

MEMOIRS
OF THE
ENTOMOLOGICAL SOCIETY
OF
SOUTHERN AFRICA

Mem. ent. Soc. sth. Afr.



A REVISION OF THE GENUS *AFRONURUS*
LESTAGE (EPHEMEROPTERA:
HEPTAGENIIDAE) IN SOUTH AFRICA

by **H. J. SCHOONBEE**

INSTITUTE FOR ZOOLOGICAL RESEARCH, UNIVERSITY OF POTCHEFSTROOM
FOR C.H.E., POTCHEFSTROOM



PUBLISHED BY THE SOCIETY
P.O. BOX 103, PRETORIA, REPUBLIC OF SOUTH AFRICA

A REVISION OF THE GENUS *AFRONURUS* LESTAGE (EPHEMEROPTERA: HEPTAGENIIDAE) IN SOUTH AFRICA



by

H. J. SCHOONBEE

INSTITUTE FOR ZOOLOGICAL RESEARCH, UNIVERSITY OF POTCHEFSTROOM
FOR C.H.E., POTCHEFSTROOM*



PUBLISHED WITH THE AID OF A GRANT FROM THE SOUTH
AFRICAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

* Present address: Department of Zoology, Rand Afrikaans University,
P.O. Box 524, Johannesburg.

MEMOIR No. 10

CONTENTS

1. Introduction	5
2. Historical Review	6
3. The Type Specimens	8
4. Keys to the Imagines and Subimagines of the South African Species of <i>Afronurus</i> Lestage	12
5. Description of the Species	15
6. The Ratios of the Femur, Tibia, Tarsus and Tarsal Segments, and their value in the demarcation of the Genus <i>Afronurus</i> Lestage	41
7. Acknowledgements	45
8. References	46

1. INTRODUCTION

A major difficulty in the ecological study of the South African freshwater fauna is the identification of the invertebrates encountered. Many species are either new to science or their larvae are unknown. Since the author was engaged in a hydrobiological survey of the Umgeni basin in Natal, it was possible to revise the South African species of the small but nevertheless ecologically important and interesting mayfly genus *Afronurus* Lestage, 1924. This revision is based on material reared from the larval to the adult stage. A knowledge of the ecological distribution of the various species greatly assisted in the separation of those which were found to be morphologically closely related (Schoonbee, 1964).

The type material of *A. peringueyi* and *A. harrisoni* was very kindly made available to the author by Dr. A. W. Crompton, Director of the South African Museum, and Dr. A. J. Hesse, Head of the Department of Entomology of that Museum. In addition, the co-type specimens of *A. harrisoni* were studied in the British Museum (Nat. Hist.), London.

2. HISTORICAL REVIEW

Eaton (1887), in his "Revisional monograph of recent Ephemeroptera or mayflies", was apparently the first person to record the occurrence in Africa of a representative of the genus *Afronurus* Lestage when he mentioned that: "The *Ecdyurus* (sic) type of genera is represented in the Cape Colony. An undescribed ♀ specimen of a species taken by R. Trimmen at Paarl and now in the MacLach. Mus., has a superficial likeness to the species of *Heptagenia*, but differs therefrom in the proportions of its legs" (p. 301). In 1913 this author also placed "three fragmentary flies" from British East Africa, N.E. Rhodesia and N. Nigeria respectively, in the group of *Ecdyurus* but added: "To name such fragments would be foolish and reprehensible" (pp. 277-8).

It was Petersen (1913), however, who furnished the first detailed account of females and males of the genus *Ecdyonurus* from South Africa when he described specimens collected by W. E. Jones (October 1911) at Mfongosi, Zululand. He named this species *peringueyi* and provisionally referred it to the genus *Ecdyonurus*. He stated: "I have placed this species in the genus *Ecdyurus* (sic), although with some hesitation. The highly elongated and narrow forewings, the proportion between the lengths of the tarsi and tibiae and the shape of one of the claws, which is curved and plainly pointed, make in some degree the place of the species difficult to determine. The proportion between the length of the tarsal joints is the same as in the genus *Ecdyurus*; but the pale colour gives the species much likeness to a species of *Heptagenia*" (p. 187).

When Navás (1915) assigned two damaged subimagines, collected by the "Mission Laplae" at Capiri, Katanga, to *E. peringueyi*, a suspicion was created that *Ecdyonurus*, or a closely related genus, had its distribution in equatorial as well as Southern Africa. There still was, however, the general feeling amongst authors such as Lestage, that they were dealing with a genus other than *Ecdyonurus*. In 1918 Lestage strongly expresses his doubts as to whether *E. peringueyi* really was an *Ecdyonurus* and quotes Petersen (1913: 187) in support of his doubts. He further points out that, according to Eaton (1887), the penis lobes in the true *Ecdyonurus* are stout, usually broadly trilateral, expanded outwards at the tips but sometimes obovate. According to Lestage, Eaton's description evidently did not accord with Petersen's drawings of the genitalia of *E. peringueyi*. Lestage further emphasises the fact that in addition to the differences in the structure of the genitalia, the proportions of the tibiae and tarsi indicated that *peringueyi* had been wrongly placed in *Ecdyonurus*. In 1924, Lestage erected the genus *Afronurus* to accommodate the African representatives of the genus *Ecdyonurus*. He distinguished between the genera *Heptagenia*, *Ecdyonurus* and *Afronurus* largely on the basis of the shape of the penis and the proportional lengths of the femora, tibiae and tarsi, stating "... tant chez les *Heptagenia* que chez les *Ecdyonurus*, les longueurs proportionnelles des fémurs, des tarses et des tibias sont conservées, et, à mon avis, il faut en tenir compte, car c'est sur ces points que s'est fait l'évolution des représentants du groupe ecdyonurien" (Lestage, 1924: 350).

The following species of *Afronurus* Lestage, 1924 have thus far been described from the Ethiopian Region:

Afronurus peringueyi (Petersen)

Ecdyurus peringueyi Petersen, 1913, *Ann. S. Afr. Mus.* **10**: 185.

Afronurus peringueyi (Petersen); Lestage, 1924, *Revue zool. afr.* **12**: 349.

Afronurus collarti (Navas)

Adenophlebia collarti Navas, 1930, *Revue Zool. Bot. afr.* **19**: 316.

Afronurus pulcher Ulmer, 1930, *Ann. Mag. nat. Hist.* (10) **6**: 507.

Afronurus collarti (Navas); Demoulin, 1956, *Bull. Anns Soc. r. ent. Belg.* **92**: 49.

Afronurus harrisoni Barnard

Afronurus harrisoni Barnard, 1932, *Trans. R. Soc. S. Afr.* **20**: 257.

Afronurus ugandanus Kimmins

Afronurus ugandanus Kimmins, 1956, *Bull. Br. Mus. nat. Hist. Ent.* **4**: 5.

Afronurus negi Corbet

Afronurus negi Corbet, 1960, *Proc. R. ent. Soc. Lond. (B)* **29**: 68–72.

Afronurus gilliesi Corbet

Afronurus gilliesi Corbet, 1962, *Ann. Mag. nat. Hist.* (13) **4**: 573.

3. THE TYPE SPECIMENS

The type material of *Afronurus peringueyi* includes the following specimens:

One ♂ imago. Left forewing, both forelegs and left cercus lost. Two labels attached read as follows:

a. Mfongosi, Zulu L. W. E. Jones Oct. 1911. (A small printed label.)

b. *Ecdyurus peringueyi* ♂ Esb. Petersen. (This label is handwritten in Indian ink, presumably by Petersen himself.)

One ♀ imago. Apart from the wings which are in a good state of preservation, the specimen is badly damaged. A small printed label attached contains the following particulars: Mfongosi, Zulu L. W. E. Jones.

One ♀ subimago. Wings broken off at tips. Two labels are attached which read:

a. Mfongosi, Zulu L. W. E. Jones (a small printed label).

b. *Ecdyurus peringueyi* ♀ Esben-Petersen. (Handwritten in Indian ink by the same person who wrote one label of the above-mentioned ♂ specimen).

In his descriptions of Ephemeridae from South Africa, which included the account on *peringueyi*, Petersen (1913) mentions that there were three males and three females, all imagines, and one female subimago of *peringueyi* in the collection, "... all collected at Mfongosi, Zululand, October, 1911, by W. E. Jones" (p. 187). Barnard (1932), however, points out that, according to Ulmer (1916), Petersen sent him for comparison "... die Südafrikanischen Typen seiner Sammlung." It is also important to note that in his description of *peringueyi*, Petersen never designated types. Accordingly neither Petersen nor the South African Museum could claim holotypes. From Barnard's redescription of *peringueyi* (Barnard, 1932: 255-7), it does not appear as if any of the original Mfongosi material was in fact retained by the South African Museum, neither is it clear whether Petersen returned any of his specimens. [Barnard's (1932: 256) notes suggest the presence of a "*forma major*" ♀ imago and ♀ subimago in the South African Museum which could represent part of the Mfongosi, October, 1911, material].

The *peringueyi* material from the South African Museum does, however, contain Mfongosi material, with a ♂ imago (see above) bearing the full particulars of the *peringueyi* type material as given by Petersen (1913: 187). If the above-mentioned material forms part of the specimens seen by Petersen and subsequently returned to the South African Museum, then there are still two ♂ and two ♀ imagines from his original collection which cannot be accounted for. Attempts to locate some of the missing Mfongosi specimens through Mr. D. E. Kimmins of the British Museum (Nat. Hist.) proved unsuccessful and, in the revaluation of the type material, use had to be made of the *peringueyi* specimens from the South African Museum only. According to article 73 (c) of the International Code of Zoological Nomenclature (1961), the Mfongosi material, or what is left of it, qualifies as syntypes and will be considered as such in the revaluation of the material (see below).

Barnard (1932), like Petersen, did not designate holotypes. The "type material" of *Afronurus harrisoni* Barnard from the South African Museum, which consists of one ♂ imago specimen only, is provided with a label which reads: Gr. Drakenstein. Bred. fr. nymph 22/3/31. A. C. Harrison (handwritten in Indian ink). Other South African Museum material of *A. harrisoni* includes only three alcohol-preserved specimens bearing a label which reads: *Afronurus harrisoni* Brnrd. F. minor. Drakenstein. The specimens have

lost most of their colour and consist of one ♂ imago of which the last few segments of the abdomen and the genitalia are lost (or have been removed), one ♀ imago, one ♀ subimago and three nymphal pelts. Although the accompanying label bears no date, the discolouration of the specimens indicates that they must be very old. The nymphal skins as well as the wing pattern of the ♀ subimago showed these specimens to belong to the same species as that of the ♂ imago sent to me as the "type specimen" of *harrisoni*.

The South African material of *Afronurus* in the British Museum (Nat. Hist.) consists of three tubes of alcohol-preserved cotype material of *harrisoni* Barnard. The contents of the tubes are as follows:

Tube 1. Two labels are included:

- a. *Afronurus harrisoni* Brnd. Drakenstein (written by Barnard himself).
- b. Brit. Mus. 1932: 108.

This tube contains nymphal specimens of *Afronurus* which belong to *harrisoni* and to another species.

Tube 2. Provided with a cotype label and the information:

- Brit. Mus. 1932: 108. Another label, written by Barnard reads:
Afronurus harrisoni Brnd. f. *major*. Gr. Drakenstein.

Imaginal and subimaginal specimens in this tube belong, with the exception of one specimen, to *harrisoni*. These are:

- a. 1 ♀ subimago (species other than *harrisoni* of which nymphs are present in tube 1).
- b. 1 ♂ imago (*harrisoni*).
- c. 1 ♀ imago (*harrisoni*).
- d. 1 ♀ subimago (*harrisoni*).
- e. 3 nymphal skins.

Tube 3. Provided with "cotype", and "Brit. Mus. 1932: 108" labels. A third label in the handwriting of Barnard reads: *Afronurus harrisoni* Brnd. f. *minor*. Drakenstein. The specimens in this tube belong to the other species referred to above and include:

- a. 1 ♂ subimago.
- b. 2 ♀♀ imagines.
- c. 1 ♀ subimago.
- d. 3 nymphal skins.

A Revaluation of the Type Material of A. peringueyi and A. harrisoni

An examination of the relevant type material from the South African Museum and a comparison of it with cotypes in the British Museum (Nat. Hist.) and with recently reared material available to the author lead to the following conclusions:

The Mfongosi material of *Afronurus peringueyi* at present in the South African Museum, Cape Town, contains two species. This is in fact supported by Petersen's description of *peringueyi* which clearly indicates that he was dealing with the male of one species and the female of another. In his account of the abdomen of the ♀ imago (Petersen, 1913: 187), for instance, he mentions: "1st-6th abdominal segments . . . with black stigmata." Petersen does not mention this feature in his account of the male. Since these "black stigmata" are highly characteristic of two closely related South African species of *Afronurus* described in this paper, being much more pronounced in

males of this particular species of which Petersen described the female, it may be concluded that the Mfongosi material did not include males of the second species. Petersen's drawing (fig. 12, p. 187) of the ♂-genitalia of *peringueyi* is not good and could represent these organs of either of the two species present in the material. In his figure of the ♂-genitalia of *peringueyi*, however, the apical excision at the tip of each penis lobe suggests that the specimen from which he drew the genitalia most probably belonged to the "second species" and not to the one represented by the female imago described by him.

The male *peringueyi* specimen of which Barnard figured the genitalia (p. 256, fig. 46a) belongs to the same species as the male specimen described by Petersen (1913) and of which Petersen probably prepared the genitalia (p. 187, fig. 12).

The nymph assigned to *A. peringueyi* by Barnard (p. 257, fig. 47) belongs to one of the two species confused in the Mfongosi collection, but is not the nymph of the ♂ imago described as *peringueyi* by both Petersen and Barnard.

Both Barnard's and Petersen's drawings of the genitalia of *peringueyi* are misleading, largely perhaps due to the fact that dried material was used in the preparation of drawings.

