Reprinted from: *Annals of the Cape Provincial Museums*
C.S.I.R. Reprint No. RW 121

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Similar surveys in the Eastern Cape, Natal (Oliff, 1960) and the Transvaal (unpublished results of the National Institute for Water Research) show that similar communities are to be found in upper river reaches in these regions but that a whole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.

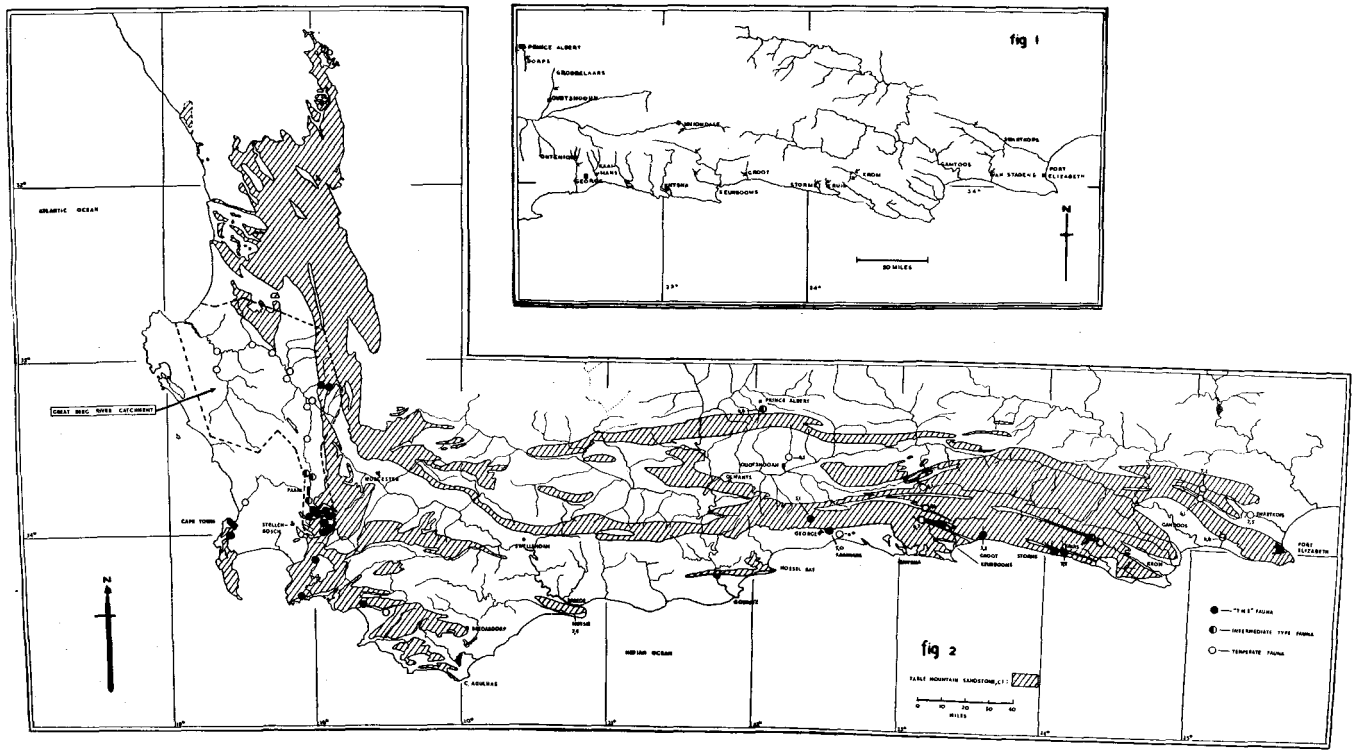
Sampling stations are shown on Fig. 1. Faunal samples were collected with standard nets (23 mesh/cm) and pH readings were taken with a Lovibond Comparator, using standard

