Arch. Hydrobiol.	62	3	405—421	Stuttgart, Oktober 1966

Recolonisation of a Rhodesian stream after drought

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With 1 figure and 7 tables in the text

Field investigations into various aspects of the biology of aquatic pulmonate snails in streams near Salisbury, Rhodesia, were carried out during the years 1962 to 1965. Concurrently, details of the composition of the rest of the invertebrate fauna were also recorded. One of the streams, the small Munwahuku stream, was seasonal and flow stopped during the dry season each year; this meant that all the runs and most of the pools dried up completely. When flow resumed, after the onset of the rainy season, recolonisation by stream fauna was studied. The aim of this paper is to present the results of detailed investigations on recolonisation made during 1962—1963, with a few observations made as a check during 1964—1965.

Methods

Physical and chemical methods: water temperatures were taken with a maximum and minimum therometer concealed in a shaded run. pH values were obtained in the field using a comparator with standard indicators. Water analyses were carried out in the laboratory using standard analytical procedures, calcium and magnesium were analysed by EDTA titrations and sodium and potassium were determined by means of a flame photometer.

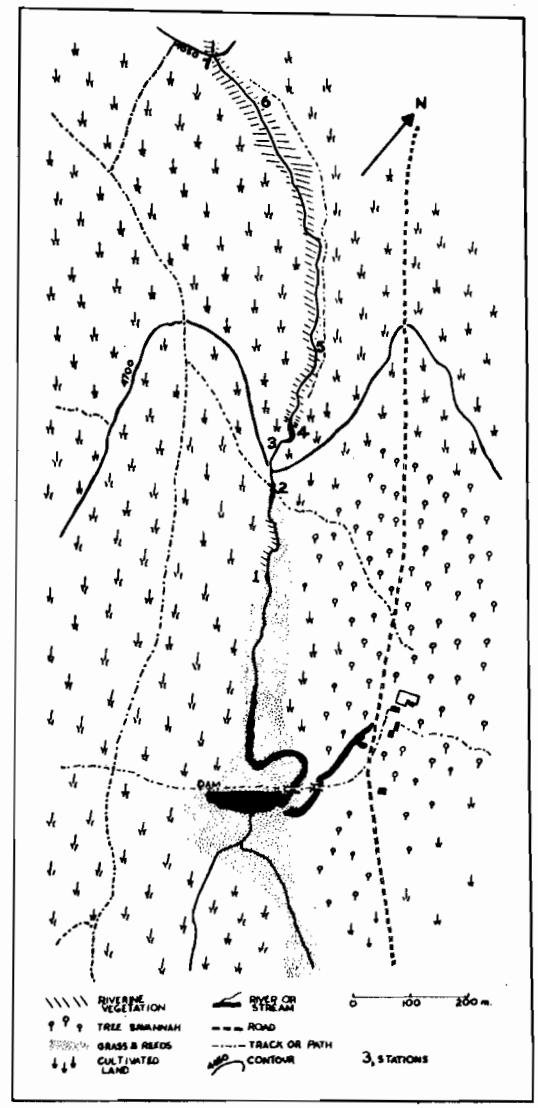
Faunal studies: Patches of emergent or marginal vegetation in pools were sampled by means of a modified HAIRSTON drag scoop (HAIRSTON et al., 1958), an elongated aluminium box, on a long handle, open at one end with a lower cutting edge, and closed at the other by means of metal gauze of 10 mesh/cm with mesh holes 0.8 mm across. The scoop used for most of the survey had an opening 12.5 cm square. Where it was not feasible to use the scoop a hand net was used made up from silk grit gauze of 23 mesh/cm, mesh size 0.3 mm, the net was 25 cm in diameter. An attempt was made to keep all scoop samples of comparable size, i.e. 2 m of vegetation, but this was very approximate. Usually three scoop samples were taken at each station on each visit, but sometimes more.

Runs: The earlier samples were taken by placing the hand net in the run and disturbing the bottom immediately in front of it. SURBUR samplers were used for the later samples and these were made from the same silk grit gauze as the hand net.

Samples were sorted in the laboratory using a method similar to that outlined by ALLANSON and KERRICH (1961). Organisms were identified to species as far as possible; larval insects were bred out occasionally and adults identified.

Description of stream and sampling stations

The Munwahuku stream lies in the Chindomora Tribal Trust Area, 36 km., NNW of the City of Salisbury, 17° 32′ S, 31° 9′ E. It is a small headwater stream of the Poti River, a tributary of the Mazoe River which



(Figure 1)

Physical and chemical conditions

Water Temperatures. Table 2 gives maximum and minimum temperatures obtained during 1963. The January and February figures give some idea of conditions during the wet summer season, and the June figures an idea of the temperature range during winter. Spring and Autumn temperatures would lie between but temperatures in drying up pools in October and November would be much higher than the January maximum.

Water Chemistry. Results of water analyses are given in table 3. The water was soft throughout the year but calcium and bicarbonate figures were lower during the wet season; nevertheless seasonal differences were not great. The October figure was obtained from station 4 when the pool was almost empty; it would seem from the low figures that the water was sinking with the water table more than evaporating. The November water sample was taken about one week after flow had resumed and, except for higher chloride and sodium values, it was much the same as water taken during the rest of the rainy season. Water was usually turbid, specially near the beginning of the rainy season, regular estimations were not carried out but a sample taken in December 1964 contained 190 mg/l of suspended solids (washed, and dried at 105° C).

