

**NOTES ON THE GENUS *NOTOGOMPHUS* SELYS, 1858 IN
CAMEROON WITH THE DESCRIPTIONS OF TWO NEW SPECIES
(ANISOPTERA: GOMPHIDAE)**

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Twelve *Notogomphus* specimens from Cameroon were available for analysis. Previously only *N. spinosus* Karsch was known from the country; its holotype and allotype have been re-examined and comments are included. *N. maryae* sp. n (holotype ♂: SW Province, Mt Kupe, Nhangse, 25-VII-1998 and *N. moorei* sp. n (holotype ♂: SW Province, Kodmin, 15-XII-1998 are described. The types are in the author's collection. A key to separate the 3 spp. is provided.

INTRODUCTION

The African genus *Notogomphus* has been defined by PINHEY (1961, 1962). The hind femora are extremely long for a gomphid and the legs reach at least to the middle of the second abdominal segment. The frons possesses a crest. Foliations on terminal segments of abdomen are usually absent or vestigial. The superior appendages of males are 'not very long', rather straight, unbranched, often ending in a spine. The inferior appendage possesses widely divaricate branches. The end segment of the penis is well developed, without flagellum, sometimes with a well formed ventral spine below the median segment. All three triangles are free. The Pt is not very elongate, sometimes short, often swollen. In the forewing there are only 1 or 2 crossveins proximal to the bifurcation of the sectors of the arc. Normally there is a basal subcostal antenodal. There is 1 Cuq in each wing, and the postdiscoidal field expands beyond the nodus. The anal loop is absent. The genus *Podogomphus* Karsch, 1890 is generally regarded as a synonym (CAMPION, 1923; FRASER, 1949; PINHEY, 1962)

About 20 species are known. It is an endemic African genus which is mainly confined to forested regions. Most of the species described to date are East African, and the range of these stretches from Ethiopia to the Republic of South Africa, with the greatest

diversity apparently in Uganda, Tanzania and Kenya. Even those described from Congo (DRC) have only been recorded in the east of that country. Further work will undoubtedly unearth some synonymy and wider ranges but the impression is clearly of a genus which is at its most speciose in East Africa. The only species that has been previously known in West Africa is *Podogomphus spinosus* Karsch, 1890, with type locality Cameroon, and now placed in *Notogomphus*. This study shows that two more species of *Notogomphus* exist in Cameroon.

Reports on the work of the Cameroon Dragonfly Project are given in VICK (1996, 1998, 1999, 2000) and CHELMICK (1999, 2001). Efforts to date have entirely been focused on the South-West Province and the adjacent areas of the Littoral Province, both provinces sharing the chain of mountains which extends north east from Mount Cameroon. In addition to taxonomic aspects, the rich odonate fauna of the region and its odonatological importance are discussed in these papers. In VICK (1999) I listed some material of *Notogomphus* which we have recorded but which I could not determine at that stage. After much study, and the examination of type material of *N. spinosus*, I believe I have resolved the situation.

It is worth quoting from PINHEY (1961) who comments that adequate material of the genus is difficult to secure and it is difficult to link up the sexes. The species are liable to appear suddenly and then disappear. I note that the males possess very distinctive anal appendages and the females have unique and complex structures on the head (vertex and occiput).

METHODS

Ten specimens of the genus have been collected by the survey, making twelve specimen available for study; all are from Cameroon. The type male and female, on loan from the Zoological Museum, Berlin (ZMB), are included.

I decided to photograph digitally important diagnostic features of all of the specimens using a JVC 3-CCD (KY-F55BE) digital camera with automontage software and a Zeiss Stemi 2000-C microscope. The software enables one to take, say, 20 separate images at different focal positions, and then it integrates them into a single picture which has the appearance of having an exceptionally large 'depth of focus'. I saved the automontage image and one or two of the separate images which were focused at different distances and decided later which image gave the best detail for my purposes. In some cases this was not the automontage image. These images have been used for comparison of specimens and to help with preparation of drawings.

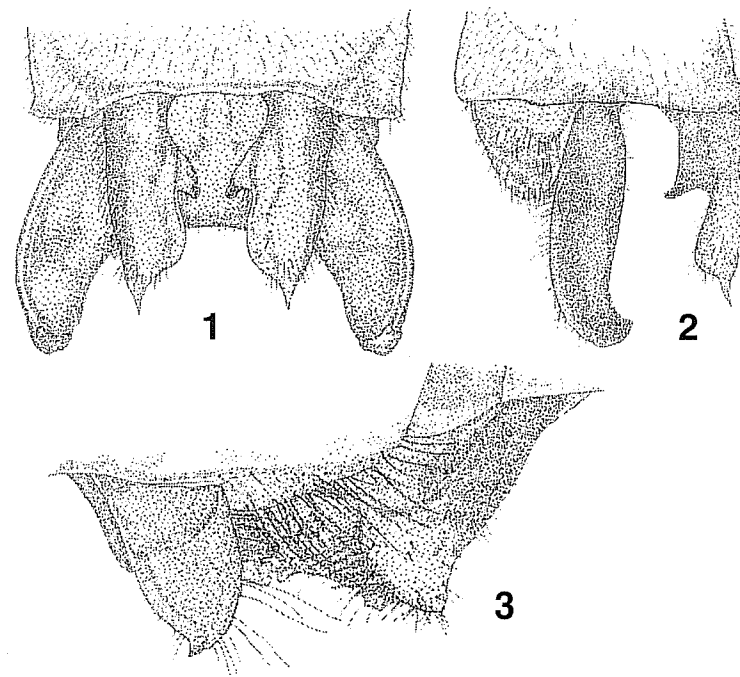
NOTOGOMPHUS MARYAE SP. NOV.

