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Benthic fauna of Ethiopian mountain streams and rivers

By A. D. HARRISON and H. B. N. HYNES

With 1 figure and 5 tables in the text

Abstract

A faunal standard of reference is established for Ethiopian montane benthos in undamaged high-level streams and rivers. The effects of population density, soil erosion and drought on source waters is described.

The Ethiopian montane aquatic fauna is compared with the faunas of other African mountain regions and its biogeographical significance is discussed.

Contents

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Introduction

The freshwaters of Ethiopia, springs, streams, rivers, lakes, impoundments and wells, constitute a valuable primary resource of great biological interest and strategic national importance. At present this resource is utilized partially for hydroelectric power, irrigation, fisheries and both industrial and potable water systems. The many source streams and rivers originating in the high peaks of the Rift Valley ranges are of particular importance and are threatened by erosion and resultant catastrophic droughts. Ethiopia's agriculture depends to an increasing extent on irrigation water coming ultimately from the highlands.

Since World War II there has been a rapid increase in rural population and in domestic animals, together with rapid deforestation in the mountains. Soil erosion has always been a feature of the Ethiopian highlands, and the rich silt in the Blue Nile floods was the mainstay of Ancient Egyptian agriculture. However, recent practices have resulted in serious damage to the uplands (KURU 1978), and now enormous quantities of silt are being passed down the rivers.

This paper is a contribution towards the understanding of the high level montane source waters which supply the rivers and ultimately the lakes and impoundments. This study is part of an extensive programme, jointly being carried out by the Biology Departments of Addis Ababa University and the University of Waterloo, on the freshwaters of Ethiopia, with particular emphasis on the Rift Valley drainage basins and lakes.

First, a description of the fauna of relatively undamaged montane streams of Ethiopia is given, establishing a basis for comparison with the fauna of damaged streams, and showing what deterioration has already occurred.

Second, a comparison is made between the Ethiopian montane stream and river fauna and that of the mountains of East and Southern Africa, and Eurasia. The montane fauna of Ethiopian streams and rivers is of biogeographical importance, as Ethiopian mountains are the most northerly of the sub-Saharan high mountain ranges and lie on a possible dispersal route for montane forms to or from Africa, through the Arabian mountains to the Eurasian mountains.

In East and Southern Africa comprehensive surveys of flowing waters have been made: the Great Berg River, Cape Fold Belt (HARRISON & ELSWORTH 1958, SCOTT 1958); other Cape Province rivers (HARRISON & AGNEW 1962); the Tugela River, Natal Drakensberg Mountains (OLIFF 1960); the Vaal River, Drakensberg (CHUTTER 1970); the Eastern Transvaal Drakensberg Mountains (HUGHES 1966); the Chimanimani Mountains, Eastern Zimbabwe (HARRISON 1965b); Mount Elgon, Uganda (HYNES & WILLIAMS 1962, WILLIAMS & HYNES 1971); Mount Kenya, Kenya (VAN SOMEREN 1950).

Most of the Southern African faunistic surveys were part of comprehensive studies on water resources. Researchers realized that the faunal communities were very sensitive to deterioration in rivers, caused by faulty agricultural practices and by domestic and industrial pollution. They saw the need for establishing a faunal standard of reference derived from unpolluted sections in the main river systems which would make possible the detection of future deterioration (HARRISON & ELSWORTH 1958).

Further information on the distribution of specific groups of aquatic organisms may be gleaned from numerous taxonomic publications, and also from studies on the ecology of specific groups in the mountains of Zaire: STATZNER (1975, 1976) and JAQUEMART & STATZNER (1981) on caddisflies; LEHMANN (1979, 1981) on Chironomidae.

Until now no information has been available on the composition of benthic communities of Ethiopian mountain streams and rivers, although some information on specific taxonomic groups has been given: HYNES (1955) on Heteroptera; KIMMINS (1963) on Trichoptera; FREEMAN & DE MEILLON (1953), UEMOTO, OGATA & MEBRAHTU (1977) and GRENIER & OVAZZA (1956) on Simuliidae; FREEMAN (1955, 1956, 1957 and 1958) on Chironomidae; and BROWN (1965) on freshwater snails.

The Ethiopian mountains

According to GOUIN (1979) the mountains of Ethiopia were produced by the major rifting process which started during the middle Miocene and continued into the Quarternary. Three recognizable dome segments were produced, two main ones lying to the north-west and to the south-east of the Rift Valley and the third, a small segment, lying north of Lake Turkana (in Gama Goffa and Kaffa). Both main segments have developed into mountain ranges, with peaks rising to over 3000 m and a few to just over 4000 m, and extensive regions of high plateau. YALDEN (1983) states that 79.7% of the 28,545 km^2 of mountains in Africa which lie above 3000 m, and 50.4% of the 371,432 km^2 lying above 2000 m are found in Ethiopia.

Rainfall in the mountains is high. Most falls during two periods, the first, called the little rains, from January to April and the second, the main rains, from June to the end of September. No mountain peak rises to above the permanent snow line so there are no permanent glaciers as on Mt. Kenya.

The botanical zones in the mountains are described by EDWARDS (1976). Above 3000 m, or down to 2500 m in some places, plants are Afro-alpine or Sub-afroalpine; the former are mainly small bushy shrubs, but the latter may include tree-heather, and even small forests of *Hagenia abyssinica* (BRUCE) J. F. GEMEL and *Hypericum revolutum* VAHL (although much of this has been felled). Below this, down to 2000 m is a zone of junipers, now mostly cut down leaving scrub and eroded hillsides. The flat areas of the plateau are natural grasslands which become swampy during the rainy season. The slopes of the wetter south and west plateau often have forests of *Podocarpus gracilior* PIGLER, or remnants of it. The upper escarpment, above the Rift Valley, has juniper forest (*Juniperus procera* HOCHST. ex ENDL.), or its degraded remains; the lower escarpment slopes have evergreen bushland and the Rift Valley floor has acacia bushland or is cultivated. Around Addis Ababa, much of the juniper forest has been replaced by eucalyptus plantations.

The study region

Mountain streams and rivers on both sides of the Rift Valley were studied during 1983 and 1984. The stations (ET) are shown on Figure 1 and listed in Table 1. Altitudes are taken from contour maps supplied by the Ethiopian Mapping Agency, Addis Ababa.

The streams and rivers sampled were part of the following river or closed lake systems:

1. Abay (Blue Nile) River System: ET 5, 6, 7, 10, 15, 16, 17, 18.
2. Awash River System: ET 1, 1A, 2, 2A, 2B, 2C, 8, 9, 13, 14, 31, 32, 35, 39.
3. Genale – Juba River System: ET 19, 20, 21, 22, 23, 24, 25, 26.
4. Wabe Shebele River System: ET 27, 28, 29, 30.
5. Lake Awasa System: ET 3, 4, 11, 12.
6. Lake Abijata System: ET 33, 34.
7. Lake Abaya – Chamo System: ET 36, 37, 38.

All stations had stony runs except ET 7, 8.

ET 2, the Abo River, at 2500 m, had a waterfall with growths of moss which was sampled. Samples were also taken from strong growths of moss and *Lemanea* BORY (Rhodophyta) at ET 19, the Danka River, at 3100 m.

Samples were taken from marginal reeds and rushes at a few stations, eg. ET 5 and ET 30.

Methods

Temperatures

These were taken with a mercury thermometer placed directly in the running water.

Water samples

Samples were collected in polythene bottles and later analyzed by the water analysis laboratory of the Department of Earth Sciences, Waterloo: cations by atomic absorption analysis, chloride and sulphate by ion chromatography using a Dinex System 12 ion chromatograph, and bicarbonate by titration with standard acid to a pH endpoint of 4.3.

pH

Field pH readings were taken in running water with a portable pH meter.

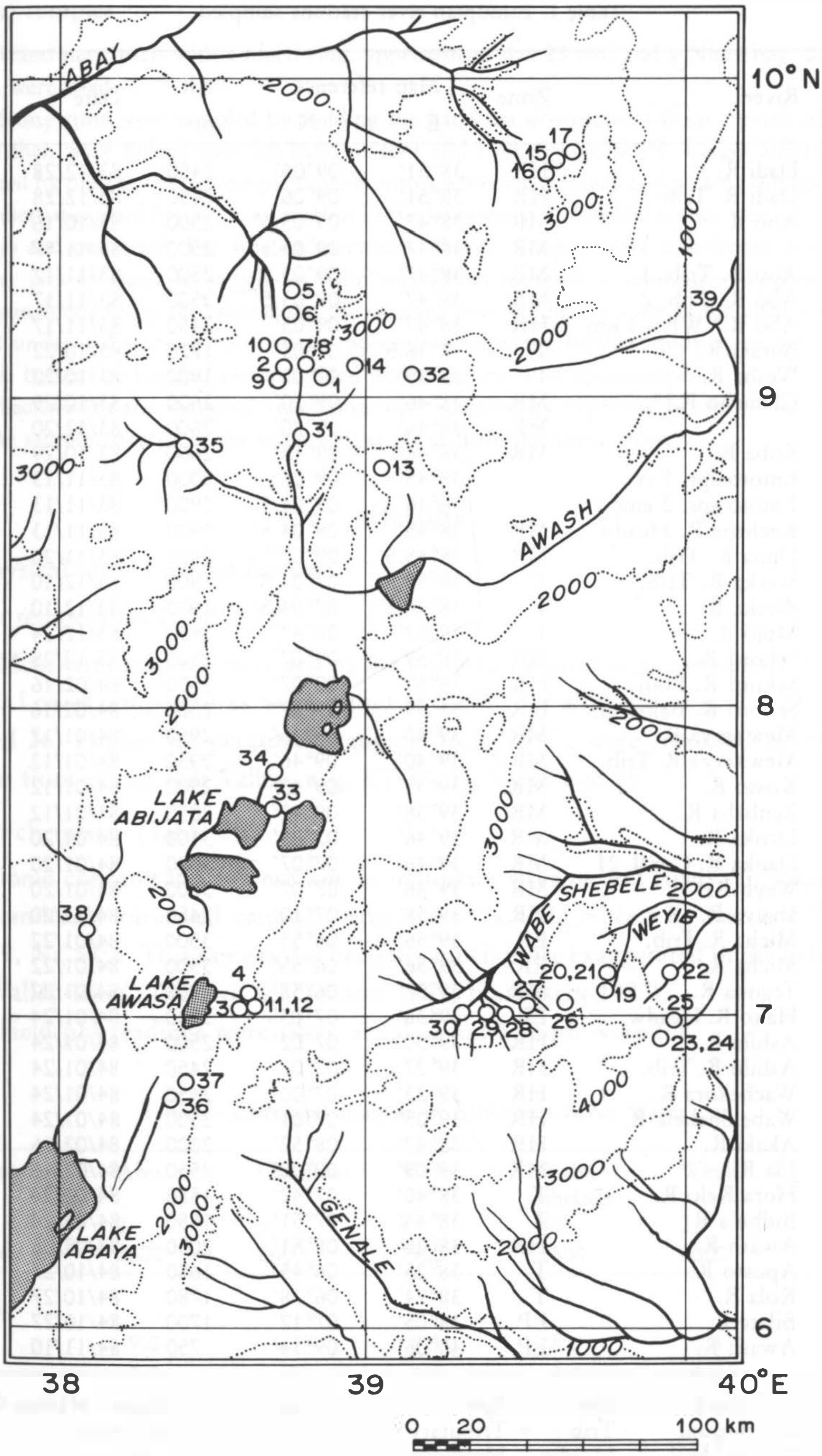

Fig. 1. Map of the study region, showing contours at 1000 m intervals, and principal drainages. Locations of the numbered ET stations (Tab. 1) are shown as open circles. Note: Weyib River is also spelled Weyb, Web or Ueb.

Table 1. Ethiopian river stations sampled.

