PHORETIC ASSOCIATION BETWEEN A SPECIES OF *SIMULIUM* AND A MAYFLY NYMPH, WITH A DESCRIPTION OF THE NYMPH.

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While investigating the medically important insects of the Volta River drainage in the Gold Coast, British West Africa, during 1950, I encountered a number of rather striking mayfly nymphs, of which a series was collected. On my return to field headquarters I examined them and found that nearly all the specimens had attached either larvæ or pupæ, or both, of a species of *Simulium* (figs. 1 and 3). Since the larva of *S. neavei* was unknown, I speculated that this might be the long-sought-for immature stage of that important species. Shortly after my return to Accra, while reading recent literature, I found that V. D. Van Someren and J. McMahon (1950, Nature, clxvi, 350–351) had just described the association of a new species of *Simulium* living phoretically with a mayfly nymph, *Afronurus peringueyi* (E.-P.). I therefore decided to withhold any description of the relationship I had found. In discussing the matter with Dr. Paul Freeman of the British Museum (Natural History) in 1952, he suggested that I send my specimens to him for determination of the *Simulium*. Because of the discovery that they represented a new species (*S. berneri* Freeman), we both felt that the mayfly nymph which may be new, should also be described.

With the mayfly fauna of West Africa practically unknown, it is difficult to place this nymph in a particular genus with confidence. I shall, however, assign it to *Elassoneuria* as suggested to me by Mr. D. E. Kimmins, British Museum (Natural History). In the order Ephemeroptera, although new species are sometimes described from the nymph, this practice is confined to those groups in which characters in the immatures are clearly distinctive. In general, nymphs of the sort described below do not show such characters. I am, therefore, not placing a specific name on my specimens.

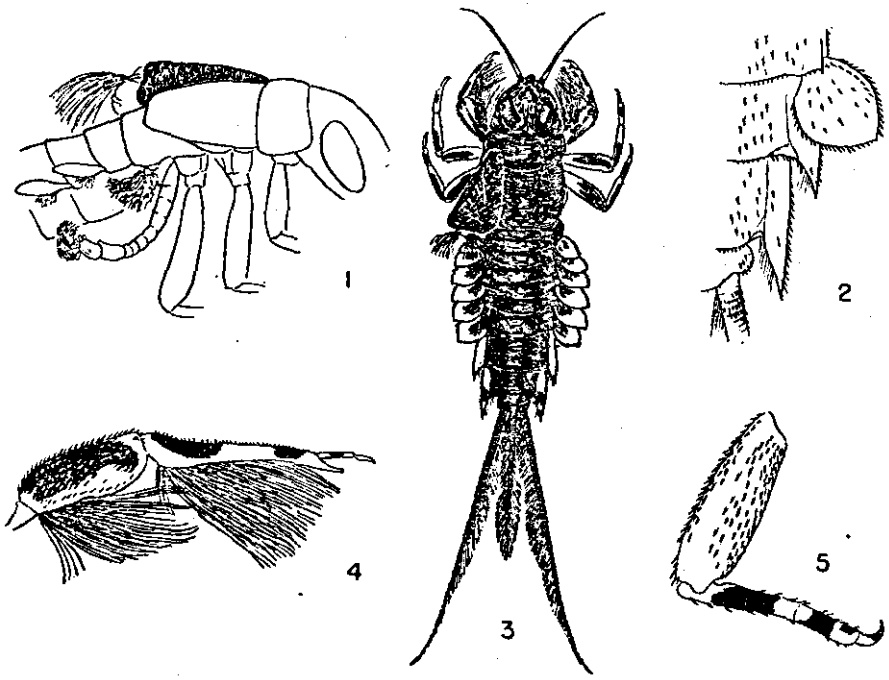
I am indebted to Mr. Kimmins for his examination of the nymphs and for his comments about its identity. Miss Esther Coogle, Staff Artist, Department of Biology, University of Florida, executed the illustrations.

Elassoneuria sp.

Mature Nymph.—Head flanged postero-laterally and emarginate behind the eyes. Outline of head somewhat undulating when viewed from above. In profile, the frontal process prolonged into small, beak-like structure below the antennæ ; frontal process carinate when viewed

from above with the ridge becoming progressively wider from the distal margin of the frons to its base between the antennæ ; carina whitish against the dark brown, lateral outline below the antennæ. Compound eyes large, slightly emarginate on inner margin where the lateral ocelli are located ; lateral ocelli large, located directly posterior to the antennal bases ; median ocellus centrally located above the carina, transversely elongate in shape. Dark brown streak above the median ocellus stretching to the lateral ocelli. Mouth-parts partially hidden when seen from above, except for the labial palps which project slightly from the sides of the head. From below, the large labium is conspicuous, as well as

Figs. 1–5.



Elassoneuria sp.

