7 A preliminary survey of the Ephemeroptera of the north east Cape rivers, South Africa

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A qualitative survey of the riverine invertebrate fauna of the north east Cape, South Africa, was undertaken in December 1990 and March 1991. A total of 41 species of mayfly in 16 genera was recorded in this study, with possibly 21 species being new. In one family, the Baetidae, approximately 27 species, many of which are unknown, were collected. These include species of the genera Acanthiops, Acentrella, Afroptilum, Baetis, Centroptiloides *and* Demoulinia. *The families Oligoneuriidae, Heptageniidae, Leptophlebiidae, Tricorythidae and Caenidae were also represented, but with fewer species.*

Fauna that have Tropical Gondwanaland or Afrotropical origins, such as members of the Baetidae, meet here with relict South Temperate Gondwanian fauna, such as Adenophlebia *and* Castanophlebia *of the Leptophlebiidae. The overlap of these two faunal stocks accounts for the highly diverse fauna of mayflies observed.*

Introduction

Knowledge of the mayfly fauna of southern Africa is slowly growing, though the taxonomy of many species is still confused. Although extensive collecting has been carried out in some parts of the country in the past, the fauna of many areas is still virtually unknown. Until recently many of the rivers of the north east Cape fell into the latter category. This region is being intensively planted with non-indigenous pines and *Eucalyptus* spp. by a forestry company. As part of a pre-afforestation survey the freshwater invertebrate fauna of these rivers was surveyed in December 1990 and March 1991 (de Moor and Barber 1992). This investigation showed that the mayfly fauna was particularly diverse.

The north east Cape is a montane grassland area that has been intensively stock farmed since the end of the last century. Poor farm management has led to erosion

in some parts causing silting of the rivers. Although it is not known how this has affected the invertebrate fauna in these rivers, Chutter (1969) found that silt and sand in rivers can have a considerable negative effect on the fauna. The introduction of rainbow trout *Oncorhynchus mykiss* (Richardson) into the north east Cape streams at the turn of the century has also undoubtedly affected the invertebrate communities (de Moor 1992). Spotted bass, *Micropterus punctulatus* Rafinesque, collected in the upper reaches of the Wildebeest River (Skelton and James 1990), may further affect the invertebrate communities of these streams. It is not known how long this species has been present here, although the first introductions to South Africa were in the 1940s (de Moor and Bruton 1988). As part of a pre-afforestation survey, the freshwater invertebrate fauna of these rivers was surveyed in December 1990 and March 1991. The aim of the research was to produce a checklist of invertebrate species found in the rivers before the introduced forests had any influence. A follow-up survey will be required once the trees have developed to determine what effects, whether direct or indirect, they may have on the species diversity of these streams. The surveys showed that the mayfly fauna was particularly rich and therefore merited separate attention.

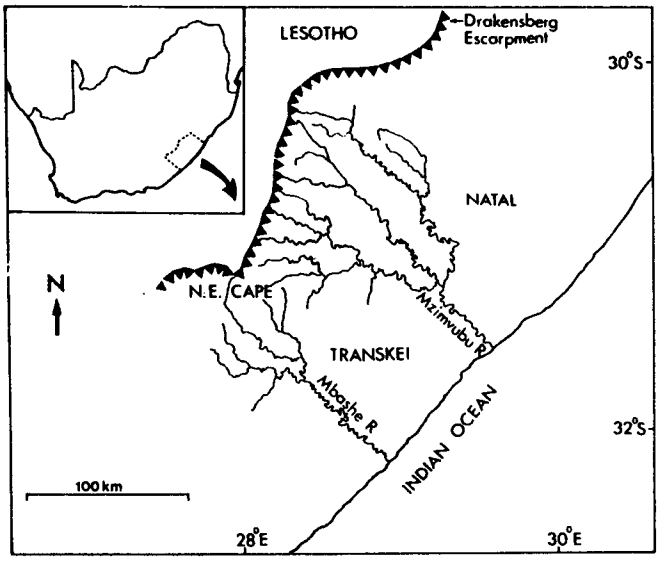
Materials and Methods

All the rivers in the region sampled flow in an easterly to southerly direction through altitudes ranging from about 2700 m to 1000 m above sea level. Based on 1:250 000 scale maps of the area, the streams range from first to fourth-order (Hynes 1970). The Drakensberg escarpment (Fig. 1) forms the divide between these rivers flowing eastwards into the Indian Ocean and those flowing westwards into the Orange River system, which eventually drains into the Atlantic Ocean. The west flowing rivers were not considered in this investigation.

