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STUDIES ON ULTIMATE INSTAR LARVAE OF NEOTROPICAL GOMPHIDAE, WITH THE DESCRIPTION OF *TIBIAGOMPHUS* GEN. NOV. (ANISOPTERA)

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Exuviae of 11 spp., referable to 10 genera, are described and illustrated. The larval type of *Gomphoides* Sel. and *Peruviogomphus* Klots is determined by reared individuals. The species identification of most of the exuviae is based on reared larvae. A key to the ultimate larval instars of the neotropical gomphid genera is constructed. *Tibiagomphus* gen.n. is erected for *Cyanogomphus uncatus* Fraser (type-species) and *C. noval* Rodrigues.

INTRODUCTION AND ACKNOWLEDGEMENTS

The supply of larval material of the neotropical Gomphidae during the past decennia has prompted me to add some new and interesting data. A full account on the larvae of the Central-American species of *Progomphus* Selys was already published by me (1991). The present paper may be considered a continuation of my studies on the ultimate instar larvae or exuviae of this family. Particular attention is paid again to reared individuals. *Tibiagomphus* gen. n. is erected for the two closely related species *Cyanogomphus uncatus* Fraser and *C. noval* Rodrigues since the similar body structures of the adults and the exceptional form of the larva furnish adequate grounds for generic separation.

The larval material studied is listed below together with the names of those to whose kindness I owe the privilege of examining it. The numbers associated with each species indicate the sequence in which the larvae of the species involved are treated.

- Dr Sidney W. DUNKLE and Prof. Dr Minter J. WESTFALL, Jr, Gainesville, USA. (FSCA = Florida State Collection of Arthropods). - *Erpetogomphus sabaleticus* Williamson: 2 reared ♂, 4 reared ♀, and 2 half grown larvae (No. 10). - *Peruviogomphus* spec. indet.: reared ♀ (No. 2).
- Dr Rosser W. GARRISON, Azusa, USA (CG = Collection Garrison). - *Progomphus zephyrus* Needham: reared ♀ (No. 4).

- Prof. Dr Angelo B.M. MACHADO, Belo Horizonte, Brazil (CM = Collection Machado). - *Aphylla theodorina* (Navás), supposition: 10 ♂ and ♀ exuviae (No. 5). - *Gomphoides infumata* Selys: reared ♀ (No. 7). - *Phyllocycla viridipleuris* (Calvert): reared ♂ and 1 ♀ exuviae (No. 6). - *Zonophora campanulata machadoi* St. Quentin: reared ♀ and 2 ♀ exuviae (No. 9).
- Dr Dennis R. PAULSON, Seattle, USA (CP = Collection Paulson). - *Archaeogomphus furcatus* Williamson: 2 reared ♂, 2 reared ♀ and several larvae (No. 1).
- Dr Hubert REYNERS, Mol, Belgium. - *Neogomphus edenticulatus* Carle & Cook: reared ♂ and 2 reared ♀ (No. 11).
- Mr Jan VAN TOL, Leiden, The Netherlands (RNHL = Rijksmuseum van Natuurlijke Historie) - *Progomphus conjectus* Belle: reared ♂ (No. 3). - *Idiogomphoides ictinia* (Selys) (supposition): 1 ♀ exuviae (No. 8).

INTRODUCTORY REMARKS

The interpretation of the predicates "reared" and "supposition" following a species name as well as the definitions of the terms "width of head" and "width of abdomen" are the same as in BELLE, 1991, p. 16.

The larval features used throughout the text of this paper hold only for ultimate instar larvae and exuviae. The measurements given for the specimens are in mm.

The illustrations were made from original camera lucida drawings (details completed by free hand) but they are not all on the same scale. The Jena oculars used are 12.5 and 6.3; the objectives 2.5, 1.6, 1 and 0.63. The combination is indicated in figure captions. Also the reproductions of the photographs of the exuviae are not all to scale owing to the great difference of size between the specimens. All figures are the work of the author except for Figures 46 and 47 which are reproductions of scanning electron micrographs (SEM) prepared by Dr Hubert R e y n e r s.

TIBIAGOMPHUS GEN. NOV.

Type species: *Cyanogomphus uncatus* Fraser, 1947.

DIAGNOSIS. - The new genus is a member of the *Agriogomphus* complex together with the two Selysian genera *Agriogomphus* and *Cyanogomphus*. It agrees with all the characters given by NEEDHAM (1944) for this group of genera except for the character "a marked enlargement of the third paranal cell and of certain cells beyond it along Cu2". Here the third paranal cell is about as large as the second paranal cell, while there is no enlargement of certain cells beyond the paranal cells along Cu2. As in *Cyanogomphus*, the new genus occasionally has a cross-vein in the discoidal triangle of the hind wing.

Tibiagomphus is most nearly allied to *Cyanogomphus* and agrees with it and differs from *Agriogomphus* in the characters earlier given by me for these two genera (BELLE, 1970: 22). Other features which are different from those of *Agriogomphus* and *Cyanogomphus* are:

B o t h s e x e s. - Wings more produced beyond the pterostigma; discoidal triangle of fore wings somewhat longer in axis of wing; sectors of arculus widely separated at their origin (cf. BELLE, 1970: pl. 5a).

M a l e. - Superior caudal appendages raggedly pointed and rearwardly diverging from each other; posterior genital hamules stout and more or less sickle--shaped (not foot-shaped with a distinct heel); spines on outer anterior margin of hind tibiae and tarsi strongly modified (cf. BELLE, 1982).

F e m a l e. - Vulvar lamina robust, subtriangular and narrowly cleft at apex; caudal appendages thick and more or less abruptly pointed (cf. BELLE, 1970).

L a r v a. - Dorsal hook of ninth abdominal segment excessively elongated, robust, straight and pointed to the back in an oblique direction (cf. RODRIGUEZ, 1984).

E t y m o l o g y. - *Tibiagomphus* from *"tibia"*, in reference to the hind tibia of the male, plus *"gomphus"*, a common generic suffix in the Gomphidae.

KEY TO ULTIMATE INSTAR LARVAE OF NEOTROPICAL GOMPHIDAE GENERA

NEEDHAM (1944) was the first to have keyed the genera of neotropical gomphid larvae. His key is based on moderate material and it is now rather inadequate. The present key still shows gaps and should be modified in the future when new larval types will have been discovered.

The immature stages of *Diaphlebia* Selys and *Mitragomphus* Needham are unknown, while the larva referred to *Idiogompoides* Belle is so merely by supposition.

There is further a *Cyanogomphus* problem. NEEDHAM (1940) described two kinds of larvae from Santa Catarina, Brazil, which he referred to this genus. The generic allocation was based on the venation of the larval wings. All four *Cyanogomphus* species occurring in the northern coastal region of continental South America have larvae with high, strongly erected, subequal middorsal hooks on the abdominal segments 6 to 9. But the abdomens of the Santa Catarina larvae have a dorsal outline that is typical of *Agriogomphus*. Pending further rearing of identical larvae I would provisionally consider the Santa Catarina larvae as belonging to *Agriogomphus*.

1	Hind tarsi two-segmented	2
--	Hind tarsi three-segmented	4
2(1)	Delicate and libelluline-like appearance. Labium spoon-shaped when lateral lobes (palpi) are retracted	***Archaeogomphus***
--	Stout appearance. Labium flat or nearly so	3
3(2)	Abdomen limpet-shaped; lateral spines on segments 7 to 9 about equal in size	***Cacoides***
--	Abdomen tent-shaped; lateral spines on segment 7 keeled on upper side and much larger than spines on other segments	***Melanocacus***
4(1)	Wing-cases widely divergent to rearward	5
--	Wing-cases parallel along mid-line	6

5(4) Mesocoxae (middle coxae) and procoxae about equally distant at their bases. Lateral caudal appendages (cerci) a trifle shorter than inferiors (paraprocts) ..... ***Erpetogomphus***

-- Mesocoxae much closer together at bases than procoxae. Lateral caudal appendages notably shorter than inferiors ..... ***Progomphus***

6(4) Abdomen without dorsal hooks 7

-- Abdomen with dorsal hooks 10

7(6) Abdominal segments 8 and 9 with large upcurving lateral spines ..... ***Zonophora***

-- Lateral margins of abdominal segments 7 to 9 ending posteriorly in an angulation or a short triangular spine 8