ET	River	Zone	Map reference E	Map reference N	Alt. m	Date	Water temp. °C
1	Dadi R.	HR	38°51′	09°06′	2450	83/12/28	20
1A	Dadi R. Trib	HR	38°51′	09°06′	2450	83/12/28	18
2	Abo R.	MR	38°47′	09°03.5′	2500	83/10/16	16
		MR	38°47′	09°03.5′	2500	83/11/17	16
2A	Abo R. Trib. 1	MR	38°47′	09°03.5′	2500	83/11/17	16
2B	Abo R. Trib. 2	MR	38°47′	09°03.5′	2500	83/11/17	14.5
2C	Abo R.* WF – 1 km	HR	38°47′	09°03′	2450	83/11/17	17.5
3	Burara R.	T	38°36.5′	07°03′	1720	83/10/22	20
4	Wesha R.	T	38°39′	07°05′	1900	83/10/22	20
5	Chancho R.**	MR	38°46′	09°20′	2600	83/10/29	21
		MR	38°46′	09°20′	2600	83/12/20	21
6	Roba R.	MR	38°46′	09°15′	2600	83/10/29	21
7	Entoto spr. 1 rt		38°45′	09°06′	3000	83/11/13	20
8	Entoto spr. 2 emc		38°46′	09°04.5′	2900	83/11/13	20
9	Kechene R. Headw.	MR	38°45′	09°04.5′	2900	83/11/13	24
10	Dima R. Trib.	MR	38°45.5′	09°07′	2850	83/11/20	12–14
11	Werka R. Trib.	T	38°38.5′	07°04.5′	1900	83/12/10	20
12	Werka R.	T	38°38.5′	07°04.5′	1900	83/12/10	20
13	Mojo R.	T	39°02′	08°47′	1850	83/12/24	20
14	Sekord R.	HR	38°59′	09°07′	2500	83/12/28	14
	Sekord R. Pool	HR	38°59′	09°07′	2500	84/02/16	17
	Sekord R. Below p.	HR	38°59′	09°07′	2500	84/02/16	18
15	Mewkerya R.	MR	39°40′	09°46′	2950	84/01/12	15.5
16	Mewkerya R. Trib.	MR	39°40′	09°46′	2950	84/01/12	20
17	Kosso R.	MR	39°39′	09°43′	2900	84/01/12	14–15
18	Zenbaba R.	MR	39°38′	09°42′	2850	84/01/12	19
19	Danka R.	MR	39°46′	07°05′	3100	84/01/20	10
20	Danka R. Confl. 21	MR	39°46′	07°07′	3000	84/01/20	14.5
21	Weyb R.***	MR	39°46′	07°07′	3000	84/01/20	15
22	Shaiya R.	HR	39°58′	07°10′	2450	84/01/20	19
23	Micha R. Trib.	ER	39°56′	06°55′	3500	84/01/22	08
24	Micha R.	ER	39°56′	06°55′	3500	84/01/22	04.5
25	Tegona R.	MR	39°58′	06°58′	2900	84/01/22	
26	Hako R. Headw.	ER	39°38′	07°03′	3550	84/01/24	07
27	Ashilo R.	HR	39°30′	07°02′	2500	84/01/24	15
28	Ashilo R. Trib.	HR	39°27′	07°02′	2450	84/01/24	18
29	Wachekora R.	HR	39°23′	07°00′	2450	84/01/24	18.5
30	Wabe Shebele R.	HR	39°03′	07°01′	2500	84/01/24	20
31	Akaki R.	HR	38°47′	08°52′	2000	84/02/16	17
32	Jila R.	MR	39°09′	09°02′	2550	84/02/16	25
33	Hora Kelo R.	T	38°40′	07°42′	1580	84/02/24	23
34	Bulbula R.	T	38°44′	07°51′	1680	84/02/24	24
35	Awash R.	HR	38°25′	08°51′	2050	84/03/08	19
36	Aposto R.	T	38°25′	06°45′	1680	84/10/27	19
37	Kola R.	T	38°24′	06°38′	1780	84/10/27	19
38	Bilate R.	EP	38°05′	07°17′	1700	84/10/27	22
39	Awash R.	EP	40°06′	09°14′	750	84/11/10	24

ER = Epirhithral
MR = Metarhithral
HR = Hyporhithral
T = Transitional

Spr = Spring
Trib = Tributary
Headw = Headwater
Confl = Confluence

emc = below Entoto Mariam Church
rt = near radio tower
EP = Epipotamal
WF = Waterfall

* This station and a number of other stations downstream (there called Kebene R.) were thoroughly sampled during wet and dry seasons of 1984 and 1985. These sampling stations extended into the polluted section running through Addis Ababa.

** Sampled on numerous occasions until Jan 1986.

*** Also spelled Weyib, Web or Ueb.

Faunal samples

Hand nets, each with a metal ring, approximate size 25 cm, and a Nitex bag, 0.20 mm mesh, were used.

Stony runs were sampled by holding the hand net downstream from a patch of stones which then were turned over by hand or foot and rubbed vigorously. Larger animals were collected by placing the net sample directly into a white enamel tray and picking out specimens for preservation and further examination in the laboratory. Individual stones were also placed in trays and examined. For smaller specimens, the net samples were transferred into plastic bags or jars of water to which formalin was added to make a solution of approximately 5% formaldehyde. In the laboratory, the samples were washed in a net of the same mesh and sorted under a dissecting microscope. Specimens requiring further study were mounted in Canada balsam or Euparal and examined under a compound microscope.

Backwaters and marginal vegetation were sampled by vigorous sweeps of the handnet and the samples treated in the same way as those from the stony runs.

Results

I. Physical and chemical factors

Water temperatures (Table 1)

Most temperatures recorded in the mountain region were between 4.5 °C and 20°C. Lower temperatures were found at the higher altitudes, e. g. ET 19, 20, 21, 24 and 26. Higher temperatures, ranging up to 25 °C, were recorded from rivers on the floor of the Rift Valley, e. g. ET 32, 34, 35, 38 and 39.

Water chemistry (Table 2)

Ionic concentrations were low in mountain streams and rivers. In some cases the commonly observed cationic order was: Ca > Mg > Na > K, but at ET 4, 30 and 19, Na > Ca. This same order becomes much more exaggerated in the Ethiopian Rift Valley lakes (TALLING & TALLING 1965, HARRISON 1987).

Field pH readings were taken at ET 2 and 5; both were 6.8.

Table 2. Chemical analysis of Ethiopian River Water.

Station	Abo	Chancho	Wesha	Wabe Shebele	Weyb	Danka
ET #	2	5	4	30	21	19
Altitude m	2500	2600	1900	2500	3000	3100
In mg l^{-1}						
Ca^{2+}	9.0	18.3	8.1	8.6	10.4	7.4
Mg^{2+}	2.0	6.5	2.6	2.0	2.6	4.3
Na^{+}	2.6	7.3	18.4	11.0	9.1	9.1
K^{+}	1.8	1.0	5.6	2.4	2.6	2.5
HCO_3^-	53.7	133.0	105.0	86.9	85.2	89.1
Cl^-	1.1	1.9	2.5	2.9	2.5	2.2
SO_4^{2-}	2.8	1.1	1.3	1.2	2.0	3.5
Si	–	–	–	22.1	6.2	6.0

– not measured

II. The fauna

1. Fauna of the source zone

The high plateau of the Bale Mountains, near Mt. Goba, was visited during the dry season, January 1984. The plateau lies mostly above 4000 m and contains a number of small lakes and ponds, many permanent. All streams on the plateau were dry at the time and it appeared that no permanent stream fauna existed.

In the mountains above Addis Ababa (ET 7) a marshy stream and spring were sampled in a source zone at 3000 m. The fauna consisted mainly of: *Dugesia* GIRARD; *Centroptilum* sp. A (see section 7. Taxonomy), *Cloeon* sp.; *Caenis* STEVENS, and *Afrocaenis* sp.; Heteroptera, including *Gerris* FABRICIUS, *Micronecta* KIRKALDY, *Sigara* FABRICIUS and *Anisops* SPINOLA; Dytiscidae including *Hydroglyphus fufai* (OMER-COOPER) (see BISTROM 1986), *Herophydrus inquinatus* (BOHEMAN) and *Agabus* sp.; Hydrophilidae including *Paracymus monticola* WOOLDRIDGE and *Laccobius scotti* D'ORCHYMONT; hydraenid beetles; a species of *Anopheles* MEIGEN; chironomids, including *Paratrichocladius micans* KIEFER, *Rheocricotopus capensis* KIEFER, *Tvetenia calvescens* (EDWARDS), *Parametriocnemus* sp. and *Rheotanytarsus* (*montanus* group).

2. Fauna of stony runs and torrents (Tables 3 and 4)

The streams of the mountain region (rhithral) have a benthic community (Table 3) consisting mainly of: *Dugesia* sp.; *Baetis harrisoni* BARNARD, *Centroptilum sudafricanum* LESTAGE, *Pseudocloeon maculosum* CRASS; *Caenis* spp., *Afrocaenis* spp.; *Afronorus "peringueyi"* ESBEN-PETERSEN; species of *Neoperla* NEEDHAM; *Chimarra* sp., *Hydropsyche* sp., *Cheumatopsyche* spp. including one species of the *C. afra* (MOSELY) type; the elmids *Microdinodes troilus* HINTON and *Stenelmis scotti* HINTON, and larvae of the Psephenid *Eubrianax* KIESENWETTER; *Simulium arabicum* CROSSKEY & BUTTIGER, *S. dentulosum, S. medusaeforme;* the Chironomidae shown in Table 4. The nymphs of *Aeschna* FABRICIUS are a common predator. The leptophlebiids, *Choroterpes* EATON (*Euthraulus* BARNARD) sp. were found commonly in the rivers of the mountains to the south-east of the Rift Valley but not in the mountains of the north-west side.

Table 3 arranges the stations according to altitude and some altitudinal zonation is apparent. Those organisms characteristic of the upper zones (3500–2500 m) are: *Centroptilum varium* CRASS (sharp spines) (see Section 7.3.1), *Afronurus "harrisoni"* BARNARD, *Cheumatopsyche* sp. G, *Stactobia* sp., *Ugandatrichia* sp., Hydraenidae, a species of *Pericoma* WALKER and *Tvetenia* sp. (Table 4, and Section 7.8.2.2). Organisms characteristic of the lower mountain zone (2500–2000 m) are: *Centroptilum varium* (blunt spines); *Naucoris obscuratus* MONTANDON; *Cheumatopsyche* sp. D; some species of Helmidae (adult types 2, 3, 5, and 7; larval types 4, 7 and 9); a species of *Antocha* OSTEN SACHEN, and *Simulium alcocki* POMEROY.

Upper zone stations (ET 15, 17 and 18: Table 3, Col. 2), in the mountains just north of Debre Birhan (2950–2850 m), lie in a region where the soil and bed erosion is particularly severe. These were sampled during the dry season when silt was not moving and the beds were temporarily stable. Nevertheless, the number of species present in these three stations (21) is considerably less than that in the more normal stations (52), (Table 3, Col. 1), *B. harrisoni* was common or abundant at all three stations and *Simulium arabicum* and *S. dentulosum* appeared to be thriving; some otherwise common species and most rarer species were absent (*Dugesia* sp., *Centroptilum varium* "sharp spines", *Pseudocloeon maculosum*, *Afronurus "peringueyi"*, *Neoperla* spp., all species of *Cheumatopsyche*, all Elmidae and some Chironomidae (Table 4)).

At about 1900 m there is a marked change in the stony run community. *Dugesia* sp. becomes less common, numbers of *Baetis harrisoni* and *Centroptilum sudafricanum* fall off and *B. glaucus* appears. Other species which disappear or become rare are: *Pseudocloeon* sp. A, *C. varium* (sharp spines), *Afrocaenis* sp., *Cheumatopsyche* spp. E and G, hydroptilid caddis, *Simulium arabicum*, *S. shoae*, *S. dentulosum*, *S. medusaeforme*, and the chironomids *Cricotopus (M.) harrisoni* and *Rheotanytarsus* sp. (black head). Species appearing in this zone are *Baetis glaucus* AGNEW, *Centroptiloides* LESTAGE, *Elassoneuria* EATON, *Tricorythus* EATON, *Ephemerythus* GILLIES, *Dicercomyzon* DEMOULIN, *Cheumatopsyche* sp. H, and some Elmidae.