Figures 1-3

Notogomphus sp. 2: VICK, 1999: 241, 247 (listing and descriptive note of 1 ♀)

Notogomphus sp. 3: VICK, 1999: 242, 247 (listing and descriptive note of 1 ♂ specimen from Muambong, incorrectly localised to 'Takamanda' on p. 247, whereas it is in the Bakossi Mountains further South)

Material (all from SW Province of Cameroon). — **Holotype** ♂: Mt Kupe, Nhiangse 25-VIII-1998



Figs 1-3. *Notogomphus maryae* sp. n., holotype ♂: (1) anal appendages, dorsal aspect; — (2) same, lateral aspect; — (3) accessory genitalia, lateral aspect.

bred in UK by David G. Chelmick (exuviae in DGC collection and adult in alcohol in my collection). — **Allotype** ♀: Nyasoso, west side of Mt Kupe, Water Catchment stream, 17/18-II-1997, O. Mesumbe leg., in my collection. — **Paratypes**: 1 ♂ Muambong, Jide River, 24-I-1998, bred (exuviae and adult in my collection, adult given KOH treatment and stored in alcohol); — 1 ♀ Mt Kupe, Nhiangse, 25-VIII-1998, bred in UK by D.G. Chelmick (adult in alcohol in my collection). Holotype and allotype will eventually pass to BMNH.

Etymology. — The species is named after my wife, Mary Christine Vick.

MALE (holotype), adult. — Colour preservation poor (in alcohol) but condition perfect. Colours are likely to be as given for the allotype.

Head. — Width across eyes 7.8 mm. Vertex and epicranium - no trace of horns.

Thorax. — Dorsum (mesepisternum). There is no yellow on the carina. Two inner antehumeral stripes and two outer antehumeral stripes. Sides of thorax - banded as in female.

Legs. — Hind femur reaches to the end of the second segment and bears an outer row of 3 large and 1 small spines.

Wings. — Nodal index forewing 14-19-18-15, hindwing 11-13-13-13. 1st and 7th or 8th Ax are strengthened. Discoidal field in forewing widens from 2 cells to 10 at margin, in hindwing widens from 3 cells to 16. Anal triangle 3-celled. No sign of anal loop. Pt

occupies 3 or 4 cells, measuring 3.3 mm in forewing and 3.5 mm in hindwing. Membranula vestigial.

Abdomen. — Segments 1-2 all yellow. Yellow basal spot on dorsum of each tergite 3-7, occupying about 0.2 of segment, segments 8-10 with yellow only on lateral surfaces. Lengths of segments in lateral aspect: 7>8>9>10. Appendages (see Figs 1-2). Superiors, in dorsal view, stout and subparallel for 0.9 of length, drawn out into acute apex in terminal 0.1. The ventral tooth arises from the inner border of the appendage at half the length and is clearly visible in dorsal view. In lateral view, each appendage exceeds segment 10 in length and is slightly curved upwards, subparallel, blunt-ended and then the upper angle is drawn out into a short point. There is a ventral tooth at half the length which is shorter than the width of the appendage, pointed and clearly arising from the inner (lateral) surface of the appendage. Inferior, in dorsal view, the branches appear very weakly divaricate, almost parallel. Each apex bears an acute tooth, facing inwards. In lateral view, curved, pointed at apex. Inferior appendage exceeds superiors in lateral view. Accessory genitalia (see Fig. 3).

Measurements (in mm). — Abdomen with appendages 40, hindwing 34.

FEMALE (allotype), adult. — Markings closely resemble those of the male, but as the female has been preserved dry they are easier to see and these notes provide a better guide to coloration.

Head. — Width across eyes 8.0 mm. Labium with ligula yellow with black lateral stripe. First segment of paraglossa yellow with distal black stripe, second segment black. Mandibles with bases yellow. Labrum, anteclypeus, postclypeus glossy black. Frons with anterior surface black in lower part and a yellow stripe in upper part, which continues narrowly onto the brown dorsal surface. Vertex and epicranium brown, with a raised ridge joining the lateral ocelli and posterior to them, the three ocelli and ridge lying within an ovoid hollow. No horns on vertex. Antennae black. Occiput black with black hairs, posterior surface with 4 weakly raised black pads. Rear of head black, with trace of yellow adjacent to eyes.

