
35 South African Ephemeroptera: Problems and priorities

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A project was initiated in 1990 on the faunistics and systematics of southern African Ephemeroptera. Revisions are necessary in Baetidae and other families. Types of many species are lost, complicating research. Regional emphasis on freshwater resources management requires updated identification guides. Southern Afrotropics data are critical to understanding the historical biogeography of the Southern Hemisphere. Extensive field work in South Africa uncovered new genera, species, undescribed stages and records. A strictly provisional checklist of some 100 species is given, highlighting those requiring immediate restudy. Priorities for each family are outlined. Collaborating world specialists and South African personnel have been enlisted.

Introduction

The first known South African mayfly was described by the German biologist H. Burmeister from the "Cape of Good Hope" in 1839 and called *Oxycypha discolor*, a species of Tricorythidae that has since been found quite commonly throughout the country and which we currently treat as *Tricorythus discolor*. By way of comparison with other developing countries in the same period, the first native species of mayflies from the United States were described in 1823, and from Australia in 1845. However, while numerous additional species were described from the United States in the late nineteenth century, many by American workers, only six other mayfly species from South Africa were discovered in that century. These were relatively large sized and showy species (including an oligoneuriid, three leptophlebiids and a polymitarcyid) taken on the wing by general collectors and eventually ending up in European collections, all to be described by Europeans. Australian mayflies were being discovered in European collections at about the same rate as those from South Africa. This rather lethargic beginning to mayfly work in southern Africa continued well into the next century, with the next ten

species being described between the years 1911 and 1930, mostly by P. Esben-Petersen or J.-A. Lestage.

It was not until 1932 that K.H. Barnard, the first South African ephemeropterist, published the first descriptive monograph dealing with South African mayflies and provided a first comparative look at the local fauna. Barnard (1932) described 23 currently recognized species and proposed the genera *Aprionyx*, *Austrocaenis*, *Austrocloeon*, *Castanophlebia*, *Euthraululus* and *Lithogloea*. He added another four species later (Barnard 1937, 1940). Most of Barnard's species were described from the western Cape, where he spent much of his time hiking in the mountains and collecting stream invertebrates. Unlike many of his contemporaries in other parts of the world, Barnard concentrated heavily on rearing mayflies to gain larva-adult associations. This may have been a result of his being an aquatic zoologist rather than a traditional entomologist of the time; but, in any case, he was one of the first workers to realize the importance of correlating and using both the adult and larval stage in Ephemeroptera systematics.

In the 1930s and 1940s, South African mayflies tended to remain in the hands of South Africans. The second major South African ephemeropterist was R.S. Crass who, in 1947, published two significant taxonomic papers. Crass (1947a, 1947b) described 20 currently recognized species and proposed the genera *Euphlebia*, *Notonurus* and *Oligoneuriopsis*. The Crass species were mainly from Natal and to a lesser extent from the eastern Cape. Crass worked for the Natal Parks Board and, being involved with the sport of angling in Natal trout streams, naturally was interested in the mayflies upon which many of the local fly patterns were based. Like Barnard, he enjoyed field work and did an excellent job of securing larva-adult associations of many of the mayflies species.

In the latter half of this century, South African mayflies continued to be described by two more South Africans and several other workers, including both Europeans and Americans. Many African mayflies were studied by D.E. Kimmins of the British Museum, mainly in the 1950s. Although he described only one species from South Africa *per se*, several of his nominal and unnamed species, especially those described originally from Nyasaland (now Malawi), have either been subsequently found in South Africa or are expected to be. In South Africa, J.D. Agnew described several new species (Agnew 1961a, 1961b, 1962, 1973), and H.J. Schoonbee (1968) undertook the first and, to date, only systematic revision of a primarily southern Afrotropical group of mayflies (i.e., the genus *Afronurus*), although a recent revision of African species previously included in the genus *Centroptilum* by the British worker M. T. Gillies did affect new combinations in a number of South African species (Gillies 1990). The Belgian ephemeropterist G. Demoulin formulated the first catalogue of Afrotropical mayflies (Demoulin 1970) and, in that work, also described five new species from South Africa. His compilation has generally been considered the baseline for continuing descriptive work on

Afrotropical Ephemeroptera. Finally, two species of South African mayflies were described by Americans as by-products of world-level revisionary research on the Ephemerellidae (Allen and Edmunds 1963) and Ephemeridae (McCafferty 1971).

