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A SURVEY OF THE CONSERVATION STATUS AND BENTHIC BIOTA OF THE MAJOR RIVERS OF THE KRUGER NATIONAL PARK

BY
C.A.MOORE AND F.M.CHUTTER

CONTRACT REPORT

NATIONAL INSTITUTE FOR WATER RESEARCH

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Final report in terms of a contract agreement between the National Institute for Water Research and the National Parks Board

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F O R E W O R D

Water is essential for the maintenance of biological diversity. It is also essential in maintaining the economic welfare of human societies. In South Africa surface water resources are limited, and largely restricted to a sparse network of perennial rivers. In terms of environmental and conservation issues, rivers have long been accepted as a vital component of ecosystems - but primarily as a source of drinking water for terrestrial animal populations, as refuges for a number of amphibious mammals or as the habitat of vertebrates of recreational or economic value to Man, such as fish populations. In the economic field rivers have all too often been regarded merely as water conduits for urban, industrial, mining, agricultural and other related uses.

The rapid increase in economic growth and human populations, over especially the last four or five decades, also sharply increased the demands on the naturally limited water supply. This, in turn, soon resulted in a water stress situation in many areas of the Republic of South Africa. The increased demands also soon resulted in a severe degradation of many of the perennial rivers, as evidenced in the decline in the water quality and quantity of the rivers. This situation was further aggravated by the release of alien fish species into the rivers for the sake of anglers. Today, few rivers are unaffected and reference to pristine conditions largely belongs to a bygone era.

It is only in recent years that the value of rivers as ecosystems in their own right has come to the fore. Late as it may be, opportunities are still available to conserve certain rivers - or sections thereof - as bench-marks of the pristine ecosystems they once were. In spite of the National Parks Board's primary conservation objective of conserving natural ecosystems in their pristine state, even the perennial rivers of the Kruger National Park have suffered severe degradation through the years. Reflecting poor land management practices, increased industrialization and mining, an increased rate of siltation, chemical and biotic pollution and even the cessation of flow has become evident.

In the light of these developments, the National Parks Board expressed its grave concern that the natural attributes and qualities of the Kruger National Park's perennial rivers were being seriously threatened. In its endeavours to rectify the situation, the need to establish a sound baseline of all the biotic and physical parameters involved in the life support systems of the rivers as functional ecosystems was identified. The baselines would serve as early warning systems in a future monitoring programme to detect any disturbances to these fragile ecosystems.

In this quest the National Institute for Water Research volunteered its expertise to survey the benthic fauna of all the major rivers in the Kruger National Park. The results of this report are the outcome of the joint venture (with the National Parks Board) that followed. The objectives were handsomely met, and though of a preliminary nature, the report not only represents a major contribution towards a better understanding of river ecology but, in fact, has also pioneered the way towards the adoption of a more responsible attitude towards river conservation, management and utilization!

S.C.J. JOUBERT

SKUKUZA

NOVEMBER 1987

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DISCLAIMER

The views presented in this report represent those of the authors and do not necessarily coincide with those of either the National Parks Board or the National Institute for Water Research.

1. INTRODUCTION

One of the main functions of the National Parks Board, as stated in the National Parks Act of 1926, is to ensure that "the park shall, as far as may be and for the benefit and enjoyment of visitors, be retained in its natural state" (Paynter & Nussey, 1986).

The Kruger National Park (K.N.P.) is the largest of South Africa's game reserves with a total area of approximately 1 945 500 ha. It has a great diversity of habitat types and a wide variety of plant and animal species. Additionally, it is world renowned as a tourist attraction.

Water is an essential resource for the maintenance of ecosystems. It follows therefore, that if the K.N.P. is to retain its natural diversity and reputation in accordance with the National Parks Act, it is vital that the K.N.P.'s limited water resources be managed with the utmost care. The rivers that flow through the K.N.P. are of major importance as a source of water for sustaining life in the K.N.P..

Unfortunately, historical events have shown that land use practices and the control of water quality and quantity outside the K.N.P. have not always been considered with the K.N.P.'s interests in mind. The rivers of the K.N.P. have very large catchments, most of which lie outside the K.N.P's boundaries (Figure 1). Thus the National Parks Board has little control over the quality or quantity of water that reaches the K.N.P. and the K.N.P.'s rivers are vulnerable to events and activities that take place in a large area of the Transvaal.

The earliest recorded case of pollution of an aquatic environment within the K.N.P. took place in 1921 (Joubert, 1986a; Anon, 1986). Several gold mines in the vicinity of the village of Sabie discharged their wastes directly into the Sabie River. The resulting pollution depleted invertebrate and lower vertebrate populations and also adversely affected the resident hippopotami. By the early 1930's the situation had deteriorated to such an extent that tourists in the K.N.P. refused to use Sabie River water for domestic purposes. It was not until 1944, when the polluted water caused the death of several head of agricultural livestock, that legislation was passed preventing the mine authorities from dumping their raw waste directly into the river.

Another problem that has been observed with increasing frequency in the K.N.P.'s rivers is siltation. This is caused primarily by the increase in poor management of agricultural activities in the upper catchments. Depletion of natural vegetation, combined with overgrazing, has accelerated natural rates of soil erosion during rain storms. The construction of dams and periodic opening of sluice gates also causes high silt loads. Increased silt loads are believed to have been responsible for large fish-kills (Joubert, 1986a). High silt loads, combined with lower and regulated flows due to abstraction of water from water courses and the building of dams, promote rapid infilling of hippo pools, which subsequently leads to overcrowding and increased mortality of the hippopotami in the remaining pools.

Invasive biota have also contributed to the degradation of the K.N.P.'s rivers. Competition from introduced fish species such as carp (*Cyprinus carpio*) and black bass (*Micropterus dolomieu*) could have a detrimental effect on the indigenous species. This is a formidable potential problem in the Sabie River and the Nwanedzi River system where three rare fish species occur, namely *Serranochromis meridianus*, *Nothobranchius orthonotus* and *N. rachovii* (Noble, 1974). Alien and pest plants such as the water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes*) profoundly influence both the natural habitat and quality of the water (Joubert, 1986a). Other exotic river bank invaders such as lantana (*Lantana camara*) and Persian Lilac (*Melia azedoracah*) contribute to the elimination of natural riparian vegetation.

Flowing water ecosystems are very sensitive to changes in the physical and chemical environment. Alteration of the natural conditions could have untold repercussions for the components of these ecosystems.

In order to take full advantage of the limited water supplies of the K.N.P., it is imperative that a clearer understanding of the biota, functioning and water requirements of the K.N.P.'s aquatic ecosystems is obtained.

2. AIMS AND OBJECTIVES

There are several advantages to using benthic (bottom-dwelling) invertebrates in the monitoring of aquatic ecosystems. These are summarized as regards water quality by Hawkes (1982) as follows:

(i) Benthic communities act as continuous monitors of the water flowing over them as opposed to intermittent samples taken for chemical analysis.

(ii) Benthic communities respond to a wide range of different water quality determinants and pollutants. Chemical monitoring requires a knowledge of the types of pollutants that are likely to be present.

(iii) Benthic communities integrate the effects of mixed pollutants in a manner similar to the way they would affect fish populations. Chemical data would need to be processed to take account of complex interactions to predict their effect on fish.

However, while benthic invertebrates indicate changes in the chemical environment, they also respond to changes in their physical environment. Additionally, identification of benthic invertebrates is very labour intensive. In South Africa, the benthic fauna is poorly known and new or undescribed species are frequently encountered. Despite these disadvantages it may be concluded that the use of benthic invertebrates is very effective in monitoring many aspects of the status of lotic ecosystems.

The study reported here was limited to the major rivers of the K.N.P., which were historically considered to be perennial, namely the Crocodile, Sabie, Olifants, Letaba, Luvuvhu and Mutale rivers. It was undertaken with several aims:

1. To record the benthic invertebrate fauna of the rivers at sampling points near the western and eastern borders of the K.N.P.. Originally planned bi-monthly sampling for a year proved logistically impossible due to the high summer level of the rivers. Consequently it was decided to undertake bi-monthly sampling in two successive winters, with the objective of providing a comprehensive baseline against which future studies may be compared.

2. To provide preliminary information on the diatom and aquatic macrophyte flora of the rivers.

3. To assess the conservation status of the rivers studied from the data on the benthic invertebrates. from field observations made during sampling visits and from data on water chemistry, which was gathered by the Hydrological Research Institute of the Department of Water Affairs.

4. To make recommendations regarding future monitoring of the rivers, to provide timely warning of threats to their biological quality.

Since the field work of the study ended in winter 1986, considerable concerns have arisen for the impact of flow regulation, water abstraction and dams on the rivers as ecosystems. This study was not designed to provide answers to these questions, but where the results permit pertinent comment, it will be made.

3. GENERAL DESCRIPTION OF THE AREA

The combined catchment area of the six rivers included in this study is 90 921 km², and therefore covers a variety of topographic and geological regions, vegetation types and land uses. Figure 1 is a map showing the catchments. Table 1 indicates localities and altitudes of the rivers.

All the rivers rise in or west of the Transvaal Drakensberg Escarpment and flow in an easterly direction. They cut through the Drakensberg Mountains in gorges and traverse less steeply sloping terrain to the K.N.P.. Regions included in the catchment areas are Gazankulu, KaNgwane, Lebowa, Venda and the Transvaal.

Major dams on the rivers include Loskop, Blyderivierspoort, Doornpoort, Rhenosterkop, Rus de Winter, Middelburg and Witbank dams in the Olifants River catchment; Ebenezer Dam and Fanie Botha Dam on the Letaba River; the Albasini Dam on the Luvuvhu River and the Braam Raubenheimer Dam on the Crocodile River.

3.1 Geology

The catchments of the rivers are underlain by a wide range of geological tems and the Swaziland Supergroup.
The variety of underlying rocks and associated soil types prevents simple correlations being drawn between the geology of the area and the water chemistry of the rivers.

3.2 Climate

The K.N.P. is situated in a subtropical region. It experiences hot, wet, humid summers and cold dry winters, with occasional periods of frost.
The mean annual temperature for the area covered by the catchments of the rivers that traverse the K.N.P. ranges from 16 to 20°C with the hottest

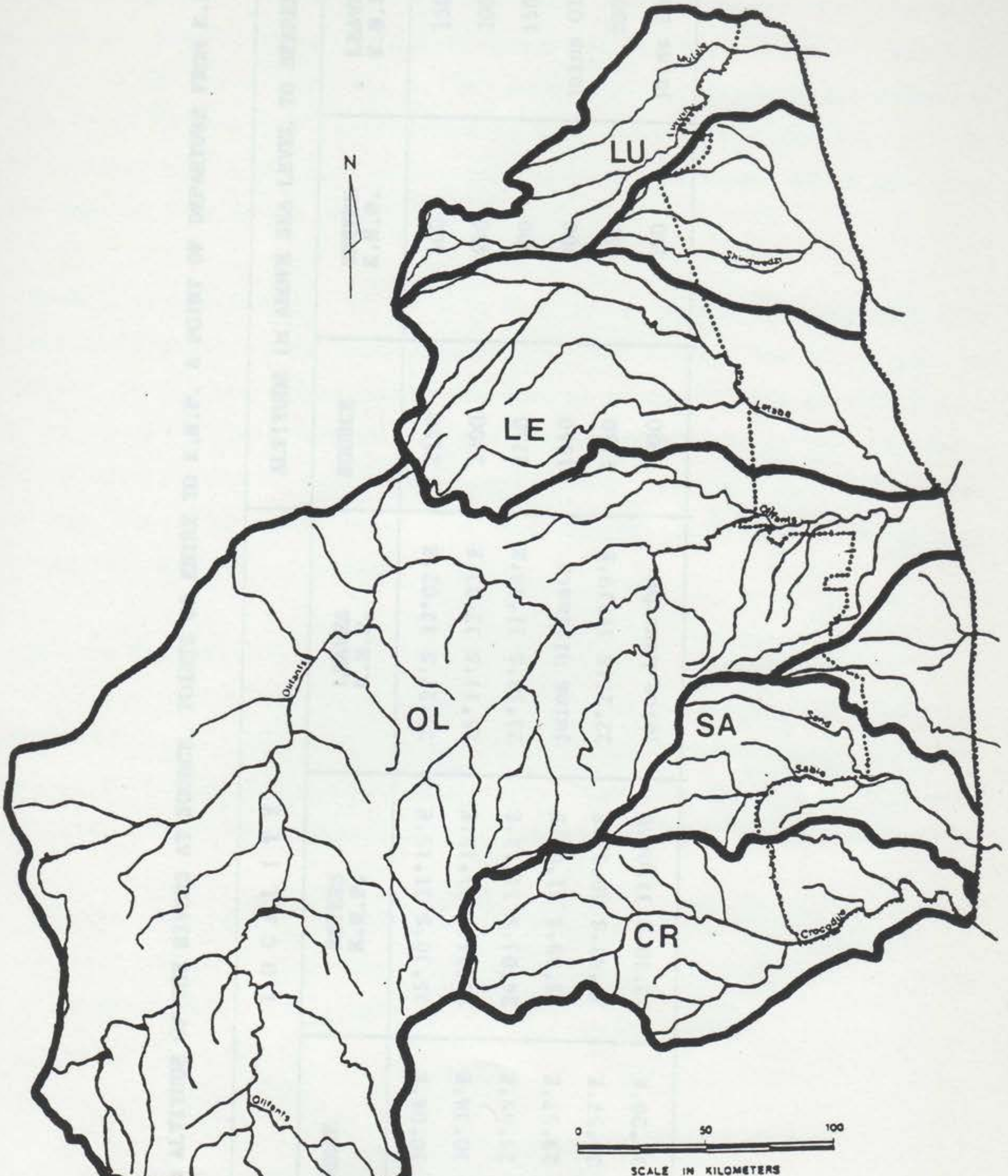

Figure 1. A map showing the boundaries of the catchments of the Crocodile (CR), Sabie (SA), Olifants (OL), Letaba (LE) and Luvuvhu (LU) rivers.

TABLE 1. LOCALITY AND ALTITUDE OF THE RIVERS AT SOURCE, POINTS OF ENTRY TO K.N.P. & POINT OF DEPARTURE FROM K.N.P.

RIVER	LOCALITY			ALTITUDE (M ABOVE SEA LEVEL TO NEAREST 50M)		
	SOURCE	ENTERS K.N.P.	LEAVES K.N.P.	SOURCE	ENTERS K.N.P.	LEAVES K.N.P.
Crocodile	25°21'S 30°06'E	25°30'S 31°15'E	25°27'S 32°02'E	2150	400	150
Sabie	25°07'S 30°38'E	25°01'S 31°15'E	25°11'S 32°03'E	2300	450	200
Olifants	25°19'S 29°45'E	24°03'S 31°12'E	23°58'S 31°48'E	2750	300	150
Letaba	23°51'S 29°57'E	23°39'S 31°09'E	joins Olifants	1850	300	joins Olifants
Luvuvhu	23°02'S 29°57'E	22°43'S 30°53'E	22°27'S 31°19'E	1150	450	200
Mutale	22°52'S 30°20'E	22°30'S 31°04'E	joins Luvuvhu	900	250	joins Luvuvhu

temperatures recorded in January and coolest in July. Temperature, evaporation and humidity are higher in the subtropical Lowveld region than elsewhere. Mean annual precipitation (M.A.P.) values for each catchment are given in Table 2. In the K.N.P. the M.A.P. is lowest in the north with the exception of the Punda Maria area. Evaporation is also lower in the Lowveld. In the Olifants River catchment, mean gross evaporation ranges from 1400 mm per annum in the west to 1900 mm per annum in the Lowveld.

The climatic characteristics of the area lead to the rivers having lowest flow and possibly slightly lower temperatures in the winter months (April to September). During the summer months (October to March) flow is generally high with spates occurring when thunder storms are experienced in the catchment. Since the rivers in the K.N.P. are at their lower reaches, once the water level has risen in summer there is a tendency for the levels to remain high until the following winter period.

3.3 Natural Vegetation

The catchments include many veld types, namely Northeastern Sand Highveld, Northeastern Mountain Sourveld, Lowveld Sour Bushveld, Bankenveld, Springbok Flats Turf Thornveld, Sourish Mixed Bushveld, Mixed Bushveld, Sour Bushveld, Mopani Veld, Lowveld Sour Bushveld, Arid Lowveld and Lowveld (Acocks 1975).

This diverse vegetation results in many complex interactions which may influence river characteristics. However, these interactions are far too intricate to be dealt with in this report.

TABLE 2. CATCHMENT AREAS, MEAN ANNUAL RUNOFF (MAR) AND MEAN ANNUAL PRECIPITATION (MAP) (FROM DEPARTMENT OF WATER AFFAIRS, 1986).

RIVER	CATCHMENT AREA (km^2)	MAR ($m^3 \times 10^6$)	MAP (mm)
Crocodile	10 455	1 238	879
Sabie	6 252	849	833
Olifants	54 434	2 284	698
Letaba	13 824	819	671
Luvuvhu & Mutale	5 956	529	731

3.4 Land Use Outside the K.N.P.

Land uses in the river catchments are urban development; industry; subtropical fruit cultivation; forestry; mining; cattle ranching and subsistence farming.

In areas of intensive fruit growing in the catchments of all of the rivers there is a relatively large application of biocides for pest control and of fertilizers. Biocide use is also fairly important in forestry areas. This could have implications on the quality of water in the rivers. Mining is also important in all of the catchments but is by far the greatest in the Olifants River catchment where coal, copper, phosphate, vermiculite, iron, emerald, mica, chrome, silica, antimony and cinnabar are mined.

All the activities listed above could have effects on river water quality and quantity, although subsistance farming in the Luvuvhu and Mutale catchments may have least impact.

4. PREVIOUS RESEARCH ON RIVERS OF THE K.N.P.

To date, published information on the rivers of the K.N.P. relates mainly to specific taxonomic groups of the fauna. Major groups of vertebrates such as the fish (Pienaar, 1961 & 1978), Hippopotami (Pienaar, 1966) and reptiles (Pienaar, Haacke & Jacobson, 1978) have been studied. Extensive studies of non-aquatic insects have also been undertaken (e.g. Prins, 1963; Kloppers & Van Son, 1978; Scholtz, 1978). Some dipterans which have an aquatic larval stage have been investigated (Schulz, Steyn & Rose-Innes, 1958; Braack, Davidson, Ledger & Lewis, 1981), although the publications were concerned with the terrestrial adult stages and larvae from non-permanent pools.

Previous research published on the river fauna includes a checklist of Decapoda and fresh-water fish which is combined with amphibians, reptiles and small mammals (Pienaar, 1961). Another list of species is a preliminary list of dragonflies (Odonata) (Balinsky, 1965). A publication by Oosthuizen (1979) concerning the leech species *Placobdella multistrata* makes several references to specimens collected from the K.N.P. and Sciacchitano (1961) published a paper (in Italian) on the leeches of the K.N.P.. Oberholzer and Van Eeden (1967) undertook an extensive survey of the freshwater molluscs of the K.N.P. with particular reference to the vectors of bilharzia. In 1978 the five major rivers flowing into the K.N.P.. (Crocodile, Sabie, Olifants, Letaba and Luvuvhu Rivers) were monitored for pesticide residues. The results of that survey indicated that pesticides had not yet posed a serious threat to wildlife in the K.N.P.. (Van Dyk, 1978). Other than newspaper articles, reviews such as Joubert (1986) and Anon (1986), and occasional popular articles in Custos (van Jaarsveld, 1985; Van Niekerk, 1986; Cilliers, Reid & Roderigues, 1987) little information has been published on K.N.P. rivers.

In 1933 a survey of the benthic fauna of the Sabie River was carried out by Bertram Jeary after long disputes between the N.P.B. and mining concerns in the Sabie area. This survey revealed that there was virtually no small aquatic life in the Sabie River. Additionally, the warden reported that the number of fish in the river had also declined. The N.P.B. then decided to pursue the matter of the pollution of the river caused by the mining companies (Joubert, 1986b).

In 1959 the Hydrobiology Division of the National Institute for Water Research (NIWR) collected benthic invertebrates from the Crocodile River at Malelane in July and November and from the Sabie River at Lower Sabie in November only. This study was executed as part of a research project on "South African Hydrobiological Regions" by Dr A.D. Harrison and J.D. Agnew and their findings are recorded in Reports 2 and 3 on NIWR file W6/6/8H. Many previously unrecorded Ephemeroptera (mayflies) and Trichoptera (caddisflies) were found, particularly at Lower Sabie. The fauna of the Sabie River was far more diverse than that of the Crocodile. It was concluded that the fauna has strong links with that of Central Africa. The collected material was catalogued and later donated to the Albany Museum, Grahamstown.

The scarcity of data on the biota and quality and quantity of water in the K.N.P. rivers seriously impedes the assessment and comparison of past and present conditions. This poses a problem when the K.N.P. management is faced with having to make decisions that have a potential impact on the K.N.P.'s rivers.

5. SAMPLING

5.1 BIOTOPES

A biotope has been defined as the smallest geographical unit of the biosphere or of a habitat that can be delimited by convenient boundaries and is characterized by its biota (Lincoln, Boxshall & Clark, 1982).

The particular biotopes that were used in this survey were: stones-in-current, stones-out-of-current, sediment and vegetation. In a river or stream in its natural state, each of these biotopes has a characteristic fauna. Each biotope was therefore sampled seperately to enable individual treatment of each fauna. This is desirable since if organic pollution has occurred the fauna changes such that taxa that are normally found in other biotopes may appear. Thus if the invertebrate fauna is to be correlated with water quality, the different biotopes must be treated separately.

5.1.1 Stones-in-current biotope

The stones-in-current biotope consists of an area of river bed with loose rocks and stones with a perceptible current of water flowing over them. These areas are often referred to as "riffles". This biotope was considered to be the most important during the survey since it is inhabited by the most pollution-sensitive species (Chandler, 1970), and is therefore the most appropriate habitat for studies of water quality. Also the stones-in-current is a biotope that is relatively easy to sample, and has a diverse fauna in unpolluted conditions.

5.1.2 Stones-out-of-current biotope

This biotope is similar to the stones-in-current biotope with the difference that the stones are located in an area of no flow (e.g. in backwaters at the river's edge). In this case, "no flow" was regarded as a situation where fine sediment could settle on the upper surfaces of the stones, undisturbed by water movements.

5.1.3 **Sediment biotopes**

Sediment biotopes is a term used here to include a variety of habitats, most commonly that of diatom growth on rocks or sand, fine sediment lying over sand or bedrock or, less commonly, sand itself. Table 3 shows localities at which the different habitats were sampled.

5.1.4 **Vegetation biotopes**

This category also includes a number of different habitats, namely fringing or marginal vegetation, trailing vegetation, and emergent vegetation. Table 4 lists localities at which the different habitats were sampled.

When analysing the data, cognisance must be taken of the fact that the sediment and vegetation biotopes both include a number of different habitat types.

5.2 **SAMPLING SITES**

The sampling sites used in this survey were selected during a preliminary study that was carried out by the N.I.W.R. at the onset of the project in 1983. Where possible, sampling sites were chosen near the western and eastern boundaries of the K.N.P., in order to observe the fauna where there is maximum and minimum influence of factors and events taking place outside the park. Further sites were selected above and below the confluence of rivers with a view to ascertaining the impacts of tributaries on the main rivers. In addition to these criteria, other factors that were taken into account during site selection were (i) the suitability of the river bed; (ii) accessibility of the site from the road and (iii) the accessibility of the biotopes, particularly the stones-in-current biotope. Figure 2 is a map of the K.N.P. indicating the sampling sites used. Table 5 gives the names, localities and brief descriptions of the sampling sites.

TABLE 3. DESCRIPTION AND LOCALITIES OF SEDIMENT BIOTOPES

RIVER	SITE NAME	SITE NO.	DATE	HABITAT TYPE	DESCRIPTION
Crocodile Crocodile Sabie Sabie Olifants	Ngondwini Ngondwini Opposite Lisbon Estates Lubye-Lubye Above confluence with Letaba River	3 3 4 5 7	Jun 85 Jun 86 Apr 85 Apr 85 Apr 85	Diatom growth	Net swirled through diatom growth overlying sand, stones or bedrock, usually in backwaters with no current
Crocodile Crocodile Crocodile Sabie Olifants Luvuvhu	Gezabahle Ngondwini Ngondwini Opposite Lisbon Estates Mamba Pafuri Picnic Site	2 3 3 4 6 14	Aug 86 Apr 86 Aug 86 Aug 86 Oct 86 Aug 86	Surface Sediment from sand	Fine particulate matter lying on bottom sand, found in backwaters with no current
Crocodile Sabie	Ngondwini Opposite Lisbon Estates	3 4	Oct 86 Jun 86	Surface sediment from bedrock	Fine particulate matter on bedrock found in backwaters with no current
Sabie Luvuvhu	Lubye-Lubye Pafuri Picnic Site	5 14	Jun 86 Jun 86	Sandy bottom	Sand on river bed sampled from area with some flow
Crocodile Sabie Sabie	Gezabahle Lubye-Lubye Lubye-Lubye	2 5 5	Jun 86 Jun 85 Jan 86	Sandy backwaters	Sand on river bed with no flow

TABLE 4. DESCRIPTION AND LOCALITIES OF VEGETATION BIOTOPES

RIVER	SITE NAME	SITE NO.	DATE	HABITAT TYPE	DESCRIPTION
Luvuvhu	Mangovane	12	Jun 85	Fringing/ Marginal Vegetation	Vegetation at margins of river in backwaters
Luvuvhu	Mangovane	12	Jun 86		
Luvuvhu	Mangovane	12	Aug 86		
Luvuvhu	Below confluence with Mutale River	13	Jun 86		
Luvuvhu	Pafuri Picnic Site	14	Aug 86		
Mutale	Above confluence with Luvuvhu River	15	Aug 86		
Olifants	Mamba	6	Jun 85	Trailing vegetation	Vegetation (eg. *Polygonum* sp.) trailing in current
Luvuvhu	Dongadziba	10	Apr 85		
Luvuvhu	Pafuri Picnic Site	14	Jun 86		
Crocodile	Gezabahle	2	Nov 85	Emergent reeds	Net swept through base of reed stems growing in bsckwaters

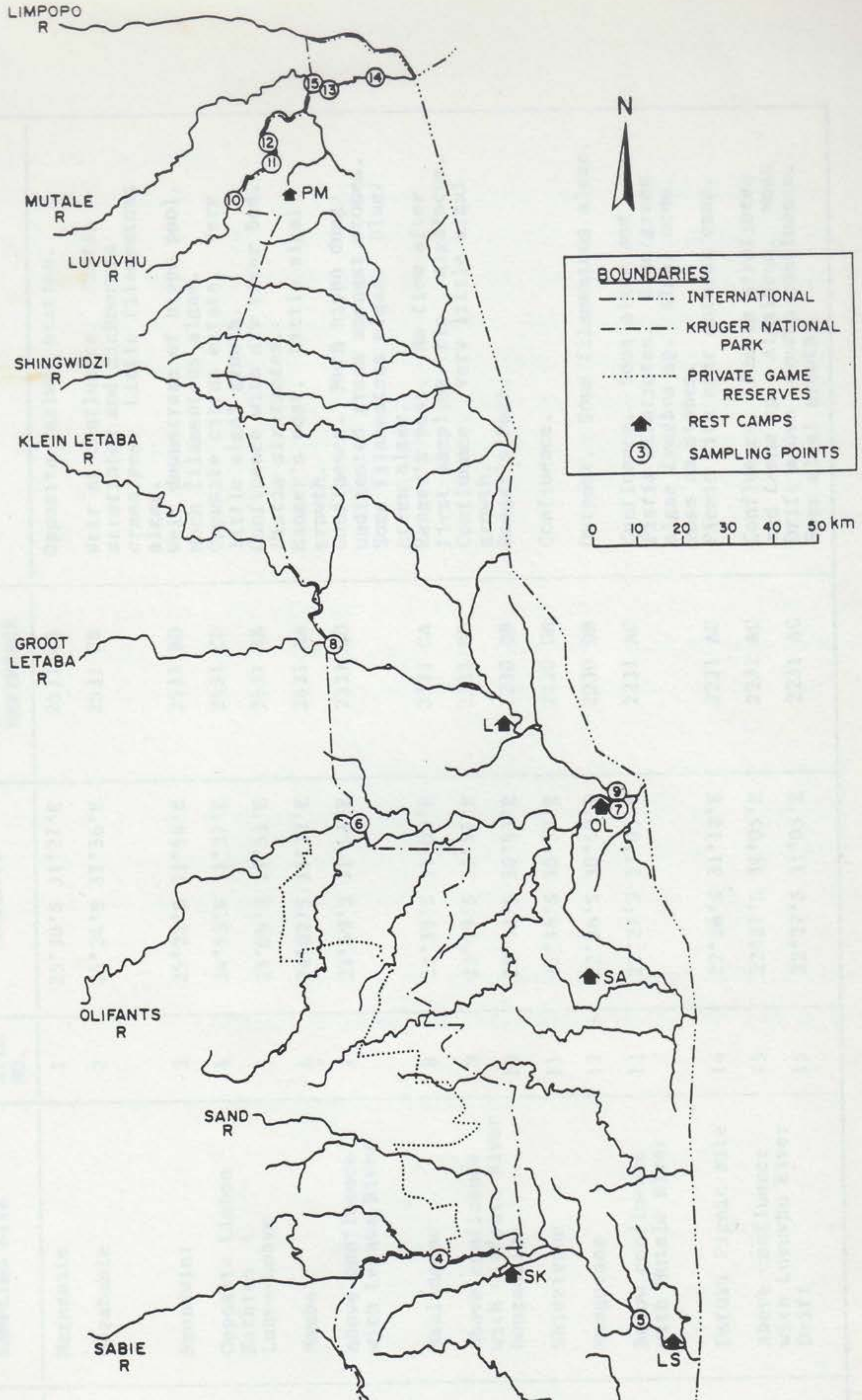

Figure 2. A map of the Kruger National Park showing sampling points. (Refer to Table 5).