8(7) Third antennal segment excessively dilated and wider than long, its inner (mesial) margin straight for whole middorsal length of labrum ..... ***Perigomphus***

-- Third antennal segment depressed to elongate oval form 9

9(8) Prementum one-third to one-half longer thand wide; median lobe (ligula) with three black denticles in middle part of front margin ..... ***Neogomphus***

-- Prementum about as long as wide anteriorly; median lobe with seven to eleven black denticles in middle part of front margin ..... ***Epigomphus***

10(6) Fore and middle tibiae with burrowing hooks 11

-- Fore and middle tibiae without burrowing hooks 16

11(10) Abdominal segment 10 excessively elongated, longer than a quarter the length of abdomen 12

-- Abdominal segment 10 shorter than segments 8 and 9 combined 13

12(11) Abdomen without lateral spines. Inner margin of lateral labial lobes with large sharp--pointed recurved teeth ..... ***Aphylla***

-- Abdominal segments 6 or 7 to 9 with short, sometimes minute, lateral spines. Inner margin of lateral labial lobes generally smooth, sometimes with a minute tooth or with a row of minute teeth ..... ***Phyllocycla***

13(11) Abdominal segment 10 about half as long as segment 9 ..... ***Desmogomphus***

-- Abdominal segment 10 as long as or longer than segment 9 14

14(13) Abdominal segments 5 to 9 with lateral spines ..... ***Idiogomphoides***

-- Abdominal segments 7 to 9 with lateral spines 15

15(14) Ligula occupying middle three-fifths of front margin of prementum, its apex with a pair of brown submedian denticles ..... ***Gomphoides***

-- Ligula occupying less than two-fifths of front margin of prementum and without brown denticles at its apex ..... ***Phyllogomphoides***

16(11) Abdomen nearly three times as long as wide; segment 10 notably longer than segment 9. Inner margin of lateral labial lobes with a row of teeth ..... ***Peruviogomphus***

-- Abdomen broadly depressed; segment 10 shorter than segment 9. Inner margin of lateral labial lobes smooth 17

17(16) Dorsal hook on abdominal segment 9 excessively elongated, robust, straight and pointed to the back in an oblique direction ..... ***Tibiagomphus***

-- Dorsal hook on abdominal segment 9 not excessively enlarged and curved at the tip 18

18(17) Dorsal hooks on abdominal segments 6 to 9 well-developed, subequal, slender and strongly erected ..... ***Cyanogomphus***

-- Dorsal hooks on abdominal segments 6 to 9 not so, the one on segment 9 larger and generally strongly tilted to the back ..... ***Agriogomphus***

DESCRIPTION OF THE LARVAE

ARCHAEOGOMPHUS FURCATUS WILLIAMSON, reared
Figures 26, 32, 35

Material. - Costa Rica: Guanacaste Prov., Rio Tempisque (11.3 mi W of Liberia), 9-VIII-1964, 1 ♂ (emerging), F.G. Thompson leg.; - Heredia Prov., Río Puerto Viejo, Finca La Selva (1.5 mi S of Puerto Viejo, 200 ft), 14-IV-1967, 1 ♀ larva (emerged 25-IV-1967), D.R. & M.L. Paulson leg.; - Mexico: State of Chiapas, Río Desplobado (8.7 mi NW of Huixtla, sea level), 31-VI-1965, 1 ♂ larva (emerged 4-VIII-1965), 1 ♀ larva (emerged 9-VIII-1965), D.R. Paulson leg., CP.

NEEDHAM (1940) was the first who described (by supposition) the larval type of *Archaeogomphus*. The description was based on a single exuviae taken in the State of Santa Catarina, Brazil; the larval skin most probably belongs to *A. densus* Belle known from that region (cf. BELLE, 1982).

The exuviae of *A. furcatus* (Fig. 35) is smaller than the Santa Catarina specimen, but larger than that of *A. nanus* Needham. The larva of the latter was described from the type locality (Surinam) by BELLE (1970). Other noteworthy differences and similarities between these larvae are:

(1) End hook of lateral labial lobe tapering in *furcatus* and shaped as in *nanus*, strongly rounded in the Santa Catarina skin.
(2) Upper outline of abdomen of *furcatus* most resembling that of the Santa Catarina skin with the dorsal hooks on the end segments more tilted to rearward than in *nanus* (Fig. 32).
(3) Teeth on lateral margins of abdominal segments 4 as widely spaced in *furcatus* as in *nanus*; they are more numerous and closer together in the Santa Catarina skin.
(4) Lateral margins of abdominal segment 3 more finely serrated than in *nanus* and more distinctly serrated near apex of segment.
(5) Relative width of abdomen in *furcatus* about as great as in *nanus* (Fig. 26); the abdomen is more slender in the Santa Catarina skin.

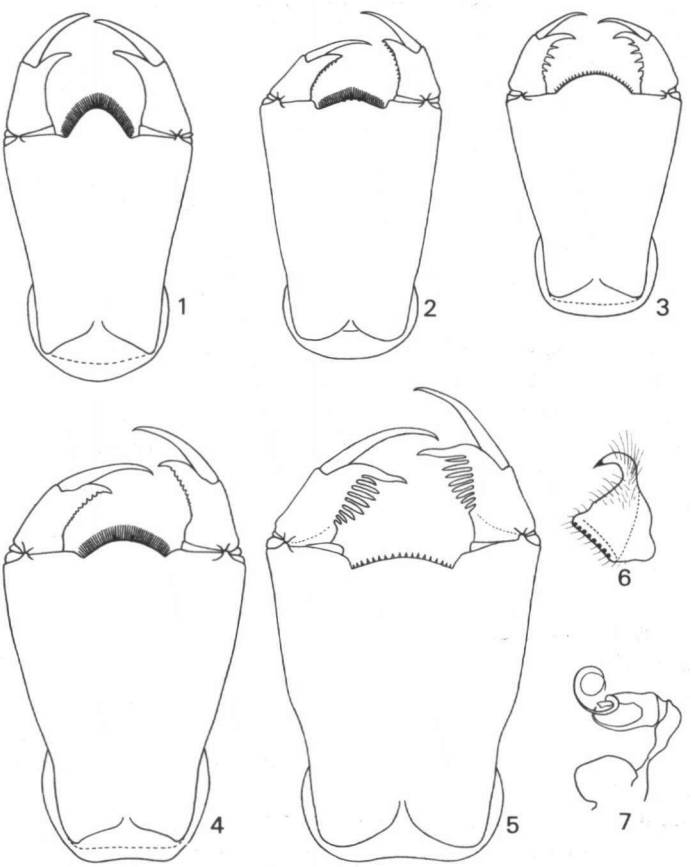
The exuviae of the reared female from Costa Rica has served for figures 26 and 32; that of the reared male from Mexico has served for the accompanying photograph (Fig. 35).

Measurements. - Total length 13-15, - abdomen 8-9.5, - width of abdomen 5.3-5.5, - width of head 3.8-3.9, - hind femur 4-4.5.

PERUVIOGOMPHUS SPEC. INDET. reared
Figures 3, 17, 24, 30, 33-34, 36

Material. - Ecuador: Prov. Napo, Limoncocha on Río Napo (elev. 300 m), XI-1980, 1 ♀ (reared), M.J. Westfall leg., FSCA.

Prof. Westfall kindly lent me for identification and description a reared indivi-



Figs 1-7. Structural features of neotropical Gomphidae: (Figs 1-5) Labium of exuviae, ventral view [6.3x1.6]: (1) *Phyllocycla viridipleuris*, - (2) *Neogomphus edenticulatus*, - (3) *Peruviogomphus* spec. indet., - (4) *Gomphoides infumata*, - (5) *Aphylla theodorina*(?); - (Figs 6-7) *Progomphus conjectus*, reared male [6.3x1.6]: (6) right posterior genital hamule, ventral view, - (7) penis, right lateral view.

dual of *Peruviogomphus* which he had collected in Limoncocha at the Río Napo during his explorations in Ecuador. The freshly emerged female was put in a vial with alcohol along with the cast-off skin from which it came. I myself took a male of *P. moyobambus* Klots in Dayuma Camp (23-IX-1990) at the Río Arajuno, near the point where this affluent flows out in the Río Napo, about 150 km upstream from Limoncocha. This male (hind wing length 25 mm) is much smaller than the reared female (hind wing length 31 mm). The unique male

(holotype) of *P. pearsoni* Belle has a hind wing length of 28 mm. A female from Arima at the Río Purus in Brazil (XI-1922, S.M. Klages, FSCA), tentatively referred to *P. pearsoni* by me, has a hind wing of comparable size (length 28.5 mm). Another female, also probably belonging to *P. pearsoni* is from the Serra de Navio, Brazil (cf. BELLE, 1979: 114). This female differs from the Arima female in not having the fore wing triangle equilateral and in having three postanal cells in each of the hind wings. The reared female from Limoncocha can easily be distinguished from the two supposed females of *P. pearsoni* by the larger size, by the two well-developed pale stripes on the sides of the pterothorax, by the much shorter spines on the outer anterior margin of the hind femora, and by the much wider lateral dilatations of the abdominal segments 8 and 9. It undoubtedly belongs to a distinct species which, in the absence of a male, has to remain unnamed.