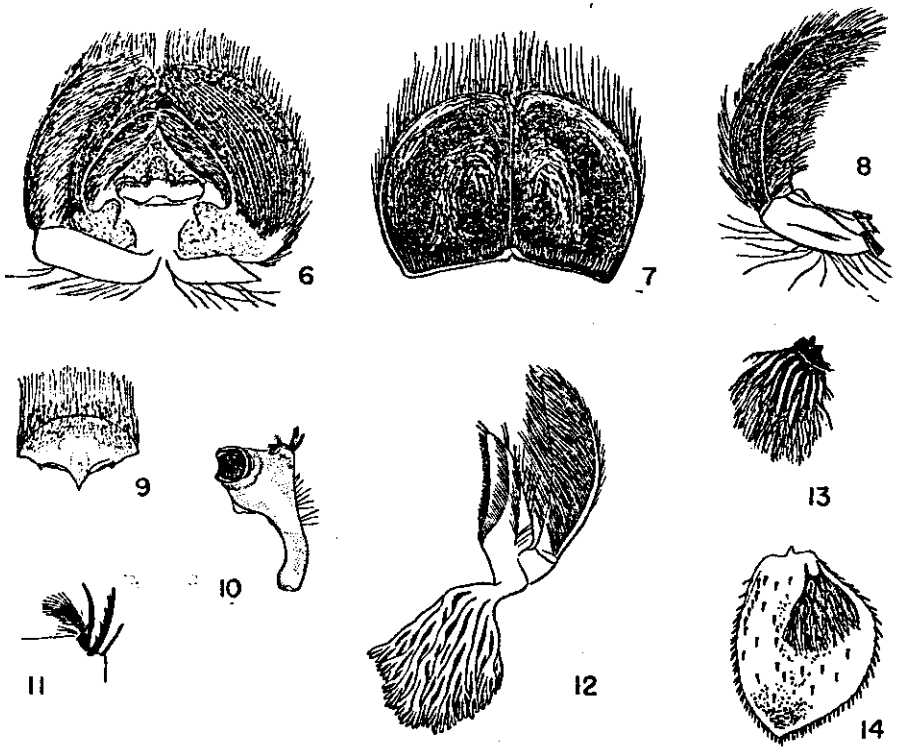
(1) lateral view of nymph showing attachment of *Simulium* larva and pupa ; (2) enlarged view of abdominal segments 8–10 ; (3) nymph with pupa of *Simulium* attached to thorax ; (4) fore leg of nymph ; (5) hind leg of nymph.

the maxillary gills, which are very large and project laterally from the ventral side of the head. Mouth-parts hirsute with numerous hairs arranged as shown in figs. 6–9, 12. Molar area of mandible unusual in being smooth with no evidence of ridging on its surface. Antennæ long and thin ; base and first few segments dark brown ; indication of a darker stripe in the basal half of each antenna. Thorax without special markings ; wing-pads well developed. At the anterior edge of the mesosternum there is a rather dense cluster of long hairs ; another cluster covers

much of the prosternum. The ventral surface of the metasternum posterior to the metathoracic legs is covered with spines similar to those on abdominal segments. Anterior margin of femur and tibia of fore legs (fig. 4) with long hairs which are arranged in double, parallel rows; on the tibia, lying between these rows of long hairs, there are shorter hairs; on the femur the very long hairs are present only in the basal half where the width of the femur is somewhat less than that of the outer half; femur with an anterior and posterior row of very heavy spines as well as some nearer the base; tibia and tarsus with short hairs that are grouped to appear hook-like on the anterior and posterior surfaces; tibial spur long but not heavily chitinized; tarsal claw heavy and large with eight teeth on inner surface. Femur of middle leg also spiny; no long hairs present except near the base where there are a few on the posterior border; tibia with a protuberance near the base and a U-shaped excavation proximal to it; spines also present but not recurved as on fore leg; two heavy spines at distal edge of tibia; heavy spines present on the anterior margin of the distal portion of the tarsus. Hind leg (fig. 5) much as the middle with very heavy spines present at the end of and along the inner surface of the tibia as well as on the tarsus; heavy spines present over the entire surface of the femur, although they tend to be much heavier on the outer surface than on the inner. Abdomen somewhat rounded with the margins of the posterior segments flattened and expanded into posteriorly projecting spines which are present on segments 4–9, becoming progressively longer posteriorly (figs. 2 and 3). The lateral spines are especially pronounced on segments 8 and 9, being approximately half as long as the tergite on segment 9; the lateral spines are covered by the gill-plates on segments 4–7. Dorsum of abdomen with few distinctive markings except on segment 9, where there is a brown band across the base of the postero-lateral spine; a heavy, brown spot is present at the anterior margin of tergites 1–9, giving the appearance of an interrupted median line; distal half of tergite 9 pale, tergite 10 dark. Dorsally there is an excavation of the tergite to receive the base of the gill on segments 5–7 (fig. 2); the dorsal edge of this excavation terminates in a lateral spine with a series of spines present along the posterior margin. Tergites 2–10, in the mid-section, are covered with roughly transverse rows of heavy spines projecting posteriorly. These rows begin at the anterior portion of the tergite and extend to the posterior margin, where on segments 3–10 they form a terminal border for each tergite; on those tergites which have the lateral margins flanged, the spines continue almost to the terminal spine. Laterally, near the expanded portions of the tergites, there are long hairs under and around each gill. The lateral margins of each segment have a row of relatively heavy spines running along almost the entire border, and becoming progressively heavier posteriorly. The spines are sparse on segments 2 and 3 and become rather numerous on the remaining abdominal segments. Ventrally there are no distinctive markings except for the transverse bar at the base of the terminal spines on the lateral margins of the ninth

segment. All sternites are covered with the same type of heavy spines that are present on the dorsum but they are more numerous on the venter and continue across the entire segment. Gill-plates brownish in colour in the basal three-fourths, outer fourth clear; the plates cover the filamentous portions except in gill 1 (figs. 13 and 14); gill-plates covered with numerous heavy spines on the outer surface; margins bordered with heavy spines as well as short ones; somewhat hirsute,

Figs. 6–14.