TABLE 5. DESCRIPTION OF SAMPLING SITES

RIVER	SAMPLING SITE	SITE NO.	LOCALITY	1:50 000 MAP REFERENCE	DESCRIPTION
Crocodile	Magnesite	1	25°30'S 31°27'E	2531 CB	Opposite railway station.
Crocodile	Gezabahle	2	25°24'S 31°36'E	2531 CB	Weir at confluence. *Pistia stratiotes* and *Eichhornia crassipes*. Little filamentous algae.
Crocodile	Ngondwini	3	25°22'S 31°58'E	2531 BD	Weir downstream of hippo pool. Much filamentous algae.
Sabie	Opposite Lisbon Estates	4	24°59'S 31°27'E	2431 CD	Opposite citrus estate. Very little algal growth.
Sabie	Lubye-Lubye	5	25°06'S 31°53'E	2531 BB	Confluence with dry river bed. *Pistia stratiotes*.
Olifants	Mamba	6	24°02'S 31°13'E	2431 AA	Ranger's post. Little algal growth.
Olifants	Above confluence with Letaba River	7	23°59'S 31°51'E	2331 DD	Confluence. Much hippo dung/undigested grass amongst stones. Some filamentous algae. Blue/green algae.
Letaba	Mahlangene	8	23°39'S 31°09'E	2331 CA	Ranger's post. No flow after first sampling trip. Algalscum.
Letaba	Above confluence with Olifants River	9	23°59'S 31°51'E	2331 DD	Confluence. Very little algal growth.
Luvuvhu	Dongadziba	10	22°43'S 30°53'E	2230 DB	Ranger's Post.
Luvuvhu	Shidzivane	11	22°38'S 30°58'E	2230 DB	Confluence.
Luvuvhu	Mangovane	12	22°36'S 30°59'E	2230 DB	Outpost. Some filamentous algae.
Luvuvhu	Below confluence with Mutale River	13	22°27'S 31°05'E	2231 AC	Confluence. Some algae and *Pistia stratiotes*. Blue/green algae *Lyngbya* sp. Algal scum, moss on stones.
Luvuvhu	Pafuri Picnic site	14	22°26'S 31°12'E	2231 AC	Picnic site near Anthrax camp.
Mutale	Above confluence with Luvuvhu River	15	22°27'S 31°05'E	2231 AC	Confluence. *Pistia stratiotes* and *Lemna* sp. Algalscum. Moss
Mutale	Drift	15	22°27'S 31°05'E	2231 AC	Drift above Luvuvhu confluence. Some algal growth.

5.3 SAMPLING PROGRAMME

The original proposed sampling programme entailed seven collecting trips, commencing in April 1985 and returning every alternate month for a period of one year. This was to be followed by an additional dry season visit. Trips were actually undertaken in April and June of 1985, but the proposed August 1985 visit was not possible due to a lack of available facilities in the Park. A visit was, however, possible in September 1985. This was followed by sampling trips in April, June, August and October of 1986. The above rescheduling was necessary due to heavy summer rainfall which made many of the sampling sites inaccessible.

The proposed timetable was planned to enable seasonal variations in faunal composition to be detected. These sampling times would also be most likely to show the effects of minimum and maximum dilution of possible pollutants.

The proposed November 1985 trip had to be aborted after only two sites had been visited (Crocodile River at Gezabahle and Sabie River at Lubye-Lubye). One additional set of samples was collected from a single site (Sabie River at Lubye-Lubye) in January 1986, whilst on vacation.

The eventual rescheduled timetable led to the collection of data through two dry seasons with a very limited amount of data available for the summer period of October to April.
Table 6 indicates the benthic fauna samples collected.

TABLE 6. BENTHIC FAUNA SAMPLES COLLECTED.

DATE / BIOTOPE	APR 85 I O S V	JUNE 85 I O S V	SEPT 85 I O S V	NOV 85 I O S V	JAN 86 I O S V	APR 86 I O S V	JUNE 86 I O S V	AUG 86 I O S V	OCT 86 I O S V
SAMPLING SITE									
Crocodile River Ngondwini	+ + - -	+ - + -	+ - - -	- - - -	- - - -	- - + -	+ P + -	+ - + -	+ - + -
Crocodile River Gezabahle	+ + - - a	+ + - -	+ + - -	- + - +	- - - -	+ + - -	+ + + -	+ + + -	+ + - -
Sabie River Lubye-Lubye	+ + + -	+ + + -	+ + - -	+ + - -	+ + + -	+ + - -	+ + + -	+ - - -	+ + - -
Sabie River Opposite Lisbon Estates	+ + + -	+ + - -	+ + - -	- - - -	- - - -	+ - - -	+ + + -	+ + + -	+ + + -
Letaba River Mahlangene	+ + - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -
Letaba River above confluence with Olifants River	+ + - -	+ + - -	- - - -	- - - -	- - - -	+ + - -	+ + - -	- - - -	- + - -
Olifants River Mamba	+ + - -	+ - - +	+ + - -	- - - -	- - - -	+ + - -	+ + - -	+ + - -	+ + + -
Olifants River above confluence with Letaba River	+ + + -	+ + - -	+ + - -	- - - -	- - - -	+ + - -	+ + - -	+ + - -	+ - - -
Luvuvhu River western site	+ + - + b	+ + - + b	- - - -	- - - -	- - - -	+ + - - c	+ + - + d	+ + - + d	+ + - - d
Luvuvhu River below confluence with Mutale River	+ + - -	+ + - -	+ + - -	- - - -	- - - -	+ + - -	+ + - +	+ + - -	+ + - -
Luvuvhu River Pafuri Picnic Site	+ + - -	+ + - -	+ - - -	- - - -	- - - -	+ + - -	+ + + +	+ + + +	- - - -
Mutale River above confluence with Luvuvhu River	+ - - -	+ + - -	+ + - - e	- - - -	- - - -	+ + - -	+ + - -	+ + - +	- - - -

6. METHODS

6.1 BENTHIC FAUNA

6.1.1 Field Collection

Benthic invertebrate samples were collected using a hand net made from bolting silk with a mesh size of 300µm which was mounted on a 0.25 m diameter brass ring attached to a 1.5 m wooden handle. In order to sample both the stones-in- and out-of-current biotopes, the net was held immediately downstream of the stones to be sampled. Selected stones were individually lifted and the animals clinging or attached to the stone were scrubbed off into the net. Those animals that had been on or under the stones-in-current and had become dislodged when the stone was moved, drifted downstream with the current into the net. This process was repeated until a representative sample had been collected. Sediment samples were collected by rapidly sweeping the net through the surface sediments several times. A similar method was used for vegetation biotopes, the net being moved back and forth through the vegetation to be sampled. The animals were transferred to a Nasco Whirl-Pak bag (Millipore South Africa (Pty) Ltd., Johannesburg) containing approximately 300 ml of water.

Formalin was added to the sample to a final concentration of approximately 4% (volume/volume) to preserve the sample until it could be sorted in the laboratory. At each site, water temperature and the time of sampling were recorded whilst the rate of water flow at the stones-in-current biotope at each site was measured using an "Ott" current meter.

6.1.2 Laboratory Techniques

In the laboratory, the preserved sample was poured into a brass sieve with a mesh aperture of 710µm, standing in a 300µm mesh silk net. The sample was then gently rinsed with a stream of tap water. Any animals remaining in the sieve constituted the macro-sample, whilst those animals that passed through the seive and were retained by the net formed the micro-sample.

Each macro-sample was thoroughly sorted using a binocular dissecting microscope. Individual animals were separated from the detritus, which together with any vegetation and pebbles was later discarded. Animals were identified to the lowest possible taxonomic rank (dependent on available literature and ease of identification) and then transferred to vials containing 80% alcohol for long-term storage. Representative collections of the animals found will be prepared for the museum at Skukuza and for the N.I.W.R. reference collection. The remaining material will be sent to the National Freshwater Invertebrate Collection at the Albany Museum, Grahamstown.

The material in the micro-sample was transferred to an octagonal beaker and tap water added to make up the sample volume to 200 ml. This was then stirred and a 25 ml sub-sample was removed, using a wide-mouthed pipette, and transferred to a square counting tray. All animals in the sub-sample were identified and counted under a binocular dissecting microscope. By multiplying the number of animals in this sub-sample by a factor of eight, an estimate of the total number of animals in the micro-sample was obtained. However, if there were fewer than fifty animals in the sub-sample, a second 25 ml sub-sample was taken and the total number of animals that were counted was multiplied by a factor of four. Full details of this method together with a statistical analysis of the technique are given by Allanson and Kerrich (1961). The whole of the micro-sample was preserved in 80% alcohol.

The animals were identified to species level where possible. However, since there is not a general taxonomic text on the freshwater invertebrates of South Africa, it was sometimes only possible to identify animals to family level using North American identification keys. In order for these animals to be identified further, they will have to be sent to experienced taxonomists.

6.1.3 Analysis and Evaluation of Data

The method of data analysis employed is the Empirical Biotic Index (Chutter, 1972). In most samples it was found that some of the smaller animals (eg. baetid juveniles) could not be identified further than to family level. Hence, before the calculation of biotic indices, these animals were apportioned to identified taxa of the same family in proportion to the abundance of the identified individuals in the sample.

Biotic indices are useful tools for obtaining a general picture of the quality of water. The types and combinations of animals present in a sample provide an indication of the level of organic pollution of the water from which they were taken. However, while the biotic index value (B.I.V) is a useful tool, it also has certain disadvantages. The first of these is that the Index is applicable only to collections of animals from the stones-in-current biotope. Secondly, it is assumed that all changes in faunal composition are due to organic pollution. This is an over-simplification, since other factors such as heavy metal pollution, biocide contamination and physical environmental parameters can also influence the structure of the faunal population. However these factors are characterized by distinctive invertebrate faunas (Hynes, 1960). Another factor that must be taken into account, when dealing with South African rivers, is considerable variability of water flow and river characteristics due to the distinct dry and wet seasons. Chutter's Empirical Biotic Index was specifically designed for South African conditions using fauna collected from the stones-in-current biotope. In this index, all animals in a sample, with the exception of the Cladocera and Copepoda, contribute to the calculation of the B.I.V.. These two orders are omitted since most of the individuals of these orders are not strictly benthic and so drift into the net with the current. Their abundance is therefore heavily influenced by the current speed and the length of time taken to collect the sample.

The B.I.V. is calculated using the quality values listed in Table 7. This differs from the table published by Chutter (1972) in that it also includes the midge tribe, Tanytarsini. Chutter (1984) concluded that this taxon should also be specified in the calculation of the biotic index, since it has been found to be numerous in association with large numbers of other types of Chironomidae whose densities are related to the amount of organic enrichment of the water.

TABLE 7: QUALITY VALUES FOR THE CALCULATION OF CHUTTER'S BIOTIC INDEX VALUE (Taken from Chutter, 1972 and Chutter, 1984).

(a)

Taxon	Quality Value	Taxon	Quality Value
Hydra spp.	6	*Amphipsyche scottae*	3
Planarians	3	*Cheumatopsyche thomasseti*	2
Rhabdocoelida	10	*Macronema capense*	3
Tardigrada	7	*Hydroptila* spp.	2
Nematoda (except Mermithidae)	7	*Orthotrichia* spp.	2
		Stenelmis spp.	3
Oligochaeta other than *Nais*	Table 7b	Psychodidae-*Psychoda* spp.	10
Nais spp.	Table 7b	Culicidae	10
Hirudinea	7	*Chironomus* spp.	10
Cypridopsis spp.	Table 7b	Chironomini (except *Chironomus*)	Table 7b
Baetis harrisoni	Table 7c		
Choroterpes (Euthraulus) sp.	1	Orthocladiinae	Table 7b
		Tanytarsini	Table 7b
		Simuliidae	Table 7b
Caenidae	1	*Eristalis* spp.	10
Micronecta spp.	4	Ancylidae	4

Quality Value for all other taxa is 0, but Cladocera and Copepoda are omitted.

(b)

Baetid Emphemeroptera		Quality values (dependent on Baetid Ephemeroptera shown on the left)			
Number of species	**Individuals as % of whole fauna***	**Oligochaeta other than *Nais***	***Nais***	***Cypridopsis*, Chironomini (except *Chironomus*) Orthocladiinae Tanytarsini**	**Simuliidae**
5 or more	any	8	1	1	0
3 or 4	20	8	1	1	0
	10-20	8	3	3	3
	5-10	8	5	3	3
	5	8	5	5	3
1 or 2	20	8	1	1	1
	10-20	8	3	3	3
	5-10	8	5	5	5
	5	8	8	7	5
Absent	-	10	10	7	5

(c)

Ephemeroptera	***B. harrisoni* Quality Value**	**To arrive at Baetid per cent for (b) multiply *B. harrisoni* numbers by**
B. harrisoni	6	0.5
B. harrisoni and 1 other species	4	0.5
B. harrisoni and 2 other species	2	0.5
B. harrisoni and 3 or more species	0	1.0

*1. Fauna is all animals in sample except Cladocera and Copepoda
2. The percentage is calculated after multiplying the *Baetis harrisoni* numbers by either 0.5 or 1 as shown in Table 7c.

Chutter's Biotic Index Value is calculated as follows:

$$B.I.V. = \frac{\Sigma(a \times b)}{c}$$

where a= number of individuals of a taxon

b= quality value assigned to that taxon

c= total number of individuals in the sample.

The interpretation of Chutter's B.I.V. is:

B.I.V.	Interpretation
0-2	Clean unpolluted waters.
2-4	Slightly enriched waters, the slight enrichment may be due either to the natural occurrence of organic matter or to high quality effluents containing a little organic matter or its breakdown products. Chemical changes in the water may be hardly detectable.
4-7	Enriched waters, the higher the B.I.V. the greater the enrichment. Obvious increases in the Biological Oxygen Demand, high levels of nitrogenous compounds in the water and rather wide diurnal fluctuations in the dissolved oxygen are to be expected.
7-10	Polluted waters in which there will be great increases in the chemical parameters associated with organic pollution.

6.2 DIATOM FLORA

In September 1985 Dr R.E.M. Archibald collected samples of the diatom flora at nine of the sampling sites.

6.2.1 Field Collection

Diatoms were collected in the field by scraping them from the substrate, (e.g., rocks, stones, sand) with a metal spoon. The diatoms were then transferred to a 50 ml glass bottle containing a few millilitres of water. Formalin was added to a final concentration of approximately 4% (volume/volume). These preserved samples were then taken to the laboratory for further treatment and analysis.

6.2.2 Laboratory techniques

In the laboratory, the diatoms were oven-dried at 90°C until dry. The samples were then cleaned and prepared for microscopic analysis. A detailed description of the methods used can be found in Schoeman and Archibald (1977) and Welsh (1964). Microscopic examination was carried out at 1250x magnification on samples mounted in Naphrax.

6.3. WATER CHEMISTRY

The chemistry of the water of the rivers included in this study is routinely monitored by the Hydrological Research Institute (H.R.I.) of the Department of Water Affairs. The analyses that are performed are electrical conductivity, pH, total dissolved solids, total hardness, calcium, magnesium, potassium, sodium, total alkalinity, chloride, fluoride, silicon, sulphate, ammonium, nitrate + nitrite, kjeldahl nitrogen, inorganic phosphorus and total phosphorus.

Table 8 gives the locations of the sites from which chemical data was obtained and used in this study. Means, standard deviations and coefficients of variation have been calculated for wet (October to March) and dry (April to

September) seasons. The mean values for pH were calculated using the pH units recorded by H.R.I.,ignoring the fact that the pH scale is logarithmic.

TABLE 8. LOCATION OF DEPARTMENT OF WATER AFFAIRS (DWA) CHEMICAL SAMPLING POINTS

RIVER	OLD DWA NUMBER	NEW DWA NUMBER	STATION NAME	LOCALITY
Crocodile	X2Q06	X2M49	Mbyamiti confluence	25°19'S 31°45'E
Crocodile	X2Q07	X2M50	Crocodile Bridge Rest Camp	25°22'S 31°54'E
Sabie	X3Q02	X3M13	National Parks Dept. Powerline	24°59'S 31°35'E
Sabie	X3Q04	X3M15	Lower Sabie Rest Camp	25°07'S 31°55'E
Olifants	B7Q01	B7M15	Mamba Ranger's Post	24°03'S 31°13'E
Olifants	B7Q04	B7M18	Hiking Trail Camp	24°00'S 31°48'E
Letaba	B8Q07	B8M28	Mahlangene	23°39'S 31°09'E
Letaba	B8Q09	B8M30	Klipkoppiesdrif	23°57'S 31°44'E
Luvuvhu	A9Q01	A9M08	Shidzivane	22°38'S 30°58'E
Luvuvhu	A9Q02	A9M09	Madzaringwe	22°30'S 31°04'E
Luvuvhu	A9Q04	A9M11	Pafuri	22°25'S 31°13'E

7. RESULTS

7.1 WATER CHEMISTRY

Table 9 summarizes the chemical data that has been collected by the H.R.I. at their routine monitoring sites (Table 8) from October 1983 to October 1986. Due to the lack of water flow data for the rivers in the vicinity of the K.N.P., it was not possible to ascertain actual flows on sampling dates. In the analysis of the data, each year was divided into a winter season (April to September) and a summer season (October to March). It is apparent from Table 9 that the coefficient of variation (C.V) is very high for most means, so it is probable that the winter and summer periods chosen do not coincide exactly with wet and dry periods. However, since the C.V. values are so high, the many differences in chemical concentrations between different dates and different sites cannot be regarded as statistically significant. This implies that comparisons of the arithmetic means (x) should be made with caution. However, there does seem to be a general trend in chemical concentrations. This general trend is that the Olifants River has very high values for all of the chemical components that were measured. Mean concentrations in the Letaba and Crocodile Rivers were lower and similar in the two rivers. The Sabie River had the lowest overall values with the Luvuvhu also having relatively low chemical concentrations.

From the recorded coefficients of variation the mean values for the Olifants River were more variable than those for the Sabie River. Mean potassium and sulphate concentrations in the Olifants River were particularly greater than in the other rivers, while fluoride and silica concentrations were no higher in the Olifants than elsewhere.

A notable exception to this general trend was the concentrations of nitrates and nitrites in the Crocodile River which were as high as those in the Olifants River.

Table 9. A summary of the chemical data provided by the Department of Water Affairs

RIVER		CROCODILE				SABIE				OLIFANTS				LETABA				LUVUVHU					
SAMPLING POINT[1]		X2M49		X2M50		X3M13		X3M15		B7M15		B7M18		B8M28		B8M30		A9M08		A9M09		A9M11	
SEASON[2] PROPERTY		W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
Electrical Conductivity (ms/m)	n[3]	24	27	23	26	35	33	28	35	74	78	38	30	71	27	7	14	65	61	37	40	37	40
	x	43.8	32.6	45.3	35.1	12.5	12.1	13.7	13.3	110.7	71.7	87.3	74.8	43.1	32.2	32.4	31.5	13.2	13.5	21.2	18.3	14.3	20.8
	s	10.3	14.7	11.2	15.2	0.9	3.4	1.2	2.5	47.7	51.4	25.5	56.1	15.7	23.9	6.3	12.0	2.0	4.1	25.5	7.1	3.8	16.7
	cv	23	45	25	43	7	28	9	19	43	72	29	75	36	74	19	38	15	30	120	39	26	80
pH	n	24	27	23	26	35	33	28	35	74	78	38	30	11	27	7	14	65	61	37	40	37	40
	x	8.0	7.8	8.0	8.0	7.1	6.9	7.2	7.1	7.9	7.9	8.1	8.1	7.7	7.6	7.4	7.6	7.2	7.1	7.2	7.2	7.2	7.3
	s	0.3	0.4	0.4	0.5	0.3	0.5	0.3	0.4	0.2	0.3	0.3	0.4	0.3	0.5	0.4	0.6	0.3	0.5	0.4	0.5	0.3	0.6
	cv	4	5	5	6	4	7	4	6	2	4	4	4	4	7	5	8	4	7	5	7	4	8
Total Dissolved Solids (mg/l)	n	24	27	23	26	35	33	28	35	74	78	37	30	11	27	7	14	65	61	37	40	37	40
	x	330.6	234.7	337.9	257.6	85.9	82.4	92.4	89.5	792.8	520.0	628.4	551.7	288.4	224.9	229.1	220	91.3	96.6	139.0	130.1	95.7	157.2
	s	95.1	114.5	101.6	123.0	8.1	21.6	8.8	17.5	360.4	420.6	216.1	445.0	109.5	175.2	51.2	97.0	12.9	32.5	175.3	54.2	24.1	136.6
	cv	29	49	30	48	9	26	9	19	45	81	34	82	38	78	22	44	14	34	126	42	25	87
Total Hardness (mg/l $CaCO_3$)	n	24	27	23	26	35	33	28	35	74	78	38	30	11	22	7	14	65	61	37	40	37	40
	x	136.7	98.7	139.2	109.4	40.5	36.5	39.3	37.2	370.9	246.8	291.5	259.5	111.9	85.6	98	93	41.7	41.0	58.0	55.8	42.2	62.3
	s	37.5	32.3	38.8	42.5	5.3	11.5	6.2	8.5	176.9	212.0	104.0	224.5	38.6	51.6	27.8	40.5	6.5	14.7	80.8	24.9	11.6	38.7
	cv	27	33	28	39	14	31	16	23	48	86	36	86	34	60	28	44	16	36	139	44	27	62
Ca Dissolved (mg/l)	n	24	27	23	26	35	33	28	35	74	78	38	30	11	27	7	14	65	61	37	40	37	40
	x	19.3	14.8	19.9	16.4	7.7	7.0	7.5	7.1	45.7	34.8	39.1	37.1	23.1	17.9	20.3	19.9	8.1	7.5	9.1	11.1	7.9	12.0
	s	4.6	3.7	4.8	5.9	1.3	2.3	1.4	1.6	17.2	21.3	11.2	21.8	7.2	8.3	5.7	8.6	1.4	2.5	9.1	5.1	2.3	5.8
	cv	24	25	24	36	17	33	19	22	38	61	29	59	7.6	8.5	28	43	18	33	100	46	29	48
Mg Dissolved (mg/l)	n	24	27	23	26	35	33	28	35	74	78	38	30	11	27	7	14	65	61	37	40	37	40
	x	21.5	15.1	21.9	16.7	5.3	4.8	5.0	5.9	62.4	38.9	47.1	40.7	13.2	10.0	11.4	10.6	5.4	5.4	8.6	7.0	5.6	8
	s	6.4	5.7	6.7	6.8	0.9	1.6	0.8	1.3	33.5	38.8	19.2	41.5	4.8	7.5	3.4	4.9	0.9	2.2	14.2	3.3	1.6	6.4
	cv	30	38	30	41	17	33	16	26	54	100	41	102	36	75	30	46	16	41	164	48	29	80
K Dissolved (mg/l)	n	24	27	23	26	35	33	28	35	74	78	38	30	11	27	7	14	65	62	37	40	37	40
	x	1.2	1.5	1.3	1.5	0.6	1.1	0.9	1.6	19.1	11.8	12.8	11.7	4.6	5.0	6.0	5.6	1.3	1.8	1.3	2.5	1.0	2.6
	s	0.4	0.7	0.9	0.8	0.2	0.6	0.3	0.8	14.9	14.2	8.2	13.4	0.6	1.5	0.9	1.8	1.0	1.0	3.4	2.0	0.8	1.7
	cv	33	47	69	53	33	54	33	50	78	120	64	115	13	30	15	32	77	54	261	79	80	65

Table 9. A summary of the chemical data provided by the Department of Water Affairs (Cont.)