Samples were collected from 35 sites on the Mbashe and Mzimvubu River systems (Figs. 1 and 2). Collecting was done in December 1990 (sites 1 - 18) and March 1991 (sites 19 - 35). Most collecting was done using a hand net, to sample where possible, the following aquatic biotopes — stones in and out of current, marginal vegetation in and out of current, bedrock and sediment samples. In some cases a kick screen was used. Light trapping was also done, but the material collected has not been included in this report. Some mature mayfly nymphs were reared through to the adult stage for identification. At most sites, measurements of temperature (°C) using a mercury thermometer, pH using a Lovibond comparator and conductivity (mS m^{-1}) using a Hanna conductivity meter were taken.

Many of the identifications of the collected material were based on the work of Agnew (1961, 1973, 1980), Barnard (1932, 1940), Crass (1947), Demoulin (1970), Gillies (1990), Peters and Edmunds (1964) and Schoonbee (1968). A preliminary

Figure 1. **Location of the north east Cape rivers, showing the two river systems into which they flow.**



key to the Ephemeroptera of Southern Africa, (W.P. McCafferty 1990, unpublished) also was used. All material is housed in the Albany Museum collection of freshwater invertebrates (ECR catalogue).

Results and Discussion

A checklist of the species collected is presented in Table 1. A total of 31 species in 16 genera is recorded from this area. Of these, 21 taxa cannot be identified to species level and may represent undescribed species. The characteristics of the sampling sites are summarised in Table 2.

The Antelope Park Spruit (site 2), with 25 species in 11 genera, was the most diverse site. This was the only site that was extensively collected in both December (summer) and March (autumn). There was only a 2°C difference in water temperature between the two collecting dates, and pH and conductivity were similar (Table 2). This proved to be one of the more species rich sites. The material collected in autumn exhibited a higher diversity than material collected in summer. Nearby sites, collected only in December, had similar species assemblages but were less diverse.

Figure 2. **Collecting sites on the north east Cape rivers surveyed during 1990 and 1991.**

