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NOTES ON SOME DAMSELFLY LARVAE FROM CAMEROON (ZYGOPTERA: PERILESTIDAE, AMPHIPTERYGIDAE, PLATYCNEMIDIDAE)

G.S. VICK
Crossfields, Little London, Tadley, Hants RG26 5ET, United Kingdom

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A description of the larva of *Nubiolestes diotima* (Schmidt) (Perilestidae) is given. Comments are also made on the larva of *Pentaphlebia stahli* Förster (Amphipterygidae) which was previously described by Fraser. The larvae of another zygopteran which inhabits the water-film on vertical rock-faces associated with waterfalls is described, and its probable determination as *Stenocnemis pachystigma* (Sel.) (Platycnemididae) is discussed. All of the material was collected in Cameroon (SW Province, Meme District, Mount Kupe).

INTRODUCTION

In the course of studies on the Odonata of Mount Kupe in the South-West Province of Cameroon, I discovered the larvae of two of the most interesting odonates in Africa: the amphipterygid *Pentaphlebia stahli* Foerster, 1909 and the perilestid *Nubiolestes diotima* (Schmidt, 1943). Larvae of another species of Zygoptera, probably the platycnemidid *Stenocnemis pachystigma* (Selys, 1886), were found living in the water-film on vertical rocks associated with a waterfall. The habitat on Mount Kupe is described in COLLAR & STUART (1988) and a preliminary odonate species inventory is given in VICK (1996). The vegetation is closed-canopy evergreen rainforest of a montane character and the forest cover is extremely well preserved in the area investigated, from the level of the village of Nyasoso (850 m) to the summit (2050 m). The rainfall is extremely heavy: the annual total in Nyasoso is over 4000 mm and even in the driest month, December, 80 mm is recorded. The climate is equatorial with strong monsoonal influences. Permanent streams flow down the mountain; these have rapid flow and a bed of gravel, boulders and, locally, coarse silt. In March 1995, before the 'wet season', the flow rate of the R.

Nyesosoh at the point where larvae were collected was 21 cm/s The temperature here has been measured in March 1995 and July 1996 and found to lie in the range 21-23°C; seasonal fluctuations are likely to be insignificant.

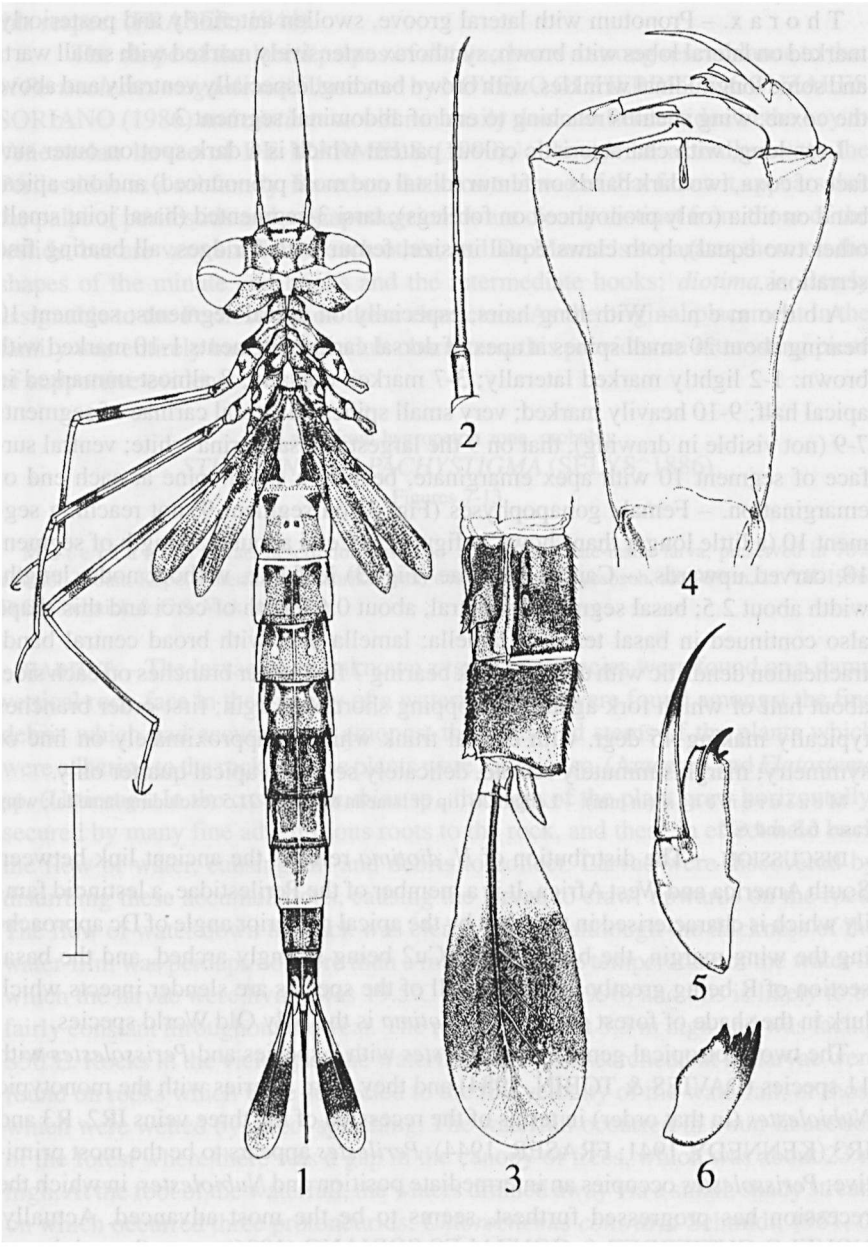
NUBIOLESTES DIOTIMA (SCHMIDT, 1943)
Figures 1-6