Thorax. — Black marked with yellow as follows. The impression is of a black thorax marked with 5 bands on each side: 2 on dorsum and 3 on lateral surface. Prothorax with central dorsal spot. Synthorax marked as follows. Dorsum (mesepisternum) with 2 inner antehumerals (about 0.8 mm wide), well-separated from carina and not confluent with yellow on collar. 2 outer antehumerals, very narrow (0.4 mm wide), widening to form dorsal spots, but narrowly broken just below spots. Sides of thorax: mesepimeron with green (rather than yellow) vertical stripe (0.6 mm wide); mesinfraepisternum half green; metepisternum, metepimeron and metinfraepisternum almost all green except for brown on second suture. Ventral surfaces pale. Antealar triangles brown. Axillaries yellow.

Legs. — Coxae and trochanters pale brown. Femora pale brown shading to black distally. Tibiae and tarsi black. Spination of hind femora with an outer row of 6-7 spines with the basal one smallest.

Wings. — Hyaline, weakly enfumed to just beyond triangle. Venation dark brown.

Nodal index of forewing 13-19-21-13, and of hindwing 12-12-12-12. 1st and 6th antenodals strengthened in forewing, 1st and 7th or 8th in hindwing. Discoidal field of forewing expanding from 2 cells to 11 or 12, of hindwing from 3 to 16 or 17. Anal loop absent. Pt pale brown, subtending 4 to 4.5 cells in all wings, length 3.5 mm in forewing, 3.8 mm in hindwing. Membranula vestigial.

Abdomen. — Segment 2 with vestigial auricle. Tergites very dark brown marked with yellow as follows. In lateral view: segment 1 and 2 laterally banded, segment 3 with narrow lateral spots, segments 4-6 with 2 separated lateral spots also visible dorsally. Segment 7 with a basal spot. Segments 9-10 weakly and indistinctly marked with yellow. In dorsal view: segments 2-4 with narrow longitudinal streak; segments 3-6 dorsum with small pair of basal spots; segment 7 with large pair of basal spots which are almost confluent. Appendages. Superiors cylindrical, subparallel, pointed in apical 0.3 of length. Vulvar scale decumbent, broad basally, abruptly narrowed, strongly bifurcated, extending 0.7 length of sternite 8.

Measurements (in mm). — Abdomen with appendages 41, hindwing 37.

NOTOGOMPHUS MOOREI SP. NOV.

Figures 4-11

Material (all from Cameroon). — **Holotype:** ♂, South-West Province, Kodmin, 1475m, 15-XII-1998, Menze leg. — **Allotype:** ♀, South-West Province, Kodmin, 1520m, 16-XII-1998, Menze leg. — **Paratypes:** 1 ♂ Littoral Province, Mt Nlonako, Nguengue, 1240m, 26-XI-1998, (severely damaged); 1 ♀ South West Province, Kodmin, 1380m, 16-XII-1998, Menze leg. (specimen lacks terminal half of abdomen). — All material is in the author's collection and will eventually pass to BMNH (none was available when I was preparing VICK, 1999).

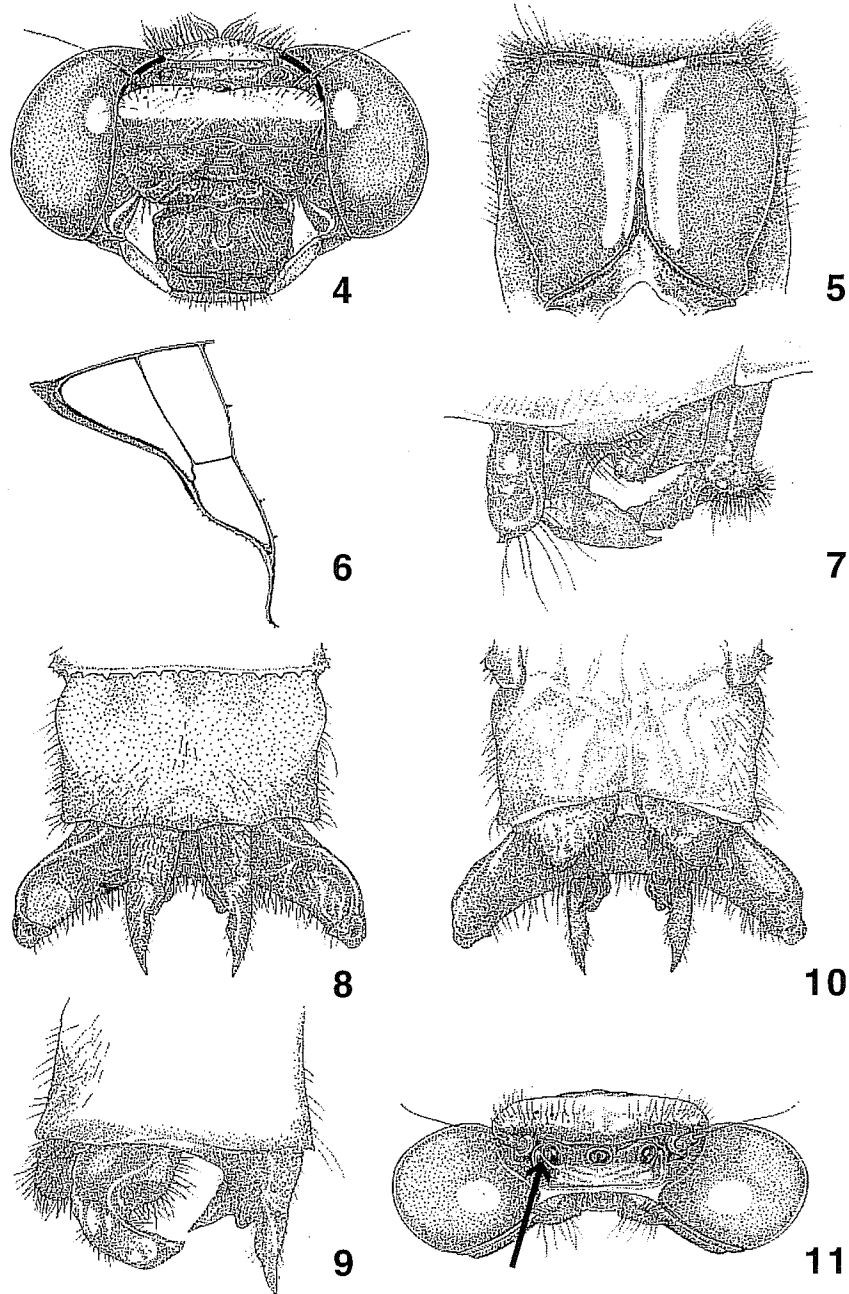
Etymology. — The new species is dedicated to Professor Norman Moore who has done so much to further the interests of dragonfly conservation.

