A NEW SPECIES OF *AFRONURUS* (EPHEMEROPTERA) AND ITS ASSOCIATION WITH *SIMULIUM* IN UGANDA

By Philip S. Corbet

On 28th March, 1959 my wife and I spent a few minutes collecting lithophilic insects in the Sebwe River, Toro, Uganda. Our collection was made at the point where the main Kasese–Fort Portal road crosses the river, some 10 miles from Kasese. There the river is about 10–15 metres wide and takes the form of shallow rapids. Although the altitude is probably no more than 1300 metres, the water is extremely cold, having descended abruptly from the eastern foothills of the Ruwenzori Mountains. We collected from a spot where people wash and obtain water, and where the rate of flow is less than that of the main river. Clinging to the surfaces of submerged stones were larvae of Plecoptera and Ephemeroptera. Among the latter were some large Heptageniidae, several of which bore pupal cocoons and pupae of *Simulium*. A few minutes after sunset the same evening three of these larvae disclosed adults. It is the purpose of this paper to describe the adults and larvae of this mayfly, and to remark upon its association with *Simulium*. I name this species after my wife.

Family Heptageniidae

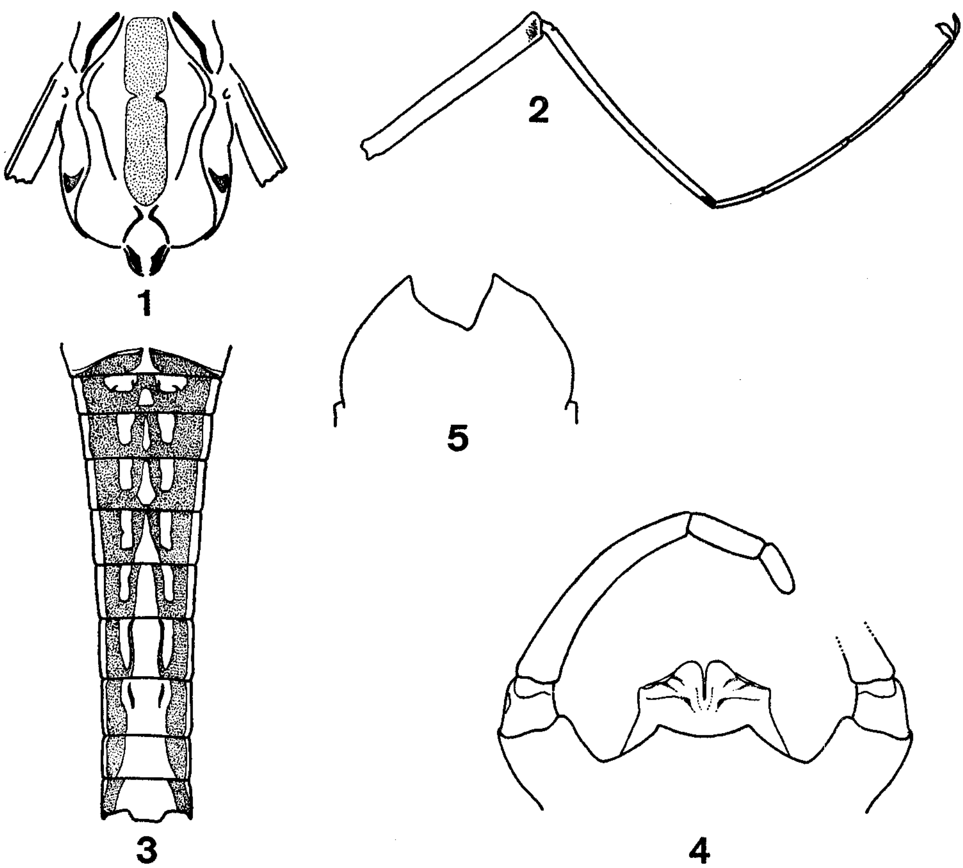
Afronurus negi sp. n.

In subimaginal characters, this species closely resembles *Afronurus pulcher* Ulmer (1930), of which no male imagines are known. Recently, however, Demoulin (1956) has placed *pulcher* in the synonymy of *A. collarti* (Navás). If Demoulin is correct, the species described here must be regarded as new, since it differs markedly from *collarti* in imaginal characters. In the male of *A. negi* the fused penis-lobes lack the paired digitate projections present in *collarti* (as figured by Demoulin), and the distal margin of the tenth sternite is distinctly concave instead of being convex as in *collarti*. The female differs from that of *collarti* in that the subanal plate possesses a deep terminal sulcus flanked by pointed tips, instead of being smoothly convex.