* 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 *Wardia hygrometrica* in torrents. Marginal *Prionium serratum.*	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. *P. serratum* and *Scirpus prolifer* present	
Outeniqua Pass	Small mountain trickle with *Wardia hygrometrica* and other moss.	
Storms River ..	Similar to Kruis River above Marginal *Scirpus prolifer* and *Prionium serratum* present	
Groot River ..	Just above estuarine influence. Shallow stony run and marginal *Scirpus prolifer* and *S. fluitans.*	
Dorps River ..	Mountain stream. Stony runs with moss and roots in interstices. *P. serratum* present	Slightly acid (pH = 6·0 – 6·9) clear water.
Krom River ..	Stony runs and marginal vegetation, *P. serratum S. fluitans* etc., Heavy gelatinous growths on both stones and vegetation (Chlamydobotrys). 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. (*P. serratum* 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 Uniondale	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: *P. serratum, Scirpus prolifer, S. fluitans, Nymphea stellata* etc.,	
Grobbelaars ..	Broad open river with stony runs. Little marginal vegetation. *Prionium serratum* present.	Alkaline (pH = 8·5) clear water.



Figs. 1 and 2.

Fig. 1. The sampling stations, indicated by arrows.

Fig. 2. The distribution of the faunas and the Table Mountain Sandstone, discussed further in the text.

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. $CaCO_3$	1·0–5·6	0·0	4·6	—	8·8
Total Acidity p.p.m. $CaCO_3$	—	13·0	—	—	—
Sulphate, p.p.m. SO_4	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. $CaCO_3$	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).

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
		%	%	%	%	%	
Nemouridae ..	Aphanicercopsis type nymphs	38·8	15·4	18·9	13·0	7·4	Not classifiable to spp.
	Aphanicerella type nymphs..	—	0·8	2·1	—	3·8	Not classifiable to spp.
Baetidae	Baetis harrisoni	—	—	—	17·7	3·8	
	Pseudocloeon vinosum ..	—	11·8	19·9	1·5	1·3	
Leptophlebiidae ..	*Aprionyx peterseni*	0·9	—	—	—	—	
	Castanophlebia calida ..	4·4	9·3	1·2	1·2	5·1	
Ephemerellidae ..	*Lithogloea penicillata* ..	—	6·3	1·5	0·4	5·8	
Megaloptera ..	*Chlorionella* sp.	—	0·5	0·5	0·2	0·3	
	Platychauliodes sp.	—	0·6	—	P	—	
	Taeniochauliodes sp. ..	0·6	—	—	—	—	
Sericostomatidae..	*Barbarochthon cf. brunneum*..	—	2·1	0·6	0·6	—	Species determination difficult.
	Dyschimus sp.	0·6	—	—	—	—	
	Petroplax sp.	—	—	—	—	P	
	Sinion cf. hageni	1·2	—	—	—	—	
Leptoceridae ..	*Athripsodes sp. near bergensis*	—	1·7	0·3	1·3	19·6	
	Leptoceridae	4·7	—	—	—	—	
Hydropsychidae ..	*Sciadorus cf. obtusus*.. ..	4·4	—	—	—	—	
	Cheumatopsyche afra ..	—	—	—	0·8	—	
	Cheumatopsyche thomasseti	—	—	—	1·4	—	
Polycentropodidae	*Polyplectropus sp.* .. .. (Berg River type)	0·3	0·2	—	—	—	
Philopotamidae ..	Chimarrha spp.	—	1·2	8·8	14·3	2·6	Not classifiable to spp.
Rhyacophilidae ..	*Agapetus agilis*	—	—	1·4	1·8	0·3	
Elmidae ..	*Berg River Type GBG 8J* ..	1·8	12·5	0·4	7·4	2·9	Mostly Stenelmis
	Berg River Type GBG 6AA ..	21·2	13·2	2·2	7·5	13·4	Limnius and larvae.
Ptilodactylidae ..		—	1·8	—	P	—	
Helidodae ..	*sp. A.*	—	—	17·5	P	—	
	sp. B	—	1·1	P	P	0·1	
Simuliidae ..	Simulium larvae	—	—	5·6	9·9	2·6	
Total Chironomidae		9·8	7·5	10·4	3·5	27·9	
Rhagionidae ..	Atherix-type larvae	—	1·5	1·2	—	1·6	
Anura	Heleophryne 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, Assegaibos 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
		%	%	%	%
Nemouridae	Aphanicercopsis (type)	—	5·4	—	—
	Aphanicercella (type)	3·2	0·9	0·8	P
Baetidae	Austrocloeon africanum	—	—	—	59·4
	Pseudocloeon vinosum	40·2	—	2·3	—
Caenidae	Caenidae	—	0·9	—	P
Ephemerellidae	*Lithogloea harrisoni*	4·4	P	1·5	—
	Lithogloea penicillata	3·7	—	—	—
Odonata	Total Anisoptera	0·2	7·2	3·1	—
	Total Zygoptera	0·7	6·3	—	—
Leptoceridae	*Athripsodes spp. near bergensis*	19·7	39·9	41·7	1·4
	Athripsodes spp.	—	1·8	—	—
Sericostomatidae	*Barbarochthon brunneum*	0·7	6·3	6·8	—
Elmidae	8*J*	0·7	—	1·5	1·4
	6*AA*	0·9	—	3·0	1·4
	Others	0·2	—	—	—
Ptilodactylidae	Larvae	0·1	1·8	1·5	—
Helodidae	*sp. A*	—	0·9	—	—
	sp. B	3·0	—	—	—
Chironomidae	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.