Barnard also confused at least two species in his description of *harrisoni*. This is attested both by Barnard's own remarks (pp. 257-8) and statements made by Harrison (1950), and confirmed by the *harrisoni* cotype material in the British Museum (Nat. Hist.). In his description of *A. harrisoni*, for instance, Barnard points out that two forms occur, which can be distinguished as *forma major* and *forma minor*. Harrison (1950), after whom this species was named and who participated in the rearing of the specimens, also wrote (p. 20): "When the investigations were commenced, some 20 years ago, it was thought that there might be more than one species of this family in local rivers . . . This was because so many smaller individuals were present in any locality where the fully fed nymphs were nearly ready for the midsummer 'hatch', but Dr. Barnard found only one local species in all the material collected, and showed that the confusion arose from the fact that it includes *major* and *minor* forms." The fact that, with the exception of one female subimago, the *forma major* cotype specimens all belong to the one species and, furthermore, the tube labelled *forma minor* contains specimens of another smaller species only, which breeds from the partridge mottled type of nymph, clearly confirms the author's own conclusions viz. that Barnard mistook the two species as forms of one and the same species. For example, describing the nymphs, both Barnard and Harrison distinguish two types which they designate as "tawny-yellow" and "partridge mottled" respectively, about which Harrison reports as follows (p. 20): "This further complication gave rise to some expectation that we might be harbouring a real 'March Brown' coloured species, as well as something else, but it was not so, and when a large number of subimagos was obtained by 'breeding' from collected nymphs, it was found that 'Tawny Yellow' fitted them all, no matter whether the nymphs from which they emerged had been 'tawny-yellow', 'partridge mottled' or almost 'self-coloured!' In his description of the subimagines Barnard recognizes three different variations of wing colouration (p. 256) which all emerged from either the "partridge mottled" or "tawny-yellow" types of nymphs. Since, in the author's personal experience, the wing patterns of the subimagines are highly diagnostic of the species, the possibility is therefore not excluded that a third species might have been involved in the species confusion. The material in the author's possession, and that in the British Museum (Nat. Hist.) however, suggests the presence of two species only. The second of the two species confused, of which no adult South African Museum material exists, but which is represented in the cotype

material in the British Museum (Nat. Hist.), can be recognized from Barnard's description of the abdomen of *harrisoni*, which has laterally, "... a dark comma-shaped mark on each segment . . ." (p. 257). This is *not* present in either the male or female imagines or the subimagines represented by the male specimen contained in the *harrisoni* material from the South African Museum and which, from the author's own experience, breeds from the "partridge mottled" type of nymph.

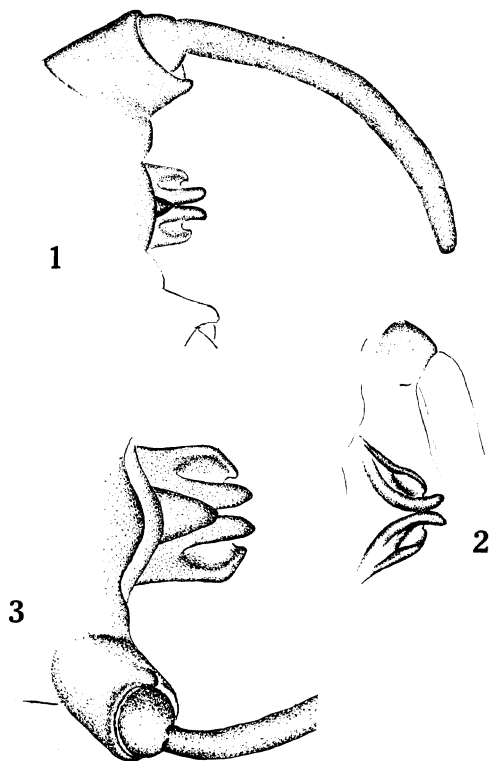
Since the male specimen in the Mfongosi material of *peringueyi* is also the only specimen provided with a label bearing the complete particulars of the Mfongosi collection, as mentioned by Petersen (1913: 187), namely, "Mfongosi Zulu L. W. E. Jones Oct. 1911", I designate this specimen as the lectotype of *Afronurus peringueyi* Petersen. My descriptions of the nymphal, subimaginal and imaginal developmental stages of this species are, however, based upon freshly reared and correlated material.

In the case of Barnard's material of *A. harrisoni*, the "*forma major*" species, of which cotype material exists in the British Museum (Nat. Hist.), from Barnard's own description and drawings, clearly enjoys priority. In this case a lectotype must be selected from the cotype material. I designate the ♂ imago from the above-mentioned cotype specimens in the British Museum (Nat. Hist.) as the lectotype of *A. harrisoni*. A detailed description of *harrisoni*, based on freshly reared material collected in the vicinity of the original type locality, which supplements Barnard's own description of this particular species, is given elsewhere in this paper.

4. KEYS TO THE IMAGINES AND SUBIMAGINES OF THE SOUTH AFRICAN SPECIES OF *AFRONURUS*

The subimago and imago of every species studied closely agree with each other in respect of their body markings, and the colouration of the head, thorax, legs and abdomen. The only differences are to be found in the intensity of the colouration, which is more dull in the subimago. This difference, however, only holds for live or unpreserved material because the brighter underlying colour of the imago immediately shows up clearly once the subimago is transferred to water or preservatives. Unfortunately, the colours and markings of the subimago do not last in preservatives as long as those of the imagines, and, even in the latter, much of the colour is lost within the first year.

The major permanent difference between the subimago and imago lies in the wing pattern. In contrast to the imagines where the wings are of secondary importance in the identification of the species, those of the subimaginal specimens, with their attractive and contrasting colouration, are highly diagnostic. The male genitalia and



Figs. 1–3. *Afronurus* species, male genitalia. 1. *peringueyi*. 2. *peringueyi* (lectotype). 3. *barnardi*.

female ventral plates are, however, already recognizable in the subimagines and the key to the imagines, which is largely based on the structure of the genitalia, can therefore also be employed in the identification of the subimagines.

The male imagines

1. Penis bilobed; each lobe distinctly excised apically to form a narrow digitiform inner lobe and a shorter but wider outer lobe 2
- Penis bilobed, even if only at tip; lobes not as above 3
2. Inner digitiform lobe of each penis lobe distinctly longer than outer lobe (fig. 1); wing membrane hyaline with costal strip pale yellow before bulla and milky towards wing tip; abdominal tergites reddish-brown dorsally **peringueyi**
- Inner digitiform lobe only slightly longer than outer lobe (fig. 3); wing membrane pale yellowish with costal strip darker yellow; abdominal tergites dark brown or purplish-brown dorsally in first 6–8 segments **barnardi**
3. Penis only superficially cleft ventrally; each lobe with an inner thickened ridge curving outwards; ventral surface of each lobe with a wide shallow concavity (fig. 6); wing membrane hyaline; costal strip bright yellow, slightly milky towards wing tip; cross veins milky; abdominal tergites with roughly triangular purplish-brown markings along ventrolateral surfaces (plate 1) 4
- Penis almost square, roughly truncate posteriorly with parallel sides; very shallowly excised apically and grooved along the mid-ventral line; each penis lobe weakly excised, its slightly longer inner lobe being formed by a thickening of the inner margin of the penis lobe; two lobes of each penis lobe separated from each other ventrally by a longitudinal running concavity (fig. 5); longitudinal veins of forewing brownish; cross veins dark brown; wing membrane in the costal strip yellowish-brown **oliffi**
4. Inner thickened ridge of each penis lobe tapering towards its apex (fig. 7) **scotti**
- Inner thickened ridge of each penis lobe not distinctly tapering towards apex of penis lobe (fig. 8) **harrisoni**

The female imagines

1. Abdominal terga with purplish-brown markings along their ventrolateral margins 2
- Abdominal terga without such markings 3
2. Ventral plate tapering towards apex with almost straight lateral edges; apical excision almost V-shaped (fig. 9) **scotti**
- Ventral plate curving inwards towards apex in its posterior $\frac{1}{3}$; apical excision shallowly concave (fig. 10) **harrisoni**
3. Wing membrane yellowish-brown in costal strip; cross veins dark brown (plate 2); ventral plate with evenly rounded lateral sides; apical excision V-shaped (fig. 11) **oliffi**
- Wing membrane pale yellowish or milky in costal strip; cross veins milky; ventral plate with almost straight lateral sides 4
4. Ventral plate clearly excised apically (fig. 12); abdominal terga reddish or reddish-brown dorsally **peringueyi**
- Ventral plate virtually truncate posteriorly (fig. 13); abdominal terga brownish or purplish-brown dorsally **barnardi***

The subimagines

1. Subimaginal wing membrane yellowish with a brownish tinge, forming characteristic broad dark brown stripes covering cross veins of the enclosed imaginal wings (plate 3) 2
- Subimaginal wing membrane predominantly grey, except in the costal strip which is pale yellow; without dark brown stripes covering cross veins (plates 4–5) 3
2. Longitudinal and cross veins of imaginal wing within subimaginal sheath distinctly dark brown; no dark brown markings along ventrolateral surfaces of abdominal tergites **oliffi**
- Longitudinal and cross veins of wing inside subimaginal sheath pale yellow; roughly triangular dark brown marking along ventrolateral line of each abdominal tergite; genitalia as in figs. 8 and 10 **harrisoni**
- genitalia as in figs. 7 and 9 **scotti**

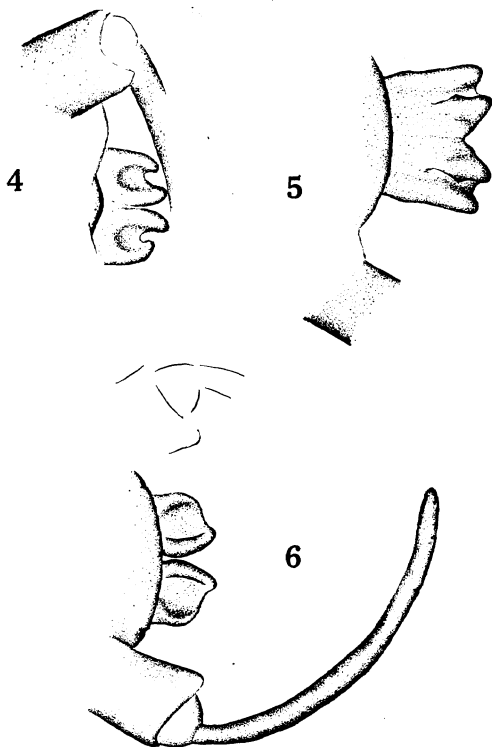
*In *barnardi* specimens from the Cape, the ventral plate is virtually rounded apically.

3. Area of wing immediately below costal strip and along the posterior border, dark grey, enclosing a pale brownish region stretching across the wing from near its tip into the cubito-anal area where this lighter coloured portion is at its widest (plate 5) . . . **barnardi**
- Wing membrane, with the exception of the costal strip, predominantly grey with short lighter coloured streaks between the longitudinal veins (plate 4) **peringueyi**

5. DESCRIPTIONS OF THE SPECIES

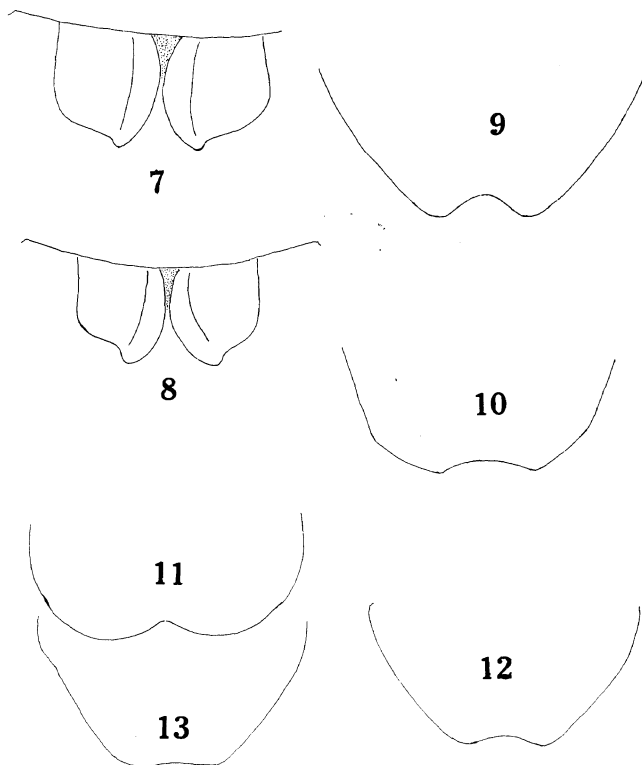
Afronurus scotti spec. nov., figs. 6, 7, 9, 14–26, plates 1, 3

Afronurus peringueyi (Petersen); Barnard, 1932, *Trans. R. Soc. S. Afr.* **20**: 257, fig. 47; Crass, 1947, *Proc. R. ent. Soc. Lond. (B)* **16**: 126; *Ann. Natal Mus.* **11**: 109; Oliff, 1960, *Hydrobiologia* **14**: 312–3, 327.



Figs. 4–6. *Afronurus* species, male genitalia. 4. *barnardi* (specimen from the *harrisoni* “type material”); 5. *oliffi*. 6. *scotti*.

MALE: length 12.0 mm; *forewing*: length 11.0 mm, width 4.0 mm; *hindwing*: length 3.70 mm, width 2.20 mm; *fore leg*: femur 3.10 mm, tibia 3.35 mm, tarsus 3.57 mm, claw 0.25 mm; *middle leg*: femur 3.00 mm, tibia 2.30 mm, tarsus 1.24 mm, claw 0.25 mm; *hind leg*: femur 3.20 mm, tibia 2.45 mm, tarsus 1.09 mm, claw 0.25 mm, Ratio of tarsal segments: *fore leg* $2 > 3 > 4 = 1 > 5$; *middle leg* $5 > 2 > 1 > 3 > 4$; *hind leg* $5 > 1 > 2 > 3 > 4$. Number of cross veins in C, Sc and R_1 : *left forewing* C = 30, Sc = 21, R_1 = 17; *right forewing* C = 30, Sc = 25, R_1 = 19.



Figs. 7-13. Male genitalia and female ventral plates of *Afronurus* species. 7. Line diagram of ♂ genitalia, *scotti*. 8. Line diagram of ♂ genitalia, *harrisoni*. 9. ♀ ventral plate, *scotti*. 10. ♀ ventral plate, *harrisoni*. 11. ♀ ventral plate *oliffi*. 12. ♀ ventral plate, *peringueyi*. 13. ♀ ventral plate, *barnardi*.

Head: Portion of head between compound eyes and ocelli and, also, anterior to the latter, with minute blackish dots and streaks. Compound eyes large, almost contiguous mediodorsally, silvery-grey with two brown bands: Encircling the eye dorsolaterally there is a broad reddish-brown band (plate 1) which gets progressively narrower towards the inner edges of the compound eye, tapering and fading out before the circle is completed, exposing the greyish ground colour at the inner angles of the eyes. Dorsal surface of eye, enclosed by the above-mentioned brown ring, has a distinct reddish-brown tinge, particularly so mid-dorsally. This colouration is however absent in some specimens. A second, much shorter and dark brown band stretches along the antero-ventral edges of each compound eye, tapering and fading out posterolaterally (plate 1). Between these bands the colour of the eyes is predominantly grey, except for a narrow yellow zone immediately dorsally of the ventral band.

Thorax: Pale yellowish-brown. Mesonotum with two pairs of dark brown longitudinal bands, one pair of which stretches across a large portion of the mesonotum. Metanotum without markings. Pleura yellowish-brown with brown markings at base of forewing and near coxae of second and third legs.

Legs: Fore leg yellowish-brown, darker than middle and hind legs which are mainly yellow; femora reddish-brown towards apices with thinly scattered dark brown spots and streaks on anterior surfaces; tarsal segments brownish.

Wings: Forewing hyaline with faint yellowish tinge. Costa, subcosta and radius yellowish-brown and costal strip bright canary yellow; other longitudinal veins predominantly yellow; intercalaries creamy white and, in contrast to the dark brown markings which define the latter on the wing sheaths of the subimagines (plate 3), they are not so readily distinguishable in the imagines. Hindwing canary yellow in costal strip, especially near costal brace.

