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A. D. HARRISON \*  
and  
J. D. AGNEW

NATIONAL INSTITUTE FOR WATER  
RESEARCH: SOUTH AFRICAN  
COUNCIL FOR SCIENTIFIC AND  
INDUSTRIAL RESEARCH.

The distribution  
of invertebrates  
endemic to acid streams  
in the Western  
and Southern Cape Province

A hydrobiological survey of the Great Berg River in the Western Cape Province (Harrison and Elsworth, 1958) showed that there were characteristic animal communities present in the mountain and upper foot-hill reaches. This is usual for most rivers which have a mountain source and the characteristic species are presumed to have a preference for very clean, siltless water and lower temperatures.

Similar surveys in the Eastern Cape, Natal (Oliff, 1960) and the Transvaal (unpublished results of the National Institute for Water Research) show that similar communities are to be found in upper river reaches in these regions but that a whole group of species found in the Western Province does not recur. These are mainly Ephemeroptera and Trichoptera but other groups are also represented. Sampling of other mountain and upper foothill streams in the Western Cape and records collected by Barnard (1931 to 1947) indicated that these characteristic species appeared to be limited to acid-water streams originating in the Table Mountain Sandstone System, specially in regions of high rainfall; it was therefore expected that they would also be found in the acid streams of the Southern Cape in the neighbourhood of George, Knysna and the Tsitsikamma Forest.

During March, 1960, faunal samples were taken and field pH measurements were made in this southern Cape Region; acid, near neutral and alkaline streams were studied:

1. To determine if the distinctive elements of the fauna of the acid upper streams of the Berg River catchment, and of other acid streams near Cape Town, extended along the Table Mountain Sandstone formations to the limit of their extent near Port Elizabeth.
2. To determine the extent to which this distinctive "Table Mountain Sandstone association" was associated with low pH, i.e. if it was truly "acidobiontic" as suggested by the Berg River studies.

A secondary purpose was:

3. To determine the extent to which temperate or "High Veld" species had penetrated the non-acid streams of the region. Only a limited number had been found in the lower, non-acid zones of the Great Berg River.

Sampling stations are shown on Fig. 1. Faunal samples were collected with standard nets (23 mesh/cm) and pH readings were taken with a Lovibond Comparator, using standard

\* Now at Zoology Department, University College of Rhodesia and Nyasaland.

TABLE 1  
SAMPLING STATIONS

Station	Remarks	River Type
Kruis River ..	Fast current connecting deep pools. Stony bottoms with growths of <i>Wardia hygrometrica</i> in torrents. Marginal <i>Prionium serratum</i> .	Stongly acid (pH = 5.0 – 5.9), unbuffered water with low total dissolved solids, peat stained.
Kaaimans River	Stony runs, and quieter pools with sand bottoms containing leaves and stones. <i>P. serratum</i> and <i>Scirpus prolifer</i> present	
Outeniqua Pass	Small mountain trickle with <i>Wardia hygrometrica</i> and other moss.	
Storms River ..	Similar to Kruis River above Marginal <i>Scirpus prolifer</i> and <i>Prionium serratum</i> present	
Groot River ..	Just above estuarine influence. Shallow stony run and marginal <i>Scirpus prolifer</i> and <i>S. fluitans</i> .	
Dorps River ..	Mountain stream. Stony runs with moss and roots in interstices. <i>P. serratum</i> present	Slightly acid (pH = 6.0 – 6.9) clear water.
Krom River ..	Stony runs and marginal vegetation, <i>P. serratum</i> <i>S. fluitans</i> etc., Heavy gelatinous growths on both stones and vegetation (Chlamydotrys). Polluted?	
Assegaaibosch	Small shaded tributary of Krom above. Stones in current.	
van Staden ..	Stream at bottom of pass. Small stony runs and deeper quiet pools with marginal vegetation. ( <i>P. serratum</i> etc)	
Near Kaaimans	Small shaded stream entering Touws River. Shallow stony runs.	
Keurbooms River	Foothill stream with shallow stony runs and vegetations.	
Buffelsnek near Knysna ..	Mountain stream with shallow stony runs and vegetation in current.	
Between Avontuur and Uniendale	Mountain stream—stones in current and marginal vegetation.	
Upper Swartkops River above Uitenhage (Sept. 1958) ..	Stream in valley about 10 miles above Groendal Dam. Stony runs and pools. Vegetation: <i>P. serratum</i> , <i>Scirpus prolifer</i> , <i>S. fluitans</i> , <i>Nymphaea stellata</i> etc.,	
Grobbelaars ..	Broad open river with stony runs. Little marginal vegetation. <i>Prionium serratum</i> present.	



indicators. One water sample from a typically brown acid stream was analysed. The results are preliminary in nature but are compared with those from the Great Berg River, from the Swartkops River, near Uitenhage, and from the upper Buffalo River near King William's Town.

### Sampling Stations (Fig. 1, Table 1)

In Table 1 all the localities visited have been classified into river types with short notes on habitat and vegetation. The streams have been classified according to the pH of the water measured at the time, i.e. strongly acid, pH below 6.0, weakly acid, pH 6 to 7, and alkaline. It was found possible to correlate the pH with the geology to some extent, as discussed later. In presenting the biological results the samples have been grouped according to this scheme.

### Chemical Results (Table 2)

It was not the intention of this survey to give a detailed picture of the water quality of the region but merely to relate faunal associations with pH readings. However, Table 2 gives the water analysis from one of the strongly acid streams, the Storms River, as well as analyses from the upper Great Berg River, the weakly acid upper Swartkops River and the upper Buffalo River, Eastern Cape. The results show the unbuffered nature of the water of the acid streams, specially the Storms River, and that the dissolved solids were mainly chlorides. Detailed pH values are shown in Fig. 2. Experience from the upper Berg River shows that the pH in these unbuffered acid streams varies considerably though within a definite range, from this experience the snap pH values have been used to classify the streams in Table 1.