MALE (holotype), adult. — Colour preservation good although not acetone-dried. Pale markings clear. Paratype similar except where stated but colour preservation poor. Specimen broken and in several pieces. The paratype is similar to the holotype, except where stated.

Head (Fig. 4). — Width across eyes 8.2 mm. Labium with ligula brown and first segment of paraglossa yellow, second segment black. Mandibles with bases yellow. Labrum shiny black.

Anteclypeus and postclypeus reddish brown. Frons with anterior surface with lower half brown and upper half yellow, dorsal surface yellow. Vertex and epicranium brown, dorsal surface yellow posteriorly bordering occiput, swollen around lateral ocelli, just perceptible trace of horns (as in female but much smaller) arising from yellow swellings. Antennae having all segments black. Occiput bright yellow, hind border slightly convex, bordered with long black hairs (length of these about equal to width of occiput), dorsal surface bearing 8 or 9 roughly concentric curved wrinkles. Rear of head black, with traces of yellow.

Thorax. — Prothorax dark brown marked with yellow on mid dorsum, confluent



with stripe on mesepisternum. Synthorax (Fig. 5) dark brown, marked as follows. Dorsum (mesepisternum) with yellow on carina and inner antehumeral stripe abutting it. No outer antehumeral stripes, black on humeral suture and on metastigma, narrow (0.5 mm) yellow stripe on mesepimeron, mesepisternum yellow in posterior half, metinfraepisternum yellow, metepimeron almost all yellow. Ventral surfaces yellow or pale brown. Antealar triangles brown with yellow central longitudinal stripe. Axillary plates yellow.

Legs. — Coxae yellow, otherwise entirely black. Hind femur bearing two sharp apical spines and one shorter one basal to them (four large spines in paratype). Hind tibia with about 16 small spines.

Wings. — Hyaline, enfumed with yellow brown beyond triangle to 8th antenodal, veins black. Nodal index forewing 13-17-17-14 (paratype 12-17-16-13) with 1st and 7th antenodals strengthened (8th in one wing of paratype), hindwing 13-12-12-13 (paratype 13-12-12-12) with 1st and 7th antenodals strengthened. Basal crossvein present in all wings. Discoidal field in forewing with 2 or 3 rows, expanding after nodus and reaching 10 or 11 cells at margin (12 in paratype), in hindwing with 3 rows, expanding after nodus and reaching 14 cells at margin (17 in paratype). Triangle of forewing 1 celled, hindwing 1 celled (paratype has 2 cells in hindwing triangle). Anal triangle (Fig. 6) 3 cells. Anal loop none. Pt reddish-brown, framed in black, subtending approximately 4 cells. Length 3.7 mm and 4.0 mm in fore and hindwing respectively. Membranula vestigial, extending to half length of anal triangle.

A b d o m e n. — Black, marked with yellow as follows: on segment 1 laterally; on segment 2 laterally, enclosing auricle, and dorsally as a narrow central longitudinal stripe; on segment 3 laterally to the intersegmental suture, and dorsally with a narrow central longitudinal stripe which stops at intersegmental suture; on segment 7 on the basal half of dorsum only. Appendages (see Figs 8-10). Superiors acute, approximately parallel in dorsal view, thick and parallel-sided for about 0.4 of length then tapered gently to apex. In lateral view, with a strong ventrally directed tooth bearing a prominent swelling at its base in the exterior angle. These contrast with those of *spinus* in which the superiors in dorsal view are parallel-sided for about 0.8, then abruptly narrowed and drawn out into a point, and in lateral view, there is no swelling in the angle between the ventral projection and the apical section of the appendage is of a different shape. Inferiors with branches curved at tips, extremely divaricate in dorsal view. Accessory genitalia (see Fig. 7).