RIVER		CROCODILE				SABIE				OLIFANTS				LETABA				LUVUVHU					
SAMPLING POINT[1]		X2H49		X2H50		X3H13		X3H15		B7H15		B7H18		B8H28		B8H30		A9H08		A9H09		A9H11	
SEASON[2]		W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
PROPERTY																							
Na dissolved (mg/l)	n	24	24	23	26	35	33	28	35	74	78	38	30	11	27	7	14	65	62	37	40	37	40
	x	41.0	28.4	42.9	29.9	6.1	7.1	8.8	9.5	88.5	55.7	73.2	62.1	38.4	30.4	22.3	23.4	7.9	8.3	18.2	12.7	9.9	17.8
	s	14.3	24.5	15.4	20.3	1.1	2.3	1.9	3.6	39.6	4.7	24.4	52.3	18.6	40.3	4.3	8.7	1.8	3.0	25.2	6.7	3.7	25.4
	cv	35	86	36	68	18	32	21	38	45	75	33	84	48	132	19	37	22	36	138	53	37	143
Alk.Tot. (mg/l $CaCO_3$)	n	24	27	23	26	35	33	28	35	74	78	38	30	11	27	7	14	65	62	37	40	37	40
	x	153.1	99.6	152.6	108.4	36.0	29.8	35.8	31.3	143.0	110.9	156.7	122.2	109.4	83.1	91.3	89.2	36.8	37.3	46.1	50.1	38.8	67.3
	s	52.8	54.5	51.7	49.3	5.5	11.7	7.1	10.7	25.6	30.3	29.9	35.4	49.6	56.5	23.4	50.3	1.0	18.6	47.9	26.1	12.6	76.3
	cv	34	55	34	45	15	39	20	34	18	27	19	29	45.0	68	26	56	27	50	104	52	32	113
Cl Dissolved (mg/l)	n	24	27	23	26	35	33	28	35	74	78	38	30	11	27	7	14	65	62	37	40	37	40
	x	25.9	21.9	28.8	24.6	8.2	10.9	20.9	13.3	80.8	49.2	73.1	66.2	50.9	40.4	26.6	29.3	11.8	13.2	26.5	21.4	15.1	19.4
	s	7.0	14.8	8.5	16.2	1.9	5.6	12.1	4.8	32.4	38.1	25.3	46.3	23.4	51.4	2.6	8.5	2.1	3.0	31.8	9.6	4.2	7.4
	cv	27	67	29	66	23	51	58	36	40	77	35	70	46	127	10	29	17	23	120	45	28	38
F Dissolved (mg/l)	n	24	27	23	26	35	33	28	35	74	78	38	30	11	27	7	14	65	62	37	40	37	40
	x	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.2	1.2	0.7	0.9	0.7	0.3	2.9	0.3	0.2	0.1	0.2	0.2	0.2	0.1	0.2
	s	0.1	0.1	0.1	0.1	0.04	0.07	0.05	0.08	0.7	0.7	0.4	0.6	0.1	3.5	0.1	0.07	0.04	0.2	0.2	0.3	0.03	0.1
	cv	33	33	33	33	40	70	50	40	58	100	45	76	33	124	32	35	36	100	100	183	30	50
Si (mg/l)	n	24	27	23	26	35	33	28	35	74	78	38	30	11	27	7	14	65	62	37	40	37	40
	x	10.1	10.9	9.8	11.2	6.3	6.7	6.0	7.3	8.3	8.5	7.0	7.5	6.1	7.2	8.5	7.7	6.4	7.5	5.0	6.2	5.7	7.2
	s	2.4	1.1	2.0	2.1	1.3	1.3	1.3	0.7	1.4	0.9	1.6	1.5	3.9	1.4	1.0	1.7	1.5	1.0	2.8	1.5	1.0	1.8
	cv	24	10	20	19	21	19	22	9	17	10	23	20	64	19	12	22	23	14	54	25	18	25
SO_4 Dissolved (mg/l)	n	24	27	23	26	35	33	28	35	74	78	38	28	11	27	7	14	65	62	37	40	37	40
	x	25.3	18.3	24.3	22.8	7.3	7.9	3.1	7.3	310.0	181.9	183.7	88.2	18.1	10.9	20.3	11.9	4.3	6.3	13.9	6.7	3.2	6.7
	s	8.3	9.2	7.6	19.1	3.3	3.7	3.0	3.7	221.1	269.9	113.5	258.6	10.2	9.9	13.8	10.8	2.8	5.2	59.8	5.4	1.5	6.2
	cv	33	50	31	84	45	47	37	51	71	148	62	137	56	91	68	91	65	82	430	81	47	92
NH_4 (mg/l)	n	24	27	23	26	35	33	28	35	74	78	38	30	11	27	7	14	65	62	37	40	37	40
	x	0.06	0.05	0.06	0.05	0.05	0.07	0.07	0.07	0.09	0.09	0.06	0.06	0.1	0.2	0.06	0.09	0.09	0.09	0.05	0.08	0.06	0.09
	s	0.02	0.02	0.01	0.02	0.02	0.09	0.03	0.06	0.08	0.06	0.02	0.03	0.12	0.2	0.02	0.1	0.2	0.06	0.02	0.05	0.03	0.07
	cv	33	40	17	40	40	128	43	86	89	67	38	52	100	100	33	111	188	66	39	69	50	78
NO_3+NO_2 (mg/l)	n	24	27	23	26	35	33	28	35	74	78	38	30	11	27	7	14	65	62	37	40	37	40
	x	0.8	0.5	0.7	0.5	0.2	0.2	0.1	0.2	0.5	0.8	0.1	0.3	0.1	0.4	0.4	0.6	0.3	0.4	0.1	0.4	0.1	0.4
	s	0.3	0.3	0.3	0.3	0.1	0.2	0.07	0.2	0.5	1.0	0.3	0.4	0.2	0.4	0.4	0.4	0.3	0.4	0.08	0.5	0.1	0.4
	cv	37	60	43	60	50	100	70	100	100	125	208	35	200	100	100	67	100	100	80	106	100	100

Table 9. A summary of the chemical data provided by the Department of Water Affairs (Cont.)

RIVER		CROCODILE				SABIE				OLIFANTS				LETABA				LUVUVHU					
SAMPLING POINT[1]		X2H49		X2H50		X3H13		X3H15		B7H15		B7H18		B8H28		B8H30		A9H08		A9H09		A9H11	
SEASON[2] PROPERTY		W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
N KJEL (mg/l)	n	3	7	3	6	3	8	1	8	4	18	-	-	-	5	-	-	4	16	4	6	4	6
	x	0.7	0.4	0.6	0.3	0.6	0.7	0.4	0.9	0.9	1.9	-	-	-	1.9	-	-	0.6	0.5	1.0	0.5	1.1	0.6
	s	0.2	0.2	0.2	0.2	0.1	1.1	-	0.8	0.2	3.9	-	-	-	0.9	-	-	0.04	0.2	0.5	0.4	0.7	0.3
	cv	28	50	33	67	17	157	-	89	22	205	-	-	-	47	-	-	7	49	49	79	64	50
P total inorganic (mg/l)	n	24	27	23	26	35	33	28	35	74	78	38	30	11	27	7	14	65	62	37	40	37	40
	x	0.02	0.02	0.1	0.02	0.01	0.02	0.01	0.03	0.04	0.04	0.02	0.03	0.04	0.05	0.06	0.07	0.02	0.05	0.02	0.09	0.02	0.09
	s	0.01	0.02	0.009	0.01	8.1	0.03	0.008	0.04	0.09	0.1	0.008	0.03	0.06	0.09	0.03	0.04	0.03	0.09	0.01	0.2	0.02	0.2
	cv	50	100	9	50	81000	150	80	133	225	250	40	100	150	180	50	57	145	189	50	244	100	222
P total (mg/l)	n	3	7	3	6	3	6	1	8	4	18	-	-	-	5	-	-	4	16	4	6	4	6
	x	0.08	0.05	0.06	0.04	0.03	0.1	0.07	0.09	0.1	0.3	-	-	-	0.3	-	-	0.05	0.04	0.1	0.06	0.2	0.08
	s	0.04	0.02	0.04	0.02	0.02	0.2	-	0.1	0.04	0.5	-	-	-	0.09	-	-	0.02	0.008	0.2	0.03	0.3	0.04
	cv	50	40	67	50	67	200	-	111	40	167	-	-	-	30	-	-	42	19	122	48	150	50

1. Sampling point numbers from Department of Water Affairs (Table 8).

2. W - Winter (April to September), S - Summer (October to March).

3. n= number of samples; x= arithmetic mean; s= standard deviation; cv= coefficient of variation (100s/x).

7.2 ZOOBENTHOS

7.2.1 Stones-in-current fauna

Whenever possible, the rate of flow of the water from which the stones-in-current samples were taken was measured. Table 10 shows the recorded current speeds. It is apparent from this table that most of the current speeds were of the same order, with the exception of Crocodile River at Ngondwini in September, 1985 and Sabie River at Lubye-Lubye in August 1986. However the values are still low and it is assumed that the current speed did not greatly influence the faunal differences between stones-in-current samples.

Tables A1 to A12 list the taxa found in the stones-in-current samples. Numbers of individuals present are expressed as a percentage of the total number of animals in each sample, which normalizes abundance and allows for comparisons between samples.

Figures 3 and 4 are stacked bar charts showing the number of taxa for each major taxonomic group for each stones-in-current sample. They give a visual indication of the relative diversity of taxa within each sample. The values for *Simulium* sp. may be misleading since they are indicative of presence or absence and not of the number of species in the sample.

The total number of taxa recorded at each sampling point is shown in Table 11. The number of taxa collected is related to the number and size of samples and this should be borne in mind in interpreting the information in Table 11. To some extent low sampling frequency accounts for the small number of taxa recorded from the Letaba River sampling points. However it is clear from Figure 4 and the Appendix Tables that the number of taxa in the separate samples from the Letaba River were always at or near the bottom of the range of numbers from other sampling points in the months when they were collected. Table 11 shows that the numbers of taxa recorded from the stones-in-current were greatest in the Sabie River, followed by the Crocodile, the Mutale, Luvuvhu and the Olifants (between which there was little difference) and finally by

TABLE 10. MEAN CURRENT SPEEDS (ms^{-1}) FOR STONES IN CURRENT BIOTOPE

SAMPLING SITE / DATE	JUNE 85	SEPT 85	APR 86	JUNE 86	AUG 86	OCT 86
Crocodile River Ngondwini	-	0.97	-	0.68	0.38	0.44
Crocodile River Gezabahle	0.64	0.45	0.34	-	0.51	0.55
Sabie River Lubye-Lubye	0.37	0.64	0.32	0.45	1.02	0.42
Sabie River Opposite Lisbon Estates	0.50	0.40	-	0.40	-	0.55
Letaba River above confluence with Olifants River	-	-	0.51	0.48	-	-
Olifants River Mamba	0.72	0.86	0.69	0.61	0.77	0.60
Olifants River above confluence with Letaba River	-	0.40	0.78	0.58	0.56	0.77
Luvuvhu River western site	0.50 (a)	-	-	0.63 (b)	0.38 (b)	0.53 (b)
Luvuvhu River below confluence with Mutale River	-	0.39	-	-	0.49	0.25
Luvuvhu River Pafuri Picnic Site	-	0.57	-	0.77	-	-
Mutale River above confluence with Luvuvhu River	0.53	0.49 (c)	-	0.43	0.49	-

a-Dongadziba b-Mangovane c-Drift above confluence with Luvuvhu R.

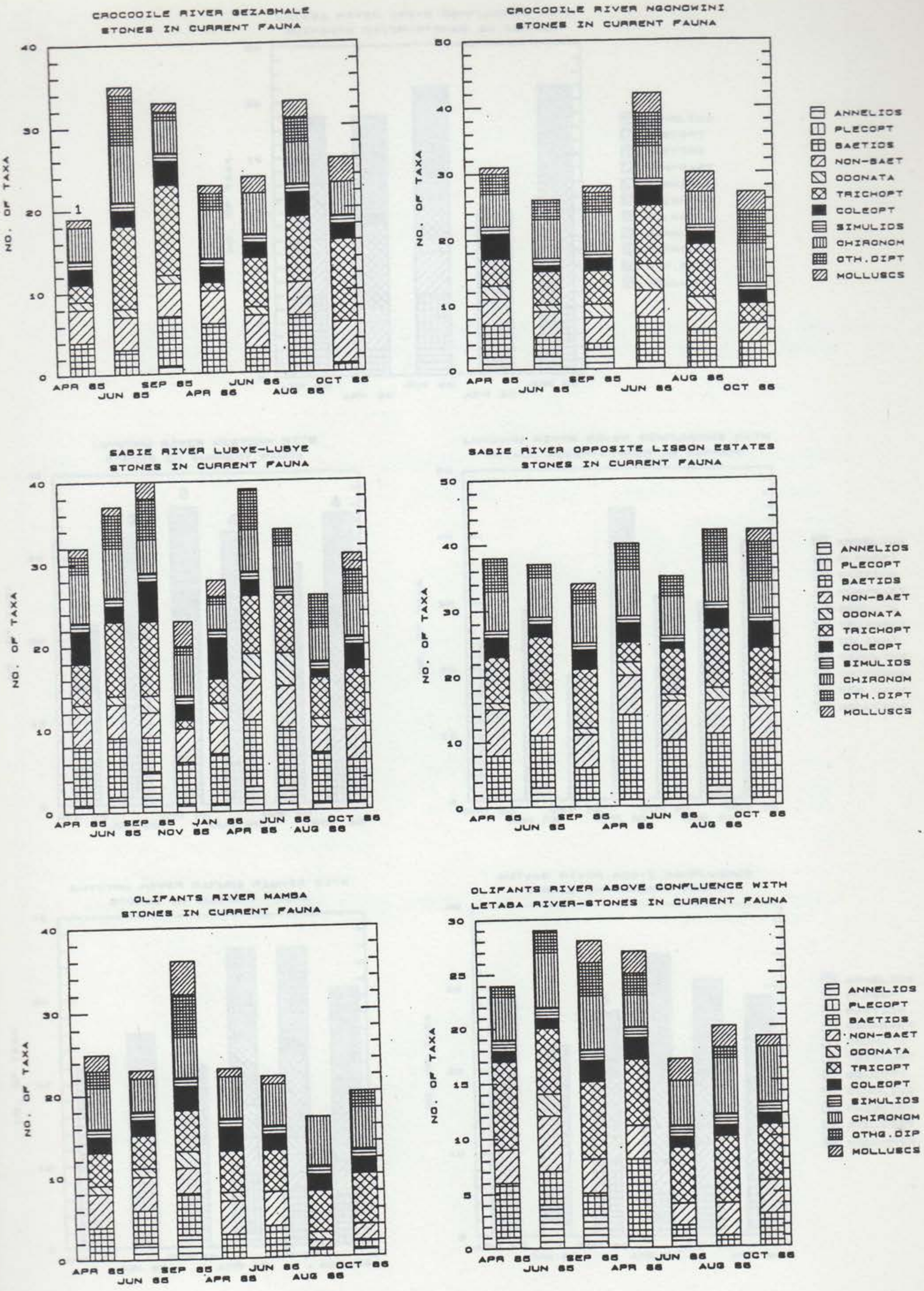

Figure 3. Stacked barcharts showing the number of taxa of the major taxonomic groups from the stones-in-current in the Crocodile, Sabie and Olifants rivers. 1- sample collected at Magnesite.

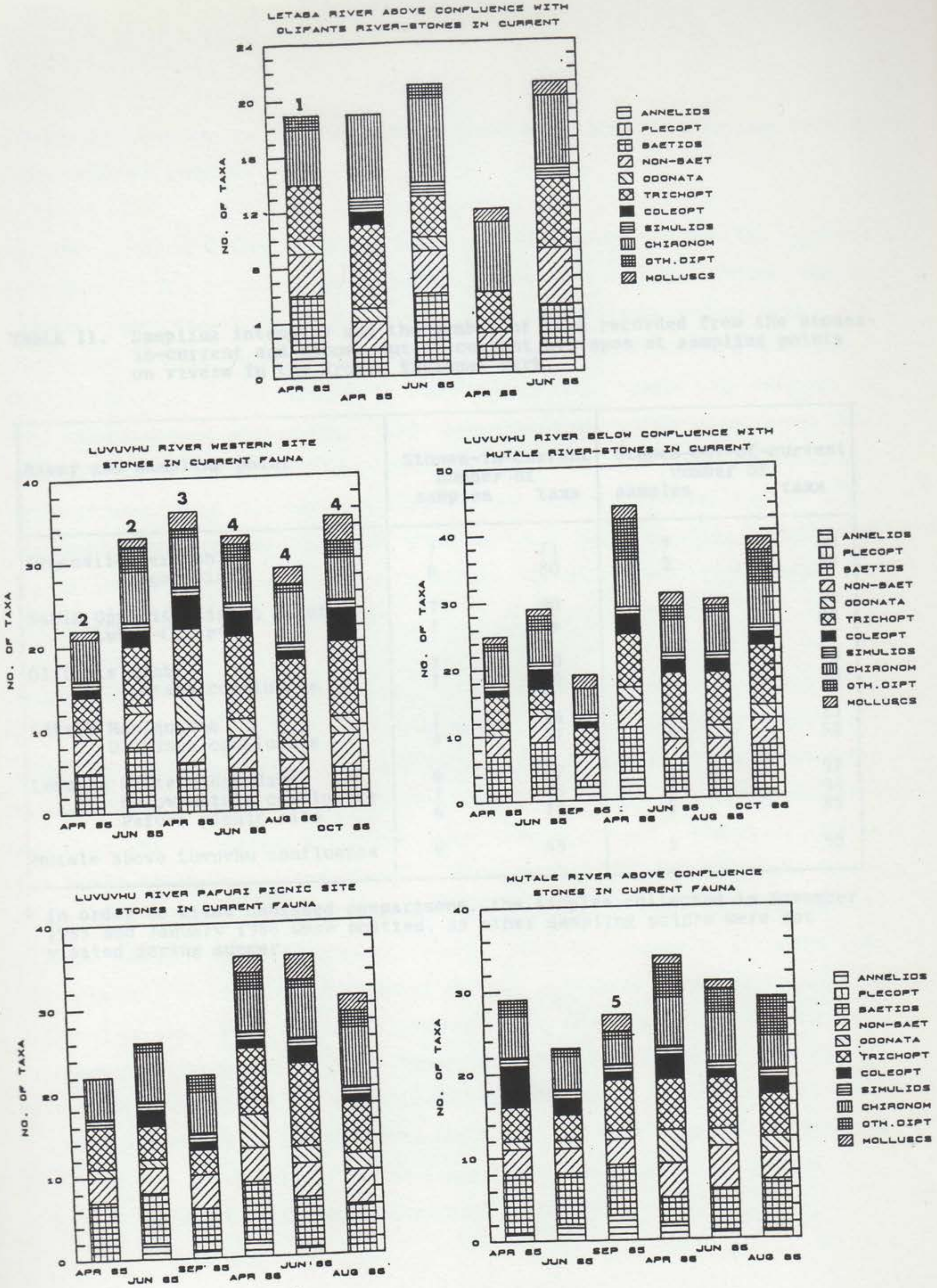

Figure 4. Stacked barcharts showing the number of taxa of the major taxonomic groups from the stones-in-current in the Letaba, Luvuvhu and Mutale rivers. Samples collected at 1- Mahlangene; 2- Dongadziba; 3- Shidzivane; 4- Mangovane; 5- Drift.

TABLE 11. **Sampling intensity and the number of taxa recorded from the stones-in-current and stones-out-of-current biotopes at sampling points on rivers in the Kruger National Park.**

River and sampling point	Stones-in-current number of samples	Stones-in-current taxa	Stones-out-of-current number of samples	Stones-out-of-current taxa
Crocodile Gezabahle	7	71	7	82
Ngondwini	6	80	2	38
Sabie Opposite Lisbon Estates	7	90	6	93
Lubye-Lubye*	7	86	6	88
Olifants Mamba	7	70	6	79
Letaba confluence	7	60	7	88
Letaba Mahlangene	1	24	1	23
Olifants confluence	4	47	4	52
Luvuvhu Western boundary	6	67	6	97
below Mutale confluence	7	75	7	94
Pafuri picnic site	6	72	5	85
Mutale above Luvuvhu confluence	6	65	5	95

* In order to allow unbiased comparisons, the samples collected in November 1985 and January 1986 were omitted, as other sampling points were not visited during summer.

the Letaba in which, as explained above, there were usually fewer taxa than at other sampling points.

The data given in Tables A1 to A12 indicate that several taxa of the zoobenthos occur in almost all of the samples. These taxa are the mayflies, *Baetis glaucus*, *Choroterpes* sp., *Tricorythus* "lowveld" and *Austrocaenis* sp.; the caddis-fly, *Cheumatopsyche thomasseti*; the Simuliidae and the major chironomid tribes. In addition to these common taxa, other taxa seem to be well represented at most sites. These less common but widely distributed taxa include the oligochaete worms *Pristina* sp. and *Nais* sp.; water mites, Hydracarina; seed shrimps, Ostracoda; the stonefly, *Neoperla spio*; the mayflies, *Centroptilum medium* and *Afronurus* sp.; the dragonfly, *Zygonyx* sp.; the leptocerid and hydroptilid caddis-flies; the riffle beetle, *Stenelmis* sp. and biting midges, Ceratopogonidae.

Table 12 shows the results of the B.I.V. calculations. In the Crocodile River 6 of the 13 values recorded lay in the range 2.0 to 2.7 indicating slight organic enrichment (see p. 25). This is confirmed by the rather high value for nitrites plus nitrates for this river (Table 9). Together with other nutrients and light, bound nitrogen stimulates autochthonous primary production, raising the levels of organic matter present. Filamentous algae were particularly obvious at Ngondwini. Enhanced levels of nitrogenous compounds are also indicative of enhanced levels of organic matter, since both occur in effluents from the treatment of organically polluted water. A further source of organic enrichment in the K.N.P. rivers is hippopotomus dung, which obviously contributed to the organic load at Ngondwini, particularly as the samples were mainly collected during extremely low flow conditions. As may be seen from Figure 3 and Tables A1 and A2, when the B.I.V. was high, the diversity of the Ephemeroptera, particularly the Baetidae, was characteristically low (cf. Crocodile River data with Sabie River data in Fig. 3).

TABLE 12. BIOTIC INDEX VALUES (Chutter, 1972) FOR STONES-IN-CURRENT BIOTOPE

DATE	APR 85	JUNE 85	SEPT 85	NOV 85	JAN 86	APR 86	JUNE 86	AUG 86	OCT 86
SAMPLING SITE									
Crocodile River Ngondwini	1.2	2.2	2.5	-	-	-	0.8	1.0	2.0
Crocodile River Gezabahle	1.6 a	2.4	0.6	-	-	0.4	2.7	0.7	2.6
Sabie River Lubye-Lubye	0.6	0.5	3.5	0.6	0.3	0.4	0.5	0.4	1.3
Sabie River Opposite Lisbon Estates	0.8	0.9	1.8	-	-	0.6	0.5	0.7	0.8
Letaba River Mahlangene	1.1	-	-	-	-	-	-	-	-
Letaba River above confluence with Olifants River	1.4	1.8	-	-	-	5.9	2.6	-	-
Olifants River Mamba	1.5	0.5	1.3	-	-	0.6	2.3	5.1	4.4
Olifants River above confluence with Letaba River	0.9	3.1	5.0	-	-	0.3	3.6	3.7	2.0
Luvuvhu River western site	0.7 b	0.8 b	-	-	-	0.5 c	0.6 d	1.8 d	1.4 d
Luvuvhu River below confluence with Mutale River	0.5	1.8	0.8	-	-	1.2	0.3	0.7	0.7
Luvuvhu River Pafuri Picnic Site	0.7	0.8	1.9	-	-	0.7	0.6	0.8	-
Mutale River above confluence with Luvuvhu River	0.7	0.6	0.4 e	-	-	0.5	0.5	0.6	-

a - Magnesite b - Dongadziba c - Shidzivane d - Mangovane e - Drift above confluence with Luvuvhu R.

B.I.V.'s for the Sabie River ranged from 0.3 to 1.8 with the exception of a value of 3.5 for Lubye-Lubye in September 1985. The reason for the high B.I.V. is the presence of only 3 baetid mayfly species (organic enrichment is known to adversely affect baetid mayfly species without totally eliminating them (Hynes, 1960)), and high abundances of *Hydra* sp., Planaria, Nematoda, oligochaetes, *Stenelmis* and chironomids, all of which have high values in the calculation of the B.I.V. and most of which are pollution-tolerant species (Hellawell, 1986). An alternative explanation for this faunal composition is that a poor sample was collected on that occasion. The water level of the river was very low, and there were few suitable rocks in the current for the collection of a representative stones-in-current sample. The barchart (Figure 3) shows that a poor sample was collected in November 1985. This was due to the high water level and the fact that the stones had only recently become submerged. The presence of Plecoptera is indicative of unenriched water (Mason, 1981). The plecopteran, *Neoperla spio* occurred in nearly all of the Sabie River samples. This indicates unenriched conditions.

There are few B.I.V's for the Letaba River (Table 12) since the river ceased to flow for long periods during the dry season. Values range from 1.1 to 2.6 with a high value of 5.9 in April 1986. A possible explanation for this very high value is that an unrepresentative sample was collected due to the fact that the river had only been flowing for a few days, and so the benthos had not had time to recolonize the river bed.

The B.I.V.'s for the Olifants River at Mamba ranged from 0.5 to 5.1. The high values for August and October 1986 are noteworthy for several reasons. Firstly, although the water level was low there was still much stones-in-current biotope available. Secondly, there was no obvious hippopotamus dung contamination and thirdly, an abnormal benthic fauna has been subsequently found in the western reaches of the river within the park (Dr B.R. Davies, personal communication). Fourthly, the high B.I.V.'s, reflected in a very low Ephemeroptera diversity, (Table A7, Fig.3), coincided with an absence of

Mollusca (snails) and the virtual disappearance of Oligochaeta (worms).

The values for the biotic index for the Olifants River above the confluence with the Letaba River varied between 0.3 and 5.0. The values were highest during the dry months of June 1985, September 1985, June 1986 and August 1986 when they were 3.1, 5.0, 3.6 and 3.7 respectively. These values may be due to the presence of a hippo pool upstream of the sampling site. The stones from which the samples were taken acted as a trap for undigested vegetation from hippo dung on every occasion that the site was sampled. It is possible that during the drier months, hippo pools dry up and so hippos move to form larger groups in the remaining pools. This concentration of hippos together with the higher concentrations of organic matter that they produce could, due to reduced dilution, be responsible for the high B.I.V.'s during the winter.

Biotic Index values for the sampling points on the Luvuvhu and Mutale Rivers were all less than 2.0 (Table 12), confirming that these rivers are chemically unpolluted (cf Table 9) and similar in status to the Sabie. It is perhaps surprising that the Mutale River is similar in status to the++ Sabie, since the Mutale River has been reported as drying out in severe droughts. However the Mutale sampling point was close to the Luvuvhu confluence, so that there may be assumed to be rapid recolonisation of the Mutale from the Luvuvhu.

7.2.2 **Stones-out-of-current fauna**

Tables B1 to B12 list the taxa collected from the stones-out-of-current biotope and give values of abundance as the percentage of the total number of animals in the sample.

Unlike the stones-in-current fauna, there were no particular species or taxa that occurred in each sample. However, there are several taxa that were abundant in many samples. As expected, these taxa differ from the abundant taxa of the stones-in-current biotope. Common taxa of the stones-out-of current biotope include *Cloeon africanum*, *Centroptilum* "near excisum", *C. medium*, *Austrocaenis* sp., oligochaetes, copepods, ostracods, *Micronecta* sp. (a corixid bug), chironomids and ceratopogonids.