Table 2. Water Temperatures, 1963.

	January	February	June
Maximum, °C	28.3	27.8	17.8
Minimum, °C.	20.6	19.4	11.0

Table 3. Water Analyses, 1962 to 1963.

	May — Sept. Dry season	October Drying up	November Reflooding	Dec. — April Wet season
Conductivity, micromhos	40—50	72	49	27—48
pH	6.7—6.8	7.0	6.7	6.5—6.8
Bicarbonates, mg/l as $CaCO_3$	24.0—40.0	20.0	18.2	15.0—29.0
Chlorides, mg/l as Cl.	0.8—1.2	0.5	2.6	0.9—1.5
Sodium, mg/l as Na.	6.0—12.8	11.7	12.7	4.2—5.0
Potassium, mg/l as K	1.0*	9.6	1.3	0.7—1.0
Calcium, mg/l as Ca.	6.0*	7.6	3.8	2.2—5.2
Magnesium, mg/l as Mg	0.5*	2.3	0.6	0.1—2.5

* September only

Results of faunal studies

Detailed Studies, 1963—1964

The results of the samplings from the two pools, stations 2 and 4 are given in tables 4 and 5. The faunal composition was much the same in the

dry season (May to October) as in the wet (December to April), except for the disappearance of current dwellers, such as *Baetis bellus*, during periods of slow flow. During October and early November the stream bed at station 2 and much at station 4 consisted of dry dusty sand baked hot by the sun, so all aquatic animals would have been killed except those with definite aestivating powers, those with resting eggs or those able to follow the water table. The first samples were taken about 10 days after reflooding and the first colonisers were: small nematodes and the oligochaete, *Limnodrilus hoffmeisteri*, both of which could have found refuge in damp soil nearer the water table or under the banks, *Cyclops* spp., probably from resting eggs, and the larvae of *Chironomus satchelli*. The latter were early arrivals in all parts of the stream and persisted for about two months but were not found at other times of the year. Nine days later common permanent stream species had begun to appear, such as early instars of *Cloen crassi* and Libellulidae. In the middle of December, about a month after flow restarted, the faunal composition appeared to be more or less normal except that *Chironomus satchelli* still peristed and *Caenis* spp. and members of the Trichoptera had still to appear. By the first of February the fauna was indistinguishable from that of permanent streams in the district.

The pool at station 4 was quite empty before the onset of the rains but the bottom was damp in the deepest parts. Recolonisation followed much the same pattern as at station 2 except that the first samples, taken 10 days after refilling contained early instars of some insect larvae such as *Lestes* sp., *Pseudagrion* sp., Culicini, *Bezzia* spp. and the chironomid *Procladius* sp. The normal faunal composition was established by December 13 and the early coloniser, *Chironomus satchelli*, had almost gone. It was interesting to note that final nymphal instars of *Anisops* sp. were caught on 17th January, which must have come from eggs which could not have been laid much more than two months before.

Results from the two runs are given in tables 6 and 7. The main substrata at station 5 were trailing roots and *Nitella* sp. Seasonal differences in the fauna were apparent and were probably due mainly to the slower current speeds in the dry season (May—July), which could account for the drop in numbers of Baetidae and *Cheumatopsyche* spp. The bed was dry and dusty during September and October but aestivating animals would have been helped by the fact that it was shaded from the sun by *Syzygium cordatum*. After the early November rains the bed was merely damp but water began to flow between 21st and 30th November, probably nearer the former date. The first sample was taken about a week after the reappearance of running water and early colonisers included nematodes, oligochaetes, *Cyclops* spp. and large numbers of *Chironomus satchelli*. True running water forms had also become established, principally the larvae of *Simulium rufi-*

corne, with atypical pupae, and Orthocladiinae, mainly *Rheocricoptopus capensis*. A most interesting discovery were three advanced larvae of the caddis *Setodes* sp. with sand grain cases. These had obviously survived the dry period and it could be seen clearly where they had started to add new sand grains on resuming activity. They could have been sheltering among matted roots in deep shade.

The re-establishment of a faunal composition similar to that in permanent streams took longer than in the pools; *Rheotanytarsus guineensis* returned between the first and third weeks and Baetidae and *Cheumatopsyche* spp. (Trichoptera) between the third and sixth week.

Conditions in the stony run at station 7 were similar. Marked seasonal differences were apparent but these were probably due to the slower flow and more settled conditions during the dry season (July and September). These would account for the general increase in numbers, specially *Caenis* spp. and Chironomidae. During the dry period no trace of moisture could be detected under the stones or in the gravel and sand beneath them to a depth of 10 cm. or more. Water started running at this station about a week earlier than at station 5 and the same early colonisers appeared. Baetidae and *Cheumatopsyche* spp. returned at about the same time and on 17th January (about the 9th week) the fauna was more or less back to its normal composition.

Faunal samples at the other stations, not reported on here, gave very similar results.