M a t e r i a l. – 1 ♀ exuviae of ultimate-instar larva (found with newly emerged adult) from Mt Kupe, Shrike Trail, R. Nyesosoh 920 m, 8-IV-1995, G.S. Vick leg.

HABITAT. – The exuviae of a larva of *Nubiolestes*, the only African representative of the Perilestidae, were found with the emerging adult about 20 cm above the water level on a boulder adjacent to a gently-flowing part of the stream. Larvae of *Pentaphlebia stahli* occurred nearby in more rapidly flowing sections of the same stream. Adults of *diotima* occurred fairly commonly on stretches of the stream which were clearly similar to those described by WILLIAMSON & WILLIAMSON (1924) in Colombia where *Perissolestes* spp. were found: forest streams, with gentle flow containing pools alternating with short ripples, the bed having mixed mud and gravel, and the stream being shaded by overhanging bushes. GONZALEZ SORIANO & DEL PINAR VILLEDA (1978) regard the neo-tropical perilestids as inhabitants of primary rainforests and the known habitats of *diotima* would suggest agreement with this.

DESCRIPTION. – Colour pattern and markings (Fig. 1): long slender larva, transparent cuticle of exuviae marked strongly with brown; a dorsal white line running down abdomen.

H e a d. – About twice as broad as long; occipital margin concave; cephalic lobes minutely setose, especially on ventral margins. – Antennae (Fig. 2) long and slender, 7-segmented; first segment marked with brown on lateral surfaces; second with brown basal and sub-apical bands; others unmarked; total length of antenna about 4.5 mm and segments in ratio 11 : 25 : 16 : 17 : 9 : 6 : 4 with second easily the longest segment; first segment thick (length/width 3.5) and each subsequent segment about 2/3 width of previous segment. – Prementum (Fig. 4) longer than wide (length/width about 1.4); base reaching to mid-legs when retracted; mental and palpal setae absent; median lobe convex with minute crenulations and deep central cleft which widens basally to form a tear-drop outline. – Palpus (Fig. 5) with 3 apical teeth, middle one longest and curved, the upper one intermediate in size and the lowest one smallest; gap between upper and middle teeth on labial palp narrow (less than the thickness of the upper tooth); movable hook, middle and lower teeth reddish. – Mandibles (Fig. 6) stout, the right mandible with 4 teeth in incisor row, numbering from 1 (dorsal) to 4 (ventral) the lengths being in the order (largest first) 4-3-1-2, and 2 teeth in molar row; the left mandible with 5 teeth in incisor row, the lengths being in the order 4-5-2-3-1, and 2 teeth in molar row.