TABLE 2  
MINERAL ANALYSIS OF WATER

	Upper* Berg River	Storms River	Upper Swart- kops	Upper	Buffalo†
				Forest Head Streams	Just above Maden Dam
pH	4.3-6.8	—	6.8-7.2	6.5-6.7	7.2
Total Dissolved Solids, p.p.m.	10.0-78.0	68.0	110.0	19.0-26.0	35.0
Total Alkalinity as p.p.m. CaCO <sub>3</sub>	1.0-5.6	0.0	4.6	—	8.8
Total Acidity p.p.m. CaCO <sub>3</sub>	—	13.0	—	—	—
Sulphate, p.p.m. SO <sub>4</sub>	0.0-3.0	4.0	6.5	—	1.1
Chloride p.p.m. Cl	3.0-14.0	25.0	52.0	6.5-7.0	10.0
Total hardness p.p.m. CaCO <sub>3</sub>	1.0-6.7	14.0	24.0	—	11.8
Calcium, p.p.m. Ca	0.1-1.5	2.0	2.4	—	2.4
Magnesium, p.p.m. Mg.	0.0-1.5	3.6	7.2	—	1.4
Sodium, p.p.m. Na	—	14.0	28.0	—	—
Potassium, p.p.m. K.	—	0.4	0.9	—	—

\* Harrison and Ellsworth, 1958.

† By permission of the City Engineer (City of East London, February 1961).

DISTRIBUTION OF INVERTEBRATES ENDEMIC TO ACID STREAMS OF WESTERN AND SOUTHERN C.P.

THE FAUNA

*The fauna of the strongly acid, peat-stained waters*

Tables 3, 4, 5 and 6 give the percentage analyses of the faunal samples from the various stations and from the following biotopes respectively:

- Stones in fast current,
- Moss (*Wardia hygrometrica*) on rocks in torrent,
- Stones in quiet backwater,
- Marginal vegetation.

TABLE 3  
PER CENT ANALYSIS OF FAUNA OF STONES IN CURRENT  
(acid, peat stained rivers)

		Outeniqua Pass	Kruis River	Kaaimans	Storms	Groot	Remarks
<i>Nemouridae</i>	<i>Aphanicercopsis</i> type nymphs	38·8	15·4	18·9	13·0	7·4	Not classifiable to spp. Not classifiable to spp.
	<i>Aphanicerella</i> type nymphs	—	0·8	2·1	—	3·8	
<i>Baetidae</i>	<i>Baetis harrisoni</i>	—	—	—	17·7	3·8	
	<i>Pseudocloeon vinosum</i>	—	11·8	19·9	1·5	1·3	
<i>Leptophlebiidae</i>	<i>Aprionyx peterseni</i>	0·9	—	—	—	—	
	<i>Castanophlebia calida</i>	4·4	9·3	1·2	1·2	5·1	
<i>Ephemerellidae</i>	<i>Lithogloea penicillata</i>	—	6·3	1·5	0·4	5·8	
<i>Megaloptera</i>	<i>Chlorionella</i> sp.	—	0·5	0·5	0·2	0·3	
	<i>Platychniodes</i> sp.	—	0·6	—	P	—	
	<i>Taeniochauliodes</i> sp.	0·6	—	—	—	—	
<i>Sericostomatidae</i>	<i>Barbarochthon cf. brunneum</i>	—	2·1	0·6	0·6	—	Species determination difficult.
	<i>Dyschimus</i> sp.	0·6	—	—	—	P	
	<i>Petroplax</i> sp.	—	—	—	—	—	
	<i>Sinion cf. hageni</i>	1·2	—	—	—	—	
<i>Leptoceridae</i>	<i>Athripsodes</i> sp. near <i>bergensis</i>	—	1·7	0·3	1·3	19·6	
	<i>Leptoceridae</i> .. .. .	4·7	—	—	—	—	
<i>Hydropsychidae</i>	<i>Sciadorus cf. obtusus</i>	4·4	—	—	—	—	
	<i>Cheumatopsyche afra</i>	—	—	—	0·8	—	
	<i>Cheumatopsyche thomasseti</i>	—	—	—	1·4	—	
<i>Polycentropodidae</i>	<i>Polypsectopus</i> sp. (Berg River type)	0·3	0·2	—	—	—	
<i>Philopotamidae</i>	<i>Chimarra</i> spp.	—	1·2	8·8	14·3	2·6	Not classifiable to spp.
<i>Rhyacophilidae</i>	<i>Agapetus agilis</i>	—	—	1·4	1·8	0·3	
<i>Elmidae</i>	<i>Berg River Type GBG 8J</i>	1·8	12·5	0·4	7·4	2·9	Mostly <i>Stenelmis</i> <i>Limnius</i> and larvae.
	<i>Berg River Type GBG 6AA</i>	21·2	13·2	2·2	7·5	13·4	
<i>Ptilodactylidae</i>		—	1·8	—	P	—	
<i>Heliodidae</i>	<i>sp. A</i>	—	—	17·5	P	—	
	<i>sp. B</i>	—	1·1	P	P	0·1	
<i>Simuliidae</i>	<i>Simulium</i> larvae	—	—	5·6	9·9	2·6	
<i>Total Chironomidae</i>		9·8	7·5	10·4	3·5	27·9	
<i>Rhagionidae</i>	<i>Atherix</i> -type larvae	—	1·5	1·2	—	1·6	
<i>Anura</i>	<i>Heleophryne</i> sp.	P	P	—	P	—	
	Total	88·7	87·5	92·5	82·6	98·5	

Note; Species in italics — acid water, endemic forms.

In all cases species were identified as far as possible and those species common to the upper Great Berg River and these streams, but absent elsewhere, have been underlined. The underlined species are considered to be endemic to acid waters of the Western and Southern Cape.

As will be seen these underlined endemic species usually form an appreciable part of the fauna in all habitats sampled from the strongly acid streams.

*The Fauna of slightly acid streams*

These were all clean, unpolluted and non-turbid streams in the same region, but mainly further from the coast. Three were mountain streams, i.e. Dorps, near Prince Albert, Assaigabos stream and the Buffelsnek stream, and the latter two were only a few miles from strongly acid streams with the typical fauna. Results are given in Tables 7 and 8 from the following biotopes:

- Stones in fast current,
- Marginal vegetation.

