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

M.Sc. (Zoology)

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

by

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**A survey of the conservation status
and benthic biota of the
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ABSTRACT

The benthic macro-invertebrate fauna of the six major rivers of the Kruger National Park was surveyed during 1985 and 1986. Samples were collected with a handnet from stones-in-current, stones-out-of-current, sediment and vegetation biotopes where possible. Water temperature and current speed were recorded for each site. Observations were made on aquatic macrophytes on each sampling trip. Analyses of the data collected using biotic index values, two methods of cluster analysis, two-way indicator species analysis (TWINSpan) and detrended correspondence analysis (DECORANA) showed that the diversity of organisms decreased from the Sabie to the Luvuvhu and Mutale rivers, followed by the Crocodile and then the Olifants River. The Letaba River was not flowing consistently during the survey and faunal diversity was generally low. A number of uncommon mayfly taxa were encountered and there was a distinct tropical element to the fauna rarely encountered elsewhere in South Africa.

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CHAPTER 1

INTRODUCTION

The objectives of conservation have been defined by the International Union for the Conservation of Nature and Natural Resources (IUCN) (IUCN 1980) as the maintenance of essential ecological processes and life support systems, preservation of genetic diversity and sustainable utilization of species and ecosystems. Patrick (1988) stresses the importance of diversity since it characterizes and maintains the flexibility of biological communities and provides protection against natural and human-caused catastrophes. Usher (1986) defined conservation as the retention of a viable, and hence self-perpetuating, nature resource. Conservation status can be defined as the extent to which the IUCN objectives are met.

In the Kruger National Park (KNP), the primary use of the rivers is the maintenance of diversity of the organisms living in and making use of the rivers. This is directly in accordance with the IUCN conservation objectives.

The conservation of rivers and streams in South Africa has, until recently, been largely ignored. This may have been due to the difficulties of managing rivers. They are longitudinal systems and are influenced by events taking place in the whole catchment, and not just at the particular site in question. Rivers have traditionally been used as boundaries between states, between provinces and between different landowners. The use of rivers as boundaries has led to major problems associated with shared resources and shared responsibility (O'Keeffe 1988).

Several studies have been carried out on some major rivers of South Africa. They described chemical and physical conditions, topography, flora and fauna (Harrison & Elsworth 1958; Harrison & Agnew 1960; Allanson 1960; Oliff 1960, 1963; Chutter 1963, 1970, 1971; Coetzer 1978; King 1981). No extensive river surveys have yet been carried out on the rivers of the K.N.P., although with the development of the Kruger National Park Rivers Research Programme (Anon. 1989), this situation will surely change.

These general studies have led to further investigations into the effects of pollution on the biota of the rivers. The importance of benthic invertebrates as indicators of a river's state of pollution has been recognized for many years. In 1956 Gaufin &

Tarzwell published a paper on aquatic macro-invertebrates as indicators of organic pollution in Lytle Creek, Ohio. Harrison (1960) reported on the role of river fauna in the assessment of pollution. He outlined the effects of four different types of pollution on the fauna. Gaufin (1973) wrote on fauna and flora as representatives of prevailing conditions. Chutter (1975) used invertebrates to assess the trophic status of flowing waters. He compared biotic index values with nitrogen, phosphate and B.O.D. values. Herricks & Buikema (1977) compiled a literature review on the effects of pollution (mainly toxic substances) on freshwater invertebrates. Godfrey (1978) concluded that diversity can be influenced by physical changes in a river and not only by pollution. Buikema, Benfield & Pittinger (1983) gave a brief literature review on the effects of pollution (particularly toxic substances) on freshwater invertebrates. The effects of pollution on freshwater organisms was also the subject of an extensive summary by Stephan, Spehar, Roush, Phipps & Pickering (1986).

There are several advantages to using benthic (bottom-dwelling) invertebrates in the monitoring of aquatic ecosystems (Hellowell 1977; Hawkes 1982; Hellenthal 1982). These are summarized as follows:

- (i) the wide diversity and abundance of species in almost all freshwater habitats,
- (ii) their sedentary habit which allows the presence of most taxa to be related directly to environmental conditions at their place of capture,
- (iii) benthic communities act as continuous monitors of the water flowing over them as opposed to intermittent samples taken for chemical analysis,
- (iv) they integrate the effects of a range of environmental stresses,
- (v) 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,
- (vi) many species are important accumulators and concentrators of toxic substances,
- (vii) they have effective dispersal and colonization mechanisms which means that there are very few sites outside the potential range of species,
- (viii) qualitative sampling is easy and inexpensive.

According to Hellowell (1986), macro-invertebrate communities constitute a heterogeneous assemblage of taxa. It is likely that some members of the community will respond to whatever stresses they are subjected to. Sedentary species help in locating the precise point of pollutant source. Some macro-invertebrate species have long life histories so temporal changes can be measured and the effects of long-term

exposure to variable concentrations of pollutant can be monitored. Extended life-cycles of benthic organisms justify periodic sampling.

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, notably in the Eastern Transvaal Lowveld, the benthic fauna is poorly known and new or undescribed species are likely to be encountered. Despite these disadvantages, the use of benthic invertebrates is very effective in monitoring many aspects of the status of lotic ecosystems.

Despite the wealth of information on rivers and riverine fauna in general, published data on the conservation status of South Africa's rivers is pitifully lacking. Noble (1974) wrote on the conservation status of aquatic biotopes outlining South Africa's role in the International Biological Programme's Freshwater Productivity Section's Project Aqua. The aim of the project was to list and describe aquatic sites of scientific importance. Gaigher (1978) reported on the importance of the Kruger National Park (K.N.P.) and the conservation of its fish species. Pienaar (1978) warned of the deleterious effects of an introduced fish species to the conservation status of the rivers of the K.N.P.. Gaigher, Hamman & Thorne (1980) discussed the conservation status of indigenous freshwater fish of the Cape Province. O'Keeffe (1985a) reported on the conservation status of the Sabie and Letaba Rivers, two of the rivers that flow through the K.N.P.. In the same year he wrote a paper stressing the importance of river conservation in South Africa (O'Keeffe 1985b). Davies & Day (1986) co-authored a book on the biology and conservation of South Africa's vanishing waters. This book compared the state of South Africa's water bodies with the way they used to be, and made some attempt to predict what is in store for the future. O'Keeffe (1986) edited the proceedings of a workshop on the conservation of South African Rivers. This workshop highlighted the lack of previous research on conservation and South Africa's valuable water resources, particularly rivers. O'Keeffe, Danilewitz & Bradshaw (1987) developed an expert system referred to as the River Conservation System which attempted to classify rivers according to their conservation status. This system used parameters such as indigenous and endemic biota and invertebrate diversity as indicators of conservation status. A map showing the conservation status of many South African rivers was produced in 1988 as a result of the workshop convened by O'Keeffe (1986).

O'Keeffe (1986) summarized conservation criteria as naturalness; representativeness, diversity, rarity, fragility, geographical position and size. He summarized conservation

goals as the maintenance of diversity of function; the sustainable utilization of resources; the maintenance of ecosystem functioning and the preservation of representative types of rivers. The difficulties associated with assessing representativeness and suggested methods for doing so are described by Mackey, Nix, Hutchinson, MacMahon & Fleming (1988).

One of the main functions of the National Parks Board (N.P.B.), 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). This statement encompasses the conservation goals outlined by O'Keeffe (1986).

Previous research on the rivers of the K.N.P. to date relates mainly to specific taxonomic groups of the fauna. Major groups of vertebrates have been studied (Pienaar, 1961; 1966 & 1978; Pienaar, Haacke & Jacobson 1978). Extensive studies of non-aquatic insects have also been undertaken (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.

Work 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 multistriata* makes several references to specimens collected from the K.N.P. and Sciacchitano (1961) published a paper on the leeches of the K.N.P.. Oberholzer & 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), occasional popular articles in *Custos* (van Jaarsveld 1985; Van Niekerk 1986; Cilliers, Reid & Roderigues 1987; Moore 1989) and unpublished reports such as Davies (1987), little information is available 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, Hamburger, de Villiers, Gouws & van Zyl 1985).

The Hydrobiology Division of the National Institute for Water Research (NIWR) collected benthic invertebrates from the Crocodile River at Malelane in July and November 1959 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" (Harrison & Agnew 1960). Many previously unrecorded Ephemeroptera (mayflies) and Trichoptera (caddis-flies) 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.

The K.N.P. is the largest South African game reserve totalling an area of 1 948 528 ha (Greyling & Huntley 1984). It is situated in the Eastern Transvaal Lowveld (Fig. 1). 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 appeal to visitors in accordance with the National Parks Act, it is vital that the Park'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 Park.

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 (Fig. 1). Thus the National Parks Board has little control over the quality or quantity of water that reaches the K.N.P. and the

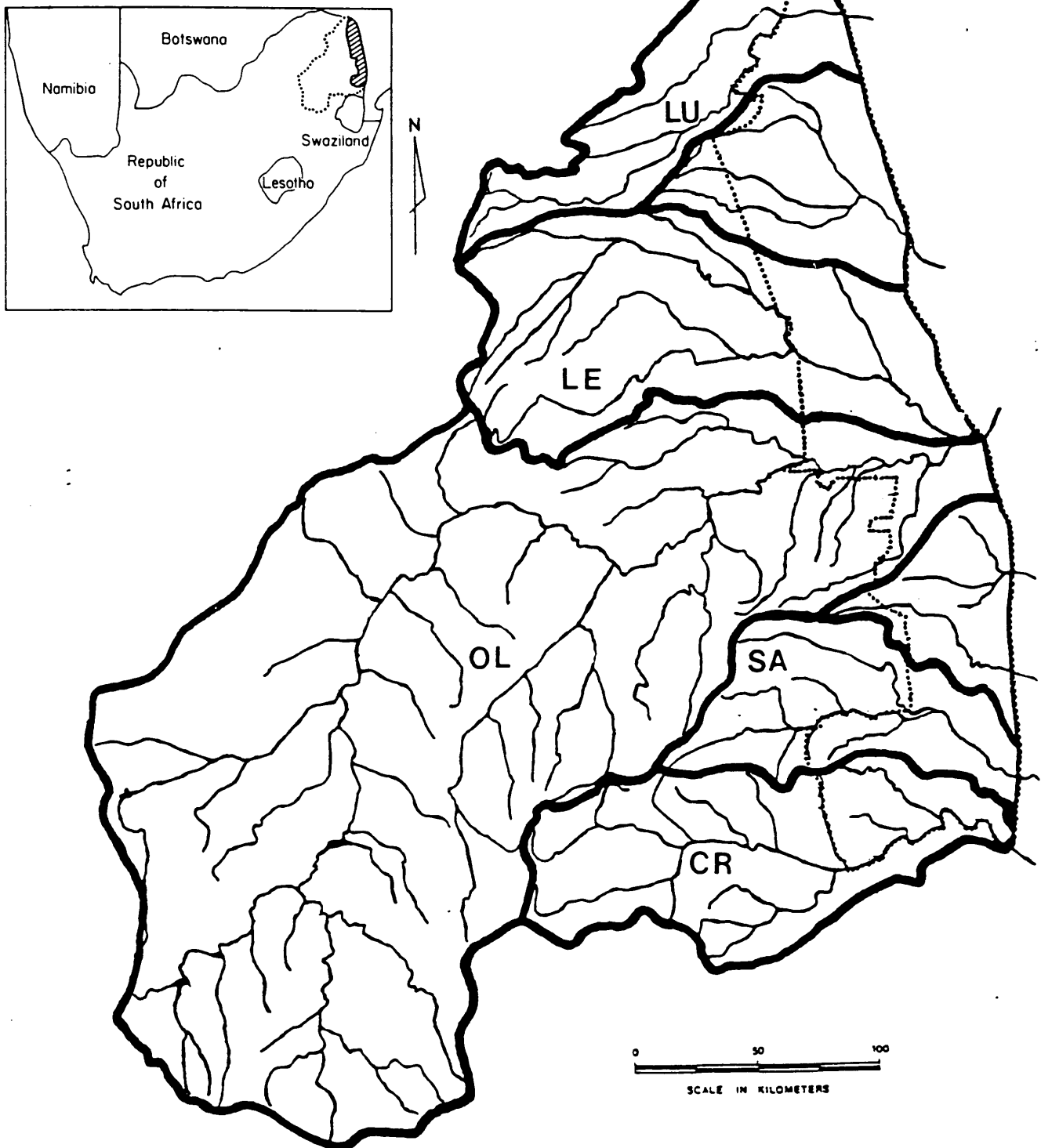


Figure 1. Map showing the boundaries of the catchments of the Crocodile (CR), Sabie (SA), Olifants (OL), Letaba (LE) and Luvuvhu (LU) rivers (—) and the Kruger National Park (---).

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 1986; 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 mines 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 the area of agricultural land in the upper catchment that is subjected to poor management practices.

Human 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 1986). 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 where the rare fish species *Serranochromis meridianus* occurs (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 1986). Other exotic river bank invaders such as lantana (*Lantana camara*) and Persian Lilac or Seringa (*Melia azedarach*) 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 be obtained.

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.

This study was undertaken with the following aims:

1. To record the scarcely known benthic invertebrate fauna of the rivers at sampling points near the western and eastern borders of the K.N.P.
2. 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.
3. To use the data arising from this survey to compare different methods for analyzing macro-invertebrate data.
4. To make recommendations regarding future monitoring of the rivers, to provide timely warning of threats to their biological quality.

CHAPTER 2

GENERAL DESCRIPTION OF THE AREA

The combined catchment area of the six rivers included in this study is 90 921 km² (Fig.1), and therefore covers a variety of topographic and geological regions, vegetation types and land uses.

TOPOGRAPHY

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. Provinces and states included in the catchment areas are Gazankulu, KaNgwane, Lebowa, Venda and the Transvaal.

The Crocodile River rises north of Dullstroom in the Eastern Transvaal. It flows through KaNgwane before reaching the K.N.P.. The Crocodile River merges with the Inkomati River in the Republic of South Africa. It then flows through the Lebombo Mountains into Mozambique from where it flows into the Indian Ocean. The Braam Raubenheimer Dam is the major dam on the Crocodile River.

The Sabie River rises near Long Tom Pass in the Eastern Transvaal. It flows down the Drakensberg Escarpment and past the town of Sabie. It passes through Gazankulu, KaNgwane and Lebowa before entering the K.N.P.

The Olifants River rises in the Transvaal Highveld south of Witbank. It flows north and then eastwards through Loskop Dam, past the Leolo Mountains and down the Drakensberg Escarpment. In the K.N.P. the western portion is a sand-bed river, thereafter the river enters a much more rocky area, running through deep gorges. Other major dams in the Olifants River catchment include Blyderivierspoort, Doornpoort, Rhenosterkop, Rust der Winter, Middelburg and Witbank dams.

The Letaba River rises in mountainous territory near Magoebaskloof in the Transvaal from where it flows into Ebenezer Dam. It then flows north- east into Fanie Botha Dam at the town of Tzaneen and east through Lebowa and Gazankulu to the K.N.P.

Table 1. Locality and altitude of the rivers at source, point of entry to the K.N.P. and point of departure from the K.N.P.

River	Locality			Altitude (m above sea level to nearest 50m)		
	Source	Enters KNP	Leaves KNP	Source	Enters KNP	Leaves KNP
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

In the Park the Letaba River, like the Olifants River, flows over a broad sandy bed in the west before entering a narrow gorge from which it enters the Olifants River.

The Luvuvhu River rises north-east of Louis Trichardt in the Soutpansberg Range and flows into Albassini Dam. It flows through Venda before forming the north-west boundary of the K.N.P. Due-west of Pafuri the river course changes to an easterly direction. It then flows through a series of deep gorges and eventually joins the Limpopo River which forms the border with Mozambique. The Luvuvhu River catchment also includes part of Gazankulu.

The Mutale River rises to the north-east of the Luvuvhu River. After travelling through gorges and a wider valley in Venda, the Mutale River flows into the Luvuvhu River just inside the K.N.P.

GEOLOGY

The catchments of the rivers are underlain by a wide range of geological formations. 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.

The Crocodile River catchment includes five major geological formations, namely the Karoo Sequence, Transvaal Sequence, Dolomite, Basement Complex and the Swaziland Supergroup. In addition there are small areas of granite including Salisbury Kop granite. Areas of the catchment to the south of the K.N.P. also include basic and ultrabasic intrusive rocks. The soil of the mountainous western areas of the catchment are poor, shallow, rocky soils of low agricultural potential, whilst the soils of the Nelspruit/White River area are sandy to heavy loam with a high erosion potential. Towards the eastern boundary of the catchment the soils have a high sodium content.

Like the Crocodile River, the Sabie River traverses the Karoo and Transvaal Sequences, Dolomite and the Basement Complex. Many of the rocks in the western parts of the catchment are gold-bearing.

The Olifants and Letaba River catchments incorporate sedimentary rock in the Transvaal Highveld. Dolomite occurs in the region south of Bronkhortspruit. The central part of the Olifants River catchment consists of igneous rock. From the Drakensberg the rivers cross metamorphic rock in an easterly

direction to the K.N.P. The Letaba River catchment also incorporates migmatite, gneiss and ultrametamorphic rocks with isolated patches of ultrabasic and basic intrusives.

The Luvuvhu and Mutale rivers cross migmatite, gneiss and ultrametamorphic rocks. A large portion of the catchments consists of the Waterberg and Karoo Systems, while sandstone, shale, limestone and marl are also encountered.

In the K.N.P. all of these rivers flow from west to east across three major geological areas. In the western part of the K.N.P. they cross an area that is predominantly granite with gabbro intrusions. In the south, the Crocodile and Sabie rivers then encounter a narrow strip of shales. The eastern parts of the K.N.P. are composed predominantly of basalt. The rivers meet the rhyolitic rocks of the Lebombo Mountains on the eastern boundary of the Park. The exceptions to this general pattern are the Luvuvhu and Mutale rivers. The Luvuvhu River first encounters sandstone in the west followed by shale. It enters a region of basalt. The Mutale River enters the K.N.P. where the predominantly basalt formations start.

CLIMATE

The Kruger National Park is situated in a subtropical region. It experiences hot, wet, humid summers and cold dry winters, with occasional localised periods of frost. The catchments of the rivers fall into several climatic regions, namely subtropical plateau in the north, temperate eastern plateau, plateau slopes and subtropical Lowveld (Reader's Digest 1984).

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 temperatures recorded in January when the mean daily temperature is in the 18-26°C range, and the mean daily maximum temperature is in excess of 30°C. July is generally the coolest month with a mean daily temperature in the 10-16°C range and a mean daily minimum temperature of 5-10°C (Schulze & McGee 1978). 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 Kruger National Park the M.A.P. is lowest in the north with the exception of the Punda Maria area.

Table 2. Catchment areas, mean annual runoff (MAR) and mean annual precipitation (MAP) (from Department of Water Affairs 1986).

RIVER	CATCHMENT AREA (km²)	MAR (m³ X 10⁶)	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

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 with the summer rains, there is a tendency for the levels to remain high until the following winter period.

NATURAL VEGETATION

Since the control of malaria was established in the Lowveld in the late 19th century, progressive urban and agricultural development of the Eastern Transvaal has taken its toll on the natural vegetation of the area. However, extensive areas of natural vegetation are still found in the region.

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 1988).

Within the K.N.P. a variety of vegetation types is encountered. The Crocodile River passes through Silver Clusterleaf-Sicklebush, Malelane Mountain Communities,

Mixed Combretum Veld, Delagoa Thorn Veld, Knobthorn-Maroele Veld on basalt and dolorite and Lebombo Mountain communities.

The Sabie River flows through Silver Clusterleaf-Sicklebush, Knobthorn-Maroele Veld on basalt and dolorite, Mixed Combretum-Acacia Veld, Mixed Combretum Veld, Delagoa Thorn Veld and Lebombo Mountain Communities.

The Olifants and Letaba rivers encounter Mixed Red Bushwillow-Mopane Veld, Mopane Shrub Veld, Knobthorn-Maroele Veld on basalt and dolorite and Lebombo Mountain Communities.

The Luvuvhu and Mutale rivers pass through Sandveld Communities and Mopane Shrub Veld.

This diverse vegetation results in many complex interactions which may influence some of the river characteristics.

LAND USE OUTSIDE THE K.N.P.

The catchments of the six major rivers of the K.N.P. cover a vast area (90 921 km²) and therefore contain many land-uses. These include 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 (Crocodile, Sabie, Olifants and Letaba river catchments) (Reader's Digest 1984). The main activity in the catchments of the Luvuvhu and Mutale Rivers is subsistence farming of sorghum, millet and maize. There is some formal cultivation of tea, coffee and tropical fruit, so biocide application in these catchments is small relative to the area covered and relative to the other catchments. Biocide and fertilizer application 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. The upper Olifants River catchment is important for coal-fired power generation.

All the activities listed above could have effects on river water quality and quantity,

although subsistence farming in the Luvuvhu and Mutale catchments may have least impact on water quality. Mining and subsistence farming probably have a major impact on siltation.

CHAPTER 3

MATERIALS AND METHODS

BENTHIC SAMPLING

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 study 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 separately 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. If the invertebrate fauna is to be correlated with water quality, separate analyses are essential.

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.

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.

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.

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.

The fact that the sediment and vegetation biotopes both include a number of different habitat types makes analysis of the data very complex since it introduces yet another variable.

Sampling Sites

The sampling sites used in this study were, where possible, 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 for sampling; (ii) accessibility of the site from the road and (iii) the accessibility of the biotopes, particularly the stones-in-current biotope. Figure 2 shows the sampling sites used. Table 5 gives the names, localities and brief descriptions of the sampling sites.

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

Table 3. Description and localities of sediment biotopes

River	Sampling site	Site No.	Date	Habitat	Description
Crocodile	Ngondwini	3	June 85	Diatom growth	Net swirled through diatom growth overlying sand, stones or bedrock, usually in backwaters with no current
Crocodile	Ngondwini	3	June 86		
Sabie	opposite Lisbon Estates	4	April 85		
Sabie	Lubye-Lubye	5	April 85		
Olifants	Letaba confluence	7	April 85		
Crocodile	Gezabahle	2	August 86	Surface sediment from sand	Fine particulate matter lying on bottom sand, found in backwaters with no current
Crocodile	Ngondwini	3	April 86		
Crocodile	Ngondwini	3	August 86		
Sabie	opposite Lisbon Estates	4	August 86		
Olifants	Mamba	6	October 86		
Luvuvhu	Pafuri Picnic Site	14	August 86		
Crocodile	Ngondwini	3	October 86	Surface sediment from bedrock	Fine particulate matter lying on bedrock, found in backwaters with no current
Sabie	opposite Lisbon Estates	4	June 86		
Sabie	Lubye-Lubye	5	June 86	Sandy bottom	Sand on river bed sampled from area with some flow
Luvuvhu	Pafuri Picnic Site	14	June 86		
Crocodile	Gezabahle	2	June 86	Sandy backwaters	Sand on river bed sampled from area with no flow
Sabie	Lubye-Lubye	5	June 85		
Sabie	Lubye-Lubye	5	January 86		

Table 4. Description and localities of vegetation biotopes

River	Sampling site	Site No.	Date	Habitat	Description
Luvuvhu	Mangovane	12	June 85	Fringing/marginal vegetation	Vegetation at margins of river in backwaters
Luvuvhu	Mangovane	12	June 86		
Luvuvhu	Mangovane	12	August 86		
Luvuvhu	Mutale confluence	13	June 86		
Luvuvhu	Pafuri Picnic Site	14	August 86		
Mutale	Luvuvhu confluence	15	August 86		
Olifants	Mamba	6	June 85	Trailing vegetation	Vegetation (e.g. <i>Polygonum</i> sp.) trailing in current
Luvuvhu	Dongadziba	10	April 85		
Luvuvhu	Pafuri Picnic Site	14	June 86		
Crocodile	Gezabahle	2	November 85	Emergent reeds	Net swept through base of reed stems growing in backwaters

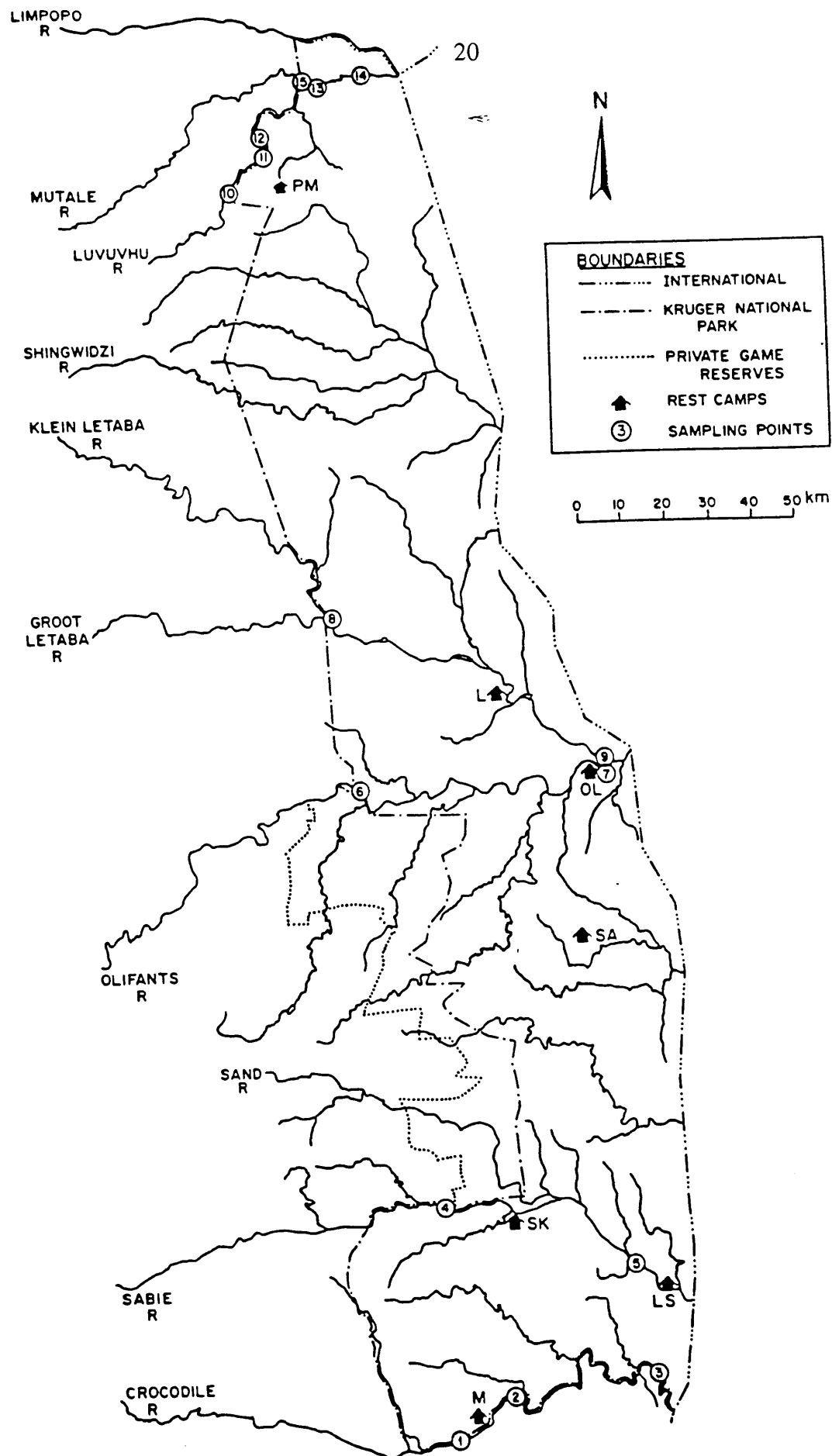


Figure 2. Map of the K.N.P. indicating sampling sites used in the survey.

Table 5. Description of sampling sites

River	Sampling site	Site No.	Locality	Description
Crocodile	Magnesite	1	25°30'S 31°27'E	Opposite railway station.
	Gezabahle	2	25°24'S 31°36'E	Weir at confluence, <i>Pistia stratiotes</i> & <i>Eichhornia crassipes</i> , little filamentous algae.
	Ngondwini	3	25°22'S 31°58'E	Weir below hippo pool, much filamentous algae.
Sabie	opposite Lisbon Estates	4	24°59'S 31°27'E	Opposite citrus estate, very little algal growth.
	Lubye-Lubye	5	24°06'S 31°53'E	Confluence with dry river bed, <i>Pistia stratiotes</i> .
Olifants	Mamba	6	24°02'S 31°13'E	Ranger's post, little algal growth.
	above confluence with Letaba River	7	23°59'S 31°51'E	Above confluence, plenty of hippo dung/ undigested grass amongst stones, some filamentous algae, blue/green algae.
Letaba	Mahlangene	8	23°39'S 31°09'E	Ranger's post, no flow after first trip, algal scum.
	Above confluence with Olifants River	9	23°59'S 31°51'E	Above confluence, very little algal growth.
Luvuvhu	Dongadziba	10	22°43'S 30°53'E	Ranger's post.
	Shidzivane	11	22°38'S 30°58'E	Confluence.
	Mangovane	12	22°36'S 30°59'E	Outpost, some filamentous algae.
	below confluence with Mutale River	13	22°27'S 31°05'E	Confluence, <i>Pistia stratiotes</i> , blue/green algae
Mutale	Pafuri Picnic Site	14	22°26'S 31°12'E	<i>Lyngbya</i> sp., algal scum, moss on stones. Picnic site near anthrax camp.
	above confluence with Luvuvhu River	15	22°27'S 31°05'E	Confluence, <i>Pistia stratiotes</i> and <i>Lemna</i> sp., algal scum, moss on stones.
	Drift	15	22°27'S 31°05'E	Road drift above confluence, some algal growth.

year. This was to be followed by an additional dry season visit when the impacts of pollution would be most evident. 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 Luby-Luby) due to the rivers being in spate. One additional set of samples was collected from a single site (Sabie River at Luby-Luby) in January 1986.

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.

Sampling Methods

Field Collection

Benthic invertebrate samples were collected using a hand net made from bolting silk with a mesh size of 300 μm 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. Stones of a size that could be easily handled 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 the fauna of at least five stones had been collected, when it was assumed that the sample would contain representatives from all the common taxa. In the stones-out-of-current biotope the net was used to scoop up animals as the stone was lifted. 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.

Table 6. Benthic fauna samples collected

Date	Apr 85	June 85	Sept 85	Nov 85	Jan 86	Apr 86	June 86	Aug 86	Oct 86
Sampling site Biotope	I O S V	I O S V	I O S V	I O S V	I O S V	I O S V	I O S V	I O S V	I O S V
Crocodile River									
Ngondwini	✓✓--	✓-✓-	✓---	----	----	--✓-	✓✓✓-	✓-✓-	✓-✓-
Gezabahle	✓✓-- ^a	✓✓--	✓✓--	-✓-✓	----	✓✓--	✓✓✓-	✓✓✓-	✓✓--
Sabie River									
Lubye-Lubye	✓✓✓-	✓✓✓-	✓✓--	✓✓--	✓✓✓-	✓✓--	✓✓✓-	✓---	✓✓--
Opposite Lisbon Estates	✓✓✓-	✓✓--	✓✓--	----	----	✓---	✓✓✓-	✓✓✓-	✓✓✓-
Letaba River									
Mahlangene	✓✓--	----	----	----	----	----	----	----	----
Olifants confluence	✓✓--	✓✓--	----	----	----	✓✓--	✓✓--	----	-✓--
Olifants River									
Mamba	✓✓--	✓--✓	✓✓--	----	----	✓✓--	✓✓--	✓✓--	✓✓✓-
Letaba confluence	✓✓✓-	✓✓--	✓✓--	----	----	✓✓--	✓✓--	✓✓--	✓---
Luvuvhu River									
Western Site	✓✓-✓ ^b	✓✓-✓ ^b	----	----	----	✓✓-- ^c	✓✓-✓ ^d	✓✓-✓ ^d	✓✓-- ^d
Mutale confluence	✓✓--	✓✓--	✓✓--	----	----	✓✓--	✓✓-✓	✓✓--	✓✓--
Pafuri Picnic Site	✓✓--	✓✓--	✓---	----	----	✓✓--	✓✓✓✓	✓✓✓-	----
Mutale River									
Luvuvhu confluence	✓---	✓✓--	✓✓-- ^e	----	----	✓✓--	✓✓--	✓✓-✓	----

KEY : I : Stones-in-current V : Vegetation a : Magnesite d : Mangovane
O : Stones-out-of-current ✓ : Sampled b : Dongadziba e : Drift
S : Sediment - : Not sampled c : Shidzivane

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 a propeller driven "Ott" current meter. Four to six readings were recorded as close as possible to the stones where the sample was collected. The arithmetic mean of the readings was calculated and used as the mean current speed at the site where the animals were collected. Since carrying out the field work it has become apparent that the 6/10 method for measuring current speed would have given a more realistic measure. The 6/10 method involves measuring the current speed at 40% of the water's depth above the substrate.

Laboratory Techniques

In the laboratory, the preserved sample was poured into a brass sieve with a mesh aperture of 710 μm , standing in a 300 μm 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 sieve 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. 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 &

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.

ANALYSIS AND EVALUATION OF DATA

The raw data obtained were in the form of a list of species for each sample and a number of individuals for each species. These data were qualitative and as such inter-sample comparisons could not be made. In order to convert the data to a quasi-quantitative form, the number of individuals for each species was converted to a percentage abundance relative to the rest of the sample. In this way, sample size was standardised and the data from different sized samples could be compared.

Biotic Index

One method of data analysis employed was 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 (Chutter 1972). 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 1972). 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, may 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 & 1984).

