged from 1,5 mg/l to 2,20 mg/l (Tables 4.1 - 4.7).

The difference in the NO_2-N and NO_3-N concentrations below the impoundments, was possibly due to high microbial activity at these localities. This then lends support to the original assumption that there seem to be increased microbial activity in the river below the impoundments.

Similar to NH_4-N, the high PO_4 and SO_4 concentrations observed below the impoundments, could also be attributed to the higher bacterial decomposion rate of foliage in this section of the stream.

From Tables 4.8 - 4.15 it is apparent that there are positive correlations between NH_4-N, NO_3-N, NO_2-N, PO_4 and SO_4. A further correlation is indicated between these nutrients and the Trichoptera and Turbellaria. As it was pointed out earlier, these nutrients were measured in higher concentrations below the impoundments possibly as a result of higher microbial and algal activity which inturn resulted in a higher nitrification rate. Higher nitrification rates speed up primary productivity, which inturn promotes secondary productivity (Vollenweider, 1969) - hence the strong correlation between Trichoptera and Turbellaria with NH_4-N, NO_3-N and PO_4.

These correlations further supported the assumption that Trichoptera and Turbellaria are forms associated with organic enrichment. The grouping in the factor analyses (Tables 4.16 - 4.23) and the Cluster diagrams (Figures 4.1 - 4.8) substantiate these correlations and Table 4.24 verifies the relationships.

Detritus supports higher bacterial populations which are used as food by benthic organisms (Cole, 1979). A measurement of nitrogen will therefore give a more reliable index of available food for benthic communities. Nitrogen values would therefore probably be used as indices of primary production potentials. From that, it appears probably that nitrogen values could be used as indices of production potentials for benthic communities. This probability is further supported by the positive correlations between the NH_4-N, NO_3-N, invertebrate numbers per unit area and biomass values (Tables 4.8 - 4.15).

These analyses show that there is a distinct relationship between invertebrate faunal densities and diversities and water quality.

From the above discussion, it is evident that a detailed investication of the bacteriological component of the river would have been of immense importance. During the discussion, one could not correlate with certainty the various nutrients monitored with the collected benthic fauna without refering to microbial populations known to occur in aquatic ecosystems.

Bacteriological investigations of the Nwanedzi River system could not be included in the present survey mainly due to lack of suitable equipment.

It is therefore recommended that in future, all similar and/or related surveys should include bacteriological analyses.

TABLE 4.24

Summary of the correlation matrices showing the highest correlation values and the season of highest correlation between abiotic parameters, as well as the ranges of abiotic factors within a season and the ranges of the entire study period.

Table 4.24

	RANGE	TURBELLARIA	ANNELIDA	POTAMON	EPHEMEROPTERA	ODONATA	PLECOPTERA	COLEOPTERA
CURRENT m/s	0,23-1,36	50 0,23-0,98 WINTER	10 0,23-0,98 WINTER	47 1,06-0,23 AUTUMN	46 0,23-0,98 SPRING	[illegible]4 0,34-1,36 AUTUMN	75 0,23-0,98 WINTER	49 0,23-0,98 WINTER
TEMPERATURE °C	13,5-25	21 20-25 SUMMER	52 22-25 AUTUMN	44 13,5-20 WINTER	69 20-25 SUMMER	59 16-20 WINTER	25 18-24,5 SPRING	38 22-25 AUTUMN
TURBIDITY %	30-62	6 42-44 SPRING	NEG CORRELATION	66 36-62 AUTUMN	66 30-46 SUMMER	55 37-52 WINTER	56 30-44 AUTUMN	46 30-44 AUTUMN
CONDUCTIVITY /cm	56-120	30 56-90 AUTUMN	14 56-90 AUTUMN	8 56-90 AUTUMN	13 62-66 WINTER	24 62-66 WINTER	26 64-120 SPRING	34 62-66 WINTER
pH	6,1-8,1	62 6,6-7,8 WINTER	45 6,3-7,4 AUTUMN	50 6,6-7,8 WINTER	65 6,1-7,1 SUMMER	74 7,1-8,1 SPRING	15 6,8-8,1 WINTER	25 6,8-8,1 WINTER
OXYGEN mg/1	7,2-12,8	27 7,2-9 SUMMER	2 7,8-8,3 AUTUMN	78 7,2-9 SUMMER	73 7,2-9 SUMMER	55 7,2-9 SUMMER	54 7,5-8,4 SPRING	27 8,8-12,8 AUTUMN
PO_4 mg/1	0,1-1,4	51 0,15-0,4 WINTER	51 0,1-0,5 WINTER	45 0,14-0,5 AUTUMN	43 0,15-0,4 WINTER	56 0,15-0,4 WINTER	27 0,14-0,8 SPRING	51 0,16-0,38 SUMMER
SO_4 mg/1	2-16	38 3-8 WINTER	40 3-8 WINTER	63 3-7 WINTER	30 2-4 AUTUMN	23 2-4 AUTUMN	40 2-4 AUTUMN	53 2-4 AUTUMN
NH_4-N mg/1	0,04-0,8	58 0,04-0,8 AUTUMN	40 0,18-0,5 AUTUMN	22 0,05-0,8 WINTER	23 0,32-0,42 WINTER	12 0,04-0,8 AUTUMN	22 0,21-0,4 SPRING	65 0,20-0,38 SPRING
NO_3-N mg/1	0,8-2,1	28 0,9-1,8 SPRING	74 0,9-1,8 SPRING	23 1,1-2,1 AUTUMN	40 1,2-1,9 WINTER	58 1,2-1,9 WINTER	48 1,2-1,9 WINTER	31 0,8-1,2 SPRING
NO_2-N mg/1	0,002-0,17	21 0,004-0,025 AUTUMN	54 0,004-0,015 WINTER	63 0,007-0,012 WINTER	0 0,1-0,17 AUTUMN	16 0,004-0,015 WINTER	39 0,007-0,012 WINTER	72 0,004-0,022 SPRING

	RANGE	TABANIDAE	SIMULIIDAE	CHIRONOMIDAE	TIPULIDAE	TRICHOPTERA	GASTROPODA
CURRENT m/s	0,23-1,36	67 0,2-0,97 SPRING	70 0,23-0,98 SPRING	27 1,06-0,23 AUTUMN	48 0,23-0,98 SPRING	55 0,32-1,12 WINTER	70 1,06-0,23 AUTUMN
TEMPERATURE °C	13,5-25	71 13,5-20 WINTER	56 13,5-20 WINTER	65 17,2-23,5 AUTUMN	19 13,5-20 WINTER	73 16-19 SPRING	44 16-19 SPRING
TURBIDITY %	30-62	56 38-44 WINTER	32 38-44 WINTER	39 30-44 AUTUMN	48 40-48 SPRING	32 30-46 SUMMER	40 30-46 SUMMER
CONDUCTIVITY /cm	56-120	43 62-66 WINTER	63 62-66 WINTER	19 58-71 AUTUMN	48 40-48 SPRING	27 64-120 SPRING	29 62.66 WINTER
pH	6,1-8,1	68 68,8-8,1 WINTER	22 6,1-7,1 SUMMER	47 6,3-7,4 AUTUMN	39 6,6-7,8 WINTER	53 6,1-6,7 AUTUMN	37 6,1-7,1 SUMMER
OXYGEN mg/1	7,2-12,8	72 7,5-8,4 SPRING	49 7,2-9 SUMMER	34 8,8-12,8 AUTUMN	38 7,8-8,3 AUTUMN	31 8,9-11,2 WINTER	63 7,2-9 SUMMER
PO_4 mg/1	0,1-1,4	54 0,15-0,4 WINTER	27 0,1-0,5 WINTER	30 0,15-0,4 WINTER	55 0,16-0,38 SUMMER	72 0,1-0,5 WINTER	41 0,62-1,4 SPRING
SO_4 mg/1	2-16	9 4-12 AUTUMN	22 3-9 SPRING	28 3-16 SPRING	41 3-8 WINTER	61 3-8 WINTER	32 3-9 SPRING
NH_4-N mg/1	0,04-0,8	25 0,04,0,8 AUTUMN	20 0,05,0,8 WINTER	37 0,20-0,38 SPRING	43 0,05-0,8 WINTER	70 0,04-0,8 AUTUMN	45 0,04-0,8 AUTUMN
NO_3-N mg/1	0,8-2,1	16 1,1-2,1 AUTUMN	26 1,1-2,1 AUTUMN	34 0,9-1,8 SPRING	44 1-1,9 WINTER	65 1,2-1,5 SUMMER	46 1-1,9 WINTER
NO_2-N mg/1	0,002-0,17	53 0,007-0,012 WINTER	26 0,002-0,031 SPRING	41 0,002-0,031 SPRING	30 0,004-0,022 SPRING	54 0,004-0,022 SPRING	57 0,004-0,015 WINTER

Table 4.24 (cont.)

TABULATED RESULTS OF SECOND YEAR SURVEY

Table 4.25

Total numbers of drifting live animals collected over a 24 hour period in the Nwanedzi River (above dam) during April 1979

SAMPLING TIME	06h00	07h00	08h00	09h00	10h00	11h00	12h00	13h00	14h00	15h00	16h00
Ephemeroptera	36	35	24	33	25	40	39	43	44	50	53
Plecoptera	3	1	3	6	4	2	5	3	6	4	7
Coleoptera	14	11	9	11	17	21	23	21	28	26	21
Simuliidae	8	13	17	20	18	22	25	30	27	36	32
Chironomidae	180	180	196	191	177	185	190	188	202	198	186
Trichoptera	10	6	8	10	5	16	13	14	11	11	7
Other Benthic	6	4	2	1	3	2	7	5	1	3	7
Total	257	250	259	272	249	288	302	304	319	328	313
Total drifting past the sampling point per hour	4 318	4 200	4 351	4 570	4 183	4 838	5 074	5 107	5 359	5 510	5 258

Table 4.25(cont.)

17h00	18h00	19h00	20h00	21h00	22h00	23h00	24h00	1h00	2h00	3h00	4h00	5h00
51	49	57	62	61	63	59	51	56	41	46	30	30
5	8	8	10	7	12	10	7	9	6	5	3	5
29	27	30	32	36	37	34	34	29	23	10	7	11
40	39	39	43	38	48	37	39	31	34	18	13	6
184	200	176	189	200	196	199	189	178	146	192	207	196
8	5	3	-	2	4	4	1	3	2	2	1	1
6	2	5	4	8	10	2	5	6	7	3	3	4
323	330	318	340	352	365	345	325	312	259	276	264	253
5 426	5 544	5 342	5 712	5 914	6 132	5 796	5 477	5 242	4 351	4 637	4 435	4 250

Flow passing sampling point in m^3/h = 1 625,4

Total drifting past the sampling point in 24 hours = 121 036

Density of drifting live organisms per m^3 = 3,10

able 4.26

otal numbers of drifting live animals collected over a 24 hour period in the Luphephe River during April 1979

Sampling Time	06h00	07h00	08h00	09h00	10h00	11h00	12h00	13h00	14h00	15h00	16h00
Ephemeroptera	37	28	33	36	34	34	31	30	33	31	37
Plecoptera	1	1	2	-	-	3	-	1	-	3	-
Coleoptera	3	4	6	5	7	5	3	6	4	9	5
Simuliidae	5	4	6	5	2	5	6	6	3	7	6
Chironomidae	173	164	167	180	160	172	179	166	170	189	180
Trichoptera	-	1	3	-	-	6	-	1	3	1	4
Other Benthic	3	1	4	-	3	-	-	2	1	3	5
Total	222	203	221	226	206	225	219	212	214	213	237
Total drifting ast the sampling oint per hour	2 131	1 949	2 122	2 170	1 978	2 160	2 102	2 035	2 054	2 045	2 275

able 4.26 (cont.)

