

**A hydrobiological investigation of the
Umgeni river system, Natal, and its
bearing on the ecological interpreta-
tion of faunal communities in
South African rivers**

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A HYDROBIOLOGICAL INVESTIGATION OF THE UMGENI RIVER
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I.

GENERAL INTRODUCTION

The Umgeni River Research Fellowship was jointly established by the Town and Regional Planning Commission of Natal and the National Institute for Water Research of the South African Council for Scientific and Industrial Research, Pretoria. Within the framework of the broad objective laid down by the sponsors, namely, to protect the quality of the water resources of the Umgeni river basin for domestic, agricultural, industrial and other uses, and at the same time to collect the basic data necessary for the formulation of stream and effluent standards and the control of pollution and bacterial contamination, a programme of investigation was evolved which largely consisted of two phases. The first phase of the investigation was planned to provide a general background necessary for the second and included the following:

- i. The mapping of the catchment to show residential areas, sewage disposal systems, industrial, agricultural and recreational activities;
- ii. A physical and chemical survey of the streams in the catchment area and the establishment of the conditions in unpolluted streams. At the same time sources of stream disturbance such as sewage and industrial effluents were located.
- iii. A general ecological investigation of the main and its major tributaries, which provided a back-

ground knowledge of the distribution of the fauna under clean, undisturbed water conditions and which at the same time located areas of stream disturbance as reflected by the faunal picture.

The second phase of the survey was aimed at establishing the faunal, faecal bacterial and physico-chemical conditions of the polluted streams, and involved detailed faunal surveys accompanied by 24-hour chemical and bacterial sampling programmes. Although this phase of the survey is not incorporated as part of the thesis itself, descriptive accounts, for reference purposes, are nevertheless included as an appendix.

One major obstacle concerning the ecological investigations of our fresh water fauna in South Africa still is the fact that there are numerous macro-invertebrate species, whose larval forms constitute the bulk of the aquatic macro-invertebrates, which are either still unnamed, or, not yet adequately correlated with their respective larval stages. I therefore found it essential to rear and correlate with adults, some of these larval forms, the outcome of which is an attempted revision of the small but nevertheless ecologically important and interesting mayfly genus Afronurus Lestage in South Africa. Apart from the advantages of being able to correlate and to describe, from fresh material, each of the developmental stages of the various species under consideration, I could draw upon a more complete knowledge concerning their respective ecological distributions and employ this in the discrimination between morphologically closely related species.

2. METHODS AND TECHNIQUES

2.1 General.

2.1.1 Survey Procedure.

As an introduction to each of the respective surveys, preliminary investigations were made of the areas traversed by clean and polluted streams. Special attention was paid to and information gathered on the topography, geology, soils, vegetation, rainfall, air temperatures, population densities and recreational and industrial activities. This was followed up by an investigation of the streams during which notes were made of the colour, turbidity and odour of the water. Stones in the streams were examined for the presence or absence of certain benthic fauna, algal and sewage fungal (Sphaerotilus) growths, silt and other deposits. In addition, limited physical and chemical analyses such as water temperatures, conductivities, pH and dissolved oxygen determinations provided useful data for quick assessment of the stream conditions at certain selected places in the rivers under survey.

The compilation of maps showing industrial, residential and agricultural activities, effluent discharges, sewage disposal systems, roads, bridges etc., rounded off the preliminary investigations. Chemical and biological sampling sites were selected at places on the main river and its major tributaries, not only to gain a knowledge of the clean undisturbed parts of the river system (phase 1), but also to cover the effluent discharges as well as the streams above and below the points of discharge (phase 2, appendix). Additional

biological and chemical sampling stations were chosen well below the entry of effluents and drains in order to provide information on the deterioration or recovery of the streams and their fauna.

In addition to the chemical sampling programme for the general hydrobiological investigation, which was undertaken by the author and the water chemist of the N.I.W.R., arrangements were also made with the Pietermaritzburg and Durban Corporations and the laboratories of the State Health Department in connection with the analysis of the chemical and bacteriological samples respectively collected during phase 2 of the investigation (see appendix), and the dates, times and duration of the sampling periods were agreed upon. In order to obtain comparable results, the chemical and bacteriological methods adopted were, with few exceptions, the same for all the surveys.

2.1.2 Sampling Techniques.

i. Faunal.

Various sampling devices have been developed and used by different research workers on problems of stream productivity (Needham, 1934; Ide, 1940; Sprules, 1947). However, since the introduction of the square foot stream bottom sampler (Surber, 1937; Davis, 1938), it has gained in popularity amongst research workers and has been widely used in the quantitative studies of stream bottom fauna in overseas countries as well as in Southern Africa, (Maciolek and Needham, 1957; Harrison and Elsworth, 1958; Oliff, 1960; Allanson, 1961;

Chutter, 1963).

A square foot (0.093 m^2) stream bottom surber sampler and a handnet were largely employed in the faunal surveys under consideration. Both the handnet, which had a brass ring of 16 inches (40.6 cm) diameter, and the surber sampler, had bags of silk grit gauze of 25 meshes to the centimetre (64/inch). Quantitative stream bottom samples comprised 2 - 3 square foot surber collections ($0.186-0.279 \text{ m}^2$) which covered the different habitats at each site. In this way a "cross section" of the fauna present at each sampling station was obtained. Marginal and submerged aquatic vegetation were sampled by sweeping the handnet vigorously upstream through the vegetation for a distance of 6 feet. Samples, together with waterproof labels bearing the necessary information such as the time of day, date and type of sample etc., were transferred to jars, treated with 40% formalin (approximate dilution 1 in 10) and transported to the laboratory where the sorting and classifying of organisms were carried out. A Birge-Eckman grab (Lenz modification) of 225. sq. cm. was mainly employed in the sampling of soft bottom habitats.

ii. Bacterial (see appendix).

All water samples for bacteriological analysis were collected in specially prepared, clean, sterilized, labelled, ground-glass stoppered, 250 millilitre bottles. Care was taken to prevent any contamination of the samples during or after collection. Bottles were submerged in the streams and effluents with their necks tilted in such a way that no water flowed over the hands into the bottle (Rubber gloves were used on most occa-

sions for protection against schistosomiasis). The glass stoppers were removed and replaced under water.

Such factors as the time spent on collection and delivery of samples, inoculation into fermentation tubes (M.P.N. tests), duration of incubation and available space in incubators and water baths all limited the number of collections to a maximum of two per week. Surveys were concluded when a reasonably representative picture of the quality and quantity of bacterial loads in the effluents and streams was obtained.

Since most industries operate on an 8, 12 or 24-hour basis the quality and quantity of the effluents were nearly always found to show a considerable variation over one working day period. As a result of this, time studies of effluents and streams were useful only in providing an "average" or representative picture of the quality and quantity of bacterial loads by smoothing out extreme values. A combination of collections of a series of snap samples, to show up variation, and composite samples, to give a representative picture of the prevailing bacterial conditions, were therefore carried out in the surveys under consideration.

In the case of the Umgeni Estuary, for instance, where the effects of the effluents of a Board Mill Factory and a Steam Laundry were studied, hourly composite samples were obtained by mixing 4 snap samples collected at 15 minute intervals during specified hours of the day (part 1 appendix). A somewhat different procedure was followed in the study of the Zeekoe river system where altogether ten studies (stations 1 - 10) were included in the special study. This necessitated the reduction of composite samples

to two samples per station. Half-hourly snap samples, collected between 8 a.m. - 11.30 a.m. and 12 noon - 3.30 p.m., made up the two composite samples for each station. The afternoon collections of composite samples were, in all surveys, kept in refrigerators and inoculated into fermentation tubes next morning. Similar procedures, as described above, were adopted for the other pollution surveys.

iii. Physical and Chemical.

During the general survey of the Umgeni river system, both snap and composite water samples were taken at selected stations on the main Umgeni river and its major tributaries at various times during the period 1959 to 1960. The snap samples were collected in glass bottles and transported to the Durban laboratory for analysis, the pH value and the electrical conductivity of the water, however, being measured in the field. The composite samples were provided by the Water Engineer's Department of the Natal Provincial Administration and were compounded from the numerous snap samples taken during the course of an investigation of the silt loads carried at various points in the Umgeni river system. These samples, which were often several weeks old before reaching Durban, were analysed for their inorganic constituents only.

Where special pollution surveys were conducted (see appendix) the collection of snap and composite water samples for physical and chemical determinations coincided with the bacteriological surveys.

2.1.3 Analysis of Samples.

i. Faunal Analyses.

In the laboratory, the contents of each sample were transferred to a conical bag of the same mesh as that used for the surber sampler and handnet. A brass ring suspended it on a tripod placed in a sink. Water was sprayed over each sample to remove the excess formalin. The sample was then transferred to a counting dish and examined under a Zeiss stereo-microscope mounted upon a scanning stand specially designed for this type of work in the C.S.I.R. workshops. Large pieces of detritus, leaves and small stones were first removed and the animals counted, identified and classified as far as possible. This information was then entered upon cards bearing all the particulars such as the time, date and sampling station.

ii. Bacterial Analyses (see appendix).

The media used for the determination of total coliforms faecal E. coli and faecal streptococci and the incubation periods are indicated in the following table.

Dilutions of samples were determined by the counts obtained from collections made during the preliminary run and adjusted, where required, after the first few determinations until the correct range of dilutions was obtained for samples from each station.

Type of Organism	Inoculation media	Temperature in °C and incubation period
Total coliform	Single strength MacConkey broth	37°C for 48 hours (incubator)
Faecal <u>E.coli</u>	Brilliant green bile lactose broth	44.5°C for 48 hours (water bath)
Faecal streptococci	Buffered azide glucose glycerol broth	44.5°C for 48 hours (water bath)

Inoculation of 1 millilitre portions of decimal dilutions of the original sample into the selective media mentioned in the table provided the most probable number (M.P.N.) of organisms capable of fermenting these media at specified temperatures. The numbers of inoculated tubes which developed gas in the MacConkey and brilliant green bile broth and those which showed a colour change in the buffered azide glucose glycerol broth were taken as positive, counted and the M.P.N. of organisms obtained from a table. The M.P.N. methods are discussed in detail by Keller, 1959 and Standard Methods, 1960.

iii. Physical and Chemical Analyses.

The analytical methods used were mainly those specified by the American Public Health Association (1955), but with the following differences:

Electrical conductivity was determined by means of a Dionic conductivity meter and expressed as micromho at 20°C.

Total dissolved solids (T.D.S.) were determined by evaporating a known volume of filtered sample (normally 100 mls.) and drying the residue for 1 hour at 180°C.

Oxygen absorbed values (O.A.) were determined by the method of the Society for Analytical Chemistry (1958) for the 4 hour permanganate value.

Biological oxygen demand (B.O.D.) was determined by incubating samples without dilution for 5 days at 20°C in the dark.

Free and saline ammonia nitrogen was sometimes determined in the field by direct nesslerisation to confirm that the zero values usually obtained by distillation did not arise by loss of ammonia during transportation.

Nitrate nitrogen was determined by sodium salicylate according to the method of Müller and Wideman (1955).

Phosphate was determined by ammonium molybdate, using ascorbic acid as reducing agent to form "molybdenum blue" by a method adapted from that of Murphy and Riley (1958).

Silica was determined colorimetrically by a method adopted by the S.A. Bureau of Standards (1951).

2.1.4 Selection of Sampling Stations.

After a preparatory investigation into the conditions of streams in the Umgeni basin, the sampling localities for the general hydrobiological and chemical surveys were selected to provide a representative picture of the faunal ecology and water quality conditions of the main river as well as of its major unpolluted tributaries (fig. 1). Streams affected by sewage and industrial effluents such as the Palmiet, and Zeekoe rivers, respectively, were covered by sampling sites only at or near their junctions with the main river. In this way it was also possible to determine, during the first part of the investigation, the possible pollution effects of these streams upon the biology and water chemistry of the main river. The sampling sites visited during the general survey are listed in table 1.

2.1.5 Habitat types sampled.

Where it was possible, the following stream bottom habitats (= water types: Allen, 1951) were sampled. The current speeds and water depths at each habitat type in the Umgeni basin roughly correspond with the findings of Harrison and Elsworth (1958).

The stony bottom water types.

- i. Back waters: "Sheltered parts of the stream, out of the main current....."
(Harrison and Elsworth, 1958, p. 136).

Usually these are less than six inches (\pm 15 cm) deep and are covered with detritus. The temperatures fluctuate much more than they do in any of the other water types during the different periods of the day.

- ii. Pools: "Water of considerable depth for the size of the stream, current generally slight, and the flow smooth apart from a small turbulent area at the head of some pools." (Allen).

"Current speed-under one foot per second; depth-over eighteen inches"
(Harrison and Elsworth).

The pools sampled in the Umgeni river generally exceeded depths of 2 feet (\pm 61 cm). At Ross`Farm, below the Sponge, for instance, a few pools sampled reached a depth of 3 feet (\pm 91.0 cm).

iii. Flats: "Water of a slight to moderate current and generally smooth flow, but of less depth than in pools" (Allen).

"Current - under one foot per second; depth - under eighteen inches" (Harrison and Elsworth).

The flats sampled in the Umgeni river never exceeded one foot (\pm 30 cm) in depth whilst the maximum current speed, at times, exceeded 1 foot/second (= 30 cm/sec.).

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

"Current - over one foot per second; depth - over one foot, runs in sandy areas are shallower." (Harrison and Elsworth).

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

"Current - over one foot per second; depth - under one foot. The same proportion might be a run in the wet season and a stickle in the dry season." (Harrison and Elsworth).

Where no clear cut distinction could be made between runs and stickles, such samples were classified under "Runs and Stickles". These are discussed separately in the text.

vi. Cascades: "Water in which a steep gradient, combined with a bed of stones or rocks large in proportion to the size of the stream, produces a very irregular flow, often with some white water." (Allen).

"Cascades and small waterfalls only occurred where streams were running down mountain slopes and valleys. Here current speeds were over 2.5 feet per second, and depth very variable but usually between four and eighteen inches." (Harrison and Elsworth).

The current speeds in cascades such as Ross`Farm and Albert Falls usually exceeded 2.5 feet/second(76.2 cm/sec.), averaging 2.75 feet/second (83.8 cm/sec.). The conditions otherwise resembled those described by Allen (1951) and Harrison and Elsworth (1958),

Marginal and aquatic vegetation.

Marginal and submerged aquatic vegetation were sampled where they fringe, or, in the case of the latter,

occur in any of the above-mentioned water types. Whereas the marginal vegetation usually predominate along the slower flowing parts of the streams, the submerged aquatic vegetation, particularly Hydrostachys natalensis, occur mainly in the stony runs and stickles.

2.2 Taxonomy.

The collection of information on the occurrence of Afronurus nymphs in South African rivers was largely facilitated by the following surveys and/or collections made by the staff of the National Institute for Water Research of the C.S.I.R.:

- i) The Hydrobiological survey of the Umgeni river system, Natal, (Schoonbee and Kemp, in preparation);
- ii) Other stream surveys conducted by the C.S.I.R. (Harrison and Elsworth, 1958; Oliff, 1960; Allanson, 1961; Chutter, 1963).
- iii) Collections of laboratory bred-out material and nymphs received from Dr. K.M.F. Scott and messrs. F.M. Chutter and J.D. Agnew.

This information was supplemented by a special collection trip undertaken in the south eastern and western Cape. Nymphs of Afronurus were taken from the localities listed in the table below where, from the above-mentioned surveys, they were known to occur in large numbers.

Sampling localities : Cape trip, December, 1961.

Locality Description	Date of collection	Altitude in feet (metres)
1. Beestekraal tributary of the Umzimhlava river upstream of the National road bridge, approximately 9 miles east of Kokstad.	30.11.61	4500 - 5,000 (1,372-1,524)
2. Umzimhlava river above National road bridge at Kokstad.	30.11.61	4,000-4,500 (1,219-1,372)
3. Tsitsa river below National road bridge, approximately 8 miles from Qumbu.	11.12.61	2,000-2,500 (610 - 762)
4. Bashee river above National road bridge downstream from the Mtentu tributary, approximately 17 miles north east of Idutywa.	11.12.61	1,000-1,500 (305 - 457)
5. Great Kei river above the National road, approximately 8 miles north east of Komgha	9.12.61	0 - 1,000 (0 - 305)
6. Toleni river about 0.5 miles above its confluence with the Great Kei river, approximately 13 miles south west of Butterworth.	2.12.61	0 - 1,000 (0 - 305)
7. Buffalo river at Pirie Forest near King Williamstown.	2.12.61	2,000-2,500 (610 - 762)
8. Grobbelaars river (tributary of the Olifants river system), at road bridge near the Kango caves, Oudshoorn.	8.12.61	2,000 (610)
9. Molenaars river (tributary of the Breede river) near du Toitskloof pass.	4.12.61	1,000 (305)
10. Great Berg river at Franschoek Forest Reserve, one mile above the Assegaaibos stream.	6.12.61	1,000-2,000 (305 - 610)
11. Great Berg river at the lower Forest Reserve, (Driefontein bridge).	6.12.61	500-1,000 (152-305)
12. Great Berg river at railways bridge above Groot Drakenstein.	6.12.61	500-1,000 (152-305)

13. Twenty four rivers (tributary of Great Berg river) near Saron on the Gouda-Piketberg road. 7.12.61 0 - 500 (0 - 152)

In at least two of the four localities, in the Umgeni basin where material was collected for the correlation of the nymphal and imaginal stages, a site could be chosen where only one particular species of Afronurus occurred in comparatively large numbers.

Since the collection of nymphal material did not require quantitative sampling, a hand net proved most useful in those streams where stones could be dislodged and their attached fauna washed into the net with the aid of the current. In deep pools, however, where the stones were too large to be handled with one hand, they were gently removed from the river bed, turned upside down and then brought to the surface. The nymphs were then found to cling to the dorsal surfaces of stones instead of falling back into the stream as they usually do when they remain on the under sides of stones. This trick of inverting the stones under water before being brought to the surface was not equally successful in clear head water streams where the nymphs often rapidly *dashed* back to the under side of undisturbed rocks and stones. This behaviour might suggest that they are particularly sensitive to light intensity.

Where this could be done the nymphs were dislodged from the stones either with a pair of forceps or a brush. Those washed into the handnet, were transferred to a white flat bottom tray from which undamaged final or penultimate instar nymphs were taken. Since it is possible to distinguish the sexes by reference to the rudiments already present of the genostyles (♂♂) or

ventral plates (♀♀), and also by dint of the larger eyes of the ♂♂ nymphs, enough material of each sex could be selected for rearing purposes during each collection trip. The collected live material was transported to the laboratory either in consul jars or thermos flasks. Final instar nymphs appear to be very sensitive to low oxygen tensions and were therefore kept separately, or at the most in very small numbers, in small quantities of water. In the summer months (December - February), when air temperatures exceeded 100°F at times, small pieces of ice were useful in keeping temperatures down and, at the same time, reducing the activity of specimens. In this way it was possible to keep nymphs alive for several hours before being transferred to aquaria.

In the laboratory, stones, collected from streams at the sampling localities and kept in buckets of water to prevent the algae and diatoms from drying out, were placed into the aquarium tanks together with the nymphs. On most occasion tap water was used and compressed air was constantly bubbled through the water. It was however, found that, even when the aeration was discontinued for indefinite periods, nymphs usually survived and also hatched, provided they were ^{kept} in water less than 2 inches deep.

The water temperatures of the aquaria at the Durban laboratories of the C.S.I.R. usually exceeded 20°C. In fact, temperatures of 25-28°C were (often) recorded. These extremes, however, did not appear to be detrimental to any of the species, including those collected from the much cooler head waters of the Umgeni river and its tributaries, since they all hatched equally well in the laboratory. However, when transferred

from the colder water of thermos flasks into the warmer water of the tanks, the nymphs of all species became very active and only calmed down after an hour or more when they attached themselves to the under sides of stones.

Nymphs about to hatch were observed to raise their bodies from the surfaces of the stones to which they clung and to remain in this position for a few hours prior to ecdysis. At the time of actual hatching most nymphs were found to leave the stones, and to attach themselves to small pebbles. Ecdysis always occurred at night, mostly before 10 p.m. The water depth at which the hatching took place did not appear to affect the process since emergence took place equally well at depths between 2 and more than 12 inches. The duration of emergence of the subimago varied from only a few seconds to just over 20 seconds. The tanks were covered with a framework of fine mesh and the subimagines were kept in the tank until transformation to imago was completed. Most subimagines were found to moult within 36 hours. In fact, about 70% of them completed the process within one day after their transformation from nymph to subimago. This agreed^s with the findings of Mr. A.C. Harrison (Barnard, 1932, p. 258).

On account of the species specificity of the colouration and colour patterns of the specimens which fade out completely in preserved material, colour prints of live or freshly killed specimens of the different species are here reproduced which should greatly facilitate correct identification in future studies on this genus.

All photographs were taken with a 35 mm. Exakta reflex camera using Kodacolor colour negative film (A.S.A. 32). By using sets of extension tubes, which were fitted to the camera with an adapter ring, the focal length of the lens, inserted into the front of the tubes, was increased so as to produce a larger than life image on the negative. All photographs were taken in indirect sunlight. The camera, with the necessary extension tubes attached, was clamped to a retort stand placed upon a table near a window. Subimagines and imagines were narcotized and the nymphs killed before being placed in a small petri dish under the camera upon a glass plate elevated approximately 6 inches above a sheet of white paper. The white paper, when out of focus, produced a beautiful blue background to the photographs. To compensate for the weaker image obtained as a result of the extension, the exposure time was increased by the square of the focal length distance. Thus the intensity of incident light (through the window) was measured and the light image reflected into the camera (without extension tubes) was taken as $1/10$ th of that of the incident light. Say, for instance, the exposure meter reading was $1/10$ th of a second at f 16, then the actual exposure time indicated by the meter was multiplied by 10 i.e. $1/10 \times 10$ seconds at f 16 = 1 second at f 16. If however extension tubes were added, a further correction factor had to be introduced. Since two sets of tubes fitted, increased the focal lens distance by 4x, the final recalculated exposure time was then $10 \times 1/10 \times (4)^2$ seconds at f 16 = 16 seconds at f 16. This procedure ensured good photographs even on overcast days.

Even though the morphological differences between the nymphal, subimaginal and imaginal developmental stages of Afronurus were adequate in separating the different species, the ecological distribution of the nymphs nevertheless played an important role in the initial process of species demarcation and identification. In addition to the revision of the species A. harrisoni and A. peringueyi which are at present known from South Africa, three more species, new to science, could be recognised.

3. GENERAL DISCRIPTION OF THE UMGENI BASIN

3.1 Topography.

The Umgeni river catchment is roughly pearshaped (fig. 2) and occupies an area of 1,695 square miles (4,390 Km²). It is bounded on the north-east by the watersheds of the Tugela, Umvoti and Umhloti rivers and on the north-west by the Karkloof and Kranskop Heights which also form the southern border of the Mooi river catchment area. It also shares a watershed with the Umlaas river to the south. A large plateau, with a general altitude of 4000-5000 feet, separates the upper catchment of the main Umgeni river from that of its largest tributary, the Umsunduzi river.

The Umgeni river and one of its tributaries, the Lions river, originate in the Umgeni sponge (fig. 5), a vlei at the far western corner of the catchment at an altitude of just over 6,000 feet (1,829 metres). In this area, which lies approximately 15-20 miles (\pm 24-32 Km.) eastward, from the Drakensberg range, the annual precipitation usually exceeds 40 inches (\pm 1000 mm.)(fig. 8).

Unlike most other South African river systems which have been studied, such as the Tugela river, Natal, the Umgeni river, at its headwaters, flows through open rolling country, whilst its last 20-25 miles (\pm 32-40 Km.) traverses a deeply dissected terrain, the Valley of a Thousand Hills, where the river has incised itself profoundly to create deep and narrow gorges. The last 5-10 miles (\pm 8-16 Km.) of the river

SAMPLING STATIONS OF THE UMGENI RIVER SYSTEM

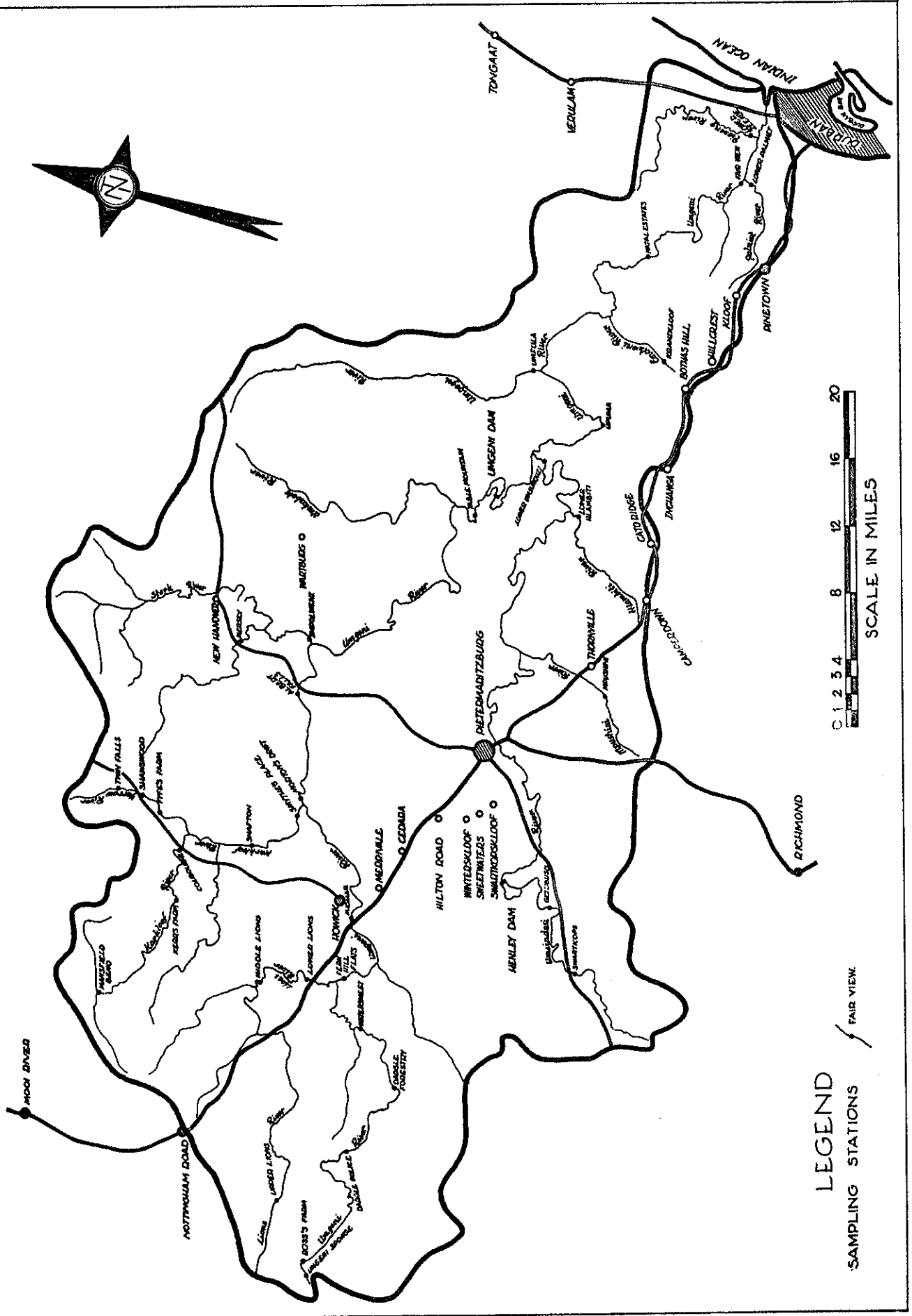


Fig. I. Sampling localities of the Umgeni river system

crosses a short flood plain. Here the numerous stony rapids of the upper reaches are replaced by a wide sandy bed. The river enters the Indian Ocean to the north of Durban Bay, approximately 145-150 river miles (\pm 233-241 Km.) from its source.

Like most other Natal rivers, the Umgeni river has a steplike profile (fig. 3), mainly determined by the monoclinical deformations of Natal (King, and King, 1959). Erosion resisting dolerite sills exercise an important additional influence upon the topography of the river basin at places like Dargle Falls (near Dargle Police Station; fig. 3), Howick and Albert Falls. Above each of these sills the river profile tends to flatten, only to regain its steep gradient below the water fall created by the sill. The presence of dolerite intrusions thus cause a series of miniature profiles within the larger Umgeni river profile (fig. 3), each with its components of a torrent and slower flowing region. Soft bottom zones are not represented in the microprofiles created above Dargle and Howick Falls (fig. 3), although such a zone is present in the microprofile between Howick and Albert Falls.

3.2 Geology.

In its course of about 145 miles, the Umgeni river traverses several geological formations (fig. 4). Flowing eastwards from their sources, the main Umgeni river and two of its larger tributaries (the Lions and Karkloof rivers) flow over exposed shales and sandstones of the Beaufort series of the Karroo system. Towards its junction with the Lions river, the Umgeni river

TOPOGRAPHY OF THE UMGENI RIVER SYSTEM

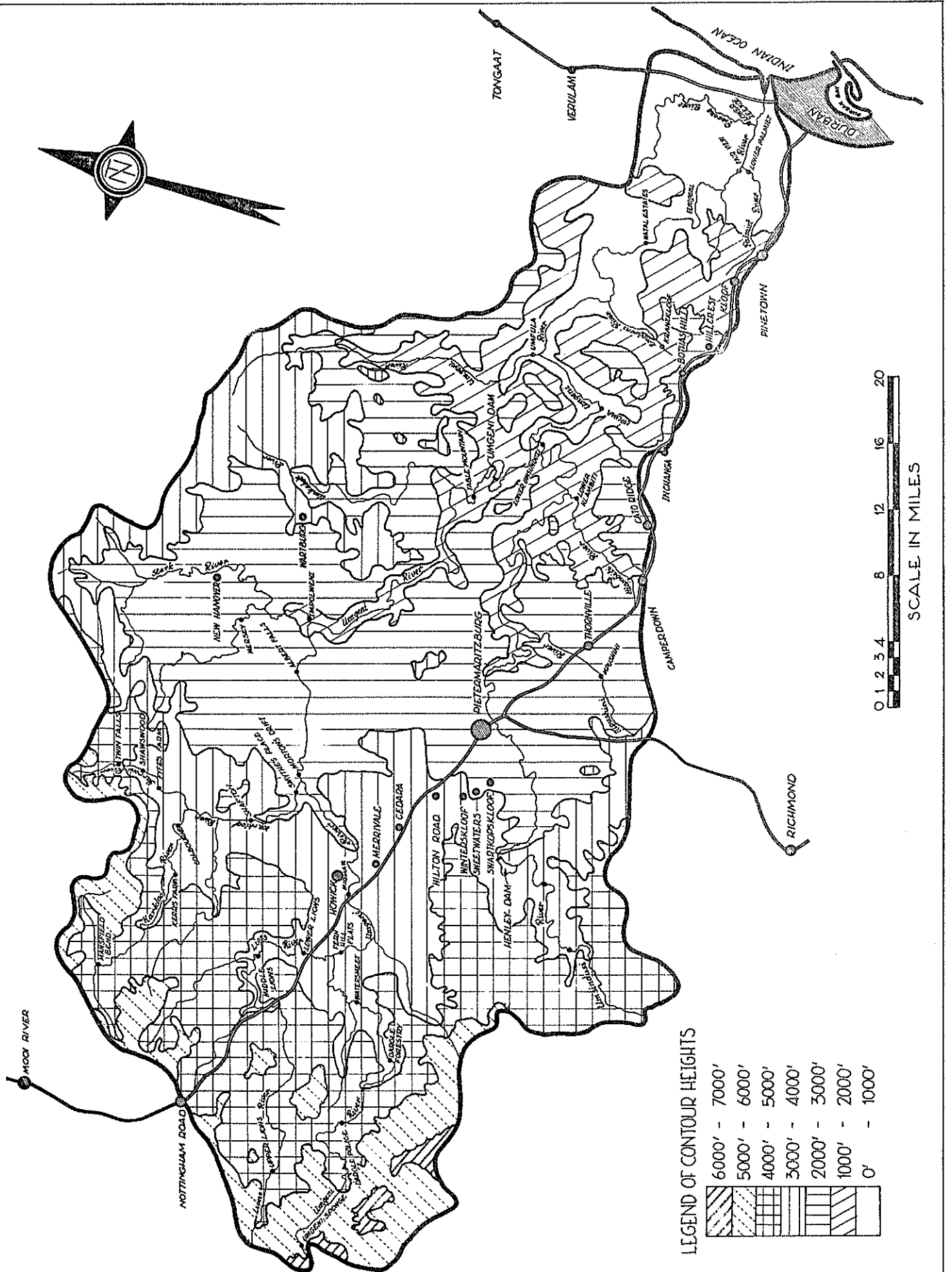


Fig. 2. Topography of the Umgeni river system

passes onto Eccca beds ^{which are} is exposed as a broad continuous belt across the catchment from south to north. In this part of the river all three stages of the Eccca series are consecutively exposed. The upper Eccca beds comprise a thin layer of soft blue shales with phosphatic concretions. The Middle Eccca stage, outcrops of which stretch in a southerly direction from Otto's Bluff on the face of the scarp separating the valleys of the Umgeni and Umsunduzi rivers, comprises sandstones and sandy shales. The Lower Eccca shales, which lie conformably on Dwyka rocks, consists of dark-blue shales and flagstones. Intrusions of Karroo dolerites, which are sparsely distributed in all the other geological formations, predominate in the Eccca series. Dolerite dykes and sills led to the creation of the Albert and Howick Falls on the main river, the Karkloof Falls at Shafton on the Karkloof river and the Gordon Falls above Endendale on the Umsunduzi river. The Umsunduzi and Sterk rivers mainly flow over Eccca beds.

Below Albert Falls there occurs a narrow zone of Dwyka formations, consisting of tillite and varved shales, which cross the Umgeni basin parallel to the Eccca beds. Tillite exposed at cuttings on the new Pietermaritzburg-Durban national road near Thornville, is of tough blue mudstones. The matrix of the tillite consists of small angular pieces of quartz set in a fine dark base, and, when decomposed, results in a deep, bright yellow, clayey, fertile subsoil. Outcrops of Table Mountain Sandstone of the Cape System play an important role in the surface topography of the basin in the area north of the Umgeni (Nagle)

dam, where strata of the almost horizontally bedded sandstone appear in the form of pink kranztes of 500 feet (152 metres) overlying granite slopes which may drop 1000 feet (305 metres) into the deeply incised valleys below. In the Valley of a Thousand Hills, to the north of Botha's Hill, the basement complex is exposed. This consists of Archean granites and schists.

As a result of a large scale monoclinial flexure which characterizes eastern Natal (King, 1951), all the geological formations, except the Beaufort Series, are encountered again in the lower narrow neck of the catchment but this time in reverse order of exposure.

Near the coast occurs the three-mile (= 4.8 Km.) long Berea ridge, largely comprising Dwyka outcrops, separates a narrow coastal plain of Recent deposits from the rest of the catchment.

3.3 Vegetation, Soils and Climate.

Pentz (1945) classified the vegetation of Natal into eight vegetation types. Of these, the following six are encountered in the Umgeni basin:-

- i. Coastal Evergreen Bush;
 - ii. Dry Thorn Veld Savannah;
 - iii. Tall Grass Veld;
 - iv. Temperate Forest;
 - v. Open Bush Sandy Country;
 - vi. Highland Sour Veld.
-
- i. Coastal Evergreen Bush.

This vegetation type forms the climax vegetation

of the coastal area and occurs along a comparatively narrow belt in the lower part of the catchment. Much of it has been replaced by canelands and survives only at places where land is not required for the cultivation of sugar cane or other crops. In places this vegetation type occur up to an altitude of 1500 feet. Coastal thorn veld, which includes species such as Acacia benthami, Dichrostachys spp. etc., predominates in the lower-lying valleys of the main river and its coastal tributaries.

The hillsides in the coastal belt consist almost entirely of soils of residual-colluvial origin of fair depth. As a result of the outcrops of various geological strata in this part of the catchment, a great diversity of soils occur here, some of which are inherently poor whilst others are very fertile. Van der Merwe (1940) describes these as gley-like podsollic soils. He states that, in ^{the} majority of cases, they are only in their initial stages of development, and that the topography inhibits the production of stable profiles, since lateral transportation of the colloidal material on the slopes prevents the normal vertical illuviation from the "A" horizon developing into a "B" horizon. A good example of this occurs in profiles from Mt. Edgecombe, in the catchment of the Piesang river tributary, where he found surface soils of sandy loams, formed, in the first instance, from bluish-grey shales on a very gentle slope and, secondly, from Dwyka tillite on a fair slope. Further details on soils in the sugar belt is given in the comprehensive study of Beater (1957). Rainfall (fig. 8) in this part of the catchment ranges from 35 to 70 inches

(± 890-1780 mm.) per annum with approximately 75% precipitation in summer.

ii. Dry Thorn Veld Savannah.

This vegetation type follows the Umgeni river from near the coast through the Valley of a Thousand Hills and expands southwards to the west of Cato Ridge towards Thornville (short-tree Acacia savannah) and Albert Falls and Mortons Drift (tall-tree thorn savannah).

The soils in this part of the catchment are largely derived from Ecca rocks.

Air temperatures may fluctuate from below 32°F (0°C) in winter to well over 100°F ^(37°C) in summer.

The rainfall is low and ranges from 25-36 inches (± 630-910 mm) per annum (fig. 8).

iii. Tall Grass Veld.

The tall grass veld occurs at an altitude of 3,500-4,500 feet along a restricted strip from Bishopstown, east of Pietermaritzburg, towards Albert Falls. The only trees contributing towards this vegetation type are Acacia species such as A. lasioptala and A. caffra. The grass species encountered include Themeda triandra, Hyparrhenia hirta and Tristachys hispida.

The soils of the tall grass veld are mainly residual soils derived either from shales of the lower Beaufort and upper Ecca rocks or from doleritic intrusions.

The annual precipitation fluctuates between 30 and 40 inches (± 762-1016 mm.).

iv. Temperate forest.

Remnants of indigenous forests in which Podocarpus (Yellow wood) species predominate are found at altitudes above 3000 feet at Pietermaritzburg, Karkloof and Dargle (fig. 7). Also present are stinkwood (Celtis kraussiana), the Cape chestnut (Calodendron capense) and sneezewood (Ptaeroxylon).

The soils are here largely derived from the Ecca and Dwyka rocks.

Air temperatures usually fluctuate round about 60 and 90° F ^(15 and 32°C) during the winter and summer seasons respectively.

v. Open Bush Sandy Country.

This veld type occurs at an altitude of 2,000 to 3,000 feet in the area north of Umgeni dam and east of Wartburg (fig. 1). In addition to this a narrow strip also occurs in the Botha's Hill-Hillcrest-Kloof area.

The soils, in which Table Mountain Sandstone predominates, are very sandy but rather shallow and for these reasons less fertile than sandy soils in the coastal belt.

Rainfall is usually lower than in the coastal belt but ranges from 30 to 40 inches (\pm 760-1010 mm). Little cultivation can therefore be carried out here except under irrigation.

vi. Highland Sour Veld.

The highland sour veld occurs in the far western corner of the Umgeni catchment at an altitude of

T A B L E 1

Biological and chemical sampling localities visited during the period of survey.

Locality Description	Approximate distance in miles (Kilometres) from the source		Altitude in feet (metres)	
	Miles	(Kilometres)	Feet	(Metres)
I. THE MAIN RIVER*				
Umgeni Sponge (Source).	0	0	6,000-6,500	(1,829-1,981)
Ross's Farm	2	(3.2)	5,000-6,000	(1,524-1,829)
Dargle Police Station	16	(25.7)	4,000-5,000	(1,219-1,524)
Dargle Forestry	25	(40.2)	3,000-4,000	(914-1,219)
Watersmeet	27	(43.5)	3,000-4,000	(914-1,219)
Fern Hill Flats	30	(48.3)	3,000-4,000	(914-1,219)
Midmar	40	(64.4)	3,000-4,000	(914-1,219)
Morton's Drift	51	(82.1)	2,000-3,000	610-914
Albert Falls	62	(99.8)	2,000-3,000	610-914
Table Mountain	96	(154.5)	1,000-2,000	305-610
Upuma	106	(170.6)	0-1,000	0-305
Natal Estates	116	(186.7)	0-500	0-152
Fairview	140	(225.3)	0-100	0-31
II. TRIBUTARIES				
<u>The Lions River.</u>				
Upper Lions	8.8	(14.2)	5,000-5,500	(1,524-1,676)
Middle Lions	26.4	(42.5)	3,500-4,000	(1,067-1,219)
Lower Lions *	34.0	(54.7)	3,500-4,000	(1,067-1,219)
<u>The Karkloof River.</u>				
Yarrow tributary at Twin Falls	3.0	(4.8)	4,500-5,000	(1,372-1,524)
Yarrow tributary at Shawswood	5.0	(8.1)	3,500-4,000	(1,067-1,219)
Yarrow at Fyfe's Farm	6.5	(10.5)	3,500	(1,067)
Karkloof river at Mansfield Bend	8.0	(12.9)	4,000-4,500	(1,219-1,372)
Karkloof river at Kerr's Farm	11.2	(18.0)	4,000	(1,219)
Karkloof river at Colbourne (Welgevonden)	18.0	(29.0)	3,500-4,000	(1,067-1,219)
Karkloof river at Shafton	22.0	(35.4)	3,500	(1,067)
Karkloof river at Smythe's Place *	25.0	(40.2)	2,000-2,500	(610-762)
<u>The Sterk River.</u>				
At Mersey	3.5	(56.3)	2,500	(762)
At Impolweni Mission Station *	18.0	(29.0)	2,000	(610)
<u>The Nonzela Stream (not on map)</u>				
At Table Mountain	2.4	(3.9)	1,500	(457)
<u>The Umsunduzi river.</u>				
At Swartkops	6.0	(9.7)	3,500-4,000	(1,067-1,219)
At Gezubuso	12.0	(19.3)	3,000-3,500	(914-1,067)
Mpushini tributary of Umsunduzi river	9.0	(14.5)	2,000-3,000	(610-914)
Lower Umsunduzi *	60.0	(96.6)	1,000	(305)
<u>The Umgegu river.</u>				
At Umfula	20.4	(32.8)	500-1,000	(152-305)

table 1 continued

Locality Description	Approximate distance in miles (Kilometres) from the source		Altitude in feet (metres)	
	<u>Miles</u>	<u>(Kilometres)</u>	<u>Feet</u>	<u>Metres</u>
<u>The Emolweni river.</u>				
At Krantzkkloof Nature Reserve	2 - 4	(3.2 - 6.4)	1,500-2,000	(457-610)
A small tributary at <u>Maritzdaal</u> (Dargle) not indicated in figure	2.0	(3.2)	2,500-3,000	(762-914)
<u>The Lower Palmiet river</u> *	-	-	0- 100	(0- 31)
<u>The Lower Zeekoe river.</u> *	-	-	0- 100	(0- 31)

* In addition to the sampling stations on the main river, regular visits were also made to those localities on the tributaries indicated by asterisks.

4,500-6,000 feet. It stretches in a broad belt across the far western corner of the Umgeni basin to the west of Howick. The typical grasses are Tristachya hispida, Themeda triandra, Monocymbium cerisaeforme, Andropogon appendiculatus, Eragrostis spp., etc.

The upper Beaufort beds in this area give rise to a brown surface soil which is rich in organic matter in its uppermost few inches. These soils may be slightly acid and, under cultivation, tend to assume a yellowish tint and to become sandy.

On the average the air temperatures are the lowest in the catchment whilst the annual precipitation usually exceeds 40 inches (1016 mm).

3.4 Hydrographic Data.

The information in this section was obtained from the Hydrographic Survey Division, Department of Water Affairs, Pretoria. The numbers, localities, catchment areas etc., of river gauging stations on the main river and its tributaries are listed in table 2.

Although the erection was proposed of additional weirs at Dargle (Umgeni river), on the Sterk river at New Hanover and Umsunduzi river near its confluence with the Umgeni river, only the latter was constructed halfway through this survey. The following briefly summarizes the flow data at the different stations between 1958 - 1961.

TABLE 2
HYDROGRAPHIC STATIONS AND RIVER FLOW DATA IN THE UMGENI CATCHMENT, 1958 to 1961.

RIVER	Hydrographic Stations		Catchment area in square mi- les(metres)	Lowest recorded flow in cusecs during pe- riod of survey : 1958-61	Remarks
	No.	Name			
Umgeni	273	Howick	378 (608.3)	21.0	weir submerged at 652 cu- secs
Umgeni	96A	Table Mountain	400 (643.7)	52.0	-
Umgeni	215	Newlands	1500 (2414.0)	16.0	-
Lions	463	Allerton	122 (196.3)	6.6	-
Karkloof	458	Shafton	122 (196.3)	10.0	weir submerged at 975 cusecs
Umsunduzi	490	Henley	83 (133.6)	4.1	-

i. Howick.

The data recorded since 1948 at this weir (table 3) presented a fairly regular seasonal pattern and show that the highest annual flows occur from December to March whilst the dry season (low flow period) usually stretches from June to August annually. Individual daily minimum flows recorded during the period of investigation were less than 30 cusecs, whereas abnormal precipitation during 1959 (March and May, table 2) resulted in the flooding of the weir.

ii. Table Mountain.

A river flow picture, similar to that obtained at Howick, was recorded here (table 4). Apart from the flood period in May 1959 when more than 14,000 cusecs was recorded at this weir, the individual flows, as a rule, did not exceed 4,000 cusecs. In fact, the monthly averages for the years 1958-1961 ranged from 76 in September 1961 to 1,936 cusecs in May, 1959. The lowest river levels recorded here since 1948, occurred in late winter and early spring (August-October). Regular annual peak flows were registered between the months of December and April.

iii. Newlands.

The data recorded between 1958-1960 generally agrees with the seasonal pattern obtained since 1948, when this weir was constructed. From table 5 the following conclusions can be drawn:-

- a. The monthly flow averages seldom exceeded 2000 cusecs;

TABLE 3
FLOW RECORDS OF THE UMGENI RIVER AT HOWICK

SEASON and MONTH	AVERAGE DAILY FLOWS IN CUSECS								
	1958		1959		1960		1961		
	Average	Range	Average	Range	Average	Range	Average	Range	
SUMMER	December	264 ⁺	60 - 652 [*]	144	68 - 209	339 ⁺	95 - 652 [*]	278	95 - 658
	January	532 ⁺	233 - 652 [*]	373 ⁺	156 - 652 [*]	131	68 - 284	316 ⁺	90 - 652 [*]
	February	549 ⁺	389 - 652 [*]	376 ⁺	100 - 652 [*]	197	103 - 352	248	116 - 595
AUTUMN	March	275	193 - 490	288 ⁺	116 - 652 [*]	153	90 - 217	415 ⁺	137 - 652 [*]
	April	246	137 - 502	108	68 - 143	167	68 - 589	393 ⁺	225 - 652 [*]
	May	148	111 - 209	419 ⁺	103 - 652 [*]	136	68 - 302	143	100 - 261
WINTER	June	95	77 - 108	186	126 - 307	70	58 - 85	87	68 - 140
	July	64	56 - 77	106	83 - 124	59	54 - 66	62	49 - 88
	August	56	51 - 66	75	66 - 81	46	35 - 58	55	34 - 92
SPRING	September	51	34 - 56	75	64 - 95	35	21 - 68	41	29 - 105
	October	35	24 - 49	104	47 - 201	45	28 - 79	51	18 - 143
	November	136	49 - 526	166	49 - 589	67	19 - 177	101	39 - 197

+, * : Weir submerged. Maximum and mean values higher than those given here.

TABLE 4
FLOW RECORDS OF THE UMGENI RIVER AT TABLE MOUNTAIN

SEASON and MONTH	AVERAGE DAILY FLOWS IN CUSCS											
	1958			1959			1960			1961		
	Average	Range		Average	Range		Average	Range		Average	Range	
SUMMER	December	689	141 - 1799	480	190 - 917	778	282 - 3100	529	229-1033			
	January	1181	461 - 1928	1,140	491 - 2547	342	190 - 734	1024	335-3226			
	February	1696	872 - 4198	1,249	382 - 3332	483	267 - 587	856	363-5280			
AUTUMN	March	634	402 - 1061	704	378 - 974	321	232 - 463	611	383- 963			
	April	663	366 - 1142	289	214 - 382	445	231 - 1278	816	535-1680			
	May	394	251 - 589	1,936	246 - 14690	345	204 - 750	348	242- 557			
WINTER	June	224	184 - 253	469	327 - 726	156	132 - 200	202	158- 242			
	July	159	129 - 184	275	215 - 321	124	95 - 245	133	119- 158			
	Augustus	114	94 - 126	182	146 - 207	88	77 - 98	117	81- 181			
SPRING	September	121	87 - 222	166	112 - 249	81	53 - 133	76	55-193			
	October	81	57 - 158	183	103 - 486	118	72 - 187	107	66-253			
	November	314	89 - 1038	293	142 - 663	214	52 - 540	286	117-507			

TABLE 5
FLOW RECORDS OF THE UMGENI RIVER AT NEWLANDS

SEASON and MONTH	AVERAGE DAILY FLOWS IN CUSECS											
	1958			1959			1960			1961		
	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range
SUMMER	December	-	-	611	90 - 1,062	926	109 - 1965	588	149 - 1250			
	January	1514	500 - 2960	1,446	388 - 3,555	170	38 - 580	719	258 - 1472			
	February	2387	1165 - 5360	1,348	91 - 5,688	515	90 - 975	640	177 - 955			
AUTUMN	March	485	168 - 1105	752	119 - 1,430	208	60 - 478	895	179 - 1640			
	April	931	442 - 1635	137	57 - 246	465	110 - 1115	1,233	428 - 1980			
	May	367	107 - 823	3,911	91 - 18,810	446	107 - 1125	321	96 - 2160			
WINTER	June	164	144 - 188	726	290 - 1,560	125	93 - 160	192	93 - 220			
	July	119	90 - 144	307	175 - 372	81	16 - 160	130	90 - 212			
	August	71	66 - 88	131	44 - 172	29	21 - 41	68	39 - 97			
SPRING	September	177	70 - 595	168	47 - 232	38	24 - 100	51	37 - 110			
	October	47	37 - 81	310	58 - 1,290	113	38 - 390	92	67 - 125			
	November	559	48 - 1211	382	64 - 936	116	57 - 350	415	155 - 826			

- b. Maximum flows were recorded between December and May;
- c. During the dry season average daily flows may be as low as 37 cusecs (October, 1958). Operations at the diversion weirs of the Umgeni (Nagel) dam at Table Mountain were most likely responsible for some of these very low river levels;
- d. The abnormally high rainfall and peak flows which occurred during May 1959 also affected the records here as testified by the volume of flow which exceeded 18,000 cusecs.

iv. Lions River at Allerton.

The monthly averages of flows (table 6) provided seasonal patterns which corresponded with those obtained at the weirs on the main river. The highest monthly average flows mainly fluctuated round about 200 cusecs, whilst the lowest flow records were obtained in late winter and early spring (July-October).

v. Karkloof River at Shafton.

The flows recorded here (table 7) shows this tributary to contribute much water to the main river. It drains that part of the Umgeni basin where the highest annual precipitation occurs. The fact that the weir was submerged on several occasions both in summer (1958-1959) and autumn (1959), indicates that the maximum flows can exceed 1000 cusecs. A drop in the flow level usually occurred during June to September when individual recordings were as low as 10 cusecs.

TABLE 6
 FLOW RECORDS OF THE LIONS RIVER AT ALLERTON NEAR THE RAILWAY
 STATION.

SEASON and MONTH	AVERAGE DAILY FLOWS IN CUSECS											
	1958			1959			1960			1961		
	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range		
December	113	23 - 326	48.9	19.4 - 108	159	31 - 562	-	-	-	-		
January	199	60 - 360	197	91 - 413	45	22 - 96	139	31 - 1035				
February	210	125 - 446	257	75 - 942	67	29 - 101	116	47 - 697				
March	101	64 - 170	189	93 - 331	54	32 - 92	112	70 - 177				
April	81	49 - 152	65	50 - 90	71	25 - 202	137	84 - 279				
May	54	37 - 73	212	47 - 965	48	35 - 95	60	46 - 84				
June	37	35 - 48	84	64 - 131	32	24 - 35	39	33 - 47				
July	30	24 - 35	52	41 - 64	27	18 - 33	29	24 - 58				
August	21	17.2- 24	34	26 - 38	17.8	16.4- 23	25	16 - 64				
September	24	15.2- 31	29	23 - 45	15.6	6.6- 31	22	13 - 77				
October	15	8.3-20.1	-	-	16	5.5- 100	-	-				
November	57	15.2- 247	29	11.2 - 64	49	13 - 399	-	-				

TABLE 7
FLOW RECORDS OF THE KARKLOOF RIVER AT SHAFTON

SEASON and MONTH	AVERAGE DAILY FLOWS IN CUSECS											
	1958			1959			1960			1961		
	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range		
SUMMER	December	180	33 - 313	110	36 - 573	155	67 - 326	-	-	-	-	
	January	173	162 - 188	165	65 - 466	88	28 - 502	265	80 - 778			
	February	579 ⁺	162 - 975 [*]	287 ⁺	9.8 - 975 [*]	178	97 - 374	155	80 - 637			
AUTUMN	March	645	504 - 734	199	74 - 399	65	43 - 116	151	69 - 252			
	April	379	296 - 490	45	24 - 72	143	51 - 564	271	97 - 975 [*]			
	May	122	37 - 285	212 ⁺	18 - 975 [*]	76	41 - 181	66	41 - 116			
WINTER	June	32	28 - 34	90	65 - 145	34	30 - 41	42	32 - 65			
	July	24	20 - 28	54	41 - 93	26	20 - 32	25	20 - 34			
	August	17.5	14.7- 20	35	28 - 47	18.7	16.4- 20	20	14 - 39			
SPRING	September	26	13.9- 39	28	18 - 51	19.4	11.2- 41	20	10 - 85			
	October	15.5	14.7- 18	39	18 - 100	33	16 - 76	23.7	11 - 80			
	November	97	14.7- 205	45	27 - 85	72	11 - 279	96.6	11 - 231			

+ and * : Weir submerged on occasions. Maximum and mean values higher than those recorded here.

vi. The Umsunduzi River above Henley Dam.

Since this weir is located in the upper half of the Umsunduzi river catchment, flow values obtained here are not true reflections of the river's cumulative runoff. The monthly averages recorded are mainly below 100 cusecs with flows of less than 10 cusecs in winter (table 8).

TABLE 8
FLOW RECORDS OF THE UMSUNDUZI RIVER ABOVE HENLEY DAM.

SEASON AND MONTH	AVERAGE DAILY FLOWS IN CUSECS											
	1958			1959			1960			1961		
	Average	Range	Maximum	Average	Range	Maximum	Average	Range	Maximum	Average	Range	Maximum
DECEMBER	83 ⁺	9.9 - 346 ⁺		25	15.6 - 71		63	21 - 174		-		
JANUARY	79.0	38 - 157		83 ⁺	-		15.9	12.3 - 33		45	23 - 98	
FEBRUARY	95.0 ⁺	51 - 302 ⁺		157.0 ⁺	27 - 563 ⁺		25	10.1 - 76		62	28 - 404	
MARCH	-	-		44.0	28 - 59		35	14.9 - 138		47	26 - 224	
APRIL	54.0	28 - 138		20.0	17.2 - 27		62	25 - 292		74	28 - 281	
MAY	29.0	21 - 40		-	-		29	19.2 - 50		33	23 - 116	
JUNE	17.9	14.9 - 21		43.0	28 - 81		16	12.8 - 19.2		20	15 - 23	
JULY	13.1	9.96 - 14.9		24.0	18.2 - 33		11	8.8 - 14		14	12 - 23	
AUGUST	9.1	8.1 - 11.7		17.7	13.4 - 28		8.9	8.0 - 10		10	7.4 - 12	
SEPTEMBER	10.1	5.4 - 37		17.7	10.6 - 46		8.2	5.6 - 22		-	-	
OCTOBER	6.6	4.1 - 8.4		15.9	9.96 - 30		16	5.7 - 133		-	-	
NOVEMBER	23.0	5.4 - 124		29 ⁺	11.7 - 119 ⁺		26	5.7 - 257		-	-	

+ : Weir submerged. Maximum and mean values higher than those recorded here.

4.

ZONATION OF THE UMGENI RIVER

For the purpose of faunal comparison, a physical zonation scheme was adopted for the Umgeni river (table 9) similar to the one employed by Oliff (1960) in his investigation ^{into} the ecology of the Tugela river, Natal. One of the major differences between the two river systems is the absence in the Umgeni river of a true mountain source. Furthermore, the Umgeni river, which has about $\frac{1}{4}$ th the length of the Tugela river, arises at an altitude of 6500 ft. (1981 m.) which is 3,900 ft. (1189 metres) lower than the source of the Tugela river. Other differences which also exist are discussed later in the text.

Zone 1. The Source: 6500-6000 ft. (1,981-1,829 metres).

The Umgeni originates as a marshy, sunk in area at the foothill of the Drakensberg escarpment upon a plateau of smooth, undulating highland sour veld country, exposing, at places, outcrops of the Stormberg sediments (Cave sandstone). Numerous small streams arise from the sponge (fig. 6) and converge to form several headstreams of the Umgeni river. A rich variety of semi-aquatic vegetation occurs here, the most common of which are Cyperus unioloides, Scirpus corymbosus, Juncus oxycarpus, Xyris natalensis, Eriochaulon rhulandii, Dierama robustum and Sebaea rudolphi.

The water of the sponge remained reasonably clear during the various seasons of the year but developed dense reddish deposits which appeared to be caused by iron bacteria. Most of the pH values recorded were between 6 and 7, but the water usually became alkaline during the rainy seasons. While the lowest day temperature recorded during mid winter (fig. 10) was 9.2°C, the night tempera-

T A B L E 9

THE PHYSICAL ZONATION OF THE UMGENI RIVER COMPARED WITH THAT OF THE TUGELA RIVER

TUGELA RIVER			UMGENI RIVER			
Physical Zones	Length in miles (Kilometres)	Altitude in feet (metres)	Physical Zones	Length in miles (Kilometres)	Altitude in feet (metres)	Sampling localities in Zones
Source zone	0.8 mi. (1.29 Km.)	10,400-10,000 feet (3,170-3,048 m.)	Source		6,500-6,000 feet (1,981-1,829 m.)	Umgeni Sponge (A).
Waterfall zone	1.5 mi. (2.41 Km.)	10,000-7,500 feet (3,048-2,286 m.)	Absent			
Mountain torrent	4.3 mi. (6.92 Km.)	7,500-5,000 feet (2,286-1,524 m.)	Absent			
Foothill torrent	10.5 mi. (16.90 Km.)	5,000-4,000 feet (1,524-1,219 m.)	Upper foothill torrent	14 mi. (22.53 Km.)	6,000-4,100 feet (1,829-1,250 m.)	Ross' Farm (R). Dargle Police (A).
			Lower foothill torrent	28 mi. (45.06 Km.)	4,100-3,000 feet (1,250-914 m.)	Dargle Forestry (R). Watersmeet (A). Fern Hill Flats (A). Midmar (R).
Foothill sand bed	106 mi. (170.06 Km.)	4,000-3,000 feet (1,219-914 m.)	Foothill soft bottom	10 mi. (16.09 Km.)	2,300-2,200 feet (701-671 m.)	Morton's Drift (R)
Rejuvenated river	71 mi. (114.26 Km.)	3,000-1,380 feet (914-420 m.)	Rejuvenated river	45 mi. (72.42 Km.)	2,200-1,000 feet (671-305 m.)	Albert Falls (R). Table Mountain (R). Upuma (R).
Valley sand bed	125 mi. (201.17 Km.)	1,380-10 feet (420-3.05 m.)	Valley sand bed	39 mi. (62.76 Km.)	1,000-10 feet (305-3.05 m.)	Natal Estates (A). Fair View (R).
Estuary	0.5 mi. (0.81 Km.)	below 10 feet (below 3.05 m.)	Umgeni estuary	1.0 mi. (1.61 Km.)	below 10 feet (below 3.05 m.)	Covered by extensive pollution survey. (see appendix).

(R) = Regular sampling sites - at least seasonal visits.

(A) = Additional sampling localities - infrequent visits.

tures of the water should reach zero or drop to below freezing point during this season of the year.

Faunal collections were made at the sponge itself (marginal and aquatic vegetation) from some of the small streams leaving it (fig. 6).

Zone 2. The Upper Foothill Torrent: 6,000-4,100 ft.
(1,829-1,250 metres)

This part of the river is characterized by an initial steep decline immediately below the sponge, at and below Ross' farm, with a gradient fluctuating between 147 and 73 feet/mile (28 and 14 m/Km) but barely exceeding 21 feet/mile (4 m/Km) above Dargle Falls where the profile flattens considerably as a result of the dolerite sill lying across the path of the river, retarding the down cutting and retreat of the river bed. Despite the steepness of the profile at Ross' Farm and the predominance of rapids cascading over large rocks and boulders strewn over the stream bed, occasional deep pools are found, shaded at places by indigenous forest trees (fig. 11) which occur at the foot of the sponge, against the eastern slopes of the hills (fig. 7). The streams at Ross' Farm carry very little silt during the summer rains and are crystal clear in winter. The temperatures recorded during winter were below 10°C but these increased in summer to exceed 20°C. The dissolved solids, as reflected by conductivity measurements, are low (fig. 9) whereas the ^{pH} values were just below 7 in winter and alkaline in summer.

There is virtually no marginal vegetation at Ross' Farm with two of the very few species represented being Mariscus congestus and Uncus effusus.

Zone 3. Lower Foothill Torrent: 4,100-3,000 ft.
(1,250-914 metres).

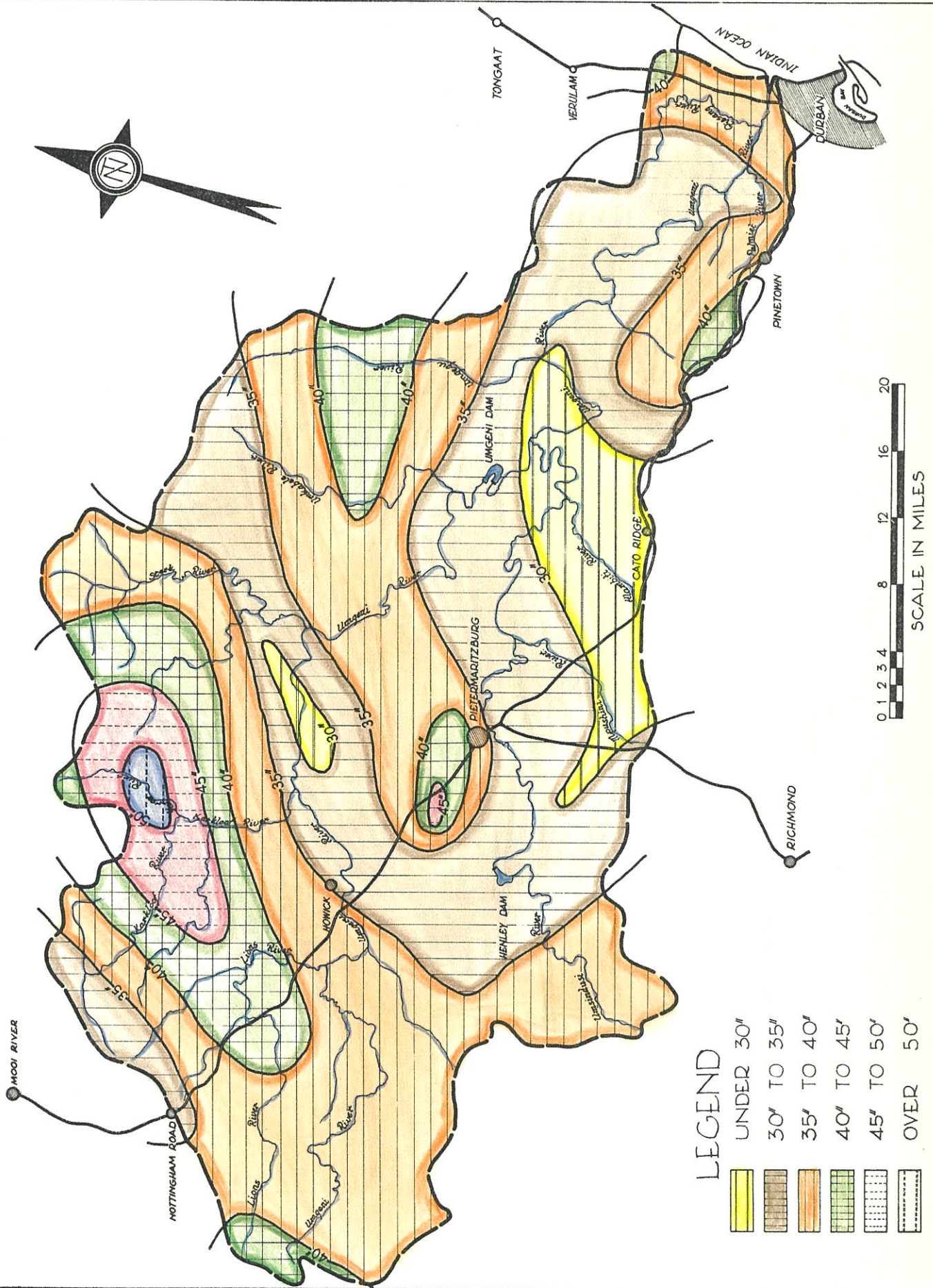
Like the Upper foothill torrent this zone also comprises a steeper portion which gradually flattens towards Midmar. The mean gradient is, however, much lower, being 100-80 feet/mile (18-15 m/Km) from below Dargle Falls towards Dargle Forestry, approximately 15 feet/mile (2-3 m/Km) at Watersmeet and less than 10 feet/mile (1.8 m/Km) above and below Fern Hill Flats. At Midmar, above Howick Falls, the gradient again increases to about 70-75 feet/mile (14 m/Km). Due to the general lack of fast current at Watersmeet and Fern Hill Flats, an appreciable amount of silt was deposited here, resulting in a much less turbid river water downstream from Midmar during summer. True aquatic vegetation in this zone largely consists of Hydrostachys natalensis, which occur in the fast current habitats, and Nitella spp., in the slow current and shallow pools.

There is a steady average increase in dissolved solids (fig. 9) and water temperatures (fig. 10) from Dargle Forestry to Midmar. A similar tendency was found in the series of pH measurements, taken during collection trips for biological samples, which fluctuated between 7.1 and 7.8.

Zone 4. Foothill Soft Bottom: 2,300-2,000 ft.
(701-671 m).