TABLE 4  
PER CENT ANALYSIS, MARGINAL VEGETATION FAUNA  
(acid, peat stained rivers)

		Kruis	Kaaimans	Storms	Groot
<i>Nemouridae</i> .. .. .	<i>Aphaniceropsis</i> (type) .. .. .	%	%	%	%
	<i>Aphanicerella</i> (type) .. .. .	3.2	0.9	0.8	P
<i>Baetidae</i> .. .. .	<i>Austrocloeon africanum</i> .. .. .	—	—	—	59.4
	<i>Pseudocloeon vinosum</i> .. .. .	40.2	—	2.3	—
<i>Caenidae</i> .. .. .	<i>Caenidae</i> .. .. .	—	0.9	—	P
<i>EphemereUidae</i> .. .. .	<i>Lithogloea harrisoni</i> .. .. .	4.4	P	1.5	—
	<i>Lithogloea penicillata</i> .. .. .	3.7	—	—	—
<i>Odonata</i> .. .. .	Total Anisoptera .. .. .	0.2	7.2	3.1	—
	Total Zygoptera .. .. .	0.7	6.3	—	—
<i>Leptoceridae</i> .. .. .	<i>Athripsodes spp. near bergensis</i> .. .. .	19.7	39.9	41.7	1.4
	<i>Athripsodes</i> spp. .. .. .	—	1.8	—	—
<i>Sericostomatidae</i> .. .. .	<i>Barbarochthon brunneum</i> .. .. .	0.7	6.3	6.8	—
<i>Elmidae</i> .. .. .	8J .. .. .	0.7	—	1.5	1.4
	6AA .. .. .	0.9	—	3.0	1.4
	Others .. .. .	0.2	—	—	—
<i>Prilodactylidae</i> .. .. .	Larvae .. .. .	0.1	1.8	1.5	—
<i>Helodidae</i> .. .. .	<i>sp. A</i> .. .. .	—	0.9	—	—
	<i>sp. B</i> .. .. .	3.0	—	—	—
<i>Chironomidae</i> .. .. .	Total .. .. .	17.6	9.9	33.4	33.8
		92.3%	81.3%	95.6%	97.4%

Note: species in italics—acid water endemic forms.

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Again the acid water endemic species have been underlined and it will be noted that in the stones in the current (Table 7) there are far fewer in the weakly acid streams well within the endemic region, and that there are none at all in similar streams on the fringe of the endemic region. In the marginal vegetation no acid water endemic species were found at all. (Table 8). The fauna of these streams is more typical of neutral to alkaline streams in temperate parts of the country. However, it is a depleted fauna and appears to consist of those species which can stand the slightly acid pH. Many of them are actually an important part of the fauna of the strongly acid streams as well and those which are not have been marked on the tables.

*The fauna of alkaline streams*

Only one truly alkaline stream was sampled, the Grobbelaar's River between Oudtshoorn and the Cango Caves, which had a pH of 8.5. It is a foothill stream. The faunal associations are given in Tables 9 and 10. Both the fauna of the stones in the current and of the marginal vegetation were found to be typical of alkaline streams of the High Veld of the Transvaal and the upland regions of Natal.

TABLE 5  
STRONGLY ACID STREAMS. MOSS (*WARDIA HYGROMETRICA*) IN TORRENT  
(Per cent analysis)

		Upper Berg River (Zone I*)	Kruis River
<i>Nemouridae</i>	<i>Aphanicercopsis</i> -type nymphs .. .. .	2.0	17.5
<i>Baetidae</i>	<i>Acentrella capensis</i> .. .. .	1.0	—
	<i>Pseudocloeon vinosum</i> .. .. .	—	17.6
<i>Leptophlebiidae</i>	<i>Castanophlebia calida</i> .. .. .	1.0	0.01
<i>Ephemerellidae</i>	<i>Lithogloea sp. Berg River sp. B.</i> .. .. .	26.3	1.2
<i>Megaloptera</i>	<i>Chlorionella sp.</i> .. .. .	—	0.01
	<i>Platychniodes sp.</i> .. .. .	1.0	0.04
<i>Trichoptera</i>	<i>Barbarochthon brunneum</i> .. .. .	0.5	0.3
	<i>Petrothrincus triangularis</i> .. .. .	3.5	—
	<i>Athripsodes—A. bergensis type</i> .. .. .	—	0.01
	<i>Sciadorus</i> .. .. .	1.5	—
<i>Hydraenidae</i>	Total .. .. .	5.0	0.01
<i>Elmidae</i>	<i>Berg River type 8J</i> .. .. .	6.5	16.2
	<i>Berg River type 6AA</i> .. .. .	4.5	—
	<i>Berg River type 128A</i> .. .. .	3.5	—
	Others .. .. .	0.5	2.6
<i>Simuliidae</i>	<i>Simulium medusaeforme</i> .. .. .	10.1	0.5
<i>Total Chironomidae</i>	.. .. .	29.3	40.0
		96.2	95.9

\*Taken in November, 1950, with a coarser net—11 mesh/cm.  
Note: italic species—acid water endemic forms.

## DISCUSSION

Two distinctive faunal associations were found in clean, permanent streams in the area surveyed:

1. Table Mountain Sandstone, acid water association; details of this are given in appendix 1. This occurred in streams with a pH below 6 and was similar to that which has been studied in detail in the upper parts of the Great Berg River. Many of the characteristic species of this association appear to be limited to acid water only but others may merely be species demanding rigidly oligotrophic (very clean) conditions. The association also includes a number of fairly ubiquitous non-pH-sensitive species such as *Baetis harrisoni*, *Afronurus harrisoni* and *Pseudocloeon vinosum*. No aquatic snails occur but *Pisidium* spp. are found.