17h00	18h00	19h00	20h00	21h00	22h00	23h00	24h00	01h00	02h00	03h00	04h00	05h00
41	44	39	41	46	40	43	39	39	41	40	38	34
-	-	2	5	4	2	6	-	4	1	-	2	2
4	1	3	4	9	7	6	8	5	6	4	5	2
8	8	7	10	9	11	6	7	5	3	4	6	3
181	176	168	173	180	183	179	160	166	158	170	181	165
-	-	-	5	-	1	-	-	4	-	3	-	-
-	4	6	5	2	4	3	6	5	-	-	4	4
234	233	225	243	250	248	243	240	228	209	221	236	210
2 246	2 237	2 160	2 333	2 400	2 381	2 333	2 304	2 189	2 006	2 122	2 266	2 016

low passing sampling point in m^3/h =777,6

otal drifting past the sampling point in 24 hours = 52 014

ensity of drifting live organisms per m^3 = 2,79

able 4.27

otal numbers of drifting live animals collected over a 24 hour period in the Nwanedzi River (below dam) during April 1979

Sampling Time	06h00	07h00	08h00	09h00	10h00	11h00	12h00	13h00	14h00	15h00	16h00
Ephemeroptera	26	21	32	29	25	17	22	20	16	19	22
Plecoptera	5	3	1	4	6	2	5	5	4	5	3
Coleoptera	4	6	3	5	2	1	5	3	3	1	4
Simuliidae	11	18	12	10	15	11	9	13	10	11	15
Chironomidae	377	350	333	340	352	326	374	382	396	382	365
Trichoptera	47	58	44	60	63	48	55	67	38	51	43
Other Benthic	4	6	3	7	2	4	8	6	3	5	4
Total	480	462	428	455	465	409	478	496	470	474	456
Total drifting past the sampling point per hour	12 595	12 123	11 231	11 939	12 202	10 732	12 543	13 015	12 333	12 438	11 965

ble 4.27 (cont.)

17h00	18h00	19h00	20h00	21h00	22h00	23h00	24h00	01h00	02h00	03h00	04h00	05h00
26	36	42	47	40	51	58	37	43	49	33	29	31
1	2	6	8	7	9	6	11	9	7	8	5	6
6	8	8	11	9	12	8	10	9	5	8	5	7
18	14	19	26	22	28	31	26	22	19	12	21	16
388	405	365	352	402	390	408	400	391	378	340	367	383
39	28	31	25	18	17	21	19	30	22	12	22	19
7	6	9	8	13	11	7	9	12	10	7	5	8
485	499	480	477	511	517	539	512	516	490	420	454	470
12 726	13 094	12 595	12 516	13 409	13 566	14 143	13 435	13 540	12 858	11 021	11 913	12 333

ow passing sampling point in m^3/h = 5 018,4

otal drifting past the sampling point in 24 hours = 300 265

ensity of drifting live organisms per m^3 = 2,49

able 4.28

otal numbers of drifting live animals collected over a 24 hour period in the Nwanedzi River (above dam) during July 1979

Sampling Time	06h00	07h00	08h00	09h00	10h00	11h00	12h00	13h00	14h00	15h00	16h00
Ephemeroptera	16	14	14	20	29	28	33	40	44	47	51
Plecoptera	6	3	2	6	7	7	5	6	4	7	5
Coleoptera	12	8	10	15	19	21	26	25	26	24	26
Simuliidae	9	16	11	10	15	18	22	24	29	31	28
Chironomidae	140	136	147	163	181	172	165	184	180	169	187
Trichoptera	4	3	1	7	7	8	5	10	9	11	7
Other Benthic	8	4	7	5	3	4	1	2	6	11	3
Total	195	184	192	226	261	258	257	291	298	300	307
Total drifting past the sampling point per hour	2 730	2 576	2 688	3 164	3 654	3 612	3 598	4 074	4 172	4 200	4 298

ble 4.28 (cont.)

17h00	18h00	19h00	20h00	21h00	22h00	23h00	24h00	01h00	02h00	03h00	04h00	05h00
48	50	49	55	57	47	47	51	35	26	20	18	8
8	7	10	8	14	4	2	6	7	3	3	5	2
27	29	30	30	34	29	31	26	26	21	6	10	6
33	36	31	39	44	40	37	39	30	23	9	6	5
157	188	189	183	178	170	182	186	148	150	146	130	130
5	3	4	6	4	-	-	2	1	3	1	4	2
7	8	5	1	9	2	6	3	4	-	3	5	7
285	321	318	322	337	292	305	313	245	226	188	178	160
3 990	4 494	4 452	4 508	4 718	4 088	4 270	4 382	3 430	3 164	2 632	2 492	2 240

ow passing sampling point in m^3/h = 1 260

tal drifting past the sampling point in 24 hours = 87 626

nsity of drifting live organisms per m^3 = 2,89

able 4.29

otal numbers of drifting live animals collected over a 24 hour period in the Luphephe River during July 1979

Sampling Time	06h00	07h00	08h00	09h00	10h00	11h00	12h00	13h00	14h00	15h00	16h00
Ephemeroptera	11	9	4	6	4	9	15	12	17	8	12
Plecoptera	3	-	1	2	1	1	2	4	-	-	3
Coleoptera	3	3	1	4	1	2	1	3	4	2	1
Simuliidae	4	6	-	-	3	4	-	5	7	3	6
Chironomidae	120	94	123	116	139	88	132	126	101	99	123
Trichoptera	3	4	1	2	2	4	5	3	1	1	2
Other Benthic	1	3	1	1	4	-	1	2	5	4	2
Total	145	119	111	131	144	108	146	145	135	117	149
Total drifting past the sampling point per hour	870	714	666	786	864	648	876	870	810	702	894

able 4.29 (cont.)

17h00	18h00	19h00	20h00	21h00	22h00	23h00	24h00	01h00	02h00	03h00	04h00	05h00
6	19	22	25	18	21	26	24	19	22	23	17	18
1	2	1	4	5	3	2	4	3	2	1	2	1
3	5	2	3	6	4	5	3	4	-	2	1	2
11	8	5	14	8	6	2	9	3	5	4	1	3
106	126	131	103	126	136	102	135	108	100	104	96	101
4	3	-	1	-	-	2	-	-	-	2	1	4
3	1	6	3	5	2	7	3	5	3	4	2	3
134	164	167	183	163	172	166	178	139	132	140	120	142
804	984	1 002	1 098	978	1 032	996	1 068	834	792	840	720	852

ow passing sampling point in m^3/h = 256,5

otal drifting past the sampling point in 24 hours = 20 700

nsity of drifting live organisms per m^3 = 3,36

able 4.30

otal numbers of drifting live animals collected over a 24 hour period in the Nwanedzi River (below dam) during July 1979

Sampling Time	06h00	07h00	08h00	09h00	10h00	11h00	12h00	13h00	14h00	15h00	16h00
Ephemeroptera	39	29	33	26	18	20	14	19	23	22	29
Plecoptera	5	4	6	3	1	2	4	4	3	5	6
Coleoptera	3	3	1	4	2	1	3	5	4	3	1
Simuliidae	11	7	5	6	6	5	4	7	5	9	8
Chironomidae	278	269	271	266	279	276	269	277	269	284	297
Trichoptera	30	29	33	39	38	45	48	40	43	39	31
Other Benthic	4	2	4	3	1	3	1	2	2	4	6
Total	370	334	353	347	336	352	343	348	349	366	358
Total drifting past the sampling point per hour	9 472	8 550	9 037	8 883	8 602	9 011	8 781	8 909	8 934	9 370	9 165

able 4.30 (cont.)

17h00	18h00	19h00	20h00	21h00	22h00	23h00	24h00	01h00	02h00	03h00	04h00	05h00
32	37	35	34	38	41	40	41	39	40	40	38	35
4	6	8	7	10	9	10	6	9	5	7	8	5
5	8	7	10	9	11	7	9	8	5	6	7	4
10	12	16	14	17	12	14	13	11	16	14	10	9
281	276	288	283	280	240	276	289	271	269	266	272	262
26	29	23	20	19	20	17	18	15	20	21	23	26
8	9	7	10	11	9	5	7	7	4	6	3	5
366	377	384	378	384	392	369	383	360	359	360	340	346
9 370	9 651	9 830	9 677	9 830	10 035	9 446	9 805	9 216	9 190	9 216	8 704	8 858

ow passing sampling point in m^3/h = 3 744

tal drifting past the sampling point in 24 hours = 220 542

nsity of drifting live organisms per m^3 = 2,45

able 4.31

otal numbers of drifting live animals collected over a 24 hour period in the Nwanedzi River (above dam) during October 1979

Sampling Time	06h00	07h00	08h00	09h00	10h00	11h00	12h00	13h00	14h00	15h00	16h00
Ephemeroptera	30	28	20	28	21	33	32	36	37	42	44
Plecoptera	3	2	4	5	3	1	4	3	5	3	6
Coleoptera	11	10	4	8	9	6	12	10	14	20	18
Simuliidae	8	14	9	9	14	16	20	22	26	28	25
Chironomidae	144	160	148	151	162	149	156	157	144	153	161
Trichoptera	4	7	6	8	4	8	10	9	11	7	6
Other Benthic	5	4	1	3	2	1	7	3	4	6	9
Total	205	225	192	212	215	214	241	240	241	259	169
Total drifting past the sampling point per hour	2 460	2 700	2 304	2 544	2 580	2 568	2 892	2 880	2 892	3 108	3 228

able 4.31 (cont.)

17h00	18h00	19h00	20h00	21h00	22h00	23h00	24h00	01h00	02h00	03h00	04h00	05h00
42	41	48	52	51	53	49	43	47	34	38	25	28
4	9	7	8	6	10	8	6	8	5	4	4	4
24	22	25	27	30	31	29	28	24	19	8	6	10
30	32	28	35	40	36	33	35	27	21	8	5	7
157	149	150	158	160	163	160	155	153	147	152	160	153
5	3	3	5	2	1	3	1	4	6	3	3	5
5	7	1	8	10	4	7	11	5	6	4	3	8
267	263	262	263	299	298	289	279	268	238	217	206	215
3 204	3 156	3 144	3 156	3 588	3 576	3 468	3 348	3 216	2 856	2 604	2 472	2 580

low passing sampling point in m^3/h = 1 134

otal drifting past the sampling point in 24 hours = 70 525

ensity of drifting live organisms per m^3 = 2,59

able 4.32

otal numbers of drifting live animals collected over a 24 hour period in the Luphephe River during 1979

Sampling Time	06h00	07h00	08h00	09h00	10h00	11h00	12h00	13h00	14h00	15h00	16h00
Ephemeroptera	24	34	30	24	20	22	27	21	20	26	30
Plecoptera	-	2	2	1	3	-	1	-	3	-	3
Coleoptera	4	3	-	4	3	2	1	1	2	4	-
Simuliidae	9	6	4	4	8	5	4	5	3	4	6
Chironomidae	164	169	155	169	173	170	149	157	166	174	180
Trichoptera	1	2	1	1	3	2	2	4	1	-	1
Other Benthic	3	4	2	-	6	3	1	2	1	5	5
Total	205	220	194	194	216	204	185	190	196	213	225
Total drifting past the sampling point per hour	984	1 056	931	931	1 037	979	888	912	941	1 022	1 080

ble 4.32 (cont.)