The stones-out-of-current fauna appeared to be more diverse with 184 taxa as opposed to 153 taxa in the stones-in-current biotope. The Ephemeroptera (mayflies), Odonata (dragonflies), Hemiptera (bugs) and Mollusca (snails and mussels) were diverse in the stones-out-of-current biotope and many taxa were recorded from this biotope and not from the stones-in-current. The data recorded from the stones-out-of-current biotope at all sampling points (Table 11) shows that numbers of taxa were greatest in the Mutale and Luvuvhu rivers, followed by the Sabie, the Olifants and Crocodile (which were about equal) and the Letaba. As in the case of the stones-in-current fauna, on a month by month basis of comparison, diversity in the Letaba samples was usually lowest or nearly lowest. The Ephemeroptera (mayflies) in particular were more diverse in the Sabie and Luvuvhu rivers than in the other rivers. The table shows that the higher number of taxa from the stones-out-of-current biotope as opposed to the stones-in-current biotope was common to all sampling points except the Letaba at Mahlangene. The difference was most marked in the Luvuvhu and Mutale rivers.

Some of the stones-out-of-current samples had a poor diversity of animals. In most cases this was due to the fact that the stones that were sampled had only recently been submerged as the water level of the river had only risen a few days prior to sampling. Such samples were collected from the Crocodile River at Gezabahle and the Sabie River at Lubye-Lubye in November 1985 and the Letaba and Olifants rivers at their confluence in April 1986. A poor sample was also collected from the Sabie River opposite Lisbon Estates in October 1986 because there were very few stones-out-of-current at that site.

7.2.3 The sediment fauna

Tables C1 - C7 list the taxa found in sediment biotopes. On several occasions samples were collected from surface sediment that had settled on rocks, stones and sand. Eighty-nine taxa were identified from sediment biotopes. Although the fauna was not as diverse as the stony biotope faunas, several of the animals that were collected had unique adaptations to the environment in which they were living. The most spectacular of these adaptations was found in the mayfly *Machadorhythus* sp. This animal has its eyes protruding from its head and one pair of its gills form a 'box' around the other gills allowing the circulation of water over the gills in a unidirectional flow. Mayflies, dragonflies, bugs, caddis-flies, beetles, chironomids, ceratopogonids and molluscs were well represented in this biotope.

The nature of the sediments sampled varied considerably and many of the observed sampling point to sampling point faunal differences should be ascribed to differences in biotopes sampled, rather than to major variation following differences between rivers. The faunal lists in Tables C1 to C7 should be taken together with the information in Table 3 to illustrate the types of invertebrate communities that may be found in various sediment types.

7.2.4 **The vegetation fauna**

Sampling of invertebrates from fringing vegetation was seldom possible because of the low dry season flows, which meant that at most places the water level was below the base of the vegetation. Tables D1 - D6 list the taxa found in vegetation biotopes. As with the sediment fauna, samples were collected from vegetation biotopes on several occasions when such biotopes were easily accessible. One hundred and eighteen taxa were identified from this biotope. The taxa that had a better representation in this biotope than in the other biotopes were the Odonata (dragonflies), Hemiptera (true bugs) and Coleoptera (beetles). Other taxa such as mayflies, caddisflies, true flies and molluscs were also well represented.

7.3 **DIATOM FLORA**

Diatom samples were collected from nine sites in September 1985. Tables E1 - E10 are preliminary lists of the species that have been identified during an initial scanning of the samples. The species found in the Crocodile River at Gezabahle are indicative of slight organic enrichment. The sample from further downstream at Ngondwini indicates fairly clean water with improved quality from the site upstream. Both of the samples from the Sabie River contained species found only in unenriched waters. At Mamba on the Olifants River *Nitzschia* species were most prominent. These diatoms are usually abundant in greatly enriched waters. The samples collected from the Letaba, Luvuvhu and Mutale Rivers contained too few diatoms to permit comment on water quality. The reason for the poor sample from the Letaba River was probably the low flow conditions, whilst in the Luvuvhu River the opposite was true. The river had come down in flood five days prior to collecting the samples and diatoms had been flushed away. There had not been a long enough period since the flooding for the diatom flora to recover, and light penetration was greatly reduced due to the high turbidity of the river.

7.4 **AQUATIC MACROPHYTES**

The following remarks on the aquatic macrophytes are based on field observations rather than on close study. *Pistia stratiotes* (water lettuce) occurred in the Mutale River and in the Luvuvhu downstream of the Mutale confluence and at Pafuri Picnic Site. It was also seen in the Sabie River at Lubye-Lubye, but not at the sampling point opposite Lisbon Estates. *Pistia stratiotes* also occurred in the Crocodile River at Gezabahle in October 1986. *Eichhornia crassipes* (water hyacinth) is present in the Crocodile River, but during this study was not nearly as abundant as it has been in the past.

Phragmites sp. (the reed) is well known to be abundant in Lowveld rivers. It was less abundant at the Mutale River, Luvuvhu below Mutale confluence, Luvuvhu at Pafuri Picnic Site and Sabie opposite Lisbon Estates sampling points than elsewhere. At the Pafuri Picnic Site a large bank of floating *Polygonum* sp. was present in June 1986. The roots of aquatic mosses were present on stones at Lubye-Lubye (Sabie River), below the Mutale confluence and at the Pafuri Picnic Site (Luvuvhu River).

8. DISCUSSION

When first studies are made of the benthic invertebrates in previously unexplored regions, it is advisable to rear as many lavae as possible to the adult stage, at which the species can be identified and, if necessary, described. Unfortunately, due to the limited duration of field visits to the K.N.P., it was not possible to rear the aquatic insect larvae encountered to the adult stage. Many of the species identifications in the appended faunal lists are tentative and should therefore be treated with caution. Nevertheless, it is quite clear, from the genera encountered, that the insect fauna of the K.N.P. rivers is rather unlike that of other parts of the country. The Ephemeroptera (mayflies) are relatively easily separable into different genera and were particularly diverse. Taxa such as *Afrobaetodes berneri*, *Centroptiloides ?spinulosa*, *Elassoneuria* sp., *Adenophlebiodes* sp., *Dicercomyzon* sp. and *Machadorhythus* sp. have seldom been previously collected in South Africa. Certain of them, such as *A. berneri* and *Dicercomyzon* have previously seldom been recorded in the Transvaal and were described from Central Africa.The leptophlebid mayfly, *Masharikella* sp. and the tricorythid,*Machadorhythus* were previously uncrecorded in South Africa. This confirms that the benthic fauna of the K.N.P. rivers includes a tropical element that has spread southwards from the warmer parts of Africa. Within the Republic of South Africa these forms are restricted to the Lowveld. Were taxa such as the Trichoptera more readily identifiable, it is certain that species with a tropical origin would also be found. The benthic fauna of the rivers of the K.N.P. is therefore of considerable interest to biogeographers.

A rather surprising outcome of the study was that no seasonal trends of occurrence of the taxa encountered occurred within the two winters which were studied. In other parts of the country, certain taxa are known to occur in large numbers at certain times within a season. In fact the numbers of individuals of the various taxa, expressed as percentages of the total number of animals encountered in the samples, varied rather widely from month to month. Much of this variation must be due to factors such as subtle variations in the nature of the biotope sampled. This type of variation is to be expected in places, such as the rapids in the K.N.P. rivers, where physical conditions vary considerably following flow (depth and current speed) and size and shape of the stones. This means that particularly large collections of invertebrates are necessary to ensure that the majority of species present are collected. As can be seen from the total number of animals in the samples given in the Appendix Tables, most samples contained over a thousand invertebrates and several samples contained up to three thousand. Nevertheless, many taxa were recorded in low numbers.

Comparison of the data on benthic invertebrates collected in 1959 by the National Institute for Water Research from the Crocodile and Sabie rivers with present results suggests that the differences between the two rivers observed during the present study are not new. The 1959 studies showed that the invertebrate biota of the Sabie River was considerably more varied than that of the Crocodile. In fact there would appear to have been little change over the 27 year period, although more taxa were encountered in the present study because of the greater intensity of sampling. This is encouraging, because it shows that the increasing human pressures on the catchments of both rivers have yet to be reflected in serious changes in water quality and biota.

The present study showed that the rivers could be ranked as regards faunal diversity in the following order - Sabie, Luvuvhu, Mutale, Crocodile, Olifants, Letaba. The concentrations of solutes in both the Sabie and the Luvuvhu rivers were lower than in the other rivers, allowing for the fact that no chemical analyses were available for the Mutale River. Aquatic mosses were found only in the Sabie and Luvuvhu rivers. Chemical and biological indications of nutrient enrichment in the Crocodile River were apparent. There was no evidence that biocide application in the intensive agriculture along the banks of the river had any effect on the invertebrate fauna, which would be likely to be evident as the absence of aquatic insects.

The condition of the Olifants and Letaba Rivers gives great cause for concern.

In all seasons the total dissolved solids concentration in the Olifants River was higher by a factor of approximately 2 than elsewhere in the Lowveld rivers. Moreover, the coefficient of variation of the mean seasonal concentrations was higher too, indicating, particularly in the winter, that the river was sporadically receiving effluents contaminated by dissolved material. The fact that the biotic index values (Table 12) rose sharply in August and October 1986 and that during his recent (1987) visit to the K.N.P., Prof B.R. Davies (University of Cape Town) found that the Olifants River benthic fauna was considerably modified for a long stretch beginning at the western boundary, suggests that the chemical changes in this river have recently been sufficient to have a major impact on the invertebrate fauna. From the absence of molluscs and the poor representation of oligochaetes in the stones-in-current in August and October 1986, heavy metal pollution might be expected (Hynes, 1960). However, this is by no means certain, since these susceptible groups of animals remained in the stones-out-of-current. The benthic fauna of the Olifants River should be studied outside the park to pin-point the source(s) and nature of the pollutants bringing about the observed faunal changes.

The threat to the Letaba River is of a different nature. As can be seen from the frequency of sampling of the two sampling points on this river there was only one occasion during the two survey periods when there was a flow at Mahlangene (Table A5). On this occasion there was in fact only a small trickle of water and, as can be seen from the table, the list of species found was very restricted. Flowing water was more frequently encountered in the Letaba River near its confluence with the Olifants River (Table A6). The sampling point was within 200 m of the Olifants River and the longer list of species encountered here was no doubt due to its proximity to the perennial Olifants River.

Two aspects of the K.N.P. rivers are of great interest to conservation. The recovery of the Sabie River from the gold mine pollution of the 1920's and 1930's gives great cause for hope that degraded river systems can recover, provided that the cause of the degradation is removed. However, it is prudent to bear in mind that the Sabie River fauna recovered at a time when the stress on the rivers around it was much lower than is probably the case today. There were therefore most probably many places where the rich fauna of the Sabie River of today found refuge, from which it could reinvade the Sabie River. This would not necessarily be so in the future. The second point that arises out of the observations on the benthic invertebrates is that hippopotami play an important role in the nutrient dynamics of these rivers, particularly when the flow is low. Certainly the load of hippo dung in the water at the eastern sampling points in the Olifants and Crocodile Rivers was sufficient to cause obvious accumulation of fragmented terrestrial vegetation among the stones and rapids and an accompanying drop in the diversity of the sensitive mayflies, reflected in the biotic index values in Table 12. This could perhaps be regarded as a natural event, though it does suggest that abstraction of water to the point where the hippopotamus population becomes high in relation to the volume of flowing water, could have untoward consequences for the benthic invertebrates in certain stretches of the rivers.

It must be noted that as abstraction of water from the rivers increases and the volume of flowing water decreases, both natural events and human activities are going to have an increasing effect on the riverine ecosystem. Factors such as irrigation and industrial effluent which might in the past have had little effect on the rivers may have an increasing effect even though these factors themselves do not change.

9. CONCLUSIONS

1. The rivers of the eastern Transvaal Lowveld within the K.N.P. have an invertebrate fauna which is unique in the Republic of South Africa and is therefore worthy of conservation in its own right.

2. The threat to the continued survival of this fauna and of the rivers as natural ecosystems is real. The Letaba and Luvuvhu rivers are, due to the excessive abstraction of water, no longer perennial rivers and the diversity of the invertebrate fauna particularly in the Letaba River has dropped considerably. In other words, many species have already been lost from this river. It would appear that the benthic fauna of the Olifants River has been adversely effected and its diversity reduced, probably due to chemical pollution.

3. The Sabie River contains the most diverse benthic invertebrate fauna, and therefore appears to have been least effected by man's activities. It should enjoy the highest priority for conservation and should not be neglected as a river which is "looking after itself".

4. The taxonomy of the benthic fauna of the rivers of the K.N.P. is poorly known at the species level.

10. RECOMMENDATIONS

Recommendations regarding future actions arising out of this study are:

1. Urgent priority should be given to a further investigation of the water chemistry and benthic biology of the Olifants River both inside and to the west of the K.N.P., in order to locate the source of the water which would appear to be detrimental to the benthic invertebrate fauna (it is also most probably detrimental to the fish fauna).

2. It would be advisable to set up a programme to monitor the benthic invertebrates of the rivers to provide warning of insidious changes taking place in them. Such a monitoring programme should be based on dry season sampling, probably best executed in June, July or August. The monitoring programme should be backed up by a capacity and willingness to undertake further studies along the courses of the rivers, if necessary to the west outside the K.N.P., should untoward changes be observed. Biotopes to be sampled and sampling methods should be as described in this report.

3. There is an urgent need for flow data for the rivers in the park to supplement the data on chemical concentrations and to allow for more meaningful interpretations of the changes in concentration of dissolved substances, which can presently be observed.

4. If it is deemed desirable to maintain the Letaba River in a more natural condition, it is essential that the dry season flow of the river be ensured.

5. An aquatic entomologist/invertebrate zoologist should be appointed to the staff of the National Parks Board with principal duties to monitor the benthic invertebrate fauna of the rivers, to extend the data base of the invertebrate fauna by undertaking sampling during the summer and to rear aquatic insect larvae through to the adult stage, to allow for a better

taxonomic knowledge of the fauna than is presently available. Arrangements could be made with the NIWR as regards the training of such a scientist. Alternatively the necessary studies could be carried out on a contract basis, but this would require that the scientists spend more time in the K.N.P. in order to collect and rear the aquatic insect larvae than was the case in the present study.

6. It would appear that the other aquatic ecosystems of the K.N.P. such as wetlands, pans and temporary streams which rise within the boundary of the K.N.P. are poorly known. These ecosystems must be among the aquatic ecosystems least impacted by man in Southern Africa. For this reason they are worthy of study as benchmarks of what aquatic ecosystems should or might be like in other parts of the country, were they not affected by development.

7. A study of the dry season survival strategies of the fauna of temporary streams should be undertaken. Such a study would reveal whether the fauna of these streams is re-established every year by re-invasion from nearby perennial rivers or not. It would also provide information as to whether the present fauna of the perennial rivers would be likely to survive the abstraction of water to the point where the rivers dried up every dry season. In this connection it would also be useful for a study to be made of the fauna of the Letaba River when it flows.

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APPENDICES.

TABLE A1. PERCENTAGE COMPOSITION OF THE STONES-IN-CURRENT FAUNA FROM THE CROCODILE RIVER AT GEZABAHLE.

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86	OCT 86
	*						
Planaria	0	0.1	0.4	0	P	0.8	3.3
Nematoda	0	0	0	1.6	0.1	0.1	0
Other oligochaetes	0	0	0.6	0	0	0	0
Stenocypris sp.	0	0	0.6	1.6	0	0	0
Hydracarina sp.1	0	0.3	0.6	0	0.9	1.7	0.5
Collembola	0	0	0	1.6	0	0	0
Neoperla spio	3.8	P	0.1	0	0	0.1	0
Centroptilum excisum	0.2	0	0.2	2.6	0	0	0
Centroptilum "near excisum"	0	0	1.5	0.7	0	0	0
Centroptilum flavum	0	1.7	4.2	9.3	P	0	0
Centroptilum medium	0.5	0	1.3	10.7	P	0.4	0
Cloeon africanum	0	0	0	0	0	0.1	0
Baetis glaucus	5.2	4.7	7.9	28.5	3.1	4.1	3.6
Other baetid sp. diag.A	0	0	0	0.7	0	0.1	0
" " " " H	0	0	0	0	0	0.1	0
" " " " J	0	0	0	0	0	0.1	0
Choroterpes sp.	17.8	13.8	10.0	0.8	0.4	0.6	4.3
Adenophlebiodes sp.	0	0	0	0	0	0	0.2
Tricorythus "lowveld"	10.8	9.6	13.1	3.9	17.8	1.8	25.0
Austrocaenis sp.	0.9	3.5	2.2	7.0	0.9	3.7	1.2
Afronurus sp.	3.8	1.2	0.6	0.4	2.0	0.1	3.9
Zygonyx sp.1	1.6	0.6	0	0	0	0	0
Libellulid sp.1	0	0	0.1	0	P	0	0
Anisopterans	0	0	0	0	0.2	0	0
Naucoridae	0	0	0	0	0	0	0.2
Micronecta sp.	0	P	0	0	0	0	0
Other hemipterans	0	0	0	1.6	P	0	0
Sisyridae	0	0	0	0	0	0	0.2
Aethaloptera sp.	0	0.1	0	0	0	0	0
Amphipsyche scottae	0	P	1.0	0	P	0	0
Cheumatopsyche thomasseti	6.7	12.1	7.0	1.2	5.8	2.6	16.5
Cheumatopsyche afra	0	0.2	0.5	0	P	0	0.7
Ecnomus sp.	0	0.1	0.2	0	0	0	0.2
Chimarrha sp.	0	4.9	4.0	0	1.1	0.5	1.2
Leptocerus ?inflatus	0	0	0	0	0.1	0.1	0
Trichosetodes sp.	0	1.2	1.1	0	0	1.5	1.0
?Barbarochthon sp.	0	0	0	0	0	0	0.5
Leptoceridae	0	0	0.2	0	0	0.1	0
Oecetis sp.	0	0.2	0.2	0	P	0	0.2
Hydroptila capensis	0	0.7	0.5	0	0	0	0
Orthotrichia barnardi	0	0	0.6	0	0	0.2	0.2
Catoxyethira sp.	0	0	0	0	0	0.2	0.7
Hydroptilid juveniles	0.9	0.2	0.2	0	0	1.0	0.7
Pyralidae	0	0	0.2	0	0	0	0
Dytiscidae	0	0	0	0.4	0	0	0
Gyrinidae	0	0.1	0.2	2.0	P	0.1	0
Stenelmis sp.	1.3	1.5	0.8	0	0.1	0.8	1.5
Other elmidae	0	0	0.1	0	0	0.1	0.5
Coleopterans	0.5	0	0	0	0	0	0
Tipulidae	0	P	0	0.4	0	0	0
Simulium spp.	8.4	10.0	22.8	1.2	35.7	21.9	7.4
Chironomini	1.6	7.1	1.4	2.7	3.2	4.2	2.7
Tanytarsini	24.5	11.3	8.2	2.3	10.0	29.4	9.1
Corynoneura sp.	0	0.3	0	3.1	0	0	0

Table A1. Crocodile River at Gezabahle. Stones-in-current (cont.)

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86	OCT 86
Theinemanniella sp.	0	0.3	0	0	0	0	0
Orthocladinae	7.1	9.2	6.0	7.8	16.0	21.1	11.4
Cricotopus sp.	0	0.9	0	2.3	1.1	1.2	0
Pentaneura sp.	2.2	1.8	1.0	1.2	0.2	0.4	0.3
Dasyhelea-type larvae	0	P	0	1.6	0	0.4	0
Bezzia-type larvae	0	0	0	0	0	0.1	0
Forcipomyia sp.	0	0.3	0	0	0	0	0
Tabanidae	0	0.2	0	0	0	0	0
Rhagionidae	0	P	0	0	0	0	0
Muscidae	0	0.3	0.1	0	0	0	0
Anthomyidae	0	0	0	0	0	0.2	0
Melanoides sp.	0	0	0	0	0	0.1	0
Ancylidae	0	0	0	0	0	0	0.8
Eupera sp.	0	0	0	0	0.8	0	0.7
Corbicula africana	0	0	0	0	0	0.5	2.0
Other pelecypoda	2.3	1.1	0.6	3.1	0	0	0
Chiloglanis sp.	0	0	0	0	P	0	0
TOTAL NO. OF INDIVIDUALS	445	2529	1297	256	2231	1898	608

TABLE A2. PERCENTAGE COMPOSITION OF THE STONES-IN-CURRENT FAUNA FROM THE CROCODILE RIVER AT NGONDWINI.

TAXON	APRL 85	JUNE 85	SEPT 85	JUNE 86	AUG 86	OCT 86
Hydra sp.	0	0	0.5	0	0	0
Planaria	0	0	3.5	0	10.1	23.0
Prostoma sp.	0	0	0.3	0	0	1.7
Nematoda	0	0	0.2	0.1	0	0.7
Pristina sp.	7.9	5.8	0.1	0	0	0
Nais sp.	0	0.1	0.1	0	0	0
Other naids	1.5	0	0	0	0	0
Tubificidae	0	0	0.1	0	0	0
Branchiobdellidae	0	0	0	1.1	0	0
Daphnia sp.	0	0.1	0	0	0	0
Cyclopoid copepods	0	0	0	0	0.7	1.3
Pionocypris sp.	0	0	0	0	0.9	11.5
Stenocypris sp.	0	0.6	11.3	0.2	0	0.7
Hydracarina sp.1	0	0	0	0	0.7	0.2
Centroptiloides ?spinulosa	1.2	0	0	0.2	0	0
Centroptilum excisum	0	0	0	0.2	0	0
Centroptilum "near excisum"	0	0	0	0.2	0	0
Centroptilum flavum	0	0	0	0.2	0	0
Centroptilum medium	0	2.2	0	2.7	3.4	7.6
Pseudocloeon vinosum	0	0.7	0	0	0	0
Baetis bellus	5.6	0	0	0	0	0.8
Baetis glaucus	0.4	9.4	6.1	6.3	10.8	4.6
Afrobaetodes berneri	0.8	0	0	0	0	0
Other baetid sp. diag.E	0	0	0	0.5	0	0.5
" " " " G	0	0	0	0	0.7	0
" " " " H	0	0	0	0	6.3	0
" " " " J	0	0	0	0	1.1	0
Other baetid spp.	0.4	0	0	0	1.9	0
Choroterpes sp.	8.6	5.2	20.3	0.7	2.4	0.2
Tricorythus "lowveld"	28.1	6.2	8.5	6.7	0	7.8
Austrocaenis sp.	2.0	0.5	2.9	3.9	2.9	1.8
Afronurus sp.	0.1	0.3	0.1	0.1	0.3	0
Zygopterans	0.1	0	0	0	0	0
Gomphidae	0	0	0	0.1	0	0
Zygonyx sp.1	0.1	0.1	0.2	0.1	0.2	0
Libellulid sp.1	0	0	0.1	0.2	0.2	0
Anisopterans	0	0	0	0.6	0	0
Micronecta sp.	0	1.3	0.5	0	0	0.2
Other hemipterans	0	0	0	0	0.2	0
Cheumatopsyche thomasseti	4.9	17.6	12.1	9.2	4.5	12.3
Cheumatopsyche afra	0	1.1	0	0	0	0
Ecnomus sp.	0	0	0	0.1	0	0
Chimarrha sp.	3.7	6.0	0.1	0.5	0.7	2.5
Leptoceridae	0.1	0	0	0.5	0	0
Oecetis sp.	0.6	0	0.1	0.3	0.4	0
Hydroptila capensis	0	0	1.7	0.4	0.3	0
Orthotrichia barnardi	0	0.1	0	0.2	0.3	0
Catoxyethira sp.	0	0.6	0	0	2.8	0
Hydroptila sp.1	0	0	0	0.1	0.2	0
Hydroptilid juveniles	0	0	1.9	0.4	0.7	1.5
Pyralidae	0	0	0	0.3	0	0
Dytiscidae	0	0	0	0	0	0.2
Gyrinidae	0.1	0	0	0.1	0	0
Hydrophilidae	0	0	0.1	0	0	0

Table A2. Crocodile River at Ngondwini. Stones-in-current (cont.)

TAXON	APRL 85	JUNE 85	SEPT 85	JUNE 86	AUG 86	OCT 86
Dryopidae	0	0	0	0.1	0	0
Stenelmis sp.	1.4	0.5	7.4	0.9	3.3	8.0
Other elmidae	0.1	0	0	0	0.2	0
Pseudancyronyx sp.	0.1	0	0	0	0	0
Tipulidae	0	0	0.1	0.4	0	0
Simulium spp.	5.2	9.3	1.5	11.6	7.1	5.6
Chironomini	8.0	7.1	1.8	2.9	3.6	0.7
Tanytarsini	5.2	18.7	12.9	26.7	9.7	1.5
Corynoneura sp.	0	0.1	0.5	0	0	0.7
Orthocladinae	10.4	4.5	2.8	9.1	14.9	0.8
Cricotopus sp.	0.6	0.8	0.2	2.6	0.7	0.3
Pentaneura sp.	2.0	0.9	1.0	2.9	0.5	0.7
Dasyhelea-type larvae	0.1	0.1	0	0	0	0.2
Bezzia-type larvae	0	0	0.4	0.1	0	0.2
Forcipomyia sp.	0	0	0	0	0	0.2
Tabanidae	0.1	0	0	0	0	0.2
Rhagionidae	0.1	0	0	0.1	0	0
Empididaeae	0	0.1	0	0	0	0
Muscidae	0	0	0	0	0	0.2
Lymnophora sp.	0	0	0	0.2	0	0
Higher dipterans	0	0.1	0.1	0.1	0	0
Ancylidae	0	0	0	0.1	1.0	0.5
Eupera sp.	0	0	0	0.5	0.3	1.0
Corbicula africana	0	0	0.8	6.3	5.9	0.5
Other pelecypoda	0.8	0	0	0	0	0
Chiloglanis sp.	0.1	0.1	0.1	0	0	0.2
TOTAL NO. OF INDIVIDUALS	1550	1280	1755	2208	577	601

Table A3. Sabie River at Lubye-Lubye. Stones-in-current (cont.)