TABLE 6  
STRONGLY ACID STREAMS. BACKWATERS

		Kruis River	Kaaimans River
<i>Copepoda</i>	<i>Cyclops</i> spp. .. .. .	% 4.1	% —
<i>Hydrachnellae</i>	Various species .. .. .	1.4	3.5
<i>Nemouridae</i>	<i>Aphanicercella</i> type nymphs .. .. .	0.7	5.9
	<i>Aphanicercopsis</i> type nymphs .. .. .	1.5	15.2
<i>Baetidae</i>	<i>Austrocloeon</i> sp. .. .. .	—	2.4
	<i>Pseudocloeon</i> sp. ( <i>Berg River</i> sp. A) .. .. .	49.5	—
	<i>Pseudocloeon vinosum</i> .. .. .	6.6	—
<i>Leptophlebiidae</i>	<i>Aprionyx peterseni</i> .. .. .	2.6	—
	<i>Choroterpes nigrescens</i> .. .. .	—	1.2
	<i>Castanophlebia calida</i> .. .. .	—	1.2
<i>Ephemerellidae</i>	<i>Lithogloea penicillata</i> .. .. .	2.2	—
<i>Ecdyonuridae</i>	<i>Afronurus harrisoni</i> .. .. .	1.9	—
<i>Zygoptera</i>	<i>Allocnemis leucosticta</i> .. .. .	—	17.6
<i>Trichoptera</i>	<i>Barbarochthon brunneum</i> .. .. .	0.3	4.7
	<i>Athripsodes</i> sp. cf. <i>bergensis</i> .. .. .	12.1	18.8
	<i>Chimarra</i> sp. .. .. .	—	2.4
	<i>Polylectropus</i> sp. .. .. .	2.9	—
<i>Elmidae</i>	<i>Berg River</i> type 6AA .. .. .	5.8	10.6
<i>Ptilodactylidae</i>	.. .. .	0.3	1.2
<i>Helodidae</i>	<i>Berg River</i> sp. A .. .. .	—	1.2
<i>Chironomidae</i> (total)	.. .. .	6.2	9.4
		97.9	95.3

Note: italic species—acid water endemic forms.



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2. Temperate climate association. This term is used for want of a better one, as this association has been found in all permanent streams in High Veld and other temperate parts of the country. It is best developed in definitely alkaline streams, such as the Grobbelaars River.

Some of the species comprising it are also found in weakly acid streams along with the non-pH-sensitive species mentioned above. Details of this association are given in appendix 2.

Both these association types show considerable "internal variations" in that the species composing them vary according to the river zone where they are found. For instance special species appear in the upper mountain streams in the Table Mountain System as shown by the fauna of the stream on the Outeniqua Pass, Table 4.

TABLE 7  
PER CENT ANALYSIS—STONES IN CURRENT FAUNA. CLEAR, SLIGHTLY ACID RIVERS

		Dorps	Krom	Assegaa- Bosch	Buffels- nek	Near Touw R.	After Avon- tuur*	Keur booms*	V. Stadens	Upper Swart- kops	
		%	%	%	%	%	%	%	%	%	
<i>Perlidae</i>	† <i>Neoperla spio</i>	—	—	—	0.3	—	—	—	—	—	
<i>Nemouridae</i>	<i>Aphaniceropsis</i> (type)	9.5	3.3	—	—	16.3	—	—	—	—	
	<i>Aphanicerella</i> (type)	2.0	—	2.0	—	—	—	—	—	—	
<i>Baetidae</i>	<i>Acentrella cf. capensis</i>	0.2	—	—	—	0.2	—	—	—	—	
	<i>Baetis harrisoni</i>	0.8	0.7	8.1	2.1	—	P	P	—	9.7	
	<i>Baetis bellus</i>	—	—	—	—	—	P	—	—	—	
	<i>Centroptilum sudaffricanum</i>	14.1	—	25.2	10.1	8.2	P	P	4.7	—	
	† <i>Centroptilum varium</i>	0.1	—	—	—	—	—	—	—	—	
	† <i>Centroptiloides bifasciata</i>	—	2.3	—	—	—	—	—	—	—	
	<i>Pseudocloeon maculosum</i>	—	15.4	—	—	—	—	P	—	0.6	
	<i>Pseudocloeon vinosum</i>	—	4.6	—	1.5	—	—	—	0.1	—	
<i>Leptophlebiidae</i>	<i>Adenophlebia peringueyella</i>	0.7	—	6.6	1.6	4.0	P	P	0.1	—	
	<i>Castanophlebia calida</i>	2.5	—	—	—	0.4	—	—	—	—	
<i>Ephemereillidae</i>	<i>Lithogloea penicillata</i>	—	—	5.6	0.3	—	—	—	—	—	
<i>Tricorythidae</i>	† <i>Neurocaenis discolor</i>	9.5	—	—	2.1	—	—	—	—	—	
<i>Ecdyonuridae</i>	<i>Afronus harrisoni</i>	—	—	—	3.7	—	—	—	—	—	
<i>Leptoceridae</i>	<i>Athripsodes</i> spp.	0.7	—	P	—	P	—	—	—	—	
<i>Hydropsychidae</i>	<i>Cheumatopsyche afra</i>	3.5	11.8	2.0	4.2	2.7	P	P	0.8	3.8	
	† <i>Cheumatopsyche thomasseti</i>	—	—	—	2.4	—	—	—	—	—	
	† <i>Macronema</i> sp.	—	10.2	0.5	—	—	—	—	0.1	—	
<i>Philopotamidae</i>	<i>Chimarra</i> sp.	8.5	—	—	1.3	5.5	—	—	—	—	
<i>Hydroptilidae</i>	<i>Hydroptila</i> sp.	P	—	—	—	—	—	P	—	—	
<i>Elmidae</i>	8J	2.5	4.0	11.6(?)	} 15.3 }	9.3	—	—	—	—	
	6AA	1.3	0.3	—			—	—	P	—	—
	(Others)	3.9	3.0	—			—	—	—	—	—
<i>Helodidae</i>	<i>Helodid sp A</i>	0.8	2.6	—	—	4.6	—	—	—	—	
	<i>Helodid sp B</i>	0.8	0.3	—	—	—	—	—	—	—	
<i>Simuliidae</i>	<i>Simulium</i> larvae	7.6	3.0	P	11.3	26.2	P	P	73.1	73.7	
<i>Chironomidae</i>	Total Chironomidae	8.9	34.4	21.6	19.5	14.4	P	P	9.4	5.8	
<i>Rhagionidae</i>	<i>Atherix</i> type larvae	1.0	—	2.0	—	—	—	—	—	—	
		78.8	95.9	85.2	72.0	91.8	—	—	88.3	93.6	

\*N.B.—At these two stations, per cent analyses are not available. P indicates presence, (not necessarily in small numbers in these two columns).