17h00	18h00	19h00	20h00	21h00	22h00	23h00	24h00	01h00	02h00	03h00	04h00	05h00
29	35	40	42	37	44	40	41	36	33	37	31	28
2	4	3	5	5	3	4	5	2	4	3	2	1
5	4	4	3	5	5	6	7	4	8	3	4	2
9	8	6	10	9	10	12	8	11	7	6	8	3
171	179	169	141	173	169	179	180	171	166	168	159	161
2	-	-	-	1	3	-	-	2	1	2	-	1
1	7	6	4	6	5	2	6	3	4	3	1	-
219	233	228	235	236	239	243	247	229	223	222	205	196
1 051	1 118	1 094	1 128	1 133	1 147	1 166	1 186	1 099	1 070	1 066	984	941

ow passing sampling point in m^3/h = 378

tal drifting past the sampling point in 24 hours = 24 966

nsity of drifting live organisms in m^3 = 2,75

able 4.33

otal numbers of drifting live animals collected over a 24 hour period in the Nwanedzi River (below dam) during October 1979

Sampling Time	06h00	07h00	08h00	09h00	10h00	11h00	12h00	13h00	14h00	15h00	16h00
Ephemeroptera	31	28	30	23	20	24	25	18	23	20	21
Plecoptera	7	2	5	6	5	3	4	3	2	3	5
Coleoptera	5	6	3	4	2	1	1	3	6	5	7
Simuliidae	15	11	13	12	10	13	15	14	14	13	17
Chironomidae	361	344	354	369	351	359	366	371	358	360	371
Trichoptera	40	37	39	44	40	48	53	50	55	51	49
Other Benthic	7	3	5	2	6	3	7	4	5	3	6
Total	466	431	398	460	434	451	471	463	463	455	476
Total drifting past the sampling point per hour	8 947	8 275	7 642	8 832	8 333	8 659	9 043	8 890	8 890	8 736	9 139

able 4.33 (cont.)

17h00	18h00	19h00	20h00	21h00	22h00	23h00	24h00	01h00	02h00	03h00	04h00	05h00
26	36	42	36	47	40	49	51	48	49	38	29	30
7	6	10	7	9	6	8	11	7	5	8	5	7
6	8	9	7	10	8	6	7	8	8	5	7	7
16	14	17	20	19	21	18	19	14	20	17	21	16
366	365	371	374	369	361	376	361	352	365	370	341	333
49	36	39	29	30	25	20	18	14	20	19	22	22
9	5	8	9	7	11	9	5	7	8	6	4	5
479	470	496	482	491	472	486	472	450	426	463	429	420
9 197	9 024	9 523	9 254	9 427	9 062	9 331	9 062	8 640	8 179	8 890	8 237	8 064

ow passing sampling point in m^3/h = 3 499,2

otal drifting past the sampling point in 24 hours = 211 276

ensity of drifting organisms per m^3 = 2,52

able 4.34

otal numbers of drifting live animals collected over a 24 hour period in the Nwanedzi River (above dam) during January 1980

Sampling Time	06h00	07h00	08h00	09h00	10h00	11h00	12h00	13h00	14h00	15h00	16h00
phemeroptera	11	10	17	9	20	27	25	35	28	40	40
lecoptera	2	1	3	4	1	6	5	3	1	2	8
oleoptera	10	9	4	7	8	5	11	9	13	11	16
imuliidae	6	10	13	15	13	17	19	23	21	28	25
hironomidae	98	104	100	96	78	86	100	120	70	119	54
richoptera	5	4	1	5	6	9	11	11	9	10	7
ther Benthic	3	1	6	-	7	2	6	7	3	1	-
otal	135	139	144	136	133	152	177	208	145	211	158
otal drifting ast the sampling oint per hour	1 620	1 668	1 728	1 632	1 596	1 824	2 124	2 496	1 740	2 532	1 896

able 4.34 (cont.)

17h00	18h00	19h00	20h00	21h00	22h00	23h00	24h00	01h00	02h00	03h00	04h00	05h00
38	41	39	50	51	47	49	33	21	30	16	17	7
6	5	10	8	6	12	7	5	5	3	1	3	2
20	21	24	23	26	20	19	20	10	13	7	8	5
31	29	30	33	28	26	27	25	24	26	14	10	4
136	130	140	143	130	101	117	130	128	116	101	112	108
3	1	-	2	1	3	-	-	1	1	-	2	1
-	8	4	5	1	4	5	1	3	3	7	4	6
234	235	247	264	243	213	224	214	192	192	146	156	133
2 808	2 820	2 964	3 168	2 916	2 556	2 688	2 568	2 304	2 304	1 752	1 872	1 596

.ow passing sampling point in m^3/h = 891

otal drifting past the sampling point in 24 hours = 52 872

ensity of drifting live organisms per m^3 = 2,47

Table 4.35

Total numbers of drifting live animals collected over a 24 hour period in the Luphephe River during January 1980

Sampling Time	06h00	07h00	08h00	09h00	10h00	11h00	12h00	13h00	14h00	15h00	16h00
Ephemeroptera	17	23	15	15	21	25	20	17	23	19	17
Plecoptera	2	1	2	-	3	1	3	2	4	-	2
Coleoptera	4	2	1	3	5	2	6	3	4	2	5
Simuliidae	4	3	-	2	1	-	3	3	4	2	5
Chironomidae	146	141	156	150	135	128	141	152	143	154	150
Trichoptera	3	1	4	2	-	-	1	3	-	5	4
Other Benthic	5	3	1	-	4	4	3	5	2	1	5
Total	181	174	179	172	169	160	177	185	180	183	188
Total drifting past the sampling point per hour	2 172	2 088	2 148	2 064	2 028	1 920	2 124	2 220	2 160	2 196	2 256

ble 4.35(cont.)

17h00	18h00	19h00	20h00	21h00	22h00	23h00	24h00	01h00	02h00	03h00	04h00	05h00
21	27	22	26	18	30	25	30	24	20	28	24	21
4	3	5	6	3	6	4	5	4	3	2	3	4
7	6	4	8	6	5	8	4	5	5	3	1	2
4	6	5	6	1	5	7	3	2	6	1	3	2
126	137	148	150	141	148	151	143	150	151	147	144	138
2	6	-	-	-	1	1	2	-	2	3	1	1
7	3	4	8	1	6	4	5	2	3	1	-	2
171	188	188	204	170	201	200	192	187	190	185	176	170
2 052	2 256	2 256	2 248	2 040	2 412	2 400	2 304	2 244	2 280	2 220	2 112	2 040

ow passing sampling point in m^3/h = 783

tal drifting past the sampling point in 24 hours = 52 440

nsity of drifting live organisms per m^3 = 2,79

Table 4.36

Total numbers of drifting live animals collected over a 24 hour period in the Nwanedzi River (below dam) during January 1980

	06h00	07h00	08h00	09h00	10h00	11h00	12h00	13h00	14h00	15h00	16h00
Ephemeroptera	11	20	9	15	20	11	7	5	12	11	8
Plecoptera	3	6	4	2	3	1	-	2	1	-	4
Coleoptera	2	6	3	4	2	1	1	3	5	2	4
Simuliidae	10	7	9	7	6	4	2	8	7	5	9
Chironomidae	157	161	160	144	153	140	148	138	146	157	153
Trichoptera	10	14	11	21	19	30	41	29	38	33	26
Other Benthic	6	9	4	2	1	5	2	5	4	6	3
Total	199	223	200	195	204	192	201	190	213	214	207
Total drifting past the sampling point per hour	3 821	4 282	3 840	3 744	3 917	3 684	3 859	3 648	4 090	4 109	3 974

'able 4.36 (cont.)

17h00	18h00	19h00	20h00	21h00	22h00	23h00	24h00	01h00	02h00	03h00	04h00	05h00
13	19	23	36	39	41	33	39	36	29	17	27	21
3	5	4	7	5	6	7	5	11	7	9	5	3
4	7	9	6	11	8	10	9	5	6	3	5	3
11	14	10	18	16	20	21	17	22	18	19	15	12
51	161	152	148	141	162	158	154	148	165	160	133	143
14	17	10	13	8	7	11	12	6	4	8	7	11
6	8	6	8	10	7	11	4	8	3	7	5	4
202	231	214	236	230	249	251	240	236	232	223	197	197
3 878	4 435	4 109	4 531	4 416	4 781	4 819	4 608	4 531	4 454	4 282	3 782	3 782

low passing sampling point in m^3/h = 1 641,6

otal drifting past the sampling point in 24 hours = 99 377

ensity of drifting live organisms per m^3 = 252

Table 4.37

Comparison between seasonal diurnal and nocturnal invertebrate drift in the Nwanedzi River System over a 24 hour period

	Nwanedzi (Above dam) April 1979		Luphephe April 1979		Nwanedzi (Below dam) April 1979		Nwanedzi (Above dam) July 1979		Luphephe July 1979	
0600-1800 Day 1800-0600 Night	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Ephemeroptera	486	592	412	477	285	486	418	429	121	246
Plecoptera	54	85	10	29	41	87	67	72	17	31
Coleoptera	244	297	59	62	47	97	256	261	30	35
Simuliidae	319	354	66	76	156	253	273	312	53	66
Chironomidae	2 277	2 248	2 084	2 056	4 393	4 553	2 029	1 932	1 373	1 362
Trichoptera	114	33	19	13	594	283	76	27	32	13

able 4.37 (Cont.)

Nwanedzi (Below dam) July 1979		Nwanedzi (Above dam) October 1979		Luphephe October 1979		Nwanedzi (Below dam) October 1979		Nwanedzi (Above dam) January 1980		Luphephe January 1980		Nwanedzi (Below dam) January 1980	
DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
302	460	392	498	318	373	294	490	330	371	243	285	150	352
48	89	49	73	21	37	51	90	45	64	25	45	31	72
41	86	157	248	29	55	52	81	134	185	46	51	42	77
84	157	253	283	66	99	162	217	244	253	33	41	90	198
3 314	3 274	1 847	1 855	2 022	2 000	4 334	4 334	1 193	1 424	1 713	1 757	1 812	1 821
470	252	84	40	19	10	551	298	77	16	28	11	293	107

Table 4.38

Summary of mean seasonal drift rates per hour, drift densities per m^3 and benthic densities per m^2

Season		Nwanedzi above impoundment	Luphephe	Nwanedzi below impoundment
Autumn	Drift Rate per hour	5 043	2 168	12 511
(April)	Drift Density per m^3	3,10	2,79	2,49
	Benthic Density per m^2	288	156	368
Winter	Drift Rate per hour	3 651	863	9 190
(July)	Drift Density per m^3	2,89	3,36	2,45
	Benthic Density per m^2	376	92	756
Spring	Drift Rate per hour	2 980	1 041	8 803
(October)	Drift Density per m^3	2,59	2,75	2,52
	Benthic Density per m^2	368	84	340
Summer	Drift Rate per hour	2 203	2 185	4 141
(January)	Drift Density per m^3	2,47	2,79	2,52
	Benthic Density per m^2	368	68	312

4.2 DRIFT

INTRODUCTION

The second part of the present study included a survey of the hourly fluctuations of some relevant chemical and physical parameters of the stream, as well as an attempt to establish the downstream invertebrate drift on a qualitative and quantitative basis. In order to gain a better understanding of the general limnological features of the river an attempt was also made to establish possible correlations between chemo-physical parameters and invertebrate drift occurences.

Townsend and Hildrew (1976) undertook an experimental field study of colonization and redistribution of stream benthos and came to the conclusion that under normal circumstances, invertebrate drift influences community dynamics of benthic communities in negative as well as positive ways. The two major factors involved are the continuous loss reducing benthic densities as well as the continuous recolonization of drift from upstream areas. In a natural riverine ecosystem, these two factors would normally be in equilibrium. However, it follows logically that under abnormal circunstances such as heavy floods there would be a sudden large scale loss of benthic organisms which could result in a period of denudation. In the post-flood period a gradual recolonization would take place.