Abdomen: Yellowish-brown to reddish-brown dorsally with characteristic yellow markings (plate 1). Abdominal tergites 2–5, predominantly brownish dorsally with tergites 6–9 assuming a more reddish-brown colour. Tergite 10 yellowish. Dark purplish-brown markings on the ventrolateral sides of the abdominal terga 1–9 more prominent than in female (plate 1). Sternites of abdomen as in ♂ subimago with a faint reddish medio-ventral stripe.

Genitalia: Styliger plate yellowish-brown, rounded posteriorly. Basal segment of genostyle short, cone-shaped, followed by long cylindrical second segment which in turn tapers into two shorter segments. Third segment slightly longer than fourth. (This description of genostyles also holds for the other species under consideration.)

Penis brown, apically excised. Each lobe is concave ventrally with their inner margins contiguous in the middle, diverging distally and apically (figs. 6–7). These curved inner margins of each penis lobe appear as thickened folds. Dorsally, each lobe is swollen basally, flattened at its tip with the inner edges of each lobe tapering and curving upwards.

Terminal filaments: Reddish-brown near base, turning consecutively brown and yellow towards tips.

FEMALE: length 12.6 mm; *fore leg*: femur 3.20 mm, tibia 2.65 mm, tarsus 1.66 mm, claw 0.22 mm; *middle leg*: femur 3.50 mm, tibia 2.60 mm, tarsus 1.17 mm, claw 0.30 mm; *hind leg*: femur 3.40 mm, tibia 2.62 mm, tarsus 1.12 mm, claw 0.30 mm. Ratio of tarsal segments: *fore leg* $5 > 2 > 1 > 3 > 4$; *middle leg* $5 > 1 > 2 > 3 > 4$; *hind leg* $5 > 1 > 2 > 3 > 4$.

Head: Colouration and markings as in ♂ imago. Ocelli hyaline, with greenish-black bases medially (lateral ocelli) and dorsally (median ocellus). Compound eyes mainly pale yellowish. When viewed from above, a bright reddish-brown band can be observed to stretch along the inner, anterior and anterolateral edge of the compound eye, tapering and fading out laterally, approximately opposite the posterior margin of the vertex. That part of the eye ventral to the above-mentioned reddish-brown band is yellow with a slightly reddish tinge.

Thorax: Predominantly yellowish-brown. Markings and colouration of thoracic segments as in male.

Legs: Fore leg dark brown. Middle and hind legs more yellow. Coxae, as in males, with dark brown edges distally at points of attachment with trochanters. Posterior halves of trochanters generally darker than their anterior surfaces. Markings on femora as in male.

Wings: As in male.

Abdomen: Abdominal terga reddish-brown dorsally and pale yellowish laterally, with a faint narrow yellowish stripe along mid-dorsal line of abdomen. Minute dark spots and stripes resembling those on femora occurring on terga, particularly near posterior margins of segments. Characteristic brown markings along ventrolateral line of each abdominal tergum, as in male, the colour of which increases in intensity towards the seventh segment, fading out in segments eight to ten. Abdominal sternites pale yellow.

Ventral plate: Subgenital plate prominent, strongly curved downwards, slightly rounded at base, tapering gradually towards a distinctly excised, shallow, V-shaped apex (fig. 9).

Terminal filaments: As in male.

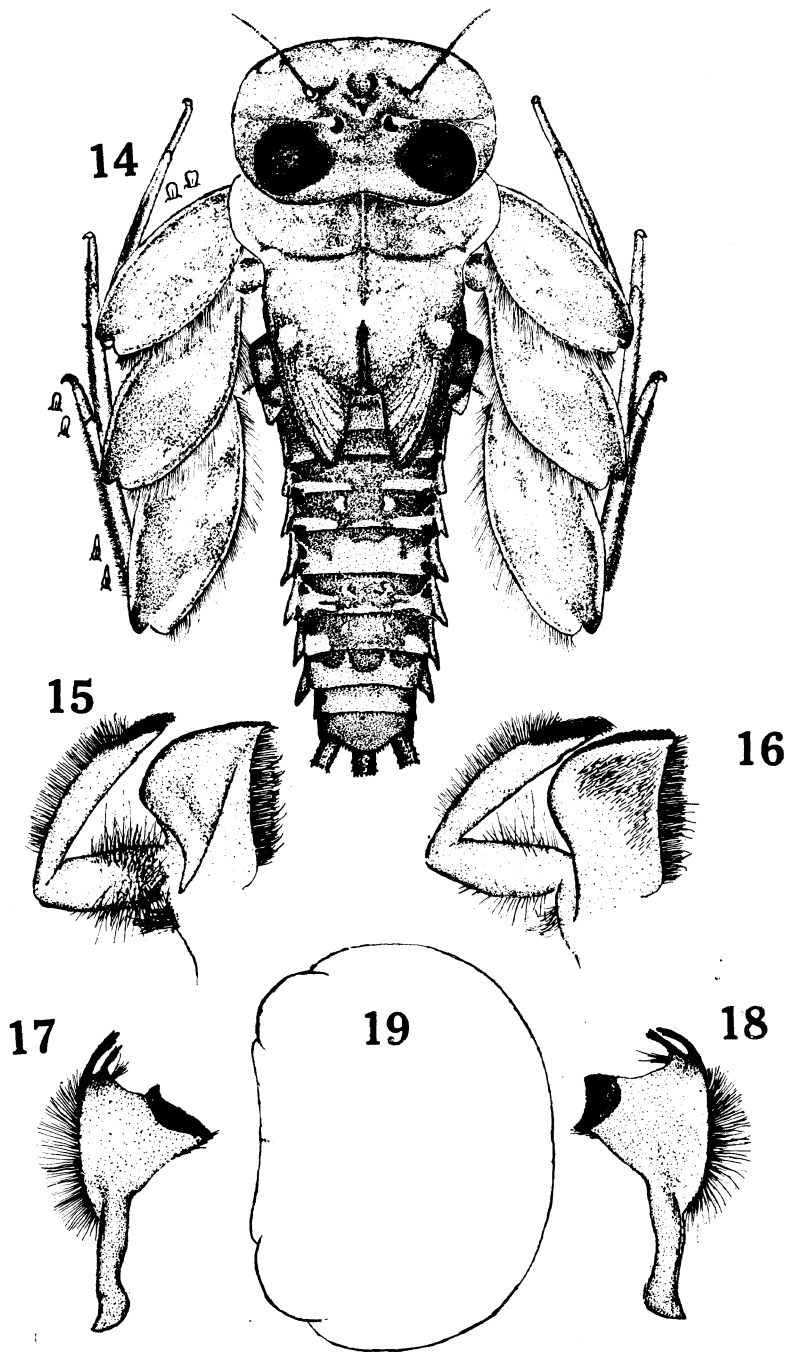
SUBIMAGINES: Colouration and markings of body and legs as in imagines only darker and more dull in intensity. Forewings bright yellow in costal strip as in adults. Rest of wing pale yellowish with a faint tinge of purplish brown. Costa dark brown; subcosta, radius, media, cubital and anal veins pale yellow; cross veins brownish and very distinct largely due to a brownish pigmentation on the subimaginal wing sheath covering and flanking cross veins (plate 3). Hind wings bright yellow near costal brace but pale, yellowish-brown elsewhere. Colour of longitudinal and cross veins as in forewings. Abdominal patterns as in adults, only slightly darker. Terminal filaments reddish-brown at bases becoming progressively browner towards tips. Genitalia as in imagines.

NYMPH: Colour predominantly brownish with characteristic yellow markings on head, thorax, femora and abdomen. Intensity of lighter coloured pattern varies with the different seasons, with marking on thorax, although remaining diagnostic, being more subject to variation during nymphal development than those on abdominal terga.

Head: Usually less than 1.5 times as wide as long, slightly rounded anteriorly, rounded anterolaterally and weakly rounded laterally in younger nymphs (fig. 14) but progressively approaches rectilinearity in the older nymphal stages. Second segment of the maxillary palp strongly setose along proximal two-thirds of its inner, outer and dorsal surfaces (figs. 15–16). These setae are generally much longer than those of the third palpal segment. Outer canine of right mandible provided with three teeth of which central one is stoutest. Prosthema with three thin pointed teeth. Outer canine of the left mandible serrate along inner surface with its prosthema more stout and provided with three teeth similar to those on outer canine of right mandible, but with central tooth here subequal to, but more than half the length of lateral and terminal teeth.

Thorax: Pronotum as wide as, or slightly narrower than head but wider than meso- and metanota, expanded laterally into rounded, flattened lobes. Yellowish pattern on pro- and mesonotum varies during nymphal development, the most common pattern of which is illustrated in fig. 14.

Legs: Stout; femora strongly flattened; tibiae setose with few spines; tarsi sparsely setose with comparatively fewer spines than the tibiae. Spines on first femur mainly obcordate (fig. 14), with those along its ventral margin more lanceolate, more strongly developed and longer than rest of the spines. A row of fine sinuous setae occurs along the anterior ridge of the tibia, together with a few dark brown spines (usually 7–11 in



Figs. 14–19. *Afronurus scotti* spec. nov., nymph. 14. Dorsal view of nymph, gills omitted. 15–16. Dorsal and ventral aspects of right and left maxillae. 17–18. Ventral aspects of right and left maxillae. 19. Outline of head, dorsal view.

number), which are spread over the entire length of the tibia. A second much shorter row of setae occurs along posteroventral edge of tibia, near its point of attachment to the femur. In addition to these, a few scattered setae are found on rest of fore tibia. Anterior rows of setae and spines are continued on tarsus which, likewise, bear a few scattered setae elsewhere. Claw stout and curved, with a row of 5-6 (usually 5) denticles near its tip. The middle leg largely resembles the fore leg with the following differences: Its femur bears two types of spines viz. a few with rounded tips (fig. 14) in small numbers near its point of attachment to the trochanter, and a number of pointed, lanceolate ones elsewhere. Claw with five apical denticles. Spines on the hind leg femur are lanceolate and slightly more stout than those on fore and middle femora (fig. 14). The number and shape of the denticles on the hindleg claw are the same as those of the middle leg.

Abdomen: Abdominal segments gradually tapering towards tenth (fig. 14). Tergites spinulose along posterior margins. Very characteristic of this species are the pointed, posterior ventrolateral edges of tergites 3-8, which become progressively longer towards segment eight. As in the case of the abdominal pattern of the nymphs of all the other species, the pattern shows the least variation, and constitutes one of the most reliable and distinctive features of this species.

From a detailed study of the variations of the abdominal pattern an "average" pattern was compiled (fig. 14) from which it should be possible to recognize this species from any of the nymphal stages, excluding perhaps the very first few nymphal instars.

Gills: All gills bearing branchial filaments on their inner edges, with filaments of seventh gill being minute. With the exception of the first gill lamella, which is banana-shaped, and the last which is approximately pear-shaped, the 2nd-6th gills are subtriangular (figs. 20-26). The fifth and sixth gills, however, differ slightly from the 2nd-4th in the possession of a small terminal lobe.

Terminal filaments: Segments of cerci and paracercus spinulose around posterior margins; paracercus thinner, usually lighter in colour than the two cerci; all segments of terminal filaments short and thick near abdomen, becoming gradually longer and thinner towards tips of filaments.

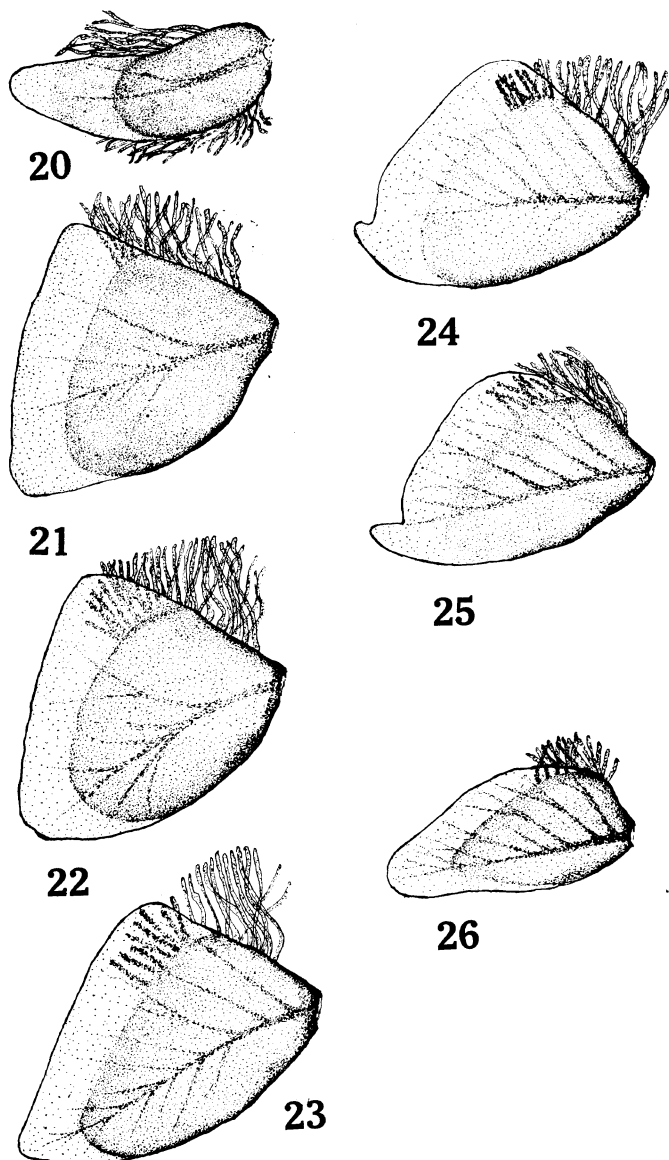
TYPE LOCALITY: Umgeni River below Albert Falls, Natal.

TYPE MATERIAL. ♀-*Holotype*: Bred from nymph 12/IV/1962; coll. H. J. Schoonbee Albert Falls, Natal. *Paratypes*: All bred from nymphs. Albert Falls, Natal, coll. H. J. Schoonbee, 2 ♂♂ 11/IV/1962, 2 ♂♂ 14/IV/1962, 1 ♂ subimago 13/IV/1962, 1 ♀ subimago 11/III/1962; Crocodile river system at Rietvlei, C.S.I.R. Cat. No. Rietvlei 27, 1 ♀ bred from nymph 30/XI/1960, coll. J. D. Agnew. Paratypes from the Esben Petersen material included: 1 ♀, dried and pinned specimen, printed label attached reads "M. Fongosi Zulu L. W. E. Jones", date probably October, 1911; 1 ♀ subimago, dried and pinned specimen, two labels attached, small printed label reads: "M. Fongosi Zulu L. W. E. Jones"; handwritten label reads: "Ecdyurus Peringueyi ♀. Esben Petersen", date probably October, 1911.

Afronurus harrisoni Barnard, figs. 8, 10

Afronurus harrisoni Barnard, 1932, *Trans. R. Soc. S. Afr.* **20**: 257-8 (= *forma major*), figs. 45c, 46b; Harrison, 1950, *Piscator* **13**: 19-26 (= *forma major*, "tawny yellow").