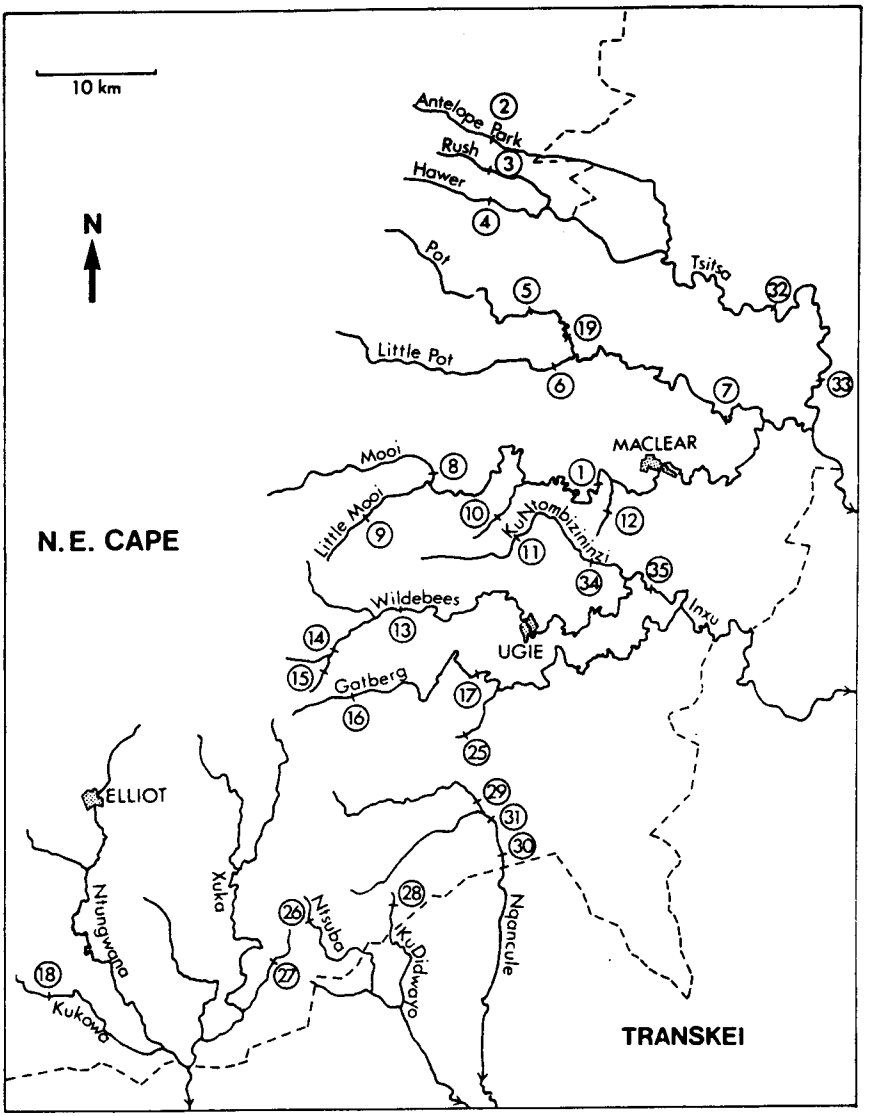


Table 1. **Ephemeroptera species collected in the rivers of the north east Cape in December 1990 (D) and March 1991 (M), arranged according to main river systems; site numbers refer to Fig. 2; * represents the presence of a species; a number indicates that more than one unidentified species was present.**

	RIVER SYSTEM	MZIMVUBU																						MBASHE						
	MAIN RIVERS	Tsitsa						Pot				Mooi				Inxu								Mbashe					Xuka	
SPECIES	MONTH	D	M	D	D	M	M	D	M	D	D	D	D	D	D	M	M	M	D	D	D	D	D	M	M	M	M	M	M	D
	SITE NO.	2	2	3	4	32	33	5	19	6	7	8	1	9	10	11	34	35	15	14	13	16	17	25	29	30	31	28	26	27	18
BAETIDAE																														
1. *Acanthiops* sp.							*		*																					
2. *Acentrella capensis* Barnard							*		*						*			*	*						*					*
3. *A.monticola* Crass	*	*								*	*																			
4. *A.natalensis* Crass	*	*							*	*	*	*					*										*		*	
5. *Afroptilum excisum* (Barnard)																														
6. *A.flavum* (Crass)		*							*								*									*				
7. *A.sudafricanum* (Lestage)		3	*	*	*	4	*	2				*	*	*			3	*					*	*	2	*	*	*			
8. *Afroptilum* spp. (6 spp.)		*			*	*																			*	*	*				
9. *Baetis glaucus* Agnew	*	*	*	*	*	*	*	*	*	*	*	*	*			*	*	*		*					*	*	*			*	
10. *B.harrisoni* Barnard	*	*	*	*			*		*	*	*					*				*					*	*	*	*			
11. *B.latus* Agnew	*	3	*	*	2	5		2			*		*	*	*		*	*	*	*	*	*	*	*	2	4	*	2	*	*	*
12. *Baetis* spp. (5 spp.)						*																			*	*					
13. *Centroptiloides bifasciata* (E-P.)		2			2	*		2		*							*	2						*	*	2		*			
14. *Cloeon* spp. (2 spp.)						*																				*					
15. *Demoulinia* sp.																															
16. *Pseudocloeon vinosum* Barnard																															
OLIGONEURIIDAE																															
17. *Oligoneuropsis lawrencei*							*		*																	*	*				
HEPTAGENIIDAE																															
18. *Afronurus barnardi* Schoonbee									*				*																		
19. *A.oliffi* Schoonbee	*							*																							
20. *A.peringueyi* (Esben-Petersen)	*	*																													
21. *Afronurus* sp.		*			*																										
LEPTOPHLEBIIDAE																															
22. *Adenophlebia auriculata* (Eaton)		*							*																	*		*		*	*
23. *A.sylvatica* Crass								*	*																					*	
24. *Adenophlebia* sp.		*							*			*			*	*											*			*	
25. *Castanophlebia* sp.	*		*			*	*	*	*			*	*							*					*		*			*	
26. *Euthralus ?elegans* Barnard																															
TRICORYTHIDAE	*																														
27. *Tricorythus reticulatus* Barnard	*	*						*	*			*	*	*	*	*				*	*	*			*	*	*		*		
28. *Tricorythus* sp./spp.																															
CAENIDAE																		*													
29. *Caenis capensis* (Barnard)	*	*					*		*									*	*	*		*	*							*	*
30. *Caenis* sp.	*	*		*	*			*	*	*	*			*		*	*	*	*	*	*	*	*	*	*	*	*	*		*	
31. *Caenomedea* sp.																															
TOTAL NUMBER OF SPECIES COLLECTED		12	20	5	5	9	19	8	20	6	6	5	6	5	5	5	9	9	4	6	5	4	4	4	10	17	9	12	2	8	6