TAXON	APRL 85	JUNE 85	SEPT 85	NOV 85	JAN 86	APRL 86	JUNE 86	AUG 86	OCT 86
Methles sp.	0	0	0	0	0.2	0	0	0	0
Stenelmis sp.	1.7	1.8	7.3	0.4	1.6	0.7	0	0.5	1.7
Other elmidae	0.8	0	0.1	0	0.7	0.9	0	0	0.1
Coleopterans	P	0	0	0	0	0	0	0	0
Tipulidae	0	P	0.7	0	0	0	0	0.1	2.0
Psychodidae	P	0	0	0	0	0	0	0	0
Simulium spp.	11.4	6.8	2.7	8.9	5.1	1.4	2.2	40.8	0.1
Chironomini	2.0	3.5	6.3	7.2	3.9	4.0	2.3	3.9	4.9
Tanytarsini	9.5	12.2	30.8	9.4	3.3	4.2	6.4	3.3	8.3
Corynoneura sp.	0	0.7	0	0	0	0	0	0	0
Theinemanniella sp.	P	0	0	0	0	0	0	0	0
Orthocladinae	3.9	11.0	6.6	3.8	1.6	3.7	17.6	23.4	6.0
Cricotopus sp.	P	1.7	0	1.7	0	0.2	3.5	2.4	6.8
Pentaneura sp.	1.3	1.1	1.6	2.6	0	2.6	1.6	0	2.5
Tanypod pupae	0	0	0	1.7	0	0	0.2	0	0
Dasyhelea-type larvae	P	0.1	0.1	0	0	0	0	0.1	0
Bezzia-type larvae	0	0	0.1	0	0.2	0.1	0.1	0	0.8
Forcipomyia sp.	0	0	0.9	0	0	0.1	0	0	0
Tabanidae	0	0.1	0	0	0	0.1	0	0	0
Rhagionidae	0	0.2	0	0	0	0.2	0	0	0.1
Ephyridae	0	0	0	0	0	0	0	0.1	0
Muscidae	0	0	0.1	0	0	0	0	0	0
Higher dipterans	0	0	0	0	0	0.1	0	0.1	0
Bulinus sp.	0	0	0	0.4	0	0	0	0	0
Ancylidae	0	0	0	0.4	0	0	0	0	0
Eupera sp.	0	0	0.3	0	0.1	0	0	0	0.1
Corbicula africana	0	0	0.1	2.1	0.9	0	0	0	1.0
Other pelecypoda	0.7	0.7	0	0	0	0	0	0	0
Chiloglanis sp.	0	0	0	0	0	0	0	0	0.1
TOTAL NO. OF INDIVIDUALS	2480	2548	1733	235	1280	903	1121	1190	1029

Table A3. Sabie River at Lubye-Lubye. Stones-in-current (cont.)

TAXON	APRL 85	JUNE 85	SEPT 85	NOV 85	JAN 86	APRL 86	JUNE 86	AUG 86	OCT 86
Choroterpes sp.	10.2	2.4	2.2	4.3	0.3	7.1	0.6	0.7	2.7
Adenophlebiodes sp.	0	0	0	0	0	0.8	0	0	0
Tricorythus "lowveld"	32.4	8.7	3.1	3.8	34.8	9.3	17.5	9.9	22.1
Austrocaenis sp.	0.2	2.4	2.2	12.3	1.9	5.2	1.4	0	1.7
Afronurus sp.	P	0.4	0	0.4	2.3	1.4	3.8	0.3	1.9
Dicercomyzon sp.	0	0	0	0	0	0	0.4	0	0
Zygopterans	0	0	0	0	0	0.6	0.1	0	0
Gomphidae	0	0	0	0	0.1	0	0	0	0
Zygonyx sp.1	1.8	0	0	0	0	0	0.1	0.6	0
Libellulid sp.1	0	0.4	0.4	0	0	1.1	0.1	0	0.7
Anisopterans	0	0	0.2	0	1.0	0.1	0.1	0	0
Naucoridae	0	0	0.1	0	0	0	0	0	0
Micronecta sp.	0	0	0	0	0	0.3	0	0	0
Other hemipterans	0	0	0.2	0	0	0.1	0	0	0
Amphipsyche scottae	0	P	0	0	0	0	0	0	0
Cheumatopsyche thomasseti	12.9	4.4	1.3	0.9	1.1	1.8	1.8	0.6	8.9
Cheumatopsyche afra	0	0	0.8	0	0	0	0	0	0
Ecnomus sp.	0	0.1	0.3	0	0	0.2	0	0	0.3
Chimarrha sp.	11.6	4.2	4.3	0	13.7	4.1	0.8	0.1	2.1
Leptocerus ?inflatus	0	0	0	0	0	0.1	0.1	0	0
Trichosetodes sp.	0.7	0.7	1.1	0	1.0	4.6	0.4	0.3	1.0
Leptoceridae	0	0	0.5	0	0	0.1	1.5	0	0
Oecetis sp.	0.2	P	0	0	0	0	0	0	0
Hydroptila capensis	0	0.5	2.4	0	0	0	0	0.3	0
Orthotrichia barnardi	0	0.1	0.3	0	0	0.1	0.5	0	0
Catoxyethira sp.	0	0	0	0	0	0	0	0	0.9
Hydroptilid juveniles	0.1	0.3	3.8	0	0	0	0.1	0.8	0.8
Pyralidae	P	0	0	0	0.8	0.4	0	0.3	0.1
Dytiscidae	0	0	0	0.9	0.2	0	0	0	0.1
Gyrinidae	0.2	0.2	0.1	0	0.2	0	0	0	0
Hydrophilidae	0	0	0.2	0	0	0	0	0	0
Hydraenidae	0	0	0.5	0	0	0	0	0	0

TABLE A3. PERCENTAGE COMPOSITION OF THE STONES-IN-CURRENT FAUNA FROM THE SABIE RIVER AT LUBYE-LUBYE.

TAXON	APRL 85	JUNE 85	SEPT 85	NOV 85	JAN 86	APRL 86	JUNE 86	AUG 86	OCT 86
Hydra sp.	0	0	1.8	0	0	0	0	0	0
Planaria	0	P	4.9	0	0	0	0	0.5	1.2
Nematoda	0	P	0.1	0	0	0	0	0	0.1
Pristina sp.	0.1	0	1.4	1.7	0	0.2	0.1	0	0
Nais sp.	0	1.8	4.2	0	0	0	3.6	0.8	0.8
Dero sp.	0	0	0.3	0	0	0	0	0	0
Branchiobdellidae	0	0	0.9	0	0	0.1	0.7	0	0
Other oligochaetes	0	0.3	0.6	0	0.6	0.3	0	0	0
Hirudinea	0	0	0	0.4	0	0	0	0	0
Ceriodaphnia/Simocephalus sp.	0	0	0	5.1	0	0	0	0	0
Cyclopoid copepods	0	0	0.5	0	0	1.3	0	0	0.8
Pionocypris sp.	0	0	0	0	0	0	0	0	3.9
Stenocypris sp.	0.3	0	0	0	0.7	4.2	0	0.7	0
Decapod juveniles	0	0	0	0.4	0	0	0	0	0.1
Hydracarina sp.1	0.7	1.3	0.1	1.7	1.9	2.0	0.4	3.5	0.8
Neoperla spio	0.6	0.5	0.9	0	0.7	0.1	0.1	0.1	0.4
Elassoneuria sp.	0	0	0	0	0.1	0	0	0	0
Centroptiloides bifasciatum	0	0.1	0	0	0	0	0	0	0
Centroptiloides ?spinulosa	0.5	0	0	0	0	0	0	0.2	0
Centroptilum "near excisum"	0	0	0	0	0	0.8	1.0	0	0
Centroptilum flavum	0	0.2	0	1.2	1.3	0.6	1.1	0	0
Centroptilum medium	1.8	0.2	0.4	1.2	4.7	21.3	7.5	0.2	1.5
Centroptilum varium	0	0	0.9	0	0	0	0	0	0
Cloeon africanum	0	0	0	0	0	3.5	0	0	0
Baetis glaucus	5.0	30.8	1.3	23.1	14.8	5.6	18.2	3.3	11.3
Baetis (Acentrella) sp.	0	0.2	0	0	0	0	0	0.2	0
Afrobaetodes berneri	0.2	0	0	0	0.3	0	0	0	0
Other baetid sp. diag.A	0	0.2	0	2.7	0	0.2	0.2	0.2	1.5
" " " " B	0.1	0	0	0	0	0	0	0	0
" " " " E	0	0	0	0	0	0	0	0	0.3
" " " " G	0	0	0	0	0	0	2.8	0	0
Other baetid spp.	0.3	0	0	1.2	0	4.0	0	0	0

see previous page also

Table A4. Sabie River opposite Lisbon Estates. Stones-in-current (cont.)

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86	OCT 86
Dyschimus sp.	0	0	0	0.2	0	0	0
Hydroptila capensis	0	0.1	0.5	0	0	0.2	1.0
Orthotrichia barnardi	0	0.2	0.5	0	0	0	0.3
Hydroptila sp.1	0	0	0.5	0	0.1	P	0
Catoxyethira sp.	0	0.1	0	0	0	0.1	1.8
Hydroptilid juveniles	0	2.1	0.5	0	0.1	0	0.6
Hydropsychid juveniles	0	0	0	0	0	2.0	0
Trichopterans	0	0	0.5	0.2	0	0	0
Dytiscidae	0.1	0	0	0.2	0	0	0
Gyrinidae	0	0	0.3	0.9	0	0.1	0
Hydrophilidae	0	0	0	0	0	0	0.1
Stenelmis sp.	3.7	0.5	0.3	0	0	0.6	5.9
Other elmidae	0.2	0.6	1.2	0.8	0	0.2	1.9
Coleopterans	0	0	0	0	0.4	0	0.7
Tipulidae	0.3	0.5	0.6	0.8	0	P	0
Simulium spp.	2.7	4.0	0.3	6.6	28.0	27.9	5.0
Chironomini	4.3	5.9	10.2	4.2	3.7	4.0	3.7
Tanytarsini	23.5	20.9	19.8	3.0	6.2	33.6	2.8
Corynoneura sp.	1.7	1.0	0	0.8	2.9	0.2	0
Theinemanniella sp.	0	0	1.2	0	0	0	0
Orthocladinae	11.9	15.7	3.6	21.0	30.2	13.4	4.1
Cricotopus sp.	0.1	0.1	0.6	1.1	2.2	1.7	0.6
Pentaneura sp.	1.6	2.3	0.9	0.4	0.9	0.6	2.9
Tanypod pupae	0	0	0	0.2	0	0	0
Dasyhelea-type larvae	0.1	0	0	0.2	0	0	21.3
Bezzia-type larvae	0	0	0	0	0.1	0.1	1.0
Forcipomyia sp.	0	0	0	0	0	0	0.3
Ceratapogonid pupae	0	0	0	0	0	0	0.6
Tabanidae	0.3	0	0	0.2	0.1	0.1	0
Rhagionidae	0.4	0.4	0.3	0	0.1	0.1	0.4
Ephyridae	0	0	0	0	0	0	0
Empididae	0.1	0	0	0	0	0.2	0.1
Muscidae	0	0	0	0.2	0	0	0
Ancylidae	0	0	0	0	0	0	0
Corbicula africana	0	0	0	0	0	0	0.6
Other pelecypoda	0	0	0.3	0	0	0	1.2
Chiloglanis sp.	0.2	0.2	0	0	0	0	0
TOTAL NO. OF INDIVIDUALS	938	819	333	532	1530	3318	675

TABLE A5. PERCENTAGE COMPOSITION OF THE STONES-IN-CURRENT FAUNA OF THE LETABA RIVER AT MAHLANGENE.

TAXON	APRL 85
Nais sp.	0.3
Other naids	P
Cladocerans	61.5
Cyclopoid copepoda	2.9
Stenocypris sp.	0.1
Elassoneuria sp.	0.2
Centroptilum excisum	0.2
Centroptilum medium	0.6
Other baetid sp. diag.B	1.0
" " " " D	0.1
Choroterpes sp.	6.6
Tricorythus "lowveld"	11.4
Austrocaenis sp.	1.6
Zygonyx sp.1	P
Gerridae	P
Amphipsyche scottae	8.8
Aethaloptera sp.	0.3
Cheumatopsyche thomasseti	0.6
Ecnomus sp.	0.6
Chironomini	0.2
Tanytarsini	0.1
Orthocladinae	P
Pentaneura sp.	2.6
Tabanidae	P
TOTAL NO. OF INDIVIDUALS	3012

TABLE A6. PERCENTAGE COMPOSITION OF THE STONES-IN-CURRENT FAUNA FROM THE LETABA RIVER ABOVE CONFLUENCE WITH OLIFANTS RIVER.

TAXON	APRL 85	JUNE 85	APRL 86	JUNE 86
Hydra sp.	0	19.0	0	1.7
Nematoda	0	0	0.5	1.0
Pristina sp.	0	0.3	0	0.1
Branchiobdellidae	0	0	0	0.5
Other oligochaetes	0	0	3.2	0
Hirudinea	0	0	0	0.1
Ceriodaphnia/Simocephalus sp.	0	0	69.5	0
Daphnia sp.	0	0	1.0	0
Chydorids	0	P	0	0
Cyclopoid copepods	1.8	0.3	0.1	0
Harpactacoid copepods	0	0	19.9	0
Stenocypris sp.	0	0	0.5	0.1
Povilla adusta	0	0	0	0.1
Centroptilum flavum	0	0.1	0	0.2
Centroptilum medium	3.1	0.7	0	1.8
Cloeon africanum	0	0	0.6	0
Baetis glaucus	12.1	3.9	0	4.4
Baetis (Acentrella) sp.	0	0.1	0	0
Other baetid spp.	0	0.7	0	0
Choroterpes sp.	3.8	0.4	0	1.3
Tricorythus "lowveld"	27.4	4.8	0	4.5
Austrocaenis sp.	0	3.1	0.1	1.3
Zygonyx sp.1	P	0	0	0
Anisopterans	0	P	0	0
Micronecta sp.	0	0.2	0	0.4
Other hemipterans	0	0	0.1	0.1
Aethaloptera sp.	0.1	0	0	0
Amphipsyche scottae	4.1	2.1	0.2	15.2
Cheumatopsyche thomasseti	23.2	16.1	0.2	8.6
Ecnomus sp.	0	0.5	0	0.3
Chimarrha sp.	0.1	0	0	0
Orthotrichia barnardi	0.4	0	0	0.9
Hydroptilid juveniles	0.2	0	1.2	0.5
Stenelmis sp.	0.2	0	0	0
Simulium spp.	15.6	22.7	0	23.9
Chironomini	2.1	9.6	2.5	25.3
Tanytarsini	3.1	12.8	0.2	2.8
Corynoneura sp.	0	P	0	1.4
Theinemanniella sp.	0.1	0	0	0
Orthocladinae	2.2	2.4	0.1	3.0
Cricotopus sp.	P	P	0	0
Pentaneura sp.	0.3	0.3	0.1	0.2
Tanypod pupae	0	0	0.1	0
Higher dipterans	0	P	0	0
Other gastropoda	0	0	0.1	0
Corbicula africana	0	0	0	0.5
Chiloglanis sp.	0.1	0	0	0
TOTAL NO. OF INDIVIDUALS	2254	2351	1727	1584

TABLE A7. PERCENTAGE COMPOSITION OF THE STONES-IN-CURRENT FAUNA FROM THE OLIFANTS RIVER AT MAMBA.

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86	OCT 86
Hydra sp.	0	0	0.5	0	0	0	0
Planaria	0	0	0.9	0	0	P	0.1
Nematoda	0	0.1	0	0	0	P	0
Pristina sp.	0.4	1.1	0	0	0	0	0
Nais sp.	0	0	1.2	0	0	0	0
Dero sp.	0	0.1	0	0	0	0	0
Other oligochaetes	0	0	1.6	0	0	0	0.1
Ceriodaphnia/Simocephalus sp.	0	0.1	4.4	0.1	0	0	0
Cyclopoid copepods	0	0	0	0	0	P	0
Harpactacoid copepods	0	0	2.1	0	0	0	0
Stenocypris sp.	0	0	10.6	0	0	0	0
Hydracarina sp.1	0	0	0.1	0	0	0	0
sp.2	0	0	0.1	0	0	0	0
Collembola	0	0	0.9	0	0	0	0
Neoperla spio	P	0	0	0	0	0	0
Elassoneuria sp.	0	0	0	0	0.2	0	0
Centroptilum excisum	0.3	0	0	0	0	0	0
Centroptilum "near excisum"	0	0	0.5	0	0	0	0
Centroptilum flavum	0	0	0	0.3	0	0	0
Centroptilum medium	0.1	0.2	0.5	3.6	0.3	0	0
Pseudocloeon maculosum = Pseudopannota	0	0	0	0	0.5	0	0
Baetis glaucus	7.7	18.7	2.2	2.4	6.6	P	4.9
Other baetid sp. diag.E	0	0.2	0.5	0	0	0	0
Other baetid spp.	0	0.2	2.2	0	0	0	0
Choroterpes sp.	4.0	4.4	0.8	0.4	0.6	0	0
Castanophlebia sp.	0	0	0	0.5	0	0	0
Tricorythus "lowveld"	20.0	28.0	0.1	67.2	12.1	0.2	0.4
Austrocaenis sp.	0.1	0.1	31.7	0.9	0.2	0	1.0
Afronurus sp.	0.3	0.2	0	0	0.5	0	0
Zygopterans	0	0	0.1	0	0	0	0
Zygonyx sp.1	0.5	0.2	0	0	0	0	0
Anisopterans	0	0	0.1	0.2	0	P	0
Gerridae	P	0	0	0	0	0	0
Veliidae	0	0	0.1	0	0	0	0
Other hemipterans	P	0	0	0.5	0	0	0
Aethaloptera sp.	15.4	0.2	0	0.2	0.3	0	0
Amphipsyche scottae	3.3	0	0.1	2.8	0.8	P	1.9
Cheumatopsyche thomasseti	7.9	14.9	8.4	7.2	6.7	0.1	28.9
Ecnomus sp.	0	0	0	0	0	0	0.3
Oecetis sp.	0	0.1	0	0	0	0	0
Hydroptila capensis	0	0	0.2	0	0	0.1	0
Orthotrichia barnardi	0	0.2	0.3	0.2	0.1	0	0.5
Catoxyethira sp.	0	0	0	0	0.2	0.1	2.5
Hydroptilid juveniles	1.3	0	0.9	0.8	0	0.2	6.6
Pyralidae	0	0	0.1	0	0.1	P	0
Dytiscidae	0	0	0	0	0	0	0.1
Gyrinidae	P	0.2	0.1	0.1	0.1	0.1	0.1
Hydrophilidae	0	0	0.1	0	0	0	0
Stenelmis sp.	0.1	0.1	0.2	0.9	0.2	0	0
Other elmidae	0	0	0	0.5	0	0.3	0
Culicidae	P	0	0	0	0	0	0
Simulium spp.	25.2	23.6	17.7	3.0	63.1	90.9	3.3
Chironomini	8.5	5.1	1.0	5.5	1.8	2.4	7.2
Tanytarsini	0.6	0.8	1.4	0	0.1	0.1	29.1

Table A7. Olifants River at Mamba. Stones-in-current (cont.)

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86	OCT 86
Corynoneura sp.	P	0	0.5	0.6	0	0.3	0
Orthocladinae	3.7	1.5	0.4	1.9	5.7	4.6	8.2
Cricotopus sp.	0	0	0	0.1	0.1	0.1	3.4
Pentaneura sp.	0.4	0.2	0.2	0.1	0.2	0.1	1.1
Dasyhelea-type larvae	P	0	0.4	0	0	0	0
Bezzia-type larvae	0	0	0.4	0	0	0	0
Forcipomyia sp.	0	0	0.2	0	0	0	0
Tabanidae	0	0	0	0	0	0	0.1
Muscidae	0	0	0.1	0	0	0	0
Lymnophora sp.	0	0	0.3	0	0	0	0.1
Bulinus sp.	0	0	0.1	0	0	0	0
Burnupia sp.	0	0	0.1	0	0	0	0
Lymnaea sp.	0	0	0.1	0	0	0	0
Melanoides sp.	0.1	0	0	0	0	0	0
Corbicula africana	0	0	0.1	0.2	0	0	0
Other pelecypoda	0.3	0.3	0	0	0.1	0	0
TOTAL NO. OF INDIVIDUALS	3122	1845	2029	1513	1909	3030	790

TABLE A8. PERCENTAGE COMPOSITION OF THE STONES-IN-CURRENT FAUNA FROM THE OLIFANTS RIVER ABOVE CONFLUENCE WITH THE LETABA RIVER.

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86	OCT 86
Hydra sp.	0	0	0.7	0	0	0	0
Nematoda	0	0	P	0	0	0	0
Pristina sp.	1.0	4.3	0.2	0	0	0	0
Nais sp.	0	0.3	0.2	0	0	0	0
Other naids	0	0.3	0	0	0	0	0
Tubificidae	0	0.1	0	0	0	0	0
Other oligochaetes	0	0	1.1	0.3	0.2	0	0
Hirudinea	0	0	0	0.1	0.2	0	0.2
Macrothrix sp.	0	0	0	P	0	0	0
Chydorids	0	0	0	0	0	0.5	0
Collembola	0	0	0	0	0	0.1	0
Elassoneuria sp.	5.9	0	0	0.1	0	0	0
Centroptilum excisum	0	0	0.1	0.1	0	0	0
Centroptilum flavum	1.7	0	0	0.2	0	0	0.3
Centroptilum medium	1.3	0.1	0	2.8	0	0	4.0
Baetis glaucus	14.7	2.5	0.7	0.9	2.7	2.5	4.0
Other baetid sp. diag.E	0	0	0	0.4	0	0	0
Other baetid spp.	0.4	0.1	0	1.8	0	0	0
Choroterpes sp.	1.8	0.4	1.1	0.5	1.1	0.5	0.8
Castanophlebia sp.	0	1.0	0	0	0	0	0
Tricorythus "lowveld"	22.2	5.7	0	79.9	17.4	0.3	0.8
Austrocaenis sp.	3.5	0.3	0.1	1.9	0	0.1	0.2
Afronurus sp.	0	P	0.1	0	0	0	0
Paragomhpus sp.	0	P	0	0	0	0	0
Aeschna sp.	0	P	0	0	0	0	0
Gerridae	0	P	0	0	0	0	0
Micronecta sp.	0	0	0	0	0.2	0	0
Aethaloptera sp.	0.2	0	0	0.1	1.2	0	0
Amphipsyche scottae	0.9	P	0.5	3.2	2.6	1.5	1.9
Cheumatopsyche thomasseti	31.5	18.6	21.1	2.6	9.5	34.5	23.8
Hydropsychid pupae	0	0	0.7	0	0	0	0
Ecnomus sp.	0	0	0.1	0	0	0.1	0
Chimarrha sp.	0.1	0.2	0	0	0	0	0
Leptocerus ?schoenobates	0.3	0	0	0	0	0	0
Trichosetodes sp.	0.1	0	0.1	0	0	0	0
Leptoceridae	0	P	0	0	0	0	0
Oecetis sp.	0.8	0.4	0	P	0	0	0
Hydroptila capensis	0	0	3.1	0	0.8	3.0	0
Orthotrichia barnardi	0.1	0	0.4	P	0.1	0	0.1
Catoxyethira sp.	0	0	0	P	0	1.8	11.1
Hydroptilid juveniles	0	P	4.0	P	0	13.2	8.0
Dytiscidae	0	0	0	0	0	0.5	0
Stenelmis sp.	0	0.9	1.4	1.8	0.9	0.8	12.7
Other elmidae	0.2	0	P	0.1	0	0	0
Culicidae	0	0	P	0	0	0	0
Simulium spp.	12.0	42.5	0.2	0.3	51.2	3.3	1.0
Chironomini	3.3	10.8	20.9	1.5	6.2	15.9	12.2
Tanytarsini	1.7	7.8	36.5	0	0.1	5.5	9.9
Corynoneura sp.	0	0	0	0.2	0	0	0
Orthocladinae	3.5	1.9	2.3	0	3.5	11.6	3.7
Cricotopus sp.	0	0.4	0.4	0	0.1	0.6	2.7
Pentaneura sp.	2.8	1.0	0.7	0.2	0	0.1	0.1
Dasyhelea-type larvae	0.1	0.1	0	0	0	0	0
Forcipomyia sp.	0	0	0	P	0	0	0

Table A8. Olifants River above confluence with Letaba River.
Stones-in-current (cont.)

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86	OCT 86
Tabanidae	0	0	P	P	0	0	0
Higher dipterans	0	0.1	P	0	0	0.2	0
Ancylidae	0	0	0	0	0.1	0	0
Eupera sp.	0	0	3.1	0.1	2.2	0.4	0
Corbicula africana	0	0	0.1	0.9	0	3.1	2.7
Chiloglanis sp.	P	0	0	0	0	0	0
TOTAL NO. OF INDIVIDUALS	1585	2961	3915	3702	1329	1569	1021

TABLE A9. PERCENTAGE COMPOSITION OF THE STONES-IN-CURRENT FAUNA FROM THE LUVUVHU RIVER AT THE WESTERN SITE.

TAXON	APRL 85 DON.	JUNE 85 DON.	APRL 86 SHI.	JUNE 86 MAN.	AUG 86 MAN.	OCT 86 MAN.
Hydra sp.	0	0	0	0	0	0.6
Planaria	0	0.1	0	0.5	0.1	0.6
Nais sp.	0	0.1	0	0	0	0
Ceriodaphnia/Simocephalus sp.	0	0	0	0	0.9	0
Decapod juveniles	0	0	0.1	0	0	0
Hydracarina sp.1	0	0	0.4	0	0	1.3
Neoperla spio	0	0.8	0.1	0	0	0.2
Elassoneuria sp.	0.3	0	0	0	0	0
Centroptiloides ?spinulosa	0.4	0	0	0	0	0
Centroptilum excisum	0	0.1	0	0	0	0
Centroptilum flavum	0	0.1	0	0	0	0.4
Centroptilum medium	2.5	0	25.2	1.7	0	0
Pseudocloeon sp.A Kimmins 1955	0.3	0.3	0.2	0	1.1	0.9
Baetis glaucus	8.1	6.9	1.7	16.0	6.3	2.3
Baetis (Acentrella) sp.	0	5.8	0.2	2.3	0	0.4
Other baetid sp. diag. A	0	0	0	0.6	0	0
" " " E	0	0.1	0	0	0	0
Other baetid spp.	0	0	0.5	0.6	1.1	0
Choroterpes sp.	7.8	3.5	2.8	2.0	1.6	4.0
Tricorythus "lowveld"	18.4	0.4	4.2	0.6	0	1.7
Austrocaenis sp.	0.2	6.6	4.6	4.5	6.8	15.3
Afronurus sp.	3.3	0.8	2.1	0.4	2.1	0.7
Chlorocypha sp.	0	0	0	0	0.1	0
Zygopterans	0	0	0.1	0	0	0
Zygonyx sp.1	1.2	1.4	0.3	0.1	0	0.2
Libellulid sp.1	0	0	0.3	0.1	0.6	0.6
Anisopterans	0	0	0.1	0	0	0
Gerridae	0	0	0	0	0.3	0
Other hemipterans	0	0	0	0	1.5	0
Amphipsyche scottae	0.2	0.1	3.4	0.4	0.1	2.8
Cheumatopsyche thomasseti	19.6	13 3	7.7	11.7	3.1	14.1
Cheumatopsyche afra	0	0	0	0.1	0	0.1
Ecnomus sp.	0	0	0	0	0.4	0.3
Chimarrha sp.	0	1.4	27.2	21.2	9.4	11.4
Leptocerus ?inflatus	0	0.9	1.2	0	0.2	0
Trichosetodes sp.	0.3	0.1	0.1	0.1	0.7	0
?Barbarochthon sp.	0	0	0	0.8	1.0	2.1
Leptoceridae	1.5	0	0	0.1	0	0.8
Hydroptila capensis	0	0.2	0.1	0.4	1.2	0
Orthotricia barnardi	0	0	0.1	0.1	0	0.6
Catoxyethira sp.	0	0	0	0	2.3	0
Hydroptilid juveniles	0	0.2	2.0	0.2	8.5	4.9
Pyralidae	0	0.7	0	0.7	0	0.6
Gyrinidae	0	0	0.2	0.4	0.6	0.2
Psephenidae	0	0	0.1	0	0	0.1
Stenelmis sp.	0.9	4.5	0.5	0.4	0	1.5
Other elmidae	0	1.7	0.6	0.9	0	0.9
Tipulidae	0	0.1	0.1	0	0.2	0.5
Simulium spp.	14.0	5.2	0.1	3.8	18.4	0.6
Chironomini	4.6	9.7	5.4	10.1	5.4	5.7
Tanytarsini	5.0	4.0	2.2	0.8	2.6	3.3
Corynoneura sp.	0	0	0.1	0	0	0
Theinemanniella sp.	0	0.1	0	0	0	0
Orthocladinae	10.1	10.9	3.1	16.6	17.6	4.0

Table A9. Luvuvhu River at Western Site. Stones-in-current (cont.)