In contrast to the subimaginal and imaginal stages of the species *harrisoni* Barnard and *scotti* spec. nov. which clearly resemble each other in body markings and the colouration of their wings, the various development stages of the nymphs of the former show marked differences from those of the latter. Some of the most striking features of *harrisoni*



Figs. 20-26. *Afronurus scotti* spec. nov., tracheal gills of nymph. 25-31. Gills 1-7 respectively.

are their "tawny-yellow" colouration (Barnard, 1932; Harrison, 1950), and the possession of a comparatively wide frontoclypeus which gives the head a triangular appearance. Barnard (1932: 258) describes the nymphs of *harrisoni* as tawny-yellow, "with predominating yellowish ground colour and broad reddish-brown markings on head, thorax, abdomen, and legs . . ." Apart from the presence of clear-cut morphological discrepancies, the above-mentioned two species also differ with regard to their respective ecological distributions in South African rivers. The description of the imaginal stages, which supplements Barnard's (1932) own description of this species is based on laboratory reared material received from Dr. K. M. F. Scott.

MALE: length 9.1 mm; *forewing* length 10.5 mm. Ratio of tarsal segments: *fore leg* $2 > 3 > 1 = 4 > 5$; *middle leg* $5 > 1 > 2 > 3 > 4$; *hind leg* $5 > 1 > 2 > 3 > 4$.

Head: Pale yellowish-brown with dark brown mottles on clypeal portion of head as in *scotti*. Ocelli hyaline. Compound eyes silvery grey, somewhat faded, to appear slightly milky. Characteristic bands encircling compound eye just visible.

Thorax: Prothorax yellow with purplish pigmentation flanking middorsal line of pronotum. Meso- and metanota yellowish brown. Markings on pleura as in *scotti* (plate 1).

Legs: Fore legs dark brown. Femora of middle and hind legs reddish-brown with their tibiae and tarsi respectively yellow, and yellowish with a dark brown tinge.

Wings: Forewing canary yellow in costal strip with a dark brown marking near subcosta, between costal brace and costal strip. Rest of wing hyaline with a pale yellowish tinge. Longitudinal veins predominantly yellow. Cross veins yellow with faint brownish tinge. Hind wing hyaline, yellowish near costal brace. Longitudinal and cross veins pale yellow.

Abdomen: Yellowish-brown with purplish-brown pigmentation dorsally on terga. Abdominal sterna also tinged purplish-brown, with lighter yellowish markings on each segment, resembling those in specimens of *scotti*. Dark purplish-brown markings along ventrolateral edges of the abdominal terga 1-9 well developed and clearly recognizable with the naked eye as in *scotti* (plate 1).

Genitalia: Although there are only slight differences between the ♂-genitalia of *harrisoni* and *scotti* spec. nov., it is possible to separate the two species on the basis of the penis, once these differences have been recognized. In both species the styliger plate is evenly rounded posteriorly, the penis is apically excised, and, when viewed from below, the two lobes are ostensibly separated over their entire exposed lengths, each forming a thick ridge medially, curving away from the midventral line. Apically these thickened inner sides of the lobes terminate in small protuberances dorsally. Due to a slight thickening of the lateral side of each lobe, they are shallowly concave ventrally. The outlines of the lobes are so depicted in figs. 7 and 8. The major differences in this structure between the two species are as follows: in *scotti* the posterior margin of each lobe slopes more gradually rostrad than in *harrisoni* and the lobes are widest in their posterior halves (fig. 7), whereas their inner thickened edges narrow down distinctly distally. In *harrisoni* the lateral parts of the lobes are almost parallel and their thickened inner edges retain virtually the same width throughout (fig. 8).

Terminal filaments: Yellowish with reddish bands at joints of segments.

FEMALE: Apart from the shape of the ventral plate, this female specimen closely resembles *scotti* in respect of body markings and colouration. Some of the colour has already faded, particularly that of the eyes, so that no proper comparison can be made with *scotti* as far as colouration is concerned. *Body length* 9.8 mm. *Forewing length* 11.3 mm. Ratios of tarsal segments: *fore leg* $5 > 2 > 1 > 3 > 4$; *middle leg* $5 > 1 > 2 > 3 > 4$; *hind leg* $5 > 1 > 2 > 3 > 4$.

Head: Yellowish-brown with markings on head as in ♂ imago. Ocelli hyaline with dark bases. Compound eye pale yellow, almost cream with a brownish band, although considerably faded, still visible along inner, anterior and anterolateral margin.

Thorax: Colouration and markings as in ♂ imago.

Legs: As in ♂ imago.

Wings: As in ♂ imago.

Abdomen: Abdominal segments luteous. Dorsal surfaces of terga pigmented reddish with no discernible pattern. Dark brown markings on ventrolateral aspects of abdominal terga, characteristic of *harrisoni*, clearly visible in segments 1–8, just present in segment 9 and absent in segment 10. Abdominal sterna with some brownish pigmentation but, unlike ♀ subimagines and imagines, without any definite pattern.

Ventral plate: The subgenital plate is distinctly different from that of *scotti*, being angularly rounded with a shallow apical concavity (fig. 10).

Terminal filaments: As in ♂ imago.

SUBIMAGINES: Markings and colouration of body as in the imagines, but more dull than in the latter. Wing membrane, with the exception of a dark brown marking near subcosta between costal strip and costal brace, as in the subimago of *scotti* (plate 3). *Forewing* yellow in costal strip with subimaginal wing sheaths yellowish-brown and tinged purplish. Subimaginal wing sheaths strongly pigmented with brown opposite cross veins as in *scotti*. All longitudinal and cross veins except costa, milky yellow. Hind wing bright yellow near base, otherwise resembling forewing. Some measurements made of a male and female subimago received from Dr. K. M. F. Scott, are as follows: *Male subimago:* *Body length* 9.1 mm. *Forewing length* 10.2 mm. Ratio of tarsal segments: *fore leg* $2 > 3 > 5 > 1 > 4$; *middle leg* $5 > 1 > 2 > 3 > 4$; *hind leg* $5 > 1 > 2 > 3 > 4$. *Female subimago.* Ratio of tarsal segments: *fore leg* $5 > 2 > 3 > 1 > 4$; *middle leg* $5 > 1 = 2 > 3 > 4$; *hind leg* tarsi missing.

NYMPH. Head: Usually more than 1.5 times wider than long; dirty yellow in colour. Some markings on dorsal surface of head brownish, resembling those of *scotti*. Antennae yellowish-brown. Anterior margin of head almost straight, only very weakly rounded. Head widest in frontoclypeal region with its maximum width at the level of, or immediately anterior to, antennal sclerite. Posterolateral parts of head converging sharply towards the dark reddish-brown compound eyes, giving head a triangular appearance. Second segment of maxillary palp lacking setae on dorsal surface in contrast to that of *scotti* (fig. 15) which is profusely setose. The number of chitinized combs borne along the anterior margin of maxilla exceeds 22 (usually 24–26) compared with the 19–22 combs in *scotti*. Structure of mandibles similar to those of *scotti*.

Thorax: The pronotum is narrower than the head and wider than both the meso- and metanota, with the lateral lobes rounded as in *scotti*. Thoracic pattern is indistinct, largely due to the yellow colouration of the body. Consequently, these markings cannot be utilized profitably in further defining this species.

Legs: Predominantly yellow in colour with brown colouration towards the tips of the femora and tarsi. The single row of long stout setae which occur along the dorsal edges of the femora are, like those of *scotti*, setose along their posterior margins.

Fore leg: Trochanter lacks spines on anterior surface. With the exception of a few spines with rounded tips, occurring mediodorsally on the distal half of fore femur, all spines are pointed. Spines along the dorsal edge of femur most strongly developed, especially towards distal half of femur where they are comparatively longer and more erect than in any other part of femur. Setae and spines on fore tibia and tarsus are similar to those of *scotti*, with the claw also bearing five denticles near its tip.

Middle leg: Trochanter bears spines on its anterior surface. Spines on femur similar to those on foreleg of which only a few have rounded tips. Tibia, tarsus and claw resemble those of *scotti*.

Hind leg: Trochanter bears spines on anterior surface. Spines on femur lanceolate. Tibia, tarsus and claw as in *scotti*.

Abdomen: Dirty yellow with little or no indication of abdominal pattern. Segments of abdomen tapering gradually towards the tenth with the terga spinulose along posterior margins. The only clear-cut resemblance between the abdominal segments of *scotti* and *harrisoni*, is the pointed, outwardly directed, posterior ventrolateral edges of tergites 3-8.

Gills: Shapes and sizes of the respective gills as in *scotti* except that the seventh pair of gills are without an inner tuft of branchial filaments.

Terminal filaments: Colour of the cerci and paracercus predominantly yellow. Otherwise, as in *scotti*.

MATERIAL STUDIED: *Lectotype* ♂ imago. Tube specimen preserved in a 2% formaldehyde solution in the British Museum (Nat. Hist.). Cotype specimens, 1 ♀ imago and 1 ♀ subimago also in the British Museum (Nat. Hist.). In addition, bred material collected in the vicinity of the original type locality, which include 1 ♂ imago, 1 ♀ imago and 1 ♀ subimago, is deposited in the Institute for Zoological Research, Dept. of Zoology, University of Potchefstroom for C.H.E., Transvaal. Material collected by Dr. K. M. F. Scott, (C.S.I.R. Cat. No. Misc. 151A, 6/III/1961).

Afronurus oliffi spec. nov., figs. 5, 11, 12, 27-40, plates 2, 6

Afronurus harrisoni Barnard; Crass 1947, *Ann. Natal Mus.* **11**: 43, 47, 109; Oliff, 1960, *Hydrobiologia* **14**: 309, 312, 324, 427.

Although some subimaginal characters resemble those of *harrisoni* and *scotti*, particularly with respect to the pattern and colour of the wing sheaths, there are very distinctive features whereby the imagines and subimagines can be separated from all the other South African species of *Afronurus*. The nymphs are brown with a yellowish ground colour. The intensity of the yellowish pattern of the abdomen and the thorax of these nymphs tends to fade during certain seasons of the year, being at times completely absent in all the different nymphal developmental stages. It is, therefore, not always possible to use these patterns in the identification of the species. One character, not present in any of the other species and which remains recognizable throughout the year in all development stages of the nymphs is the presence of dark brown, almost black,

markings on their abdominal tergites (plate 7). In addition, the spines on the femora are very characteristic of the species.

The nymphs of this species share with *harrisoni* the possession of a very wide frontoclypeus which gives the head a triangular appearance.

MALE: length 11.50 mm; *forewing* length 10.70 mm, width 4.00 mm; *hindwing* length 3.55 mm, width 2.00 mm; *fore leg* femur 2.85, tibia 3.00 mm, tarsus 3.99 mm, claw 0.19 mm; *middle leg* femur 2.73 mm, tibia 2.10 mm, tarsus 1.09 mm, claw 0.17 mm; *hind leg* femur 2.90 mm, tibia 2.10 mm, tarsus 0.97 mm, claw 0.17 mm. Ratio of tarsal segments: *fore leg* $2 > 3 > 1 > 4 > 5$; *middle leg* $5 > 2 > 1 > 3 > 4$; *hind leg* $5 > 1 > 2 > 3 > 4$. Number of cross veins in C, Sc and R_1 : left forewing C = 29, Sc = 22, R_1 = 21; right forewing C = 29–30, Sc = 24, R_1 = 21.

Head: Pale yellowish-brown. Epicranium brownish between compound eyes. Clypeus reddish-brown, devoid of dark brown markings such as those of *harrisoni*. Area of head immediately below median ocellus, pale yellow. Antennal sclerites yellowish-grey; antennal scape and pedicel yellowish-brown, flagellum fuscous. Male specimens of this species differ from all the other species of *Afronurus* described in this paper, in having pale yellow compound eyes (plate 2) in contrast to the silvery coloured eyes of the others. Black tinge of underlying ommatidia, which replaces the yellow colour in preservatives, distinctly visible through yellow surface colour of eye. Stretching from the inner anterior corner of each compound eye there is a short light brown band which fades out along its anterolateral border. This is the only brownish coloured stripe present on the compound eyes of the ♂ specimens of *oliffi* and, in this respect, *oliffi* also differs from all the other South African species. Ocelli hyaline, slightly milky, each with its base successively surrounded by a bright yellow area and a greenish-brown region.

Thorax: Prothorax predominantly yellow, reddish-brown dorsally. Meso- and metanota yellowish-brown with brown markings. Pleura yellowish. Terga yellowish-brown. A purplish-brown streak stretches anteriorly from base of each forewing along the latero-ventral edges of the mesonotum. Purplish-brown streaks also occur on the pleura anterior to the coxae of the mid and hind legs and at the base of the forewing, opposite the subcosta, where there are two purplish-brown markings, the one immediately below the wing being in the form of a stripe whilst the more ventrally situated one is more roundish in shape (plate 2).

Wings: Longitudinal and cross veins of forewing well developed (plates 2, 6) and clearly visible with the naked eye; cross veins dark brown in contrast to the lighter brownish longitudinal veins (plate 2). Wing membrane in costal strip brownish before bulla, yellowish-brown distally; otherwise almost hyaline. Hind wings hyaline, yellowish in costal strip; cross veins dark brown as in forewing.

Legs: Mainly yellowish-brown; femora luteous, brownish towards apices; tibiae yellow, brownish distally; tarsi yellow with a dark brown tinge.

Abdomen: Abdominal segments mainly yellowish; terga reddish-brown dorsally with bright yellow lateral sides; sterna yellowish with markings in the form of shallow indentations, resembling somewhat those of *harrisoni*. Pattern on mediodorsal surfaces of the terga (plate 2) very characteristic of the species.

Genitalia: Styliiger plate and genostyles yellow. Penis yellowish-brown, almost square, bilobed, shallowly excised at its apex, with each penis lobe having a shallow concavity along its ventrolateral side (fig. 5) which gives the penis an almost four lobed appearance when viewed from below.

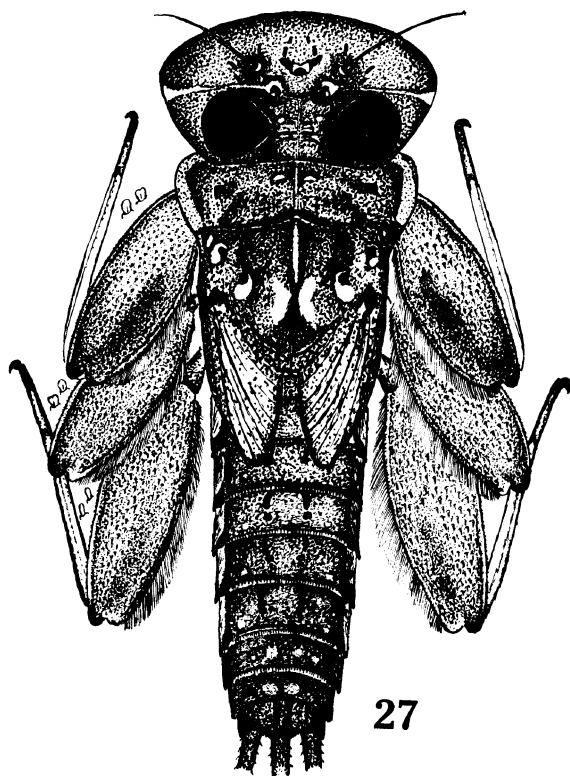


Fig. 27. *Afionurus oliffi* spec. nov., nymph, dorsal view, gills omitted.