Considerable research on stream ecology in South Africa has been generated over the past several years. Studies have directly or indirectly contributed some valuable data on mayflies, both in terms of general ecology and in terms of ecological and geographic distribution (e.g., Harrison and Elsworth 1958; Harrison and Barnard 1972; King 1981; Palmer et al. 1991). While such studies blossomed, mainly due to their relationship to water quality management in a basically arid country where freshwater is a highly limited resource, systematic research on mayflies, and other aquatic insects for that matter, has not been on a par with them. In fact, not only have we found the relative systematic knowledge of Ephemeroptera in South Africa to be primitive in comparison to Northern Hemisphere regions and the Australian region, but the ecological studies themselves are often limited by a general inability to correlate measured parameters with specifically identifiable populations. This is particularly troublesome since much of the taxonomy that is in use for South African mayflies has been antiquated or suspect with respect to generic concepts and faulty with respect to accounting for intra- and interspecific variability.

Previous South African ephemeropterists were all basically self-taught mayfly taxonomists, their involvement with mayflies having been very limited geographically and more of a sideline or pastime than anything else. On the other hand, taxonomists outside Africa usually worked with very limited series of museum specimens, often without knowledge of either the larval or adult stage, and with little if any biological or ecological data or insight regarding the material.

The Ephemeroptera Project

Our motivation for undertaking a general initiative on the systematics of mayflies stems from the poor systematic status and largely undescribed nature of the southern Africa fauna and the dearth of diagnostic aids presently available to ecologists and environmental managers in the region. Also, from a broader perspective, there is the obvious importance of being able to more thoroughly understand the southern Afrotropical Ephemeroptera with respect to current hypotheses concerning the evolution of world lineages, higher classification and historical biogeography of the Southern Hemisphere. We fortunately were able to secure grant funds, primarily from the South African Foundation for Research Development (also see others in Acknowledgements), to evaluate mayfly systematics in South Africa first hand, prioritize and commence systematic research and disseminate practical information to all interested individuals and institutions.

The project was begun in earnest in September of 1990, when the first author began a three month visitation to the country. During that time, collaboration and training of personnel at the Albany Museum and Rhodes University in Grahamstown took place. Systematic trends and literature were covered but major emphasis was on field sampling techniques and field and laboratory rearing techniques. Some of those individuals have since had success in securing samples from some areas where the first author was unable to collect.

A lecture tour to major universities and clubs in the country was undertaken by the first author, where academic and government personnel and other interested individuals such as fly fishermen were told of the recent advances in Ephemeroptera biology and acquainted with the practical environmental applications of knowing and using the mayfly fauna. The project was encouraged wholeheartedly.

Museums in the country that have acted as repositories of Ephemeroptera specimens were visited or contacted, and the status of collections were evaluated. This led to the unfortunate discovery that numerous, if not the majority of, type specimens of species described from South Africa and deposited there have been inadvertently lost or destroyed. Many of the Barnard types, supposedly at the South African Museum in Cape Town, cannot be located. All of the Crass types had evidently dried up and were destroyed at the Natal Museum in Pietmaritzburg some time ago. In addition, many of the Agnew types (those left at the University of Witwatersrand at Johannesburg and not given to the Transvaal Museum in Pretoria) were unknowingly discarded. This lack of stewardship has resulted in a very serious situation, still being investigated by us; it undoubtedly will make the study of species concepts extremely difficult. It has already affected the study of the Oligoneuriidae by the first author and A.G.B. Thomas of Toulouse, France. The concept of *Oligoneuriopsis* cannot presently be ascertained because the male genitalia have never been completely described and figured (we now know genitalia are critical for comparing *Oligoneuriopsis* with *Oligoneuriella*), and no adult specimens, including the types of the type species, are presently available in any institutional or private collections.

The CSIR laboratory in Pretoria that is primarily responsible for river surveys in the country was visited and several problematic specimens were studied. That laboratory has subsequently provided numerous specimens for study, principally from the Eastern Transvaal. This is an area where many equatorial or semi-tropical genera and species extend southward, and it is thus where most new records have recently been discovered.