Below 1900 m, in the foothill zone (Table 3, Col. 4), it is clear that the mountain community described in the first paragraph of this section is being replaced by another. This is not so obvious in those cases where the rivers run straight out of the high mountains so that water temperatures are kept low and elements of the mountain community are common in the drift, specially in the rainy season (ET 3, 4, 11, 12, 13, 36 and 37). However, ET 38 on the Bilate River, on the Rift Valley floor at 1700 m, is separated from the mountain region by a long series of canal-like stretches and marshes; the stony run was at the beginning of a zone of rejuvenation. Here, *B. harrisoni* and most of the rest of the mountain stream community were absent and were replaced by such species as *Baetis glaucus*, other species of *Baetis*, *Centroptiloides* sp., *Elassoneuria* sp., *Ephoron* WILLIAMSON, *Tricorythus* sp. *Cheumatopsyche* sp. H, and *Simulium bovis*. The chironomids were much the same as those of the mountain zone and no obviously new species appeared.

ET 39, on the Awash River at 750 m, was a stony run artificially created by an irrigation barrage. The river here was well into the epipotamon and far from the mountains; the fauna was similar to that at ET 38, with *B. harrisoni* completely replaced by *B. glaucus*, *Centroptiloides* sp. and some other baetids. No *Elassoneuria* sp. were found but Leptophlebiid type A was abundant (Section 7.3.4). There was also a species of the large amphibious Elmid *Potamodytes* GROUVELLE (Section 7.7.2). A number of species from the lower mountain zones were also

Table 3. Fauna of stony runs, showing comparative density* and percentage (%) stations where found.

Altitude range m	3500–2500		2950–2850		2500–2000		1900–1680	
Stations	2, 2A, B, 5, 9, 19, 20, 21, 24, 25		15, 17, 18		1, 1A, 2C, 14, 22, 27, 28, 29, 30, 31, 35		3, 4, 11, 12, 13, 36, 37, 38	
Bed and land erosion	none or mild		severe		moderate – severe		moderate – severe	
	*	%	*	%	*	%	*	%
Planariidae:								
Dugesia sp.	f–A	100	n		n–C	72	n–C	62
Aeschnidae:								
Aeschna spp.	n–f	60	n		n–f	45	n–p	25
Baetidae:								
Baetis harrisoni BARNARD	C–A	100	C–A	100	C–A	100	n–A	75
Baetis glaucus AGNEW	n		n		n		n–C	25
Centroptilum sudafricanum LESTAGE	n–C	90	n–f	33	n–A	64	n–C	50
C. varium (blunt spines)	n		n		n–C	55	n–f	50
C. varium (sharp spines)	f–C	100	n		n–f	18	n	
C. sp. A	n–A	70	n		n–A	45	n	
Pseudocloeon maculosum CRASS	n–A	60	n		n–C	73	n–f	63
Pseudocloeon sp. A	n–f	40	n		n–C	36	n	
Centroptiloides sp.	n		n		n		n–p	13
Oligoneuriidae:								
Elassoneuria sp.	n		n		n		n–C	13
Caenidae:								
Caenis spp.	n–f	90	n–A	66	p–A	100	f–C	100
Afrocaenis sp.	n–C	20	n–C	33	n–C	45	n	
Caenodes sp.	n		n		n		n–f	25
Tricorythidae:								
Tricorythus sp.	n		n		n		n–C	75
Ephemerythus sp.	n		n		n		n–p	25
Diceromyzon sp.	n		n		n		n–p	50

Leptophlebiidae:								
Choroterpes (Euthraulus) sp.	n–C	40	n		n–A	45	n–f	25
Heptageniidae:								
Afronurus "harrisoni" BARNARD	n–C	40	n		n		n	
A. "peringueyi" ESBEN-PETERSEN	n–C	80	n		n–A	82	n–A	75
Perlidae:								
Neoperla spp.	n–C	60	n		n–f	54	n–C	88
Naucoridae:								
Naucoris obscuratus MONTANDON	n		n		n–f	36	n–p	27
Philopotamidae:								
Chimarra sp.	n–A	50	n–p	33	n–f	27	n–A	38
Hydropsychidae:								
Hydropsyche sp.	n–C	10	n–p	33	n–C	64	n–p	25
Cheumatopsyche afra (MOSELY)	n–f	50	n		n–f	27	n	
C. thomasetti-type	n		n		n–C	36	n–f	63
C. sp. B	n–C	50	n		n–f	45	n–C	25
C. sp. F	n–C	70	n–C	33	n–C	36	n–C	63
C. sp. G	n–C	30	n		n–p	9	n	
C. sp. H	n		n		n		n–p	38
C. sp. I	n		n		n–C	9	n	
Lepidostomatidae:								
Goerodes sp.	n–f	60	n		n–C	36	n	
Hydroptilidae:								
Hydroptilid sp. A	n–p	20	n		n–f	9	n	
Orthotrichia spp.	n–p	30	n		n–f	36	n	
Stactobia sp.	n–f	10	n		n		n	
Dytiscidae:								
Hydroglyphus fufai (OMER-COOPER)	n–f	40	n		n–p	9	n	
Potomonectes abyssinicus (SHARP)	n–f	10	n–p	33	n–p	26	n	
Herophydrus inguinatus (BOHEMAN)	n–p	20	n		n–p	9	n	
Agabus sp.	n–p	30	n–p		n–p	18	n	
Hydrophilidae:								
Paracymus monticola WOOLDRIDGE	n–f	60	n–p	33	n		n	
Laccobius scotti D'ORCHYMONT	n–f	20	n–p	33	n		n	

Table 3 (continued 1)

Altitude range m	3500–2500		2950–2850		2500–2000		1900–1680	
Stations	2, 2A, B, 5, 9, 19, 20, 21, 24, 25		15, 17, 18		1, 1A, 2C, 14, 22, 27, 28, 29, 30, 31, 35		3, 4, 11, 12, 13, 36, 37, 38	
Bed and land erosion	none or mild		severe		moderate – severe		moderate – severe	
	*	%	*	%	*	%	*	%
Hydraenidae: adults	n–f	20	n–p	33	n		n	
Helodidae: larvae	n–C	50	n		n–p	9	n–p	13
Psephenidae:								
Eubrianax sp.	n–p	20	n		n–f	27	n–f	38
Elmidae:								
Adults:								
Stenelmis scotti HINTON	n–f	20	n		n–p	36	n	
Microdinodes troilus HINTON	n–f	30	n		n–f	27	n–p	13
Type 2	n		n		n–f	45	n–p	13
Type 3	n		n		n–f	9	n–p	13
Type 5	n		n		n–p	9	n	
Type 7	n		n		n–p	9	n–p	13
Larvae:								
Type 1	n–f	50	n		n–f	27	n–f	13
Type 2	n–f	40	n		n–f	36	n–p	38
Type 3	n		n		n		n–p	13
Type 4	n		n		n–f	18	n	
Type 5	n		n		n		n–p	13
Type 6	n		n		n		n–p	13
Type 7	n		n		n–p	9	n–p	13
Type 8	n		n		n		n–p	13
Type 9	n		n		n–p	9	n	

Tipulidae:								
Tipula sp.	n		n–p	66	n–C	36	n–f	25
Limnophila sp.	n		n		n–p	9	n–f	50
Antocha sp.	n–f	20	n		n–p	27	n	
Psychodidae:								
Pericoma sp.	n–f	30	n		n		n	
Simuliidae:								
Simulium arabicum CROSSKEY & BUTTIG.	n–A	90	n–C	100	p–C	100	n–p	13
S. dentulosum ROUBAUD	n–A	80	n–A	100	n–A	45	n	
S. shoae GRENIER & OVAZZA	n		n–f	66	n–A	45	n	
S. medusaeforme POMEROY	n–C	40	n		n–C	45	n	
S. alcocki POMEROY	n		n		n–p	27	n–p	13
S. bovis DE MEILLON	n		n		n		n–p	13
S. vorax POMEROY	n		n		n		n–p	13
Ceratopogonidae:								
Bezzia-type larvae	n–p	40	n		n–p	27	n–A	38
Muscidae:								
Limnophora sp.	n–f	50	n–f	66	n–C	27	n–p	25
Hydracarina:	n–p	60	n–p	33	n–f	27	n–p	13

* Densities: A = abundant; C = common; f = few; p = present; n = not found in sample.

Table 4. Chironomidae from stony runs in Ethiopian rivers; comparative density* and percentage stations (%) where found.

Altitude range m	3500–2500		2950–2850		2500–2000		1900–1680	
Stations	2, 2A, B, 5, 21, 24, 25.		15, 17, 18.		1, 1A, 2C, 14, 22, 27, 28, 29, 30, 31, 35.		3, 4, 11, 12, 13, 36, 37, 38.	
Soil and bed erosion	none or mild		severe		moderate to severe		moderate to severe	
	*	%	*	%	*	%	*	%
Tanypodinae:								
Conchopelopia trifascia FREEMAN	C	70	C	66	C	45	f	50
Nilotanypus sp.	n		n		n		C	13
Larsia sp.	f	20	n		f	18	f	13
Paramerina sp.	f	10	n		f	9	n	
Orthocladiinae:								
Corynoneura sp.	C	50	f	33	f	27	C	25
Cricotopus bizonatus FREEMAN	p	10	p	33	p	9	n	
C. flavozonatus FREEMAN	p	10	p	33	A	9	n	
C. (Marius) harrisoni FREEMAN	C	40	n		C	45	n	
Cardiocladius oliffi FREEMAN	C	50	f	33	p	18	p	25
Tvetenia calvescens (EDWARDS)	C	50	n		n		n	
Parametriocnemus scotti FREEMAN	C	70	f	100	f	45	C	38
Paratrichocladius micans KIEFFER	f	50	n		p	27	p	13
Rheocricotopus capensis FREEMAN	C	60	n		f	18	f	38
Thienemaniella sp.	A	60	f	33	C	45	f	25
Chironominae:								
Polypedilum sp. type 1	C	30	n		C	36	C	63
Polypedilum sp. type 2	C	30	n		C	27	p	63
Rheotanytarsus cf. *montanus* LEHMANN	A	50	f	100	A	45	f	27
Rheotanytarsus cf. *fuscus* FREEMAN	A	10	n		n		n	
Rheotanytarsus sp. black h.	C	40	f	66	f	66	n	

* Densities: A = abundant; C = common; f = few; p = present; n = none present in samples.

present: *Centroptilum varium* (blunt spines), *Afronurus "peringueyi"*, *Tricorythus* sp. and *Cheumatopsyche* type D (?*thomasseti*) and the chironomids. The only additional chironomid was a species of *Nilotanypus* KIEFFER.

3. Fauna of backwaters and quiet spots

Although we devoted less attention to tranquil waters than to stony runs, we made some observations on the fauna of such places:

Among the neuston, *Gerris gobana* POISSON occurred on several pools near Addis Ababa, from 2000–3000 m, but was not seen on the southern side of the Rift Valley. This distribution was also found in 1944 (HYNES 1955). In 1944 both *Rhagovelia hynesi* POISSON and *Erymetra natalensis* (DISTANT) were common on streams on both sides of the Rift Valley, but during the present study the first was not seen at all, and the latter was found only at ET 10. Other water striders, however, remained present on lower, larger water courses, such as ET 33, 34 and 39. These included *Gerris swakopensis* (STÅL), *Hynesionella aethiopica* POISSON (only ET 33 and 34), *Rhagovelia nigricans* (BURMEISTER) and *Mesovelia vittigera* HORVATH.

BRINCK (1955), reported one species of *Gyrinus*, three of *Aulonogyrus* and three of *Dineutus* from Ethiopia, and he also reported (1956) five species of the difficult genus *Orectogyrus* from the same area. Of these we found *Aulonogyrus abyssinicus* REGIMBART commonly on streams between 2950 and 1900 m, and *Dineutus gondaricus* REICHE fairly frequently on slower reaches from 2850 to 2450 m. Less common were: a species of *Orectogyrus* REGIMBART (*Lobogyrus* BRINCK) found on two streams at 2600 and 1900 m, and *A. ater* BRINCK, found in small numbers on three small streams between 2900 and 2450 m. Some specimens of *Lobogyrus* and a few of *A. abyssinicus* were infected with fungi of the Laboulbeniales (TAVORES 1979). Only two types of gyrinid larvae were found, distinguished by the thickness of their gill filaments; they occurred from 2900–2450 m, sometimes together.