Measurements (in mm). — Abdomen with appendages 47.5 (paratype broken and impossible to measure); hindwing 42 (paratype 40).

FEMALE (allotype). — Colour preservation poor but specimen in good condition. — Paratype similar except where stated. Where apparent, markings closely resemble those

Figs 4-11. *Notogomphus moorei* sp. n., holotype ♂ (Figs 4-10) and allotype ♀ (Fig. 11): (4) head, anterior aspect; — (5) mesepisternum, dorsal aspect; — (6) anal triangle, ventral aspect; — (7) accessory genitalia, lateral aspect; — (8) anal appendages, dorsal aspect; — (9) same, lateral aspect; — (10) same, ventral aspect; — (11) head, dorsal aspect; arrow indicates horn on vertex.

of the male holotype, and I have not repeated the same information.

Head (Fig. 11). — Width across eyes 8.2 mm. On vertex and epicranium posterior to, and touching, the circular lateral ocelli there are two upright horns (height about equal to the diameter of an ocellus); hind border yellow and strongly ridged. Occiput with large black swellings against each eye and a recessed yellow central flattened area, all three of approximately equal width.

Thorax. — Legs. — Outer row of spines on hind femora with 6 spines, the central 4 being largest (7 and 5 respectively in paratype).

Wings. — Nodal index forewing 13-16-17-14 (12-17-18-15 in paratype), hindwing 13-11-12-14 (14-13-12-12 in paratype). 1st and 6th or 7th antenodals strengthened. Discoidal field reaching 12 or 13 cells at margin in forewing and 14 or 15 in hindwing. Anal loop weak presence with 3 cells. Pt length 4.2 mm and 4.7 mm in fore and hindwing respectively.

Abdomen. — Segments 1, 2, 3 and 7 marked with yellow, apparently similar to male. Trace of auricle. Appendages about equal in length to segment 10, evenly tapered to fine apices. Vulvar scale approximately equilateral with apex divided to about 0.3 of length, its overall length about 0.2 times the length of segment 9.

Measurements (in mm). — Abdomen with appendages 45, hindwing 42.

NOTOGOMPHUS SPINOSUS KARSCH, 1890

Figures 12-13

Notogomphus spinosus: VICK, 1999: 242 (listing).

Notogomphus sp. 1: VICK, 1999: 241, 247 (listing and note on a 1 ♀ specimen from Lala).

Material (all from Cameroon). — **Holotype** ♂: on loan from ZMB, with labels: "Kamerun, Staudinger V.", described by KARSCH (1890) as the ♂ of *Podogomphus spinosus*. — **Allotype** ♀: SW Province, Kumba, collected in 1890 or earlier, on loan from ZMB, with labels: "Typus: Kamerun, Barombi Stat.; Preuss S_g. *Podogomphus spinosus* nob."; — Other material: 1 ♀, Littoral Province, Lala and Ndibe Streams, E side of Mt Kupe, 18/22-IV-1995, O. Mesumbe leg. (immature specimen in my collection); — 1 ♀ Littoral Province, Mt Nlonako, Nguengue, 1240m, 30-XI-1998, O. Mesumbe leg. (rear of abdomen missing, specimen in my collection).

My two females closely resemble the allotype and the occipital armature is identical. I am confident that they are conspecific.

COMMENTS ON THE MALE (HOLOTYPE) SPECIMEN. — Only the male type has been examined. I have no other material of this sex. Although only the female received from Berlin has the 'typus' label, this specimen was sent as the 'type' and it is clearly the same specimen (e.g. the same nodal formulae etc.) which Karsch described in 1890 (before he went on to describe the female). Colour preservation good.

Measurements (in mm). — Abdomen 45; hindwing 38.

The two species, *spinosus* and *moorei*, are clearly closely related and both are large dark members of the genus with a characteristic triple-striped pattern on the central

thoracic dorsum and no outer antehumerals. However, there are certain characters which are very different. It differs from *moorei* above as follows.

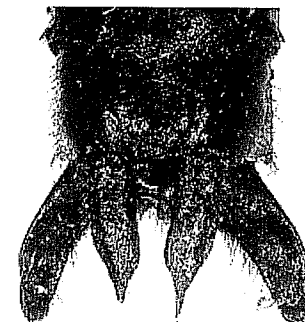
Yellow only on the dorsal surface of the frons, and not on the anterior surface. It bears a straight lateral ridge behind the lateral ocelli. The occiput is yellow but it is not wrinkled. The inner antehumeral stripes are shorter than in *moorei*, diffusely merging with the collar, but in both species the inner antehumeral is only very narrowly separated from the yellow of the carina. Abdominal segment 1 is yellow. Abdominal segment 2, entirely yellow, except for a thick V-shaped mark on posterior border (point of V facing caudally and fusing with the segmental ring). Abdominal segment 3, has yellow patches on lateral surfaces of tergite in anterior half. The spination on the posterior femur consists of 5 spines, the 3 middle ones longest. The nodal formula is: forewing 13-17-18-15; hindwing 16-12-12-13 (1st and 7th strengthened). The discoidal field widens from 3 to 11 cells in forewing and 3 to 13 or 15 in hindwing. The anal triangle does not reach as near to the anal angle in *spinosus* as it does in *moorei* and the length to width ratio is 1.6 in *spinosus* and 2.0 in *moorei*. The Pt is longer than in *moorei*: 4.1 mm and 4.2 mm in forewing and hindwing respectively.