(a)

Taxon	Quality value	Taxon	Quality value
<i>Hydra</i> spp.	6	<i>Amphipsyche scottae</i>	3
Planarians	3	<i>Cheumatopsyche thomasseti</i>	2
Rhabdocoelidae	10	<i>Macronema capense</i>	3
Tardigrada	7	<i>Hydroptila</i> spp.	2
Nematoda (except Mermithidae)	7	<i>Orthotricia</i> spp.	2
Oligochaeta (except <i>Nais</i>)	Table 7b	<i>Stenelmis</i> spp.	3
<i>Nais</i> spp.	Table 7b	Psychodidae- <i>Psychoda</i> spp.	10
Hirudinea	7	Culicidae	10
<i>Cypriodopsis</i> spp.	Table 7b	<i>Chironomus</i> spp.	10
<i>Baetis harrisoni</i>	Table 7c	Chironomini (except <i>Chironomus</i> spp.)	Table 7b
<i>Choroterpes</i>	1	Orthocladiinae	Table 7b
(<i>Euthraulus</i>) spp.		Tanytarsini	Table 7b
Caenidae	1	Simuliidae	Table 7b
<i>Micronecta</i> spp.	4	<i>Eristalis</i> spp.	10
		Ancylidae	4

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

Table 7 (cont.) Quality values for the calculation of Chutter's biotic index value (Taken from Chutter 1972 & 1984).

(b)

Baetid Ephemeroptera		Quality values (dependent on Baetid Ephemeroptera shown on left)			
No. of species	Individuals as % of whole fauna *	Oligochaeta other than <i>Nais</i>	<i>Nais</i> spp.	<i>Cypriodopsis</i> , Chironomini (except <i>Chironomus</i>), Orthocladinae, 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	3	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

* Fauna is all animals in a sample excluding Cladocera & Copepoda, % is calculated after multiplying *Baetis harrisoni* numbers by 0.5 or 1 as shown in Table 7c.

(c)

Ephemeroptera	<i>B. harrisoni</i> quality value	For % Baetid in Table (b) multiply <i>B. harrisoni</i> by :
<i>B. harrisoni</i>	6	0.5
<i>B. harrisoni</i> and 1 other species	4	0.5
<i>B. harrisoni</i> and 2 other species	2	0.5
<i>B. harrisoni</i> and 3 or more other species	0	1.0

Chutter's Biotic Index Value is calculated as follows:

$$\frac{\sum_{i=1}^n (A_i B_i)}{\sum_{i=1}^n A_i}$$

where A_i = the number of individuals of the i th taxon

B_i = the quality value assigned to the i th taxon

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.

Multivariate analysis

Multivariate analysis, the branch of mathematics that deals with the examination of numerous variables simultaneously (Gauch 1982), was used in the comparison of biological samples based on their species composition. Multivariate methods rather than other methods of analysis were chosen because statistical methods treating only one or a limited number of variables at a time are generally tedious, impractical and ineffective for large, complex data sets.

Multivariate analysis involves four components of the data, namely noise, redundancy, relationships and outliers (Gauch 1982). Replicate biological samples are rarely identical. The variation in species composition of the samples of a data

set is due in part to interesting variation in environmental factors and in part to uninteresting noise. The data are "noisy" in that samples from identical environmental conditions are not identical in species composition (Gauch 1982). The biological causes of noise are intricate and include chance distribution and establishment of individuals, animal activity and local disturbances. Noise is also caused by statistical limitations of finite samples and from limitations in measuring species abundance (Gauch 1982). Redundancy, the opposite of noise, occurs when a large number of samples represents few significantly different groups. An outlier in this study was a sample that has peculiar species composition and had inexplicably low similarity to other samples.

A major role of multivariate analysis is to receive bulky raw data and, by summarization of redundant structure, to produce economical, brief results (Gauch 1982).

Multivariate analysis has three major advantages:-

- (i) it enables the ecologist to discover structure in data,
- (ii) it provides relatively objective, easy summarization of the data, and
- (iii) unlike other statistical methods which test hypotheses, multivariate analysis contributes to the generation of hypotheses.

The aim of using multivariate analysis in this study was to express as much of the significant coordinated data structure as possible, whilst disregarding noise, redundancy and outliers as much as possible. Two areas of multivariate analysis are used in this study, namely (i) cluster analysis and (ii) classification and ordination using two-way indicator species analysis (TWINSPAN) (Hill 1979a) and detrended correspondence analysis (DECORANA) (Hill 1979b) respectively.

Data analysis was performed only on the fauna from the stones-in-current biotope. The reason for this was that of the four biotopes sampled, the stones-in-current biotope was the only one to have a very distinct fauna whose response to changes in water quality are reasonably well known. Additionally, the samples collected from the sediment and vegetation biotopes were relatively few and from a variety of different habitat types, which would have introduced too many variables to permit meaningful interpretation of the data.

Cluster Analysis

Cluster analysis is one means of classifying data. It is used as a descriptive method for gauging the similarities of objects in a sample (Romesburg 1984). Nemec & Brinkhurst (1988) list the advantages of cluster analysis as:

- (i) flexibility in handling both continuous and discrete data,
- (ii) ease of computation,
- (iii) wide accessibility of computer programmes,
- (iv) graphical display of results,
- (v) intuitive appeal.

A major limitation is the lack of objective criteria for distinguishing between features of a dendrogram that reflect real relationships among underlying communities ("statistically significant") and those that are the result of random effects (Nemec & Brinkhurst 1988). Further disadvantages of cluster analysis (Pimentel & Smith 1986) are:

- (i) cluster analysis provides a one-dimensional summary of relationships which may be multi-dimensional
- (ii) although cluster analysis uses all data at every step, the (n-1) steps necessitate (n-1) decisions in forming the dendrogram
- (iii) owing to sampling error inherent in any data set, the probability of incorrect decisions cannot be ignored,
- (iv) cluster analysis may use a dissimilarity index which is vulnerable to nonlinearity, this is a greater problem in one-dimensional solutions and there is no method for countering this effect,
- (v) there is no clear-cut basis for choosing among the large number of methods available. Different methods can produce substantially different results.

In spite of the apparent disadvantages of cluster analysis techniques, it was still felt that there was enough merit in cluster analysis to warrant its use as a tool for analyzing the data in this study.

There are six basic steps in the clustering process. They are listed by Romesburg (1984) as follows:-

1. Obtain data matrix
2. Standardize data matrix
3. Compute resemblance matrix
4. Execute the clustering method
5. Rearrange the data and resemblance matrices
6. Compute the cophenetic correlation coefficient

The data matrix consists of the raw data (i.e. samples and species). Standardizing the data matrix is an optional step which is particularly relevant if the data matrix contains a variety of units of measure. Since the data gathered in this study had already been normalized by converting them to percentage abundance, the data matrices used in this study had consistent units so further standardization was not necessary. Two methods of computing the resemblance matrix were used. One method (Percentage Similarity) used the data as quantitative whilst the other method used (Czekanowski's coefficient) treated the data as binary (i.e. taxa were either present or absent).

The two methods for calculating the resemblance matrix were described by Magurran (1988) as follows:-

Sørensen coefficient (sometimes called the Czekanowski index (Kemp, Chutter & Coetzee 1976)) in which

$$C_s = \frac{2j}{a+b}$$

where

a = the number of species in sample A

b = the number of species in sample B

and

j = the number of species found in both A and B.

and Sørensen quantitative coefficient (sometimes called the Bray-Curtis measure of similarity (Kemp *et al.* 1976) in which

$$C_N = \frac{2jN}{(aN+bN)}$$

where jN = the sum of the lesser measures of abundance of each species
common to both communities

and aN = the sum of measures of abundance in community A

bN = the sum of measures of abundance in community B

Where the data had been transformed to percentage similarities as was the case in this study, Kemp *et al.* (1976) referred to this method as the Percentage Similarity. This nomenclature was used in this study.

Clustering was executed using the unweighted pair-group method using arithmetic averages, commonly referred to as UPGMA. One of the advantages of this method is that it causes less distortion when comparing graphical output with the input matrix than weighted clustering techniques and it can be applied effectively to similarity coefficients or dissimilarity coefficients (Sneath & Sokal 1973). The output from the clustering step was reproduced graphically as dendrograms. The step of cluster analysis in which the data and resemblance matrices are rearranged to highlight the similarities between objects is basically a duplication of the function of producing dendrograms therefore this step was omitted in the analysis. The final step in cluster analysis is to calculate the cophenetic correlation coefficient. This coefficient has a value between -1 and 1. It gives an indication of the amount of distortion occurring in the analysis, that is, how exactly the dendrogram represents the raw data. A cophenetic correlation coefficient of 1 indicates perfect positive concordance, 0 indicates the point of no concordance and a negative value indicates negative concordance.

TWINSPAN & DECORANA Classification and Ordination

Classification involves grouping similar entities together. Advantages of classification are that noise can be reduced by combining like samples into a single average or composite sample; classification summarizes the data which eliminates redundancy in the data; relationships among samples or species can be expressed and outliers are easily detected (Gauch 1982).

TWINSPAN is a classification technique which arranges site groups into a hierarchy on the basis of their taxonomic composition, and species are classified simultaneously on the basis of their occurrence in site groups. Indicator species are also identified, these showing the greatest difference between site-groups in their frequency of occurrence (Ormerod & Edwards 1987).

Ordination is the process of arranging samples in relation to one or more environmental gradients or axes (Whittaker 1973).

Ordination of species abundance data can be used to reduce redundancy and noise, elucidate relationships among variables and identify outliers (Gauch 1982).

DECORANA is an ordination technique which aims to summarize community patterns by placing similar entities (either samples or species) close together in low dimensional space along mathematically derived orthogonal axes (axes at right angles to one another) (Metcalf 1988). DECORANA is analogous to reciprocal averaging, but it eliminates the arch or horseshoe effect seen in reciprocal averaging (Larsen, Omernik, Hughes, Dudley, Rohm, Whittier, Kinney & Gallant 1986). Additionally it eliminates a further problem encountered in reciprocal averaging namely the undefined scaling of the axes (Gauch 1982). However, the method for flattening the arch effect has come under criticism from Wartenburg, Ferson & Rohlf (1987).

Detrended correspondence analysis (DCA) was chosen as the ordination method since Leland, Carter & Fend (1986) compared several ordination techniques and found DCA to be the most effective for summarizing variation in benthic insect composition data and for detecting underlying gradients. Additionally it was found to display species-specific responses to biotic and abiotic gradients. A further advantage as pointed out by Gauch (1982) is that due to the availability of computer programmes, minimal training is required and all investigators obtain the same results from the same data.

TWINSPAN and DECORANA were carried out on the percentage composition data that was used for the cluster analyses.

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	DWA Station Number	Station Name	Locality
Crocodile	X2M49	Mbyamiti confluence	25°19'S 31°45'E
Crocodile	X2M50	Crocodile Bridge Rest Camp	25°22'S 31°54'E
Sabie	X3M13	National Parks Dept Powerline	24°59'S 31°35'E
Sabie	X3M15	Lower Sabie Rest Camp	25°07'S 31°55'E
Olifants	B7M15	Mamba Ranger's Post	24°03'S 31°13'E
Olifants	B7M18	Hiking Trail Camp	24°00'S 31°48'E
Letaba	B8M28	Mahlangene	23°39'S 31°09'E
Letaba	B8M30	Klipkoppiesdrif	23°57'S 31°44'E
Luvuvhu	A9M08	Shidzivane	22°38'S 30°58'E
Luvuvhu	A9M09	Madzaringwe	22°30'S 31°04'E
Luvuvhu	A9M11	Pafuri	22°25'S 31°13'E

CHAPTER 4

RESULTS

ZOOBENTHOS

The principal objective of the sampling strategy was to obtain a comprehensive list of taxa for each site within the limitations of the sampling frequency, sample timing and time required for sorting and identification. The zoobenthos is dealt with according to the habitat in which it was collected.

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 9 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 Luby-Luby in August 1986. Therefore 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 3-5 are stacked barcharts 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. It is apparent from the number of different groups of taxa in each bar that the fauna is diverse and hence not affected by gross organic pollution.

The total number of taxa recorded at each sampling point is shown in Table 10. 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 10.

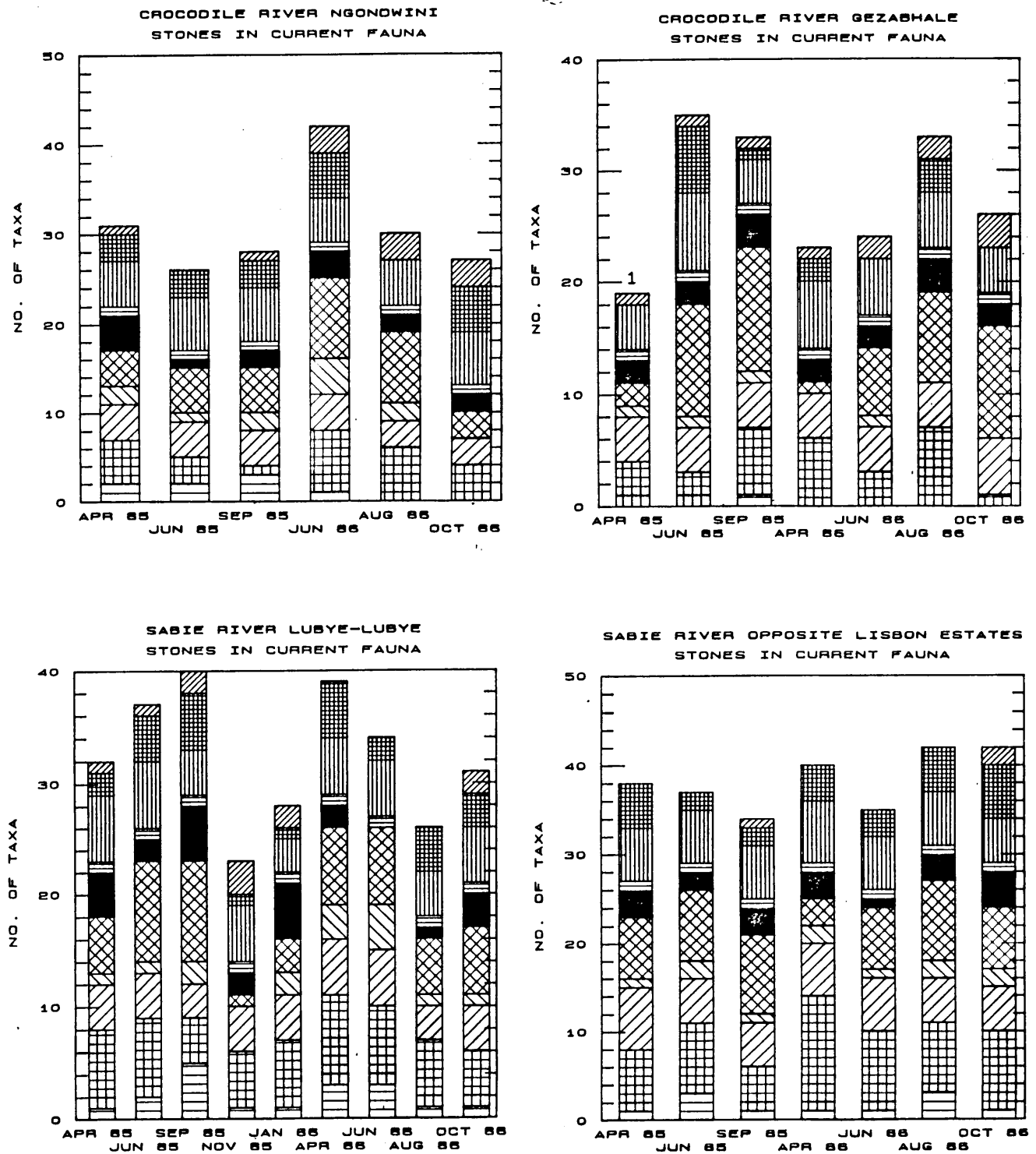


Figure 3. Stacked barcharts showing the number of taxa of the major taxonomic groups from the stones-in-current from the Crocodile and Sabie rivers (see Fig. 4 for key). 1 - sample collected at Magnesite.

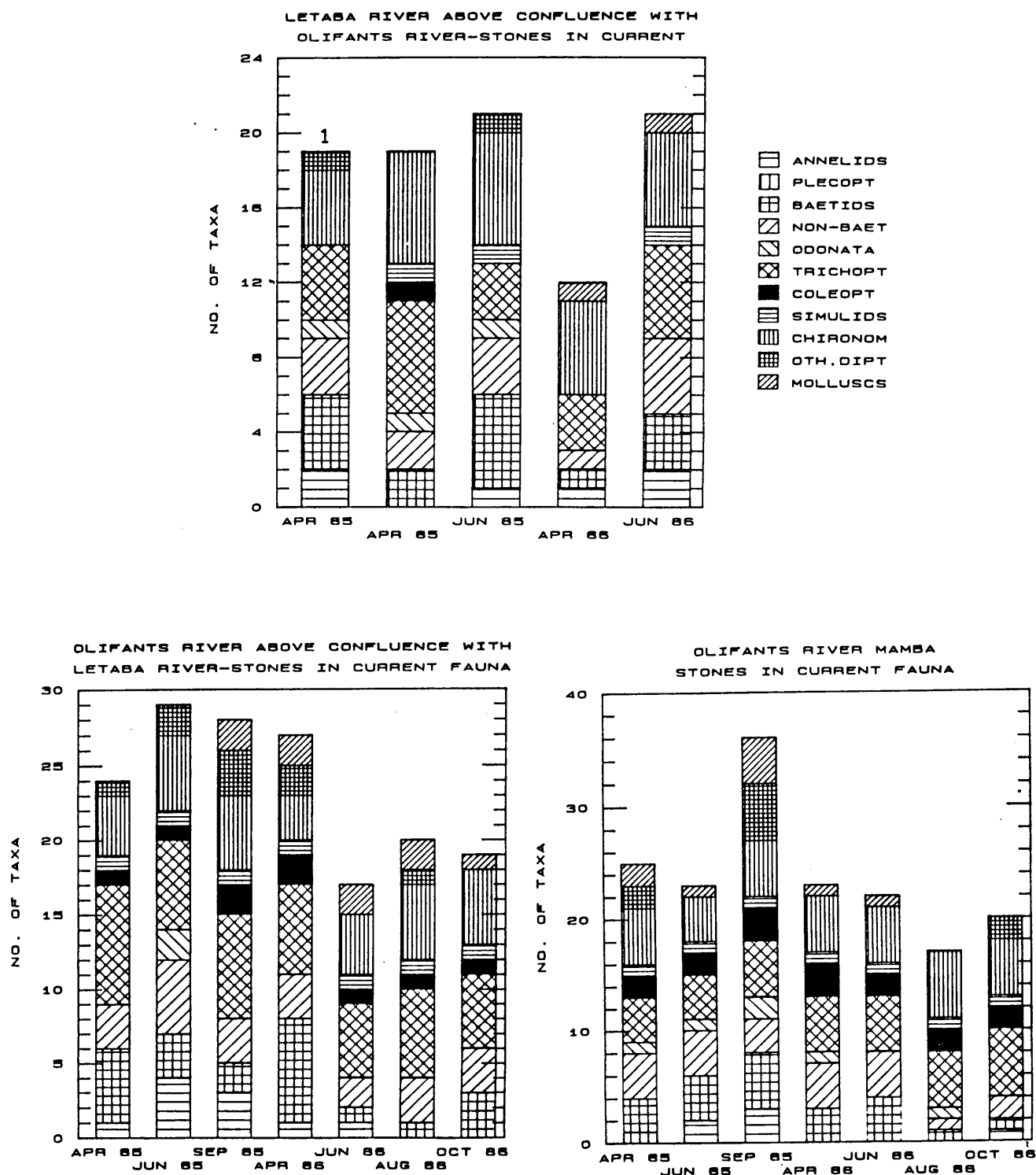


Figure 4. Stacked barcharts showing the number of taxa of the major taxonomic groups from the stones-in-current from the Letaba and Olifants rivers. 1 - sample collected at Mahlangene.

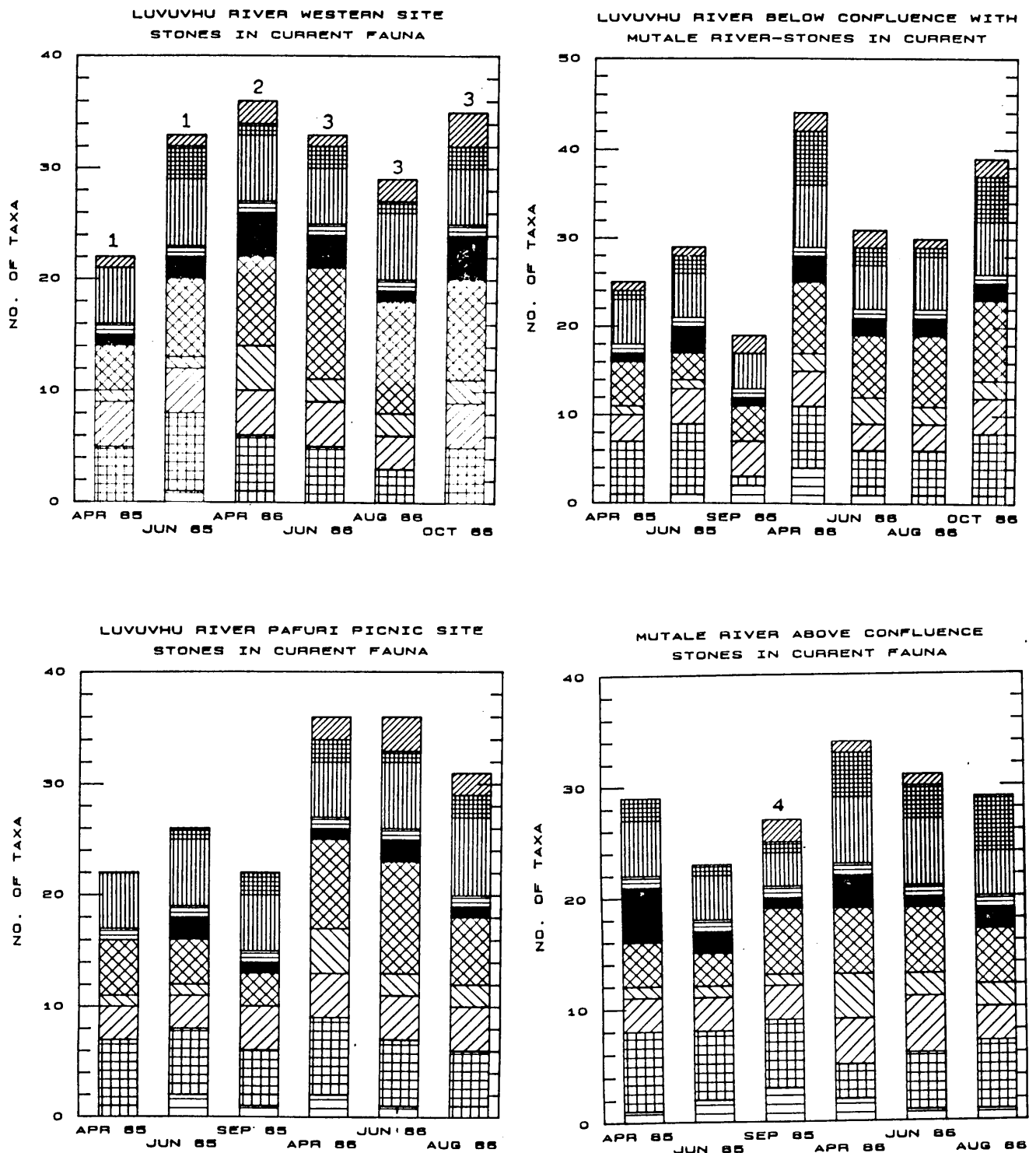


Figure 5. Stacked barcharts showing the number of taxa of the major taxonomic groups from the stones-in-current from the Luvuvhu and Mutale rivers (see Fig. 4 for key). 1-4 - samples collected at Dongadziba, Shidzivane, Mangovane and road drift respectively.

Table 9. Mean current speeds (ms^{-1}) for stones-in-current biotope.

SAMPLING SITE	DATE	June 1985	Sept 1985	April 1986	June 1986	Aug 1986	Oct 1986
Crocodile River							
Ngondwini		-	0.97	-	0.68	0.38	0.44
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
Lisbon Estates		0.50	0.40	-	0.40	-	0.55
Letaba River							
Olifants confl.		-	-	0.51	0.48	-	-
Olifants River							
Mamba		0.72	0.86	0.69	0.61	0.77	0.60
Letaba confl.		-	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
Mutale confl.		-	0.39	-	-	0.49	0.25
Pafuri Picnic Site		-	0.57	-	0.77	-	-
Mutale River							
Luvuvhu confl.		0.53	0.49 ^c	-	0.43	0.49	-

a - Dongadziba b - Mangovane c - Drift above Luvuvhu confl.

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 10 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 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.

Table 10. Sampling intensity and the number of taxa recorded from the stones-in-current and stones-out-of-current biotopes at sampling sites in the Kruger National Park.

RIVER AND SAMPLING SITE		STONES-IN-CURRENT		STONES-OUT-OF-CURRENT	
		Number of		Number of	
		samples	taxa	samples	taxa
Crocodile	Gezabahle	7	71	7	82
	Ngondwini	6	80	2	88
Sabie	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 site	6	67	6	97
	Mutale confluence	7	75	7	94
	Pafuri Picnic Site	6	72	5	85
Mutale	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 sites were not visited during summer.

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.

Biotic Index

Table 11 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. 28). This is confirmed by the rather high value for nitrites plus nitrates for this river (Table 15). 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 hippopotamus 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).

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 Luby-Luby 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 (Fig. 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 were few B.I.V.s for the Letaba River (Table 12) since the river ceased flowing 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.

Table 11. Biotic Index Values for stones-in-current biotope.

DATE SAMPLING SITE	April 1985	June 1985	Sept 1985	Nov 1985	Jan 1986	April 1986	June 1986	Aug 1986	Oct 1986
Crocodile River									
Ngondwini	1.2	2.2	2.5	-	-	-	0.8	1.0	2.0
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
Lisbon Estates	0.8	0.9	1.8	-	-	0.6	0.5	0.7	0.8
Letaba River									
Mahlangene	1.1	-	-	-	-	-	-	-	-
Olifants confl.	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
Letaba confl.	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
Mutale confl.	0.5	1.8	0.8	-	-	1.2	0.3	0.7	0.7
Pafuri Picnic Site	0.7	0.8	1.9	-	-	0.7	0.6	0.8	-
Mutale River									
Luvuvhu confl.	0.7	0.6	0.4 ^e	-	-	0.5	0.5	0.6	-

a - Magnesite

b - Dongadziba

c - Shidzivane

d - Mangovane

e - Drift above Luvuvhu confluence

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 (Prof. B.R. Davies, University of Cape Town, pers. comm.). Fourthly, the high B.I.V.'s, reflected in a very low Ephemeroptera diversity and high *Simulium* abundance (90% of the sample in August 1986), (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 11), confirming that these rivers are chemically unpolluted (cf Table 15) 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.

Cluster Analysis

The results of UPGMA cluster analysis of the stones-in-current samples using Czekanowski's similarity coefficient and percentage similarity did not show any apparent seasonal or geographic trends.

In order to consolidate the information contained in the dendrograms produced by the cluster analysis, the results were clustered again. This was done as follows. A matrix was drawn up in which the percentage of total occurrences that sampling sites

fell into the same clusters in the initial cluster analysis was recorded. This percentage was calculated by dividing the number of actual occasions that sites clustered together by the number of occasions that they could potentially cluster together. The matrix is presented in Table 12.

The matrix (Table 12) was then subjected to UPGMA cluster analysis. The resultant dendrograms are shown in Figures 6 and 7 for Czekanowski's similarity coefficient and Percentage Similarity respectively.

The dendrogram of cluster analysis of the clustering using Czekanowski's similarity coefficient (Fig. 6) shows some fairly strong geographical variation. The Luvuvhu and Mutale river samples clustered together on 62% of the occasions or more. The Olifants River samples clustered together 57% of the time. The Crocodile and Sabie River samples clustered together 33% or more of their occurrence. The Letaba River samples were dissimilar to all other samples. The sample from Mahlangene did not cluster with any other sample whilst the samples from above the Olifants confluence only clustered with other samples 4% of the time.

The fact that the Letaba River was so different from the other rivers was probably due to the fact that during the course of this survey the river was not flowing at the western boundary of the Park (Mahlangene) and only occasionally at the Olifants confluence. Even when the Letaba River was flowing at the confluence, samples were often taken either when the flow was only recent or the flow was weak. This would have lead to unrepresentative stones-in-current samples.

The dendrogram produced from the cluster analysis of percentage similarity clusters (Fig. 7) had a different pattern. The two sampling sites where the Olifants and Letaba rivers joined always clustered together indicating similar taxonomic abundances. This was indeed the case as *Tricorythus* "lowveld", hydropsychid caddis-fly larvae, *Simulium* species and chironomids were generally most abundant indicating a degree of organic enrichment. The exception to this tendency was the sample from the Letaba River in April 1986 where Cladocera and Copepoda made up 90% of the sample. This may be attributed to the fact that the river had only been flowing for a few days when the sample was collected since the benthic community had not had sufficient time to re-establish itself, whilst the Cladocera had been gathering in pools upstream and had been flushed down with the newly flowing water. Slight organic enrichment was also indicated by the B.I.V.s which ranged from 0.9 to 5.9 with 7 out of 11 B.I.V.s > 2.0. The sample taken from Mahlangene on the Letaba River was once again isolated from the other samples. This was due to the poor diversity (24 taxa, Table 10) as a result of the lack of flowing water.

Table 12. A matrix illustrating the percentage of time that sampling sites clustered together using Czekanowski's similarity coefficient and the percentage similarity.

		PERCENTAGE SIMILARITY											
		A	B	C	D	E	F	G	H	I	J	K	L
C Z E K A N O W S K I	A		16	33	33	0	0	0	50	20	33	60	40
	B	50		29	43	0	0	14	0	33	29	16	16
	C	33	29		29	0	0	0	14	0	0	0	0
	D	33	57	29		0	0	0	29	0	0	16	0
	E	0	0	0	0		0	0	0	0	0	0	0
	F	0	25	25	25	0		0	0	25	25	25	25
	G	0	14	0	14	0	0		57	16	0	0	16
	H	0	14	29	29	0	100	14		16	14	33	20
	I	60	16	67	16	0	25	0	16		66	60	60
	J	16	0	29	0	0	25	0	14	50		83	83
	K	40	33	0	0	0	0	0	0	60	67		83
	L	40	16	67	16	0	0	0	0	60	16	50	

- A - Crocodile River Ngondwini
- B - Crocodile River Gezabahle
- C - Sabie River Luby-Luby
- D - Sabie River opposite Lisbon Estates
- E - Letaba River Mahlangene
- F - Letaba River above Olifants confluence
- G - Olifants River Mamba
- H - Olifants River above Letaba confluence
- I - Luvuvhu River Western Site
- J - Luvuvhu River above Mutale confluence
- K - Luvuvhu River Pafuri Picnic Site
- L - Mutale River above Luvuvhu confluence

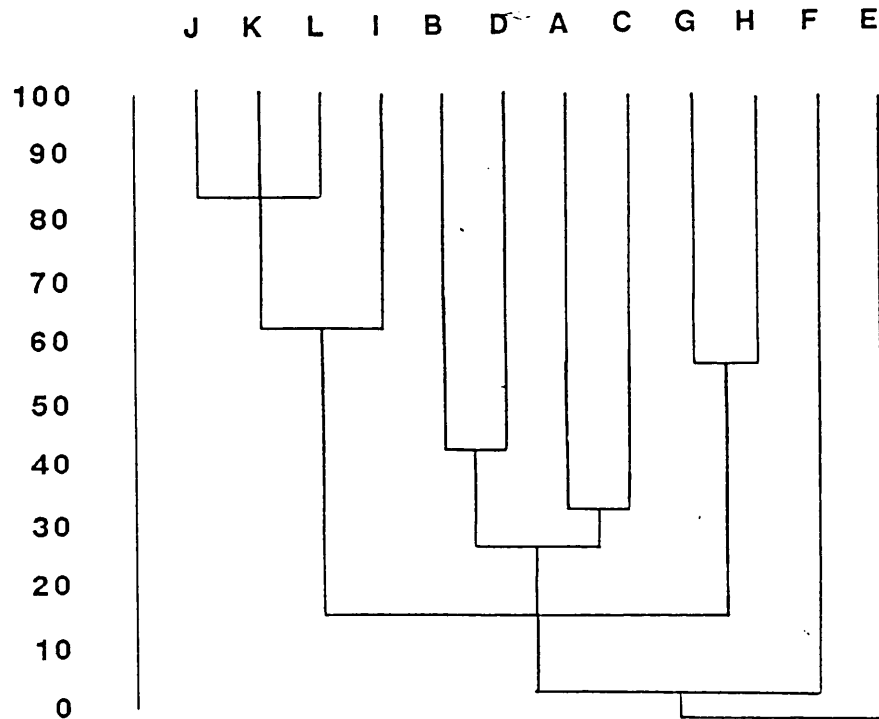


Figure 6. Dendrogram of UPGMA cluster analysis of results of clustering using Czekanowski's similarity coefficient.