Dixiid and anopheline larvae were also taken in several high altitude localities.

In the water, bugs of the species *Laccotrephes brachialis* GERSTACKER were found in spring pools, ET 7 and 8. *Micronecta dimidiata* POISSON was common in many localities from 3000 m down, and was replaced by *M. scutellaris* STÅL at ET 33 and 34, which both drain Rift Valley lakes where the species is common (HYNES 1955). At those low-altitude localities the hemipteran fauna of quiet reaches was enriched by the addition of *Plea pullula* STÅL and *Sphaerodema grassei* POISSON; and members of the genera *Sigara*, *Nychia* STÅL and *Anisops* occurred sporadically at several stations.

Mayflies of the genus *Cloeon* occurred in several localities up to 3000 m (some of the nymphs resembling *C. crassi* AGNEW). In streams above 2500 m, quiet waters were inhabited by *Centroptilum* sp. A, which was replaced below 2000 m by *Baetis bellus* BARNARD. Zygoptera larvae were also widespread, but Gomphidae were found only at lower altitudes, below 1900 m.

Snails were scarce, apart from Ancylidae of swift water (mainly *Ancylus fluviatilis* MÜLLER), but *Physa acuta* DRAPARNAUD was common in the Akaki River, ET 31. Members of the genera *Bulinus* MÜLLER, *Lymnaea* LAMARCK and *Afrogyrus* BROWN & MANDAHL-BARTH, as well as *Melanoides tuberculata* (MÜLLER) were collected in the Bulbula River, ET 34.

4. Fauna of moss in torrents (ET 2, 2500 m; ET 19, 3100 m)

The communities were similar to those of the nearby stony runs, but some species were far more abundant and others were only found in this biotope.

At the waterfall at ET 2 characteristic species were: Hydroptilid sp. A (Section 7.6.3), *Pericoma* sp. (Psychodidae) and a larva resembling *Limnophora* ROBINEAU-DESVOIDY but clearly different from the common one in the runs. Stony run species particularly abundant were *Cardiocladius oliffi* FREEMAN and *Tvetenia calvescens.*

At ET 19 there was a luxuriant growth of moss and *Lemanea* sp. which supported a very dense fauna. The only characteristic species was hydroptilid sp. A but the following stony run forms were particularly abundant: *Centroptilum sudafricanum, Chimarra* sp., elmid larvae and adults, *Conchopelopia* sp., *Thienemaniella* sp., *Corynoneura* sp., *Rheocricotopus* sp., *Tvetenia calvescens, Cricotopus (M.)* sp., *Rheotanytarsus* sp. cf. *fuscus* and *Rheotanytarsus* sp. cf. *montanus.*

5. Fauna of marginal vegetation

Marginal vegetation was sampled at ET 5, 12, 14, 30, 37 and 39 (2550–750 m). Organisms also common in nearby stony runs were: *Neoperla* sp., *B. harrisoni, C. varium, Tricorythus* sp., *Caenis* spp. *Choroterpes (E.)* spp., *Cheumatopsyche* spp. and Elmidae. In addition, there was another group specific to this habitat: *Baetis bellus* (covering the whole altitude range, ET 5, 37 and 39), *Baetis latus* AGNEW (ET 12), *Centroptilum excisum* BARNARD (ET 5), *Pseudocloeon vinosum* BARNARD (ET 30), nymphs of *Pseudagrion* SELYS (ET 37, 39), libellulid nymphs (ET 30), *Micronecta dimidiata* POISSON (ET 30, 37), dytiscid, hydophilid and hydraenid adults (ET 5), Dixidae (ET 5), and caddis *Mystacides* sp. (ET 14) and *Athripsodes* sp. (ET 37).

6. Fauna of slow-flowing streams

Two slow-flowing streams on the floor of the Rift Valley were sampled:

First, the Bulbula River (ET 34) which flows out of Lake Ziway. A waterfall and marginal vegetation were sampled. *Baetis harrisoni* was found on the waterfall as well as *Baetis* sp. B, *Amphipsyche* sp. (Section 7.6.2), and *Orthotrichia* sp. The community in marginal vegetation consisted mainly of *Cloeon* cf. *crassi, Pseud-*

agrion sp. and libellulid larvae, a species of *Triaenodes* McLachlan, larvae of *Enochrus* Thomson, and an assemblage of chironomids characteristic of ponds: *Procladius brevipetiolatus, Chironomus formosipennis* Kieffer, *Einfeldia disparilis* (Goetghebuer) and *Dicrotendipes 14-punctatus* (Goetghebuer). There was one common prosobranch, *Melanoides tuberculata,* and one pulmonate, *Bulinus* cf. *truncatus* (Audouin).

Second, the Hora Kela R., the outflow of Lake Langano into Lake Abijata (ET 33). Apart from being slow-flowing this stream was of particular interest as Lake Langano water is fairly highly mineralized (conductivity 1600 $\mu S\ cm^{-1}$; principal ions in $mg\ l^{-1}$: Ca^{2+} 4.7, Mg^{2+} 2.5, Na^{+} 350, K^{+} 23, HCO_3^{2-} 766, Cl^{-} 18, SO_4^{2-} 15.2; the Na concentration was much higher than the Ca). The faunal community consisted of: *Cloeon* cf. *crassi, Caenis* sp.; *Pseudagrion* sp., libellulid larvae, *Paragomphus* sp. (probably from sand, but many were in the marginal vegetation ready to emerge); *Rhagovelia infernalis africana* Lundblad; *Ecnomus* probably *E. thomasetti* Mosely; a species of *Mystacides* Berthold (a first record of this holarctic genus from Africa), a species of *Oecetis* McLachlan, larvae similar to *Triaenodes* McLachlan; *Simulium adersi* Pomeroy; the chironomids *Cricotopus (C.) scottae, Nilodorum brevibucca* Kieffer, *Dicrotendipes 14-punctatus* and *Dicrotendipes* sp. No molluscs were found. The cyprinodont minnow, *Aplocheilichthys antinorii* (Vinciguerra) was common.

7. Faunal identifications and species distribution

7.1 Oligochaeta

The Tubificid *Bothrioneurum vejdovskyanum* Stolc was found at ET 19, 24 and 25; this species was also found on Mt. Elgon (Williams & Hynes 1971). *Aulodrilus pigueti* Kowalewski was found at ET 34.

Small Naididae occurred infrequently: *Pristinella jenkinae* (Stephenson) (ET 17, 25, 32); *Pristina proboscidea* Beddard (ET 18); *Dero D.* ? *obtusa* D'Udekem (ET 31).

7.2 Crabs

Crabs of the genus *Potamonautes* sp. were found only in the streams in the mountains to the south-east of the Rift Valley. None was found in the north-western mountains in spite of extensive search, although one of the authors (HBNH) had found some in the T'afo River (west of ET 14) in 1944. Our collection contains two species that Mr. T. Williams informs us seem to be new.

7.3 Ephemeroptera

7.3.1 Baetidae

These were all identified from their nymphs. One of the authors (ADH) is very familiar with the southern African Baetidae from the Cape to the Zambezi, including those from many type localities; the other author (HBNH) is familiar with Baetidae from the East African mountains. Most of the Ethiopian specimens fit in closely with those of species from southern Africa and have been assigned to them.

Baetis harrisoni nymphs and adults corresponded closely to those described by BARNARD (1932), and we have similar nymphs from Mt. Elgon. *B. bellus* nymphs were similar to those described by BARNARD (1932) in all respects. Nymphs of *B. glaucus* and *B. latus* closely resembled those described by AGNEW (1961).

Pseudocloeon maculosum nymphs were first described by CRASS (1947), from the Yarrow stream, Natal; he suspected that they were of this species but was not able to correlate them himself. One of us (ADH) was able to correlate nymphs from specimens collected near Harare, Zimbabwe, and the identifications were confirmed by CRASS. The nymphs collected in Ethiopia varied greatly in size and colouration. Those from higher altitudes were larger and darker and showed little sign of the light dorsal abdominal stripe pictured by CRASS (1947), but those from lower altitudes were smaller and had a clear stripe; this was especially the case with those from ET 38. It was suspected that there was more than one species involved, but intermediate forms were found.

Centroptilum spp.: *C. sudafricanum* nymphs closely resembled those described by BARNARD (1932) and we have similar nymphs from Mt. Elgon. This species may be very close to *C. montanum* KIMMINS, the nymphs of which have yet to be described. There were two types of nymph similar to those of *C. varium* (CRASS, 1947): the first type had a single row of sharp dorsal abdominal spines and resembled those collected by ADH in Zimbabwe and in parts of South Africa. The identification of these was confirmed by CRASS (personal communication) who stated that his figure was faulty in that it should have shown the abdominal spines. The mouthparts of the Ethiopian specimens resembled those figured by CRASS. The second type of nymph, more typical of the lower zones (Table 3), had much blunter abdominal spines and appears to be a new species closely related to *varium*. These two nymphal types correspond to sp. C and sp. A of "*Acentrella*" of HYNES & WILLIAMS (1962) on Mt. Elgon.

Centroptilum sp. A is a nymph with long oval gills not resembling any other species described from Africa and appears to be new. It was found in slow current areas on both sides of the Rift Valley and seems to be indigenous to Ethiopia.

Pseudocloeon sp. A nymphs appear to be the same as those reported as *P.* sp. nov. from the Chimanimani Mountains, eastern Zimbabwe (HARRISON 1965b). The Chimanimani nymphs were found in waterfalls and fast torrents, and sub-imagos were found emerging in quiet spots nearby; these developed into imagos which keyed out to *Pseudocloeon.* Nymphs and adults were deposited in the British Museum (Natural History) (Catalogue Nos. SRE. 3A, 3B and 3C, 14 May, 1963). HBNH collected similar nymphs ("*Acentrella* sp. B") on Mt. Elgon (WILLIAMS & HYNES 1971) and there is a photograph of a similar nymph from Mt. Kenya in VAN SOMEREN (1950).

7.3.2 Caenidae

There were probably several species of *Caenis* as well as nymphs of *Caenodes* (Demoulin 1970). *Afrocaenis* nymphs resembled those figured for *A. major* Gillies, a species described from Ethiopia (Gillies 1982).

7.3.3 Tricorythidae

Most nymphs of *Tricorythus* appeared to belong to the same species but these seemed to be accompanied by a larger species in the Wabe Shebele R. (ET 30).

7.3.4 Leptophlebiidae

Nymphs of *Choroterpes (Euthraulus)* sp. were found in the mountains to the south-east of the Rift Valley but not in those to the north-west. Nymphs of Leptophlebiid type A were found at ET 39 at 750 m. Dr. W. L. Peters (private communication) informs us that these nymphs closely resemble those of *Choroterpes (Euthraulus)* in the structure of the thorax and abdomen, including the gills, but that the mouthparts are highly modified for filter feeding. The species is closer to *Choroterpides* than to any other genus, but does not fit into this genus as currently defined. *Choroterpides* has been found so far in Asia and Madagascar.

7.3.5 Heptageniidae

The nymphs we call *Afronurus "harrisoni"* and *A. "peringueyi"* were similar to those in Barnard (1932) but we realize that they could represent species groups. *A. pulcher* Ulmer could be the adult of our *A. "peringueyi"* nymphs, judging from the locations where it was collected (Ulmer 1930). We have similar nymphs from Mt. Elgon.

7.4 Heteroptera

Naucoris obscuratus was the species collected also by Hynes (1955) and identified by R. Poisson.

7.5 Lepidoptera

7.5.1 Pyralidae

A few larvae were collected from marginal vegetation, and a few larvae closely similar to the Hydrocampidae reported by Williams & Hynes (1971) from several lower-altitude localities on Mt. Elgon, were found in the Weyb River (ET 21).