The very first true soft bottom zone in the Umgeni river occurs from below the confluence of the Karkloof river, i.e. from above Morton's Drift to Albert Falls, a distance of 7.5 miles (12.1 kilometres). Here, the

ISOHYETAL MAP OF THE UMGENI CATCHMENT

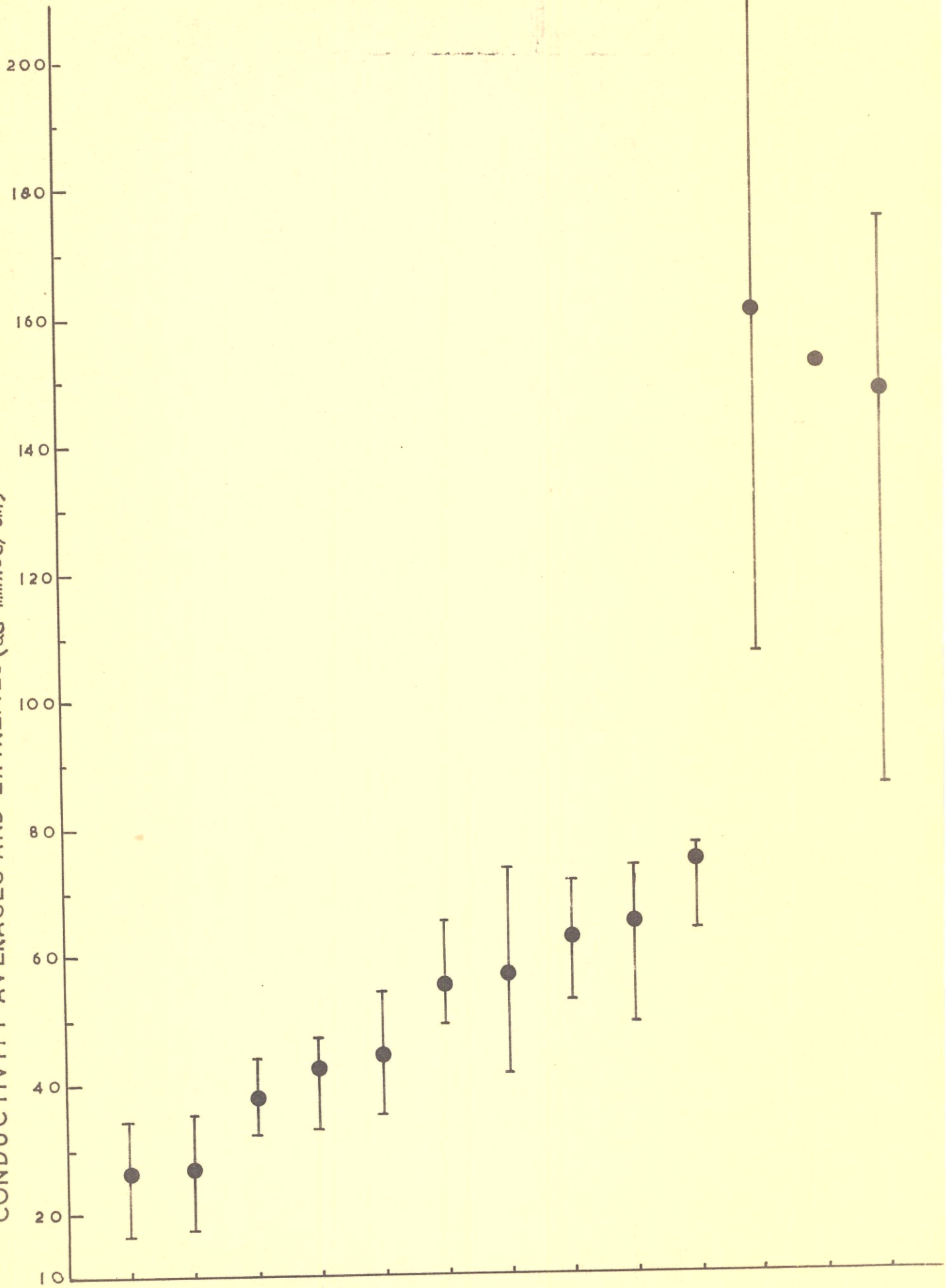


LEGEND

[Yellow box]	UNDER 30"
[Light green box]	30" TO 35"
[Orange box]	35" TO 40"
[Dark green box]	40" TO 45"
[Light blue box]	45" TO 50"
[Dark blue box]	OVER 50"

Fig. 8. Isohyetal map of the Umgeni Catchment

CONDUCTIVITY AVERAGES AND EXTREMES (as mmhos/cm) RECORDED DURING SURVEY.



UMGENI RIVER SAMPLING STATIONS FROM SOURCE TO MOUTH

Fig. 9. Conductivity averages and extremes recorded during survey.

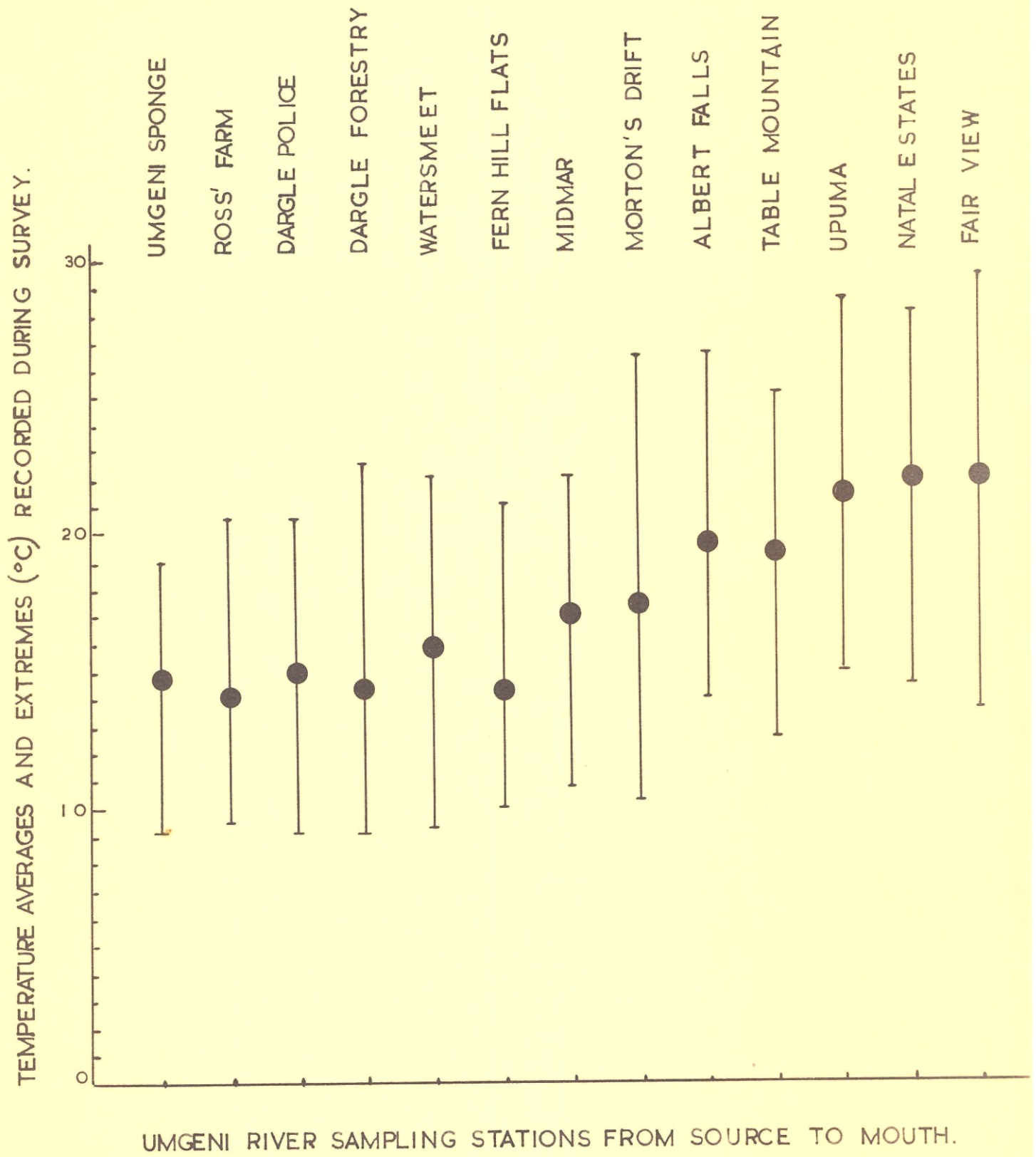


Fig. 10. Temperature averages and extremes recorded during survey.

gradient of the river bed averages less than (8 feet/mile)(± 1.8 m/Km). The marginal vegetation mainly comprised Cyperaceae, Polygonaceae and Gramineae of which the more abundant species were Mariscus congestus, Scirpus paludicola Kunth, Cyperus fastigiatus Rottb., Polygonum setulosum Rich., Polygonum sp., Echinochloa crus-pavonis (H.B.K.) Schult., Miscanthidium capense (Nees) Stapf., Paspalum distichum L. and P. urvillei Steud.

Water temperatures fluctuated from about 10°C in winter to over 26°C in summer (fig. 10) and the average and extreme conductivity values indicate a further increase in dissolved solids between Midmar and Morton's Drift (fig. 9).

Zone 4. The Rejuvenated River: 2,200-1,000 feet (671-305m.)

This zone is characterized by having a short stretch of approximately 0.5 miles (± 0.8 kilometres) with a steep gradient of more than 30 feet/mile (15 m/Km) immediately below Albert Falls, followed by a meandering reach of about 17 mile (27 Kilometres) with an average gradient of 12-13 feet/mile (3.81 m/Km). A further gradient increase occurs in the next 39 miles (± 62.36 Kilometres) of the river, from above Nagle dam towards Upuma, where the average fall exceeds 30 feet/mile (5.68 m/Km). This zone then gradually intergrades with the valley sand bed zone.

The marginal vegetation of this zone represents a rich variety of species, the most commonly occurring of which are the following:

<u>Species</u>	<u>Family</u>
<u>Polygonum setosulum</u> A Rich.	Polygonaceae

<u>Polygonum lapathifolium</u> Linn.	Polygonaceae
<u>Polygonum salicifolium</u> .	"
<u>Polygonum meisnerianum</u>	"
<u>Cyperus leptocladus</u> Kunth.	Cyperaceae
<u>Cyperus difformis</u> Linn.	"
<u>Cyperus distans</u> Linn. F.	"
<u>Cyperus fastigiatus</u> Rottb.	"
<u>Cyperus marginatus</u> Thb.	"
<u>Scirpus prolifer</u> Rotth.	"
<u>Pycnus polystachys</u> Beauv.	"
<u>Kylkinzia eliator</u> Kunth.	"
<u>Matricaria nigellaefolia</u> D.C.	Compositae
<u>Coix lacrima-jobi</u> Linn.	Gramineae
<u>Panicum laevifolium</u> Hack.	"
<u>Paspalum distichum</u> L.	"
<u>Paspalum urvillei</u> Steud.	"

The very low gradient of the river in the foothill soft bottom zone has a most marked effect upon the turbidity of the river water at Albert Falls. Flood waters from the Karkloof tributary which, on occasions, carried heavy yellowish coloured silt loads into the Umgeni river above Morton's Drift, discoloured the whole river at the top of the soft bottom zone and yet this same water, when reaching Albert Falls, was almost clear. Even during the heaviest floods, differences in the turbidity at Morton's Drift above and at Albert Falls below the soft bottom zone, could still be noticed.

The gradual average increase in dissolved solids from the source zone downwards, was maintained at Albert Falls and Table Mountain. A considerable rise at Upuma (fig. 9) was largely caused by the diversion of the Umgeni water into Nagle Dam and the consequent exaggerated effect of the

mineralized water from the Umsunduzi river tributary upon that of the Umgeni river (Schoonbee, 1962). Two tributaries which largely contribute towards silt loads in the Umgeni, and, which both enter the main river in the rejuvenated river zone, are the Sterk and the Umsunduzi rivers.

Zone 5. The Valley Sand Bed: 1,000 - 10 feet
(305 - 3.05 m.)

Below Upuma, towards the Umgegu river confluence in the lower part of the valley of a thousand hills, the wide meandering river bed is characterized by large boulders and thick deposits of coarse sand (fig. 12) which gradually replaces the former as the river progresses towards its mouth. Throughout most of the valley sand bed zone, the gradient averages about 14 feet/mile (± 7 m/Km). The turbidity of the water was low, except in summer, and especially when rivers such as the Umsunduzi and Sterk rivers ^{were} in flood. The water temperatures averaged more than 20°C (fig. 10) but were not found to exceed 30°C.

Some of the most commonly occurring species represented in the marginal vegetation of this zone are listed below:

<u>Species</u>	<u>Family</u>
<u>Cyperus distans</u> Linn. F.	Cyperaceae
<u>Fimbristylis diphylla</u> Vahl.	"
<u>Fimbristylis hispida</u> (Vahl) Kth.	"
<u>Mariscus congestus</u> C.B.C.I.	"
<u>Scirpus prolifer</u> Rottb.	"
<u>Cyperus immensis</u> C.B.C.I.	"
<u>Pycnus polystachys</u> Beauv.	"
<u>Pycnus flavescens</u> (L) Reich.	"
<u>Polygonum lapathifolium</u> Linn.	Polygonaceae
<u>Polygonum</u> sp.	"

5. THE GENERAL CHEMISTRY OF THE UMGENI RIVER SYSTEM

The analytical results of the general survey are summarised in tables 10-11.

A detailed study of the analysis of all the samples taken, showed, that apart from mere dilution or concentration effects, the Umgeni system underwent no marked seasonal chemical changes during the course of the survey.

During the winter of 1959 the flow of all the rivers of the system was very low. The Zeekoe tributery (= Lower Zeekoe; fig. 1.) yields water containing the greatest concentration of organic mater, but even so it only showed 4.2 ppm. O.A. and 1.7 ppm. B.O.D. No ammonia nitrogen was detected in any sample but again the Zeekoe tributary gave the highest concentrations of nitrate and nitrite nitrogen (0.89 and 0.032 ppm. respectively). The pH values lay between 7.0 and 7.6, so that the alkalinity of the waters was due solely to bicarbonates. The calculated values (at 25°C) of the saturation pH of the waters (pH_s) and of the stability index ($2pH_s - pH$) showed that, except for the Mpushini and the Lower Zeekoe rivers, all the waters possessed corrosive properties. In the main river there was a progressive increase in the pH, conductivity, T.D.S. and the concentration of the major inorganic solutes from source to mouth, whilst the pH_s and stability index showed a progressive decrease.

Owing to the unusually low rainfall in the summer of 1959-60 (see tables 3-8) no really high flows occurred in any of the rivers. In most cases the conductivity values were comparably higher than is normal reaching, for this time in some cases, half the dry season values. The corresponding changes in the T.D.S. values were not so marked, but this could have been due to experimental errors

and, in particular, to the lack of equipment necessary to achieve a proper clarification of silty samples prior to the T.D.S. determination. Higher than normal turbidities were recorded in a few instances, but the highest values were recorded in November 1959 after the first rains. In the main river during the rainy season rather low values were found for B.O.D. and the concentrations of most of the inorganic solutes, although the values for phosphate and nitrite nitrogen were somewhat highish at Upuma (table 10). The latter were associated with traces of ammonia nitrogen (less than 0.1 ppm.) at some stations. A high O.A. value (20.8 ppm., table 11) at Fair View was noteworthy and appeared to be related to the anomalously high turbidity (252 ppm.) prevailing at this time, probably as a result of the disturbance of the river bed by sand dredging. The tributaries presented a picture similar to that of the main river, except that the higher nitrite concentrations were not observed. Throughout the whole system, pH values higher than 7 were recorded, but, without any corresponding systematic changes in the pH_s or stability index. The very high value of 132 ppm. recorded for the turbidity of the lower Umsunduzi (table 12) was to be expected since this tributary is known to carry large quantities of silt, originating from eroded land around its upper reaches, into the Umgeni during the rainy season.

The analysis showed little chemical evidence of pollution in the river system (table 11). Ammonia nitrogen usually was undetectable, nitrite nitrogen was only of low concentration as was also the nitrate nitrogen, except on some occasions in the lower Umsunduzi and the lower Zeekoe rivers. These two stations also on occasions showed phosphate concentrations that were on the high side (maximum values 0.40 and 0.48 ppm. as PO_4 respectively). The B.O.D. values, however, never exceeded 3.2 ppm. (observed once at Fair View) anywhere in

the main river above the estuary and the O.A. values usually never exceeded 3.3 ppm., except for one occasion at Fair View when the very high value of 20.8 ppm. was recorded. The lower Umsunduzi and the Zeekoe rivers, however, showed O.A. values of up to 6.6 and 4.6 ppm. respectively. (table 11)

It is of interest to note that, although the dissolved oxygen was not determined at any time, samples from the lower Zeekoe river consistently gave a much lower initial titration in the B.O.D. determination (about five-eighths that of the other samples). This initial titration although it does not accurately measure the dissolved oxygen in the water at the time of sampling, is a measure of the dissolved oxygen at the start of the B.O.D. determination and indicates that the water of the Lower Zeekoe river was consistently low in dissolved oxygen.

The consistently high total dissolved solids (T.D.S.) and conductivity values obtained for the Lower Zeekoe river definitely indicated pollution of this tributary, for experience has shown that unpolluted rivers in Natal never have T.D.S. values greater than 500 ppm., nor conductivities greater than 750 micromho.

The analytical results thus indicate that, although there was no serious disturbances of the water quality in most of the major streams of the Umgeni system, signs of pollution were recorded in the Zeekoe, and probably also in the Umsunduzi river.

TABLE 10

Results of the chemical analysis of the main Umgeni river

SAMPLING STATION	No. of samples examined	pH	pH _s	Stability index	Conductivity (micromho)	EXPRESSED AS PARTS PER MILLION (P.P.M.)						
						T.D.S.	Turbidity (silica scale)	O.A.	B.O.D.	Free and saline ammonia as N	Nitrate as N	Nitrate as N
1. Umgeni Sponge	Mean Range 1	7.0	10.1	13.2	14	11	5	0.9	0.1	Nil	0.001	0.04
2. Ross' Farm	Mean Range 2	7.3 7.1-7.4	9.8 9.5-10.0	12.3 11.9-12.6	29 27-30	35 29-41	7 6-7	2.2 2.0-2.4	0.4 0.1-0.6	Nil	0.004 0.002-0.005	0.03 0.02-0.04
3. Dargle Forestry	Mean Range 1	7.3	9.2	11.1	47	52	9	1.6	0.6	Nil	0.005	TR
4. Watersmeet	Mean Range 10	7.3 6.4-8.2	9.3 9.0-9.8	11.4 10.8-12.5	51 36-66	45 (9) 31-58	8 (3) 8-9	1.0 (3) 0.2-2.0	0.6 (3) 0.2-1.0	Nil (3)	0.002 (3) 0.000-0.003	0.03 (3) 0.03-0.04
5. Howick	Mean Range 6	7.3 6.7-7.7	9.2 8.9-9.6	11.2 10.4-11.9	53 41-68	51 46-56	11 (3) 7-15	1.4 (3) 0.4-2.0	1.0 (3) 0.1-1.6	Nil (3)	0.004 (3) 0.001-0.006	0.08 (3) 0.004-0.12
6. Morton's Drift	Mean Range 1	7.1	9.0	10.9	67	63	12	0.5	0.7	Nil	0.001	0.06
7. Albert Falls	Mean Range 3	7.3 7.1-7.6	9.3 9.0-9.6	11.2 10.8-11.9	63 48-77	61 53-72	15 12-19	1.5 0.3-2.1	0.8 0.4-1.1	Nil Nil-TR	0.007 0.005-0.008	0.08 0.03-0.12
8. Nagle Dam	Mean Range 7	7.6 6.7-9.5	9.2 8.7-10.2	10.8 10.1-12.2	72 41-102	68 (5) 53-77	38 (3) 9-87	1.5 (3) 0.2-2.7	1.0 (3) 0.2-2.1	Nil (3) Nil-TR	0.005 (3) 0.001-0.010	0.14 (3) 0.07-0.24
9. Upuma	Mean Range 3	7.7 7.3-8.2	8.8 8.6-9.0	10.0 9.8-10.3	123 83-166	104 88-122	32 12-70	1.5 0.0-3.0	0.8 0.5-1.1	Nil Nil-TR	0.012 0.009-0.014	0.30 0.06-0.53
10. Natal Estates	Mean Range 5	7.7 6.8-9.0	8.9 8.7-9.5	10.1 9.6-10.8	127 64-175	101 (3) 88-109	23 (2) 15-30	1.1 (2) 0.6-1.6	1.0 (2) 0.7-1.2	Nil (2)	0.003 (2) 0.000-0.005	0.31 (2) 0.29-0.32
11. Fair View	Mean Range 2	7.7 7.6-7.7	8.7 (1)	9.7 (1)	158 154-161	-	252 (1)	10.8 0.8-20.8	1.9 0.5-3.2	Nil (1)	0.010 (1)	0.65 (1)

Figures in parentheses give the number of samples analysis where this does not correspond to the number given in third column.

-630-
-62-

table 10 continued

SAMPLING STATION	No. of samples examined	EXPRESSED AS PARTS PER MILLION (P.P.M.)									
		Phosphate as PO ₄	Alkalinity as CaCO ₃	Total Hardness as CaCO ₃	Ca	Mg	Na	K	Sulphate as SO ₄	Chloride as Cl	Silica as SiO ₂
1. Umgeni Sponge	1 Mean Range	0.06 -	13.0 -	6.0 -	1.4 -	0.6 -	1.0 -	0.2 -	Nil -	2.3 -	6.0 -
2. Ross' Farm	2 Mean Range	0.18 0.17-0.18	15.7 9.8-21.6	12.0 11.3-12.6	2.8 2.5-3.1	1.2 0.8-1.6	2.0 1.9-2.1	0.4 0.3-0.4	2.2 0.0-4.3	0.6 0.0-1.2	10.7 9.9-11.5
3. Dargle Forestry	1 Mean Range	0.15 -	29.6 -	17.9 -	4.9 -	1.4 -	3.5 -	0.8 -	Nil -	0.2 -	15.6 -
4. Watersmeet	10 Mean Range	0.18 (3) 0.13-0.26	31.6 19.6-42.4	19.4 13.0-26.6	4.0 1.7-5.9	2.2 1.0-3.3	4.1 3.1-5.6	0.8 0.4-1.1	1.1 0.0-8.2	1.2 0.2-4.4	13.8 9.9-16.5
5. Howick	6 Mean Range	0.18 (3) 0.12-0.26	38.7 27.4-59.4	20.0 16.6-23.4	4.7 3.6-6.0	2.3 1.5-3.9	4.3 2.8-5.6	0.8 0.7-0.9	1.6 0.0-4.0	1.7 0.2-3.4	14.5 12.8-16.0
6. Morton's Drift	1 Mean Range	0.20 -	36.8 -	24.0 -	5.4 -	2.5 -	5.1 -	0.9 -	3.3 -	4.0 -	14.0 -
7. Albert Falls	3 Mean Range	0.19 0.11-0.32	35.8 31.8-39.0	23.0 18.6-26.1	5.4 4.1-6.3	2.3 2.0-2.7	5.5 4.4-6.3	0.8 0.6-1.0	1.4 0.0-4.0	3.8 1.5-6.2	14.5 14.4-14.5
8. Nagle Dam	7 Mean Range	0.21 (3) 0.15-0.27	37.4 15.6-51.0	25.9 8.6-34.4	5.9 1.3-10.0	2.7 1.3-4.2	7.1 3.5-9.8	1.5 0.6-3.2	1.3 0.0-3.7	3.7 2.3-8.9	12.4 7.9-15.0
9. Upuna	3 Mean Range	0.24 0.20-0.31	50.8 42.8-66.0	38.8 24.0-58.1	7.7 5.4-10.1	4.1 2.5-6.0	13.1 5.4-20.2	1.3 0.9-1.8	1.8 0.0-5.3	15.3 5.8-32.4	17.0 16.2-18.0
10. Natal Estates	5 Mean Range	0.22 (2) 0.16-0.27	47.4 22.8-59.4	33.4 15.0-45.2	7.1 2.8-9.0	3.8 2.0-5.5	16.7 8.7-22.2	1.8 1.3-2.9	1.8 0.0-5.2	14.5 5.1-29.6	12.8 9.2-16.8
11. Fair View	2 Mean Range	0.29 (1) -	46.4 (1) -	32.6 (1) -	6.6 (1) -	3.9 (1) -	24.1 (1) -	1.7 (1) -	2.7 (1) -	24.2 (1) -	14.1 (1) -

T A B L E 11

Results of the chemical analysis of tributaries of the Umgeni river

SAMPLING STATION	No. of samples examined	pH	pHs	Stability index	Conductivity micromho	EXPRESSED AS PARTS PER MILLION (P.P.M.)						
						T.D.S.	Turbidity silica scale	O.A.	B.O.D.	Free and saline ammonia as N	Nitrite as N	Nitrate as N
12. Lions River (lower)	5 Mean Range	7.3 7.1-7.6	9.2 8.9-9.4	11.0 10.5-11.6	62 51-70	61 54-67	16 (3) 12-19	3.1 (3) 0.6-3.3	1.3 (3) 0.2-1.5	Nil (3) -	0.005 (3) 0.000-0.009	0.11 (3) 0.08-0.14
13. Karkloof (Shafton)	3 Mean Range	7.3 7.1-7.7	9.2 9.1-9.4	11.1 11.0-11.3	50 43-60	53 47-60	14 13-15	1.3 0.8-1.8	0.5 0.3-0.6	Nil -	0.004 0.000-0.007	0.10 0.06-0.14
14. Sterk (Impolweni)	5 Mean Range	7.4 7.0-8.1	9.5 9.3-9.8	11.7 11.2-12.3	59 48-85	45 (4) 34-56	12 (4) 8-15	0.7 (4) 0.2-1.2	0.9 (4) 0.7-1.2	Nil (4) Nil TR	0.005 (4) 0.004-0.006	0.12 (4) 0.07-0.14
15. Henley Dam	2 Mean Range	6.4 6.2-6.6	9.1 9.0-9.1	11.7 11.6-11.8	74 65-82	66 (1) -	- -	- -	- -	- -	- -	- -
16. Lower Umsunduzi	6 Mean Range	7.5 6.3-8.8	8.4 8.0-8.8	9.2 7.6-11.3	277 170-394	186 (5) 139-230	60 (4) 15-132	3.2 (4) 0.4-6.6	1.0 (4) 0.7-1.5	Nil (4) Nil TR	0.014 (4) 0.011-0.023	0.80 (4) 0.33-1.17
17. Mpushini	5 Mean Range	7.8 7.5-8.4	7.7 7.4-7.8	7.1 6.9-7.9	431 (4) 403-485	278 248-302	25 (3) 9-41	1.4 (3) 0.8-2.0	1.1 (3) 0.5-1.6	Nil (3) Nil TR	0.009 (3) 0.005-0.012	0.44 (3) 0.31-0.64
18. Umgegu (Umfula)	2 Mean Range	7.7 7.5-7.9	9.1 9.0-9.1	10.4 10.1-10.7	109 107-110	79 71-87	14 12-16	1.3 1.2-1.3	0.5 0.1-0.8	Nil Nil TR	0.005 0.002-0.007	0.28 0.26-0.30
19. Palmiet (lower)	3 Mean Range	7.2 7.0-7.5	8.6 -	10.0 9.7-10.2	186 156-209	113 99-137	9 3-18	1.3 1.0-1.7	0.6 0.5-0.8	Nil -	0.003 0.000-0.009	0.01 0.00-0.04
20. Zeekoe (lower)	3 Mean Range	7.4 7.4-7.5	7.4 7.3-7.5	7.4 7.2-7.6	821 561-978	553 453-622	22 13-28	4.3 4.0-4.6	1.1 0.7-1.7	Nil -	0.015 0.004-0.032	0.73 0.17-1.12

Figures in parenthesis gave the number of samples analysed where this does not correspond to the numbers given in third column above.

table 11 continued

SAMPLING STATION	No. of samples examined	EXPRESSED AS PARTS PER MILLION (P.P.M.)									
		Phosphate as PO ₄	Alkalinity as CaCO ₃	Total Hardness as CaCO ₃	Ca	Mg	Na	K	Sulphate as SO ₄	Chloride as Cl	Silica as SiO ₂
12. Lions River	5 Mean Range	0.26 (3) 0.18-0.33	31.4 16.3-39.1	31.3 20.6-66.4	5.1 3.7-6.6	2.8 2.2-3.5	5.1 4.6-5.5	1.1 0.8-1.6	1.0 0.0-3.1	1.7 0.1-4.0	16.6 15.7-18.0
13. Karkloof (Shafton)	3 Mean Range	0.20 0.18-0.23	29.4 23.8-33.4	18.0 15.8-22.8	4.5 3.5-5.1	1.8 1.2-2.6	4.3 3.2-4.6	0.6 0.5-0.8	3.0 0.0-5.1	2.7 1.0-5.4	15.9 15.5-16.5
14. Sterk (Impolweni)	5 Mean Range	0.16 (4) 0.05-0.27	27.3 23.2-31.8	19.7 15.4-28.7	3.3 2.5-4.1	2.8 2.1-4.9	5.4 3.4-8.2	0.6 0.5-0.8	1.7 0.0-5.5	6.3 1.5-12.1	10.0 8.2-11.7
15. Henley Dam	2 Mean Range	- -	34.9 29.8-40.0	24.3 21.0-27.6	5.6 5.5-5.6	2.6 1.7-3.4	6.8 6.3-7.2	1.6 1.1-2.0	Nil -	2.2 2.0-2.4	14.3 13.6-15.0
16. Lower Umsunduzi	6 Mean Range	0.35 (4) 0.28-0.40	41.1 43.7-118.6	66.4 34.2-104.8	13.7 7.2-20.2	7.8 2.7-13.2	35.2 22.1-47.0	2.5 1.9-3.0	10.0 7.3-17.3	36.4 18.8-71.6	16.6 14.1-19.4
17. Mpushini	5 Mean Range	0.21 (3) 0.10-0.30	191.1 166.9-233.2	143.4 125.2-156.3	29.0 26.2-31.5	17.2 14.5-19.3	50.5 44.0-58.6	1.6 0.9-3.0	1.6 0.0-4.7	51.4 32.4-77.5	24.4 20.3-29.0
18. Umgegu (Umfula)	2 Mean Range	0.14 0.16-0.27	42.0 41.4-42.6	25.5 25.2-25.8	5.4 5.1-5.6	3.9 3.8-3.9	14.0 13.4-14.5	1.4 1.3-1.5	Nil -	10.1 8.4-11.7	20.4 19.0-21.7
19. Palmiet (lower)	3 Mean Range	0.06 0.01-0.14	63.0 53.4-70.7	44.0 39.1-48.0	8.8 7.9-9.5	5.4 4.7-6.3	24.9 19.1-33.2	1.5 1.2-1.9	1.9 0.0-5.7	28.1 15.8-51.5	14.7 11.7-16.7
20. Zeekoe (lower)	3 Mean Range	0.36 0.21-0.48	241.1 192.2-306.2	224.5 184.2-257.0	39.5 34.1-44.2	30.6 24.0-38.1	135.3 123.4-147.4	2.4 1.3-2.9	40.5 27.2-58.7	178.3 118.7-295.5	18.9 18.4-19.3

6. THE FAUNA OF THE DIFFERENT PHYSICAL ZONES
OF THE MAIN UMGENTI RIVER

Regular sampling stations (R, table 9) were visited for faunal collections at two-monthly intervals, or, where this was not possible at least once every season. Additional sampling localities (A, table 9) visited less frequently, assisted in the elucidation of the picture of the longitudinal distribution of the fauna. All the results are considered on a seasonal basis, the seasons of the year being as follows;

Summer ; December - February

Autumn ; March - May

Winter ; June - August

Spring ; September - November

The physical zones and their corresponding sampling localities are listed in table 9 and ^{the} results are considered in the same order downstream from source to mouth.

6.1 The source zone.

The Stony bottom fauna, (table 12).

Two sets of collections were made from the small streams leaving the sponge, one during late summer and one in autumn. Both collections are atypical, the fauna of the summer sample pointing towards organic enrichment of the water of the sponge, and the autumn sample representing an almost summer picture since rain fell late in February 1960 (see flow figures of tables 4 and 5), which led to a reduction in dissolved solids, an increase in the pH of the water, and, judged by the faunal composition, a general improvement of the water quality.

The organic enrichment of the water during summer, is largely indicated by the following (table 12):

- i. The high percentage incidences of the Oligochaeta, particularly the genus Aulophorus, and of the Crustacea.
- ii. The relatively low total percentage, and presence, of only three species of mayfly (Ephemeroptera) namely Austrocloeon virgiliae, Centroptilum near excisum and Adenophlebia sylvatica.
- iii. The comparatively larger number of individuals per square foot as compared with the autumn collection ($1 \text{ ft}^2 = 0.093 \text{ m}^2$).

In the autumn collection there is a sharp reduction in the percentage incidence of the Oligochaeta, only Nais spp. being present. The Crustacea also occurred in reduced numbers and species, whilst the Ephemeroptera, which constitutes more than 40% of the total number of organisms collected, includes the species Baetis harrisoni, Centroptilum sudafricanum, C. near excisum, Caenis sp. 4, Aprionyx tricuspидatus, Adenophlebia auriculata, A. sylvatica and Castanophlebia calida. The Trichoptera also show an increase in the number of species and percentage incidence with Cheumatopsyche afra (Mosely) type 2, being the most common species. A richer species variety and comparatively high percentage incidence of the Diptera also occurs in this collection, but the "bloodworm", Chironomus sp., recorded in the summer collection, is absent. Some of the truly head water stony bottom species, which also occur in the upper foothill torrent zone immediately below the source, were collected. These are the following:

Plecoptera	:	<u>Aphanicercella</u> sp.
Ephemeroptera	:	<u>Centroptilum</u> near <u>excisum</u> <u>Adenophlebia sylvatica</u> <u>Castanophlebia calida</u>

T A B L E 12

Percentage composition of fauna : Stones in the current
at the Umgeni sponge (small streams)

Group of Organisms	Summer	Autumn
	Flats	Flats
<u>COELENTERATA</u>		
Hydra sp.	0.4	-
<u>HELMINTHES AND ANNELIDA</u>		
Nematoda	0.7	-
Naididae	1.9	-
Chaetogaster sp.	0.5	-
Nais sp.	7.9	10.8
Aulophorus sp.	20.9	-
<u>CRUSTACEA</u>		
Chydorus spp.	2.3	-
Cyclops spp.	5.6	5.8
Elaphoidella sp.	1.4	-
Ostracoda	34.7	8.6
Potamon sidneyi Rathburn	0.1	-
<u>COLLEMBOLA</u>		
	-	0.7
<u>PLECOPTERA</u>		
Aphanicerrella sp.	-	0.7
<u>EPHEMEROPTERA</u>		
Austrocloleon virgiliae Brnrd.	0.1	-
Baetis harrisoni Brnrd.	-	1.4
Centroptilum sudafricanum Lest.	-	10.1
C. near excisum Brnrd.	4.4	2.9
Caenis sp.4	-	0.7
Aprionyx tricuspидatus Crass	-	0.7
Adenophlebia auriculata Eaton	-	14.4
A. sylvatica Crass	5.6	13.0
Castanophlebia calida Brnrd.	-	0.7

table 12 continued

Group of Organisms	Summer	Autumn
	Flats	Flats
<u>ODONATA</u>		
Aeschna sp.	-	2.2
Anax sp.	0.1	-
Orthetrum sp.	0.1	-
<u>HEMIPTERA</u>		
Micronecta dimidiata Poisson	0.5	-
<u>TRICHOPTERA</u>		
Athripsodes ? bergensis Scott	-	P
Cheumatopsyche afra type 2	-	6.5
Hydroptila cruciata Ulmer	-	1.4
Hydroptila sp. nov (sand grain case)	0.5	1.4
Oxyethira sp.	0.7	-
<u>COLEOPTERA</u>		
Gyrinidae larvae	-	0.7
Elmidae larvae sp.6	0.2	-
<u>DIPTERA</u>		
Dixa sp.	-	0.7
Culicidae	1.5	-
Simulium larvae	-	1.4
Chironomidae	1.6	7.2
Pentaneura sp.	0.7	0.7
Clinotanytus sp.	-	1.4
Orthocladinae	-	2.2
Tanytarsini	0.2	-
Rheotanytarsus sp.	-	1.4
Chironominae	-	1.4
Chironomus sp.	0.2	-
<u>MOLLUSCA</u>		
Pisidium sp.	-	0.7
TOTAL NUMBER OF ORGANISMS	860	139
NUMBER OF ORGANISMS PER 1 FT. ² (0.093 m. ²)	860	139

Trichoptera : Athripsodes near bergensis

The marginal and aquatic vegetation fauna

The fauna from the truly aquatic and the semi-aquatic vegetation types at the Sponge do not differ very much (table 13) because, not only was the latter partly submerged but, at most places, where samples were collected, the two vegetation types also occurred together. The highest numbers of organisms occurred in the summer and autumn collections - which largely contained Cladocera, Copepoda and, in particular, Ostracoda. The Oligochaeta and Nematoda showed their highest percentage incidences in Spring, together comprising more than 50% of the number of organisms. On the whole, the marginal and aquatic vegetational fauna of the source zone indicated mild to heavy organic enrichment. These conditions could in part have been caused by the large numbers of sheep which were watered at the source and which grazed in the immediate vicinity of the sponge. The following are some of the most noteworthy features of the fauna of these habitats:

- i. The very high incidence of the Crustacea.
- ii. The presence of only two species of Ephemeroptera viz. Austrocloeon virgiliae and Adenophlebia sylvatica.
- iii. The presence of several species of Odonata and Hemiptera.
- iv. The relative abundance, amongst the Trichoptera, of an Oxyethira sp.
- v. The high incidence of the Chironomidae throughout the Autumn, Winter and Spring.

6.2

The upper foothill [^]torret zone

Marginal vegetation at Ross' Farm are sparsely distributed and, due to the steep gradient of the river bed, the vegetation very seldom remains in permanent contact with

T A B L E 13

Percentage composition of the fauna: Marginal and aquatic vegetation at the Ungeņi sponge.

Group of Organisms	Spring	Summer	Autumn		Winter
	A.V.	M.V.	M.V.	A.V.	A.V.
<u>COELENTERATA</u>					
Hydra sp.	-	0.3	0.5	-	-
<u>HELMINTHES & ANNELIDA</u>					
Planariidae	-	-	-	-	0.2
Nematoda	30.6	-	5.0	2.2	1.1
Naididae (unidentified)	3.1	2.1	0.5	6.8	10.4
Nais sp.	18.3	2.1	-	-	3.4
Aulophorus furcatus Oken.	-	6.0	-	5.9	-
Pristina sp.	0.8	-	-	0.3	-
Lunbriculidae	-	-	1.6	-	-
<u>CRUSTACEA</u>					
Simocephalus capensis	-	0.3	5.5	-	-
Alona sp.	-	-	-	1.5	0.9
Chydorus sp.	0.4	-	2.5	13.9	-
Cyclops spp.	6.2	4.2	36.5	4.9	3.6
Elaphoidella sp.	0.8	-	-	-	2.3
Ostracoda	3.3	60.5	0.5	47.9	20.7
Potamon sidneyi Rathburn	-	0.3	-	-	-
<u>COLLEMBOLA</u>					
<u>EPHEMEROPTERA</u>					
Austrocloeon virgiliae Brnrd.	-	0.3	6.6	2.5	0.2
Adenophlebia sylvatica Crass.	0.1	-	-	-	-

table 13 continued

- 73 -

Group of Organisms	Spring	Summer	Autumn		Winter
	A.V.	M.V.	M.V.	A.V.	A.V.
<u>ODONATA</u>					
Chlorolestes spp.	-	0.3	-	-	-
Pseudagrion sp.	0.2	1.2	0.5	-	0.8
Enallagma sp.	0.1	-	2.0	1.1	-
Anax sp.	-	-	0.8	-	0.1
Orthetrum sp.	0.2	-	0.3	0.1	-
Pantala flavescens (F.)	-	-	0.1	-	-
<u>HEMIPTERA</u>					
Mesovelia sp.	0.1	1.5	1.0	0.1	-
Gerris sp.	-	0.6	-	-	-
Enithares sobria Stål	-	-	0.2	-	-
Plea piccanina Hutch.	-	-	0.2	-	-
Micronecta sp.	0.1	-	0.2	-	-
Sigara sjostedti Kirk	0.1	0.3	0.2	0.8	-
Laccocoris limnigenus Stål	-	-	0.1	-	-
<u>TRICHOPTERA</u>					
Athripsodes prionii Scott	-	-	-	-	0.1
Cheumatopsyche afra (Mosely) type 1	-	-	0.1	-	-
Ecnomus sp.3	-	-	-	-	1.8
Hydroptila cruciata Ulmer	0.1	-	0.1	p	-
Hydroptila sp. nov (sand grain case)	-	0.3	-	-	-
?Ochrotrichia (round case)	p	-	-	-	-
Oxyethira sp.1	1.2	6.3	0.7	p	6.8
<u>LEPIDOPTERA</u>					
Pyralidae	-	-	-	-	0.2

table 13 continued

Group of Organisms	Spring	Summer	Autumn		Winter
	A.V.	M.V.	M.V.	A.V.	A.V.
<u>COLEOPTERA</u>					
Dytiscidae	0.1	-	0.1	-	0.1
Gyrinidae larvae	-	-	0.1	-	-
Dineutus grossus Modeer	-	-	0.3	-	-
Gyrinus natalensis Reg.	-	-	0.2	-	-
Hydrophilidae larvae	-	-	0.1	-	0.1
Hydraenidae larvae	0.1	-	-	-	-
Elmidae larvae sp.6	0.1	-	-	-	-
<u>DIPTERA</u>					
Dixa sp.	-	0.3	-	-	0.3
Culicidae	0.1	-	-	0.1	-
Chironomidae	31.6	2.4	24.5	6.2	22.6
Pentaneura spp.	2.4	0.9	0.2	p	4.5
Tanypus sp.	-	-	1.0	-	-
Procladius sp.	-	4.8	5.8	-	-
Corynoneura sp.	-	-	-	2.5	2.3
Cricotopus scottae Freeman	-	-	-	-	2.3
Tanytarsini	-	-	-	-	1.1
Tanytarsus sp.	-	-	-	0.1	7.1
Chironomus sp.	-	-	0.6	-	-
Ceratopogonidae	0.2	-	-	-	4.7
<u>ACARINA</u>					
Hydrachnellae	-	4.2	-	1.2	1.9
<u>MOLLUSCA</u>					
Burnupia sp.	-	-	-	-	-
Pisidium sp.	0.1	0.3	-	-	0.4

table 13 continued

Group of Organisms	Spring	Summer	Autumn		Winter
	A.V.	M.V.	M.V.	A.V.	A.V.
<u>AMPHIBIA</u>					
Rana tadpoles	-	0.3	-	0.3	-
NUMBER OF ORGANISMS PER 6 FT. (1.83 m.) VEGETA- TION	1309	3340	2001	3239	1062

the stream water for periods longer than a few days. Faunal collections at Ross' Farm were therefore restricted to the stony bottom habitats of which a great variety exists. At Dargle Police Station the marginal vegetation was sampled in a poollike stretch immediately above the falls.

The stony bottom fauna

High percentage incidences of Olygohaeta at Ross' Farm, in the late Spring and early Summer, (table 14) coincided with heavy growths of diatoms and algae in the fast current water types and the decay of detritus accumulated in the slow current. The rich species variety of the fauna, in particular that of the Ephemeroptera, however, indicated clean unpolluted conditions.

Even though most species recorded from this zone extended into successive physical zones downstream, certain organisms were largely restricted to, and also had their highest incidence in this zone. Some of these characteristic organisms are the following:

Plecoptera:	<u>Aphanicercella</u> spp.
Ephemeroptera:	<u>Pseudocloeon inzingae</u> , <u>Baetis cataractae</u> <u>Acentrella monticola</u> , <u>Centroptilum</u> near <u>excisum</u> , <u>Aprionyx tricuspидatus</u> , <u>Adenophlebia sylvatica</u> , <u>Castanophlebia calida</u> and <u>Afronurus</u> sp 1.
<u>Megaloptera</u> :	<u>Taeniochauloides ochraceopennis</u>
<u>Trichoptera</u> :	<u>Goerodes cafrariae</u> , <u>Sinion</u> sp., <u>Cheumatopsyche afra</u> (type 1) and <u>Ithytrichia</u> sp.
<u>Coleoptera</u> :	<u>Afropsephenoides</u> spp.

Diptera: Elporia near natalensis, Simulium impukane,
certain species of Rheotanytarsus and
Ceratopogonidae.

Amphibia: Rana umbraculata (cf Oliff, 1960).

As in all the other physical zones in which more than one sampling locality was established, a gradual longitudinal (downstream) faunal change was observed. The successive sampling localities within each zone usually contained components of the fauna of localities higher up on the one hand, and organisms which extend upstream from other physical zones lower down. For this reason no two sampling localities in any particular physical zone were exactly similar with regard to this fauna. On the contrary each locality represented part of a changing fauna. The two localities Ross' Farm and Dargle Police Station were no exception. The latter, already lacking most of the truly "head water" organisms listed above, shared with Ross' Farm the following organisms which extended upstream from the other physical zones further downstream (table 15).

Plecoptera: Neoperla spio

Ephemeroptera: Prosopistosoma sp., Acentrella natalensis,
Centroptilum sudafricanum, C. varium,
Centroptiloides bifasciatum, Caenis spp.
Neurocaenis discolor, Adenophlebia
aurieulata Euthraulus bugandensis and
Afronurus sp. 3

Trichoptera: Cheumatopsyche afra Mosely (type 2),
C. thomasseti (Ulmer), Cimarrha sp 1,
Hydroptila? cruciata, Orthotrichia sp

Coleoptera: Largely Psephenidae and Elmidae spp.

Some organisms, not found at Ross' Farm but which were recorded in the summer and autumn collections at Dargle Police

Percentage composition of the fauna : stones in the current in the Umgeni river at Ross' Farm
(below the sponge).

Group of Organisms	Spring						Summer			Autumn			Winter			
	B.W.	P.	R+S [†]	S ^{††}	CASC.	FL.	P.	S.	CASC.	P.	R.S.	S.	CASC.	R.S.	R.S.	S.
<u>HELMINTHES AND ANNELIDA</u>																
Planariidae	-	1.9	-	-	1.6	3.7	1.3	-	-	1.1	-	-	P	1.6	2.2	-
Nematoda	-	2.8	-	-	2.4	5.9	-	-	-	-	-	-	-	-	-	-
Naididae	-	1.4	-	-	25.4	-	22.6	-	-	-	-	-	-	-	-	-
Nais spp.	4.5	7.1	-	-	-	2.9	1.9	2.6	-	-	3.7	-	-	9.8	14.5	-
Limnodrilus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lumbriculidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-
<u>CRUSTACEA</u>																
Cyclops spp.	1.8	2.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ostracoda	0.5	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamon sidneyi Rathburn	-	-	-	-	-	0.7	-	-	-	-	0.5	0.2	-	-	0.3	-
<u>PLECOPTERA</u>																
Aphanicercella sp.	0.5	-	-	-	-	8.1	-	0.2	-	1.1	0.5	-	-	-	-	-
Neoperla spio (Neuman)	-	-	-	-	-	-	-	-	-	-	-	2.9	-	2.2	5.0	2.3
<u>EPHEMEROPTERA</u>																
Pseudocloeon inzingae Crass.	7.2	11.3	-	-	-	-	17.6	-	-	2.2	-	-	-	-	-	-
Baetis harrisoni Brnrd.	0.9	4.3	-	4.0	3.2	-	2.5	7.1	0.5	4.4	29.7	7.5	-	31.5	20.3	21.2
B. cataractae Crass	-	-	-	-	-	-	-	0.7	-	-	-	-	-	-	-	0.3
Acentrella natalensis Crass.	-	-	-	14.5	7.9	5.2	-	12.4	5.0	-	4.2	12.4	0.7	11.4	7.8	13.7
A. monticola Crass.	-	0.9	-	1.5	-	-	-	6.7	-	2.2	7.1	19.3	-	-	-	-
Centroptilum sudaffricanum Lest.	15.3	8.5	-	-	-	14.0	10.1	1.6	0.7	13.3	-	-	-	4.4	-	1.3
C.near excisum Brnrd.	11.7	0.7	-	-	-	-	4.4	-	-	-	-	-	-	-	-	-
C. indusii Crass.	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. varium Crass.	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-

table 14 continued

Group of Organisms	Spring				Summer				Autumn				Winter			
	B.W.	P.	R.+S†	S††	CASC.	FL.	P.	S.	CASC.	P.	R.S.	S.	CASC.	R.S.	R.S.	S.
<i>Centroptilum</i> sp. 2	1.8	0.7	-	-	-	-	1.9	-	-	16.7	-	-	-	-	-	-
<i>Centroptiloides bifasciatum</i> Lest.	-	-	-	-	-	-	-	-	0.2	-	-	-	0.2	-	-	-
<i>Caenis</i> sp. 1	1.8	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Caenis</i> sp. 2	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
<i>Caenis</i> sp. 3	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-
<i>Caenis</i> sp. 4	-	-	-	-	-	-	1.3	-	-	1.1	-	-	-	-	-	-
<i>Neurocaenis discolor</i> (Brnrd.)	-	-	-	-	-	-	0.6	3.7	-	1.1	4.2	3.7	-	-	0.3	12.4
<i>Aprionyx tricuspoidatus</i> Crass.	-	-	-	-	-	5.2	-	-	-	-	-	-	-	-	-	-
<i>Adenophlebia auriculata</i> Eaton	-	-	-	-	-	-	-	-	-	21.1	-	0.4	-	0.5	-	-
<i>A. sylvatica</i> Crass.	-	-	-	-	-	3.7	11.3	0.9	-	-	-	-	-	-	-	-
<i>Castanophlebia calida</i> Brnrd.	-	-	-	-	-	5.9	-	-	-	6.7	2.8	7.5	P	6.5	-	9.1
<i>Euthraulus?bugandensis</i> Kimmins	-	1.4	-	-	-	-	-	-	-	1.1	-	1.5	-	4.4	0.6	-
<i>Afronurus</i> sp. 3	-	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7
<i>Afronurus</i> sp. 1	0.9	-	-	-	-	-	5.0	-	-	13.3	2.8	-	-	-	-	-
<i>Afronurus</i> sp. 2	-	4.3	-	-	-	-	-	0.5	-	-	1.4	0.8	-	-	-	-
<u>HEMIPTERA</u>																
<i>Micronecta dimidiata</i> Poisson	0.9	5.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>MEGALOPTERA</u>																
<i>Taeniochauloides ochraceopennis</i>	-	-	-	-	-	4.4	-	-	-	-	-	-	-	-	-	-
<u>TRICHOPTERA</u>																
<i>Goerodes cafrariae</i>	-	-	-	-	-	2.2	-	-	-	-	-	-	-	-	-	-
<i>Sinion</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-
<i>Cheumatopsyche afra</i> (Mosely) type 1	-	-	-	-	-	-	3.1	8.5	-	5.6	-	6.0	-	0.5	10.0	-
<i>C. afra</i> (Mosely) type 2	-	-	-	-	-	-	-	-	-	-	4.9	-	-	-	-	-
<i>C. afra</i> (Mosely) near type 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.9
<i>C. thomasseti</i> (Ulmer)	-	-	-	-	-	3.7	-	-	-	-	-	-	-	1.1	-	-
<i>Ecnomus</i> sp. 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.7	-
<i>Chimarra</i> sp. 1	-	-	-	-	-	5.9	-	3.2	-	-	-	-	-	2.2	-	0.7

table 14 continued

Group of Organisms	Spring			Summer			Autumn			Winter				
	B.W.	P.	R.+S.+ S.++ CASC.	FL.	P.	S.	CASC.	P.	R.S.	S.	CASC.	R.S.	R.S.	R.S.
Hydroptilidae (oval case)	-	-	-	-	0.6	-	-	-	-	-	-	-	-	-
Hydroptila? cruciata Ulmer	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-
Ithytrichia sp. (or Saranganotrichia)	-	-	-	-	-	-	-	-	-	0.2	-	-	1.3	-
Orthotrichia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydroptila sp. nov. (sandgrain case)	-	-	0.1	-	-	-	-	-	-	1.0	-	-	-	-
Oecetis sp.	-	0.7	-	-	1.3	-	-	-	-	-	-	-	-	-
<u>COLEOPTERA</u>														
Dytiscidae adults	-	-	-	0.7	-	-	-	-	-	-	-	-	-	-
Hydrophilidae (adults)	-	-	0.1	-	-	-	-	-	-	-	-	-	0.3	-
Hydraenidae	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Afropsephenoides sp.	0.9	0.7	-	-	-	-	-	2.2	-	-	-	-	-	-
Eubrianax sp.	0.9	-	-	-	-	-	-	3.3	4.0	-	-	1.1	0.6	-
Elmidae adults (unsorted)	-	-	-	-	-	-	-	-	-	-	-	-	0.9	0.3
Elmidae larvae sp. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elmidae larvae sp. 2	-	-	-	-	-	-	-	-	0.9	-	-	-	0.6	1.3
Elmidae larvae sp. 3	-	-	-	-	-	-	-	-	2.4	4.6	-	3.3	1.3	-
Elmidae larvae sp. 4	-	-	-	-	-	-	-	-	0.2	-	-	2.2	-	-
Elmidae larvae sp. 5	-	-	-	-	-	-	-	-	-	0.2	-	-	2.8	-
Helodidae larvae	-	-	-	2.2	-	-	-	-	0.7	2.3	0.1	1.6	8.7	2.3
<u>DIPTERA</u>														
Elporia natalensis Stuck	-	-	0.3	-	-	1.8	0.4	-	-	0.4	0.2	-	-	-
Tipulidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psychoda sp.	-	-	-	0.7	-	-	-	-	-	-	-	-	-	-
Dixa sp.	-	-	-	2.2	-	-	-	-	-	-	-	-	-	-
Simulium larvae	0.5	0.5	75.9	8.1	1.3	46.2	76.5	-	4.9	9.9	98.0	4.4	3.1	13.0
S. adersi Pom.	-	-	-	-	-	-	-	-	0.5	0.2	-	-	-	-
S. alcocki form occidentale Freeman and de M.	-	-	-	-	-	0.2	-	1.1	-	-	-	-	-	-

table 14 continued

Group of Organisms	Spring				Summer				Autumn				Winter			
	B.W.	P.	R.+S. ⁺	S. ⁺⁺	CASC.	FI.	P.	S.	CASC.	P.	R.S.	S.	CASC.	R.S.	R.S.	R.S.
<i>S. cavum</i> Gibbins	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-
<i>S. damnosum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. impukane</i> de M.	0.9	-	-	-	0.1	-	-	-	-	-	-	-	-	p	-	-
<i>S. medusaeforme</i> Pom.	-	-	-	-	0.4	-	-	-	0.2	-	-	-	-	-	-	0.3
<i>S. rutherfordi</i> de M.	-	-	-	P	-	-	-	P	-	-	-	-	-	-	-	0.7
<i>S. vorax</i> Pom.	-	-	-	0.1	-	-	-	-	-	-	0.5	-	-	-	-	-
Chironomidae	4.5	5.6	-	-	6.4	3.7	-	2.8	5.0	-	6.6	6.0	0.2	5.4	3.1	8.1
Pentaneura spp.	-	1.4	-	0.2	0.5	2.2	4.4	-	-	-	0.2	-	-	-	-	-
Clinotanytus sp.	-	2.8	-	-	-	-	-	-	-	1.1	-	-	-	-	-	-
Corynoneura sp.	2.7	-	-	-	-	2.9	-	-	-	-	-	-	-	-	-	-
Orthocladinae	0.9	1.4	-	2.3	9.0	-	-	-	11.2	-	3.8	2.7	0.3	1.6	-	6.5
Tanytarsini	1.8	2.4	-	-	-	-	3.8	-	-	-	-	-	-	-	-	-
Rheotanytarsus spp.	36.0	20.3	-	0.3	-	1.5	3.8	1.2	-	-	4.5	-	-	5.0	5.0	-
Chironominae	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-
Chironomus sp.	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ceratopogonidae	3.2	7.1	-	0.5	0.5	4.5	-	0.2	-	-	0.2	0.2	-	-	-	-
Empididae	-	-	-	-	1.6	-	-	0.5	0.4	1.1	0.5	3.1	P	2.5	2.5	-
Rhagionidae	-	-	-	-	1.5	-	0.6	-	-	-	0.7	-	-	-	-	-
Muscidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>ACARINA</u>																
Hydrachnellae (unsorted)	-	0.5	-	-	-	-	0.6	-	-	-	2.6	2.1	-	-	-	-
Attractides sp.	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-
<u>MOLLUSCA</u>																
Burnupia sp.	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-
<u>AMPHIBIA</u>																
<i>Rana vertebralis</i>	-	-	-	-	P	-	-	P	-	-	P	-	-	-	P	-
Total number of Organisms (1 ft ² = 0.093 m ²)	222	424	1241	756	136	79.5	217.5	561.0	90	425	483	2644	92.0	161.0	307.0	

T A B L E 15

Percentage composition of the fauna: stones in the current in the Umgeni river at Dargle Police station.

Group of Organisms	Summer	Autumn
	ST.	R.
<u>HELMINTHES AND ANNELIDA</u>		
Planariidae	2.0	0.3
Nematoda	-	1.4
<u>CRUSTACEA</u>		
Ostracoda	-	1.4
<u>PLECOPTERA</u>		
Neoperla spio (Neuman)	1.0	0.3
<u>EPHEMEROPTERA</u>		
Prosopistoma sp.	-	0.3
Oligoneuriopsis lawrencei Crass.	1.8	-
Baetidae juveniles	-	3.0
Baetis harrisoni Brnrd.	25.2	16.4
B. glaucus Agnew	-	0.1
Acentrella natalensis Crass	2.6	0.7
Centroptilum sudafricanum Lest.	7.3	8.2
C. medium Crass	0.4	-
C. parvum Crass	6.5	16.7
C. varium Crass	-	0.1
Centroptiloides bifasciatum Lest.	-	0.1
Caenis sp. 2	-	2.7
Caenis sp. 3	-	1.4
Neurocaenis discolor (Brnrd.)	9.8	6.3
Adenophlebia auriculata Eaton.	0.8	0.1
Euthraululus? ugandensis	0.6	0.3
Afronurus sp. 3	2.4	2.7

table 15 continued

Group of Organisms	Summer	Autumn
	ST..	R.
<u>ODONATA</u>		
Aeschna rileyi Calvert	0.2	-
<u>HEMIPTERA</u>		
Rhagovelia sp.	-	0.1
Laccocoris limnogenus Stäl	0.2	0.1
<u>TRICHOPTERA</u>		
Trichosetodes sp.	2.4	0.4
Hydropsyche ? longifurca	-	0.4
Cheumatopsyche afra type 2 (Mosely)	-	0.3
C. thomasseti (Hairy) (Ulmer)	0.2	-
Ecnomus sp. a	0.4	-
Ecnomus sp. b	0.2	-
Chimarra sp. 1	2.2	-
Hydroptila cruciata Ulmer	0.6	0.3
Ochrotrichia sp.	0.2	0.6
Orthotrichia sp.	0.4	0.1
<u>COLEOPTERA</u>		
Gyrinidae larvae	0.4	-
Afropsephenoides sp.	-	0.1
Eubrianax sp.	2.6	-
Dryopidae larvae	-	0.1
Elmidae sp. b	-	1.4
Elmidae sp. f	1.2	2.7
Elmidae sp. 1	0.4	-
Elmidae sp. 1	-	0.7
Elmidae sp. 2	0.4	2.9
Elmidae sp. 3	-	1.4
Elmidae sp. 5	0.2	1.1

table 15 continued

Group of organisms	Summer	Autumn
	ST.	R.
<u>DIPTERA</u>		
Eriocera sp.	-	0.1
Simulium larvae	19.5	15.1
Chironomidae	4.9	5.5
Pentaneura sp.	0.6	-
Orthocladinae	1.6	1.4
Ceratopogonidae (unidentified)	-	0.1
Forcipomyia sp.	0.2	-
Wiedemannia sp. (Empididae)	-	0.1
<u>ACARINA</u>		
Hydrachnellae	P	P
<u>MOLLUSCA</u>		
Burnupia sp.	0.2	0.1
TOTAL NUMBER OF ORGANISMS (QUALITATIVE)	492	730

Station, include Oligoneuriopsis lawrencei, Centroptilum parvum, Baetis glaucus, Hydropsyche? longifurca, Dryopidae and certain species of the Elmidae family. All these also occur in larger numbers in physical zones downstream from the upper foothill torrent zone.

The marginal vegetation fauna.

Virtually all species recorded from the marginal vegetation at Dargle Police Station (table 16) have a much wider distribution in the Umgeni river and, consequently, are not peculiar to this or any other particular physical zone. Oligochaeta were represented by Nais sp. only. Nematoda had a high incidence in the trailing vegetation in summer. In the slow current, Copepoda and Ostracoda showed some numerical increase in autumn compared with the summer samples. The major orders of aquatic insects which dominated the fauna both in species and in numbers, were the Ephemeroptera and Diptera. Individual species which occurred in comparatively high percentages were Pseudocloeon vinosum (summer), Centroptilum sudafricanum (summer and autumn) Caenis sp 4 (summer and autumn), Laccocoris limnogenus (summer), Athripsodes? prionii (summer) Simulium spp. (summer) and species of the Chironomidae.

6.3. The lower foothill torrent zone.

This zone is shared by at least three different faunal components. They are:

- i. The "head water faunal element", which is largely restricted to the upper foothill torrent zone (see above), but which partly extends and terminates in this zone.
- ii. A group of organisms which have a wide longitudinal distribution in the Umgeni river, occurring throughout

T A B L E 16

Percentage composition of the fauna : marginal vegetation in the Umgeni river near Dargle Police Station (above falls).

Group of Organisms	Summer		Autumn
	M.V. ⁺⁺	M.V. ⁺	M.V. ⁺⁺
<u>HELMINTHES AND ANNELIDA</u>			
Planariidae	2.5	-	2.3
Nematoda	-	20.4	1.1
Nais sp.	3.8	-	-
<u>CRUSTACEA</u>			
Cyclops spp.	-	-	4.5
Ostracoda	-	-	11.3
Potamon sidneyi Rathburn	-	0.3	-
<u>COLLEMBOLA</u>			
	-	-	1.1
<u>EPHEMEROPTERA</u>			
Austrocloeon virgiliae Brnrd.	3.2	-	-
Austrocloeon sp.	-	-	0.1
Pseudocloeon vinosum Brnrd.	15.2	-	0.2
Baetis harrisoni Brnrd.	-	0.3	-
B. bellus Brnrd.	3.8	2.4	3.4
B. latus Agnew	-	1.7	-
Baetidae juveniles	-	-	9.0
Centroptilum sudafricanum Lest.	6.3	16.3	20.3
C. excisum Brnrd.	-	0.7	-
Adenophlebia auriculata Eaton	-	-	3.5
Caenis spp. (unsorted)	-	-	3.4
Caenis sp. 2	-	0.3	-
Caenis sp. 4	11.4	8.2	18.1

table 16 continued

Group of Organisms	Summer		Autumn
	M.V. ⁺⁺	M.V. ⁺	M.V. ⁺⁺
<u>ODONATA</u>			
Pseudagrion spp.	1.9	-	-
P. natalense Ris.	-	0.7	2.2
<u>HEMIPTERA</u>			
Mesovelia sp.	-	-	0.3
Rhagovelia sp.	1.9	-	-
Micronecta sp.	-	-	0.6
Laccocoris limnogenus Stål	-	9.5	1.1
<u>TRICHOPTERA</u>			
Athripsodes ? prionii Scott	7.6	-	-
Trianodes sp.	-	-	1.9
Trichosetodes sp.	1.3	-	-
Cheumatopsyche afra (Mosely) type I	-	0.3	-
Hydroptila sp. nov (sand grain case)	-	-	0.2
Oxyethira sp.	-	-	0.1
<u>DIPTERA</u>			
Dixa sp.	2.5.	-	-
Simulium larvae	-	24.5	0.1
S. adersi Pom.	-	-	0.2
Chironomidae (unsorted)	22.8	8.16	7.9
Pentaneura spp.	10.1	1.17	3.4
Corynoneura spp.	-	4.1	-
Othocladinae	-	0.3	-
Ceratopogonidae	-	-	0.3
Rhagonidae	-	0.1	-

table 16 continued

Group of Organisms	Summer		Autumn
	M.V. ++	M.V. +	M.V. ++
<u>MOLLUSCA</u>			
Lymnaea sp.	0.6	-	-
Gyraulus corniculum Conn.	3.2	-	1.8
Burnupia sp.	-	-	0.6
Pisidium sp.	-	-	0.1
<u>AMPHIBIA</u>			
Rana sp.	-	-	0.1
Total number of Organisms per 6 ft. (1.83 metres) marginal vegetation.	158	294	884

+ Trailing vegetation ; moderate to fast current.

++ In very slow current or stagnant waters.

all the physical zones, but with its optimal distribution in, and between, the foothill torrent and rejuvenated river zones.

- iii. A small component of organisms which mainly occupy the upper and lower foothill torrent zones.

A detailed discussion of this association is given elsewhere. (chapter 8).

The stony bottom fauna

The Helminthes, Annelida and Crustacea constituted small proportions of the stony bottom fauna at all the sampling localities of this zone (tables 17 - 20). With the exception of the localities at Watersmeet and Fern Hill Flats, where slow current conditions largely prevailed, and, where the habitats were visibly affected by deposits of silt, all the insect orders were dominated both numerically, and, with the exception of the Diptera, also in species variety, by the stony bottom Ephemeroptera which attained the highest percentage incidences at Dargle Forestry, where, excluding one sample, they constituted more than 50% of the total number of organisms collected. Some of the most noteworthy features of the stony bottom fauna of this zone are summarized below.

With the exception of silt deposits in the slower flowing regions of this zone no, visible signs of stream disturbance were detected during the period of survey. Neither did the fauna indicate unhealthy conditions.

Helminthes and Annelida: Present in small numbers.

Oligochaeta mainly represented by Nais sp. which seldom exceeded a 10% incidence.

Crustacea:

Included Copepoda, Cladocera, Ostrocods and Decapoda all of which

occured in small numbers; Decopoda were represented by Potamon dubius and P. sidneyi.

Plecoptera:

Only one species present viz. Neoperla spio. It disappeared from the fauna at Dargle Forestry (table 17) and Midmar (table 20) during late spring and early summer and was completely absent in the slower flowing regions of Watersmeet (table 18) and Fern Hill Flats (table 19).

Ephemeroptera:

Mayflies, which were abundant throughout the year, included Baetis harrisoni, Neurocaenis discolor, Afronurus sp 3, Centroptilum sudafricanum and, to a lesser extent, Acentrella natalensis. All these species showed a drop in incidence at Watersmeet and Fern Hill Flats, with B. harrisoni and N. discolor being apparently less affected than the other three species. If Harrison's (1958) contention that N. discolor (= Tricorythus discolor, Harrison) seems to prefer distinctly muddy water with its associated microplankton be correct, one would expect the incidence of this species to increase at Watersmeet and Fern Hill Flats. In the Umgeni river, however, this species was more abundant in clear water both higher upstream and further downstream (tables 17 and 20) thus lending no support to Harrison's assumption.

Other Ephemeroptera which occurred in reduced numbers and, which showed distinct seasonal fluctuations, being absent or just present during parts of the year are:

<u>Centroptilum indusii</u> :	Maximum numbers in summer and autumn.
<u>Centroptilum medium</u> :	Maximum numbers in summer and autumn.
<u>Centropfilum parvum</u> :	Absent in winter.
<u>Centroptilum</u> sp 2:	Absent in winter.
<u>Centroptilum</u> sp 3:	Present in summer and autumn.
<u>Centroptiloides bifasciatum</u> :	Absent in winter; most common during autumn.
<u>Baetis glaucus</u> :	Present in autumn (Dargle Forestry); in summer and autumn (Midmar).
<u>Pseudocloeon maculosum</u> :	Absent in winter; most common in autumn (Midmar).
<u>Adenophlebia auriculata</u> :	Present in summer and autumn.
<u>A. sylvatica</u> :	Present in autumn.
<u>Afronurus</u> sp 2.	Absent in winter.
<u>Ephoron savigni</u> :	Present in summer and autumn.
<u>Oligoneuriopsis lawrencei</u> :	Present in summer and autumn.