The greatest differences are in the appendage morphology (see Figs 12-13). In dorsal view, the superiors are parallel sided for about 0.8 of their length and then abruptly narrowed and drawn out into a fine point; in lateral aspect, the large ventral tooth forms an angle of 90° with the apical section of the appendage (60° in *moorei*) and there is no swelling at the junction with the apical section of the appendage.

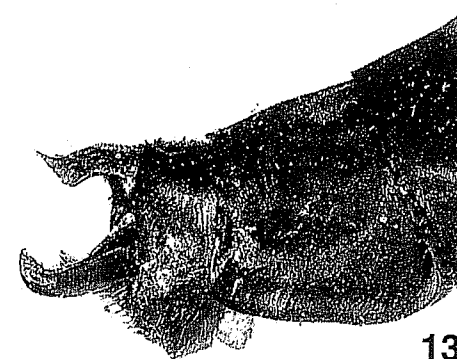
COMMENTS ON THE FEMALE SPECIMENS. — The allotype was described by KARSCH (1890). It is badly discolored but otherwise perfect.

Measurements (in mm). — Abdomen 47; hindwing 44.

My two females are identical to the allotype in the structure of the armature of the head and other morphological details. The immature specimen shows the markings most clearly, and these closely resemble those of the male, including the possession of the characteristic mark on the dorsum of segment 2.



12



13

Figs 12-13. *Notogomphus spinosus* Karsch, 1890, holotype ♂, anal appendages: (12) dorsal aspect; — (13) lateral aspect.

The horns on the vertex are much smaller than in *moorei* and they are decumbent rather than erect; they are separated from the lateral ocelli which are ovoid. The occipital structure is very different also: there is a raised and swollen central area and two smaller raised lateral areas (cf. *moorei* in which there are two very large lateral swollen pads, and a depressed central area. The mesepisternum is marked as in the male; the entire side of the thorax is dark brown except for a pale line on the metepimeron. The hind femora have an outer row of 6 spines (the middle four largest). The abdomen is brown marked with yellow: segment 1 entirely; segment 2 entirely except for a broad V-shaped brown mark (on the dorsum); segment 3 on dorsum only; segment 7 on dorsum on basal half. Nodal index: forewing 14-19-19-14; hindwing 14-14-12-14. The Pt is longer than in *moorei*: 4.5 mm and 5.0 mm in forewing and hindwing respectively.

The vulvar scale is longer than in *moorei*, not decumbent but making about 30° with the abdomen; in ventral view it is triangular with a deep closed apical cleft.

DISCUSSION

TERMINOLOGY

In the descriptions above, I have referred to the 'outer' and 'inner' antehumeral stripes. Strictly speaking, it is the 'outer' stripe which is the antehumeral; the 'inner' stripe is adjacent to the mid-dorsal carina and could perhaps be referred to as the post-dorsal or post-carinal stripe. However, I felt that the terms used would be easier to follow.

ASSOCIATION OF MATERIAL COLLECTED

Material of this genus is clearly very difficult to collect. This is illustrated by the fact that we have only collected ten specimens, and this includes some which have been bred from larvae, from a total of several thousands of dragonflies which I have received between 1995 and the present. In an area such as Cameroon which had in the past been inadequately studied, it is not surprising that the existence of new species had been missed. Including the types of *spinosus*, I have been able to study 12 specimens (5♂ and 7♀).

The main problem has been to make correct associations of the sexes of the material. All of the material comes from the same small area of Kumba (Barombi Station in the German days) and the Bakossi Mountains and the greatest distance between the sites is about 70 km (from Kumba to Mt Nlonako).

Firstly, when considering the seven females, a careful examination of the material showed that there were three species present.

Five of the specimens have a very characteristic pattern on the dorsum of the thorax, with the carina enclosed within a yellow stripe which broadens anteriorly and reaches about 2/3 of the carina posteriorly. There is a pair of antehumeral stripes very close to

this, only narrowly separated from it by a distance less than the width of the stripes. These stripes extend almost to the dorsal carina. There is no trace of an outer antehumeral stripe in the more usual position. However, the structure of the vertex and occiput of the heads show that there are two distinct species. Both possess 'horns' adjacent to the lateral ocelli, but in one species they lie just above the plane of the vertex and they are directed outwards (i.e. they are divergent and they appear almost 'horizontal'); in this species the rear of the occiput bears one central bulge and a smaller one on each side. These females are identical to the allotype of *spinosus* taken at Barombi Station (= Kumba); this was my *Notogomphus* sp. 1 (VICK, 1999) and I have three specimens including the allotype.