A clinic on the identification of freshwater invertebrates was given at the Albany Museum for personnel from throughout South Africa and Namibia that were responsible for sorting stream and river samples. A number of taxonomic specialists participated. The first author was able to offer mayfly identification as a

major section of the clinic, and a preliminary working key to South African genera was formulated. The clinic resulted in several new contacts and sources of specimens, and some cooperative programs have begun between the University of the North in South Africa and Purdue University.

Perhaps most importantly during the visitation, numerous field expeditions were undertaken and considerable collections and rearings made. A total of 64 sites was collected, involving mainly the Mooi and Umgeni River systems of Natal, including many high altitude locations; the Eerste River system in the Jonkershoek Mountains of the western Cape and the small streams draining Table Mountain in the Cape Town area; in the Eastern Transvaal, streams of the high veld, along with several streams such as the Sand, Sabie and Olifants rivers both within and outside Kruger National Park; and the Great Fish River system and many small desert streams in the interior of the eastern Cape and Karoo area. Various park, conservation and academic people facilitated the trips and often participated in sampling (see Acknowledgements). Kruger Park personnel made it possible for us to collect in regions that are generally inaccessible and have never previously been collected for mayflies. All of these collections now reside at Purdue University, and will form much of the basis of future systematic research on South African mayflies. At least some types of all new species will be deposited with the Albany Museum, assuming continued national support for the maintenance of the museum is possible.

There remain critical areas in South Africa that need to be sampled extensively. The mountainous region of the eastern Cape is one such region. The second author and H. Barber of the Albany Museum have recently collected some of this rich area and have discovered new and interesting taxa (see Barber this volume). Other areas of immediate interest include the northern area of the western Cape, where ecologists from the University of Cape Town have been working, and the extreme southern Cape. In addition, unusual but promising habitats for collecting include some of the larger sand-bottomed rivers, such as the Great Fish River in the eastern Cape and the Orange River in the Orange Free State and northern Cape. Already, concentrating on sand substrates in rivers such as the Umgeni, which are often written off as unproductive habitats for benthos, allowed the first author to find some Caenidae and Baetidae that are new or unexpected in the southern part of Africa.

In Table 1 we present a provisional checklist of the South African fauna, including those taxa that have been newly confirmed to occur within the boundaries of the country. The list is merely a starting point and is expected to be heavily revised. We have not made an attempt to give the many literature records of unnamed or unidentifiable species of genera [see some in Demoulin (1970)], but have simply indicated presence of one or more such records by "sp." or "spp." under the genus name in the listing. Any additions are indicated with an asterisk. Some initial nomenclatural changes are included in the Table and mentioned

Table 1. Provisional checklist of South African Ephemeroptera: * indicates a new geographic record for the country; † indicates dubious generic placement; sp. and spp. indicate one or more unidentified species, which may or may not be new.

Suborder Pisciforma

Baetidae

Acanthiops Waltz & McCafferty†*varius* (Crass), 1947, n.comb.*Acentrella* Bengtsson†*capensis* Barnard, 1932†*monticola* Crass, 1947†*natalensis* Crass, 1947*Afrobaetodes* Demoulin, 1970*berneri* Demoulin, 1970*delicatissimus* (Barnard), 1932*Afroptilum* Gillies†*excisum* (Barnard), 1932†*falcatum* (Crass), 1947†*flavum* (Crass), 1947†*industrii* (Crass), 1947†*medium* (Crass), 1947*parvum* (Crass), 1947*sudafricanum* (Lestage), 1924

spp.

Baetis Leach†*bellus* Barnard, 1932†*cataractae* Crass, 1947†*glaucus* Agnew, 1961*harrisoni* Barnard, 1932†*latus* Agnew, 1961†*lawrencei* Crass, 1947†*parvulus* Crass, 1947†*quintus* Agnew, 1961

†spp.