Odonata: The species recorded belong to the genera Chlorocypha, Aeschna, Anax, Trithemis and Zygonyx.

Hemiptera: Poorly represented in this zone; the species recorded were Laccocoris limnogenus and Micronecta dimidiata.

Neuroptera: Sialis sp., present at all sampling localities in this zone.

Trichoptera: Noteworthy was the absence of Goerodes caffrariae, Sinion sp and Ithytrichia sp.

These were characteristic of the fauna at Ross' Farm in the upper foothill torrent zone. Other species which were first recorded here included Pseudoneureclipsis spp. 1 and 2 and Macronema natalensis. Hydropsyche longifurca increased in numbers downstream from Dargle Forestry towards Midmar.

Lepidoptera: Nymphula sp. Recorded in summer and autumn only. Not very abundant.

Coleoptera: Of the eight families of Coleoptera viz. Gyrinidae, Dytiscidae, Hydrophilidae, Hydraenidae, Psephenidae, Dryopidae, Helodidae and Elmidae, the last mentioned family was represented by the most species and, at most localities also dominated the other families in their abundance.

Diptera: The Simuliidae never attained the same numerical importance as in the upper foothill torrent zone. However, together with the Chironomidae and its subfamilies the Orthocladinae and Chironominae, they still constituted the bulk (numbers) of the Diptera.

Hydrachnellae: The highest percentage occurrence of the Hydrachnellae was recorded at the slow current localities of Watersmeet and Fern Hill Flats. (tables 18 and 19).

Mollusca: In addition to Burnupia, which occurred in small numbers at all stations throughout the year, Lymnaea columella recorded from Fern Hill Flats (table 19) was the only other snail present.

The marginal and aquatic vegetation fauna.

With the exception of an occasional high incidence of Nais spp. at Midmar (table 24), and a somewhat rich species variety of the Helminthes and Annelida at Watersmeet (table 22), the water quality of this zone, as indicated by the fauna of the marginal and aquatic vegetation, agreed with the picture presented by the stony bottom fauna, viz. that the water was undisturbed and clean. The Crustacea were present in small numbers and few species. The Ephemeroptera included amongst others, species which are usually mainly confined to the marginal or aquatic vegetation, others which normally occupy the slow current of the river bed and which are usually found in small numbers in the marginal vegetation, and, finally, a group which, as a rule, occupies the stony bottom habitats of the river. This last group when present in the marginal vegetation, can be regarded as stray animals. Some of the mayflies ^{belonging} to the abovementioned groups, and which were collected in the marginal vegetation of this zone, are the following:

- i. The truly marginal vegetation species: Austrocloeon virgiliae, A. near virgiliae, Centroptilum pulchrum, Baetis bellus, B. latus and Pseudocloeon vinosum.
- ii. The slow current dwellers which occurred in small numbers are Centroptilum excisum, C. sudafricanum, Adenophlebia auriculata and Euthraulius? bugandensis.
- iii. The truly stony bottom inhabitants recorded from the marginal vegetation of this zone, included Acentrella natalensis, Baetis harrisoni, B. cataractae, B. glaucus and Afronurus sp 3. In most instances, these nymphs were largely penultimate or ultimate instars, ready to hatch.

The Odonata mainly consisted of nymphs of Pseudagrion species such as natalense, salisburyense and kersteni. Other genera recorded were Zygonyx, Trithemis, Chlorocypha and Paragomphus spp.

The Hemiptera of the marginal vegetation comprised a richer species variety than was the case in the stony bottom habitats. Several genera were found, non of which were confined to this particular zone. The most common species recorded were Rhagovelia ? nigricans, Micronecta dimidiata and Laccocoris limnogenus.

In addition to the occurrence of the truly marginal vegetation Trichoptera such as Athripsodes ? prionii, Trianodes sp. and Oxyethira sp., many other species present, such as Hydropsyche and Cheumatopsyche, are typical stream bottom organisms.

The Dytiscidae and Gyrinidae contained in the samples, were mainly adults. Typical marginal vegetation Coleoptera recorded were Haliphus sp., and, of the Elmidae, larva sp. 7 and adult sp. j.

Amongst the insect orders, the Diptera had the highest total percentage incidence, largely comprising species of the Chironomidae. Simulium larvae, on the other hand, were not well represented but showed percentage increases in the vegetation trailing in the fast current.

The Hydrachnellae of the marginal vegetation were comparatively more numerous at the Watersmeet sampling locality (table 22) than elsewhere in this zone.

The Mollusca included, Burnupia, Pisidium and Lymnaea spp.

Group of Organisms	Spring						Summer						Autumn						Winter						
	FL.	R.	P.	P.	R.	FL.	BW.	P.	R.	ST.	FL.	FL.	P.	R.	R.	ST.	R.	FL.	R.	R.	FL.	R.	R.		
<i>Neurocaenis discolor</i> (Brnrd.)	-	6.2	6.8	-	7.0	4.1	3.7	3.5	3.3	-	5.2	6.8	-	19.4	6.2	2.2	17.8	10.2	5.1	13.2					
<i>Adenophlebia auriculata</i> Eaton	-	-	-	-	-	-	2.7	-	17.4	-	3.5	9.5	4.6	7.8	-	0.2	-	-	-	-	-	-	-	-	
<i>A. sylvatica</i> Crass.	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Euthraulus bugandensis</i> Kimmens	5.7	0.2	1.2	14.1	-	5.5	-	-	-	-	4.1	-	8.0	1.3	0.4	7.4	-	-	5.8	-	-	-	-	-	
<i>Afronurus</i> sp. 3	17.0	0.6	9.0	15.6	15.7	16.4	1.8	16.5	7.2	0.6	4.7	4.1	23.9	2.4	-	-	-	2.5	6.9	0.4	-	-	-	-	
<i>Afronurus</i> sp. 2	-	-	-	-	4.7	-	-	4.7	-	-	-	-	5.6	0.7	-	-	-	-	-	-	-	-	-	-	
<u>ODONATA</u>																									
<i>Chlorocypha</i> sp.	-	-	-	-	-	-	-	1.2	-	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	
<i>Aeschna</i> sp.	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Zygonyx</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	
<u>HEMIPTERA</u>																									
<i>Laccocoris limnogenus</i> Stål	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<u>MEGALOPTERA</u>																									
<i>Sialis</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-
<u>TRICHOPTERA</u>																									
<i>Oecetis</i> sp.	1.0	-	0.2	1.2	-	-	-	4.7	-	-	-	0.7	-	0.6	-	-	0.3	-	-	-	-	-	-	-	
<i>Hydropsyche</i> ? <i>longifurca</i>	-	0.4	-	-	0.3	-	-	-	-	1.3	0.5	0.7	0.3	-	0.9	1.4	-	0.9	1.1	2.5	-	-	-	-	
<i>Cheumatopsyche afra</i> (Mosely) type 2	0.4	-	0.2	-	-	-	-	-	-	0.6	3.5	1.0	-	2.2	2.2	3.1	0.5	-	-	-	-	-	-	-	
<i>C. afra</i> (Mosely) type 3	-	-	-	-	-	-	-	-	-	-	-	-	-	1.2	-	-	0.5	-	-	0.4	-	-	-	-	
<i>C. afra</i> (Mosely) type 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	0.7	-	-	1.5	-	-	-	-	
<i>C. thomasseti</i> (Ulmer)	2.8	0.7	3.5	0.4	-	-	-	-	1.5	-	1.0	-	-	1.6	-	-	0.7	1.1	0.7	1.1	-	-	-	-	
<i>Macronema natalensis</i> Ulmer	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	
<i>Pseudoneureclipsis</i> sp. 1	3.8	0.2	0.8	0.4	-	0.7	-	8.2	0.9	-	-	1.7	3.4	3.6	0.4	-	P	1.7	1.1	-	-	-	-	-	
<i>Pseudoneureclipsis</i> sp. 2	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Ecnomus</i> sp. 2	P	0.1	-	-	-	1.0	-	-	0.6	-	0.4	-	-	P	-	-	-	-	-	0.4	1.4	-	-	-	
<i>Ecnomus</i> sp. 4	0.6	-	-	-	-	-	-	-	-	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-	-	
<i>Chimarra</i> sp. 2	-	-	-	-	0.3	6.2	-	-	-	-	1.9	-	-	0.4	-	-	0.5	0.9	-	-	-	-	-	-	

table 17 continued

Group of Organisms	Spring							Summer							Autumn							Winter				
	FL.	R.	P.	P.	P.	R.	FL.	BV.	P.	R.	ST.	FL.	FL.	P.	R.	R.	ST.	R.	FL.	R.	R.	FL.	R.	R.	R.	
Chironomidae	5.7	1.8	-	0.8	1.8	1.0	8.2	1.2	3.3	-	7.2	9.5	0.6	1.8	11.0	17.2	3.5	3.4	3.5	5.7	3.5	3.4	5.7	3.5	3.5	
Pentaneura sp.	4.4	2.8	0.8	-	-	-	4	-	0.6	-	-	-	-	-	-	-	1.0	-	-	1.5	-	-	1.5	-	-	
Blinotarxpus sp.	-	-	-	-	-	-	-	-	-	-	0.5	-	0.9	-	-	-	-	-	-	-	-	-	-	-	-	
Myrnoneura sp.	-	0.1	0.6	-	-	-	-	-	-	-	-	-	-	3.4	-	-	-	-	-	1.8	-	-	-	-	-	
Orthocladinae	1.9	6.6	1.4	-	-	-	-	-	1.1	15.39	-	4.8	5.7	-	9.9	34.8	2.0	0.9	6.5	6.5	2.0	0.9	6.5	4.2	4.2	
Panytarsini	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-	1.5	-	-	
Rheotanytarsus sp.	1.3	-	-	-	-	-	-	-	2.1	-	3.1	-	-	0.4	-	1.4	2.2	-	-	2.2	-	-	2.2	-	-	
Meratopogonidae	1.0	-	0.2	-	-	-	-	-	-	5.1	-	-	-	-	0.4	-	-	-	-	-	-	-	-	5.6	5.6	
Pabanidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.1	
Empididae	1.3	0.7	0.8	-	-	2.4	-	-	0.3	0.6	0.2	0.3	-	0.6	0.6	0.7	-	-	-	-	-	-	-	-	-	
Rhagionidae	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	-	-	0.4	1.0	-	0.4	2.2	2.2	
<u>ACARINA</u>																										
Hydracarina	-	1.0	0.8	0.4	0.6	-	-	-	1.1	1.3	-	-	-	2.8	-	-	-	-	1.7	-	-	1.7	-	1.4	1.4	
<u>MOLLUSCA</u>																										
Burnupia sp.	-	-	-	0.8	-	-	-	3.5	-	-	-	-	0.3	1.0	-	-	-	-	-	1.1	-	-	1.1	-	-	
Total number of Organisms per sample	159.0 sq.ft. qual.	1071	513 qual. qual.	256	343	146.0 sq.ft. qual.	219 qual. qual.	85	11.0	156	580	294	350	500	547	581.0 sq.ft. qual.	405	354.0 sq.ft. qual.	276.0	723	405	354.0 sq.ft. qual.	276.0	723	723	

qual. = qualitative
sq. ft. = (0.093 m.²)

Percentage composition of the fauna : Stones in the current in the Umgeni river at
Watersmeet (Dargle)

Group of Organisms	Spring			Summer	Autumn		
	Early	Late	R.		R.	R.+S.	P.
	P.	P.	R.	R.	R.	P.	
<u>HELMINTHES AND ANNELIDA</u>							
Prostoma sp. (Nemertea)	0.5	-	0.8	-	1.8	1.0	-
Nematoda	-	-	-	-	1.2	-	1.1
Nais sp.	1.5	6.1	2.2	-	-	-	5.0
<u>CRUSTACEA</u>							
Chydorus sp.	-	-	0.3	-	-	-	-
Cyclops sp.	-	-	0.6	-	-	-	-
<u>EPHEMEROPTERA</u>							
Prosopistoma sp. nov.	0.3	-	-	-	-	-	-
Oligoneuriopsis lawrencei Crass.	-	-	0.5	-	-	-	0.3
Pseudocloeon vinosum Brnrd.	-	-	-	-	-	-	1.4
Baetis harrisoni Brnrd.	11.8	11.8	18.9	11.0	23.7	-	-
Acentrella natalensis Crass.	-	-	2.2	-	0.3	-	-
Centroptilum varium Crass.	-	-	-	-	0.2	-	-
Centroptiloides bifasciatum Lest.	-	-	-	-	0.8	-	-
Caenis sp. 3	1.0	-	0.6	-	-	-	-
Neurocaenis discolor (Brnrd.)	5.9	-	12.8	14.1	15.2	0.6	-
Euthraulus elegans Brnrd.	-	0.8	-	-	-	-	-
<u>ODONATA</u>							
Chlorocypha sp.	-	-	-	1.2	-	-	-
Zygonyx natalensis (Martin)	-	-	0.6	1.2	0.7	-	-
<u>HEMIPTERA</u>							
Micronecta dimidiata Poisson	-	-	-	0.6	-	-	-

Group of Organisms	Spring		Summer	Autumn	
	Early	Late		R.	R.+S.
	P.	P.	R.	R.	P.
<u>TRICHOPTERA</u>					
Oecetis sp.	-	-	-	-	0.3
Hydropsyche ? longifurca	0.5	-	-	1.4	-
Cheumatopsyche afra (Mosely) type 1	-	-	-	5.4	-
C. afra (Mosely) type 2	0.5	-	3.9	7.4	-
C. thomasseti (Ulmer)	0.5	-	-	-	-
Hydroptila ? cruciata Ulmer	-	1.6	-	0.3	0.6
Hydroptila sp. nov. (sand grain case)	0.3	-	-	1.8	3.9
<u>COLEOPTERA</u>					
Gyrinidae larvae	0.3	-	-	2.2	-
Afropsephenoides sp. 2	-	-	-	2.5	-
Elmidae larvae sp. 2	1.5	4.1	-	11.7	1.7
Elmidae larvae sp. 3	-	-	-	-	-
Elmidae larvae adults sp. f	-	0.6	-	0.6	0.3
Elmidae adults sp. L	-	-	8.6	-	-
Large Brown Coleoptera	-	-	1.7	-	-
<u>DIPTERA</u>					
Antocha sp.	-	0.4	0.3	-	0.3
Simulium larvae	8.9	4.1	9.44	11.0	3.3
S. adersi Pom.	-	-	0.3	-	-
S. unicornutum form rotundum Gibbins	-	-	0.2	-	-
Chironomidae	26.3	30.1	15.0	1.8	46.8
Pentaneura sp.	2.0	1.22	-	-	2.8
Corynoneura sp.	-	0.8	-	-	-
Orthocladinae	20.7	13.0	5.3	8.6	5.0
Pheotanytarsus sp.	2.0	6.5	2.8	-	10.0
Chironominae	4.4	11.4	2.8	1.2	3.3

Group of Organisms	Spring		Summer		Autumn		
	Early	Late	R.		R.	R.+S.	P.
	P.	P.					
Atherix sp.	-	0.4	-	-	-	-	-
Hemerodromia sp.	1.0	1.2	0.8	-	-	-	-
Wiedemannia sp.	-	-	-	-	-	0.2	-
<u>ACARINA</u>							
Hydrachnellae	8.9	6.5	8.3	12.9	6.1	13.4	
<u>MOLLUSCA</u>							
Burnupia sp.	-	-	1.1	8.6	-	-	-
Total number of Organisms	406 qual.	246 sq. ft.	360 qual.	163 qual.	591 qual.	359 qual.	

1 sq. ft. (ft.²) = 0.93 m.²

T A B L E 19

Percentage composition of the fauna : stones in the current in the Umgeni river at Fern Hill Flats

Group of Organisms	Spring		Summer		Autumn		Winter	
	R.+St.	R.	R.	R.	R.	R.+St.	Early	Late
<u>PORIFERA</u>	-	-	p	-	-	-	-	-
<u>HELMINTHES AND ANNELIDA</u>								
Planariidae	-	-	-	-	1.2	-	1.8	-
Nematoda	-	-	1.8	-	-	-	-	-
Nais sp.	4.5	9.8	-	2.1	1.2	34.2	4.5	-
<u>EPHEMEROPTERA</u>								
Prosopistoma sp.	-	-	-	-	-	-	0.2	-
Oligoneuriopsis lawrencei Crass.	-	3.0	-	0.3	-	-	-	-
Elassoneuria trimeniana McLach.	4.5	-	-	-	-	-	-	-
Pseudocloeon vinosum Brnrd.	-	0.2	-	-	-	-	-	-
Baetis harrisoni Brnrd.	20.4	3.5	0.3	6.2	6.7	2.6	4.1	-
Acentrella natalensis Crass.	0.8	-	-	0.2	-	-	-	-
Centroptilum sudafricanum Lest.	-	-	1.6	-	-	-	1.8	-
C. indusii Crass.	-	-	-	0.7	-	-	p	-
C. varium Crass.	0.4	-	-	-	-	-	-	-
Centroptilum sp. 2	-	-	0.3	1.0	-	-	-	-
Centroptiloides bifasciatum Lest.	-	0.2	0.2	-	-	-	-	-
Caenis sp. 2	0.4	-	-	-	1.2	0.7	-	-
Neurocaenis discolor (Brnrd.)	3.8	6.1	-	5.2	-	4.6	11.3	-
Euthraulus bugandensis Kimm.	-	-	-	-	-	-	0.9	-
Afronurus sp. 3	-	-	-	-	0.3	-	1.4	-
<u>ODONATA</u>								
Chlorocypha sp.	-	-	-	-	0.6	-	-	-
Aeschna spp.	0.4	-	-	0.2	0.3	-	-	-
Anax sp.	-	-	-	-	-	0.3	0.2	-

Group of Organisms	Spring		Summer		Autumn		Winter			
	R.+St.	R.	R.	R.	R.	R.+St.	R.	Early	Late	
Trithemis sp.	0.4	-	-	-	-	1.5	0.3	0.2	-	
Zygonyx natalensis (Martin)	0.8	0.3	-	0.5	-	-	-	-	-	
<u>TRICHOPTERA</u>										
Hydropsyche ? longifurca	-	-	0.2	0.5	-	-	-	-	-	
Cheumatopsyche afra (Mosely) type 2	2.3	4.7	-	1.7	-	-	-	0.2	0.2	
C. afra (Mosely) type 3	-	-	-	-	-	4.3	-	-	1.4	
C. afra (Mosely) type 4	-	-	-	-	-	-	0.3	-	-	
C. thomasseti (Ulmer)	-	-	-	-	-	-	-	-	-	
Hydroptila cruciata Ulmer	-	0.3	-	-	-	-	-	-	-	
Hydroptila sp. nov. (sand grain case)	0.4	0.5	-	0.2	-	0.6	-	-	0.2	
Orthotrichia sp.	-	0.2	-	-	-	-	-	-	-	
Oxyethira sp.	-	0.3	-	-	-	-	-	-	-	
<u>LEPIDOPTERA</u>										
Pyralidae	-	-	0.2	-	-	-	-	-	-	
<u>COLEOPTERA</u>										
Gyrinidae	-	0.3	-	-	-	0.3	-	0.2	-	
Hydrophilidae	0.4	-	-	-	-	-	-	-	-	
Hydraenidae	-	-	-	0.3	-	-	-	0.2	-	
Eubrianax sp.	-	-	-	-	-	-	-	0.2	-	
Elmidae (unsorted)	1.9	-	0.2	-	-	3.7	0.7	0.2	-	
Elmidae adults sp.c	-	0.2	-	-	-	-	-	-	-	
Elmidae adults sp.f	-	0.5	-	1.4	-	-	-	-	-	
Elmidae adults sp.1	-	1.9	-	0.7	-	-	-	-	-	
Elmidae larvae sp.1	-	0.2	-	0.3	-	-	-	-	-	
Elmidae larvae sp.2	2.3	0.3	3.2	4.5	-	2.4	0.6	1.4	-	
Elmidae larvae sp.3	-	-	-	-	-	0.6	-	-	-	
Elmidae larvae sp.4	-	-	-	-	-	-	0.2	-	-	
Elmidae larvae sp.5	-	-	-	-	-	0.3	0.4	-	-	

Group of Organisms	Spring		Summer		Autumn		Winter			
	R.+St.	R.	R.	R.	R.	R.+St.	Early		R.	
							R.+St.	R.		
<u>DIPTERA</u>										
Tipulidae	-	-	-	-	0.2	-	-	-	-	-
Simulium larvae	6.0	7.4	-	-	24.7	45.0	31.0	27.2	-	-
S. alcocki Pom.	-	0.3	-	-	-	-	-	-	-	-
S. ? impukane de M.	-	-	-	-	-	-	-	P	-	-
S. bequaerti Gibbins	-	0.2	-	-	-	-	-	0.5	-	-
S. cervicornotum Pom.	-	0.5	-	-	-	-	-	-	-	-
S. unicornotum Pom.	0.4	0.7	-	-	0.3	-	-	2.3	-	-
S. medusaeforme Pom.	-	0.3	-	-	-	-	P	-	-	-
Chironomidae	-	12.1	9.6	15.8	7.2	13.7	19.0	-	-	-
Pentaneura sp.	-	0.7	-	-	-	-	0.9	-	-	-
Corynoneura sp.	-	-	-	-	-	-	0.5	-	-	-
Orthocladinae	43.8	40.4	57.8	20.6	4.9	3.3	4.5	-	-	-
Rheotanytarsus sp.	2.3	2.4	3.2	2.1	-	-	1.4	-	-	-
Chironominae	-	0.5	4.8	4.1	-	-	4.1	-	-	-
Ceratopogonidae	0.8	-	-	-	-	-	-	-	-	-
Empididae	-	0.5	-	-	-	-	-	-	-	-
Rhagionidae	-	-	-	-	-	-	0.2	-	-	-
<u>ACARINA</u>										
Hydrachnellae	3.4	1.5	12.8	4.5	15.2	6.5	4.1	-	-	-
<u>MOLLUSCA</u>										
Lymnaea sp.	-	-	0.3	-	-	-	-	-	-	-
Purnupia sp.	P	P	3.3	1.4	2.1	0.2	3.1	-	-	-
Total number of organisms	265.0 qual.	594.0 qual.	623.0 qual.	583.0 qual.	165.0 ft.2	614.0 qual.	221.0 ft.2	-	-	-

qual. = qualitative

ft.² = 0.93 m.²

Percentage composition of the fauna : stones in the current in the Ungeni river at Midmar

Group of Organisms	Spring						Summer			Autumn			Winter		
	Early			Late			R. + ST.	ST.	R.	FL.	R.	FL.	R.	FL.	
	FL.	ST.	ST.	FL.	ST.	FL.									
<u>HELMINTHES AND ANNELIDA</u>															
Planariidae	4.0	0.7	1.5	3.3	2.2	3.2	3.5	P	4.0						
Nematoda	-	-	-	-	-	-	-	-	0.4						
Nais sp.	3.0	2.1	23.1	13.1	10.7	0.7	-	-	-	5.0					
Branchiura sowerbyi Bedd.	-	-	-	0.6	-	-	-	-	-	-					
<u>CRUSTACEA</u>															
Ostracoda	-	-	-	-	-	-	-	-	-	-					0.2
Potanon dubius (Br. Cap)	-	P	-	-	-	P	-	-	-	-					-
<u>PLECOPTERA</u>															
Neoperla spio (Neuman)	0.3	-	-	-	1.3	-	2.3	-	0.6						0.4
<u>EPTHEMEROPTERA</u>															
Prosopistoma crassi	-	-	-	-	-	-	-	-	0.4						
Ephoron savigni (Pict.)	-	-	-	0.2	0.2	-	-	-	-						
Oligoneuriopsis lawrencei Crass.	-	-	-	-	1.6	6.3	-	-	-						
Elassoneuria trimeniana McLach.	-	-	-	0.4	-	-	0.9	-	-						
Pseudocloeon maculosum Crass.	-	0.1	0.3	-	-	-	1.8	0.7	-						
Baetis harrisoni Brnrd.	18.1	13.7	3.6	7.8	7.6	18.9	11.4	4.3	8.0	21.5					17.5
B. glaucus Agnew (type a and type b)	-	-	-	-	1.4	-	7.0	2.1	3.6						
Acentrella natalensis Crass.	-	0.1	2.3	0.6	-	2.4	-	-	-						0.4
Centropitilum sudafricanum Iest.	5.0	0.3	1.5	13.3	3.2	2.4	2.3	-	2.0	0.8					1.1
C. indusii Crass.	-	-	-	-	-	-	2.3	-	2.4						1.3
C. medium Crass.	-	-	-	-	-	1.6	5.8	-	2.4						-
C. varium Crass.	-	-	-	-	-	-	1.2	-	-						-
Centropitiloides bifasciatum Iest.	-	-	0.4	-	0.5	-	1.2	-	-						-
Caenis sp. 2	0.1	-	-	0.2	-	21.3	-	-	-	1.7					-
Caenis sp. 3	-	-	-	0.4	2.2	-	-	-	2.0						-

table 20 continued

Group of Organisms	Spring				Summer			Autumn		Winter	
	Early		Late		R ⁺ ST.	ST.	ST.	R.	FL.	R.	FL.
	FL.	ST.	ST.	FL.							
<i>Neurocaenis discolor</i> (Brnrd.)	19.1	4.9	2.7	20.4	32.4	14.2	14.0	13.6	6.6	5.0	21.7
<i>Adenophlebia auriculata</i> Eaton	-	-	-	-	3.1	-	0.3	1.4	3.6	-	1.3
<i>Euthraulus? bugandensis</i> Kimm.	7.0	-	-	2.6	3.4	-	0.9	-	15.3	0.8	2.1
<i>Afronurus</i> sp. 3	6.1	0.5	1.0	3.3	2.5	-	5.3	17.4	4.8	-	5.5
<i>Afronurus</i> sp. 2	1.1	0.3	-	0.6	0.9	-	1.8	-	1.2	-	-
<u>ODONATA</u>											
<i>Aeschna</i> sp.	0.2	-	-	-	-	-	-	-	0.2	-	-
<i>Trithemis</i> sp.	-	0.2	-	-	-	-	0.6	-	-	0.8	-
<i>Zygonyx natalensis</i> (Martin)	-	-	0.1	-	-	-	2.1	0.7	-	-	-
<u>HEMIPTERA</u>											
<i>Micronecta dimidiata</i> Poisson	-	-	-	-	-	-	-	-	-	-	0.9
<u>TRICHOPTERA</u>											
<i>Oecetis</i> sp.	-	-	-	-	-	-	-	-	1.0	-	0.4
<i>Hydropsyche? longifurca</i>	-	0.1	0.4	-	0.4	2.4	3.5	2.1	1.8	0.8	0.6
<i>Cheumatopsyche afra</i> (Mosely) type 2	0.2	-	0.8	1.6	-	-	8.2	4.8	-	2.9	3.6
<i>C. afra</i> (Mosely) type 3	1.0	0.3	-	-	2.5	2.4	-	2.0	-	-	-
<i>C. thomasseti</i> (Ulmer)	0.3	-	-	0.4	-	-	-	-	2.2	-	0.4
<i>Macronema natalensis</i> Ulmer	3.5	-	-	3.1	3.6	-	2.6	-	2.2	-	1.9
<i>Pseudoneureclipsis</i> sp. 1	0.4	-	-	-	-	-	0.9	-	-	-	-
<i>Ecnomus</i> sp. 1	-	-	-	-	-	-	-	-	1.0	-	-
<i>Ecnomus</i> sp. 2	0.2	0.1	-	0.2	0.9	-	-	-	0.8	-	0.2
<i>Ecnomus</i> sp. 4	0.2	-	-	-	0.2	-	-	0.7	2.0	-	-
<i>Hydroptila cruciata</i> Ulmer	0.3	0.2	-	0.6	-	-	-	-	2.2	-	0.6
<i>Hydroptila</i> sp. nov. (sand grain case)	0.2	-	-	-	-	-	-	2.1	-	-	-
<i>Orthotrichia</i> sp.	0.3	0.3	-	-	-	-	1.5	-	0.6	-	-
<u>LEPIDOPTERA</u>											
Pyralidae	-	-	-	-	-	0.8	-	0.4	-	-	-

Group of Organisms	Spring						Summer			Autumn			Winter		
	Early		Late		ST.	FL.	R ⁺ ST.	ST.	ST.	R.	FL.	R.	FL.	R.	FL.
	FL.	ST.	ST.	FL.											
Empididae	0.2	0.3	-	-	-	-	-	0.6	0.4	-	-	-	-	-	-
Rhagionidae	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-
<u>ACARINA</u>															
Hydrachnellae	0.2	1.4	-	-	-	3.3	-	-	5.7	-	-	0.8	0.4	-	-
<u>MOLLUSCA</u>															
Burnupia sp.	P	0.5	P	P	P	P	1.4	P	1.2	P	P	P	P	P	P
Total number of organisms *	497.5	875.0	799.0	183.3	185.0	127.0	342.0	140.5	166.0	242.0	235.0	242.0	166.0	242.0	235.0
	sq.ft.	qual.	qual.	sq.ft.	sq.ft.	qual.	qual.	sq.ft.	sq.ft.	qual.	sq.ft.	qual.	sq.ft.	qual.	sq.ft.

* 1 sq. ft. (ft.²) = 0.93 m.²

T A B L E 21

Percentage composition of the fauna : marginal vegetation in the Ungeni River at Dargle Forestry

GROUP OF ORGANISMS	SUMMER	AUTUMN
<u>COELENTERATA</u>		
Hydra sp.	0.3	-
<u>VERMES</u>		
Nematoda	1.4	0.3
Nais sp.	-	0.9
<u>CRUSTACEA</u>		
Cyclops spp.	2.0	-
Ostracoda (unidentified)	-	6.8
Potamon Sydneyi Rathburn	-	0.3
<u>EPHEMEROPTERA</u>		
Pseudocloeon vinosum Brnrd.	15.9	10.2
Baetis bellus Brnrd.	3.9	6.8
B. latus Agnew	-	3.4
B. cataractae Crass	0.1	-
Centroptilum sudfricanum Lest.	8.9	18.6
C. excisum Brnrd.	2.0	-
C. varium Crass	-	0.3
C. pulchrum Crass	4.3	0.6
Caenis sp. 3	1.1	-
Caenis sp. 4	6.7	3.4
Adenophlebia auriculata Eaton	8.1	2.3
Euthraulus elegans Brnrd.	1.4	-
<u>ODONATA</u>		
Pseudagrion sp.	0.3	0.6
<u>HEMIPTERA</u>		
Rhagovelia nigricans Burm.	2.3	4.5
Enithares cf. sobria Stäl	0.4	-
Micronecta inidiata poisson	4.3	5.1
M. youngiana Hutch.	1.1	-
Laccocoris limnogenus Stäl	0.4	0.6

table 21 continued

GROUP OF ORGANISMS	SUMMER	AUTUMN
<u>TRICHOPTERA</u>		
Athripsodes ?prionii Scott	0.3	-
Trianodes sp.	-	0.3
Cheumatopsyche afra (Mosely) type 2	-	0.9
<u>COLEOPTERA</u>		
Gyrinidae larvae	0.1	0.3
Orectogyrus spp. (adults)	0.7	0.8
Elmidae larvae sp. 1	p	-
Elmidae larvae sp. 2	-	0.3
Elmidae larvae sp. 7	0.4	1.1
Elnidae (adults) sp. f	-	0.3
<u>DIPTERA</u>		
Simulium larvae	-	10.7
S. alcocki Pom.	-	0.3
Chironomidae	26.0	6.8
Pentaneura	1.8	2.0
Clinotanypus	-	0.6
Corynoneura	2.2	-
Tanytarsus sp.	0.6	7.9
Chironominae	2.4	-
Ceratopogonidae	0.1	-
Empididae	-	0.3
<u>ACARINA</u>		
Hydrachnellae	-	2.8
<u>MOLLUSCA</u>		
Pisidium sp.	-	0.6
NUMBER OF ORGANISMS PER 6 FEET (1.83 metres) MARGINAL VEGETATION	716	357

Percentage composition of the fauna : marginal vegetation
in the Umgeni River at Watersmeet (below Road Bridge)

Group of Organisms	Spring	Summer	Autumn	Winter
<u>HELMINTHES + ANNELIDA</u>				
Planariidae	-	-	0.2	1.6
Prostoma sp.	-	-	0.9	1.2
Nematoda	0.9	-	-	7.9
Naididae	-	-	3.4	-
Chaetogaster sp.	-	-	-	2.0
Nais sp.	13.3	2.3	1.7	0.8
Pristina sp.	-	-	-	3.6
Lumbriculidae	-	-	-	0.4
Hirudinea	-	-	0.1	-
<u>CRUSTACEA</u>				
Chydorus sp.	3.1	-	-	-
Cyclops spp.	1.6	-	-	1.6
Talitroides sp.	-	-	0.1	-
<u>COLLEMBOLA</u>				
<u>EPHEMEROPTERA</u>				
Pseudocloeon vinosum Brnrd.	0.9	23.7	-	1.2
Baetis harrisoni Brnrd.	0.2	-	1.2	0.8
B. bellus Brnrd.	-	5.9	-	8.7
B. glaucus Agnew	-	-	0.1	-
B. latus Agnew	0.2	11.8	10.0	0.4
Caenis sp.3	-	-	0.5	-
Caenis sp.4	0.2	2.0	0.5	0.4

table 22 continued

Group of Organisms	Spring	Summer	Autumn	Winter
<u>ODONATA</u>				
Pseudagrion sp.	-	-	-	0.8
P. natalense Ris.	0.6	-	0.1	-
Chlorocypha sp.	-	-	0.2	-
Trithemis sp.	-	-	0.1	-
<u>HEMIPTERA</u>				
Mesovelia sp.	-	-	0.9	-
Metrocoris sp.	-	-	0.1	-
Rhagovelia sp.	-	27.6	0.9	p
Plea sp.	-	-	-	1.2
Idiocorus sp.	-	0.3	-	-
Micronecta dimidiata Poisson	0.2	2.3	0.9	2.8
Laccocoris limnogenus Stål	-	0.7	-	-
Ranatra sp.	0.6	-	-	-
<u>TRICHOPTERA</u>				
Oecetis spp.	-	-	0.2	-
Athripsodes ? prionii Scott	1.6	0.3	0.1	-
Trianodes sp.	-	-	0.2	-
Hydroptila cruciata Ulmer	-	-	0.2	-
Orthotrichia sp.	-	0.3	-	-
Oxyethira sp.	0.2	1.6	0.2	-
<u>LEPIDOPTERA</u>				
Pyralidae	-	-	0.1	0.4
<u>COLEOPTERA</u>				
Haliphus sp.	-	-	-	0.4
Dytiscidae adults	-	-	-	0.4
Gyrinidae adults	-	-	-	0.4
Aulonogyrus sp.	-	-	0.2	-

table 22 continued

Group of Organisms	Spring	Summer	Autumn	Winter
Hydrophilidae adults	-	-	-	2.3
Berosus sp.	1.4	-	-	-
Hydraenidae adults	-	-	0.1	0.4
Elmidae larvae (unsorted)	-	-	-	0.4
Elmidae larvae sp.2	-	0.7	0.9	-
Elmidae larvae sp.7	0.2	-	0.1	-
Elmidae adults (unsorted)	0.2	-	-	-
Elmidae adults sp.f	-	-	0.1	-
Elmidae adults sp.J	-	0.6	-	-
Helodidae larvae	-	-	4.3	-
<u>DIPTERA</u>				
Psychodidae larvae	-	-	-	p
Simulium larvae	-	-	0.1	1.2
Chironomidae (unsorted)	22.2	4.0	29.9	34.4
Pentaneura spp.	0.8	2.0	5.1	-
Clinotanytus sp.	-	1.3	-	-
Corynoneura sp.	6.6	-	-	-
Orthocladinae sp.	12.2	-	-	-
Tanytarsus sp.	0.8	0.7	-	1.2
Chironominae	31.5	5.9	-	9.5
Wiedemannia sp. (Empididae)	-	0.3	-	-
<u>ACARINA</u>				
Hydrachnellae	0.9	5.9	29.9	12.3
<u>MOLLUSCA</u>				
Lymnaea sp.	-	-	0.1	-
Burnapia sp.	-	-	-	0.8
Pisidium sp.	-	-	-	0.4
TOTAL NUMBERS OF ORGANISMS PER 6 ft. (1.83 m.) MARGINAL VEGETATION	641	304	1170	253

Percentage composition of fauna : marginal vegetation in the Umgeni River at Fern Hill Flats.

Group of Organisms	Spring	Summer	Autumn	Winter	
				Early	Late
<u>VERMES</u>					
Planariidae	-	-	1.7	4.4	2.2
Nematoda	-	-	-	3.3	-
Nais spp.	3.8	-	-	2.2	-
<u>CRUSTACEA</u>					
Cyclops spp.	-	-	-	3.3	3.6
Ostracoda	-	-	-	1.1	0.9
<u>EPHEMEROPTERA</u>					
Oligoneuriopsis lawrencei Crass.	-	1.2	-	-	-
Elassoneuria trimeniana McLach.	0.6	-	-	-	-
Austrocloeon near virgiliae	-	-	-	-	0.2
Pseudocloeon vinosum Brnrd.	5.7	8.1	35.2	-	4.5
Baetis harrisoni Brnrd.	-	-	-	1.1	-
B. bellus Brnrd.	1.3	9.3	2.6	1.1	4.5
B. latus Agnew	22.9	11.1	15.5	5.4	-
Centroptilum sudafricanum Lest.	-	-	-	-	2.7
Caenis sp. 4	7.6	0.6	3.0	3.3	1.3
Neurocaenis discolor (Brnrd.)	-	-	0.4	-	-
<u>ODONATA</u>					
Pseudagrion spp. (un- sorted)	1.9	-	2.2	3.3	-
P. kersteni Gerst.	-	-	1.3	-	-

table 23 continued

Group of Organisms	Spring	Summer	Autumn	Winter	
				Early	Late
<i>P. natalense</i> Ris.	-	1.7	-	-	-
<i>P. salisburyense</i> Ris.	-	3.5	0.4	-	-
<i>Chlorocypha</i> sp.	-	-	1.3	-	-
<i>Paragomphus</i> sp.	-	-	-	-	0.2
<u>HEMIPTERA</u>					
<i>Rhagovelia</i> ? <i>nigricans</i> Burm.	5.1	10.5	-	-	-
<i>Micronecta dimidiata</i> Poisson	7.6	1.7	-	3.3	0.5
<i>Laccocoris limnogenus</i> Stål	1.3	1.2	0.9	-	-
<u>TRICHOPTERA</u>					
<i>Cheumatopsyche afra</i> (Mosely) type 2	-	-	1.3	-	-
<i>C. afra</i> (Mosely) type 3	1.3	-	-	-	-
<i>C. thomasseti</i> (Ulmer)	0.6	-	-	-	-
<i>Hydroptila cruciata</i> Ulmer	0.6	-	-	-	-
<i>Oxyethira</i> sp.	-	-	4.7	-	0.2
<u>COLEOPTERA</u>					
Gyrinidae larvae	0.6	0.6	-	-	-
Hydroscaphidae	-	-	-	-	0.2
Hydraenidae adults (un- sorted)	-	-	1.3	4.4	0.5
<i>Linnebius</i> larvae	-	0.6	-	-	-
Elmidae adults (unsorted)	0.6	-	-	-	-
Elmidae adults sp. J	-	3.5	-	-	-
Elmidae adults sp. e	-	-	2.2	-	-
Elmidae larvae sp. 5	-	-	-	-	0.5
Elmidae larvae sp. 7	-	0.6	0.9	-	-

table 23 continued

Group of Organisms	Spring	Summer	Autumn	Winter	
				Early	Late
<u>DIPTERA</u>					
Simulium larvae	1.9	5.8	2.6	-	5.6
Chironomidae (unsorted)	5.1	2.3	-	19.6	26.7
Pentaneura sp.	3.8	-	-	4.4	3.6
Pentaneura sp. a	-	7.0	0.4	-	-
Clinotanytus sp.	-	-	1.7	-	-
Corynoneura sp.	-	3.5	-	-	11.1
Orthocladinae	3.8	3.5	-	-	6.7
Cricotopus scottae Freeman	-	-	-	-	1.3
Tanytarsus sp.	-	5.8	-	1.1	4.0
Rheotanytarsus sp.	-	-	5.2	-	-
Chironominae	22.9	16.3	15.5	38.0	16.7
<u>ACARINA</u>					
Hydrachnellae	-	1.7	-	-	2.2
<u>MOLLUSCA</u>					
Pisidium costulosum	0.6	-	-	1.1	0.2
TOTAL NUMBER OF ORGANISMS PER 6 ft. MARGINAL VEGETA- TION (1.83 m.)	157	176	233	92	449

Percentage composition of the fauna : marginal and aquatic vegetation in the Umgeni river at Midmar (Howick)

Group of Organisms	Spring		Summer	Autumn		Winter
	Early	Late		M.V. +	M.V. +	
	M.V. ++	A.V.	M.V. +			A.V.
<u>TURBELLARIA</u>						
Planariidae	1.3	0.2	1.0	0.9	0.7	-
<u>HELMINTHES AND ANNELIDA</u>						
Nematoda	-	-	-	0.9	-	-
Nais spp.	47.6	1.4	2.6	4.8	33.8	11.4
Lumbriculidae	-	-	-	-	0.2	-
<u>CRUSTACEA</u>						
Cyclops spp.	3.9	-	-	-	-	-
Ostracoda	2.0	-	-	-	12.1	-
<u>COLLEMBOLA</u>						
	-	-	-	-	-	17.1
<u>EPTHEMEROPTERA</u>						
Oligoneuriopsis lawrencei Crass.	-	-	-	-	0.4	-
Pseudocloeon maculosum Crass.	-	1.5	-	-	2.3	-
P. vinosum Brnrd.	2.0	-	1.0	-	4.4	-
Baetis harrisoni Brnrd.	1.3	2.1	-	0.9	1.1	8.6
B. bellus Brnrd.	0.3	-	15.4	13.9	6.1	17.1
B. ? cataractae Crass.	0.3	-	-	-	-	-
B. glaucus Crass.	-	-	-	-	1.8	-
B. latus Agnew	2.6	-	-	6.1	2.3	11.4
Acentrella natalensis Crass.	-	0.7	-	-	-	-
Centroptilum sudafricanum Lest.	3.0	8.4	33.9	0.9	2.7	2.9
C. excisum Brnrd.	6.9	-	1.0	-	0.8	-
C. indusii Crass.	-	-	3.1	0.4	1.0	-
C. medium Crass.	-	-	-	-	0.4	-

table 24 continued

Group of Organisms	Spring		Summer	Autumn		Winter
	Early	Late		M.V. ⁺	M.V. ⁺	
	M.V. ⁺⁺	A.V.	M.V. ⁺	M.V. ⁺	A.V.	M.V. ⁺
<i>Centroptiloides bifasciatum</i> Lest.	-	2.4	-	0.4	2.0	-
Caenidae (unsorted)	2.6	-	-	-	-	-
Caenis sp. 2	-	0.5	-	-	-	-
Caenis sp. 4	-	-	-	3.0	-	-
Caenis sp. 5	-	-	-	-	0.1	-
<i>Neurocaenis discolor</i> (Brnrdr.)	-	3.1	-	0.4	1.7	-
<i>Adenophlebia auriculata</i> Eaton	-	-	-	0.4	0.4	2.9
<i>Afronurus</i> sp. 3	-	-	-	1.3	-	-
<u>ODONATA</u>						
<i>Pseudagrion</i> spp. (unsorted)	-	-	-	-	0.4	-
<i>P. natalense</i> Ris.	-	-	-	-	0.2	-
<i>P. salisburyense</i> Ris.	-	-	-	-	0.3	-
<i>Trithemis</i> sp.	-	-	-	-	0.3	-
<i>Zygonyx natalensis</i> (Martin)	-	-	-	-	0.1	-
<u>HEMIPTERA</u>						
<i>Rhagovelia ?nigricans</i> Burm.	-	-	8.2	-	0.5	2.9
<i>Micronecta dimidiata</i> Poisson	0.5	-	-	-	-	-
<i>Sigara</i> sp.	0.7	-	-	-	-	-
<u>TRICHOPTERA</u>						
<i>Hydropsyche ? longifurca</i>	-	1.4	-	-	1.1	-
<i>Cheumatopsyche afra</i> (Mosely) type 2	-	1.7	-	2.2	1.5	-
<i>C. afra</i> (Mosely) type 3	-	-	-	2.6	-	-
<u>LEPIDOPTERA</u>						
Pyralidae	-	0.5	-	0.4	0.2	1.7
<u>COLEOPTERA</u>						
<i>Halipus</i> sp.	0.2	-	-	-	-	-

Group of Organisms	Spring		Summer	Autumn		Winter
	Early	Late		M.V. +	M.V. +	
	M.V. ++	A.V.	M.V. +	M.V. +	A.V.	M.V. +
Cyprinidae larvae	-	0.5	-	-	-	-
Aulonogyrus sp..	1.3	-	1.0	-	-	5.7
Dineutes sp..	-	-	-	-	0.1	-
Elmidae larvae (unsorted)	0.3	-	-	3.9	-	-
Elmidae larvae sp. 1	-	-	-	-	0.2	-
Elmidae larvae sp. 2	-	-	-	-	2.5	-
Elmidae larvae sp. 3	0.8	0.2	-	-	0.3	-
Elmidae larvae sp. 7	-	-	-	-	0.2	-
Elmidae adults sp. a	-	0.3	-	-	-	-
Elmidae adults sp. j	-	-	1.5	-	-	-
Elmidae adults sp. l	-	-	-	-	0.1	-
Helodidae larvae	-	-	0.5	-	-	-
<u>DIPTERA</u>						
Tipulidae (Tipula sp.)	-	-	0.5	-	-	-
Simulium larvae	2.3	20.5	9.2	6.9	4.5	5.7
S. unicornutum form rotundum Gibbins	0.2	0.2	-	-	0.1	-
S. damnosum Theobald	-	0.2	-	-	-	-
Chironomidae (unsorted)	6.6	47.9	10.8	12.1	16.0	14.3
Pentaneura sp.	2.0	-	3.6	-	-	-
Clinotanypus sp.	-	-	-	-	0.8	-
Corynoneura sp.	4.6	-	-	-	-	-
Orthocladinae	-	6.2	-	24.2	18.2	17.8
Cricotopus scottae Freeman	0.5	-	-	-	-	-
Rheotanytarsus sp.	-	-	-	-	1.8	-
Chironominae	3.3	-	6.2	10.4	1.8	-
Empididae	-	-	-	0.4	-	-
Muscidae	0.2	-	-	-	0.5	-
<u>ACARINA</u>						
Hydrachnellae	2.0	-	-	2.2	-	0.5

table 24 continued

Group of Organisms	Spring		Summer M.V. ⁺	Autumn		Winter M.V. ⁺
	Early M.V. ⁺⁺	Late A.V.		M.V. ⁺	M.V. ⁺ A.V.	
<u>MOLLUSCA</u>						
Burnupia sp.	-	-	-	3.5	-	-
Pisidium costulosum	0.2	-	-	-	0.7	-
<u>AMPHIBIA</u>						
Tadpoles (Rana sp.)	0.5	-	-	-	-	-
Number of Organisms per 6 ft. (1.83 m.) marginal vegetation.	609	585	195	231	1,317	35

M.V.⁺ = trailing in current

M.V.⁺⁺ = in slow current and pools

A.V. = aquatic vegetation in the fast current

6.4 The foothill soft bottom zone.

The stony bottom fauna.

There were no marked differences between the faunal composition of this zone and that of the lower foothill torrent zone. With the exception of Nais sp., which had an unusual incidence of 26.8% in early spring (table 25), the numbers of the Helminthes and Annelida remained small. Most ephemeropteran species, comparatively numerous in the previous zone, also occurred in appreciable numbers here. They are Baetis harrisoni, Acentrella natalensis, Neurocaenis discolor and Afronurus sp 3. Centroptilum sudafricanum, however, markedly declined in numbers. Some of the dominant Trichoptera of this zone, which also showed a gradual numerical increase downstream from the foothill torrent zones, were Hydropsyche ?longifurca and Cheumatopsyche thomasseti. Also noteworthy was the absence of C. afra, (type 2) recorded in the foothill torrent zones. The Elmidae remained the most successful Coleopteran family, being present in all the water types sampled, and dominating the other families in incidence and species variety. Characteristic of the Diptera was the following:

- i. The occurrence of the blepharocerid Elporia flavopicta which appeared to be restricted to this zone.
- ii. The gradual successive increase, from the zones up-
stream, of the chironomid subfamily Orthocladinae, coupled with the falling off in numbers of the rest of the Chironomidae which, in this zone, was clearly exceeded by the former.
- iii. The lower incidence of Simulium compared with the zones upstream.

The Hydrachnellae, although not numerous, were constantly present in samples throughout all seasons. This also applies to the Burnupia spp.

The marginal and aquatic vegetation fauna.

Some of the most noteworthy features of the fauna of the marginal and aquatic vegetation (table 26) are:

- i. The high incidence of a Nais sp. amongst the aquatic vegetation. At least three species of Nais could be distinguished in samples from the Umgeni river, of which this particular species not only differs distinctly morphologically from the others, but appeared to be associated mainly with Hydrostachys natalansis.
- ii. The numerical importance of the Crustacea. This coincided with the presence of Simocephalus spp. and Caridina nilotica, the latter having been recorded, for the first time, in this zone.
- iii. The presence, amongst the aquatic vegetation, of most of ^{the} truly stony bottom Ephemeroptera such as Elassoneuria trimeniana, Oligoneuriopsis lawrencei, Pseudocloeon maculosum, Baetis harrisoni, B. glaucus, Centroptilum parvum, C. varium, Centroptiloides bifasciatum, Neurocaenis discolor and Afronurus sp 3. Also recorded from the aquatic vegetation was an Ephemerellid Lithogloea near harrisoni.
- iv. The first occurrence of Notonurus sp.
- v. The rich species variety of the Odonata and Hemiptera.
- vi. The presence, throughout all seasons and in comparatively high numbers in both autumn and winter, of the caddisfly larva Athripsodes ?prionii.

Percentage composition of the fauna: large stones in the current in the Umgeni river
at Mortons Drift

Group of Organisms	Spring		Summer	Autumn			Winter
	Early	Late		Early	Late		
	R + S	R + S	S	P	R	S	R + S
<u>HELMINTHES + ANNELIDA</u>							
Planarians	1.5	1.1	2.4	3.2	1.9	0.2	1.4
Nematoda	1.2	-	-	-	-	-	-
Nais spp.	26.8	1.1	-	-	-	3.3	-
<u>CRUSTACEA</u>							
Potamon dubius (Br.Cap.)	-	P	-	P	-	-	-
<u>PLECOPTERA</u>							
Neoperla spio (Neuman)	-	0.2	-	0.4	1.1	-	-
<u>EPHEMEROPTERA</u>							
Prosopistosoma crassi Gillies	-	-	-	-	-	-	0.3
Prosopistosoma sp.	0.3	-	-	0.7	-	-	0.3
Pseudocloeon maculosum Crass.	-	-	-	0.3	-	-	-
Baetis harrisoni Brnrd.	-	9.1	14.2	1.1	9.6	10.5	39.2
Baetis glaucus Agnew	-	-	-	1.4	3.7	0.3	-
Acentrella natalensis Crass.	1.8	3.9	2.4	-	-	0.3	8.4
Centroptilum sudafricanum Lest.	-	-	-	-	1.1	-	-
Centroptilum indusii Crass.	-	-	-	-	0.8	-	-
Centroptilum medium Crass.	-	-	-	21.6	8.8	0.3	-
Centroptilum parvum Crass.	-	2.6	1.4	2.9	2.1	0.5	-
Centroptilum varium Crass.	-	0.7	9.9	-	-	1.7	-
Centroptilum sp. 2	-	-	-	0.4	0.8	-	-
Centroptilum sp. 3	-	2.0	-	5.4	0.5	-	-

table 25 continued

Group of Organisms	Spring		Summer		Autumn			Winter	
	Early		Late		P	Early		Late	
	R + S	R + S	R + S	R + S		R	S	R + S	R + S
Caenis sp. 1	-	-	-	-	-	-	-	-	0.5
Caenis sp. 2	0.5	-	-	-	-	-	-	-	-
Caenis sp. 3	0.7	-	-	-	0.4	-	-	-	-
Neurocaenis discolor (Brnrdr.)	-	6.5	4.7	2.9	4.8	2.7	6.5	7.9	
Afronurus sp. 3	1.8	0.4	6.6	19.4	15.5	0.5	5.1	3.5	
Afronurus sp. 2	-	-	0.9	-	P	-	P	P	
Euthraulus ?bugandensis Kimm.	2.4	-	3.3	10.1	1.6	-	-	2.2	
<u>ODONATA</u>									
Chlorocypha sp.	-	-	-	0.4	-	-	-	-	-
Ceratogomphus sp.	-	-	-	-	0.3	-	-	-	-
Zygonyx ? natalensis (Martin)	-	-	-	-	0.5	0.3	-	-	-
Trithymis sp.	0.3	-	-	-	-	0.2	-	-	-
<u>TRICHOPTERA</u>									
Hydropsyche ? longifurca	0.3	1.3	0.9	1.1	-	0.8	4.6	4.7	
Cheumatopsyche afra (Mosely) type 3	-	0.5	-	-	-	-	0.5	0.7	
Cheumatopsyche thomasseti (Ulmer)	0.5	-	6.6	1.1	3.7	-	3.2	2.5	
Pseudoneureclipsis sp. 1	-	-	-	-	-	-	0.5	-	
Ecnomus sp. 1	-	-	-	0.7	2.9	-	-	-	
Ecnomus sp. 3	-	-	-	1.1	-	-	-	-	
Hydroptila ? cruciata Ulmer	-	0.7	-	-	0.8	-	-	-	
Orthotrichia sp.	-	0.3	0.5	1.1	-	2.0	-	-	
<u>LEPIDOPTERA</u>									
Pyralidae	-	0.1	0.5	-	-	0.2	-	-	
<u>COLEOPTERA</u>									
Hydraenidae adults	-	-	-	-	0.3	-	-	-	
Eubrianax sp.	0.9	0.7	1.9	1.4	-	-	0.5	1.0	

table 25 continued

Group of Organisms	Spring		Summer	Autumn			Winter
	Early	Late		Early		Late	
	R + S	R + S	S	P	R	S	R + S
Dryopidae	0.2	-	-	-	-	-	-
Elmidae (unsorted)	-	0.2	-	-	-	-	0.5
Elmidae larvae sp. 1	-	-	-	-	0.3	-	0.5
Elmidae larvae sp. 2	3.6	2.0	0.5	0.4	1.1	0.3	3.0
Elmidae larvae sp. 3	0.3	0.7	-	0.4	3.2	0.2	1.0
Elmidae larvae sp. 4	0.3	-	-	2.9	-	-	-
Elmidae larvae sp. 5	1.2	1.1	-	-	-	-	0.5
Elmidae larvae sp. 7	-	0.1	-	-	-	-	-
Elmidae adults sp. L	-	-	0.9	-	-	-	-
Large brown Coleoptera	-	1.1	14.2	-	-	0.3	-
<u>DIPTERA</u>							
Elporia flavopicta Edwards	-	-	-	-	P	-	-
Simulium larvae	26.8	-	6.6	2.2	9.6	16.0	3.5
S. cervicornotum Pom.	-	-	0.5	-	-	-	-
S. alcocki Pom.	-	-	-	-	-	-	0.5
S. medusaeforme Pom.	0.3	-	-	-	-	-	-
Chironomidae	6.5	24.2	2.4	5.8	4.8	16.0	-
Chironominae	-	-	-	-	-	-	2.7
Orthocladinae	9.8	31.4	9.0	6.5	14.9	40.0	24.2
Pentaneura spp.	1.3	0.4	-	0.7	-	-	0.3
Rheotanytarsus sp.	2.7	2.6	1.9	-	-	1.0	0.5
Ceratopogonidae	-	-	-	-	0.3	-	0.3
Rhagionidae	-	-	-	-	-	-	0.3
Empididae	0.9	-	0.5	-	0.5	-	0.3
Tabanidae	0.2	-	-	-	-	-	-
Tipulidae	-	-	0.5	-	0.3	0.3	-

Group of Organisms	Spring		Summer	Autumn		Winter	
	Early	Late		Early	Late		
	R + S	R + S	S	R	R	R + S	R + S
<u>ACARINA</u>							
Hydrachnellae	6.7	2.0	1.9	5.4	3.2	P	3.2
<u>MOLLUSCA</u>							
Burnupia sp.	P	P	3.3	P	P	P	1.4
Number of Organisms (1 ft. ² = 0.093 m. ²)	673.0	308.0	106.0	278.0	375.0	300.0	217.0
	qual.	1 ft. ²	1 ft. ²	1 ft. ²	qual.	1 ft. ²	1 ft. ²
							405.0
							1 ft. ²

Percentage composition of the fauna : marginal and aquatic vegetation in the Ungeni river at Morton's Drift

Group of Organisms	Spring		Summer		Autumn		Winter	
	Early	Late			Early	Late	Early	Late
	M.V.	M.V. A.V.	M.V.	A.V.	M.V.	A.V.	M.V.	M.V.
<u>COELENTERATA</u>								
Hydra sp.	-	-	-	0.1	-	-	-	-
<u>HELMINTHES AND ANNELIDA</u>								
Planariidae	-	1.5	-	0.3	-	-	-	-
Metertea (Prostoma sp.)	1.3	0.9	2.2	0.1	-	-	2.9	0.9
Nematoda	1.3	8.0	-	-	-	-	1.5	0.9
Naididae (unidentified)	-	8.8	-	-	-	-	-	-
Nais spp.	-	5.0	-	41.9	-	35.1	-	0.9
Branchiura sowerbyi Bedd.	-	5.3	-	-	-	-	-	-
<u>CRUSTACEA</u>								
Simocephalus spp.	-	2.4	-	-	-	-	-	1.3
Cyclops spp.	10.3	0.6	-	-	-	1.7	4.4	11.9
Ostracoda	5.1	3.5	-	-	-	-	-	-
Potamon sidneyi Rathburn	-	-	0.5	-	0.4	-	-	-
Caridina nilotica Roux	1.9	32.5	29.6	-	18.8	3.5	23.5	4.0
<u>COLLEMBOLA</u>								
	-	-	-	0.5	6.7	-	-	1.8
<u>PLECOPTERA</u>								
Neoperla spio (Neuman)	-	-	-	0.1	-	-	-	-
<u>EPTHEMEROPTERA</u>								
Oligoneuriopsis lawrencei Crass	-	-	-	0.1	-	-	-	-
Elassoneuria trimeniana McLach	-	-	-	0.3	-	0.1	-	-
Unidentified	6.4	0.0	0.1	0.4	0.0	0.0	0.0	0.0

table 26 continued

Group of Organisms	Spring		Summer		Autumn		Winter	
	Early	Late	M.V.	A.V.	Early	Late	Early	Late
	M.V.	M.V.	M.V.	A.V.	M.V.	M.V.	M.V.	M.V.
A. near virgiliae	-	-	-	-	-	-	-	14.5
Pseudocloeon maculosum Crass	-	0.3	-	1.9	1.3	-	-	-
P. vinosum Brnrd.	-	-	-	-	9.2	2.6	-	-
Baetis harrisoni Brnrd.	1.3	4.3	-	1.9	0.9	-	-	-
B. bellus Brnrd.	-	0.7	7.4	-	16.1	12.1	5.9	8.7
B. glaucus Crass	-	0.2	-	-	0.6	-	-	-
B. latus Agnew	-	0.7	-	-	2.6	-	2.9	-
Acentrella natalensis Crass	-	0.1	-	-	-	-	-	-
Centroptilum sudafricanum Lest	-	3.9	-	13.7	-	-	-	-
C. excisum Brnrd.	-	-	-	-	-	-	-	1.3
C. indusii Crass	-	P	-	-	-	-	-	-
C. parvum Crass	-	2.5	-	19.3	0.4	-	-	-
C. varium Crass	-	-	-	0.1	0.2	-	-	-
Centroptiloides bifasciatum Lest	-	0.1	-	0.8	1.4	-	-	-
Caenis sp. 1	-	2.1	-	-	-	-	-	-
Caenis sp. 2	-	0.6	-	1.1	-	-	-	-
Caenis sp. 4	1.3	1.2	0.5	-	-	16.4	7.4	4.4
Caenis sp. 5 (near sp. 2)	-	-	-	-	1.3	-	-	-
Lithogloea near harrisoni	-	-	-	0.1	-	-	-	-
Neurocaenis discolor (Brnrd.)	-	5.0	-	12.8	5.0	-	-	-
N ? reticulatus (Brnrd.)	-	P	-	-	-	-	-	-
Afronurus sp. 3	-	P	-	-	-	-	-	-
Notonurus sp.	-	-	1.1	-	0.1	2.6	1.5	0.9
<u>ODONATA</u>								
Lestes sp.	-	-	-	-	0.3	-	-	-

table 26 continued

Group of Organisms	Spring		Summer		Autumn		Winter		
	Early	Late	M.V.	A.V.	Early	Late	Early	Late	
	M.V.	M.V.	A.V.	M.V.	A.V.	M.V.	M.V.	M.V.	
<i>P. salisburyense</i> Ris.	-	-	-	-	-	-	2.9	-	
<i>Anax</i> sp.	-	-	-	-	2.0	-	1.5	-	
<i>Trithemis</i> sp.	-	0.1	-	1.0	0.2	-	-	-	
<i>Zygonyx natalensis</i> (Martin)	-	0.1	-	-	0.1	-	-	-	
<u>HEMIPTERA</u>									
<i>Trepobates</i> sp.	-	-	-	-	-	0.9	-	-	
<i>Rhagovelia ?nigricans</i> Burm.	-	0.1	1.6	-	6.0	1.7	-	-	
<i>Nychia limpida limpida</i> Stål	-	-	0.5	-	-	-	-	-	
<i>Plea pullula</i> Stål	-	0.6	-	-	-	-	-	0.9	
<i>Micronecta dimidiata</i> Poisson	-	3.5	3.2	-	-	-	8.6	6.6	
<i>M. scutellaris</i> Stål	-	0.7	-	-	-	-	-	-	
<i>Laccocoris limnigenus</i> Stål	-	-	-	-	-	-	-	-	
<i>Nepa</i> sp.	-	0.3	-	-	-	-	-	-	
<i>Ranatra</i> sp.	-	-	1.1	-	-	-	-	-	
<i>Sphaerodema nepoides</i> Fabricius	-	1.5	5.8	-	0.7	-	-	-	
<u>NEUROPTERA</u>									
<i>Sisyra</i> sp.	-	-	-	0.1	-	-	-	-	
<u>TRICHOPTERA</u>									
? <i>Goerodes</i> sp.	-	-	-	-	-	-	1.5	-	
<i>Oecetis</i> sp.	-	-	-	0.1	-	-	-	-	
<i>Athripsodes prionii</i> Scott	2.6	4.1	4.2	-	3.0	12.1	7.4	16.3	
<i>Hydropsyche ? longifurca</i>	-	-	-	0.4	-	-	-	-	
<i>Cheumatopsyche afra</i> (Mosely) type 3	-	-	-	-	-	-	-	-	
<i>C. thomasseti</i> (Ulmer)	-	2.5	-	0.7	-	-	-	-	
<i>Orthotrichia</i>	-	-	-	0.5	-	-	0.9	-	

table 26 continued

Group of Organisms	Spring		Summer		Autumn		Winter	
	Early	Late	M.V.	A.V.	Early	Late	Early	Late
	M.V.	M.V.	M.V.	A.V.	M.V.	M.V.	M.V.	M.V.
<u>LEPIDOPTERA</u>								
Pyralidae	-	0.3	-	0.4	-	0.9	1.5	-
<u>COLEOPTERA</u>								
Haliphus sp.	-	-	-	-	0.7	-	-	-
Dytiscidae (adults)	1.9	0.3	-	-	-	-	-	0.4
Gyrinidae (adults)	-	-	-	-	-	-	-	1.8
Hydrophilidae (adults)	-	-	-	-	-	0.9	-	1.3
Hydraenidae	-	-	-	-	-	-	1.5	-
Elmidae larvae sp. 2	-	-	-	-	0.3	-	-	-
Elmidae larvae near sp. 4	-	-	-	0.2	-	-	-	-
Elmidae larvae sp. 5	-	-	-	-	-	0.9	-	-
Elmidae larvae sp. 7	0.6	0.3	P	-	-	-	-	-
Elmidae adults sp. d	-	-	-	-	-	-	0.1	-
Helodidae	0.6	-	0.5	-	-	1.7	-	0.9
Large Black Coleoptera	-	-	-	-	-	-	0.1	-
<u>DIPTERA</u>								
Tipulidae	-	P	-	-	-	-	-	-
Culicidae	-	-	-	-	1.0	2.6	-	-
Antocha sp.	0.6	-	-	-	-	-	-	-
Simulium larvae	0.6	0.2	-	2.9	-	-	2.7	-
Chironomidae	38.5	5.9	26.7	36.0	8.1	7.8	13.2	43.5
Pentaneura sp.	-	0.9	0.8	-	2.0	8.6	-	12.3
Clinotanypus sp.	-	-	-	0.1	4.0	-	-	-
Corynoneura sp.	11.5	-	0.3	1.0	-	-	-	-
Orthocladinae sp.	14.1	2.1	-	-	3.4	3.5	17.5	21.7
Tanytarsini	-	2.7	0.3	-	-	-	-	-

table 26 continued

Group of Organisms	Spring		Summer		Autumn		Winter				
	Early	Late	M.V.	A.V.	Early	Late	Early	Late			
	M.V.	M.V.	M.V.	A.V.	M.V.	M.V.	M.V.	M.V.			
Tanytarsus sp.	-	0.8	-	-	-	-	-	-			
Rheotanytarsus sp.	-	-	-	11.5	5.6	-	-	-			
Chironominae	-	-	-	-	-	12.1	5.9	-			
Chironomus	-	0.4	-	-	-	-	-	-			
Ceratopogonidae	-	2.1	-	-	0.3	-	-	-			
Empididae	-	-	-	0.1	0.2	-	-	-			
Rhagionidae	-	-	-	-	-	-	4.4	-			
Ephydriidae	-	-	-	-	1.3	-	-	-			
<u>ACARINA</u>											
Hydrachnellae	-	1.1	-	2.9	-	-	-	5.7			
<u>MOLLUSCA</u>											
Lymnaea spp.	-	0.2	-	-	-	0.9	-	4.4			
Anisus sp.	-	-	-	-	-	-	-	0.4			
Segmentina planodiscus	-	0.2	-	-	-	-	-	-			
Pisidium costulosum	-	0.3	-	-	-	-	-	-			
<u>AMPHIBIA</u>											
Rana sp.	-	P	-	-	-	1.7	-	8.7			
Pisces	-	-	-	-	0.3	-	-	-			
Total Number of Organisms per 6 ft. (1.83 metres) marginal or aquatic vegetation.	156.0	678.0	7,181.0	189.0	1,048	289.0	1,368	116.0	68.0	23.0	227.0

- vii. The abundance of the Chironomidae and of its sub-families which comprised the bulk of the Diptera.
- viii. The occurrence of at least four species of snails, viz. *Lymnaea* sp., *Anisus natalensis*, *Segmentorbis planodiscus* and *Pisidium costulosum*.