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
		%	%
Nemouridae	Aphanicercopsis-type nymphs	2·0	17·5
Baetidae	Acentrella capensis	1·0	—
	Pseudocloeon vinosum	—	17·6
Leptophlebiidae	Castanophlebia calida	1·0	0·01
Ephemerellidae	*Lithogloea sp. Berg River sp. B.*	26·3	1·2
Megaloptera	*Chlorionella sp.*	—	0·01
	Platychauliodes sp.	1·0	0·04
Trichoptera	*Barbarochthon brunneum*	0·5	0·3
	Petrothrincus triangularis	3·5	—
	Athripsodes—A. bergensis type	—	0·01
	Sciadorus	1·5	—
Hydraenidae	Total	5·0	0·01
Elmidae	*Berg River type 8J*	6·5	16·2
	Berg River type 6AA	4·5	—
	Berg River type 128A	3·5	—
	Others	0·5	2·6
Simuliidae	Simulium medusaeforme	10·1	0·5
Total Chironomidae		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
		%	%
Copepoda	Cyclops spp.	4·1	—
Hydrachnellae	Various species	1·4	3·5
Nemouridae	Aphanicercella type nymphs	0·7	5·9
	Aphanicercopsis type nymphs	1·5	15·2
Baetidae	Austrocloeon sp.	—	2·4
	Pseudocloeon sp. (Berg River sp. A)	49·5	—
	Pseudocloeon vinosum	6·6	—
Leptophlebiidae	*Aprionyx peterseni*	2·6	—
	Choroterpes nigrescens	—	1·2
	Castanophlebia calida	—	1·2
Ephemerellidae	*Lithogloea penicillata*	2·2	—
Ecdyonuridae	Afronurus harrisoni	1·9	—
Zygoptera	Allocnemis leucosticta	—	17·6
Trichoptera	*Barbarochthon brunneum*	0·3	4·7
	Athripsodes sp. cf bergensis	12·1	18·8
	Chimarrha sp.	—	2·4
	Polyplectropus sp.	2·9	—
Elmidae	*Berg River type 6AA*	5·8	10·6
Ptilodactylidae		0·3	1·2
Helodidae	*Berg River sp. A*	—	1·2
Chironomidae (total)		6·2	9·4
		97·9	95·3

Note: italic species—acid water endemic forms.