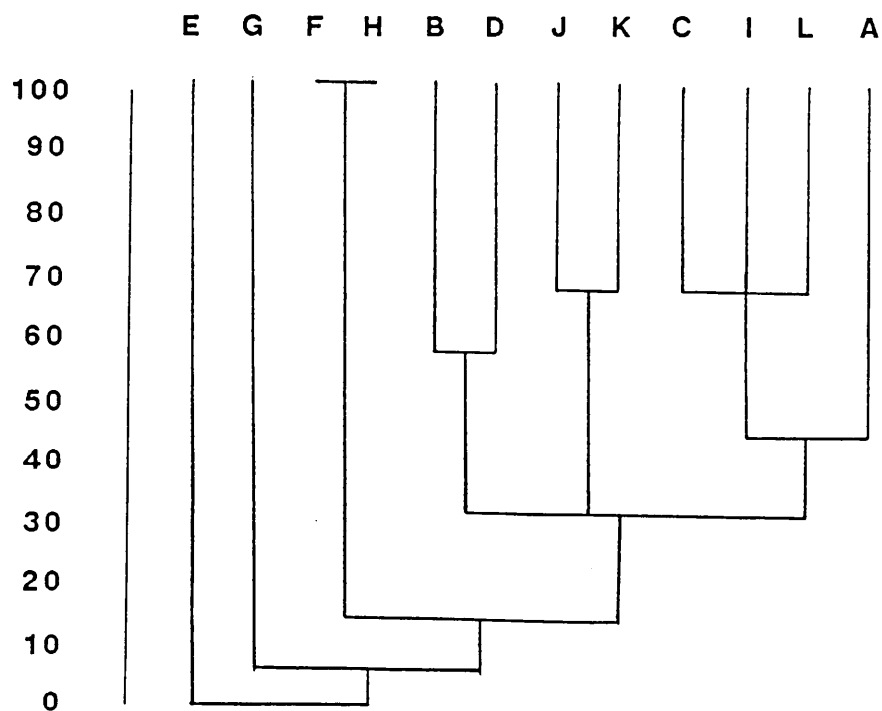


Figure 7. Dendrogram of UPGMA cluster analysis of results of clustering using Percentage Similarity.

The Olifants River at Mamba was quite different from other sampling sites. This was apparent in the field, especially on the last two sampling trips (August and October, 1986) when the fauna was impoverished. This may be attributed to some form of pollution, but a detailed survey upstream of the K.N.P. would be necessary to determine the nature and source of the pollution. As with Czekanowski's similarity, the Crocodile River at Gezabale and the Sabie River opposite Lisbon Estates clustered together. This shows the similarity in species composition at both sites with high proportions of *Baetis glaucus*, *Tricorythus* "lowveld", *Choroterpes* sp., *Cheumatopsyche thomasseti*, *Simulium* spp., Tanytarsini and Orthocladiinae. The Luvuvhu River samples from Pafuri Picnic Site and above the confluence with the Mutale River shared high *Centroptilum medium* numbers. The Luvuvhu River at the Western Site, Mutale River above confluence with Luvuvhu River and Sabie River at Luby-Luby clustered together 62% of the time. These samples had similar composition to the Crocodile River at Gezabale and the Sabie River opposite Lisbon Estates, with the addition of high abundance of *Austrocaenis* sp. and *Chimarra* sp. The Crocodile River at Ngondwini differed from other samples by the inclusion of relatively abundant *Stenelmis* sp. beetles.

Classification and Ordination

TWINSPAN and DECORANA have often been used to investigate the relationships between samples and environmental or physico-chemical variables (Metcalf 1988; Moss *et al.* 1987; Ormerod and Edwards 1987). In this study, chemical samples were not collected at the same time as benthic samples due to financial constraints. The chemical data presented in Table 15 was taken from the Department of Water Affairs' routine monitoring database. Additionally, there were no distinct spatial or temporal trends in the sample classification. Direct correlations between chemical or environmental variables and benthic data would therefore be unreliable. However, there are some patterns apparent from the data analysis.

The results of classification using TWINSPAN are presented in Figures 8 and 9 and Table 13. Eleven TWINSPAN groups were produced at the fourth level of division and twenty groups at the seventh level (Fig. 8). The patterns apparent from the fourth level illustrate general trends whilst the groups at the seventh level relate to the specific faunal composition of the samples.

At the fourth TWINSPAN division it was apparent that Group 3 (C, D, E and F) contained all of the 1986 Luvuvhu and Mutale river samples except for the August samples from Luvuvhu River Pafuri Picnic Site and Mutale River above Luvuvhu

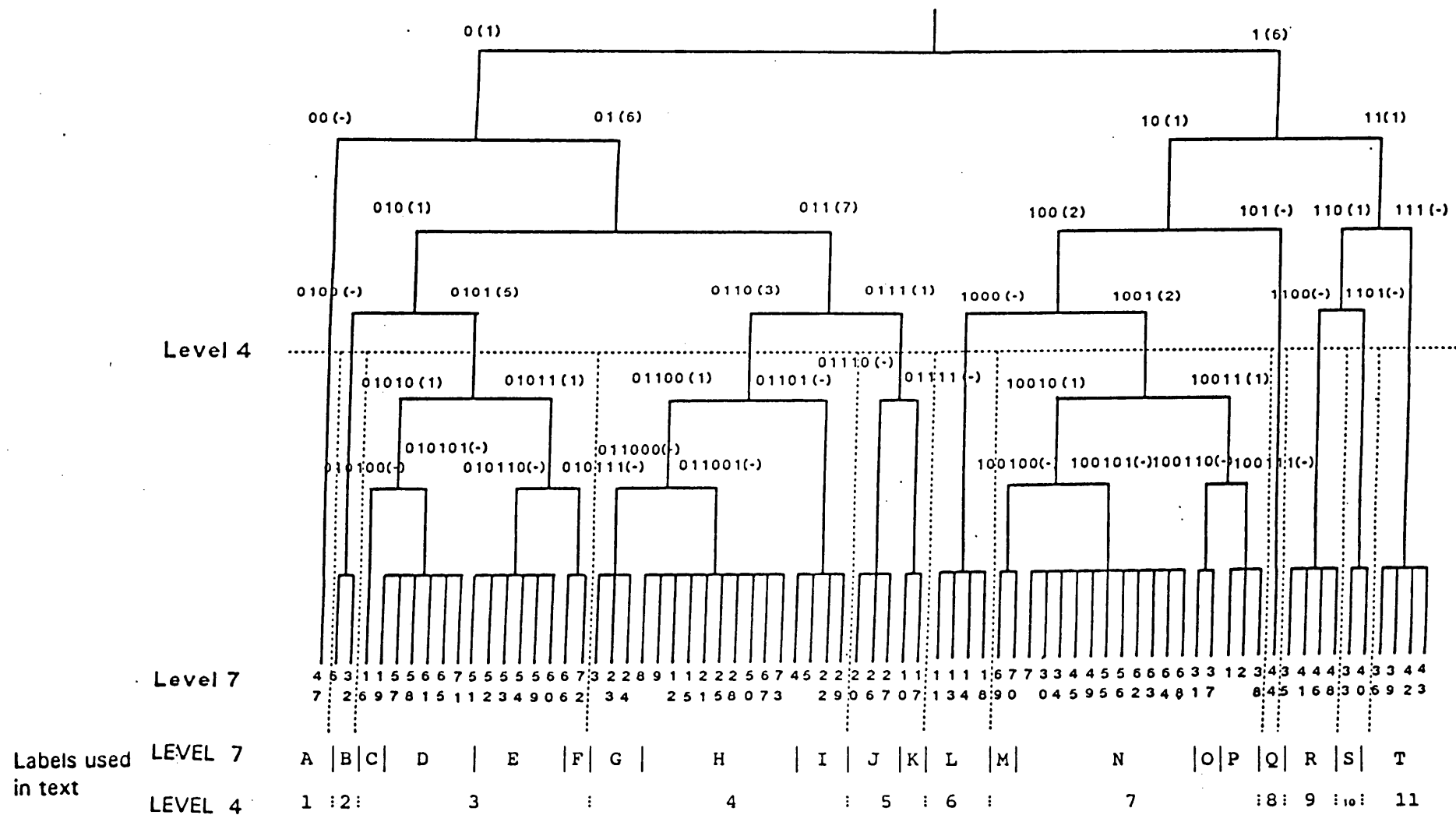
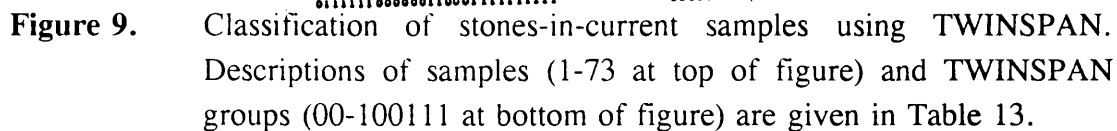


Figure 8. Dendrogram of TWINSpan classification of samples from stones-in-current (see Table 13 for TWINSpan groups and sample descriptions). Numbers in parentheses are the number of indicator species for that division.



confluence. Group 7 (M, N, O and P) includes all April 1985 samples except for Letaba River at Mahlangene and the Sabie River samples and all June 1985 samples except Crocodile River Gezabale, Letaba River above Olifants River confluence, Luvuvhu River Western Site and the Sabie River samples. Groups 9, 10 and 11 (R, S and T) incorporates the Olifants and Letaba river 1986 samples with the exception of Olifants River Mamba June 1986 (Group 7), Letaba River above Olifants confluence April 1986 (sole member of Group 1). Olifants River above Letaba confluence September 1985 is also included in Group 11. The Sabie River samples all fall into Groups 3, 4, 5 and 6 (C-L) mainly with samples from the Luvuvhu and Mutale rivers with some of the Crocodile River samples (mostly 1986). Group 8 comprised the Letaba Mahlangene sample.

At the seventh TWINSpan division faunal patterns were as follows. Group A (Table 13) consisted of a lone sample (Letaba River above confluence with Olifants River, April 1986). This sample was comprised of almost 90% Cladocera and Copepoda which may not be regarded as strictly benthic species. This was probably due to the fact that the river had only been flowing for a few days when the sample was collected. The B.I.V. of 5.9 indicated that, excluding the Cladocera and Copepoda, the fauna was not diverse and was characterised by taxa tolerant of organically enriched conditions. Group B (Crocodile River Ngondwini, October 1986 and Olifants River Mamba, September 1985) was also characterised by non-benthic organisms, namely ostracods. Group C, another single sample (Sabie River Luby-Luby, September 1985), had high numbers of chironomids, especially Tanytarsini and showed a lack of baetid diversity and a large variety of annelids indicative of slight organic enrichment (B.I.V. = 3.5). All of the samples (6) in Group D contained high percentages of *Centroptilum medium*. The six samples in Group E had high proportions of *Chimarra* sp. From Figure 7 it appears that *Simulium* spp. account for the grouping of the two samples in Group F. Group G was high in *Choroterpes* sp. and Tanytarsini. Groups H and I were not unique in specific taxa, but were similar in general composition of samples. The three samples in Group J were dominated by orthoclad chironomids whilst the samples in Group K (Crocodile River Gezabale, April 1986 and Sabie River Luby-Luby, November 1985) had high numbers of *Baetis glaucus*. Group L (4 samples) had large proportions of *Baetis glaucus*, *Cheumatopsyche thomasseti* and *Simulium* species, but *Tricorythus* sp. probably had the strongest influence on the grouping. Group M was characterised by *Baetis glaucus* and Orthocladinae. Groups N and O had high portions of *Tricorythus* sp., *Cheumatopsyche thomasseti* and *Simulium* spp. whilst Group O also had a large number of *Baetis glaucus*. The three samples of Group P had similar overall composition but no dominant taxa. Group Q (Letaba River Mahlangene, April 1985) was dominated by Cladocera. This was not

surprising since the sample taken could not really be described as truly stones-in-current as the river was barely flowing. *Simulium* spp. dominated the four samples of Group R. Group S (Olifants River at Mamba and above Letaba confluence, April 1986) were distinguished by *Tricorythus* sp. and *Amphipsyche scottae*. Group T was differentiated by *Cheumatopsyche thomasseti* and particularly by *Catoxyethira* sp.

Table 14 and Figures 10-15 show the results of the ordination of the stones-in-current samples using DECORANA. Figure 10 was difficult to interpret so it was broken down into component groups in Figs. 11-15.

The TWINSpan groups were strongly related to axis 1 of the DECORANA ordination and less strongly related to axis 2 (Table 14 and Figure 10).

Table 13. Labels for stones-in-current samples in the TWINSpan analysis illustrated in Figures 8 and 9.

TWINSpan Group	Level 4 Label	Level 7 Label	Sample No.	Sample Description	Sample Date
00	1	A	47	Letaba River above confl. with Olifants River	April 1986
0100	2	B	6 32	Crocodile River Ngondwini Olifants River Mamba	October 1986 September 1985
010100	3	C	16	Sabie River Luby-Luby	September 1985
010101		D	19 57 58 61 65 71	Sabie River Luby-Luby Luvuvhu River above confl. with Mutale River Luvuvhu River above confl. with Mutale River Luvuvhu River above confl. with Mutale River Luvuvhu River at Pafuri Picnic Site Mutale River above confl. with Luvuvhu River	April 1986 September 1985 April 1986 October 1986 April 1986 April 1986

Table 13. Labels for stones-in-current samples in the TWINSPAN analysis illustrated in Figures 8 and 9 (cont.)

TWINSPAN Group	Level 4 Label	Level 7 Label	Sample No.	Sample Description	Sample Date
010110	3	E	51	Luvuvhu River Western Site	April 1986
			52	Luvuvhu River Western Site	June 1986
			53	Luvuvhu River Western Site	August 1986
			54	Luvuvhu River Western Site	October 1986
			59	Luvuvhu River above confl. with Mutale River	June 1986
			60	Luvuvhu River above confl. with Mutale River	August 1986
010111	3	F	66	Luvuvhu River Pafuri Picnic Site	June 1986
			72	Mutale River above confl. with Luvuvhu River	June 1986
011000	4	G	3	Crocodile River Ngondwini	September 1985
			23	Sabie River opposite Lisbon Estates	April 1985
			24	Sabie River opposite Lisbon Estates	June 1985
011001	4	H	8	Crocodile River Gezabahle	June 1985
			9	Crocodile River Gezabahle	September 1985
			12	Crocodile River Gezabahle	August 1986
			15	Sabie River Luby-Luby	June 1985
			21	Sabie River Luby-Luby	August 1986
			25	Sabie River opposite Lisbon Estates	September 1985
			28	Sabie River opposite Lisbon Estates	August 1986
			50	Luvuvhu River Western Site	June 1985
			67	Luvuvhu River Pafuri Picnic Site	August 1986
			73	Mutale River above confl. with Luvuvhu River	August 1986

Table 13. Labels for stones-in-current samples in the TWINSPAN analysis illustrated in Figures 8 and 9 (cont.)

TWINSpan Group	Level 4 Label	Level 7 Label	Sample No.	Sample Description	Sample Date
01101	4	I	4	Crocodile River Ngondwini	June 1986
			5	Crocodile River Ngondwini	August 1986
			22	Sabie River Luby-Luby	October 1986
			29	Sabie River opposite Lisbon Estates	October 1986
01110	5	J	20	Sabie River Luby-Luby	June 1986
			26	Sabie River opposite Lisbon Estates	April 1986
			27	Sabie River opposite Lisbon Estates	June 1986
01111		K	10	Crocodile River Gezabale	April 1986
			17	Sabie River Luby-Luby	November 1985
1000	6	L	11	Crocodile River Gezabale	June 1986
			13	Crocodile River Gezabale	October 1986
			14	Sabie River Luby-Luby	April 1985
			18	Sabie River Luby-Luby	January 1986
100100	7	M	69	Mutale River above confl. with Luvuvhu River	June 1985
			70	Mutale River above confl. with Luvuvhu River	September 1985

Table 13. Labels for stones-in-current-samples in the TWINSPAN analysis illustrated in Figures 8 and 9 (cont.)

TWINSPAN Group	Level 4 Label	Level 7 Label	Sample No.	Sample Description	Sample Date
100101	7	N	7	Crocodile River Gezabale	April 1985
			30	Olifants River Mamba	April 1985
			34	Olifants River Mamba	June 1986
			45	Letaba River above confl. with Olifants River	April 1985
			49	Luvuvhu River Western Site	April 1985
			55	Luvuvhu River above confl. with Mutale River	April 1985
			56	Luvuvhu River above confl. with Mutale River	June 1985
			62	Luvuvhu River Pafuri Picnic Site	April 1985
			63	Luvuvhu River Pafuri Picnic Site	June 1985
			64	Luvuvhu River Pafuri Picnic Site	September 1985
			68	Mutale River above confl. with Luvuvhu River	April 1985
100110	7	O	31	Olifants River Mamba	June 1985
			37	Olifants River above confl. with Letaba River	April 1985
100111		P	1	Crocodile River Ngondwini	April 1985
			2	Crocodile River Ngondwini	June 1985
			38	Olifants River above confl. with Letaba River	June 1985
101	8	Q	44	Letaba River Mahlangene	April 1985
1100	9	R	35	Olifants River Mamba	August 1986
			41	Olifants River above confl. with Letaba River	June 1986
			46	Letaba River above confl. with Olifants River	June 1985
			48	Letaba River above confl. with Olifants River	June 1986
1101	10	S	33	Olifants River Mamba	April 1986
			40	Olifants River above confl. with Letaba River	April 1986

Table 13. Labels for stones-in-current samples in the TWINSPAN analysis illustrated in Figures 8 and 9 (cont.)

TWINSpan Group	Level 4 Label	Level 7 Label	Sample No.	Sample Description	Sample Date
111	11	T	36	Olifants River Mamba	October 1986
			39	Olifants River above confl. with Letaba River	September 1985
			42	Olifants River above confl. with Letaba River	August 1986
			43	Olifants River above confl. with Letaba River	October 1986

Table 14. Eigenvalues, cumulative percentage variance explained and lengths (standard deviations) of each DECORANA axis.

AXIS	EIGENVALUE	CUMULATIVE VARIANCE EXPLAINED (%)	AXIS LENGTH (sd)
1	0.805	56.4	4.80
2	0.259	74.5	2.80
3	0.194	88.1	2.20
4	0.170	100.0	2.36

The primary and secondary axes of ordination, which together explained almost 75% of the variance in the data set, were 4.8 and 2.8 standard deviations in length respectively. DECORANA axis 1 accounted for most of the variance (56%) and although the axis was relatively long (4.8 standard deviations), the individual TWINSpan groups generally fell within a narrow band along that axis. The fact that axis 1 was greater than four standard deviations long showed that there was no similarity between the extreme samples (Hill 1979b). However, Figs. 11-15 show that in any one group at the fourth TWINSpan level, there was never more than one standard deviation separating the extreme samples along axis 1. In many cases, the within-group variation along the second (y) axis was two standard deviations. Implicit in this is the assumption that the factor(s) influencing the positioning along the x-axis (axis 1) was far more influential than the factor(s) governing the y-axis. However, in spite of these observations, it was not possible in this study to determine what the factors influencing the axes were. Ormerod and Edwards (1987)

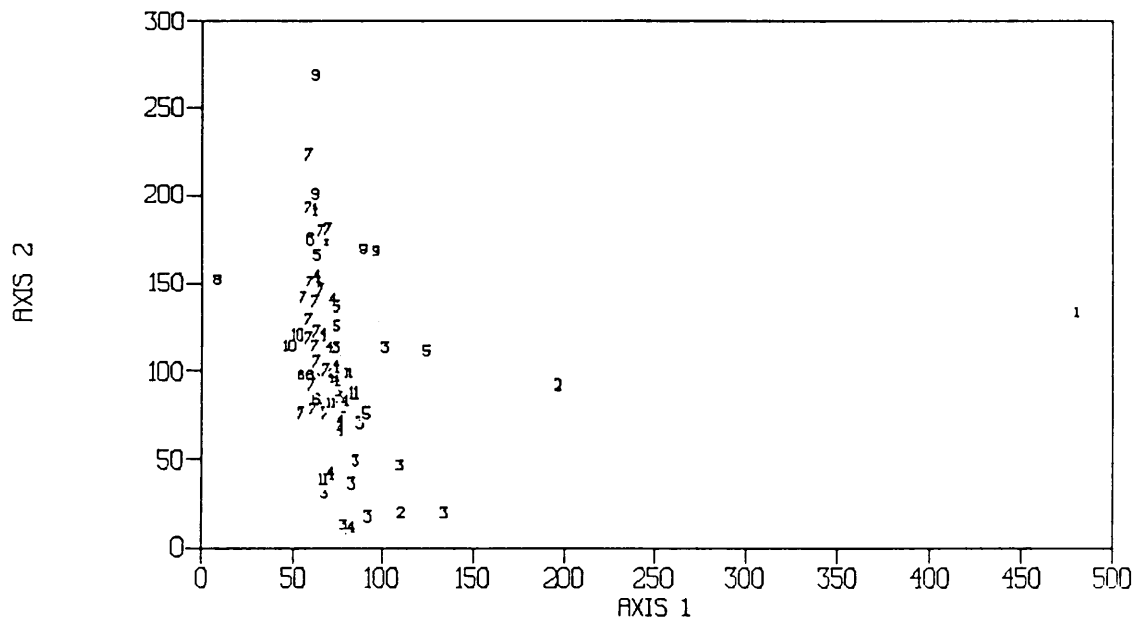


Figure 10. Scatterplot of DECORANA axes 1 and 2 indicating TWINSpan groups (all groups at Level 4).

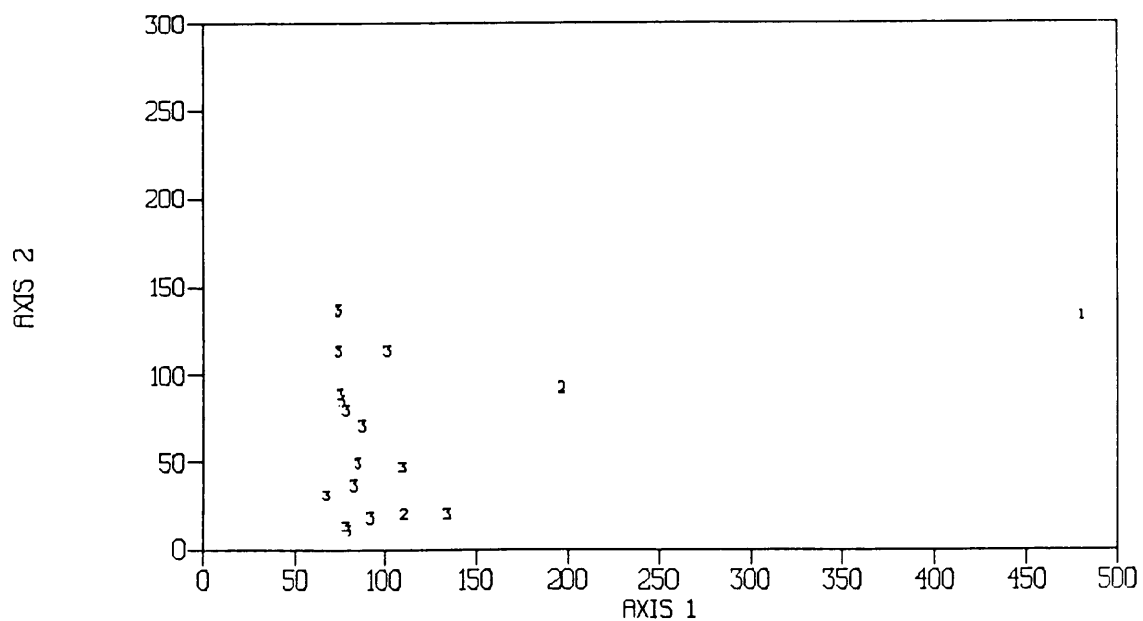


Figure 11. Scatterplot of DECORANA axes 1 and 2 indicating TWINSpan groups (Groups 1, 2 and 3 at Level 4).

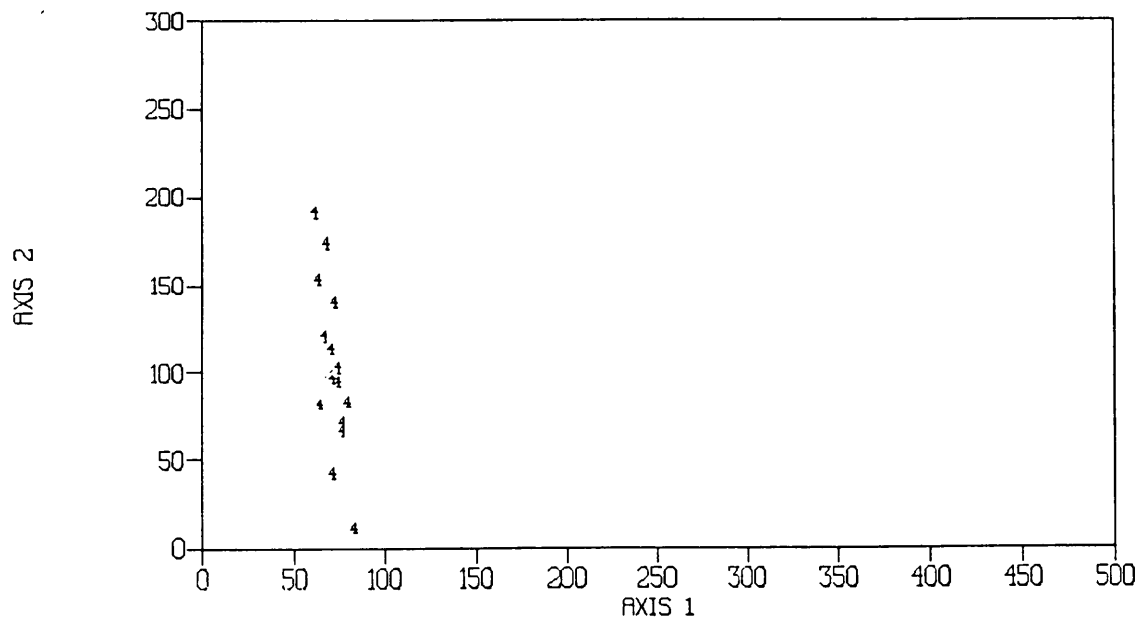


Figure 12. Scatterplot of DECORANA axes 1 and 2 indicating TWINSpan groups (Group 4 at Level 4).

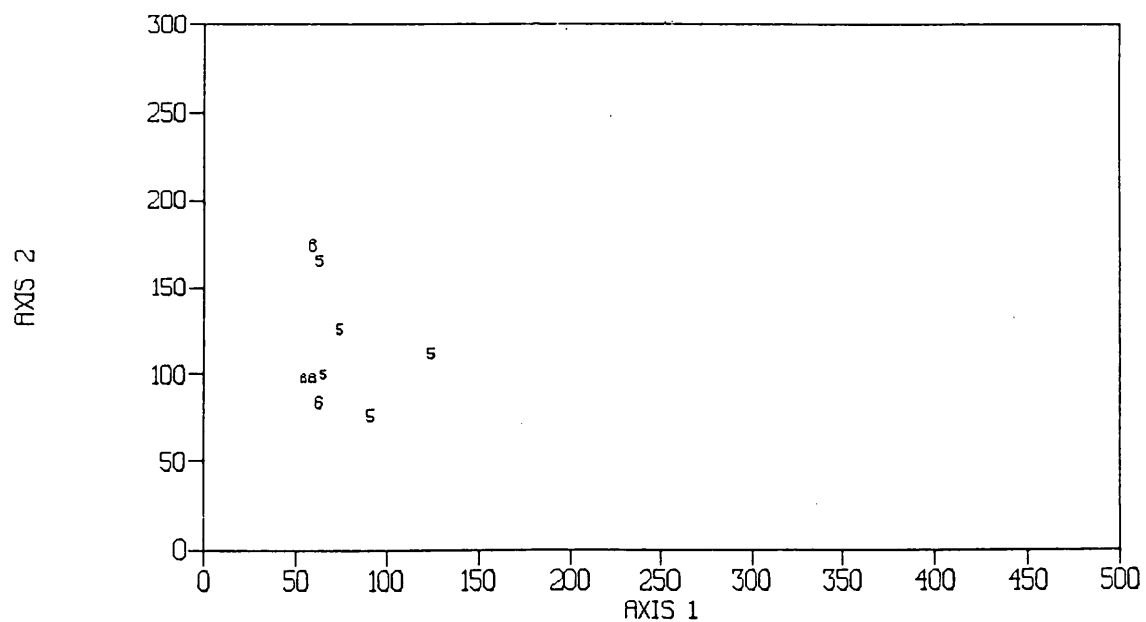


Figure 13. Scatterplot of DECORANA axes 1 and 2 indicating TWINSpan groups (Groups 5 and 6 at Level 4).

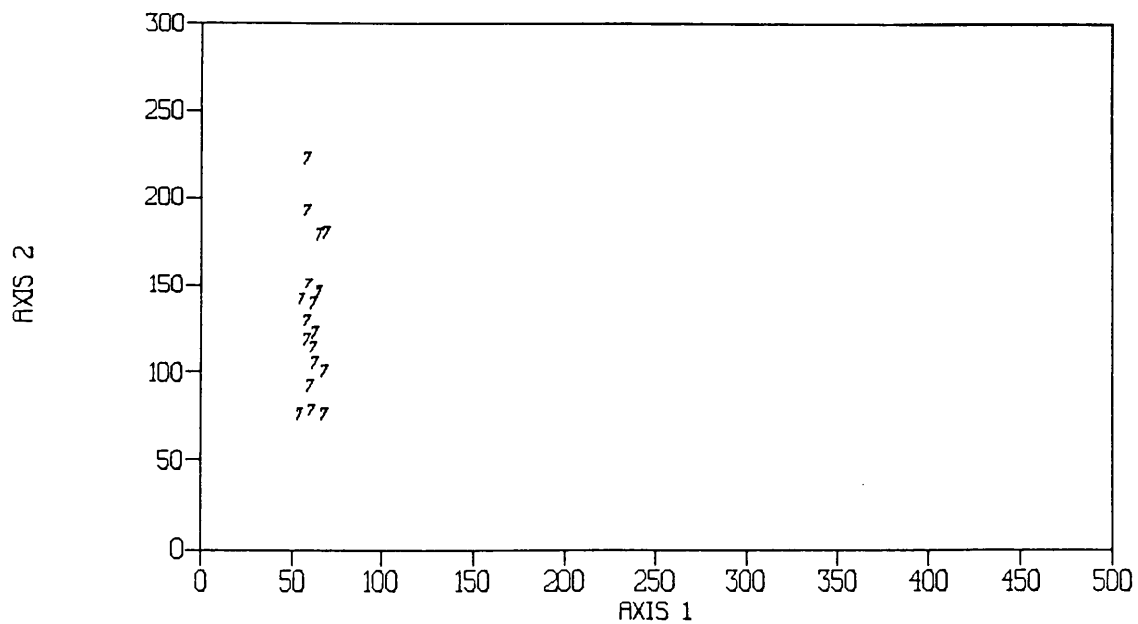


Figure 14. Scatterplot of DECORANA axes 1 and 2 indicating TWINSpan groups (Group 7 at Level 4).

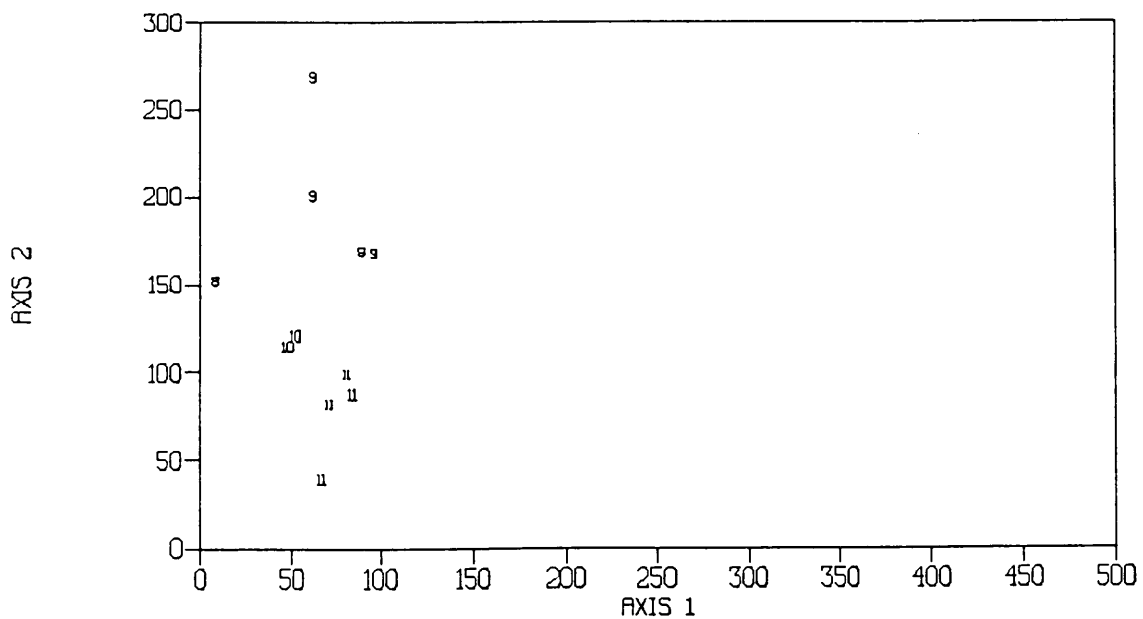


Figure 15. Scatterplot of DECORANA axes 1 and 2 indicating TWINSpan groups (Groups 8, 9, 10 and 11 at Level 4).

found the x and y-axes in their study on the macroinvertebrates of the River Wye, represented pH or total hardness and slope or distance from source respectively, whilst Wright, Moss, Armitage and Furse (1984) found that the x-axis distinguished between types of rivers (upland and lowland) and the y-axis reflected variation along the length of the rivers. Factors which may have influenced the K.N.P. fauna could have been, for example, north-south axis (influence of temperature), local water chemistry, proximity to hippo pools, influence of land use practices outside the K.N.P., etc. Unfortunately, the data available from this study was inadequate to identify the governing variable(s).