Terminal filaments: Cerci yellowish with dark brown bands at the joints of the segments.

FEMALE: Length 11.70 mm; *forewing* length 12.90 mm, width 4.50 mm; *hindwing* length 4.30 mm, width 2.25 mm. Ratio of tarsal segments: *fore leg* $2 > 5 > 3 > 1 > 4$; *middle leg* $5 > 2 > 1 > 3 > 4$; *hind leg* $5 > 1 > 2 > 3 > 4$.

Head: Mainly yellowish-brown; clypeus dark brown, devoid of markings. Antennae brown. Compound eyes pale yellow. Ocelli hyaline with dark greenish-brown bases.

Thorax: As in male imago.

Wings: As in male imago.

Legs: As in male imago.

Abdomen: Sterna yellowish; terga brownish dorsally with their lateral parts clearly divided into brownish dorsal and yellowish-brown ventral portions. Markings on sternal segments resembling those of *harrisoni*. Abdominal pattern along the medio-dorsal line of the abdomen as in the ♂ specimens of *oliffi*, but not so well developed. In segments 9–10 the colour of the abdomen is predominantly yellow with only a very faint tinge of reddish-brown.

Ventral plate: Ventral plate with almost evenly rounded lateral sides, curving gently inwards to form a very shallow excision at the apex (fig. 11).

Terminal filaments: As in ♂ imago; with dark brown rings at the joints of the segments.

SUBIMAGINES: Apart from wing colouration which somewhat resembles those of *harrisoni* and *scotti*, the markings, colouration and body patterns of the imagines and subimagines are similar, being more dull in the latter.

Wings: Wing membranes of subimago predominantly grey brown with a purplish tinge; yellowish-brown in the costal strip. Light brown longitudinal, and darker coloured cross veins clearly visible through the subimaginal wing sheaths which are pigmented brownish opposite both the longitudinal and cross veins. Like *harrisoni* there is a dark purplish-brown spot on the forewing near the subcosta, in the region between the costal brace and costal strip.

Abdomen: Colouration as in imagines, only more dull.

Genitalia: Styliiger plate and male genostyles dark brown. Penis dark brown with its structure as in ♂ imago.

Terminal filaments: Cerci brownish with characteristic dark brown rings at joints.

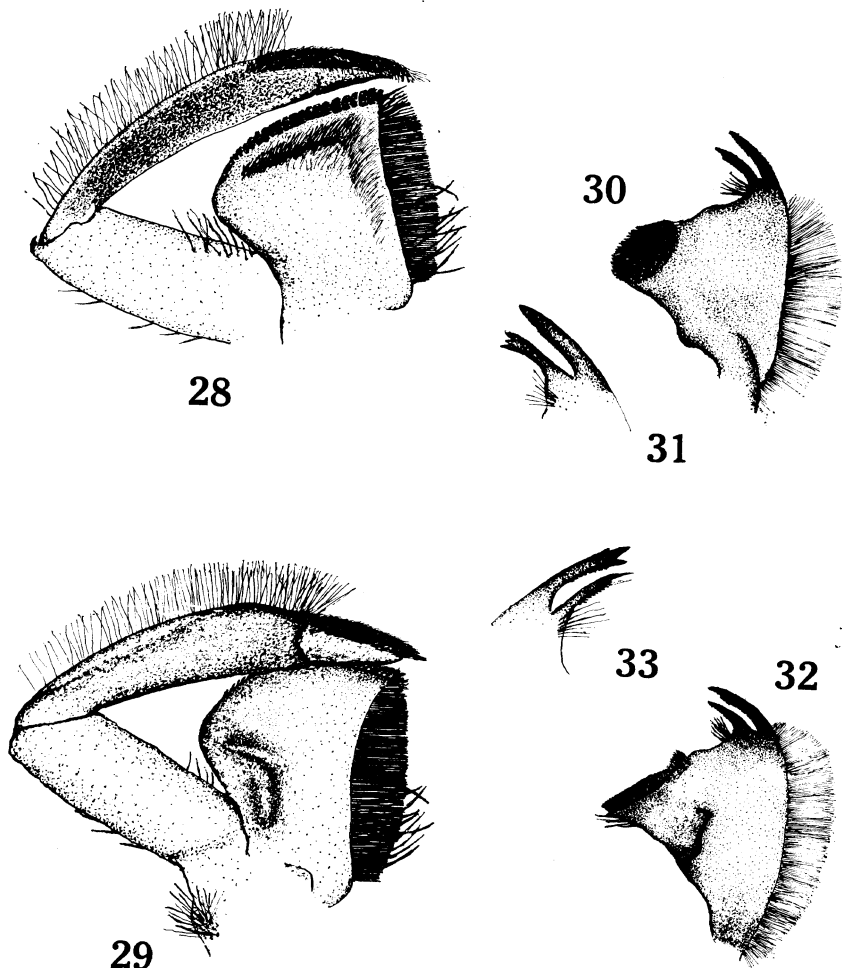
NYMPH: Head brown with markings between antennae and ocelli (fig. 27) well defined; normally more than 1.5 times as wide as long, being widest at the level of or slightly anterior to antennal sclerites. Compound eyes dark brown. A close resemblance exists between the maxillae of *oliffi* and *harrisoni* with respect to the shapes, ratios and sizes of palpal segments, the comparative widths of the galeae and the number of combs of the galea, which, in the case of *oliffi*, also exceeds 22 (there are usually 24–26 combs). The maxilla of *oliffi* can be characterized as follows: posterior (i.e. outer) edge of second segment of maxillary palp sparsely setose, the setae being much shorter than those which occur along outer edge of third palpal segment (figs. 28–29). A small cluster of comparatively longer setae occur proximally on enterodorsal and anterior (i.e. inner) surface of second palpal segment (figs. 28–29). Otherwise, dorsal and ventral surfaces of latter segment devoid of setae; central tooth of prostheca of left mandible minute, being less than half the length of other two terminal teeth (fig. 31), denticles along ventral edge of left prostheca produced into spines. Such spines are completely absent in *scotti*, and are limited to a few along the distal half of this prostheca in *harrisoni*.

Thorax: Pronotum narrower than head, its lateral lobes being less rounded than in the other species (fig. 27). Sides of the lobes weakly curved (almost straight), slightly wider in front, curving strongly inwards anteriorly; Intensity of the markings on thorax are very variable, but when distinguishable they somewhat resemble those of *scotti*. Thoracic markings, typical of *oliffi*, are illustrated in fig. 27.

Legs: Legs brownish with pale yellowish markings, the intensity of which, like those of thorax and abdomen, varying with the seasons. *Fore leg*. Spines on trochanter sparse and mainly pointed. Those on the femur widest terminally and predominantly obcordate along posterior edge and surface (fig. 27). Some spines on anterior half and edge of femur with rounded tips but these are comparatively few in number; tibia pale yellowish-brown with setae and spines similar to those of the other species; both tarsus and claw dark brown, the latter being provided with four well developed denticles near tip.

Middle leg: Spines on trochanter with rounded tips tending to be lanceolate. Most spines on femur obcordate (fig. 27) with those along distal anterior edge successively becoming linear, pointed and lanceolate. In density setae and spines on tibia and tarsus resembling those of the other species; tibia yellowish-brown and tarsus dark brown; claw bears four denticles, the posterior one of which is less strongly developed than other three.

Hind leg: Spines on trochanter lanceolate, whereas those on femur mainly linear and digitate with almost flattened tips (fig. 27). As in the case of the other femora, spines along distal half of anterior edge of third femur deviate most from general shapes of rest



Figs. 28-33. *Afonurus oliffi* spec. nov., mouth parts of nymph. 28-29. Ventral and dorsal aspects of right and left maxillae respectively. 30-31. Left mandible. 32-33. Right mandible.

of spines. They are here developed best and are clearly lanceolate. Tibia yellowish-brown, tarsus dark brown; spines on tibia and tarsus similar to those in the other species; claw bears four denticles which are, however, less prominent than in either fore or middle leg.

Abdomen: Stout, gradually tapering towards tenth segment; brownish with a pale yellow pattern, which, however, may be absent; abdominal tergites spinulose along posterior margins; ventrolateral posterior margins of terga are weakly spinulose but spines do not project away from abdomen as in *harrisoni*; dark brown markings characteristic of *oliffi* occur on either side of the mid-dorsal line of each abdominal tergite (fig. 27).

Gills: Branchial filaments borne on all gills except seventh; tracheation of outer gill lamellae partly obscured by a purplish-brown pigmentation which covers dorsal halves of gills. The shapes of the different gills are given in figs. 34–40.

Terminal filaments: Cerci and paracercus yellowish-brown near bases, with segments becoming dark brown distally; structure of terminal filaments resembling that of other species of *Afronurus*.

TYPE LOCALITY: Yarrow river at Shawswood, Umgeni Basin (Natal).

TYPE MATERIAL: *Holotype*: ♂ imago, Yarrow river at Shawswood, Umgeni river system (Natal), nymph collected 30/IV/1962, bred out 2/V/1962, coll. H. J. Schoonbee.

Paratypes: All bred from nymphs. Yarrow river at Shawswood, Natal, coll. H. J. Schoonbee, 1 ♂ 3/V/1962, 1 ♀ 3/V/1962, both specimens deposited in the British Museum (Nat. Hist.); "Mtebezane," Giants Castle, Natal 2 ♀♀, 1 ♂ 21/XII/1950, coll. R. S. Crass.

Afronurus peringueyi (Petersen), figs. 1, 2, 12, 41–42, plate 4

Ecdyurus peringueyi Petersen, 1913, *Ann. S. Afr. Mus.* **10**: 185–7.

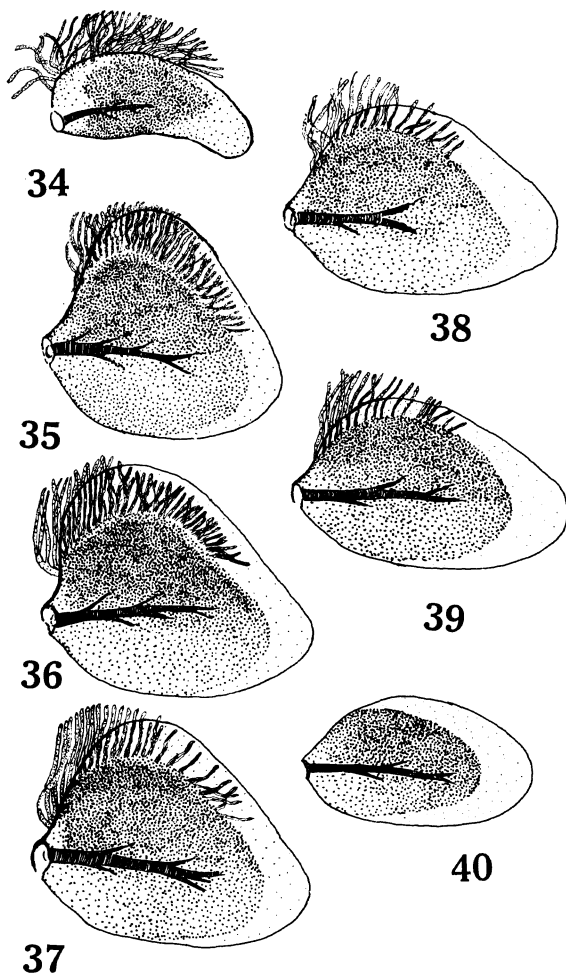
Afronurus peringueyi (Petersen); Lestage, 1924, *Rev. zool. afr.* **12**: 350.

Afronurus sp. 1, Oliff, 1960, *Hydrobiologia* **14**: 313, 324, 326–7.

Although the nymphal, subimaginal and imaginal development stages of the species *peringueyi* and *barnardi* closely resemble each other, their different ecological preferences (Schoonbee, 1964) offered definite evidence that they must be different species rather than varieties of the same species. This is confirmed by some clear cut morphological differences whereby all the development stages could be separated without the risk of confusing one species with the other. The colouration and body pattern once more constitute distinctive features of the nymphs of *peringueyi*. In colour the nymphs resemble those of *barnardi*, except that the grey brown body colouration does not prevail throughout the penultimate and ultimate nymphal stages which progressively attain a more yellowish-brown colour.

MALE: length 8.50 mm; *forewing* length 8.50 mm, width 2.90 mm; *hindwing* length 2.85 mm, width 1.70 mm; *fore leg* femur 2.40 mm, tibia 2.65 mm, tarsus 2.37 mm, claw 0.18 mm; *middle leg* femur 2.50 mm, tibia 1.90 mm, tarsus 0.70 mm, claw 0.16 mm; *hind leg* femur 2.70 mm, tibia 2.00 mm, tarsus 0.68 mm, claw 0.17 mm. Ratio of tarsal segments: *fore leg* $2 > 3 > 1 > 4 > 5$; *middle leg* $5 > 1 > 2 > 3 > 4$; *hind leg* $5 > 1 > 2 > 3 > 4$. Number of cross veins in C, Sc and R_1 : *left forewing* C = 23, Sc = 21, R_1 = 16; *right forewing* C = 22, Sc = 18, R_1 = 15.

Head: Epicranium yellowish-brown; frontoclypeus cream with minute brownish speckles along ventral margin of clypeus. Antennae brownish. Compound eyes predominantly silvery grey with brown bands. Dorsal surface of compound eye silvery grey, tinged luteous, enclosed by an oval shaped light brown band which is almost complete but for a narrow region at the inner edge of the eye where the silvery grey is exposed. The lateral margin of the compound eye below this light brown band consists of a wider grey band and a more ventrally situated horse-shoe shaped dark brown band which encloses the eye ventrolaterally. A second narrower and shorter brownish band occurs along the outer ventral edges of the compound eyes. The ocelli are hyaline with dark greenish bases.



Figs. 34–40. *Afronurus oliffi* spec. nov., gills 1–7 respectively.

Thorax: Prothorax pale yellow. Meso- and metathorax yellowish-brown. Thoracic pleura yellowish with well defined purplish-brown markings behind coxae of first, second and third legs. Mesonotum yellowish-brown with one short and one long brown band on either side of the mid dorsal line, resembling those in *harrisoni*.

Legs: Coxae yellow; femora luteous, darker distally; tibiae yellowish; tarsi yellowish with a dark brown tinge.

Wings: Wing membrane hyaline with a very faint yellow tinge; pale yellow in costal strip before bulla, milky towards tip. Costa yellowish-brown; other longitudinal veins yellowish; cross veins milky.