7.6 Trichoptera

7.6.1 Philopotamidae

Kimmins (1963) reports two species of *Chimarra,* the most widespread being *C. abyssinica* Banks. Dr. K. M. F. Scott says that males we collected at ET 20 were of a new species (private communication).

7.6.2 Hydropsychidae

KIMMINS (1963), who worked with a collection of adults, reports two species of *Hydropsyche* from Ethiopia; the most widespread is *Hydropsyche abyssinica* KIMMINS. He reports seven species of *Cheumatopsyche;* he had numerous specimens of *C. afra* and *C. nubila* KIMMINS, which he says is very similar to *C. thomasseti* (ULMER). He reports three species of *Amphipsyche.* Dr. K. M. F. SCOTT says that our larvae resembles *A. senegalensis* (BRAUER), (see also SCOTT 1983).

7.6.3 Hydroptilidae

Dr. K. M. F. SCOTT informs us (private communication) that the larvae we have called "Hydroptilid sp. A", a very dark larva in algal cases, cannot be placed into a known genus; possible candidates are *Dhatrichia* MOSELY and *Madioxyethira* SCHMID, but these larvae could belong to yet another genus. A mature male pupa of *Orthotrichia* we collected at ET 30 was *O. straeleni* JACQUEMART.

7.7 Coleoptera

7.7.1 Dytiscidae

The species of *Agabus* appears to be new.

7.7.2 Elmidae

We found the two species described by HINTON (1940), *Microdinodes troilus* and *Stenelmis scotti.* We also found a species of *Potamodytes* in the lower epipotamal of the Awash River (ET 39); BOLLOW (1939) reports *P. zavattarii* from Ethiopia and Somalia. The genus has been found in the middle and lower epipotamal in West Africa (FORGE 1981), in Zimbabwe (ADH records) and on Mt. Kenya (HBNH records).

7.7.3 Psephenidae

HINTON (1940) also reports larval *Eubrianax* from Ethiopia, from a high-altitude stony run.

7.8 Diptera

7.8.1 Simuliidae

Few *Simulium* species occurred in the high streams, and our material available for specific identification was mostly pupal. The commonest species were *S. arabicum* CROSSKEY & BUTTIGER, a member of the *nigritarse* complex (FAIN & DUJARDIN 1983), and *S. dentulosum* ROUBAUD, both of which occurred up to 3500 m.

At 2850 m these were joined by *S. shoae* GRENIER & OVAZZA, a species that was originally described as a form of *S. dentulosum* ROUBAUD, but which seems to be distinct and indigenous to Ethiopia. At some stations it replaced *S. dentulosum,* and neither was found at lower altitudes.

S. medusaeforme form *hargreavesi* GIBBINS, as illustrated by FREEMAN & DE MEILLON (1953), was found in scattered localities from 3000–2050 m, and a few specimens of *S. alcocki* POMEROY occurred over a somewhat similar altitudinal range. *S. ruficorne* MACQUART was found in the dry season in the Upper Kebene River just after the river enters Addis Ababa. The pupae were atypical with respiratory filaments longer and thinner than usual, similar to those found in Zimbabwe by ADH in 1966 and identified by Dr. R.W. CROSSKEY.

Other species were found only at lower altitudes: *S. adersi* POMEROY only in the two lake outlets, ET 33 and 34; *S. vorax* POMEROY only at ET 4; *S. bovis* DE MEILLON at ET 37. We searched for larvae of the phoretic species found on Mt. Elgon (HYNES, WILLIAMS & KERSHAW 1961) but found none; adults of the group *neavei* have been recorded from Ethiopia (FAIN & OOMEN 1968).

7.8.2 Chironomidae

7.8.2.1 Tanypodinae

All adult and pharate adult *Conchopelopia* over the whole region were *C. trifascia* (FREEMAN). The adult *Larsia* were close to *L. uniformis* (GOETGHEBUER) and the few specimens of *Paramerina* FITTKAU bred out appeared to be of a new species.

7.8.2.2 Orthocladiinae

Numerous adult *Corynoneura dewulfi* GOETGHEBUER were caught or bred out over the whole region; no other species was found.

Cricotopus (C.) bizonatus FREEMAN was found from both sides of the Rift Valley and many were bred out and correlated with larvae from the Abo-Kebene River (ET 2C and downstream); they became very abundant in sections of the stream receiving mild pollution as it flowed through Addis Ababa. At least four other species occurred; one resembles *C. (C.) flavozonatus* FREEMAN and the others appear to be new.

Cricotopus (Marius) harrisoni FREEMAN is widespread and fits into the diagnosis for the subgenus, *Marius* (LEHMANN 1981). It has been correlated with its larva which shows distinct differences from the larvae of the other subgenera of *Cricotopus*. No other species of the subgenus were found.

Our Ethiopian specimens of *Tvetenia calvescens* could not be separated from other African or Holarctic *T. calvescens* EDWARDS on anatomical grounds.

All adult *Parametriocnemus* caught throughout the region were *P. scotti* FREEMAN.

Paratrichocladius micans KIEFFER and *Rheocricotopus capensis* KIEFFER were found throughout the region and correlated with larval specimens from the Abo-Kebene River. *R. capensis* became very abundant at times in the polluted section in Addis Ababa. No other species of these genera were found.

The few adult *Thienemaniella* captured or bred out were *T. lineola*.

Adults of *Limnophyes natalensis* Kieffer were commonly netted from bank vegetation in upper zones but larvae were rarely found.

7.8.2.3 Chironominae

Type 1 larvae of *Polypedilum* bred out to *P. alticola* Kieffer and Type 2 to *P. wittei* Freeman. The adults of these occurred over the whole region. All stages of *Chironomus allaudi* were found in the polluted section of the Kebene R., below ET 2C, and *Chironomus formosipennis* Kieffer was abundant in the slow-flowing, but unpolluted Bulbula stream (ET 34); they were identified from pharate adults.

7.8.2.4 Tanytarsini

The commonest larvae of *Rheotanytarsus* had light yellowish brown heads; those bred out from the Abo-Kebene River were close to *R. montanus* Lehmann. Abundant larvae with brown heads were found at ET 19; adults captured there resembled *R. fuscus* Freeman. A third species occurred, having almost black adults and larvae with black heads; this appears to be new.

7.9 Mollusca

The palaearctic snail *Ancylus fluviatilis* Müller was found at ET 12, 20, 21, 22, 23 and 26. It was also found by Brown (1980) in this region.

Physa acuta Draparnaud was found at ET 33; Brown (1980) considers this to be a North American species which has invaded most of Africa, possibly through Europe. He also found it in the Ethiopian Highlands.

Species of *Burnupia* Walker were found occasionally (ET 6, 8, 12, 29 and 30), Brown (1965) reports *B. caffra* (Krauss) from the Ethiopian Highlands.

7.10 Pisces

Numerous small cyprinid fish were seen often in the pools of mountain streams and rivers in the region. They invariably proved to be species of the genus *Garra*. *G. dembeensis* (Rüppell) was found at ET 2C, 13, 35 and the Muger River, a tributary of the Awash R. near ET 35, and 38; *G. quadrimaculata* (Rüppell) at ET 1 and 31; *Garra* cf. *quadrimaculata* at ET 14.

The small catfish, *Amphilius lampei* Pietschmann was collected in stony runs at ET 30.

Brown and rainbow trout were introduced into the Weyb River (ET 21) some years ago and appear to be thriving; they are frequently caught by anglers.

III. Discussion

D.1 Effects of soil and bed erosion on Ethiopian mountain river fauna

Soil and river bed erosion was very severe at ET 15, 16, 17 and 18 in the mountains to the northeast of Debre Birhan (2850–2950 m). The mountain slopes were severely denuded of topsoil, and river banks were cut back or collapsed in many places. During heavy rains, when the river is in spate, much mud and silt is carried by the turbulent water; gravel, stones and even rocks are then on the move in the bed.

The faunal samples were taken at least three months after the last catastrophic spate but the community still had fewer species than those of more normal rivers at the same altitude (21 vs. 52). Absentee species included all triclads (*Dugesia* sp.), Hydropsychidae and Elmidae. Some hardier forms, such as *Baetis harrisoni* and *Simulium* spp., survived the rainy season and multiplied rapidly to become common or abundant during the dry season.

A similar situation is reported by CHUTTER (1969) from the mountain zone of the Vaal River, South Africa. He compared badly damaged rivers (his "high level depositing zone") with more normal mountain rivers (his "eroding zone") and found that there was reduction in "kinds of animals" as well as in actual numbers during the dry season. Among his groups reduced were the triclads, Hydropsychidae and Elmidae. CHUTTER considered these changes to be caused mainly by the instability of the sediments and abrasion rather than by a smothering effect.

In Ethiopian rivers most of the faunal reduction is the result of abrasion by sand and the molar effects of rolling stones and rocks. Nevertheless, large amounts of silt also strongly affect the feeding efficiency of the Hydropsychidae and other groups. It is obvious that wide-spread severe soil and bank erosion could lead to the extinction of many sensitive aquatic species in the Ethiopian mountains. Overgrazing and other faulty farming practices are responsible for land and river deterioration in many areas (KURU 1978).

D.2 Pollution of Ethiopian rivers

There are few large-scale industrial plants in Ethiopia and so the serious chemical and organic pollution seen in more developed countries does not occur or is very localized. Even in Addis Ababa there is little industrial waste water and at present most domestic wastes are disposed of in septic tanks or in open pit or uncovered sites, although this will change in the near future.

The only seriously polluted river seen was the Abo-Kebene flowing from ET 2 through Addis Ababa. Near its exit from the city it showed the usual signs of organic pollution with the loss of all Trichoptera and many Ephemeroptera, although there were usually some to many *B. harrisoni* still present. The community consisted of tubificid worms and more hardy chironomids such as *Cricotopus bizonatus*, and other *Cricotopus* spp., *Paratrichocladius micans* and *Chironomus allaudi* Kieffer.

About 10–15 km below this, after the river has passed through more built-up regions and the town of Akaki (just above ET 31), the fauna was almost normal with many of the usual Ephemeroptera, Trichoptera and other stony run organisms. Noticeably, however, here and also in some of the other degraded streams north of the Rift Valley, there were dense growths of *Cladophora*. There were also places within Addis Ababa where "sewage fungus", probably *Sphaerotilus* was abundant.

A more subtle effect was the apparent disappearance of many water striders, such as *Rhagovelia hynesi* and *Eurymetra natalensis*, from many streams in the region. This we put down to the extensive use of artificial detergents by women washing their clothes in the streams. Powdered detergents used in a basin at streamside have completely replaced the traditional "cake of soap on the rocks" techniques of earlier times.

D.3 Biogeography

Biogeography of Afrotropical mountain stream fauna

Africa was originally part of the Jurassic southern continent of Gondwanaland. The southern part of this continent had a temperate to Antarctic climate and broke up in late Jurassic to Cretaceous times (King 1978) to form what is now southern Africa, southern South America, Antarctica, Australasia, the Indian subcontinent and other territories. The northern portion had a subtropical to tropical climate and broke up during the Cretaceous to form northern South America and tropical and North Africa and the Arabian Peninsula. The Tethys Sea separated the Afro-Arabian portion from Eurasia until the sea closed up and the two land masses came into contact during the middle Miocene (Axelrod & Raven 1978). With this event the exchange of fauna and flora began.

Edmunds (1975) considers that a number of mayfly lineages evolved primarily in tropical Gondwanaland, before the Cretaceous breakup. He lists the Asthenopodinae (Polymictarcidae), Tricorythidae, Oligoneuriidae and Baetidae and thinks that the North American members of these families derived from the South American ones, and the Eurasian from the African ones.

Scott (1986) sees a similar pattern for certain Trichoptera but feels that much more evidence is needed to establish the pattern.

The African Simuliidae are interesting as some have affinities with Holarctic and some with Neotropical species (Crosskey 1969), the latter could have derived from tropical Gondwanian species.

It seems, therefore that tropical Africa had varied freshwater communities consisting of these and other invertebrate groups before contact was established with Eurasia.