Figs 1-6. *Nubiolestes diotima* (Schmidt): (1) entire exuviae (dorsal view), scale line = 5 mm; – (2) left antenna (dorsal view); – (3) abdominal segments 9 and 10, cercus and lateral caudal lamella (left lateral view); – (4) prementum (dorsal view); – (5) left palpus (dorsal view); – (6) right mandible (dorsal view).

T h o r a x. – Pronotum with lateral groove, swollen anteriorly and posteriorly, marked on lateral lobes with brown; synthorax extensively marked with small warts and some longitudinal wrinkles, with brown banding, especially ventrally and above the coxae; wing sheaths reaching to end of abdominal segment 3.

Legs long, with characteristic colour pattern which is a dark spot on outer surface of coxa, two dark bands on femur (distal one more pronounced) and one apical band on tibia (only pronounced on forelegs); tarsi 3-segmented (basal joint small, other two equal), both claws equal in size; femur with 5 ridges, all bearing fine serrations.

A b d o m e n. – With long hairs, especially on apical segments; segment 10 bearing about 20 small spines at apex of dorsal carina; segments 1-10 marked with brown: 1-2 lightly marked laterally; 3-7 marked dorsally; 8 almost unmarked in apical half; 9-10 heavily marked; very small spines on lateral carinae of segments 7-9 (not visible in drawing), that on 9 the largest; dorsal carina white; ventral surface of segment 10 with apex emarginate, bearing a small spine at each end of emargination. – Female gonapophyses (Fig. 3) on segment 9, not reaching segment 10 (a little longer than shown in figure). – Cerci about 0.5 length of segment 10, curved upwards. – Caudal lamellae (Fig. 3) leaf-like, without node; length/width about 2.5; basal segment triquetral, about 0.6 length of cerci and this shape also continued in basal tenth of lamella; lamella pale with broad central band; tracheation dendritic with central trunk bearing 7 first-order branches on each side, about half of which fork again; all stopping short of margin; first-order branches typically making 45 degr. with central trunk which is approximately on line of symmetry; margins minutely serrate, delicately setose in apical quarter only.

M e a s u r e m e n t s (in mm). – Length 26 (tip of lamella to head); 21.5 (excluding lamella); wing cases 6.8 and 6.2.

DISCUSSION. – The distribution of *N. diotima* reflects the ancient link between South America and West Africa. It is a member of the Perilestidae, a lestinoid family which is characterised in the adult by the apical posterior angle of Dc approaching the wing margin, the basal part of Cu2 being strongly arched, and the basal section of R being greatly thickened. All of the species are slender insects which lurk in the shade of forest streams. *N. diotima* is the only Old World species.

The two neotropical genera are *Perilestes* with 7 species and *Perissolestes* with 11 species (DAVIES & TOBIN, 1984) and they form a series with the monotypic *Nubiolestes* (in that order) in terms of the recession of the three veins IR2, R3 and IR3 (KENNEDY, 1941; FRASER, 1944). *Perilestes* appears to be the most primitive; *Perissolestes* occupies an intermediate position and *Nubiolestes*, in which the recession has progressed furthest, seems to be the most advanced. Actually, NOVELO GUTIERREZ & GONZALES SORIANO (1986) quote the opinion of Garrison that the two neotropical genera are not clearly separable and should be considered synonymous. Nevertheless, *Nubiolestes*, in which the recession has progressed most, seems to be less primitive than its neotropical relatives, at least in

this respect (FRASER, 1944).

The shape of the labial palpus of *diotima* bears a strong resemblance to that of *Perissolestes magdalenae*, illustrated by NOVELO GUTIERREZ & GONZALES SORIANO (1986) and *diotima* would run easily down to Perilestidae in the key to Venezuelan larvae of DE MARMELS (1990), although he actually treats the Perilestidae as a subfamily. Based on the known larvae of that fauna it appears that the palpi of perilestids and megapodagrionids are clearly distinct from those of the lestids, but are very similar to each other, and De Marmels separates them on the shapes of the minute end hooks and the intermediate hooks; *diotima* is clearly assignable to the Perilestidae on these characters. As the original placement in the family was entirely based upon adult characters, this provides an interesting piece of supportive evidence.