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	Assegaai-Bosch	Buffels-nek	Near Touw R.	After Avon-tuur*	Keur booms*	V. Stadens	Upper Swart-kops
		%	%	%	%	%	%	%	%	%
Perlidae ..	†Neoperla spio	—	—	—	0·3	—	—	—	—	—
Nemouridae ..	Aphanicercopsis (type) ..	9·5	3·3	—	—	16·3	—	—	—	—
	Aphanicercella (type) ..	2·0	—	2·0	—	—	—	—	—	—
Baetidae ..	Acentrella cf. capensis ..	0·2	—	—	—	0·2	—	—	—	—
	Baetis harrisoni	0·8	0·7	8·1	2·1	—	P	P	—	9·7
	Baetis bellus	—	—	—	—	—	P	—	—	—
	Centroptilum sudafricanum	14·1	—	25·2	10·1	8·2	P	P	4·7	—
	†Centroptilum varium ..	0·1	—	—	—	—	—	—	—	—
	†Centroptiloides bifasciata	—	2·3	—	—	—	—	—	—	—
	Pseudocloeon maculosum	—	15·4	—	—	—	—	P	—	0·6
	Pseudocloeon vinosum ..	—	4·6	—	1·5	—	—	—	0·1	—
Leptophlebiidae	Adenophlebia peringueyella	0·7	—	6·6	1·6	4·0	P	P	0·1	—
	Castanophlebia calida ..	2·5	—	—	—	0·4	—	—	—	—
Ephemerellidae	*Lithogloea penicillata* ..	—	—	5·6	0·3	—	—	—	—	—
Tricorythidae	†Neurocaenis discolor ..	9·5	—	—	2·1	—	—	—	—	—
Ecdyonuridae	Afronurus harrisoni ..	—	—	—	3·7	—	—	—	—	—
Leptoceridae .	Athripsodes spp.	0·7	—	P	—	P	—	—	—	—
Hydropsychidae	Cheumatopsyche afra ..	3·5	11·8	2·0	4·2	2·7	P	P	0·8	3·8
	†Cheumatopsyche thomasseti	—	—	—	2·4	—	—	—	—	—
	†Macronema sp.	—	10·2	0·5	—	—	—	—	0·1	—
Philopotamidae	Chimarrha sp.	8·5	—	—	1·3	5·5	—	—	—	—
Hydroptilidae	Hydroptila sp.	P	—	—	—	—	—	P	—	—
Elmidae ..	8*J*	2·5	4·0	11·6(?)	15·3	9·3	—	—	—	—
	6*AA*	1·3	0·3	—			—	P	—	—
	(Others)	3·9	3·0	—			—	—	—	—
Helodidae ..	*Helodid sp A*	0·8	2·6	—	—	4·6	—	—	—	—
	Helodid sp B	0·8	0·3	—	—	—	—	—	—	—
Simuliidae ..	Simulium larvae	7·6	3·0	P	11·3	26·2	P	P	73·1	73·7
Chironomidae	Total Chironomidae ..	8·9	34·4	21·6	19·5	14·4	P	P	9·4	5·8
Rhagionidae ..	Atherix 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 ("acidobiontic") 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
		%	%	%	%	%
Nematoda ..	Nematodes	—	31·1	P	P	8·5
Nemertea ..	†Prostoma sp.	6·3	6·4	P	P	5·3
Baetidae ..	Baetis bellus	10·6	—	P	—	—
	Centroptilum excisum	—	0·3	P	—	—
	Centroptilum sudafricanum	4·3	0·4	P	P	—
	Pseudocloeon vinosum	8·5	3·6	—	—	—
Coenagriidae	Pseudagrion sp.	6·3	3·4	P	P	—
Hydroptilidae	Oxyethira (=Argyrobothrus) velocipes	6·3	3·4	—	P	11·2
	Hydroptila	P	—	—	P	—
Simuliidae ..	Simulium larvae	10·6	13·8	P	P	1·8
Chironomidae	Total	14·9	26·4	P	P	34·0
Mollusca ..	†Burnupia 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.

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	*Centroptilum indusii*	0·2
Euthraulus elegans	7·1	Centroptilum pulchrum	0·2
Afronurus harrisoni	4·4	Baetid juveniles	32·1
Aeschna sp.	0·2	Euthralus 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	*Psephenidae (Eubrianax)*	0·1
Psephenidae (Eubrianax)	2·2	Corynoneura spp.	1·9
Simulium larvae	1·8	Pisidium sp.	0·7
Orthocladiinae	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 Orthocladiinae	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 1

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

EPHEMEROPTERA

Baetidae

Pseudocloeon sp. A (E) (Berg River)

Leptoplebiidae

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

Ephemerellidae

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

Chloroniella peringueyi E.-P. (E) (*e*)	
Platychauliodes tenuis (MacLach.) (*e*)	Platychauliodes capensis Barnard
Platychauliodes woodi Barnard (*e*) (E?)	Platychauliodes thorni Barnard

TRICHOPTERA

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

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

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. 125E (E)
GBG. 3M

GBG. 6AA (E)
GBG. 230C
GBG. 81B (Berg River species)

Helodidae

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

Berg River sp. B (E)

DIPTERA

Blepharoceridae

Elporia barnardi (Edw.) (*e*)
Elporia spinulosa Edw.
Elporia capra Barnard

Elporia capensis Edw.
Elporia uniradius Barnard (*e*)

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.

