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FOUR NEW LARVAE OF *PHYLLOGOMPHOIDES* BELLE FROM MEXICO (ANISOPTERA: GOMPHIDAE)

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Larvae of *P. duodentatus* Donnelly, *P. luisi* González & Novelo, *P. pacificus* (Sel.) and *P. suasus* (Sel.) are described and illustrated for the first time. Comments on their habitat and habits, and the relationships with South American members of the genus are added.

INTRODUCTION

The genus *Phyllogomphoides* Belle, 1970, comprises a group of 42 species of neotropical dragonflies known to date. The larvae are typical stream-dwellers, inhabiting small and large forest streams (Belle, 1984). The larval stages of only seven species are known, viz. the North American and Mexican *P. stigmatus* (Sel.) and *P. albrighti* (Needh.) and the South American *P. andromeda* (Sel.), *P. cristatus* (Needh.), *P. fuliginosus* (Hag.), *P. major* Belle and *P. undulatus* (Needh.). The larvae of the former two species were described by NEEDHAM (1904) and NEEDHAM & WESTFALL (1955), respectively; those of the others by BELLE (1970). The hitherto unknown larvae of four species, all from Mexico and Central America, are described in this paper.

CHARACTERIZATION OF *PHYLLOGOMPHOIDES* LARVA

As stated by BELLE (1970) and supplemented by myself: Body of *Gomphus*-like appearance, tapering caudad. Prementum parallel-sided, ligula prominent, with long, flat scale-like setae; movable hook about as long as inner side of palpus; end hook sharply or bluntly pointed and more or less incurved; inner

margin of palpus smooth, crenate or with few blunt teeth while in some species the apical half is slightly expanded. Abdominal segments 2-9 with dorsal hooks; segments 7-9 with well-developed lateral spines, the tips of these spines slightly upcurved and incurved or straight and divergent. Abdominal segment 10 as long as or longer than segment 9. Caudal appendages about equal in length.

HABITAT AND HABITS

Larvae of *Phyllogomphoides* usually inhabit muddy or sandy banks along the shores of rivers and streams, especially where decayed leaves are abundantly deposited. They are quite cryptic in this substrate and when exposed they strike a motionless attitude even when prodded with twigs or pincers.

The caged larvae feed at night. The emergence always happened 3 or 4 hours after midnight, at least in the species studied. To emerge, mature larvae climb on rocks and undergo ecdysis almost in a horizontal position.

The lifespan of the larvae is apparently very long. A medium-age (female) larva of *P. duodentatus* which I kept in captivity for three years, underwent four moults before emerging.

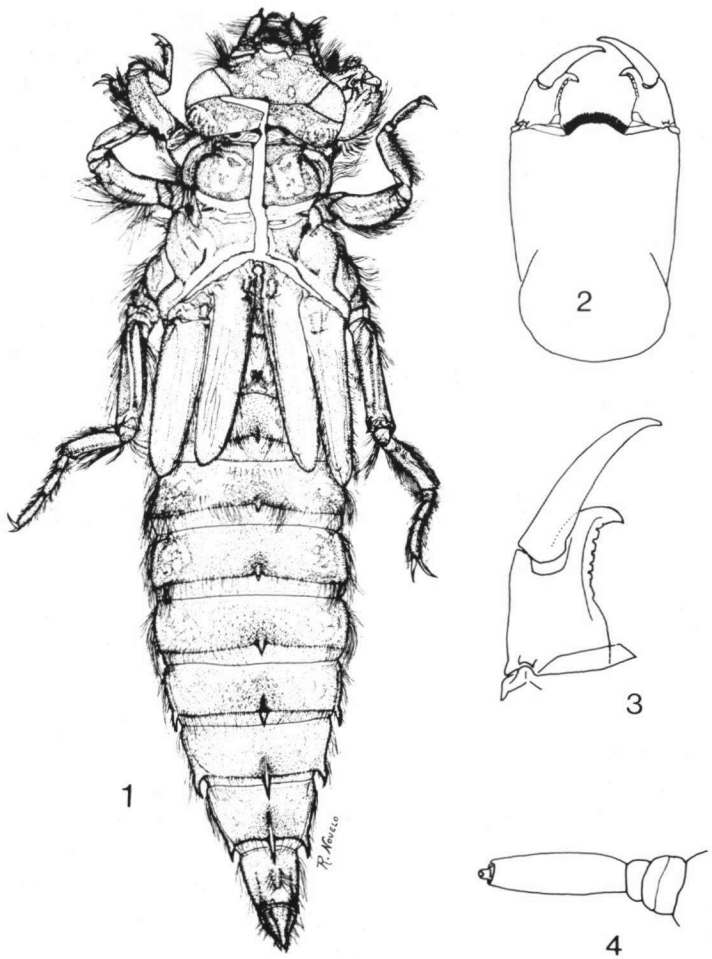
PHYLLOGOMPHOIDES DUODENTATUS DONNELLY, 1979

Figures 1-5, 9A, 10, 20, 28

Material. – 1 exuviae (♀, reared). MÉXICO: Veracruz, Los Tuxtlas, Estación de Biología Tropical "Los Tuxtlas", Río de la Laguna Escondida, 23-V-84, R. Novelo leg., 1 ♀ (as young instar larva). Deposited in author's collection.

DESCRIPTION. – Exuviae (female) preponderantly yellow, segment 10 reddish-yellow; body enlarged and tapering caudad (Fig. 1).