Larva from hygropetric zone, probably
STENOCNEMIS PACHYSTIGMA (SELYS, 1886)
Figures 7-13

M a t e r i a l. – 6 larvae, description based on 1 ♂ penultimate-instar larva, preserved in 70% ethanol. Mount Kupe, waterfall near Shrike Trail, tributary of R. Nyesosoh, alt. 980 m, 11-VII-1996, D.G. Chelmick & G.S. Vick leg.

HABITAT. – The larvae of an unknown zygopteran species were found on a damp vertical rock-face in the vicinity of a waterfall. They were found amongst the fine debris which had accumulated amongst the roots and stems of the plants which were adhering to the rocks. These plants were *Anubias* sp. (Araceae) and *Elatostema* sp. (Urticeae). In the case of *Anubias* sp., the stem of the plant grew horizontally, secured by many fine adventitious roots to the rock, and these in effect held back the flow of water, causing silt and debris to collect. Larvae were discovered by disturbing these accumulations, causing the larvae to crawl upwards on the rock. The flow of water down the rock was clearly visible although the thickness of the water-film was perhaps no more than a millimetre. The temperature of the water in which the larvae were living was 19.5°C (on 11 July 1996) and this is likely to be fairly constant throughout the year. The rock was about 5.5 m high and was facing S50°E. Rocks in the vicinity of the waterfall were also searched but no larvae were found on rocks which were subjected to the full velocity of the waterfall, or those which were wetted by direct splashing. The waterfall occurred in a sun-lit section of the forest where there was a gap in the canopy of trees, which was about 23 m high. At the foot of the waterfall, the waters drained away via a small, shady stream on which occurred three protoneurids: *Chlorocnemis contraria* Schmidt, 1951, *C. nigripes* Selys, 1863 and *Elattoneura nigra* Kimmins, 1938.

DESCRIPTION. – General appearance (Fig. 7) stout, short-legged, very hairy, almost uniform brown with darker patches of colour on wing sheaths just basal to the nodus and on legs at joint of femur and tibia.

H e a d. – Broad, with greatest breadth about twice the greatest length; numerous stout spinulose setae on post-ocular lobes; frontal shelf flat, with long forwardly-directed hairs which reach almost to the end of the 2nd antennal segment. – Mandibles 4 teeth in incisor row, numbering from 1 (dorsal) to 4 (ventral) the lengths being in the order (largest first) 4-3-1-2, and 2 teeth in molar row. – Antenna (Fig. 8) 6-segmented, 1st segment stout; first three segments parallel-sided, 4th and 5th swelling distally; 6th swelling to reach greatest width at midlength; lengths of segments in ratio 8 : 11 : 5.5 : 5 : 3 : 2; whorls of long soft hairs on 1st and 2nd segments (especially on 2nd); sparse hairs on 3rd-5th. – Prementum (Fig. 12) approximately square, without premental setae; distal border obtuse and finely crenulate; lateral margins with fine setae; strongly concave; no trace of apical cleft; when retracted, it reaches to base of forelegs. – Palpus (Fig. 13) bearing two large setae (distal one longer) and six very small setae; movable hook slightly curved, dark-brown; middle hook blunt, shortest of three, half the length of movable hook; lowest hook of intermediate length, acute. – Labrum width/length about 5.0, bearing long pale hairs almost as long as the labrum itself.