6.5 The rejuvenated river zone.

In considering the fauna of the three sampling localities of this zone viz. Albert Falls, Table Mountain and Upuma, there are several factors which should be taken into account. Some of the most important of these, which undoubtedly had an important effect on the composition of the aquatic fauna at the abovementioned localities are the following:

1. The effect of the long, slowflowing foothill soft bottom zone upon the water quality. As mentioned previously a considerable amount of silt and detritus were deposited in the foothill soft bottom zone so that the turbidities of the water at Albert Falls and further down, remained comparatively low, even during periods of peak flows, being in this respect, very similar to the water in the foothill torrent zones. In addition, the foothill soft bottom zone developed a distinctive plankton faunal component. Many of these organisms, washed down the river, were caught in the nets at Albert Falls and at sampling localities further downstream.
2. The contribution of appreciable amounts of silt loads during the rainy season by the Sterk river (upstream from Table Mountain) and the Umsunduzi river (upstream from Upuma) tributaries

3. The addition to the Umgeni river of highly mineralized, and, occasionally, organically enriched water from the Umsunduzi river tributary, which clearly affected the concentration of dissolved solids in the main river at Upuma and further down (fig. 9).

The stony bottom fauna.

Coelenterata : Hydra spp. were recorded at Upuma during the spring collection (table 29).

Porifera and Bryozoa : Although not found in samples at Table Mountain and Upuma, colonies of both were constantly present at all three localities of this zone. They were, however, particularly common at the Albert Falls sampling site (table 27).

Helminthes and Annelida : The highest percentage occurrence of this group as a whole occurred at Albert Falls. The numerically important species here, were those of Nais (late winter and spring), - the highest densities coinciding with rich growths of filamentous algae and diatoms on the stones in the current. At the other two downstream localities this group had a markedly lower percentage incidence during the same seasons. In addition to Nais spp., the Planariidae also were more common at Albert Falls than elsewhere. The Nemertea (Prostoma sp.), and Nematoda were respectively more numerous at Upuma, during spring, summer and autumn and summer, autumn and winter.

Judged by the species present in this group, and their numerical importance, conditions of this zone were, at the most mildly organically enriched.

This conclusion is also supported by the representatives of the other insect orders, in particular those of the Ephemeroptera and Diptera (see below).

- Crustacea : The highest numbers were recorded in winter at Albert Falls. The species encountered included Daphnia c.f. longispina, Simocephalus spp., Bosmina sp., Scapholeberis sp., Chydorus spp., Cyclops spp., Lovenula sp. and Elaphoidella sp. Ostracoda were not very common. The decapod Potamon dubius occurred both at Albert Falls and at Table Mountain.
- Plecoptera : Neoperla spio was fairly common at all three stations throughout the year. There was a distinct percentage increase of this species at Table Mountain during winter.
- Ephemeroptera : This order generally progressively declined in prominence from Albert Falls downstream towards Upuma, being the numerically dominant insect order in most samples from Albert Falls, but replaced in numbers by the Diptera at Table Mountain and Upuma. Some mayflies (Ephemeroptera) which distinctly declined in numbers, or, which disappeared entirely from the fauna in this

zone were Prosopistosoma sp., Ephoron savigni, Oligoneuriopsis lawrencei, Acen-trella natalensis, Centroptilum sudafricanum, C. indusii, C. medium, C. parvum and Centroptilum sp. 2. Other mayflies which were still common at localities in this zone during parts of the year, but, which numerically declined from the zones upstream, include Baetis harrisoni, Euthraulius ? bugandensis, Neurocaenis discolor and Afronurus sp. 3. Species recorded from this zone or further downstream only were Centroptilum sp. 1, a baetid with ventral abdominal gills (= Baëtidae nymph A, Kirmins 1955) and Afronurus sp. 4. Another mayfly, largely restricted to this zone (it was also found amongst Hydrostachys natalensis at Morton's Drift in the foothill soft bottom zone) is the ephemereid Lithogloea near harrisoni. Some mayflies which showed distinct seasonal tendencies in this zone are:

- i. Baetis harrisoni, most abundant during winter and early spring. At Upuma it disappeared completely from the fauna during late spring and early summer.
- ii. Baetis glaucus. This species occurred throughout all seasons in the lower part of the rejuvenated river zone, only in late spring, summer and autumn at Albert Falls and mainly in autumn in the foothill soft bottom and lower foothill torrent zone.

iii. A baetid with ventral abdominal gills. This species also had its widest seasonal occurrence in the lower parts of the rejuvenated river zone, being present at Upuna in summer and autumn, at Table Mountain in early autumn and at Albert Falls only during late autumn.

iv. Centroptilum sp. 1 had seasonal tendencies similar to the ventral gill baetid and was also found upstream from Upuna as far as Albert Falls. At the latter locality this species was not present in the survey samples but was found during some of the special collection trips.

Odonata : The number of species and numerical importance of the Odonata increased downstream from Albert Falls. Species of the following genera were recorded: Pseudagrion, Chlorocypha, Paragomphus, Ceratogomphus, Aeschna, Trithemis and Zygonyx sp.

Hemiptera : Lacoccoris limnogenus was the only species recorded from the stony bottom habitats (Table Mountain, table 28).

Trichoptera : Species which dominated the Trichoptera in this zone and which also had their highest incidence here were Hydropsyche ? longifurca and Cheumatopsyche thomasseti. Both species gradually increased in numbers downstream from the foothill torrent zones. Also fairly common at Upuna were Oecetis spp. and Hydroptila cruciata.

- Lepidoptera (Pyralidae) : *Nymphula* sp., recorded mainly during winter.
- Neuroptera : *Sisyra* sp. (spongilla fly), recorded at Albert Falls.
- Coleoptera : Families which tended to disappear from the fauna were the Hydrophilidae and Psephenidae (*Eubrianax* sp.). Although the Elmidae also showed a reduction in species, the elmid larval sp. 5 assumed a dominant position amongst the Coleoptera of this zone.
- Diptera : The Diptera were characterized by the numerical importance of the Chironomidae, particularly the subfamily Orthocladinae. Also significant was the percentage increase, downstream from Albert Falls, of the Simuliidae, which, at Upuma, had its maximum occurrence in winter and spring. *Simulium* species, identified from pupae, included alcocki, bequaerti, cervicornotum, nigritarsus, adersi, medusaeforme f. hargreavsi, vorax, milloti and bovis.
- Hydrachnellae : Highest numbers were recorded at Upuma.
- Mollusca : *Burnupia* sp. was present in small numbers at all localities.
- Pisces : Amphilius natalensis was caught in the nets at Albert Falls. This species appeared to be mainly confined to the rejuvenated river zone.

The marginal and aquatic vegetation fauna.

The effect of the foothill soft bottom zone was clearly demonstrated in the fauna of the marginal vegetation at Albert Falls and Table Mountain (tables 30 and 31), particularly by the numerical importance of the plankton. As was the case for the stony bottom organisms, the incidence of the plankton declined towards Upuma. The main characteristics of the marginal and aquatic vegetation fauna can be briefly summarized as follow:

1. The dominance of the fauna, at Albert Falls, and to a lesser extent at Table Mountain, by the Crustacea. Numerically important were species of Simocephalus, Alona, Chydorus, Cyclops, Lovenula and Caridina. Ostracoda also assumed prominence in autumn at Table Mountain (table 31).
2. The Helminthes and Annelida were not numerically important. The occasional high numbers of Nematoda, Nais spp. (tables 30, 31 and 32) and Chaetogaster sp. (table 32) did not reflect serious signs of stream disturbance.
3. Ephemeroptera were represented by a great species variety at most localities. Species which were prominent during parts of the year included Pseudocloeon vinosum which were particularly abundant in the marginal vegetation at Table Mountain and Upuma (tables 31 and 32). Other prominent mayflies were Baetis bellus (all three localities) and B. latus (Table Mountain and Upuma). High numbers of the following species were also occasionally recorded: Baetis glaucus (Upuma, summer; table 32), Centroptilum excisum (Upuma, Autumn), Austrocloeon virgiliae

(Albert Falls, summer; table 30) and Notanurus sp. (Upuma, late spring and autumn). The presence of Centroptilum sudafricanum at Upuma was the lowermost record of this species in the Umgeni river. Of interest, also, was the presence, in the marginal vegetation, of the ephemereid Lithogloea near harrisoni (Table Mountain, table 31).

4. The Odonata were mainly represented by species of Pseudagrion but also included the genera Chlorolestes, Aeschna, Anax, Trithemis and Zygonyx. Most of the genera mentioned above occurred in the samples from Albert Falls (table 30).
5. The Hemiptera, although not numerically important, also showed its richest species variety at Albert Falls (table 30), declining towards Upuma where only three species were recorded.
6. The dominant species amongst the Trichoptera at Albert Falls was Athripsodes ? prionii. At Table Mountain and Upuma, however, the stony bottom species Cheumatopsyche thomasseti, Oecetis sp. and Hydroptila ? cruciata invaded the marginal vegetation (tables 31 and 32).
7. Lepidoptera: The Pyralidae (Nymphula sp.) occurred sparingly at Albert Falls and Table Mountain (tables 30 and 31).
8. The elmid larva sp. 7 appeared to be the most widespread marginal vegetation species of this family, occurring almost over the entire length of the river. In this zone also, it was consistently present at all the sampling localities. At Upuma Gyrinidae larvae were common, being present throughout all seasons.

9. The Diptera mainly consisted of species of the Chironomidae. Other dipteran families, represented in small numbers only, were the Simuliidae (mainly S. alcocki, medusaeforme and niloti), Culicidae, Rhagionidae, Ceratopogonidae and Muscidae.
10. Hydrachnellae: These were not consistently present in the samples but were recorded throughout all seasons.
11. The Mollusca were most numerous at the Albert Falls locality (table 30). In addition to Lymnaea, Gyraulus spp., Anisus natalensis, Segmentorbis planodiscus and Bulinus forskalii, Bulinus (Physopsis) africanus was also collected, on two occasions from the marginal vegetation in pools immediately below the falls. On a third occasion this species was also found in the river at a depth of about three feet.
12. Ranidae tadpoles occurred at Albert Falls and Table Mountain during autumn and spring.

6.6 The Valley Sand Bed Zone.

This zone is characterized by the increase of marginal vegetation habitats on the one hand, and the decline and disappearance, below the Natal Estates sampling locality, of the stony bottom habitats. Unlike the marginal vegetation fauna of the other physical zones upstream, those of the valley sand bed zone contained organisms distinctive of, and mainly restricted to, this part of the river.

The stony bottom fauna.

There was a marked decline in species variety of all the major groups of organisms (table 33). Some of the

numerically important species present include Baetis glaucus, Cheumatopsyche thomasseti, Simulium spp. and species of the chironomid family.

The marginal vegetation fauna.

With the exception of a high incidence of Branchiura sowerbyi (Fair View, table 34), the numbers of the Helminthes and Annelida never assumed numerical importance. Species dominating the fauna during most seasons were the following:

Crustacea : Caridina nilotica

Ephemeroptera : Pseudocloeon vinosum and Baetis bellus.

Organisms highly characteristic of this zone were Caridina typus, Macrobrachium equidens and M. lepidactylus. Another noteworthy feature was the comparatively high incidence, in the marginal vegetation, of the mayfly Pseudocloeon vinosum, which occurred in increasingly larger numbers downstream from the foothill torrent zones ,(In the Berg river (Harrison, 1958) the distribution of P. vinosum differs from that in the Umgeni river in being more abundant at the headwaters, decreasing downstream towards his station 21).

table 28 continued

Group of Organisms	Spring						Autumn						Winter						
	Early			Late			Early			Late			Early			Late			
	R.+S.	FL.	S.	P.	S.	P.	S.	P.	S.	R.+S.	S.	P.	S.	FL.	P.	S.	R.+S.	P.	
<i>C. excisum</i> Brnrd.	-	2.3	-	6.3	-	-	-	-	-	2.5	-	-	-	-	-	-	-	-	-
<i>C. indusii</i> Crass.	-	-	-	-	-	-	-	-	-	-	-	-	3.2	-	-	-	-	-	-
<i>C. medium</i> Crass.	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>C. varium</i> Crass.	-	-	-	-	0.4	-	1.2	-	-	-	-	-	-	-	-	0.1	-	-	-
<i>Centroptilum</i> sp. 1	-	-	-	-	5.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Centroptilum</i> sp. 2	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Centroptiloides bifasciatum</i> Lest.	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Caenis</i> spp. (unsorted)	2.2	-	-	-	-	-	-	-	-	3.3	7.1	-	-	-	-	-	-	-	-
<i>Caenis</i> sp. 1	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Caenis</i> sp. 3	-	1.1	-	-	-	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Caenis</i> sp. 4	-	-	-	-	-	-	2.7	-	-	-	-	-	-	5.1	-	-	-	-	-
<i>Neurocaenis discolor</i> (Brnrd.)	-	-	0.6	-	7.4	3.5	-	-	-	-	-	-	-	-	-	-	-	-	4.2
<i>Euthraulus bugandensis</i> Kimmins	1.3	10.2	-	4.2	-	0.8	1.5	3.6	-	1.9	3.6	-	-	-	3.2	-	-	-	-
<i>Afronurus</i> sp. 3	0.5	4.5	0.4	6.3	-	-	1.0	10.7	-	-	10.7	-	-	-	6.5	20.6	0.5	2.5	-
<i>Afronurus</i> sp. 1 (lower river type)	-	1.7	0.1	31.3	-	34.9	-	-	1.7	-	-	-	-	-	-	-	-	-	-
<u>ODONATA</u>																			
<i>Pseudagrion</i> spp.	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-
<i>Paragomphus</i> sp.	-	-	-	-	-	-	-	-	0.4	-	-	-	3.2	-	-	-	-	-	-
<i>Aeschna</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Trithemis</i> sp.	1.3	-	-	-	-	-	-	-	0.4	0.4	-	-	-	-	-	-	2.6	-	-
<i>Zygonyx</i> sp.	-	-	0.4	-	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>HEMIPTERA</u>																			
<i>Laccocoris limnogenus</i> Stål	-	-	-	-	-	-	-	-	-	-	-	-	3.2	-	-	-	-	-	-
<u>TRICHOPTERA</u>																			
<i>Oecetis</i> sp.	0.4	1.7	0.1	2.1	-	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Athripsodes prionii</i> Scott	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-
<i>Hydropsyche longifurca</i>	1.9	-	1.2	-	0.1	-	-	-	-	0.4	-	-	7.7	-	-	-	0.8	5.9	-

Group of Organisms	Spring						Autumn						Winter						
	Early			Late			Early			Late			Early			Late			
	R.+S.	FL.	S.	P.	S.	P.	S.	P.	S.	R.+S.	S.	P.	FL.	S.	P.	S.	R.+S.	P.	
<i>S. milloiti</i> Grenier and Doucet	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. vorax</i> Pom.	-	-	0.2	-	0.3	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironomidae	12.0	13.6	1.6	-	34.5	-	-	-	-	4.6	-	-	10.3	-	-	17.7	14.9	-	2.5
<i>Pentaneura</i> spp.	-	3.4	0.4	2.1	-	-	-	-	-	1.7	-	-	-	-	-	-	-	-	-
<i>Corynoneura</i> spp.	-	2.3	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-
Orthocladinae	4.5	1.1	37.0	-	-	-	-	-	-	-	-	-	-	-	-	-	23.7	39.0	-
<i>Rheotanytarsus</i> sp.	2.2	4.5	1.4	-	-	-	-	-	-	1.9	-	-	-	16.1	5.9	1.5	-	-	-
Chironominae	-	-	-	-	-	18.0	-	-	-	13.6	-	-	-	-	-	-	-	-	6.8
Ceratopogonidae	0.1	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-
Tabanidae	0.1	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-
Empididae	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhagionidae	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-
<u>MOLLUSCA</u>																			
<i>Burnupia</i> sp.	1.8	1.1	0.8	2.1	-	1.2	-	-	-	-	-	-	P	-	-	1.3	-	-	P
<u>AMPHIBIA</u>																			
Ranidae	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>PISCES</u>																			
<i>Barbus</i> sp.	-	18.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>ACARINA</u>																			
Hydrachnellae	0.5	1.7	0.7	12.5	-	5.0	1.9	2.9	14.3	-	-	-	-	-	-	-	-	-	-
Number of Organisms per Sample (sq. ft. = 0.093 m.2)	802 qual.	88.5 sq.ft.	1728 qual.	48 qual.	958 qual.	261 qual.	413	120.5 sq.ft.	28.0 sq.ft.	39.0 sq.ft.	31.0 sq.ft.	17.0 sq.ft.	389 qual.	59					

Group of Organisms	Spring						Summer						Autumn		Winter				
	Early			Late			St.	R.	R.	FL.	R.+S.	R.	R.	R.+S.	R.	R.	R.+S.	FL.	
	St.	R+St.	R.	FL.	R.	R+St.													Early
<i>Baetis harrisoni</i> Brnrd.	0.1	15.3	8.9	10.1	-	-	-	-	-	-	-	-	-	0.9	6.5	3.4	3.4	4.7	
<i>B. bellus</i> Brnrd.	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>B. glaucus</i>	0.5	1.9	1.2	4.5	3.4	7.9	6.3	7.3	-	-	-	-	7.9	-	-	5.7	0.7	5.7	
Baetid (ventral gills)	-	-	-	-	0.7	-	1.0	1.7	-	-	-	-	-	0.1	-	-	-	-	
<i>Pentoptilum excisum</i> Brnrd.	-	-	-	1.4	-	-	-	-	-	-	-	-	-	0.8	-	-	-	-	
<i>P. indusii</i> Crass.	-	-	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	
<i>P. medium</i> Crass.	-	-	-	-	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	
<i>P. varium</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	
<i>Pentoptilum</i> sp. 1	-	-	-	-	-	-	1.0	-	-	0.4	1.0	-	-	0.2	-	-	-	-	
<i>Pentoptilum</i> sp. 2	-	-	-	-	-	-	-	-	1.3	-	-	-	-	-	-	-	-	-	
<i>Pentoptiloides bifasciatum</i> Lest.	-	-	-	-	-	-	-	-	0.5	-	0.5	-	-	0.5	-	-	-	-	
<i>Psocenus</i> sp. (unsorted)	0.3	9.3	2.8	9.7	-	-	-	-	-	-	-	-	-	0.8	-	-	0.7	0.9	
<i>Psocenus</i> sp. 2	-	-	-	-	-	-	-	-	-	-	1.9	-	-	-	-	-	-	-	
<i>Psocenus</i> sp. 3	-	-	-	-	-	4.7	1.9	1.1	-	-	1.0	-	-	-	-	-	-	-	
<i>Psococenus discolor</i> (Brnrd.)	-	-	-	-	14.2	7.4	3.4	8.5	3.0	3.0	-	-	10.9	0.4	-	-	-	-	
<i>P. ? reticulatus</i> (Brnrd.)	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	-	-	-	-	
<i>Psithraulus elegans</i> Brnrd.	-	0.5	0.6	1.4	-	-	-	1.1	-	-	-	-	-	0.3	2.3	-	-	0.5	
<i>Psithogloea</i> sp. near <i>harrisoni</i>	-	-	-	-	-	-	-	-	0.8	0.8	-	-	-	-	-	-	-	-	
<i>Pronurus</i> sp. 3	0.1	0.2	-	0.8	-	0.3	2.1	0.3	0.2	0.2	0.3	0.3	-	0.3	-	-	-	0.5	
<i>Pronurus</i> sp. 4	-	-	-	-	-	-	-	2.0	1.2	1.2	-	-	-	-	-	-	-	-	
<u>DONATA</u>																			
<i>Chlorocypha</i> sp.	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Paratogomphus</i> sp.	-	-	0.1	-	-	-	-	-	-	-	-	-	-	0.1	-	-	0.2	-	
<i>Paratogomphus pictus</i> Hagen	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	
<i>Paratogomphus</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Pithemis</i> sp.	0.1	-	0.2	-	-	0.3	-	0.6	-	-	-	-	0.2	-	-	-	0.2	0.5	
<i>Ptygonyx natalensis</i> (Martin)	-	-	-	-	-	-	-	-	-	-	-	-	1.0	-	-	-	-	-	

	Spring										Summer			Autumn			Winter								
	Early					Late					R.	R.	R.	R.	R.	R.	R.	R.	R.						
	St.	R+St.	R.	FL.	R.	R+St.	St.	R.	R.	FL.										R+S.	Early	Late	Early	Late	FL.
unicornutum form rotundum Gibbins	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-				
adersi Pom.	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
milloti Grenier and Doucet	0.3	0.1	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
medusaeforme Pom.	0.1	-	-	-	-	1.9	-	0.2	-	-	-	-	-	-	0.3	-	-	-	-	0.9	-	-	-		
vorax Pom.	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
hironomidae	5.5	7.4	11.8	4.0	4.7	11.1	3.6	5.7	3.4	-	17.0	-	-	-	-	-	-	-	-	1.8	16.1	15.9	34.3	6.6	
entaneura spp.	1.1	5.6	7.1	9.7	7.9	3.7	-	2.6	-	-	2.8	-	-	-	-	-	-	-	-	0.4	-	5.6	1.0	1.9	
orynoneura sp. (long head)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
rthocladinae	2.3	11.1	5.3	3.2	14.2	15.8	18.6	23.7	8.7	3.4	-	-	-	-	-	-	-	-	-	11.9	-	36.4	2.9	13.2	
anytarsini	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.0	-	-	-	-
heotanytarsus sp.	1.4	14.7	8.9	28.3	2.4	9.3	4.6	17.0	28.9	-	-	-	-	-	-	-	-	-	-	0.4	6.5	5.7	1.6	5.7	
hironominae	-	-	-	-	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.6	1.6	1.9
hironomus sp. pupae	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
eratopogonidae	-	-	-	-	-	-	1.2	0.6	2.4	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
abanidae (Tabanus sp.)	-	-	-	-	-	-	-	0.9	0.7	-	-	-	-	-	-	-	-	-	-	-	1.0	-	-	-	-
mpididae	-	-	-	-	-	-	-	0.8	0.7	-	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
hagionidae	-	-	0.1	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
phydridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-
uscidae	0.2	0.4	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0	-	-	0.3	-
CARINA																									
ydrechnellae	0.2	1.9	1.2	2.4	-	5.6	0.4	7.9	2.9	-	13.6	-	-	-	-	-	-	-	-	1.3	6.5	-	-	2.0	-
OLLUSCA																									
urnupia sp.	-	P	-	P	P	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	-	P
total no. of Organisms per sample sq. ft. = 0.093 m.2)	1163.0	1297	1014	165.0	127	54	1128	345	415	-	354	-	-	-	-	-	-	-	-	337.3	31.0	44.0	613	53.0	
	sq.ft.	-	-	sq.ft.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	sq.ft.	sq.ft.	sq.ft.	-	sq.ft.	

Group of Organisms	Spring		Summer		Autumn		Winter		
	Early	Late	Early	Late	Early	Late	Early	Late	
	M.V.	M.V.	A.V.	M.V.	M.V.	M.V.	M.V.	M.V.	
<u>Ephemeroptera</u>									
Austrocloeon spp.	0.7	0.5	-	-	-	-	-	0.6	1.9
Austrocloeon africanum Brnrd.	-	-	-	2.1	-	1.0	-	-	-
A. virgiliae Brnrd.	-	-	-	7.9	9.9	-	-	-	-
A. near virgiliae	-	-	-	-	-	8.8	-	-	-
Pseudocloeon vinosum Brnrd.	-	-	0.3	-	-	2.1	-	0.4	-
Baetis harrisoni Brnrd.	-	-	-	-	-	-	-	-	p
B. bellus Brnrd.	-	p	-	10.7	28.8	3.9	-	1.4	-
B. latus Agnew	-	-	-	-	-	2.5	-	2.1	-
Centroptilum sudafricanum Lest.	-	-	2.4	-	-	-	-	-	-
C. indusii Crass.	-	-	-	3.4	-	-	-	-	-
Caenis spp. (unsorted)	-	0.2	-	-	-	0.7	-	0.5	-
C. sp. 2	-	-	0.3	-	-	-	-	-	-
C. sp. 4	-	-	0.4	-	0.3	-	-	-	-
Neurocaenis discolor (Burm.)	-	-	p	-	-	-	-	-	-
Notonurus sp.	-	0.1	-	-	0.3	1.3	-	0.2	-
<u>Odonata</u>									
Chlorolestes	-	-	-	0.1	-	-	-	-	-
Pseudagrion spp. (unsorted)	-	p	-	2.3	-	0.8	1.5	0.2	-
P. ? citricola Brnrd.	-	-	-	-	-	-	-	2.2	-
P. natalense Ris.	-	-	-	1.4	-	-	-	-	1.4
P. ? salisburyense Ris.	-	-	-	-	0.8	-	-	-	-
Aeschna spp.	0.1	-	-	-	-	-	-	0.1	-
Anax sp.	-	-	-	2.3	0.1	1.0	-	-	-
Trithemis spp.	0.1	-	-	-	-	-	-	-	-
Zygonyx natalensis (Martin)	-	-	0.3	-	-	-	-	-	-
<u>Hemiptera</u>									
Mesovelia sp.	-	-	-	1.1	-	-	-	-	-
Gerris sp.	-	-	-	0.6	-	-	-	-	-

table 30 continued

Group of Organisms	Spring		Summer		Autumn		Winter				
	Early	Late	Early	Late	Early	Late	Early	Late			
	M.V.	M.V.	A.V.	M.V.	M.V.	M.V.	M.V.	M.V.			
<i>Enithares chinae</i> Jaczenski	-	-	-	0.6	-	-	-	-	-		
<i>Anisops aglaia</i> Hutch	-	-	-	-	-	0.7	-	-	-		
<i>A. gracilis</i> Hutch	-	-	-	-	-	1.0	-	-	-		
<i>Anisops</i> sp.	-	p	-	-	-	-	1.0	0.4	-		
<i>Nychia marshalli</i> (Scott)	-	-	-	-	-	0.3	-	-	-		
<i>Plea pullula</i> Stål	-	0.1	-	-	-	-	1.5	-	-		
<i>Idiocorus</i> sp.	-	-	-	-	-	0.3	-	-	-		
<i>Micronecta hessei</i> Hutch	-	-	-	1.1	-	-	-	-	-		
<i>M. dimidiata</i> Poisson	-	-	-	1.7	0.1	0.4	0.5	0.3	0.1		
<i>Ranatra</i> sp.	-	-	-	-	0.1	-	-	-	-		
<i>Sphaerodema</i> sp.	-	-	-	-	0.1	-	-	-	0.1		
<u>TRICHOPTERA</u>											
<i>Athripsodes prionii</i> Scott	-	0.2	-	0.6	-	1.2	2.5	8.8	3.3	2.1	1.4
<i>Athripsodes</i> sp.	-	p	-	-	2.9	-	-	-	-	-	-
<i>Triazenodes</i>	-	-	0.1	-	-	-	-	-	-	-	-
<i>Hydropsyche longifurca</i>	-	-	0.4	-	-	-	-	-	-	-	-
<i>Orthotrichia</i> sp.	-	-	-	-	0.4	-	-	-	-	-	-
<i>Oxyethira</i> sp.	-	-	-	2.8	0.1	-	-	-	-	-	-
<i>Hydroptila</i> sp.	-	-	-	-	0.1	-	-	-	-	-	-
<u>LEPIDOPTERA</u>											
Pyralidae larvae	-	-	0.5	-	-	-	0.3	2.0	-	-	-
<u>COLEOPTERA</u>											
Dytiscidae	-	0.1	-	-	-	-	-	-	-	0.1	-
Gyrinidae	-	0.1	-	-	-	-	-	-	-	-	-
Hydrophilidae	-	p	-	-	-	-	1.0	3.4	-	0.2	0.5
Elmidae larvae sp. 7	0.1	-	-	4	-	-	-	-	-	-	-
Elmidae larvae sp. 2	-	-	-	-	-	-	-	-	-	-	0.5
Helodidae larvae	-	-	-	-	-	-	0.2	-	-	0.5	-

T A B L E 31

Percentage composition of the fauna : Marginal vegetation in the Umgeni river at Nagle Dam

Group of Organisms	Spring	Summer	Autumn		Winter
			Early	Late	
<u>HELMINTHES AND ANNELIDA</u>					
Nemertea (Prostoma sp.)	0.4	-	-	-	-
Chaetogaster sp.	-	-	-	-	3.9
Nais sp.	8.6	-	-	-	-
<u>CRUSTACEA</u>					
Simocephalus capensis (Sars)	-	-	-	5.8	-
S. vetula (Sars)	-	-	-	20.8	-
Alona sp.	6.5	-	-	-	-
Cyclops spp.	34.5	-	-	2.4	-
Ostracoda	-	2.8	-	25.3	-
Caridina nilotica Roux	-	-	2.2	2.7	1.3
<u>COLLEMBOLA</u>					
	-	P	-	P	-
<u>EPHEMEROPTERA</u>					
Austrocloeon virgiliae Brnrd.	-	P	-	17.7	-
Pseudocloeon vinosum Brnrd.	-	19.3	7.7	-	-
Baetis bellus Brnrd.	4.3	44.0	33.2	1.8	-
B. glaucus Crass.	0.7	3.7	-	-	-
B. latus	8.6	1.8	13.3	-	-
Centroptilum excisum Brnrd.	2.2	-	1.1	-	2.6
C. varium Crass.	-	-	2.8	-	-
Caenis sp. 3	-	4.6	-	-	-
Caenis sp. 4	4.3	1.8	3.9	-	-
Lithogloea near harrisoni	0.4	-	-	-	-
Notonurus sp.	1.1	11.0	6.6	0.3	-

table 31 continued

Group of Organisms	Spring	Summer	Autumn		Winter
			Early	Late	
<u>ODONATA</u>					
Pseudagrion sp.	2.2	-	2.2	2.4	-
Anax sp.	-	-	-	0.3	-
<u>HEMIPTERA</u>					
Mesovelia sp.	-	-	-	1.2	-
Rhagovelia ? nigricans Burm.	-	-	-	0.6	-
Anisops sp.	-	-	-	1.8	-
Micronecta dimidiata Poisson	-	-	-	0.3	-
Sigara sp.	-	-	-	0.9	-
Ranatra sp.	-	-	-	0.3	-
Sphaerodema sp.	0.4	-	-	-	-
<u>TRICHOPTERA</u>					
Cheumatopsyche thomasseti (Ulmer)	-	0.9	-	-	-
Hydroptila ? cruciata Ulmer	-	-	-	0.3	-
<u>LEPIDOPTERA</u>					
Pyralidae	-	-	-	1.5	-
<u>COLEOPTERA</u>					
Dytiscidae	-	-	-	0.3	-
Hydrophilidae	-	-	0.6	0.6	-
Elmidae larvae sp. 3	0.4	-	-	-	-
Elmidae larvae sp. 5	-	-	0.6	-	-
Elmidae larvae sp. 7	0.4	-	1.1	-	-
Helodidae	-	-	-	-	1.3
<u>DIPTERA</u>					
Culicidae	-	-	-	0.6	-
Simulium larvae	-	-	-	0.3	-
S. milloti Grenier and Doucet	0.4	-	-	-	-

table 31 continued

Group of Organisms	Spring	Summer	Autumn		Winter
			Early	Late	
Chironomidae	4.3	4.6	10.5	7.5	-
Pentaneura sp.	2.2	1.8	2.8	3.0	-
Corynoneura sp.	-	-	-	0.3	5.2
Orthocladinae	-	-	-	-	62.3
Tanytarsus sp.	2.2	1.8	-	-	-
Chironominae	-	-	4.4	-	23.4
Rhagionidae	0.4	-	-	-	-
<u>ACARINA</u>					
Hydrachnellae	4.3	-	5.5	-	-
<u>MOLLUSCA</u>					
Lymnaea natalensis Krs.	-	-	-	0.3	-
Anisus natalensis	-	-	-	0.3	-
Gyraulus costulatus	-	-	1.7	-	-
<u>AMPHIBIA</u>					
Ranidae tadpoles	11.5	-	-	0.3	-
<u>PISCES</u>					
Total number of organisms per 6 ft. (= 1.83 metres) marginal vegetation.	278.0	109.0	181.0	249.0	77.0

TABLE 32

Percentage composition of the fauna : Marginal vegetation in the Umgeni river at Upuma (valley of a thousand hills).

Group of Organisms	Spring		Summer	Autumn		Winter
	Early	Late		Early	Late	
<u>COELENTERATA</u>						
Hydra sp.	5.7	-	-	-	-	-
<u>HELMINTHES AND ANNELIDA</u>						
Nematoda	-	-	-	-	-	0.9
Chaetogaster sp.	0.3	-	-	-	-	44.6
Nais spp.	0.9	-	-	-	1.6	-
<u>CRUSTACEA</u>						
Elaphoidella sp.	-	-	-	-	-	0.2
Caridina nilotica Roux	-	-	0.2	-	-	-
<u>Ephemeroptera</u>						
Prosopistoma crassi Gillies	0.2	-	-	-	-	-
Pseudocloeon vinosum Brnrd.	41.3	20.5	19.5	18.3	5.1	2.8
Baetis harrisoni Brnrd.	-	-	-	-	-	0.5
B. bellus Brnrd.	13.8	54.6	41.9	23.7	10.2	3.3
B. glaucus Agnew	0.4	-	27.9	-	-	-
Baetis latus Agnew	27.5	9.1	-	15.8	8.1	0.7
C. excisum Brnrd.	-	-	-	-	29.1	0.5
Centroptilum sudafricanum Lest.	-	-	-	-	-	0.2
Caenis spp. (largely sp. 4)	2.3	-	-	-	-	-
Caenis sp. 3	-	1.1	1.2	-	-	-
Caenis sp. 4	-	3.4	-	7.0	2.7	-
Neurocaenis discolor (Burn.)	-	-	-	4.2	-	-
Notonurus sp.	0.1	-	-	-	10.5	-
<u>ODONATA</u>						
Chlorolestes sp.	-	-	-	-	-	-

table 32 continued

Group of Organisms	Spring		Summer	Autumn		Winter
	Early	Late		Early	Late	
<u>HEMIPTERA</u>						
Rhagovelia sp.	-	-	-	2.8	0.8	-
Laccocoris limnogenus Stål	-	-	-	2.8	-	-
Sphaerodema sp.	0.1	-	-	-	-	-
<u>TRICHOPTERA</u>						
Oecetis sp.	-	-	2.1	-	-	-
Cheumatopsyche thomasseti (Ulmer)	-	-	-	2.8	-	-
Hydroptila? cruciata Ulmer	1.6	-	-	-	-	0.2
<u>COLEOPTERA</u>						
Gyrinidae larvae	0.2	1.1	0.2	1.4	-	0.7
Aulonogyrus sp.	0.2	-	-	-	-	-
Orectogyrus conformis Reg.	0.5	-	-	-	-	-
Berosus sp.	-	1.1	-	-	-	-
Elmidae sp. 7	-	-	0.2	-	-	-
<u>DIPTERA</u>						
Simulium larvae	0.3	2.3	-	-	-	9.4
S. alcocki Pom.	0.1	-	-	-	-	-
S. mesudaeforme Pom.	-	-	-	1.4	-	-
Chironomidae	1.5	6.8	1.2	8.5	-	-
Pentaneura spp.	1.7	2.2	0.5	-	5.4	2.4
Corynoneura sp.	-	-	-	-	10.8	1.2
Orthocladinae	0.3	-	-	-	-	11.7
Tanytarsus sp.	1.8	-	0.2	5.6	8.1	0.5
Rheotanytarsus sp.	-	-	4.9	-	-	-
Chironominae	-	-	-	-	2.7	20.0
Ceratopogonidae	-	-	-	-	-	0.2
Muscidae pupae	0.1	-	-	-	-	-
<u>ACARINA</u>						

table 32 continued

Group of Organisms	Spring		Summer	Autumn		Winter
	Early	Late		Early	Late	
<u>MOLLUSCA</u>						
Lymnaea sp.	-	2.2	-	1.4	-	-
<u>PISCES</u>						
Barbus sp.	-	2.2	-	-	-	-
Total number of organisms per 6 ft. (1.83 metres) marginal vegetation.	2180	88.0	430	71	371	426

T A B L E 33

Percentage composition of the fauna : Stones in the current in the Umgeni river at Natal Estates.

Group of Organisms	Spring	Summer
	R.+St.	R.+St.
<u>HELMINTHES</u>		
Prostoma sp.	4.7	-
<u>CRUSTACEA</u>		
Caridina nilotica Roux	1.6	-
<u>EPHEMEROPTERA</u>		
Baetis harrisoni Brnrd.	3.1	-
B. glaucus Agnew	18.8	1.4
Centroptilum varium Crass.	3.1	-
Centroptilum sp. 1	1.6	0.3
Elassoneuria trimeniana McLach.	-	0.3
Neurocaenis discolor (Burm.)	3.1	3.6
<u>ODONATA</u>		
Trithemis sp.	-	0.2
Zygonyx natalensis	1.6	-
<u>TRICHOPTERA</u>		
Cheumatopsyche thomasseti (Ulmer)	18.8	4.2
Hydroptila ? cruciata Ulmer	1.6	-
<u>DIPTERA</u>		
Simulium larvae	25.0	10.9
S. medusaeforme	-	0.9
S. cervicornotum	1.6	-
Chironomidae	-	10.9
Orthocladinae	1.6	37.3
Pentaneura sp.	3.1	-
Rheotanytarsus sp.	9.4	27.9

table 33 continued

Group of Organisms	Spring	Summer
	R.+St.	R.+St.
Muscidae larvae	-	0.3
Wiedemannia sp.	-	0.2
Number of organisms 1 ft. ² (= 0.093 m. ²)	64.0	220.0

Percentage composition of the fauna : Marginal vegeta-
tion in the Umgeni river at Natal Estates

Group of Organisms	Spring		Summer	Autumn	Winter
	Early	Late			
<u>ANNELIDA</u>					
Nais sp.	3.2	-	-	-	-
<u>CRUSTACEA</u>					
Cyclops sp.	0.1	-	-	-	-
Caridina typus M. Edw.	-	-	1.8	7.8	-
C. nilotica Roux	0.3	23.5	10.5	77.6	13.2
Macrobrachium equidens Brnrd.	-	-	-	3.6	-
M. lepidactylus Hilg.	-	-	-	2.5	-
<u>COLLEMBOLA</u>					
	2.7	-	-	-	-
<u>EPHEMEROPTERA</u>					
Pseudocloeon vinosum Brnrd.	42.8	40.3	8.7	-	21.1
Baetis bellus Brnrd.	9.6	20.1	24.5	6.8	10.5
B. glaucus Agnew	1.6	-	-	-	-
B. latus Agnew	5.4	-	-	-	-
Centroptilum excisum Brnrd.	0.8	-	2.6	-	-
Caenis spp. (unsorted)	4.8	-	-	-	2.1
Caenis sp. 4	-	2.5	-	-	-
<u>ODONATA</u>					
Chlorolestes sp.	-	0.8	-	-	-
<u>HEMIPTERA</u>					
Microvelia spp.	1.1	-	-	1.4	-
Rhagovelia sp.	-	-	5.2	-	-
Plea sp.	0.1	-	-	-	-
Micronectadinidiata Poisson	0.8	-	-	-	-
Laccocorus limnigenus Stäl	-	5.0	-	-	-

table 34 continued

Group of Organisms	Spring		Summer	Autumn	Winter
	Early	Late			
Ranatra sp.	-	-	0.4	-	-
Sphaerodema nepoides Fabr.	0.8	-	-	-	0.5
<u>TRICHOPTERA</u>					
Oecetis spp.	-	1.7	0.9	-	-
Trianodes sp.	-	-	0.4	-	-
Hydroptila ? cruciata Ulmer	-	-	2.2	-	-
<u>LEPIDOPTERA</u>					
Pyralidae	-	-	3.9	-	-
<u>COLEOPTERA</u>					
Dytiscidae	0.1	-	-	-	-
Hydrophilidae larvae	-	0.8	-	-	-
Hydrophilidae adults	-	-	-	0.4	-
Hydraenidae adults	0.3	-	-	-	-
Elmidae adults	0.1	-	-	-	-
<u>DIPTERA</u>					
Culicidae	0.3	-	-	-	-
Simulium vorax Pom.	-	0.8	-	-	-
Chironomidae	11.3	2.5	29.7	-	34.2
Pentaneura spp.	0.3	1.7	3.1	-	1.6
Corynoneura sp.	0.4	-	-	-	4.7
Rheotanytarsus sp.	-	-	5.2	-	2.6
<u>MOLLUSCA</u>					
Lymnaea natalensis Krs.	0.3	-	-	-	-
<u>AMPHIBIA</u>					
Tadpoles (Ranidae)	12.9	-	0.9	-	9.5
Number of organisms per 6 ft. (1.83 metres) marginal vegetation	747.0	119.0	229.0	281.0	190.0

T A B L E 35

Percentage composition of the fauna : Marginal vegetation in the Umgeni river at Fair View.

Group of Organisms	Spring	Summer	Autumn	Winter	
				Early	Late
<u>HELMINTHES AND ANNELIDA</u>					
Prostoma sp.	-	1.9	-	-	-
Nais spp.	-	1.9	-	-	-
Branchiura sowerbyi Bedd.	-	-	23.1	-	-
<u>CRUSTACEA</u>					
Caridina typus M. Edw.	-	1.9	-	-	-
C. nilotica Roux	-	29.6	43.6	62.1	5.5
<u>COLLEMBOLA</u>					
	-	1.2	-	-	5.0
<u>EPHEMEROPTERA</u>					
Pseudocloeon vinosum Brnrd.	25.7	17.3	30.8	17.2	34.0
Baetis bellus Brnrd.	56.4	29.6	-	13.8	15.0
B. latus Agnew	-	-	-	-	6.0
Caenis sp. 4	2.6	1.9	-	-	4.0
Notonurus sp.	-	1.7	-	-	-
<u>ODONATA</u>					
Pseudagrion spp.	-	-	-	3.5	-
<u>HEMIPTERA</u>					
Rhagovelia nigricans Burn.	-	1.2	-	-	-
<u>TRICHOPTERA</u>					
Hydroptila? cruciata Ulmer	-	1.2	-	-	-

table 35 continued

Group of Organisms	Spring	Summer	Autumn	Winter	
				Early	Late
<u>DIPTERA</u>					
Simulium larvae	-	1.2	-	3.5	-
Chironomidae	6.8	-	2.6	-	2.5
Corynoneura sp.	5.1	-	-	-	5.0
Tanytarsini	-	0.6	-	-	-
Tanytarsus sp.	-	-	-	-	14.0
Chironominae	-	-	-	-	5.0
Empididae	-	-	-	-	3.0
<u>ACARINA</u>					
Hydrachnellae	1.7	2.5	-	-	-
<u>MOLLUSCA</u>					
Lymnaea columella Say	-	1.9	-	-	-
<u>AMPHIBIA</u>					
Ranidae (tadpoles)	-	3.1	-	-	-
Total number of organisms per 6 ft. (1.83 metres) marginal vegetation.	117.0	162.0	39.0	29.0	200.0

7. COMPARISON OF THE UMGENI RIVER FAUNA WITH
THOSE OF OTHER SOUTH AFRICAN RIVERS.

One of the major obstacles concerning the comparison of the fauna of the few South African rivers thusfar investigated (Harrison and Elsworth, 1958; Oliff, 1960; Allanson, 1962, Chutter, 1963) is to be found in the fact that large numbers of organisms, mainly the larval forms of insects, had to be numbered as a result of the small amount of literature available on the systematics of most South African orders of aquatic insects. Where literature is available, the accounts, as a rule, mainly deal with the adult stages of such organisms and, only scant or no attention is given to the larval stages. In many of those instances where accounts on the larval forms are included, no proper correlations between the larvae and adults were made with the result that considerable species confusion may arise. A good example illustrating the pitfalls encountered when having to utilize inadequate descriptions of larval forms is found when one attempts to compare the fauna of the Tugela, Great Berg and Jukskei-Crocodile rivers. In comparing the fauna of mountain torrent and upper foothill torrent zones of the Tugela and Berg rivers, for instance, Oliff (1960, p. 343, table 14) was lead to conclude that Afronurus harrisoni was common to both these rivers. Allanson (1962) likewise found this species to occur in the hard bottom stony run zone of the foothill type of the Jukskei-Crocodile river system. As will be pointed out (Chapter 9), however, the present investigation revealed that

- i. Harrison and Elsworth (1958) unwittingly confused at least two species of Afronurus with each other by identifying both as harrisoni, whereas, in fact, only one of them represented this species.

ii. The species called harrisoni by Oliff (1960) turned out to be a new species, described here as A. oliffi, whereas A. harrisoni recorded from the Jukskei-Crocodile river system (Allanson, 1962) must be regarded as a new species viz. A. barnardi. But for this new information, I might also have been lead to report A. harrisoni in the Umgeni river where in fact, it does not occur.

7.1 Comparison with the fauna of the Tugela river (Oliff, 1960)

For the reasons put forward above, I have not attempted to compare in detail the fauna of the Umgeni river with that of either the Berg river or the Jukskei-Crocodile river system but largely restricted my comparison to the Umgeni and Tugela rivers. This could be done with confidence not only because Oliff and myself conducted our respective surveys simultaneously from the same laboratory, but also because I, as a check, could myself collect faunal samples from parts of the Tugela river. In many instances where undescribed species had to be recorded by reference to numbers, my own numbers correspond to those employed by Oliff for the same species. Wherever my own system of numbering differed from Oliff's, his equivalent numbers are given in brackets.

As mentioned before, the Umgeni river originates at an altitude, approximately 3,900 feet (1189 metres) lower than does the Tugela river. The Umgeni river furthermore, lacks the waterfall and nountain torrent zones of the Tugela river. The equivalent zones of the two river systems, therefore, only begin with the foothill torrent zones (table 9) which, in the Umgeni river, has been subdivided

into an upper and a lower foothill torrent zone. However, even here, the respective physical zones in the Tugela river occur at slightly higher elevations than the corresponding zones in the Umgeni river (table 9). Although it is impossible to make detailed comparisons of the water temperatures in the two rivers, Oliff's records (1960, p. 298 and fig. 5) suggest an expected overall lower water temperature in the Tugela, upstream from and including the foothill torrent zone, than my own limited findings for the Umgeni river (fig. 10). If, therefore, higher altitudes, and, consequently, lower water temperatures, play a decisive role in the longitudinal distribution of the fauna in rivers as is generally assumed, then a comparison of the faunal distribution in these two Natal rivers could be expected to provide positive proof that this, in fact, is so. It should also be possible to find out whether any particular type of physical zone, such as for instance the mountain torrent zone, which, by definition, is not represented in the Umgeni river, has a distinctive type of fauna, in other words, whether the stream fauna is actually associated with a particular type of physical zone or not. Since the stony bottom fauna of rivers are, as a rule, more specific in their distribution than the fauna of either the marginal vegetation or, ^{of} the bottom sediments (Harrison and Elsworth, 1958; Oliff, 1960; Chutter, 1963), my comparisons of the fauna of the Umgeni and Tugela rivers have been mainly confined to the former.

i. The source zones.

The dominant species of the Tugela source zone include the mayflies Adenophlebia auriculata, Centroptilum sudafricanum and Acentrella natalensis. A. auriculata and C. sudafricanum, although not restricted to the source zone

only of the Umgeni, were comparatively numerous here in autumn (table 12). All three species, however, also occur at even lower altitudes in the Umgeni river, extending downstream at least as far as the lower foothill torrent zone. This also applies to the distribution of the Simulium species nigritarsus and unicornotum, which Oliff (1960) maintain, are restricted to the source zone of the Tugela river. These two species were collected in the Umgeni river in the lower foothill torrent and rejuvenated zones far below its source zone. Simulium species which do, however, appear to be restricted to the head water regions of the Umgeni river and, also, of that of its tributaries, are S. impukane and S. rutherfoordi. Both species favoured shaded areas in streams of the Umgeni which agrees with Harrison's (1958) findings on rutherfoordi. The pupa of rutherfoordi closely resembles that of nigritarsus (Freemand and de Meillon, 1953) and it could well be that Oliff mistook rutherfoordi for nigritarsus. Although Rana vertebralis (= Rana umbraculata, Oliff, 1960), did not occur at the source zone of the Umgeni river itself, it was nevertheless recorded from the upper foothill torrent zone in this river at Ross' Farm. I did not, however, recover the isopod Crangonyx robertsii or Baetis lawrencei from the marginal vegetation, both of which Oliff found at the Tugela river's source. Other head water species which were prominent at the Umgeni source and also occurred at Ross' Farm in the upper foothill torrent zone, were Castanophlebia calida, Centroptilum near excisum, Adenophlebia sylvatica and Athripsodes near bergensis. Most of these organisms were characteristic of the fauna in the mountain torrent zone of the Tugela river which as far as the fauna is concerned, must undoubtedly be regarded as the equivalent of the upper foothill torrent zone of the Umgeni river (see below). A comparison of the source zones of these two

Natal rivers therefore indicates that, despite an altitudinal difference of almost 4,000 feet (1,219 metres), the prominent species of the zones compared, were very similar. The small differences which admittedly exist, are insufficient to justify their separation into two different physical zones.

- ii. The mountain torrent zone of the Tugela river and the upper foothill torrent zone of the Umgeni river.

Quite apart from altitudinal differences, the mountain torrent zone of the Tugela river has no real equivalent in the Umgeni river as far as the physical zonation goes. In spite of this the main features of the fauna of the two zones showed a marked similarity which cannot be explained on the basis of the slight overlap in altitude of the lower part of the mountain torrent zone of the former and the top part of the upper foothill torrent zone of the latter. Characteristic species common to both zones were Aphanicerella spp., Afronurus sp. 1 (= Afronurus harrisoni, Oliff), Aprionyx tricuspидatus, Adenophlebia sylvatica, Baetis cataractae and R. vertebralis (= Rana umbraculata, Oliff). Also recorded from both zones were Goerodes sp., Centroptilum sudafricanum, Baetis harrisoni and Acentrella natalensis. Although I did not come across the isopod Protojanira perbrincki, other organisms were in the head waters of the Umgeni river at Ross' Farm and at those of its major unpolluted tributaries, which were also encountered in the head streams of other Natal rivers during my collecting of Afronurus sp. 1 and which must be present in the mountain torrent zones of some of the Tugela river's tributaries. These are: Pseudocloeon inzingae, Acentrella monticola, Taeniochauloides ? ochraceopenni, Cheumatopsyche afra (type 1) and Ithytrichia sp. Two of

these viz. Pseudocloeon inzingae and Acentrella monticola not specifically mentioned in his text, are nevertheless listed by Oliff as occurring in the mountain torrent zone of the Tugela river. From the foregoing evidence there can be no doubt that a close similarity exists between the faunal composition of the two distinctly different physical zones of the two rivers. A picture similar to this is presented by the Emolweni tributary which, at less than 3,000 feet (914 metres) in the Krantzkloof nature reserve, supports most of the species which characterize both the mountain torrent zone of the Tugela river at 7,500-5,000 feet (2,286-1,524 metres) and the upper foothill torrent zone of the Umgeni river at 6,000-4,100 feet (1,829-1,250 metres). The following organisms, which featured prominently at the above-mentioned head water zones of the Tugela and the Umgeni rivers, were also collected at Krantzkloof in the Emolweni river:

- Amphibia : R. vertebralis (= Rana umbraculata, Oliff)
- Plecoptera : Aphanicercella spp.
- Ephemeroptera : Pseudocloeon inzingae, Baetis cataractae,
Aprionyx tricuspoidatus, Adenophlebia
sylvatica, Afronurus sp. 2 (Not recorded
by Oliff but characteristic of the upper
and lower foothill torrent zone in the
Umgeni river).
- Trichoptera : Goerodes caffrariae
Cheumatopsyche afra (type 1) (= C.
maculata, Oliff)
- Coleoptera : Afropsephenoides sp. (not recorded by
Oliff).
- Diptera : Elporia ? natalensis (According to mr.
Stuckenberg of the Natal Museum, this

could be a species other than the one found at Ross' Farm (personal communications).

Simulium impukane (not recorded by Oliff)

S. rutherfoordi (not recorded by Oliff)

iii. The other physical zones.

The fauna of the foothill torrent zone of the Tugela river roughly corresponds with those in the lower foothill torrent zone of the Umgeni river. Most species which Oliff indicates as being numerically important in the former were also prominent in the latter during some or other season of the year. However, whereas Centroptilum sudafricanum and Acentrella natalensis already disappeared from the fauna of this zone in the Tugela river, they remained prominent amongst species of Ephemeroptera of the Umgeni river as far downstream as the rejuvenated river zone. Whereas in the Umgeni, the foothill soft bottom zone supported a fauna similar to that of the lower foothill torrent zone, the Tugela river's foothill sand bed zone contained species characteristic of the rejuvenated zone of this river. A few noteworthy points of difference between the rejuvenated river in the Umgeni and the foothill sand bed zone of the Tugela, are as follows:

- (i.) Afronurus sp. 4 (= Afronurus sp. 1, Oliff), highly characteristic of the rejuvenated river zone only in the Umgeni river, already occurred in the foothill sand bed zone of the Tugela river;
- (ii.) Neurocaenis discolor, which remained common in the Umgeni but was not well represented in the Tugela river.

The fauna of the rejuvenated river zones of both rivers were very similar and contained a characteristic

"lower river" faunal element. However, while, species such Afronurus sp. 4 (= Afronurus sp. 1, Oliff) and Centroptilum sp. 1, were characteristic of, and, common to both rivers, a baetid with ventral gills and the ephemereid Lithogloea near harrisoni were mainly confined to this zone of the Umgeni but apparently not found in the Tugela river.

In the valley sand bed zones of both rivers the decapod Macrobrachium equidens was very common. Crustacea which were restricted to the estuarine zone in the Tugela but which occurred upstream from the estuary in the valley sand bed zone of the Umgeni river are Macrobrachium lepidactylus and Caridina typus, collected from Natal Estates at the head of the valley sand bed zone.

Since the Umgeni estuary was subject to pollution (see appendix) a detailed comparison of this zone of the Umgeni river with that of the Tugela river serves no purpose in the context of this paper.

Of particular interest was the seasonal migration of the Umgeni river fauna which was best illustrated by the fauna of the rejuvenated river zone. This migration always coincided with and seemed to be determined by, heavy growths of filamentous algae and diatoms which commenced during autumn at and below Upuma. These growths which appeared in rapid succession upstream at Albert Falls and Morton's Drift in early winter, and, in late winter (August) was also evident in the foothill torrent zones. By this time however the algae and diatoms at Upuma already began to decay and to become detached from the stones. This process of decay and disappearance of algae growths followed the same pattern as was the case with the algal bloom. Simultaneously with these heavy growths, animal species were found upstream from Upuma towards Albert Falls, which Oliff (1960, p. 326) and Harrison (personal communications) regarded as the

"tropical element" in Natal rivers. Particularly noteworthy in this connection is the fact that this "tropical element" tended to move upstream into comparatively cooler water during the colder months of the year. Special surveys of the rejuvenated river during summer, autumn and winter, for instance, revealed the following: Centroptilum sp. 1, common at Natal Estates in spring and summer, was present at Upuma in summer and autumn, and at Table Mountain in autumn, where due to heavy floods no summer collections were made. Special surveys revealed its presence at Albert Falls in autumn and winter. A similar migrational picture was obtained for Afronurus sp. 4, which predominated at Upuma in the lower Umgeni river during the warmer months of the year (December-February) appearing at Albert Falls towards late summer and autumn. Furthermore, the baetid with ventral abdominal gills was encountered, in increasing numbers, upstream from Upuma towards Albert Falls. This organisms was mainly associated with the upstream increase in algae growths which also coincided with the decrease in the water temperature. Although it is not suggested here that this so called "tropical element" of which the abovementioned organisms form part, favours colder water temperatures, none of the preceding findings would be in disagreement with such an interpretation.

The overall picture derived from a broad comparison of the fauna of the Umgeni and Tugela rivers, therefore, suggests that:

- (i.) Differences in altitude and, possibly, differences in prevailing water temperatures of the two rivers compared, did not appear to have a marked limiting effect upon the longitudinal distribution of the fauna.

(ii.) A particular fauna was not necessarily associated with, or restricted to, any one type of physical zone. This was clearly demonstrated by the similarities in the fauna of the mountain torrent zone of the Tugela river and the foothill torrent zone of the Umgeni river.

(iii.) Despite decreasing altitudes, the "head water element" in the Umgeni river extended downstream in the Umgeni river far beyond the head water zone of the river whilst the "lower river" fauna, which characterizes the rejuvenated and sand bed zones of the Umgeni river occurred over comparatively longer stretches in the Tugela river.

7.2

Comparison with the Great Berg river, the Jukskei-Crocodile river system and the Vaal river in the Vereeniging area.

The abovementioned rivers were respectively surveyed and reported upon by Harrison and Elsworth (1958), Allanson (1960) and Chutter (1963).

One of the most noteworthy differences between the head water regions of the Umgeni river (i.e. the upper foothill torrent zone) and the Berg river (i.e. the mountain torrent zone) lies in the respective growths of filamentous algae and diatoms which are always noticeable in the Umgeni river, being at times, during the dry seasons, luxurious. In the mountain torrent zone of the Berg river, on the other hand, growths of algae appeared to be very slight. A possible explanation for the general scarcity of algae and diatoms in the Berg river may perhaps be found in Harrison and Elsworth's remarks on the geology of this drainage basin, which, at its head waters, exposes outcrops of Table Mountain

Sandstone, mainly comprising quartzite which gives rise to waters which are notably low in dissolved salts. In contrast to this the Umgeni river traverses beds of the Beaufort series. This scarcity of algae may, in turn, have an important limiting effect upon the presence or absence of certain organisms in the mountain torrent zone of the Berg river. Furthermore, the waters of the Berg river is distinctly acid whereas that of the Umgeni river very seldom attains pH values below 7. As ^{could} therefore be expected, these two rivers, at their head waters (= zone II, mountain torrent, Berg river and upper foothill torrent, Umgeni river), support markedly different faunas, with only a few species being common to both. These are listed below.

Plecoptera: Aphanicerca spp. A species belonging to the Aphanicerella group, although not present in the Umgeni river as such, was found at the head waters of the Emolweni tributary of the Umgeni river.

Ephemeroptera : Baetis harrisoni
Pseudocloeon vinosum
Castanophlebia calida
Neurocaenis discolor (= Tricorythus discolor,
Harrison and Elsworth)

Trichoptera: Cheumatopsyche afra (= C. maculata, Harrison and Elsworth).

In zones III B - IV (i.e. lower foothill torrent - foothill soft bottom zones) of the Berg river, however, there occur progressively more species which are also common to the Umgeni and other rivers from Natal (c.f. Oliff, 1960, p. 343, table 14) and the Transvaal (c.f. Allanson, 1962, p. 62; Chutter, 1963, p. 47 and tables 25 - 26).

Allanson (1960) mainly devoted his attention to the physical, chemical and biological conditions of polluted streams in the Jukskei-Crocodile river systems. For this reason, direct comparisons of the aquatic fauna listed for these rivers with those in the Umgeni river, are not always possible. Where he does describe the fauna of clean streams or his "Recovery II fauna", of the Jukskei-Crocodile system (p. 62), these communities include several organisms which are characteristic of the lower foothill torrent - rejuvenated river zones in the Umgeni river.

Chutter (1963) found the fauna of the Vaal river in the Vereeniging area to resemble those in the foothill sand bed zone of the Tugela river and in the foothill soft bottom zone at stations 13, 14 and 18 of the Great Berg river. Many of the species listed by Chutter in his table 26, occur between the Dargle Forestry and Albert Falls sampling localities i.e. in the lower foothill torrent - rejuvenated river zones of the Umgeni river.

8. THE ECOLOGICAL DISTRIBUTION OF THE STONY BOTTOM
EPHEMEROPTERA IN THE UMGENI RIVER.

From the findings of the faunal survey of the Umgeni river system (chapter 6), it was obvious that the longitudinal distribution of the faunal communities did not necessarily coincide with any one particular type of physical zone. In some instances, for example, particular faunal associations were found to be very much restricted to a part of a physical zone (e.g. at Ross' Farm) whilst in others, some associations occurred over several physical zones. The findings of the faunal distribution in the Umgeni river, therefore, do not entirely agree with those of Harrison and Elsworth (1958) according to which the zonation of the fauna of the Berg river followed the same pattern as the zonation of the river although the latter was based on physical features. In his discussion of the species composition of the stony bottom fauna in the upper river zones (i.e. the source, mountain torrent and foothill torrent zones) of the Tugela river, Oliff (1960) also found the fauna of these zones to differ sharply amongst themselves, despite the fact^{that} the zones are short. The latter author, however, did find several prominent species to occur in more than one of the successive physical zones in the Tugela river. If my own findings be accepted, it follows that either the physical zones in the Umgeni river, although based on the same definitions, do not agree with those in the Great Berg and Tugela rivers and that consequently, the system of physical zonation, if taken to reflect the ecological distribution and zonation of the fauna, is not applicable to all South African rivers without further qualification, or, an entirely different approach, involving the biological zonation, must be sought for, because the primary aim in studies of this nature is to define the ecological boundaries

for the organisms in rivers. It is to be regretted that in South Africa, an appreciable proportion of the aquatic invertebrate fauna caught in the nets of mesh size 25/centimetres (64/inch) and, which mainly comprize larvae forms of insects, are either unnamed or have not been properly correlated with their respective adult stages. The only insect order which, taxonomically, is well documented (Barnard, 1932; Crass, 1947) and which, numerically, constituted the bulk of the organisms in the Umgeni river samples (tables 12 - 35), was the Ephemeroptera. Moreover, practically all the Ephemeroptera nymphs, which are aquatic, have been correlated with their adult stages so that the ecology of virtually all species of this insect order could be individually studied and compared with each other with respect to both habitat selection and longitudinal distribution, without much fear of confusing different species with each other. For these reasons, the discussion of the habitat selection and longitudinal ecological distribution of the fauna in the Umgeni river is confined to that of the Ephemeroptera. Furthermore, since the stony bottom fauna and, in particular, the stony bottom Ephemeroptera, are far more specific with respect to habitat selection and longitudinal downstream distribution than is the case for the fauna from the marginal vegetation (Oliff, 1960; Chutter, 1963), the discussion below is largely limited to the stony bottom Ephemeroptera.

8.1 The habitat selection of the stony bottom Ephemeroptera.

In tables 36 - 41, the number of samples (N) obtained for each species, include all the samples taken from all the Umgeni river localities falling within a particular stretch of the river where such a species occurs, irrespective of its percentage incidence and numerical importance at any of the

localities concerned. If, for example, Afronurus sp. 2 occurs in the Umgeni river at Ross' Farm, Dargle Forestry and Midmar (table 42), but was not collected between these stations at Dargle Police Station, Watersmeet and Fern Hill Flats (fig. 1) this species was nevertheless considered as being potentially present in all the samples from all the habitats at these localities. Such samples are therefore included with those in which this species was actually recorded. The values in the "% pos." column (tables 36 - 41) for each habitat are then based on the actual number of positive samples out of the total number of theoretically positive samples. Figures in the "% pos." column, therefore, roughly reflect the occurrence frequency of each species in a particular habitat. When considering the habitat selection of the stony bottom Ephemeroptera, certain families, represented by a few species only, are grouped together in some of tables 36 - 47, merely for the sake of convenience.

The Heptageniidae

Altogether four species were recognized (table 36) of which Afronurus sp. 1 predominated in slow current habitats. It was absent from the stony stickles and cascades and had its highest individual and average percentage incidence in pools.

Afronurus sp. 2 was recorded from all habitats except the stony back waters and cascades. It was fairly common in the moderately fast current habitats such as the stony flats, runs and stickles but, like Afronurus sp. 1, had its highest average percentage incidence in pools.

Afronurus sp. 3 was, numerically, the most abundant species of the stony bottom Heptageniidae. It occurred in all habitats (table 36) but was most common in the flats, runs and stickles. The smallest percentage incidences were

T A B L E 36

Habitat distribution of the Heptageniidae

HABITAT	S P E C I E S											
	Afronurus sp. 1		Afronurus sp. 2		Afronurus sp. 3		Afronurus sp. 4					
	N	% pos.	N	% pos.	N	% pos.	N	% pos.				
BACK WATERS	1	100.0	2	-	2	50.0	-	-				
POOLS	3	66.7	10	20.0	12	66.7	4	50.0				
FLATS	1	-	10	30.0	23	73.9	12	25.0				
RUNS	-	-	17	17.7	26	57.7	10	10.0				
RUNS AND STICKLES	2	50.0	12	33.3	22	59.1	11	9.1				
STICKLES	4	-	12	41.7	23	73.9	10	20.0				
CASCADES	3	-	3	-	6	50.0	3	33.3				

recorded from the stony back waters and cascades. This species distinctly gave preference to pools.

Afronurus sp. 4, as also the remaining four species of this genus, was most common in the pools, comprising an average incidence of 16.6% (table 36). Apart from the stony back waters, which was not sampled in the zone of occurrence of Afronurus sp. 4, this species, however, also invaded other habitat types.

From the fore-going it is clear that all four Afronurus species distinctly favoured poollike conditions. These findings somewhat disagree with those of Crass (1947) who found Afronurus to be a specially adapted swift water form, "..... distinctly intolerant of still waters" (p. 41). In fact, its strongly dorsoventually flattened body shape does not appear to be an adaptation to swift current, as was previously suspected, but rather to life under stones and in crevices. This would be in agreement with the findings of Dodds and Hisaw (1924) who, in their studies on the adaptation of mayfly nymphs to swift streams, concludes that the flattened bodies of Ecdyurus and Drunella probably enabled these species to creep into narrow crevices under stones.

Compared with other mayfly genera the nymphs of Afronurus have large eyes. They appear to be sensitive to light intensity which may perhaps in part explain their commonness in pools where much of the effective light penetration decrease with increasing depth of the water. In captivity, nymphs were found to leave the stones at night during the period of ecdysis. All four species are very sensitive to stream disturbance and are amongst the first Ephemeroptera to disappear from the fauna when such conditions arise (part 4, appendix). Their presence in streams can therefore always be taken as as indicative of clean unpolluted waters.

The Oligoneuriidae

Although represented by two genera viz. Oligoneuriopsis and Elassoneuria, the nymphs of the two species O. lawrencei and E. trimeniana not only are morphologically very similar but also occupy the same ecological niches. In both species the nymphs usually "cluster" under stones. In contrast to species such as those of the genus Afronurus, nymphs of both species appeared to be intolerant of stagnant waters. O. lawrencei, for instance, was not recorded from any one of 18 samples collected from pools (table 37). It furthermore occurred in increasingly larger numbers in habitats with increased current speeds (flats - stickles, table 37) which in turn coincided with increases in the percentage sample incidences (% pos., table 37). Elassoneuria trimeniana appear to be slightly less specific in habitat preference, being present in all the habitat types except pools (stony back waters were not sampled). The largest average percentage was recorded from the stony runs and stickles.