Table 1. (continued)

Centroptiloides Lestage*bifasciata* (Esben-Petersen), 1913**Cloeodes* Traver*izingae* (Crass), 1947, n.comb.†*saxophilus* (Agnew), 1961, n.comb.*Cloeon* Leach*aeneum* Barnard, 1932†*africanum* Esben-Petersen, 1913†*agnewi* Hubbard, 1973[=*C. exiguum* (Crass), 1947]*chaplani* Barnard, 1932†*crassi* Agnew, 1961*elevatum* Agnew, 1961*lacunosum* Barnard, 1932*perkinsi* Barnard, 1932*rhodesiae* Barnard, 1932†*virgiliae* (Barnard), 1932

spp.

Demoulinia Gillies*crassi* (Demoulin), 1970[=*Centroptilum pulchrum* Crass, 1947]

*n. sp.

Dicentropilum Wuillot & Gillies*spinulosum* (Demoulin), 1970*Ophelmatostoma* Waltz & McCafferty*camerunense* (Ulmer), 1920**Potamocloeon* Gillies

*†n. sp.

Pseudocloeon Klapálek†*magae* Barnard, 1932†*vinosum* Barnard, 1932

†spp.

Table 1. (continued)

Pseudopannota Waltz & McCafferty
maculosa (Crass), 1947
 *n. sp.
 *N. Gen. and n. sp.

Oligoneuriidae
Elassoneuria Eaton
trimeniana (McLachlan), 1868
Oligoneuriopsis Crass
 †*elisabethae* Agnew, 1973
 †*jessicae* Agnew, 1973
 †*lawrencei* Crass, 1947

Heptageniidae
Afronurus Lestage
barnardi Schoonbee, 1968
harrisoni Barnard, 1932
oliffi Schoonbee, 1968
peringueyi (Esben-Petersen), 1913
scotti Schoonbee, 1968
ugandanus Kimmins, 1956
 sp.
Componeuriella Ulmer
 †*bequaerti* (Navas), 1930
 †*njalensis* (Kimmins), 1937

Suborder Rectracheata
 Infraorder Lanceolata
 Leptophlebiidae
Adenophlebia Eaton
auriculata (Eaton), 1871
dislocans (Walker), 1860
peringueyella Lestage, 1924
sylvatica Crass, 1947
 spp.

Table 1. (continued)

Adenophlebiodes Ulmer
bicolor (Crass), 1947
masonella Agnew, 1961

Aprionyx Barnard
argus Barnard, 1940
 †*intermedius* Barnard, 1932
natalicus (Lestage), 1924
 †*pellucidulus* (Esben-Petersen), 1920
peterseni (Lestage), 1924
rubicundus Barnard, 1932
tabularis (Eaton), 1884
 †*tricuspidatus* Crass, 1947

Castanophlebia Barnard
albicauda Barnard, 1940
calida Barnard, 1932

Choroerpes Eaton
 †*ndebele* Agnew, 1962
 †*nigrescens* Barnard, 1932

Euthraulius Barnard
elegans Barnard, 1932

Hyalophlebia Demoulin, 1955
 †*patriciae* (Agnew), 1962, n.comb.

Thraulius Eaton
 sp. [as *Masharikella*]

Polymitarcyidae
Afroplocia Lestage
sampsoni (Barnard), 1937

Ephoron Williamson
savignyi (Pictet), 1843

Povilla Navas
adusta Navas, 1911

Table 1. (continued)

Ephemeridae	
<i>Afromera</i> Demoulin	
	<i>natalensis</i> (Barnard), 1932
<i>Eatonica</i> Navas	
	<i>schoutedeni</i> (Navas), 1911
<i>Ephemera</i> Linnaeus	
	<i>mooiana</i> McCafferty, 1971
Suborder Rectracheata	
Infraorder Pannota	
Ephemerellidae	
<i>Ephemerellina</i> Lestage	
	<i>barnardi</i> Lestage, 1924
	<i>brincki</i> Demoulin, 1970
	<i>crassi</i> Allen & Edmunds, 1963
<i>Lestagella</i> Demoulin	
	† <i>penicillata</i> (Barnard), 1940
<i>Lithogloea</i> Barnard	
	<i>harrisoni</i> Barnard, 1932
Tricorythidae	
<i>Diceromyzon</i> Demoulin	
	<i>costale</i> Kimmins, 1957
* <i>Ephemerythus</i> Gillies	
	*sp.
<i>Machadorythus</i> Demoulin	
	<i>palanquim</i> Demoulin, 1959
	*n. sp.
<i>Tricorythus</i> Eaton	
	† <i>discolor</i> (Burmeister), 1839
	† <i>reticulatus</i> Barnard, 1932
	*n. sp.