†Species not found in strongly acid streams.

Note: italic species—acid water endemic forms.

*Extent of the Table Mountain Sandstone, acid water ("acidobiotic") association*

Sampling stations visited during this survey have been plotted on Fig. 2, together with a few stations studied previously on the Swartkops River, near Port Elizabeth and all the Stations used during the survey of the Great Berg River. In addition a few other scattered records have been plotted. The pH readings have been inserted next to the station when available except in the case of the Great Berg River. It will be noted that the faunal type is indicated symbolically according to the key.

What is here called the Table Mountain Sandstone, acid water fauna was found to extend to very near the eastern limit of the T.M.S., especially in the acid, peat-stained, dystrophic waters of the George-Tsitsikamma region. The fauna is obviously one of very acid streams and these are only found flowing off T.M.S. formations.

As has been already pointed out, this fauna appears to be not only associated with the acid conditions but with conditions of high rainfall. If it were to appear anywhere else in the country it would be expected in the mountain regions of the Eastern Cape Province and specially in the Amatola Mountains where the rainfall is high and south temperate forest, similar to the Tsitsikamma Forest, occurs. Samples were taken in the upper Buffalo River and its headwater streams in the Amatola Mountains in January, 1961 (Table 11). Although the pH of the water of the headwater streams was slightly acid and that of the upper Buffalo neutral, (Table 2) none of the acid water species, endemic to the Western and Southern Cape, recurred.

TABLE 8  
PER CENT ANALYSIS—MARGINAL VEGETATION FAUNA  
CLEAR, SLIGHTLY ACID RIVERS

		Krom	Buffels- nek	Near Avon- tuur*	Keur- booms*	V. Stadens
<i>Nematoda</i> ..	Nematodes .. .. .	%	%	%	%	%
<i>Nemeritea</i> ..	†Prostoma sp. .. .. .	6.3	31.1 6.4	P P	P P	8.5 5.3
<i>Baetidae</i> ..	<i>Baetis bellus</i> .. .. .	10.6	—	P	—	—
	<i>Centroptilum excisum</i> .. .. .	—	0.3	P	—	—
	<i>Centroptilum sudafricanum</i> .. .. .	4.3	0.4	P	P	—
	<i>Pseudocloeon vinosum</i> .. .. .	8.5	3.6	—	—	—
<i>Coenagriidae</i>	<i>Pseudagrion</i> sp. .. .. .	6.3	3.4	P	P	—
<i>Hydroptilidae</i>	<i>Oxyethira</i> (= <i>Argyrobothrus</i> ) <i>velocipes</i>	6.3	3.4	—	P	11.2
	<i>Hydroptila</i> .. .. .	P	—	—	P	—
<i>Simuliidae</i> ..	<i>Simulium</i> larvae .. .. .	10.6	13.8	P	P	1.8
<i>Chironomidae</i>	Total .. .. .	14.9	26.4	P	P	34.0
<i>Mollusca</i> ..	† <i>Burnupia</i> sp. .. .. .	2.1	2.3	P	P	—
		69.9	91.1	—	—	60.8

\*% figures not available.

P indicates presence, not necessarily in small numbers, in these two columns.

†Not found in strongly acid streams.

DISTRIBUTION OF INVERTEBRATES ENDEMIC TO ACID STREAMS OF WESTERN AND SOUTHERN C.P.

TABLES 9 AND 10

THE FAUNA OF GROBBELAARS RIVER (ALKALINE RIVER)  
PER CENT ANALYSIS

TABLE 9 STONES IN CURRENT		%	TABLE 10 MARGINAL VEGETATION		%
Planaria .. .. .	1.8	Prostoma .. .. .	1.3		
Nematoda .. .. .	1.6	Nematoda .. .. .	3.9		
Lumbricidae .. .. .	0.2	Lumbricidae .. .. .	4.1		
Potamon cf. sidneyi .. .. .	0.4	Hydrachnellae .. .. .	1.3		
Hydrachnellae .. .. .	10.9	Caenidae .. .. .	1.9		
Baetis harrisoni .. .. .	28.3	Austrocloeon sp. .. .. .	4.9		
Pseudocloeon maculosum .. .. .	7.7	Baetis bellus .. .. .	1.1		
Caenidae .. .. .	1.6	Centroptilum excisum .. .. .	1.1		
Adenophlebia peingueyella .. .. .	0.8	<i>Centroptilum indusii</i> .. .. .	0.2		
Euthraulus elegans .. .. .	7.1	Centroptilum pulchrum .. .. .	0.2		
Afronurus harrisoni .. .. .	4.4	Baetid juveniles .. .. .	32.1		
Aeschna sp. .. .. .	0.2	Euthraulus elegans .. .. .	0.1		
Ecnomus sp. .. .. .	0.2	Micronecta piccanin .. .. .	1.3		
Cheumatopsyche afra .. .. .	0.6	Micronecta juvs. .. .. .	43.7		
Cheumatopsyche thomasseti .. .. .	9.1	Strina sp. .. .. .	0.1		
Orthotrichia sp. .. .. .	3.8	<i>Psephenidae (Eubrianax)</i> .. .. .	0.1		
<i>Psephenidae (Eubrianax)</i> .. .. .	2.2	Corynoneura spp. .. .. .	1.9		
Simulium larvae .. .. .	1.8	Pisidium sp. .. .. .	0.7		
Orthoclaadiinae .. .. .	8.9		100.0		
Other Chironomidae .. .. .	6.5				
Tabanidae .. .. .	1.6				
Burnupia .. .. .	0.2				
	99.9				

Note: species in italics are found in northern and eastern South Africa but this is the first record for the S.W. Cape region.

Weakly acid streams in the Southern Cape had a mixed fauna, mainly of non-pH-sensitive forms (see Appendix 3) with a few acid water forms, when connected to an acid stream, and a few of the more resistant species normally found in alkaline streams in temperate parts of the country (appendix 2). Very often, as was the case in the Van Staden's Pass stream and the upper Swartkops River, the fauna could be looked on as a somewhat depleted "temperate" association.