Notes on early colonisation

Simulium ruficorne Macquart. Early instars appeared in large numbers in the runs within the first week after flow had resumed; within about two or three weeks they developed into atypical pupae with respiratory filaments much longer and thinner than usual. Adults from these were identified by Dr. R. W. Crosskey as typical *S. ruficorne* but he confirmed that the pupae were atypical and similar to those he found in an identical situation in Nigeria (private communication). In the Munwaluku stream all the Simulium larvae collected in November and most of these collected in December 1962 were of this species but it disappeared from subsequent samples and was replaced by *S. medusaeforme*, *S. nigritarsis*, *S. bequaerti* and *S. alcocki*. A few typical pupae of *S. ruficorne* were found at various times after December 1962. Development of the atypical *S. ruficorne* was rapid; minute larvae were collected at station 5 on 30th November when they could not have been more than a few days old, they were cultured in the laboratory and the first pupa appeared on 6th December and adults began to emerge on 10th December. On 28th December 1963, a sample was taken from station 7 which was almost dry, no *S. ruficorne* were found in the sample but part was cultured and, after seven days, a large number of minute larvae appeared.

Table 4. Station 2. Pool. Animals in hand net samples. 1962 to 1963.

	May	June	July	Sept.	Oct.	Nov.	Nov.	Dec.	Feb.	Feb.	March	April
					DRY							
NEMATODA	1	30	21	141		47	57	18	155	5	20	20
OLIGOCHAETA												
Nais spp.	1	—	—	345		—	—	24	75	104	1	16
Limnodrilus hofmeisteri	18	16	18	51		60	6	—	599	10	17	19
CLADOCERA												
Ilyocryptus sordidus	5	15	—	10			4	21	90	—	118	63
Macrothrix sp.	—	60	—	5		—	—	—	15	10	20	20
Chydorus spp.	—	35	—	35		—	—	—	5	20	20	5
OSTRACODA	2	45	1	245		—	—	6	295	15	56	35
COPEPODA												
Cyclops spp.	—	296	5	286		2	5	30	101	97	241	443
Harpacticidae	—	—	1	15		—	—	—	—	9	5	—
EPHEMEROPTERA												
Cloeon crassi	—	28	3	22		—	1	9	—	27	8	79
Procloeon rhodesiae	2	2	—	—		—	—	6	—	1	1	4
Baetis bellus	52	—	—	—		—	—	—	1	9	220	73
Caenis sp.	3	8	3	92		—	—	—	33	25	91	33
ODONATA												
Lestes spp.	1	1	3	—		—	—	3	1	—	2	1
Pseudagrion spp.	—	2	1	—		—	—	3	6	20	38	17
Orthetrum spp.	—	—	—	—		—	4	—	1	5	—	—
Other Libellulidae	1	—	—	—		—	1	18	6	—	6	9
HETEROPTERA												
Micronecta scutellaris	2	1	—	5		—	1	—	—	—	5	6
Micronecta dimidiata	1	40	—	11		—	—	3	—	6	187	45
TRICHOPTERA												
Leptocerina sp.	—	—	—	—		—	—	—	1	4	2	2
Ecnomus spp.	3	—	1	—		—	—	—	—	1	23	2
Hydroptila cf. *capensis*	—	—	—	11		—	—	—	11	2	16	7
COLEOPTERA												
Larval Dytiscidae	—	—	1	34		—	1	9	27	18	17	4
Adult Dytiscidae	—	—	—	—		—	—	—	1	2	1	3
Hydrochus sp. (Hydrophilidae)	—	—	—	—		—	—	—	—	1	1	5
Haliplus spp.	—	—	—	—		—	—	—	—	1	2	1
DIPTERA												
Psychoda sp.	—	—	—	—		—	3	15	5	—	—	—
Bezzia spp. (Ceratopogonidae)	6	11	7	9		—	—	—	5	—	29	27
Other Ceratopogonidae	2	5	3	7		—	—	21	5	1	5	—
Chironomidae												
Procladius spp.	7	7	—	—		—	5	24	76	7	14	13
Pentaneura spp.	2	9	11	21		—	2	9	45	2	41	52
Tanytarsini	—	—	—	29		—	—	—	18	37	40	15
Chironomus spp.	—	—	—	—		1	53	36	2	—	—	—
Other Chironomidae	8	31	29	91			10	12	282	101	554	173
ACARINA — ORIBATOIDES												
Hydrozetes sp.	—	5	—	5		—	—	—	—	5	30	5
Other Oribatoides	—	—	—	40		—	—	—	15	—	—	15
GASTROPODA												
Bulinus forskalii	—	—	—	—		—	—	—	5	3	1	—
B. (Physopsis) africana	—	—	—	—		—	—		7	10	10	3
Total	77	648	122	1580		110	153	453	2083	631	1894	1275

Table 5. Station 4. Pool. Animals in 3 scoop samples. 1962 to 1963.
(Figures in brackets — hand net samples)