Imago. (Figs. 1–5)

Male.—Head pale yellowish-brown; compound eyes grey, ocelli pearly-white, rimmed with grey at base, especially of central ocellus; clypeo-frontal ridge marked with purplish-brown, particularly above bases of antennae; ventral margin of clypeus heavily, and longitudinal carinate ridge lightly, marked with purplish-brown. Thorax pale yellowish-brown, with broad mid-dorsal longitudinal band of darker brown; otherwise marked with well-defined small purplish-brown streaks, dorsally as in figure 1, and laterally below fore wing bases and near coxae. Wings hyaline, venation very pale yellow except for purplish-brown marks on basal half of costa and on costal wing brace. Legs yellowish-brown; all femora with reddish-brown spot at apex; tarsi uniformly coloured; in legs 2 and 3 slightly darker than tibiae; fore tarsus (fig. 2) with first joint shorter than second or third but longer than fifth; hind tarsus much shorter than femur or tibia; first joint of hind tarsus slightly shorter than second. Abdomen (fig. 3) pale yellowish-brown with broad longitudinal bands of magenta occupying about half the width of each tergite; these bands bear three white markings which become more extensive posteriorly, and have coalesced by about segment VIII; cerci marked strongly with magenta on 6 basal segments only, distally only on segmental sutures; forceps (fig. 4) robust, unmarked, 4-segmented; penes (fig. 4) united, with a broad apical cleft; markedly concave on dorsal surfaces; pale yellowish-brown marked slightly on protuberances with purplish-brown; posterior margin of tenth sternite between forceps bases of characteristic form. Length of fore wing 11·5 mm.

Female.—Resembles male except in following respects: compound eyes purple and grey; antennae yellowish-brown, unmarked; wings with venation orange-brown, the costa, subcosta and radius being particularly strongly coloured; purplish-brown line along edge of costa up to about three-quarters of its length. (Mid-legs missing in allotype.) Fore tibiae unmarked; tarsi uncoloured, same colour as tibiae, segments nearly equal: in order of length (fore) second, first, fifth, third, fourth; (hind) fifth, first, second, third, fourth. Pale central abdominal markings more extensive than in male, becoming more or less confluent from segment IV posteriorly, and occupying progressively more of dark tergal area; cerci pale magenta on basal 8–10 segments; thereafter magenta progressively restricted to basal ring; subanal plate prominent with a deep terminal sulcus flanked by pointed tips: sulcus asymmetrical in allotype (fig. 5); whole plate curves downwards. Length of fore wing 15·5 mm.



FIGS. 1–5.—*Afronurus negi* sp. n., imaginal characters: (1) male thorax, dorsal view; (2) male fore leg; (3) male abdomen, dorsal view; (4) male forceps, forceps base and penes, ventral view (right forceps omitted); (5) female subanal plate, ventral view.

SUBIMAGO

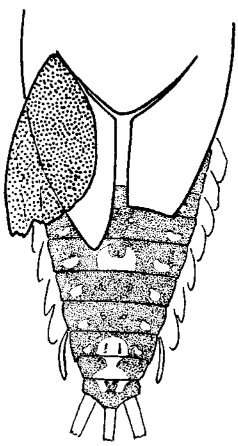
Male.—General ground colour pale cream; dorsum of thorax with 2 longitudinal dark brown streaks converging slightly posteriorly, and 2 dark brown anterior spots; abdominal pattern light magenta, identical with that of imago; bases of cerci bright magenta. Form of penes and posterior margin of tenth sternite recognisably similar to that of imago and differing from *A. pulcher* (as figured by Ulmer) as follows: penis-lobes with mesial protuberances demarcated less from main lobes and apical cleft not so deep; posterior margin of tenth sternite broadly concave, instead of broadly convex with a central incision.

Material.—♂ type, ♀ imago and ♂ subimago allotypes, UGANDA: Sebwe River, Toro, 28.iii.1959. Specimens in British Museum (Nat. Hist.).

LARVA. (Figs. 6–9)

Closely resembles larva of *Afronurus ugandanus* Kimmins (Corbet, 1960) in body-shape and habit, but differs from it in size, abdominal pattern and shape of gills. Dimensions, to nearest half mm., of final instar larvae, male and, in brackets, female : body-length 12 (14) (24·5 (28·5) including cerci) ; head-width 4 (4) ; wing-sheaths 3·5 (4·5). Abdominal pattern resembles that of *A. ugandanus* in so far as the same segments are pale, but differs from it and from *A. peringueyi* (Esben-Petersen) (*see* Barnard, 1932) in the shape of the markings (fig. 6). Gills differ from those of *A. ugandanus* only in shape, as shown in figures 7–9 ; those on V and VI lack apical filaments.

Material.—2 ♂, 1 ♀, which disclosed type and allotype imagines, and allotype subimago ; 1 ♂, 2 ♀ final instar larvae ; two penultimate instar and two smaller larvae, UGANDA : Sebwe River, Toro, 28.iii.1959. Specimens in British Museum (Nat. Hist.).



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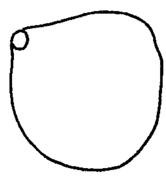

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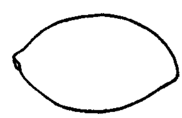

FIGS. 6–9.—*Afronurus negi* sp. n., larval characters : (6) diagram of abdomen and part of thorax, dorsal view, showing abdominal pattern and site of attachment of *Simulium* pupal case ; (7–9) shapes of gills on segments I, II and VII, respectively, right side posterior view (filaments on I and II omitted).