Two females from Kodmin, a mountain area to the north of Mount Kupe, however, clearly belonged to another species which was not recorded in VICK (1999). This is a very similar insect with the dorsum of the thorax marked approximately the same as in *spinosus*, but the structure of the head is very different: the horns adjacent to the lateral ocelli are upright and at the rear of the occiput there are strong bulges at each side and a weak central bulge. This is the species which is described above as *N. moorei* sp. n.

A female, obtained at the water catchment on Mount Kupe, clearly represented a third species which I have referred to as *Notogomphus* sp. 2 (VICK, 1999). This is a smaller species; there are no horns on the vertex, no bulges to the rear of the occiput. On each side of the thorax it bears 5 stripes, and this is totally differently marked from those of the two previously mentioned species. This is the species which I described above as *N. maryae* sp.n. I also possess a bred female specimen also from Mount Kupe which was stored in alcohol; this is clearly conspecific.

The five males (including the holotype of *spinosus*) were examined carefully and it was clear that they belong to three distinct species.

The two alcoholic specimens are both from the area of Mount Kupe (one from Muambong and the other from Nhiangse). These are recorded as *Notogomphus* sp. 3 in VICK (1999). They are both smaller than the other males (hindwing 35 mm and abdomen 42 mm) and it is clear from the better preserved specimen which was bred out from a collected larva, that the 5-striped thoracic pattern is exactly like that of the sp. 2 female. The anal appendages are very different from those of the larger species with the branches of the inferior being less widely divaricate and the superiors bearing a small ventral tooth and the apices of the main section of the appendage being abruptly narrowed and drawn out into a fine apex. These males are the holotype and paratype of *N. maryae* sp. n.

The other three male specimens are larger and the thoracic markings match those of the females of the other two species (which have horns on the vertex). Also, there are clearly two separate species present. A specimen from Kodmin is in excellent condition; it bears superior appendages with a massive ventral

Table I
Comparative data showing length of Pt at wing margin (mm)

Species	♂ fw	♂ hw	♀ fw	♀ hw
<i>maryae</i>	3.3	3.5	3.5	3.8
<i>moorei</i>	3.7	4.0	4.2	4.7
<i>spinosus</i>	4.1	4.2	4.5	5.0

tooth which is longer and more massive than the rest of the appendage; there is a large bulge at the exterior angle between the tooth and the rest of the appendage. From its markings, collection data and all aspects of appearance I think it is almost certainly the male which corresponds to the female which has upright horns on the vertex and this male has become the holotype of *N. moorei* sp. n. Another male from Mt Nlonako was severely damaged and broken when received, but it is possible to see that it resembles it closely; this will be the paratype male of *N. moorei* sp. n.

The remaining male which I have studied is the holotype male described by Karsch as *spinosus* from the Berlin Museum. I believe that it has been correctly associated with the female allotype by Karsch. The male has appendage morphology quite distinct from that of *N. moorei*. The markings, especially, match closely one of my slightly teneral females of *spinosus* (which is the only specimen which is not discolored). KARSCH (1890) described *spinosus* from a male taken in Kamerun and a female taken at Barombi Station. In a later contribution, (KARSCH, 1891), he put on record 1 ♂, 2 ♀ also from Barombi Station taken by Dr Paul Preuss, but I have not seen this material.

RELATIONSHIP TO OTHER TAXA

The two species, *spinosus* and *moorei*, seem to stand apart from other *Notogomphus*: they are larger and more robust insects than their congeners; the dorsal thoracic pattern is specialised; their general coloration is very dark, with black faces, jet-black legs, and relatively sparse paler markings; the structure of the vertex and occiput of the females is distinctive and the vertex bears horns. They seem to form a distinct 'species-group' within the genus. However, FRASER (1955) rather inadequately described the species *anaci* from a *Anthrenus*-damaged female from Bambesa (East DRC); this appears to have a different structure of vertex and occiput, but in size and coloration (abdomen 45 mm, hindwing 41 mm) it is similar to the two Cameroon taxa. Its male is not known. It is possible that this taxon also belongs to the same 'species group'. Pending a revision of the genus it would be wrong to create subgenera but Karsch's *Podogomphus* would be available.

The other species, *maryae*, is very different from *spinosus* and *moorei*; it shows some affinity with other members of the genus. It is fairly close to *dendrohyrax* of Tanzania, Zimbabwe and Malawi but it differs in many structural characters. It is perhaps closest to *butoloensis* of Kenya and Uganda, but the morphology of the inferior anal appendage is different.