	May 31	June 27	July 24	Sept. 18	Oct. 17	Oct.	Nov. 21	Nov. 30	Dec. 13	Jan. 4	Jan. 17	Feb. 1	Feb. 22	March 21	April 16
NEMATODA	8	2	30	33	-	Y	2	48	(15)	75	—	34	78	—	30
OLIGOCHAETA						R									
Nais spp.	8	—	—	—	(1)		-	1	(5)	15	61	4	78	(74)	-
Limnodrilus hofmeisteri	1	5	23	—	(5)	D	1	15	(5)	48	128	105	49	(5)	78
CLADOCERA															
Ilyocryptys sordidus	—	—	—		(45)		—	—	—	4	15	—	22	(58)	65
Macrothrix sp.	2	—	-	—	(15)		-	—	—	—	—	—	8	(15)	5
OSTRACODA	2	5	15	—	(68)		2	—	(66)	174	252	83	21	(10)	40
COPEPODA															
Cyclops spp.	2	12	35	—	(1355)		2	22	(574)	202	18	18	69	(235)	211
EPHEMEROPTERA															
Cloeon crassi	9	3	6	—	-		—	16×	(14)	18	2	3	12	(121)	66
Procloeon rhodesiae	1	—	—	—	(3)		—	—	(6)	—	—	-	3	(1)	16
Caenis spp.	11	1	1	8	(3)		—	—	-	45	—	8	30	(114)	206
ODONATA															
Lestes spp.	2	3	4	3	-		2	—	—	12	5	—	1	—	3
Enallagma-type nymphs	—	—	—	—	—		—	—	(2)	24	—	—	1	—	—
Pseudagrion spp.	8	—	6	1	(1)		6	—	—	7	15	1	15	(4)	13
Hemianax sp.	—	—	—	2	—		—	—	(8)	12	3	-	2	(2)	—
Orthetrum spp.	1	—	—	—	—		—	—	(5)	3	2	9	1	—	4
Other Libellulidae	1	1	1	—	(1)		—	—	(6)	24	15	4	4	(2)	30
HETEROPTERA															
Micronecta dimidiata	1	—	—	31	2		—	—	(5)	—	3	—	—	—	3
Enithares spp.	—	—	—	1	(1)		—	—	(1)×	—	—	—	-	(5)	—
Anisops spp.	1	1	—	9	(18)		—	—	(5)×	4	2*	—	1	—	—
Laccocoris limigenus	—	—		4	(2)		1	4	(1)	—	1		—	(1)×	—
TRICHOPTERA															
Ecnomus spp.	8	8	4	—	—		—	-	—	—	2		2	(6)	8
COLEOPTERA															
Larval Dytsicidae	—	-	—	2	(6)		—	-	(8)	16	5	2	3	(21)	12
Adult Dytiscidae	1	1	1	6	(4)		2	—	-	12	2	1		(7)	3
Hydroscaphidae	—	—	1	—	(5)		—	—	(10)×	12	—	—	-	(1)	5
Helodidae (larvae)	1	—	—	—	—		—	—	(1)	2	—	—	—	-	—
DIPTERA															
Culex spp.	—	—	—	1	(8)		9	18	—	—	—	—	-	—	16
Bezzia spp. (Ceratopogonidae)	10	12	145	168	(50)		2	—	-	8	12	—	5	(18)	80
Other Ceratopogonidae	—	—	22	46	-		—	1	(5)	—	3	9	2	(4)	20
Chironomidae															
Procladius spp.	—	—	21	4	(20)		1	1	(66)	13	1	2	9	(8)	139
Pentaneura spp.	1	6	13	1	—		2	—	(11)	1	—	1	9	(4)	96
Tanytarsini	2	5	26	—	(1)		—	15	(6)	9	2	10	67	(12)	26
Chironomus spp.	—	—	—	—	(7)		4	72	(2)	—	—	—	-	—	-
Other Chironomidae	21	93	216	96	(30)		—	65	(27)	27	33	74	144	(359)	110
ACARINA — ORIBATOIDES															
Hydrozetes sp.	10	—	7	42	(30)		4	—	(25)	4	4	—	9	(21)	10
Other Oribatoides	2	—	5	—	—		1	—	(5)	30	—	9	8	(10)	10
GASTROPODA															
Ferrissia sp.	1	1	7	1	—		—	—	—	—	—	—	1	—	—
Bulinus forskalii	—	—	—	—	—		—	—	—	4	9	1	2	—	—
B. (Physopsis) africana	-	1	-	—	—		—	—	—	-	—	—	2	(5)	10
Total	140	171	660	499	(2128)		42	324	(898)	849	615	390	765	(1234)	1388

× Early instars * Last nymphal instars

Table 6. Station 5. Run among roots of *Syzygium cordatum* and *Nitella* sp. animals per sample*), 1962 to 1963.