It must be concluded from the results of the analyses on the stones-in-current fauna that it would be meaningless to continue these sophisticated analyses any further without more data on the abiotic environment.

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 each sample.

Unlike the stones-in-current fauna, there were no particular species or taxa that occurred in all samples. 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*, *Centropilum* "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 10) 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 Luby-Luby 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.

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 formed 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.

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, caddis-flies, true flies and molluscs were also well represented.

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 Luby-Luby, but not at the sampling point opposite Lisbon Estates. *Pistia stratiotes* also occurred in the Crocodile River at Gezabale 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 Luby-Luby (Sabie River), below the Mutale confluence and at the Pafuri Picnic Site (Luvuvhu River).

WATER CHEMISTRY

Table 15 summarizes the chemical data 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 (dry) season (April to September) and a summer (wet) season (October to March). It is apparent from Table 15 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 ($\bar{x}$) 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 15. Summary of chemical data provided by the Department of Water Affairs

RIVER		CROCODILE				SABIE				OLIFANTS				LETABA				LUVUVHU					
SAMPLING POINT		X2M49		X2M50		X3M13		X3M15		B7M15		B7M18		B8M28		B8M30		A9M08		A9M09		A9M11	
SEASON		W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
VARIABLE																							
Electrical Conductivity (mS/m)	n	24	27	23	26	35	33	28	35	74	78	38	30	71	27	7	14	65	61	37	40	37	40
	$\bar{x}$	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
	$\bar{x}$	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
	$\bar{x}$	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	220.0	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
	$\bar{x}$	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	98.0	93.0	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
	$\bar{x}$	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	17	65	61	37	40	37	40
	$\bar{x}$	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
	$\bar{x}$	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 15 (cont). Summary of chemical data provided by the Department of Water Affairs

RIVER		CROCODILE				SABIE				OLIFANTS				LETABA				LUVUVHU					
SAMPLING POINT		X2M49		X2M50		X3M13		X3M15		B7M15		B7M18		B8M28		B8M30		A9M08		A9M09		A9M11	
SEASON		W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
VARIABLE																							
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
	$\bar{x}$	41.0	28.4	42.9	29.9	61.1	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
Total Alkalinity (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
	$\bar{x}$	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	54.4	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	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
	$\bar{x}$	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
	$\bar{x}$	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
	$\bar{x}$	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
	$\bar{x}$	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
	$\bar{x}$	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	387	30	11	27	7	14	65	62	37	40	37	40
	$\bar{x}$	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 15 (cont). Summary of chemical data provided by the Department of Water Affairs

RIVER		CROCODILE				SABIE				OLIFANTS				LETABA				LUVUVHU					
SAMPLING POINT		X2M49		X2M50		X3M13		X3M15		B7M15		B7M18		B8M28		B8M30		A9M08		A9M09		A9M11	
SEASON		W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
VARIABLE																							
N Kjel (mg/l)	n	3	7	3	6	3	8	1	8	4	18	-	-	-	5	-	-	4	16	4	6	4	6
	$\bar{x}$	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
Total P (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
	$\bar{x}$	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
Total P (mg/l)	n	3	7	3	6	3	6	1	8	4	18	-	-	-	5	-	-	4	16	4	6	4	6
	$\bar{x}$	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	0.1	0.03	0.3	0.04
	cv	50	40	67	50	67	200	-	111	40	167	-	-	-	30	-	-	42	19	122	48	150	50

W - winter (April to September)

S - summer (October to March)

n - number of samples

$\bar{x}$ - arithmetic mean

s - standard deviation

cv - coefficient of variation ($100s/\bar{x}$)

CHAPTER 5

DISCUSSION

When first studies are made of the benthic invertebrates in previously unexplored regions, it is advisable to rear as many larvae 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 berner*, *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. berner* and *Dicercomyzon* have previously seldom been recorded in the Transvaal and were described from Central Africa. The leptophlebid mayfly, *Masharikella* sp. was previously unrecorded 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 more recent (1987) visit to the K.N.P., Prof B.R. Davies, University of Cape Town (pers. comm.) 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.

The data analyses carried out on the data collected were disappointing in many respects. Neither the cluster analysis based on presence of taxa nor the cluster analysis based on the abundance of taxa showed any distinct patterns such as geographical variation, seasonal variation or variation due to other physical patterns. This lack of order in the cluster analysis results can probably be attributed to the lack of taxonomic knowledge on the K.N.P. fauna. Many of the identifications were only at the family level and some of the other identifications were only tentative. For example, it is possible that some of the unidentified baetid mayflies could have been more or less mature specimens of some of the identifiable individuals. This "coarseness" of taxonomic identification could well be hiding significant trends in the data. However, when the results of the cluster analysis were subjected to further clustering, it became apparent that the clustering of the Czekanowski similarity coefficient showed geographical trends in which the Luvuvhu and Mutale rivers clustered together and the Sabie and Crocodile rivers clustered together. The Olifants and Letaba river samples clustered separately.

TWINSpan analysis at the fourth division showed some spatial and temporal patterns. It seemed that the Sabie, Luvuvhu and Mutale rivers grouped together although there were differences between April 1985 samples and other samples whilst the 1986 Olifants and Letaba rivers grouped separately. The grouping of the Sabie, Luvuvhu and Mutale rivers is consistent with observations on faunal diversity.

DECORANA analysis showed that there was a strong influential factor acting on the TWINSpan groups, especially along DECORANA axis 1 (accounting for 56% of the variance) but less so along axis 2 (18% of the variance). If the factors affecting both DECORANA axes were equally as strong, the TWINSpan groups would have formed much more compact, discrete, less dispersed groups on the DECORANA scatterplots. It can therefore be concluded that at least two factors, one with a much stronger influence than the other, determined the distribution of samples in species-space during DECORANA ordination, but without more data on abiotic variables and biotic inter-relationships, such as predation, it would be speculation to suggest what factors were causing that influence.

A very important point that comes out of the above discussion is that when a macro-invertebrate survey such as the one reported here is performed, it is beneficial, if not vital to collect not only specific biological data but also physical, chemical and

additional biotic data in order to determine what factors are responsible for the patterns of species distributions found within samples.

CHAPTER 6

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 due to its Central and East African tropical component and is therefore worthy of conservation in its own right.
2. The threat to the continued survival of the fauna of the K.N.P. rivers and of the rivers as natural ecosystems is real. The Letaba and Luvuvhu rivers are, due to the excessive abstraction of water particularly for irrigation, no longer perennial rivers and the diversity of the invertebrate fauna especially 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, not only at the species level but also at the genus level. There is also much confusion over the correct nomenclature for some taxa.
5. Of the four methods of data analysis used (UPGMA cluster analysis of Percentage Similarity and Czekanowski's Similarity coefficients, Two-way indicator species analysis (TWINSpan) and Detrended correspondence analysis (DECORANA)) it was found that cluster analysis and TWINSpan revealed some clustering on a spatial basis.
6. The fact that the first DECORANA axis accounted for 56% of the variance between samples with each of the other axes contributing 18% or less implied that there was one dominant factor or a combination of factors influencing the grouping of the samples in species-space. Unfortunately, due to the lack of

chemical and physical data and the lack of complete biotic data (e.g. presence of carnivorous stone-dwelling fish), it was not possible to pin-point the responsible factor(s).

SUMMARY

Until recently little was known of the zoobenthos of the Kruger National Park. A survey of the Crocodile, Sabie, Olifants, Letaba, Luvuvhu and Mutale rivers was carried out during 1985/86. The zoobenthos for stones-in-current, stones-out-of-current, sediment and vegetation biotopes was sampled with a handnet. Observations on aquatic macrophytes were recorded.

The survey showed that the faunal diversity was highest in the Sabie river followed by the Luvuvhu and Mutale rivers, although the fact that the latter two rivers ceased to be perennial during the later stages of the study will undoubtedly have affected the fauna. The fauna of the Crocodile river was obviously influenced by nutrient enrichment. The fauna of the Olifants River was considerably modified, particularly towards the western border of the Park and towards the end of the study period. The Letaba River ceased flowing at the western border of the Park in mid-1985, but it was usually flowing at the confluence with the Olifants River. The diversity of the fauna collected at the confluence was evidently due to its close proximity to the Olifants River. Several taxa were found to be present in most samples, these included mayflies, a caddis-fly, Simuliidae and chironomids. Other less common taxa were encountered. These included the mayflies, *Afrobaetoides bernerii*, *Centropiloides ?spinulosa*, *Elassoneuria* sp., *Dicercomyzon* sp., *Machadorhythus* sp. and an unnamed baetid (*Pseudocloeon* sp.A, Kimmins 1955) previously recorded from Malawi. A mayfly that was collected from the Luvuvhu River which had not previously been recorded in South Africa was the leptophlebid, *Masharikella* sp.

Four methods were used to analyze the data, namely cluster analysis of two different measures of similarity, detrended correspondence analysis (DECORANA) and two-way indicator species analysis (TWINSPAN).

It was concluded that the benthic fauna of the Kruger National Park included a large tropical element which has rarely been encountered elsewhere in the Republic of South Africa and should therefore be considered worthy of conservation.

OPSOMMING

Tot onlangs was min oor die soöbentos van die Nasionale Krugerwildtuin bekend. 'n Opname van die Krokodil-, Sabie-, Olifants-, Letaba-, Luvuvhu- en Mutaleriviere is gedurende 1985/86 uitgevoer. Die soöbentos vir klippe in, sowel as buite die stroom, asook sediment en plantegroei biotope is met 'n handnet gemonster. Wanneer akwatiese makrofiete waargeneem is, is dit aangeteken.

Die opname het getoon dat die grootste verskeidenheid fauna in die Sabie-, gevolg deur die Luvuvhu- en Mutaleriviere voorgekom het, alhoewel die feit dat laasgenoemde twee riviere nie meer tydens die laaste stadia van die studie standhoudend gevloei het nie, beslis 'n invloed op die fauna sou hê. Die fauna van die Krokodilrivier was duidelik deur voedingstofverryking beïnvloed. Die fauna van die Olifantsrivier was aansienlik gewysig, veral teen die einde van die studieperiode in die rigting van die westelike grens van die Wildtuin. Teen middel 1985 het die Letabarivier by die westelike grens van die Wildtuin opgehou vloei, maar dit het nog meestal by die samevloeiing met die Olifantsrivier gevloei. Die verskeidenheid fauna wat by die samevloeiing versamel is, is klaarblyklik toe te skryf aan die nabyheid van die Olifantsrivier. 'n Hele aantal taksons is in die meeste monsters aangetref, onder andere Ephemeroptera, 'n Trichoptera, Simuliidae en Chironomidae. Ander minder algemene taksons sluit in die Ephemeroptera *Afrobaetoides berneri*, *Centroptiloides ?spinulosa*, *Elassoneuria* sp., *Diceromyzon* sp., *Machadorhythus* sp. en 'n onbenaamde baetid (*Pseudocloeon* sp.A, Kimmins 1955) wat nog net in Malawi aangetref is. Die leptophlebid *Masharikella* sp., wat nog nie vantevore in Suid-Afrika waargeneem is nie, is in die Luvuvhurivier versamel.

Vier metodes is gebruik om die data te ontleed, naamlik trosanalise van twee verskillende maatstawwe van gelyksoortigheid, ooreenstemmingsanalise waarvan die neigings verwyder is (DECORANA) en tweerigting indikatorspesie-analise (TWINSPAN).

Daar is tot die gevolgtrekking gekom dat die bentiese fauna van die Nasionale Krugerwildtuin 'n groot tropiese element, wat selde in die res van die Republiek van Suid-Afrika aangetref is, bevat. Om hierdie rede behoort dit as bewaringswaardig beskou te word.

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APPENDICES

NOTE : In all appendix tables "p" indicates the presence of taxa at $< 0.044\%$ of the total sample.

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

	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86	OCT 86
TAXON	*						
<i>Planaria</i>	0	0.1	0.4	0	P	0.8	3.3
<i>Nematoda</i>	0	0	0	1.6	0.1	0.1	0
Other oligochaetes	0	0	0.6	0	0	0	0
<i>Stenocypris</i> sp.	0	0	0.6	1.6	0	0	0
<i>Hydracarina</i> sp.1	0	0.3	0.6	0	0.9	1.7	0.5
<i>Collembola</i>	0	0	0	1.6	0	0	0
<i>Neoperla spio</i>	3.8	P	0.1	0	0	0.1	0
<i>Centroptilum excisum</i>	0.2	0	0.2	2.6	0	0	0
<i>C. "near excisum"</i>	0	0	1.5	0.7	0	0	0
<i>Centroptilum flavum</i>	0	1.7	4.2	9.3	P	0	0
<i>Centroptilum medium</i>	0.5	0	1.3	10.7	P	0.4	0
<i>Cloeon africanum</i>	0	0	0	0	0	0.1	0
<i>Baetis glaucus</i>	5.2	4.7	7.9	28.5	3.1	4.1	3.6
Other baetid sp. 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
<i>Choroterpes</i> sp.	17.8	13.8	10.0	0.8	0.4	0.6	4.3
<i>Adenophlebiodes</i> sp.	0	0	0	0	0	0	0.2
<i>Tricorythus "lowveld"</i>	10.8	9.6	13.1	3.9	17.8	1.8	25.0
<i>Austrocaenis</i> sp.	0.9	3.5	2.2	7.0	0.9	3.7	1.2
<i>Afronurus</i> sp.	3.8	1.2	0.6	0.4	2.0	0.1	3.9
<i>Zygonyx</i> sp.1	1.6	0.6	0	0	0	0	0
<i>Libellulid</i> sp.1	0	0	0.1	0	P	0	0
Anisopterans	0	0	0	0	0.2	0	0
<i>Naucoridae</i>	0	0	0	0	0	0	0.2
<i>Micronecta</i> sp.	0	P	0	0	0	0	0
Other hemipterans	0	0	0	1.6	P	0	0
<i>Sisyridae</i>	0	0	0	0	0	0	0.2
<i>Aethaloptera</i> sp.	0	0.1	0	0	0	0	0
<i>Amphipsyche scottae</i>	0	P	1.0	0	P	0	0
<i>Cheumatopsyche afra</i>	0	0.2	0.5	0	P	0	0.7
<i>C. thomasseti</i>	6.7	12.1	7.0	1.2	5.8	2.6	16.5
<i>Ecnomus</i> sp.	0	0.1	0.2	0	0	0	0.2
<i>Chimarra</i> sp.	0	4.9	4.0	0	1.1	0.5	1.2
<i>Leptocerus ?inflatus</i>	0	0	0	0	0.1	0.1	0
<i>Trichosetodes</i> sp.	0	1.2	1.1	0	0	1.5	1.0
<i>Leptocerid</i> sp.1	0	0	0	0	0	0	0.5
<i>Leptoceridae</i>	0	0	0.2	0	0	0.1	0
<i>Oecetis</i> sp.	0	0.2	0.2	0	P	0	0.2
<i>Hydroptila capensis</i>	0	0.7	0.5	0	0	0	0
<i>Orthotrichia barnardi</i>	0	0	0.6	0	0	0.2	0.2
<i>Catoxyethira</i> sp.	0	0	0	0	0	0.2	0.7
<i>Hydroptilid juveniles</i>	0.9	0.2	0.2	0	0	1.0	0.7
<i>Pyrallidae</i>	0	0	0.2	0	0	0	0
<i>Dytiscidae</i>	0	0	0	0.4	0	0	0
<i>Gyrinidae</i>	0	0.1	0.2	2.0	P	0.1	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
<i>Stenelmis</i> 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
<i>Simulium</i> 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
<i>Corynoneura</i> sp.	0	0.3	0	3.1	0	0	0
<i>Theinmanniella</i> sp.	0	0.3	0	0	0	0	0
Orthocladinae	7.1	9.2	6.0	7.8	16.0	21.1	11.4
<i>Cricotopus</i> sp.	0	0.9	0	2.3	1.1	1.2	0
<i>Pentaneura</i> sp.	2.2	1.8	1.0	1.2	0.2	0.4	0.3
<i>Dasyhelea</i> -type larvae	0	P	0	1.6	0	0.4	0
<i>Bezzia</i> -type larvae	0	0	0	0	0	0.1	0
<i>Forcipomyia</i> 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
<i>Melanoides</i> sp.	0	0	0	0	0	0.1	0
Ancylidae	0	0	0	0	0	0	0.8
<i>Eupera</i> sp.	0	0	0	0	0.8	0	0.7
<i>Corbicula africana</i>	0	0	0	0	0	0.5	2.0
Other Pelecypoda	2.3	1.1	0.6	3.1	0	0	0
<i>Chiloglanis</i> sp.	0	0	0	0	P	0	0
TOT. NO.OF INDIVIDS.	445	2529	1297	256	2231	1898	608

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

TAXON	APRIL 85	JUNE 85	SEPT 85	JUNE 86	AUG 86	OCT 86
<i>Hydra</i> sp.	0	0	0.5	0	0	0
<i>Planaria</i>	0	0	3.5	0	10.1	23.0
<i>Prostoma</i> sp.	0	0	0.3	0	0	1.7
Nematoda	0	0	0.2	0.1	0	0.7
<i>Pristina</i> sp.	7.9	5.8	0.1	0	0	0
<i>Nais</i> 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
<i>Daphnia</i> sp.	0	0.1	0	0	0	0
Cyclopoid copepods	0	0	0	0	0.7	1.3
<i>Pionocypris</i> sp.	0	0	0	0	0.9	11.5
<i>Stenocypris</i> sp.	0	0.6	11.3	0.2	0	0.7
<i>Hydracarina</i> sp.1	0	0	0	0	0.7	0.2
<i>Centroptiloides ?spinulosa</i>	1.2	0	0	0.2	0	0
<i>Centroptilum excisum</i>	0	0	0	0.2	0	0
<i>Centroptilum</i> "nr excisum"	0	0	0	0.2	0	0
<i>Centroptilum flavum</i>	0	0	0	0.2	0	0
<i>Centroptilum medium</i>	0	2.2	0	2.7	3.4	7.6
<i>Pseudocloeon vinosum</i>	0	0.7	0	0	0	0
<i>Baetis bellus</i>	5.6	0	0	0	0	0.8
<i>Baetis glaucus</i>	0.4	9.4	6.1	6.3	10.8	4.6
<i>Afrobaetodes bernerii</i>	0.8	0	0	0	0	0
Other baetid sp. 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
<i>Choroterpes</i> sp.	8.6	5.2	20.3	0.7	2.4	0.2
<i>Tricorythus</i> "lowveld"	28.1	6.2	8.5	6.7	0	7.8
<i>Austrocaenis</i> sp.	2.0	0.5	2.9	3.9	2.9	1.8
<i>Afronurus</i> 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
<i>Zygonyx</i> 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
<i>Micronecta</i> sp.	0	1.3	0.5	0	0	0.2
Other hemipterans	0	0	0	0	0.2	0
<i>Cheumatopsyche thomasseti</i>	4.9	17.6	12.1	9.2	4.5	12.3
<i>Cheumatopsyche afra</i>	0	1.1	0	0	0	0
<i>Ecnomus</i> sp.	0	0	0	0.1	0	0
<i>Chimarra</i> sp.	3.7	6.0	0.1	0.5	0.7	2.5
Leptoceridae	0.1	0	0	0.5	0	0
<i>Oecetis</i> sp.	0.6	0	0.1	0.3	0.4	0
<i>Hydroptila capensis</i>	0	0	1.7	0.4	0.3	0

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

TAXON	APRL 85	JUNE 85	SEPT 85	JUNE 86	AUG 86	OCT 86
<i>Orthotrichia barnardi</i>	0	0.1	0	0.2	0.3	0
<i>Catoxyethira</i> sp.	0	0.6	0	0	2.8	0
<i>Hydroptila</i> sp.1	0	0	0	0.1	0.2	0
Hydroptilid juveniles	0	0	1.9	0.4	0.7	1.5
Pyrilidae	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
Dryopidae	0	0	0	0.1	0	0
<i>Stenelmis</i> sp.	1.4	0.5	7.4	0.9	3.3	8.0
Other Elmidae	0.1	0	0	0	0.2	0
<i>Pseudancyronyx</i> sp.	0.1	0	0	0	0	0
Tipulidae	0	0	0.1	0.4	0	0
<i>Simulium</i> 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
<i>Corynoneura</i> sp.	0	0.1	0.5	0	0	0.7
Orthocladinae	10.4	4.5	2.8	9.1	14.9	0.8
<i>Cricotopus</i> sp.	0.6	0.8	0.2	2.6	0.7	0.3
<i>Pentaneura</i> sp.	2.0	0.9	1.0	2.9	0.5	0.7
<i>Dasyhelea</i> -type larvae	0.1	0.1	0	0	0	0.2
<i>Bezzia</i> -type larvae	0	0	0.4	0.1	0	0.2
<i>Forcipomyia</i> 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
Empididae	0	0.1	0	0	0	0
Muscidae	0	0	0	0	0	0.2
<i>Lymnophora</i> sp.	0	0	0	0.2	0	0
Higher dipterans	0	0.1	0.1	0.1	0	0
Ancyliidae	0	0	0	0.1	1.0	0.5
<i>Eupera</i> sp.	0	0	0	0.5	0.3	1.0
<i>Corbicula africana</i>	0	0	0.8	6.3	5.9	0.5
Other Pelecypoda	0.8	0	0	0	0	0
<i>Chiloglanis</i> sp.	0.1	0.1	0.1	0	0	0.2
TOTAL NO. OF INDIVIDS.	1550	1280	1755	2208	577	601

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
<i>Hydra</i> sp.	0	0	1.8	0	0	0	0	0	0
<i>Planaria</i>	0	P	4.9	0	0	0	0	0.5	1.2
Nematoda	0	P	0.1	0	0	0	0	0	0.1
<i>Pristina</i> sp.	0.1	0	1.4	1.7	0	0.2	0.1	0	0
<i>Nais</i> sp.	0	1.8	4.2	0	0	0	3.6	0.8	0.8
<i>Dero</i> 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
<i>Placobdelloides multistriatus</i>	0	0	0	0.4	0	0	0	0	0
<i>Ceriodaphnia/Simocephalus</i> 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
<i>Pionocypris</i> sp.	0	0	0	0	0	0	0	0	3.9
<i>Stenocypris</i> 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
<i>Hydracarina</i> sp.1	0.7	1.3	0.1	1.7	1.9	2.0	0.4	3.5	0.8
<i>Neoperla spio</i>	0.6	0.5	0.9	0	0.7	0.1	0.1	0.1	0.4
<i>Elassoneuria</i> sp.	0	0	0	0	0.1	0	0	0	0
<i>Centroptiloides bifasciatum</i>	0	0.1	0	0	0	0	0	0	0
<i>Centroptiloides ?spinulosa</i>	0.5	0	0	0	0	0	0	0.2	0
<i>Centroptilum</i> "near excisum"	0	0	0	0	0	0.8	1.0	0	0
<i>Centroptilum flavum</i>	0	0.2	0	1.2	1.3	0.6	1.1	0	0
<i>Centroptilum medium</i>	1.8	0.2	0.4	1.2	4.7	21.3	7.5	0.2	1.5
<i>Centroptilum varium</i>	0	0	0.9	0	0	0	0	0	0
<i>Cloeon africanum</i>	0	0	0	0	0	3.5	0	0	0
<i>Baetis glaucus</i>	5.0	30.8	1.3	23.1	14.8	5.6	18.2	3.3	11.3
<i>Baetis</i> (Acentrella) sp.	0	0.2	0	0	0	0	0	0.2	0
<i>Afrobaetodes berneri</i>	0.2	0	0	0	0.3	0	0	0	0
Other baetid sp. 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
<i>Choroterpes</i> sp.	10.2	2.4	2.2	4.3	0.3	7.1	0.6	0.7	2.7
<i>Adenophlebiodes</i> sp.	0	0	0	0	0	0.8	0	0	0
<i>Tricorythus</i> "lowveld"	32.4	8.7	3.1	3.8	34.8	9.3	17.5	9.9	22.1
<i>Austrocaenis</i> sp.	0.2	2.4	2.2	12.3	1.9	5.2	1.4	0	1.7
<i>Afronurus</i> sp.	P	0.4	0	0.4	2.3	1.4	3.8	0.3	1.9
<i>Dicercomyzon</i> 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
<i>Zygonyx</i> 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
<i>Micronecta</i> sp.	0	0	0	0	0	0.3	0	0	0
Other hemipterans	0	0	0.2	0	0	0.1	0	0	0

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

TAXON	APRIL 85	JUNE 85	SEPT 85	NOV 85	JAN 86	APRIL 86	JUNE 86	AUG 86	OCT 86
<i>Amphipsyche scottae</i>	0	P	0	0	0	0	0	0	0
<i>Cheumatopsyche thomasseti</i>	12.9	4.4	1.3	0.9	1.1	1.8	1.8	0.6	8.9
<i>Cheumatopsyche afra</i>	0	0	0.8	0	0	0	0	0	0
<i>Ecnomus</i> sp.	0	0.1	0.3	0	0	0.2	0	0	0.3
<i>Chimarra</i> sp.	11.6	4.2	4.3	0	13.7	4.1	0.8	0.1	2.1
<i>Leptocerus ?inflatus</i>	0	0	0	0	0	0.1	0.1	0	0
<i>Trichosetodes</i> 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
<i>Oecetis</i> sp.	0.2	P	0	0	0	0	0	0	0
<i>Hydroptila capensis</i>	0	0.5	2.4	0	0	0	0	0.3	0
<i>Orthotrichia barnardi</i>	0	0.1	0.3	0	0	0.1	0.5	0	0
<i>Catoxyethira</i> 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
Pyalidae	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
<i>Methles</i> sp.	0	0	0	0	0.2	0	0	0	0
<i>Stenelmis</i> 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
<i>Simulium</i> 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
<i>Corynoneura</i> sp.	0	0.7	0	0	0	0	0	0	0
<i>Theinmanniella</i> 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
<i>Cricotopus</i> sp.	P	1.7	0	1.7	0	0.2	3.5	2.4	6.8
<i>Pentaneura</i> 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
<i>Dasyhelea</i> -type larvae	P	0.1	0.1	0	0	0	0	0.1	0
<i>Bezzia</i> -type larvae	0	0	0.1	0	0.2	0.1	0.1	0	0.8
<i>Forcipomyia</i> 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
<i>Bulinus</i> sp.	0	0	0	0.4	0	0	0	0	0
Ancylidae	0	0	0	0.4	0	0	0	0	0
<i>Eupera</i> sp.	0	0	0.3	0	0.1	0	0	0	0.1
<i>Corbicula africana</i>	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
<i>Chiloglanis</i> 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 A4. PERCENTAGE COMPOSITION OF THE STONES-IN-CURRENT FAUNA FROM THE SABIE RIVER OPPOSITE LISBON ESTATES.

TAXON	APRIL 85	JUNE 85	SEPT 85	APRIL 86	JUNE 86	AUG 86	OCT 86
<i>Hydra</i> sp.	0.9	0	0	0	0	0	0
<i>Planaria</i>	0	0	0.9	0	0.1	0.1	1.9
<i>Pristina</i> sp.	0	0.6	0	3.0	0.1	P	0.6
<i>Nais</i> sp.	0.1	0.1	0	0	0	0.3	0
Other naids	0	0.5	0	0	0	0	0
Other oligochaetes	0	0	0.3	0	0	0.1	0
<i>Hydracarina</i> sp.1	1.7	0.6	0	0.9	1.4	0.1	1.2
<i>Collembola</i>	0	0	0	0.8	0	0	0
<i>Neoperla spio</i>	0.4	1.7	1.5	0.8	1.1	0.1	0
<i>Elassoneuria</i> sp.	0.9	0	0	0.2	0	0	0
<i>Oligoneuriopsis elizabethae</i>	0	0	0	0	0	0	1.0
<i>Centroptiloides bifasciatum</i>	0	0.1	0	0	0.2	0	0
<i>Centroptiloides ?spinulosa</i>	0	0	0	0.2	0	0	0
<i>Centroptilum excisum</i>	0	0	0	1.1	0.9	0	0
<i>Centroptilum</i> "near excisum"	0	0	0	0.2	0	P	0
<i>Centroptilum flavum</i>	1.1	2.8	0.8	2.6	1.1	0.2	0.4
<i>Centroptilum medium</i>	0.2	0.1	0	1.1	0.6	0	0.7
<i>Centroptilum varium</i>	0	0.1	0	1.1	0.2	0	1.1
<i>Cloeon africanum</i>	0	0	0	0.2	0	0	0
<i>Baetis glaucus</i>	3.5	4.5	2.5	19.5	1.1	4.1	0.7
<i>Baetis</i> (<i>Acentrella</i>) sp.	0	0	0	0	0	P	0
<i>Afrobaetodes berneri</i>	0	0	0.8	0.7	0	0	0
Other baetid sp. A	0.9	3.9	2.5	10.7	6.9	0.2	0.8
" " " E	0	0	0	0	0	0	0.1
" " " H	0	0	0	0	0	0.2	0
" " " J	0	0	0	0	0	0.2	0.1
Other baetid spp.	1.5	0.1	0	1.1	0.2	0	0.1
<i>Choroterpes</i> sp.	6.7	5.7	13.8	4.3	6.4	2.4	8.3
<i>Adenophlebiodes</i> sp.	0.1	0	0	0	0	0	0
<i>Tricorythus</i> "lowveld"	7.3	4.8	2.1	2.3	0.2	2.8	4.9
<i>Austrocaenis</i> sp.	1.1	1.1	4.2	1.3	0.1	0.2	9.5
<i>Afronurus</i> sp.	1.3	1.2	2.1	2.6	1.8	1.7	1.2
<i>Dicercomyzon</i> sp.	0.1	0	0	0.8	0.3	0	0
<i>Prosopistoma</i> sp.	0.9	0.7	0.6	0.8	0.1	0.2	0.1
Zygopterans	0	0.5	0	0	0	0	0
<i>Zygonyx</i> sp.1	1.0	0.4	0	0	0	0.2	0.3
<i>Libellulid</i> sp.1	0	0	0.3	0.2	0.1	P	0
Anisopterans	0	0	0	0.4	0	0	0.1
<i>Micronecta</i> sp.	0.9	0	0	0	0	0	0
Other hemipterans	0	0	0	0.2	0	0	0
<i>Aethaloptera</i> sp.	0.5	0	0	0	0	0	0
<i>Cheumatopsyche thomasseti</i>	5.1	9.7	21.6	1.9	0.6	1.1	7.9
<i>Cheumatopsyche afra</i>	0	0	0	0	0	0.6	0
<i>Ecnomus</i> sp.	0.3	0	0	0	0	0	0
<i>Psychomyiellodes</i> sp.	0	0	0.5	0	0	0	0
<i>Chimarra</i> sp.	7.8	4.5	0.8	0	0.1	P	0
Diplectroninae	3.2	0	0	0	0	0	0
<i>Leptocerus ?schoenobates</i>	0	0	0	0	0.1	0	0
<i>Athripsodes</i> sp.	0	0	0	0.2	0	0	0

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

TAXON	APRIL 85	JUNE 85	SEPT 85	APRIL 86	JUNE 86	AUG 86	OCT 86
<i>Trichosetodes</i> sp.	0	0	2.1	0	0.3	P	1.2
Leptoceridae	0	0.1	0	0	1.4	P	0.3
<i>Oecetis</i> sp.	0.8	0.7	0	0	0	0	0
Psychomyidae pupae	0.3	0	0	0	0	0	0
<i>Dyschimus</i> sp.	0	0	0	0.2	0	0	0
<i>Hydroptila capensis</i>	0	0.1	0.5	0	0	0.2	1.0
<i>Orthotrichia barnardi</i>	0	0.2	0.5	0	0	0	0.3
<i>Hydroptila</i> sp.1	0	0	0.5	0	0.1	P	0
<i>Catoxyethira</i> 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
<i>Stenelmis</i> 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
<i>Simulium</i> 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
<i>Corynoneura</i> sp.	1.7	1.0	0	0.8	2.9	0.2	0
<i>Theinmanniella</i> sp.	0	0	1.2	0	0	0	0
Orthocladinae	11.9	15.7	3.6	21.0	30.2	13.4	4.1
<i>Cricotopus</i> sp.	0.1	0.1	0.6	1.1	2.2	1.7	0.6
<i>Pentaneura</i> 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
<i>Dasyhelea</i> -type larvae	0.1	0	0	0.2	0	0	21.3
<i>Bezzia</i> -type larvae	0	0	0	0	0.1	0.1	1.0
<i>Forcipomyia</i> 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	0.6
<i>Corbicula africana</i>	0	0	0	0	0	0	1.2
Other Pelecypoda	0	0	0.3	0	0	0	0
<i>Chiloglanis</i> 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.