*Penetration of "Temperate" species*

As previously mentioned the fauna of the alkaline parts of the Great Berg River, and of other alkaline streams in the Western Cape Province, is composed of species which are found in the streams of the temperate High Veld of the Transvaal and O.F.S. and the uplands of Natal. (See Oliff, 1960). However, many species found in the latter areas are not found in the Great Berg, not even in the lower reaches where the pH is neutral to alkaline. This survey has shown that a number of these "missing species" are present in the eastern part of the Cape System Region. These include *Centroptilum varium*, *Centroptilum indusii*, *Centroptiloides bifasciata*, *Neoperla spio*, *Eubrianax* sp., and *Simulium bequaerti*. Some of these are also found in the warmer region of South Africa.

It must be pointed out that it is difficult to delineate the various associations clearly at present as the taxonomy of a number of groups still has to be worked out; these include the Hydrachnellae, Trichoptera, Chironomidae and Dryopoidea. Progress is being made with all these except the last.

TABLE 11  
FAUNA OF UPPER BUFFALO RIVER, KING WILLIAM'S TOWN  
STONES IN CURRENT

	Forest head stream Evelyn Valley 26/1/1961	Buffalo just above Maden Dam 23/1/1961
	%	%
Nematoda .. .. .	0.5	0.9
Tubificidae .. .. .	3.8	—
Hydrachnellae .. .. .	1.0	0.9
Aphanicercopsis-type nymphs .. .. .	15.0	0.9
Baetis harrisoni .. .. .	—	0.1
Acentrella natalensis .. .. .	7.9	—
Centroptilum sudafricanum .. .. .	7.1	2.6
Neurocaenis sp. .. .. .	2.3	10.4
Castanophlebia calida .. .. .	9.7	—
Euthraulus elegans .. .. .	—	0.1
Cheumatopsyche afra .. .. .	5.1	3.1
Cheumatopsyche thomasseti .. .. .	—	0.9
Oxyethira velocipes .. .. .	1.8	—
Hydroptila capensis .. .. .	—	0.1
Eubrianax sp. .. .. .	—	0.2
Helodidae .. .. .	6.1	—
Simulium larvae .. .. .	11.2	41.5*
Pentaneura spp. .. .. .	0.5	0.4
Other Chironomidae mostly Orthoclaadiinae .. .. .	11.7	23.7
Corynoneurinae .. .. .	3.0	5.1
Bezzia-type larvae and pupae .. .. .	1.6	—
Rhagionidae .. .. .	—	1.4
Empidae .. .. .	3.1	—

\*A pupa of *Simulium impukane* de M. was present.  
(The authors thank Miss P. Hoal of The East London Municipality, who assisted with these samples).

SUMMARY

1. The results of faunal sampling of streams in the Southern Cape are presented, together with some considerations of river chemistry in this region.
2. On the basis of these results and other data (some published), it is shown that there is a fauna endemic to the acid streams of the Southern Cape.

APPENDIX I

Preliminary list of Table Mountain sandstone, acid-water species (South Western Cape). This list is built mainly from the survey of the Great Berg River and other records from the Western Cape Province. Species marked "E" were found during the recent survey of the eastern part of the Cape System Region, those marked (e) by previous workers in this eastern area, (mainly Barnard 1931, 1932, 1934A, 1934B, 1937, 1940 and 1947).

PLECOPTERA

*Nemouridae* (Leuctridae)

Aphanicerca capensis Till. (e)	Aphanicercoopsis denticulata (Till).
Aphanicerca uncinata Barnard	Aphanicercoopsis tabularis Barnard
Aphanicerca lyrata Barnard	Aphanicercoopsis outeniquae Barnard (e)
Aphanicerca bicornis Barnard	Aphanicercoopsis hawaquae Barnard
Aphanicerca bovina Barnard	
Aphanicerca tereta Barnard	
Aphanicercella barnardi Till	Desmonemoura pulchellum Till. (e)
Aphanicercella scutata Barnard	
Aphanicercella bifurcata Barnard	
Aphanicercella nigra Barnard	
Aphanicercella quadrata Barnard	

EPHEMEROPTERA

*Baetidae*

Pseudocloeon sp. A (E) (Berg River)

*Leptoplebiidae*

Aprionyx peterseni (Lest.) (E)	Aprionyx intermedius Barnard (e)
Aprionyx tabularis (Eaton)	Aprionyx rubicundus Barnard (E?)
Aprionyx pellucidulus (E.-P).	
Castanophlebia albicauda Barnard	

*Ephemerellidae*

Ephemerellina barnardi Lest.	
Lithogloea harrisoni Barnard (E)	Lithogloea penicillata Barnard (E)
Lithogloea sp. A (Berg River) (E)	Lithogloea sp. B. (Berg River)

(Note: the specimens of *L. Harrisoni* reported from the Amatola Mountains by Crass, 1947, appear to belong to another species which extends from this locality, in montane regions, through Natal and the Transvaal to Nyasaland and possibly further).

## ODONATA

Brinck, 1955b, lists *Presba piscator* Barnard (Anisoptera) and *Ecchlorolestes peringueyi* (Ris), *E. nylephtha* Barnard, *Chlorolestes conspicua* Sélys and *C. umbrata* Sélys (Zygoptera) as being endemic to the South-Western Cape Region. It is not known, however, if any of these are limited to acid streams, they are all mountain species.