ADULT FEMALE (freshly emerged, preserved in alcohol). - Total length 46, - abdomen 35 (incl. caud. app. 1.5), - hind wing 31, - greatest width of hind wing 8.5 - costal edge of pterostigma in fore wing 3.3.

P t e r o t h o r a x. - Sides of pterothorax with broad pale mesepimeral and metepimeral stripes (It is not improbable that in aged specimens these stripes and other pale markings become brownish and less characteristic).

H e a d. - Occipital plate twice as wide as middorsal length; its hind margin almost straight, slightly concave in middle part.

L e g s. - Femora becoming darker toward knees. Outer anterior margin of hind femora with a row of 14-19 short spines, the longest of these spines about one-fourth the diameter of femur.

W i n g s. - Venation of wings closely resembling that of the Serro do Navio female (cf. BELLE, 1979, fig. 11) but triangle in fore wings equilateral, triangle in left hind wing uncrossed, trigonal interspace in left fore wing starting with a single cell against triangle, and with two postanal cells in either hind wing. Second primary antenodal cross-vein the sixth. Nodal index 11:17-18:12/10:17-14:12 and intermedian cross-veins 8-8/5-6.

A b d o m e n. - Middorsum of abdomen pale, especially on segments 7 to 9. Segment 3 to 8 paler toward base of segment. Sides of segment 8 and 9 dilated (Fig. 34); the dilatations of segment 8 about 0.3 mm wide. Vulvar lamina reaching middle of ninth sternum; posterior margin of vulvar lamina widely and deeply excised (Fig. 33).

EXUVIAE (Fig. 36). - Body clean, pale sandy-coloured and patternless, almost bare, but with pale hair fringes along abdomen and legs.

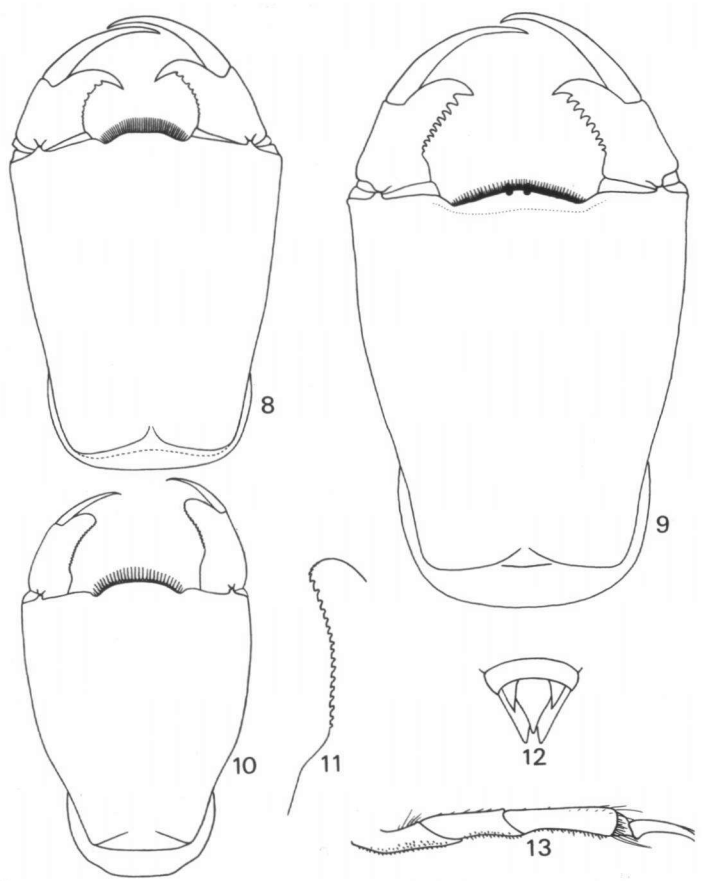
Antenna slender (Fig. 17). The third segment subcylindric, three times as long as the two basal segments together, very slightly upcurved and sparsely provided with long pale hairs at lateral sides.

Labium delicate and entirely pale (Fig. 3). Prementum about twice as long as wide at base, regularly widening forward and being at the front about one and a half times as wide as at the hinge. Middle lobe prominent and subcircular, occupying nearly half the width of the front, rimmed with about 40 minute, sharply pointed pale scales. Lateral lobes regularly widening to base, the end hook long and slender. Movable hook also slender and about one and a half times as long as the end hook. Before the end hook the inner margin of the lateral lobe has five spaced slender teeth, the first three teeth are the largest and

subequal. Proximally the others diminish in size toward base of palpus.

Wing-cases reaching apex of abdominal segment 4.

Legs slender. Tibiae of fore and middle legs without burrowing hooks, the outer sides of these tibiae with rather long pale hairs. Hind tarsi three quarters as long as hind tibiae.



Figs 8-13. Structural features of neotropical Gomphidae: - (Figs 8-9) Labium of exuviae, ventral [6.3x1.6]; (8) *Idiogomphoides ictinia*(?), - (9) *Zonophora campanulata machadoi*; - (Figs 10-11) *Erpetogomphus sabaleticus*, exuviae: (10) labium, ventral view [6.3x2.5]; - (11) inner margin of left palpus, ventral view [12.5x4]; - (Fig. 12) *Neogomphus edenticulatus*, tenth abdominal segment and caudal appendages in female exuviae, dorsal view; - Fig. 13. *Gomphoides infumata*, left hind tarsus and claws of exuviae, left lateral view [6.3x1.6].

Abdomen widest on segment 6, regularly tapering to rearward but segment 10 notably longer than preceding segments. Segment 10 subcylindric but ventral side flattened at base. Ventral longitudinal sutures on segment 9 present. Dorsal spines on segments 3 to 9, small on 3 but becoming successively larger, more acute and more reclined rearwardly on posterior segments (Fig. 30). Lateral spines on segments 7 to 9; these spines slightly increasing in size to rearward (Fig. 24). Midventral length of segments 7 to 10 approximately in ratio 9:10:11:14, with the caudal appendages 5 on the same scale. Caudal appendages pale, the superior (epiproct) and laterals are each successively a trifle shorter than the inferiors.

Measurements. - Total length 25, - abdomen 17.5 (incl. caud. app. 1.3), - tenth abdominal segment 2.8, - hind femur 4.5, - hind tibia 4.5, - hind tarsus 3.1, - antenna 2.2, - width of head 4.6, - width of abdomen 6.

PROGOMPHUS CONJECTUS BELLE, reared
Figures 6-7, 19-20

Material. - Suriname: Brokopondo Distr., Gansee (on sandy bank of Suriname R.), 26-IX-1938, 1 ♂ exuviae, D.C. Geijskes, leg.; - same locality, 5-VIII-1951, 1 ♂ (freshly emerged adult resting on its exuviae, at 10 p.m.; **allotype**, Heyde, leg., RNHL.

The larva which I referred to this species was first described by NEEDHAM (1944) on the basis of a single exuviae taken in Surinam by the late Dr D.C. Geijskes. In 1966 I gave additional notes and illustrations on an exuviae of the same kind, taken by myself in the same country (BELLE, 1966a). Now, Mr Jan van Tol (Leiden) kindly turned over to me for examination and description a conspecific exuviae, along with the male that had emerged from it. The material in question was found in the collection of Surinam Odonata, formerly owned by Geijskes. Both the very teneral male and its exuviae are preserved dry, the cast-off skin pinned and the imago separately stored in a small triangular envelope. The exuviae is slightly crushed but can well be studied. The imago, however, is badly flattened and barely recognizable as the matching male of *P. conjectus*, a species known only from a unique female collected in Suriname. The male is described below. The measurements may be somewhat larger in a fully mature male.