The Prosopistosomatidae

Even though their body shape may suggest an adaptation to swift current conditions, the nymphs of Prosopistosoma were most common in slow and moderate current habitat types, i.e. pools, flats and runs (table 37). Prosopistosoma sp. was mainly found in stony flats and runs but also occurred in pools. Nymphs of P. crassi, which are much more dorsoventrally depressed compared with Prosopistosoma sp., were frequent in the slow flowing or stagnant waters of pools (table 37). Both species live under stones.

The Tricorythidae

Neurocaenis discolor as a rule occurs under stones. In the Umgeni river it invaded all stony bottom habitats from

T A B L E 37

Habitat distribution of the Oligoneuriidae and Prosopistosomatidae

HABITATS	S P E C I E S											
	Oligoneuriopsis lawrencei		Elassoneuria trimeniiana		Prosopistosoma sp. nov.		Prosopistosoma crassi					
	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.
BACK WATERS	-	-	-	-	-	-	1	-	-	-	-	-
POOLS	18	-	-	4	-	-	12	0.08	16.7	5	1.64	40.0
FLATS	11	0.03	9.1	16	0.2	25.0	21	0.28	19.1	16	0.03	6.3
RUNS	21	0.17	9.5	17	0.04	11.8	28	0.20	32.1	13	-	-
RUNS AND STICKLES	10	0.19	20.0	21	0.28	19.1	20	0.08	30.0	16	0.18	25.0
STICKLES	15	0.79	26.7	16	0.09	12.5	19	0.04	10.5	16	0.04	12.5
CASCADES	3	-	-	3	0.13	33.3	3	-	-	3	-	-

virtually stagnant waters in pools to the fastest current (table 38). The nymphs preferred the moderate current of the stony flats and runs to the faster current conditions of the stickles and cascades. The smallest individual and average numbers obtained for this species were those from the back waters and pools (table 38).

The Caenidae

At least five species could be recognized from the nymphs alone, some of which definitely appeared to favour slow current conditions. *Caenis* sp. 4, for instance, usually were frequent in stagnant waters and amongst the marginal vegetation. In table 38, the five species are, however, grouped together. Species of Caenis occurred in all habitats with the lowest average percentage incidences in the cascades. If sorted to the species and correlated with adults, some species may certainly prove to be tolerant of the fast current conditions in runs, stickles and cascades.

The Polymitarciidae

This family is represented in the Umgeni river by one species only, namely Ephoron savigni. It occurred amongst small stones or in gravelly types of stream bottom at Midmar and Albert Falls. The nymphs favoured habitats with moderate to fast current conditions (table 38). The largest average percentage incidence was registered from the cascades.

The Ephemerellidae

The recovery of Lithogloea near harrisoni from the Umgeni river system represented the first record of this genus in Natal. Crass (1947) claims that he found an ephemerellid at the Yarrow falls (=Twin falls, fig. 1) on

T A B L E 38

Habitat distribution of the Tricorythidae, Caenidae, Polymitarcyidae and Ephemerelellidae

HABITAT	S P E C I E S											
	Neurocaenis discolor			Caenis spp.			Ephoron savigni			Lithogloea near harrisoni		
	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.
BACK WATERS	2	1.85	50.0	1	1.8	100.0	-	-	-	-	-	-
POOLS	22	1.94	60.0	15	1.2	53.3	1	1.4	100.0	4	1.2	100.0
FLATS	15	5.08	63.6	23	1.4	69.6	11	0.04	18.2	12	0.20	8.3
RUNS	27	5.70	70.4	28	1.1	53.6	7	0.1	14.3	10	-	-
RUNS AND STICKLES	26	4.24	57.7	23	1.3	69.6	7	0.03	14.3	11	-	-
STICKLES	22	4.12	72.7	23	1.2	39.1	9	-	-	10	0.08	10.0
CASCADES	7	2.67	57.1	6	0.2	50.0	3	0.26	33.3	3	-	-

the Yarrow river the description of which (personal communications) fits a similar species collected during the Umgeni river survey at Impolweni on the Sterk river (Schoonbee, unpublished data). A nymph of this particular, or, a closely related species was provisionally placed by De Moulin (1959) in the new genus and species of Machadorythus palanqium. Lithogloea near harrisoni was not very common and apart from its presence in the stony bottom habitats, it was also collected from the trailing marginal vegetation at Table Mountain, and from the aquatic vegetation Hydrostachys natalensis at Morton's Drift. In the stony bottom habitats it mainly occurred in moderate current conditions of the stony flats.

The Leptophlebiidae

Of the five species of the leptophlebiid family found in the main Umgeni river viz. Castanophlebia calida, Aprionyx tricuspidatus, Adenophlebia sylvatica, Adenophlebia auriculata and Euthraulius ? bugandensis, only the nymphs of Castanophlebia calida appeared to favour swift current conditions (table 39). The latter species, however, also occurred in pools where the water was virtually stagnant. A. tricuspidatus was not very common in the Umgeni river and, furthermore, was very much restricted in its habitat preference. Its nymphs were found only in habitats with slow or moderate current speeds such as the stony flats and, in some instances (Emolweni tributary; unpublished data), amongst the marginal vegetation in the slow current. The nymphs of A. sylvatica had their highest average percentage incidences in the flats and pools. Compared with sylvatica, A. auriculata nymphs appeared to be capable of invading more habitat types. Even so, this species, like sylvatica, was more abundant in the pools and flats (table 39). Similarly, Euthraulius ? bugandensis also selected the pools and stony flats, being absent

T A B L E 39

Habitat distribution of the Leptophlebiidae

HABITAT	S P E C I E S											
	Castanophlebia calida		Aprionyx tricuspidatus		Adenophlebia sylvatica		Adenophlebia auriculata		Euthraulus bugandensis			
	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.
BACK WATERS	1	-	-	-	-	-	2	1.40	50.0	2	-	-
POOLS	3	2.23	33.3	3	-	14.2	7	3.67	28.6	15	2.96	60.0
FLATS	2	3.30	100.0	2	2.95	100.0	8	2.80	50.0	11	2.94	45.5
RUNS	-	-	-	-	-	-	8	-	-	11	2.43	36.4
RUNS AND STICKLES	3	3.10	66.7	3	-	-	3	-	-	4	0.90	50.0
STICKLES	4	4.15	50.0	4	-	16.7	6	0.15	16.7	11	0.16	36.4
CASCADES	-	p*	-	3	-	-	3	-	-	3	-	-

p* Present but not recorded from survey sample.

only from the stony back waters and cascades.

The Baetidae

Two species of Acentrella were encountered, namely monticola and natalensis. Both distinctly favoured fast current conditions, having their highest average percentage incidences in the stony stickles (table 40), their average percentage numbers per sample decreasing successively in the slower current habitats. Of interest is the downstream distribution in the Umgeni river of Acentrella natalensis which became progressively more restricted to one particular type of microhabitat where a thin film of water skin rapidly over stone and rock surfaces in the stickles and cascades. This contrasts sharply with the presence of natalensis nymphs in most stony bottom habitats at or near the head water region of the Umgeni river. (This species with its very small and rounded gills appeared to be sensitive to concentrations of dissolved oxygen.)

The two species of Pseudocloeon showed marked differences with respect to habitat preferences. Pseudocloeon inzingae, for instance, favoured the slow current or stagnant waters of the pools and back waters (table 40), whereas P. maculosum largely occurred in the faster current, being, on the average, most common in the stony stickles. The percentage of samples in which it actually occurred, consequently reflects an increase of this species from the slower to the faster current habitats (table 40). Baetis harrisoni was, numerically, the most important mayfly species in the Umgeni river. It invaded most habitats but occurred in larger numbers in moderate to fast current habitats such as the stony flats, runs and stickles (table 40). Baetis glaucus, although not as prominent, numerically, as harrisoni, had a habitat preference

T A B L E 40

Habitat distribution of the Baetidae : the genera Acentrella, Baetis and Pseudocloeon

HABITAT	S P E C I E S											
	Acentrella monticola			Pseudocloeon inzingae			Baetis cataractae			Acentrella natalensis		
	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.
BACK WATERS	1	-	-	1	7.2	100.0	2	-	-	2	0.25	50.0
POOLS	3	1.03	66.7	3	10.37	100.0	7	-	-	14	0.07	14.3
FLATS	2	-	-	1	-	-	7	0.04	14.3	20	1.48	45.0
RUNS	-	-	-	-	-	-	7	-	-	22	1.22	27.3
RUNS AND STICKLES	2	3.55	50.0	2	-	-	2	-	-	17	2.35	58.8
STICKLES	3	9.16	100.0	4	-	-	4	0.25	50.0	21	5.52	66.7
CASCADES	-	-	-	3	-	-	3	-	-	5	2.57	83.3

table 40 continued

HABITAT	S P E C I E S											
	Baetis harrisoni		Baetis glaucus		Pseudocloeon maculosum		Baetid with ventral gills					
	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.
BACK WATERS	2	0.9	100.0	1	-	-	-	-	-	-	-	-
POOLS	15	8.1	73.3	12	0.12	8.3	5	0.06	20.0	4	0.30	25.0
FLATS	22	13.9	90.9	21	1.26	38.1	16	0.17	18.8	12	0.08	8.3
RUNS	28	14.8	85.7	18	1.33	33.3	13	0.09	15.4	10	0.07	10.0
RUNS AND STICKLES	28	12.0	76.0	12	2.48	47.8	16	0.16	31.3	11	0.16	9.1
STICKLES	23	14.0	95.7	11	1.22	42.1	16	0.24	37.5	10	0.12	10.0
CASCADES	5	10.1	100.0	3	0.80	66.2	3	0.20	66.7	3	0.10	33.3

very similar to the latter. The nymphs of B. cataractae, on the other hand, distinctly favoured very swift currents. Where this species was found in moderate current habitats, the nymphs mainly comprised penultimate or final instars. The ventral gill baetid (=Baetidae nymph A, Kimmins, 1955) occurred in all the habitats sampled (back waters were not sampled). Its nymphs were more common in the runs and stickles where they were found to cling to the steep surfaces of rocks and stones. In captivity these nymphs were found to die soon unless a current was created against an object where they usually attached themselves, facing the current.

Species of Centroptilum (table) which are mainly distributed in slow current habitats include Centroptilum near excisum, C. sudafricanum, C. indusii, Centroptilum sp. 2, Centroptilum sp. 3 and C. medium. Of these, C. sudafricanum is the most common species, occurring in all stony bottom habitats, with C. near excisum being restricted to the stony back waters, pools and flats. Centroptilum parvum, which never featured prominently compared with species such as sudafricanum, appeared to be more common in the stony runs and stickles. Centroptiloides bifasciata, Centroptilum varium, C. flavum and Centroptilum sp. 1 distinctly favoured the faster current habitats. Of these, C. bifasciata and Centroptilum sp. 1 are strong clingers, both species occurring mainly on rocks and stones where the current plunged over large boulders in the cascades and stickles respectively. Centroptilum varium, like Baetis cataractae, preferred microhabitats similar to those where Acentrella natalensis occurred, i.e. where thin films of water flowed rapidly over rock surfaces in the stream.

T A B L E 41

Habitat distribution of the Baetidae : the genera Centroptilum and Centroptiloides

HABITAT	SPECIES OF <u>CENTROPTILUM</u> AND <u>CENTROPTILOIDES</u>																	
	<u>C. near excisum</u>		<u>sudafricanum</u>		<u>parvum</u>		<u>Centroptilum sp. 2</u>		<u>indusii</u>		<u>Centroptilum sp. 3</u>							
	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.			
BACK WATERS	1	11.7	100.0	2	40.5	100.0	1	0.90	100.0	2	0.90	50.0	2	-	-	1	-	-
POOLS	3	1.7	66.7	5	9.6	58.3	8	0.50	25.0	15	1.44	40.0	14	0.58	28.6	8	2.51	37.5
FLATS	3	2.4	66.7	20	5.9	55.0	16	0.02	6.3	18	0.12	16.7	22	2.73	22.7	15	0.17	13.3
RUNS	-	-	-	20	3.9	55.0	22	0.87	13.6	25	0.10	20.0	27	0.13	18.5	21	0.28	19.1
RUNS AND STICKLES	3	-	-	16	0.5	18.0	11	0.53	18.2	21	0.07	14.3	22	0.03	4.5	11	0.18	18.2
STICKLES	4	-	-	21	0.8	38.0	12	0.70	25.0	18	<0.01	5.6	22	0.11	9.1	11	0.04	9.1
CASCADES	3	-	-	6	0.1	16.7	3	-	-	6	0.08	16.7	6	-	-	3	0.37	66.7

table 41 continued

HABITAT	SPECIES OF CENTROPTILUM AND CENTROPTILOIDES														
	medium		Centroptiloides bifasciata			varium			flavum			Centroptilum sp. 1			
	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.	N	\bar{x}	% pos.
BACK WATERS	1	-	-	2	-	-	2	-	-	-	-	-	-	-	-
POOLS	12	3.48	41.7	15	0.02	6.7	15	-	-	-	-	4	-	-	-
FLATS	21	0.21	9.5	22	0.06	13.6	13	0.09	15.4	7	-	5	-	-	-
RUNS	28	0.35	10.7	28	0.04	17.9	24	0.02	8.3	4	-	6	0.22	16.7	-
RUNS AND STICKLES	20	0.05	10.0	22	0.15	22.7	22	0.35	27.2	2	<0.01	11	0.63	27.3	-
STICKLES	19	0.44	21.1	23	0.24	26.1	20	0.74	35.0	3	-	7	0.71	28.6	-
CASCADES	3	0.03	33.3	6	0.22	8.3	3	-	-	3	-	-	-	-	-

8.2

The longitudinal (downstream) distribution of the stony bottom Ephemeroptera in the Umgeni river.

For the purpose of illustrating the distribution of the stony bottom Ephemeroptera in the Umgeni river as one proceeds downstream from Ross' Farm (fig. 1), the various species are listed against their respective sampling stations and physical zones. As in the preceding section on the habitat selection of the stony bottom mayflies, species of different families are grouped together in some of the tables. In tables 42 - 47, however, the species were arranged according to their downstream distribution, those confined to the Ross' Farm locality, being placed first, followed successively by other species which predominated in consecutive stretches lower down in the river. In tables 42 - 47, the average percentage incidences (\bar{x}) and the percentage sample occurrence* (% pos.) for each locality are based on all samples from such particular locality.

Certainly one of the most striking features in the downstream distribution of the aquatic fauna in general and of the stony bottom Ephemeroptera in particular, was the existence, in communities, of more than one faunal association, each of which occupied and predominated in a particular stretch of the river. As an example of, and, also, as an introduction to the discussion of the longitudinal distribution of each of the faunal associations, the occurrence, in the river, of the four species of the heptageniid genus Afronurus, are dealt with first.

* Based on the number of positive samples for each species, and the total number of samples taken from each locality.

The Heptageniidae

Most noteworthy of the distribution of the four species of Afronurus, was the fact that even though all of them occupied the same ecological niche, each species predominated over different stretches of the river. Afronurus sp. 1, for instance, was very much restricted to the head water region at Ross' Farm (table 42), being absent at all the other downstream localities. Afronurus sp. 2, on the other hand, although never numerous, had its highest average percentage incidences in the localities of the upper and lower foothill torrent zones, disappearing from the fauna at Albert Falls, where it was collected only during special extensive surveys. Afronurus sp. 3, in contrast to the abovementioned two species, was not only a more important species, numerically, but successfully invaded all the physical zones except the source and valley sand bed zones, having its highest average percentage incidence at localities from Dargle Forestry downstream to Albert Falls. Afronurus sp. 4, was mainly restricted to the rejuvenated river zone.

This difference in longitudinal distribution of the Afronurus species, was of considerable value in the separation of species 2 and 4 which is so closely related, morphologically, that they could easily have been taken for the forma minor and forma major of a single species (c.f. Barnard, 1932). Their predominance in different stretches of the river, however, dispelled all doubts as to the actual differences between the two species. This separation of the two species, on the basis of their ecological distribution was subsequently confirmed by some clear cut morphological differences as well (chapter 9). Of particular interest was the differences, between the species, in the averages of the ratio head width/length which, with the exception of

Longitudinal (downstream) distribution of the Heptageniidae

PHYSICAL ZONES	SAMPLING LOCALITY	N	SPECIES									
			Afronurus sp. 1		Afronurus sp. 2		Afronurus sp. 3		Afronurus sp. 4			
			\bar{x}	% pos.	\bar{x}	% pos.	\bar{x}	% pos.	\bar{x}	% pos.		
Source	Umgeni Sponge	2	-	-	-	-	-	-	-	-	-	-
Upper Foothill Torrent	Ross' Farm	14	1.6	28.6	0.5	28.6	0.15	14.3	-	-	-	-
	Dargle Police Station	2	-	-	-	-	2.55	100.0	-	-	-	-
Lower Foothill Torrent	Dargle Forestry	20	-	-	0.55	15.0	8.18	90.0	-	-	-	-
	Watersmeet	6	-	-	-	-	p*	-	-	-	-	-
	Fern Hill Flats	7	-	-	-	-	0.24	28.6	-	-	-	-
	Midmar	11	-	-	0.54	54.5	4.22	81.8	-	-	-	-
Foothill Sand Bed	Morton's Drift	8	-	-	-	-	6.60	100.0	-	-	-	-
Rejuvenated River	Albert Falls	19	-	-	p*	-	14.95	89.5	0.63	21.1	-	-
	Table Mountain	14	-	-	-	-	3.64	64.3	4.98	35.7	-	-
	Upuma	17	-	-	-	-	0.28	52.9	0.19	17.7	-	-
Valley Sand Bed	Natal Estates Fair View	2	-	-	-	No stony bottoms	-	-	p*	-	-	-

* present but not recorded from survey samples

Afronurus sp. 3, declined in the same successional order as their downstream occurrence in the river. In the nymphs, the decline in this ratio furthermore coincided with a concordant decrease in the average numbers of algal rakers on the maxillae, which in turn, can be correlated with the general downstream increase in algal growths. The head ratio of A. harrisoni from the mountain torrent zone in the Great Berg river is even higher than it is in Afronurus sp. 1 from the upper foothill torrent in the Umgeni river, and this seems to fall in line with the findings put forward above in as much as the algal and diatom growths appeared to be much less in this zone of the Berg river than they are even in the foothill torrent zone of the Umgeni river.

The Oligoneuriidae and Prosopistosomatidae

Although none of the four species under consideration were numerous, the following distributional tendencies were observed:

O. lawrencei occurred over four successive physical zones (table 43), having its highest average percentage incidences as well as percentage sample occurrence in the upper and lower foothill torrent zones. Compared with the distribution of the four species of Afronurus, O. lawrencei, although not recorded from Ross' Farm, roughly agrees with that of Afronurus sp. 2.

Prosopistosoma sp. had a comparatively wide range of distribution, occurring from Ross' Farm downstream up to Upuma. Its average percentage incidence as well as its percent sample occurrence, however, revealed this species to be most common in the foothill sand bed and rejuvenated river zones. Its outstretched longitudinal distribution suggests ecological preferences similar to those of Afronurus sp. 3.

The distribution of E. trimeniana appears to be intermediate between that of Afronurus sp. 3 and sp. 4. It can, however,

Longitudinal (downstream) distribution of the Oligoneuriidae and
Prosopistosomatidae

PHYSICAL ZONES	SAMPLING LOCALITY	N	S P E C I E S										
			Oligoneuriopsis lawrencei		Prosopistosoma sp. nov.		Elassoneuria trimeniana		Prosopistosoma crassi				
			\bar{x}	% pos.	\bar{x}	% pos.	\bar{x}	% pos.	\bar{x}	% pos.			
Source	Umgeni Sponge	2	-	-	-	-	-	-	-	-	-	-	-
Upper Foothill Torrent	Ross' Farm Dargle Police Station	14 2	-	-	p*	-	-	-	-	-	-	-	-
Lower Foothill Torrent	Dargle Forestry	20	-	-	0.11	10.0	-	-	-	-	-	-	-
	Watersmeet	6	0.13	33.3	0.05	16.6	-	-	-	-	-	-	-
	Fern Hill Flats	7	0.47	28.6	0.03	14.2	0.64	14.3	-	-	-	-	-
	Midmar	11	0.72	18.2	-	-	0.12	18.2	0.04	9.1	-	-	-
Foothill Sand Bed	Morton's Drift	8	-	-	0.16	37.5	-	-	0.04	12.5	-	-	
Rejuvenated River	Albert Falls	19	0.01	5.3	0.14	31.6	0.11	21.1	p*	-	-	-	
	Table Mountain	14	0.26	7.1	0.30	28.6	0.01	7.1	0.68	42.9	-	-	
	Upuma	17	-	-	0.21	29.4	0.19	23.5	0.11	5.9	-	-	
Valley Sand Bed	Natal Estates Fair View	2	-	-	-	-	0.15	50.0	-	-	-	-	

* present but not recorded from survey samples

be best compared with the distribution of Afronurus sp. 3 since this species occurred from the lower foothill torrent zone downstream as far as the valley sand bed zone. Unfortunately, its average percentage incidence does not show any marked predominance in any part of the river.

Even though Prosopistosoma crassi had a wider (upstream) distributional range than Afronurus sp. 4, the highest average numbers of crassi occurred in the rejuvenated river zone, thus agreeing well with Afronurus sp. 4.

The Tricorythidae, Caenidae, Polymitarciidae and Ephemerellidae

Numerically, Neurocaenis discolor was one of the most common species of mayflies in the Umgeni river, having, like Afronurus sp. 3, an extended range of longitudinal distribution (table 44). The stretch of the river in which it had its highest average percentage incidence and percentage sample occurrence, also was comparable to that of Afronurus sp. 3.

The specimens of Caenis were not sorted to the species and, consequently, are treated as a group (table 44), which showed two peaks in average incidence, one in the upper foothill torrent and one in the rejuvenated river zone. It is, however, not possible to state at this stage whether individual species were responsible for these peaks.

Lithogloea near harrisoni occurred in small numbers. Its distribution is very similar to that of Afronurus sp. 4, being mainly confined to the rejuvenated river zone.

The Leptophlebiidae

Of the five species of the stony bottom leptophlebiids encountered in the main river, at least two species were very much restricted to the head waters at Ross' Farm (table 45). They are Castanophlebia calida and Aprionyx tricuspoidatus. Both species were, also in the tributaries, found to be

Longitudinal (downstream) distribution of the Tricorythidae, Caenidae, Polymitarcyidae and Ephemerellidae

PHYSICAL ZONES	LOCALITY	N	SPECIES								
			Neurocaenis discolor		Caenis spp.		Ephoron savigni	Lithogloea near harrisoni			
			\bar{x}	% pos.	\bar{x}	% pos.	\bar{x}	% pos.	\bar{x}	% pos.	
Source	Umgeni Sponge	2	-	-	0.35	50.0	-	-	-	-	-
Upper Foothill Torrent	Ross' Farm	14	1.86	50.0	2.19	57.1	-	-	-	-	-
	Dargle Police Station	2	8.05	100.0	2.10	50.0	-	-	-	-	-
Lower Foothill Torrent	Dargle Forestry	20	6.04	80.0	0.96	55.0	-	-	-	-	-
	Watersneet	6	8.10	83.3	0.27	33.3	-	-	-	-	-
	Fern Hill Flats	7	0.24	28.6	0.33	42.9	-	-	-	-	-
	Midmar	11	14.06	100.0	0.53	45.5	0.04	18.2	-	-	-
Foothill Sand Bed	Morton's Drift	8	4.50	87.5	0.26	37.5	-	-	p*	-	-
Rejuvenated River	Albert Falls	19	2.33	78.9	1.13	73.7	0.09	15.8	0.13	5.3	
	Table Mountain	14	1.12	28.6	1.36	42.9	-	-	<0.01	7.1	
	Upuma	17	2.81	41.2	2.34	76.5	-	-	0.05	5.9	
Valley Sand Bed	Natal Estates Fair View	2	3.35	100.0	-	-	-	-	-	-	-
				No stony bottoms							

* present in aquatic vegetation

associated with Afronurus sp. 1 (Schoonbee, unpublished data). A third species Adenophlebia sylvatica, although having a slightly more extended longitudinal range of distribution than Afronurus sp. 1 (table 45), had its largest average percentage incidences at the source and at Ross' Farm and, consequently, can also be included with those Ephemeroptera which were confined to the head of the upper foothill torrent zone. Adenophlebia auriculata had a distribution resembling that of Afronurus sp. 2, being more common at the source but, in contrast to Afronurus sp. 1 and its associated fauna, it extended downstream as far as Midmar. The distributional range of Euthraulus bugandensis, as well as its higher average percentage incidences in localities from the lower foothill torrent, foothill sand bed and upper part of the rejuvenated river zones (table 45), suggest an ecological distribution similar to that of Afronurus sp. 3.

The Baetidae

Four species, which had longitudinal distributions similar to that of Afronurus sp. 1, included Pseudocloeon inzingae, Baetis cataractae, Acentrella monticola and Centroptilum near excisum (tables 46 - 47), all of which were very much restricted in their longitudinal distribution. Mayfly species which predominated in the same stretch of the river as Afronurus sp. 2 included Acentrella natalensis, Centroptilum sudafricanum, C. parvum and Centroptilum sp. 2. All these species numerically declined downstream from the foothill torrent zones. Those baetids which best fitted the distributional pattern of Afronurus sp. 3, included the species C. medium, C. indusii, Centroptilum sp. 3 and Baetis harrisoni. Species which were mainly confined to, or, had their highest average percentage incidences in the rejuvenated river zone were Baetis glaucus, Pseudocloeon maculosum, a baetid with ventral abdominal gills and Centroptilum sp. 1. Centroptiloides bifasciata which never

attained large average percentage incidences anywhere in the river, nevertheless showed increases at localities in the lower foothill torrent and foothill sand bed zones and in this respect, should be placed with the group of mayflies associated with Afronurus sp. 3. Centroptilum varium which occurred in all zones from Ross' Farm, in the upper foothill torrent zone, to the end of the rejuvenated river zone, showed increases in average percentage incidence in that part of the river from Midmar to Natal Estates. In this respect varium appeared to be virtually intermediate in distribution between the Afronurus spp. 3 and 4 associations, sharing the extended longitudinal range of occurrence with the Afronurus sp. 3 association, but, on the other hand showing distinct average numerical increases in the rejuvenated river zone. Since the Afronurus sp. 4 association was restricted and mainly confined to the rejuvenated river zone, varium is provisionally placed with the Afronurus sp. 4 association. Centroptilum flavum was recorded in the main river from Albert Falls only, and is therefore also provisionally grouped with the Afronurus sp. 4 association.

From the findings on the longitudinal (= downstream) distribution of the stony bottom Ephemeroptera in the Umgeni river, the following pattern evolved:

- i. The faunal communities at most sampling localities comprized more than one association of stony bottom Ephemeroptera.
- ii. Each association was confined to, and predominated in, one particular region or stretch of the river. Furthermore, the associations were found to overlap and to replace each other in an orderly sequence downstream, each intergrading with components of other associations which extended either upstream or downstream from those stretches in the river where they predominated.

table 46 continued

PHYSICAL ZONES	SAMPLING LOCALITIES	N	SPECIES									
			Baetis harrisoni		Baetis glaucus		Pseudocloeon maculosum		Baetid with ventral gills			
			\bar{x}	% pos.	\bar{x}	% pos.	\bar{x}	% pos.	\bar{x}	% pos.		
Source	Ungeni Sponge	2	0.7	100.0	-	-	-	-	-	-	-	-
Upper Foothill Torrent	Ross' Farm	14	9.9	100.0	-	-	-	-	-	-	-	-
	Dargle Police Station	2	20.8	100.0	0.05	50.0	-	-	-	-	-	-
Lower Foothill Torrent	Dargle Forestry	20	25.9	95.0	0.09	15.0	-	-	-	-	-	-
	Watersmeet	6	15.4	83.3	-	-	-	-	-	-	-	-
	Fern Hill Flats	7	6.3	100.0	-	-	-	-	-	-	-	-
	Midmar	11	12.0	100.0	1.28	36.4	0.20	36.4	-	-	-	-
Foothill Sand Bed	Morton's Drift	8	13.0	87.5	0.68	37.5	0.38	25.0	-	-	-	-
Rejuvenated River	Albert Falls	19	14.6	84.2	1.26	42.1	0.18	31.6	0.02	5.3	0.02	5.3
	Table Mountain	14	9.4	85.7	2.01	28.6	0.21	21.4	0.17	14.3	0.17	14.3
	Upuma	17	3.1	52.9	3.14	76.5	0.09	29.4	0.21	23.5	0.21	23.5
Valley Sand Bed	Natal Estates Fair View	2	1.5	50.0	9.95	100.0	-	-	-	-	-	-
					No stony bottom							

Longitudinal (downstream) distribution of the Baetidae : the genera Centroptilum
and Centroptiloidea

PHYSICAL ZONES	SAMPLING LOCALITIES	N	SPECIES OF CENTROPTILUM AND CENTROPTILOIDES									
			C. near excisum		sudafricanum		parvum		Centroptilum sp. 2			
			\bar{x}	% pos.	\bar{x}	% pos.	\bar{x}	% pos.	\bar{x}	% pos.		
Source	Umgeni Sponge	2	3.65	100.0	5.05	50.0	-	-	-	-	-	-
Upper Foothill Torrent	Ross' Farm	14	1.50	31.3	4.9	57.1	-	-	1.51	28.6		
	Dargle Police Station	2	-	-	7.8	100.0	11.6	100.0	-	-		
Lower Foothill Torrent	Dargle Forestry	20	-	-	14.3	80.0	0.12	15.0	0.27	35.0		
	Watersmeet	6	-	-	-	-	-	-	-	-		
	Fern Hill Flats	7	-	-	0.5	28.6	-	-	0.19	28.6		
	Midmar	11	-	-	2.9	90.9	p*	-	-	-		
Foothill Sand Bed	Morton's Drift	8	-	-	0.1	12.5	1.59	75.0	0.15	25.0		
Rejuvenated River	Albert Falls	19	-	-	<0.01	10.5	0.02	5.3	0.04	15.8		
	Table Mountain	14	-	-	<0.01	7.1	-	-	<0.01	7.1		
	Upuna	17	-	-	-	-	-	-	0.03	5.9		
Valley Sand Bed	Natal Estates Fair View	2	-	-	-	-	-	-	-	-		

* C. excisum not included

table 47 continued

PHYSICAL ZONES	SAMPLING LOCALITIES	N	SPECIES OF CENTROPTILUM AND CENTROPTILOIDES										
			indusii		Centroptilum sp. 3		medium		Centroptiloides bifasciata				
			\bar{x}	% pos.	\bar{x}	% pos.	\bar{x}	% pos.	\bar{x}	% pos.			
Source	Umgeni Sponge	2	-	-	-	-	-	-	-	-	-	-	
Upper Foothill Torrent	Ross' Farm	14	0.03	6.7	-	-	-	-	-	0.03	14.3	0.03	14.3
	Dargle Police Station	2	-	-	-	-	0.2	50.0	-	0.05	50.0	-	-
Lower Foothill Torrent	Dargle Forestry	20	0.40	30.0	0.79	15.0	1.04	25.0	0.19	30.0	0.13	16.7	
	Watersmeet	6	-	-	-	-	-	-	-	-	-	-	
	Fern Hill Flats	7	0.10	28.6	-	-	-	-	0.06	28.6	-	-	
	Midmar	11	0.55	27.3	-	-	0.89	27.3	0.16	18.2	-	-	
Foothill Sand Bed	Morton's Drift	8	0.1	12.5	0.99	37.5	3.80	37.5	0.44	50.0	-	-	
Rejuvenated River	Albert Falls	19	2.89	10.5	0.44	42.1	0.12	10.5	0.07	26.3	-	-	
	Table Mountain	14	0.25	7.6	-	-	0.03	7.1	0.01	12.5	-	-	
	Upuma	17	0.04	5.9	-	-	0.05	11.8	0.03	5.9	-	-	
Valley Sand Bed	Natal Estates Fair View	2	-	-	-	No story bottom	-	-	-	-	-	-	

table 47 continued

PHYSICAL ZONES	SAMPLING LOCALITIES	N	SPECIES OF CENTROPTILUM AND CENTROPTILOIDES					
			varium		flavum		Centroptilum sp. 1	
			\bar{x}	% pos.	\bar{x}	% pos.	\bar{x}	% pos.
Source	Umgeni Sponge	2	-	-	-	-	-	-
Upper Foothill Torrent	Ross' Farm	14	0.02	7.1	-	-	-	-
	Dargle Police Station	2	0.05	50.0	-	-	-	-
Lower Foothill Torrent	Dargle Forestry	20	0.01	5.0	-	-	-	-
	Watersmeet	6	0.03	16.7	-	-	-	-
	Fern Hill Flats	7	0.06	14.3	-	-	-	-
	Midmar	11	0.11	9.1	-	-	-	-
Foothill Sand Bed	Morton's Drift	8	1.54	37.5	-	-	-	-
Rejuvenated River	Albert Falls	19	-	-	<0.01	5.3	P*	-
	Table Mountain	14	0.12	21.4	-	-	0.36	7.1
	Upuma	17	0.27	23.5	-	-	0.37	11.8
Valley Sand Bed	Natal Estates Fair View	2	1.50	50.0	-	-	0.95	100.0
				No stony bottom				

- iii. Each association, although clearly recognizable from the position it occupied in the river, contained species which extended beyond the range of the association and which could be regarded as being transitional in distribution between two successive associations.
- iv. The different associations were not necessarily confined to particular physical zones, but, in most instances, extended over more than one zone.
- v. The distribution of the associations of stony bottom Ephemeroptera in the Umgeni river can be summarized as follows:

- Afronurus sp. 1 association --- : Restricted to the head of the upper foothill torrent zone at Ross' Farm. Members of this association had their highest average incidences at the source and at Ross' Farm. The association is composed of the following Ephemeroptera: Afronurus sp. 1, Aprionyx tricuspidatus, Castanophlebia calida, Adenophlebia sylvatica, Baetis cataractae, Acen-trella monticola, Centroptilum near excisum.
- Afronurus sp. 2 association --- : Overlapping association 1 at Ross' Farm but with a comparatively more extended distributional range which normally stretched from Ross' Farm to Dargle Forestry. Some species of this association however, tailed off at Albert Falls, at the head of the rejuvenated river. These species can always be recognized as

belonging to association 2 from the circumstance that their highest average and individual incidences occurred in the upper foothill torrent zone. The association comprises Afronurus sp. 2, Adenophlebia auriculata, Centroptilum sulaffricanum, Centroptilum sp. 2, Centroptilum parvum, Acentrella natalensis and Oligoneuriopsis lawrencei.

Afronurus sp. 3 association

: This association, to which Afronurus sp. 3 belongs, was the most widespread of all. It overlapped associations 1 and 2 in the upper foothill torrent zone on one hand and, with association 4, in the rejuvenated river on the other hand. Characteristic of this association is its predominance in the lower foothill torrent, the foothill sand bed and, the head of the rejuvenated river zone at Albert Falls. It includes Afronurus sp. 3, Euthraulius ? bugandensis, Baetis harrisoni, Centroptilum indusii, Centroptilum sp. 3, Centroptilum medium, Centroptiloides bifasciata, Neurocaenis discolor, Prosopistosoma sp. and Elassoneuria trimeniana.

Afronurus sp. 4 association

: This is largely confined to the river in the rejuvenated zone below Albert Falls. Some members of this association penetrated upstream into the foothill soft bottom zone. The highest

average numbers of species of this association occurred between Albert Falls and Upuna. The species comprising it are Afronurus sp. 4, Baetis glaucus, Pseudocloeon maculosum, Centroptilum sp. 1, C. flavum, the baetid with ventral abdominal gills, Protopistosoma crassi and Lithogloea near harrisoni.

Although the above-mentioned associations are defined primarily by reference to the distribution of the stony bottom Ephemeroptera, there are definite indications (chapter 6) that the distribution of the rest of the fauna also fits into this scheme.

9 THE GENUS AFRONURUS LESTAGE (EPHEMEROPTERA) IN
SOUTH AFRICA.

9.1 Historical review.

Eaton (1887), in his "Revisional monograph of recent Ephemeroptera or mayflies", was, to my knowledge, the first person to record the occurrence in Africa of a representative of the genus Afronurus Lestage 1924 when he mentioned that: "The Ecdyurus (sic) type of genera is represented in the Cape Colony. An undescribed ♀ specimen of a species taken by R. Trimen at Paarl and now in the Maclach. Mus., has a superficial likeness to the species of Heptagenia, but differ therefrom in the proportions of its legs" p. 301. In 1913 this author also placed "three fragmentary flies" from British East Africa, N.E. Rhodesia and N. Nigeria respectively, in the group of Ecdyurus but added: "To name such fragments would be foolish and reprehensible" (p. 277).

It was Petersen (1913), however, who furnished the first detailed account of ♀♀ and ♂♂ imagines of the genus Ecdyonurus from South Africa when he described specimens collected by W.E. Jones (October 1911) at Mfongosi, Zululand. He named this species peringueyi and provisionally referred it to the genus Ecdyonurus. He stated: "I have placed this species in the genus Ecdyurus (sic), although with some hesitation. The highly elongated and narrow forewings, the proportion between the lengths of the tarsi and tibiae and the shape of one of the claws, which is curved and plainly pointed, make in some degree the place of the species difficult to determine. The proportion between the length of the tarsal joints is the same as in the genus Ecdyurus; but the pale colour gives the species much likeness to a species of Heptagenia" (p. 187).

When Navás (1915) assigned two damaged subimagines, collected during the "Mission Laplae" at Capiri, Katanga, to E. peringueyi a suspicion was created that Ecdyonurus, or a closely related genus, had its distribution in Southern as well as equatorial Africa. There still was, however, the general feeling amongst authors such as Lestage, that they were dealing with a genus other than Ecdyonurus. In 1918 Lestage strongly expresses his doubts as to whether E. peringueyi really was an Ecdyonurus and quotes Petersen (1913, p. 187) in support of his doubts. He further points out that, according to Eaton (1887), the penis lobes in the true Ecdyonurus are stout, usually broadly trilateral, expanded outwards at the tips but sometimes obovate. According to Lestage, Eaton's description evidently did not fit the drawings of the genitalia of E. peringueyi made by the original author. He further emphasizes the fact that, in addition to the differences in the structures of the genitalia, there were the proportional dimensions of the tibiae and tarsi, which also had to be considered, and which disqualified peringueyi as representing a species of the genus Ecdyonurus. Finally in 1924, Lestage erected the genus Afronurus to accommodate the African representatives of the genus Ecdyonurus. He distinguished between the genera Heptagenia, Ecdyonurus, and Afronurus largely on the basis of the shape of the penis and the proportional lengths of the femurs, tibiae and tarsal joints, stating "..... tant chez les Heptagenia que chez les Ecdyonurus, les longueurs proportionnelles des femurs, des tarsees et des tibias sont conservées, et, à mon avis, il faut en tenir compte, car c'est sur ces points que s'est faite l'évolution des représentants du groupe ecdyonu-

rien" (p. 350).

Crass (1947) added to the heptageniid family another African genus namely Notonurus, with a single species, cooperi, based on one ♂ imago collected by J. Omer-Cooper in the Pirie Forest near KingWilliams-town, Eastern Cape Province, South Africa.

The following species of Afronurus and Notonurus have thus far been recorded from the Ethiopian Region.

AFRONURUS LESTAGE 1924.

- i. Afronurus peringueyi (Petersen).
Ecdyurus peringueyi Petersen, 1913. Ann.
S.A. Mus. 10: 185.
Afronurus ugandanus Kimmins, 1956, Bull. Brit.
Mus.(nat. Hist.) Ent., 4,
2: 5 (Syn nov.).
Afronurus peringueyi (Petersen). Lestage,
1924. Rev. Zool. Afr. 12: 349.
- ii. Afronurus collarti (Navas).
Adenophlebia collarti Navás, 1930. Rev. Zool.
Bot. Afr. 19: 316.
Afronurus pulcher Ulmer, 1930. Ann. Mag.
Nat. Hist. (10), 6: 507.
Afronurus collarti (Navás). De-Moulin, 1956
Bull. Ann. Soc. Roy. Ent.
Belg. 92, I-II: 49.
- iii. Afronurus harrisoni Barnard.
Afronurus harrisoni Barnard, 1932. Trans.
Roy. Soc. S.A. 20, 3: 257.
- iv. Afronurus negi Corbett.
Afronurus negi Corbett, 1960. Proc. Roy.
Ent. Soc. Lond. (B), 29,
5-6: 68.

NOTONURUS GRASS 1947.

- i. Notonurus cooperi Grass.
Notonurus cooperi Grass, 1947. Proc. Roy.
Ent. Soc. Lond. (B), 16,
9-10: 126.
- ii. Notonurus bequaerti (Navás).
Adenophlebia bequaerti Navás, 1930. Rev.
Zool. Bot. Afr. 19: 316.
Adenophlebia eatoni Navás, 1931. Rev. Zool.
Bot. Afr. 20: 271.
Adenophlebia inflexa Navás, 1932. Rev. Zool.
Bot. Afr. 22: 285.
Notonurus bequaerti (Navás). De-Moulin,
1956. Bull. Ann. Soc. Roy.
Ent. Belg. 92, I-II: 45.
- iii. Notonurus tortinervis (Navás).
Adenophlebia tortinervis Navás, 1930. Rev.
Zool. Bot. Afr. 19: 317.
Notonurus tortinervis (Navás). De-Moulin,
1956. Bull. Ann. Soc. Roy.
Ent. Belg. 92, I-II: 48.

9.2 The type materials of Afronurus peringueyi and A. harrisoni.

After the task of correlating the nymphal, sub-imaginal and imaginal stages of the four different species of Afronurus (collected in the Umgeni and other Natal rivers) had been completed, the type materials of the species peringueyi and harrisoni were obtained from the South African Museum, Cape Town, for the

purpose of comparison. These type specimens, having been kept in a dried, pinned condition for more than 30 years, were not in a very good state of preservation. Even so, I did not find it difficult to equate my correlated specimens with those in the South African Museum collection and also to arrive at some definite conclusions.

9.3. The type specimens.

The "type material" of Afronurus peringueyi includes the following specimens:

- i. One ♂ imago. Left forewing, both forelegs and left cercus lost. Two labels attached read as follows:
 - a. Mfongosi, Zulu L. W.E. Jones Oct. 1911 (A small printed label);
 - b. Ecdyurus Peringueyi ♂ Esb. Petersen (This label is handwritten in India ink, presumably by Petersen himself).

- ii. One ♀ imago. Apart from the wings which are in a good state of preservation, the specimen is badly damaged. A small printed label attached contains the following particulars:

Mfongosi, Zulu L. W.E. Jones.

- iii. One ♀ subimago. Wings broken off at tips. Two labels are attached which read:
 - a. Mfongosi, Zulu L. W.E. Jones (A small printed label);
 - b. Ecdyurus peringueyi ♀ Esben-Petersen (Handwritten in India ink by the same person who wrote one label of the above-mentioned ♂ specimen).

In his description of Ephemerae from South Africa, which included the account on peringueyi, Petersen (1913) mentions that there were three males and three females, all imagines, and one female subimago of peringueyi in the collection, "..... all collected at M'fongosi, Zululand, October, 1911, by W.E. Jones" (p. 187). It is also important to note that in his description of peringueyi, Petersen does not mention anything about holotypes etc. Barnard (1932), however, points out that, according to Ulmer (1916), Petersen sent him for comparison ".... die Südafrikanischen Typen seiner Sammlung." Accordingly neither Petersen nor the South African Museum could claim holotypes. From Barnard's redescription of peringueyi (p. 255-257), it does not appear as if any of the original Mfongosi material was in fact retained by the S.A. Museum, neither is it clear whether Petersen returned any of his specimens. (Barnard's notes (p. 256) suggest the presence of a "forma major" ♀ imago and ♀ subimago in the S.A. Museum which could represent part of the Mfongosi October, 1911, material).

The peringueyi material which I received from the S.A. Museum does, however, contain M'fongosi material, with a ♂ imago specimen (see above) bearing the full particulars of the peringueyi type material as given by Petersen (p. 187). If the above-mentioned material forms part of the specimens seen by Petersen and subsequently returned to the S.A. Museum, then there are still 2 ♂♂ and 2 ♀♀ imagines from his original collection which cannot be accounted for. Attempts to locate some of the missing M'fongosi specimens through Mr. D.E. Kimmins of the British

Museum (Nat. Hist.) proved unsuccessful and, in the revaluation of the type material, I had to make use of the peringueyi specimens from the S.A. Museum only. Article 73(c) of the International Code of Zoological Nomenclature (1961) specifies: "If a new nominal species has no holotype, all the specimens of a type series are "syntypes", of equal value in nomenclature." It further states that syntypes may include specimens labelled "cotype", "type", or some other term, or with no identifying label. Syntypes may also include ". . . . specimens not seen by the author but which were the bases of previously published description or figures upon which he founded his taxon in whole or in part." The Mfongosi material, or what is left of it, therefore qualifies as syntypes and will be considered as such in the revaluation of the material (see below).

The "type material" of Afronurus harrisoni Barnard, which consists of one ♂ imago specimen only, is provided with a label which reads: Gr. Drakenstein. Bred. fr. nymph 22/3/31. A.C. Harrison (Handwritten in India ink). During my visit to the S.A. Museum in 1961, I also obtained three alcohol preserved specimens of Afronurus bearing a label which reads: Afronurus harrisoni Brnrd. f. minor Drakenstein. The specimens have lost most of their colour and consist of:

- i. One ♂ imago of which the last few segments of the abdomen and the genitalia are lost (or have been removed).

- ii. One ♀ imago.
- iii. One ♀ subimago.
- iv. Three nymphal pelts.

Although the accompanying label bears no date, the discoloration of the specimens indicate that they must be very old. The nymphal skins as well as the wing pattern of the ♀ subimago showed these specimens to belong to the same species as that of the ♂ imago sent to me as the "type specimen" of harrisoni.

Barnard (1932) likewise does not claim holotypes in his description of harrisoni and, since only one specimen is left of the original type material of harrisoni, this ♂ specimen, provided it does not represent another species confused with harrisoni, should ipso facto become the holotype.

9.4 A revaluation of the type materials of peringueyi and A. harrisoni.

An examination of the respective type materials from the South African Museum and, a comparison of these with my correlated material, lead to the following conclusions:

- i. The Mfongosi material of Afronurus peringueyi at present existing in the South African Museum, Cape Town, contains two different species. This is supported by Petersen's description of peringueyi which clearly indicates that he was dealing with the ♂ specimen of one species and the ♀ specimen of another. In his account of the abdomen of the ♀ imago (p. 187), for instance, he mentions: "1st-6th abdominal segments with black stigmata." Petersen does not mention this feature in his account of the ♂. Since my own experience has shown these "black stigmata" to be highly characteristic of one

species of Afronurus, and to be much more pronounced in ♂ specimens of this species of which Petersen described the ♀, one can only conclude that the Mfongosi material did not include ♂ specimens of the second species. Petersen's drawing (fig. 12, p. 187) of the ♂ genitalia of peringueyi is not good and could represent these organs of either of the two species present in the material. In his figure of the ♂ genitalia of peringueyi, however, the apical excision at the tip of each penis lobe suggest that the specimen from which he drew the genitalia belonged to the "second species" and not to the one represented by the ♀ imago described by him.

- ii. Barnard also confused at least two species in his description of harrisoni. This is testified to, both by Barnard's own remarks (pp. 257-258) and statements made by Harrison (1950). In his description of A. harrisoni, for instance, Barnard points out that two forms occur, which can be distinguished as forma major and forma minor. Harrison (1950), after whom this species is named and who participated in the rearing of the specimens, also wrote (p. 20): "When the investigations were commenced, some twenty years ago, it was thought that there might be more than one species of this family in local rivers This was because so many smaller individuals were present in any locality where the fully ~~fed~~ nymphs were nearly ready for the midsummer "hatch", but Dr. Barnard found only one local species in all the material collected,

and showed that the confusion arose from the fact that it includes major and minor forms." In describing the nymphs, both Barnard and Harrison distinguish two types which they designate as "tawny-yellow" and "partridge mottled" respectively, about which Harrison reports as follows (p. 20): "This further complication gave rise to some expectation that we might be harbouring a real "March Brown" coloured species, as well as something else, but it was not so, and when a large number of subimagoes was obtained by "breeding" from collected nymphs, it was found that "Tawny Yellow" fitted them all, no matter whether the nymphs from which they emerged had been "tawny-yellow", "partridge mottled" or almost self-coloured." In his description of the subimagines Barnard recognises three different variations of wing coloration (p. 256) which all emerged from either the "partridge mottled" or "tawny-yellow" types of nymphs. (Since, in my own experience, the wing patterns of the subimagines are highly diagnostic of the species, the possibility is therefore not excluded that a third species might have been involved in the species confusion. The material in my possession, however, only suggest the presence of two different species). The second of the two species confused, of which not adult museum material exists, can be recognized from Barnard's description of the abdomen of harrisoni, which has laterally, "... a dark comma-shaped mark

on each segment....." (p. 257). This is not present in either the ♂ or ♀♀ imagines or the subimagines represented by the ♂ specimen contained in the harrisoni material and which, from my own experience, breeds from the "partridge mottled" type of nymph. Since the "tawny-yellow" species is, as a rule, the largest of the two species confused, I am furthermore convinced that most, if not all the specimens of the latter, must constitute Barnard's forma major. The tube of specimens which is labelled, presumably by Barnard, forma minor, also lends support to the foregoing conclusion (see above), by reason of the fact that they all belong to the smaller, "partridge mottled" species. Barnard's drawing of the ♀ ventral plate of harrisoni (fig. 45c, p. 256) depicts that of the "tawny-yellow" species. In fig. 46b the shape of the posterior margin of the styliger plate, as well as the comparative size and the shape of the penis, also suggest that Barnard's ♂ forma major belongs to the "tawny-yellow" species.

Although Barnard's drawing of the ♂ genitalia of the "forma minor" or "partridge mottled" species (fig. 46c) differs from that of the actual ♂ specimen in the harrisoni collection (fig. 54B) in that each penis lobe is without a clear cut apical excision, this species can nevertheless be recognized from his drawing by the convex curvature of the posterior margin of the styliger plate opposite the penis. The nymph of harrisoni described and figured by

Barnard (p. 258, fig. 48) belongs to the "partridge mottled", "forma minor" species.

- iii. The ♂ peringueyi specimen of which Barnard drew the genitalia (p. 256, fig. 46a) belongs to the same species as the ♂ specimen described by Petersen (1913) and, of which he probably drew the genitalia (p. 187, fig. 12).
- iv. The nymph assigned to A. peringueyi by Barnard (p. 257, fig. 47) belongs to one of the two species confused in the Mfongosi collection, and is not the nymph of the ♂ imago described as peringueyi by both Petersen and Barnard.
- v. Both Barnard's and Petersen's drawings of the genitalia of peringueyi are misleading, largely perhaps, due to the fact that dried material had to be used in the preparation of drawings.
- vi. The present species confusion necessitates a complete taxonomic revision of the genus Afronurus in South Africa.

9.5 Designation of types for Afronurus peringueyi and A. harrisoni.

Since the ♂ imago specimen in the Mfongosi material of peringueyi is also the only specimen provided with a label bearing the complete particulars of the Mfongosi collection, as mentioned by Petersen, namely, "Mfongosi Zulu L. W.E. Jones Oct. 1911," (p. 187) I designate this specimen as the lectotype of Afronurus peringueyi Peters. My description of the nymphal, subimaginal and imaginal developmental stages

of this species are, however, based upon freshly reared and correlated material.

In the case of Barnard's material of A. harrisoni, the "forma major" species, of which no type material exists, enjoys priority in having been first described and drawn by Barnard. Here a neotype had to be substituted. The neotype and paraneotype material was collected in the proximity of the original type locality in the Western Cape.

9.6 The nymphs of Afronurus Lestage.

9.6.1 General description.

The bodies and legs of Afronurus nymphs are strongly flattened dorsoventrally. This could be interpreted as an adaptation to very swift currents. Barnard (1932, p. 255) and Crass (1947, p. 109), in fact, maintain that these nymphs are well adapted to, and are commonest in swift waters. My own findings, however, appear to contradict this conclusion in so far as that I found Afronurus nymphs to predominate, numerically, in slow currents and, particularly, in pools. To my mind the flattened body of the nymph can be regarded, rather as a very successful adaptation to life under stones and between crevices amongst stones, their usual microhabitat in streams, than as an adaptation to swift currents. (chapter 8). A feature of the Afronurus nymph, which could be a disqualification to life in a fast current, but which would certainly favour life in slow currents or even stagnant waters where low oxygen levels might prevail, is the compara-

tively large gills and the presence of gill filaments (figs. 14 & 17). In fact, their ability to move their gills freely from a position at right angles to the abdomen would also be in line with this conclusion.

9.6.1.1. The head.

Like the body, the head is dorsoventrally depressed, slightly convex dorsally, rounded in front and truncated posteriorly. In some species the headshape is roughly quadrangular whereas, in others, (c.f. barnardi and oliffi) it approaches a triangular shape (fig. 21) as a result of its widening in the clypeo-frontal region. In all five species the epicranium is brownish with some characteristic dark brown markings flanking the coronal sutures mediodorsal to the compound eyes, as well as on the fronto-clypeus, anterior to the lateral ocelli, i.e. mediodorsal of the antennae. The frontal sutures leave the coronal suture almost at right angles and extend sideways in the direction of the lateral ocelli, from where they proceed towards the lateral margins of the head, anterior of the compound eyes, thereby separating the fronto-clypeus from the vertex.

The compound eyes are dark brown or black and are larger in the ♂ specimens, especially in the final instar nymphs. The lateral ocelli are bean-shaped (fig. 13) with the triangular median ocellus situated slightly in front of them.

The antennal sclerites, which usually are unpigmented, are yellowish-white in appearance. The antennal scape is shorter than the darker coloured pedicel.

The ventrally flattened labium is strongly developed with stout, two-segmented labial palps. The basal segment of the palp is rounded at its base and tapers towards the second segment. A small tuft of setae is present on this segment at its junction with the mentum. The distal (second) segment is roughly crescent-shaped and deflected inwards to leave the first segment at an inner angle of $90 - 110^{\circ}$. The tip and outer edge of this segment is strongly chitinized and is provided with dense rows of stiff setae. The distal portion of its dorsal surface is covered with short spinelike bristles and is surrounded along its edge by longer setaceous ones. The glossae are club-shaped and not fused at their bases. Each is densely setose on its inner margin particularly so at its widest portion where the setae first curve inwards and then outwards (fig. 16). Anterolaterally the glossa is devoid of setae but is ornamented with strongly chitinized bands or ridges (fig. 16). The posterolateral edge of the glossa is also setose but the setae are less dense than those along its inner surface. The paraglossa is roughly oval-shaped and approximately twice as wide as long. Long sinuous setae are sparsely distributed along the posterolateral edge of the paraglossa, becoming more stout along its anterior, inner and dorsal surfaces where very dense tufts of bristles occur.

The hypopharynx is poorly chitinized and bears two membranous flaplike structures resembling the paraglossa in shape. These processes are fringed with comparatively soft setae. The hypopharynx itself is a flattened tube, bearing a tuft of short

setae along its anteroventral margin.

The maxilla is securiform. It is widest in the frontoclypeal region of the head, which is slightly concave ventrally and strongly convex dorsolaterally, where it terminates in a membranous saclike structure opposite the point of articulation of segments 1 and 2 of the maxillary palp. The cardo is small, spoon-shaped, deflected medially and attached to the roof of the head. The ventral surface of the distal part of the maxilla is setigerous, particularly so in its anterior region. Apart from a tuft of soft sinuous setae at the base of the maxillary palp, the lateral edge of the maxilla is devoid of setae. On the inner margin of the widened portion of the maxilla, on the other hand, at least three different types of setae can be distinguished viz. stout spine-like setae which may or may not be setose and which are confined to the anterior part of the galea, long thick setae which are sparsely distributed along this edge and largely concentrated on the posterior half of this portion of the maxilla, and a dense row of stiff bristles of equal length, usually spread over the entire length of this part of the maxilla. The anterior margin of the maxilla bears a row of heavily chitinized combs. The maxillary palp consists of four segments, the basal one of which is fused instead of being jointed to the galea. The second segment is the thickest, It is longer than the first but shorter than the third, and is setigerous, especially in its proximal half. The third segment is the longest. Along its outer edge it bears a row of

setae which curve mediodorsad towards the distal end of the segment. A tuft of densely packed stiff setae projects forwards from the end of this segment to the tip of the short and pointed last segment.

Like the maxillae, each mandible has a narrow stem-like base with a flattened distal portion. The lateral edge of its wider half is fringed with a dense row of fine setose setae. On its inner surface there is a heavily chitinized molar surface, which is convex on the left and concave in the right mandible respectively. The left and right mandibles are not symmetrical. Each mandible terminates in two strongly developed spines (canines), the inner one (prosthema) of which is moveable. The prosthema of the right mandible terminates in several sharp spine-like teeth, whereas that of the left mandible is stout and bears three terminal teeth, the central one of which is the smallest. Situated at the base of the prosthema are a few stiff setose bristles. The dorsal surface of each mandible is convex and smooth except for a sclerotized protuberance situated posteriorly and slightly medially to the molar surface.

The labrum is situated immediately behind the margin of the frontoclypeus. It is roughly triangular and covered with setae which protrude from underneath the frontoclypeus so as to be visible from above.

9.6.1.2 The thorax.

The thorax is shorter than the abdomen and bears two pairs of wings. The nota are more sclerotized

than the terga. The thoracic coloration and colour patterns are species specific. The pronotum is short and as wide as but not wider than the head. It is much wider than either the meso- or metathorax, is expanded sideways with flattened and rounded lateral edges, and demarcated from the mesonotum by a deep suture. The mesonotum is longer than the other two thoracic segments and covers the metanotum, especially in older nymphs with well developed wing pads. The metanotum is slightly pointed postero-mediadorsally.

The coxae are shorter than the trochanters. The femora are robust, dorsoventrally flattened, smooth ventrally, with spines on their anterior surfaces (figs. 18 A - C). The spines along their anterior and posterior margins are usually more strongly developed than elsewhere. The posterior margins also bear a row of long setae each (fig. 13). Each femur terminates in a small darker coloured lobe (fig. 13) which becomes progressively longer and pointed in the successive legs. The tibiae are slender and angular in cross section, and are provided with rows of fine setae and a few spines. The tibiae of the first legs are sparsely setose, those of the second and third legs being strongly setose and more spinulose. The tarsi are much shorter than the tibiae, but, like the latter, they bear more spines and are more setose in the second and third legs. The claws are prominent and dentate.

9.6.1.3 The abdomen.

The abdomen is ten-segmented, tapering slightly

towards the last segment which bears three terminal filaments viz. two lateral cerci and a median paracercus (figs. 13 & 14). The tergites are slightly or strongly spinulose along their posterior borders (figs. 21 and 13). The abdominal colouration and colour patterns, are, especially those of segment five (figs. 14 and 53), highly diagnostic of the species. Seven pairs of gills are borne on the posterolateral margins of tergites 1 - 7 (figs. 14 & 17). Gills 1-6 always consist of an outer lamellate and an inner filamentous portion. The seventh gill may or may not possess branchial filaments which if present, are reduced to a comparatively small tuft.

9.6.2

Key to the nymphs.

1. Head distinctly widest at level of, or anterior to the antennal scapes; seventh pair of gills always without branchial filaments 2
- Head widest posterior of antennal scapes; seventh pair of gills with or without branchial filaments 3
2. Body colour tawny-yellow; spines on anterior (=dorsal) surfaces of first, second and third femora pointed, lanceolate (figs. 20A - C); largely confined to Western Cape province.....
..... harrisoni Barnard.
- Body colour brownish; spines on anterior surfaces of first and second femora mainly obcordate (figs. 24A -B), with those on third

femur being mainly cuneate, others oblong with rounded tips (fig. 24 C); dorsal half of outer gill lamellae usually pigmented dark brown (fig. 26) oliffi sp.nov.

3. Seventh pair of gills without branchial filaments 4

Seventh pair of gills with branchial filaments (fig. 17); spines on first femur obcordate (fig. 18A), on proximal 5th of second femur oblong with rounded tips (fig. 18B) but lanceolate on rest of femur, and pointed, lanceolate on third femur (fig.18C); abdominal tergites 4-8, each clearly acuminate ventrolaterally, with spines becoming progressively stronger towards segment eight (fig.13); abdominal pattern as in figures 13 & 14
..... scotti sp. nov.

4. Dorsally, near the anterior margin of abdominal segment five, the lighter coloured U-shaped pattern terminates anteriorly in two convex "legs" with a posteriorly rounded or truncated brown coloured pattern enclosed between them (figs.27 & 28) barnardi sp. nov.

Lighter coloured V-shaped pattern on segment five of abdomen terminating anteriorly in sharp points with a posteriorly tapering brownish colouration enclosed between them (figs. 35B and 36) peringeuyi Petersen.

9.6.3 Description of nymphs.

9.6.3.1. Afronurus scotti sp. nov.

The colour of the live nymphal specimens is predominantly brownish with characteristic yellowish markings upon the head, thorax, femora and abdomen. The intensity of this lighter coloured pattern varies with the various seasons, with the markings on the thorax, although remaining diagnostic, being more subject to variation during nymphal development than those on the tergites of the abdomen.

HEAD

Head usually less than 1.5 times as wide as long. It is slightly rounded anteriorly, rounded anterolaterally and weakly rounded laterally in younger nymphs (fig. 15 E) but progressively approaches rectilinearity in the older nymphal stages. The posterior margin of the head is slightly concave (figs. 13 and 14). The second segment of the maxillary palp is strongly setose along the proximal two thirds of its inner, outer and dorsal surfaces (fig. 15 A). These setose setae are generally much longer than those of the third palpal segment.

The outer⁺ canine of the right mandible is more strongly developed than the prostheca (= inner canine) and is provided with three teeth of which the central one is the stoutest. The prostheca bears three thin, pointed teeth. The outer canine of the left mandible is serrate along its inner surface. The prostheca is more stout and provided

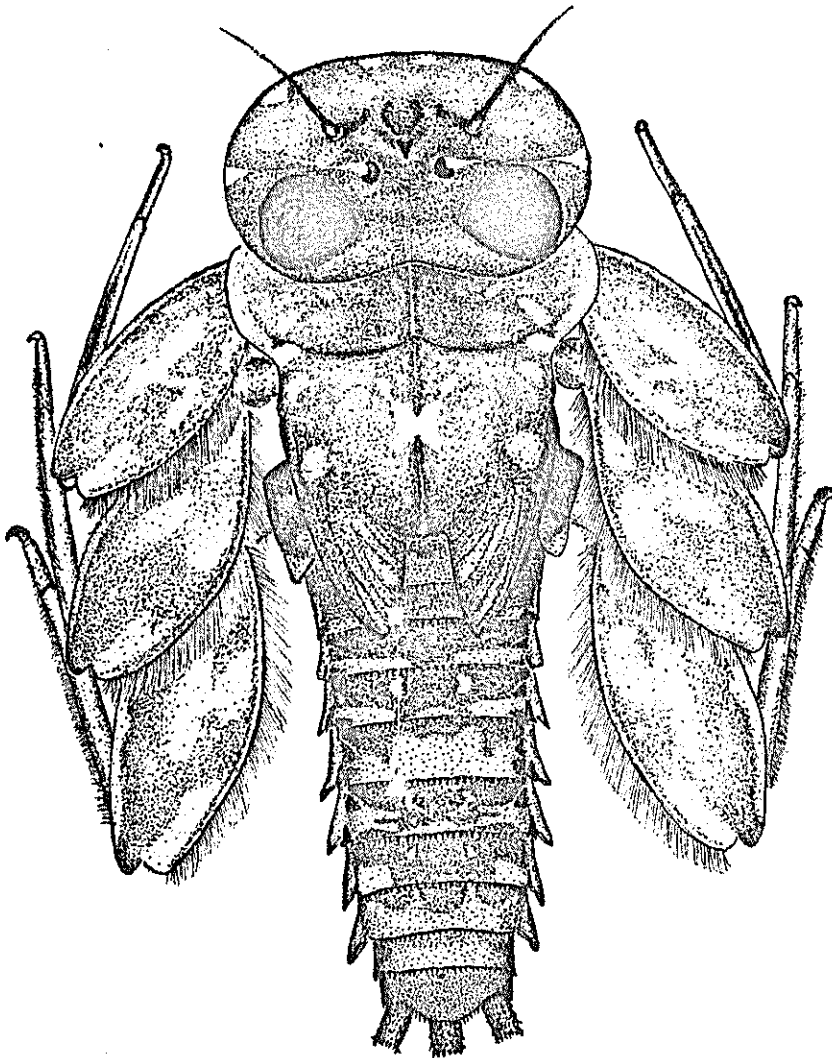


Fig. 13. Afromurus scotti sp. nov. Young nymph
(gills omitted).

Fig. 14.. Afronurus scotti sp. nov. Fully grown nymph. Although the thoracic pattern is more subject to variation than that of the abdomen, during nymphal growth and development, it nevertheless remains diagnostic of the species.

with three teeth similar to those on the outer canine of the right mandible, but the central tooth is here subequal to, but more than half the length of the lateral and terminal teeth.

THORAX

The pronotum is short, as wide as, or slightly narrower than the head but wider than both the meso- and metanota. It is expanded laterally into rounded, flattened lobes (figs. 13 & 14), separated from the mesonotum by a deep suture. The metanotum is covered by the wing sheaths of the mesonotum. The yellowish pattern on the pro- and mesonotum varies during nymphal development but the most common patterns of the young and older nymphs are illustrated in figures 13 and 14 respectively.

Legs

The legs are stout. The first, second and third femora are strongly flattened and their anterior surfaces face upwards, thus occupying a dorsal position, when placed against the body of the nymph. The posterior margins of these structures are fringed with fine setous setae. The tibiae are setulose with few spines. The tarsi are sparsely setose with comparatively fewer spines than the tibiae.