	May	June	July	Sept. & Oct.	Nov.	Dec.	Jan.	Jan.	Feb.	Feb.	March	April
	31	27	24		30	13	4	17	1	22	21	16
PLANARIANS	5	3	—	Y	—	—	—	—	—	4	—	—
NEMATODA	—	17	—	R	86	25	28	16	26	11	11	66
OLIGOCHAETA				D								
Nais spp.	—	—	—		55	1	140	242	30		30	15
Limnodrilus hofmeisteri	—	—	—	|	16	1	2	—	10	1	6	81
OSTRACODA	7	—	—		—	—	5	36	10	30	11	5
COPEPODA												
Cyclops spp.	2	—	16		75	25	15	473	10	—	—	—
EPHEMEROPTERA												
Baetis bellus	16	5	2		—	—	—	1	—	—	1	—
Baetis latus	7	1	27		—	—	34	117	42	166	21	15
Pseudocloeon maculosum	16	—	1		—	—	2	15	58	134	94	53
Caenis spp.	43	34	13		—	10×	2	26	4	27	40	33
ODONATA												
Libellulidae	1	3			—	—	—	2	1	—	—	1
TRICHOPTERA												
Goerodes sp.	27	3	4		—	—	—		1	—	—	—
Oecetis sp.	6	8	9		—	—	—	1×	10×	1	6	5
Leptocerinae cf. *Setodes*	4	1	1		3	—	—	—	—	—	—	1
Cheumatopsyche afra	4	—	—		—	—	1	—	—	19	2	7
Cheumatopsyche thomasetti	—	—			—	—	1	1	15	41	—	1
Macronema sp.	13	12	—		—	—	—	—	—	3	1	2
Chimarra sp.	3	4	—		—	—	—		1	15	1	—
COLEOPTERA												
Gyrinidae — larvae	—	—	—		—	25	4	1	5	1	1	1
Helodidae, cf. *Hydrocyphon*	9	7	5		—	—	—	—	—	7	—	—
Hydrosephidae	—	—	—		—	—	15×	5×	5		—	—
DIPTERA												
Tipulidae	15	29	5		3	—	—	—	—	—	—	—
Simulium spp.	358	126	138		30	186	64	20	41	65	27	13
Bezzia spp. (Ceratopogonidae)	5	20	—		—	1	1	—	—	—	—	9
Other Ceratopogonidae	1	—	—		—	10	—	—	1	—	8	8
Chironomidae												
Pentaneura spp.	43	54	70		5	—	2	9	13	14	25	25
Corynoneurinae	30	5	110		—	—	—	25	—	—	—	—
Stempellina sp.	2	—	5		—	—	—	—	10	1	4	
Rheotanytarsus sp.	127	75	67		—	28	32	89	54	53	48	62
Other Tanytarsini	39	40	47		—	—	3	—	29	19	155	10
Chironomus spp.	—	—	—		76	3	—	—	—	—	—	—
Other Chironomidae (Mainly Orthocladiinae)	83	72	102		106	89	266	234	93	71	54	167
TOTAL	904	586	690		446	414	658	1453	502	800	608	648

* Samples taken by hand net except those for March and April which were taken by Surbur sampler and are expressed as number per 225 sq. cm.

Early instars

Table 7. Station 7. Stony run. Animals per sample*. 1962 to 1963.

	S	O	N	D	J	F	M	A	M	J	J	S
		21	30	13	4	17	1	22	21	16	26	28
PLANARIANS	W	—	2	1	5	1	—	1	—	—	—	—
NEMATODA	E	21	—	4	25	—	—	—	—	2	—	2
OLIGOCHAETA	T											
Nais sp.		—	—	—	96	15	—	10	—	—	—	—
Other Naididae		—	55	—	—	—	—	—	1	—	3	—
Limnodrilus hofmeisteri		1		—	—	—	—	—	—	3		1
OSTRACODA		—	—	2	—	15	10	5	—	—	—	—
COPEPODA												
Cyclops spp.		10	35	24	1	10	—	5	—	—	1	84
EPHEMEROPTERA												
Baetis harrisoni		—		—	32	77	60	9	3	1	82	—
Baetis bellus		—	—	—	—	—	—	—	1	—	1	2
Baetis latus		—	—	—	2	37	99	44	4	4	11	52
Pseudocleon maculosum		—	—	—	7	2	21	72	9	10	48	44
Caenis spp.		—	1	—	—	1	—	1	—	2	39	395
Euthraulus sp.		—	—	—	—	—	3	—	1	1	3	19
ODONATA												
Zygonyx sp.		—		—	—	1	1	—	—	1	—	—
TRICHOPTERA												
Cheumatopsyche afra		—		—	4	13	16	23	2	4	19	—
Cheumatopsyche thomasetti		—	—	—	—	—	2	—	1	—	18	—
Macronema sp.		—	—	—	—	—	—	1	1	1	1	—
Chimarra sp.		—		—	—	1	—	1	—	1	—	—
COLEOPTERA												
Gyrinidae — larvae		—	—	1	4	7	1	1	1	—	—	—
Elmidae — imagines		—	—	—	—	—	5	1	1	1	—	—
Elmidae — larvae		—	—	—	—	—	—	—	—	1	5	3
DIPTERA												
Simulium spp.		—	1	80	523	183	7	46	4	3	44	20
Chironomidae												
Procladius spp.		5	5	—	—	—	—	—	—	—	—	—
Pentaneura spp.		96	12	—	—	10	6	1	1	—	12	17
Rheotanytarsus sp.		—	—	—	—	5	7	—	1	2	48	6
Other Tanytarsini		—	—	2	6	—	—	—	—	—	36	14
Chironomus spp.		14	2	—	—	—	—	—	—	—	—	—
Nanocladius sp.		—	—	—	20	3	5	5	1	1	—	—
Other Chironomidae (Mainly Orthocladiinae)		—	2	5	12	9	16	16	2	1	49	15
Clinocerinae		—	—	2	1	—	—	1	—	1	—	—
ACARINA — ORIBATOIDES												
Hydrozetes sp.		5	5	—	1	—	—	5	—	—	—	—
Total		260	158	123	749	398	387	266	31	35	464	827

* Samples taken by hand net except those for March to September which were taken by Surbur sampler and are expressed as numbers per 225 sq. cm.