ADULT MALE (**allotype**). - A flattened shrivelled teneral specimen. - Total length ca 47, - abdomen ca 34 (incl. caud. app. ca 2.1), - hind wing ca 29.

Pterothorax. - Although not well coloured a thoracic pattern is discernible which agrees with that of the holotype (cf. BELLE, 1966a: fig. 44).

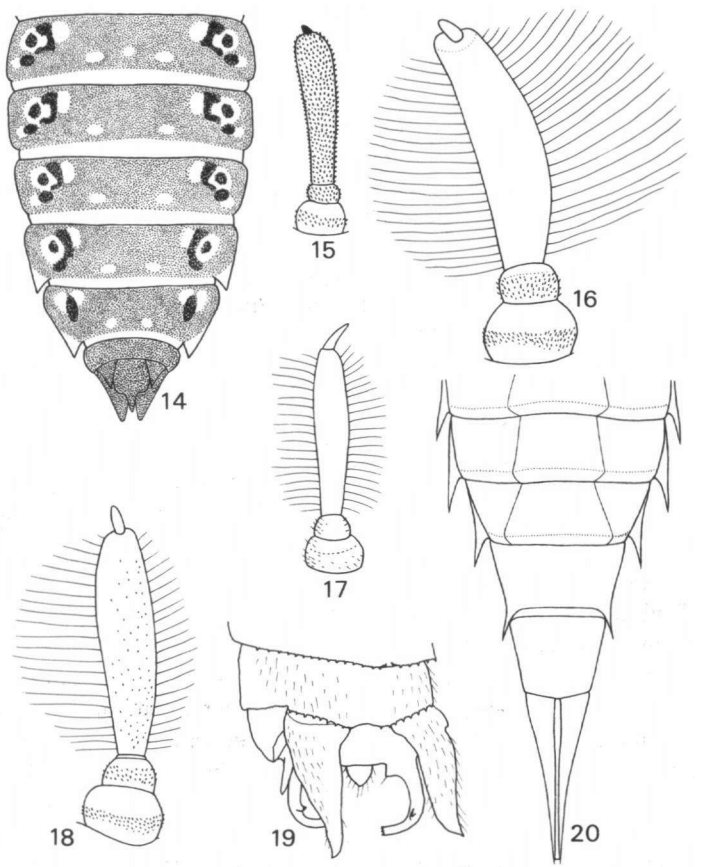
Head. - Occipital crest almost straight, fringed with rather long (ca. 0.6 mm) pale brown hairs.

Wings. - Basal subcostal cross-vein present in all wings. Supratriangles open. Subtriangles two-celled. Discoidal triangles three-celled, the dividing cross-veins tri-radiate from centre. Outer side of triangles angulate, in hind wings more than in fore wings. Trigonal interspaces starting with three cells against triangle followed by two rows of cells.

L e g s. - Third tibiae a trifle longer than the tarsus they bear. Lamina tibialis of first tibiae about one-third the tibial length.

A b d o m e n. - Auricles with about 25 minute black denticles.

Accessory genitalia. - Penis guard and anterior hamule of the usual form, the tip of the penis guard with a deep median excision, the tip of the anterior hamule deeply excised. Posterior hamule shaped as shown in Figure 6, tufted with long pale brown hairs, the frontal border straight and armed with 7 (left) and 8 (right) teeth; tip of posterior hamule slender, regularly curving inward and ending in a sharp black tooth. Penis with a very long, upwardly curving ventral spine on median segment and with two long curled flagellae at tip (Fig. 7).



Figs 14-20. Structural features of neotropical Gomphidae: (14) *Neogomphus edenticulatus*, colour pattern of apical abdominal segments and caudal appendages in male exuviae, dorsal view [6.3x1]; - (Figs 15-18) Right antenna of exuviae, dorsal view [6.3x2.5]: (15) *Erpetogomphus sabaleticus*. - (16) *Idiogomphoides ictinia*(?), - (17) *Peruviogomphus* spec. indet., - (18) *Gomphoides infumata;* - (Figs 19-20) *Progomphus conjectus:* (19) tenth abdominal segment and caudal appendages of reared male (flattened), dorsal view [6.3x1.6], - (20) apex of abdomen of exuviae (hairs omitted), ventral view [6.3x1].

Caudal appendages. - Inferior carina of superior caudal appendage with about 10 black denticles preceded by a triangular basal externo-lateral spine. Branches of inferior caudal appendage slender, regularly curving inward, the tips ending with two (right) and three (left) black denticles (Fig. 19).

The EXUVIAE here referred to *P. conjectus* agrees with the characters numbered (1), (2), (3), (5), (7), (8) and (10) for the *obscurus* group (cf. Belle, 1991: 13). Most striking is the agreement with character (3): the abdominal segment 9 has no ventral longitudinal sutures. The characters of the present exuviae which differ are:

(4) The anal pyramid is twice as long as the ninth abdominal segment (midventral length of ninth abdominal segment 2 mm, of anal pyramid 4 mm).

(5) The ventral inner margins of the inferior caudal appendages are slightly concave on the basal half (Fig. 20).

(6) The third antennal segment is superiorly covered with short stiff hairs which are strongly directed rearward; the hairs on the lateral sides are long and also directed rearward. The fourth antennal segment is a cylindric, bluntly pointed, erected rudiment which is nearly as long as the third segment is wide near the tip.

The characters here numbered (4), (5) and (6), which differ from the *obscurus* group, are not found in the members of the *risi* group and *pygmaeus* group; they are apparently typical of a new group to which *Progomphus conjectus* belongs.

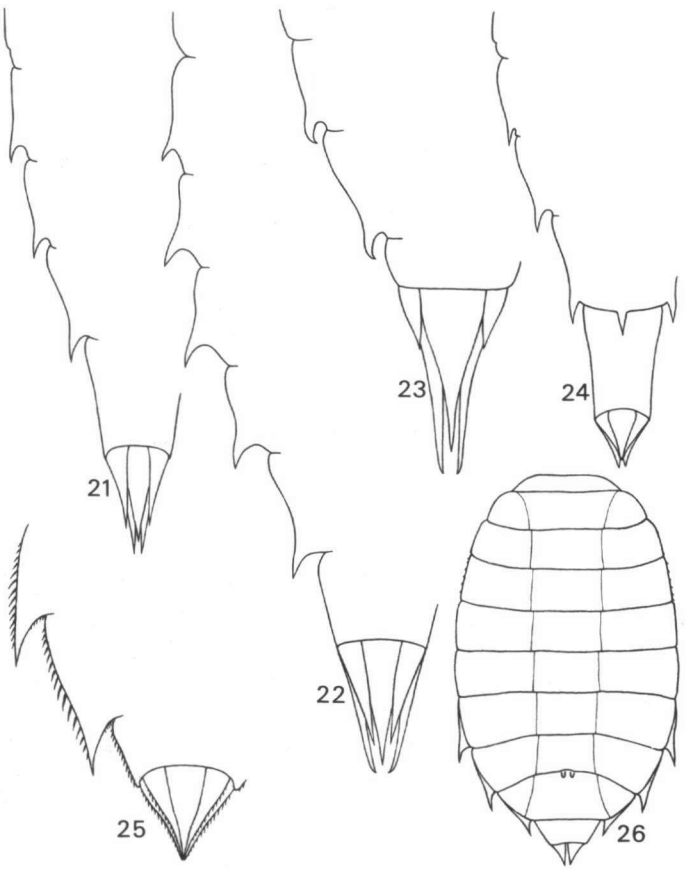
PROGOMPHUS ZEPHYRUS NEEDHAM, reared
Figure 38

M a t e r i a l. - Dominican Republic: Santiago Prov., Rio Inoa, 8.5 km W of San José de las Matas, 480 m, 5-VIII-1983, 1 ♀ (freshly emerged), R.W. Garrison leg., CG.