First leg:

The respective shapes of the spines on the first femur are mainly obcordate (fig. 18A). However those along its ventral margin clearly become lan-

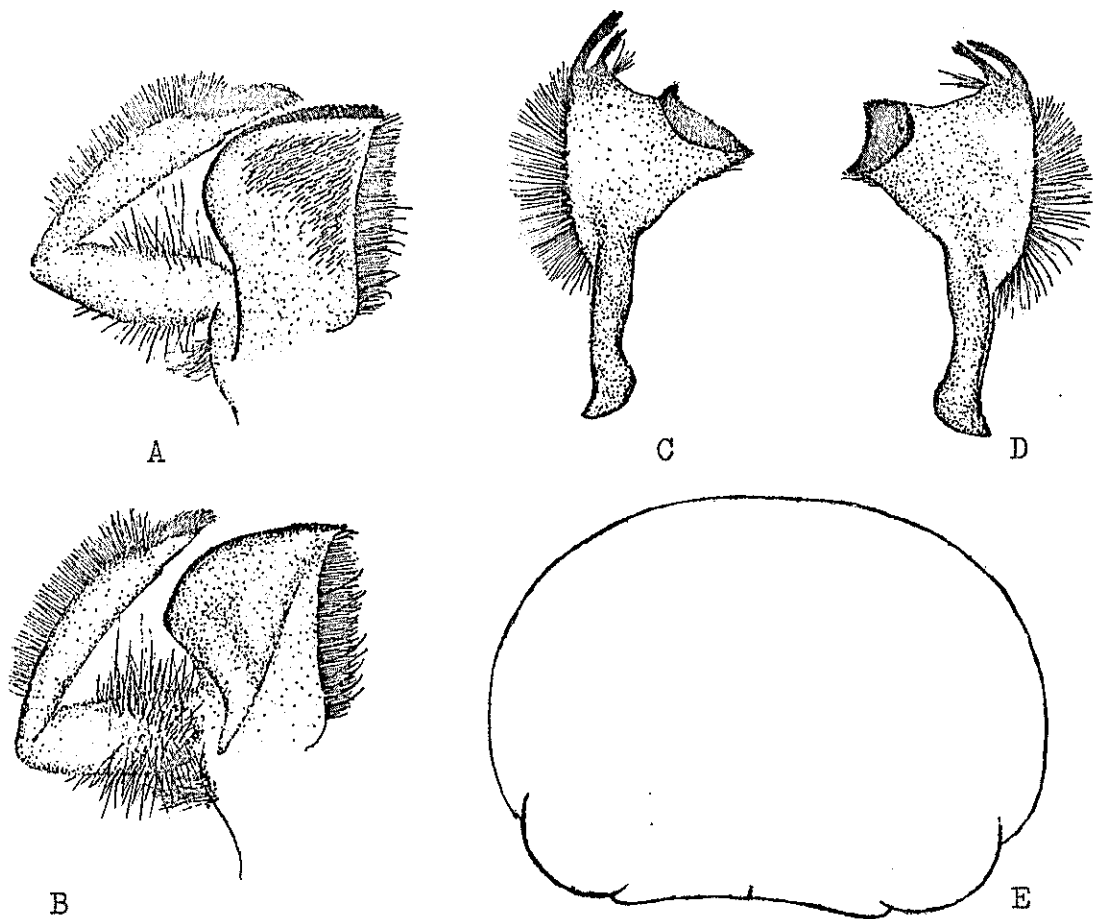


Fig. 15. Afronurus scotti sp. nov. Outline of head and mouth parts of nymph. A and B - ventral and dorsal aspects of right and left maxillae respectively. C and D - ventral aspects of right and left mandibles respectively. E - outline of head (dorsal view).

ceolate, are ^{more} ~~stronger~~ ^{ly} developed and longer than the rest of the spines. A row of fine sinuous setae occurs along the anterior ridge of the tibia, together with a few dark brown spines (usually 7-11 in number), which are spread over the entire length of the tibia. A second, much shorter, row of setae occurs along the posteroventral edge of the tibia, near its point of attachment to the femur. In addition to these a few scattered setae are found on the rest of the first tibia. The anterior row of setae and spines are continued on the tarsus which, likewise, bear a few scattered setae elsewhere. The claw is stout and curved, with a row of 5-6 (usually 5) denticles near its tip.

Second leg:

In contrast to the first leg, the anterior surface of the trochanter of the second leg bears several spines. The femur resembles that of the first leg with the following differences: It bears two types of spines viz. a few with rounded tips (fig. 18B), in small numbers near its point of attachment to the trochanter, and a number of pointed, lanceolate ones elsewhere. The largest of the latter occur along the dorsal and ventral edges of the anterior surface of the femur. The posteroventral row of setae of the second tibia is much longer than those on the fore legs, spread over more than two-thirds of the length of the tibia. For the rest, the density of the setae and the number of the spines of the second tibia and tarsus are very similar to those of the first leg. Like the latter the claw bears five apical denticles on its inner surface.

Third leg:

The anterior surface of the trochanter bears spines. Those on this femur are lanceolate and slightly more stout than those on first and second femora (fig. 18 C). The setae on the tibia are more strongly developed than those of either the first or second tibia. Spines also occur along the front edge of the anterior surface of the tibia. Short spines are also borne along the ventral surface of the hind tarsus. The number and shape of the denticles on the claw are the same as those of the second leg.

ABDOMEN

The ^aAbdominal segments gradually taper towards the tenth (fig. 14). The tergites are spinulose along their posterior margins. Very characteristic of this species are the pointed, posterior ventrolateral edges of tergites 3-8 (fig. 13), which become progressively longer towards segment eight. As in the case of the abdominal pattern of the nymphs of all the other species, the pattern shows the least variation, and constitutes one of the most reliable distinctive features of this species.

From a detailed study of the variations of the abdominal pattern an "average" pattern was compiled (fig. 13) from which it should be possible for anyone to recognize this species from any of the nymphal stages, excluding perhaps the very first few nymphal instars.

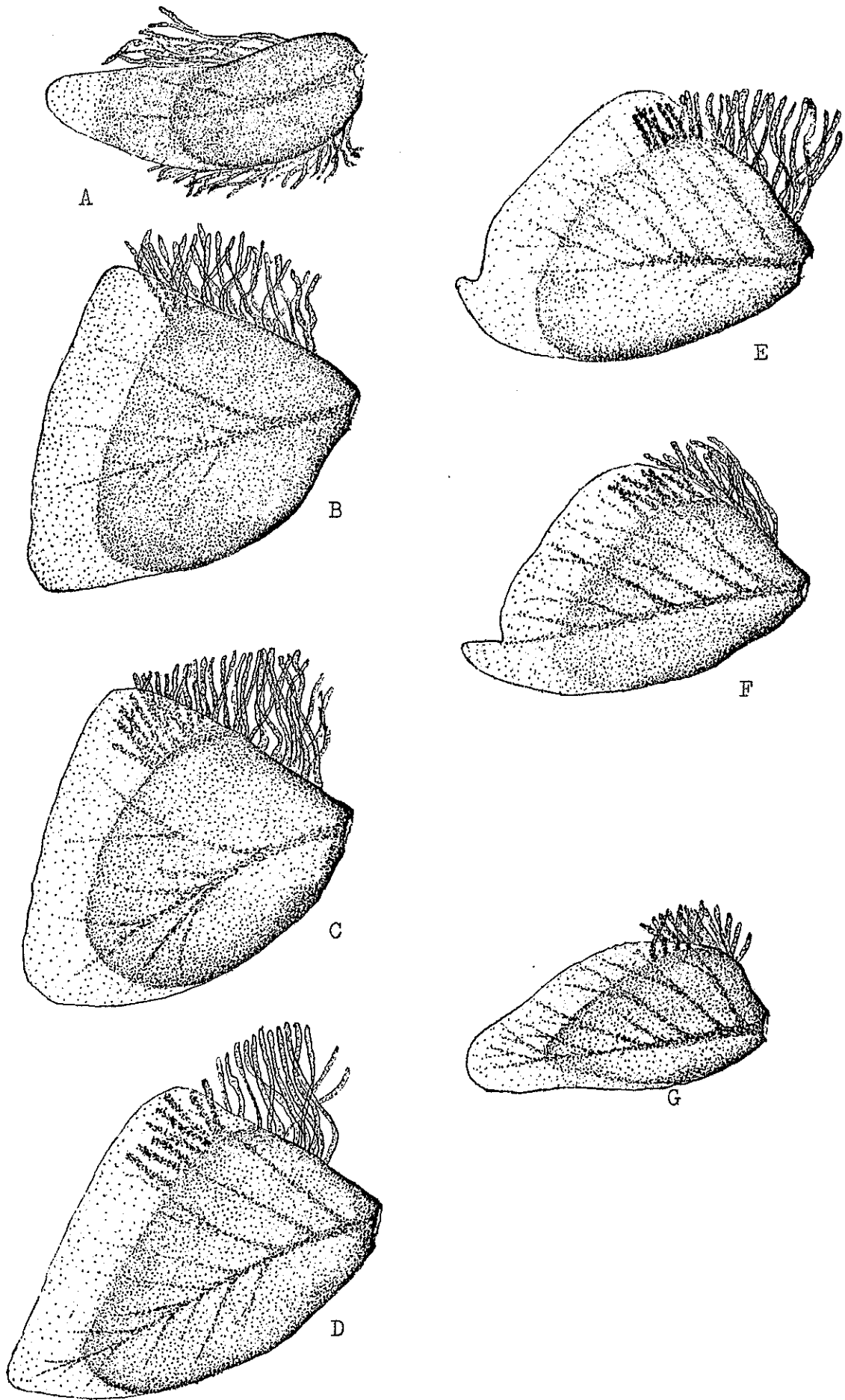


Fig. 17. *Afronurus scotti* sp. nov. Tracheal gills of nymph. A - G - gills 1 - 7 respectively.

Gills

All the gills bear branchial filaments on their inner edges, with the filaments of the seventh gill being minute. With the exception of the first gill lamella, which is banana-shaped (fig. 17A), and the last which is roughly pear-shaped (fig. 17G), the 2nd-6th gills are roughly triangular (fig. 17B - F). The fifth and sixth gills, however, differ slightly from the 2nd-4th in the possession of a small terminal lobe (fig. 17E-F).

Terminal filaments

The segments of the cerci and paracercus are spinulose around their posterior margins. The paracercus is thinner and usually lighter in colour than the two cerci. All the segments of the terminal filaments are short and thick near the abdomen, each segment becoming gradually longer and thinner towards the tips of the filaments.

9.6.3.2

Afronurus harrisoni Barnard

In contrast to the subimaginal and imaginal stages of the species harrisoni and scotti, which clearly resemble each other in body markings and the colourations of their wings respectively, the various developmental stages of the nymphs of the former show marked differences ^{compared} with those of the latter. Some of the most striking features of harrisoni are their "tawny-yellow" colouration

(Barnard, 1932; Harrison, 1950), and the possession of a comparatively wide fronto-clypeus which gives the head a triangular appearance. Barnard (1932, p. 258) describes the nymphs of harrisoni as tawny-yellow, "with predominating yellowish ground colour and broad reddish brown markings on head, thorax, abdomen, and legs" Apart from the presence of clear cut morphological discrepancies, the above-mentioned two species also differ with regard to their respective ecological distributions in South African rivers.

HEAD

The head is usually more than 1.5 times wider than it is long, and is of a dirty yellow colour. Some markings on the dorsal surface of the head are brownish, resembling those of scotti. The antennae are yellowish brown. The anterior margin of the head is almost straight, being only very weakly rounded. The head is widest in the fronto-clypeal region with its maximum width at the level of, or, immediately anterior to the antennal sclerite. The posterolateral sides of the head converge sharply towards the dark reddish brown compound eyes, giving the head a triangular appearance. The posterior margin of the head is slightly concave. The second segment of the maxillary palp lacks setae on its dorsal surface in contrast to that of scotti (fig. 15B) which is profusely setulose. The number of chitinized combs borne along the anterior margin of the maxilla exceeds 22 (usually

24 - 26 in number) compared with the 19 - 22 combs in scotti. The ratio of the third and fourth palpal segments usually exceeds 4.00. The structure of the mandibles ~~are~~ ^{is} similar to those of scotti.

THORAX

The pronotum is narrower than the head and is wider than both the meso- and metanota, with the lateral lobes rounded as in scotti. The thoracic pattern is indistinct, largely due to the yellow colouration of the body. Consequently, these markings cannot be utilized profitably in further defining this species.

Legs

The legs are predominantly yellow in colour with brown colourations towards the tips of the femora and tarsi. The single row of long stout setae which occur along the dorsal edges of the femora are, like those of scotti, setose along their posterior margins.

First leg:

The trochanter lacks spines on its anterior surface. With the exception of a few spines with rounded tips, which occur mediodorsally on the distal half of the first femur, all the spines are pointed as illustrated in figure 20A. The spines along the dorsal edge of the femur are the most strongly developed, especially towards the distal half of the femur where they are comparatively longer and more erect than in any other part of the femur. The

setae and spines on tibia I and tarsus I are similar to those of scotti, with the claw also bearing five denticles near its tip.

Second leg:

The trochanter bears spines on its anterior surface. The spines on the femur are similar to those on the first leg (fig. 20B) of which only a few have rounded tips. The tibia, tarsus and claw resemble those of scotti.

Third leg:

The trochanter bears spines on its anterior surface. The spines on femur are as illustrated in figure 20 C . The tibia, tarsus and claw agree with those of scotti.

ABDOMEN

The abdomen is dirty yellow with little or no indication of an abdominal pattern. The segments of the abdomen taper gradually towards the tenth with the terga spinulose along their posterior margins. The only clear cut resemblance between the abdominal segments of scotti and harrisoni, is the pointed, outwardly directed, posterior ventro-lateral edges of tergites 3-8 (c.f. fig.13).

Gills

The shapes and sizes of the respective gills resemble those of scotti except that the seventh pair of gills are without an inner tuft of branchial filaments.

Terminal filaments

The colour of the cerci and paracercus is predominantly yellow. Otherwise, they resemble those of scotti.

9.6.3.3

Afronurus oliffi sp. nov.

The nymphs are brown with a yellowish ground colour. The intensity of the yellowish pattern of the abdomen and the thorax of these nymphs tends to fade out during certain seasons of the year, being at times completely absent in all the different nymphal developmental stages. It was, therefore, not always possible to use these patterns in the identification of the species. One characteristic, not present in any of the other species and which remain recognisable throughout the year in all developmental stages of the nymphs is the presence of dark brown, almost black, markings on their abdominal tergites (figs. 18 and 25). The spines on the femora are very characteristic of the species.

The nymphs of this species share with harrisoni the possession of a very wide fronto-clypeus which gives the head a triangular appearance (fig. 21).

HEAD

The head is brown and the markings between the antennae and ocelli are well defined (fig. 21). The head is normally more than 1.5 times as wide as

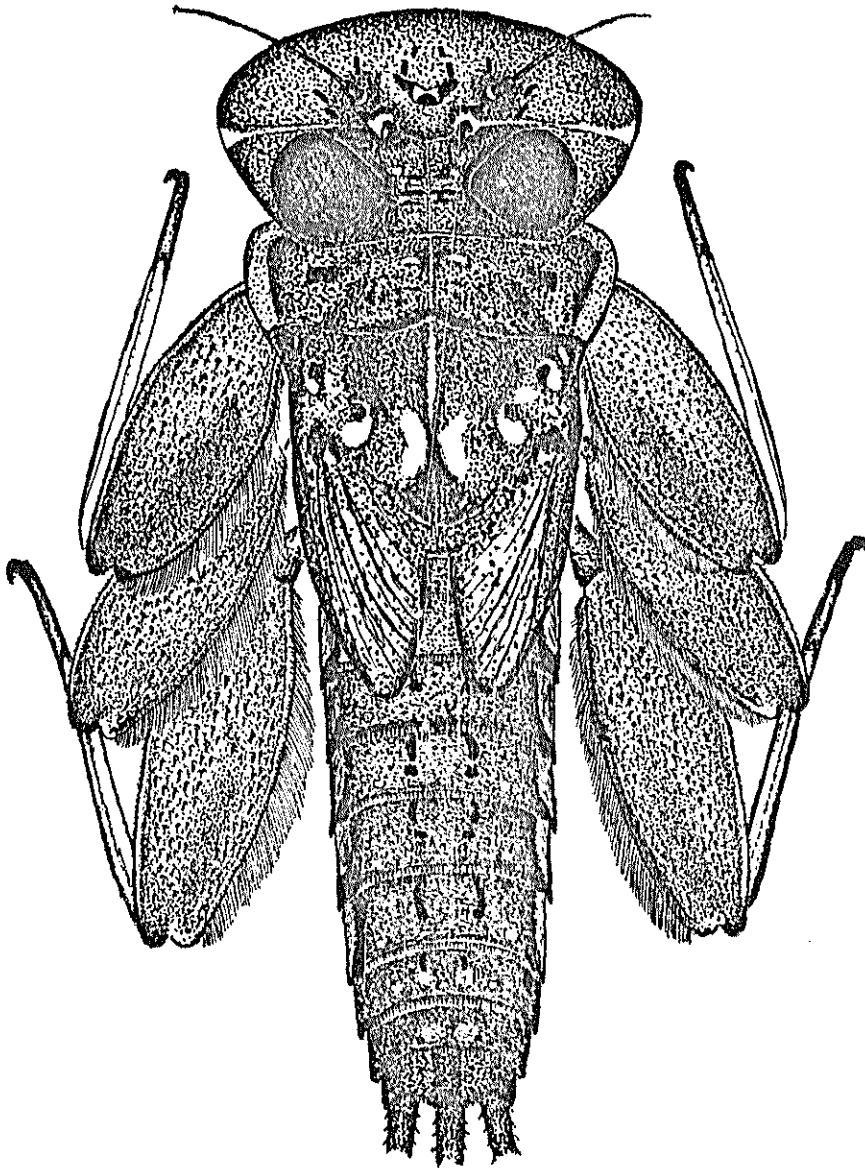


Fig. 21. Afronurus oliffi sp. nov. Nymph (gills omitted).

it is long, being widest at the level of or slightly anterior to the antennal sclerites. The compound eyes are dark brown. A very close resemblance exists between the maxillae of oliffi and those of harrisoni with respect to the shapes, ratios and sizes of the palpal segments, the comparative widths of the galeae and the number of combs of the galeae, which, in the case of oliffi, also exceeds 22 (there are usually 24-26 combs). The maxilla of oliffi can be characterized as follows: The posterior (i.e. outer) edge of the second segment of the maxillary palp is sparsely setose, the setae being much shorter than those which occur along the outer edge of the third palpal segment (fig. 22A-B). A small cluster of comparatively longer setae occur proximally on the anterodorsal and anterior (i.e. inner) surface of the second palpal segment (figs. 22 A - B). Otherwise, the dorsal and ventral surfaces of the latter segment are devoid of setae. The central tooth of the prostheca of the left mandible is minute, being less than half the length of the other two terminal teeth. The denticles along the ventral edge of left prostheca are produced into spines. Such spines are completely absent in scotti, and are limited to a few along the distal half of this prostheca in harrisoni.

THORAX

The pronotum is narrower than the head and its lateral lobes are less rounded than in the other species (fig. 21). The sides of the lobes are

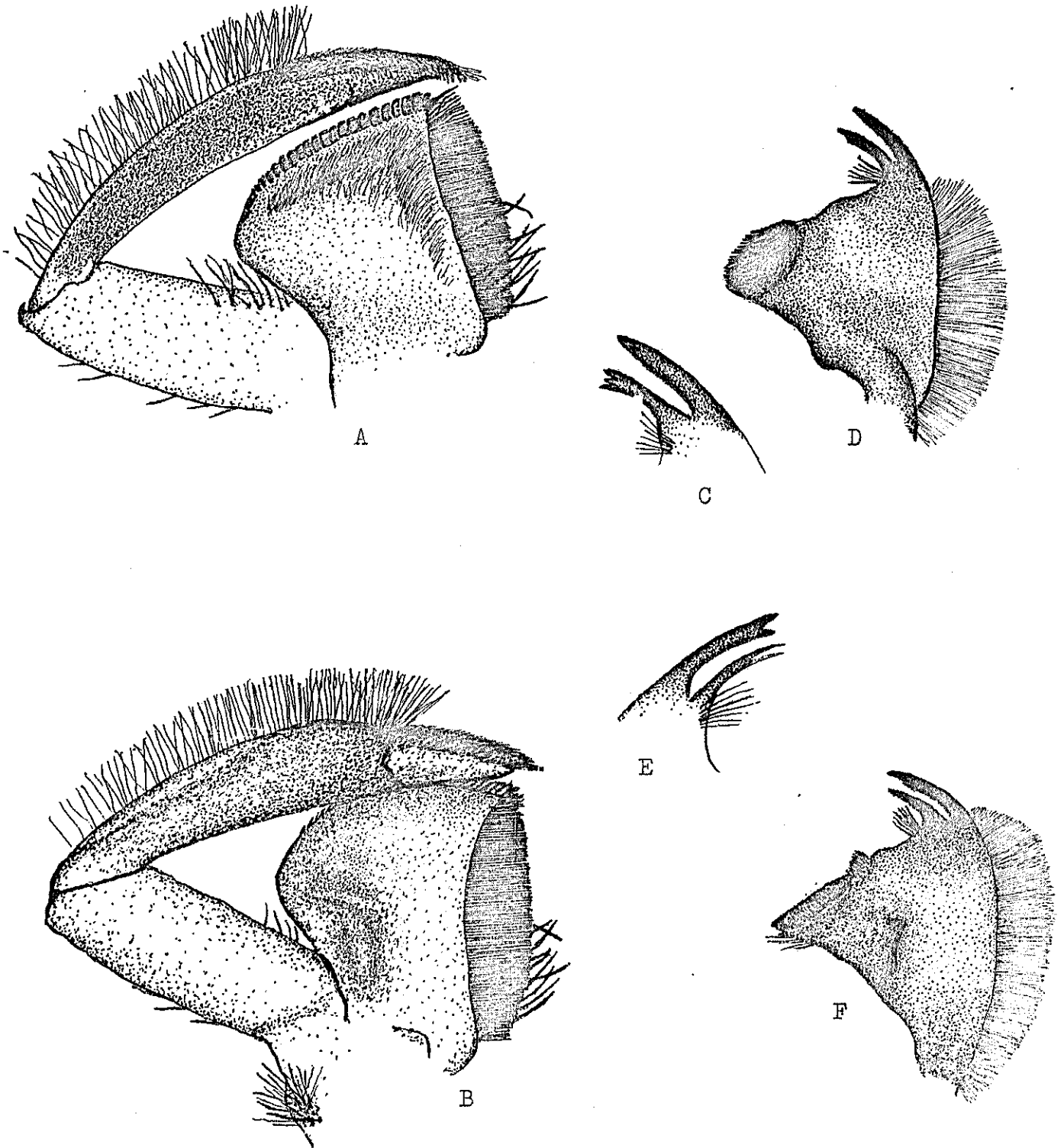


Fig. 22. Afronurus oliffi sp. nov. Mouth parts of nymph. A and B - ventral and dorsal aspects of right and left maxillae respectively. C and D and E and F - left and right mandibles respectively.

weakly curved (almost straight), slightly wider in front, and curve strongly inwards anteriorly. The intensity of the markings on the thorax are very variable, but when distinguishable they somewhat resemble those of scotti. The thoracic markings, typical of oliffi, are illustrated in fig. .

Legs

The legs are brownish with pale yellowish markings, the intensity of which, like those of the thorax and abdomen, varies with the seasons.

First leg:

The spines on the trochanter are sparse and mainly pointed. Those on the femur are widest terminally and ^{are} predominantly obcordate along the posterior edge and surface (fig. 24 A). Some spines on the anterior half and edge of the femur have rounded tips but these are comparatively few in numbers. The tibia is pale yellowish brown with setae and spines similar to those of the other species. Both the tarsus and its claw are dark brown and the latter is provided with four well developed denticles near its tip.

Second leg:

The spines on the trochanter have rounded tips and tend to be lanceolate. Most spines on this femur are obcordate (fig. 24 B) with those along the distal anterior edge successively becoming linear, pointed and lanceolate. In density the setae and spines on the tibia and tarsus resemble those of the other species. The tibia is yellowish brown

and the tarsus dark brown. The claw bears four denticles, the posterior one of which is less strongly developed than the other three.

Third leg:

The spines on the trochanter are lanceolate, whereas those on the femur are mainly linear and digitate with almost flattened tips (fig. 24C). As in the case of the other femora, those spines along the distal half of the anterior edge of the third femur deviate most from the general shapes of the rest of the spines. They are here developed best and are clearly lanceolate. The tibia is yellowish brown and the tarsus dark brown. The spines on the tibia and tarsus are similar to those in the other species. The claw bears four denticles which are, however, less prominent than in either the first or second femur.

ABDOMEN

The abdomen is stout and gradually tapers towards the tenth segment. It is brownish with a pale yellow pattern, which, however, may be absent. The abdominal tergites are spinulose along their posterior margins. The ventrolateral posterior margins of the terga are weakly spinulose but the spines do not project away from the abdomen as they do in harrisoni. Dark brown markings occur on either side of the mid-dorsal line of each abdominal tergite and are characteristic of this species (figs. 21 and 25).

Fig. 25. Nymphal skin of Afronurus oliffi sp.
nov. Note dark brown markings in
the form of curved streaks along mid
dorsal line of abdomen.

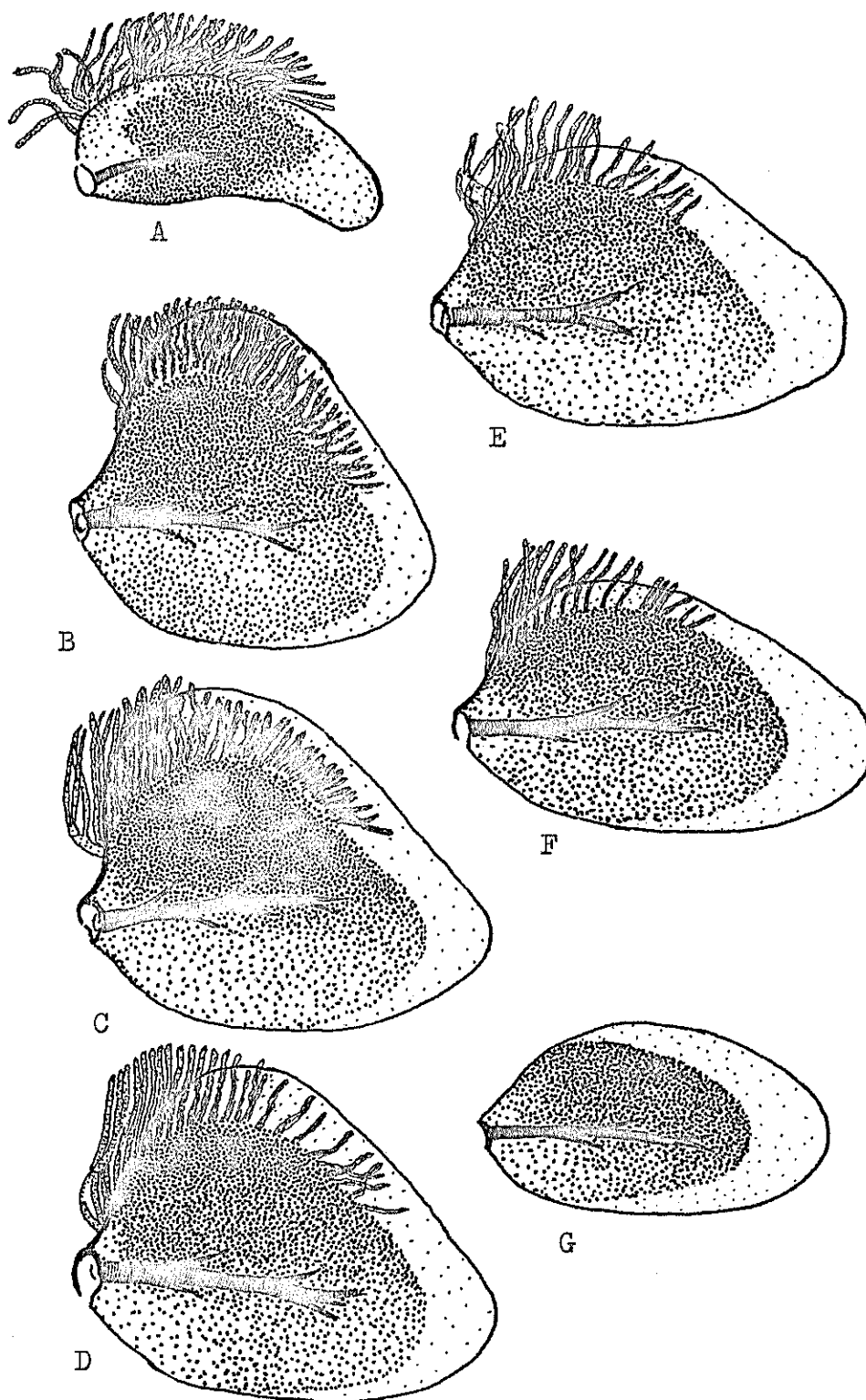


Fig. 26. Afronurus oliffi sp. nov. Tracheal gills of nymphs A - G - gills 1 - 7 respectively. Note intensity of pigmentation in upper portions of each gill lamella.

Gills

The branchial filaments are borne on all gills except the seventh. The tracheation of the outer gill lamellae is partly obscured by a purplish brown pigmentation which cover the dorsal halves of the gills (fig. 26). The shapes of the different gills are given in figure 26

Terminal filaments

The cerci and paracercus are yellowish brown near their bases, with the segments becoming dark brown distally. The structure of the terminal filaments resembles that of other species of Afronurus.

9.6.3.4 Afronurus barnardi sp. nov.

This species is very common in Natal, the Transvaal, and the Eastern and Western Cape Province. The specimens from these regions all display definite regional characteristics, largely in respect of their body patterns, without, however, affecting the diagnostic value of this feature. Since a proper study of this geographic variation could be done only with regard to the nymphs, the erection of subspecies on this evidence alone seems to be premature. In respect of the body pattern and the ratio head width/length, the Western Cape specimens appear to have deviated most from the general characteristics of this species (table 48).

The nymphs are grey brown with a yellowish ground colour. In live specimens canary yellow

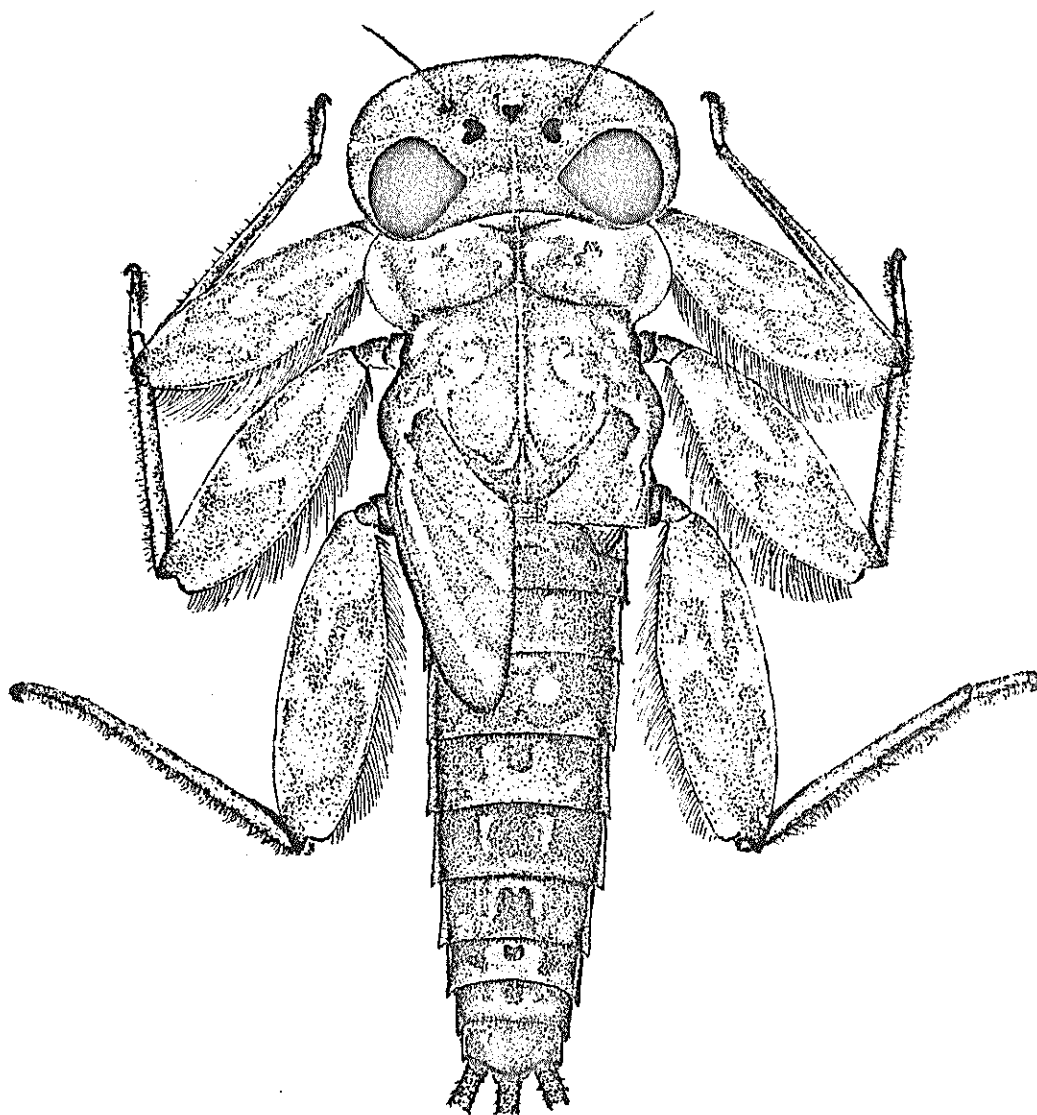


Fig. 27. Afronurus barnardi, sp. nov. Nymph (gills omitted), with typical thoracic and abdominal patterns.

Fig. 28.. Afronurus barnardi sp. nov. (Western.
Cape). Nymph. Note the deviation of
the thoracic and abdominal pattern from
those of the Natal specimens (fig. 27).

markings can be observed on the head, in the vicinity of the ocelli, as well as on the femora of all the legs. These markings soon disappear after death.

HEAD

The average head width of specimens from Natal, Transvaal and the Eastern Cape usually is less than 1.5 times that of its length, whilst this ratio for the Western Cape specimens averages more than 1.5

Although the heads may be very slightly wider in front of the antennal sclerites they do not taper sharply towards the eyes in a triangular fashion as they do in oliffi, but, instead, curve in gradually (fig. 29). The anterior margin of the head is weakly curved (fig. 29). The setae of the proximal half of the second palpal segment of the maxilla of barnardi agrees with that of scotti and peringueyi in being densely setose on its dorsal, anterior (inner) and posterior (outer) surfaces (figs. 29A-B & 30). The setae are, like those of scotti and peringueyi, much longer than those of the third palpal segment. The number of combs on the galea is less than 22. The prostheca of the right mandible terminates in two teeth of which the ventral one is the best developed. The dorsal tooth of the right prostheca projects away from its axis and the denticles along the ventral edge of the latter are spine-like. The left prostheca bears three teeth. In specimens from Natal and the Eastern and Western Cape Province, the ventral and dorsal teeth of the latter are of approximately equal length.

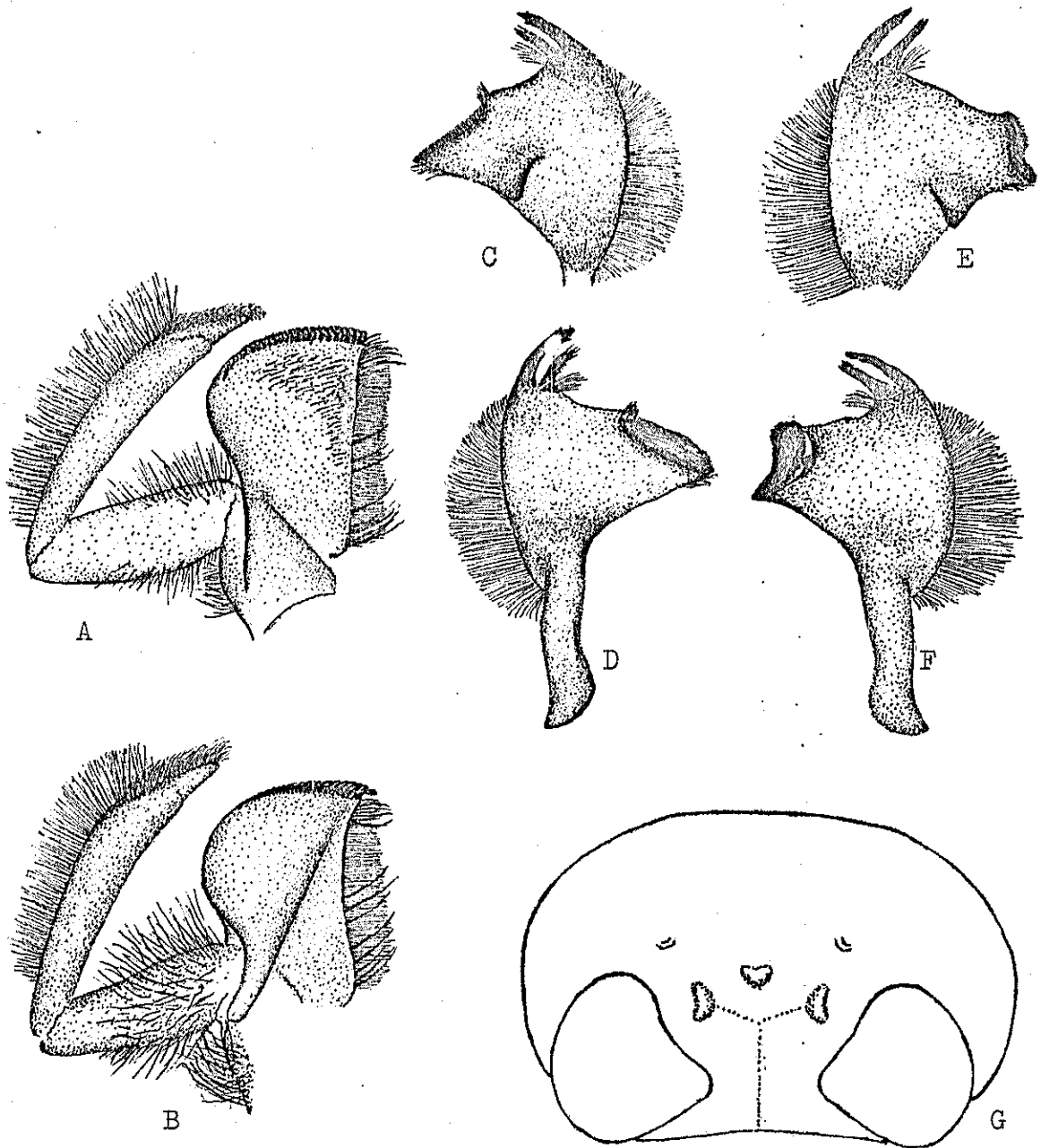


Fig. 29. Afronurus barnardi sp. nov. Outline of head (dorsal view) and mouth parts of nymph. A and B - ventral and dorsal aspects of right and left maxillae respectively; C and D and E and F - dorsal and ventral views of right and left mandibles respectively; G - outline of head.

In some nymphs collected from parts of the Transvaal, the ventral tooth is distinctly longer than the other two teeth. In all specimens, however, the central tooth of the left prostheca is the smallest of the three.

THORAX

As previously stated, the thoracic pattern of this species shows regional characteristics which cannot be ascribed entirely to normal intrapopulation variation. The pattern presented in figure 27 is typical of specimens found in Natal rivers while fig. 53 depicts patterns typical of specimens from the Transvaal and the Western Cape.

The pronotum is as wide as the head, with rounded lateral lobes which are wider in front. The lateral margins of the pronotum are not evenly rounded but distinctly shouldered anteriorly.

The meso- and metanota are narrower than the pronotum.

Legs

First leg:

The first trochanter only bears a few spines, which are largely digitate with rounded tips. Three types of spines can be distinguished on the first femur of the Natal specimens, digitate, lanceolate and obcordate spines. Proximally they are exclusively digitate with rounded tips (fig. 31 A). These spines are replaced along the dorsal and ventral surfaces by lanceolate ones which in turn are replaced distally

by a few spines which are obcordate in shape. The Transvaal specimens differ from this in having few, if any, obcordate spines, while those occurring on the distal surface of the femur are largely digitate with flattened tips. In specimens from the Western Cape, only the most proximal spines are digitate while the rest are distinctly lanceolate and pointed. The tibia and tarsus are sparsely setose with a few spines. The claw bears three to six denticles.

Second leg:

The spines on the second trochanter are mostly lanceolate. In the Transvaal specimens the spines on the proximal third of the antero-medial surface of the femur are digitate but these are replaced distally by lanceolate spines which also occur along the edges of the femur. In the Cape specimens all the spines of this femur are lanceolate. The Natal specimens agree more with those from the Transvaal in having digitate spines with rounded tips proximally and more or less lanceolate spines elsewhere (fig. 31B). They differ from those from the Transvaal and the Western Cape in having a few digitate spines distally with flattened or incised tips. In all specimens the spines along the dorsal and ventral edges are well developed and, without exception, lanceolate. The claw bears four to six denticles.

Third leg:

The spines on the trochanter are predominantly lanceolate although those of the Cape specimens are almost filiform. In all specimens the spines of this femur are lanceolate (fig. 31C). As in the case

of the other femora, those spines along the dorsal and ventral edges are the strongest developed and end in sharply pointed tips. The tibia bears two dense rows of setae interspersed with long setaceous spines. In addition to these, short stout lanceolate spines are also borne on the third tibia. There are four to six denticles on the claw.

ABDOMEN

The abdomen is slender compared with that of harrisoni, particularly in the older nymphal stages. The abdominal tergites are spinulose posteriorly and, except in the Western Cape specimens, their posterolateral edges terminate in weakly developed spines. The nymphs from the Western Cape have well developed spines which resemble those of harrisoni Barnard.

The abdominal pattern, although somewhat variable (figs. 53B, D.F) again proved to be one of the most useful diagnostic features for the species.

Gills

The seventh gill lacks an inner tuft of branchial filaments. The respective gills are depicted in figure 32 .

Terminal filaments

The cerci and paracercus of the Western Cape specimens are yellowish with distinct brownish rings around their joints in contrast to specimens from Natal and Transvaal which have uniformly coloured, usually brownish, terminal filaments.

9.6.3.5

Afronurus peringueyi (Petersen).

Although the nymphal, subimaginal and imaginal developmental stages of the species peringueyi and barnardi closely resemble each other, their different ecological preferences offered definite evidence that they must be different species rather than varieties of the same species. This was confirmed by some clear cut morphological differences whereby all the developmental stages could be separated without the risk of confusing one species with the other. The colouration and body pattern once more constituted distinctive features of the nymphs of peringueyi. In colour the nymphs resemble those of barnardi, except that the grey brown body colouration does not prevail throughout the penultimate and ultimate nymphal stages which progressively attain a more yellowish brown colour.

HEAD

The head is greyish brown with distinct dark brown markings between the antennae and ocelli. The scape and pedicel of the antenna are brown and the flagellum is fuscous. The compound eyes are black. The head is almost square when viewed from above, with its width usually less than 1.5 times that of its length. The sides of the head are almost straight equatorially with the head already attaining its maximum width behind the level of the antennal sclerites. The maxilla differs from that of barnardi in that the number of combs on the galea usually are

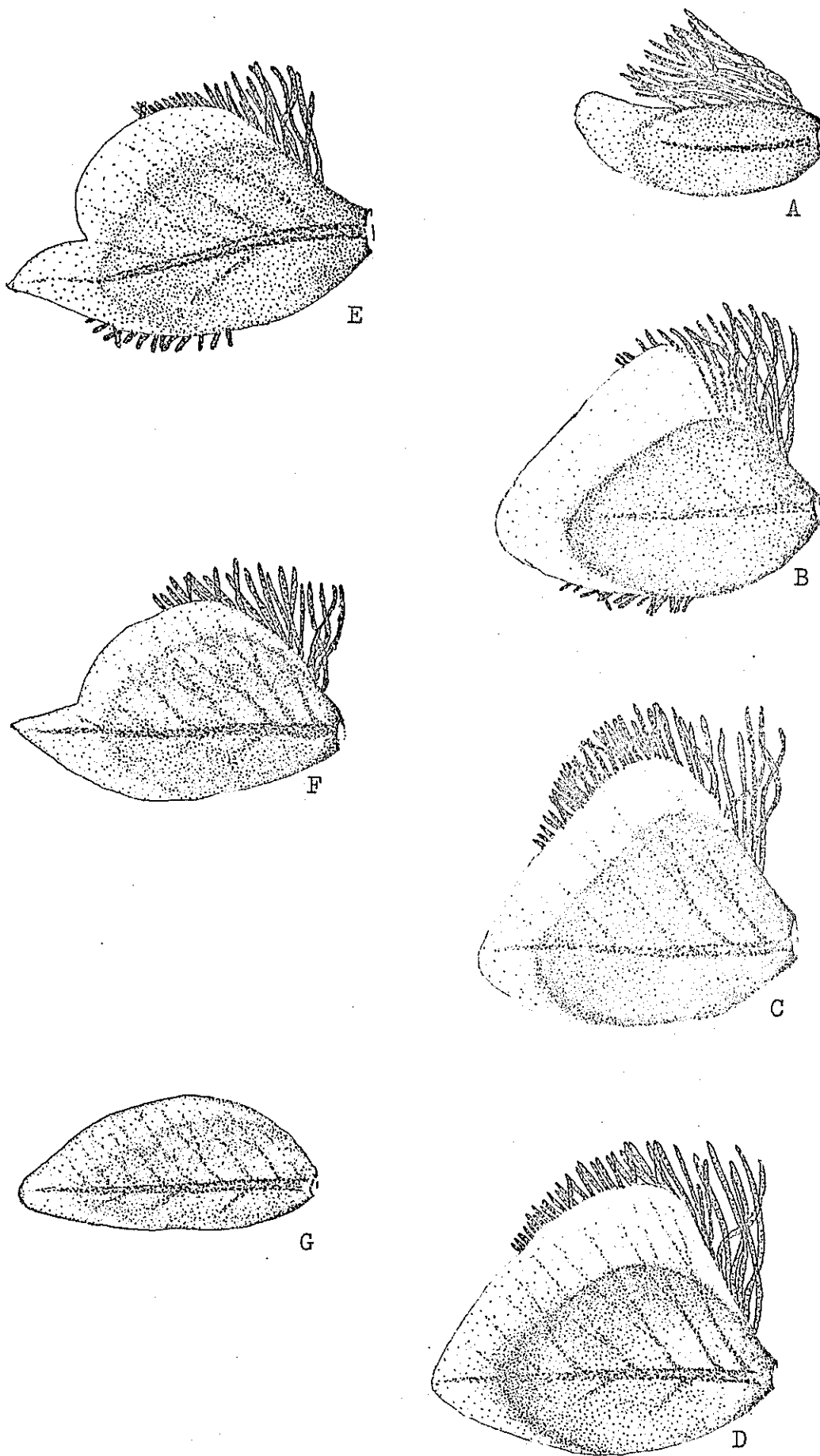


Fig. 32. Afronurus barnardi. Tracheal gills of nymphs. A - G - first to seventh gill respectively.

less than twenty. The canines and prosthecae of the mandibles are like those of barnardi, with the right prosthaca ending in two spine-like teeth whilst the left one terminates in three teeth of which the central tooth is subequal to the dorsal and ventral ones, which are of about the same length.

THORAX

The pattern on the mesothorax retains its diagnostic value in all the nymphal stages (fig. 35). The shape of the pronotum is like that of barnardi.

Legs

First leg:

The trochanter normally lacks spines, but, when present, they are almost setaceous. The spines on the femur somewhat resembles those on the first femur of the Natal specimens of barnardi. Along the dorsal edge of the femur, most of the spines are digitate with incised tips and tend to be obcordate. Those along the ventral edge are digitiform proximally, and lanceolate distally. Those in the mid dorsal surface of the femur are digitate with rounded tips in the proximal half, while digitate spines with incised tips and spines which are distinctly obcordate, occur intermingled on the distal half. The claw usually bears six denticles.

Second leg:

The trochanter bears lanceolate spines. The first fourth of the anterior surface of the femur is covered by spines, the shapes of which are somewhat intermediate between digitate and lanceolate (fig. 34C).

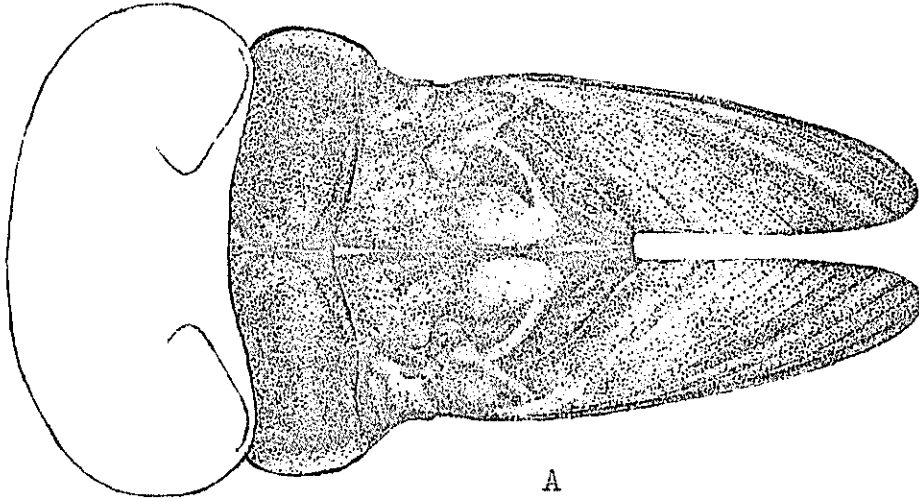
These spines gradually become more pointed and lanceolate in the distal half of the femur although those along the edges mainly remain lanceolate. Of the six denticles borne on the claw, the sixth (posterior) one usually is poorly developed compared with the other five.

Third leg:

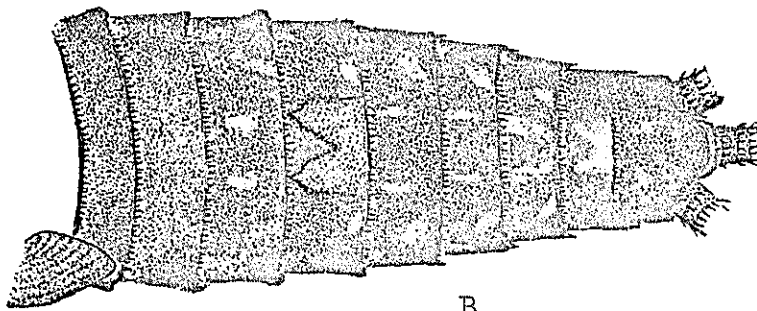
The spines borne on the trochanter are lanceolate. Those of the femur are likewise, virtually all lanceolate, except for a few spines in its proximal fourth where the shape is intermediate between lanceolate and digitate. As in barnardi, the tibia also bears several long setaceous spines amongst the rows of setae. The hind claw usually bears six denticles of which the last one is poorly developed.

ABDOMEN

Like barnardi, the abdomen of the nymphs are, as a rule, slender when compared with species such as harrisoni. As in all the other species of Afro-nurus, the pattern on the abdomen is less subject to variation, and consequently, of much value in the process of identification. Although the tergites of segments 3 - 8 are pointed along their posterior ventrolateral edges, the spines are not directed away from the body and can therefore not be easily observed in a dorsal view. The pattern on the fifth tergite (fig. 35B) is useful in separating peringueyi from barnardi. In both species the lighter coloured pattern terminates anteriorly in two "legs". These



A



B

Fig. 35. *Afronurus peringueyi* (E.P.). A and B - thorax abdomen of nymph showing the typical patterns diagnostic of this species.

"legs" in peringueyi are Λ -shaped, the apices of which are further constricted to end in sharp points (fig. 35). The brown area included between these "legs" is distinctly V-shaped.

Gills

The gills are like those described for barnardi (fig. 32). The seventh pair of gills also lack an inner tuft of branchial filaments.

Terminal filaments

The terminal filaments are yellowish brown near the abdomen, becoming darker towards their tips.

- 9.6.4 The ratios head width/length and femur length/width of the nymphs, and their statistical significance in the separation of the species of the genus Afronurus

Apart from the markings and body patterns, characteristic of the nymphs of Afronurus species, there are also certain other morphological differences whereby some species could be identified. Two such characteristics, which appear to be of specific value, are the shapes of the head and femora. Since it is possible to measure the widths and lengths of the heads and femora, the results, which can be expressed numerically in the form of ratios etc., were subjected to statistical evaluation. I could,

in this way, compare specimens of the same species from widely separated geographical areas in South Africa as well as specimens of different species from the same areas. A knowledge of their ecology, however, was invaluable for the interpretation of the data, which, on the morphological evidence alone, could not have been explained adequately (see chapter 8).

In tables 48-62 and figs. 37 - 52 the symbols used denote the following:

N, N_1, N_2 : The number of organisms analysed for a certain characteristic;

$\bar{X}, \bar{X}_1, \bar{X}_2$: The mean value;

S_x^2, S_1^2, S_2^2 : The Variance;

S_x, S_1, S_2 : The Standard Deviation;

$S_{y \cdot x}$: The Standard Error of Estimate.

In comparing the differences between the means of the above-mentioned ratios for the various species, Student's t-test was employed by using the following formula (Simpson et al, 1960):

$$t = \frac{(\bar{X}_1 - \bar{X}_2) \sqrt{\frac{N_1 N_2}{N_1 + N_2}}}{\sqrt{\frac{(N_1 - 1) S_1^2 + (N_2 - 1) S_2^2}{N_1 + N_2 - 2}}}$$

The coefficient of variability (C.V.) was calculated from the formula:

$$C.V. = \frac{100 S_x}{\bar{x}}$$

Straight lines were fitted to the scatter diagrams (figs. 37 - 52) by means of the Method of Least Squares (Mills, 1955).

9.6.4.1 The ratio head width/length (tables 48 - 49
 and figs. 37 - 40).

The scatter diagrams in figs. 37 - 40 , of the values of head length (vertical scales) and head width (horizontal scales) for oliffi, barnardi (Emolweni river, Natal), harrisoni, scotti and peringueyi show almost perfect linear correlations with positive regressions of lengths (Y) on widths (X). Also, the close groupings of the values around the lines of average relationship, determined by means of the Method of the Least Squares, as well as the small values of the Standard Error of Estimate $S_{y \cdot x}$, which are measures of the degree of scatter about these lines, all suggest very strong linear correlation to exist for the ratio head width/length in the species under consideration. The very low values of the coefficient of variability (C.V.) . serve as further confirmation of the consistently low degree of variation of this ratio, which never exceeded 5.00 (table 48), despite the fact that the numbers of specimens analysed were, with the exception perhaps of harrisoni, more than adequate to show up extreme variations. Considering the findings on the other species, one can assume, with a fair degree of confidence, that the ratio head width/length should behave similarly for harrisoni, of which only a few specimens could be analysed (table 48), and which, consequently, was not treated statistically so extensively.

Since a linear relationship was found to exist with respect to head width/length, the next step was

TABLE 48

Ratios of head width/length in the different South African species of Afronurus

SPECIES	LOCALITY	n	\bar{x}	Range	n-1 Sx^2	Sx^2	Sx	C.V.
<u>Afronurus oliffi</u>	Small mountain stream, Cathedral Peak, Drakensberg, Natal.	23	1.523	1.469-1.599	0.0292	0.0013273	0.03643	2.39
<u>Afronurus barnardi</u>	Emolweni river, Krantzkloof Nature reserve, Kloof, Natal	42	1.464	1.375-1.645	0.1093	0.0026659	0.05163	3.53
<u>Afronurus barnardi</u>	Saron, Great Berg river, Western Cape Province	13	1.521	1.449-1.578	0.0150	0.001250	0.03536	2.33
<u>Afronurus scotti</u>	Umgeni river at Dargle Forestry, Dargle, Natal	20	1.387	1.33-1.463	0.0297	0.0015632	0.03954	2.85
<u>Afronurus harrisoni</u>	Great Berg river. Western Cape Province.	4	1.588	1.564-1.618	0.0018	0.00060	0.02450	1.54
<u>Afronurus peringueyi</u>	Vaal river, Skandinawie-drift, Border between the Transvaal and Orange Free State	38	1.454	1.379-1.770	0.1386	0.003746	0.06120	4.21

to establish whether the differences between the means of this ratio for the various species represented variational tendencies only, or whether these differences obtained were significant for the different species. If such significant differences could be found, it would mean that the ratio head width/length will be a valid criterion for separating species or even subspecies from each other.

From table 48 and figures 37 - 40 the following preliminary conclusion can be drawn:

1. The two species scotti and harrisoni have the lowest and highest mean values for the ratio head width/length;
2. The mean values of this ratio for barnardi from the Cape (Great Berg river system, Saron) appear to differ considerably from those of the same species found in Natal, but, on the other hand, its mean value approaches that of oliffi;
3. The mean head ratio width/length of barnardi from Natal are virtually identical to that of peringueyi.

In order to find out whether the differences between the mean values head width/length mentioned above were in fact differences other than variational tendencies the Students t-distribution test was employed. The results of these comparisons are listed in table 49 . At the 95% level of confidence, highly significant differences were obtained between

TABLE 49

A statistical comparison of the ratios head width/ head length of the different South African species of Afronurus
(2-sided t-test)

Species compared	n	\bar{x}	n-1 s_x^2	d.f.	t	P	Differences between sample means
<u>oliffi</u> and <u>barnardi</u>	23 42	1.52339 1.46405	0.0292 0.1093	63	4.880	<0.001	highly significant
<u>oliffi</u> and <u>scotti</u>	23 20	1.52339 1.38655	0.0292 0.0297	41	11.808	<0.001	highly significant
<u>oliffi</u> and <u>peringueyi</u>	23 38	1.52339 1.45397	0.0292 0.1386	59	4.927	<0.001	highly significant
<u>barnardi</u> * and <u>scotti</u>	42 20	1.46405 1.38655	0.1093 0.0297	60	5.927	<0.001	highly significant
<u>barnardi</u> * and <u>peringueyi</u>	42 38	1.46405 1.45397	0.1093 0.1386	78	0.799	0.4-0.5	nonsignificant
<u>scotti</u> and <u>peringueyi</u>	20 38	1.38655 1.45397	0.0297 0.1386	56	4.452	<0.001	highly significant
<u>barnardi</u> ** and <u>barnardi</u>	13 42	1.52054 1.46405	0.0150 0.1093	53	3.717	<0.001	highly significant
<u>barnardi</u> ** and <u>oliffi</u>	13 23	1.52054 1.52339	0.0150 0.0292	34	0.228	0.8-0.9	nonsignificant
<u>barnardi</u> ** and <u>scotti</u>	13 20	1.52054 1.38655	0.0150 0.0297	31	9.906	<0.001	highly significant
<u>barnardi</u> ** and <u>peringueyi</u>	13 38	1.52054 1.45397	0.0150 0.1386	49	3.700	<0.001	highly significant

** : Great Berg river system. Near Saron, Western Cape.

* : Emolweni river. Kloof, Natal.

† : Krantzklouf Nature reserve.

FIG. 37

Head length against head width in nymphs of Afronurus scotti (Dargle Forestry, Natal).

$$Y = 0.038 + 0.72 X.$$

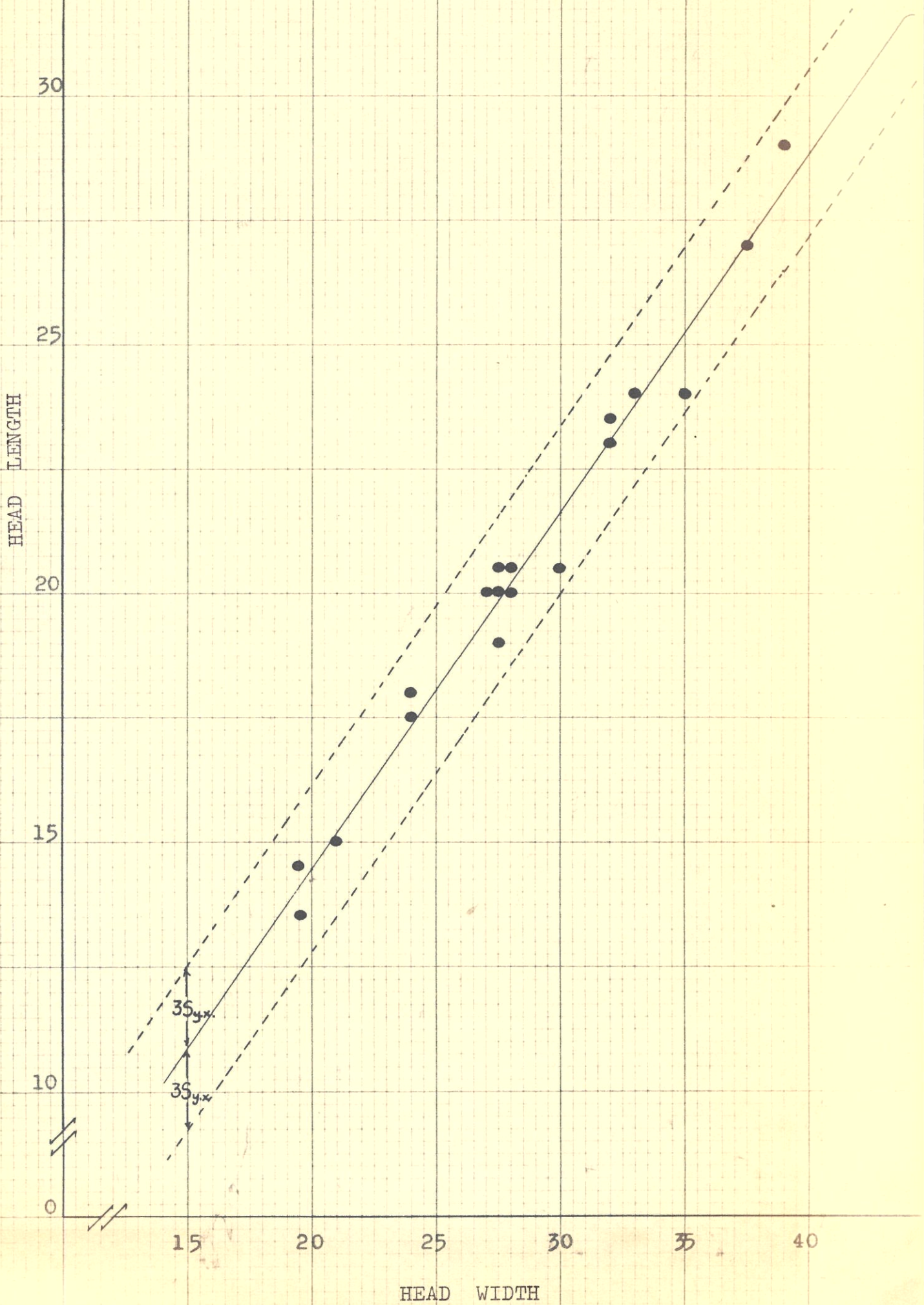


FIG. 38

Head length against head width in nymphs of Afronurus oliffi (Cathedral Peak, Natal).

$$Y = 0.322 + 0.65 X.$$

Cathedral Peak. Afronurus oliffi sp. nov. Natal head L.
 $y = 0.7752$ $y = 0.322 + 0.65X$

HEAD LENGTH

HEAD WIDTH

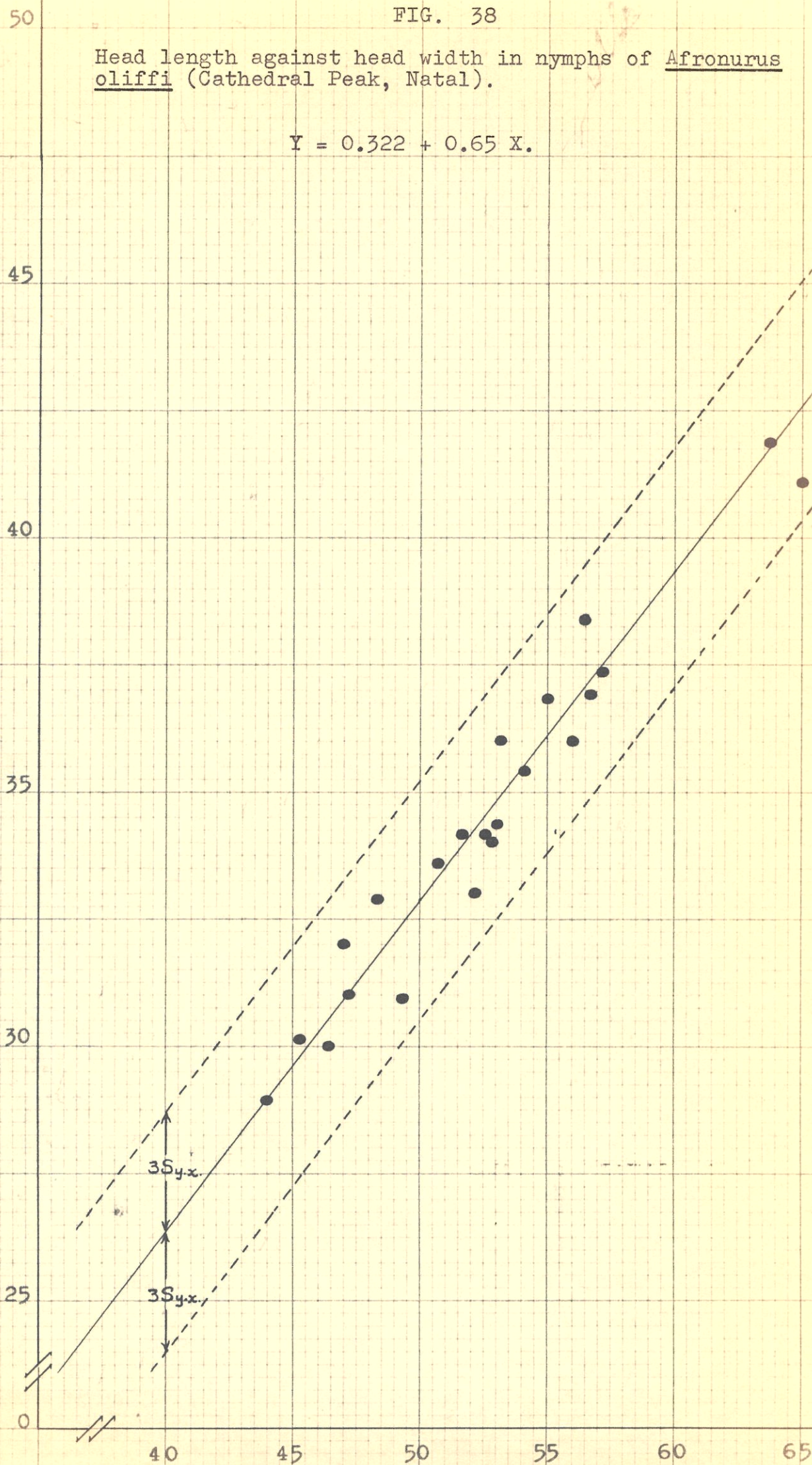


FIG. 39A

Head length against head width in nymphs of Afronurus barnardi (Emolweni river, Natal).

$$Y = 1.165 + 0.641 X.$$

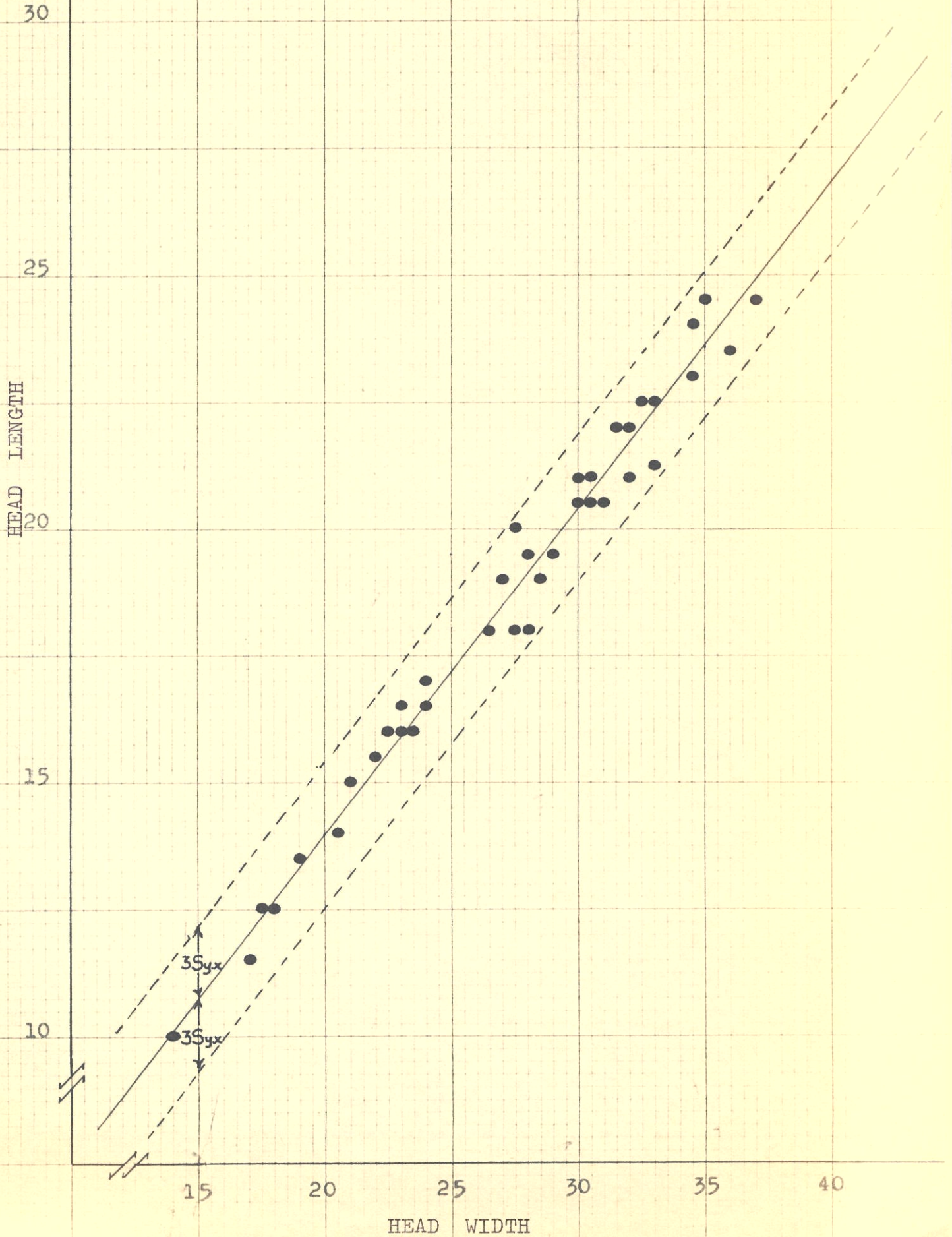


FIG. 40

Head length against head width in nymphs of Afronurus peringueyi (Vaal river, Skandinawië-drift, Transvaal).

$$Y = 3.892 + 0.779 X.$$

HEAD LENGTH

HEAD WIDTH

35
30
25
20
15
10
0

25 30 35 40 45 50

$3S_{y.x}$

$3S_{y.x}$

all species compared except for barnardi & peringueyi, and barnardi (Cape) & barnardi (Natal), (table 49).