In the Nwanedzi drift station above the impoundment this phenomenon was clearly observed. During January 1981, a heavy flood occured which even changed the course of the stream at some places. Two weeks after the flood a series of bottom samples were collected with the aid of a Surber Sampler and these yielded no benthic organisms at all. During the 1981 seasons this section of the river will be sampled at regular intervals in order to obtain information concerning the rate of benthic recolonization.

Amongst the earliest studies on invertebrate drift were those of Needham (1928). These were primarily concerned with the drift of terrestrial insects as a source of fish food. In capturing these organisms with a net stretched across a small stream, drifting aquatic forms were simultaneously collected. Several subsequent investigations were conducted, leading to the conclusion that a continuous drift of invertebrates must be considered a natural feature of streams (Waters, 1972). In trying to account for the continuous removal of immature forms without depopulation of upper reaches, Müller (1954) brought forward the so called Colonization cycle concept which assumes that adults constantly migrate upstream to oviposit in the headwaters. Invertebrate drift has also been studied with particular reference to its circadian rhythm, defined by waters (1962), as a recurrent temporal pattern within a period of 24 hours. Non-catastrophic drift, which could also be defined as drift under normal conditions, exhibits a diel periodicity. This phenomenon was first documented by Tanaka (1960).

The drift features of the Nwanedzi River system are in many respects similar to those reported for other streams. The fauna is generally nocturnal, a phenomenon reported by almost all workers who have studied the fauna of temperate streams, e.g. Tanaka (1960) in Japan, Waters (1962) in U.S.A., Elliott (1967 and 1970) in England and Bishop and Hynes (1969) in Canada.

Drift tendencies in the Nwanedzi River system

For all four seasonal drift surveys undertaken at the three selected stations in the Nwanedzi system, drifting invertebrates were numerically lower during daylight hours (Tables 4.25 - 4.36). The numbers in the drift appeared to be related to fluctuations in light intensity, with fluctuations in water temperature (Fig. 4.9 - 4.20) as another possibility.

The relationship between drift and light intensity as well as between drift and temperature has already been reported on by Waters (1962) and Elliott (1965). Elliott (1967) ascribed the nocturnal active trait to foraging behaviour. Presumably this foraging behavioural pattern has evolved from the selective value of maximum protection against daylight predators.

In the Luphephe Stream and the Nwanedzi River the Ephemeroptera, Plecoptera, Coleoptera and Simuliidae exhibited a periodicity in which they were night active, with higher drift occuring in darkness (Table 4.37). Usually there appeared an increase at about the time of full darkness, building up to a peak and a return to daytime levels at dawn. The Trichoptera, however, proved to be day-active, showing higher rates of drifting during daylight hours (Table 4.37). These findings are in accordance with the findings of Anderson (1967), Waters (1968) and Bishop and Hynes (1969).

The Chironomid larvae, which were responsible for the high drift values in the Nwanedzi River system (numerically constituting 70% to 80% of the total drift), show little propensity to drift in a diel periodicity (Table 4.37). This lack of diel periodicity was also reported by McLay (1968) and Bishop and Hynes (1969).

The immediate fate of drifting invertebrates when washed into lakes is a matter of biological interest. Experiments showed that stream animals could survive the thermal and chemical conditions of the lake for at least two weeks. During calm weather most of them were able to burrow into the lake bottom near the river mouth, while during periods of wave action the animals were not able to do so and were washed out with debris on the beach. Death of these organisms almost certainly followed (Dendy, 1944).

Though zooplankton was not studied in this survey, it was noted that the Nwanedzi River below the impoundments had relatively high densities of zooplankton; this is a common feature of streams draining lakes and dams (Clifford, 1972 and Armitage, 1977).

There appeared to be no correlation between the rate of aquatic drift and the density of the benthos (Table 4.38).

From Tables 4.25 to 4.36 it is also evident that drift densities expressed as numbers per cubic meter of water were relatively stable for all the different localities sampled as well as for the various seasons.

Chutter (1975) investigated the invertebrate drift of the Mlaas River in Natal, South Africa, and similarly found daily drift densities to remain remarkably constant for a wide range of flows, as well as for continuous daily sampling efforts for periods of up to one week duration. The investigations of Elliott (1967 and 1970), Waters (1969) and Clifford (1972) confirm these observations.

The faunal data collected in the drift sampler per hour per volume of flow was used to calculate the total faunal discharge of the stream at various sampling localities over a 24 hour period (Tables 4.25 - 4.36).

Such figures provide an additional, but highly essential basis for comparing the biological productivities of different streams and provide a more accurate index of the amount of food available for fish. It should further be pointed out that from an Ichthyological point of view, such drift rates and drift densities would be of extreme value only if such could be concurrently surveyed and correlated with dietary and fish population studies.

Unfortunately no similar surveys were previously conducted on riverine systems in South Africa with which to compare the Nwanedzi River productivity. Masihleho (in prep.) surveyed drift phenomena in the Mohlapitse tributary of the Olifants River.

Comparison between mean drift densities of the Nwanedzi River system and the Mohlapitse River indicates that the latter is on average approximately 17% more productive in terms of invertebrate occurence (1,5/m^3 against 3/m^3 respectively).

Waters (1966) concluded that drift was a mechanism for removing excess production, therefore, drift rate could be used as an index of the production rate of the benthos. During this survey, as is evident from Table 4.38, there appears to be no similarity between benthic standing crop and drift. In the Nwanedzi River system, drift rates would probably be of little value as indices of invertebrate production rates.

Waters (1965) and Elliott (1967) estimated the distance of daily drift and concluded that most of the aquatic invertebrates in the drift returned to the substratum after travelling only a short distance. From this it is clear that organisms in the drift are not necessarily entirely removed from a section of the stream and therefore, they can not be regarded as excess production.

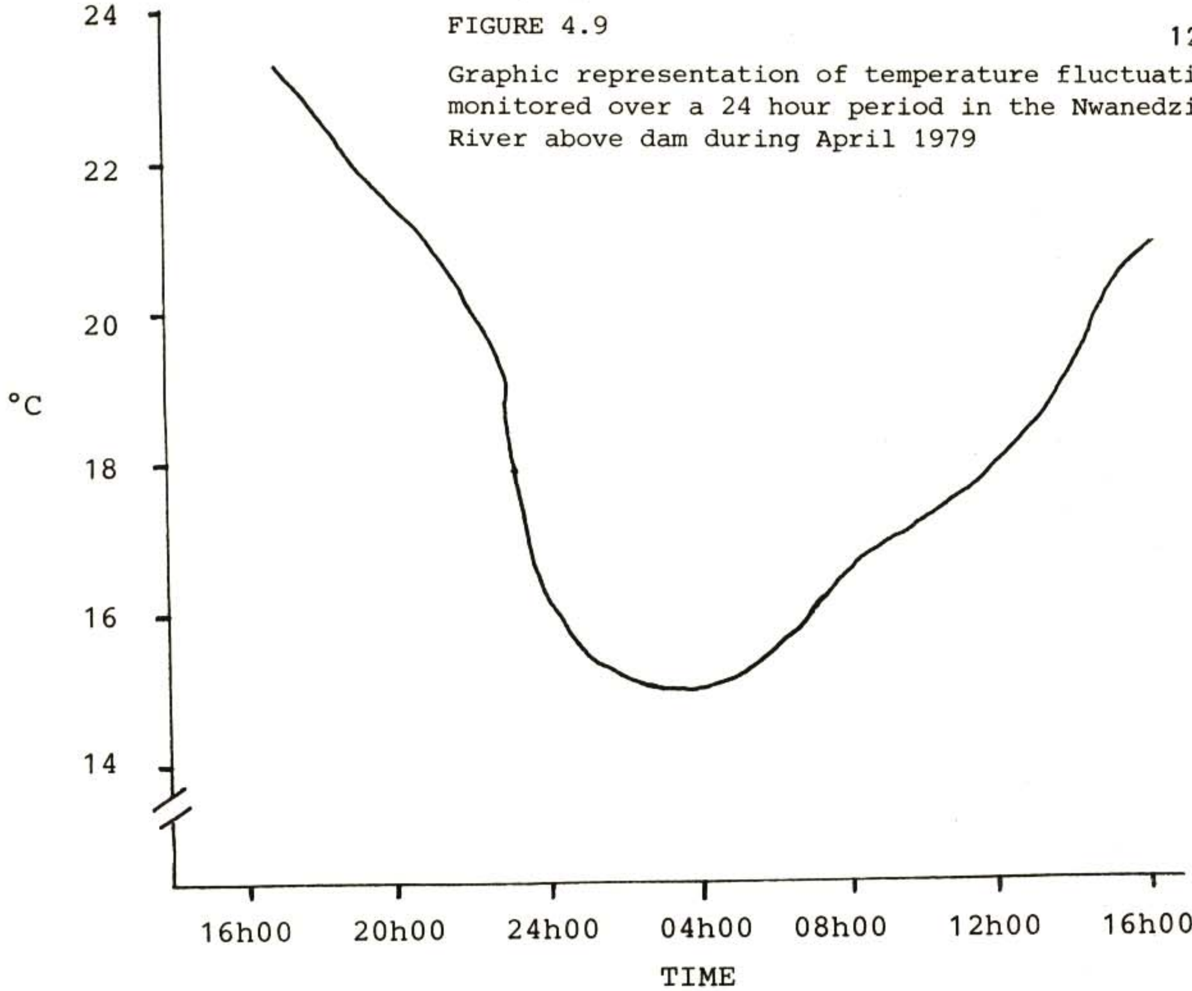


FIGURE 4.9

Graphic representation of temperature fluctuations monitored over a 24 hour period in the Nwanedzi River above dam during April 1979

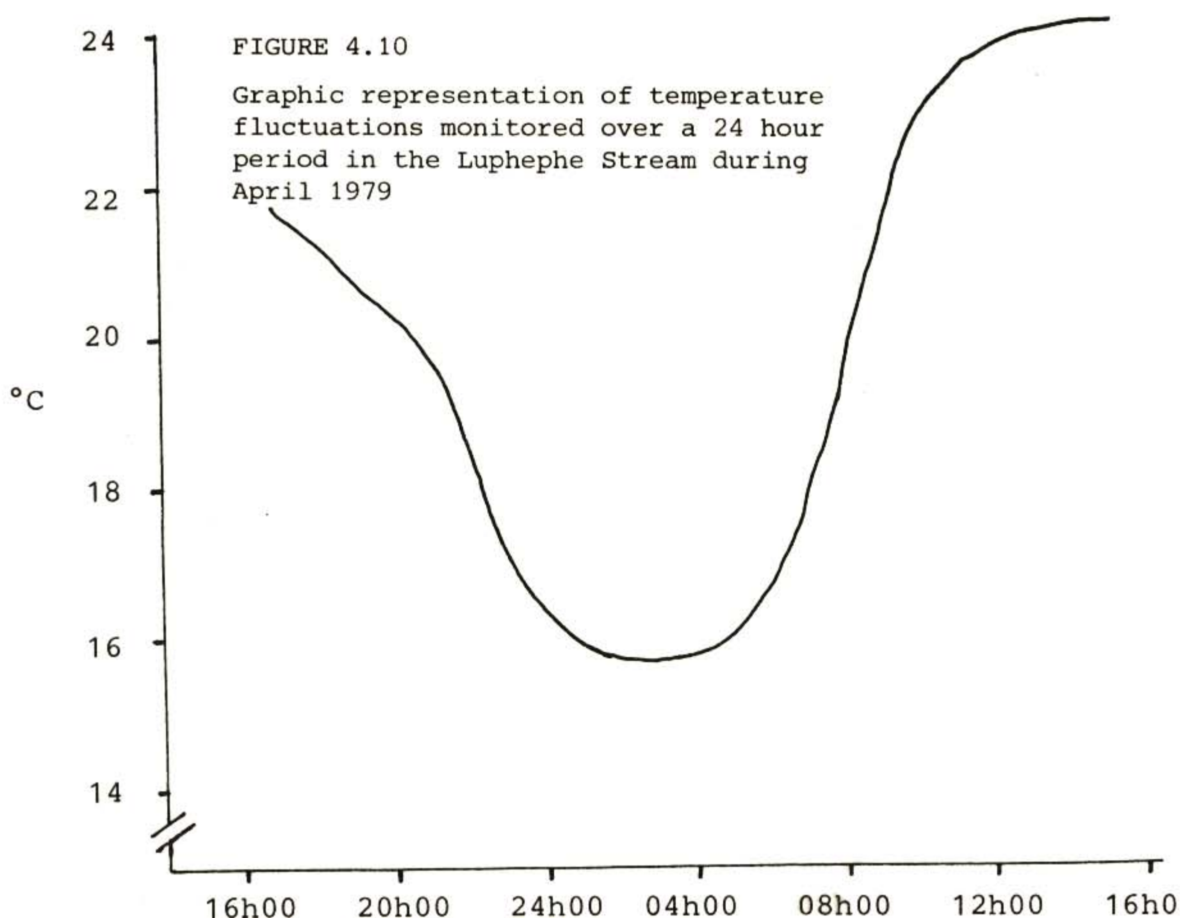


FIGURE 4.10

Graphic representation of temperature fluctuations monitored over a 24 hour period in the Luphephe Stream during April 1979