	APRL 85
TAXON	
<i>Nais</i> sp.	0.3
Other naids	P
Cladocerans	61.5
Cyclopoid copepods	2.9
<i>Stenocypris</i> sp.	0.1
<i>Elassoneuria</i> sp.	0.2
<i>Centroptilum excisum</i>	0.2
<i>Centroptilum medium</i>	0.6
Other baetid sp. B	1.0
" " " D	0.1
<i>Choroterpes</i> sp.	6.6
<i>Tricorythus</i> "lowveld"	11.4
<i>Austrocaenis</i> sp.	1.6
<i>Zygonyx</i> sp.1	P
Gerridae	P
<i>Amphipsyche scottae</i>	8.8
<i>Aethaloptera</i> sp.	0.3
<i>Cheumatopsyche thomasseti</i>	0.6
<i>Ecnomus</i> sp.	0.6
Chironomini	0.2
Tanytarsini	0.1
Orthocladinae	P
<i>Pentaneura</i> 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	APRIL 85	JUNE 85	APRIL 86	JUNE 86
<i>Hydra</i> sp.	0	19.0	0	1.7
Nematoda	0	0	0.5	1.0
<i>Pristina</i> sp.	0	0.3	0	0.1
Branchiobdellidae	0	0	0	0.5
Other oligochaetes	0	0	3.2	0
<i>Barbronia</i> sp.	0	0	0	0.1
<i>Ceriodaphnia/Simocephalus</i> sp.	0	0	69.5	0
<i>Daphnia</i> sp.	0	0	1.0	0
Chydorids	0	P	0	0
Cyclopoid copepods	1.8	0.3	0.1	0
Other copepods	0	0	19.9	0
<i>Stenocypris</i> sp.	0	0	0.5	0.1
<i>Povilla adusta</i>	0	0	0	0.1
<i>Centroptilum flavum</i>	0	0.1	0	0.2
<i>Centroptilum medium</i>	3.1	0.7	0	1.8
<i>Cloeon africanum</i>	0	0	0.6	0
<i>Baetis glaucus</i>	12.1	3.9	0	4.4
<i>Baetis (Acentrella)</i> sp.	0	0.1	0	0
Other baetid spp.	0	0.7	0	0
<i>Choroterpes</i> sp.	3.8	0.4	0	1.3
<i>Tricorythus</i> "lowveld"	27.4	4.8	0	4.5
<i>Austrocaenis</i> sp.	0	3.1	0.1	1.3
<i>Zygonyx</i> sp.1	P	0	0	0
Anisopterans	0	P	0	0
<i>Micronecta</i> sp.	0	0.2	0	0.4
Other hemipterans	0	0	0.1	0.1
<i>Aethaloptera</i> sp.	0.1	0	0	0
<i>Amphipsyche scottae</i>	4.1	2.1	0.2	15.2
<i>Cheumatopsyche thomasseti</i>	23.2	16.1	0.2	8.6
<i>Ecnomus</i> sp.	0	0.5	0	0.3
<i>Chimarra</i> sp.	0.1	0	0	0
<i>Orthotrichia barnardi</i>	0.4	0	0	0.9
Hydroptilid juveniles	0.2	0	1.2	0.5
<i>Stenelmis</i> sp.	0.2	0	0	0
<i>Simulium</i> 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
<i>Corynoneura</i> sp.	0	P	0	1.4
<i>Theinmanniella</i> sp.	0.1	0	0	0
Orthocladinae	2.2	2.4	0.1	3.0
<i>Cricotopus</i> sp.	P	P	0	0
<i>Pentaneura</i> 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
<i>Corbicula africana</i>	0	0	0	0.5

Table A6. Letaba River above confluence with Olifants River. Stones-in-current (cont.)

	APRL 85	JUNE 85	APRL 86	JUNE 86
TAXON				
<i>Chiloglanis</i> 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	APRIL 85	JUNE 85	SEPT 85	APRIL 86	JUNE 86	AUG 86	OCT 86
<i>Hydra</i> sp.	0	0	0.5	0	0	0	0
<i>Planaria</i>	0	0	0.9	0	0	P	0.1
Nematoda	0	0.1	0	0	0	P	0
<i>Pristina</i> sp.	0.4	1.1	0	0	0	0	
<i>Nais</i> sp.	0	0	1.2	0	0	0	0
<i>Dero</i> sp.	0	0.1	0	0	0	0	0
Other oligochaetes	0	0	1.6	0	0	0	0.1
<i>Ceriodaphnia/Simocephalus</i> sp.	0	0.1	4.4	0.1	0	0	0
Cyclopoid copepods	0	0	0	0	0	P	0
Other copepods	0	0	2.1	0	0	0	0
<i>Stenocypris</i> sp.	0	0	10.6	0	0	0	0
<i>Hydracarina</i> 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
<i>Neoperla spio</i>	P	0	0	0	0	0	0
<i>Elassoneuria</i> sp.	0	0	0	0	0.2	0	0
<i>Centroptilum excisum</i>	0.3	0	0	0	0	0	0
<i>Centroptilum</i> "near excisum"	0	0	0.5	0	0	0	0
<i>Centroptilum flavum</i>	0	0	0	0.3	0	0	0
<i>Centroptilum medium</i>	0.1	0.2	0.5	3.6	0.3	0	0
<i>Pseudocloeon maculosum</i>	0	0	0	0	0.5	0	0
<i>Baetis glaucus</i>	7.7	18.7	2.2	2.4	6.6	P	4.9
Other baetid sp. E	0	0.2	0.5	0	0	0	0
Other baetid spp.	0	0.2	2.2	0	0	0	0
<i>Choroterpes</i> sp.	4.0	4.4	0.8	0.4	0.6	0	0
<i>Castanophlebia</i> sp.	0	0	0	0.5	0	0	0
<i>Tricorythus</i> "lowveld"	20.0	28.0	0.1	67.2	12.1	0.2	0.4
<i>Austrocaenis</i> sp.	0.1	0.1	31.7	0.9	0.2	0	1.0
<i>Afronurus</i> sp.	0.3	0.2	0	0	0.5	0	0
Zygopterans	0	0	0.1	0	0	0	0
<i>Zygonyx</i> 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
<i>Aethaloptera</i> sp.	15.4	0.2	0	0.2	0.3	0	0
<i>Amphipsyche scottae</i>	3.3	0	0.1	2.8	0.8	P	1.9
<i>Cheumatopsyche thomasseti</i>	7.9	14.9	8.4	7.2	6.7	0.1	28.9
<i>Ecnomus</i> sp.	0	0	0	0	0	0	0.3
<i>Oecetis</i> sp.	0	0.1	0	0	0	0	0
<i>Hydroptila capensis</i>	0	0	0.2	0	0	0.1	0
<i>Orthotrichia barnardi</i>	0	0.2	0.3	0.2	0.1	0	0.5
<i>Catoxyethira</i> 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

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
Gyrinidae	P	0.2	0.1	0.1	0.1	0.1	0.1
Hydrophilidae	0	0	0.1	0	0	0	0
<i>Stenelmis</i> 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
<i>Simulium</i> 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
<i>Corynoneura</i> 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
<i>Cricotopus</i> sp.	0	0	0	0.1	0.1	0.1	3.4
<i>Pentaneura</i> sp.	0.4	0.2	0.2	0.1	0.2	0.1	1.1
<i>Dasyhelea</i> -type larvae	P	0	0.4	0	0	0	0
<i>Bezzia</i> -type larvae	0	0	0.4	0	0	0	0
<i>Forcipomyia</i> 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
<i>Lymnophora</i> sp.	0	0	0.3	0	0	0	0.1
<i>Bulinus</i> sp.	0	0	0.1	0	0	0	0
<i>Burnupia</i> sp.	0	0	0.1	0	0	0	0
<i>Lymnaea</i> sp.	0	0	0.1	0	0	0	0
<i>Melanoides</i> sp.	0.1	0	0	0	0	0	0
<i>Corbicula africana</i>	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	APRIL 85	JUNE 85	SEPT 85	APRIL 86	JUNE 86	AUG 86	OCT 86
<i>Hydra</i> sp.	0	0	0.7	0	0	0	0
Nematoda	0	0	P	0	0	0	0
<i>Pristina</i> sp.	1.0	4.3	0.2	0	0	0	0
<i>Nais</i> 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
<i>Barbronia</i> sp.	0	0	0	0.1	0.2	0	0.2
<i>Macrothrix</i> 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
<i>Elassoneuria</i> sp.	5.9	0	0	0.1	0	0	0
<i>Centroptilum excisum</i>	0	0	0.1	0.1	0	0	0
<i>Centroptilum flavum</i>	1.7	0	0	0.2	0	0	0.3
<i>Centroptilum medium</i>	1.3	0.1	0	2.8	0	0	4.0
<i>Baetis glaucus</i>	14.7	2.5	0.7	0.9	2.7	2.5	4.0
Other baetid sp. E	0	0	0	0.4	0	0	0
Other baetid spp.	0.4	0.1	0	1.8	0	0	0
<i>Choroterpes</i> sp.	1.8	0.4	1.1	0.5	1.1	0.5	0.8
<i>Castanophlebia</i> sp.	0	1.0	0	0	0	0	0
<i>Tricorythus</i> "lowveld"	22.2	5.7	0	79.9	17.4	0.3	0.8
<i>Austrocaenis</i> sp.	3.5	0.3	0.1	1.9	0	0.1	0.2
<i>Afronurus</i> sp.	0	P	0.1	0	0	0	0
<i>Paragomphus</i> sp.	0	P	0	0	0	0	0
<i>Aeschna</i> sp.	0	P	0	0	0	0	0
Gerridae	0	P	0	0	0	0	0
<i>Micronecta</i> sp.	0	0	0	0	0.2	0	0
<i>Aethaloptera</i> sp.	0.2	0	0	0.1	1.2	0	0
<i>Amphipsyche scottae</i>	0.9	P	0.5	3.2	2.6	1.5	1.9
<i>Cheumatopsyche thomasseti</i>	31.5	18.6	21.1	2.6	9.5	34.5	23.8
Hydropsychid pupae	0	0	0.7	0	0	0	0
<i>Ecnomus</i> sp.	0	0	0.1	0	0	0.1	0
<i>Chimarra</i> sp.	0.1	0.2	0	0	0	0	0
<i>Leptocerus ?schoenobates</i>	0.3	0	0	0	0	0	0
<i>Trichosetodes</i> sp.	0.1	0	0.1	0	0	0	0
Leptoceridae	0	P	0	0	0	0	0
<i>Oecetis</i> sp.	0.8	0.4	0	P	0	0	0
<i>Hydroptila capensis</i>	0	0	3.1	0	0.8	3.0	0
<i>Orthotrichia barnardi</i>	0.1	0	0.4	P	0.1	0	0.1
<i>Catoxyethira</i> sp.	0	0	0	0	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
<i>Stenelmis</i> 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
<i>Simulium</i> spp.	12.0	42.5	0.2	0.3	51.2	3.3	1.0

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

	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86	OCT 86
TAXON							
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
<i>Corynoneura</i> sp.	0	0	0	0.2	0	0	0
Orthocladinae	3.5	1.9	2.3	0	3.5	11.6	3.7
<i>Cricotopus</i> sp.	0	0.4	0.4	0	0.1	0.6	2.7
<i>Pentaneura</i> sp.	2.8	1.3	0.7	0.2	0	0.1	0.1
<i>Dasyhelea</i> -type larvae	0.1	0.1	0	0	0	0	0
<i>Forcipomyia</i> sp.	0	0	0	P	0	0	0
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
<i>Eupera</i> sp.	0	0	3.1	0.1	2.2	0.4	0
<i>Corbicula africana</i>	0	0	0.1	0.9	0	3.1	2.7
<i>Chiloglanis</i> 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	APRIL 85	JUNE 85	APRIL 86	JUNE 86	AUG 86	OCT 86
	DON.	DON.	SHI.	MAN.	MAN.	MAN.
<i>Hydra</i> sp.	0	0	0	0	0	0.6
<i>Planaria</i>	0	0.1	0	0.5	0.1	0.6
<i>Nais</i> sp.	0	0.1	0	0	0	0
<i>Ceriodaphnia/Simocephalus</i> sp.	0	0	0	0	0.9	0
Decapod juveniles	0	0	0.1	0	0	0
<i>Hydracarina</i> sp.1	0	0	0.4	0	0	1.3
<i>Neoperla spio</i>	0	0.8	0.1	0	0	0.2
<i>Elassoneuria</i> sp.	0.3	0	0	0	0	0
<i>Centroptiloides ?spinulosa</i>	0.4	0	0	0	0	0
<i>Centroptilum excisum</i>	0	0.1	0	0	0	0
<i>Centroptilum flavum</i>	0	0.1	0	0	0	0.4
<i>Centroptilum medium</i>	2.5	0	25.2	1.7	0	0
<i>Pseudocloeon</i> sp.A Kimmins 1955	0.3	0.3	0.2	0	1.1	0.9
<i>Baetis glaucus</i>	8.1	6.9	1.7	16.0	6.3	2.3
<i>Baetis (Acentrella)</i> sp.	0	5.8	0.2	2.3	0	0.4
Other baetid sp. 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
<i>Choroterpes</i> sp.	7.8	3.5	2.8	2.0	1.6	4.0
<i>Tricorythus</i> "lowveld"	18.4	0.4	4.2	0.6	0	1.7
<i>Austrocaenis</i> sp.	0.2	6.6	4.6	4.5	6.8	15.3
<i>Afronurus</i> sp.	3.3	0.8	2.1	0.4	2.1	0.7
<i>Chlorocypha</i> sp.	0	0	0	0	0.1	0
Zygopterans	0	0	0.1	0	0	0
<i>Zygonyx</i> 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
<i>Amphipsyche scottae</i>	0.2	0.1	3.4	0.4	0.1	2.8
<i>Cheumatopsyche thomasseti</i>	19.6	13.3	7.7	11.7	3.1	14.1
<i>Cheumatopsyche afra</i>	0	0	0	0.1	0	0.1
<i>Ecnomus</i> sp.	0	0	0	0	0.4	0.3
<i>Chimarra</i> sp.	0	1.4	27.2	21.2	9.4	11.4
<i>Leptocerus ?inflatus</i>	0	0.9	1.2	0	0.2	0
<i>Trichosetodes</i> sp.	0.3	0.1	0.1	0.1	0.7	0
<i>?Barbarochthon</i> sp.	0	0	0	0.8	1.0	2.1
Leptoceridae	1.5	0	0	0.1	0	0.8
<i>Hydroptila capensis</i>	0	0.2	0.1	0.4	1.2	0
<i>Orthotricia barnardi</i>	0	0	0.1	0.1	0	0.6
<i>Catoxyethira</i> 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
<i>Stenelmis</i> sp.	0.9	4.5	0.5	0.4	0	1.5

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

TAXON	APRL 85	JUNE 85	APRL 86	JUNE 86	AUG 86	OCT 86
Other Elmidae	0	1.7	0.6	0.9	0	0.9
Tipulidae	0	0.1	0.1	0	0.2	0.5
<i>Simulium</i> 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
<i>Corynoneura</i> sp.	0	0	0.1	0	0	0
<i>Theinmanniella</i> sp.	0	0.1	0	0	0	0
Orthocladinae	10.1	10.9	3.1	16.6	17.6	4.0
<i>Cricotopus</i> sp.	0.2	2.7	0.8	0.1	0.6	0.1
<i>Pentaneura</i> sp.	1.4	0.5	1.0	0.3	1.4	0.7
Tanypod pupae	0	0	0	0	0.1	0
<i>Dasyhelea</i> -type larvae	0	0	0	0.1	0	0
<i>Bezzia</i> -type larvae	0	0	0	0	0	0.9
<i>Forcipomyia</i> 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
<i>Burnupia</i> sp.	0	0	0	0	0	0.3
<i>Eupera</i> sp.	0.3	0	1.1	0.9	1.2	14.3
<i>Corbicula africana</i>	0	0	2.1	0	1.1	0.2
Other Pelecypoda	0	16.7	0	0	0	0
<i>Anguilla</i> 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	APRIL 85	JUNE 85	SEPT 85	APRIL 86	JUNE 86	AUG 86	OCT 86
<i>Hydra</i> sp.	0	0	0.9	0.4	0	0	2.0
<i>Planaria</i>	0	0.6	2.1	0.2	0.9	3.8	1.4
<i>Prostoma</i> sp.	0	0	0	0	0	0	0.1
<i>Pristina</i> sp.	0	0	0.9	0.9	0	0	0
<i>Nais</i> 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
<i>Stenocypris</i> sp.	0	0	0	0.4	0	0	0
<i>Hydracarina</i> sp.1	0.5	0	2.6	P	3.1	2.7	0.1
sp.2	0	0	0	0.6	0	0	0
<i>Neoperla</i> spio	0.2	P	0	0	0.2	0.3	0.1
<i>Centroptiloides bifasciatum</i>	0	0.1	0	0	0	0	0
<i>Centroptiloides ?spinulosa</i>	5.6	1.0	0	0	0	0	0
<i>Centroptilum</i> "near excisum"	0	0	0	0.7	0	0	1.3
<i>Centroptilum flavum</i>	0	0.2	0	0	0	0	0
<i>Centroptilum medium</i>	0.6	0	20.8	14.5	7.9	0.3	8.0
<i>Pseudocloeon</i> sp.A Kimmins 1955	0.2	0.4	0	0.2	0	0.6	0.1
<i>Baetis glaucus</i>	16.3	4.8	0	3.6	46.6	16.6	2.5
<i>Baetis</i> (<i>Acentrella</i>) sp.	0	0.1	0	0	0.7	2.6	0
Other baetid sp. 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
<i>Choroterpes</i> sp.	4.3	5.6	15.6	6.2	6.1	7.8	4.4
<i>Tricorythus</i> "lowveld"	19.3	0.4	0.2	1.1	0	0	0
<i>Austrocaenis</i> sp.	0	0.2	0.2	10.0	3.2	6.1	3.6
<i>Afronurus</i> sp.	1.0	0.7	16.1	1.0	0.2	0.3	5.1
<i>Dicercomyzon</i> sp.	0	0	0	0	0	0	1.1
<i>Allocnemis</i> sp.	0	0	0	0	0	0	0.1
Zygopterans	0	0	0	0	0.1	0	0
<i>Zygonyx</i> 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
<i>Micronecta</i> 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
<i>Amphipsyche scottae</i>	0.3	0.1	0	0	0	0	0
<i>Cheumatopsyche thomasseti</i>	17.2	10.6	6.0	3.8	3.7	9.1	11.2
<i>Ecnomus</i> sp.	0	0	0	P	0.2	0.1	0.9
<i>Chimarra</i> sp.	3.0	7.3	5.3	6.1	2.9	11.5	7.1
<i>Leptocerus ?inflatus</i>	0	0	0	P	0	0	0
<i>Trichosetodes</i> sp.	0	0	3.3	0.1	0	0.3	0.4
? <i>Barbarochthon</i> sp.	0	0	0	0	0.2	0.1	0

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

TAXON	APRIL 85	JUNE 85	SEPT 85	APRIL 86	JUNE 86	AUG 86	OCT 86
Leptoceridae	0.1	0	0	0	0.1	0	0.1
<i>Hydroptila capensis</i>	0	0	0.5	1.0	0.2	0.8	0.1
<i>Orthotrichia barnardi</i>	0.1	0	0	0.8	0.2	0.2	1.7
<i>Catoxyethira</i> 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
<i>Stenelmis</i> sp.	0.9	2.3	0	0.7	1.5	0.7	0.4
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
<i>Simulium</i> 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
<i>Corynoneura</i> sp.	0	0	0	0.8	0.6	0.9	0.6
<i>Theinmanniella</i> sp.	0	0	0	0.9	0	0	0
Orthocladinae	4.3	23.3	3.2	2.8	5.6	18.5	8.1
<i>Cricotopus</i> sp.	0.1	2.1	0.2	1.3	0	0.5	1.6
<i>Pentaneura</i> sp.	1.0	0.5	0	1.1	1.0	0.3	4.4
<i>Dasyhelea</i> -type larvae	0	0	0	0.1	0	0	0
<i>Bezzia</i> -type larvae	0	0	0	0.5	0	0	0.4
<i>Forcipomyia</i> 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
<i>Lymnophora</i> 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
<i>Eupera</i> sp.	0.2	0	0.7	14.4	5.0	1.7	9.7
<i>Corbicula africana</i>	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	APRIL 85	JUNE 85	SEPT 85	APRIL 86	JUNE 86	AUG 86
<i>Hydra</i> sp.	0	0	0	2.2	0.2	0.1
<i>Planaria</i>	0	0.1	11.8	0	1.1	2.9
<i>Nais</i> sp.	0	1.3	0	0.1	0	0
<i>Dero</i> sp.	0	0.1	0	0	0	0
Branchiobdellidae	0	0	0	0.4	0	0
Other oligochaetes	0	0	0.2	0	P	0
<i>Batrachobdelloides tricarinatus</i>	0	0	0	0.1	0	0
Cyclopoid copepods	0	0	0	0.4	0	0
<i>Stenocypris</i> sp.	0	0	0	0.4	0.2	1.1
Decapod juveniles	0	0	0	1.0	0	0
<i>Hydracarina</i> sp.1	0	0	0	0	0.5	0.3
<i>Neoperla spio</i>	0.1	0.1	0.3	0.1	0	0.1
<i>Elassoneuria</i> sp.	1.8	0.1	0	0.2	0	0
<i>Centroptiloides bifasciatum</i>	0	0	0	0	0.5	0
<i>Centroptiloides ?spinulosa</i>	0	0.2	0	0	0	0
<i>Centroptilum</i> "near excisum"	0	0	0	0.2	0	0
<i>Centroptilum flavum</i>	1.0	0	0.4	0	0	0
<i>Centroptilum medium</i>	11.3	0.1	6.5	38.9	1.6	0
<i>Pseudocloeon</i> sp.A Kimmins 1955	0.2	0.1	0	0.4	2.6	2.2
<i>Baetis glaucus</i>	9.2	9.9	7.4	2.5	10.4	5.4
<i>Baetis (Acentrella)</i> sp.	0	0	0	0	0	0.3
Other baetid sp. 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
<i>Choroterpes</i> sp.	8.6	9.1	16.9	6.3	3.8	11.8
<i>Tricorythus</i> "lowveld"	29.7	6.4	0.2	3.5	13.9	0.1
<i>Austrocaenis</i> sp.	0	0	0.8	0.7	4.3	2.0
<i>Afronurus</i> sp.	0.4	1.0	1.6	2.8	0.1	0.1
<i>Pseudagrion</i> sp.	0	0	0	0.1	0	0
Zygopterans	0	0	0	0.1	0	0
<i>Zygonyx</i> 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
<i>Aethaloptera</i> sp.	0	0.1	0	0	0	0
<i>Amphipsyche scottae</i>	1.0	1.0	0	0.4	0	0
<i>Cheumatopsyche thomasseti</i>	27.7	17.4	16.6	11.6	15.8	4.7
<i>Ecnomus</i> sp.	0	0	0.3	0.2	0.1	0
<i>Chimarra</i> sp.	0.9	1.6	0	1.7	3.1	7.8
<i>Leptocerus ?inflatus</i>	0.1	0	0	0	P	0
<i>Trichosetodes</i> sp.	0	0	0	0	P	0
Leptoceridae	0	0	0.3	0.1	P	0.1
<i>Oecetis</i> sp.	0.2	0	0	0	P	0

Table All. Luvuvhu River at Pafuri Picnic Site. Stones-in-current.

TAXON	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86
<i>Hydroptila capensis</i>	0	0	0	0.2	P	0.2
<i>Orthotrichia barnardi</i>	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
<i>Stenelmis</i> 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
<i>Simulium</i> 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
<i>Corynoneura</i> sp.	0	0	0	0	1.1	0.7
<i>Theinmanniella</i> sp.	0	0.5	0.6	0	0	0
Orthocladinae	1.6	14.7	14.3	4.5	5.7	27.2
<i>Cricotopus</i> sp.	0.2	6.1	0	2.1	0.3	2.1
<i>Pentaneura</i> sp.	1.4	0.4	0.4	0.7	0.6	3.5
Tanypod pupae	0	0	0	0	0	0.1
<i>Dasyhelea</i> -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
<i>Biomphalaria</i> sp.	0	0	0	0	P	0
<i>Eupera</i> sp.	0	0	0	2.1	0.8	1.0
<i>Corbicula africana</i>	0	0	0	2.3	1.4	1.0
<i>Anguilla</i> sp.	0.1	0	0	0	0	0
<i>Chiloglanis</i> 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
<i>Pristina</i> sp.	0	0.7	0.5	0	0	0
<i>Nais</i> sp.	0	0.1	0.1	0.4	0	0.6
<i>Branchiura</i> sp.	0.1	0	0	0	0	0
Other oligochaetes	0	0	0.1	0.1	0.1	0
<i>Stenocypris</i> sp.	0	0	0	0.7	0.4	0
<i>Hydracarina</i> sp.1	0	0	0.5	0	0.6	0
<i>Elassoneuria</i> sp.	0.5	0	0	0	0	0
<i>Centroptiloides bifasciatum</i>	0	0	0	0	0	0.2
<i>Centroptiloides ?spinulosa</i>	0.2	0.2	0	0	0	0
<i>Centroptilum excisum</i>	0.5	0	0	0	0	0
<i>Centroptilum medium</i>	12.5	0.3	3.1	21.7	10.3	0.5
<i>Centroptilum varium</i>	0	0.2	0.2	0	0	0
<i>Pseudocloeon</i> sp.A Kimmins 1955	0.2	1.8	2.2	0	0.2	0.5
<i>Baetis glaucus</i>	24.2	43.3	19.6	1.6	16.9	7.5
<i>Baetis (Acentrella)</i> sp.	0	0	0	0	0	1.5
Other baetid sp. 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
<i>Choroterpes</i> sp.	9.0	9.5	3.4	4.8	2.4	3.9
<i>Tricorythus</i> "lowveld"	10.0	0.9	0	8.9	1.4	0
<i>Austrocaenis</i> sp.	0	0	0.5	5.1	2.8	0.7
<i>Afronurus</i> sp.	0.3	4.3	2.8	0.3	0.2	0.1
<i>Diceromyzon</i> sp.	0	0	0	0	0.5	0
<i>Pseudagrion</i> sp.	0	0	0	0.1	0	0
Zygopterans	0	0	0	0.2	0	0.1
<i>Zygonyx</i> sp.1	0.3	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
<i>Amphipsyche scottae</i>	0.1	0	0	0	0	0
<i>Cheumatopsyche thomasseti</i>	24.5	9.5	2.7	2.5	2.5	3.1
<i>Ecnomus</i> sp.	0	0	0.1	0	0.1	0
<i>Chimarra</i> sp.	1.3	0	1.3	16.3	0.4	0.2
<i>Trichosetodes</i> sp.	0	0	0	0	0.1	0
Leptoceridae	0	0	0	P	0	0
<i>Hydroptila capensis</i>	0	0	0	0.3	0.7	2.6
<i>Orthotrichia barnardi</i>	0.9	0.1	0.5	0.5	0	1.2
<i>Catoxyethira</i> sp.	0	0	0.1	0	0	0
Hydroptilid juveniles	0	0.6	0.5	3.5	1.5	1.0
Pyrilidae	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
<i>Stenelmis</i> sp.	0.2	0.7	0	0.1	0	0.2
Other Elmidae	0.1	0	0	0.1	0	0

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

	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86
TAXON						
Tipulidae	0	0	0	0	0.5	0.2
<i>Simulium</i> 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
<i>Corynoneura</i> sp.	0	0	0	1.2	0.9	0
<i>Theinmanniella</i> sp.	0.2	0	0	0	0.5	0
Orthocladinae	8.9	17.0	13.5	7.1	18.8	24.7
<i>Cricotopus</i> sp.	0	0	0.2	1.1	3.9	1.2
<i>Pentaneura</i> sp.	1.1	0.6	0	0.8	0.6	1.5
<i>Dasyhelea</i> -type larvae	0	0	0.1	0	0	0
<i>Bezzia</i> -type larvae	0	0	0	0.8	0.1	0.3
<i>Forcipomyia</i> 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
<i>Biomphalaria</i> sp.	0	0	0.1	P	0	0
Ancyliidae	0	0	0.1	0	0	0
<i>Eupera</i> sp.	0	0	0	0	0.1	0
<i>Chiloglanis</i> 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
*								
<i>Hydra</i> sp.	0	0.3	1.0	0	0	0	0	0
<i>Planaria</i>	0.5	0	0	0	0	0.2	0	0
<i>Nematoda</i>	0	P	0.2	0	17.5	1.3	1.9	2.3
<i>Pristina</i> sp.	1.5	1.9	2.0	5.6	22.1	0	0	0
<i>Nais</i> sp.	0	0	0	0	0	0.1	0	0
<i>Branchiura</i> sp.	0	0.1	0	0	0.1	0	2.80	0
<i>Branchiobdellidae</i>	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
<i>Barbronia</i> sp.	0	0	0	0	0	0	0	0.6
<i>Batrachobdelloides tricarinatus</i>	0	0	0.2	0	0	0	0	0
<i>Ceriodaphnia/Simocephalus</i>	0	0	4.4	0	0	0	0	2.0
<i>Chydorids</i>	0	0.3	0	0	0	0	0	0
Cyclopoid copepods	0	1.5	10.9	0	19.9	0	7.4	0.4
<i>Stenocypris</i> sp.	0	1.0	5.9	0	3.5	3.9	4.2	18.0
<i>Pionocypris</i> sp.	0	0	0	12.2	0	0	33.8	45.6
<i>Hydracarina</i> sp.1	0	0	0.2	0	0	0	0	0
sp.2	0	0	2.2	0	0	0	0	0
<i>Collembola</i>	0	0	3.5	0	0	0	0	0
<i>Neoperla spio</i>	2.0	0	0	0	0	0	0	0
<i>Centroptilum excisum</i>	0	0.3	0	0	0	0	0	0
<i>Centroptilum</i> "near excisum"	0	1.6	3.8	0	0	0.3	0.9	0.2
<i>Centroptilum flavum</i>	0	0.1	0	0	0	0.3	0	0
<i>Centroptilum medium</i>	0	0.1	0.8	0	0	1.6	0.9	0
<i>Cloeon africanum</i>	0	1.9	3.0	0	3.8	0.6	2.5	0.7
Other baetid sp. 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
<i>Choroterpes</i> sp.	15.3	1.8	0.2	0	0	3.1	0	0
<i>Castanophlebia</i> sp.	0	P	0	0	0	0	0	0
<i>Tricorythus</i> "lowveld"	3.5	0	0	0	0	0.2	0	0.1
<i>Austrocaenis</i> sp.	3.0	11.0	1.2	0	5.7	7.9	3.2	4.4
<i>Afronurus</i> sp.	3.5	0	0	0	0	2.8	0	0
<i>Zygopterans</i>	0	0	0	0	0	0.1	0	0
<i>Phyllomacromia</i> sp.	0	P	0	0	0	0	0	0
<i>Libellulid</i> sp.1	0	P	0	0	0	0.2	0	0
<i>Anisopterans</i>	0	0.3	0	0	1.3	0	2.3	0.4
<i>Notonectidae</i>	0	0	0	0	0.1	0	0	0.1
<i>Naucoridae</i>	0	0	0	0	0	0.1	0.5	0
<i>Micronecta</i> 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
<i>Cheumatopsyche thomasseti</i>	2.5	0	0	0	0	0.2	0	0
<i>Ecnomus</i> sp.	0	0.1	0	0	0.1	0.3	0	0
<i>Chimarra</i> sp.	0	0	0	0	0	0.1	0	0
<i>Leptocerus ?inflatus</i>	0	0.3	0	0	0	0	0	0
<i>Leptocerus ?schoenobates</i>	0	0.1	0	0	0	0	0	0.1
<i>Trichosetodes</i> sp.	0	0.4	0	0	0	1.1	0	0