Table 2. Recorded characteristics of sites and some physico-chemical parameters of the water at the time of sampling in December 1990 and March 1991.

River	Site No.	Months	Temp. °C	pH	Conductivity m^{-1}	Altitude m asl	Substratum
Antelope Park	2	Dec	17.9	7.8	11.4	1750	Bedrock
		Mar	15.9	7.6	8.3		Boulders
							Cobbles
							Gravel
Rush	3	Dec	-	-	-	1750	Bedrock
							Cobbles
							Gravel
Hawer	4	Dec	19.5	-	9.0	1700	Bedrock
							Cobbles
							Gravel
Tsitsa	32	Mar	19.6	7.6	7.9	1250	Sand
							Silt
	33	Mar	20.9	7.9	8.0	1200	Bedrock
							Boulders
							Sand
Pot	5	Dec	19.2	7.9	5.2	1350	Boulders
							Cobbles
	19	Mar	17.4	7.6	6.5	1300	Bedrock
							Boulders
							Cobbles
Little Pot	6	Dec	21.0	-	7.0	1350	Bedrock
							Boulders
Lower Pot	7	Dec	21.0	7.8	11.0	1200	Bedrock
							(potholes)
Mooi	8	Dec	20.0	7.6	6.5	1530	Cobbles
	1	Dec	19.0	6.9	7.3	1350	Bedrock
							Sand
							Silt

Table 2. (continued)

Little Mooi	9	Dec	26.0	7.7	6.0	1400	Cobbles Sand Silt
Unnamed tributary	10	Dec	22.5	7.1	3.4	1410	Bedrock Boulders Cobbles Silt
KuNtombizininzi	11	Mar	23.0	6.8	2.0	1350	Bedrock Cobbles Silt
	34	Mar	22.4	7.0	3.6	1350	Cobbles Gravel Sand Silt
Inxu	35	Mar	19.4	7.3	6.5	1300	Bedrock Cobbles Gravel Silt Floating- macrophytes
Wildebees	15	Dec	18.0	7.4	7.0	1400	Bedrock Pebbles Gravel
	14	Dec	18.0	7.4	7.6	1400	Boulders Cobbles Sand Silt
	13	Dec	18.5	7.8	7.9	1350	Cobbles Gravel Sand Silt

Table 2. (continued)