While collecting at a stream in the Dominican Republic Dr R.W. Garrison found a newly hatched female of *Progomphus* and a larval cast-off skin which was apparently left behind at the transformation of this female. He wrote 16 May 1991: "I found the teneral female very near the cast skin (exuviae), and I thought that the female had just emerged from it. It is possible, but I think unlikely, that the two are separate. I did not rear it. I collected them early in the morning." And on 17 July 1991 he wrote: "My skin and female were collected along a fairly wide stream at a moderately high elevation. I had attempted to go to Needham's type locality to get *zephyrus*, but I was not able to find the locality. - The stream was shallow but wide (about 50-60 feet wide, if I remember correctly); there were pines nearby, I believe. So these specimens were definitely at a highland elevation. - Again I am fairly certain that the skin and teneral female are correctly associated. They were found together (only inches apart!) on the open stream bank." I have the specimens, adult female and the exuviae from which it apparently emerged, kindly sent me by Dr Garrison for examining and reporting. After careful study of the material I was surprised to find the

larval skin agreeing with NEEDHAM's (1941) description of the larva of *P. zephyrus*.

By the courtesy of Dr E. Richard Hoebeke, Curator at the Cornell University Collections, Ithaca, New York, I was able to study the larval "holotype" of *P. zephyrus* and to compare it directly with the exuviae of Garrison's reared female. Both specimens proved to be conspecific as expected. Needham's reared female of *P. serenus* was very incomplete. I received only the wings; the left and right pair were separately mounted on slides. Needham's figure 1, on p. 228, is a depiction of the transposed left pair of wings. The venation of the wings of the



Figs 21-26. Exuviae of neotropical Gomphidae: - (Figs 21-25) Left margin of apical abdominal segments and caudal appendages of exuviae (hairs omitted), dorsal view: (21) *Gomphoides infumata* [6.3x1], - (22) *Idiogomphoides ictinia*(?) [6.3x1], - (23) *Zonophora campanulata machadoi* [6.3x1], - (24) *Peruviogomphus* spec. indet. [6.3x1], - (25) *Erpetogomphus sabaleticus* [6.3x1.6]; - (Fig. 26) *Archaeogomphus furcatus*, abdomen of exuviae, ventral view [6.3x1].

reared female of *zephyrus* does not differ substantially from that displayed in this figure, having for example the two rows of cells in the anal field of the fore wings reaching to beyond the posterior angle of the triangle.

The female of *P. zephyrus* is similar in stature and general coloration to the female of *P. serenus* but it is somewhat darker. The most striking colour differences are the following:

(1) Labrum black except for a narrow pale band along free border; in *serenus*, pale all around border, with a black basal spot covering half the surface of labrum.
(2) Pale colour of facial lobes not reaching to the pale anteclypeus; in *serenus*, reaching to the pale anteclypeus.
(3) First pale antehumeral stripe short and not connected with the pale mesothoracic "half collar"; in *serenus*, longer and normally confluent with the pale mesothoracic "half collar".
(4) Dorsal surface of lamina supra-analis black; in *serenus*, pale with a black basal spot.

The most striking morphological difference is found in the structure of the vertex. The female of *P. zephyrus* has a distinct tubercle between each lateral ocellus and the eye border; there is no such tubercle in the female of *P. serenus*.

A complete description of the female of *P. zephyrus* may well wait further collecting when fully mature adults, males and females, are available.

APHYLLA THEODORINA (NAVAS), supposition
Figures 5, 27, 39

Material. - Brazil: State of Minas Gerais, Florestal, X-1977, 10 ♂ and ♀ exuviae, A. & E. Machado, leg.; CM (but 2 exuviae in RNHL).

The exuviae photographed (Fig. 39) is described below. It is the cast-off skin of a last instar female larva.

A patternless silt-covered skin, almost hairless but with hair fringes on sides of legs.

Third antennal segment sub-cylindric and slightly upcurved. Fourth antennal segment a slender sub-conical rudiment, erect and about half as long as the third antennal segment is wide near apex.

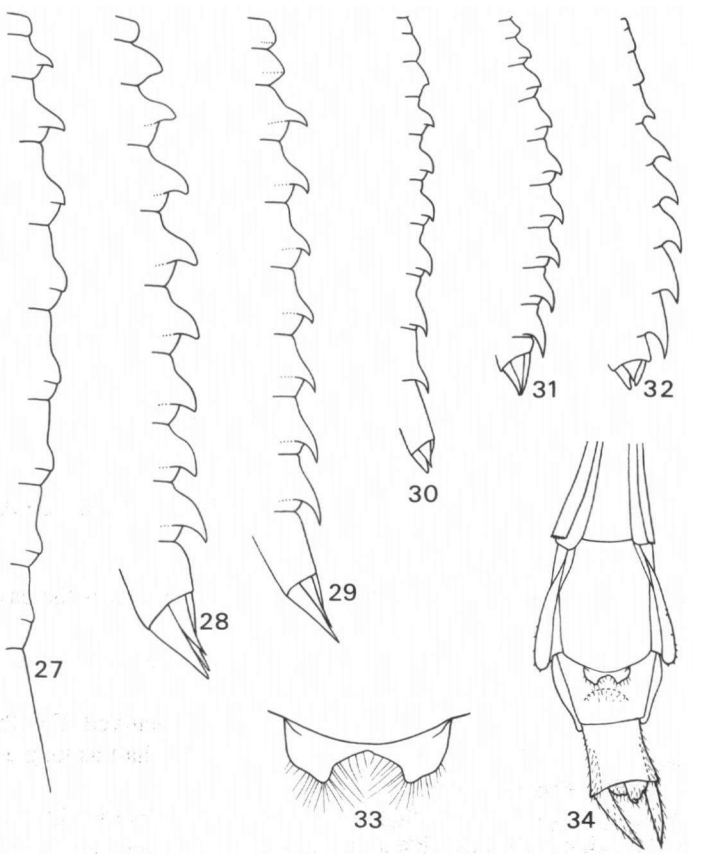
Labium shaped as shown in Figure 5. Prementum distinctly widened forward, at hinge about three-fifths as wide as at front margin. Median lobe of prementum covering a little more than one-third the frontal breadth, its free border fringed with about 20 short and sharply pointed scales. End hook of lateral lobes long, strong and sinuate. Before the end hook the inner margin of the lateral lobe has eight long and sharply pointed recurved teeth, the longest tooth is the second one, the three proximal teeth decrease strongly in size to the base.

Burrowing hooks on first two pairs of tibiae rather small. Posterior sides of

apical joint of first and second tarsi with stiff outwardly directed hairs.

Abdomen with well-developed dorsal hooks on segments 2 and 3, the one on segment 3 somewhat larger than the one on segment 2 (Fig. 27). Dorsal hook on segment 4 no more than a low hump. Other segments without dorsal hook. Segment 10 becoming dark brown to apex. Caudal appendages as long as segment 10 is wide at apex, the laterals a trifle shorter than the others.

M e a s u r e m e n t s. - Total length 52, - abdomen 39, - tenth abdominal segment 14 (incl. caud. app. 1.4), - hind femur 5, - hind tibia 4, - hind tarsus 3, - antenna 3.5, - third antennal segment 2.5, - width of abdomen 6.5, - width of head 6.



Figs 27-34. Structural features of neotropical Gomphidae: - (Figs 27-32) Upper outline of abdomen of exuviae, left lateral: (27) *Aphylla theodorina*(?) [6.3x0.63], - (28) *Idiogomphoides ictinia*(?) [6.3x0.63], - (29) *Gomphoides infumata* [6.3x0.63], - (30) *Peruviogomphus* spec. indet. [6.3x0.63], - (31) *Erpetogomphus sabaleticus* [6.3x0.63], - (32) *Archaeogomphus furcatus* [6.3x1]; - (Figs 33-34) *Peruviogomphus* spec. indet., reared female: (33) vulvar lamina, ventral view [6.3x4], - (34) apical segments of abdomen, ventral view [6.3x1].

This skin may belong to *A. theodorina* which occurs commonly in the same locality. Some of the exuviae are smaller than the one here described; the total length varies from 49 to 52 mm. The number of teeth before the end hook of the lateral lobe is generally eight but sometimes six or seven.

PHYLLOCYCLA VIRIDIPLEURIS (CALVERT), reared
Figures 1, 40

M a t e r i a l. - Brazil: State of Minas Gerais, Florestal, 10-X-1982, 1 ♂ larva (emerged in laboratory 20-X-1982); - 1 ♀ exuviae, Machado leg.; CM.