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

TAXON	APRIL 85	JUNE 85	SEPT 85	NOV 85	APRIL 86	JUNE 86	AUG 86	OCT 86
Leptoceridae	1.5	0	0	0	0	0	0	0.1
<i>Oecetis</i> sp.	0	0	0.2	0	0	0	0	0
<i>Hydroptila capensis</i>	0	0.2	0	0	0	0	0.5	0
<i>Orthotrichia barnardi</i>	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
<i>Methles</i> sp.	0	0	0	5.6	0	0	0	0
<i>Lanistes</i> sp.	0	0	0	1.1	0	0	0	0
Dytiscidae	0	0	1.7	5.6	0	0	0	0.9
Hydrophilidae	0	0	8.8	0	0	0	0	0
Hydroboriinae	0	0	0	5.5	0	0	0	0
<i>Stenelmis</i> 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
<i>Simulium</i> 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
<i>Corynoneura</i> sp.	0.5	P	0	0	0	0.1	0	0
<i>Theinmanniella</i> 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
<i>Cricotopus</i> sp.	0	3.9	0	0	1.2	4.3	2.3	0
<i>Pentaneura</i> 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
<i>Dasyhelea</i> -type larvae	5.4	P	6.2	0	0	0.8	5.1	3.4
<i>Bezzia</i> -type larvae	0	0.1	0	0	1.3	0.1	0.5	0.7
<i>Forcipomyia</i> sp.	0.5	0.1	3.7	0	0	0.3	0.5	0
Ceratopogonid 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
<i>Biomphalaria</i> sp.	0	0	0	0	0.1	0	0	0
<i>Bulinus</i> sp.	0	0	0	0	2.2	0	0	0
<i>Melanoides</i> sp.	0	0	0	0	0.1	0	0.5	0
<i>Physopsis</i> sp.	0	0	0	0	0.1	0	0	0
Other Gastropoda	0	0	0	0	2.3	0	0	0
<i>Eupera</i> sp.	0	0	0	0	0	2.0	0	0.4
<i>Corbicula africana</i>	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	APRIL	JUNE
	85	86
Planaria	2.3	0.6
<i>Prostoma</i> sp.	0.3	0
<i>Pristina</i> sp.	1.2	0
Tubificidae	0.1	0
Branchiobdellidae	0	2.3
Other oligochaetes	4.1	0.3
Copepods	0.6	0
<i>Stenocypris</i> sp.	6.1	1.1
<i>Pionocypris</i> sp.	0	1.1
Hydracarina sp.1	0	1.1
<i>Centroptilum medium</i>	0	11.5
<i>Baetis glaucus</i>	0	15.6
<i>Baetis quintus</i>	6.0	0
<i>Choroterpes</i> sp.	0	5.1
<i>Tricorythus</i> "lowveld"	0	1.7
<i>Austrocaenis</i> sp.	7.3	2.6
<i>Afronurus</i> sp.	0	0.6
<i>Paragomphus</i> sp.	0.7	0
Anisopterans	0.3	0.6
Naucoridae	0.1	0
Corixidae	0.1	0
<i>Micronecta</i> sp.	1.0	0
<i>Cheumatopsyche thomasseti</i>	0	3.4
<i>Ecnomus</i> sp.	0	3.4
Dytiscidae	0.6	0
Gyrinidae	0	0.6
Hydrophilidae	0.1	0
<i>Stenelmis</i> sp.	0.6	0
Tipulidae	0	0.9
<i>Simulium</i> spp.	0	3.4
Chironomini	9.8	2.3
Tanytarsini	0.6	17.7
Orthocladinae	0.7	4.2
<i>Cricotopus</i> sp.	0	2.3
<i>Pentaneura</i> sp.	5.8	4.3
Muscidae	1.5	0
<i>Eupera</i> 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	APRIL 85	JUNE 85	SEPT 85	NOV 85	JAN 86	APRIL 86	JUNE 86	OCT 86
<i>Hydra</i> sp.	0	0.6	1.9	0	0	0	0	0
<i>Planaria</i>	0	0.5	0.1	0	0	0	0.4	0.2
<i>Nematoda</i>	1.8	0	0	0	1.5	0	0	0
<i>Pristina</i> sp.	2.7	5.2	0	0	4.4	3.9	1.0	0.2
<i>Nais</i> sp.	0	0.8	0.3	0	0	0	2.0	1.9
<i>Branchiura</i> sp.	0	0	1.9	0	0	1.8	0	0
<i>Dero</i> sp.	0	0.2	0.6	0	0	0	0	0
<i>Branchiobdellidae</i>	0	0	4.7	0	0	0	0	0
Other oligochaetes	0	0	1.0	1.8	0.4	5.9	0	1.4
<i>Helobdella conifera</i>	0	0	0	0	0.4	1.4	0.1	0
<i>Ceriodaphnia/Simocephalus</i> sp.	0	0	0	4.4	0	0	0.1	0.7
<i>Chydorids</i>	0	0	0	0	0	0	0.8	0
Cyclopoid copepods	0	0	33.1	24.0	0	10.7	3.8	0.7
<i>Pionocypris</i> sp.	0	0	0	4.4	1.5	0	0	6.0
<i>Stenocypris</i> sp.	0.4	3.8	3.8	0	0	21.4	11.0	1.4
<i>Caridina</i> sp.	0	0.2	0	0	0.7	0	0.3	0
Decapod juveniles	0	0	0	0	0	0	0	0.5
<i>Hydracarina</i> sp.1	0	0	0.1	0	0	0.1	0	2.8
<i>Neoperla spio</i>	1.8	0	0.2	0	0.7	0	0	0
<i>Centroptilum "near excisum"</i>	0	0	0	2.3	0	0	0	0
<i>Centroptilum medium</i>	19.5	0	0.2	0	25.8	0	5.0	2.3
<i>Cloeon africanum</i>	0	6.6	3.6	13.5	2.1	4.4	20.9	0.6
<i>Baetis bellus</i>	0	0	0	4.6	0	0	0	0
Other baetid sp. 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
<i>Choroterpes</i> sp.	12.0	0.9	2.1	0	6.9	1.8	4.1	3.0
<i>Adenophlebiodes</i> sp.	0	0	0	0	0.7	3.0	0.2	0
<i>Castanophlebia</i> sp.	0	5.2	0	0	0	0.1	0	0
<i>Tricorythus "lowveld"</i>	0	0	0	0	6.6	0	0	0
<i>Austrocaenis</i> sp.	21.7	14.9	3.7	0	20.4	17.3	16.9	1.4
<i>Afronurus</i> sp.	1.3	0	0	0	1.1	0.1	4.7	0.7
<i>Elattoneura</i> sp.	0	0	0	0	0	0	0	0.4
<i>Allocnemis</i> sp.	0	0	0.1	0	0	0	0	0
<i>Enallagma</i> sp. or <i>Ischnura</i> sp.	0	0.2	0	0	0	0	0	0
Zygopterans	0	0	0	0	0	0.2	0	0
<i>Paragomphus</i> sp.	0	0	0	0	0	0.1	0	0
<i>Aeschna</i> sp.	0	0.4	0	0	0	0	0	0
<i>Zygonyx</i> sp.1	2.2	0.1	0	0.9	0	0	0	0
<i>Libellulid</i> 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
<i>Micronecta</i> sp.	0	1.8	0	16.9	0.4	1.3	0.7	23.4

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

TAXON	APRIL 85	JUNE 85	SEPT 85	NOV 85	JAN 86	APRIL 86	JUNE 86	OCT 86
Other hemipterans	0	0	0	2.6	0	0	0	1.2
<i>Cheumatopsyche thomasseti</i>	0	0	0	0	1.8	0	0	0.2
<i>Ecnomus</i> sp.	0	0	0	0	0	0	0	1.6
<i>Chimarra</i> sp.	0	0	0	0	2.9	0	0	0
<i>Athripsodes</i> sp.	0	1.3	0	0	0	0	0	0
<i>Trichosetodes</i> 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
<i>Oecetis</i> sp.	0	0	0	0	0	0.1	0	0
<i>Hydroptila capensis</i>	0	0	1.7	0	0	0	0	0
<i>Orthotrichia barnardi</i>	0	0	0.1	0	0	0	0.1	0
<i>Catoxyethira</i> 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
<i>Peschetius</i> 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
<i>Leptelmis</i> sp.	0	0	0	0	0.4	0	0	0
<i>Stenelmis</i> 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
<i>Simulium</i> 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
<i>Cricotopus</i> sp.	0	0	0	0	1.5	1.0	0.1	3.5
<i>Pentaneura</i> sp.	2.2	1.1	0.5	0	2.6	1.3	1.7	5.1
<i>Procladius</i> sp.	0	0.2	0.2	0	0	0.1	0	0
<i>Dasyhelea</i> -type larvae	0	0	0	0	0	0	1.6	0
<i>Bezzia</i> -type larvae	0	0.9	1.4	0	0.7	3.1	0.2	1.1
<i>Forcipomyia</i> 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
<i>Biomphalaria</i> sp.	0	0	0	0	0	0	0	0.4
<i>Bulinus</i> sp.	0	0	0.6	0	0	0	0	0
<i>Melanoides</i> sp.	0	0	0	0	0	0.1	0	0
<i>Physopsis</i> sp.	0	0	0	0	0	0.5	0	0
Ancylidae	0	0	2.3	0	0	0.2	0	0
<i>Eupera</i> sp.	0	0.5	0	0	0	0	0.8	10.2
<i>Corbicula africana</i>	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

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

	APRL 85	JUNE 85	SEPT 85	NOV 85	JAN 86	APRL 86	JUNE 86	OCT 86
TAXON								
<i>Xenopus</i> 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
<i>Hydra</i> sp.	0	0	2.6	0	0	0
<i>Planaria</i>	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
<i>Pristina</i> sp.	0	0.3	12.2	0	2.0	0
<i>Nais</i> sp.	0	0.4	0	0	0	0
<i>Branchiura</i> sp.	0	0	0.1	0	0	0
<i>Dero</i> 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
Other copepods	0	0.7	0	0	0	0
<i>Pionocypris</i> sp.	0	0	0	0	0.1	0
<i>Stenocypris</i> sp.	0	0.6	0	0	0	0
<i>Caridina</i> sp.	0	P	0	0	0	0
<i>Hydracarina</i> sp.1	1.2	0	0.9	1.3	1.4	0
<i>Neoperla spio</i>	0.3	0	0	0	0	0
<i>Machadorhythus</i> sp.	0	0.1	0.1	0.1	0.1	0
<i>Centroptilum excisum</i>	0	0	0.8	0	2.5	0
<i>Centroptilum</i> "near excisum"	0	12.7	28.5	13.3	10.7	0
<i>Centroptilum flavum</i>	0	0	0	0	1.0	0
<i>Centroptilum medium</i>	37.7	0	0	1.4	0.5	0
<i>Centroptilum varium</i>	1.0	0	0	0	1.0	0
<i>Cloeon africanum</i>	0	5.1	1.6	6.6	2.5	0
<i>Cloeon</i> sp.	0	0.3	0	0	0	0
<i>Baetis glaucus</i>	1.8	0	0	0	0	0
<i>Baetis quintus</i>	1.8	0	0	0	0	0
Other baetid sp. 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
<i>Choroerpes</i> sp.	9.6	3.3	4.6	2.2	3.0	0
<i>Adenophlebiodes</i> sp.	0.4	0	0	1.1	0	0
<i>Castanophlebia</i> sp.	0	0.1	0	0	0	0
<i>Tricorythus</i> "lowveld"	0	0	0	0	0.1	0
<i>Austrocaenis</i> sp.	5.2	13.5	9.6	23.9	16.5	0
<i>Afronurus</i> sp.	4.5	0.3	0	0	0.1	0
<i>Dicercomyzon</i> sp.	0.3	0	0	0.1	0.1	0
<i>Prosopistoma</i> sp.	0	0	0	0	0.7	0
<i>Metacnemis</i> sp.	0.3	0	0	0	0	0
<i>Allocnemis</i> sp.	0	0	0	0.1	0	0
<i>Chlorocypha</i> 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
<i>Zygonyx</i> 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

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

TAXON	APRIL 85	JUNE 85	SEPT 85	JUNE 86	AUG 86	OCT 86
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
<i>Micronecta</i> sp.	0	7.8	5.0	4.5	0.7	10.5
Other hemipterans	0	0	1.6	0	0	0
<i>Aethaloptera</i> sp.	0	P	0	0	0	0
<i>Leptocerus ?schoenobates</i>	0	0.1	0	0.2	0	0
<i>Athripsodes</i> sp.	0	0	0.2	0.1	0	0
<i>Trichosetodes</i> sp.	0	0.6	0.6	0.5	0.1	1.2
<i>?Barbarochthon</i> sp.	0	0	0	0.1	0	0
Leptoceridae	2.1	0.1	0.1	0	0	0
<i>Dyschimus</i> sp.	0	0	0	0.1	0	0
<i>Hydroptila capensis</i>	0.9	0.1	0.3	0	0.1	0
<i>Orthotrichia barnardi</i>	0.3	0	0.1	0	0	0
<i>Catoxyethira</i> sp.	0	0	0	0	0.2	0
<i>Hydroptila</i> 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
<i>Stenelmis</i> 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
<i>Simulium</i> 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
<i>Corynoneura</i> sp.	0.6	0	0	0	0.7	0
<i>Theinmanniella</i> sp.	0	0	0.8	0	0	0
Orthocladinae	15.4	3.6	1.3	5.6	10.6	0
<i>Cricotopus</i> sp.	0	0.2	0	0	6.3	0
<i>Pentaneura</i> sp.	2.7	1.8	3.0	1.4	1.9	0
<i>Procladius</i> sp.	0	0.1	0.1	0.1	0	0
Tanypod pupae	0	0.1	0	0	0	0
<i>Dasyhelea</i> -type larvae	0.6	0	0	0	0	0
<i>Bezzia</i> -type larvae	0	0.4	2.0	0.4	0.1	3.5
<i>Forcipomyia</i> sp.	0.3	0	0.2	0.1	0.1	5.8
Ceratopogonid pupae	0	0	0	0	0.1	3.5
Tabanidae	0	0.1	0	0.1	0	0
Rhagionidae	0	0.1	0	0	0.1	0
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
<i>Eupera</i> sp.	0	0.3	0	0	0	0
<i>Corbicula africana</i>	0	0	0	0.9	0	0

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

	APRL	JUNE	SEPT	JUNE	AUG	OCT
	85	85	85	86	86	86
TAXON						
Other Pelecypoda	0.3	0	0	0	0	0
<i>Oreochromis mossambicus</i>	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 FAUNA FROM THE LETABA RIVER AT MAHLANGENE.

	APRL 85
TAXON	
<i>Hydra</i> sp.	52.9
Nematoda	0.6
<i>Branchiura</i> sp.	0.7
Other oligochaetes	2.2
<i>Diaphanosoma</i> sp.	6.4
Cyclopoid copepods	1.3
Other copepods	0.6
<i>Stenocypris</i> sp.	2.2
<i>Centroptilum flavum</i>	0.6
<i>Centroptilum medium</i>	1.2
Other baetid sp. A	0.1
" " " D	1.5
Other baetid spp.	0.6
<i>Choroterpes</i> sp.	8.2
<i>Austrocaenis</i> sp.	13.7
<i>Pseudagrion</i> sp.	0.2
Anisopterans	0.2
<i>Ecnomus</i> sp.	0.7
<i>Stenelmis</i> sp.	0.6
Chironomini	0.2
Orthocladinae	0.6
<i>Pentaneura</i> sp.	4.3
Other Pelecypoda	0.1
 TOTAL NO. OF INDIVIDUALS	 1251

TABLE B6. PERCENTAGE COMPOSITION OF THE STONES-OUT-OF-CURRENT FAUNA FROM THE LETABA RIVER ABOVE CONFLUENCE WITH THE OLIFANTS RIVER.

TAXON	APRIL 85	JUNE 85	APRIL 86	JUNE 86
<i>Hydra</i> sp.	0	0.1	0	0
Nematoda	0	0	1.4	3.4
<i>Pristina</i> sp.	0	0.2	0.6	0.6
<i>Nais</i> sp.	0	0	0	1.9
<i>Branchiura</i> sp.	0.1	0	0	0.1
Branchiobdellidae	0	4.0	0	0
Other oligochaetes	0.3	0.1	2.2	6.7
<i>Barbronia</i> sp.	0	0	0	0.8
<i>Ceriodaphnia/Simocephalus</i> sp.	0	0	3.1	3.9
Chydorids	0	43.1	20.1	0
Cyclopoid copepods	0	20.0	49.6	6.1
Other copepods	0	5.3	0.4	0
<i>Stenocypris</i> sp.	0	0	5.7	6.0
Hydracarina sp.1	0	0.4	0	0.1
Collembola	0	0	1.3	0
<i>Povilla adusta</i>	0	0.4	0	0.3
<i>Centroptilum excisum</i>	0.6	0	0	0
<i>Centroptilum</i> "near excisum"	2.5	2.1	0	0
<i>Centroptilum medium</i>	72.2	5.6	0	0
<i>Cloeon africanum</i>	0	0	1.9	24.3
<i>Choroterpes</i> sp.	15.7	3.8	0	0.2
<i>Tricorythus</i> "lowveld"	0.1	0	0	0
<i>Austrocaenis</i> sp.	2.5	4.2	0.6	3.0
Anisopterans	0	P	0	0
Naucoridae	0	0	0	0.1
<i>Micronecta</i> sp.	0.1	0.7	8.5	17.9
<i>Amphipsyche scottae</i>	0	0	0	0.6
<i>Cheumatopsyche thomasseti</i>	0.6	0	0	0
<i>Ecnomus</i> sp.	0.9	0.2	0	0.2
<i>Orthotrichia barnardi</i>	0	0.1	0.1	0.2
Dytiscidae	0	0	0.1	0.1
Hydrophilidae	0	0	0.1	0
Culicidae	0	0.3	0	0
<i>Simulium</i> spp.	0.1	0	0	0.1
Chironomini	0.1	2.4	2.5	7.7
Tanytarsini	0	0.4	0.3	4.3
<i>Corynoneura</i> sp.	0.6	1.3	0	1.7
Orthocladinae	0	1.9	0.1	0.2
<i>Cricotopus</i> sp.	0	0.1	0	0.7
<i>Pentaneura</i> sp.	1.5	1.2	0.3	0
<i>Procladius</i> sp.	0	0	0	1.5
Tanypod pupae	0.1	0	0	0
<i>Dasyhelea</i> -type larvae	0	0	1.3	1.2
<i>Bezzia</i> -type larvae	0.2	0	0	0
<i>Forcipomyia</i> sp.	0	0	0	0.1
Tabanidae	0.1	0	0	0.1

Table B6. Letaba River above confluence with Olifants River. Stones-out-of-current (cont.)

TAXON	APRL	JUNE	APRL	JUNE
	85	85	86	86
<i>Bulinus</i> sp.	0	0.2	0	4.2
<i>Septaria</i> sp.	0	0	0	0.1
<i>Eupera</i> sp.	0	0.4	0	0.7
<i>Corbicula africana</i>	0.1	0	0	5.3
<i>Oreochromis mossambicus</i>	0	0.1	0	0
TOTAL NO. OF INDIVIDUALS	1379	2514	1275	1442

TABLE B7. PERCENTAGE COMPOSITION OF THE STONES-OUT-OF-CURRENT FROM THE OLIFANTS RIVER AT MAMBA.

TAXON	APRIL 85	SEPT 85	APRIL 86	JUNE 86	AUG 86	OCT 86
<i>Hydra</i> sp.	0	1.7	0	0	0.1	0.9
Nematoda	0	0	0	0.2	0	0.1
<i>Pristina</i> sp.	1.2	2.8	0	0	0	0
<i>Branchiura</i> 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
<i>Batrachobdelloides tricarinatus</i>	0	0	0	0	0	1.0
<i>Ceriodaphnia/Simocephalus</i> 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
<i>Pionocypris</i> sp.	0	0	0	0.7	1.8	19.5
<i>Stenocypris</i> 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
<i>Centroptilum excisum</i>	5.7	1.7	0	3.0	0.7	1.4
<i>Centroptilum</i> "near excisum"	0	5.5	0	3.2	3.2	1.2
<i>Centroptilum flavum</i>	1.7	0	3.5	10.6	0	0
<i>Centroptilum medium</i>	21.0	0	52.5	22.9	0	0.7
<i>Cloeon africanum</i>	0	0	2.3	0	0.7	1.6
<i>Cloeon</i> sp.	0	1.7	0	0	0	0
<i>Baetis bellus</i>	0.2	0	0	0	0	0
Other baetid spp.	0	1.7	0	2.1	0	0
<i>Choroterpes</i> sp.	2.5	0	5.0	9.2	1.9	0
<i>Tricorythus</i> "lowveld"	0	0	0	1.3	0.1	0
<i>Austrocaenis</i> sp.	0.4	0	5.8	15.1	2.1	12.7
<i>Afronurus</i> sp.	0	0	0.4	0.8	0	0
<i>Pseudagrion mossiaicum</i>	0.1	0	0	0	0	0
<i>Pseudagrion</i> sp.	0	0	0	0	0	0.1
Zygopterans	0	0	0	0.2	0	0.1
<i>Zygonyx</i> 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
<i>Micronecta</i> sp.	0.1	0.6	0.4	0	5.3	6.8
Other hemipterans	0	6.8	0	0.2	0	0
<i>Aethaloptera</i> sp.	2.7	0	0	0	0	0
<i>Cheumatopsyche thomasseti</i>	0	0	0	0.7	0	0.1
<i>Ecnomus</i> sp.	0	0	0	0.5	0	0.1
<i>Leptocerus ?schoenobates</i>	0	0	0	0	0.1	0
<i>Athripsodes</i> sp.	0	0	0.4	0	0	0
<i>Trichosetodes</i> sp.	0	0	0	0.5	0.2	0.1
Leptoceridae	0	0	0	0	0	0.2
<i>Orthotrichia barnardi</i>	0	0	0.4	0	0.1	0.2
<i>Hydroptila</i> sp.	0	0	0	0	0.1	0

Table B7. Olifants River at Mamba. Stones-out-of-current (cont.)

TAXON	APRL 85	JUNE 85	APRL 86	JUNE 86	AUG 86	OCT 86
Hydroptilid juveniles	0	0	1.5	0	0	0
Haliplidae	0.1	0	0	0	0	0
<i>Peschetius</i> 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
Dryopidae	0	0.3	0	0	0	0
<i>Stenelmis</i> 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
<i>Simulium</i> 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
<i>Corynoneura</i> 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
<i>Cricotopus</i> sp.	2.0	0	0	3.3	0	0.2
<i>Pentaneura</i> sp.	1.5	0.3	3.5	1.8	0.3	0.3
Tanypod pupae	0.1	0	1.5	0	0	0
<i>Dasyhelea</i> -type larvae	2.9	1.4	1.5	0.3	13.3	0.5
<i>Forcipomyia</i> sp.	0	0	0	0	8.2	0.1
Ceratopogonid 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
<i>Lymnophora</i> sp.	0	0	0	0	0	0.1
Higher dipterans	0	0.3	0	0	0	0
<i>Biomphalaria</i> sp.	0	0	0	0	0	0.1
<i>Corbicula africana</i>	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
<i>Xenopus</i> sp.	0	0.3	0	0	0	0
TOTAL NO. OF INDIVIDUALS	691	351	259	598	888	871

TABLE B8. PERCENTAGE COMPOSITION OF THE STONES-OUT-OF-CURRENT FROM THE OLIFANTS RIVER ABOVE CONFLUENCE WITH THE LETABA RIVER.

TAXON	APRIL 85	JUNE 85	SEPT 85	APRIL 86	JUNE 86	AUG 86	OCT 86
<i>Hydra</i> sp.	0	0.4	1.8	0	0	0	0
<i>Planaria</i>	0	0	0	0	0	0	0.1
Nematoda	1.8	0.3	0.4	22.7	0	0.5	0
<i>Pristina</i> sp.	10.8	7.1	6.5	0	P	1.2	3.2
<i>Nais</i> sp.	0	0	0.3	0	0	0.1	0
<i>Branchiura</i> sp.	0	0.1	P	0.4	P	0	0
<i>Dero</i> sp.	0	0.1	0	0	0	0	0
Branchiobdellidae	0	6.0	2.7	0	2.6	0	2.1
Other oligochaetes	0.4	0	6.1	56.3	1.4	3.7	6.7
<i>Barbronia</i> sp.	0	0	0	0	0.2	0	0
<i>Batrachobdelloides tricarinatus</i>	0	0	P	0.9	0	0.2	3.7
<i>Macrothrix</i> sp.	0	0.7	0	0	0	0	0
Chydorids	0	1.4	0	0	0	0	0
Other cladocerans	0	0	2.0	1.7	0	0	0
Cyclopoid copepods	0.6	0	0.6	0	0	3.5	1.1
Other copepods	0	0.3	0	0	0	0	0
<i>Pionocypris</i> sp.	0	0	0	0	0	0.5	12.9
<i>Stenocypris</i> sp.	0.1	P	9.9	0	1.4	4.2	3.3
<i>Hydracarina</i> sp.1	0	P	0	0	0	0	0
sp.2	0	0	0	0.4	0	0	0
Collembola	0	0	0	0.4	0	0	0
<i>Centroptilum excisum</i>	3.2	1.6	0.1	0	0	0.8	0
<i>Centroptilum</i> "near excisum"	0	1.6	1.0	0	3.7	2.7	0
<i>Centroptilum flavum</i>	0	2.9	0	0	1.2	0.2	0
<i>Centroptilum medium</i>	9.1	18.5	0.3	0	2.9	0	0
<i>Cloeon africanum</i>	0	2.9	3.0	0	0	7.2	2.6
Other baetid sp. E	0.2	0	0	0	0	0	0
" " " G	0	0	0	0	P	0	0
" " " H	0	0	0	0	0.9	0	0
Other baetid spp.	1.8	2.6	0	1.7	P	0	0
<i>Choroterpes</i> sp.	9.9	3.0	2.0	0	1.8	1.8	0
<i>Tricorythus</i> "lowveld"	0.1	0	0	0	0.2	0	0
<i>Austrocaenis</i> sp.	24.4	5.4	3.3	0.4	8.1	5.4	4.4
<i>Afronurus</i> sp.	0	0.3	P	0	0	0	0
<i>Dicercomyzon</i> sp.	0	0	0	0	P	0	0
<i>Elatoneura</i> sp.	0	0.6	0	0	0	0	0
<i>Pseudagrion</i> sp.	0	P	0	0	0	0	0
Zygopterans	0.3	0.3	0	0	0	0	0
<i>Paragomphus</i> sp.	0	0	0	0	0.1	0	0
Gomphidae	0	P	0	0	0	0	0
<i>Zygonyx</i> sp.1	0.1	0	0	0	0	0	0.3
Anisopterans	0	P	0	0	0	0.1	0.1
Gerridae	0.1	0	0	0	0	0	0
Naucoridae	0	0.1	P	0	0.1	0	0.3
<i>Micronecta</i> sp.	0	P	0.5	0	0.3	0.7	3.3
Other hemipterans	0	0	0	0	0.1	0	0
<i>Amphipsyche scottae</i>	0	0	0.2	0	0.1	0	0
<i>Cheumatopsyche thomasseti</i>	0	1.2	0	0.4	0.7	0.1	0
<i>Ecnomus</i> sp.	0	P	0.1	0	0	0.4	0.4
<i>Leptocerus ?inflatus</i>	0	0.1	0	0	0	0	0

Table B8. Olifants River above confluence with the Letaba River. Stones-out-of- current (cont.)

TAXON	APRIL 85	JUNE 85	SEPT 85	APRIL 86	JUNE 86	AUG 86	OCT 86
<i>Trichosetodes</i> sp.	0	0.7	0.2	0	0.1	0.2	0.2
Leptoceridae	0.2	0	0	0	0	0.1	0
<i>Oecetis</i> sp.	1.7	0.3	0	0	P	0	0
<i>Hydroptila capensis</i>	0	0.1	0.3	0	0	0	0
<i>Orthotrichia barnardi</i>	0	0.1	0.4	0	0.3	0	0.7
<i>Catoxyethira</i> sp.	0	0	0	0	0	0.1	0
<i>Hydroptila</i> sp.	0	0	0	0	0	0.1	0
Hydroptilid juveniles	0	1.8	0.6	0	0	0.1	0
Dytiscidae	0	0	0	2.6	0.1	0.1	0.1
Hydrophilidae	0	0	0	0.4	0	0	0.3
Hydraenidae	0	0	0	0	0	0.1	0
Dryopidae	0	0	0	0	0	0.2	0
<i>Stenelmis</i> sp.	0.3	0.7	1.9	0.4	P	1.3	0
Other Elmidae	0	0	0.1	0	0	0	0.1
<i>Simulium</i> spp.	0	0.9	0	0	P	0.1	0
Chironomini	8.3	13.4	20.8	0	4.6	20.2	3.9
Tanytarsini	11.6	3.3	7.7	0	0.2	9.5	32.4
<i>Corynoneura</i> sp.	0.3	1.1	0	0	0.4	1.0	0
<i>Theinmanniella</i> sp.	0	0.7	0	0	0	0	0
Orthocladinae	7.8	2.9	1.2	0	0.5	4.7	0
<i>Cricotopus</i> sp.	0	4.4	0	0	0.5	0	0
<i>Pentaneura</i> sp.	3.8	3.6	2.0	0	0.9	0.4	0
<i>Procladius</i> sp.	0	0	0	0	0.1	0	0
Tanypod pupae	0.1	6.3	0	0	0.2	0.1	0
<i>Dasyhelea</i> -type larvae	1.4	0	0	0	0	0	0
<i>Bezzia</i> -type larvae	0	0	0.2	0	P	0.1	0.1
<i>Forcipomyia</i> sp.	0.4	P	0	0	0.1	0	0
Ceratopogonid pupae	0.1	0	0	0	0	0	0
Tabanidae	0	0	P	0	P	0	0.1
<i>Lymnophora</i> sp.	0	0	0	0	0	0	0.3
Dolichopodidae	0	0	0	0.9	P	0	0
Dipteran puparia	0	0	0	3.4	0	0	0
<i>Burnupia</i> sp.	0	0	0	0	0	0	3.7
<i>Melanoides</i> sp.	0	0	P	0	0.1	0	0
Other Gastropoda	0.3	0	0	0	0	0	0
<i>Eupera</i> sp.	0	0	0	0	2.4	2.7	2.1
<i>Corbicula africana</i>	0	0	0	0	63.5	25.9	11.3
Other Pelecypoda	0.4	1.5	25.5	6.5	0	0	0
<i>Oreochromis mossambicus</i>	0	0	0	0.4	0	0	0

TOTAL NO. OF INDIVIDUALS	721	2331	2866	232	2414	1595	750
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TABLE B9. PERCENTAGE COMPOSITION OF THE STONES-OUT-OF-CURRENT FAUNA FROM THE LUVUVHU RIVER AT THE WESTERN SITE.

TAXON	APRL	JUNE	APRL	JUNE	AUG	OCT
	85	85	86	86	86	86
	DON.	MAN.	SHI.	MAN.	MAN.	MAN.
<i>Hydra</i> sp.	0	0.1	0	0	2.1	0
<i>Planaria</i>	0	0	1.0	0.3	0.1	0.1
Nematoda	1.0	2.8	0.8	0	0	0
<i>Pristina</i> sp.	2.0	0.6	1.3	0	0	3.2
<i>Nais</i> sp.	0	8.7	0	0	1.5	0
<i>Branchiura</i> sp.	0	0	0.4	0	0	0.3
Branchiobdellidae	0	0.9	0	0	0	0
Other oligochaetes	0	0	3.3	0	0.1	4.3
<i>Batracobdelloides tricarinatus</i>	0	0.1	0	0	0	0
<i>Bosmina longirostris</i>	1.0	0	0	0	0	0
<i>Macrothrix</i> sp.	0	0.5	0	0	0	0
Chydorids	0	1.8	0	0.7	2.5	0
Other cladocerans	0	0	0	0	0	0
Cyclopoid copepods	2.0	0.5	2.2	0.7	1.5	1.1
Other copepods	0	0.9	0	0	0	0
<i>Pionocypris</i> sp.	0	0	0	0	7.0	1.1
<i>Stenocypris</i> sp.	2.0	20.6	28.7	2.2	0.4	0.1
Crab	0	0	0	0.1	0	0
<i>Hydracarina</i> sp.1	0	0.5	0	3.0	7.7	0
<i>Neoperla spio</i>	0	0	0	0.1	0	0
<i>Ephoron</i> sp.	0	0	0	0	0	0.1
<i>Centroptilum excisum</i>	3.8	0	0	0	0.9	0
<i>Centroptilum</i> "near excisum"	0	6.5	0	1.2	4.6	0
<i>Centroptilum flavum</i>	0	0	0	0.6	0	0
<i>Centroptilum medium</i>	24.2	0.4	3.4	42.5	4.3	0
<i>Cloeon africanum</i>	0	5.5	3.0	1.5	6.6	5.9
<i>Cloeon</i> "longtoes"	9.4	0	0	0	0	0
<i>Baetis</i> (<i>Acentrella</i>) sp.	0	0.2	0	0	0	0
Other baetid sp. A	0	0	0	2.9	2.0	0
" " " E	0	0	0	0	0.3	0
" " " F	0	0	0	4.9	5.2	0
" " " H	0	0	0	0	1.2	0
Other baetid spp.	0	0	15.4	1.8	0	0
<i>Choroterpes</i> sp.	20.6	1.2	1.4	4.6	5.7	1.9
<i>Adenophlebiodes</i> sp.	0	0.3	0.5	0	0.2	0
<i>Tricorythus</i> "lowveld"	0	0.1	0	0	0	0.1
<i>Austrocaenis</i> sp.	3.4	4.9	3.7	7.6	12.3	43.0
<i>Masharikella</i> sp.	0	0	0	0	0	0.1
<i>Afronurus</i> sp.	7.4	0.6	0	1.8	0.2	0
<i>Elatoneura</i> sp.	0	0	0	0	0.1	0
<i>Allocnemis</i> sp.	0	0.1	0	0	0	0
<i>Enallagma</i> sp. or <i>Ischnura</i> sp.	0	0	0.8	0	0.1	0
<i>Chlorocypha</i> sp.	0	0	0	0	0.1	0
Zygopterans	0	0.1	0	0.2	0.4	1.1
Gomphidae	0	0.1	0	0	0	0
<i>Phyllomacromia</i> sp.	0	0	0	0	0.1	0

Table B9. Luvuvhu River at Western Site. Stones-out-of-current (cont.)