Table 1. (continued)

Caenidae	
<i>Caenis</i> Stephens	
	<i>basuto</i> Demoulin, 1970
	<i>capensis</i> (Barnard), 1932, n.comb.
	<i>liebenauae</i> Malzacher, 1990
	spp.
	* <i>Clypeocaenis</i> Soldán
	*n. sp.
	*N. Gen. and n. sp.
Prosopistomatidae	
<i>Prosopistoma</i> Latreille	
	<i>crassi</i> Gillies, 1954
	spp.

below. Those many species, which we presently know to have a dubious generic status requiring study and possible revision, are indicated with a cross (there may be others).

The Baetidae will be the most challenging group to research. Generic concepts in the group have undergone considerable change in the recent past (e.g., Gillies 1990; McCafferty and Waltz 1990) and southern African baetids must be brought into line. The collaborator on this phase of research is R.D. Waltz of the Indiana Division of Entomology and Plant Pathology. Preliminary work suggests that there not only are new genera involved, but that some other genera reported from South Africa may not exist as such. Intriguing questions include to what extent true *Baetis* and *Acentrella* are represented and to what genera do "*Pseudocloeon*" spp. belong [see status of *Pseudocloeon* in Waltz and McCafferty (1987)]. Also, are the genera *Centroptilum*, *Procloeon* and *Pseudocentroptiloides* represented in southern Africa? Determining generic status of the Baetidae will resolve the extent to which baetid species have Palearctic, Gondwanian, Oriental or other affinities. Our research will be conducted in cooperation with J.M. Elouard (presently with ORSTOM in Madagascar) and M.T. Gillies, both of whom are describing baetid taxa in other parts of Africa.

The Oligoneuriidae will be researched in collaboration with A.G.B. Thomas, as discussed previously.

In the Heptageniidae, some species of *Afronurus* may prove to be population variants, but series must be examined to determine this. The relationship of *Afronurus* and *Compsoeuriella* is not well understood.

The Leptophlebiidae will be researched in collaboration with W.L. Peters of Florida A & M University. Preliminary work suggests that some new genera will be described for species now in *Aprionyx*, and, as reflected in Table 1, we are recognizing *Hyalophlebia* and *Euthraulius* as genera.

The Ephemerae (and Polymitarciidae) are relatively well understood, but the genus *Afromera* remains poorly known in the larval stage (see McCafferty and Gillies 1979).

There are major questions to be resolved concerning the higher classification of the major lineages of what are now considered Tricorythidae and Ephemerellidae, and the constitution of these families may change radically. This will be resolved only with a thorough cladistic analysis. The Tricorythinae will be researched in collaboration with H. Barber. We have found the differences between *Tricorythus* and *Neurocaenis* to be trivial; we have also found new species in this group.

The Caenidae will be researched in collaboration with A.V. Provonsha of Purdue University. Some new descriptions of South African Caenidae are being published elsewhere and reflect the new taxa indicated in Table 1. We can find no reason to maintain *Austrocaenis* as distinct from *Caenis*. We shall cooperate with V.P. Malzacher of Ludwigsburg, Germany, who has been describing African caenids.

The Prosopistomatidae will be researched in collaboration with H. Barber. We have found what appear to be undescribed species of *Prosopistoma* from the Transvaal. We shall cooperate with W. L. Peters.

In summary, from the preliminary examination of collections and our evaluation of the present state of systematics in southern Africa, it has become obvious that considerable effort will be necessary to meet our project objectives: 1) to accurately describe the fauna, its variability and its ecological and geographic distribution; 2) to bring appropriate systematic expertise to bear on resolving relationships and hence generic placement of species; and 3) to provide fully illustrated regional guides and keys that can be utilized by a broad range of environmental personnel, biologists and naturalists. These will be realized only with the aid of world specialists, trained collaborators within South Africa and the general support of interested agencies, individuals and institutions both within and without South Africa.

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