## MEGALOPTERA

*Corydalidae*

- |  |  |
|--|--|
| <i>Chloroniella peringueyi</i> E.-P. (E) (e) |  |
| <i>Platychauiodes tenuis</i> (MacLach.) (e)  | <i>Platychauiodes capensis</i> Barnard |
| <i>Platychauiodes woodi</i> Barnard (e) (E?) | <i>Platychauiodes thorni</i> Barnard   |

## TRICHOPTERA

- |  |   |
|--|---|
| <i>Dyschimus thrymmifer</i> Barnard                | <i>Dyschimus collyrifer</i> Barnard (e)     |
| <i>Sinion hageni</i> Barnard (E?)                  |   |
| <i>Rhoizema saxiferum</i> Barnard                  | <i>Rhoizema montanum</i> Barnard (e)        |
| <i>Rhoizema spinosum</i> Barnard                   | <i>Rhoizema furciferum</i> Barnard          |
| <i>Aselas camella</i> Barnard                      | <i>Cheimacheramus caudalis</i> Barnard      |
| <i>Petroplax caricis</i> Barnard                   | <i>Petroplax phleophila</i> Barnard (e)     |
| <i>Petroplax prionii</i> Barnard                   | <i>Petroplax curvicosta</i> Scott           |
| <i>Barbarochthon brunneum</i> Barnard (e) (E)      |   |
| <i>Hydrosalpinx sericea</i> Barnard                | <i>Petrothrincus triangularis</i> Barnard   |
| <i>Petrothrincus circularis</i> Barnard            | <i>Athripsodes tabularis</i> Barnard        |
| <i>Athripsodes schoenobates</i> (Barnard) (e) (E)  | <i>Athripsodes longistylis</i> (Barnard)    |
| <i>Athripsodes promontorii</i> (Barnard)           | <i>Athripsodes potes</i> (Barnard) (e)      |
| <i>Athripsodes cedri</i> (Barnard)                 | <i>Athripsodes scramasax</i> (Barnard)      |
| <i>Athripsodes sylvaticus</i> (Barnard)            | <i>Athripsodes tuckeri</i> (Barnard)        |
| <i>Athripsodes securis</i> (Barnard) (e)           | <i>Athripsodes corrivalis</i> (Barnard)     |
| <i>Athripsodes amplexus</i> (Barnard)              | <i>Athripsodes stephanus</i> (Barnard) (e)  |
| <i>Athripsodes oryx</i> (Barnard)                  | <i>Athripsodes caricarcia</i> (Barnard)     |
| <i>Athripsodes elaphus</i> (Barnard)               | <i>Athripsodes spatula</i> (Barnard)        |
| <i>Athripsodes bibulus</i> (Barnard)               | <i>Athripsodes prionii</i> Scott            |
| <i>Athripsodes dieseli</i> (Barnard)               |   |
| <i>Athripsodes bergensis</i> Scott (E)             | <i>Leptecho lupi</i> (Barnard)              |
| <i>Leptecho scirpi</i> (Barnard)                   |   |
| <i>Leptecho helicotheca</i> Scott                  | <i>Oecetis lucipetens</i> Barnard           |
| <i>Oecetis modesta</i> (Barnard) (e)               | <i>Homilia knysnaensis</i> (Barnard) (e)    |
| <i>Homilia elephas</i> Barnard                     | <i>Sciadorus obtusus</i> (Barnard) (e) (E?) |
| <i>Sciadorus acutus</i> Barnard                    |   |
| <i>Polyplectropus</i> sp (E?) (Berg River species) | <i>Chimarrha cerceris</i> Barnard           |
| <i>Chimarrha ambulans</i> Barnard (e) (E)          |   |
| <i>Chimarrha georgensis</i> Barnard (e)            | <i>Thylakion forcipatum</i> Barnard         |
| <i>Thylakion urceolus</i> Barnard (e)              | <i>Agapetus murinus</i> (Barnard).          |
| <i>Agapetus agilis</i> (Barnard) (E)               |   |

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COLEOPTERA

*Gyrinidae*

Brinck, 1955a, in his monograph on Southern African Gyrinidae lists 15 species of Gyrinidae, mostly Aulonogyrus, endemic to the Cape System Region. It is not known if these are affected by the pH of the water though most of them are confined to T.M.S. mountains.

*Hydraenidae*

There appear to be many species found only in acid streams of this region but none of them has been described. J. Balfour-Browne is producing a monograph.

*Dryopidae*

Strina sp GBG. 7U (E)	GBG species 128A (Berg River species)
-----------------------	--

*Elmidae*

GBG. 8J (E)	GBG. 6AA (E)
GBG. 125E (E)	GBG. 230C
GBG. 3M	GBG. 81B
	(Berg River species)

*Helodidae*

Berg River sp. A (E)	Berg River sp. B (E)
Berg River sp. C (E?)	

DIPTERA

*Blepharoceridae*

Elporia barnardi (Edw.) (e)	Elporia capensis Edw.
Elporia spinulosa Edw.	Elporia uniradius Barnard (e)
Elporia capra Barnard	

*Simuliidae*

Probably no species are limited to acid stream except, perhaps, *Simulium hessei* Fr. & de M. which has only been found in T.M.S. mountains.

*Chironomidae*

Of the 80 or so species recorded by Scott (1958) from the Great Berg River and other localities in the Western Province, none is known to be limited to acid streams, and most are found in other parts of South Africa.

HYDRACHENELLAE

It is possible that some of the species described by Viets from acid waters in the Western Province are "acidobionts" and limited to T.M.S. streams and pools. The following are suggested.

Plesiohygrobatas pectinipalpis Viets	Atractides coriacellus Viets
Atractides pulcher Viets	Diversibates pilosus Viets
Ambiguobates permixtus Viets	
Ambiguobates (Ambiguobatella) pelto-	
phorus Viets	
Tortipalpus obscuriporus Viets.	

The specimens collected on the last expeditions still have to be worked up.

A number of the species listed in this appendix may not be truly acid water species but oligotrophic (clean water species) and endemic to the Cape System mountains. Many, probably, can be considered to belong to a palaeogenic, montane element, e.g. the Nemouridae, the Ephemerellidae, the Odonata, the Corydalidae, some Trichoptera and the Blepharoceridae; other cannot, e.g. the Baetidae, Leptophlebiidae and certain caddis, Athripsodes spp. and Chimarra spp.

## APPENDIX II

“Temperate” species which appear to prefer alkaline water. Some are also found in slightly acid streams. This is a preliminary list of those found in the Cape System Region. New records for the region, found during the recent survey of the eastern part are marked (N).

## NEMERTINI

*Prostoma* sp.