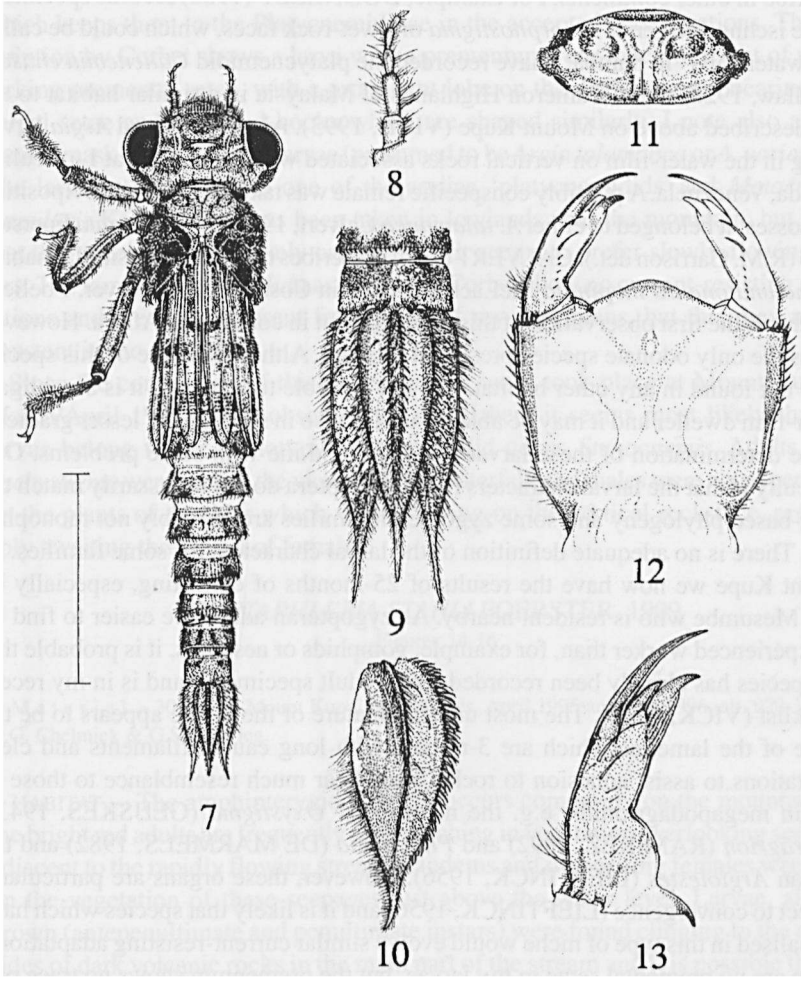
T h o r a x. – Prothorax (Fig. 9) broad with greatest breadth 2.3 times greatest length, bearing stout spinulose setae on anterior carina, on a pair of warts in the anterior half, and on the lateral projections which are at mid-length; a longitudinal groove present. – Synthorax with groups of stout spinulose setae on dorsum of epm2 and epm3. – Wingsheaths reaching to the end of abdominal segment 4; length 4.5 and 4.9 mm; bearing stout curved setae on tracks of main longitudinal veins.

Legs: each femur flattened, bearing stout setae in apical halves; each tibia widening apically and bearing numerous very long hairs (between 1 and 2 times width of tibia in length) and about 10 short spinulose setae at the end of the tibia, directed towards tarsus; each tarsus 3-segmented, basal segment elongate (length/width about 2), middle segment square and apical segment very elongate (length/width about 5); claws equal.

A b d o m e n (Fig. 7). – Dorsum segments with distal row of spinulose setae, bunches of longer, more curved setae on the small lateral projections which extend onto ventrum, and sparser setae on basal and central parts of segment. – Cerci minute, triangular, about one-third length of segment 10. – Median caudal lamella (Figs 10, 11) bilaterally symmetrical; 3-ribbed with cross-section approximately in shape of inverted T, the dorsal and the two lateral ribs very strongly indicated and bearing numerous spines and backward-curving setae; the ventral surface flattened but with evidence of longitudinal fold on mid-line which is clothed with fine hairs and no setae; other two surfaces between ribs concave (in specimen described, but expanded in some specimens, giving saccoid impression to gill) and smooth, and bearing only occasional small setae; apical quarter drawn out into a slender filament, furnished with long delicate setae. – Lateral caudal lamellae (Fig. 10) essentially triquetral in cross-section; saccoid; bilaterally symmetrical about mid-lateral plane; 3-ribbed with cross-section in shape of a T, rotated through a quarter turn;

ribs much weaker than in median lamella, with abundant spinulose setae on dorso-lateral and ventro-lateral surfaces and very long white hairs on lateral margins; dorso-ventral surface flattened, without setae (surface possibly rotated to lateral position in life to assist adhesion on rock-surface), bearing longitudinal fold (or 'seam') and, at base, a concave almost-hemispherical depression, about one-sixth length of lamella in diameter (perhaps a suction-cup); apical third of lamella drawn out into slender filament, furnished with long delicate setae.