Plesiohygrobates pectinipalpis Viets
Atractides pulcher Viets
Ambiguobates permixtus Viets
Ambiguobates (Ambiguobatella) peltophorus Viets
Tortipalpus obscuriporus Viets.

Atractides coriacellus Viets
Diversibates pilosus 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 Chimarrha 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

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

INSECTA PLECOPTERA

Perlidae

Neoperla spio (Newm.) (N)

EPHEMEROPTERA

Baeridae

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

Caenidae

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

Tricorythidae

Neurocaenis discolor Burm.

Leptophlebiidae

Euthraulus elegans Barnard.

TRICHOPTERA

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

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 bequaerti Gibbins (N)
Simulium hirsutum Pomeroy (Swartkops River)
Simulium bovis de Meillon
Simulium alcocki Pomeroy (Swartkops 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
Pseudocloeon vinosum Barnard
Austrocloeon africanum Barnard (U)
Adenophlebia peringueyella Lest and other species
Castanophlebia calida Barnard
Afronurus harrisoni Barnard
Centroptilum excisum Barnard (U)
Austrocloeon virgiliae Barnard (U)
Acentrella capensis Barnard
Choroterpes nigrescens Barnard

TRICHOPTERA

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

DIPTERA

Simuliidae

Simulium medusaeforme Pomeroy
Simulium impukane de Meillon (U)
Simulium unicornutum Pomeroy (U)
Simulium nigritarsis Coquillet (U)
Simulium harrisoni Fr. & de M.
Simulium merops de Meillon
Simulium adersi Pomeroy (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.

REFERENCES

BARNARD, K. H., 1931. The Cape Alder-flies (Neuroptera, Megaloptera) Trans. R. Soc. S. Afr., XIX, 169–184

BARNARD, K. H., 1932. South African May-flies (Ephemeroptera). Trans. R. Soc. S. Afr. XX, 201–299.

BARNARD, K. H., 1934A. South African Caddis-flies (Trichoptera). Trans. R. Soc. S. Afr. XXI, 291–394.

BARNARD, K. H., 1934B. South African Stone-flies (Perlaria) with descriptions of new species. Ann. S. Afr. Mus. XXX (17), 511–548.

BARNARD, K. H., 1937. Notes on Dragon-flies (Odonata) of the S.W. Cape, with descriptions of nymphs and of new species. Ann. S. Afr. Mus. XXXI (3), 169–260.

BARNARD, K. H., 1940. Additional records and descriptions of new species of South African Alder-flies (Megaloptera), May-flies (Ephemeroptera), Caddis-flies (Trichoptera), Stone-flies (Perlaria), and Dragon-flies (Odonata). Ann. S. Afr. Mus, XXXII (6), 609–661.

BARNARD, K. H., 1947. The Blepharoceridae (Diptera) of the S.W. Cape. J. Ent. Soc. S. Afr. X, No. 1. 3–15.

BRINCK, Per, 1955a. A Monograph of the Whirligig Beetles of Southern Africa. South African Animal Life, Vol. I, 329–518. Uppsala.

BRINCK, 1955b. Odonata. South African Animal Life, vol. 2, 191–233. Uppsala.

CRASS, R. S., 1947. The May-flies (Ephemeroptera) of Natal and the Eastern Cape. Ann. Natal Mus XI (1) 37–110.

HARRISON, A. D. and ELSWORTH, J. F. 1958. Hydrobiological studies on the Great Berg River, Western Cape Province. Part I: General description, chemical studies and main features of the flora and fauna. Trans. R. Soc. S. Afr. XXXV (3) 125–226.

OLIFF, W. D., 1960. Hydrobiological studies on the Tugela River System. Part I: The main Tugela River. Hydrobiologia XVI (3–4), 281–385.

SCOTT, K. M. F., 1958. Hydrobiological studies on the Great Berg River, Western Cape Province. Part 3: The Chironomidae.

VIETS, Karl., 1956. Wassermilben aus Südafrika. Systematische, faunistische und ökologische Untersuchungen. Zool. Jb. (Systematik), 84 (1), 1–31.

VIETS, Karl., 1959. Über Einige Südafrikanische Wassermilben (Acari, Hydrachnellae). Mitt. Zool. Mus. Berlin. 35 (1), 45–56.

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

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.