Abdomen: Abdominal sterna yellowish; lateral sides of terga yellowish-brown, reddish-brown dorsally in segments 1–6, becoming progressively lighter in intensity and more brownish towards segments 7, 8 and 9. Tenth segment predominantly yellow with faint brownish tinge. (In freshly moulted specimens segment 10 is bright yellow). Yellowish pattern, consisting of a pair of curved streaks per segment, clearly visible along mid dorsal line of abdominal terga. This pattern fades out in the 9th and 10th segments where it blends with the yellow colour of the terga. Posterior margins of terga with small brownish speckles.

Genitalia: Styliiger plate and genostyles yellowish-brown. Penis light brown, bilobed, with each lobe cleft at the apex to form two shorter lobes each, the inner one of which is narrow, digitate, curving away from the middle whilst the tip of outer lobe is shorter, wider and more triangular in appearance (fig. 1).

Terminal filaments: Cerci light brown becoming creamy towards tips.

FEMALE: length 9.8 mm; *forewing* length 10.3 mm, width 3.1 mm; *fore leg* femur 2.55 mm, tibia 2.05 mm, tarsus 1.28 mm, claw 0.18 mm; *middle leg* femur 2.70 mm, tibia 2.04 mm, tarsus 0.85 mm, claw 0.90 mm; *hind leg* femur 2.90 mm, tibia 2.00 mm, tarsus 0.82 mm, claw 0.16 mm. Ratio of tarsal segments: *fore leg* $5 > 1 = 2 > 3 > 4$; *middle leg* $5 > 1 > 2 > 3 > 4$; *hind leg* $5 > 1 > 2 > 3 > 4$.

Head: Epicranium brown with purplish tinge; frontoclypeus creamy becoming brownish towards ventral margin of head. Antenna yellowish. Ocelli hyaline with greenish bases and bright yellow border. Ground colours of compound eyes silvery grey with brown bands; inner sides of dorsal surface tinged with yellowish-brown and bordered by a curving brown band which follows lateral contour of eye which, in turn, is followed laterally on the dorsal surface by a clear streak of silvery grey. A narrow silvery grey streak is exposed along the lateral margin of compound eye with a short light brown band situated below the latter along the ventral edge of the anterior margin of the eye.

Thorax: As in male imago.

Legs: As in male imago.

Wings: As in male imago.

Abdomen: Terga brownish becoming yellowish towards tenth segment. Sterna yellowish. In addition to a faint mediodorsal yellowish line there are also a pair of short, yellowish streaks per segment flanking the former. This pattern resembles that of the ♂♂ but they differ in being slightly wider spaced from the mid dorsal line; in segment 2 the yellowish streaks are broader than long, occupying less than half the length of the tergum, becoming slightly longer in the third, and being longer than half the segments in terga 4–9. *Ventral plate*: Rounded at base, tapering towards apex which is almost truncate but still shows a slight excision (fig. 12).

Terminal filaments: Cerci pale yellow, darker distally.

SUBIMAGINES: Markings and colouration of body as in imagines.

Wings: Membrane of forewing predominantly dark grey; costal strip pale yellow, creamy towards tip of wing. Longitudinal veins yellowish-brown, cross veins milky. Wing sheath with broken lighter bands running between the longitudinal veins of the middle field and cubito-anal areas (plate 4). Hind wings dark grey, yellowish near costal brace.

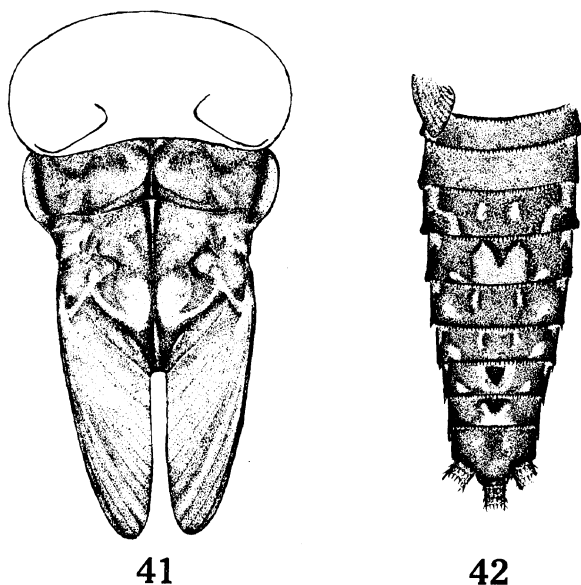
Legs, genitalia and terminal filaments as in imagines, but darker in colour.

NYMPH: Head. The head is greyish-brown with distinct dark brown markings between the antennae and ocelli. Scape and pedicel of antenna brown; flagellum fuscous. Compound eyes black. Head almost square when viewed from above, with its width usually less than 1.5 times that of its length. Sides of head almost straight equatorially with head already attaining its maximum width behind level of antennal sclerites. Maxilla differs from that of *barnardi* in that the number of combs on galea usually are less than 20. Canines and prosthecae of mandibles like those of *barnardi*, with right prostheca ending in two spine-like teeth while left one terminates in three teeth of which central tooth is subequal to dorsal and ventral ones, which are of about the same length.

Thorax: The pattern on the mesothorax retains its diagnostic value in all the nymphal stages (fig. 41). The shape of the pronotum is like that of *barnardi*.

Legs: Fore leg. Trochanter normally lacks spines, but, when present, they are almost setaceous. Spines on femur somewhat resembling those on first femur of Natal specimens of *barnardi*. Along dorsal edge of femur, most spines are digitate with incised tips tending to be obcordate. Those along ventral edge are digitiform proximally, and lanceolate distally. Those in mid dorsal surface of femur are digitate with rounded tips in proximal half, while digitate spines with incised tips and spines which are distinctly obcordate, occur intermingled on distal half. Claw usually bearing six denticles. *Middle leg:* Trochanter bears lanceolate spines. First fourth of anterior surface of femur covered by spines, the shapes of which are somewhat intermediate between digitate and lanceolate. These spines gradually become more pointed and lanceolate in distal half of femur although those along the edges mainly remain lanceolate. Of the six denticles borne on the claw, the sixth (posterior) one usually is poorly developed compared with the other five. *Hind leg:* Spines borne on trochanter are lanceolate. Those of femur are similar, virtually all lanceolate except for a few spines in its proximal fourth where the shape is intermediate between lanceolate and digitate. As in *barnardi*, the tibia also bears several long setaceous spines amongst the rows of setae. The hind claw usually bears six denticles of which the last one is poorly developed.

Abdomen: Like *barnardi*, the abdomen of the nymph is as a rule slender when compared with species such as *harrisoni*. As in all the other species of *Afronurus*, the pattern on the abdomen is less subject to variation, and consequently, of much value in identification. Although the tergites of segments 3–8 are pointed along their posterior ventrolateral edges, the spines are not directed away from the body and can therefore not easily be observed in a dorsal view. The pattern on the fifth tergite (fig. 42) is useful in separating *peringueyi* from *barnardi*. In both species the lighter coloured pattern terminates anteriorly in two “legs”. These “legs” in *peringueyi* are A-shaped, the apices of which are further constricted to end in sharp points. The brown area included between these “legs” is distinctly V-shaped:



Figs. 41–42. *Afronurus peringueyi* (Petersen), thoracic and abdominal patterns of nymphs.

Gills: The gills are like those described for *barnardi* (figs. 51–57). The seventh pair of gills also lacks an inner tuft of branchial filaments.

Terminal filaments: The terminal filaments are yellowish-brown near the abdomen, becoming darker towards their tips.

TYPE LOCALITY. Mfongosi, Zululand.

TYPE MATERIAL. *Lectotype*: ♂ imago, Mfongosi, Zululand, October 1911, coll. W. E. Jones, deposited in the South African Museum, Cape Town.

ADDITIONAL MATERIAL: All bred from nymphs, coll. H. J. Schoonbee, Umgeni river (Natal) at Table Mountain, above Nagle dam, 1 ♂ 18/IV/1962, 1 ♀ 20/IV/1962, 2 ♀♀ 21/4/1962, 1 ♀ subimago 23/4/1962; Vaal river at Skandinawiedrift, border of Transvaal-Orange Free State, 1 ♂, 1 ♂ subimago 1/I/1963, 2 ♀ subimagines 1/I/1963 [specimens deposited in British Museum (Nat. Hist.)]; Umgeni river at Albert Falls 2 ♀♀ 20/IV/1962 [specimens deposited in British Museum (Nat. Hist.)].

Afronurus barnardi spec. nov., figs. 3, 4, 13, 43–59, plate 5

Afronurus harrisoni Barnard, 1932, *Trans. R. Soc. S. Afr.* **20**: 256–8 (= *forma minor*); Harrison, 1950, *Piscator* **13**: 19–20, 22 (= *forma minor*); Allanson, 1960, *Hydrobiologia* **18**: Table 32.

This species is very common in Natal, the Transvaal, and the Eastern and Western Cape Province. The specimens from these regions all display definite regional characters, largely in respect of their body patterns, without, however, affecting the diagnostic value of this feature. Since a proper study of this geographic variation could

be made only with regard to the nymphs, the erection of subspecies on adult colour pattern alone seems to be premature. In respect of the body pattern and the ratio head width/length, the Western Cape specimens appear to have deviated most from the general characters of this species.

The species *barnardi* and *peringueyi* are very closely related, showing an even closer resemblance in the subimaginal and imaginal forms than in their respective nymphs. There are some characteristics, however, whereby these two species can easily be separated. These are the wing patterns of the subimagines, the male genitalia and the female ventral plates of both adult developmental stages, and the respective nymphal abdominal patterns.

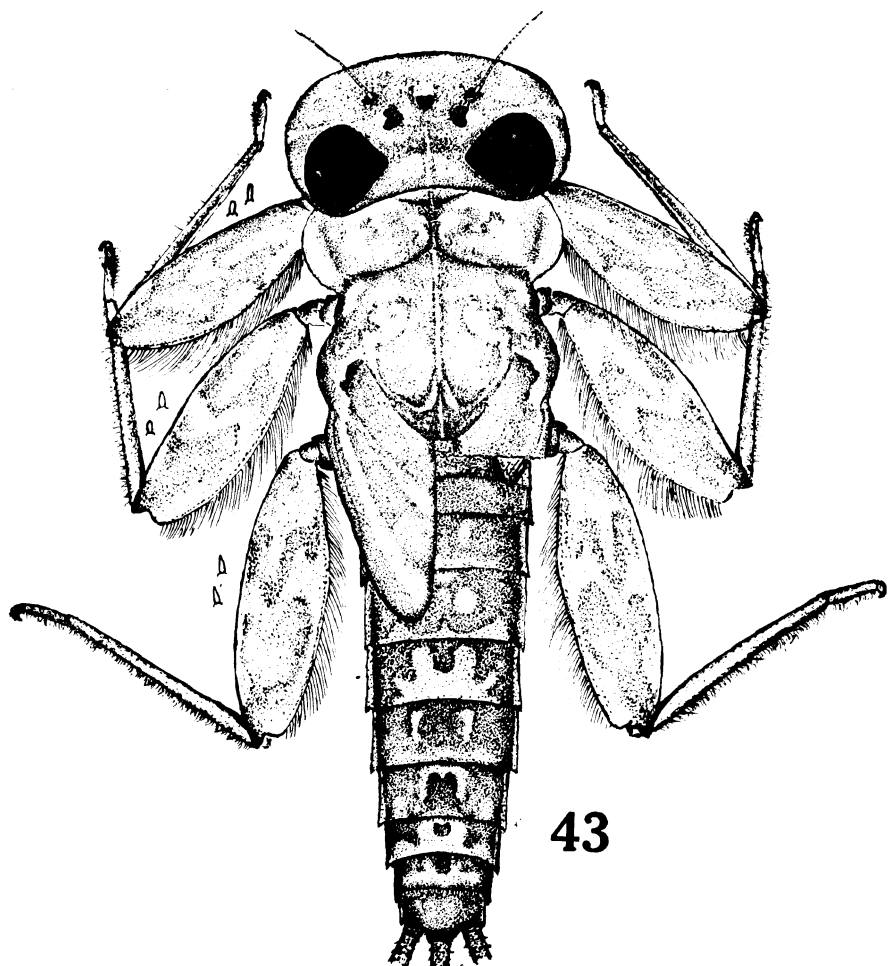


Fig. 43. *Afronurus barnardi* spec. nov., nymph, gills omitted.

MALE: length 8.30 mm; *forewing* length 9.30 mm, width 3.00 mm; *hindwing* length 2.70 mm, width 1.60 mm; *fore leg* femur 2.58 mm, tibia 2.70 mm, tarsus 2.84 mm, claw 0.14 mm; *middle leg* femur 2.48 mm, tibia 1.80 mm, tarsus 0.92, claw 0.16 mm; *hind leg* femur 2.62 mm, tibia 1.85 mm, tarsus 0.83 mm, claw 0.14 mm. Ratio of tarsal segments: *fore leg* $2 > 3 > 1 > 4 > 5$; *middle leg* $5 > 1 > 2 > 3 > 4$; *hind leg* $5 > 1 > 2 > 3 > 4$. Number of cross veins in C, Sc and R_1 : *left forewing* C = 23, Sc = 25, R_1 = 17; *right forewing* C = 26, Sc = 22, R_1 = 19.

Head: Epicranium reddishbrown, bright yellow dorsally in vicinity of frontal sutures; brownish between lateral ocelli, with a yellowish streak immediately below, and encircling each ocellus ventrally. Antennal sclerite creamy; antenna brown. Carina yellow with faint reddish tinge. Clypeus yellowish with dark brown speckles. Ground colour of compound eye greyish, with light reddish-brown band encircling eye dorsally, and dark brown horseshoe-shaped band enclosing eye from the side. Ocelli hyaline with greenish-black bases.

Thorax: Prothorax yellow, tinged purplish with dark purplish-brown circular markings flanking mid-dorsal line of notum. Similar markings occur above the fore coxae. Meso- and metanota yellowish-brown, pleura yellow, tinged faint purplish with markings resembling those in *peringueyi*.

Legs: Coxa yellow; femur luteous; fore femur darker than mid and hind femora; tibia yellowish; tarsus greyish-yellow. All femora with minute dark brown speckles on anterior surfaces.

Wings: With a distinct yellowish tinge; brighter yellow in costal strip. Wing base purplish. Costa, subcosta and radius yellowish-brown, other longitudinal veins yellowish; cross veins milky.

Abdomen: Mainly yellow; purplish-brown dorsally; each segment with two curved yellowish streaks mediodorsally resembling somewhat the abdominal pattern of *peringueyi*; pattern best developed in segments 3-4; yellowish streaks in segments 3-7 longer than half their respective segments but shorter in segments 8-9. Segment 10 yellowish-brown.

Genitalia: Styliiger plate and genostyles yellowish; penis yellowish-brown, bilobed, with each lobe excised at apex, the inner lobes of which are digitate, curving outwards as in *peringueyi*, but differing from the latter in being only slightly longer than its outer; wider and more triangular, lobe (compare figs. 1 and 3).

Terminal filaments: Mainly yellowish-brown.