However, we are interested in tracing the development of cool-adapted montane communities. It seems to be agreed that, prior to the rifting process which began in the Miocene, Africa was mostly a highly-eroded peneplain. Nevertheless, AXELROD & RAVEN (1978) believe that there is evidence of pre-Miocene regions of high altitude in the Hogar, Air and Tibetsi massifs, now in the Sahara region, and the East African and Ethiopian warps which preceded vulcanism there. It appears that these warps had summits of 1500 to 1600 m at the close of the Palaeocene and this, in combination with wetter and cooler climates, enabled certain tropical rainforest plant taxa to radiate upwards into a temperate montane zone.

This zone would have been available also for development of cool-adapted stream invertebrates, especially if forests were present to keep temperatures low. Baetidae and Hydropsychidae could have been among the radiating forms able to move up into the cold, high mountains when these appeared, leading to the distribution seen today.

AXELROD & RAVEN also make the point that these high altitude regions would allow north temperate and south temperate African plants and animals to extend their range towards or even past the equator. Species from the cooler southern parts of Africa could have followed this route into equatorial regions but HARRISON (1978) points out that very few of the true cold-adapted stenotherms belonging to the southern Gondwanian community appear to have reached the tropics.

The development of the African Rift system, and its associated orogenies, in the late Oligocene and Miocene down to the Quarternary, resulted in extensive mountain building, with altitudes over 3000 and 4000 m and with a number of glaciated regions. This allowed colonization by true cold stenotherms, but there is no evidence that the original African fauna contributed any of these.

The only aquatic group that seems to be confined to glacial melt streams in Africa are species of the chironomid, *Diamesa*. WILLASSEN & CRANSTON (1986) consider that African species of this genus came from stock following a high altitude dispersal route from their Laurasian centre of distribution. They suggest a more or less continuous, mid-Tertiary montane route from the Caucasus and E and SE Turkey through the Levant, Dead Sea, Nubia (and presumably the southern Arabian mountains) and the Ethiopian Highlands.

This route could have been used also for dispersal in both directions by other montane forms, many not as cold-stenothermal as *Diamesa*. Prominent among these would have been the montane Orthocladiinae which are considered to have had a northern (Laurasian) origin. The montane forms of the other chironomid sub-families would have used the same route but the direction they were taking is not known.

Biogeographical status of Ethiopian mountain river fauna

This two-way dispersal route finally was interrupted by the Red Sea rift which started in the late Pliocene and still continues. The Ethiopian mountains underwent many changes from the late Pliocene until the present day; Pliocene mountains eroded away to be replaced by Pleistocene mountains.

The climate followed that of the rest of East Africa with alternate warm and dry, and cool and wet periods, sometimes with glaciation now lost (Livingstone 1975). Today the Ethiopian Highlands are well separated from the other East African mountains by a large gap containing the Nile Valley, and from the mountains of S. Arabia and the Sinai Peninsula by the Red Sea and low-lying desert country.

In spite of the physical separation, the Ethiopian mountain riverine fauna (rhithron) is clearly strongly linked to its East African and Southern African counterparts. Table 5 shows how many of the common genera and species (even though many of these may represent "species groups") are found in mountains all the way from Ethiopia to the Cape. In fact, there seems to be a basic community in the stony runs consisting of such forms as: *Dugesia* spp., *Baetis harrisoni, Centroptilum sudafricanum, Afronurus* spp., *Choroterpes (E.)* spp., *Cheumatopsyche afra, Ch. thomasseti,* chironomids such as *Conchopelopia trifasciata, Cricotopus flavozonatus, Paratrichocladius micans, Rheocricotopus capensis, Thienemanniella lineola* Freeman and *Parametriocnemus scotti,* and the *Simulium medusaeforme* group. Some of the species found in quieter spots also extend from Ethiopia to the Cape, such a *Baetis bellus, Pseudocloeon vinosum* and *Micronecta dimidiata.*

Other species such as *Pseudocloeon* sp.A, and some chironomids and simuliids are found only in the mountains of tropical East and Central Africa, or only as far south as the northern mountains of South Africa.

Links with the fauna to the east and north are less obvious. Botosaneanu (1973) sees a strong connexion between the S. Arabian montane Trichoptera and those of Mt. Sinai and of suitable habitats in the Negev and Dead Sea Depression.

Most of these seem to have Asiatic affinities but a few are related to species found in Ethiopia and other parts of tropical Africa. The latter must have been previously dispersed along the Pliocene route. Since then this eastern and northern caddis fauna seems to have diverged markedly from the Ethiopian fauna.

On the other hand some Ethiopian aquatic organisms appear to represent the southernmost penetration of Palaearctic forms. Scott (1986) lists the caddis *Mesophylax aethiopicus* Malicky, and *Mystacides,* but these are not true mountain forms and she suggests that they could have come down the Nile during a wetter, cooler period.

The freshwater snail, *Ancylus fluviatilis,* common in streams in the Ethiopian Highlands and SW Arabia is more cool-adapted and might have been part of a Pliocene montane fauna common to both regions.

Impoverished Ethiopian rhithron

Although we noted the strong connexions between the African mountain communities, we also noted that the Ethiopian fauna seemed to be comparatively impoverished. For instance, the following appear to be lacking: species of *Adenophlebia* and *Prosopistoma* reported from Uganda by WILLIAMS & HYNES (1971) and from Zaire by KOPELKE (1980, 1981), *Baetis cataractae* CRASS, *Castanophlebia* sp., *Acentrella natalensis* CRASS, and *Oligoneuriopsis lawrencei* CRASS (all identified by CRASS) reported from Mt. Kenya by VAN SOMEREN (1950), and species of the caddis genera *Agapetus, Dolophilodes, Leptonema, Pseudoneureclipsis, Lype* and *Catoxyethira* reported from mountain streams in Zaire by STATZNER (1975) and JAQUEMART & STATZNER (1981).

KIMMINS (1963) did not find these caddis species in his Ethiopian collection either. In addition, BAFORT, GAIN & SILBERSTEIN (1977) report a number of species of *Simulium* from Mt. Kenya not found by us in Ethiopia. All these either may not have reached the region, or climatic rigours during dry periods may have led to their extinction. *Diamesa* probably disappeared with the Ethiopian glaciers.

Endemics in Ethiopian rhithron

YALDEN (1983) suggests that the large area of high land in Ethiopia may account for the high proportion of endemic terrestrial species. This certainly seems to be true for terrestrial plants and animals.

KIMMINS (1963) reports 24 endemic species of Trichoptera out of a collection of 53 Ethiopian species he studied; 17 of these endemics could have come from mountain streams and rivers. His results suggest to us that 5 of the 7 species of *Cheumatopsyche* we found were endemic.

We also consider that many of our Elmidae will prove to be new species and all seem to be endemic. Certainly none of them is the same as species collected by WILLIAMS & HYNES (1971) on Mt. Elgon. Nevertheless, there seems to be little endemicity in the Ephemeroptera and Chironominae; we found only one new baetid (*Centroptilum* sp. A), or two if the upper zone form of *Pseudocloeon maculosum* proves to be new. There are two or three apparently new species of chironomids which could be endemic. Endemic simuliids have been reported by UEMOTO, OGATA & MEBRAHTU (1977), but we did not find any of their species. BRINCK (1956) reports three endemic gyrinids, and our collection appears to contain a few endemic dytiscids as well.

D.4 Zonation

Zonation of Sub-Saharan montane streams and rivers

The longitudinal zonation of southern African rivers is discussed by HARRISON (1965 a, 1978). He uses the system proposed by ILLIES & BOTOSANEANU (1963),

Table 5. Mountain stream fauna common to Ethiopia, and Eastern and Southern Africa.

Mountain Fauna	Ethiopian Highlands		East Africa		Zimbabwe		Eastern Transvaal		Tugela R. Natal.		Great Berg R.		Table Mtn.
Baetidae:													
Baetis harrisoni Barnard	c	U	c	U	c	U	c	U	c	U	c	UM	c
Baetis glaucus Agnew	c	M	–		c	M	c	L	c	L	c	L	n
Centroptilum sudafricanum Lestage	c	U	c	U	c	U	c	U	c	U	c	U	c
Centroptilum varium Crass sharp spines	f	U	p	U	r	F	–		f	L	n		n
Pseudocloeon maculosum Crass	c	A	–		p	M	p	UL	c	M	f	L	n
Pseudocloeon sp. A	f	U	p	U	c	U	n		n		n		n
Caenidae:													
Caenis spp.	c	A	c	A	c	A	c	A	c	A	c	A	p
Afrocaenis sp.	c	U	p		n		n		n		n		n
Caenodes sp.	p	T*	p		n		n		n		n		
Tricorythidae:													
Tricorythus spp.	c	L	c	L	c	L	f	L	c	ML	c	L	n
Leptophlebiidae:													
Choroterpes (Euthraulus) spp.	f	U**	p	U***	c	U	f	L	c	M	r	UM	n
Heptageniidae:													
Afronurus "harrisoni" Barnard	f	U	p	U	p	U	c	U	c	U	c	UM	n
Afronurus "peringueyi" Esben-Petersen	c	ML	p	ML	p		n		c	M	n		n
Philopotamidae:													
Chimarra spp.	c	U	c	U	f	U	f	U	f	U	c	U	c
Hydropsychidae:													
Hydropsyche spp.	c	U	c	UM	p	U	n		c	M	n		n
Cheumatopsyche afra (Mosely)	c	U	p		c	U	p		c	U	c	U	p
Cheumatopsyche thomasseti (Ulmer)	c	M	p		c	M	n		c	ML	c	L	n
Tanypodinae:													
Conchopelopia trifascia (Freeman)	c		p		p		p		p	U	p		n
Paramerina spp.	c	UM	p		p		p		p		p		n

Table 5 (continued)

Mountain Fauna	Ethiopian Highlands	East Africa	Zimbabwe	Eastern Transvaal	Tugela R. Natal.	Great Berg R.	Table Mtn.
Orthocladiinae:							
Corynoneura dewulfi GOETGHEBUER	c A	p	c	p	p U	c A	c
Cricotopus (C.) bizonatus FREEMAN	c U	n	p	n	p M	n	n
Cricotopus (C.) flavozonatus FREEMAN	c U	p	p	n	p	p	p
Cricotopus (M.) harrisoni FREEMAN	c U	p	p	n	p M	n	n
Cardiocladius oliffi FREEMAN	c UM	n	p U	n	p M	n	n
Tvetenia calvescens (EDWARDS)	f U	p U	n	n	n	c UM	n
Paratrichocladius micans (KIEFFER)	c A	p	c A	p	c M	p M	c
Rheocricotopus capensis (FREEMAN)	c A	p	c	p	c M	c A	c
Thienemanniella lineola FREEMAN	c A	p	c	p	c U	c A	c
Parametriocnemus scotti (FREEMAN)	f A	p	p	p	p U	f U	p
Chironominae:							
Polypedilum alticola KIEFFER	f U	p	p	p	p	n	n
Polypedilum dewulfi GOETGHEBUER	c A	p	c	n	p	n	n
Rheotanytarsus "guineensis" (KIEFFER)	c A	p	p	p	n	n	n
Rheotanytarsus "fuscus" FREEMAN	c U****	p	p	n	c UM	c A	c
Simuliidae:							
Simulium medusaeforme POMEROY	p A	p	c	p	c U	c U	c

n = no record
p = present
f = few
c = common
A = all levels

U = upper zones
M = middle zones
T = transitional zones
L = lower zones
F = foothills

* Wendo Genet only
** Southeastern Rift mountains only
*** Mt. Elgon and Mt. Kenya
**** Danka (Weyb trib.) only

Sources for information on table:
Ethiopian Highlands: Present survey; KIMMINS 1963
East Africa: VAN SOMEREN 1950; FREEMAN 1955, 1956, 1957, 1958; KIMMINS 1960; WILLIAMS & HYNES 1971
Zimbabwe: HARRISON 1965a, 1965b; and ADH's own records
Eastern Transvaal: HUGHES 1966
Tugela R., Natal: OLIFF 1960
Great Berg R.: HARRISON & ELLSWORTH 1958; SCOTT 1958
Table Mtn.: HARRISON & BARNARD 1972

who divide rivers into three main zones: first, the kryon, the source zone where the water originates from glacial melt or from springs or streams in small marshes among the peaks; second, the rhithron (mountain torrent zone or erosion zone) and, third, the potamon (the foothill and flood plain zone, or deposition zone). They divide the rhithron and potamon into three subzones, designated epi-, meta- and hypo-. However, Steffan (1965) pointed out that the suffix -on should only be applied to biocenoses (communities) and that the suffix -al should be used for biotopes (habitat).