## MOLLUSCA

<i>Lymnaea natalensis</i> (Swartkops R.) Kraus	<i>Bulinus tropicus</i> Kraus
<i>Lymnaea columella</i> Say. (exotic from U.S.A.)	<i>Anisus natalensis</i> (Kraus)
<i>Burnupia stenochorias</i> M + P	<i>Burnupia gordonensis</i> M + P
<i>Ferrissia connollyi</i> Walker	
<i>Tomichia ventricosa</i> Rve.	
<i>Pisidium costulosum</i> Conn.	

## INSECTA PLECOPTERA

*Perlidae*

*Neoperla spio* (Newm.) (N)

## EPHEMEROPTERA

*Baetidae*

<i>Baetis bellus</i> Barnard (also sub-tropical)	<i>Baetis</i> sp. A Berg River
<i>Baetis</i> sp. B. Berg River	<i>Centroptilum sudafricanum</i> Lest.
<i>Centroptilum varium</i> Crass (N)	<i>Centroptilum indusii</i> Crass (N)
<i>Centroptilum pulchrum</i> Crass	<i>Centroptiloides bifasciata</i> E.-P. (N)
<i>Cloeon lacunosum</i> Barnard	

*Caenidae*

Too little is known of this group to place the species.

*Tricorythidae*

*Neurocaenis discolor* Burm.

*Leptophlebiidae*

*Euthraulius elegans* Barnard.



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TRICHOPTERA

- Cheumatopsyche thomasseti (Ulmer)  
Macronema sp. (? natalensis Ulmer)      Ecnomus spp.  
Dipseudopsis capensis Wlkr.

COLEOPTERA

*Psephenidae*

Eubrianax sp. (N)  
Numerous Dytiscidae, Hydrophilidae, Hydraenidae, Dryopidae and Helmidae almost certainly belong here but not enough is known of their distribution and taxonomy at the moment to place them.

DIPTERA

*Simuliidae*

- Simulium ruficorne Macquart      Simulium bovis de Meillon  
Simulium bequaerti Gibbins (N)      Simulium alcocki Pomeroy (Swartkops  
Simulium hirsutum Pomeroy (Swartkops      River).  
River)

*Chironomidae*

Scott (1958) gives a full list of the species found in the acid and alkaline parts of the Great Berg River.

APPENDIX III

Species which appear not to be pH-sensitive. Most are limited to the temperate parts of the country, others are also found in sub-tropical parts (U). This is a preliminary list of those found in the Cape System Region.

DECAPODA

- Potamon perlatus-sidneyi complex (U)

EPHEMEROPTERA

- Baetis harrisoni Barnard      Centroptilum excisum Barnard (U)  
Pseudocloeon vinosum Barnard      Austrocloeon virgiliae Barnard (U)  
Austrocloeon africanum Barnard (U)      Acentrella capensis Barnard  
Adenophlebia peringueyella Lest and other  
species  
Castanophlebia calida Barnard      Choroterpes nigrescens Barnard  
Afronurus harrisoni Barnard

TRICHOPTERA

- Athripsodes harrisoni Barnard  
Cheumatopsyche afra (Mosely)  
Hydroptila capensis (U)      Oxyethira (syn. Argyrobothrus) velocipes  
(Barnard) (U)  
Orthotrichia sp (U)

## DIPTERA

*Simuliidae*

<i>Simulium medusaeforme</i> Pomeroy	<i>Simulium harrisoni</i> Fr. & de M.
<i>Simulium impukane</i> de Meillon (U)	<i>Simulium merops</i> de Meillon
<i>Simulium unicornutum</i> Pomeroy (U)	<i>Simulium adersi</i> Pomeroy (U)
<i>Simulium nigratarsis</i> Coquillet (U)	

*Note:* The following groups have not been considered in these appendices: all Crustacea below Decapoda, all Heteroptera, all Dytiscidae, Hydrophilidae and Hydraenidae. Chironomidae are only known from the Western Cape Province and from the Swartkops River, near Port Elizabeth and not from the rest of the region. The distribution of Odonata is discussed by Brinck, 1955b.

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## DISCUSSION

- Mr. Grindley:* Macan (*Biol. Rev.* 36: 151) concludes that pH is of no significance as a factor limiting the distribution of freshwater animals, except in the case of certain protozoa. What does Dr. Harrison think about this? Do the mountain streams of the South-west Cape form a very special case?
- Dr. Harrison:* Yes, perhaps—a case rather special to South Africa. In the Transvaal an artificial situation has been created by the breakdown of pyrites in the gold mines. As a result one may find streams with a pH of about 2.9 for about 20 miles. Much life is eliminated but they are carpeted with sphagnum moss and *Baetis harrisoni* and chironomids occur. This indicates that pH does play a part. Again, in Zeekoevlei where the pH goes to 10, certain animals are restricted. Dr. Cholnoky can name the

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pH of a given water just by examining its diatoms, judging not by individual species but on the percentage composition of the flora. We have checked him a number of times and have always found him right.

*Prof. Ewer:* I understand that, although *Baetis harrisoni* may occur in acid streams, it is not restricted to them. Are there any organisms which are so restricted?

*Dr. Harrison:* Not that I know of. There is a chironomid in the Transvaal which occurs in neutral or slightly acid waters and seems happiest in acid streams, but none are completely restricted.

*Prof. Ewer:* This work of Harrison's is potentially of great ecological importance because pH has, as Mr. Grindley says, fallen into disrepute as a possible limiting factor. I would like to see it now taken a stage further and experimentally treated to determine whether the important factor is really acidity or something else often associated with it, such as organic content of the water.

*Dr. Harrison:* While organic matter might be important, some of the acid streams are peaty but others are not.

*Dr. Stuckenberg:* This paper brings out very clearly that, as far as stream-breeding species go, we are often dealing with two different animals: the larval and adult stages. This work is chiefly concerned with the eco-geography of larvae.

TAXONOMIC ADDENDUM

Since going to press, the following new names have become available:

For *Pseudocloeon* sp. A read *Pseudocloeon saxophilum* Agnew.  
For *Beatis* sp. A read *Beatis glaucus* Agnew.  
For *Beatis* sp. B read *Beatis latus* Agnew.

REFERENCE

AGNEW, J. D. 1961. New Beatidae (Ephem.) from South Africa. *Novos Taxa Entomológicos*, 25: 1-18.