Prof. A.B.M. Machado has referred a reared male of *Phyllocycla* to this species. I can accept this allocation though the imago differs from the holotype by the presence of a brown mesepisternal spot near to the sub-alar crest. The exuviae of the reared male has been photographed (Fig. 40) and is here described.

A clean slender skin with a long tapering abdomen, sandy-coloured but abdominal segments 4 to 9 (except for flexible apical rim) successively darker coloured on the rear segments being dark brown at apex of segment 10 (including caudal appendages).

Antennae hairy on sides. Third antennal segment slightly longer than twice the length of the two basal segments combined; it is slender, circular in cross--section and slightly upcurved. Fourth antennal segment a tusk-like rudiment, erect and nearly twice as long as segment 3 is wide at tip.

Labium shaped as shown in Figure 1. Prementum one and a half times longer than wide anteriorly, widened forward being at the middle hinge about half as wide as it is at the front margin. Median lobe of prementum produced in a semi-elliptical plate that is densely fringed with long scales. Lateral lobe widest at base; its end hook two-thirds as long as inner side of lateral lobe; inner margin of lateral lobe toothless; movable hook strong and about as long as outer side of lateral lobe.

Wing-cases reaching anterior part of abdominal segment 4. Legs with hair fringes along sides. Burrowing hooks of first and second tibiae very small.

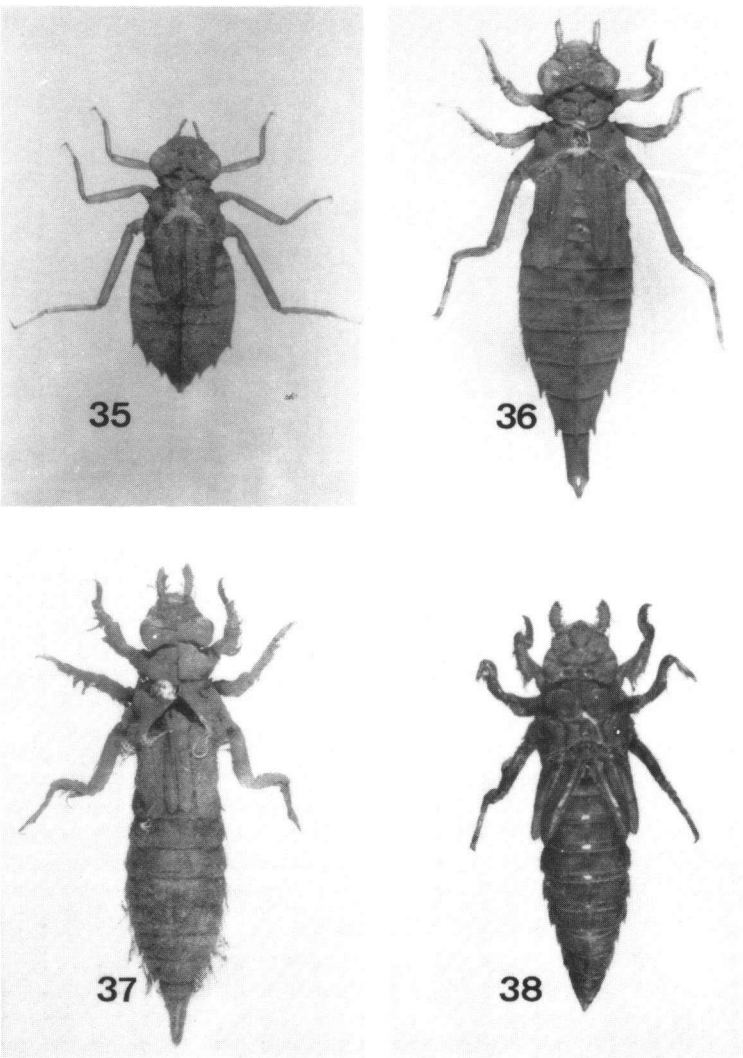
Abdomen with small dorsal hooks on segments 3 to 7; the hooks diminish regularly in size to rearward; the hook on segment 7 is no more than a low hump. Lateral spines on segments 7 to 9; these spines small and sub-equal.

M e a s u r e m e n t s. - Total length 35, - abdomen 25, - tenth abdominal segment 8 (incl. caud. app. 1.1), - hind femur 4, - hind tibia 3.8, - hind tarsus 2.6, - antenna 3.5, - width of abdomen 4, - width of head 4.3.

The other female exuviae was stored in a triangular envelope with the field note (in Prof. Machado's handwriting) that the skin was taken from the bank vegetation of the same stream. The skin is very similar to the one described and may belong to the same species.

The female exuviae of *Phyllocycla* tentatively referred to *viridipleuris* by

NEEDHAM (1944: 378) possibly belongs to *P. propinqua* Belle, a species known from the locality where his specimen has been found.



Figs 35-38. Exuviae in dorsal aspect (from photographs): (35) *Archaeogomphus furcatus*, - (36) *Peruviogomphus* spec. indet., - (37) *Zonophora campanulata machadoi*, - (38) *Progomphus zephyrus*.

GOMPHOIDES INFUMATA SELYS, reared
Figures 4, 13, 18, 21, 29, 41

Material. - Brazil: State of Minas Gerais, Florestal, II-1982, 1 ♀ (emerging), E. Machado, leg.; CM.

The adult female and the exuviae from which it came, are preserved in alcohol and here described.

Body clean, almost bare and patternless but abdominal segment 3 to 9 (except for flexible apical rim) and segment 10 (including appendages) becoming gradually somewhat darker brown.

Frontal margin of labrum fringed with hairs. Third antennal segment (Fig. 18) slender, a little clavate, three times as long as the two basal segments together, slightly depressed and upcurved, covered with minute black spinules, both sides scarcely provided with long pale hairs. Fourth antennal segment a small slender erected rudiment which is as long as segment 3 is wide at tip.

Labium shaped as shown in Figure 4. Prementum one-fifth longer than wide, strongly widened forward, at the middle hinge half as wide as at the front margin. Middle lobe occupying middle three-fifths of front margin, evenly convex, with a pair of black submedian denticles and densely fringed with pale hair-like scales. Lateral lobe short and almost parallel-sided. Movable hook about one and a half times as long as portion of lateral lobe beyond base of movable hook. Before the strong end hook the inner margin of the lateral lobes has a row of 11 (right) and 13 (left) short recurved blunt teeth which decrease in size toward base of palpus.

Wing cases reaching middle of fourth abdominal segment.

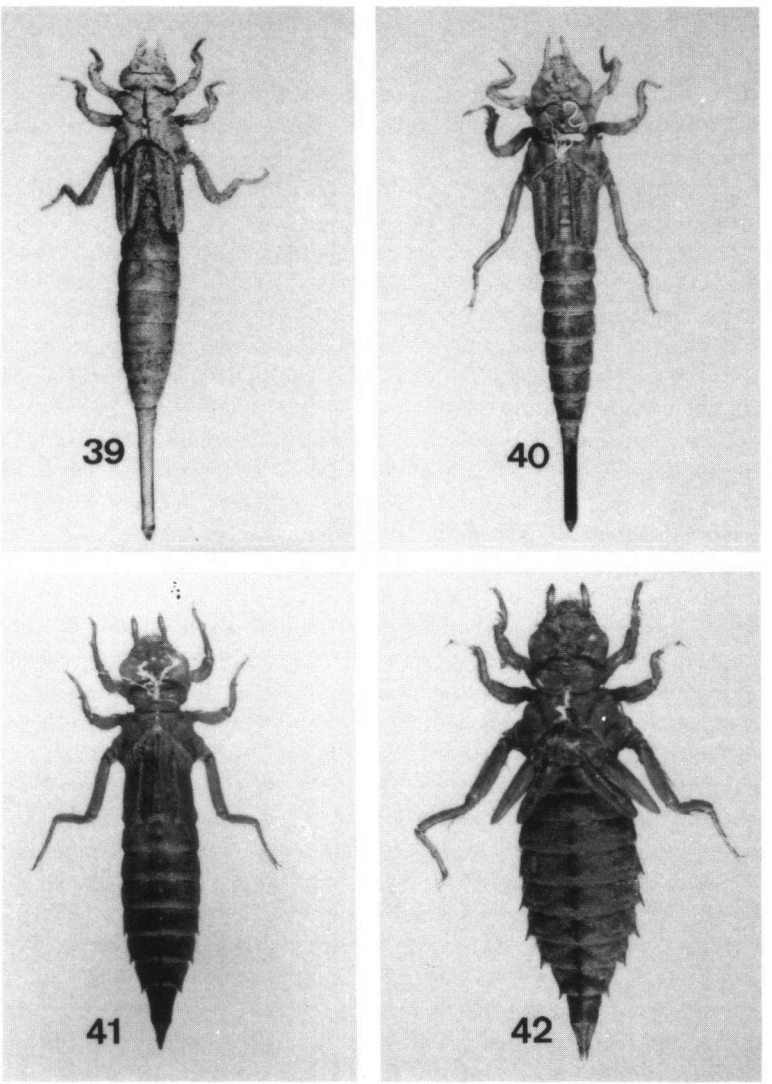
Legs slender, almost bare, the longitudinal edges of tibiae and tarsi granulated. Plantar surface of front and middle tarsi very finely granulated, but that of hind tarsi also finely spinulous (Fig. 13). Front and middle tibiae with distinct burrowing hooks.