Gatberg	16	Dec	17.0	7.1	5.5	1400	Silt
							Weed beds
	17	Dec	17.5	7.0	5.8	1300	Boulders
							Cobbles
							Silt
Unnamed tributary	25	Dec	-	-	-	1500	Cobbles
							Sand
							Silt
Nqancule	29	Mar	23.1	7.3	21.3	1300	Sand
	30	Mar	-	-	-	1250	Bedrock
							Sand
	31	Mar	18.0	7.4	14.0	1300	Bedrock
							Boulders
							Cobbles
							Sand
KuDidwayo	28	Mar	18.6	7.3	7.8	1400	Pebbles
							Silt
Ntsuba	26	Mar	15.4	6.8	12.4	1450	Bedrock
							Boulders
							Silt
Xuka tributary	27	Mar	17.9	7.7	23.7	1300	Cobbles
							Silt
KuKowa	18	Dec	20.0	7.9	-	1350	Bedrock
							Cobbles

Twenty-two species from 11 genera were collected from two sites along the Tsitsa River (sites 32 and 33). The oligoneuriid mayfly, *Oligoneuriopsis lawrencei*, was locally abundant under stones at site 33, as were the rarely collected baetids (*Acanthiops* sp., *Centroptiloides bifasciata* and *Pseudocloeon vinosum*). Far fewer species were found at site 32, 21 km upstream, probably because of habitat

degradation at this site, with the river being badly silted up and overgrown with exotic trees along the banks. Site 33 consisted of solid bedrock with cascades and a large waterfall and was probably more resistant to siltation. A more detailed study following the course of the Tsitsa River would be necessary to find out how isolated or restricted suitable habitats are for the rarer species.

Acanthiops sp. was found at only one other site, in the middle region of the Pot River (site 19). *Oligoneuropsis lawrencei* was collected here only from the gut of a trout caught in this stream. More *O. lawrencei* could not be found at this site despite intensive collecting. Since the mayfly nymph was hardly digested, it is unlikely that the trout would have fed on the specimen downstream in the Tsitsa River where *O. lawrencei* was recorded. The only other site where *O. lawrencei* was found was the Nqancule River (sites 30 and 31), which had a similar bedrock and cobble substrate to site 33 at the Tsitsa River.

Other isolated species discoveries include *Demoulinia* sp., found only in the Little Pot River (site 6), and *Pseudocloeon vinosum*, found at the same sites as *O. lawrencei* in the Tsitsa (site 33) and Nqancule (site 31) rivers.

The three leptophlebiid genera (*Adenophlebia, Castanophlebia, Euthralus*) were distributed throughout the surveyed area, although were largely absent from the Inxu River and its associated tributaries (Table 1). All three genera occurred in the Antelope Park Spruit (site 2), though *Adenophlebia* and *Castanophlebia* were collected only in autumn, while *Euthralus* was collected only in summer. These genera were also found in the Pot River (site 19) and KuKowa Stream (site 18). The *Castanophlebia* nymphs were very small in the March samples, suggesting that nymphal development begins here in late summer, maturing over winter to emerge sometime in spring or summer. Most of the small specimens were collected from marginal vegetation and drift, whereas the more mature nymphs collected in December were found in the stones-in-current biotope, suggesting a change in biotope as the nymphs mature.

Three species of Heptageniidae were identified using the descriptions of Barnard (1932), Schoonbee (1968) and Demoulin (1970). These species were not found in any stream south of the Mooi River. *Afronurus barnardi* was collected only from the Pot River (site 19), whereas *A. peringueyi* was found only in the Antelope Park Spruit, both in March and December. *Afronurus oliffi* was the most common species, overlapping with *A. peringueyi* at the Antelope Park Spruit and occurring also in the Pot and Mooi rivers. G.F. Edmunds Jr. (University of Utah, personal communication) suggests that *A. oliffi* may not represent true *Afronurus*, but this cannot be properly resolved until the phylogeny of this group can be studied in more detail.

An unknown *Tricorythus* species was collected from several rivers (species 28, Table 1). The nymphs of this species are sexually dimorphic, with the males

having more pronounced eyes and generally smaller bodies than the females. Nymphs from the Pot River (site 19) were successfully reared to confirm this dimorphism, and the imagos clearly represent an undescribed species. The nymphs in the south-flowing rivers are more darkly pigmented, with mature nymphs a little smaller than those in the east-flowing rivers. This may represent a local variation, or another species.