Association with Simulium

Altogether ten larvae of *Afronurus negi* were collected, and five of these each bore one pupal cocoon of *Simulium*. In three cocoons pupal exuviae were still present. One detached larva of *Simulium* was also present amongst the material, but probably became detached after capture.

Two pupal exuviae were in good condition and could be identified according to the characters given by Freeman and de Meillon (1953). The abdominal armature conformed exactly with both forms of *Simulium copleyi* Gibbins and with *S. diceros* Freeman and de Meillon ; the respiratory filaments agreed with those of *S. copleyi* form *marlieri* Grenier in being branched near their apices, but there were about 40, instead of 30, terminal filaments. However, giving due consideration to the other characters, the pupae can be assumed to be *S. copleyi* form *marlieri*. This material remains attached to the *Afronurus* larvae deposited in the British Museum (Nat. Hist.).

Of the *Afronurus* larvae which bore *Simulium* pupal cases, four (2 ♂, 2 ♀) were in the final instar and one was in the penultimate instar. All the final instar larvae were pharate, and three (2 ♂, 1 ♀) emerged on 28th March. The remaining larva

(♀) was killed on 29th March, but obviously soon would have emerged. The five other *Afronurus* larvae showed no signs of *Simulium* attachment. These comprised two final instar (♂♀, both pharate), one penultimate, and two earlier instars (6 and 7 mm. long).

The pupal cases were all attached to *Afronurus* larvae as shown in figure 6, four being on the left, and one on the right side. Each was attached to the wing-sheath. On final instar larvae the anterior part of the pupal case extended very slightly on to the dorsum of the thorax. On the penultimate instar larva, which has a smaller wing-sheath, the pupal case extended correspondingly further on to the thorax. This position is the same as that recorded for this species when attached to larvae of undetermined species of *Afronurus* and *Baëtis* (Marlier, 1950). Since the mayfly larvae customarily face upstream, the *Simulium* pupae must face downstream, as is usual for free-living members of the genus (Freeman and de Meillon, 1953).

In phoretic associations of this kind, attention has sometimes been drawn to the need for emergence of the two partner species to be synchronised, or at least temporally related. Thus the chironomid, *Epoicocladius ephemerae* Kieffer, postpones its pupation until after the emergence period of its semivoltine host, *Ephemera danica* L. In this way the helpless pupae are prevented from arriving prematurely at the water surface and being carried downstream (Gillies, 1951). In the first published account of phoretic association between *Simulium* and mayfly larvae, Marlier (1950) remarked that pupae and pharate final instar larvae of *Simulium* were always found on final instar or pharate mayfly larvae. Van Someren and McMahon (1950), describing a similar association, stated that the *Simulium* " always pupates after the *Afronurus* has completed its last nymphal moult ", and that, on the same night, " the emergence of both adults takes place in the hours of darkness within an interval of one or two hours ". Freeman and de Meillon (1953) review these reports and refer to the " remarkable timing of eclosion to coincide, within an hour or two, with that of the final nymphal moult of the mayfly ".

It is surprising, however, that in such examples of phoresis there should be any necessity for emergence to be synchronised. Although strictly comparative data are lacking, there can be very little doubt from published accounts (*e.g.* Freeman and de Meillon, 1953 ; Harker, 1952 ; Macan, 1957 ; Needham, Traver and Hsu, 1935) that *Simulium* develop much more rapidly than Heptageniid mayflies. If this is so, and unless for some reason young larvae of *Afronurus* are unsuitable for attachment, there seems no reason *a priori* why the *Simulium* should not complete its development significantly earlier than the mayfly. As in the situation described by Gillies (1951), it would seem that the *Simulium* is exposed to no danger by developing *faster* than the mayfly, but only by maturing *later*—when it would be liable to get swept downstream on the mayfly larval exuvia.

Recent observations tend to support this interpretation. Berner (1954) found a pupa, or pupal cocoon, of *S. berneri* Freeman on an *Elassoneuria* larva which was not yet in the final instar. Also, I have recently examined specimens from the Victoria Nile at Jinja, in which pupae of *S. lumbwanus* de Meillon were attached to penultimate instar larvae of *Afronurus ugandanus* Kimmins (*see* Corbet, 1960). And in the material described here, an empty pupal case of *S. copleyi* form *marlieri* occurred on a penultimate instar larva of *Afronurus negi* ; and furthermore, the four other pupal cases found on larvae had all been vacated before emergence of the mayfly. Thus it seems that, in these cases at any rate, *Simulium* can develop more rapidly than, and emerge before, the mayfly to which it is attached, and that therefore no synchronisation is necessary.

When the problem is viewed in this light, the precise timing of emergence reported by Van Someren and McMahon (1950) becomes all the more remarkable. If further work could reveal the ecological factors which necessitate such synchronisation, it is certain that they would prove of great biological interest.

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SUMMARY

1. The adult and larva of a new species of mayfly, *Afronurus negi*, are described and figured.

2. The association of larvae of *A. negi* with immature stages of *Simulium copleyi* form *marlieri* Grenier is recorded and discussed.

3. It is concluded that in certain instances a synchronised emergence of the two insects involved in such an association is unnecessary.

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