We take Steffan's advice, also followed by Botosaneanu (1979), and use the terms "the rhithral" and "the potamal" for the habitats.

The rhithral is mainly torrential, although pools and backwaters are present, temperatures are usually below 20°C at all seasons and silt loads and turbidities are very low. The rhithron is cold stenothermic, mostly torrent dwelling and very sensitive to turbidity and siltation. Harrison (1965a) points out that species living in backwaters or quieter spots are particularly sensitive to high silt content.

In the potamal there are fewer torrential sections, mostly in the epipotamal, and these disappear eventually as the flood plain is reached. In an elevated continent such as Africa the epipotamal can be very long and there is often rejuvenation as the rivers run over harder geological strata. Temperatures are usually above 20°C at some season of the year and turbidities and silt loads are higher than in the rhithral; pools are often floored with mud.

Rhithron, because of their intolerance of silt, are particularly sensitive to human activities such as agriculture, including grazing, mining and construction projects. Much of the typical community may disappear with rising silt loads. Potamon are less likely to be affected by human activities except under extreme conditions.

The rivers and streams in the Ethiopian mountains fall mainly into rhithral and upper epipotamal categories.

Zonation in Ethiopian montane rivers

a. The Kryal (Source Zone)

The Ethiopian mountains are not high enough to have a permanent snow line or glaciation, although snow falls above 3500 m and Afro-alpine plants are found at about 4000 m. The high plateau of the Bale Mountains, near Mt. Goba, was visited during the dry season (January, 1984); there are a number of small cirque lakes and ponds on this plateau but the streams originating from them were all dry at that time.

It appears that the glaciers on the Ruwenzori Mountains and on Mt. Kenya store enough water to keep the streams of the kryal running permanently and to sustain the only true kryon forms known from Africa, species of *Diamesa.* It is possible that species of this chironomid were found in Ethiopia when glaciers were present (WILLASSEN & CRANSTON 1986), but disappeared with them when the streams became seasonal.

The fauna of the streams just below the Mt. Goba plateau is discussed below. The fauna found at ET 7, a lower source region at 3000 m, was typical of a slow-flowing stream with nothing special about it.

b. The Rhithral (Mountain Torrent Zone) (2000 m and above)

The highest streams studied were at 3500 m (ET 23, 8°C and ET 24, 4.5°C), in the sub-Afro-alpine or tree-heath zone. These could be classified as the epirhithral. The benthic community was essentially the same as that of the region immediately below (Table 3, column one); there were no special forms of epirhithron. It would be interesting to know how the life cycles of common species were affected by the low temperatures.

The stations listed in Table 3, column 1 can be classified as the metarhithral. ET 19 and 20 were particularly good as there was very little sign of human interference; ET 2 was also fairly free of siltation.

A few species which were common at these stations disappeared or became rare in the next zone downstream (Table 3, column 3). These were *Pseudocloeon* sp. A, *Centroptilum* sp. A, *Afronurus "harrisoni"*, Hydroptilid sp. A, *Stactobia* sp., *Ugandatrichia Centroptilum varium* (sharp spines), *Pericoma* sp. and *Tvetenia calvescens*. Most of the rest of the community consisted of species typical of the whole mountain region.

The stations in Table 3, column three can be classified as the hyporhithral. The fauna is basically the same as that of the zone above, except for those few species that disappear, but there are a number of additions to the hyporhithron: *Centroptilum varium* (blunt spines), *Cheumatopsyche thomasseti*-type, four additional elmid adults, three additional elmid larvae, *Simulium shoae,* and *S. adersi.*

c. Transition Zone (1900–1650 m)

The stations in Table 3, column 4, mostly constitute a transitional zone, as the rivers enter the foothills and rhithron begins to give way to potamon. Nearly all of the species characteristic of the rhithral disappear at some stage in the epipotamal, but most are still present in this transition zone, probably because many are maintained by drift from upstream.

d. The Potamal

ET 38 and 39 give some indication of epipotamon in Ethiopian rivers. In this fauna the replacement of *Baetis harrisoni* by *B. glaucus* and other baetid species was complete and *Tricorythus* sp. had become the predominant mayfly, but *Elassoneuria* sp. was also common. Both *Cheumatopsyche afra*-type larvae, typical of the upper parts of the rhithral, and *C. thomasseti,* typical of the lower rhithral and the transitional zone, had disappeared and were replaced by another species.

This type of community is also found in the epipotamal of the Sabi R. in Zimbabwe (ADH, personal observation) and in the lower Tugela River, Natal (Oliff 1960) and in West Africa (Durand & Lévêque 1981, Dejoux, Elouard, Forge & Maslin 1983).

Summary

The major facts emerging from this study are as follows:

1. The fauna of high altitude Ethiopian streams is typical of that of cool streams over much of Africa (pp. 8–22; 24–26) (Tabs. 3, 4, 5), but it lacks several taxa that are present south of the dry country of northern Kenya (p. 27). It also includes, like the terrestrial flora, a few elements of apparently recent Palaearctic origin.
2. Although taxonomical knowledge is still scanty, it seems that there are few endemic taxa (p. 27) in the Ethiopian stream fauna. Most of our material has been matched with species which occur further south. However, one *Centroptilum* species seems to be new; *Simulium shoae* is probably endemic, as are most of the Elmidae. We have discussed these points in the light of what is known about the biogeographical history of Africa.
3. Recently the human population of the Ethiopian Highlands has greatly increased, leading to severe soil erosion. This erosion has very obvious effects on the streams, because it eliminates several groups of invertebrates, severely simplifying the fauna (p. 23; Tab. 3).
4. Other human activities (pp. 23–24) also seem to eliminate some stream taxa. Gerridae and Veliidae have become very scarce, possibly because of the use of detergents for washing clothes in streams. Crabs seem to have disappeared from the area north of the Rift Valley, although there are streams that seem to be suitable for them; they were present in the northern area during the 1940's.
5. We found few effects of pollution (pp. 23–24) except in Addis Ababa, where tributaries of the Akaki River show severe effects of urban pollution. We hope to publish further on this point.
6. The kryal (high-altitude cold-water zone) found on very high mountains further south (pp. 30–31) seems to be absent from Ethiopia, as there is no permanent snow line. The rhithral (mountain torrent zone) has a characteristic fauna and extends down to about 2000 m (p. 31; Tabs. 3, 4). There follows a transition zone extending down to about 1650 m (p. 31; Tabs. 3, 4), and below that a potamal (lower zone) which contains a fauna that is similar to that of much of Africa (p. 31–32).

Zusammenfassung

Die vorliegende Studie hat im wesentlichen folgendes ergeben:

1. Die Fauna hochgelegener Flüsse in Äthiopien weist die typischen Merkmale kühler Flüsse in großen Teilen Afrikas auf (S. 8–22; 24–26; Tab. 3, 4, 5), jedoch fehlen ihr mehrere Taxa, die im Süden des Trockenlandes Nordkenia vorkommen (S. 27). Sie umfaßt ebenso wie die terrestrische Flora einige Elemente anscheinend jüngeren paläarktischen Ursprungs.
2. Obwohl das taxonomische Wissen hier noch spärlich ist, scheint es wenige endemische Taxa (S. 27) in der äthiopischen Flußfauna zu geben. Der Großteil unseres Materials konnte mit den Arten identifiziert werden, die weiter südlich vorkommen. Eine *Centroptilum*-Art scheint jedoch neu zu sein. *Simulium shoae* ist wahrscheinlich endemisch, ebenso wie die meisten der Elmidae. Wir haben diese Punkte im Lichte dessen diskutiert, was über die biogeographische Geschichte Afrikas bekannt ist.

3. In letzter Zeit ist die Einwohnerzahl des äthiopischen Hochlandes stark gestiegen, was zu schwerwiegender Bodenerosion geführt hat. Diese Erosion hat sehr offensichtliche Auswirkungen auf die Flüsse, da sie mehrere Gruppen von Invertebraten eliminiert und so die Fauna drastisch simplifiziert hat (S. 23; Tab. 3).

4. Ebenso scheinen andere menschliche Aktivitäten (S. 23–24) einige Flußtaxa zu eliminieren. Gerridae und Veliidae sind wahrscheinlich wegen des Gebrauchs von Waschmitteln in Flüssen sehr selten geworden. Krebse scheinen aus dem Gebiet nördlich des Rift Valley verschwunden zu sein, obwohl es dort Flüsse gibt, die ihnen günstige Lebensbedingungen böten; während der 40er Jahre kamen sie im nördlichen Gebiet vor.

5. Außer in Addis Abeba, wo Zuflüsse des Akaki-Flusses deutliche Auswirkungen urbaner Verschmutzung zeigten, konnten wir nur wenige Anzeichen von Verschmutzung feststellen (S. 23–24). Wir hoffen, zu diesem Punkt weitere Veröffentlichungen folgen zu lassen.

6. Ein Kryal wie auf den sehr hohen Bergen weiter südlich scheint (S. 30–31; Tab. 3, 4) es in Äthiopien nicht zu geben, da es dort keine ständige Schneegrenze gibt. Das Rhithral weist eine charakteristische Fauna auf und reicht bis ca. 2000 m hinab (S. 31; Tab. 3, 4). Dort folgt eine Übergangszone, die sich bis ca. 1650 m erstreckt (S. 31; Tab. 3, 4), und darunter liegt ein Potamal mit einer Fauna, die der des Großteils Afrikas ähnlich ist (S. 31–32).

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References

Agnew, J. D. (1961): New Baetidae (Ephem.) from South Africa. – Novos Taxa Entomologicos (Sup. Rev. Entomol. Moçambique) 25: 1–18.

Axelrod, D. I. & Raven, P. H. (1978): Late Cretaceous and Tertiary vegetation history of Africa. – [In:] Werger, M. J. A. & Van Bruggen, A. C.: Biogeography and ecology of Southern Africa. – Monographiae Biologicae 31: 77–130. Junk, Den Haag.

Bafort, J. M.; Fain, A. & Siberstein, A. (1977): Simulies du Mont Kenya (Diptera: Simuliidae) II. Étude des espèscés récoltées avec une revue des Simulies des montagnes de l'Est Africain. – Rev. Zool. afr. 31: 587–606.

Barnard, K. H. (1932): South African mayflies. – Trans. r. Soc. sth Afr. 20: 201–259.

Bistrom, O. (1986): Review of the genus *Hydroglyphus* Motschulsky (= *Guignotus* Houlbert) in Africa (Coleoptera, Dytiscidae). – Acta zool. Fenn. 182: 56 pp.

Bollow, H. (1939): Eine neue Dryopiden-Gattung aus Abessinien. – Atti Museo Civ. Storia Natur. Trieste 14: 149–152.