Measurements (in mm). – Length 16.8 (including lamellae); 14.3 (excluding lamellae).



Figs 7-13. *Stenocnemis pachystigma* (Sel.)[?] larva found in hygropetric zone: (7) entire larva (dorsal view), scale line = 5 mm; – (8) left antenna (dorsal view); – (9) prothorax (dorsal view); – (10) abdominal segment 10 and caudal lamellae (dorsal view); – (11) median caudal lamella (left lateral view); – (12) prementum (dorsal view, right palpus unshaded); – (13) left palpus (dorsal view).

DISCUSSION. – The ability to survive in the water-film on vertical rock-faces associated with waterfalls occurs fairly commonly in some orders of insects. For example, larvae of many species of the psychomyiid caddisfly genus *Tinodes* Leach, 1815 occupy these hygropetric zones, but it is an unusual habitat for odonates. It is quite distinct from the habitat of species of *Zygonyx* such as *natalensis* (Martin, 1900), in which larvae are found clinging to rocks over which waterfalls are pouring (GAMBLES, 1963) and hence have evolved adaptations to cope with the high water velocity. There are records of dragonflies occupying the type of habitat I describe in other continents. For example, DONNELLY (1986) records specimens of the ischnurine genus *Amorphostigma* on "wet-rock faces, which could be called tiny water-falls" in Samoa. I have recorded the platycnemidid *Calicnemia chaseni* (Laidlaw, 1928) in the Cameron Highlands of Malaysia in a similar habitat to the one described above on Mount Kupe (VICK, 1993). Also, I obtained *Argia* larvae living in the water-film on vertical rocks associated with a waterfall at La Azulita, Merida, Venezuela. A possibly conspecific female was taken there while ovipositing on mosses; it belonged to either *A. talamanca* Calvert, 1907 or *A. variegata* Foerster, 1914 (R.M. Garrison det.). CALVERT (1914) describes the somewhat similar habitat of *Thaumatoneura inopinata* McLachlan, 1897 in Costa Rica. However, I believe that this is the first observation of this larval habitat in continental Africa. However, it was the only odonate species present at this site. Although larvae of this species were not found in any other habitat, it is not possible to state that it is an obligate water-film dweller and it may be able to survive also in seepages of lesser gradient.

The determination of these larvae has presented me with some problems. One difficulty is that the larval characters in the Zygoptera do not necessarily match the adult-based phylogeny and some zygopteran families are probably not monophyletic. There is no adequate definition of the larval characters for some families. At Mount Kupe we now have the results of 25-months of collecting, especially by Otto Mesumbe who is resident nearby. As zygopteran adults are easier to find by an experienced worker than, for example, gomphids or aeshnids, it is probable that the species has already been recorded (from adult specimens) and is in my recent checklist (VICK, 1996). The most unusual feature of the larvae appears to be the shape of the lamellae which are 3-ribbed, with long caudal filaments and clear adaptations to assist adhesion to rocks. They bear much resemblance to those of certain megapodagrionids, e.g. the neotropical *Oxystigma* (GEIJSKES, 1943), *Heteragrion* (RAMIREZ, 1992) and *Philogenia* (DE MARMELS, 1982) and the Papuan *Argiolestes* (LIEFTINCK, 1956). However, these organs are particularly subject to convergence (LIEFTINCK, 1956) and it is likely that species which have specialised in this type of niche would evolve similar current-resisting adaptations. There are no premental setae in my larvae, but the prementum shows no trace of a median cleft and there are palpal setae present; these two characters appear to rule out a megapodagrionid identity (see DE MARMELS, 1990). The only megapodagrionid which has been found at the site is *Neurolestes trinervis* Selys, 1885, but

one other megapodagrionid, *Nesolestes nigeriensis* Gambles occurs further north (GAMBLES, 1970). *Neurolestes trinervis* had initially been considered to be the most likely determination. Two possible identities have been put forward for the larvae: either one of the *Metacnemis/Mesocnemis* 'platycnemidids' with argiine affinities, or *Stenocnemis pachystigma* (Selys, 1886), an atypical platycnemidid.