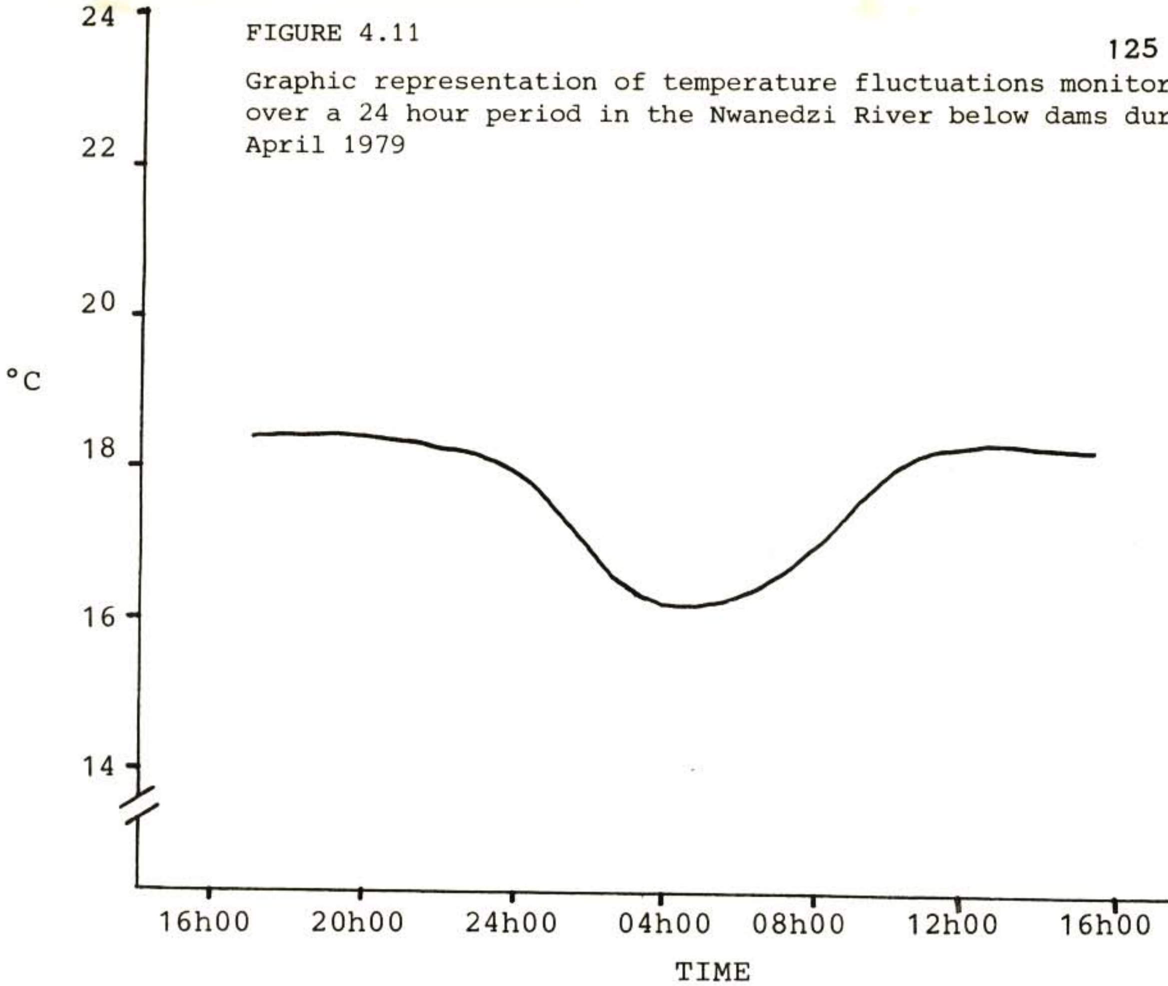


FIGURE 4.11

Graphic representation of temperature fluctuations monitored over a 24 hour period in the Nwanedzi River below dams during April 1979

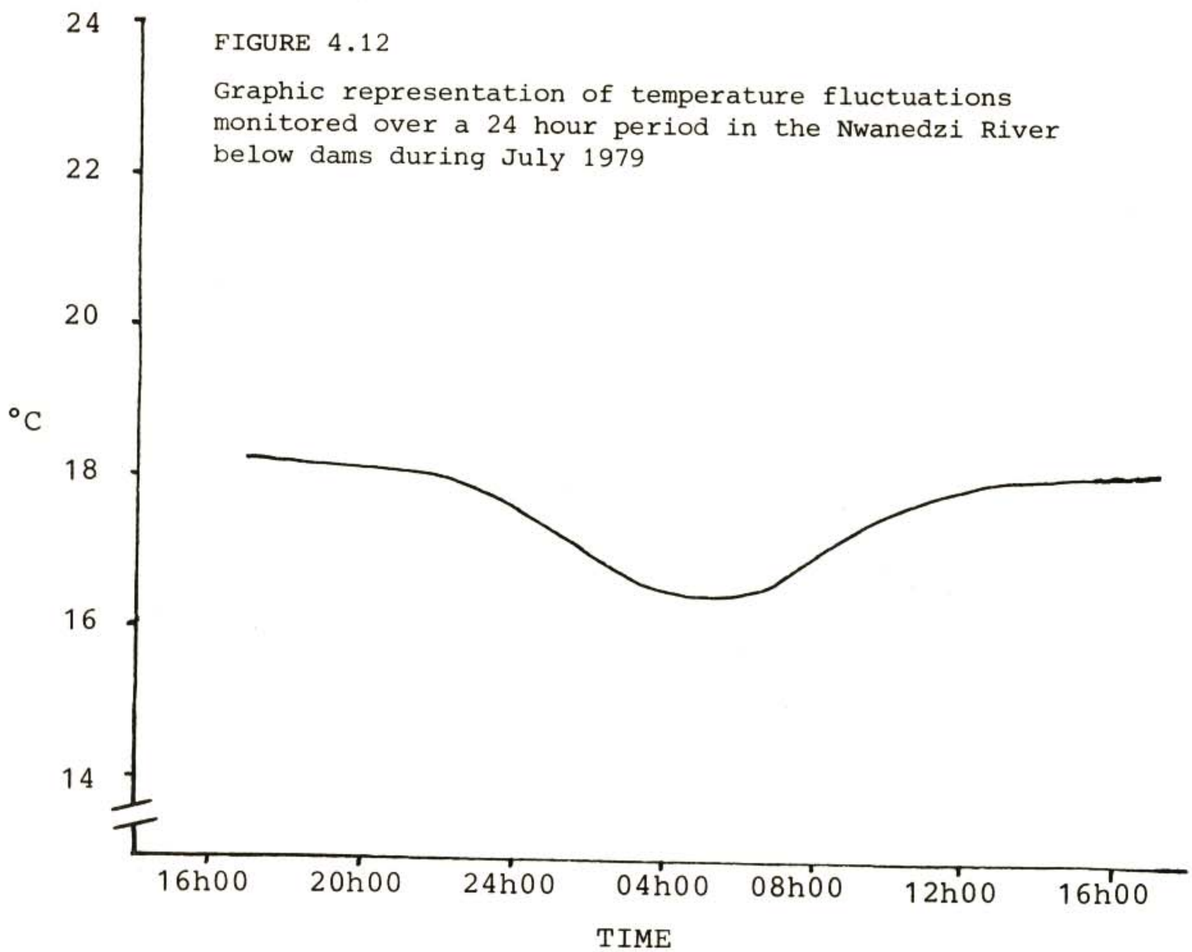


FIGURE 4.12

Graphic representation of temperature fluctuations monitored over a 24 hour period in the Nwanedzi River below dams during July 1979

FIGURE 4.13

Graphic representation of temperature fluctuations monitored over a 24 hour period in the Nwanedzi River above dam during July 1979