FEMALE: length 9.80 mm; *forewing* length 11.00 mm, width 3.70 mm; *hindwing* length 3.20 mm; *fore leg* femur 2.60 mm, tibia 2.15 mm, tarsus 1.45 mm, claw 0.18 mm; *middle leg* femur 2.78 mm, tibia 2.10 mm, tarsus 1.00 mm, claw 0.18 mm; *hind leg* femur 2.90 mm, tibia 2.20 mm, tarsus 0.90 mm, claw 0.15 mm. Ratio of tarsal segments: *fore leg* $5 > 2 > 1 > 3 > 4$; *middle leg* $5 > 1 > 2 > 3 > 4$; *hind leg*, $5 > 1 > 2 > 3 > 4$. Number of cross veins in C, Sc and R_1 : *left forewing*: C = 24 Sc = 23, R_1 = 24; *right forewing*: C = 24, Sc = 26, R_1 = 21.

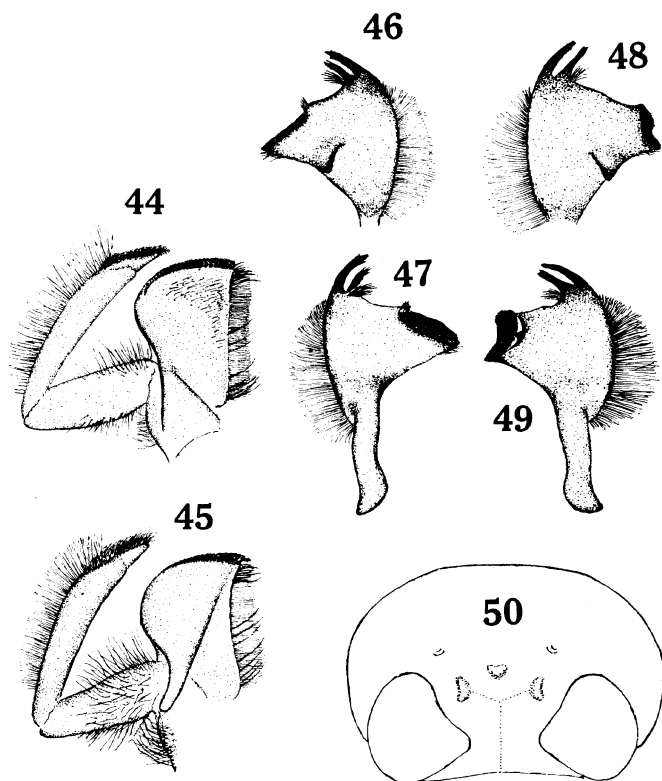
Head: Dark brown in region of fusion with compound eyes, yellowish between ocelli and purplish-brown elsewhere. Antennal scape and pedicel brownish, flagellum fuscous. Inner dorsal edges of compound eye purplish-brown, suffusing with luteous tinge occupying much of the dorsal surface of the eye. Along its laterodorsal and lateral

surface, this luteous colouration is replaced by a silvery grey, bisected by a brownish band which runs from the anterodorsal surface, along its laterodorsal margin, fading out in its posterior inner angle. This brown band has reddish dorsal and ventral edges. Ocelli hyaline, greenish along inner bases.

Legs: Coxae and trochanters of fore, middle and hind femora more yellow; all femora brownish towards apices. Tibia yellow with a brownish tinge. Tarsus fuscous.

Wings: As in male imago.

Abdomen: Dull yellow, brownish dorsally. Brown markings in the form of a mediodorsal longitudinal streak which fades out towards the seventh segment, flanked on each side by a laterodorsal row of brown spots which are almost continuous with the median brown streak in segments 1-3, but becoming progressively smaller towards the seventh segment. Yellowish pattern along mid-dorsal line of abdomen in the form of two curved streaks on each segment, very faint and not always easily recognizable. Posterior margins of terga with minute blackish speckles.



Figs. 44-50. *Afronurus barnardi* spec. nov., outline of head and mouth parts of nymph. 44-45. Ventral and dorsal aspects of right and left maxillae. 46-47. Dorsal and ventral views of right mandible. 48-49. Dorsal and ventral views of left maxilla. 50. Outline of head.

Ventral plate: Subgenital plate luteous with faint reddish tinge; each side curved at the base, tapering towards the apex which is truncate, or, at the most, very poorly excised apically (fig. 13).

Terminal filaments: Mainly yellowish-brown.

SUBIMAGINES: Colouration and markings of body slightly darker in intensity than in imagines. Otherwise the same.

Wings: Wing membrane mainly yellow in costal strip, milky beyond bulla; middle field and cubito-anal region of wing dark grey with a broad creamy strip occupying its central portion, being wider near the cubito-anal region and tapering towards wing tip. Costa yellowish-brown, other longitudinal veins mainly yellow; cross veins milky (plate 5).

Genitalia: As in imagines.

Terminal filaments: Cerci luteous, greyish-white distally.

NYMPH: The nymphs are grey brown with a yellowish ground colour. In live specimens canary yellow markings can be observed on the head, in the vicinity of the ocelli, as well as on the femora of all the legs. These markings soon disappear after death.

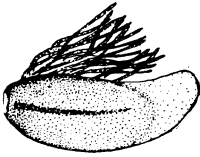
Head: The average head width of specimens from Natal, Transvaal and the Eastern Cape usually is less than 1.5 times that of its length, whilst this ratio for the Western Cape specimens averages more than 1.5. Although the heads may be very slightly wider in front of the antennal sclerites they do not taper sharply towards the eyes in a triangular fashion as they do in *oliffi*, but, instead, curve in gradually (fig. 43). Anterior margin of head weakly curved; setae of proximal half of second palpal segment of maxilla of *barnardi* agrees with that of *scotti* and *peringueyi* in being densely setose on its dorsal, anterior (inner) and posterior (outer) surfaces (figs. 44–45); setae are, like those of *scotti* and *peringueyi*, much longer than those of third palpal segment; number of combs on galea less than 22; prosthema of right mandible terminates in two teeth of which ventral one is best developed; dorsal tooth of right prosthema projects away from its axis, the denticles along ventral edge of latter being spine-like; left prosthema with three teeth. In specimens from Natal and the Eastern and Western Cape Province, the ventral and dorsal teeth of the latter are of approximately equal length. In some nymphs collected from parts of the Transvaal, the ventral tooth is distinctly longer than the other two teeth. In all specimens, however, the central tooth of the left prosthema is the smallest of the three.

Thorax: As previously stated, the thoracic pattern of this species shows regional characteristics which cannot be ascribed entirely to normal intrapopulation variation. The pattern presented in fig. 43 is typical of specimens found in Natal rivers while figs. 58–59 depict patterns typical of specimens from the Transvaal and the Western Cape.

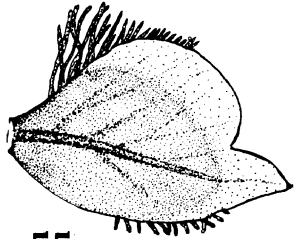
The pronotum is as wide as the head, with rounded lateral lobes which are wider in front. The lateral margins of the pronotum are not evenly rounded but distinctly shouldered anteriorly.

The meso- and metanota are narrower than the pronotum.

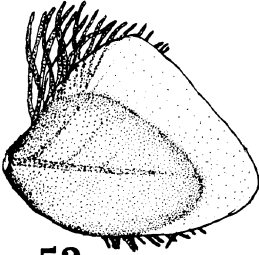
Legs: Fore trochanter only bears a few spines, which are largely digitate with rounded tips. Three types of spines can be distinguished on first femur of the Natal specimens, viz. digitate, lanceolate and obcordate spines. Proximally they are exclusively digitate



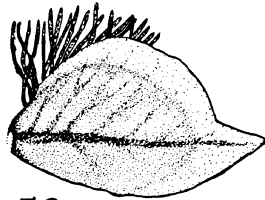
51



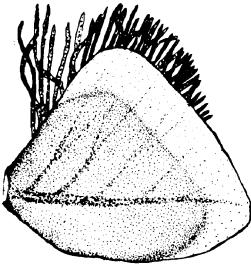
55



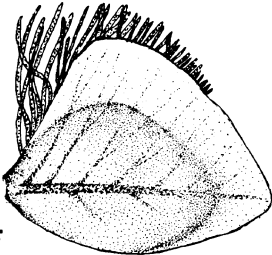
52



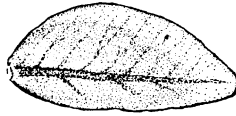
56



53



54



57

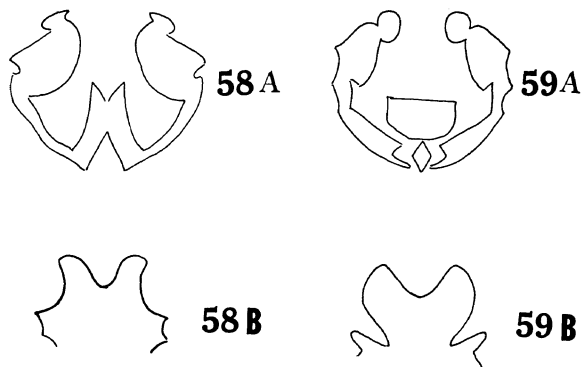
Figs. 51-57. *Afronurus barnardi* spec. nov., gills 1-7 respectively.

with rounded tips (fig. 43). These spines are replaced along the dorsal and ventral surfaces by lanceolate ones which in turn are replaced distally by a few spines which are obcordate in shape. The Transvaal specimens differ from this in having few, if any, obcordate spines, while those occurring on the distal surface of the femur are largely digitate with flattened tips. In specimens from the Western Cape, only the most proximal spines are digitate while the rest are distinctly lanceolate and pointed. The tibia and tarsus are sparsely setose with a few spines. The claw bears three to six denticles.

Middle leg: Spines on the second trochanter are mostly lanceolate. In the Transvaal specimens the spines on the proximal third of the antero-medial surface of the femur are digitate but these are replaced distally by lanceolate spines which also occur along the edges of the femur. In the Cape specimens all the spines of this femur are lanceolate. The Natal specimens agree more with those from the Transvaal in having digitate spines with rounded tips proximally and more or less lanceolate spines elsewhere (fig. 43). They differ from those from the Transvaal and the Western Cape in having a few digitate spines distally, with flattened or incised tips. In all specimens the spines along the dorsal and ventral edges are well developed and, without exception, lanceolate. The claw bears four to six denticles.

Hind leg: Spines on the trochanter are predominantly lanceolate although those of the Cape specimens are almost filiform. In all specimens the spines of this femur are lanceolate (fig. 43). As in the case of the other femora, those spines along the dorsal and ventral edges are the strongest developed and end in sharply pointed tips. The tibia bears two dense rows of setae interspersed with long setaceous spines. In addition to these, short stout lanceolate spines are also borne on the third tibia. There are four to six denticles on the claw.

Abdomen: The abdomen is slender compared with that of *harrisoni*, particularly in the older nymphal stages. The abdominal tergites are spinulose posteriorly and, except in the Western Cape specimens, their posterolateral edges terminate in weakly developed spines. The nymphs from the Western Cape have well developed spines which resemble those of *harrisoni* Barnard. The abdominal pattern, although somewhat variable (fig. 43) is one of the most useful diagnostic features for the species.



Figs. 58–59. *Afronurus barnardi* spec. nov., nymph, variational tendencies in the patterns of the mesothorax (58A, 59A) and abdominal segments 5 (58B, 59B). 58A–58B. Transvaal specimens; 59A–59B. Western Cape specimens.

Gills: The seventh gill lacks an inner tuft of branchial filaments. The respective gills are depicted in figs. 51-57.

Terminal filaments: The cerci and paracercus of the Western Cape specimens are yellowish with distinct brownish rings around their joints in contrast to specimens from Natal and Transvaal which have uniformly coloured, usually brownish, terminal filaments.

TYPE LOCALITY: Emolweni river at Krantzkloof, Umgeni river system, Natal.

TYPE MATERIAL: *Holotype*: ♂ imago, Emolweni river at Krantzkloof, nymph coll. 20/IV/1962, bred out 21/IV/1962, coll. H. J. Schoonbee. *Paratypes*: All bred from nymphs, coll. H. J. Schoonbee, Emolweni at Krantzkloof, Natal, 1 ♂ 22/IV/1962, ♂ subimago 22/IV/1962, 2 ♀♀ 21/IV/1962, 3 ♀♀ 22/IV/1962 [one of the ♀ specimens deposited in the British Museum (Nat. Hist.)], 1 ♀ 25/IV/1962, 1 ♀ subimago 22/IV/1962 [deposited in British Museum (Nat. Hist.)]; Mooi river Transvaal, ♂ 20/XII/1962; Vaal river at Skandinawiëdrift, Transvaal-Orange Free State boarder, 1 ♀ subimago 21/IX/1962.

Paratypes from Barnard's *harrisoni* material: 1 ♂, Label attached reads "Gr. Drakenstein. Bred fr. Nymph 22/3/1931. A. C. Harrison." (This specimen returned to the South African Museum, Cape Town.)

Paratypes from the *harrisoni* cotype material in the British Museum (Nat. Hist.) a tube of alcohol preserved specimens with labels which read "Brit. Mus. 1932: 108", and "*Afronurus harrisoni* Brnrd. f. *minor*. Drakenstein." This particular tube contains 2 ♀, 1 ♂ subimago, 1 ♀ subimago and 3 nymphal skins.

6. THE RATIOS OF THE FEMUR, TIBIA, TARSUS AND TARSAL SEGMENTS, AND THEIR VALUE IN THE DEMARCATION OF THE GENUS *AFRONURUS* LESTAGE.

One of the main criteria employed by Lestage (1924) in the separation of the genera *Ecdyonurus*/*Heptagenia* and *Afronurus*, is the relative length of the femur, tibia and tarsus, and the comparative lengths of the tarsal segments in each leg, which he (Lestage) maintains should be taken into consideration, since these dimensions form the basis on which the ecdyonurid group was established. Although the number of adult male and female specimens in my possession is inadequate for a reliable statistical evaluation of the leg formulae laid down for the genus *Afronurus* by Lestage, the data presented in Tables 1 and 2 appear to justify the following preliminary conclusions:

1. The ratios of the leg segments are subject to greater variation than Lestage must have anticipated;
2. The formulae given by Lestage for the first leg of the *Afronurus* males viz. tarsus < femur < tibia, approximately applies only to *peringueyi* (Table 1). The species *barnardi* (Cape) and *harrisoni* (Cape) also approach this formula but *oliffi*, *barnardi* (Transvaal and Natal) and *scotti* agree better with Lestage's formulae for *Heptagenia*;
3. The ratios of the tarsal segments (Table 2), likewise, are not constant for the genus.

Until such time, therefore, as more material becomes available for statistical treatment, these formulae must be applied with caution.