Note: Live samples taken on 28th September, 1963, and cultured in the laboratory produced numerous larval *Simulium ruficorne* by 4th October which developed into atypical pupae 14 days later.

These developed into the atypical *S. ruficorne* pupae two weeks later. Further samples were taken and cultured after another week when flow had ceased in the run but the underside of stones was still damp; no larvae appeared. It would seem that adult females select small trickles when laying eggs; these trickles can be the last remnants of flow, as in September 1963, or the early beginnings of flow, as in November 1962, but the eggs apparently cannot stand prolonged desiccation. The normal form of this species is characteristic of slow-flowing water but not necessarily small trickles (FREEMAN and DE MEILLON, 1953).

Chironomidae: A characteristic phenomenon observed during the first four or five weeks of flow was the appearance of larvae of *Chironomus (Chironomus)* spp. in all habitats, runs as well as pools. Most of these had loosely constructed, unattached cases which they carried about after the manner of *Stempellina* spp.; on culturing these developed into *Chironomus (Chironomus) satchelli* FREEMAN, a small green species. A culture from station 2, taken on 20th November produced large numbers of *Ch. satchelli* adults from 27th November to 4th December, and no other species. Another collected at station 5 on 4th December, began to produce a few *Pentaneura meilloni* and *Corynoneura dewulfi* within a few days and then large numbers of *Chironomus satchelli;* after 11th December a few *Chironomus (Chironomus) callichirus* appeared. Other chironomids from this culture, which unlike the *Chironomus* spp. were also common during the following months, were: *Limnophyes natalensis, Rheocricotopus capensis, Cricotopus albitibia* (Orthocladiinae); *Corynoneura dewulfi* (Coroynoneurinae); *Polypedilum (Polypedilum) kibatiense, Polypedilum (Polypedilum) dewulfi, Polypedilum (Pentapedilum) calvescens, Polypedilum (Pentapedilum) anale* (Chironomini);*Tanytarsus (Tanytarsus) pallidulus, Tanytarsus (Tanytarsus) luctuosus, Tanytarsus (Cladotanytarsus)* cf. *reductus, Tanytarsus (Rheotanytarsus) guineensis* (Tanytarsini); *Pentaneura (Ablabesmyia) dusoleili* (Tanypodinae). Many additional species were cultured from samples taken later in the rainy season (see Appendix).

Faunal observations in 1964–1965

The dry season in 1964 was far more severe than that of 1962, runs were dry for eight months and all pools dried up completely. The only water in the system was a small pool in the dam. In spite of this colonisation followed the same pattern as before. Flow started in mid-December and by the end of the month the early colonisers were abundant and more permanent members of the fauna, such as *Baetis harrisoni,* had begun to appear. The faunal composition on 4th February, 1965, was essentially the same as on 1st February, 1963 (tables 4 to 7).

Discussion

Most streams in Southern Africa start amongst hills on the elevated plateau and not in mountains, and a large number of these streams are dry or partly dry for a period every year. This is not only the case in regions of low rainfall; BALINSKY (1962) gives a map of a drought zone or "drought corridor" which extends without interruption from the Western Cape Province and South West Africa across the continent in a north easterly direction to the Somali Peninsula. This zone includes regions where the rainfall may be moderate or even high but almost completely limited to one season of the year, usually summer; the result is that practically no rain falls during three or four months of the dry season. This is what happens over most of Rhodesia where small streams dry up and large streams and rivers are reduced to mere trickles. In may cases pools retain water but runs are quite dry and running water fauna is exterminated.

The Munwahuku stream is typical of many small streams in the region around Salisbury which are regularly recolonised after dry periods. These studies suggest that recolonisation is from three sources:

1. Resting eggs of such forms as entomostraca, platyhelminths etc.
2. Forms capable of aestivation in protected situations; some, such as small nematodes and *Limnodrilus hofmeisteri*, probably follow the water table and retreat to damp situations under the bank, others, such as the pulmonate snails, *Bulinus (Bulinus) forskalii, Bulinus (Physopsis) africana*, and larvae of the caddis *Setodes* sp., go into a resting condition and seal off their shells and cases.
3. Eggs laid by flying adults migrating from nearby permanent streams or upstream from permanent rivers. There was no evidence that any insect eggs survived the dry period.

Some of the pool fauna was able to persist in 1962 but, even in that year, most of the insect larvae in recently refilled pools were early instars.

An interesting feature of the early recolonisation was the appearance of large numbers of *Chironomus satchelli* and the atypical *Simulium ruficorne* during the first few weeks, giving the appearance of some form of "succession" before the more stable faunal composition was established. Nothing similar was seen in a few samples taken from another stream 10.5 km. to the south west; however, in this instance only the runs dried up and the large permanent pools retained most of the normal fauna, also the field stations were only 300 or 400 m. away from the confluence with a permanent river, which would have facilitated the rapid return of the normal species to the runs. In addition the water quality was different, bicarbonates 133 mg/l as $CaCO_3$, calcium 20.6 mg/l as Ca, which could have prevented colonisation by *Chironomus satchelli*, other observations have shown that this species is only common in softer waters.