TAXON	APRL 85 DON.	JUNE 85 DON.	APRL 86 SHI.	JUNE 86 MAN.	AUG 86 MAN.	OCT 86 MAN.
Cricotopus sp.	0.2	2.7	0.8	0.1	0.6	0.1
Pentaneura sp.	1.4	0.5	1.0	0.3	1.4	0.7
Tanypod pupae	0	0	0	0	0.1	0
Dasyhelea-type larvae	0	0	0	0.1	0	0
Bezzia-type larvae	0	0	0	0	0	0.9
Forcipomyia sp.	0	0	0	0.2	0	0
Tabanidae	0	0.2	0	0	0	0
Higher dipterans	0	0.1	0	0	0	0
Burnupia sp.	0	0	0	0	0	0.3
Eupera sp.	0.3	0	1.1	0.9	1.2	14.3
Corbicula africana	0	0	2.1	0	1.1	0.2
Other pelecypoda	0	16.7	0	0	0	0
Anguilla sp.	0	0	0	0.1	0	0
TOTAL NO. OF INDIVIDUALS	665	1215	2003	1173	891	1318

DON. -Dongadziba
SHI. -Shidzivane
MAN. -Mangovane

TABLE A10. PERCENTAGE COMPOSITION OF THE STONES-IN-CURRENT FAUNA FROM THE LUVUVHU RIVER BELOW CONFLUENCE WITH THE MUTALE RIVER.

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86	OCT 86
Hydra sp.	0	0	0.9	0.4	0	0	2.0
Planaria	0	0.6	2.1	0.2	0.9	3.8	1.4
Prostoma sp.	0	0	0	0	0	0	0.1
Pristina sp.	0	0	0.9	0.9	0	0	0
Nais sp.	0	0.2	0.5	0.7	0	0	0
Branchiobdellidae	0	0	0	0.1	0	0	0
Other oligochaetes	0	0	0	7.3	0.1	0	0
Stenocypris sp.	0	0	0	0.4	0	0	0
Hydracarina sp.1	0.5	0	2.6	P	3.1	2.7	0.1
sp.2	0	0	0	0.6	0	0	0
Neoperla spio	0.2	P	0	0	0.2	0.3	0.1
Centroptiloides bifasciatum	0	0.1	0	0	0	0	0
Centroptiloides ?spinulosa	5.6	1.0	0	0	0	0	0
Centroptilum "near excisum"	0	0	0	0.7	0	0	1.3
Centroptilum flavum	0	0.2	0	0	0	0	0
Centroptilum medium	0.6	0	20.8	14.5	7.9	0.3	8.0
Pseudocloeon sp.A Kimmins 1955	0.2	0.4	0	0.2	0	0.6	0.1
Baetis glaucus	16.3	4.8	0	3.6	46.6	16.6	2.5
Baetis (Acentrella) sp.	0	0.1	0	0	0.7	2.6	0
Other baetid sp. diag. A	0.2	0.1	0	0	0	0	0.1
" " " " E	0	0	0	P	0	0	0
" " " " F	0	0	0	0.4	0	0	0.1
" " " " H	0	0	0	0	0	0	0.1
" " " " J	0	0	0	0	0	0.3	0
Other baetid spp.	0.2	0	0	4.2	0.7	0	0
Choroterpes sp.	4.3	5.6	15.6	6.2	6.1	7.8	4.4
Tricorythus "lowveld"	19.3	0.4	0.2	1.1	0	0	0
Austrocaenis sp.	0	0.2	0.2	10.0	3.2	6.1	3.6
Afronurus sp.	1.0	0.7	16.1	1.0	0.2	0.3	5.1
Dicercomyzon sp.	0	0	0	0	0	0	1.1
Allocnemis sp.	0	0	0	0	0	0	0.1
Zygopterans	0	0	0	0	0.1	0	0
Zygonyx sp.1	0.6	0.4	0	0	0	0.5	0
Libellulid sp.1	0	0	0	0.6	0.3	0.8	0.2
Anisopterans	0	0	0	0.7	0.8	0	0
Micronecta sp.	0	0	0.5	0	0	0	0
Other hemipterans	0	0	0	0.6	0	0	0
Sisyridae	0	0	1.4	P	0	0	0.1
Amphipsyche scottae	0.3	0.1	0	0	0	0	0
Cheumatopsyche thomasseti	17.2	10.6	6.0	3.8	3.7	9.1	11.2
Ecnomus sp.	0	0	0	P	0.2	0.1	0.9
Chimarrha sp.	3.0	7.3	5.3	6.1	2.9	11.5	7.1
Leptocerus ?inflatus	0	0	0	P	0	0	0
Trichosetodes sp.	0	0	3.3	0.1	0	0.3	0.4
?Barbarochthon sp.	0	0	0	0	0.2	0.1	0
Leptoceridae	0.1	0	0	0	0.1	0	0.1
Hydroptila capensis	0	0	0.5	1.0	0.2	0.8	0.1
Orthotrichia barnardi	0.1	0	0	0.8	0.2	0.2	1.7
Catoxyethira sp.	0	0	0	0	0	0	0.1
Hydroptilid juveniles	0	0	0	3.8	0	0.6	2.1
Pyralidae	0	0.1	0	0.4	1.1	0.1	0.3
Gyrinidae	0	0.1	0.5	0	0	0.1	0
Psephenidae	0	0	0	P	0	0	0
Stenelmis sp.	0.9	2.3	0	0.7	1.5	0.7	0.4

Table A10. Luvuvhu River below confluence with the Mutale River. Stones-in-current (cont.)

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86	OCT 86
Other elmidae	0	0.3	0	0.1	0.2	0	0.2
Tipulidae	0	0	0	0.1	0.8	1.6	0.4
Simulium spp.	20.9	24.7	9.7	0.3	1.8	5.9	3.0
Chironomini	1.5	10.4	5.9	4.3	2.9	2.8	3.8
Tanytarsini	1.6	2.0	0.5	1.1	0.5	1.8	4.9
Corynoneura sp.	0	0	0	0.8	0.6	0.9	0.6
Theinemanniella sp.	0	0	0	0.9	0	0	0
Orthocladinae	4.3	23.3	3.2	2.8	5.6	18.5	8.1
Cricotopus sp.	0.1	2.1	0.2	1.3	0	0.5	1.6
Pentaneura sp.	1.0	0.5	0	1.1	1.0	0.3	4.4
Dasyhelea-type larvae	0	0	0	0.1	0	0	0
Bezzia-type larvae	0	0	0	0.5	0	0	0.4
Forcipomyia sp.	0	0	0	P	0	0	0.1
Tabanidae	0.1	P	0	0	0.1	0	0.1
Rhagionidae	0	0	0	0	0	0	0.1
Lymnophora sp.	0	0	0	P	0	0	0
Higher dipterans	0	P	0	0.1	0	0	0
Ancylidae	0	0	1.9	0	0	0	0
Eupera sp.	0.2	0	0.7	14.4	5.0	1.7	9.7
Corbicula africana	0	0	0	0.8	0.9	0	1.1
Other pelecypoda	0	1.4	0	0	0	0	0
TOTAL NO. OF INDIVIDUALS	1729	3222	422	2533	1328	886	1601

TABLE A11. PERCENTAGE COMPOSITION OF THE STONES-IN-CURRENT FAUNA FROM THE LUVUVHU RIVER AT PAFURI PICNIC SITE.

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86
Hydra sp.	0	0	0	2.2	0.2	0.1
Planaria	0	0.1	11.8	0	1.1	2.9
Nais sp.	0	1.3	0	0.1	0	0
Dero sp.	0	0	0	0.4	0	0
Branchiobdellidae	0	0	0.2	0	P	0
Other oligochaetes	0	0	0.2	0	P	0
Hirudinea	0	0	0	0.1	0	0
Cyclopoid copepods	0	0	0	0.4	0	0
Stenocypris sp.	0	0	0	0.4	0.2	1.1
Decapod juveniles	0	0	0	1.0	0	0
Hydracarina sp.1	0	0	0	0	0.5	0.3
Neoperla spio	0.1	0.1	0.3	0.1	0	0.1
Elassoneuria sp.	1.8	0.1	0	0.2	0	0
Centroptiloides bifasciatum	0	0	0	0	0.5	0
Centroptiloides ?spinulosa	0	0.2	0	0	0	0
Centroptilum "near excisum"	0	0	0	0.2	0	0
Centroptilum flavum	1.0	0	0.4	0	0	0
Centroptilum medium	11.3	0.1	6.5	38.9	1.6	0
Pseudocloeon sp.A Kimmins 1955	0.2	0.1	0	0.4	2.6	2.2
Baetis glaucus	9.2	9.9	7.4	2.5	10.4	5.4
Baetis (Acentrella) sp.	0	0	0	0	0	0.3
Other baetid sp. diag C	0.2	0	0	0	0	0
" " " " G	0	0	0	0	1.1	0
" " " " H	0	0	0	0	0	7.3
" " " " J	0	0	0	0	0	1.3
Other baetid spp.	0	0	0.8	4.4	7.9	0
Choroterpes sp.	8.6	9.1	16.9	6.3	3.8	11.8
Tricorythus "lowveld"	29.7	6.4	0.2	3.5	13.9	0.1
Austrocaenis sp.	0	0	0.8	0.7	4.3	2.0
Afronurus sp.	0.4	1.0	1.6	2.8	0.1	0.1
Pseudagrion sp.	0	0	0	0.1	0	0
Zygopterans	0	0	0	0.1	0	0
Zygonyx sp.1	0.2	0.1	0	0	0	0.1
Libellulid sp.1	0	0	0	0.5	P	0.3
Anisopterans	0	0	0	0.1	P	0
Other hemipterans	0	0	0	0.3	0	0
Sisyridae	0	0	0	0.1	0	0
Aethaloptera sp.	0	0.1	0	0	0	0
Amphipsyche scottae	1.0	1.0	0	0.4	0	0
Cheumatopsyche thomasseti	27.7	17.4	16.6	11.6	15.8	4.7
Ecnomus sp.	0	0	0.3	0.2	0.1	0
Chimarrha sp.	0.9	1.6	0	1.7	3.1	7.8
Leptocerus ?inflatus	0.1	0	0	0	P	0
Trichosetodes sp.	0	0	0	0	P	0
Leptoceridae	0	0	0.3	0.1	P	0.1
Oecetis sp.	0.2	0	0	0	P	0
Hydroptila capensis	0	0	0	0.2	P	0.2
Orthotrichia barnardi	0	0	0	0.9	1.0	0.2
Hydroptilid juveniles	0	0	0	2.1	1.2	1.6
Gyrinidae	0	0.1	0	0	0	0
Stenelmis sp.	0	2.1	1.1	2.1	0.8	1.1
Staphylinidae	0	0	0	0	P	0
Sisyridae	0	0	0	0.1	0	0
Tipulidae	0	0	0	0.1	0	0

Table A11. Luvuvhu River at Pafuri Picnic Site. Stones-in-current (cont.)

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86
Simulium spp.	0.5	21.8	9.6	0.5	15.5	8.4
Chironomini	1.5	5.1	6.4	2.8	2.8	9.2
Tanytarsini	2.4	0.4	2.6	0.2	1.8	5.5
Corynoneura sp.	0	0	0	0	1.1	0.7
Theinemanniella sp.	0	0.5	0.6	0	0	0
Orthocladinae	1.6	14.7	14.3	4.5	5.7	27.2
Cricotopus sp.	0.2	6.1	0	2.1	0.3	2.1
Pentaneura sp.	1.4	0.4	0.4	0.7	0.6	3.5
Canypod pupae	0	0	0	0	0	0.1
Dasyhelea-type larvae	0	0	0.8	0	0	0
Tabanidae	0	0	0.2	0.2	0.1	0.1
Rhagionidae	0	0	0	0	0	0.1
Higher dipterans	0	0.3	0	0	0	0
Biomphalaria sp.	0	0	0	0	P	0
Eupera sp.	0	0	0	2.1	0.8	1.0
Corbicula africana	0	0	0	2.3	1.4	1.0
Anguilla sp.	0.1	0	0	0	0	0
Chiloglanis sp.	0	0	0.2	0	0	0
TOTAL NO. OF INDIVIDUALS	1023	1468	627	1922	3975	1532

TABLE A12. PERCENTAGE COMPOSITION OF THE STONES-IN-CURRENT FAUNA FROM THE MUTALE RIVER ABOVE CONFLUENCE WITH THE LUVUVHU RIVER.

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86
Planaria	0.7	0.8	1.9	0.3	0.3	1.2
Pristina sp.	0	0.7	0.5	0	0	0
Nais sp.	0	0.1	0.1	0.4	0	0.6
Branchiura sp.	0.1	0	0	0	0	0
Other oligochaetes	0	0	0.1	0.1	0.1	0
Stenocypris sp.	0	0	0	0.7	0.4	0
Hydracarina sp.	1.0	0	0.5	0	0.6	0
Elassoneuria sp.	0.5	0	0	0	0	0
Centroptiloides bifasciatum	0	0	0	0	0	0.2
Centroptiloides ?spinulosa	0.2	0.2	0	0	0	0
Centroptilum excisum – Barnardara	0.5	0	0	0	0	0
Centroptilum medium	12.5	0.3	3.1	21.7	10.3	0.5
Centroptilum varium – afroptiloides	0	0.2	0.2	0	0	0
Pseudocloeon sp.A Kimmins 1955	0.2	1.8	2.2	0	0.2	0.5
Baetis glaucus	24.2	43.3	19.6	1.6	16.9	7.5
Baetis (Acentrella) sp.	0	0	0	0	0	1.5
Other baetid sp. diag. A	0.2	0	0.7	0	0.2	0
" " " " J	0	0	0	0	0	0.2
Other baetid spp.	0	0.2	0.5	0.5	3.4	0
Choroterpes sp.	9.0	9.5	3.4	4.8	2.4	3.9
Tricorythus "lowveld"	10.0	0.9	0	8.9	1.4	0
Austrocaenis sp.	0	0	0.5	5.1	2.8	0.7
Afronurus sp.	0.3	4.3	2.8	0.3	0.2	0.1
Dicercomyzon sp.	0	0	0	0	0.5	0
Pseudagrion sp.	0	0	0	0.1	0	0
Zygopterans	0	0	0	0.2	0	0.1
Zygonyx sp.	10.3	0.6	0.3	0	0.2	0
Libellulid sp.	1.0	0	0	0.5	0.1	0.5
Anisopterans	0	0	0	0.8	0	0
Other hemipterans	0	0	0	0.4	0.4	0
Amphipsyche scottae	0.1	0	0	0	0	0
Cheumatopsyche thomasseti	24.5	9.5	2.7	2.5	2.5	3.1
Ecnomus sp.	0	0	0.1	0	0.1	0
Chimarrha sp.	1.3	0	1.3	16.3	0.4	0.2
Trichosetodes sp.	0	0	0	0	0.1	0
Leptoceridae	0	0	0	P	0	0
Hydroptila capensis	0	0	0	0.3	0.7	2.6
Orthotrichia barnardi	0.9	0.1	0.5	0.5	0	1.2
Catoxyethira sp.	0	0	0.1	0	0	0
Hydroptilid juveniles	0	0.6	0.5	3.5	1.5	1.0
Pyralidae	0	0	0	0	0.6	0
Dytiscidae	0.1	0	0	0	0	0
Gyrinidae	0.2	0.1	0.1	P	0.1	0.1
Dryopidae	0.1	0	0	0	0	0
Stenelmis sp.	0.2	0.7	0	0.1	0	0.2
Other elmidae	0.1	0	0	0.1	0	0
Tipulidae	0	0	0	0	0.5	0.2
Simulium spp.	1.4	8.3	43.6	1.9	25.3	35.9
Chironomini	2.2	0.3	1.3	7.0	1.8	5.4
Tanytarsini	0.2	0.1	0	10.1	0.3	4.7
Corynoneura sp.	0	0	0	1.2	0.9	0
Theinemanniella sp.	0.2	0	0	0	0.5	0
Orthocladinae	8.9	17.0	13.5	7.1	18.8	24.7
Cricotopus sp.	0	0	0.2	1.1	3.9	1.2

Table A12. Mutale River above confluence with the Luvuvhu River.
Stones-in-current (cont.)

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86
Pentaneura sp.	1.1	0.6	0	0.8	0.6	1.5
Dasyhelea-type larvae	0	0	0.1	0	0	0
Bezzia-type larvae	0	0	0	0.8	0.1	0.3
Forcipomyia sp.	0	0	0	P	0	0.3
Tabanidae	0.1	0	0	0	0	0
Rhagionidae	0	0	0	0.1	0	0
Muscidae	0	0	0	0	0	0.1
Biomphalaria sp.	0	0	0.1	P	0	0
Ancylidae	0	0	0.1	0	0	0
Eupera sp.	0	0	0	0	0.1	0
Chiloglanis sp.	0	0	0	P	0	0
TOTAL NO. OF INDIVIDUALS	1831	1337	1754	2275	1947	1547

TABLE B1. PERCENTAGE COMPOSITION OF THE STONES-OUT-OF-CURRENT FAUNA FROM THE CROCODILE RIVER AT GEZABAHLE.

TAXON	APRL 85 *	JUNE 85	SEPT 85	NOV 85	APRL 86	JUNE 86	AUG 86	OCT 86
Hydra sp.	0	0.3	1.0	0	0	0	0	0
Planaria	0.50	0	0	0	0.2	0	0	
Nematoda	0	P	0.2	0	17.5	1.3	1.9	2.3
Pristina sp.	1.5	1.9	2.0	5.6	22.1	0	0	0
Nais sp.	0	0	0	0	0	0.1	0	0
Branchiura sp.	0	0.1	0	0	0.1	0	2.8	0
Branchiobdellidae	0	0.1	0	0	0	0.7	0	0
Other oligochaetes	0	0.2	13.8	31.7	9.2	0	3.2	0.4
Hirudinea	0	0	0.2	0	0	0	0	0.6
Ceriodaphnia/Simocephalus sp.	0	0	4.4	0	0	0	0	2.0
Chydorids	0	0.3	0	0	0	0	0	0
Cyclopoid copepods	0	1.5	10.9	0	19.9	0	7.4	0.4
Stenocypris sp.	0	1.0	5.9	0	3.5	3.9	4.2	18.0
Pionocypris sp.	0	0	0	12.2	0	0	33.8	45.6
Hydracarina sp.1	0	0	0.2	0	0	0	0	0
sp.2	0	0	2.2	0	0	0	0	0
Collembola	0	0	3.5	0	0	0	0	0
Neoperla spio	2.00	0	0	0	0	0	0	
Centroptilum excisum	0	0.3	0	0	0	0	0	0
Centroptilum "near excisum"	0	1.6	3.8	0	0	0.3	0.9	0.2
Centroptilum flavum	0	0.1	0	0	0	0.3	0	0
Centroptilum medium	0	0.1	0.8	0	0	1.6	0.9	0
Cloeon africanum	0	1.9	3.0	0	3.8	0.6	2.5	0.7
Other baetid sp. diag. A	0	0	0	0	0	0.6	0	0
" " " " F	0	0	0	0	0	0	0.9	0
Other baetid spp.	2.5	0	0	0	0	0.3	0	0
Choroterpes sp.	15.3	1.8	0.2	0	0	3.1	0	0
Castanophlebia sp.	0	P	0	0	0	0	0	0
Tricorythus "lowveld"	3.5	0	0	0	0	0.2	0	0.1
Austrocaenis sp.	3.0	11.0	1.2	0	5.7	7.9	3.2	4.4
Afronurus sp.	3.5	0	0	0	0	2.8	0	0
Zygopterans	0	0	0	0	0	0.1	0	0
Phyllomacromia sp.	0	P	0	0	0	0	0	0
Libellulid sp.1	0	P	0	0	0	0.2	0	0
Anisopterans	0	0.3	0	0	1.3	0	2.3	0.4
Notonectidae	0	0	0	0	0.1	0	0	0.1
Naucoridae	0	0	0	0	0	0.1	0.5	0
Micronecta sp.	0	0.7	2.2	22.2	1.2	0.4	1.9	0.1
Other hemipterans	0	0.2	0	3.3	0.3	0	0	0
Cheumatopsyche thomasseti	2.5	0	0	0	0	0.2	0	0
Ecnomus sp.	0	0.1	0	0	0.1	0.3	0	0
Chimarrha sp.	0	0	0	0	0	0.1	0	0
Leptocerus ?inflatus	0	0.3	0	0	0	0	0	0
Leptocerus ?schoenobates	0	0.1	0	0	0	0	0	0.1
Trichosetodes sp.	0	0.4	0	0	0	1.1	0	0
Leptoceridae	1.5	0	0	0	0	0	0	0.1
Oecetis sp.	0	0	0.2	0	0	0	0	0
Hydroptila capensis	0	0.2	0	0	0	0	0.5	0
Orthotrichia barnardi	0	0.4	0	0	0	0	0	0.1
Hydroptilid juveniles	0	0.8	0	0	0	0	0	0
Trichopterans	0	0	0	0	0.3	0.6	0	0
Methles sp.	0	0	0	5.6	0	0	0	0
Lanistes sp.	0	0	0	1.1	0	0	0	0
Dytiscidae	0	0	1.7	5.6	0	0	0	0.9

Table B1. Crocodile River at Gezabahle. Stones-out-of-current (cont.)

TAXON	APRL 85 *	JUNE 85	SEPT 85	NOV 85	APRL 86	JUNE 86	AUG 86	OCT 86
Hydrophilidae	0	0	8.8	0	0	0	0	0
Hydroboriinae	0	0	0	5.5	0	0	0	0
Stenelmis sp.	0	0.8	0	0	0	0.1	0.5	0
Other elmidae	0	0.1	0.7	1.1	0	0	0.5	0.2
Culicidae	0	0	0	3.3	0.3	0	0	0.1
Simulium spp.	2.5	0	0	0	0	0.7	0	0
Chironomini	4.5	30.2	7.4	0	2.6	6.3	2.3	1.7
Tanytarsini	24.8	31.2	5.9	0	1.7	50.3	6.5	17.0
Corynoneura sp.	0.5	P	0	0	0	0.1	0	0
Theinemanniella sp.	2.0	0	0	0	0	0	0	0
Orthocladinae	12.9	5.6	4.9	0	0	5.7	9.7	0.2
Cricotopus sp.	0	3.9	0	0	1.2	4.3	2.3	0
Pentaneura sp.	6.0	0.9	0.2	0	0	2.4	2.8	0
Tanypod pupae	0	0.2	0	0	0	0.1	0	0
Dasyhelea-type larvae	5.4	P	6.2	0	0	0.8	5.1	3.4
Bezzia-type larvae	0	0.1	0	0	1.3	0.1	0.5	0.7
Forcipomyia sp.	0.5	0.1	3.7	0	0	0.3	0.5	0
Ceratapogonid pupae	0	0	0	1.1	0	0	0.9	0.1
Muscidae	0	0.3	3.0	1.1	0	0	0.9	0.4
Higher dipterans	0	P	1.2	0	0	0.1	0	0
Other dipterans	0	0	0.2	0	0.1	0	0	0
Biomphalaria sp.	0	0	0	0	0.1	0	0	0
Bulinus sp.	0	0	0	0	2.2	0	0	0
Melanoides sp.	0	0	0	0	0.1	0	0.5	0
Physopsis sp.	0	0	0	0	0.1	0	0	0
Other gastropoda	0	0	0	0	2.3	0	0	0
Eupera sp.	0	0	0	0	0	2.0	0	0.4
Corbicula africana	0	0.7	0	0	0	0	0.5	0
Other pelecypoda	3.0	0	0	0	2.3	0	0	0
Fish juvenile	0	0	0	0	0.1	0	0	0
TOTAL NO. OF INDIVIDUALS	202	2592	405	90	684	1271	216	2172

* sample collected at Magnesite

TABLE B2. PERCENTAGE COMPOSITION OF THE STONES-OUT-OF-CURRENT FAUNA FROM THE CROCODILE RIVER AT NGONDWINI.

TAXON	APRL 85	JUNE 86
Planaria	2.3	0.6
Prostoma sp.	0.3	0
Pristina sp.	1.2	0
Tubificidae	0.1	0
Branchiobdellidae	0	2.3
Other oligochaetes	4.1	0.3
Harpactacoid copepods	0.6	0
Stenocypris sp.	6.1	1.1
Pionocypris sp.	0	1.1
Hydracarina sp.1	0	1.1
Centroptilum medium	0	11.5
Baetis glaucus	0	15.6
Baetis quintus	6.0	0
Choroterpes sp.	0	5.1
Tricorythus "lowveld"	0	1.7
Austrocaenis sp.	7.3	2.6
Afronurus sp.	0	0.6
Paragomphus sp.	0.7	0
Anisopterans	0.3	0.6
Naucoridae	0.1	0
Corixidae	0.1	0
Micronecta sp.	1.0	0
Cheumatopsyche thomasseti	0	3.4
Ecnomus sp.	0	3.4
Dytiscidae	0.6	0
Gyrinidae	0	0.6
Hydrophilidae	0.1	0
Stenelmis sp.	0.6	0
Tipulidae	0	0.9
Simulium spp.	0	3.4
Chironomini	9.8	2.3
Tanytarsini	0.6	17.7
Orthocladinae	0.7	4.2
Cricotopus sp.	0	2.3
Pentaneura sp.	5.8	4.3
Muscidae	1.5	0
Eupera sp.	0	13.1
Other pelecypoda	49.9	0
TOTAL NO. OF INDIVIDUALS	685	350

TABLE B3. PERCENTAGE COMPOSITION OF THE STONES-OUT-OF-CURRENT FAUNA FROM THE SABIE RIVER AT LUBYE-LUBYE.