TABLE 1. Leg formulae of the South African species of *Afronurus*

Species	Sex	Leg	Formula
<i>peringueyi</i>	♂	First	Tarsus < femur ≤ tibia
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
	♀	First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
<i>scotti</i>	♂	First	Femur < tibia < tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
	♀	First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus

Species	Sex	Leg	Formula
<i>barnardi</i> Transvaal and Natal specimens	♂	First	Femur < tibia < tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
	♀	First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
<i>barnardi</i> Western Cape specimens	♂	First	Femur \geq tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
	♀	First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
<i>oliffi</i>	♂	First	Femur < tibia < tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
	♀	First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
<i>harrisoni</i> Western Cape specimens	♂	First	Femur \geq tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus
	♀	First	Femur > tibia > tarsus
		Second	Femur > tibia > tarsus
		Third	Femur > tibia > tarsus

TABLE 2. Tarsal formulae for the South African species of *Afronurus* compared with those of Lestage's

Species	Number of specimens analysed	Formulae of tarsal segments	
		Legs	Formulae
<i>peringueyi</i> (Lestage, 1924)	? ♂ ♂	First	$2 = 3 > 1 > 4 > 5$
		Second	
		Third	$5 > 1 > 2 > 3 > 4$
	? ♀ ♀	First	$5 > 2 > 3 > 1 > 4$
		Second	$5 > 1 = 2 > 3 > 4$
		Third	$5 > 1 > 2 > 3 > 4$
<i>peringueyi</i>	6 ♂ ♂	First	$2 > 3 > 1 > 4 > 5$
		Second	$5 > 1 > 2 > 3 > 4$
		Third	$5 > 1 > 2 > 3 > 4$
	4 ♀ ♀	First	$5 > 1 \leq 2 > 3 > 4$
		Second	$5 > 1 > 2 > 3 > 4$
		Third	$5 > 1 > 2 > 3 > 4$
<i>scotti</i>	8 ♂ ♂	First	$2 > 3 > 4 \leq 1 > 5$
		Second	$5 > 1 \leq 2 > 3 > 4$
		Third	$5 > 1 \leq 2 > 3 > 4$
	9 ♀ ♀	First	$5 > 2 > 1 \leq 3 > 4$
		Second	$5 > 1 > 2 > 3 > 4$
		Third	$5 > 1 > 2 > 3 > 4$
<i>barnardi</i>	10 ♂ ♂	First	$2 \leq 3 > 1 > 4 > 5$
		Second	$5 > 1 > 2 > 3 > 4$
		Third	$5 > 1 > 2 > 3 > 4$
	6 ♀ ♀	First	$5 > 2 > 3 > 1 > 4$
		Second	$5 > 1 > 2 > 3 > 4$
		Third	$5 > 1 > 2 > 3 > 4$

Species	Number of specimens analysed	Formulae of tarsal segments	
		Legs	Formulae
<i>oliffi</i>	4 ♂ ♂	First	2 > 3 > 1 > 4 > 5
		Second	5 > 1 ≤ 2 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4
	5 ♀ ♀	First	2 > 5 > 3 > 1 > 4
		Second	5 > 2 ≤ 1 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4
<i>harrisoni</i>	2 ♂ ♂	First	2 > 3 > 4 > 1 ≤ 5
		Second	5 > 1 > 2 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4
	2 ♀ ♀	First	5 > 2 > 1 > 3 > 4
		Second	5 > 1 > 2 > 3 > 4
		Third	5 > 1 > 2 > 3 > 4

7. ACKNOWLEDGEMENTS

The author wishes to record his appreciation to the following people: Mr D. E. Kimmins of the British Museum (Nat. Hist.) for his much appreciated help; Professors J. A. van Eeden, P. A. J. Ryke and Dr K. M. F. Scott for their criticism; Dr A. J. Hesse, Head of the Department of Entomology and Dr A. W. Crompton, Director of the South African Museum for the type material of *A. peringueyi* and *A. harrisoni*; Dr K. M. F. Scott, for laboratory reared material of *A. harrisoni*; Messrs F. M. Chutter and J. D. Agnew for *Afronurus* material from localities in the Transvaal. Also, the author is very much indebted to the Council for Scientific and Industrial Research whose financial assistance made possible the publication of this paper.

8. REFERENCES

- ALLANSON, B. R. 1961. Investigations into the Ecology of Polluted Inland Waters in the Transvaal. *Hydrobiologia* **18**: 2-76.
- BARNARD, K. H. 1932. South African Mayflies (Ephemeroptera) *Trans. R. Soc. S. Afr.* **20**: 201-59.
- CORBET, P. S. 1960a. Larvae of certain East African Ephemeroptera. *Revue Zool. Bot. afr.* **61**: 119-20.
- 1960b. A new species of *Afronurus* (Ephemeroptera) and its association with *Simulium* in Uganda. *Proc. R. ent. Soc. Lond. (B)* **29**: 68-72.
- 1962. *Afronurus gilliesi* Corbet. *Ann. Mag. nat. Hist. (13)* **4**: 573.
- CRASS, R. S. 1947. The May-Flies (Ephemeroptera) of Natal and the Eastern Cape. *Ann. Natal Mus.* **11**: 37-110.
- DE MOULIN, G. 1956. Révision de quelques Ephéméroptères décrits du Congo belge par L. Navas II. *Bull. Annl. Soc. r. ent. Belg.* **92**: 44-52.
- HARRISON, A. C. 1950. Cape Mayflies. *Piscator* **13**: 19-23.
- LESTAGE, J. A. 1918. Les Ephémères d'Afrique. (Notes critiques sur les espèces connues). *Revue zool. afr.* **6**: 65-114.
- 1924. Les Ephémères de l'Afrique du Sud. Catalogue critique & systématique des espèces connues et description de trois genres nouveaux et de sept espèces nouvelles. *Ibidem* **12**: 316-52.
- NAVAS, L. 1915. Notes sur quelques Neuroptères du Congo Belge. *Revue Zool. Bot. afr.* **4**: 172-3.
- 1930. Insectes du Congo Belge. *Ibidem* **19**: 316.
- 1931. Idem. *Ibidem* **20**: 271.
- 1932. Idem. *Ibidem* **22**: 285.
- OLIFF, W. D. 1960. Hydrobiological studies on the Tugela River System. Part 1. The Main River. *Hydrobiologia* **15**: 281-385.
- SCHOONBEE, H. J. 1964. A hydrobiological investigation of the Umgeni river system, Natal, and its bearing on the ecological interpretation of faunal communities in South Africa (Unpublished thesis, Potchefstroom University for C.H.E.).
- ULMER, G. 1916. Ephemeropteren von Äquatorial-Afrika. *Arch. Naturgesch.* **71**: 1-19.
- 1930. *Ann. Mag. nat. Hist. (10)* **6**: 507.

Manuscript received August 15, 1967

PLATE 1. *Afronurus scotti* spec. nov., ♂ imago, dorsal view (above) to show pattern on abdomen;
lateral view (below) showing markings along lateral margins of abdominal terga.



Plate 1
A. scotti sp. n.

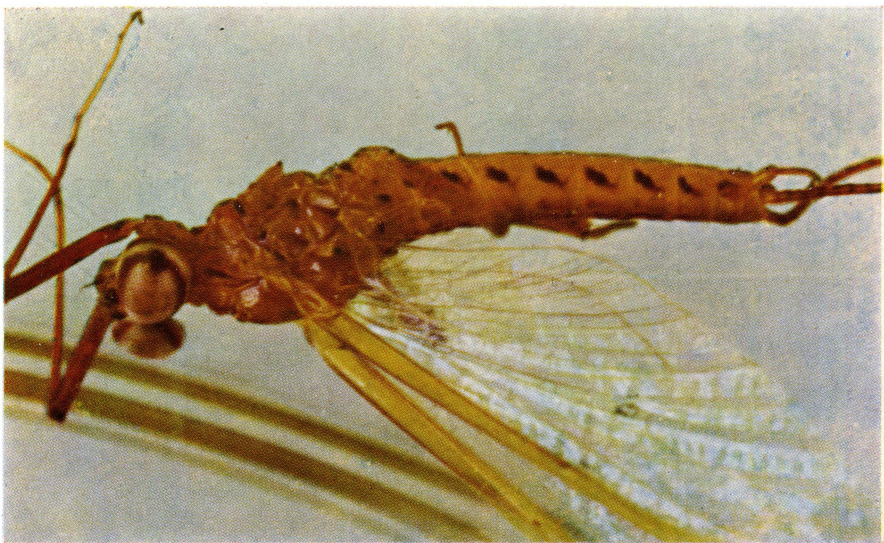


PLATE 2. *Afronurus oliffi* spec. nov., ♂ imago, dorsal view (below) to show pattern on abdomen; lateral view (above) showing absence of bands on eyes and dark brown colouration of cross veins.



Plate 2
A. oliffi sp.n.



PLATE 3. *Afronurus scotti* spec. nov., ♀ subimago, lateral view to show colouration and markings on wing sheaths.



Plate 3.
A. scotti

PLATE 4. *Afronurus peringueyi* (Petersen), ♂ subimago, lateral view to show colouration and pattern on wing sheaths.



Plate 4. *A. peringueyi*

PLATE 5. *Afronurus barnardi* spec. nov., ♂ subimago, lateral view to show colouration and markings on wing sheaths.



Plate 5. *A. barnardi* sp. n.

PLATE 6. *Afronurus oliffi* spec. nov., forewing.

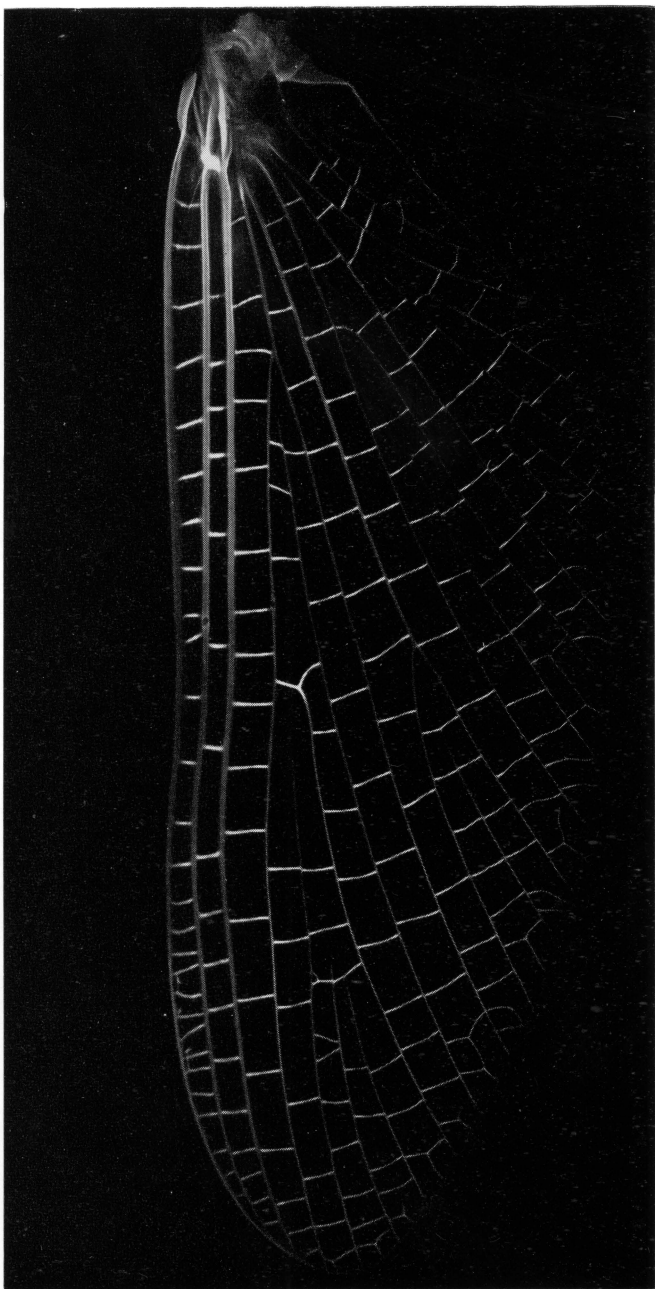


Plate 6. *A. oliffi* Spin.

PLATE 7. *Afronurus oliffi* spec. nov., nymphal skin showing markings on abdomen.

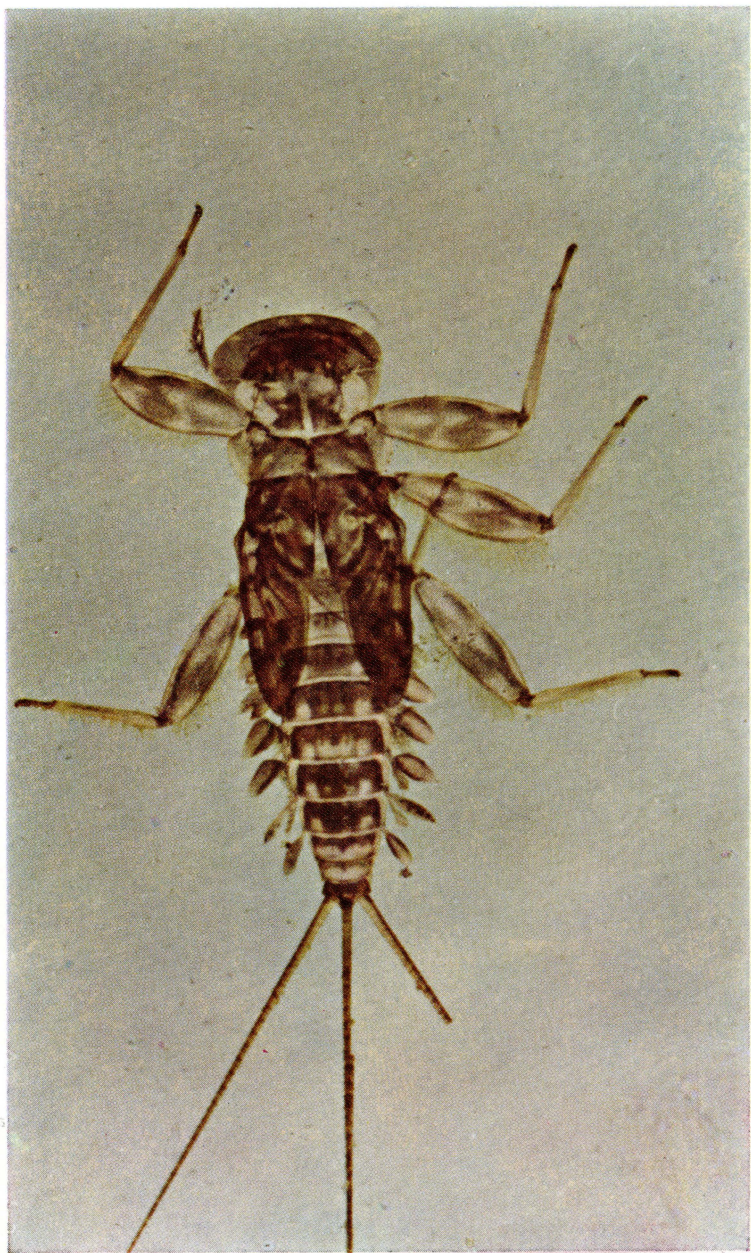


Plate 7. *A. olivacea* sp. n.