TAXON	APRL 85 DON.	JUNE 85 DON.	APRL 86 SHI.	JUNE 86 MAN.	AUG 86 MAN.	OCT 86 MAN.
<i>Zygonyx</i> sp.1	0	0	0	0	0	0.1
Libellulid sp.1	0	0	0	0	0.1	0
Anisopterans	3.4	0.3	0.1	0	0.2	0
Notonectidae	0	0	0	0	0	1.2
Naucoridae	0	0	0	0	0	0.1
Corixidae	0	0	0	0.2	0	0
<i>Micronecta</i> sp.	0	1.8	1.6	0	1.0	3.2
<i>Cheumatopsyche thomasseti</i>	0	0	0	0.1	0	1.2
<i>Ecnomus</i> sp.	0.5	0	0.2	0.4	0	0.4
<i>Chimarra</i> sp.	0	0	0.1	0	0.3	0
<i>Athripsodes</i> sp.	0	0	0	0	0.5	0
<i>Trichosetodes</i> sp.	0	0	0.3	0.1	1.5	0.1
Leptoceridae	0	0	0	0	0.6	0.1
<i>Oecetis</i> sp.	0	0	0.2	0	0.1	0.1
<i>Hydroptila capensis</i>	0	0	0	0	0.1	0.7
<i>Orthotrichia barnardi</i>	0	0	0	0.4	1.0	1.3
Hydroptilid juveniles	0	0.6	0	0	0.9	2.3
Trichopterans	0	0	0.1	0	0	0
Pyalidae	0	0	0	0	0.2	0
Dytiscidae	0	0	0	0	0.2	1.1
Gyrinidae	0	0	0	0.1	0	0
Hydraenidae	0	0	0	0.1	0	0
Dryopidae	0	0	0	0	0.3	0
<i>Stenelmis</i> sp.	0	0.1	0.1	0	0.1	0.8
Other Elmidae	0	0	0.3	0.1	0.1	0.4
Helodidae	0	0	0	0	0.1	0
Chrysomyelidae	0	0	0.1	0	0	0
Coleopterans	0	0.1	0	0	0	0
Culicidae	0	0	0	0	0	2.2
<i>Simulium</i> spp.	0	0.2	0	1.6	0.2	0
Chironomini	9.3	11.2	4.6	2.4	6.3	12.2
Tanytarsini	3.9	1.9	0.1	2.1	3.3	4.3
<i>Corynoneura</i> sp.	1.0	0.5	1.5	1.5	0.3	0
Orthocladinae	2.0	11.9	3.4	12.3	3.2	1.1
<i>Cricotopus</i> sp.	0	2.2	2.3	0.7	1.5	0
<i>Pentaneura</i> sp.	1.5	2.3	0.8	0.7	4.0	1.3
<i>Procladius</i> sp.	0	0	0.1	0	0	0
Tanypod pupae	0	0	0	0.2	0.3	0
<i>Dasyhelea</i> -type larvae	0	0.8	0	0.2	0	0
<i>Bezzia</i> -type larvae	0	0	0.2	0	0.9	2.3
<i>Forcipomyia</i> sp.	1.0	0.1	0	0	0.1	0
Tabanidae	0	0.1	0	0	0	0
Rhagionidae	0	0	0	0	0.1	0
Higher dipterans	0	0.1	0	0	0	0
<i>Biomphalaria</i> sp.	0	0	0.3	0	0.3	0
<i>Bulinus</i> sp.	0	0.4	0	0	0	0

Table B9. Luvuvhu River at Western Site. Stones-out-of-current (cont.)

	APRL 85 DON.	JUNE 85 DON.	APRL 86 SHI.	JUNE 86 MAN.	AUG 86 MAN.	OCT 86 MAN.
TAXON						
<i>Melanoides</i> sp.	0	0	1.5	0.1	0.1	0.5
Ancylidae	0	2.3	1.0	0	0.2	0
Other Gastropoda	0	0	2.9	0	0	0
<i>Eupera</i> sp.	0	0	1.7	0.2	3.0	0.3
<i>Corbicula africana</i>	0	0	1.4	0	2.3	0
Other Pelecypoda	2.0	5.8	9.5	0	0	0
TOTAL NO. OF INDIVIDUALS	204	1714	1094	1089	1168	744

DON. -Dongadziba

SHI. -Shidzavane

MAN. -Mangovane

TABLE B10. PERCENTAGE COMPOSITION OF THE STONES-OUT-OF-CURRENT FAUNA FROM THE LUVUVHU RIVER BELOW CONFLUENCE WITH THE MUTALE RIVER.

TAXON	APRIL 85	JUNE 85	SEPT 85	APRIL 86	JUNE 86	AUG 86	OCT 86
<i>Hydra</i> sp.	0	0	0	0	0	1.7	0
<i>Planaria</i>	0	0.4	0.8	0.2	0.2	0.8	0.5
Nematoda	0	1.7	0	2.1	0	1.1	0
<i>Pristina</i> sp.	0	5.4	0	6.3	0.1	0.1	23.9
<i>Nais</i> sp.	0	32.6	0	0	0	0	0
<i>Branchiura</i> sp.	0	0.7	0.8	0.5	0.1	0	0
<i>Dero</i> sp.	0	2.6	0	0	0	0	0
<i>Aulophora</i> sp.	0	0	0	0.1	0	0	0
Branchiobdellidae	0	0	0	2.1	0	0	8.1
Other oligochaetes	0	0	13.2	13.9	0.1	2.6	7.0
<i>Placobdelloides multistriatus</i>	0	0	0	0.1	0.1	0.1	0
Chydorids	0	0	1.7	0	0	0	1.3
Cyclopoid copepods	0.1	3.5	1.7	4.3	0	4.8	11.4
Harpacticoid copepods	0	2.6	0	0	0	0	0
<i>Pionocypris</i> sp.	0	0	0	2.0	0	6.2	7.5
<i>Stenocypris</i> sp.	0.2	4.5	5.0	9.8	7.3	0.2	0.2
Other ostracods	0	0	0	0	0	0.1	0
Decapod juveniles	0	0	2.1	0	0	0	0
Hydracarina sp.1	0	0	0	0	1.0	0.2	0.2
Collembola	0	0	0	0	0	0.1	0
<i>Centroptilum</i> "near excisum"	0.2	0.7	11.1	0	1.3	0	1.5
<i>Centroptilum medium</i>	0.6	1.6	3.5	8.6	17.8	1.9	2.7
<i>Cloeon africanum</i>	0.6	2.1	0	0.4	2.9	7.0	1.1
<i>Baetis glaucus</i>	0	0.7	0	0	0	0	0.3
Other baetid sp. F	0	0	0	0.7	0	0	0
" " " H	0	0	0	0	3.1	0	0
Other baetid spp.	0.5	0.2	18.0	0	0	0	0
<i>Choroterpes</i> sp.	7.3	2.6	10.0	7.2	6.4	19.5	0.2
<i>Adenophlebiodes</i> sp.	0	0	0	0.2	0	0.1	0
<i>Tricorythus</i> "lowveld"	0	0.1	0	0	0	0	0
<i>Austrocaenis</i> sp.	1.9	1.4	3.7	19.2	35.4	6.4	5.8
<i>Afronurus</i> sp.	0	0	0.4	0.1	1.1	0.1	0
<i>Metacnemis</i> sp.	0.2	0	0	0	0	0	0
<i>Pseudagrion</i> sp.	0	0	0.4	0	0	0.1	0
<i>Paragomphus</i> sp.	0	0	0	0	0	0.1	0
Gomphidae	0.3	0	0	0	0	0	0
<i>Phyllomacromia</i> sp.	0	0	0	0	0	0.1	0
<i>Crocothemis</i> sp.	0	0	0	0	0	0.1	0
<i>Sympetrum</i> sp.	0	0	0.8	0	0	0	0
Libellulid sp.1	0	0	0	0.1	0	0	0
Anisopterans	3.3	5.3	0	1.3	0.6	2.4	0.2
Gerridae	0	0.1	0	0	0	0	0
Notonectidae	0	0.1	0	0.2	0	0	0
Naucoridae	0.1	0.1	0	0.1	0.1	1.1	0
<i>Micronecta</i> sp.	0.9	0	4.1	0.3	0.4	0.2	0.5
Other hemipterans	0	0	0	0.7	0	0	0

Table B10. Luvuvhu River below confluence with the Mutale River.
Stones-out-of-current (cont.)

TAXON	APRIL 85	JUNE 85	SEPT 85	APRIL 86	JUNE 86	AUG 86	OCT 86
<i>Ecnomus</i> sp.	0.1	0	0.4	0	0.1	0	0
<i>Chimarrha</i> sp.	0	0	0.4	0	0	0	0
<i>Athripsodes</i> sp.	0	0	0	0	0	1.3	0
<i>Trichosetodes</i> sp.	0	0.1	0	0.1	0.1	0.6	0
Leptoceridae	0	0	0	0	0	0.1	0
<i>Oecetis</i> sp.	0.8	0	0	0	0.2	0	0
<i>Hydroptila capensis</i>	0	0	0	0.3	2.0	0.9	0
<i>Orthotrichia barnardi</i>	1.0	0	0	0.3	0.5	0.8	0.3
Hydroptilid juveniles	0	0	0	0	1.6	1.5	0
Pyrilidae	0	0	0	0	0	0.1	0
<i>Methles</i> sp.	0	0	0	0	0	0.4	0
<i>Peschetius</i> sp.	0	0	0	0	0	0.4	0
Dytiscidae	0.4	0.1	0	0.4	0	0.3	2.2
Gyrinidae	0.2	0	0	0	0	0	0
<i>Tropisternus</i> sp.	0	0	0	0	0	0.1	0
Hydrophilidae	1.0	0.1	0	0.8	0	0.2	0
Hydraenidae	0.1	0.1	0	0.3	0	1.0	0
<i>Helichus</i> sp.	0	0	0	0	0	0.1	0
Dryopidae	0.1	0	0	0.2	0	0	0
<i>Stenelmis</i> sp.	0.2	0	0	0	0	0	0
Other Elmidae	0	0	0	0.2	0	0	0
Tipulidae	0	0	0	0.1	0	0.1	0
Culicidae	0.9	1.4	0	1.1	0.1	7.5	6.6
<i>Simulium</i> spp.	0	1.1	0	0	0.8	0.2	0.2
Chironomini	17.7	1.8	6.2	0.6	3.8	2.2	1.2
Tanytarsini	0.1	3.7	0	1.3	0.5	0.4	0.5
<i>Corynoneura</i> sp.	0	2.6	0	0.6	3.2	0	1.4
Orthocladinae	0.4	3.4	2.5	0.6	0.8	0	0.4
<i>Cricotopus</i> sp.	0.6	1.7	0	0.2	0.8	1.3	1.4
<i>Pentaneura</i> sp.	7.1	2.3	3.7	2.1	2.2	3.9	2.4
Tanypod pupae	0.2	0.4	0	0.8	0	0.2	0
<i>Dasyhelea</i> -type larvae	0.1	0	0	0.4	0	0	8.4
<i>Bezzia</i> -type larvae	2.6	1.4	2.1	0.3	0	0.5	0.2
<i>Forcipomyia</i> sp.	0.3	0	0	0.8	1.6	12.0	0.2
Tabanidae	0.2	0.1	0	0	0.1	0	0
Muscidae	0	0	3.7	0	0	0	0.6
<i>Lymnophora</i> sp.	0	0	0	0.2	0	0	0
Higher dipterans	0	0.1	0	0.7	0	0	0
<i>Anisus</i> sp.	0	0	0	0.1	0	0	0
<i>Biomphalaria</i> sp.	0.1	1.1	0.8	0	0	0	0.2
<i>Bulinus</i> sp.	0	0	0	0.1	0	0	0
<i>Ferrisia</i> sp.	0	0	0	0.5	0	0	0
<i>Melanoides</i> sp.	0	0	0	0.1	0	0.1	0
Ancylidae	2.0	7.6	0	0	0	0.4	0
<i>Eupera</i> sp.	3.0	1.3	2.5	4.9	0.3	0.9	2.0
<i>Corbicula africana</i>	0.1	0	0	2.4	3.5	4.9	0

Table B10. Luvuvhu River below confluence with the Mutale River.
Stones-out-of-current (cont.)

	APRL 85	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86	OCT 86
TAXON							
Fish juvenile	0	0	0.4	0	0	0	0
Anuran juveniles	0	0.2	0	0	0	0.1	0
TOTAL NO. OF INDIVIDUALS	887	919	242	1311	1002	924	640

TABLE B11. PERCENTAGE COMPOSITION OF THE STONES-OUT-OF-CURRENT FAUNA FROM THE LUVUVHU RIVER AT PAFURI PICNIC SITE.

TAXON	APRIL 85	JUNE 85	APRIL 86	JUNE 86	AUG 86
<i>Hydra</i> sp.	0	0.5	0	0	0.5
<i>Planaria</i>	0.1	0	0	0	3.8
Nematoda	0.2	0	0.1	0.6	0.5
<i>Pristina</i> sp.	1.7	4.5	15.7	0	0
<i>Nais</i> sp.	6.1	47.2	0.1	0	0
Other naids	2.3	0.6	0	0	0
<i>Branchiura</i> sp.	0	0	0.1	0	0.1
Tubificidae	0	0.8	0	0	0
Branchiobdellidae	0	0	10.1	0	0
Other oligochaetes	1.3	0	12.3	0	0
<i>Batrachobdelloides tricarinatus</i>	0	0.1	0	0.1	0
Chydorids	0	0	1.1	0	0
Cyclopoid copepods	0	0	12.0	0.6	1.6
<i>Pionocypris</i> sp.	0	0	0	0.1	3.2
<i>Stenocypris</i> sp.	1.4	0.2	13.0	4.2	32.0
<i>Hydracarina</i> sp.1	0	0.3	0	1.6	0.5
sp.2	0	0	1.1	0	0
<i>Elassoneuria</i> sp.	0.2	0	0	0	0
<i>Centroptilum excisum</i>	0	0.8	0	0	0
<i>Centroptilum</i> "near excisum"	0	0	1.2	1.6	2.2
<i>Centroptilum medium</i>	5.4	1.0	3.5	23.0	0.6
<i>Cloeon africanum</i>	0	0.8	0.4	3.5	7.6
<i>Baetis quintus</i>	1.7	0	0	0	0
Other baetid sp. A	0	0	0	0.2	0
" " " F	0	0	0.5	0.6	0.2
" " " G	0.2	0	0	0	0
" " " H	0	0	0	1.5	0
Other baetid spp.	0	0	0.4	0	0
<i>Choroterpes</i> sp.	8.6	5.1	2.6	8.7	11.2
<i>Adenophlebiodes</i> sp.	0	0	0.1	0	0
<i>Tricorythus</i> "lowveld"	0.3	0.1	0	0	0
<i>Austrocaenis</i> sp.	3.6	2.5	1.1	18.9	5.9
<i>Afronurus</i> sp.	0.7	0.7	0	1.7	0
<i>Metacnemis</i> sp.	0	0.1	0	0	0
<i>Pseudagrion</i> sp.	0	0.1	0	0	0.3
<i>Enallagma</i> sp. or <i>Ischnura</i> sp.	0	0	0	0.1	0
Zygopterans	0.1	0	0	0.4	0
<i>Phyllomacromia</i> sp.	0	0	0	0	0.3
Anisopterans	1.7	2.0	0.5	0.3	2.5
Naucoridae	0.1	0	0.1	0.1	0.3
Corixidae	0.2	0	0	0	0
<i>Micronecta</i> sp.	0	0	0.4	0	0.5
Other hemipterans	0	0	0.1	0.1	0
<i>Cheumatopsyche thomasseti</i>	1.4	0.2	0	0	0.1
<i>Ecnomus</i> sp.	0.1	0	0	0	0.3
<i>Trichosetodes</i> sp.	0	0	0	0	0.1

Table B11. Luvuvhu River at Pafuri Picnic Site. Stones-out-of-current fauna (cont.)

TAXON	APRIL 85	JUNE 85	APRIL 86	JUNE 86	AUG 86
Leptoceridae	0	0.1	0	0	0
<i>Oecetis</i> sp.	0.1	0	0	0	0
<i>Hydroptila capensis</i>	0.1	0	0	0	0.4
<i>Orthotrichia barnardi</i>	1.2	1.2	0.1	0.7	0.9
Hydroptilid juveniles	0.2	1.6	0	0.6	0.5
Trichopterans	0	0	0.4	0	0
Pyrilidae	0	0	0	0	0.1
Dytiscidae	0.1	0	0.1	0.1	0
Hydrophilidae	0	0	0.8	0	0.3
Hydraenidae	0.1	0	0	0	0
<i>Stenelmis</i> sp.	0	0.5	1.2	0	0
Other Elmidae	0	0	0.3	0	0
Tipulidae	0	0	0.5	0	0
Culicidae	0.2	0	1.5	0	0.4
<i>Simulium</i> spp.	0	1.0	0	2.3	0
Chironomini	4.7	7.1	1.7	3.6	1.9
Tanytarsini	0.8	0.8	0.3	6.4	3.5
<i>Corynoneura</i> sp.	0.7	1.7	0	7.5	1.6
<i>Theinemaniella</i> sp.	0	0	0	0	0.1
Orthocladinae	8.6	10.5	0	2.6	1.5
<i>Cricotopus</i> sp.	3.7	2.6	0.1	1.0	0.9
<i>Pentaneura</i> sp.	1.2	0.8	1.4	0.7	2.1
Tanypod pupae	0	0	0.7	0	0
<i>Dasyhelea</i> -type larvae	38.6	0.5	3.8	0.3	0.5
<i>Bezzia</i> -type larvae	0.1	0	1.8	0	0
<i>Forcipomyia</i> sp.	0.7	0.4	0.3	0.1	4.2
Ceratopogonid pupae	0.7	0	0	0	0
Tabanidae	0	0	0	0	0.1
Rhagionidae	0	0	0	0.1	0
Muscidae	0.3	0.2	0	0	0
Dolichopodidae	0	0	0.3	0	0
<i>Ancyclus</i> sp.	0	0	0	0.1	0
<i>Biomphalaria</i> sp.	0	0	0.3	0	0
<i>Bulinus</i> sp.	0	0	2.1	0	0
<i>Ferrisia</i> sp.	0	0	0.1	0	0
<i>Eupera</i> sp.	0	0	6.2	5.5	3.2
<i>Corbicula africana</i>	0	0	0.1	0	6.1
Other Pelecypoda	0.7	0.2	0	0	0
TOTAL NO.OF INDIVIDUALS	1206	869	731	693	759

TABLE B12. PERCENTAGE COMPOSITION OF THE STONES-OUT-OF-CURRENT FAUNA FROM THE MUTALE RIVER ABOVE CONFLUENCE WITH THE LUVUVHU RIVER.

TAXON	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86
		*			
<i>Hydra</i> sp.	0	0	0	0.6	0
<i>Planaria</i>	0.4	0	0.3	2.5	P
Nematoda	1.3	0.8	1.2	0.3	0.4
<i>Pristina</i> sp.	9.8	9.2	4.2	0.1	0
<i>Nais</i> sp.	13.3	0.1	0.9	0.1	0.8
<i>Branchiura</i> sp.	0	0.1	0.1	0	0
<i>Dero</i> sp.	4.3	0	0	0	0
<i>Aulophora</i> sp.	0.4	0	0	0	0
Branchiobdellidae	0	0	0	0	0.3
Other oligochaetes	0	0.8	13.9	1.3	P
<i>Batrachobdelloides tricarinatus</i>	0.3	0	0	0	0
<i>Helobdella conifera</i>	0	0.1	0	0	0
<i>Ceriodaphnia/Simocephalus</i> sp.	0	1.6	0	0	0
Chydorids	0	1.1	0.3	0	0
Cyclopoid copepods	4.3	10.3	5.0	0.3	7.9
<i>Pionocypris</i> sp.	0	0	0	4.5	34.9
<i>Stenocypris</i> sp.	0	11.7	57.2	0.6	0.4
<i>Caridina</i> sp.	0	0	0	0.2	P
<i>Hydracarina</i> sp.1	0	0.4	0.1	0	0
sp.2	0	0	0	P	0
Collembola	0	0	0	0.1	0
<i>Centroptilum</i> "near excisum"	1.4	0.6	0	0	0.5
<i>Centroptilum medium</i>	4.0	0.2	0.7	1.2	0
<i>Cloeon africanum</i>	5.8	5.1	1.0	0.6	2.7
<i>Baetis glaucus</i>	0	0	0	0.1	0
Other baetid sp. F	0	0	0.2	0	0
" " " H	0	0	0	16.4	0.2
Other baetid spp.	0	0	P	0	0
<i>Choroterpes</i> sp.	0.1	0.4	0.5	0.1	1.4
<i>Adenophlebiodes</i> sp.	0	0.1	0.1	0	0
<i>Austrocaenis</i> sp.	5.7	3.2	5.1	33.3	13.7
<i>Afronurus</i> sp.	1.0	0	0	0.7	0
<i>Elattoneura</i> sp.	0.1	0	0	0	0.1
<i>Pseudagrion</i> sp.	0	0	0	0.2	0.1
Zygopterans	0.4	0	0	10.5	0
Libellulid sp.1	0	0	P	0	0
Anisopterans	12.2	1.8	0.2	0.7	1.6
Hebriidae	0	0	0	P	0
Gerridae	0.2	0	0	0	0
<i>Rhagovelia</i> sp.	0	0	0	8.2	0
Notonectidae	0.1	0.2	0	0	P
Pleidae	0	0	0.1	0.1	0
Naucoridae	0	0.4	0.1	0.2	0.1
<i>Micronecta</i> sp.	0.4	0.1	0	P	0.1
Other hemipterans	0	0	P	0.5	0.1
Sisyridae	0	0	0	0	0.1

Table B12. Mutale River above confluence with the Luvuvhu River.
Stones-out-of-current (cont.)

TAXON	JUNE 85	SEPT 85	APRIL 86	JUNE 86	AUG 86
		*			
<i>Cheumatopsyche thomasseti</i>	0	0	0	0	0.1
<i>Ecnomus</i> sp.	0.1	0	0	0	0.1
<i>Leptocerus ?inflatus</i>	0.1	0	0	0	0
<i>Leptocerus ?schoenobates</i>	0.1	0	0	0	0
<i>Trichosetodes</i> sp.	0.5	0	0.1	0	0
Leptoceridae	0	0	P	P	0
<i>Hydroptila capensis</i>	0	0	0	0	0.4
<i>Orthotrichia barnardi</i>	0.1	0	0.1	0.2	0
<i>Catoxyethira</i> sp.	0	0	0	0	P
Hydroptilid juveniles	0	0	P	1.0	1.7
Trichopterans	0	0	0	P	0
Haliplidae	0	0	P	0	0
Dytiscidae	0	0.4	0	0.1	0.5
Gyrinidae	0	0	0	0.3	0
Hydrophilidae	0	0	0.4	0.1	0
Hydroscaphidae	0	0	0	0.1	0
Hydraenidae	0	0.1	0.1	0.1	0.1
Psychodidae	0	0	0.1	0	0
<i>Stenelmis</i> sp.	0.1	0	P	0	0
Other Elmidae	0	0	P	0	0
Tipulidae	0	0.5	0	P	0
Culicidae	0	0	0.2	0.2	1.4
<i>Simulium</i> spp.	0	0.1	0	1.0	0.2
Chironomini	1.4	3.4	0.6	5.9	5.0
Tanytarsini	0.4	2.8	0.1	0.7	3.6
<i>Corynoneura</i> sp.	0.7	0	0	2.4	1.1
<i>Theinemaniella</i> sp.	0	0	0	0.1	0
Orthocladinae	8.1	6.1	P	1.3	8.0
<i>Cricotopus</i> sp.	0.3	0.6	0	1.5	3.5
<i>Pentaneura</i> sp.	4.5	12.5	0.4	0.3	6.3
<i>Procladius</i> sp.	0	0.5	0	0	0
Tanypod pupae	0.3	0.6	0	P	0.3
<i>Dasyhelea</i> -type larvae	0	0.3	3.3	0	1.9
<i>Bezzia</i> -type larvae	0.9	0.9	1.5	P	0.5
<i>Forcipomyia</i> sp.	0	0.1	0.7	0.1	P
Tabanidae	0.4	0.2	0	0	P
Ephyridae	0	0	0	0	0.1
Muscidae	0	0.1	0	0	0
Anthomyidae	0	0	P	0	0
Higher dipterans	0	0.1	1.1	0	0
<i>Biomphalaria</i> sp.	1.9	20.4	0.2	0.4	0
<i>Lymnaea</i> sp.	0	0	0	0.1	0
<i>Melanoides</i> sp.	0	0.4	P	0	0
Ancylidae	14.0	1.0	P	0	0
Other Gastropoda	0	0	P	0	0
<i>Eupera</i> sp.	0.1	0.6	0.1	0	0

Table B12. Mutale River above confluence with the Luvuvhu River.
Stones-out-of-current (cont.)

TAXON	JUNE 85	SEPT 85	APRL 86	JUNE 86	AUG 86
		*			
<i>Corbicula africana</i>	0	0	0.1	0	0
Anuran juveniles	0	0.1	0	0	0
TOTAL NO. OF INDIVIDUALS	1112	1549	3059	3011	2343

* sample collected at drift

TABLE C1. PERCENTAGE COMPOSITION OF THE SEDIMENT FAUNA FROM THE CROCODILE RIVER AT GEZABAHLE.

TAXON	JUNE 86	AUG 86
Other oligochaetes	1.1	2.6
Chydorids	P	0
Cyclopoid copepods	P	1.3
<i>Pionocypris</i> sp.	3.9	1.3
<i>Stenocypris</i> sp.	0	2.6
Hydracarina sp.1	0.3	0
<i>Centroptilum</i> "near excisum"	2.2	11.3
<i>Centroptilum flavum</i>	0.1	1.5
<i>Centroptilum varium</i>	0.1	0
<i>Cloeon africanum</i>	0	2.3
<i>Baetis bellus</i>	1.0	0
<i>Choroterpes</i> sp.	P	0
<i>Austrocaenis</i> sp.	38.8	9.8
Gomphidae	0.3	0.5
Naucoridae	P	0
<i>Micronecta</i> sp.	4.4	3.3
Other hemipterans	0.3	0
Hydraenidae	P	0
<i>Stenelmis</i> sp.	0.1	0
Other Elmidae	1.4	0
<i>Simulium</i> spp.	P	2.8
Chironomini	6.6	26.1
Tanytarsini	0.9	24.8
<i>Corynoneura</i> sp.	0.6	0
Orthocladinae	0.4	4.6
<i>Cricotopus</i> sp.	0.3	0
<i>Pentaneura</i> sp.	1.0	0
Tanypod pupae	0.1	0
<i>Dasyhelea</i> -type larvae	0	1.3
<i>Bezzia</i> -type larvae	0.4	1.3
<i>Eupera</i> sp.	0	2.6
<i>Corbicula africana</i>	35.5	0
TOTAL NO. OF INDIVIDUALS	2884	612

TABLE C2. PERCENTAGE COMPOSITION OF THE SEDIMENT FAUNA FROM THE CROCODILE RIVER AT NGONDWINI.

TAXON	JUNE 85	APRL 86	JUNE 86	AUG 86	OCT 86
Planaria	0	0	0	0	0.1
<i>Prostoma</i> sp.	0	0	0	0	3.2
<i>Pristina</i> sp.	0.9	0	0	0	0.1
Other oligochaetes	9.8	0	5.9	3.0	27.6
<i>Ceriodaphnia/Simocephalus</i> sp.	0	0	0	0	0.2
Cyclopoid copepods	0	0	0	7.4	5.7
<i>Pionocypris</i> sp.	0.9	0	4.3	39.0	40.1
<i>Stenocypris</i> sp.	0.9	0.3	4.6	0.2	1.9
Hydracarina sp.1	0	0	0	0	1.0
<i>Centroptilum</i> "near excisum"	35.0	19.6	4.4	4.7	2.0
<i>Centroptilum medium</i>	0	0	0	0	0.2
<i>Centroptilum varium</i>	0	0.9	0	0	0
<i>Cloeon africanum</i>	0	0	0	0.6	0.2
<i>Baetis bellus</i>	0	0	0	1.7	0.2
<i>Baetis glaucus</i>	0	0	1.0	0	0
Other baetid sp. F	1.8	0	0	0	0
<i>Choroterpes</i> sp.	0	1.7	0	0	0
<i>Tricorythus</i> "lowveld"	0	0	0.2	0	0
<i>Austrocaenis</i> sp.	20.8	48.5	31.1	31.4	0.2
Gomphidae	2.3	0.3	3.0	1.5	0
Libellulidae	0	0	0	1.5	0.1
Naucoridae	0.1	0.7	0	0	1.4
Notonectidae	0	0	0	0.2	0
<i>Micronecta</i> sp.	11.8	11.9	0	4.5	0.4
<i>Cheumatopsyche thomasseti</i>	0.1	0	0	0	0.1
Trichopterans	0	1.4	0	0	0
<i>Methles</i> sp.	0	0	0	0	0.1
<i>Peschetius</i> sp.	2.5	8.9	0	0	0
Hydrophilidae	1.4	0	1.8	0	0
Hydrobiinae	0.1	0	0	0	0
Other Elmidae	0	0	0.2	0	0
Coleopterans	0.9	1.4	0	0.2	0
Culicidae	0	0	0	0	0.1
<i>Simulium</i> spp.	0	0	0	0.2	0
Chironomini	4.4	0	2.4	1.5	4.9
Tanytarsini	0	0	1.4	1.5	5.1
<i>Corynoneura</i> sp.	0	1.7	0	0	0
Orthocladinae	0.9	0	4.3	0.2	0
<i>Cricotopus</i> sp.	0	0	1.4	0	0
<i>Pentaneura</i> sp.	1.0	2.8	11.2	0	0.2
<i>Procladius</i> sp.	0	0	0	0.2	0
Tanypod pupae	0.9	0	0	0	0.1
<i>Dasyhelea</i> -type larvae	0.9	0	0	0	0
<i>Forcipomyia</i> sp.	0	0	0	0.2	0.1
Ancylidae	0.2	0	0	0	0
<i>Eupera</i> sp.	0.1	0	0	0	0

Table C2. Crocodile River Ngondwini. Sediment fauna.

TAXON	JUNE 85	APRL 86	JUNE 86	AUG 86	OCT 86
<i>Corbicula africana</i>	2.2	0	23.0	0.6	0
Anuran juveniles	0	0	0	0	1.7
TOTAL NO. OF INDIVIDUALS	902	293	562	538	841

TABLE C3. PERCENTAGE COMPOSITION OF THE SEDIMENT FAUNA FROM THE SABIE RIVER AT LUBYE-LUBYE.

TAXON	APRIL 85	JUNE 85	JAN 86	JUNE 86
Nematoda	0	0	0	P
<i>Pristina</i> sp.	0	0	0	P
<i>Nais</i> sp.	0	2.0	0	0.2
Branchiobdellidae	0	0.3	0	0
Other oligochaetes	0	0	0	P
<i>Batracobdelloides tricarinatus</i>	0	P	0	0
<i>Ceriodaphnia/Simocephalus</i> sp.	0	2.1	0	0
Chydorids	0	0	0	0.6
Cyclopoid copepods	0	1.2	1.0	1.0
<i>Pionocypris</i> sp.	0	1.5	1.0	5.5
<i>Stenocypris</i> sp.	0	1.2	2.9	3.9
Hydracarina sp.1	3.3	0.3	0	0.6
<i>Machadorhythus</i> sp.	0.8	P	0	0.4
<i>Centroptilum</i> "near excisum"	0	8.3	0.5	5.2
<i>Centroptilum flavum</i>	0.5	0	0	0
<i>Cloeon africanum</i>	0	0.2	0	0.5
<i>Baetis bellus</i>	0	0	0	0
<i>Baetis glaucus</i>	0	0	0	0.1
Other baetid spp.	2.2	0.1	0	0
<i>Choroterpes</i> sp.	0	P	0	0.1
<i>Adenophlebiodes</i> sp.	0	0	0.1	0
<i>Tricorythus</i> "lowveld"	1.2	0	0.1	P
<i>Austrocaenis</i> sp.	6.0	34.7	47.0	13.4
<i>Pseudagrion</i> sp.	0.2	0	0	0
Zygopterans	0.2	0	0	0.1
Gomphidae	0	0.7	0.7	0.1
Libellulidae	0	0.3	0	0.6
Naucoridae	0	P	0	0
<i>Micronecta</i> sp.	64.9	13.5	22.9	28.2
Other hemipterans	0	0	0	P
<i>Leptocerus ?inflatus</i>	0.2	0	0	0
<i>Trichosetodes</i> sp.	0	0	0	0.1
Leptoceridae	0	0	0	P
<i>Hydroptila capensis</i>	0	0	0	P
<i>Catoxyethira</i> sp.	0	0	0	P
Hydropsychid juveniles	1.7	0	0	0
Pyalidae	0	P	0	0
<i>Peschetius</i> sp.	0	0	0.2	0.2
Hydrophilidae	0	0.1	0	0.9
Hydrobiinae	0	0	0	2.2
<i>Stenelmis</i> sp.	0	2.0	0	1.1
Other Elmidae	0.2	0	0	0.1
Helodidae	0	0	0	P
Staphylinidae	0	0	0	P
Coleopterans	0	0	0	P
Culicidae	0	0	0	P

Table C3. Sabie River at Luby-Luby. Sediment biotopes (cont.)

TAXON	APRL 85	JUNE 85	JAN 86	JUNE 86
<i>Simulium</i> spp.	0	0	1.0	0.4
Chironomini	5.6	15.1	8.4	15.7
Tanytarsini	3.7	9.2	8.4	11.8
Orthocladinae	2.1	2.7	0	0.1
<i>Cricotopus</i> sp.	1.7	0.5	1.0	0
<i>Pentaneura</i> sp.	0	2.2	0	0.8
<i>Procladius</i> sp.	1.9	0	0	0
Tanypod pupae	0	P	0	P
<i>Dasyhelea</i> -type larvae	0.2	0.3	0	0.1
<i>Bezzia</i> -type larvae	0	1.0	2.9	3.0
Muscidae	0	0	0	0.3
Higher dipterans	0	P	0	0
Ancyliidae	0	0	0	P
Other Gastropoda	0	0	0	P
<i>Eupera</i> sp.	0	0	0	2.0
<i>Corbicula africana</i>	0	0.4	2.0	0
Other Pelecypoda	3.5	0	0	0
TOTAL NO. OF INDIVIDUALS	484	2646	834	2505

TABLE C4. PERCENTAGE COMPOSITION OF THE SEDIMENT FAUNA FROM THE SABIE RIVER OPPOSITE LISBON ESTATES.