TAXON	**APRL 85**	**JUNE 85**	**SEPT 85**	**NOV 85**	**JAN 86**	**APRL 86**	**JUNE 86**	**OCT 86**
Hydra sp.	0	0.6	1.9	0	0	0	0	0
Planaria	0	0.5	0.1	0	0	0	0.4	0.2
Nematoda	1.8	0	0	0	1.5	0	0	0
Pristina sp.	2.7	5.2	0	0	4.4	3.9	1.0	0.2
Nais sp.	0	0.8	0.3	0	0	0	2.0	1.9
Branchiura sp.	0	0	1.9	0	0	1.8	0	0
Dero sp.	0	0.2	0.6	0	0	0	0	0
Branchiobdellidae	0	0	4.7	0	0	0	0	0
Other oligochaetes	0	0	1.0	1.8	0.4	5.9	0	1.4
Hirudinea	0	0	0	0	0.4	1.4	0.1	0
Ceriodaphnia/*Simocephalus* sp.	0	0	0	4.4	0	0	0.1	0.7
Chydorids	0	0	0	0	0	0	0.8	0
Cyclopoid copepods	0	0	33.1	24.0	0	10.7	3.8	0.7
Pionocypris sp.	0	0	0	4.4	1.5	0	0	6.0
Stenocypris sp.	0.4	3.8	3.8	0	0	21.4	11.0	1.4
Caridina sp.	0	0.2	0	0	0.7	0	0.3	0
Decapod juveniles	0	0	0	0	0	0	0	0.5
Hydracarina sp.1	0	0	0.1	0	0	0.1	0	2.8
Neoperla spio	1.8	0	0.2	0	0.7	0	0	0
Centroptilum "near excisum"	0	0	0	2.3	0	0	0	0
Centroptilum medium	19.5	0	0	0.2	0	25.8	0	0
canum	0	6.6	3.6	13.5	2.1	4.4	20.9	0.6
Baetis bellus	0	0	0	4.6	0	0	0	0
Other baetid sp. diag. A	0	0	0.5	0	1.2	0	0.2	3.6
" " " " F	5.3	0	0	0	3.4	0	0.2	0
" " " " H	0	0	0	0	0	0	0	0.6
Other baetid spp.	0	0.1	0.2	0	0	0	0	0
Choroterpes sp.	12.0	0.9	2.1	0	6.9	1.8	4.1	3.0
Adenophlebiodes sp.	0	0	0	0	0.7	2.0	0.2	0
Castanophlebia sp.	0	5.2	0	0	0	0.1	0	0
Tricorythus "lowveld"	0	0	0	0	6.6	0.1	0	0
Austrocaenis sp.	21.7	14.9	3.7	0	20.4	17.3	16.9	1.4
Afronurus sp.	1.3	0	0	0	1.1	0.1	4.7	0.7
Elattoneura sp.	0	0	0	0	0	0	0	0.4
Allocnemis sp.	0	0	0.1	0	0	0	0	0
Enallogma sp. or *Ischnura* sp.	0	0.2	0	0	0	0	0	0
Zygopterans	0	0	0	0	0	0.2	0	0
Paragomphus sp.	0	0	0	0	0	0.1	0	0
Aeschna sp.	0	0.4	0	0	0	0	0	0
Zygonyx sp.1	2.2	0.1	0	0.9	0	0	0	0
Libellulid sp.1	0	0	0.2	0	0	0	0	0.9
Anisopterans	0.9	0.2	0	0	0	0.3	0	0
Mesoveleidae	0	0.6	0.2	0	0	0	0	0
Notonectidae	0	0	0	0.9	0	0	0	0
Naucoridae	0	0.2	0.4	0	0	0	0	0.2
Micronecta sp.	0	1.8	0	16.9	0.4	1.3	0.7	23.4
Other hemipterans	0	0	0	2.6	0	0	0	1.2
Cheumatopsyche thomasseti	1.0	0	0	0	1.8	0	0	0.2
Ecnomus sp.	0	0	0	0	0	0	0	1.6
Chimarrha sp.	0	0	0	0	2.9	0	0	0
Athripsodes sp.	0	1.3	0	0	0	0	0	0
Trichosetodes sp.	0	0	1.4	0	0.4	3.1	2.5	1.0
Leptoceridae	0.4	0.1	0	0	0	0.1	0.7	0.4
Oecetis sp.	0	0	0	0	0	0.1	0	0

Table B3. Sabie River at Lubye-Lubye. Stones-out-of-current (cont.)

TAXON	APRL 85	JUNE 85	SEPT 85	NOV 85	JAN 86	APRL 86	JUNE 86	OCT 86
Hydroptila capensis	0	0	1.7	0	0	0	0	0
Orthotrichia barnardi	0	0	0.1	0	0	0	0.1	0
Catoxyethira sp.	0	0	0	0	0	0	0	1.6
Hydroptilid juveniles	0	0	0.1	0	2.9	0	0.1	0.7
Trichopterans	0	0	0.2	0	0	0.1	0	0
Pyralidae	0	0	0	0	0	0	0	0.2
Peschetius sp.	0	0	0	0.9	0.4	0	0	0
Dytiscidae	0	0	1.2	0.9	0	0.5	0	0
Noteridae	0	0.3	0	0	0	0	0	0
Hydrophilidae	0	0	0	0.9	0	0	0	0
Hydraenidae	0	0	0.1	0	0	0	0	0.2
Leptelmis sp.	0	0	0	0.4	0	0	0	0
Stenelmis sp.	1.8	2.4	0.7	0	0	0.2	0.1	3.5
Other elmidae	0	0	0	0	0	0.2	0	0
Tipulidae	0.4	0	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0	0	1.4
Simulium spp.	0.4	0	0.1	0	0	0	0	0
Chironomini	10.2	40.5	8.0	19.6	2.2	4.8	9.2	3.3
Tanytarsini	4.9	1.3	16.6	0	4.7	1.3	4.3	7.4
Orthocladinae	0.9	8.7	3.9	0	0	1.0	3.5	0.7
Cricotopus sp.	0	0	0	0	1.5	1.0	0.1	3.5
Pentaneura sp.	2.2	1.1	0.5	0	2.6	1.3	1.7	5.1
Procladius sp.	0	0.2	0.2	0	0	0.1	0	0
Dasyhelea-type larvae	0	0	0	0	0	0	1.6	0
Bezzia-type larvae	0	0.9	1.4	0	0.7	3.1	0.2	1.1
Forcpomyia sp.	0	0	2.0	0	0	1.2	1.0	0
Ceratapogonid pupae	0	0	0	2.6	0	0	0	0
Tabanidae	0	0	0	0	0	0	0.1	0.5
Rhagionidae	0.4	0	0	0	0	0	0.3	0.4
Empididae	0	0	0	0	0	0	0	0.2
Muscidae	0	0	0	0	0	0.1	0	0
Biomphalaria sp.	0	0	0	0	0	0	0	0.4
Bulinus sp.	0	0	0.6	0	0	0	0	0
Melanoides sp.	0	0	0	0	0	0.1	0	0
Physopsis sp.	0	0	0	0	0	0.5	0	0
Ancylidae	0	0	2.3	0	0	0.2	0	0
Eupera sp.	0	0.5	0	0	0	0	0.8	10.2
Corbicula africana	0	0.1	0	0	0	0	1.7	2.6
Other pelecypoda	8.8	0	1.2	0	1.5	6.6	0	0
Xenopus sp.	0	0.1	0	0	0	0	0	0
Anuran juveniles	0	0	0	0	0	0	0	0
TOTAL NO. OF INDIVIDUALS	226	1265	1331	414	274	828	1051	569

TABLE B4. PERCENTAGE COMPOSITION OF THE STONES-OUT-OF-CURRENT FAUNA FROM THE SABIE RIVER OPPOSITE LISBON ESTATES.

TAXON	APRL 85	JUNE 85	SEPT 85	JUNE 86	AUG 86	OCT 86
Hydra sp.	0	0	2.6	0	0	0
Planaria	0	0	0.1	0	0.2	0
Nematoda	0	0.1	0.2	0	0	0
Tardigrada	0	0.3	0	0	0	0
Pristina sp.	0	0.3	12.2	0	2.0	0
Nais sp.	0	0.4	0	0	0	0
Branchiura sp.	0	0	0.1	0	0	0
Dero sp.	0	0.3	0	0	0	0
Other oligochaetes	0	0	2.3	0	1.0	47.7
Cyclopoid copepods	0	0.3	0.8	1.7	0.5	5.8
Harpactacoid copepods	0	0.7	0	0	0	0
Pionocypris sp.	0	0	0	0	0.1	0
Stenocypris sp.	0	0.6	0	0	0	0
Caridina sp.	0	P	0	0	0	0
Hydracarina sp.1	1.2	0	0.9	1.3	1.4	0
Neoperla spio	0.3	0	0	0	0	0
Machadorhythus sp.	0	0.1	0.1	0.1	0.1	0
Centroptilum excisum	0	0	0.8	0	2.5	0
Centroptilum "near excisum"	0	12.7	28.5	13.3	10.7	0
Centroptilum flavum	0	0	0	0	1.0	0
Centroptilum medium	37.7	0	0	1.4	0.5	0
Centroptilum varium	1.0	0	0	0	1.0	0
Cloeon africanum	0	5.1	1.6	6.6	2.5	0
Cloeon sp.	0	0.3	0	0	0	0
Pseudocloeon sp.	1.0	0	0	0	0	0
Baetis glaucus	1.8	0	0	0	0	0
Baetis q[illegible]us	1.8	0	0	0	0	0
Other baetid sp. diag. A	0	0.3	5.2	0	3.0	0
" " " " E	0	0	0	0	0.5	0
" " " " H	0	0	0	0	1.0	0
Choroterpes sp.	9.6	3.3	4.6	2.2	3.0	0
Adenophlebiodes sp.	0.4	0	0	1.1	0	0
Castanophlebia sp.	0	0.1	0	0	0	0
Tricorythus "lowveld"	0	0	0	0	0.1	0
Austrocaenis sp.	5.2	13.5	9.6	23.9	16.5	0
Afronurus sp.	4.5	0.3	0	0	0.1	0
Dicercomyzon sp.	0.3	0	0	0.1	0.1	0
Prosopistoma sp.	0	0	0	0	0.7	0
Metacnemis sp.	0.3	0	0	0	0	0
Allocnemis sp.	0	0	0	0.1	0	0
Chlorocypha sp.	0.6	0	0	0	0	0
Zygopterans	0.6	P	0	0	0	0
Gomphidae	0	0.1	0.9	0.2	0	0
Zygonyx sp.1	0.9	0	0	0	0	0
Anisopterans	0.6	0.4	0.1	0.1	0.2	3.5
Gerridae	0	0	0	0.1	0	0
Notonectidae	0	0	0.1	0	0	0
Naucoridae	0.3	0	0	0.2	0	1.2
Corixidae	0	0	0.9	0	0	0
Micronecta sp.	0	7.8	5.0	4.5	0.7	10.5
Other hemipterans	0	0	1.6	0	0	0
Aethaloptera sp.	0	P	0	0	0	0
Leptocerus ?schoenobates	0	0.1	0	0.2	0	0
Athripsodes sp.	0	0	0.2	0.1	0	0

Table B4. Sabie River Opposite Lisbon Estates. Stones-out-of-current (cont.)

TAXON	APRL 85	JUNE 85	SEPT 85	JUNE 86	AUG 86	OCT 86
Trichosetodes sp.	0	0.6	0.6	0.5	0.1	1.2
?Barbarochthon sp.	0	0	0	0.1	0	0
Leptoceridae	2.1	0.1	0.1	0	0	0
Dyschimus sp.	0	0	0	0.1	0	0
Hydroptila capensis	0.9	0.1	0.3	0	0.1	0
Orthotrichia barnardi	0.3	0	0.1	0	0	0
Catoxyethira sp.	0	0	0	0	0.2	0
Hydroptila sp.	0	P	0.1	0	0.2	0
Hydroptilid juveniles	2.1	0.2	0.8	0	2.5	0
Dryopidae	0	0	0	0.1	0	0
Psychodidae	0	0	0	0	0.1	0
Stenelmis sp.	0	0.6	0.9	1.4	0.4	0
Other elmidae	0	0.2	0	0.2	0	0
Staphylinidae	0	P	0	0	0	0
Sisyridae	0	0	0	0	0.1	0
Tipulidae	0	0.1	0.1	0	0	0
Culicidae	0	0	0	0	0	8.1
Simulium spp.	0	0	0	0	2.1	0
Chironomini	1.2	28.4	1.2	10.0	8.1	0
Tanytarsini	5.2	15.5	9.1	22.2	17.4	0
Corynoneura sp.	0.6	0	0	0	0.7	0
Theinemanniella sp.	0	0	0.8	0	0	0
Orthocladinae	15.4	3.6	1.3	5.6	10.6	0
Cricotopus sp.	0	0.2	0	0	6.3	0
Pentaneura sp.	2.7	1.8	3.0	1.4	1.9	0
Procladius sp.	0	0.1	0.1	0.1	0	0
Tanypod pupae	0	0.1	0	0	0	0
Dasyhelea-type larvae	0.6	0	0	0	0	0
Bezzia-type larvae	0	0.4	2.0	0.4	0.1	3.5
Forcipomyia sp.	0.3	0	0.2	0.1	0.1	5.8
Ceratapogonid pupae	0	0	0	0	0.1	3.5
Tabanidae	0	0.1	0	0.1	0	0
Rhagionidae		0		0.1	0	0.1
Empididae	0	0	0	0	0.1	0
Muscidae	0	0.1	0	0	0	9.3
Higher dipterans	0	0	0	0.1	0	0
Eupera sp.	0	0.3	0	0	0	0
Corbicula africana	0	0	0	0.9	0	0
Other pelecypoda	0.3	0	0	0	0	0
Oreochromis mossambicus	0	0	0	0.1	0	0
TOTAL NO. OF INDIVIDUALS	330	2793	951	1882	1741	86

TABLE B5. PERCENTAGE COMPOSITION OF THE STONES-OUT-OF-CURRENT FROM THE OLIFANTS RIVER AT MAMBA.

TAXON	APRL 85	SEPT 85	APRL 86	JUNE 86	AUG 86	OCT 86
Hydra sp.	0	1.7	0	0	0.1	0.9
Nematoda	0	0	0	0.2	0	0.1
Pristina sp.	1.2	2.8	0	0	0	0
Branchiura sp.	0	0	0.8	0	0.6	0.3
Branchiobdellidae	0	6.3	0	0	2.9	0
Other oligochaetes	0	0	0	0.8	0.1	3.2
Hirudinea	0	0	0	0	0	1.0
Ceriodaphnia/Simocephalus sp.	1.2	0	0	0	0	0
Chydorids	0	5.4	0	0	0.1	0
Other cladocerans	0	1.1	0	0	0	0
Cyclopoid copepods	0.6	8.0	9.3	4.7	9.0	0
Pionocypris sp.	0	0	0	0.7	1.8	19.5
Stenocypris sp.	3.5	27.6	1.5	0	2.7	2.0
Hydracarina sp.1	0	0.3	0	0	0	0
Collembola	0	0	0	0.2	0	0
Centroptilum excisum	5.7	1.7	0	3.0	0.7	1.4
Centroptilum "near excisum"	0	5.5	0	3.2	3.2	1.2
Centroptilum flavum	1.7	0	3.5	10.6	0	0
Centroptilum medium	21.0	0	52.5	22.9	0	0.7
Cloeon africanum	0	0	2.3	0	0.7	1.6
Cloeon "longtoes"	0.2	0	0	0	0	0
Cloeon sp.	0	1.7	0	0	0	0
Baetis bellus	0.2	0	0	0	0	0
Other baetid spp.	0	1.7	0	2.1	0	0
Choroterpes sp.	2.5	0	5.0	9.2	1.9	0
Tricorythus "lowveld"	0	0	0	1.3	0.1	0
Austroca[illegible]s sp.	0.4	0	5.8	15.1	2.1	12.7
Afronurus sp.	0	0	0.4	0.8	0	0
Pseudagrion mossiaicum	0.1	0	0	0	0	0
Pseudagrion sp.	0	0	0	0	0	0.1
Zygopterans	0	0	0	0.2	0	0.1
Zygonyx sp.1	0	0	0.4	0	0	0
Anisopterans	1.4	0	0	1.0	0.2	0
Gerridae	0.1	0	0	0	0	0
Notonectidae	0	12.8	0	0	0	0
Naucoridae	0	0	0.4	0	0	0.1
Micronecta sp.	0.1	0.6	0.4	0	5.3	6.8
Other hemipterans	0	6.8	0	0.2	0	0
Aethaloptera sp.	2.7	0	0	0	0	0
Cheumatopsyche thomasseti	0	0	0	0.7	0	0.1
Ecnomus sp.	0	0	0	0.5	0	0.1
Leptocerus ?schoenobates	0	0	0	0	0.1	0
Athripsodes sp.	0	0	0.4	0	0	0
Trichosetodes sp.	0	0	0	0.5	0.2	0.1
Leptoceridae	0	0	0	0	0	0.2
Orthotrichia barnardi	0	0	0.4	0	0.1	0.2
Hydroptila sp.	0	0	0	0	0.1	0
Hydroptilid juveniles	0	0	1.5	0	0	0
Haliplidae	0.1	0	0	0	0	0
Peschetius sp.	0	0	0	0	0	0.1
Dytiscidae	0	0.3	0	0	0	0
Gyrinidae	0.1	0	0	0	0	0
Hydrophilidae	0	0.3	0	0	0	0.1
Hydraenidae	0	0	0	0	0.1	0

Table B5. Olifants River at Mamba. Stones-out-of-current (cont.)

TAXON	APRL 85	JUNE 85	APRL 86	JUNE 86	AUG 86	OCT 86
Dryopidae	0	0.3	0	0	0	0
Stenelmis sp.	0	0	0	0	0.2	0
Other elmidae	0	0	0	0	0	0.1
Culicidae	0.6	0	0	0	0.1	0
Simulium spp.	0	0	0	1.7	0.1	0.1
Chironomini	22.6	0.3	0.4	0.7	5.9	5.2
Tanytarsini	15.5	9.1	0	1.2	17.8	19.6
Corynoneura sp.	1.9	1.1	4.6	0.7	2.7	8.5
Orthocladinae	9.0	2.3	1.5	14.2	15.0	10.9
Cricotopus sp.	2.0	0	0	3.3	0	0.2
Pentaneura sp.	1.5	0.3	3.5	1.8	0.3	0.3
Tanypod pupae	0.1	0	1.5	0	0	0
Dasyhelea-type larvae	2.9	1.4	1.5	0.3	13.3	0.5
Forcipomyia sp.	0	0	0	0	8.2	0.1
Ceratapogonid pupae	0	0	0	0	3.4	0.3
Tabanidae	0.1	0	0	0.2	0	0
Ephyridae	0	0	0	0	0.2	0
Muscidae	0	0	0	0	0.5	0
Lymnophora sp.	0	0	0	0	0	0.1
Higher dipterans	0	0.3	0	0	0	0
Biomphalaria sp.	0	0	0	0	0	0.1
Corbicula africana	0	0	2.3	2.2	0	0.9
Other pelecypoda	0.4	0	0	0	0	0
Fish juvenile	0.1	0	0	0	0	0
Xenopus sp.	0	0.3	0	0	0	0
TOTAL NO. OF INDIVIDUALS	691	351	259	598	888	871

TABLE C5. PERCENTAGE COMPOSITION OF THE SEDIMENT FAUNA FROM THE OLIFANTS RIVER AT MAMBA

TAXON	OCT 86
Other oligochaetes	0.1
Chydorids	0.7
Cyclopoid copepods	2.2
Pionocypris sp.	11.2
Stenocypris sp.	5.3
Centroptilum "near excisum"	3.5
Austrocaenis sp.	7.9
Aeschna sp.	P
Phyllomacromia sp.	P
Gomphidae	P
Micronecta sp.	7.4
Other hemipterans	P
Trichosetodes sp.	0.1
Leptoceridae	0.3
Hydrophpilidae	0.1
Chironomini	1.4
Tanytarsini	58.0
Dasyhelea-type larvae	0.1
Melanoides sp.	0.1
Corbicula africana	1.3
TOTAL NO. OF INDIVIDUALS	3205

TABLE C6. PERCENTAGE COMPOSITION OF THE SEDIMENT FAUNA FROM THE OLIFANTS RIVER ABOVE CONFLUENCE WITH THE LETABA RIVER.

TAXON	APRL 85
Pristina sp.	4.8
Other oligochaetes	2.7
Ceriodaphnia/Simocephalus sp.	0.7
Pionocypris sp.	0.7
Centroptilum "near excisum"	8.6
Baetis bellus	0.7
Other baetid sp. diag.F	0.5
Austrocaenis sp.	34.3
Tricorythus"lowveld"	0.3
Libellulidae	0.2
Gomphidae	0.5
Naucoridae	0.3
Micronecta sp.	0.5
Other hemipteran	0.7
Oecetis sp.	1.2
Hydroptila capensis	0.2
Simulium spp.	0.3
Chironomini	15.6
Tanytarsini	16.0
Corynoneura sp.	1.4
Cricotopus sp.	0.2
Pentaneura sp.	6.3
Tanypod pupae	0.5
Dasyhelea-type larvae	1.4
Forcipomyia sp.	0.3
Ephyridae	0.7
Dolichopodida	0.2
Fish juvenile	0.2
TOTAL NO. OF INDIVIDUALS	583

TABLE C7. PERCENTAGE COMPOSITION OF THE SEDIMENT FAUNA FROM THE LUVUVHU RIVER AT PAFURI PICNIC SITE.

TAXON	JUNE 86	AUG 86
Branchiobdellidae	0	7.0
Other oligochaetes	1.0	0.3
Ceriodaphnia/Simocephalus sp.	0.5	0
Cyclopoid copepods	1.8	27.2
Pionocypris sp.	3.7	P
Stenocypris sp.	2.3	1.0
Hydracarina sp.1	0	0.7
Centroptilum "near excisum"	21.4	10.4
Cloeon africanum	12.0	0
Baetis bellus	1.6	0
Choroterpes sp.	0	0.9
Austrocaenis sp.	45.4	17.4
Gomphidae	0.4	0.2
Libellulidae	0.1	P
Naucoridae	0	0.3
Micronecta sp.	4.3	19.9
Other hemipterans	0	P
Cheumatopsyche thomasseti	0	P
Hydroptila capensis	0	P
Hydroptilid juveniles	0	P
Peschetius sp.	0.1	0
Dytiscidae	0	P
Simulium spp.	0	0.4
Chironomini	3.6	5.8
Tanytarsini	1.1	4.7
Corynoneura sp.	0	P
Orthocladinae	2.0	0.1
Cricotopus sp.	0	1.2
Pentaneura sp.	2.0	1.6
Bezzia-type larvae	1.0	0.2
Melanoides sp.	0.1	0
Eupera sp.	0.2	0
Corbicula africana	1.5	0.5
TOTAL NO. OF INDIVIDUALS	1758	2309

TABLE D1. PERCENTAGE COMPOSITION OF THE VEGETATION FAUNA FROM THE CROCODILE RIVER AT GEZABAHLE.

TAXON	NOV 85
Other oligochaetes	6.2
Cyclopoid copepods	2.1
Pionocypris sp.	6.2
Hydracarina sp.1	2.1
Baetis bellus	6.6
Cloeon africanum	34.6
Gomphidae	2.6
Notonectidae	5.2
Micronecta sp.	18.6
Other hemipterans	1.0
Simulium spp.	2.1
Chironomini	4.6
Orthocladinae	4.1
Ceratapogonid pupae	4.1
TOTAL NO. OF INDIVIDUALS	194

TABLE D2. PERCENTAGE COMPOSITION OF THE VEGETATION FAUNA FROM THE OLIFANTS RIVER AT MAMBA.

TAXON	JUNE 85
Pristina sp.	0.1
Branchiobdellidae	1.3
Ceriodaphnia/Simocephalus sp.	0.1
Cyclopoid copepods	0.4
Pionocypris sp.	0.4
Centroptilum excisum	0.2
Centroptilum "near excisum"	1.0
Centroptilum flavum	1.8
Centroptilum medium	0.4
Baetis glaucus	16.9
Other baetid sp. diag.H	18.3
" " " " J	10.2
Other baetid spp.	22.3
Austrocaenis sp.	2.8
Tricorythus "lowveld"	0.2
Elattoneura sp.	0.1
Pseudagrion sp.	0.2
Zygopterans	0.1
Pleidae	0.1
Micronecta sp.	0.4
Other hemipterans	2.2
Cheumatopsyche thomasseti	0.5
Leptocerus ?schoenobates	0.1
Gyrinidae	1.5
Hydrophilidae	0.1
Simulium spp.	5.3
Chironomini	4.0
Tanytarsini	0.1
Corynoneura sp.	4.7
Orthocladinae	0.1
Cricotopus sp.	2.9
Pentaneura sp.	0.7
Ceratapogonid pupae	0.8
TOTAL NO. OF INDIVIDUALS	2030

TABLE D3. PERCENTAGE COMPOSITION OF THE VEGETATION FAUNA FROM THE LUVUVHU RIVER AT THE WESTERN SITE.

TAXON	**APRL 85 DON.**	**JUNE 85 MAN.**	**JUNE 86 MAN.**	**AUG 86 MAN.**
Hydra sp.	0	1.1	0	0
Planaria	0	0	P	0
Nematoda	0	0.1	0	0
Pristina sp.	1.8	1.1	0	0
Nais sp.	3.8	8.9	0.1	0
Other oligochaetes	0	0	1.2	0
Hirudinea	0	0	0.1	0
Ceriodaphnia/Simocephalus sp.	0	0	0.5	1.5
Chydorids	0	0	2.6	0
Cyclopoid copepods	2.7	0	3.1	1.9
Pionocypris sp.	0	1.1	5.7	0.1
Stenocypris sp.	6.9	4.7	8.4	0.1
Caridina sp.	9.8	0.7	2.0	0.5
Hydracarina sp.1	0	0	0.4	0.7
sp.2	0	0	0.3	0
Centroptilum "near excisum"	0	0.8	0	0
Centroptilum flavum	1.1	0	0	0
Centroptilum medium	1.1	0	0	0.5
Cloeon africanum	17.2	1.4	18.6	0.5
Cloeon sp.	1.1	0	0	0
Baetis bellus	0	0	21.5	0
Baetis glaucus	0	4.4	0	0
Other baetid sp. diag.F	0	0	0.3	0
" " " " H	0	13.8	0	7.4
" " " " J	0	0	0	2.8
" " " " K	0	0.8	0	0.7
Other baetid spp.	0	11.9	0.6	20.5
Choroterpes sp.	0	0.1	P	0.2
Austrocaenis sp.	0.4	0.7	7.1	2.9
Afronurus sp.	5.8	0.5	0.6	2.4
Elattoneura sp.	0.2	0	0	0
Pseudagrion sp.	0.2	0.3	0.3	0.2
Zygopterans	0	0.4	0.4	0.1
Anisopterans	0	0.4	0.6	0
Phyllomacromia sp.	0	0	0.1	0
Orthetrum sp.	0	0	P	0
Pantala sp.	0	0	P	0
Anisopterans	0	0	0	0.4
Mesoveleidae	0	0	0.2	0
Gerridae	0	0	0.1	0
Veliidae	0	0	1.2	0
Notonectidae	0.2	0.7	0.2	0.6
Pleidae	0	0	P	0
Naucoridae	0	0	0.1	0
Nepidae	0	0	0.1	0
Micronecta sp.	0	0	0.7	0.1
Other hemipterans	0.7	4.0	0.6	3.0
Ecnomus sp.	0.2	0	0	0
Leptocerus ?inflatus	1.8	0.1	0.1	0.6
Leptoceridae	0	0	0	0.3
Oecetis sp.	0.2	0.1	0.1	0.2
Orthotrichia barnardi	0	0.3	P	0.2
Catoxyethira sp.	0	0	0	0.2
Hydroptilid juveniles	0	0	P	0
Pyralidae	1.1	0	0.4	0
Methles sp.	0	0	0.3	0
Peschetius sp.	0	0	0.7	0
Dytiscidae	0.2	0.2	1.2	0
Pseudancyronyx sp.	0.2	0	0	0
Gyrinidae	0	0.1	P	0.1

Table D3. Luvuvhu River at the Western Site. Vegetation biotopes (cont

TAXON	APRL 85 DON.	JUNE 85 MAN.	JUNE 86 MAN.	AUG 86 MAN.
Hydrophilidae	0	0	0.2	0
Ochthebius sp.	0	0	0.1	0
Hydraenidae	0	0	0.7	0.2
Leptelmis sp.	0	0	0	0.2
Other elmidae	0.4	0.2	0.3	0
Helodidae	0	0	0.3	0
Aleocharinae	0	0	0.1	0
Chrysomelidae	0	0	P	0.2
Coccinellidae	0	0	P	0
Culicidae	3.5	0	0.2	0.6
Simulium spp.	0	1.5	P	28.8
Chironomini	26.0	10.4	6.0	7.6
Tanytarsini	0	4.3	0.3	3.4
Corynoneura sp.	3.6	1.1	1.9	1.7
Orthocladinae	5.8	6.1	0.2	4.4
Cricotopus sp.	1.8	13.0	P	2.2
Pentaneura sp.	0	1.5	2.5	1.4
Bezzia-type larvae	0	0.1	0.1	0.1
Ceratapogonid pupae	0.2	0	0	0
Tabanidae	0	0	0.3	0
Muscidae	0	0	0.1	0
Anthomyidae	0	0.1	0	0
Biomphalaria sp.	0	0.1	0.1	0
Lymnaea sp.	0	0	0.1	0
Melanoides sp.	0	0	0.1	0
Ancylidae	0	0	0.5	0.1
Eupera sp.	0	0.3	0.9	0.1
Corbicula africana	0	21.5	0	0
Other pelecypoda	0.2	0	0	0
Barbus sp.	0	0	P	0
TOTAL NO. OF INDIVIDUALS	447	744	2419	1231

DON. -Dongadziba
MAN. -Mangovane

TABLE D4. PERCENTAGE COMPOSITION OF THE VEGETATION FAUNA FROM THE LUVUVHU RIVER BELOW CONFLUENCE WITH THE MUTALE RIVER.