CORBET (1956) described the larva of *Metacnemis valida*, an East African species in a genus which is arguably considered to be in the Platycnemididae (DAVIES & TOBIN, 1984). The genera *Metacnemis* and *Mesocnemis*, however, have clear affinities with *Argia* in the Coenagrionidae, and it is mainly the shape of the Dc which keeps them in the Platycnemididae in the accepted classifications. The description by Corbet shows a larva with a prementum very much like that of mine, lacking premental setae, with a prominent lobe on the distal margin, bearing two palpal setae and with end-hooks which are shaped similarly. I note also a very similar mask on my Andean larvae (presumed to be *Argia talamanca* or *A. variegata*). The larvae may belong to one of the argiine 'platycnemidids' and *Metacnemis singularis* Karsch, 1981 has been taken in lowlands near the mountain, but I feel that this species is an unlikely candidate as it seems to prefer slowly-flowing waters. The lamellae of *M. valida* as shown by Corbet show no current-resisting adaptations and are very different from those of my specimens, but this may not be constant in the genus.

Since the completion of this paper, further work took place at Mount Kupe in March/April 1997. From observations made then, it seems most likely that the larvae belong to the monotypic platycnemidid genus *Stenocnemis*. Adults of *S. pachystigma* were seen in the vicinity of the waterfall, and males were noted perching on the plants of *Anubias* which were growing on the vertical rock-face, presumably awaiting the arrival of females.

PENTAPHLEBIA STAHLI FOERSTER, 1909

Figures 14-16

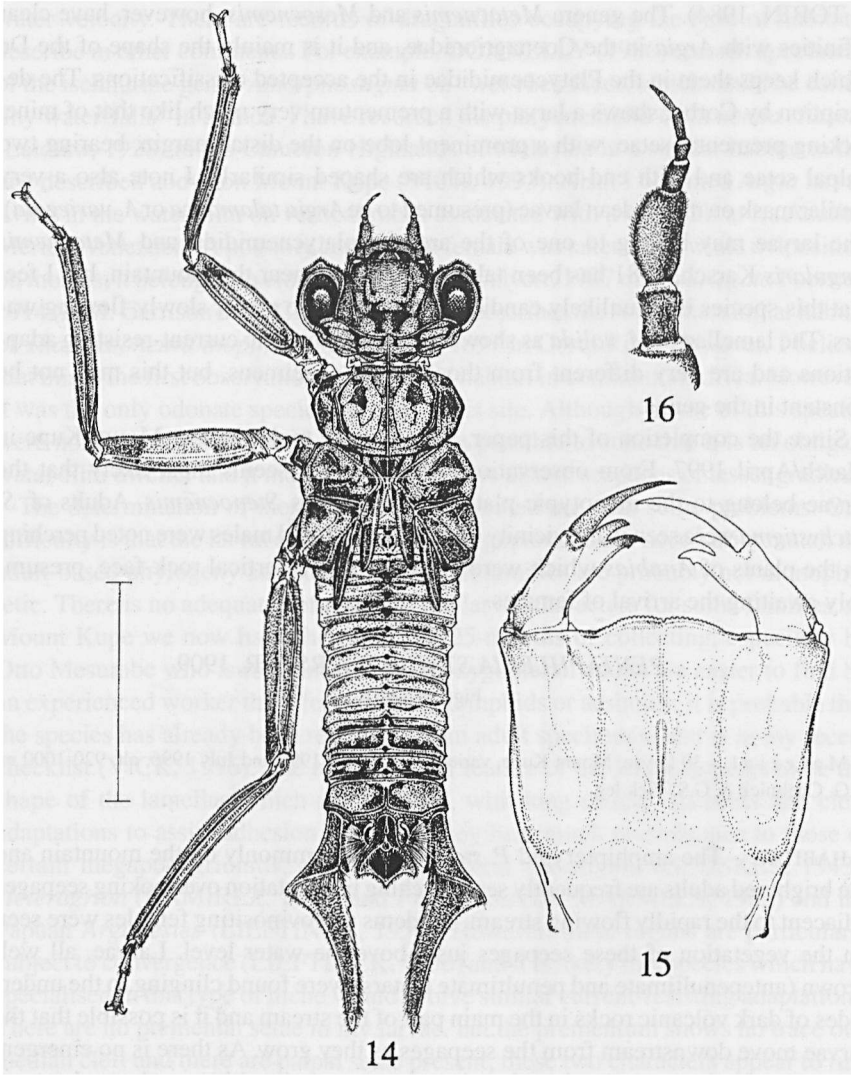
M a t e r i a l. – 30 larvae, Mount Kupe, various sites, April 1995 and July 1996, alt. 920-1000 m; D.G. Chelmick & G.S. Vick leg.