TAXON	APRL 85	JUNE 86	AUG 86	OCT 86
Planaria	0	0	0	0.2
<i>Pristina</i> sp.	0	1.2	0.6	2.9
Other oligochaetes	0	0	0.4	0
Cyclopoid copepods	0	1.2	10.1	0.7
<i>Stenocypris</i> sp.	0	0.4	0.3	0.7
Hydracarina sp.1	0	1.7	0.9	0.7
<i>Machadorhythus</i> sp.	0	0.3	0.5	0
<i>Centroptilum</i> "near excisum"	0	3.8	8.6	17.9
<i>Centroptilum varium</i>	0	10.5	0	0
<i>Baetis bellus</i>	0	0	0.1	0
Other baetid sp. A	0	5.2	0	0
Other baetid spp.	11.8	0	0	0
<i>Tricorythus</i> "lowveld"	0.2	0	0	0
<i>Austrocaenis</i> sp.	4.3	18.9	9.5	9.2
Gomphidae	0	0.3	0	0.2
<i>Phyllomacromia</i> sp.	0.2	0	0	0
Libellulidae	1.3	0.1	0.2	0
Naucoridae	0.2	0	0	0
<i>Micronecta</i> sp.	4.8	6.4	27.6	46.2
<i>Leptocerus ?inflatus</i>	0	0.3	0.1	0
Hydroptilid juveniles	6.6	0	0	0
Pyrilidae	0	1.7	0	0
<i>Methles</i> sp.	0	0	0	0.2
<i>Peschetius</i> sp.	0	0	0	0.2
Hydrophilidae	0	0	0	0.9
<i>Stenelmis</i> sp.	4.1	0.1	1.3	4.4
Other Elmidae	1.3	0	0	0.7
Staphylinidae	0	0	0	1.5
Culicidae	0	0	0	1.5
<i>Simulium</i> spp.	0	2.5	0.9	0
Chironomini	31.8	18.8	18.9	5.9
Tanytarsini	7.4	15.9	19.0	0
<i>Corynoneura</i> sp.	0	0.1	0	0
Orthocladinae	26.3	8.6	0.1	0
<i>Cricotopus</i> sp.	0	0.4	0	0
<i>Pentaneura</i> sp.	0	1.0	0.8	0.9
<i>Dasyhelea</i> -type larvae	0	0	0	1.5
<i>Bezzia</i> -type larvae	0	0.1	0	0
<i>Forcipomyia</i> sp.	0	0	0	0.7
Ceratopogonid pupae	0	0	0	0.7
Empididae	0	0.1	0	0
<i>Corbicula africana</i>	0	0	0	2.0
<i>Oreochromis mossambicus</i>	0	0.1	0	0
TOTAL NO. OF INDIVIDUALS	610	692	2706	543

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

	OCT 86
TAXON	
Other oligochaetes	0.1
Chydorids	0.7
Cyclopoid copepods	2.2
<i>Pionocypris</i> sp.	11.2
<i>Stenocypris</i> sp.	5.3
<i>Centroptilum</i> "near excisum"	3.5
<i>Austrocaenis</i> sp.	7.9
<i>Aeschna</i> sp.	P
<i>Phyllomacromia</i> sp.	P
Gomphidae	P
<i>Micronecta</i> sp.	7.4
Other hemipterans	P
<i>Trichosetodes</i> sp.	0.1
Leptoceridae	0.3
Hydrophilidae	0.1
Chironomini	1.4
Tanytarsini	58.0
<i>Dasyhelea</i> -type larvae	0.1
<i>Melanoides</i> sp.	0.1
<i>Corbicula africana</i>	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.

	APRL 85
TAXON	
<i>Pristina</i> sp.	4.8
Other oligochaetes	2.7
<i>Ceriodaphnia/Simocephalus</i> sp.	0.7
<i>Pionocypris</i> sp.	0.7
<i>Centroptilum</i> "near excisum"	8.6
<i>Baetis bellus</i>	0.7
Other baetid sp. F	0.5
<i>Austrocaenis</i> sp.	34.3
<i>Tricorythus</i> "lowveld"	0.3
Libellulidae	0.2
Gomphidae	0.5
Naucoridae	0.3
<i>Micronecta</i> sp.	0.5
Other hemipteran	0.7
<i>Oecetis</i> sp.	1.2
<i>Hydroptila capensis</i>	0.2
<i>Simulium</i> spp.	0.3
Chironomini	15.6
Tanytarsini	16.0
<i>Corynoneura</i> sp.	1.4
<i>Cricotopus</i> sp.	0.2
<i>Pentaneura</i> sp.	6.3
Tanypod pupae	0.5
<i>Dasyhelea</i> -type larvae	1.4
<i>Forcipomyia</i> 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
<i>Ceriodaphnia/Simocephalus</i> sp.	0.5	0
Cyclopoid copepods	1.8	27.2
<i>Pionocypris</i> sp.	3.7	P
<i>Stenocypris</i> sp.	2.3	1.0
Hydracarina sp.1	0	0.7
<i>Centroptilum</i> "near excisum"	21.4	10.4
<i>Cloeon africanum</i>	12.0	0
<i>Baetis bellus</i>	1.6	0
<i>Choroterpes</i> sp.	0	0.9
<i>Austrocaenis</i> sp.	45.4	17.4
Gomphidae	0.4	0.2
Libellulidae	0.1	P
Naucoridae	0	0.3
<i>Micronecta</i> sp.	4.3	19.9
Other hemipterans	0	P
<i>Cheumatopsyche thomasseti</i>	0	P
<i>Hydroptila capensis</i>	0	P
Hydroptilid juveniles	0	P
<i>Peschetius</i> sp.	0.1	0
Dytiscidae	0	P
<i>Simulium</i> spp.	0	0.4
Chironomini	3.6	5.8
Tanytarsini	1.1	4.7
<i>Corynoneura</i> sp.	0	P
Orthocladinae	2.0	0.1
<i>Cricotopus</i> sp.	0	1.2
<i>Pentaneura</i> sp.	2.0	1.6
<i>Bezzia</i> -type larvae	1.0	0.2
<i>Melanoides</i> sp.	0.1	0
<i>Eupera</i> sp.	0.2	0
<i>Corbicula africana</i>	1.5	0.5
TOTAL NO. OF INDIVIDUALS	1758	2309

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

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

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

	JUNE 85
TAXON	
<i>Pristina</i> sp.	0.1
Branchiobdellidae	1.3
<i>Ceriodaphnia/Simocephalus</i> sp.	0.1
Cyclopoid copepods	0.4
<i>Pionocypris</i> sp.	0.4
<i>Centroptilum excisum</i>	0.2
<i>Centroptilum</i> "near excisum"	1.0
<i>Centroptilum flavum</i>	1.8
<i>Centroptilum medium</i>	0.4
<i>Baetis glaucus</i>	16.9
Other baetid sp. H	18.3
" " " J	10.2
Other baetid spp.	22.3
<i>Austrocaenis</i> sp.	2.8
<i>Tricorythus</i> "lowveld"	0.2
<i>Elatoneura</i> sp.	0.1
<i>Pseudagrion</i> sp.	0.2
Zygopterans	0.1
Pleidae	0.1
<i>Micronecta</i> sp.	0.4
Other hemipterans	2.2
<i>Cheumatopsyche thomasseti</i>	0.5
<i>Leptocerus ?schoenobates</i>	0.1
Gyrinidae	1.5
Hydrophilidae	0.1
<i>Simulium</i> spp.	5.3
Chironomini	4.0
Tanytarsini	0.1
<i>Corynoneura</i> sp.	4.7
Orthocladinae	0.1
<i>Cricotopus</i> sp.	2.9
<i>Pentaneura</i> sp.	0.7
Ceratopogonid 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	APRIL 85 DON.	JUNE 85 MAN.	JUNE 86 MAN.	AUG 86 MAN.
<i>Hydra</i> sp.	0	1.1	0	0
<i>Planaria</i>	0	0	P	0
Nematoda	0	0.1	0	0
<i>Pristina</i> sp.	1.8	1.1	0	0
<i>Nais</i> sp.	3.8	8.9	0.1	0
Other oligochaetes	0	0	1.2	0
<i>Batracobdelloides tricarinatus</i>	0	0	0.1	0
<i>Ceriodaphnia/Simocephalus</i> sp.	0	0	0.5	1.5
Chydorids	0	0	2.6	0
Cyclopoid copepods	2.7	0	3.1	1.9
<i>Pionocypris</i> sp.	0	1.1	5.7	0.1
<i>Stenocypris</i> sp.	6.9	4.7	8.4	0.1
<i>Caridina</i> sp.	9.8	0.7	2.0	0.5
<i>Hydracarina</i> sp.1	0	0	0.4	0.7
sp.2	0	0	0.3	0
<i>Centroptilum</i> "near excisum"	0	0.8	0	0
<i>Centroptilum flavum</i>	1.1	0	0	0
<i>Centroptilum medium</i>	1.1	0	0	0.5
<i>Cloeon africanum</i>	17.2	1.4	18.6	0.5
<i>Cloeon</i> sp.	1.1	0	0	0
<i>Baetis glaucus</i>	0	4.4	0	0
Other baetid sp. 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
<i>Choroterpes</i> sp.	0	0.1	P	0.2
<i>Austrocaenis</i> sp.	0.4	0.7	7.1	2.9
<i>Afronurus</i> sp.	5.8	0.5	0.6	2.4
<i>Elatoneura</i> sp.	0.2	0	0	0
<i>Pseudagrion</i> sp.	0.2	0.3	0.3	0.2
Zygopterans	0	0.4	0.4	0.1
Anisopterans	0	0.4	0.6	0
<i>Phyllomacromia</i> sp.	0	0	0.1	0
<i>Orthetrum</i> sp.	0	0	P	0
<i>Pantala</i> 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
<i>Micronecta</i> sp.	0	0	0.7	0.1
Other hemipterans	0.7	4.0	0.6	3.0

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

TAXON	APRIL	JUNE	JUNE	AUG
	85	85	86	86
	DON.	MAN.	MAN.	MAN.
<i>Ecnomus</i> sp.	0.2	0	0	0
<i>Leptocerus ?inflatus</i>	1.8	0.1	0.1	0.6
Leptoceridae	0	0	0	0.3
<i>Oecetis</i> sp.	0.2	0.1	0.1	0.2
<i>Orthotrichia barnardi</i>	0	0.3	P	0.2
<i>Catoxyethira</i> sp.	0	0	0	0.2
Hydroptilid juveniles	0	0	P	0
Pyrilidae	1.1	0	0.4	0
<i>Methles</i> sp.	0	0	0.3	0
<i>Peschetius</i> sp.	0	0	0.7	0
Dytiscidae	0.2	0.2	1.2	0
<i>Pseudancyrionyx</i> sp.	0.2	0	0	0
Gyrinidae	0	0.1	P	0.1
Hydrophilidae	0	0	0.2	0
<i>Ochthebius</i> sp.	0	0	0.1	0
Hydraenidae	0	0	0.7	0.2
<i>Leptelmis</i> 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
<i>Simulium</i> spp.	0	1.5	P	28.8
Chironomini	26.0	10.4	6.0	7.6
Tanytarsini	0	4.3	0.3	3.4
<i>Corynoneura</i> sp.	3.6	1.1	1.9	1.7
Orthocladinae	5.8	6.1	0.2	4.4
<i>Cricotopus</i> sp.	1.8	13.0	P	2.2
<i>Pentaneura</i> sp.	0	1.5	2.5	1.4
<i>Bezzia</i> -type larvae	0	0.1	0.1	0.1
Ceratopogonid pupae	0.2	0	0	0
Tabanidae	0	0	0.3	0
Muscidae	0	0	0.1	0
Anthomyidae	0	0.1	0	0
<i>Biomphalaria</i> sp.	0	0.1	0.1	0
<i>Lymnaea</i> sp.	0	0	0.1	0
<i>Melanoides</i> sp.	0	0	0.1	0
Ancylidae	0	0	0.5	0.1
<i>Eupera</i> sp.	0	0.3	0.9	0.1
<i>Corbicula africana</i>	0	21.5	0	0
Other Pelecypoda	0.2	0	0	0
<i>Barbus</i> 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.

	JUNE 86
TAXON	
<i>Planaria</i>	0.1
<i>Pristina</i> sp.	1.6
<i>Nais</i> sp.	0.1
Other oligochaetes	0.1
Cyclopoid copepods	0.4
<i>Pionocypris</i> sp.	2.1
<i>Stenocypris</i> sp.	1.8
Decapod juveniles	0.1
<i>Centroptilum medium</i>	1.9
<i>Baetis glaucus</i>	0.7
Other baetid sp. F	0.7
" " " H	5.9
<i>Choroterpes</i> sp.	0.1
<i>Austrocaenis</i> sp.	47.3
<i>Afronurus</i> sp.	0.1
<i>Pseudagrion</i> sp.	0.7
Zygopterans	6.1
<i>Anax</i> sp.	0.1
Anisopterans	1.4
Notonectidae	0.1
Pleidae	0.1
Naucoridae	0.2
Other hemipterans	4.1
<i>Chimarra</i> sp.	0.1
Leptoceridae	0.1
<i>Oecetis</i> sp.	0.1
<i>Hydroptila capensis</i>	0.1
<i>Orthotrichia barnardi</i>	0.6
Hydroptilid juveniles	2.1
<i>Laccophilus</i> sp.	0.2
<i>Methles</i> sp.	0.1
<i>Orectogyrus</i> sp.	0.4
Gyrinidae	0.1
<i>Tropisternus</i> sp.	0.1
Hydrophilidae	0.9
Hydraenidae	1.9
Dryopidae	0.1
Other Elmidae	0.2
Coleopterans	0.3
Culicidae	0.9
<i>Simulium</i> spp.	0.4
Chironomini	5.8
Tanytarsini	0.6
<i>Corynoneura</i> sp.	4.4
Orthocladinae	0.5
<i>Cricotopus</i> sp.	2.2

Table D4. Luvuvhu River below confluence with Mutale River. Vegetation biotopes (cont.)

	JUN
	86
TAXON	
<i>Pentaneura</i> sp.	0.7
<i>Bezzia</i> -type larvae	0.2
<i>Forcipomyia</i> sp.	0.1
Ceratopogonid pupae	0.1
<i>Bulinus</i> sp.	0.1
<i>Eupera</i> sp.	0.1
<i>Corbicula africana</i>	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	AUG
	86	86
<i>Hydra</i> sp.	0	0.5
Planaria	P	0.3
Nematoda	0.8	1.2
<i>Pristina</i> sp.	0.6	1.2
<i>Nais</i> sp.	0.3	1.3
Branchiobdellidae	1.1	4.5
Other oligochaetes	0.3	0.1
<i>Batrachobdelloides tricarinatus</i>	0.1	0
<i>Ceriodaphnia/Simocephalus</i> sp.	0	0.3
Chydorids	0.3	0
Cyclopoid copepods	1.8	2.1
<i>Pionocypris</i> sp.	3.2	4.4
<i>Stenocypris</i> sp.	10.9	1.5
<i>Caridina</i> sp.	0.8	0
<i>Centroptiloides ?spinulosa</i>	0	P
<i>Centroptilum medium</i>	0.1	0.1
<i>Cloeon africanum</i>	3.7	0.2
<i>Baetis bellus</i>	17.6	0
Other baetid sp. H	0	6.7
" " " J	0	1.9
" " " K	0	P
<i>Choroterpes</i> sp.	0.1	0.2
<i>Tricorythus</i> "lowveld"	P	0
<i>Austrocaenis</i> sp.	21.7	1.3
<i>Afronurus</i> sp.	1.7	0
<i>Pseudagrion</i> sp.	0.3	0.2
Zygopterans	2.3	2.0
<i>Phyllomacromia</i> 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
<i>Micronecta</i> sp.	P	0
Other hemipterans	0.9	2.1
<i>Chimarra</i> sp.	0	P
<i>Leptocerus ?inflatus</i>	0	P
<i>Hydroptila capensis</i>	0	0.1
<i>Orthotrichia barnardi</i>	0	0.2
Hydroptilid juveniles	P	1.9
Pyralidae	0.1	0
Dytiscidae	P	0.1
Gyrinidae	0	P

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

TAXON	JUNE 86	AUG 86
Hydrobiinae	P	0
Hydrophilidae	0.1	0.1
<i>Stenelmis</i> sp.	0	P
Staphylinidae	0	P
Curculionidae	P	P
Coleopterans	P	P
Culicidae	0	0.7
<i>Simulium</i> spp.	0	35.5
Chironomini	14.5	7.0
Tanytarsini	0.3	1.2
<i>Corynoneura</i> sp.	5.8	0.9
Orthocladinae	0.8	8.1
<i>Cricotopus</i> sp.	3.7	7.5
<i>Pentaneura</i> sp.	0.4	1.4
Tanypod pupae	P	0
<i>Dasyhelea</i> -type larvae	0	0.9
<i>Bezzia</i> -type larvae	0	0.3
Ceratopogonid pupae	0	0.3
Muscidae	0.1	0.3
<i>Lymnophora</i> sp.	0	0.1
<i>Biomphalaria</i> sp.	0.1	0.1
<i>Bulinus</i> sp.	P	0
<i>Lymnaea</i> sp.	0	P
<i>Melanoides</i> sp.	0.2	0
Ancylidae	0.1	0.2
<i>Eupera</i> 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 MUTALE RIVER ABOVE CONFLUENCE WITH THE LUVUVHU RIVER.

	AUG 86
TAXON	
<i>Hydra</i> sp.	0.7
Planaria	3.0
Cyclopoid copepods	14.3
<i>Pionocypris</i> sp.	29.6
<i>Nais</i> sp.	1.1
Other oligochaetes	1.7
<i>Caridina</i> sp.	0.5
<i>Centroptilum excisum</i>	0.3
<i>Baetis bellus</i>	11.1
<i>Cloeon africanum</i>	7.2
<i>Choroterpes</i> sp.	0.1
<i>Austrocaenis</i> sp.	4.7
<i>Afronurus</i> sp.	0.1
<i>Pseudagrion</i> sp.	0.1
Zygopterans	1.6
Anisopterans	0.1
Belastomatidae	0.2
Pleiiidae	0.2
<i>Micronecta</i> sp.	P
Other hemipterans	1.1
<i>Leptocerus ?inflatus</i>	1.1
Leptoceridae	0.1
<i>Oecetis</i> sp.	P
<i>Hydroptila capensis</i>	0.3
<i>Orthotrichia barnardi</i>	0.3
Hydroptilid juveniles	1.8
<i>Laccophilus</i> sp.	0.1
<i>Ochthebius</i> sp.	P
Hydraenidae	P
Psephenidae	P
<i>Methles</i> sp.	P
Hydrobiinae	0.2
Hydrophilidae	0.3
Chrysomelidae	0.1
Sciomyzidae	P
Culicidae	0.6
<i>Simulium</i> spp.	0.4
Chironomini	4.3
Tanytarsini	0.3
<i>Corynoneura</i> sp.	0.7
Orthocladinae	2.9
<i>Cricotopus</i> sp.	4.6
<i>Pentaneura</i> sp.	1.9
Tanypod pupae	1.4
<i>Bezzia</i> -type larvae	0.2
<i>Forcipomyia</i> sp.	0.3

Table D6. Mutale River above confluence with Luvuvhu River. Vegetation biotopes (cont.)

	AUG
TAXON	86
Ceratapogonid pupae	0.6
Muscidae	P
<i>Biomphalaria</i> sp.	0.1
Ancylidae	0.3
TOTAL NO. OF INDIVIDUALS	2441

TABLE E. TAXONOMIC LIST OF ORGANISMS RECORDED.

CLASSIFICATION	NAME USED IN TABLES
COELENTERATA	
<i>Hydra</i> sp.	<i>Hydra</i> sp.
NEMERTEA	
<i>Prostoma</i> sp.	<i>Prostoma</i> sp.
NEMATODA	Nematoda
TARDIGRADA	Tardigrada
ANNELIDA	
Oligochaeta	
Naididae	
<i>Pristina</i> sp.	<i>Pristina</i> sp.
<i>Nais</i> sp.	<i>Nais</i> sp.
<i>Dero</i>	<i>Dero</i> sp.
<i>Aulophora</i>	<i>Aulophora</i> sp.
other naids	other naids
Tubificidae	
<i>Branchiura</i> sp.	<i>Branchiura</i> sp.
other tubificids	other tubificids
Branchiobdellidae	Branchiobdellids
other oligochaetes	other oligochaetes
Hirudinea	
Glossiphoniidae	
<i>Batracobdelloides tricarinatus</i>	<i>Batracobdelloides tricarinatus</i>
<i>Helobdella conifera</i>	<i>Helobdella conifera</i>
<i>Placobdelloides multistriatus</i>	<i>Placobdelloides multistriatus</i>
Salifidae	
<i>Barbronia</i> sp.	<i>Barbronia</i> sp.

Table E. Taxonomic list of organisms recorded (cont.)**CRUSTACEA**

Cladocera

<i>Bosmina longirostris</i>	<i>Bosmina longirostris</i>
<i>Ceriodaphnia/Simocephalus</i> sp.	<i>Ceriodaphnia/Simocephalus</i>
<i>Daphnia</i> sp.	<i>Daphnia</i> sp.
<i>Diaphanosoma</i> sp.	<i>Diaphanosoma</i> sp.
<i>Macrothrix</i> sp.	<i>Macrothrix</i> sp.
Chydorids	Chydorids
other cladocerans	other cladocerans

Copepoda

Cyclopoid copepods	Cyclopoid copepods
other copepods	other copepods

Ostracoda

<i>Stenocypris</i> sp.	<i>Stenocypris</i> sp.
<i>Pionocypris</i> sp.	<i>Pionocypris</i> sp.
other Ostracoda	other Ostracoda

Decapoda

<i>Caridina</i> sp.	<i>Caridina</i> sp.
Decapod juveniles	Decapod juveniles
Crab	Crab

HYDRACARINA

Hydracarina sp.1	Hydracarina sp.1
Hydracarina sp.2	Hydracarina sp.2

INSECTA

Collembola

Collembola

Plecoptera

<i>Neoperla spio</i>	<i>Neoperla spio</i>
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Ephemeroptera

Polymitarcyidae	
<i>Ephoron</i> sp.	<i>Ephoron</i> sp.
<i>Povilla adusta</i>	<i>Povilla adusta</i>

Table E. Taxonomic list of organisms recorded (cont.)**Baetidae**

<i>Centroptiloides bifasciatum</i>	<i>Centroptiloides bifasciatum</i>
<i>Centroptiloides ?spinulosa</i>	<i>Centroptiloides ?spinulosa</i>
<i>Centroptilum excisum</i>	<i>Centroptilum excisum</i>
<i>Centroptilum</i> 'near excisum'	<i>Centroptilum</i> 'near excisum'
<i>Centroptilum flavum</i>	<i>Centroptilum flavum</i>
<i>Centroptilum medium</i>	<i>Centroptilum medium</i>
<i>Centroptilum varium</i>	<i>Centroptilum varium</i>
<i>Cloeon africanum</i>	<i>Cloeon africanum</i>
<i>Cloeon</i> 'longtoes'	<i>Cloeon</i> 'longtoes'
<i>Cloeon</i> sp.	<i>Cloeon</i> sp.
<i>Pseudocloeon maculosum</i>	<i>Pseudocloeon maculosum</i>
<i>Pseudocloeon vinosum</i>	<i>Pseudocloeon vinosum</i>
<i>Pseudocloeon</i> sp.A. Kimmins	<i>Pseudocloeon</i> sp.A. Kimmins
1955	1955
<i>Pseudocloeon</i> sp.	<i>Pseudocloeon</i> sp.
<i>Baetis bellus</i>	<i>Baetis bellus</i>
<i>Baetis glaucus</i>	<i>Baetis glaucus</i>
<i>Baetis quintus</i>	<i>Baetis quintus</i>
<i>Baetis (Acentrella)</i> sp.	<i>Baetis (Acentrella)</i> sp.
<i>Afrobaetodes berneri</i>	<i>Afrobaetodes berneri</i>
other baetid sp. A	other baetid sp. 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

<i>Oligoneuriopsis elizabethae</i>	<i>Oligoneuriopsis elizabethae</i>
<i>Elassoneuria</i> sp.	<i>Elassoneuria</i> sp.

Heptageniidae

<i>Afronurus</i> sp.	<i>Afronurus</i> sp.
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Table E. Taxonomic list of organisms recorded (cont.)

Leptophlebiidae	
<i>Adenophlebiodes</i> sp.	<i>Adenophlebiodes</i> sp.
<i>Castanophlebia</i> sp.	<i>Castanophlebia</i> sp.
<i>Choroterpes</i> sp.	<i>Choroterpes</i> sp.
<i>Masharikella</i> sp.	<i>Masharikella</i> sp.
Tricorythidae	
<i>Tricorythus</i> "lowveld"	<i>Tricorythus</i> "lowveld"
<i>Machadorythus</i> sp.	<i>Machadorythus</i> sp.
<i>Dicercomyzon</i> sp.	<i>Dicercomyzon</i> sp.
Prosopistomatidae	
<i>Prosopistoma</i> sp.	<i>Prosopistoma</i> sp.
Caenidae	
<i>Austrocaenis</i> sp.	<i>Austrocaenis</i> sp.
Odonata	
Zygoptera	
<i>Elattoneura</i> sp.	<i>Elattoneura</i> sp.
<i>Allocnemis</i> sp.	<i>Allocnemis</i> sp.
<i>Metacnemis</i> sp.	<i>Metacnemis</i> sp.
<i>Chlorocypha</i> sp.	<i>Chlorocypha</i> sp.
<i>Pseudagrion massaicum</i>	<i>Pseudagrion massaicum</i>
<i>Pseudagrion</i> sp.	<i>Pseudagrion</i> sp.
<i>Enallagma</i> sp.	<i>Enallagma</i> sp.
<i>Ischnura</i> sp.	<i>Ischnura</i> sp.
Anisoptera	
<i>Paragomphus</i> sp.	<i>Paragomphus</i> sp.
Gomphidae	
<i>Anax</i> sp.	<i>Anax</i> sp.
<i>Aeschna</i> sp.	<i>Aeschna</i> sp.
<i>Phyllomacromia</i> sp.	<i>Phyllomacromia</i> sp.
<i>Orthetrum</i> sp.	<i>Orthetrum</i> sp.
<i>Crocothemis</i> sp.	<i>Crocothemis</i> sp.
<i>Sympetrum</i> sp.	<i>Sympetrum</i> sp.
<i>Zygonyx</i> sp.	<i>Zygonyx</i> sp.
<i>Pantala</i> sp.	<i>Pantala</i> sp.
<i>Olpogastra</i> sp.	Libellulid sp.1
Libellulid	Libellulid

Table E. Taxonomic list of organisms recorded (cont.)

Hemiptera

Hebridae	Hebridae
Mesoveliidae	Mesoveliidae
Gerridae	Gerridae
Veliidae	Veliidae
<i>Rhagovelia</i> sp.	<i>Rhagovelia</i> sp.
Notonectidae	Notonectidae
Pleidae	Pleidae
Naucoridae	Naucoridae
Nepidae	Nepidae
Belostomatidae	
<i>Sphaerodema</i> sp.	<i>Sphaerodema</i> sp.
Corixidae	
<i>Micronecta</i> sp.	<i>Micronecta</i> sp.
Other hemipterans	Other hemipterans

Trichoptera

Hydropsychidae	
<i>Aethaloptera</i> sp.	<i>Aethaloptera</i> sp.
<i>Amphipsyche scottae</i>	<i>Amphipsyche scottae</i>
<i>Cheumatopsyche</i> 'afra' type	<i>Cheumatopsyche afra</i>
<i>Cheumatopsyche</i> 'thomasseti' type	<i>Cheumatopsyche thomasseti</i>
Diplectroninae	Diplectroninae
Philoptamidae	
<i>Chimarra</i> sp.	<i>Chimarra</i> sp.
Ecnomidae	
<i>Ecnomus</i> sp.	<i>Ecnomus</i> sp.
<i>Psychomyiellodes</i> sp.	<i>Psychomyiellodes</i> sp.
Leptoceridae	
<i>Athripsodes</i> sp.	<i>Athripsodes</i> sp.
<i>Leptocerus</i> ?inflatus	<i>Leptocerus</i> ?inflatus
<i>Leptocerus</i> ?schoenobates	<i>Leptocerus</i> ?schoenobates
<i>Pseudoleptocerus</i> sp.	<i>Pseudoleptocerus</i> sp.
<i>Oecetis</i> sp.	<i>Oecetis</i> sp.
<i>Trichosetodes</i> sp.	<i>Trichosetodes</i> sp.
Sp. cf. <i>Barbarochthon</i>	? <i>Barbarochthon</i> sp.
Psychomyiidae	Psychomyiidae

Table E. Taxonomic list of organisms recorded (cont.)

Lepidostomatidae	
<i>Dyschimus</i> sp.	<i>Dyschimus</i> sp.
Hydroptilidae	
<i>Hydroptila capensis</i>	<i>Hydroptila capensis</i>
<i>Hydroptila</i> sp.	<i>Hydroptila</i> sp.
<i>Catoxyethira</i> sp.	<i>Catoxyethira</i> sp.
<i>Orthotrichia barnardi</i>	<i>Orthotrichia barnardi</i>
Hydroptilid juveniles	Hydroptilid juveniles
other trichopterans	Trichopterans
Lepidoptera	
Pyrilidae	Pyrilidae
Coleoptera	
Dytiscidae	Dytiscidae
<i>Laccophilus</i> sp.	<i>Laccophilus</i> sp.
<i>Methles</i> sp.	<i>Methles</i> sp.
<i>Peschetius</i> sp.	<i>Peschetius</i> sp.
Halipilidae	Halipilidae
Gyrinidae	
<i>Orectogyrus</i> sp.	<i>Orectogyrus</i> sp.
Hydrophilidae	Hydrophilidae
? <i>Tropisternus</i> sp.	<i>Tropisternus</i> sp.
Hydraenidae	
<i>Ochthebius</i> sp.	<i>Ochthebius</i> sp.
Psephenidae	Psephenidae
Dryopidae	
? <i>Helichus</i> sp.	<i>Helichus</i> sp.
Elmidae	
<i>Leptelmis</i> sp.	<i>Leptelmis</i> sp.
<i>Stenelmis</i> sp.	<i>Stenelmis</i> sp.
<i>Pseudancyronyx</i> sp.	<i>Pseudancyronyx</i> sp.
other Elmidae	other Elmidae
Helodidae	Helodidae
Staphylinidae	
Aleocharinae	Aleocharinae

Table E. Taxonomic list of organisms recorded (cont.)

Chrysomelidae	Chrysomelidae
Curculionidae	Curculionidae
other coleopterans	other coleopterans
Diptera	
Tipulidae	Tipulidae
Psychodidae	Psychodidae
Culicidae	Culicidae
Simuliidae	Simuliidae
<i>Simulium</i> spp.	<i>Simulium</i> spp.
Chironomidae	
Chironomini	Chironomini
<i>Chironomus</i> sp.	<i>Chironomus</i>
<i>Cryptochironomus</i> sp.	<i>Cryptochironomus</i> sp.
Tanytarsini	Tanytarsini
Orthoclaadiinae	Orthoclaadiinae
<i>Cricotopus</i> sp.	<i>Cricotopus</i> sp.
<i>Corynoneura</i> sp.	<i>Corynoneura</i> sp.
<i>Thienemanniella</i> sp.	<i>Thienemanniella</i> sp.
Tanypodinae	Tanypodinae
<i>Pentaneura</i> type 1	<i>Pentaneura</i> type 1
" type 2	<i>Pentaneura</i> type 2
" type 3	<i>Pentaneura</i> type 3
" type 4	<i>Pentaneura</i> type 4
<i>Procladius</i> sp.	<i>Procladius</i> sp.
Ceratopogonidae	
<i>Bezzia</i> -type larvae	<i>Bezzia</i> -type larvae
<i>Dasyhelea</i> -type larvae	<i>Dasyhelea</i> -type larvae
<i>Forcipomyia</i> -type larvae	<i>Forcipomyia</i> sp.
Stratiomyiidae	Stratiomyiidae
Tabanidae	Tabanidae
Rhagionidae	Rhagionidae
Ephyridae	Ephyridae
Empididae	Empididae
Muscidae	Muscidae
Anthomyiidae	Anthomyiidae
<i>Limnophora</i> sp.	<i>Limnophora</i> sp.

Table E. Taxonomic list of organisms recorded (cont.)

Dolichopodidae	Dolichopodidae
higher dipterans	higher dipterans
Dipteran puparia	Dipteran puparia
MOLLUSCA	
Gastropoda	
<i>Anisus</i> sp.	<i>Anisus</i> sp.
<i>Biomphalaria</i> sp.	<i>Biomphalaria</i> sp.
<i>Bulinus</i> sp.	<i>Bulinus</i> sp.
<i>Lymnaea</i> sp.	<i>Lymnaea</i> sp.
<i>Physopsis</i> sp.	<i>Physopsis</i> sp.
<i>Melanoides</i> sp.	<i>Melanoides</i> sp.
<i>Ancylus</i> sp.	<i>Ancylus</i> sp.
<i>Ferrissia</i> sp.	<i>Ferrissia</i> sp.
other Ancyliidae	other Ancyliidae
other Gastropoda	other Gastropoda
Pelecypoda	
<i>Corbicula africana</i>	<i>Corbicula africana</i>
? <i>Eupera</i> sp.	<i>Eupera</i> sp.
other Pelecypoda	other Pelecypoda
PISCES	
<i>Anguilla</i> sp.	<i>Anguilla</i> sp.
<i>Barbus</i> sp.	<i>Barbus</i> sp.
<i>Chiloglanis</i> sp.	<i>Chiloglanis</i> sp.
<i>Oreochromis mossambicus</i>	<i>Oreochromis mossambicus</i>
Fish juveniles	Fish juveniles
ANURA	
<i>Xenopus</i> sp.	<i>Xenopus</i> sp.
Anuran juveniles	Anuran juveniles