The Caenidae are represented by two genera (*Caenomedea* and *Caenis*), with *Caenomedea* the most abundant. *Caenis* occurs in the north in the Antelope Park Spruit and in the Inxu and Xuka rivers in the south. The species of *Caenomedea* is similar to Demoulin's (1970) *Caenomedea* species "A", which was collected in 1950 from the Orange River on the Lund University Expedition. *Caenomedea* species "B" (Demoulin 1970), collected during the same expedition from the Kraai River near Rhodes, less closely resembles this species. The latter site is near to the rivers studied in this survey, separated only by the Witteberge, part of the lower edge of the Drakensberg escarpment and hence forming a tributary of the Orange River system. *Caenomedea* species have only been named from Central Africa. A. Provonsha (Purdue University, personal communication) maintains that the genus *Caenomedea* s.l. is polyphyletic, but for the present these specimens fall into the genus as it is known.

By far the greatest number of species belonged to the Baetidae (26 species in eight genera) with 11 of these, provisionally placed as *Afroptilum* spp. and *Baetis* spp., being unrecognized species. The most widespread species, common to almost every site, was *Baetis harrisoni*, known to be a eurythermal, silt-tolerant species (Harrison 1965b). Others, such as *Acanthiops* sp., *Centroptiloides bifasciata* and *Demoulinia* sp. were seldom collected.

Three species of *Acentrella* were collected. *Acentrella capensis* was collected from only one site (a small tributary of one of the south-flowing rivers) and was clearly identifiable. However, the two other species, tentatively identified as *A. natalensis* and *A. monticola* do not completely fit Crass's (1947) descriptions of these species. Most of the male nymphs collected have *A. natalensis* type markings while the female nymphs have *A. monticola* markings. However, labial palp details and hindwing presence or absence do not correlate with Crass's observations, and a few individuals of each sex had intermediate features. It is unclear at present whether two distinct species are represented here, or whether they are male and female forms of one species. This will have to be confirmed by rearing of mature nymphs and by comparison with the type material.

Conclusions

The diverse Ephemeroptera fauna seen in this area includes fauna of both Afrotropical and South Temperate Gondwanian origins. The genus *Adenophlebia*

has been recognized as having evolved from original Gondwanian stock after the separation of Africa from the rest of Gondwanaland between the mid-Jurassic and mid-Cretaceous (Tsui and Peters 1975). *Castanophlebia* is probably of an older line, apparently having affinities with the New Zealand genus *Deleatidium* Eaton (Barnard 1932). Other cold stenothermal Gondwanian species may include *Acentrella* spp. and *Pseudocloeon* spp. (Harrison 1965a). The bulk of the fauna, however, is probably Afrotropical in origin. Widespread species such as *Baetis harrisoni*, *Afroptilum sudafricanum*, *Euthraulus* spp. and *Afronurus peringueyi* are recorded throughout Africa from the Cape to Ethiopia (Harrison and Hynes 1988) and fall into this category. Unlike the cold-adapted Gondwanian species, species such as these are not confined to cooler mountain refugia. Many of the more eurythermal species are likely to be Afrotropical in origin, spreading down through Africa as the climate warmed after the landmass separated from Gondwanaland.

This study has provided an insight into the Ephemeroptera of the north east Cape. Most of the sites have been collected only once, so seasonal trends cannot be seen and some species may not have been represented at the time of collection. Recent progress in ephemeropteran systematics in Southern Africa (McCafferty and de Moor this volume), may result in changes in the generic placements of some of these mayflies. Analysis of light trap material collected will doubtless add to the number of species recorded. Further collecting in this area is envisaged, concentrating on rearing mature nymphs through to the adult stage, the use of emergence traps and light trapping.

Addendum

The baetid identified as *Acanthiops* sp. is in all likelihood a species of *Afroptilum (Afroptiloides)* sensu Gillies (1990). The caenid genus *Caenomedea* is another species of *Caenis*.

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