No similar succession has been noted by other authors although HARRISON (1958) found that typical *Simulium ruficorne* were very abundant after resumption of flow in a temporary stream near Cape Town, South Africa. PATRICK (1959) noted that *Simulium vittatum* was the first macroscopic animal to be established in an artifical stream, near Philadelphia, U. S. A., 5 days after water was first run into it from a nearby natural stream. HYNES (1958) working on a Welsh mountain stream that had been dry, found a number of unusual forms shortly after resumption of flow but considered them to be strays from other habitats or, in the case of adult beetles, visitors in transit.

In the case of the Munwahuku stream the faunal composition was essentially similar to that of nearby permanent streams within two months after flow began. In the Welsh mountain stream studied by HYNES there were many important species which did not appear, mainly Plecoptera and Ephemeroptera, but he was dealing with a mountain stream fauna (rithronic), rich in species, which must have included many forms, ill-adapted to catastrophic droughts. The Munwahuku stream only harboured widespread Southern African species, characteristic of cooler, elevated "higveld" or "middle veld" regions (HARRISON, 1965); these species are commonly found in regions where drought is an annual occurrence.

Summary

Rainfall over much of Southern Africa is limited to a discrete rainy season and little or no rain may fall during four to six months of the year. Even in regions where the rainfall is moderate or even high, headwater streams dry up regularly during the dry season. Studies on one of these temporary streams, the Munwahuku stream near Salisbury, Rhodesia, showed that: *1.* recolonisation by fauna after the annual resumption of flow was rapid, Oligochaeta, small Crustacea and infect larvae appeared within the first 10 days, 2. there was a form of "succession", *Chironomus satchelli* and atypical *Simulium ruficorne* appeared within a few days, became abundant but disappeared after two months, *3.* species typical of permanent streams returned within one month in the pools and within four to six weeks in the running water

Pulmonate snails and many Oligochaeta must have aestivated and other Oligochaetes, small Crustacea, rhabdocoeles etc. must have come from resting eggs. A few larval Trichoptera, *Setodes* sp., aestivated in shaded spots but most insect recolonisation must have been carried out by flying adults.

Zusammenfassung

In weiten Gebieten des südlichen Afrikas sind die atmosphärischen Niederschläge auf eine scharf abgegrenzte Regenzeit begrenzt. Vier bis sechs Monate des Jahres sind regenfrei. Selbst in Gegenden, wo die Niederschläge mäßig oder stark sind, trocknen die Quellwässer während der trockenen Jahreszeit regelmäßig aus. Die Untersuchung des temporären Munwahuku-Baches in der Nähe von Salisbury ergab folgende Befunde: *1.* Die erneute Ansiedlung der Fauna nach dem jährlichen

Wiederbeginn des Wasserfließens setzte schnell ein. Oligochaeten, Crustaceen und Insektenlarven erschienen bereits im Laufe der ersten zehn Tage. 2. Eine gewisse „Reihenfolge" der Tierarten stellte sich dabei ein, indem *Chironomus satchelli* und eine atypische *Simulium ruficorne* innerhalb der ersten paar Tage in Erscheinung traten und zahlreich wurden, um nach zwei Monaten wieder zu verschwinden. 3. Gattungen, die in nicht eintrocknenden Flüssen typisch sind, kehrten innerhalb eines Monats in Teichen und Gumpen und innerhalb von vier bis sechs Wochen in die betr. Fließgewässer zurück.

Wasserschnecken und viele Oligochaeten müssen den trockenen Sommer dort im Flußbett verbracht haben; andere Oligochaeten, kleine Crustaceen, Rhabdo[illegible] worden sein.

The author would like to thank Dr. N. V. Williams for assisting with the water analysis, Mr. M. H. Mason for assisting with field work, the Director of Meteorological Services for rainfall figures and the following taxonomists: Mr. D. E. Kimmins (Ephemeroptera), Dr. K. M. F. Scott (Trichoptera), Dr. R. W. Crosskey (Simuliidae) and Dr. R. O. Brinkhurst (Oligochaeta). The whole project was financed by the Rockefeller Foundation of New York.

Appendix (List of identified species)

Oligochaeta

Nais raviensis Stephenson, *Allonais paraguayensis* (Michaelson), *Limnodrilus hofmeisteri* Claparede.

Cladocera

Ilyocryptus sordidus (Lièven), *Daphnia longispina*, *Simocephalus serrulatus* (Koch), *Monspilus dispar* Sars.

Copepoda

Harpacticidae — *Elaphoidella decorata* Daday.

Ephemeroptera

Baetis harrisoni Barnard, *Baetis bellus* Brnrd, *Baetis latus* Agnew., *Pseudocloeon vinosum* Brnrd, *Pseudocloeon maculosum* Crass, *Centroptilum excisum* Brnrd, *Cloeon virgiliae* (Brnrd), *Cloeon crassi* Agnew, *Procloeon rhodesiae* (Brnrd), *Procloeon cylindroculum* Kimmins, *Euthraulus* sp. nov.