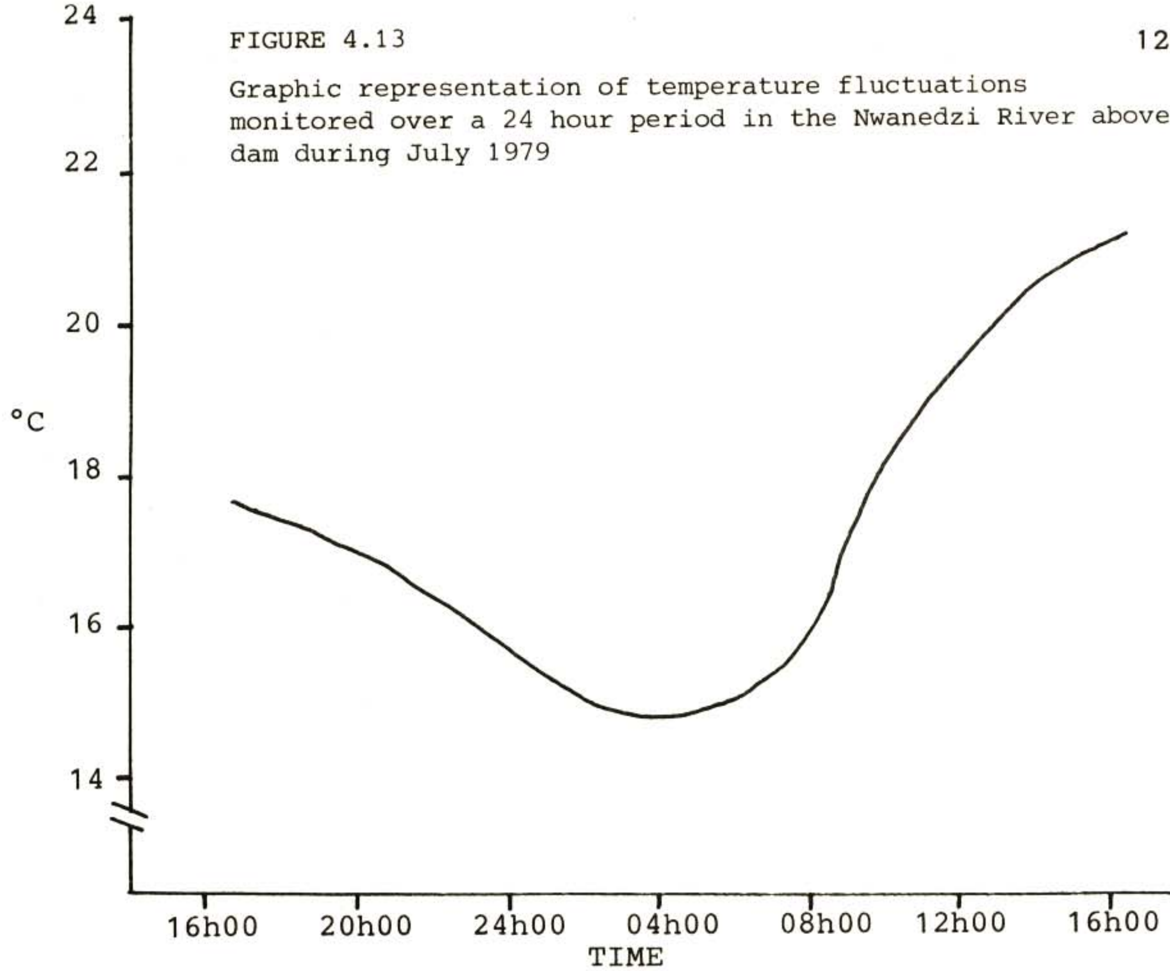
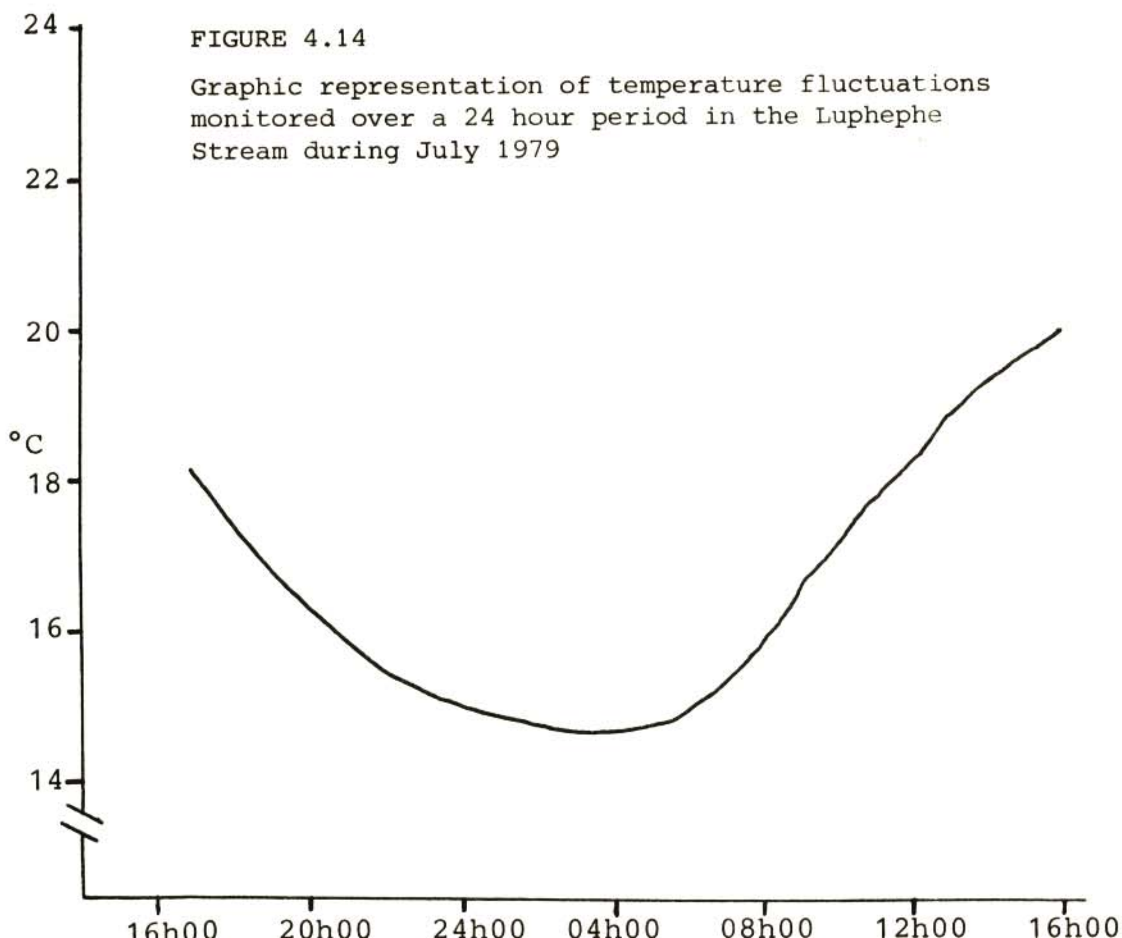


FIGURE 4.14

Graphic representation of temperature fluctuations monitored over a 24 hour period in the Luphephe Stream during July 1979



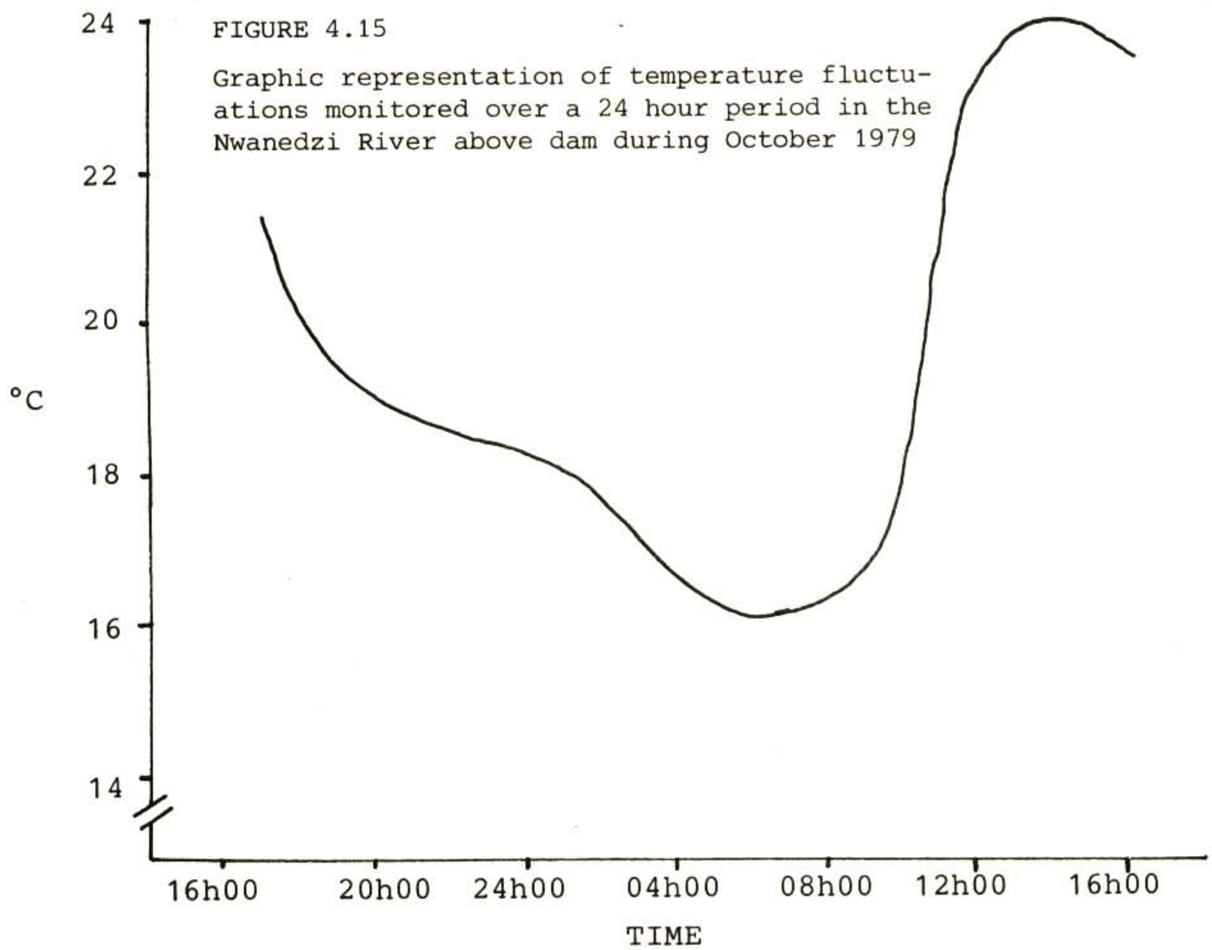


FIGURE 4.15

Graphic representation of temperature fluctuations monitored over a 24 hour period in the Nwanedzi River above dam during October 1979

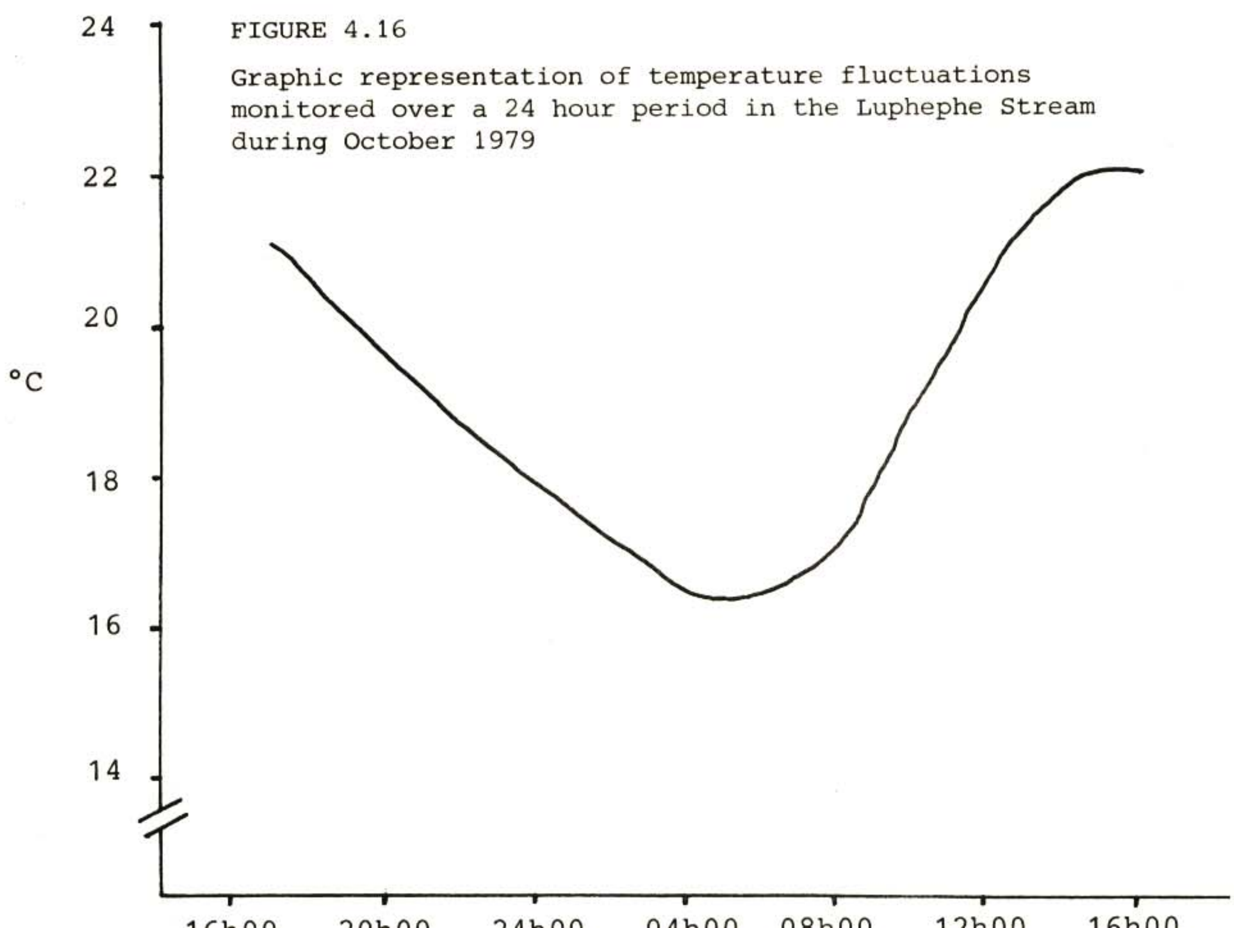


FIGURE 4.16

Graphic representation of temperature fluctuations monitored over a 24 hour period in the Luphephe Stream during October 1979