Abdomen gradually narrowing to apex (Fig. 41), bare but lateral margins scarcely provided with long pale hairs. Ventral longitudinal sutures on segment 9 present. Segment 10 notably longer than preceding segments. Midventral length of apical segments 7 to 10 approximately in ratio 10:9:8:12, with the anal appendages 9 on the same scale. There are well-developed sharply pointed dorsal hooks on segments 3 to 9, increasing in size successively on apical segments (Fig. 29). Segments 7 to 9 with well-developed lateral spines; they are subequal but the ones on segment 7 are the smallest (Fig. 21). Caudal appendages long, sharply pointed, the extreme tips dark brown, the superior appendage as long as the inferiors, the laterals two-sevenths as long as the inferiors.

Measurements. - Total length 34, - abdomen 23, - hind femur 5, - hind tibia 3.5, - antenna 3.2, - third antennal segment 2.1, - width of abdomen 6, - width of head 6.

IDIOGOMPHOIDES ICTINIA (SELYS), supposition
Figures 8, 16, 22, 28, 42

M a t e r i a l. - Surinam: Distr. Nickerie, Corantijn River, Frederik Willem Falls (on rocks of bank), 5-VIII-1959, 1 ♂ exuviae, D.C. Geijskes, leg.; RNHL.



Figs 39-42. Exuviae in dorsal aspect (from photographs): (39) *Aphylla theodorina*(?), - (40) *Phyllocycla viridipleuris*, - (41) *Gomphoides infumata*, - (42) *Idiogomphoides ictinia*(?).

This exuviae (Fig. 42) shows close affinity to the one from adjoining Guiana described in detail by NEEDHAM (1944: 197-199), but it differs in some respects, viz.:

(1) The Surinam exuviae is smaller and has the following measurements: total length 36.5, - abdomen 24 (incl. caud. app. 3), - hind femur 5.4, - hind tibia 5, - hind tarsus 4.5, - antenna 3.1, - width of abdomen 10, - width of head 6.3. The Guianan exuviae is notably larger. Its total length is 42 mm and the width of the abdomen 13 mm.

(2) The third antennal segment (Fig. 16) is about two and a half times as long as the two basal segments together. The fourth antennal segment is an erect finger-like rudiment and about as long as the third segment is wide near its tip. The third segment of the Guianan exuviae is three times as long as the two basal segments together.

(3) The labium is shaped as shown in Figure 8. The prementum is one-fifth longer than wide. The ligula is convex at the sides and slightly concave in the middle. Its is bordered with about 40 scales; in the Guianan exuviae with about 30 scales. The inner side of the lateral lobes is armed with a row of 9 (right) and 10 (left) very blunt teeth. The largest tooth is the second from the end hook; in the Guianan exuviae the largest of the teeth is in the middle of the row.

(4) The abdominal segments 5 to 9 have well-developed somewhat upcurving lateral spines (Fig. 22). These spines are all simple; in the Guianan exuviae the lateral spines on the segments 6 to 9 are provided with a pale inner subapical lobe. Ventral longitudinal sutures on abdominal segment 9 present. The upper outline of the abdomen is shaped as shown in Figure 28. The caudal appendages are shorter than segment 10, the middorsal length of the tenth segment and the length of the caudal appendages are approximately in ratio 12:11; in the Guianan exuviae the caudal appendages are longer than segment 10 and the middorsal length of the tenth segment and the length of the caudal appendages are approximately in ratio 12:15.

The above differences I would not consider of generic value. Both exuviae are species incertae sedis. Nevertheless, I venture to suggest they are referable to the two known *Idiogomphoides* species.

The other tentative "candidates" would be *Diaphlebia* and *Mitragomphus* (all three genera lacking in the key). The known representatives of *Diaphlebia* are too small to be eligible for larval skins of this size. The size of *Mitragomphus ganzanus* Needham, 1944 is in agreement and its (type) locality, the State of Pará in Brazil, is near enough. But, as pointed out by Needham, *Mitragomphus* is related to *Zonophora*, the larva of which lacks dorsal hooks on the abdomen. Therefore I believe that the two exuviae belong to *Idiogomphoides*. The size and morphology are in agreement with this supposition.

The genus is known from only three specimens taken in Brazil, at the eastern coastal regions of the South American highlands. Our exuviae are from the northern coastal region of continental South America.

The three Brazilean specimens belong to two species, the largest of the two is *I. demoulini* (St. Quentin). The Guianan exuviae then should be tentatively associated with this species, and the Surinam exuviae with the smaller *I. ictinia*.

ZONOPHORA CAMPANULATA MACHADOI ST. QUENTIN, reared
Figures 9, 23, 37

Material. - Brazil: State of Minas Gerais, Tabuoes Ibirité, 10-III-1983, 1 ♀ (exuviae found close to freshly emerged imago); - 2 ♀ exuviae (both collected near the place where the resp. emerged individuals were found), A., E., & P. Machado, leg.; CM.

In 1944 NEEDHAM described (by supposition) the larval type of *Zonophora* on the basis of a single cast-off skin, taken in Surinam by Geijskes. BELLE (1966b) gave additional notes and figures on this exuviae and referred it (by supposition) to *Z. batesi* Selys. In the same paper he also described (by supposition) the exuviae of *Z. c. calippus* Selys, collected in Surinam by himself. Now Professor A.B.M. Machado has obtained a freshly emerged female of *Z. campanulata machadoi* St. Quentin and the cast-off skin from which it came, and kindly provided these for description.

The exuviae of *Z. c. machadoi* (Fig. 37) is notably larger than those of *Z. batesi* and *Z. c. calippus*. The other differences may be seen from the following comparison:

(1) The margins of the abdomen and anal pyramid are very heavily fringed with long hairs; in *Z. batesi* and *Z. c. calippus* thinly fringed with long hairs.

(2) The number of teeth along the inner margin of the palpus before the end hook is generally 9 or 10, but sometimes 8; in *Z. batesi* generally 8 and in *Z. c. calippus* generally 6.

(3) The prementum (Fig. 9) is more stocky than in *Z. batesi* and *Z. c. calippus*, the length is smaller than in *Z. batesi* but larger than in *Z. c. calippus*. The ligula is moderately produced in a low rounded border; the same in *Z. c. calippus* but that of *Z. batesi* has a straight front border.

(4) The (upcurving) lateral spines on the abdominal segments 8 and 9 (Fig. 23) are relatively much smaller than those of *Z. batesi* and *Z. c. calippus*. The lateral spines on segment 9 are distinctly shorter than the middorsal length of abdominal segment 10. This is also the case in *Z. c. calippus*. In *Z. batesi* they are as long as the middorsal length of abdominal segment 10. Further the lateral spines on segment 8 are about half as large as the ones on segment 9; in *Z. batesi* and in *Z. c. calippus* they are about equal in size.

(5) The superior appendage is distinctly shorter (about 0.5 mm) than the inferior appendages; in *Z. batesi* almost equal in length (superior appendage about 0.1 mm shorter) and in *Z. c. calippus* as long as the inferior appendages. The lateral appendages are about one-third as long as the inferior appendages; in

Z. batesi about one-fourth and in *Z. c. calippus* about one-fifth. In common with *Z. batesi* and *Z. c. calippus* the ventral inner margin of the inferior appendages are concave at the base forming an elongate hole with elevated borders.