HABITAT. – The amphipterygid *P. stahli* occurs commonly on the mountain and the bright red adults are frequently seen perching in vegetation overlooking seepages adjacent to the rapidly flowing stream. Tandems and ovipositing females were seen on the vegetation of these seepages just above the water level. Larvae, all well grown (antepenultimate and penultimate instars) were found clinging to the undersides of dark volcanic rocks in the main part of the stream and it is possible that the larvae move downstream from the seepages as they grow. As there is no emergent vegetation in the stream and no females were seen ovipositing on the rocks, even where moss-covered, it would seem that this adaptation has arisen to protect the

smaller larvae from the full force of the current.

NOTE. – I am taking this opportunity to include a good figure of the larva (Figs 14-16) of this species, which has previously been described and illustrated by FRASER (1955, 1956).

DISCUSSION. – An extensive discussion of the taxonomic position of this species which includes a detailed description of many of the diagnostic features of the larva is given by NOVELO-GUTIERREZ (1995), although he does not figure the



Figs 14-16. *Pentaphlebia stahli* Foerster: (14) entire larva (dorsal view), scale line = 5 mm; – (15) prementum (dorsal view, right palpus unshaded); – (16) right antenna (dorsal view).

complete larva. *Pentaphlebia* is one of the two genera of rimanelline Amphipterygidae. The distribution of the subfamily also reflects the ancient connection between Africa and South America. In West Africa it contains *P. stahli* and *P. gamblesi* Parr, 1977, the latter only known from the Obudu region of Nigeria. In the Guiana shield it is represented by *Rimanella arcana* Needham, 1933. The larva of *Rimanella* was described by GEIJSKES (1940) and that of *P. stahli* by FRASER (1955, 1956). The larva of *P. gamblesi* is undescribed. The specimen that Fraser used was in the ultimate instar and was a Cameroon specimen. Comparing this with my own large series, I note that there are certain errors in Fraser's description, although his drawing does justice to the general appearance of the larva. The illustrations in this paper (Figs 14-16) show a younger larva (probably ante-penultimate), but the following comments apply to all of my series which includes some ultimate instar larvae. Fraser shows only 6 antennal segments in his illustrations whereas there are in fact seven (although he does state "6 or 7 segmented" in his 1956 paper); he has considered the third and fourth as one segment in his figure and description. He correctly shows the second segment as strongly inflated but he makes the first segment appear inflated and almost spherical, whereas it is more nearly cylindrical (Fig. 16). His drawing of the prementum is fairly good but the shape of the palpi is unclear and he has exaggerated the rectangular proportions of the prementum (see Fig. 15). The curious lateral anal appendages actually bear 3 small teeth on their inner surfaces and the median appendage is too crudely drawn by Fraser to see its shape properly. The gill tufts are omitted in Fraser's drawing but are figured and described in the key paper by WATSON (1966).

CAMEROON DRAGONFLY PROJECT

This was formed in 1996 with the aim of increasing knowledge of the dragonflies of the republic and, thereby, providing useful data to assist with habitat conservation. Professor Philip S. Corbet has kindly agreed to be president. The objectives include carrying out faunistic surveys, including any necessary taxonomic work; the production of a key to the adults (now in provisional form); and, once larvae have been described, the preparation of preliminary larval keys, especially for regions like Mount Kupe where the fauna is restricted, well-known and of exceptional interest from a conservation viewpoint. Perhaps the most important objective of all is the training of local workers. This contribution is the first of the larval studies.

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