FIGURE 4.17

Graphic representation of temperature fluctuations monitored over a 24 hour period in the Nwanedzi River below dams during January 1980

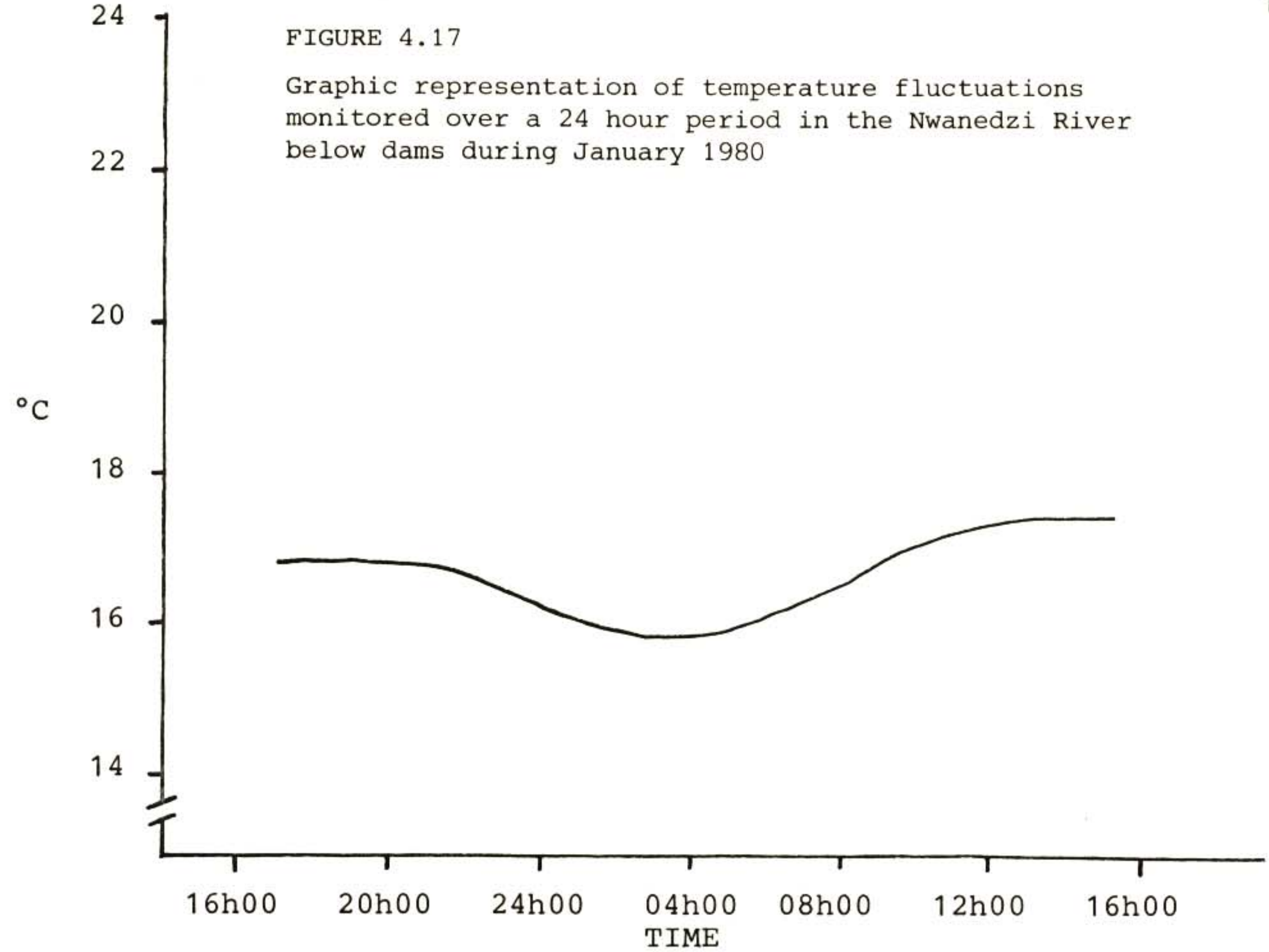


FIGURE 4.18

Graphic representation of temperature fluctuations monitored over a 24 hour period in the Nwanedzi River below dams during October 1979

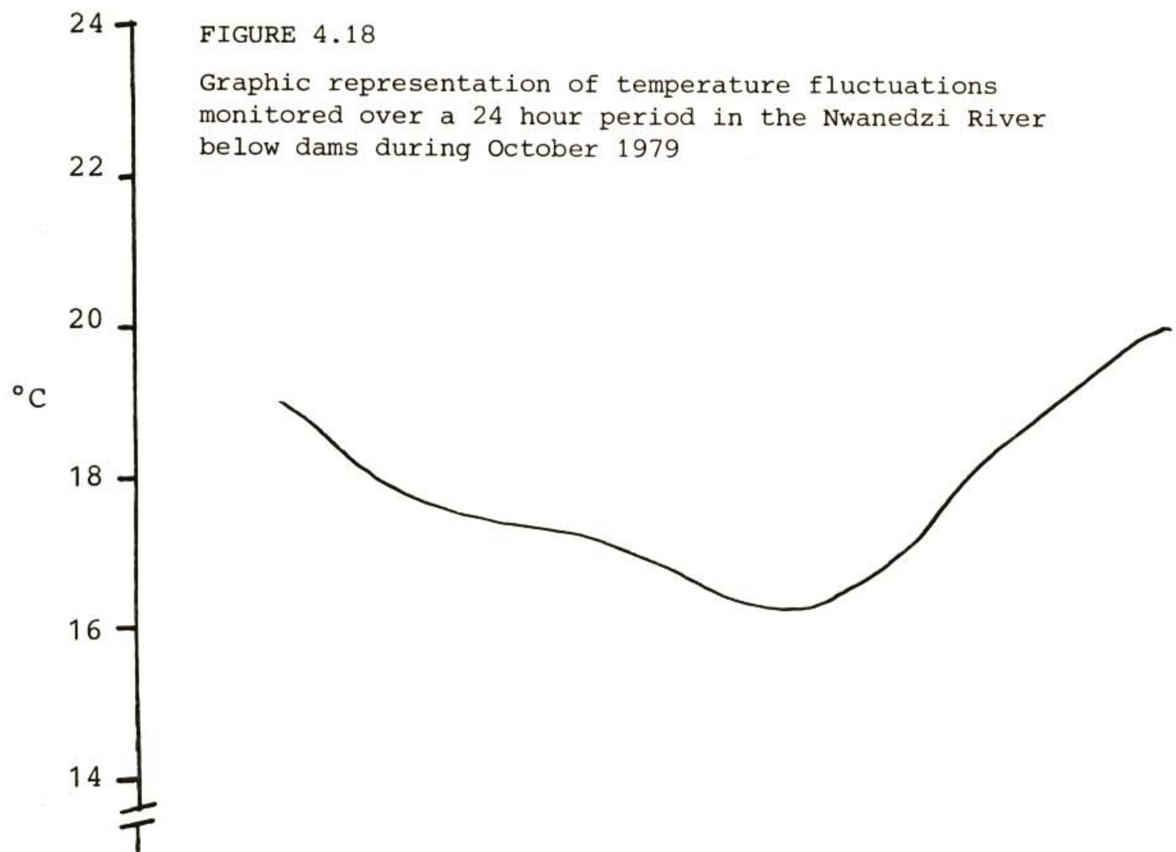


FIGURE 4.19

Graphic representation of temperature fluctuations monitored over a 24 hour period in the Luphephe Stream during January 1980