TAXON	JUNE 86
Planaria	0.1
Pristina sp.	1.6
Nais sp.	0.1
Other oligochaetes	0.1
Cyclopoid copepods	0.4
Pionocypris sp.	2.1
Stenocypris sp.	1.8
Decapod juveniles	0.1
Centroptilum medium	1.9
Baetis glaucus	0.7
Other baetid sp. diag. F	0.7
" " " " H	5.9
Choroterpes sp.	0.1
Austrocaenis sp.	47.3
Afronurus sp.	0.1
Pseudagrion sp.	0.7
Zygopterans	6.1
Anax sp.	0.1
Anisopterans	1.4
Notonectidae	0.1
Pleidae	0.1
Naucoridae	0.2
Other hemipterans	4.1
Chimarrha sp.	0.1
Leptoceridae	0.1
Oecetis sp.	0.1
Hydroptila capensis	0.1
Orthotrichia barnardi	0.6
Hydroptilid juveniles	2.1
Laccophilus sp.	0.2
Methles sp.	0.1
Orectogyrus sp.	0.4
Gyrinidae	0.1
Tropisternus sp.	0.1
Hydrophilidae	0.9
Hydraenidae	1.9
Dryopidae	0.1
Other elmidae	0.2
Coleopterans	0.3
Culicidae	0.9
Simulium spp.	0.4
Chironomini	5.8
Tanytarsini	0.6
Corynoneura sp.	4.4
Orthocladinae	0.5
Cricotopus sp.	2.2
Pentaneura sp.	0.7
Bezzia-type larvae	0.2
Forcipomyia sp.	0.1
Ceratapogonid pupae	0.1
Bulinus sp.	0.1
Eupera sp.	0.1
Corbicula africana	1.6
Anuran juveniles	0.1
TOTAL NO. OF INDIVIDUALS	1954

TABLE D5. PERCENTAGE COMPOSITION OF THE VEGETATION FAUNA FROM THE LUVUVHU RIVER AT PAFURI PICNIC SITE.

TAXON	JUNE 86	AUG 86
Hydra sp.	0	0.5
Planaria	P	0.3
Nematoda	0.8	1.2
Pristina sp.	0.6	1.2
Nais sp.	0.3	1.3
Branchiobdellidae	1.1	4.5
Other oligochaetes	0.3	0.1
Hirudinea	0.1	0
Ceriodaphnia/Simocephalus sp.	0	0.3
Chydorids	0.3	0
Cyclopoid copepods	1.8	2.1
Pionocypris sp.	3.2	4.4
Stenocypris sp.	10.9	1.5
Caridina sp.	0.8	0
Centroptiloides ?spinulosa	0	P
Centroptilum medium	0.1	0.1
Cloeon africanum	3.7	0.2
Baetis bellus	17.6	0
Other baetid sp. diag. H	0	6.7
" " " " J	0	1.9
" " " " K	0	P
Choroterpes sp.	0.1	0.2
Tricorythus "lowveld"	P	0
Austrocaenis sp.	21.7	1.3
Afronurus sp.	1.7	0
Pseudagrion sp.	0.3	0.2
Zygopterans	2.3	2.0
Phyllomacromia sp.	0	P
Anisopterans	0.1	1.0
Mesoveleidae	0.2	0
Veliidae	0.3	0
Notonectidae	0	0.1
Pleidae	0.3	0
Naucoridae	P	P
Nepidae	P	0
Belostomatidae	0.1	0
Micronecta sp.	P	0
Other hemipterans	0.9	2.1
Chimarrha sp.	0	P
Leptocerus ?inflatus	0	P
Hydroptila capensis	0	0.1
Orthotrichia barnardi	0	0.2
Hydroptilid juveniles	P	1.9
Pyralidae	0.1	0
Dytiscidae	P	0.1
Gyrinidae	0	P
Hydrobiinae	P	0
Hydrophilidae	0.1	0.1
Stenelmis sp.	0	P
Staphylinidae	0	P
Curculionidae	P	P
Coleopterans	P	P
Culicidae	0	0.7
Simulium spp.	0	35.5
Chironomini	14.5	7.0
Tanytarsini	0.3	1.2
Corynoneura sp.	5.8	0.9
Orthocladinae	0.8	8.1
Cricotopus sp.	3.7	7.5
Pentaneura sp.	0.4	1.4
Tanypod pupae	P	0

Table D5. Luvuvhu River at Pafuri Picnic Site. Vegetation biotopes (co

TAXON	JUNE 86	AUG 86
Dasyhelea-type larvae	0	0.9
Bezzia-type larvae	0	0.3
Ceratapogonid pupae	0	0.3
Muscidae	0.1	0.3
Lymnophora sp.	0	0.1
Biomphalaria sp.	0.1	0.1
Bulinus sp.	P	0
Lymnaea sp.	0	P
Melanoides sp.	0.2	0
Ancylidae	0.1	0.2
Eupera sp.	0.1	0
Other pelecypoda	3.9	0
TOTAL NO. OF INDIVIDUALS	3060	4750

TABLE D6. PERCENTAGE COMPOSITION OF THE VEGETATION FAUNA FROM THE MUTA RIVER ABOVE CONFLUENCE WITH THE LUVUVHU RIVER.

TAXON	AUG 86
Hydra sp.	0.7
Planaria	3.0
Cyclopoid copepods	14.3
Pionocypris sp.	29.6
Nais sp.	1.1
Other oligochaetes	1.7
Caridina sp.	0.5
Centroptilum excisum	0.3
Baetis bellus	11.1
Cloeon africanum	7.2
Choroterpes sp.	0.1
Austrocaenis sp.	4.7
Afronurus sp.	0.1
Pseudagrion sp.	0.1
Zygopterans	1.6
Anisopterans	0.1
Belastomatidae	0.2
Pleiidae	0.2
Micronecta sp.	P
Other hemipterans	1.1
Leptocerus ?inflatus	1.1
Leptoceridae	0.1
Oecetis sp.	P
Hydroptila capensis	0.3
Orthotrichia barnardi	0.3
Hydroptilid juveniles	1.8
Laccophilus sp.	0.1
Ochthebius sp.	P
Hydraenidae	P
Psephenidae	P
Methles sp.	P
Hydrobiinae	0.2
Hydrophilidae	0.3
Chrysomelidae	0.1
Sciomyzidae	P
Culicidae	0.6
Simulium spp.	0.4
Chironomini	4.3
Tanytarsini	0.3
Corynoneura sp.	0.7
Orthocladinae	2.9
Cricotopus sp.	4.6
Pentaneura sp.	1.9
Tanypod pupae	1.4
Bezzia type larvae	0.2
Forcipomyia sp.	0.3
Ceratapogonid pupae	0.6
Muscidae	P
Biomphalaria sp.	0.1
Ancylidae	0.3
TOTAL NO. OF INDIVIDUALS	2441

TABLE E1. DIATOM FLORA FROM THE CROCODILE RIVER.

GEZABAHLE
Achnanthes exigua
A. minutissima
Amphora copulata
A. holsatica
Caloneis bacillum
C. bacillum var. *inflata*
C. molaris
C. silicula
Cocconeis pediculus
C. placentula
Cyclotella atomus
C. kuetzingiana
C. meneghiniana
Cymbella kappii
Fragillaria fonticola
Gomphonema parvulum
Navicula gregaria
N. minima
N. rostellata
N. salinarum var. *intermedia*
N. schroeteri
N. tenella
N. tenera
N. vandamii
N. veneta
Nitzschia agnita
N. archibaldii
N. gandersheimiensis
N. inconspicuum
N. intermedia
N. lacuum
N. levidensis var. *victoriae*
N. linearis
N. obtusa
N. palea
N. tarda
Pleurosigma salinarum
Synedra ulna

Table E1 (cont.)

NGONDWINI
Achnanthes exigua
A. minutissima
Amphora holistica
Cocconeis placentula var. *euglypta*
C. scutellum
Cymbella kappii
Gomphonema intricatum var. *pumilum*
G. parvulum
G. subclavatum
Navicula cryptolyra
N. minima
N. pseudohalophila
N. rostellata
N. tenella
N. veneta
Nitzschia amphibia
N. apiculata
N. inconspicua
N. linearis
N. palea
Pleurosigma salinarum
Synedra tabulata var. *parva*
S. ulna

TABLE E2. THE DIATOM FLORA FROM THE SABIE RIVER.

LUBYE-LUBYE

Acanthea lanceolata
A. minutissima
Capartogramma crucicula
Cocconeis placentula var. *euglypta*
C. scutella
Cymbella gracilis
C. kappii
C. kolbei
C. minuta
Fragilaria fonticola
F. fragilarioides
Gomphonema clevei
G. parvulum
Melosira varians
Navicula cryptocephala
N. gregaria
N. leptostriata
N. rostellata
N. salinarum var. *intermedia*
N. schroeteri
N. tenelloides
N. tenera
N. vandamii
Nitzschia dissipata
N. linearis
N. oliffii
N. palea
Synedra ulna

Table E2 (cont.)

OPPOSITE LISBON ESTATES

Achnanthes lanceolata
A. minutissima
Cocconeis placentula
C. scutellum var. *parva*
Cymbella kolbei
C. minuta
C. naviculiformis
Gomphonema clevei
G. parvulum
G. subclavatum
Gyrosigma rautenbachiae
Navicula atomus
N. capitata
N. cryptocephala
N. gregaria
N. leptostriata Lange-Bertalot
N. rostellata
N.salinarum var. *intermedia*
N. schroeteri
N. submolesta
N. tenella
N. tenera
N. twymaniana
N. vandamii
N. zanoni
Nitzschia acicularis
N. agnita
N. dissipata
N. linearis
N. palea
N. rufitorrentis
Synedra ulna
Surirella atomus
S.ovata

TABLE E3. THE DIATOM FLORA FROM THE OLIFANTS RIVER.

MAMBA
Achnanthes minutissima
Caloneis bacillum var. *inflata*
Cocconeis pediculus
C. placentula var. *euglypta*
Cyclotella meneghiniana
C. pseudostelligera
Cymbella kolbei
Diatoma vulgare
Gomphonema parvulum
Melosira varians
Navicula cincta var. *leptocephala*
N. cryptocephala
N. frugalis
N. recens
N. rostellata
N. schroeteri
N. tenella
N. veneta
Nitzschia amphibia
N. apiculata
N. frustulum
N. inconspicua
N. intermedia
N. quadrangular
N. lacuum
N. liebetruthii
Synedra ulna

Table E3 (cont)

ABOVE CONFLUENCE WITH THE LETABA RIVER

Achnanthes exigua
Amphora cymbamphora
A. holsatica
Caloneis bacillum
Cocconeis pediculus
C. placentula var. *euglypta*
Cyclotella atomus
C. meneghiniana
Fragilaria fonticola
Gomphonema parvulum
Melosira granulata var. *angustissima*
Navicula cincta var. *leptocephala*
N. decussis
N. elginensis
N. recens
N. rostellata
N. schroeterii
N. tenella
N. veneta
Nitzschia agnita
N. apiculata
N. frustulum
N. hustedtiana
N. inconspicua
N. lacuum
N. levidensis
N. liebetruthii
N. microcephala
N. obtusa
N. palea
N. siliqua
Thalassiosira weissflogii

TABLE E4. THE DIATOM FLORA FROM THE LETABA RIVER.

ABOVE CONFLUENCE WITH THE OLIFANTS RIVER
Capartogramma crucicula
Cocconeis scutellum var. *parva*
Cymbella kappii
Diploneis subovalis
Fragilaria sp.
Navicula cincta var. *leptocephala*
N. elginensis
N. gregaria
N. tenella
N. tenera
N. veneta
Nitzschia hungarica
N. siliqua
N. vanoyei
Rhopalodia gibba
R. gibberula

TABLE E5. THE DIATOM FLORA FROM THE LUVUVHU RIVER.

BELOW CONFLUENCE WITH THE MUTALE RIVER (from silt at the edge of the river)
Achnanthes minutissima
Cocconeis placentula var. *euglypta*
Gyrosigma kutzingii
Navicula cryptocephala
N. rostellata
N. tenera
Nitzschia sp.
Pinnularia mesolepta

BELOW CONFLUENCE WITH THE MUTALE RIVER (from freshwater Porifera under rock in current)
Achnanthes lanceolata
Cocconeis placentula var. *euglypta*
Cyclotella stelligera
Gomphonema parvulum
Navicula cryptocephala
N. rostellata
N. schroeteri
N. tenelloides
N. tenera
N. sp.1
N. sp.2
Nitzschia dissipata
N. palea
Stauroneis obtusa

TABLE E6. THE DIATOM FLORA FROM THE MUTALE RIVER.

AT DRIFT

Achnanthes engelbrechtii
A. minutissima
Capartogramma crucicula
Cocconeis placentula var. euglypta
Cyclotella meneghiniana
Cymbella kolbei
Fragilaria fonticola
F. vaucheriae
Gyrosigma kuetzingii
Navicula elginensis
N. gregaria
N. heimansii
N. minima
N. rostellata
N. schroeteri
N. tenelloides
N. tenera
N. veneta
Nitzschia agnita
N. archibaldii
N. clausii
N. dissipata
N. liebetruthii
N. oliffi
N. palea
N. rufitorrentis
Surirella ovata
S. tenera

TABLE F. TAXONOMIC LIST OF ORGANISMS RECORDED.

CLASSIFICATION		NAME USED IN TABLES
COELENTERATA		
	Hydra sp.	*Hydra* sp.
NEMERTEA		
	Prostoma sp.	*Prostoma* sp.
NEMATODA		Nematoda
TARDIGRADA		Tardigrada
ANNELIDA		
Oligochaeta		
Naididae		
	Pristina sp.	*Pristina* sp.
	Nais sp.	*Nais* sp.
	Dero sp.	*Dero* sp.
	Aulophora sp.	*Aulophora* sp.
	other naids	other naids
Tubificidae		
	Branchiura sp.	*Branchiura* sp.
	other tubificids	other tubificids
Branchiobdellidae		Branchiobdellids
other oligochaetes		other oligochaetes
Hirudinea		
	Placobdella sp.	*Placobdella* sp.
	other Hirudinea	other Hirudinea
CRUSTACEA		
Cladocera		
	Bosmina longirostris (O.F.M.)	*Bosmina longirostris*
	Ceriodaphnia/Simocephalus sp.	*Ceriodaphnia/Simocephalus*
	Daphnia sp.	*Daphnia* sp.
	Diaphanosoma sp.	*Diaphanosoma* sp.
	Macrothrix sp.	*Macrothrix* sp.
	Chydorids	Chydorids
	other cladocerans	other cladocerans

Copepoda		
	Cydopoid copepods	Cydopoid copepods
	Harpactacoid copepods	Harpactacoid copepods
Ostracoda		
	Stenocypris sp.	*Stenocypris* sp.
	Pionocypris sp.	*Pionocypris* sp.
	other Ostracoda	other Ostracoda
Decapoda		
	Caridina sp.	*Caridina* sp.
	Decapod juveniles	Decapod juveniles
	Crab	Crab
HYDRACARINA		
	Hydracarina sp.1	Hydracarina sp.1
	Hydracarina sp.2	Hydracarina sp.2
INSECTA		
Collembola		Collembola
Plecoptera		
	Neoperla spio (Newman)	*Neoperla spio*
Ephemeroptera		
Polymitarcyidae		
	Ephoron sp.	*Ephoron* sp.
	Povilla adusta Navas	*Povilla adusta*
Baetidae		
	Centroptiloides bifasciatum (E.-P.)	*Centroptiloides bifasciatum*
	Centroptiloides ?spinulosa (Demoulin)	*Centroptiloides ?spinulosa*
	Centroptilum excisum Barnard	*Centroptilum excisum*
	Centroptilum 'near excisum'	*Centroptilum*'near excisum'
	Centroptilum flavum Crass	*Centroptilum flavum*
	Centroptilum medium Crass	*Centroptilum medium*
	Centroptilum varium Crass	*Centroptilum varium*
	Cloeon africanum (E.-P.)	*Cloeon africanum*

	Cloeon 'longtoes'	*Cloeon* 'longtoes' ?Demoulinia sp.
	Cloeon sp.	*Cloeon* sp.
	Pseudocloeon maculosum Crass	*Pseudocloeon maculosum*
	Pseudocloeon vinosum Barnard	*Pseudocloeon vinosum*
	Pseudocloeon sp. A. Kimmins 1955	*Pseudocloeon* sp. A. Kimmins 1955
	Pseudocloeon sp.	*Pseudocloeon* sp.
	Baetis bellus Barnard	*Baetis bellus*
	Baetis glaucus Agnew	*Baetis glaucus*
	Baetis quintus Agnew	*Baetis quintus*
	Baetis (Acentrella) sp.	*Baetis (Acentrella)* sp.
	Afrobaetodes berneri Demoulin	*Afrobaetodes berneri*
	other baetid sp. diag. A	other baetid sp. diag. A
	" C	" C
	" D	" D
	" F	" F
	" G	" G
	" H	" H
	" J	" J
	" K	" K
	other baetid spp.	other baetid spp.
	Baetid juveniles	Baetid juveniles
Oligoneuriidae		
	Oligoneuriopsis elizabethae Agnew	*Oligoneuriopsis elizabethae*
	Elassoneuria sp.	*Elassoneuria* sp.
Heptageniidae		
	Afronurus sp.	*Afronurus* sp.
Leptophlebiidae		
	Adenophlebiodes sp.	*Adenophlebiodes* sp.
	Castanophlebia sp.	*Castanophlebia* sp.
	Choroterpes sp.	*Choroterpes* sp.
	Masharikella sp.	*Masharikella* sp. ? = Thraulus.

Tricorythidae		
	Tricorythus "lowveld"	*Tricorythus* "lowveld"
	Machadorythus sp.	*Machadorythus* sp.
	Dicercomyzon sp.	*Dicercomyzon* sp.
Prosopistomatidae		
	Prosopistoma sp.	*Prosopistoma* sp.
Caenidae		
	Austrocaenis sp.	*Austrocaenis* sp.
Odonata		
Zygoptera		
	Elattoneura sp.	*Elattoneura* sp.
	Allocnemis sp.	*Allocnemis* sp.
	Metacnemis sp.	*Metacnemis* sp.
	Chlorocypha sp.	*Chlorocypha* sp.
	Pseudagrion massaicum Sjöstedt	*Pseudagrion massaicum*
	Pseudagrion sp.	*Pseudagrion* sp.
	Enallagma sp.	*Enallagma* sp.
	Ischnura sp.	*Ischnura* sp.
Anisoptera		
	Paragomphus sp.	*Paragomphus* sp.
	Gomphidae	Gomphidae
	Anax sp.	*Anax* sp.
	Aeschna sp.	*Aeschna* sp.
	Phyllomacromia sp.	*Phyllomacromia* sp.
	Orthetrum sp.	*Orthetrum* sp.
	Crocothemis sp.	*Crocothemis* sp.
	Sympetrum sp.	*Sympetrum* sp.
	Zygonyx sp.	*Zygonyx* sp.
	Pantala sp.	*Pantala* sp.
	Libellulid sp.1	Libellulid sp.1
	Libellulid	Libellulid

Hemiptera		
Hebridae		Hebridae
Mesoveliidae		Mesoveliidae
Gerridae		Gerridae
Veliidae		
	Rhagovelia sp.	*Rhagovelia* sp.
Notonectidae		Notonectidae
Pleidae		Pleidae
Naucoridae		Nauoridae
Nepidae		Nepidae
Belostomatidae		
	Sphaerodema sp.	*Sphaerodema* sp.
Corixidae		
	Micronecta sp.	*Micronecta* sp.
Other hemipterans		Other hemipterans
Trichoptera		
Hydropsychidae		
	Aethaloptera sp.	*Aethaloptera* sp.
	Amphipsyche scottae Kimmins	*Amphipsyche scottae*
	Cheumatopsyche 'afra' type	*Cheumatopsyche afra*
	Cheumatopsyche 'thomasseti' type	*Cheumatopsyche thomasseti*
	Diplectroninae	Diplectroninae
Philoptamidae		
	Chimarra sp.	*Chimarra* sp.
Ecnomidae		
	Ecnomus sp.	*Ecnomus* sp.
	Psychomyiellodes sp.	*Psychomyiellodes* sp.
Leptoceridae		
	Athripsodes sp.	*Athripsodes* sp.
	Leptocerus ?inflatus	*Leptocerus ?inflatus*
	Leptocerus ?schoenobates	*Leptocerus ?schoenobates*
	Pseudoleptocerus sp.	*Pseudoleptocerus* sp.
	Oecetis sp.	*Oecetis* sp.

	Trichosetodes sp.	*Trichosetodes* sp.
	Sp. cf. *Barbarochthon*	*?Barbarochthon* sp.
Psychomyiidae		Psychomyiidae
Lepidostomatidae		
	Dyschimus sp.	*Dyschimus* sp.
Hydroptilidae		
	Hydroptila capensis Barnard	*Hydroptila capensis*
	Hydroptila sp.	*Hydroptila* sp.
	Catoxyethira sp.	*Catoxyethira* sp.
	Orthotrichia barnardi Scott	*Orthotrichia barnardi*
	Hydroptilid juveniles	Hydroptilid juveniles
other trichopterans		Trichopterans
Lepidoptera		
Pyralidae		Pyralidae
Coleoptera		
Dyliscidae		Dytiscidae
	Laccophilus sp.	*Laccophilus* sp.
	Methles sp.	*Methles* sp.
	Peschetius sp.	*Peschetius* sp.
Haliplidae		Haliplidae
Gyrinidae		
	Orectogyrus sp.	*Orectogyrus* sp.
Hydrophilidae		Hydrophilidae
	?Tropisternus sp.	*Tropisternus* sp.
Hydraenidae		
	Ochthebius sp.	*Ochthebius* sp.
Psephenidae		Psephenidae
Dryopidae		
	?Helichus sp.	*Helichus* sp.
Elmidae		
	Leptelmis sp.	*Leptelmis* sp.
	Stenelmis sp.	*Stenelmis* sp.
	Pseudancyronyx sp.	*Pseudancyronyx* sp.
	other Elmidae	other Elmidae

Helodidae		Helodidae
Staphylinidae		
	Aleocharinae	Aleocharinae
Chrysomelidae		Chrysomelidae
Curculionidae		Curculionidae
other coleopterans		other coleopterans
Diptera		
Tipulidae		Tipulidae
Psychodidae		Psychodidae
Culicidae		Culicidae
Simuliidae		Simuliidae
Chironomidae		
	Chironomini	Chironomini
	Chironomus sp.	*Chironomus*
	Cryptochironomus sp.	*Cryptochironomus* sp.
	Tanytarsini	Tanytarsini
	Orthocladiinae	Orthocladinae
	Cricotopus sp.	*Cricotopus* sp.
	Corynoneura sp.	*Corynoneura* sp.
	Thienemanniella sp.	*Thienemanniella* sp.
	Tanypodinae	Tanypodinae
	Pentaneura type 1	*Pentaneura* type 1
	" type 2	*Pentaneura* type 2
	" type 3	*Pentaneura* type 3
	" type 4	*Pentaneura* type 4
	Procladius sp.	*Procladius* sp.
Ceratopogonidae		
	Bezzia-type larvae	*Bezzia*-type larvae
	Dasyhelea-type larvae	*Dasyhelea*-type larvae
	Forcipomyia-type larvae	*Forcipomyia*-type larvae
Stratiomyiidae		Stratiomyiidae
Tabanidae		Tabanidae
Rhagionidae		Rhagionidae
Ephyridae		Ephyridae

Empididae	Empididae
Muscidae	Muscidae
Anthomyiidae	Anthomyiidae
Limnophora sp.	*Limnophora* sp.
Dolichopodidae	Dolichopodidae
higher dipterans	higher dipterans
Dipteran puparia	Dipteran puparia
MOLLUSCA	
Gastropoda	
Anisus sp.	*Anisus* sp.
Biomphalaria sp.	*Biomphalaria* sp.
Bulinus sp.	*Bulinus* sp.
Lymnaea sp.	*Lymnaea* sp.
Physopsis sp.	*Physopsis* sp.
Melanoides sp.	*Melanoides* sp.
Ancylus sp.	*Ancylus* sp.
Ferrissia sp.	*Ferrissia* sp.
other Ancylidae	other Ancylidae
other Gastropoda	other Gastropoda
Pelecypoda	
Corbicula africana	*Corbicula africana*
?*Eupera* sp.	*Eupera* sp.
other Pelecypoda	other Pelecypoda
PISCES	
Anguilla sp.	*Anguilla* sp.
Barbus sp.	*Barbus* sp.
Chiloglanis sp.	*Chiloglanis* sp.
Oreochromus mossambicus (Peters)	Oreochromus mossambicus
Fish juveniles	Fish juveniles
ANURA	
Xenopus sp.	*Xenopus* sp.
Anuran juveniles	Anuran juveniles.

APPENDIX G.

TAXONOMIC LITERATURE CONSULTED

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BY
C.A.MOORE AND F.M.CHUTTER

CONTRACT REPORT

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