Elassoneuria sp.

(6) dorsal view of labium, right labial palp removed; (7) ventral view of labium, palps removed; (8) labial palp; (9) labrum; (10) mandible; (11) enlarged view of canines and lacinia mobilis of mandible; (12) maxilla with attached gill; (13) first abdominal gill; (14) fourth abdominal gill.

especially along the posterior border; filamentous portion rather feathery, extending to about half the length of the gill-plate. First gill is located just posterior to base of the metathoracic leg and is ventral in position. The plate-like portion, so prominent in gills 2–7, is reduced to a mere vestige with the filamentous part expanded and covering part of the metasternum posterior to the metathoracic leg. The posterior

edge of sternite 9 terminates in two sharp submedian spines projecting over the bases of the lateral caudal filaments. Caudal filaments dark brown in colour in the basal three-fourths; somewhat lighter distally. Median caudal filament dark brown in basal four-fifths. Inner margin of lateral and both lateral margins of median filament covered with long hairs which become shorter distally. All caudal filaments covered with heavy spines. Body length 16·2 mm.; outer caudal filaments 7·8 mm.; median filament 5·3 mm.

Gold Coast: All specimens from Togoland, Dayi River, near Huime (Kpandu-Hohoe road), August 17th, 1950 (*Lewis Berner*). Examples in the British Museum (Nat. Hist.) and in the Florida State Museum.

In younger nymphs, the abdominal colour pattern is more clearly evident. Tergites 2–9 have a pair of large, broadly U-shaped marks with the openings of the U at the anterior margin. The anterior U mark on each segment is interrupted at the bottom of the mark by a large, median, dark spot. The postero-lateral margins of tergites 1–9 have a large, dark-pigmented, triangular marking which extends medially to meet the posterior U-shaped mark. Lateral caudal filaments have a dark band near the middle with lighter bands on either side; the distal fourth is brown. The median filament has a dark brown band near the tip as shown in fig. 3.

The nymphs were collected from the Dayi River upstream from the bridge on the Kpandu-Hohoe road. In the area where the mayflies were collected, the stream was shallow, being not more than two or three feet deep, and moderately flowing. The water was relatively clear and the stream-bottom composed of sand overlaying a clay base. No vegetation was seen growing in the stream at the time collections were made. The stream, in the region from which the nymphs were taken, was about fifty feet across and ran through a ravine about twenty-five feet deep. A short distance above the region from which the mayflies came, there is a rock outcrop which goes halfway across and dams and deflects the water, so that it is rather deep and swift. All of the nymphs were collected from rocks or from sticks and leaves which had become anchored in the shallower parts of the stream.

A four-hour examination of this part of the Dayi produced only four free-living *Simulium* larvæ, one of the particular insects for which I was searching. It was not until I had discovered the phoretic association of the mayfly nymph and the *Simulium* larva that I could account for the paucity of blackfly larvæ in the normal habitats.

Many of the mayfly nymphs had from one to four *Simulium berneri* larvæ attached to their ventral surface. The larvæ could be found just behind the labium, between the legs, and even between the gills of the nymphs. Two nymphs were collected, each of which had a pupal case attached; there was a pupa in one, the other was empty. In both, the pupal cases were attached to the mesothoracic wing-pads of the nymphs. One of the mayfly nymphs was in the last instar and its wing-pads were beginning to swell with the developing wings. The other nymph was somewhat

younger, although well grown. The pupation of the West African *Simulium berneri* varies somewhat from that of the Kenya form described by Van Someren and McMahon, as that species always pupates after the *Afronurus* nymph has completed its last moult.

It is rather interesting to speculate with regard to this association between the two insects. *Simulium* is a food strainer, utilizing its anterior fans to gather plankton and organic debris from the water. Such a method for collecting food requires rather swiftly-flowing water to ensure a constant supply; this rapid movement of the water also ensures an adequate supply of oxygen. Nymphs of the family Oligoneuridae, as well as those of the North American mayfly genus *Isonychia*, have long hairs on the anterior pair of legs, which serve the identical purpose as the anterior fans of the *Simulium* larvæ, and the mayfly nymph grazes on the material filtered from the flowing water. In such a stream as that in which this *Simulium* larva was found, there are relatively few places for attachment. It appears logical to assume that the phoretic association is an outgrowth of identical feeding habits, high oxygen requirements of both insects, and paucity of places in the stream for attachment.

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