9.6.4.2 The ratio femur length/width.

A statistical procedure similar to that employed for the head ratios was followed in the comparison of the first, second and third femora of specimens of the same species from different localities as well as those of the different species respectively (table 50). From table 50 the following deductions can be made:

1. The mean as well as the individual values for this ratio increase from the first to the third femur i.e. femur 1 < femur 2 < femur 3, for all species from all localities under consideration;
2. The coefficient of variability (C.V.) remains small, and, being less than 10 (usually fluctuating between 4-7), reflects a small but slightly higher degree of variability than the corresponding head ratios (compare tables 48 and 50) and;
3. For the species compared, the values of the femur ratios increase in the following order:
scotti, < peringueyi, < oliffi, < barnardi, < harrisoni.

Even though the coefficient of variability (table 50) and the scatter diagrams (figs. 41-52) indicate a higher degree of variation for the different species with respect to this ratio, than

TABLE 50

The ratios of femur length/width of the nymphs of the different South African species of Afronurus

SPECIES	LOCALITY	Femur	N	\bar{x}	Range	$n-1 Sx^2$	Sx^2	Sx	C.V.	
<u>AFRONURUS OLIFFI</u>	Small mountain stream Cathedral Peak, Drakensberg, Natal.	FIRST	23	2.4190	2.267 - 2.600	0.204	0.009273	0.09630	3.98	
		SECOND	23	2.4813	2.323 - 2.886	0.393	0.01786	0.1337	5.39	
		THIRD	23	2.8266	2.671 - 3.129	0.309	0.01405	0.1185	4.19	
	Emolweni river, Krantz-kloof Nature reserve, Kloof, Natal.	FIRST	39	2.5728	2.167 - 2.947	0.866	0.02279	0.1510	5.87	
		SECOND	40	2.6962	2.421 - 3.286	1.395	0.03577	0.1891	7.01	
		THIRD	39	3.1724	2.875 - 3.917	1.888	0.04968	0.2229	7.03	
	<u>AFRONURUS BARNARDI</u>	Vaal river system various localities	FIRST	23	2.5588	2.294 - 2.875	0.467	0.02123	0.1457	5.69
			SECOND	23	2.6354	2.437 - 2.889	0.406	0.01846	0.1358	5.15
			THIRD	24	3.0714	2.722 - 3.625	1.190	0.05174	0.2275	7.41
<u>AFRONURUS SCOTTI</u>	Vaal river, Skandinawie, border between Transvaal and Orange Free State	FIRST	6	2.5740	2.440 - 2.773	0.071	0.01420	0.1191	4.63	
		SECOND	5	2.6672	2.379 - 2.933	0.154	0.03855	0.1963	7.36	
		THIRD	6	3.1600	3.036 - 3.448	0.120	0.02400	0.1549	4.90	
	Saron. Great Berg river system.	FIRST	13	2.6160	2.354 - 2.910	0.307	0.02558	0.1599	6.11	
		SECOND	13	2.8159	2.578 - 3.116	0.397	0.03308	0.1819	6.46	
		THIRD	13	3.3140	2.904 - 3.846	0.012	0.00100	0.0316	0.95	
	Umgeni river at Dargle Forestry, Dargle, Natal.	FIRST	19	2.1714	2.000 - 2.483	0.445	0.02472	0.1572	6.12	
		SECOND	19	2.2228	1.500 - 2.548	0.901	0.05006	0.2238	10.07	
		THIRD	16	2.5714	2.385 - 3.000	0.520	0.03467	0.1862	7.24	
<u>AFRONURUS PERINGUEYI</u>	Umgeni river system (various localities), Natal.	FIRST	22	2.2110	2.091 - 2.244	0.313	0.01491	0.1221	5.52	
		SECOND	23	2.3002	2.158 - 3.000	0.428	0.01946	0.1395	6.07	
		THIRD	20	2.5353	2.158 - 3.000	0.640	0.03368	0.1835	7.24	
<u>AFRONURUS HARRISONI</u>	Vaal river, Skandinawie, border between Transvaal and the Orange Free State	FIRST	39	2.3524	2.061 - 2.692	0.676	0.01779	0.1333	5.67	
		SECOND	39	2.4372	2.138 - 2.683	0.777	0.02045	0.1430	5.87	
		THIRD	39	2.8806	2.560 - 3.177	0.869	0.02287	0.1512	5.25	
<u>AFRONURUS HARRISONI</u>	Great Berg river.	FIRST	4	2.6678	2.600 - 2.732	0.016	0.00533	0.07301	2.74	
		SECOND	4	2.9013	2.767 - 2.957	0.024	0.00800	0.08945	3.08	
		THIRD	4	3.3075	3.147 - 3.438	0.080	0.02667	0.16330	4.94	

14

FIG. 41

Femur width against femur length of the first leg in nymphs of Afronurus scotti (Dargle Forestry, Natal).

$$Y = 1.861 + 0.377 X.$$

FEMUR WIDTH

13

12

11

10

9

8

7

6

5

4

0

// 10

15

20

25

30

35

FEMUR LENGTH

//

FIG. 42

Femur width against femur length of the second leg in nymphs of Afronurus scotti (Dargle Forestry, Natal).

$$Y = 1.432 + 0.383 X.$$

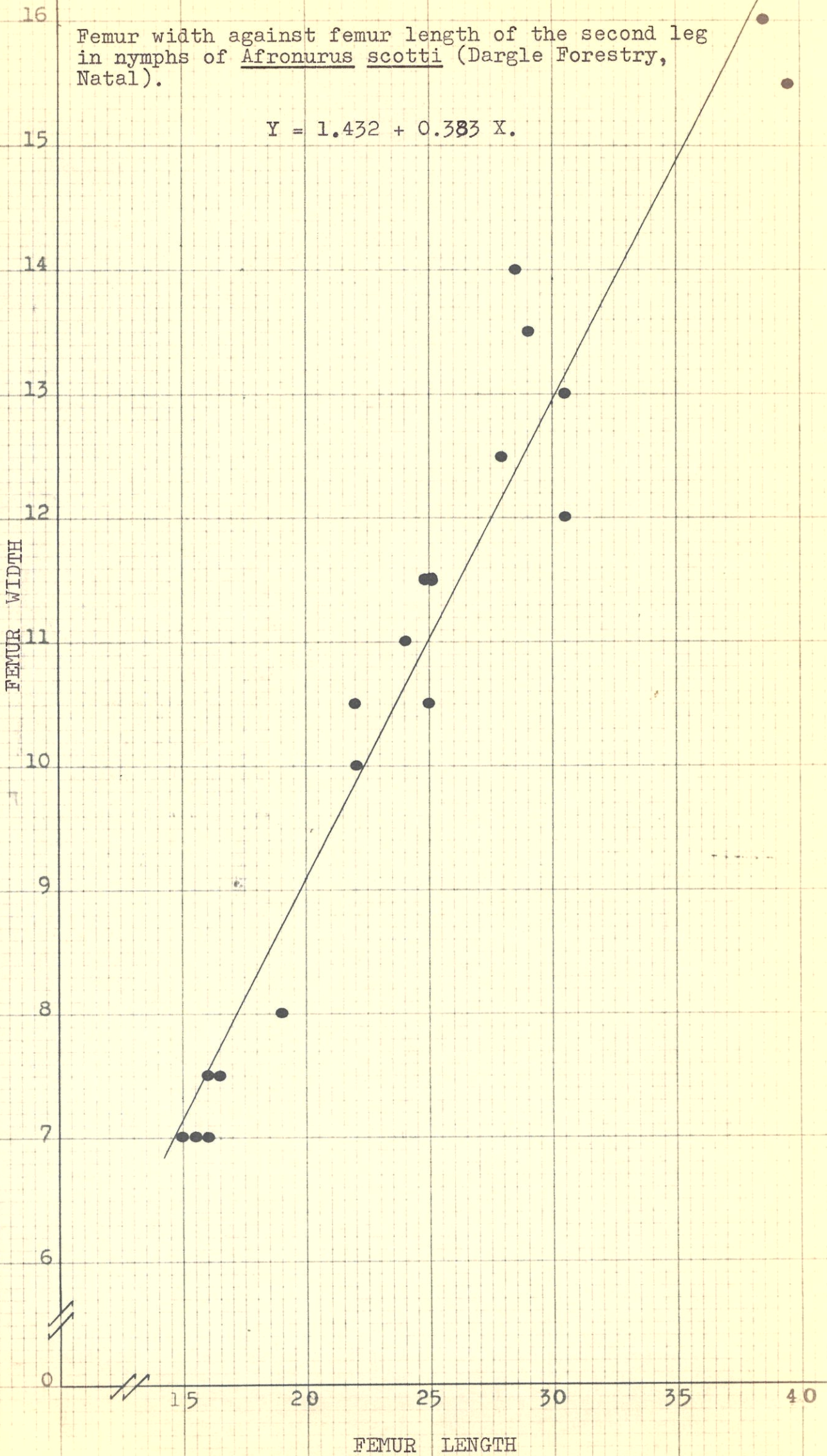


FIG. 43

Femur width against femur length of the third leg in nymphs of Afronurus scotti (Dargle Forestry, Natal).

$$Y = 0.194 + 0.399 X.$$

FEMUR WIDTH

15
14
13
12
11
10
9
8
7
6
5
0

15 20 25 30 35 40

FEMUR LENGTH

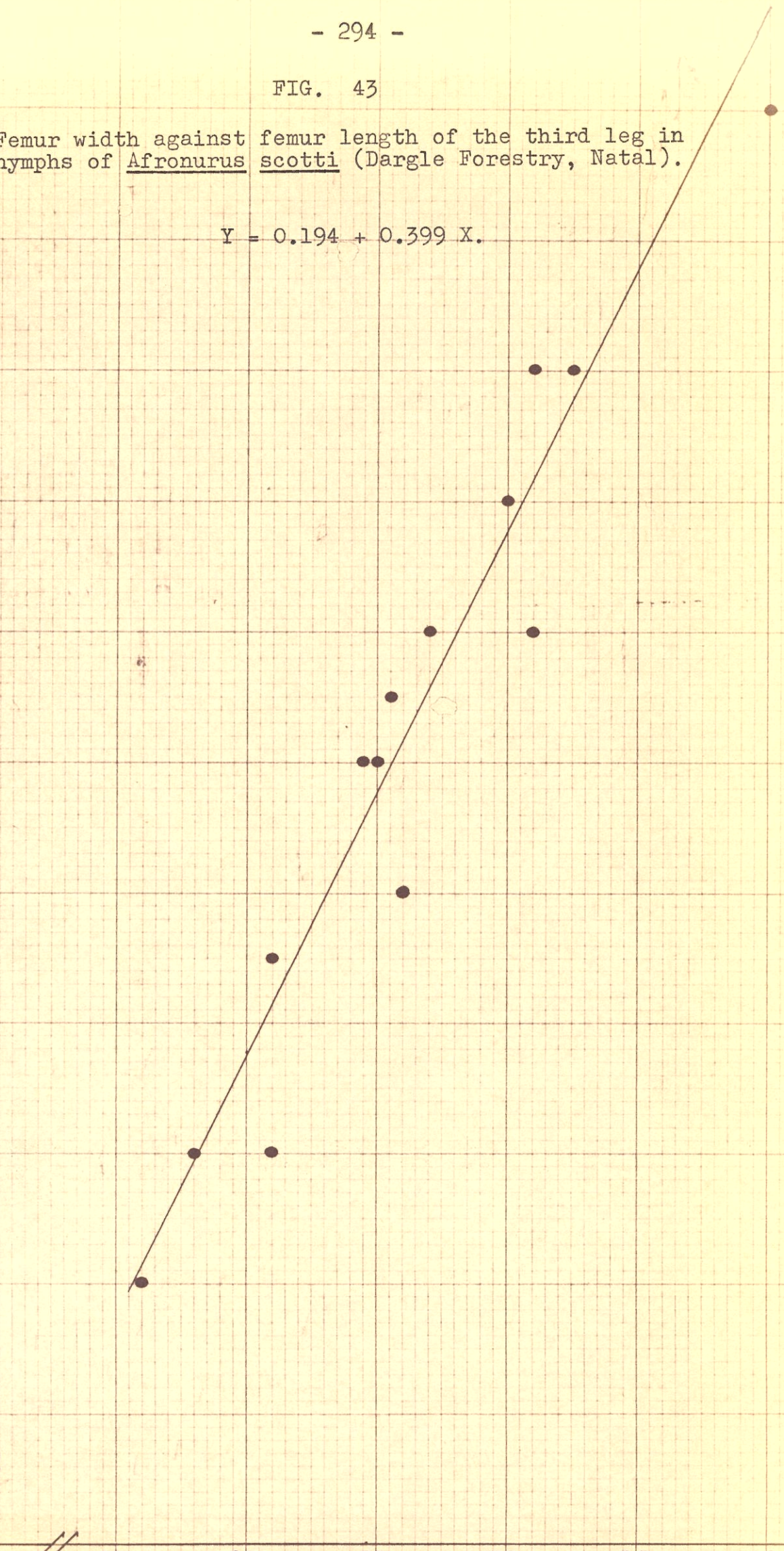


FIG. 44

Femur width against femur length of the first leg in nymphs of Afronurus oliffi (Cathedral Peak, Natal).

$$Y = 1.09 + 0.341 X.$$

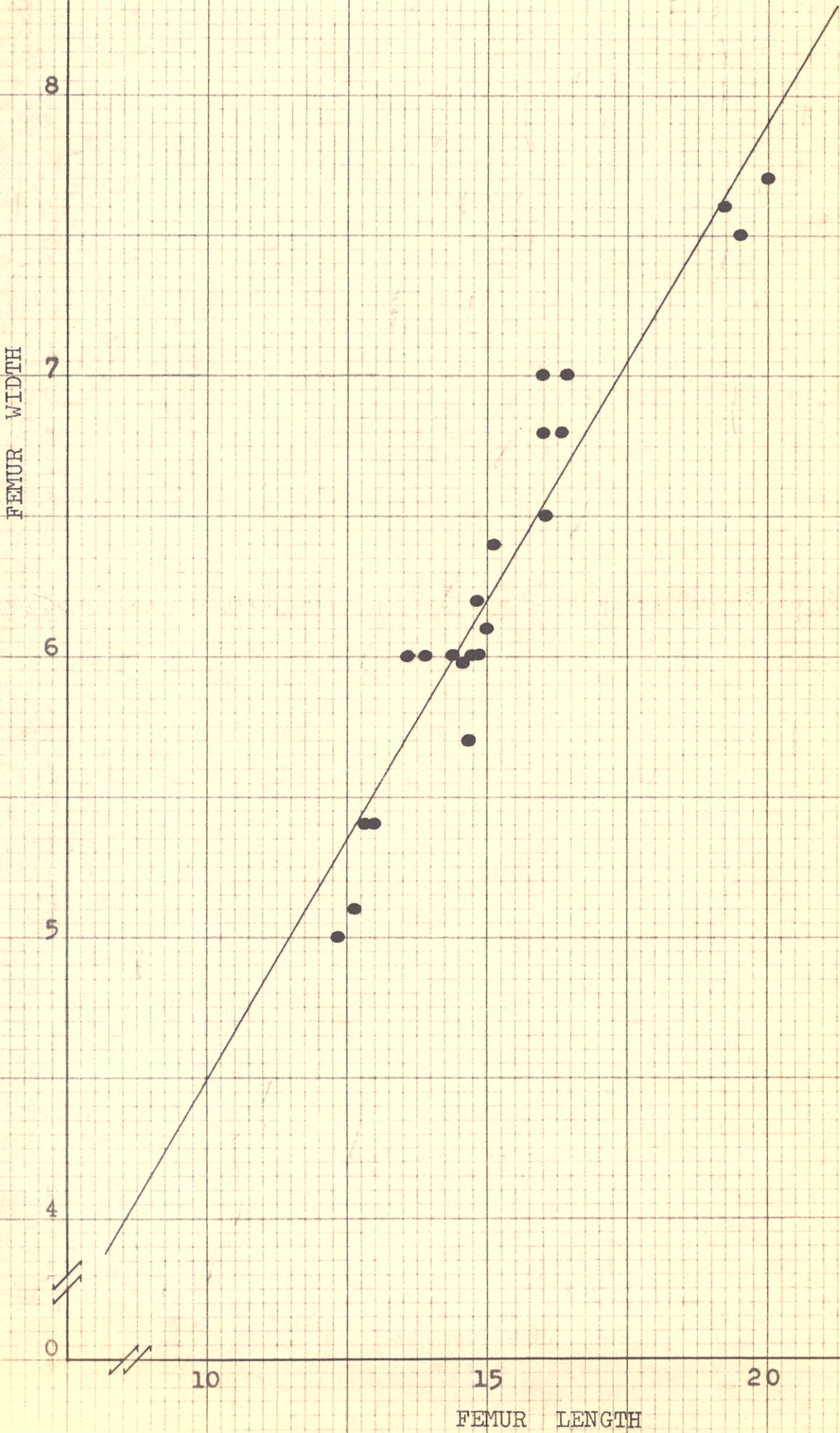


FIG. 45

Femur width against femur length of the second leg in nymphs of Afronurus oliffi (Cathedral Peak, Natal)

$$Y = 2.065 + 0.276 X.$$

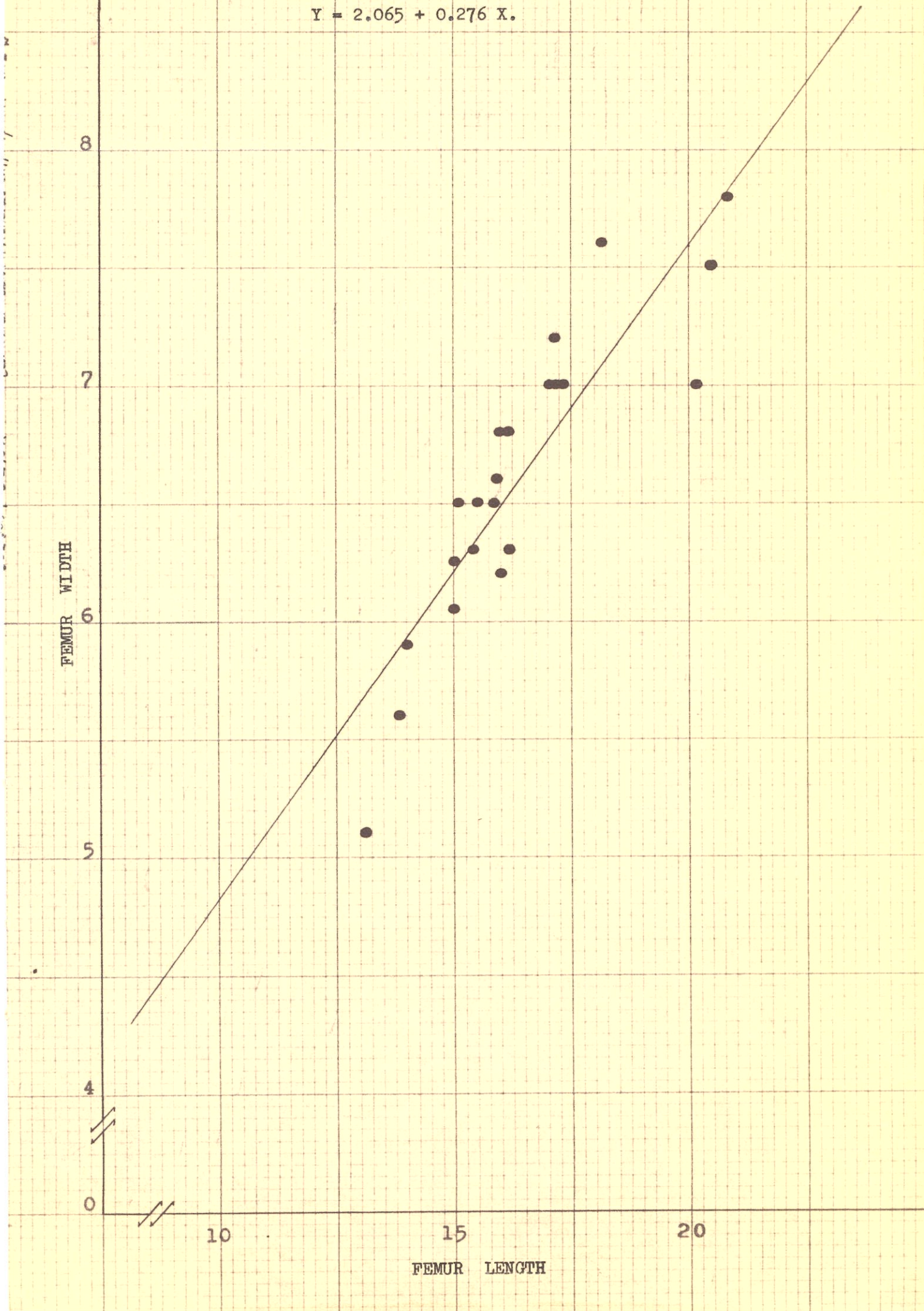


FIG. 46

Femur width against femur length of the third leg in nymphs of Afromurus oliff (Cathedral Peak, Natal).

$$Y = 1.46 + 0.271 X.$$

FEMUR WIDTH

8
7
6
5
4
0

10 15 20

FEMUR LENGTH



FIG. 47

Femur width against femur length of the first leg in nymphs of Afronurus barnardi (Vaal river, Skandinawidrift, Transvaal).

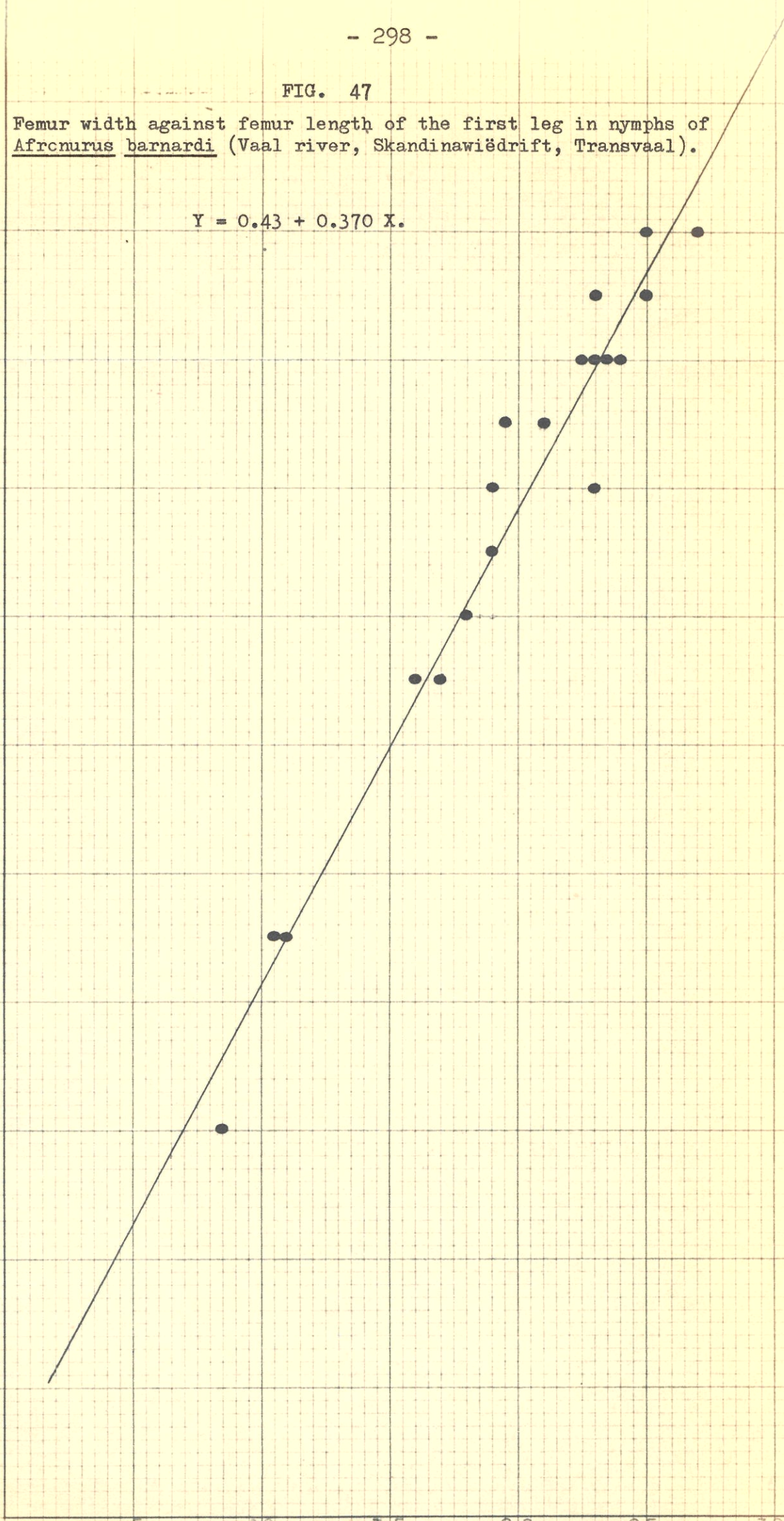
$$Y = 0.43 + 0.370 X.$$

FEMUR WIDTH

FEMUR LENGTH

11
10
9
8
7
6
5
4
3
2
1
0

5 10 15 20 25 30



11

Femur width against femur length of the second leg in nymphs of Afronurus barnardi (Vaal river, Skandinawidrift, Transvaal).

10

$$Y = 0.174 + 0.39 X.$$

9

8

7

6

5

4

3

2

1

0

FEMUR WIDTH

5

10

15

20

25

30

FEMUR LENGTH

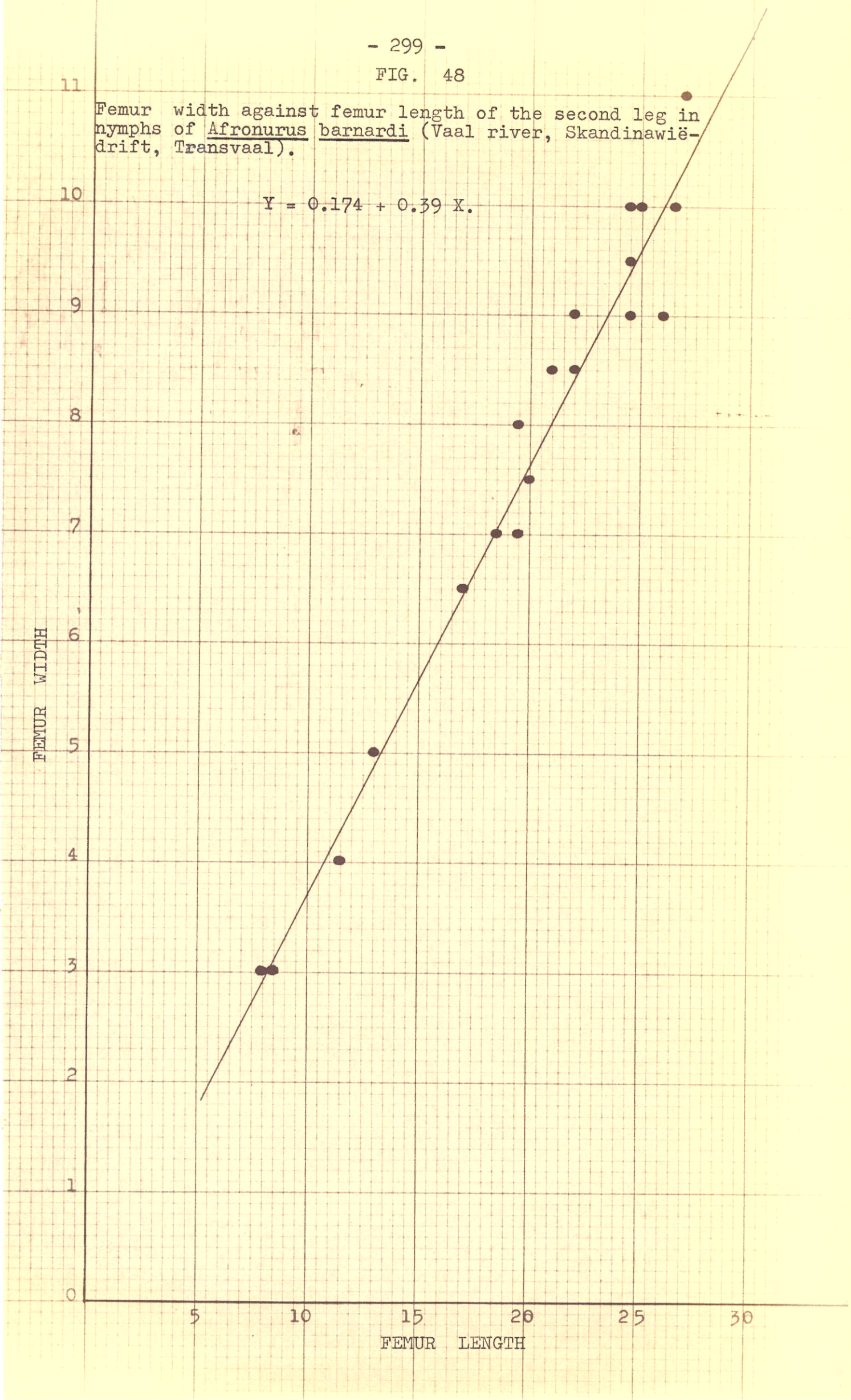


FIG. 49

Femur width against femur length of the third leg in nymphs of Afronurus barnardi (Vaal river, Skandinawië-drift, Transvaal).

$$Y = 0.905 + 0.366 X.$$

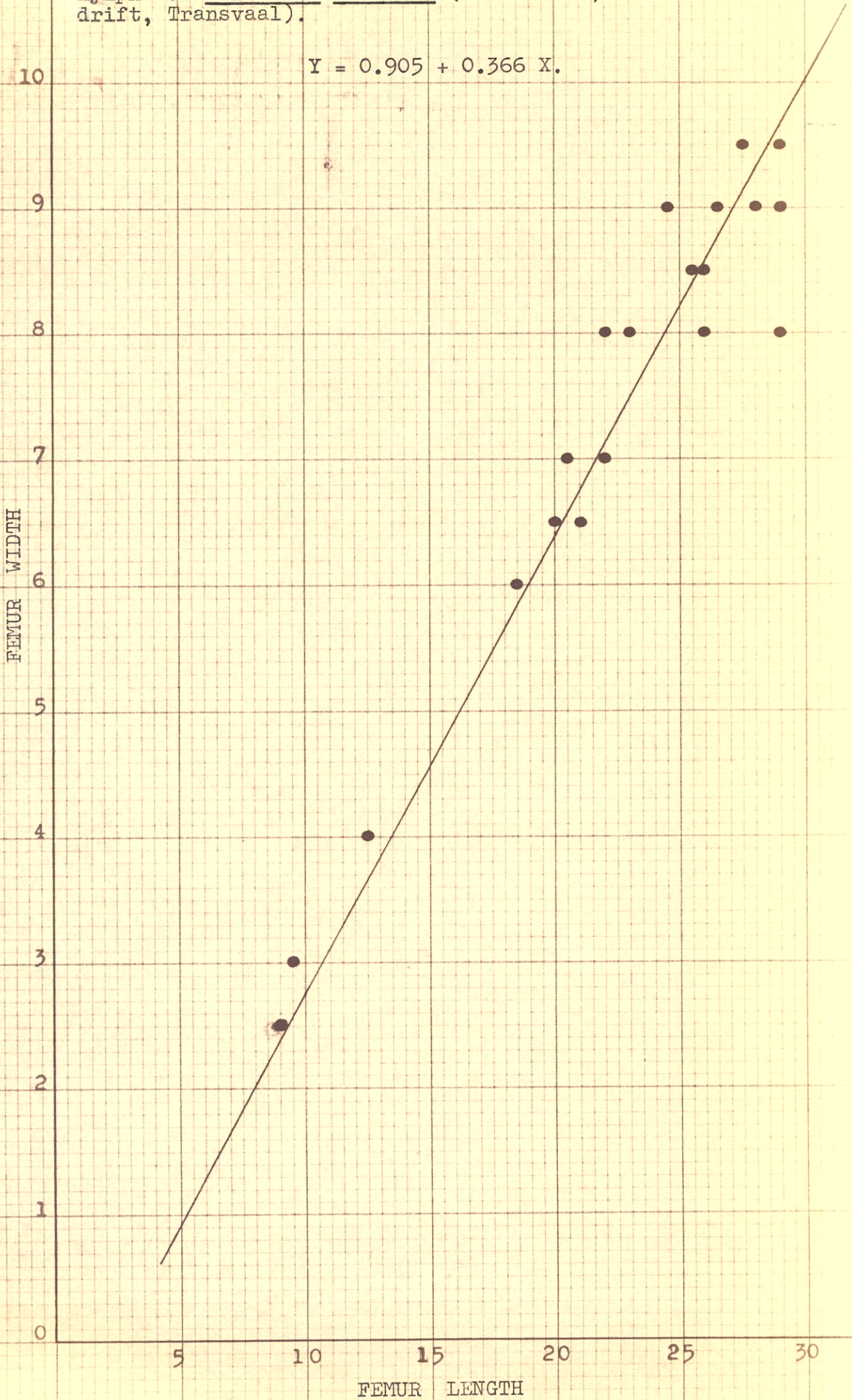
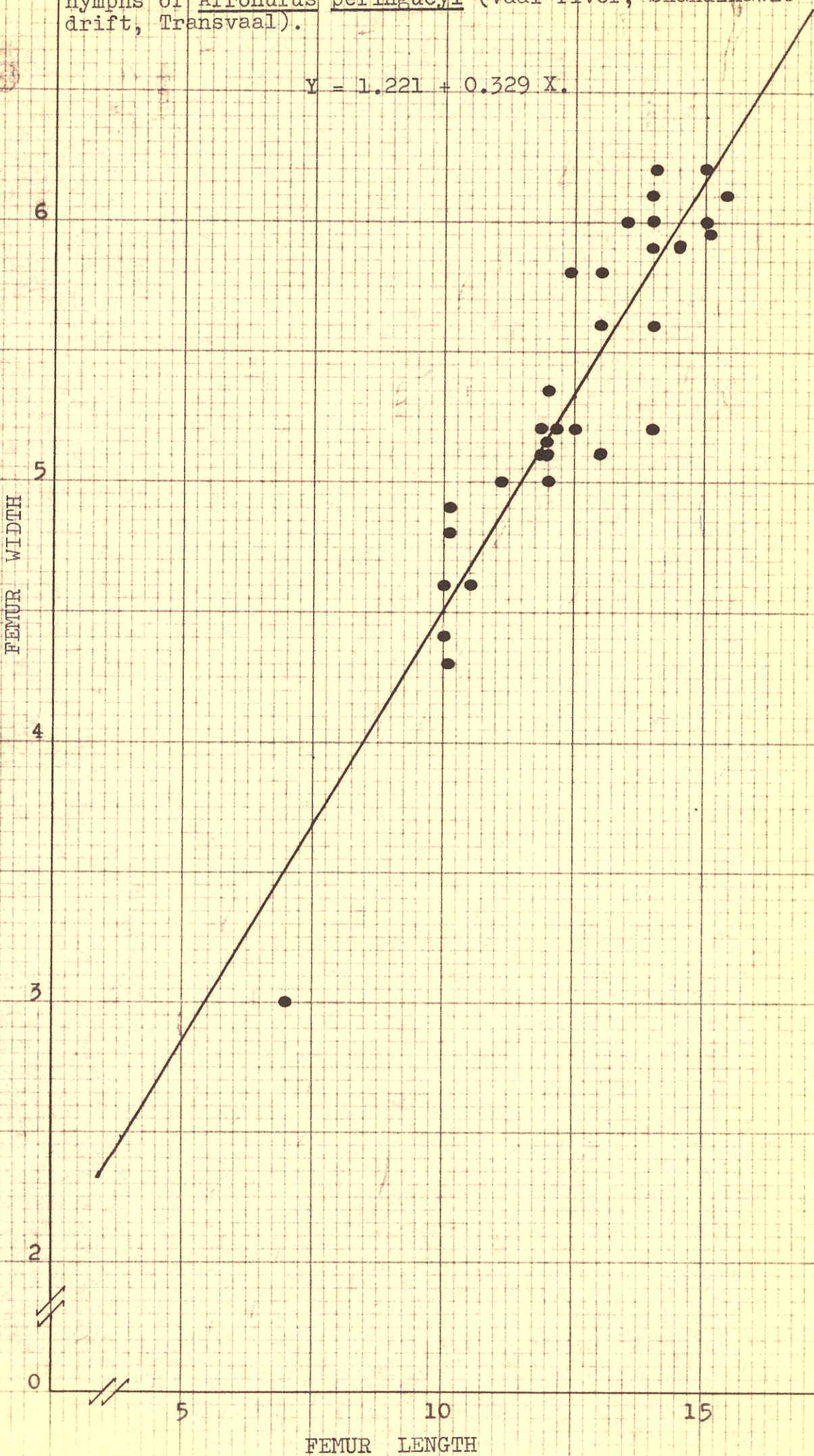


FIG. 50

Femur width against femur length of the first leg in nymphs of Afronurus peringueyi (Vaal river, Skandinawië-drift, Transvaal).

$$Y = 1.221 + 0.329 X.$$



Femur width against femur length of the second leg in nymphs of Afronurus peringueyi (Vaal river, Skandinawiedrift, Transvaal).

$$Y = 1.88 + 0.277 X.$$

FEMUR WIDTH

7
6
5
4
3
2
0

5 10 15
FEMUR LENGTH

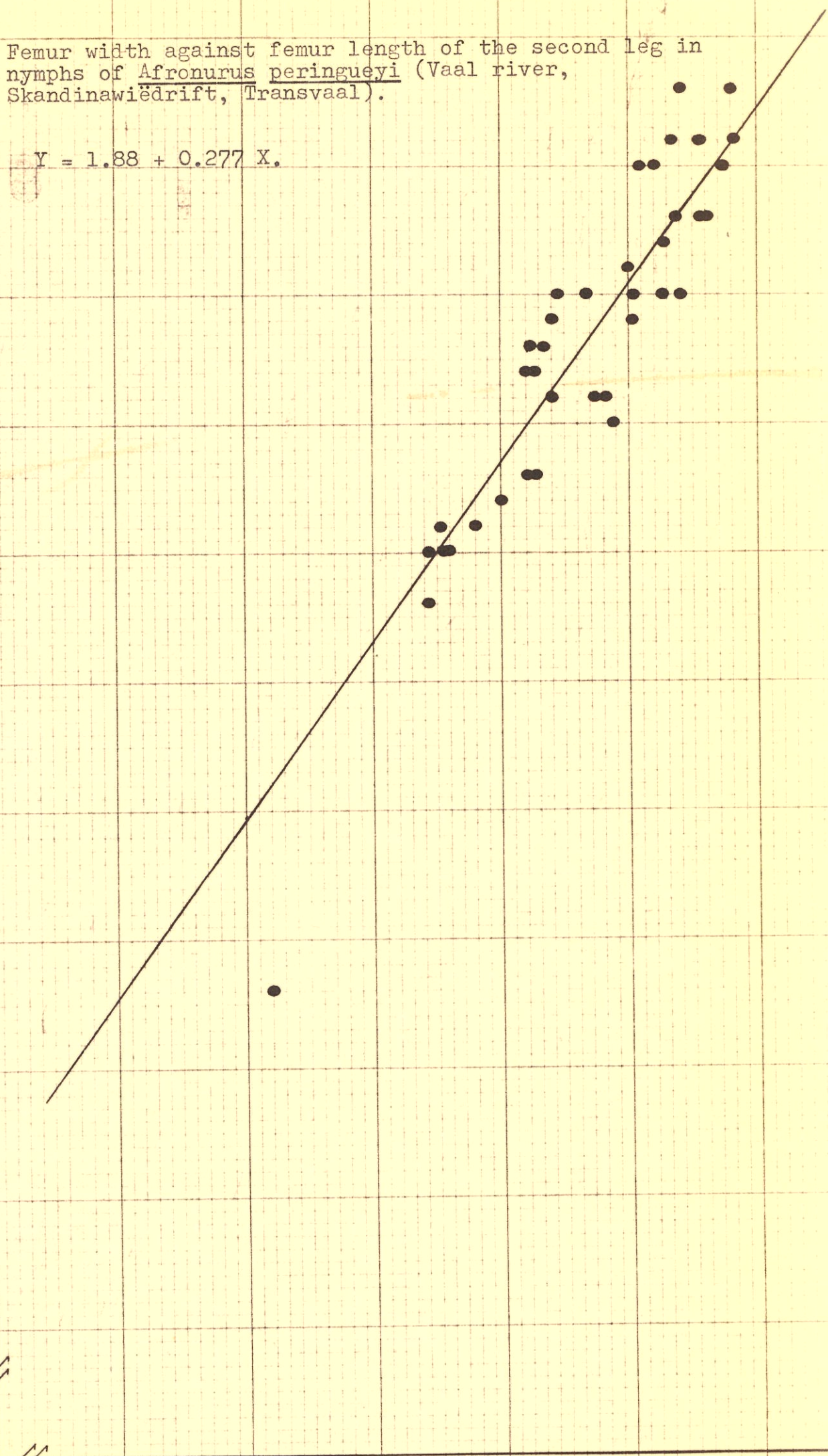


FIG. 52

Femur width against femur length of the third leg in nymphs of Afronurus peringueyi (Vaal river, Skandinawië-drift, Transvaal).

$$Y = 0.993 + 0.285 X.$$

FEMUR WIDTH

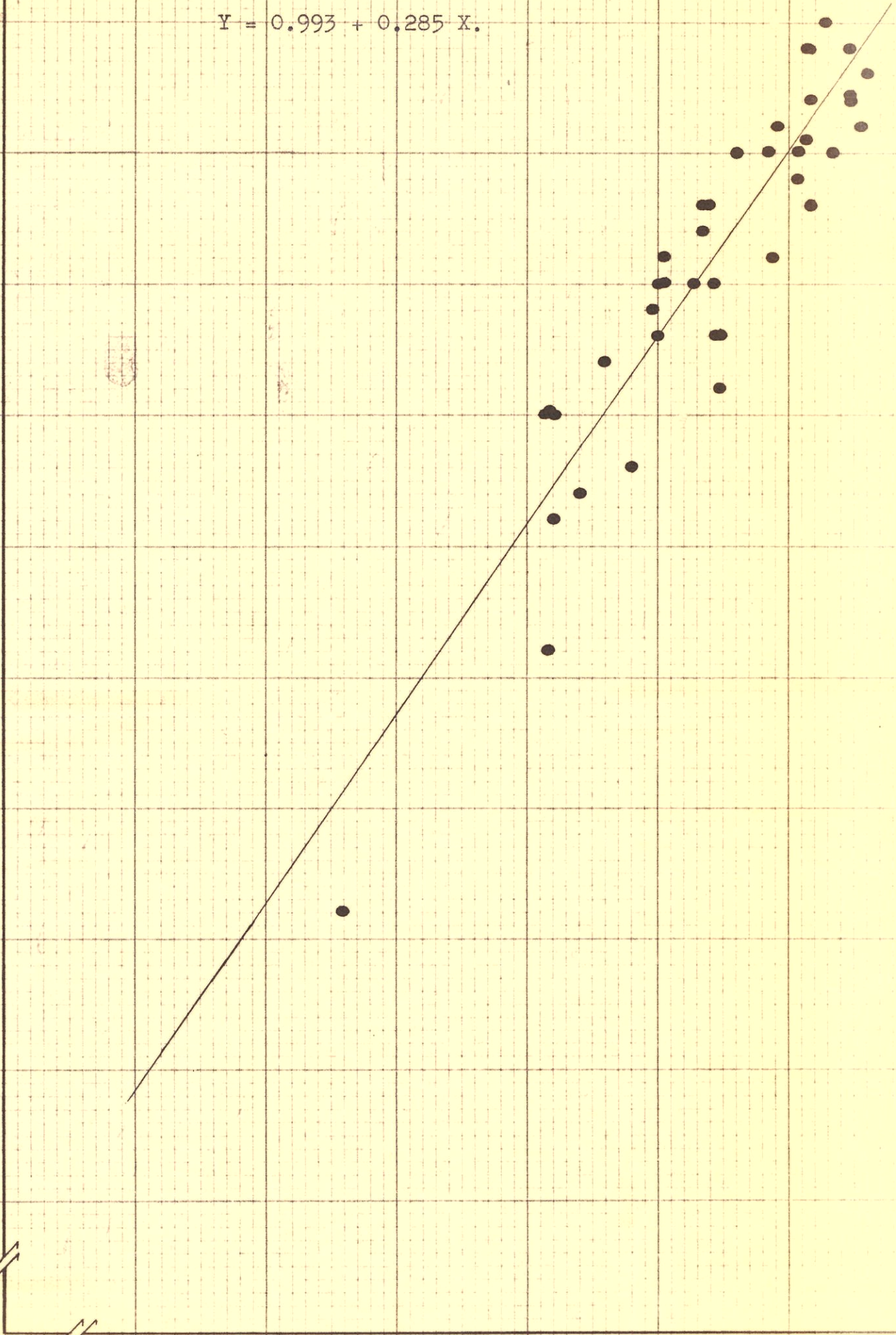
7
6
5
4
3
2
0

5

10

15

FEMUR LENGTH



Femur Length (X)	Femur Width (Y)
9.0	3.1
12.5	4.1
12.8	4.6
13.0	4.9
13.2	5.0
13.5	4.7
14.0	5.2
14.5	4.8
14.8	5.3
15.0	5.4
15.2	5.5
15.5	5.4
15.8	5.3
16.0	5.1
16.2	5.7
16.5	5.8
16.8	5.9
17.0	5.6
17.2	6.0
17.5	5.9
17.8	6.1
18.0	5.8
18.2	6.2
18.5	6.0
18.8	6.4
19.0	6.1
19.2	6.5
19.5	6.3
19.8	6.6
20.0	6.4
20.2	6.7
20.5	6.5
20.8	6.8
21.0	6.6

was the case for the head ratios, a linear correlation nevertheless exists with a positive regression of femur length (Y-axis) on femur width (X-axis).

A comparison of the means of the ratio femur length/width was subsequently carried out with the aid of the Student's t-distribution test at the 95% level of confidence. As it was necessary to know whether one of the means of the species compared were merely significantly greater or whether the means were, in fact, entirely different from each other, both the one-sided and two-sided tests were applied. The following species were compared:

1. oliffi and barnardi, tables 51 - 53.
2. oliffi and scotti, tables 54 - 55.
3. oliffi and peringueyi, table 56.
4. barnardi and scotti, table 57.
5. barnardi and peringueyi, table 58.
6. scotti and peringueyi, table 59.

Due to the small number of specimens analysed, harrisoni was not subjected to the t-test, although all indications were that this species will differ significantly from most if not all the species of Afronurus.

A highly significant difference was obtained between the means of the first, second and third femora of oliffi and barnardi from all the localities compared, for both the one-sided and the two-sided tests (tables 51-53). Similarly oliffi differs highly significantly from scotti (tables 54 & 55) as well as from peringueyi (table 56). In table 57 a comparison of the means of the ratio

femur length/width of the femora of barnardi and scotti also indicated highly significant differences between samples of both species from different localities in South Africa. Of interest was the comparison of the means, of the closely related species peringueyi and barnardi (table 58), where significant or highly significant differences were obtained. In this instance the smallest differences, which were significant at the 95% level of confidence, occurred in the comparison between the second and third femora of specimens of the two species, and then only in the two-sided t-test. The one-sided test, however, showed that the means of the ratios for the second and third femur of barnardi were highly significantly greater than those of peringueyi. The species peringueyi and scotti also differed highly significantly in both the one-sided and two-sided t-tests with respect to this ratio (table 59). Where it was possible to compare the same species from different localities (barnardi, tables 60 - 61; scotti, table 62), nonsignificant differences were obtained in both the one-sided and two-sided t-tests. The only exception was the barnardi specimens from the Cape, which differ significantly from those of the Emolweni river, Natal, in respect of the means of the second (1-sided test) and the third femur (both tests). This agrees with some of the other findings which also showed barnardi from the Western Cape to differ from this species in the Transvaal and Natal, with regard to the head ratios and the abdominal and body patterns.

The statistical results, furthermore, suggest that the barnardi specimens from the Western Cape are

TABLE 51

A comparison between the femur ratios length/width of the nymphs of the

South African species of Afronurus

A. oliffi^{**} and A. barnardi^{***}

Femur	Species	N	\bar{x}	n-1 Sx^2	d.f.	t	P		Differences between sample means	
							2-sided test	1-sided test	2-sided test	1-sided test
FIRST	<u>OLIFFI</u>	23	2.4190	0.204	60	4.381	<0.001	<0.0005	highly significant	highly significant
	<u>BARNARDI</u>	39	2.5728	0.866						
SECOND	<u>OLIFFI</u>	23	2.4813	0.393	61	4.797	<0.001	<0.0005	highly significant	highly significant
	<u>BARNARDI</u>	40	2.6962	1.395						
THIRD	<u>OLIFFI</u>	23	2.8266	0.309	60	6.873	<0.001	<0.0005	highly significant	highly significant
	<u>BARNARDI</u>	39	3.1724	1.888						

* Locality : Small mountain stream, Cathedral Peak, Natal.

*** Locality : Emolweni river, Kloof, Natal.

TABLE 52

Comparison between the femur ratios length/width of the nymphs of the South African species of Afronurus

A. oliffi* and A. barnardi**

Femur	Species	N	\bar{x}	n-1 Sx ²	d.f.	t	P		Differences between sample means	
							2-sided test	1-sided test	2-sided test	1-sided test
FIRST	<u>OLIFFI</u>	23	2.4190	0.204	27	3.350	0.001-0.010	0.0005-0.005	highly significant	highly significant
	<u>BARNARDI</u>	6	2.5740	0.071						
SECOND	<u>OLIFFI</u>	23	2.4813	0.393	26	2.597	0.01-0.02	0.005-0.010	highly significant	highly significant
	<u>BARNARDI</u>	5	2.6672	0.154						
THIRD	<u>OLIFFI</u>	23	2.8266	0.309	27	5.768	<0.001	<0.0005	highly significant	highly significant
	<u>BARNARDI</u>	6	3.1600	0.120						

* Locality : Small mountain stream, Cathedral Peak, Natal.

** Locality : Vaal river, Skandinawie, Transvaal - Orange Free State Border.

TABLE 53

Comparison between the femur ratios length/width of the nymphs of the

South African species of Afronurus

A. oliffi* and A. barnardi**

Femur	Species	N	\bar{x}	n-1 Sx ²	d.f.	t	P		Differences between sample means	
							2-sided test	1-sided test	2-sided test	1-sided test
FIRST	<u>OLIFFI</u>	23	2.4190	0.204	44	3.839	<0.001	<0.0005	highly significant	highly significant
	<u>BARNARDI</u>	23	2.5588	0.467						
SECOND	<u>OLIFFI</u>	23	2.4813	0.393	44	3.878	<0.001	<0.0005	highly significant	highly significant
	<u>BARNARDI</u>	23	2.6354	0.406						
THIRD	<u>OLIFFI</u>	23	2.8266	0.309	45	4.597	<0.001	<0.0005	highly significant	highly significant
	<u>BARNARDI</u>	24	3.0714	1.190						

* Locality : Small mountain stream, Cathedral Peak, Natal.

** Locality : Vaal river. Various localities.

TABLE 54

Comparison between the femur ratios length/width of the nymphs of the South African species of Afromurus

A. oliffi* and A. scotti

Fémur	Species	N	\bar{x}	n-1 Sx^2	d.f.	t	P		Differences between sample means	
							2-sided test	1-sided test	2-sided test	1-sided test
FIRST	<u>OLIFFI</u>	23	2.4190	0.204	43	6.361	<0.001	<0.0005	highly significant	highly significant
	<u>SCOTTI</u>	22	2.2110	0.313						
SECOND	<u>OLIFFI</u>	23	2.4813	0.393	44	4.496	<0.001	<0.0005	highly significant	highly significant
	<u>SCOTTI</u>	23	2.3002	0.428						
THIRD	<u>OLIFFI</u>	23	2.8266	0.309	41	6.262	<0.001	<0.0005	highly significant	highly significant
	<u>SCOTTI</u>	20	2.5353	0.640						

* Locality : Small mountain stream, Cathedral Peak, Natal.

** Locality : Umgeni river, (various localities), Natal.

TABLE 55

Comparison between the femur ratios length/width of the nymphs of the

South African species of Afronurus

A. oliffi^{*} and A. scotti^{**}

Femur	Species	N	\bar{x}	n-1 Sx ²	d.f.	t	P		Differences between sample means	
							2-sided test	1-sided test	2-sided test	1-sided test
FIRST	<u>OLIFFI</u>	23	2.4190	0.204	40	6.270	<0.001	<0.0005	highly significant	highly significant
	<u>SCOTTI</u>	19	2.1714	0.445						
SECOND	<u>OLIFFI</u>	23	2.4813	0.393	40	4.6360	<0.001	<0.0005	highly significant	highly significant
	<u>SCOTTI</u>	19	2.2228	0.901						
THIRD	<u>OLIFFI</u>	23	2.8266	0.309	37	5.237	<0.001	<0.0005	highly significant	highly significant
	<u>SCOTTI</u>	16	2.5714	0.520						

* Locality : Small mountain stream, Cathedral Peak, Natal

** Locality : Umgeni river at Dargle Forestry, Dargle, Natal.

TABLE 56

Comparison between the femur ratios length/width of the nymphs of the

South African species of Afronurus

A. oliffi^{*} and A. peringueyi^{**}

Femur	Species	N	\bar{x}	n-1 Sx ²	d.f.	t	P		Differences between sample means	
							2-sided test	1-sided test	2-sided test	1-sided test
FIRST	<u>OLIFFI</u>	23	2.4190	0.204	60	2.092	0.02-0.05	0.010-0.025	significant	significant
	<u>PERINGUEYI</u>	39	2.3524	0.676			nonsignificant	nonsignificant		
SECOND	<u>OLIFFI</u>	23	2.4813	0.393	60	1.2013	0.2-0.3	0.10-0.15	nonsignificant	nonsignificant
	<u>PERINGUEYI</u>	39	2.4372	0.777			nonsignificant	nonsignificant		
THIRD	<u>OLIFFI</u>	23	2.8266	0.309	60	1.466	0.1-0.2	0.05-0.10	nonsignificant	nonsignificant
	<u>PERINGUEYI</u>	39	2.8806	0.869			nonsignificant	nonsignificant		

* Locality : Small mountain stream, Cathedral Peak, Natal.

** Locality : Vaal river, Skandinawië, border of Transvaal and Orange Free State.

Comparison of the first, second and third femur ratios length/width of Afronurus barnardi and A. scotti from different localities in South Africa

FEMUR	Species	Locality*	N	\bar{x}	n-1 Sx ²	d.f.	t	F		Differences between sample means	
								2-sided test	1-sided test	2-sided test	1-sided test
FIRST	<u>barnardi</u>	Vaal river	23	2.5588	0.467	40	8.277	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Dargle Forestry	19	2.1714	0.445						
SECOND	<u>barnardi</u>	Vaal river	23	2.6354	0.406	40	7.362	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Dargle Forestry	19	2.2228	0.901						
THIRD	<u>barnardi</u>	Vaal river	24	3.0714	1.190	38	7.303	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Dargle Forestry	16	2.5714	0.520						
FIRST	<u>barnardi</u>	Vaal river	23	2.5588	0.467	43	8.658	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Umgeni	22	2.2110	0.313						
SECOND	<u>barnardi</u>	Vaal river	23	2.6354	0.406	44	8.255	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Umgeni	23	2.3002	0.428						
THIRD	<u>barnardi</u>	Vaal river	24	3.0714	1.190	42	8.485	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Umgeni	20	2.5353	0.640						
FIRST	<u>barnardi</u>	Emolweni	39	2.5728	0.866	56	9.379	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Dargle Forestry	19	2.1714	0.445						
SECOND	<u>barnardi</u>	Emolweni	40	2.6962	1.395	57	8.466	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Dargle Forestry	19	2.2228	0.901						
THIRD	<u>barnardi</u>	Emolweni	39	3.1724	1.888	53	9.502	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Dargle Forestry	16	2.5714	0.520						
FIRST	<u>barnardi</u>	Emolweni	39	2.5728	0.866	59	9.598	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Umgeni	22	2.2110	0.313						
SECOND	<u>barnardi</u>	Emolweni	40	2.6962	1.395	61	8.751	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Umgeni	23	2.3002	0.428						
THIRD	<u>barnardi</u>	Emolweni	39	3.1724	1.888	57	11.000	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Umgeni	20	2.5353	0.640						
FIRST	<u>barnardi</u>	Skandinawie	6	2.5740	0.071	23	5.738	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Dargle Forestry	19	2.1714	0.445						
SECOND	<u>barnardi</u>	Skandinawie	5	2.6672	0.154	22	4.038	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Dargle Forestry	19	2.2228	0.901						
THIRD	<u>barnardi</u>	Skandinawie	6	3.1600	0.120	20	6.877	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Dargle Forestry	16	2.5714	0.520						
FIRST	<u>barnardi</u>	Skandinawie	6	2.5740	0.071	26	6.486	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Umgeni	22	2.2110	0.313						
SECOND	<u>barnardi</u>	Skandinawie	5	2.6672	0.154	26	4.970	<0.001	<0.0005	highly significant	highly significant
	<u>scotti</u>	Umgeni	23	2.3002	0.428						
	<u>barnardi</u>	Skandinawie	6	3.1600	0.120						

TABLE 58

Comparison of the first, second and third femur ratios length/width of Afronurus barnardi and A. peringueyi

Femur	Species	Locality	N	\bar{x}	n-1 Sx ²	d.f.	t	P		Difference between sample means	
								2-sided test	1-sided test	2-sided test	1-sided test
FIRST	<u>barnardi</u>	Skandinawie	6	2.5740	0.071	43	3.834	<0.001	<0.0005	highly significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.3524	0.676						
SECOND	<u>barnardi</u>	Skandinawie	5	2.6672	0.154	42	3.252	0.01-0.001	0.005-0.0005	significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.4372	0.777						
THIRD	<u>barnardi</u>	Skandinawie	6	3.1600	0.120	43	2.026	0.05-0.02	0.025-0.010	significant	significant
	<u>peringueyi</u>	Skandinawie	39	2.8806	0.869						
FIRST	<u>barnardi</u>	Vaal river	23	2.5588	0.467	50	5.671	<0.001	<0.0005	highly significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.3524	0.676						
SECOND	<u>barnardi</u>	Vaal river	23	2.6354	0.406	50	5.597	<0.001	<0.0005	highly significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.4372	0.777						
THIRD	<u>barnardi</u>	Vaal river	24	3.0714	0.190	51	3.992	<0.001	<0.0005	highly significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.8806	0.869						
FIRST	<u>barnardi</u>	Emolweni	39	2.5728	0.866	76	6.835	<0.001	<0.0005	highly significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.3524	0.676						
SECOND	<u>barnardi</u>	Emolweni	40	2.6962	1.395	77	8.129	<0.001	<0.0005	highly significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.4372	0.777						
THIRD	<u>barnardi</u>	Emolweni	39	3.1724	1.888	76	8.078	<0.001	<0.0005	highly significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.8806	0.869						

TABLE 59

Comparison of the first, second and third femur ratios length/width of Afronurus scotti and A. peringueyi from two localities in Natal and the Transvaal

Femur	Species	locality*	N	\bar{x}	n-1 Sx ²	d.f.	t	P		Difference between sample means	
								2-sided test	1-sided test	2-sided test	1-sided test
FIRST	<u>harrisoni</u>	Dargle Forestry	19	2.1714	0.445	56	4.578	<0.001	<0.0005	highly significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.3524	0.676						
SECOND	<u>harrisoni</u>	Dargle Forestry	19	2.2228	0.901	56	4.433	<0.001	<0.0005	highly significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.4372	0.777						
THIRD	<u>harrisoni</u>	Dargle Forestry	16	2.5714	0.520	53	6.434	<0.001	<0.0005	highly significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.8806	0.869						
FIRST	<u>harrisoni</u>	Umgeni	22	2.2110	0.313	59	4.096	<0.001	<0.0005	highly significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.3524	0.676						
SECOND	<u>harrisoni</u>	Umgeni	23	2.3002	0.428	60	3.679	<0.001	<0.0005	highly significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.4372	0.777						
THIRD	<u>harrisoni</u>	Umgeni	20	2.5353	0.640	57	7.712	<0.001	<0.0005	highly significant	highly significant
	<u>peringueyi</u>	Skandinawie	39	2.8806	0.869						

TABLE 61

Comparison between the femur ratios length/width of the nymphs of the

South African species of Afronurus

A. barnardi* and A. barnardi**

Femur	Species	N	\bar{x}	n-1 Sx ²	d.f.	t	P		Differences between sample means	
							2-sided test	1-sided test	2-sided test	1-sided test
FIRST	<u>BARNARDI</u> *	13	2.5728	0.866	50	0.872	0.4-0.3	0.2-0.15	nonsignifi- cant	nonsignifi- cant
	<u>BARNARDI</u> **	39	2.6156	0.307						
SECOND	<u>BARNARDI</u> *	13	2.8159	0.397	51	1.981	0.1-0.05	0.05-0.025	nonsignifi- cant	nonsignifi- cant
	<u>BARNARDI</u> **	40	2.6962	1.395						
THIRD	<u>BARNARDI</u> *	13	3.3142	0.012	50	2.271	0.05-0.02	0.025-0.010	significant	significant
	<u>BARNARDI</u> **	39	3.1724	1.888						

* Locality : Great Berg river system near Saron, Western Cape.

** Locality : Emolweni river at Krantzklouf Nature Reserve, Kloof. Natal.

TABLE 62

Comparison of the first, second and third femur ratios length/width of Afronurus scotti from localities in the Umgeni basin Natal (2-sided t-test)

Femur	Sampling localities	N	\bar{x}	n-1 Sx ²	d.f.	t	P	Differences between sample means
FIRST	DARGLE FORESTRY	19	2.1714	0.445	39	0.904	0.4-0.3	nonsignificant
	UMGENI	22	2.2110	0.313				
SECOND	DARGLE FORESTRY	19	2.2228	0.901	40	1.370	0.2-0.1	nonsignificant
	UMGENI	23	2.3002	0.428				
THIRD	DARGLE FORESTRY	16	2.5714	0.520	34	0.583	0.6-0.5	nonsignificant
	UMGENI	20	2.5353	0.640				

somewhat different from those of Natal and Transvaal. The above results also indicate that one can assume with a high degree of certainty, that the ratios discussed here are constant for the species, and, furthermore can be used in conjunction with other characteristics to separate certain species from each other.

9.7 The subimagines and imagines of Afronurus.

The subimago and imago of every species studied, closely agree with each other in respect of their body markings, and the colouration of the head, thorax, legs and abdomen. The only differences are to be found in the intensity of the colouration, which is more dull in the subimago. This difference, however, only holds for live or unpreserved material because the brighter underlying colour of the imago immediately shows up clearly once the subimago is transferred to water or preservatives. Unfortunately, the colours and markings of the subimago do not last in preservatives as long as those of the imagines, and, even in the latter, much of the colour is lost within the first year.