BOTOSANEANU, L. (1973): Au carrefours des région orientale, éthiopienne et palearctique. Essai de reconstitution de l'histoire de quelques lignées "cool adapted" de trichoptères. – Fragmenta entomologica **9:** 61–80.
– (1979): Quinze années des recherches sur la zonation des cours d'eau: 1963–1978. – Bijdragen tot de Dierkunde **49:** 109–134.
BRINCK, P. (1955): A revision of the Gyrinidae (Coleoptera) of the Ethiopian Region I. – Lunds Univ. Årsskrift. N. F. Avd. 2, **51** (16): 1–146.
– (1956): A revision of the Gyrinidae (Coleoptera) of the Ethiopian Region II. – Lunds Univ. Årsskrift. N. F. Avd. 2, **52** (14): 1–189.
BROWN, D. S. (1965): Freshwater gastropod Mollusca from Ethiopia. – Bull. Brit. Mus. (Nat. Hist.) Zool. **12:** 39–94.
– (1980): Freshwater snails of Africa and their medical importance. – 487 pp., Taylor and Francis, London.
CHUTTER, F. M. (1969): The effects of silt and sand on the invertebrate fauna of streams and rivers. – Hydrobiol. **34:** 57–76.
– (1970): Hydrobiological studies in the catchment of Vaal Dam, South Africa. Part 1. River zonation and the benthic fauna. – Int. Rev. ges. Hydrobiol. **55:** 445–494.
CRASS, R. S. (1947): The may-flies of Natal and the Eastern Cape. – Ann. Natal Mu. **11:** 37–110.
CROSSKEY, R.W. (1969): A re-classification of the Simuliidae (Diptera) of Africa and its islands. – Bull. Brit. Mus. (Nat. Hist.) Entomol. Suppl. **14:** 1–195.
DEJOUX, C.; ELOUARD, J. M.; FORGE, P. & MASLIN, J. L. (1983): Catalogue iconographique des insectes aquatique de Côte d'Ivoire: Organisation mondiale de la Santé. – ORSTOM. OCP/VCU/HYBIO **83.2:** 178 pp. (mimeo).
DEMOULIN, G. (1970): Ephemeroptera des faune éthiopienne et malagache. – South African Animal Life **10:** 24–170.
DURAND, J. R. & LÉVÊQUE, C. (Eds.) (1981): Flore et faune aquatique de l'Afrique sahelo-soudanienne (Vols. 1 and 2). – 873 pp., ORSTOM, Paris.
EDMUNDS, G. F. (1975): Phylogenetic biogeography of mayflies. – An. Missouri Botanical Garden. **62:** 251–263.
EDWARDS, S. (1976): Some wild flowering plants of Ethiopia. – 61 pp., Addis Ababa Univ., Addis Ababa.
FAIN, A. & DUJARDIN, J. P. (1983): The *Simulium nigritarse* complex (Diptera, Simuliidae). – Rev. Zool. afr. **97:** 379–452.
FAIN, A. & OOMEN, A. P. (1968): Sur une simulie du groupe *neavei* capturée en Éthiopie (Note préliminaire). – Rev. Zool. Bot. afr. **78:** 246–250.
FORGE, P. (1981): Coléoptères. [In:] DURAND, J.-R. & LÉVÊQUE, C. (Eds.): Flore et faune aquatiques de l'Afrique sahelo-soudanienne. – p. 485–516, ORSTOM, Paris.
FREEMAN, P. (1955): A study of African Chironomidae, Part 1. – Bull. Brit. Mus. (Nat. Hist.) Ent. **4:** 1–67.
– (1956): A study of the Chironomidae (Diptera) of Africa south of the Sahara, Part 2. – Bull. Brit. Mus. (Nat. Hist.) Ent. **4:** 287–368.
– (1957): A study of the Chironomidae (Diptera) of Africa south of the Sahara, Part 3. – Bull. Brit. Mus. (Nat. Hist.) Ent. **5:** 323–426.
– (1958): A study of the Chironomidae (Diptera) of Africa south of the Sahara, Part 4. – Bull. Brit. Mus. (Nat. Hist.) Ent. **6:** 263–363.
FREEMAN, P. & DE MEILON, B. (1953): Simuliidae of the Ethiopian Region. – 224 pp., British Museum, London.
GILLIES, M. T. (1982): A second large-eyed genus of Caenidae (Ephemeroptera) from Africa. – J. nat. Hist. **16:** 15–22.

GOUIN, P. (1979): Earthquake history of Ethiopia and the Horn of Africa. – 258 pp., IDRC-118e, Ottawa.
GRENIER, P. & OVAZZA, M. (1956): Contribution à l'étude des diptères vulnérants de l'empire d'Éthiopie II. Simuliidae. Simulies et onchocercose. – Bull. Soc. Path. exot. **42:** 182–197.
HARRISON, A. D. (1965a): River zonation in southern Africa. – Arch. Hydrobiol. **61:** 380–386.
– (1965b): Geographical distribution of riverine invertebrates in southern Africa. – Arch. Hydrobiol. **61:** 387–394.
– (1966): Recolonisation of a Rhodesian stream after drought. – Arch. Hydrobiol. **62:** 405–421.
– (1978): Freshwater invertebrates (except molluscs). – [In:] WERGER, M. J. A. & VAN BRUGGEN, A. C. (Eds.): Biogeography and Ecology of southern Africa. Monographiae Biologicae, **31:** 1139–1152. Dr. W. Junk, Den Haag.
– (1987): Chironomidae of five central Ethiopian Rift Valley Lakes. – Entomologica Scandinavica, Suppl. **29:** 39–43.
HARRISON, A. D. & AGNEW, J. D. (1962): The distribution of invertebrates endemic to acid streams in the Western and Southern Cape Province. – Ann. Cape Prov. Mus. **2:** 273–291.
HARRISON, A. D. & BARNARD, K. H. (1972): The stream fauna of an isolated mountain massif: Table Mountain, Cape Town, South Africa. – Trans. roy. Soc. sth. Afr. **40** (3): 135–153.
HARRISON, A. D. & ELSWORTH, J. F. (1958): Hydrobiological studies on the Great Berg River, Western Cape Province. Part 1. General description, chemical studies and main features of the flora and fauna. – Trans. roy. Soc. sth. Afr. **35:** 125–226.
HINTON, H. E. (1940): Entomological expedition to Abyssinia 1926–7. Coleoptera, Psephenidae, Dryopidae, Elmidae. – Annals Mag. Nat. Hist. 6 (11): 297–307.
HUGHES, D. A. (1966): Mountain streams of the Barberton area, eastern Transvaal. Part I, A survey of the fauna. – Hydrobiol. **27:** 401–459.
HYNES, H. B. N. (1955): Biological notes on some East African aquatic Heteroptera. – Proc. r. ent. Soc. Lond. **30:** 43–54.
HYNES, H. B. N. & WILLIAMS, T. R. (1962): The effect of DDT on the fauna of a Central African stream. – Ann. trop. Med. Parasit. **56:** 780–791.
HYNES, H. B. N.; WILLIAMS, T. R. & KERSHAW, W. E. (1961): Freshwater crabs and *Simulium neavei* in East Africa 1. Preliminary observations made on the slopes of Mount Elgon in December, 1960, and January, 1961. – Ann. Trop. Med. Parasit. **55:** 197–201.
ILLIES, J. & BOTOSANEANU, L. (1963): Problèmes et méthodes de la classification et de la zonation écologique des eaux courantes, considérées surtout du point de vue faunistique. – Mitt. Soc. int. Limnol. 12: 1–57.
JAQUEMART, S. & STATZNER, B. (1981): Trichoptères nouveaux du Zaire. – Bull. Inst. r. Sci. nat. Belg. **53** (21): 1–25 with 15 plates.
KIMMINS, D. E. (1960): A review of the African species of the genus *Cheumatopsyche* (Trichoptera, Hydropsychidae), with special reference to those of southern Africa. – Bull. Brit. (Nat. Hist.) Ent. **9:** 255–267.
– (1963): On the Trichoptera of Ethiopia. – Bull. Brit. Mus. (Nat. Hist.) Ent. **13:** 119–170.
KING, L. (1978): The geomorphology of central and southern Africa. – [In:] WERGER, J. A. & VAN BRUGGEN, A. C.: Biogeography and ecology of southern Africa. – Monographiae Biologicae, **31:** 1–18. Dr. W. Junk, Den Haag.
KOPELKE, J.-P. (1980): Ephemeroptera aus der Emergenz des zentralafrikanischen Bergbaches Kalengo (Zaire). Teil I: Baetidae. – Entomol. Abh. Staatl. Museum f. Tierkunde in Dresden **43:** 99–129.

KOPELKE, J.-P. (1981): Ephemeroptera aus der Emergenz des zentralafrikanischen Bergbaches Kalengo (Zaire). Teil II: Leptophlebiidae, Heptageniidae, Tricorythidae, Caenidae. – Mitt. Schweiz. entomol. Gesell. **54:** 139–156.

KURU, A. (1978): The environmental impact of agriculture in Ethiopia. – Environ. Conserv. **5:** 213–221.

LEHMANN, J. (1979): Chironomidae (Diptera) aus Fließgewässern Zentralafrikas (Systematik, Ökologie, Verbreitung und Produktionsbiologie), Teil I: Kivu-Gebiet, Ostzaire. – Spixiana, Suppl. **3:** 1–144.

– (1981): Chironomidae (Diptera) aus Fließgewässern Zentralafrikas, Teil II: Die Region um Kisangani, Zentralzaire. – Spixiana, Suppl. **5:** 1–85.

LIVINGSTONE, D. A. (1975): Late Quarternary climatic changes in Africa. – Ann. Rev. Ecol. Syst. **6:** 249–280.

OLIFF, W. E. (1960): Hydrobiological studies on the Tugela River system. Part I. The main Tugela River. – Hydrobiol. **15:** 281–385.

SCOTT, K. M. F. (1958): Hydrobiological studies on the Great Berg River, Western Cape Province. Part 3. The Chironomidae. – Trans. r. Soc. sth. Afr. **35:** 277–298.

– (1983): On the Hydropsychidae (Trichoptera) of southern Africa with keys to African genera of imagos, larvae and pupae and species lists. – Ann. Cape Prov. Mus. (nat. Hist.) **14:** 299–422.

– (1986): A brief conspectus of the Trichoptera (caddisflies) of the Afrotropical region. – J. ent. Soc. sth. Afr. **49:** 231–238.

STATZNER, B. (1975): Zur Longitudinalzonierung eines zentralafrikanischen Fließgewässersystems unter besonderer Berücksichtigung der Köcherfliegen (Trichoptera, Insecta). – Arch. Hydrobiol. **76:** 153–180.

– (1976): Die Köcherfliegen-Emergenz (Trichoptera, Insecta) aus dem zentralafrikanischen Bergbach Kalengo. – Arch. Hydrobiol. **78:** 102–137.

STEFFAN, A.W. (1965): Zur Statik und Dynamik im Ökosystem der Fließgewässer und zu den Möglichkeiten ihrer Klassifizierung. – Biosoziologie, Ber. internat. Symposium Stolzenau/Weser (1960): 65–110. Junk, Den Haag.

TALLING, J. F. & TALLING, I. B. (1965): The chemical composition of African lake water. – Int. Rev. ges. Hydrobiol. **50:** 421–463.

TAVORES, I. I. (1979): The Laboulbeniales and their arthropod hosts. – [In:] BATRA, L. R. (Ed.): Insect-fungus symbiosis: nutrition, mutualism and commensalism: 229–258. Wiley, New York.

UEMOTO, K.; OGATA, K. & MEBRAHTU, Y. (1977): Black flies (Diptera: Simuliidae) of Ethiopia I. On four new and three uncertain species of *Simulium* LATREILLE. – Jap. J. sanit. Zool. **28:** 133–151.

ULMER, G. (1930): Entomological expedition to Abyssinia, 1926–27; Trichoptera and Ephemeroptera. – Ann. Mag. nat. Hist. **6:** 479–511.

VAN SOMEREN, V. D. (1950): The biology of trout in Kenya Colony. – 114 pp., Government Printer, Nairobi.

WILLASSEN, E. & CRANSTON, P. S. (1986): Afrotropical montane midges (Diptera, Chironomidae, *Diamesa*). – Zool. J. Linn. Soc. **87:** 91–123.

WILLIAMS, T. R. & HYNES, H. B. N. (1971): A survey of the fauna of streams on Mount Elgon, East Africa, with special reference to the Simuliidae (Diptera). – Freshwat. Biol. **1:** 227–248.

YALDEN, D. W. (1983): The extent of high ground in Ethiopia compared to the rest of Africa. – Sinet: Ethiop. J. Sci. **6:** 35–39.

Address of the authors:

Professor A.D. HARRISON, Professor H.B.N. HYNES, Department of Biology, University of Waterloo, Waterloo, Ontario, Canada, N2L 3G1.