Measurements of exuviae of the freshly emerged female. - Total length 42, - abdomen 28 (incl. caud. app. 5), - width of abdomen 9, - width of head 6.5, - antenna 4, - third antennal segment 3, - hind femur 6.

ERPETOGOMPHUS SABALETICUS WILLIAMSON, reared
Figures 10-11, 15, 25, 31, 43

Material. - Panama: Canal Zone, Pipeline Road, Quebrada Juan Grande, 24-I-1975, 2 half grown larvae; 28-I-1975, 2 ♂ (emerged on 5-VI-1975 and 19-VI-1975); 23-I-1977, 2 ♀ (emerged on 16-V-1977 and 27-V-1977); 2 ♀, (emerged on 20-IV-1977 and 26-IV-1977). All M.L. May leg., FSCA.

Dr M.L. May has collected and reared several larvae of this species; the adults were identified by Dr R.W. Garrison. The larva is peculiar in having the lateral margins of the abdomen, including the caudal appendages, armed with close-set, rearwardly directed spinules. If it had not been reared, I would be inclined o consider it representing a new genus.

The exuviae of the reared female, emerged on 5 June 1975, is photographed (Fig. 43) and described below. The figures of the structural details were made from an exuviae of a reared male (emerged on 27-VI-1975).

Larva very robust, with a small head and diverging wing-cases. Body clean and bare, pale sandy-brown, without colour design (save for the usual pairs of brownish dots on dorsum of abdomen).

Dorsum of head stubbly. Free border of labrum with short stiff pale hairs. Third antennal segment long, slender and also stubbly (Fig. 15). Fourth antennal segment a mere conical brown knob. Lateral sides of head between pedicel and eye border swollen, covered with stubbles and tufted with pale hairs.

Labium rather short, extending back to middle of procoxae, shaped as shown in Figure 10. Prementum one-seventh longer than wide anteriorly. Median lobe occupying middle three-sevenths of front margin of prementum; it is evenly convex and armed with a double row of scales, the first row consists of short brown scales, the second row consists of longer, close-set, bristle-like pale scales. Lateral lobe with broadly rounded end hook, the inner margin armed with about 15 low teeth (Fig. 11); movable hook slender and about four-fifths as long as portion of lateral lobe beyond base of movable hook.

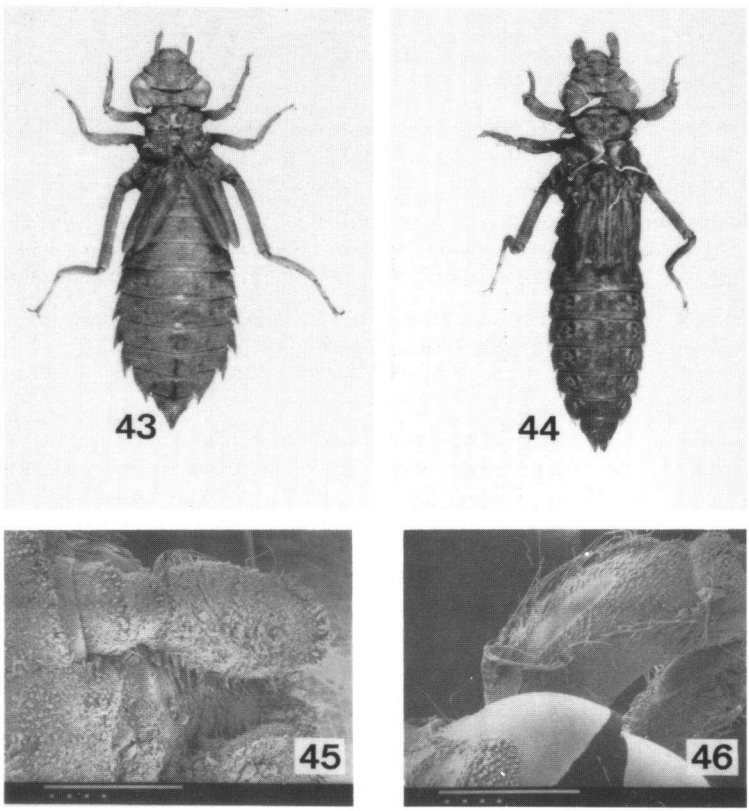
Wing-cases reaching to middle of fourth abdominal segment.

Legs bare except for tibiae which are scarcely provided with pale hairs. Burrowing hooks present on first two pairs of tibiae.

Abdomen broad, widest across segment 6, the seventh segment slightly less

wide. Segments 2 to 9 with ventral longitudinal sutures. Dorsal spines on segments 2 to 9 (Fig. 31); they regularly increase in size to rearward, the ones on end segments armed with spinules on side and upper margins. Lateral spines on segments 3 to 9, acute, small on segment 3, becoming larger on rear segments, being very large and conspicuous on segments 7 to 9, the side margins of the spines armed with close-set, rearwardly directed spinules (Fig. 25). Sides of abdominal segment 10, dorsal margin of superior appendages and outer margin of lateral and inferior appendages also spiny.

Measurements. - Total length 20, - abdomen 13 (incl. caud. app. 1.5), - width of abdomen 6.5, - width of head 4.4, - hind femur 4; - hind tibia 3.5, - hind tarsus 2.5, - antenna 2; - third antennal segment 1.4.



Figs 43-46. *Erpetogomphus sabaleticus* and *Neogomphus edenticulatus*: - (Figs 43-44) Exuviae in dorsal aspect (from photographs): (43) *E. sabaleticus*, - (44) *N. edenticulatus*; - (Figs 45-46) *N. edenticulatus* (from SEM): (45) left antenna, dorsal view, - (46) first and second left femora, showing dorsal scars.

NEOGOMPHUS EDENTICULATUS CARLE & COOK, reared
Figures 2, 12, 14, 44-46

M a t e r i a l. - Argentina: Neuquén Prov., Rio Pulmari, San Carlos de Bariloche, 31-XII-1989, 1 ♂, 2 ♀ (all emerging), A. Calzolari de Tártara, leg.; RNHL.

Dr H. Reyners (Mol, Belgium) generously provided me with a number of freshly emerged individuals of this species, taken in the Patagonic Andes by fishermen. In a letter dated 31 October 1990 he recorded the details of the capture: "With this letter, I send you also an extended report on the finding of *Neogomphus edenticulatus* in the Patagonic Andes. - In short: the larvae and imagos were collected in the Rio Pumari at a small distance from the origin of this river which comes out of the mountain lake, Lago Norquinco. The place is unpolluted and located in the national park Lanin. The collector, Adriana Calzolari de Tártara (Fernando Tártara is the husband), thinks she saw identical insects in the Quillen river which is a more southern affluent of the Rio Aluminé. The water temperature was relatively warm when the specimens hatched (17° C; pH is also given;-) on day 31/12/89 (-) at about noon with an external temperature of 28° C. The gomphids went out of the water in a quiet and shallow place with pebbles of 5 to 15 cm diameter [sic!] on the bottom. The animals hatched on nearby 15-28 cm stones (-); later on, the writer (Fernando Tártara) adds he has also seen some on a 1 m boulder. It was rather windy (50 km/h!) but I think this is normal since the place is relatively high (the given altitude was not measured; I hardly believe it was > 2000 m as claimed -) and it is located in the wuthering 40ies. Metamorphosis is said to be (incredibly?) short: 20 minutes."

The larva (Fig. 44) is very similar to *N. molestus* Selys. The latter was described by NEEDHAM & BULLOCK (1943). The most striking difference is found in the colouration of the abdomen. *N. molestus* has a more or less unpatterned greyish brown abdomen whereas *N. edenticulatus* has an abdomen with a very well-developed colour pattern (Fig. 14).

The m e a s u r e m e n t s of the exuviae are the same as those of *N. molestus*. - Total length 24, - abdomen 15 (incl. caud. app. 1.5); - width of abdomen 6, - width of head 5, - antenna 2.2, - third antennal segment 1.5, -hind femur 4.5.

S p e c i e s k e y t o u l t i m a t e i n s t a r l a r v a e o f *N e o g o m p h u s*

1	Abdomen with short triangular lateral spines on segments 6 or 7 to 9; total length 28 mm	***bidens***
–	Abdomen with short triangular lateral spines on segments 8 and 9; total length 24 mm	2
2(1)	Abdomen more or less unpatterned greyish brown	***molestus***
--	Abdomen with well-developed colour pattern	***edenticulatus***

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