The major permanent difference between the subimago and imago lies in the wing pattern. In contrast to the imagines where the wings are of secondary importance in the identification of the species, those of the subimaginal specimens, with their attractive and contrasting colouration, are highly diagnostic of the species. The male genitalia and female ventral plates are, however, already recognisable in

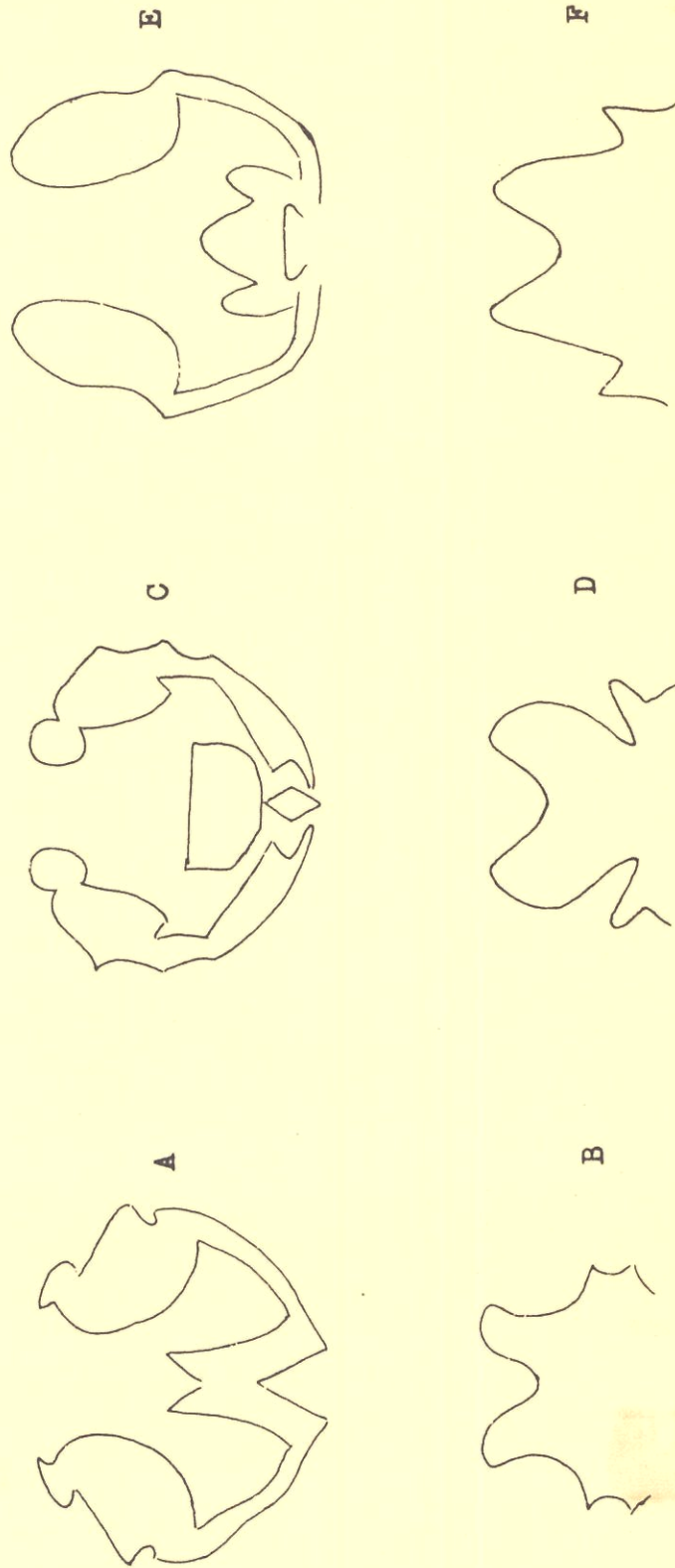


Fig. 53. Variational tendencies in the patterns of the mesothorax (A, C, E) and abdominal segment 5 (B, D, F) in nymphs of Afronurus barnardi. A & B - Transvaal specimens; C & D - Western Cape specimens; E & F - Natal specimens.

the subimagines, and, the key to the imagines, which is largely based on the structure of the genitalia, can therefore also be employed in the identification of the subimagines.

97.1

Key to the subimagines

- 1. Subimaginal wing membrane yellowish with a brownish tinge, forming characteristic broad dark brown stripes covering cross veins of the enclosed imaginal wings (fig. 55) 2

Subimaginal wing membrane predominantly grey, except in the costal strip which is pale yellow; without dark brown stripes covering cross veins.(fig. 68) 3

- 2. Longitudinal and cross veins of imaginal wing within subimaginal sheath distinctly dark brown; no dark brown markings along ventrolateral surfaces of abdominal tergites oliffi sp. nov.

Longitudinal and cross veins of wing inside subimaginal sheath pale yellow; roughly triangular dark brown marking along ventrolateral line of each abdominal tergite (fig. 55)harrisoni Barnard

- 3. Area of wing immediately below costal strip and along the posterior border, dark grey,

enclosing a pale brownish region stretching across the wing from near its tip into the cubito-anal area where this lighter coloured portion is at its widest (fig. 50)
..... barnardi sp. nov.

Wing membrane, with the exception of the costal strip, predominantly grey with short lighter coloured streaks between the longitudinal veins (fig. 68).. peringueyi (Petersen)

9.7.2

Key to the male imagines of Afronurus

- 1. Penis bilobed; each lobe distinctly excised apically to form a narrow digitiform inner lobe and a shorter but wider outer lobe 2
- Penis bilobed, even if only at tip; lobes not as above 3
- 2. Inner digitiform lobe of each penis lobe distinctly longer than outer lobe (fig. 54B A) wing membrane hyaline with costal strip pale yellow before bulla and milky towards wing tip; abdominal tergites reddish brown dorsally peringueyi Petersen
- Inner digitiform lobe^{of penis} only slightly longer than outer lobe (fig. 54B C); wing membrane pale yellowish (fig. 66) with costal strip darker yellow; abdominal tergites dark brown or purplish brown dorsally in first

6-8 segments barnardi sp. nov.

3. Penis only superficially cleft ventrally; each lobe with an inner thickened ridge curving outwards; ventral surface of each lobe with a wide shallow concavity (fig. 54B F); wing membrane hazyline; costal strip bright yellow, slightly milky towards wing tip; cross veins milky; abdominal tergites with roughly triangular purplish brown markings along ventrolateral surfaces (fig. 60)..... 4

Penis almost square, roughly truncate posteriorly with parallel sides; very shallowly excised apically and grooved along the mid ventral line; each penis lobe weakly excised, its slightly longer inner lobe being formed by a thickening of the inner margin of the penis lobe; two lobes of each penis lobe separated from each other ventrally by a longitudinal running concavity (fig. 54B E); longitudinal veins of fore wing brownish; cross veins dark brown; wing membrane in the costal strip yellowish brown oliffi sp. nov.

4. Inner thickened ridge of each penis lobe tapering towards its apex (fig. 54A B) scotti sp. nov.

Inner thickened ridge of each penis lobe not distinctly tapering towards apex of penis lobe (fig. 54A D).... harrisoni Barnard

9.7.3 Key to the female imagines of Afronurus

- 1. Abdominal terga with purplish brown markings along their ventrolateral margins 2
 Abdominal terga without such markings 3
- 2. Ventral plate tapering towards apex with almost straight lateral edges; apical excision almost V-shaped (fig.54 A A) scotti sp. nov.
 Ventral plate curving inwards towards apex in its posterior 1/3 rd; apical excision shallowly concave (fig.54A C). harrisoni Barnard
- 3. Wing membrane yellowish brown in costal strip; cross veins dark brown (fig. 62); ventral plate with evenly rounded lateral sides; apical excision V-shaped (fig.54A E) oliffi sp. nov.
 Wing membrane pale yellowish or milky in costal strip; cross veins milky; ventral plate with almost straight lateral sides 4
- 4. Ventral plate clearly excised apically (fig.54A G); abdominal terga reddish or reddish-brown dorsally peringeuyi Petersen
 Ventral plate virtually truncate posteriorly (fig.54A H); abdominal terga brownish or purplish-brown dorsally barnardi* sp. nov.

* In barnardi specimens from the Cape, the ventral plate is virtually rounded apically.

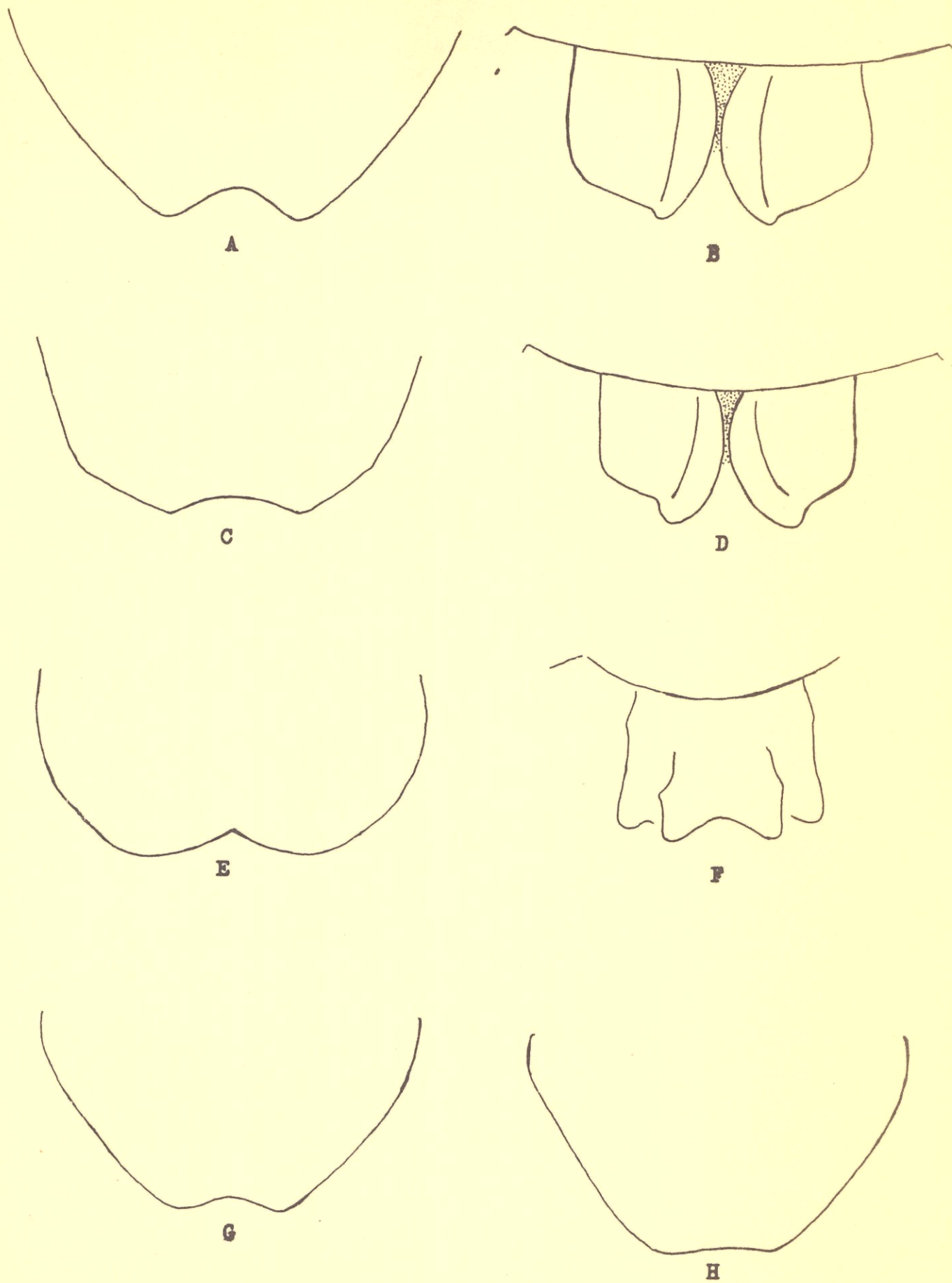


Fig. 54A. Afronurus female ventral plates (A, C, E, G, H) and male genitalia (B, D, F). A & B - scotti; C & D - harrisoni; E & F - oliffi; G - peringueyi; H - barnardi (Natal and Transvaal specimens).

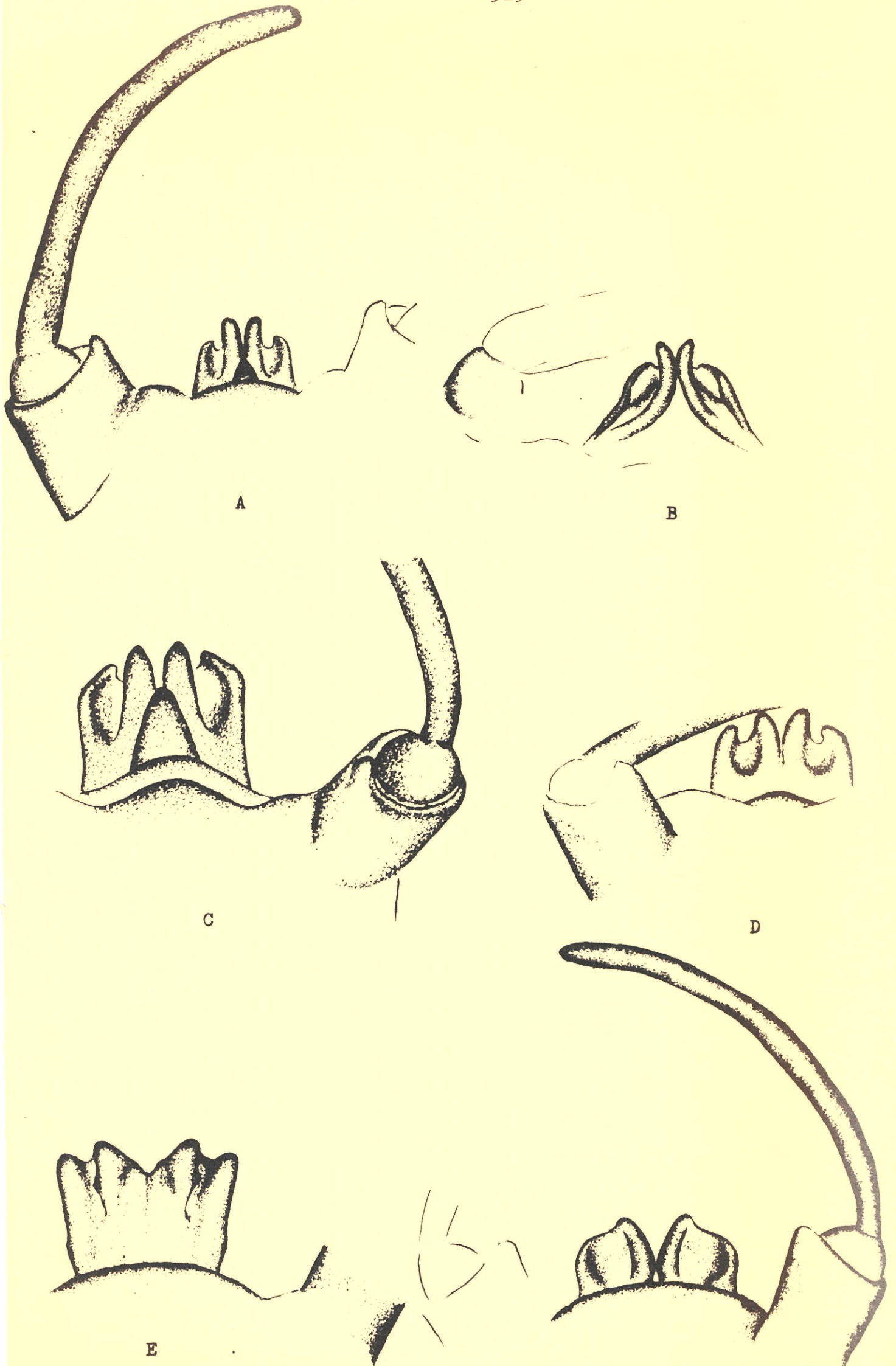


Fig. 54B. Afronurus spp. Male genitalia. A - peringueyi; B - peringueyi (lectotype); C - barnardi; D - barnardi (harrisoni "type material"); E - oliffi; F - scotti.

9.7.4 Description of subimagines and imagines

9.7.4.1 Afronurus scotti

♀ Subimago : Paratype

Body length:

Ratio of tarsal joints.

First leg : 5) 2) 1 = 3) 4.

Second leg : 5) 1) 2) 3) 4.

Third leg : 5) 1) 2) 3) 4.

HEAD

Epicranial portion between compound eyes and ocelli brown with minute blackish dots and streaks. Head dark brown in immediate vicinity of region of fusion with compound eyes. A groove in this dark brown region, follows the line of fusion between the epicranial portion and the compound eyes. Frontal region brown and speckled with markings similar to those on epicranium. Frontoclypeus provided with a carina stretching from below median ocellus to anterior margin of head. Clypeus uniformly dark brown, densely speckled, folded downwards (= backwards) along the lateral and anterior border of head. Antennae reddish brown at their bases, smooth and filiform with scape widest and shorter than pedicel; flagellum fuscous brown. Ocelli hyaline, with greenish black bases medially (lateral ocelli) and dorsally (median ocellus). Compound eye mainly pale yellowish. When viewed from above, a bright reddish brown band

can be observed to stretch along the inner, anterior and antero-lateral edge of the compound eye tapering and fading out laterally, approximately opposite the posterior margin of the vertex. That part of the eye ventral to the reddish brown band is yellow with a slightly reddish tinge. The smallest ommatidia occur on the inner, narrower portions of the compound eyes.

THORAX

Thorax pale yellowish brown. Pronotum short and saddlelike with a deep mediodorsal posterior incision. Mesonotum with two pairs of dark brown longitudinal bands, one pair of which stretches across a large portion of the mesonotum. Metanotum without markings. Pleura yellowish brown with brown markings at base of forewing and near coxae of second and third legs. Thoracic spiracles slitlike, purplish brown.

Legs

First leg dark brown. Second and third legs pale yellowish brown. All the coxae with dark brown edges distally at their points of attachment to the trochanters. Trochanters darker distally, each one terminating ventrally in two small pointed lobes, the anterior of which is light brown and bigger than the dark brown posterior lobe. Posterior halves of trochanters generally darker than their anterior surfaces. Femora brownish with thinly scattered dark spots and short streaks on their anterior surfaces but reddish brown distally. The lobes of first femur is

darker in colour, smaller and less pointed than those of second and third femur. Tibia angular in cross section, pale yellow, the first one slightly brown, second and third pale yellow. Tarsi dark brown.

Wings

Forewing bright yellow in costal strip, especially in area between costal brace and bulla. Rest of wing pale yellowish with a faint tinge of purplish brown. Costa dark brown; subcosta, radius, media cubital and anal veins pale yellow; cross veins brownish and very distinct, largely due to concentration of brownish pigmentation on subimaginal wing sheath opposite and in close proximity to cross veins (fig. 60). Hind wings bright yellow near costal brace but pale yellowish brown elsewhere. Longitudinal and cross veins of the same colour in both wings.

ABDOMEN

Abdominal terga brownish to reddish brown dorsally and pale yellowish laterally, with a faint narrow yellowish stripe along the middorsal line of abdomen. Minute dark spots and stripes, similar to those on femora, occur on terga, particularly near posterior margins of segments. Very characteristic of the species is the presence of brown markings along the ventrolateral line of each abdominal tergite, the colour of which increases in intensity towards the seventh segment but fades out in the eighth to the tenth terga. Abdominal sternites pale yellow.

Ventral plate

Subgenital plate prominent, strongly curved downwards, slightly rounded at base and tapering gradually towards distinctly excised, shallow, V-shaped apex, (fig. 54A A).

Terminal filaments

Cerci reddish brown at their bases but dark brown distally with segments becoming progressively longer and thinner towards the tips.

♂ Subimago : Paratype

Length of body : 11.0 mm.

Length of forewing : 11.0 mm.

Width of forewing : 4.1 mm.

Length of hindwing : 3.6 mm.

Width of hindwing : 2.2 mm.

Ratios of tarsal joints.

First leg : 2 > 3 > 5 > 1 > 4.

Second leg : 5 > 1 > 2 > 3 > 4.

Third leg : 5 > 1 > 2 > 3 > 4.

HEAD

Frontoclypeus pale yellowish brown with dark markings similar to those on head of ♀ subimago. Epicranium, where exposed between the large compound eyes and the ocelli, yellowish brown. Antennal sclerite pale yellow, antennal scape, pedicel and

base of flagellum yellowish brown with rest of antenna fuscous. Ocelli hyaline, each bordered ventrally by narrow yellow colouration which overlies greenish black broad base. Lateral ocelli largest. Compound eyes large, almost contiguous mediodorsally, silvery grey with two brown bands: Encircling the eye dorsolaterally there is a broad reddish brown band which gets progressively narrower towards the inner edges of the compound eye, tapering and fading out before the circle is completed, exposing the greyish ground colour at the inner angles of the compound eyes (fig. 59). Dorsal surface of eye, enclosed by the abovementioned brown ring, has distinct reddish brown tinge, particularly so mid dorsally.

Above colouration absent in some specimens. A second, much shorter and dark brown band stretches along the anteroventral edges of each compound eye, tapering and fading out posterolaterally. Between these bands the colour of the eyes are predominantly grey, except for a narrow yellow zone immediately dorsally ^{to} of the ventral band.

THORAX

Colouration and markings as in ♀ subimago.

Legs

Colouration as in ♀ subimago. First tarsus much longer than in second or third.

Wings

Colouration and wing pattern as in ♀ subimago (fig. 55).

ABDOMEN

Colouration as in ♀ subimago. Dark purplish brown markings along the lateral side of abdomen

very distinct. Mediodorsal fine yellowish line as in ♀ subimago. Characteristic yellowish markings on each tergite lateral to mediodorsal line.

Abdominal sternites pale yellow in first few segments becoming progressively browner towards stylicher plate. Genostyles dark brown, almost black. Penis yellowish brown. Cerci as in ♀ subimago. Faint reddish brown colouration along midventral line of sternites. Each sternite displays yellowish pattern appearing as shallow indentations in the integuments (fig. 56).

♀ Imago : Paratype

Measurements in mm.

Body length : 12.60

Cerci (length) : 24.00 - 26.00

Legs (length) : All measurements along dorsal surfaces of segments.

First leg: Femur 3.20; tibia 2.65; tarsus 1.66; claw 0.22.

Second leg: Femur 3.50; tibia 2.60; tarsus 1.17; claw 0.30.

Third leg : Femur 3.40; tibia 2.62; tarsus 1.12; claw 0.30.

Ratio of tarsal joints:

First leg : 5 > 2 > 1 > 3 > 4.

Second leg : 5 > 1 > 2 > 3 > 4.

Third leg : 5 > 1 > 2 > 3 > 4.

HEAD

Colouration and markings as in ♀ subimago.

THORAX

Predominantly yellowish brown, with markings and colouration similar but brighter than those of the ♀♀ and ♂♂ subimagines.

Wings

Forewing hyaline with faint yellowish tinge. Costa, subcosta and radius yellowish brown and costal strip bright canary yellow; other longitudinal veins predominantly yellow; intercalaries creamy white and, in contrast to the dark brown markings which define the latter on the wing sheaths of the subimagines (fig .

55), they are not so readily distinguishable in the imagines. Hind wing canary yellow in costal trip, especially near costal brace.

Legs

Markings and colouration as in subimagines. First femur reddish brown and darker than second and third femora which are yellowish brown. All femora darker towards their apices. Tibiae mainly yellow but luteous proximally. The yellowish brown tarsi bear slightly darker yellowish brown claws.

ABDOMEN

As in ♀ subimago. Colour intensities only brighter, reddish brown dorsally with the characteristic purplish brown lateral markings best developed in segments 3-7. Abdominal sternites yellow with

a faint brownish tinge.

Ventral plate

Subgenital plate yellow with brownish apex,
apically excised (fig.54A A).

Terminal filaments

Reddish brown near base, turning consecutively
brown and yellow towards tips. Otherwise as in
subimagines.

♂ Imago : Holotype

Measurements in mm.

Body length : 12.00

Cerci (Length) : 26.00 - 27.00

Forewing (length): 11.00

Forewing (width) : 4.00

Hindwing (length): 3.70

Hindwing (width) : 2.20

Legs (length) : All measurements along dorsal
surfaces of segments.

First leg: Femur 3.10; tibia 3.35; tarsus 3.57;
claw 0.25.

Second leg: Femur 3.00; tibia 2.30; tarsus 1.24
claw 0.25.

Third leg: Femur 3.20; tibia 2.45; tarsus 1.09;
claw 0.25.

Legs

First legs yellowish brown, darker than second and third legs which are mainly yellow. Femora reddish brown towards apices with dark splashlike markings as in ♀. Tarsi brownish.

ABDOMEN

Abdomen yellowish brown to reddish brown dorsally with characteristic yellow markings (fig. 59). Abdominal tergites 2-5, predominantly brownish dorsally with tergites 6-9 assuming a more reddish brown colour. Tergite 10 yellowish. Faint mediodorsal yellow stripe, present in ♀♀ imagines and subimagines, occurs on tergites 1-8. Dark purplish brown markings on the ventrolateral sides of the abdominal terga 1-9, more prominent than in ♀♀ (fig. 60). Sternites of abdomen as in ♂ subimago with a faint reddish medioventral stripe.

Genitalia

Styliger plate yellowish brown, short, rounded posteriorly. Basal segment of genostyle short, coneshaped, followed by long cylindrical second segment which in turn tapers into two shorter segments. Third segment slightly longer than fourth. (This description also holds for the other species under consideration).

Penis brown, apically excised. Each lobe is concave ventrally with their inner margins contiguous in the middle, diverging distally and apically (figs.

54A B & 54B F). These curved inner margins of each penis lobe appear as thickened folds. Dorsally, each lobe is swollen basally, flattened at its tip with the inner edges of each lobe tapering and curving upwards.

Terminal filaments

Cerci as in ♀ imago.

The type material of A. scotti

Type locality: Umgeni river at Albert Falls, Natal.

Type material: Holotype: ♂ imago; Umgeni river at Albert Falls; nymph collected 9.4.62, bred out 12.4.62; coll. H.J.Schoonbee.

Paratype: ♂ imago; Umgeni river at Albert Falls; nymph collected 9.4.62, correlated 11.4.62; coll. H.J.Schoonbee.

Paratypes: 2 ♂♂ imagines; Umgeni river at Albert Falls; nymphs collected, 9.4.62, correlated 14.4.62; coll. H.J. Schoonbee.

Paratype: ♂ imago; Crocodile river system at Rietvlei; correlated 30.11.60; J.D. Agnew. (Cat. No. Rietvlei 27).

Paratype: ♂ subimago; Umgeni river at Albert Falls; nymphs collected, 9.4.62, correlated 13.4.62; coll. H.J. Schoonbee.

paratypes: 2 ♀♀ imagines; Umgeni river at Albert Falls; nymphs collected 9.4.62, correlated 12.4.62; coll. H.J. Schoongee.

Paratype: ♀ imago; Crocodile river system at Rietvlei; correlated 30.11.60; coll. ? J.D. Agnew (Cat. No. Rietvlei 27).

Paratype: ♀ subimago; Umgeni river at Albert Falls; nymph collected 9.3.62, bred out 11.3.62; coll. H.J. Schoonbee.

9.7.4.2

Afronurus harrisoni Barnard

♀ Subimago : Paraneotype

Ratio of tarsal joints:

First leg : 5 > 2 > 3 > 1 > 4.

Second leg : 5 > 1 = 2 > 3 > 4.

Third leg : both tarsi missing.

This is the only ♀ subimago in the laboratory bred material of harrisoni received from Dr. K. Scott. Unfortunately it is in a damaged condition and has lost much of its colouration.

HEAD

Vertex pale yellow with a very faint purplish brown tinge in the area enclosed between the compound

eyes and ocelli. Frons and clypeus yellowish brown with the latter possessing some dark speckles not so pronounced as in scotti. Compound eye black but have lost its characteristic colouration. Ocelli hyaline with brownish tinge. If all the other similarities between the two species scotti and harrisoni be taken into consideration, the colour of the eyes of the ♀ subimago of the latter might be expected to agree with that of the former.

THORAX

Thorax pale yellow; markings on nota and pleura resembling those in ♂ subimago.

Legs

The first femur, tibia and tarsus brownish. Second and third legs more yellow. Tarsal joints 1-4 of all legs distinctly spinulose along their ventrodorsal margins.

Wings

Like those of the ♂ subimago and resembling those of scotti.

ABDOMEN

Much of the colouration of the abdomen has faded but since the markings on the dorsal surface of the terga of the ♀♀ are poorly developed in all species, they are not very important in the identification of the species. The terga and sterna are

pale yellow with the dark brown markings along the ventrolateral sides of the latter clearly recognisable.

Ventral plate

The subgenital plate somewhat resembles that of scotti by being shallowly excised at its apex, but differs from this species in the sides being rounded instead of straight (fig. 54A C).

Terminal Filaments

The cerci are similar to those described for the ♂ subimago. It is less yellow and has a brownish tinge.

♂ Subimago : Paraneotype

Body length: 9.1 cm. (head partly severed)

Forewing (length): 10.2 cm.

Ratio of tarsal joints:

First leg : 2 > 3 > 5 > 1 > 4.

Second leg : 5 > 1 > 2 > 3 > 4.

Third leg : 5 > 1 > 2 > 3 > 4.

HEAD

In contrast to scotti, the epicranium, frons and clypeus is distinctly yellow with a very faint brownish tinge. The very distinct dark brown speckles, present on the epicranium and clypeus of

scotti, are absent in harrisoni. The antennal scape is pale yellowish brown with the pedicel predominantly yellow; the flagellum is brownish. Since the specimens were preserved in alcohol, the colour of the compound eyes have already faded, so that the silvery grey ground colour has been almost completely replaced by the dark, almost black, underlying colour of the ommatidia. The brownish bands which encircle the compound eyes in live specimens, could no longer be distinguished clearly. On the limited evidence available on this species there does not appear to be marked differences in the colouration of the eyes of harrisoni and scotti.

THORAX

Thorax yellowish. Mesonotum with brown bands as in scotti. Metanotum with purplish brown stripes running diagonally on either side of the mid dorsal line. Pleura with markings as in scotti.

Legs

Legs mainly yellow; first, second and third coxa with faint purplish brown tinge; trochanter dark brown anterodistally; femur yellowish brown with reddish brown apex; first femur generally darker than second and third femora; tibia brownish proximally but yellowish brown elsewhere; tarsi yellowish brown and finely setose.

Wings

Wings similar to those of scotti. Forewings

yellow in costal strip with subimaginal wing sheaths yellowish brown and tinged purplish. Subimaginal wing sheaths strongly pigmented with brown opposite the cross veins as in scotti. All longitudinal and cross veins except costa, milky yellow.

Hind wing bright yellow near base, otherwise resembling forewing.

ABDOMEN

Markings on abdomen closely resemble those of scotti but differ slightly in intensity and colouration. Ground colour is pale yellowish brown with the colouration in the dorsal surface of the terga being more purplish than reddish brown. The markings on the dorsal surface of the terga are similar to those of scotti (fig. 59). The roughly triangular dark brown markings along the ventrolateral posterior sides of the abdominal terga are best developed in segments 1-8, just present in segment 9 and absent in the tenth tergum. The sterna of the abdominal segments are yellow, shaded with purplish brown. The markings on the sterna are similar to those of scotti but are well developed (fig. 56).

Genitalia

Morphological details as for ♂ imago.

Terminal Filaments

Cerci yellowish with reddish bands at joints of segments.

♀ Imago : Paraneotype

Body length: 9.8 cm.

Forewing (length): 11.3 cm.

Ratios of tarsal joints:

First leg : 5 > 2 > 1 > 3 > 4.

Second leg: 5 > 1 > 2 > 3 > 4.

Third leg : 5 > 1 > 2 > 3 > 4.

This ♀ specimen closely resembles scotti in respect of body markings and colouration. Some of the colour has already faded, particularly that of the eyes, so that no proper comparison can be made with scotti as far as colouration is concerned.

HEAD

Head yellowish brown. Dark brown splashlike markings on posterior margin of vertex similar to those of scotti. Clypeus brownish as in scotti, darker than rest of head and provided with a concentration of dark brown splashlike markings similar to those on epicranium. Pedicel, scape and part of flagellum yellowish brown with terminal portion of the latter fuscous. Ocelli hyaline with dark bases. Compound eye pale yellow almost cream, with brownish band, although considerably faded, still visible along inner, anterior and anterolateral margin.

THORAX

Pronotum yellowish brown with slight purplish pigmentation. Meso- and metanota yellowish brown

with markings similar to ^{to those} ~~that~~ of scotti. Colour and markings on pleura also resemble those of scotti.

Legs

First leg brownish; second and third legs more yellow. All femora darker distally, usually reddish brown in colour. First tibia brown with tarsus dark brown, almost black. Tibiae and tarsi of the second and third legs yellow.

Wings

Forewing canary yellow in costal strip with dark brown marking near subcosta, between costal brace and costal strip. Rest of wing hyaline with a pale yellowish tinge. Longitudinal veins predominantly yellow. Cross veins yellow with faint brownish tinge. Hindwing hyaline, yellowish near costal brace. Longitudinal and cross veins pale yellow.

ABDOMEN

Abdominal segments luteous. Dorsal surfaces of terga pigmented reddish with no discernable pattern. Dark brown markings on ventrolateral aspects of abdominal terga, characteristic of harrisoni, clearly visible in segments 1-8, just present in segment 9 and absent in segment 10. Abdominal sterna with some brownish pigmentation but unlike ♀♀ subimagines and imagines, without any definite pattern.

Ventral plate

The subgenital plate is distinctly different from that of *scotti*, being angularly rounded with a shallow apical concavity (fig. 54A C).

Terminal Filaments

Similar to those of subimago.

♂ Imago : Neotype

Body length: 9.1 cm.

Forewing (length): 10.4 cm.

Ratio of tarsal joints:

First leg : 2 > 3 > 1 = 4 > 5.

Second leg: 5 > 1 > 2 > 3 > 4.

Third leg : 5 > 1 > 2 > 3 > 4.

Preserved in 70% alcohol. One pair of wings and one first, second and third leg mounted on microscope slides.

Like all the other specimens preserved in alcohol or formalin, some of the colouration of the body, and, especially that of the eyes, has already been lost. Since this is one of the best preserved specimens of the *harrisoni* collection from the Cape, it is designated as the new neotype of *harrisoni* Barnard.

HEAD

Vertex and frontal region pale yellow. Clypeus brownish with dark brown splashlike markings

similar to that of scotti. Antennal scape, pedicel and flagellum yellowish brown. Ocelli hyaline. Compound eye silvery grey but somewhat faded to appear slightly milky. Characteristic brown bands, encircling compound eye, just visible.

THORAX

Prothorax yellow with purplish pigmentation flanking mid dorsal line of pronotum. Meso- and meta-nota yellowish brown. Dark brown markings on pleura resemble those of scotti.

Legs

First legs dark brown. Femora of second and third legs reddish brown with their tibiae and tarsi, respectively, yellow, and yellowish with dark brown tinge.

Wings

Colouration of the wings resemble that of ♀ imago, differing from scotti in having dark brown spot on wing membrane near subcosta, in area between costal brace and costal strip.

ABDOMEN

Abdomen yellowish brown with purplish brown pigmentation dorsally on terga. Abdominal sterna also tinged purplish brown, with lighter yellowish markings on each segment, resembling those in specimens of scotti (fig. 56). Dark purplish brown

markings along ventrolateral edges of the abdominal terga 1-9 well developed and clearly recognisable with naked eye.

Genitalia

Although there are only slight differences between the ♂ genitalia of harrisoni and scotti, it is possible to separate the two spp. on the basis of the penis, once these differences have been recognized. In both species the styliger plate is evenly rounded posteriorly, the penis is apically excised, and, when viewed from below, the two lobes are ostensibly separated over their entire exposed lengths, each forming a thick ridge medially, curving away from the mid ventral line. Apically these thickened inner side of the lobes terminate in small protuberances dorsally. Due to a slight thickening of the lateral side of each lobe, they are shallowly concave ventrally (fig. 54A D). The outlines of the lobes are so depicted in figures 54A B & D. The major differences between this structure in the two species are as follows: In scotti the posterior margin of each lobe slopes more gradually rostrad than in harrisoni and the lobes are widest in their posterior halves (fig. 54A B). whereas their inner thickened edges narrows down distinctly distally. In harrisoni the lateral sides of the two lobes are almost parallel and their thickened inner edges virtually retain the same width throughout (fig. 54A D).

Terminal Filaments

As in ♀ imago.

Afronurus harrisoni Barnard

Type locality: Great Berg river system, Western Cape.

Neotype ♂ imago; Great Berg river system;
6.3.61; coll. Dr. K.M.F. Scott. (C.S.I.R.
Cat. No. Misc. 151A).

Paraneotype ♀ imago; Great Berg river system;
6.3.61; coll. Dr. K.M.F. Scott. (C.S.I.R.
Cat. No. Misc. 151A).

Paraneotype ♀ subimago; Great Berg river system;
7.3.61; coll. Dr. K.M.F. Scott. (C.S.I.R.
Cat. No. Misc. 151A).

9.7.4.3

Afronurus oliffi sp. nov.

♀ Imago : Paratype

Measurements in mm.

Body length : 11.70
Length of cerci: 21.00
Forewing length: 12.90
Forewing width : 4.50
Hind wing length: 4.30
Hind wing width: 2.25

Ratio of tarsal joints:

First leg : 2 > 5 > 3 > 1 > 4.
Second leg : 5 > 2 > 1 > 3 > 4.
Third leg : 5 > 1 > 2 > 3 > 4.

HEAD

Epicranium and fronto-clypeus mainly yellowish brown with ventral edge of clypeus dark brown, devoid of speckles. Antennal scape and pedicel yellowish brown; flagellum dark brown, almost black. Compound eyes pale yellow (fig. 62). Ocelli hyaline with dark greenish brown bases.

THORAX

Prothorax yellowish brown. Meso- and metanota brownish, pleura yellowish brown; terga yellowish. A characteristic yellow region which is also noticeable in ♂ specimens, stretches anteriorly from the base of the forewing (fig. 64). Purplish brown streaks occurring on the thoracic pleura resemble those of the ♂♂.

Wings

As in the ♂♂ imagines. Cross veins dark brown, well developed. Longitudinal veins brownish. Costal strip yellowish brown with the rest of the wing membrane hyaline.

Legs

Coxae, trochanters and tibiae yellowish; femora yellow with brownish apices; tarsi yellowish with a dark brown, almost black tinge.

ABDOMEN

Abdominal sterna yellowish; terga brownish

dorsally with their lateral sides clearly divided into brownish dorsal and yellowish brown ventral portions. Markings on sternal segments resemble those of harrisoni. Abdominal pattern along the mediodorsal line of the abdomen as in the ♂ specimens of oliffi, but not so well developed. In segments 9-10 the colour of the abdomen is predominantly yellow with only a very faint tinge of reddish brown.

Ventral plate

♀ Ventral plate with almost evenly rounded lateral sides, curving gently inwards to form a very shallow excision at the apex (fig. 54A E).

Terminal Filaments

As in ♂ imago; with dark brown rings at the joints of the segments.

♂ Subimago : Paratype

Apart from the wing colouration, which closely resemble that of the subimagines of harrisoni, the markings, colouration and body patterns of the imago and subimago of oliffi are very similar but more dull in the latter.

Body length: 9.5 mm.

Number of cross veins in C, Sc and R₁:

Left forewing: C	= 31-32	Right forewing: C	= 30
Sc	= 24	Sc	= 24
R ₁	= 23	R ₁	= 24.

HEAD

Epicranium between compound eyes pale yellow; head yellowish brown anterior to the frontal sutures. Frontoclypeus pale yellowish brown. Clypeus reddish brown. Antennal sclerite, scape and pedicel pale yellowish brown; flagellum fuscous. Compound eyes like those of the ♂ imago, being pale yellow with short light brown streaks along their anterior surfaces which originate opposite the bases of the lateral ocelli, becoming progressively narrower and lighter in intensity sideways, fading out before the lateral margins of the eyes are reached. Ocelli hyaline with their bases greenish brown.

THORAX

Pronotum yellow. Meso- and metanota yellowish brown. Pro-meso and metapleura and -terga yellow. Mesonotum with two pairs of dark brown streaks, one short and the other stretching over the entire length of the mesonotum, both widening posteriorly and closely resembling similar thoracic markings in specimens of harrisoni. Markings on the pleura as in the ♂♂ and ♀♀ imagines.

Wings

Wing membranes of subimago predominantly grey brown with a purplish tinge; yellowish brown in the costal strip. Light brown longitudinal, and darker-coloured cross veins clearly visible through the subimaginal wing sheaths which are pigmented brownish opposite both the longitudinal and cross veins.

Like harrisoni there is a dark purplish brown spot on the fore wing near the subcosta, in the region between the costal brace and costal strip.

Legs

Coxae, trochanters and tibiae mainly yellow; femora luteus, brownish distally; tarsi dark brown.

ABDOMEN

Colour of abdomen as in ♂ imagines, but more dull; reddish brown dorsally, with yellowish lateral and ventral surfaces. Yellowish streaks along the mid dorsal line of the abdomen as in ♂ imago (fig. 63).

Genitalia

Styliger plate and genostyles dark brown. Penis dark brown with its structure distinctly resembling that of the ♂ imago.

Terminal Filaments

Cerci brownish with characteristic dark brown rings at the joints between segments.

♂ Imago : Holotype

Although the subimaginal characteristics closely resemble those of harrisoni, particularly with respect to the pattern and colour of the wing sheaths, there

are very distinctive features whereby the imagines and subimagines ^{of the two} species can be separated from all the other South African species of Afronurus.

Measurements in mm.

Body length : 11.50

Forewing length: 10.70

Forewing width : 4.00

Hind wing length: 3.55

Hind wing width: 2.00

Legs (length): All measurements along dorsal surfaces of segments.

First leg: Femur 2.85; tibia 3.00; tarsus 3.99; claw 0.19.

Second leg: Femur 2.73; tibia 2.10; tarsus 1.09; claw 0.17.

Third leg: Femur 2.90; tibia 2.10; tarsus 0.97; claw 0.17.

Ratio of tarsal joints:

First leg: 2 > 3 > 1 > 4 > 5.

Second leg: 5 > 2 > 1 > 3 > 4.

Third leg: 5 > 1 > 2 > 3 > 4.

Number of cross veins in C, Sc and R₁:

Left forewing: C = 29 Right forewing: C = 29-30

Sc = 22

Sc = 24

R₁ = 21

R₁ = 21.

HEAD

Head pale yellowish brown. Epicranium brownish between compound eyes with the coronal and frontal

sutures occurring as faint dark brown stripes. Clypeus along ventral border of head reddish brown, devoid of dark brown markings such as those of harrisoni. Carina and frontoclypeus below the median ocellus, pale yellow. Antennal sclerites yellowish grey; antennal scape and pedicel yellowish brown, flagellum fuscous. Male specimens of this species differ from all the other species of Afronurus described in this paper, in having pale yellow compound eyes (fig. 64) in contrast to the silvery coloured eyes of the others. Black tinge of underlying ommatidia, which replaces the yellow colour in preservatives, distinctly visible through yellow surface colour of eye. Stretching from the inner anterior corner of each compound eye there is a short light brown band which fades out along its latero-anterior border. This is the only brownish coloured stripe present on the compound eyes of the ♂ specimens of oliffi and, in this respect, oliffi also differs from all the other South African species. Ocelli hyaline, slightly milky, each with its base successively surrounded by a bright yellow area and a greenish brown region.

THORAX

Prothorax predominantly yellow, reddish brown dorsally. Meso- and metanota yellowish brown with brown markings. Pleura yellowish. Terga yellowish brown. Purplish brown streak stretching anteriorly from base of each forewing along the lateroventral edges of the mesonotum. Purplish brown streaks also occur on the pleura anterior to the coxae of the

second and third legs (fig. 64) and at the base of the forewing, opposite the subcosta, where there are two purplish brown markings, the one immediately below the wing being in the form of a stripe whilst the more ventrally situated one is more roundish in shape (fig. 64).

Wings

Longitudinal and cross veins of forewing well developed (fig. 61) and clearly visible with the naked eye; cross veins dark brown in contrast to the lighter brownish coloured longitudinal veins (fig. 64). Wing membrane in costal strip brownish before bulla, yellowish brown distally; otherwise almost hyaline. Hind wings hyaline, yellowish in costal strip; cross veins dark brown as in forewing (fig. 64).

Legs

Legs mainly yellowish brown; femora luteous, brownish towards apices; tibiae yellow, brownish distally; tarsi yellow with a dark brown tinge (fig. 64).

ABDOMEN

Abdominal segments mainly yellowish; terga reddish brown dorsally with bright yellow lateral sides; sterna yellowish with markings in the form of shallow indentations, resembling those of *harrisoni* (fig. 56). Pattern on mediodorsal surfaces of the terga (fig. 63) very characteristic of the species.

Genitalia

Styliger plate and genostyles yellow. Penis yellowish brown, almost square, bilobed, shallowly excised at its apex, with each penis lobe having a shallow concavity along its ventrolateral side (fig. 54B E) which gives the penis an almost four lobed appearance when viewed from below.

Terminal filaments

Cerci yellowish with dark brown bands at the joints of the segments.

The type material of oliffi

Type locality: Yarrow river at Shawswood, Umgeni Basin (Natal).

Type material: Holotype: ♂ imago; Yarrow river at Shawswood, Umgeni river system (Natal); nymph collected 30.4.62, correlated 2.5.62; described and photographed 2.5.62; coll. H.J. Schoonbee.

Paratype: ♂ imago; Yarrow river at Shawswood; nymph collected 30.4.62; correlated 3.5.62; coll. H.J. Schoonbee.

Paratype: ♀ imago; Yarrow river at Shawswood; nymph collected 30.4.62, correlated 3.5.62; coll. H.J. Schoonbee

Paratypes: 2 ♀♀ imagines; 1 ♂ imago; "Mtebezane", Witteberg, Gaints Castle, Natal; 21.12.59; coll. R.S. Crass.

Paratype: 1 ♀ subimago; Yarrow river at Shawswood; nymph caught 15.5.62, correlated 21.5.62; coll. H.J. Schoonbee.

Afronurus barnardi sp. nov.

As mentioned before, the species barnardi and peringueyi are very closely related, showing an even closer resemblance in the subimaginal and imaginal forms than in their respective nymphs. There are some characteristics, however, whereby these two species can easily be separated. These are the wing patterns of the subimagines, the ♂♂ genitalia and the ♀♀ ventral plates of both adult developmental stages.

♀ Subimago : Paratype

Body length: 9.5 mm.

Forewing (length): 10.0 mm.

Ratio of tarsal joints:

First leg : 5 > 2 > 1 > 3 > 4.
Second leg : 5 > 1 > 2 > 3 > 4.
Third leg : 5 > 1 > 2 > 3 > 4.

HEAD

Epicranium dark brown in region of fusion with compound eye, but purplish brown elsewhere. Frons

yellowish between ocelli. Genae between lateral ocelli and compound eyes purplish brown with region immediately below the lateral ocelli, near the antennal sclerite, being creamy. Clypeus dark purplish brown. Antennal scape and pedicel brownish, flagellum fuscous. Inner dorsal edges of compound eye purplish brown, suffusing with luteous tinge occupying much of the dorsal surface of the eye. Along its laterodorsal and lateral surface, this luteous colouration is replaced by a silvery grey, bisected by a brownish band which runs from the anterodorsal surface, along its laterodorsal margin, fading out in its posterior inner angle. This brown band has reddish dorsal and ventral edges. Ocelli hyaline, greenish along inner bases.

THORAX

Prothorax yellow, tinged purplish with dark purplish brown circular markings flanking mid dorsal line of notum. Similar markings occur dorsally to the fore coxae. Meso- and metanota yellowish brown, pleura yellow, tinged faint purplish with markings resembling those in peringueyi.

Legs

Coxae and trochanters of first, second and third femora yellow; first femur luteous; second and third femora more yellow; all femora brownish towards apices. Tibia yellowish with a brownish tinge. Tarsus fuscous.

Wings

Wing membrane mainly yellow in costal strip, milky beyond bulla; middle field and cubito-anal region of wing dark grey with a broad creamy strip occupying its central portion, being wider near the cubito-anal region and tapering towards wing tip (fig. 65). Costa yellowish brown, other longitudinal veins mainly yellow; cross veins milky.

ABDOMEN

Abdomen dull yellow, brownish dorsally. Brown markings of a mediodorsal longitudinal streak which fades out towards the seventh segment, flanked on each side by a laterodorsal row of brown spots which are almost continuous with the median brown streak in segments 1-3, but, becoming progressively smaller towards the 7th segment. Yellowish pattern along mid dorsal line of abdomen in the form of two curved streaks per segment, very faint and not always easily recognisable. Posterior margins of terga with minute blackish speckles.

Ventral plate

As in ♀ imago.

Terminal Filaments

Cerci luteous, greyish white distally.

Legs

Coxa yellow; femur luteous, first femur darker than second and third; tibia yellowish; tarsus greyish yellow. All femora with minute dark brown speckles on anterior surfaces.

Wings

Wings with a distinct yellowish tinge; brighter yellow in costal strip. Wing base purplish. Costa, subcosta and radius yellowish brown, other longitudinal veins yellowish; cross veins milky.

ABDOMEN

As in ♀ subimagines. Differs from peringueyi in colouration of dorsal surface, which is brownish instead of reddish brown.

Ventral plate

Subgenital plate luteous with faint reddish tinge; each side curved at the base; tapering towards the apex which is truncate, or, at the most, very poorly excised apically (fig. 54A H).

Terminal filaments

Cerci yellowish brown.

♂ Imago : Holotype

Like the ♀ imago, the dorsal colouration in the abdomen of the ♂ of barnardi differs from that of

peringueyi in having purplish brown markings instead of being reddish brown.

Measurements in mm.

Body length : 8.30

Length of cerci: 19.00-20.00

Forewing (length): 9.30

Forewing (width): 3.00

Hind wing (length): 2.70

Hind wing (width): 1.60

Legs (length): All measurements along dorsal surfaces of segments.

First leg : Femur 2.58; tibia 2.70; tarsus 2.84;
claw 0.14.

Second leg : Femur 2.48; tibia 1.80; tarsus 0.92;
claw 0.16.

Third leg : Femur 2.62; tibia 1.85; tarsus 0.83;
claw 0.14.

Ratio of tarsal joints:

First leg : 2 > 3 > 1 > 4 > 5.

Second leg: 5 > 1 > 2 > 3 > 4.

Third leg : 5 > 1 > 2 > 3 > 4.

Number of cross veins in C, Sc and R₁:

Left forewing	: C = 23	Right forewing:	C = 26
	Sc = 25		Sc = 22
	R ₁ = 17		R ₁ = 19.

HEAD

Epicranium reddish brown, bright yellow dorsally in vicinity of frontal sutures; brownish between lateral ocelli, with a yellowish streak immediately

below, and encircling each ocellus ventrally. Antennal sclerite creamy; antenna brown. Carina yellow with faint reddish tinge. Clypeus yellowish with dark brown speckles. Ground colour of compound eye greyish, with light reddish brown band encircling eye dorsally, and dark brown horse shoe shaped band enclosing eye from the side (fig. 66). Ocelli hyaline with greenish black bases.

THORAX

Yellowish brown with markings resembling those of the female.

Legs

Colouration of the legs as in ♀ imago.

Wings

As in ♀ imago (fig. 66).

ABDOMEN

Abdomen yellow, purplish brown dorsally; each segment with two curved yellowish streaks mediodorsally (fig. 67) resembling somewhat the abdominal pattern of peringueyi; pattern best developed in segments 3-4; yellowish streaks in segments 3-7 longer than half their respective segments but shorter in segments 8-9. Segment ten yellowish brown.

Genitalia

Styliger plate and genostyles yellowish; penis yellowish brown, bilobed, with each lobe excised at

apex, the inner lobes of which are digitate, curving outwards as in peringueyi, but differing from the latter in being only slightly longer than its outer wider and more triangular lobe (compare figs. 54B.C & A).

Terminal Filaments

Cerci yellowish brown.

Type material of barnardi

Type locality: Emolweni river at Krantzkloof, Umgeni river system, Natal.

Type material: Holotype: ♂ imago; Emolweni river at Krantzkloof; nymph collected 20.4.62, correlated 21.4.62; coll. H.J.Schoonbee.

Paratype: ♂ imago; Emolweni river at Krantzkloof; nymph collected 20.4.62, correlated 22.4.62; coll. H.J.Schoonbee.

Paratype: ♂ imago; Mooi river (Transvaal) at Haagner's poultry farm near Potchefstroom; nymph collected 17.12.62, correlated 20.12.62; coll. H.J.Schoonbee.

Paratype: ♂ subimago; Emolweni river at Krantzkloof; nymph collected 20.4.62, correlated 22.4.62; coll. H.J.Schoonbee.

Paratypes: 2 ♀♀ imagines; Emolweni river at Krantzkloof; nymphs collected 20.4.62; correlated 21.4.62; coll. H.J. Schoonbee.

Paratypes: 3 ♀♀ imagines; Emolweni river at Krantzkloof; nymphs collected 20.4.62, correlated 22.4.62; coll. H.J. Schoonbee.

Paratype: ♀ imago; Emolweni river at Krantzkloof; nymphs caught 20.4.62, correlated 25.4.62; coll. H.J.Schoonbee.

Paratype: ♀ subimago; Emolweni river at Krantzkloof; nymph collected 19.4.62, correlated 22.4.62; coll. H.J. Schoonbee.

Paratype: ♀ subimago; Vaal river at Skandinawië drift, Transvaal-Orange Free State border; nymph collected 17.9.62, correlated 21.9.62; coll. H.J. Schoonbee.

9.7.4.5

Afronurus peringueyi (Petersen)

♀ Subimago

Body length: 7.50 mm.

Wing (length): 10.00 mm.

Ratio of tarsal joints:

First leg : 5 > 1 = 2 > 3 > 4.

Second leg : 5 > 1 > 2 > 3 > 4.

Third leg : 5 > 1 > 2 > 3 > 4.

HEAD

Epicranium brownish; posterior margin of head dark brown. Frontoclypeus pale creamy; carina dark brown; ventral margin of clypeus greyish. Antennal sclerite milky; scape, pedicel and flagellum brownish. Ocelli hyaline with greenish bases and bright yellow border. Ground colours of compound eyes silvery grey with brown bands; inner sides of dorsal surface tinged with yellowish brown and bordered by curving brown band which follows lateral contour of eye which, in turn, is followed laterally on the dorsal surface by a clear streak of silvery grey. Purplish brown band along dorsolateral margin of head, joins the dorsally situated brownish band in the region of the mid posterior margin of the compound eye. Narrow silvery grey streak is exposed along the lateral margin, with a short light brown band situated below the latter along the ventral edge of the anterior margin of the eye.

THORAX

Prothorax pale yellow. Meso- and metathorax yellowish brown. Thoracic pleura yellowish with well defined purplish brown markings behind coxae of first, second and third legs. Mesonotum yellowish brown with one short and one long brown band on either side of the mid dorsal line, resembling those of harrisoni.

Legs.

Coxa and trochanter yellow; femur and tibia yellow with a dark brown tinge; tarsal segments almost black.

Wings

Wing colouration as in the ♂ subimago (fig. 68). Membrane of forewing predominantly dark grey; costal strip pale yellow, creamy towards tip of wing. Longitudinal veins yellowish brown, cross veins milky. Wing sheath with broken lighter bands running between the longitudinal veins of the middle field and cubito-anal areas (fig. 68). Hind wings dark grey, yellowish near costal brace.

ABDOMEN

Colour of abdomen as in ♀ imago, but duller. Terga brownish becoming yellowish towards tenth segment. Sterna yellowish. In addition to a faint mediodorsal yellowish line there are also a pair of short, yellowish streaks per segment flanking the former. This pattern resembles that of the ♂♂ but differ in being slightly wider spaced from the mid dorsal line; in segment 2 the yellowish streaks are broader than long, occupying less than half the length of the tergum, becoming slightly longer in the third, and being longer than half the segments in terga 4-9.

Ventral plate

Ventral plate rounded at base, tapering towards apex which is almost truncate but still shows a slight excision (fig. 54A G).

Terminal Filaments

Cerci pale yellow, darker distally.

♀ Imago

Measurements in mm.

Body length : 9.8 mm.

Length of cerci: 16.5-17.00

Forewing (length): 10.3

Forewing (width): 3.1

Legs (length): All measurements along dorsal
surfaces of segments.

First leg: Femur 2.55; tibia 2.05; tarsus 1.28;
claw 0.18.

Second leg: Femur 2.70; tibia 2.04; tarsus 0.85;
claw 0.90.

Third leg : Femur 2.90; tibia 2.00; tarsus 0.82;
claw 0.16.

Ratio of tarsal joints:

First leg : 5 > 1 = 2 > 3 > 4.

Second leg : 5 > 1 > 2 > 3 > 4.

Third leg : 5 > 1 > 2 > 3 > 4.

HEAD

As in ♀ subimago but with the following differences: Antenna yellowish; ventral margin of clypeus more brownish; epicranium of head brown with purplish tinge. Colour of compound eye and ocelli as described for ♀ subimago.

THORAX

As in ♀ subimago but more brightly coloured.

Legs

Coxa yellow; femur luteous, darker distally; tibia yellowish, tarsus yellowish with a dark brown tinge.

Wings

Wing membrane hyaline with a very faint yellow tinge; pale yellow in costal strip before bulla, milky towards tip. Costa yellowish brown; other longitudinal veins yellowish; cross veins milky.

ABDOMEN

As in ♀ subimago. Brownish dorsally, yellowish brown laterally with yellow sterna. Brown colour occupies much of lateral margins of sterna in first seven segments. Ninth and tenth segments almost entirely yellow.

Ventral plate

Ventral plate bright yellowish brown; structure as in ♀ subimago.

Terminal Filaments

Cerci light reddish brown proximally, becoming yellow towards their tips.

♂ Imago

Measurements in mm.

Body length: 8.50

Length of cerci : 18.00-19.00

Forewing (length): 8.50

Forewing (width): 2.90

Hind wing (length): 2.85

Hind wing (width): 1.70

Legs (length): All measurements made along dorsal surfaces of segments.

First leg : Femur 2.40; tibia 2.65; tarsus 2.37;
claw 0.18.

Second leg : Femur 2.50; tibia 1.90; tarsus 0.70;
claw 0.16.

Third leg : Femur 2.70; tibia 2.00; tarsus 0.68;
claw 0.17.

Ratio of tarsal joints:

First leg : 2 > 3 > 1 > 4 > 5.

Second leg : 5 > 1 > 2 > 3 > 4.

Third leg : 5 > 1 > 2 > 3 > 4.

Number of cross veins in C, Sc and R₁:

Left forewing: C = 23	Right forewing: C = 22
Sc = 21	Sc = 18
R ₁ = 16	R ₁ = 15.

HEAD

Epicranium yellowish brown; frontoclypeus cream with minute brownish speckles along ventral margin of clypeus. Antennae brownish. Compound eyes predominantly silvery grey with brown bands.

Dorsal surface of compound eye silvery grey, tinged luteous, enclosed by an oval shaped light brown band which is almost complete

but for a narrow region at the inner edge of the eye where the silvery grey is exposed. The lateral margin of the compound eye below this light brown band consists of a wider grey band and a more ventrally situated horse-shoe shaped dark brown band which encloses the eye ventrolaterally. A second narrower and shorter brownish band occurs along the outer ventral edges of the compound eyes. The ocelli are hyaline with dark greenish bases.

THORAX

Prothorax yellowish; meso- and metanota brownish, pleura and terga yellowish brown. Purplish brown markings on pleura as in ♀♀.

Legs

As in ♀ imago.

Wings

As in ♀ imago.

ABDOMEN

Abdominal sterna yellowish; lateral sides of terga yellowish brown, reddish brown dorsally in segments 1-6, becoming progressively lighter in intensity and more brownish towards segments 7, 8, and 9. Tenth segment predominantly yellow with faint brownish tinge. (In freshly molted specimens segment ten is bright yellow). Yellowish pattern consisting of a pair of curved streaks per segment, clearly visible along the mid dorsal line of abdominal terga. This pattern fades out in the 9th and

10th segments where it blends with the yellow colour of the terga. Posterior margins of terga with small brownish speckles.

Genitalia

Styliger plate and genostyles yellowish brown. Penis light brown, bilobed, with each lobe cleft at the apex to form two shorter lobes each, the inner one of which is narrow, digitate, curving away from the middle whilst the tip of outer lobe is shorter, wider and more triangular in appearance (fig. 54B/A).

Terminal filaments

Cerci light brown becoming creamy towards tips.

Type materials

Type locality: Mfongosi, Zululand.

Type material: Lectotype: ♂ imago; Mfongosi, Zululand; October 1911; coll. W.E. Jones.

Paralectotypes: 1 ♀ imago, 1 ♀ subimago; Mfongosi, Zululand, coll.

W.E. Jones.

Additional material: 1 ♂ imago; Umgeni river (Natal) at Table Mountain, above Nagle dam; nymph collected 17.4.62, bred out 18.4.62; coll. H.J. Schoonbee.

1 ♂ imago; 1 ♂ subimago; Vaal river at Skandinawiëdrift,

border of Transvaal-Orange
Free State; nymph collected
29.12.62, correlated 1.1.63;
coll. H.J. Schoonbee.

1 ♀ imago; Umgeni river at
Table Mountain; nymph collec-
ted 17.4.62; correlated 20.4.62;
coll. H.J. Schoonbee.

2 ♀♀ imagines; Umgeni river
at Table Mountain; nymph col-
lected 17.4.62; correlated
21.4.62; coll. H.J. Schoonbee.

2 ♀♀ imagines; Umgeni river
at Albert Falls; March 1962;
coll. H.J. Schoonbee.

1 ♀ subimago; Umgeni river at
Table Mountain; nymph collec-
ted 17.4.62; correlated 23.4.62;
coll. H.J. Schoonbee.

2 ♀♀ subimagines; Vaal river
at Skandinawiëdrift; nymph
collected 29.12.62; correlated
1.1.63.

9.7.5

The value of the ratios between the femur,
tibia, tarsus and tarsal segments in the
demarcation of the genus Afronurus Lestage.

One of the main criteria employed by Lestage
(1924) in the separation of the genera Ecdyonurus,

Heptagenia and Afronurus, is the lengths of the femur, tibia and tarsus, relative to each other, and the comparative lengths of the tarsal segments in each leg, which he (Lestage) maintains should be taken into consideration, since these dimensions form the basis on which the edyonurid group was established. Although the number of adult ♂♂ and ♀♀ specimens in my possession are inadequate for a reliable statistical evaluation of the leg formulae laid down for the genus Afronurus by Lestage, the data presented in tables 63 and 64 might justify the following preliminary conclusions.

- i. The ratios of the leg segments are subject to greater variation than Lestage must have anticipated;
- ii. The formulae given by Lestage for the first leg of the Afronurus ♂ viz. tarsus < femur < tibia, roughly applies only to peringueyi (table 63). The species barnardi (Cape) and harrisoni (Cape) also approaches this formula but oliffi, barnardi (Transvaal and Natal) and scotti agrees better with Lestage's formulae for Heptagenia;
- iii. The ratios of the tarsal segments (table), likewise, are not constant for the genus.

Until such time, therefore, as more material becomes available for statistical treatment, these formulae must be ^{employed} applied with caution.

TABLE 63

Leg formulae of the South African species of Afronurus

SPECIES	SEX	LEG	FORMULA
<u>PERINGUEYI</u>	♂	First	Tarsus < femur < tibia
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
	♀	First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
<u>SCOTTI</u>	♂	First	Femur < tibia < tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
	♀	First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
<u>BARNARDI</u> Transvaal and Natal specimens	♂	First	Femur < tibia < tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
	♀	First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
<u>BARNARDI</u> Western Cape specimens	♂	First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
	♀	First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
<u>OLIFFI</u>	♂	First	Femur < tibia < tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
	♀	First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
<u>HARRISONI</u> Western Cape specimens	♂	First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
		First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus

TABLE 64

The tarsal formulae for the South African species of Afronurus compared with those of Lestage's

SPECIES	Number of specimens analysed	Formulae of tarsal segments	
		Legs	Formulae
<u>PERINGUEYI</u> (Lestage, 1924, p.).	? ♂ ♂	First	2 = 3 > 1 > 4 > 5
		Second	
		Third	5 > 1 > 2 > 3 > 4
	? ♀ ♀	First	5 > 2 > 3 > 1 > 4
		Second	5 > 1 = 2 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4
<u>PERINGUEYI</u>	6 ♂ ♂	First	2 > 3 > 1 > 4 > 5
		Second	5 > 1 > 2 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4
	4 ♀ ♀	First	5 > 1 > 2 > 3 > 4
		Second	5 > 1 > 2 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4
<u>SCOTTI</u>	8 ♂ ♂	First	2 > 3 > 4 > 1 > 5
		Second	5 > 1 > 2 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4
	9 ♀ ♀	First	5 > 2 > 1 > 3 > 4
		Second	5 > 1 > 2 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4
<u>BARNARDI</u>	10 ♂ ♂	First	2 > 3 > 1 > 4 > 5
		Second	5 > 1 > 2 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4
	6 ♀ ♀	First	5 > 2 > 3 > 1 > 4
		Second	5 > 1 > 2 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4
<u>OLIFFI</u>	4 ♂ ♂	First	2 > 3 > 1 > 4 > 5
		Second	5 > 1 > 2 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4
	5 ♀ ♀	First	2 > 5 > 3 > 1 > 4
		Second	5 > 2 > 1 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4
<u>HARRISONI</u>		First	2 > 3 > 4 > 1 > 5
		Second	5 > 1 > 2 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4
		First	5 > 2 > 1 > 3 > 4
		Second	5 > 1 > 2 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4

10.

SUMMARY.

An investigation was made into the hydrobiology of the Umgeni river, Natal and the physiography of its basin is briefly described. The physical and chemical conditions of the water indicated clean unpolluted conditions in the main river and most of its tributaries.

Although very little attention has been paid to the possible influence of geology upon the distribution of the fauna, the type of waters and differences in algal growths in, for instance, the Umgeni and Great Berg rivers, at their head waters might be linked with the different geological strata which they traverse. In contrast to the Berg river which at its head waters traverses Table Mountain Sandstone, which gives rise to poorly mineralized waters (c.f. Harrison and Elsworth, 1958), the Umgeni river mainly flows over beds of the Lower Beaufort and Ecca series which provide waters with comparatively high dissolved material comprising mainly the bicarbonates of Calcium and Magnesium.

Differences in altitude and apparently also differences in temperature do not appear to be ~~appear to be~~ a critical determinative factor of the absence or presence of "head water organisms" since most species previously believed to be characteristic of upper river zones at high altitudes only, also featured prominently at places in the Umgeni river, such as at Ross' Farm and, in the Emolweni river tributary at Krantzkloof, at much lower altitudes.

The ephemeropteran genus Afronurus is revised and five species are recognized by reference both to their morphology and ecological distribution. Three of these are new to science.

The steplike profile of the river results in the deposition of silt at places like Watersmeet, Fern Hill Flats and upstream from Albert Falls which appear to be mainly responsible

for the absence, or numerical decline of some aquatic organisms. The deposition of silt at these places, however, also explains why the Umgeni carried little silt during practically all seasons of the year. This may perhaps explain in part the extended range of longitudinal (=downstream) occurrence in the river of Afronurus sp. 2 (=A. barnardi) and Afronurus sp. 3 (=A. scotti) and their associated faunas which, in the Tugela river, which carries comparatively higher silt loads (c.f. Oliff, 1960; Provincial water engineer's dept., Natal Provincial Administration, personal communications, and unpublished data), were largely restricted to the first 18 - 20 miles (\pm 29 - 32 Kilometres) of the Tugela river compared with approximately 40 miles (\pm 64 Kilometres) (Afronurus sp. 2 association) and 100 - 120 miles (\pm 161 - 193 Kilometres) (Afronurus sp. 3 association) in the Umgeni river.

The downstream distribution of the fauna do not necessarily coincide with the currently employed physical river zonation system. This was clearly demonstrated, in particular, by the associations of the stony bottom Ephemeroptera which were found to be spread over several physical zones. (c.f. the Afronurus sp. 2 and sp. 3 associations). In the Umgeni river therefore, and probably other South African rivers as well, a physical zonation system such as that followed by Oliff (1960) and Harrison and Elsworth (1958) cannot, without qualification be taken as indicative of the distribution of the fauna in the river.

An analysis of the stony bottom Ephemeroptera recovered from the Umgeni river and a special investigation of the five Afronurus species recognized in this paper, lead to the development of a system of biological zonation of rivers which is largely based on the stony bottom Ephemeroptera constantly associated with these Afronurus species. This provides a

new approach towards a better understanding of the faunal distribution in South African rivers, for it takes into consideration the circumstance that not all living conditions in a particular stretch of the river are being determined merely by the physical characteristics of that part of the river.

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