The impression may have been created that these three Cameroon species are 'outliers' of a genus which appears to have its origin in the East. Despite the apparently greater number of species in eastern Africa it is possible, even likely, that the genus *Notogomphus* has spread there from west and central Africa during past pluvial periods. Many species of other groups which are found in East Africa, such as those of the eastern arc forests of Tanzania, have their origin in the Guineo-Congolian forests and presumably ancestral

forms spread eastwards during the mid-Cretaceous when the forest cover was continuous (KINGDON, 1990); until about 25 million years ago, before the mid-Tertiary uplift which separated the eastern from the western lowlands, there was a continuous forest belt across central Africa from coast to coast. This dispersal pattern appears to be true for many rainforest-adapted taxa such as amphibians and reptiles. I suspect it is true also in the calopterygid genus *Umma*, with *U. declivium* as an outlier in the Usumbaras, but greatest diversity of the genus in the Cameroon and Gabon 'hotspot'. It would be interesting to investigate whether these Cameroon forms of *Notogomphus* are the more basal elements in the genus. It must also be borne in mind that the dragonfly fauna of central Africa is very poorly known, especially the Congolese region, and many species must await discovery in this vast region.

KEY TO NOTOGOMPHUS IN CAMEROON

(See also Table I for lengths of pterostigmata)

- 1 Smaller species with abdomen less than 42 mm and hindwing less than 37 mm. Thoracic dorsum (mesepleuron) black marked with green or yellow stripes as follows: none on carina, two broad inner antehumerals and two narrower outer antehumerals. Pair of small separated spots on dorsum of segment 7. Occiput black. Female with no trace of horns on the vertex *maryae* sp.n.
- Larger species with abdomen greater than 42 mm and hindwing more than 37 mm. Thoracic dorsum dark brown marked with a green or yellow stripes as follows: a band on the dorsal carina which widens towards the collar, and two adjacent inner antehumerals closely apposed to it. No outer antehumeral stripes. Dorsum of segment 7 extensively marked with yellow. Occiput with yellow markings. Female with pair of horns near lateral ocelli 2
- 2 Abdominal tergite 2 all yellow except for broad brown V-shaped mark with point directed caudally. Male superior appendage: in dorsal view parallel-sided for about 0.8 of its length and abruptly narrowed and drawn out into a fine point; in lateral view, bearing a strong ventral tooth which lacks a swelling in exterior angle. Male inferior appendage with branches enclosing an angle of less than 90°. Female with horns on vertex which are decumbent and separated from the ovoid lateral ocelli, and with occipital armature made up of a raised central area and two smaller raised areas *spinosus*
- Abdominal tergite 2 mostly black, marked with yellow laterally, enclosing auricle, and dorsally as a narrow central longitudinal stripe. Male superior appendage: in dorsal view parallel-sided for only about 0.4 of its length, after which it tapers gently to the apex; in lateral view bearing a large swelling in the exterior angle between the ventral tooth and the apical section of the appendage. Male inferior appendage with branches more widely divaricate enclosing an angle of about 130°. Female with horns on vertex erect, appearing to issue from the rear of the circular lateral ocelli, and occiput with large black pads on lateral margin against eye and a recessed central area *moorei* sp.n.

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**FORTPFLANZUNGSVERHALTEN VON
SOMATOCHLORA ARCTICA (ZETTERSTEDT)
(ANISOPTERA: CORDULIIDAE)***

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REPRODUCTIVE BEHAVIOUR IN *SOMATOCHLORA ARCTICA* (ZETTERSTEDT) (ANISOPTERA: CORDULIIDAE) – The reproductive behaviour in relation to structural habitat resources was studied at mountain bogs of the Central Alps (Tyrol, Austria). The ♂ searched for mates at small clearings in coniferous forests where numerous scattered oviposition sites were hidden in dense vegetation, using 3 tactics: (1) they scanned the oviposition sites by slow flights at low height over large vegetated areas (scan flight), (2) they patrolled restricted areas with frequent hover stops while chasing any intruder (patrol flight), (3) they dived repeatedly into gaps of emergent vegetation, searching for ♀♀ close to the water (dive flights). 62% of the ♀♀ remained undiscovered by ♂♂, 11% fled successfully and 27% accepted copulation (n = 139). The copulation was always initiated in the air or on the ground when both partners plunged into the vegetation following a clash. Immediately after the take off – and possibly after intramale sperm translocation – the tandem assumed the wheel position. The pairs often circled over the clearings for several minutes and perched on sunlit branches of spruce or pine trees, 0.8-12 m above ground (mean 2.75 m, n = 20). During copulation that lasted 31-150 min (mean 85 min, n = 14) rhythmic pumping movements of the ♂ basal abdominal segments with frequencies from 0.14 to 0.36 Hz were observed. Copulation terminated by disengagement of the genitalia, then the partners separated immediately or after a short tandem flight. Oviposition never followed directly upon copulation and always occurred unguarded. The oviposition sites were selected carefully at shallow puddles among emergent vegetation. Eggs were laid by touching soaked moss or turf mud with the tip of the abdomen during rhythmic dipping flight movements with mean frequency of 0.61 Hz. One oviposition bout lasted 1-3 min and featured an egg flow of 1.7-4.5 eggs per s. Ovipositing females were sometimes successfully attacked by frogs (*Rana temporaria*), and males were occasionally found in orb-webs of spiders (*Araneus* sp.); however, predation risk was low at rendez-vous sites. Sperm competition is discussed with respect to behaviour during copulation and to the morphology of ♂ and ♀ genitalia.

* N.W. More gewidnet, im Hinblick auf seine Verdienste um den weltweiten Schutz der Libellen.