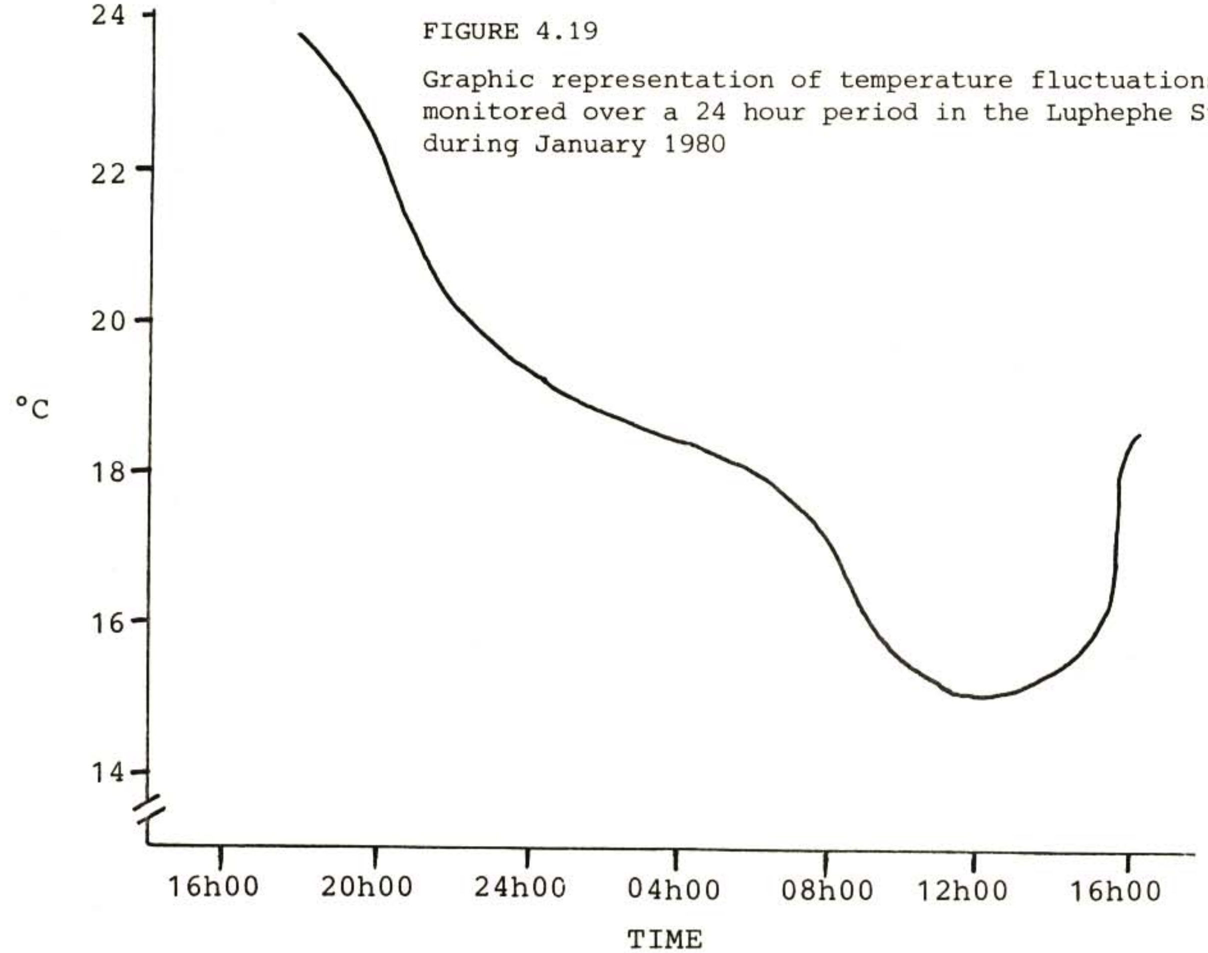
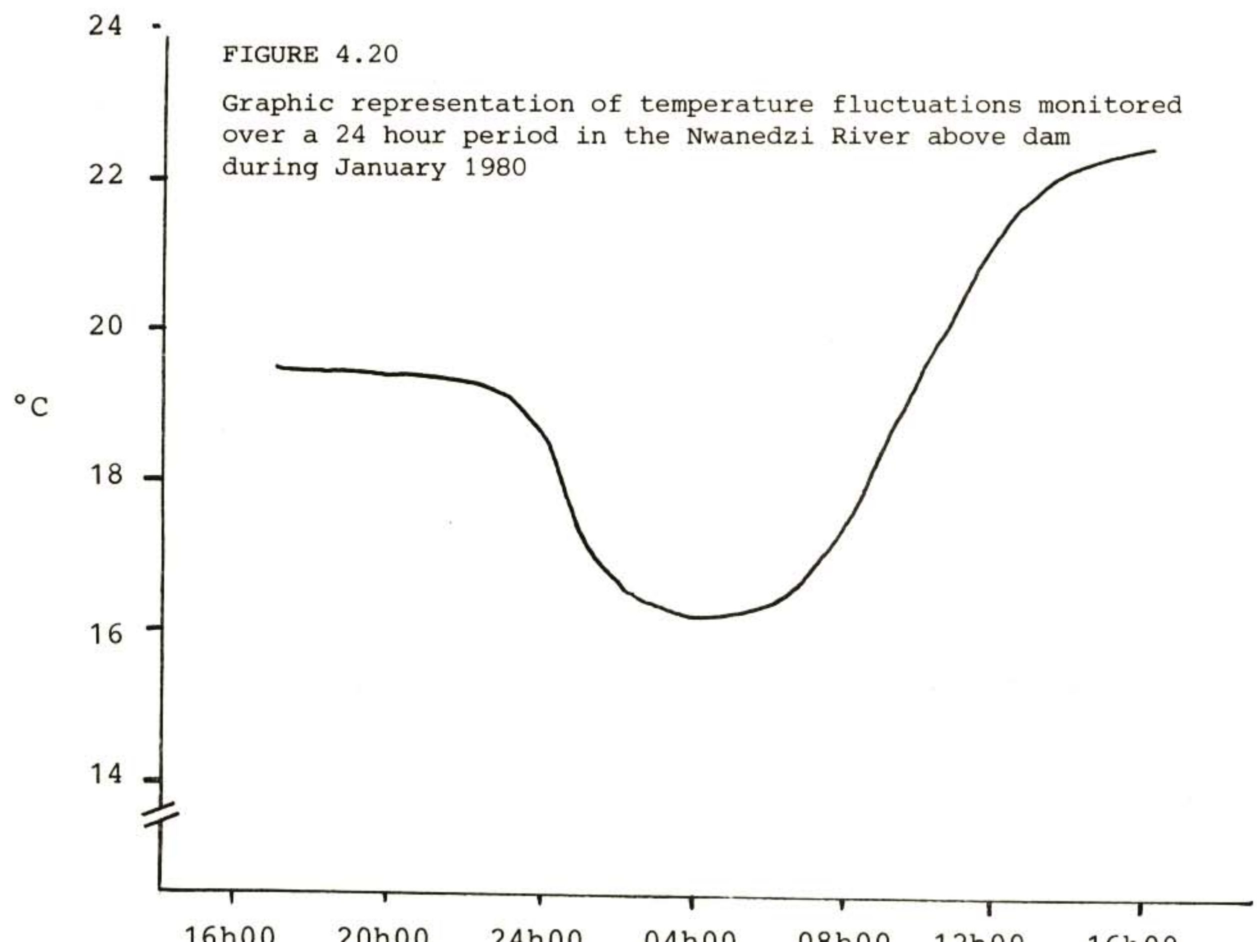


FIGURE 4.20

Graphic representation of temperature fluctuations monitored over a 24 hour period in the Nwanedzi River above dam during January 1980



SUMMARY

The invertebrate fauna of the Nwanedzi River system above and below the Luphephe-Nwanedzi twin impoundments was studied on a six-weekly basis and correlated with the chemo-physical parameters of the water. The significance of faunistic movements known to occur in running waters were also evaluated.

During the first year of this study biotic and abiotic variables were monitored at six-weekly intervals. The faunistic contents were sorted out in a live condition, counted, classified, dried, weighed and their Kjeldahl Nitrogen and Phosphate contents determined.

Cluster and Factor analyses as well as correlation matrices of both the chemo-physical and biological parameters were obtained by computer analysis.

Statistical observations include:

1. That good positive correlations were indicated between the following:

   (a) Current with Simuliidae and Trichoptera.

   (b) Temperature with Ephemeroptera, Tabanidae and Chironomidae.

   (c) Turbidity with Ephemeroptera.

   (d) pH with Odonata, Tabanidae, Ephemeroptera and Turbellaria.

(e) Dissolved oxygen with all faunistic groups.

(f) PO_4 with Trichoptera, Turbellaria, Annelida and Odonata.

(g) SO_4 with Trichoptera, Annelida and Potamon.

(h) NH_4-N with Trichoptera, Turbellaria and Coleoptera.

(i) NO_3-N with Annelida, Trichoptera and Odonata.

(j) NO_2-N with Coleoptera, Potamon, Trichoptera and Gastropoda.

2. That the Simuliidae, Ephemeroptera and Chironomidae were dominant in the Nwanedzi River above the impoundment, indicating unpolluted conditions with water of good quality.

3. That the river below the impoundments was characterised by an abundance of Turbellaria with Trichoptera as the dominant group - an indication of organic enrichment.

4. That in the Luphephe stream traces of eutrophication were detected, probably as a result of the local population.

5. That of the three stations sampled, the station below the impoundments always yielded more organisms per unit area. Maximum numbers per unit area were collected in winter.

During the second year, invertebrate drift and chemo-physical parameters were sampled on a seasonal basis. The invertebrate drift together with the abiotic variables were monitored hourly over a 24 hour period per season in order to establish any possible cyclic changes.

The Ephemeroptera, Plecoptera, Coleoptera and Simuliidae exhibited night activity, whilst the Trichoptera were found to be day active.

The Chironomidae, which constituted the bulk of the drift, did not show any diel periodicity.

The numbers in the drift appeared to be related to light intensity as well as to fluctuations in water temperature.

OPSOMMING

Die invertebraatfauna van die Nwanedzi Riversisteem is op 'n sesweeklikse basis bestudeer en in verband gebring met geselekteerde chemo-fisiese parameters van die water.

Gedurende die eerste jaar van ondersoek is die belangrikste veranderlike biotiese en abiotiese faktore gemonitor. Fauna komponente is in die lewende toestand uitgesoek, getel, in hoofgroepe geklassifiseer, oondgedroog en die droë massa sowel as Kjeldahl stikstof en fosfaatinhoude daarvan bepaal.

Groeps- en faktor-analise sowel as die korrelasiematriks is deur middel van rekenaarprogramme op die chemo-fisiese en biologiese parameters toegepas.

Die volgende is vasgestel:

1. Betroubare positiewe korrelasies tussen die volgende abiotiese faktore en invertebraatinsidensie is aangeteken:

    (a) Stroomsnelheid - Simuliidae en Trichoptera.

    (b) Temperatuur - Ephemeroptera, Tabanidae en Chironomidae.

    (c) Turbiditeit - Ephemeroptera.

    (d) pH - Odonata, Tabanidae, Ephemeroptera en Turbellaria.

    (e) Opgeloste suurstof - Alle faunistiese groepe.

    (f) PO_4 - Trichoptera, Turbellaria, Annelida en Odonata.

(g) SO_4 - Trichoptera, Annelida and Potamon.

(h) NH_4-N - Trichoptera, Turbellaria en Coleoptera.

(i) NO_3-N - Annelida, Trichoptera en Odonata.

(j) NO_2-N - Coleoptera, Potamon, Trichoptera en Gastropoda.

2. Simuliidae, Ephemeroptera en Chironomidae verteenwoordig die numeriese dominante groepe in die bentos van die Nwanedzi sisteem in die hoofstrome wat die damme voed. Hierdie bevinding dui op onbesoedelde toestande met goeie waterkwaliteite.

3. Die substraatfauna in die river benede die opgaardamme word gekenmerk deur 'n hoë voorkomsyfer van Turbellaria met die Trichoptera as die numeriese dominante groep. Hierdie toestand is 'n aanduiding van verhoogde organiese verryking.

4. In die Luphephe sytak is tekens van eutrofikasie gevind wat moontlik aan die huishoudelike aktiwiteite van die plaaslike bevolking toegeskryf kan word.

5. Die hoogste getalle organismes per eenheidsoppervlakte is gedurende die winter versamel, terwyl die stasie onderkant die damme deurgaans hoër getalle per vierkante meter opgelewer het as die stasies in die hoofstrome bokant die damme.

Gedurende die tweede jaar van opnames is ondersoek ingestel na die voorkoms van die drywende komponent van die substraatlewende organismes, terwyl geselekteerde chemo-fisiese parameters gelyktydig gemonitor is. Hierdie ondersoeke is op ŉ uurlikse basis oor 24 uur periodes en seisoenaal uitgevoer om sodoende die voorkoms van enige moontlike wisselinge te kan vasstel.

Ephemeroptera, Plecoptera, Coleoptera en Simuliidae vertoon groter aktiwiteit gedurende die nag terwyl die Trichoptera meestal gedurende die daglig-ure in ŉ drywende fase gaan.

Chironomidae verteenwoordig die numeries-dominante drywende groep en vertoon geen dag- of nagskommelinge nie.

Dit skyn asof die digtheid van drywende organismes hoofsaaklik deur ligintensiteit maar tot ŉ mate ook deur die temperatuur van die water bepaal word.

ACKNOWLEDGEMENTS

I wish to place on record my indebtedness to the following institutions and people who have assisted me towards the completion of this study.

Prof. J.E. Saayman, for his expert and sympathetic guidance during this investigation.

Dr. A. Jooste and Dr. T. Hecht, for their sound guidance, constructive criticism and encouragement during the final preparations of the manuscript.

The University of the North, Mobil Southern Africa (Pty.) Ltd., Anglo American Co-operation of Southern Africa and the Committee for Developmental Research (C.D.R.), for their financial assistance.

Mr. L. Polling, for his help in constructing some of the sampling equipment, the making of the photographs and for his unselfish help in the field.

The Rand Afrikaans University is thanked for computer time and facilities.

My colleagues in the Department of Zoology and Biology, for their help and encouragement at all times.

Mr. J. Malatji, for his assistance in reading and correcting the typescript.

The Department of Agriculture and Forestry of the Republic of Venda, for granting permission to conduct the field surveys in their area and also for other assistance in kind.

Mrs. R. Otto, for her neat typing and willing co-operation.

My parents, Samuel and Betty, for their interest and encouragement at all times.

Lastly I wish to thank Cecilia Nyoka, for her warm encouragement and hours spent compiling the statistics during the final preparation of the manuscript.

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