Heteroptera

Micronecta scutellaris Stål, *Micronecta dimidiata* Poisson, *Laccocoris limigenus* Stål, *Sigara walgreni* Lundblad, *Enithares sobria* Stål, *Enthares glauca* Bolivar, *Anisops psyche* Hutch. *Anisops eros* Hutch. *Anisops varia* Fieb, *Anisops debilis* Gerst.

Trichoptera

Goerodes brachycerca Marlier, *Leptocerina talopa* Mosely, *Oecetis vulgata* (Marlier), *Oecetis* sp. nov., *Cheumatopsyche afra* (Mosely), *Cheumatopsyche thomasseti* (Ulmer), *Oxyethira* sp. nov., *Catoxyethira* sp. nov. (*fasciata* group).

Dytiscidae

Hydrocoptus angolensis Pesch., *Canthydrus nigerrimus* Omer-Cooper, *Canthydrus quadrivittatus* Boh., *Canthydrus sedilloti* Rég., *Hydrocanthes subplanatus* Gschw., *Hyphydrus aethiopicus* J. B.-B., *Laccophilus concisus* Guign., *Laccophilus flaveolus* Rég., *Laccophilus inornatus* Zimm., *Laccophilus leonensis* Rég., *Laccophilus lineatus* Aubé, *Africophilus nesiotes* Guign., *Philaccolus lineatoguttatus*

Rég., *Uvarus perinqueyi* Rég., *Uvarus vitticollis* (Boh.), *Yola coelata* Omer-Cooper, *Yola tuberculata* Rég., *Clypeodytes meridionalis* Rég., *Herophydrus inquinatus* Boh., *Copelatus sylvaticus* Guign., *Hydaticus intermedius* Rég., *Hydaticus dorsiger* Aubé, *Hydaticus flavolineatus* Boh., *Cybister marginicollis* Rég.

Hydrophilidae

Helochares (s. str.) *dilutus* Er., *Helochares* (*Hydrobaticus*) sp. nov. 1, *Helochares* (*Hydrobaticus*) sp. nov. 2, *Berosus* (s. str.) sp. nov., *Enochrus* (*Methydrus*) *natalensis* G. & H., *Hydrochus perforatus* Rég., *Laccobius gracilis* Mots., *Cercyon* (s. str.) sp., cf. *sturmi* Roth., *Amphiops globus* Er., *Regimbartia compressa* (Boh.), *Allocotocerus subaeneus* (Er.), *Allocotocerus segrex* (Orch).

Elminthidae

Lobelmis harrisoni Delève, *Helminthopsis bifida* Delève.

Diptera — Simuliidae

Simulium alcocki Pomeroy, *S. nigritarsis* Coq., *S. ruficorne* Macq., *S. medusaeforme* Pom., *S. bequaerti* Gibbins.

Diptera — Chironomidae

Tanypodinae: *Pentaneura* (s. str.) *trifascia* Freeman, *Pentaneura* (s. str.) *interrupta* Goet., *P.* (s. str.) *meilloni* Fr., *P.* (*Ablabesmyia*) *dusoleili* Goet., *Procladius brevipetiolatus* Goet. — Orthocladiinae: *Cricotopus albitibia* Walker, *Cricotopus scottae* Freeman, *Rheocricotopus capensis* Fr., *Syncricotopus micans* Kieffer, *Nanocladius vitellinus* Kieff., *Limnophyes natalensis* Kieff., *Smittia conigera* Fr., *Smittia hirtella* Fr. — Corynoneurinae: *Corynoneura dewulfi* Goet., *Thienemanniella antennata* Fr. — Chironomini: *Chironomus* (s. str.) *callichirus* Kieff., *Chironomus* (s. str.) *satchelli* Fr., *C.* (s. str.) *peringueyi* Kieff., *C.* (*Dicrotendipes*) *pilosimanus* Kieff. subsp. *quartuordecimpunctatus* Goet., *C.* (*Dicrotendipes*) *chloronotus* Kieff. (form *latibolus*)., *C.* (*Cryptochiroomus*) *neonilicola* Freeman, *C.* (*Cryptochironomus*) *nudiforceps* Kieff., *Stenochironomus polychaetus* Kieff., *Polypedilum* (s. str.) *allansoni* Fr., *P.* (s. str.) *natalense* Kieff., *P.* (s. str.) *deletum* Goet., *P.* (s. str.) *kibatiense* Goet., *P.* (s. str.) *dewulfi* Goet., *P.* (*Pentapedilum*) *calvescens* Fr., *P.* (*Pentapedilum*) *anale* Fr., *Microtendipes taitae* Kieff. — Tanytarsini: *Tanytarsus* (s. str.) *luctuosus* Fr., *T.* (s. str.) *pallidulus* Fr., *T.* (*Cladotanytarsus*) *reductus* Fr., *T.* (*Rheotanytarsus*) *guineensis* Kieff., *Stempellina chambiensis* Goet.

Gastropoda

Bulinus (s. str.) *forskalii* (Ehrn.), *Bulinus* (*Physopsis*) *africanus* (Krs.).

Pisces

Barbus trimaculatus Peters.

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