Head wider than long, as wide as prothorax or little more; labrum bare just at midline, remainder with sparse scale-like setae, its anterior border with a fringe of long setae; anteclypeus bare, postclypeus mostly bare except at central hump-like prominence which is covered with scale-like setae; a tuft of long white setae at base of mandibles; frons and vertex with scale-like setae, bare as follows: a triangular central area with a circular one to each side of it, cephalic lobes mostly bare but with vertical rows of scale-like setae; posterior margin of head slightly concave. Antennae 4-jointed (Fig. 4), covered with scale-like setae and a fringe of long setae to each side of third antennomere, proportion of antennomeres: 0.25, 0.15, 1.0, 0.15. Mandibles biramous (Fig. 20), external branch of the left mandible with four cusps, internal one with seven cusps arranged in a semicircular manner; five and five cusps, respectively, in right mandible; maxillae with long white setae along external border, galeae pointed at apex, laciniae with four long, robust, incurved ventral hooks and three longer but less robust incurved dorsal hooks (Fig. 28). Articulation of the postmentum and prementum reaching the base of mesocoxae; prementum rectangular (Fig. 2), longer than wide, sides straight and parallel, slightly convergent at base, bare except for a ventral row of long and delicate setae just beneath the ligula; ligula moderately prominent,

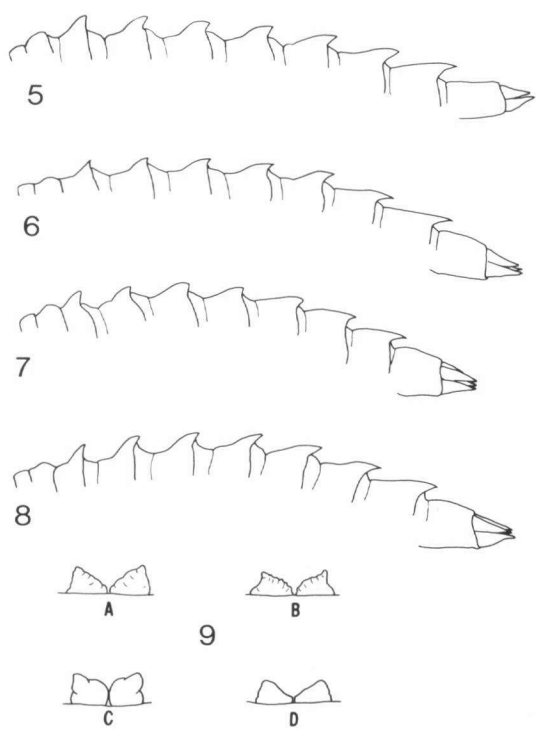


Figs 1-4. *Phyllogomphoides duodentatus*: (1) dorsal aspect of the last ♀ exuviae; – (2) prementum dorsal view; – (3) left palp, dorsal view; – (4) right antenna, dorsal view.

its convex free border very slightly concave in middle and fringed with a dense row of long, flat, truncated scale-like setae; all the dorsal surface densely covered with very minute scale-like setae. Palpi short and thick, end hook stout, its apex roughly pointed and strongly incurved, almost in 90° angle (Fig. 3), internal margin with 7-8 short, thick teeth which increase in size and thickness gradually from the base to the apex; external margin with sparse, delicate, white setae; end hook sharp, longer than palpal lobe.

T h o r a x. – Pronotum with scale-like setae except for a pair of large, subquadrangular bare areas; anterior and posterior margins almost straight. Synthorax with scale-like setae, sutures bare. Wing cases reaching to near middle of abdominal segment 4. Legs short and thick, strongly pubescent; femora and tibiae with dense longitudinal rows of scale-like setae intermingled with bare longitudinal areas; tarsi pubescent, claws long with a conical empodium.

A b d o m e n enlarged (Fig. 1), slightly widening to its maximum at 5-6, thence regularly tapering, ending in a tubular segment 10; heavily setose on lateral margins. Tergites densely covered with scale-like setae and hair-like setae, except for the usual bare areas on each side, which give to the abdomen a mottled aspect; posterior margins of 5-9 with spiniform setae; segments 7-9 with lateral sharp spines, slightly upcurved and incurved, those on 7 the smallest (Fig. 10). Tergites 2-9 with dorsal hooks (Fig. 5): on 2 merely a low hump, well-developed on 3-9, gradually increasing in size to rearward; bases of dorsal hooks on 8--9 forming a dorsal ridge which penetrate forward 0.45 and 0.55 the length of 8 and 9, respectively; in contrast, the apices of such hooks reach the basal 0.37 and 0.42 of segments 9 and 10 respectively (Fig. 1). Gonapophyses 0.08 as long as sternite 9, conic-shaped, divergent, with internal borders irregular (Fig. 9A). Caudal appendages heavily setose, acutely-pointed; epiproct yellow, cerci and paraprocts reddish-brown. Proportion of caudal appendages: cerci 0.95, epiproct 1.0, paraprocts 0.90.



Figs 5-9. Details of the morphology of *Phyllogomphoides duodentatus* (Figs 5, 9A), *P. luisi* (Figs 6, 9B), *P. pacificus* (Figs 7, 9C) and *P. suasus* (Figs 8, 9D): (5-8) dorsal outlines of abdomen, left lateral view, showing the development of dorsal hooks; – (9) female gonapophyses, ventral view.

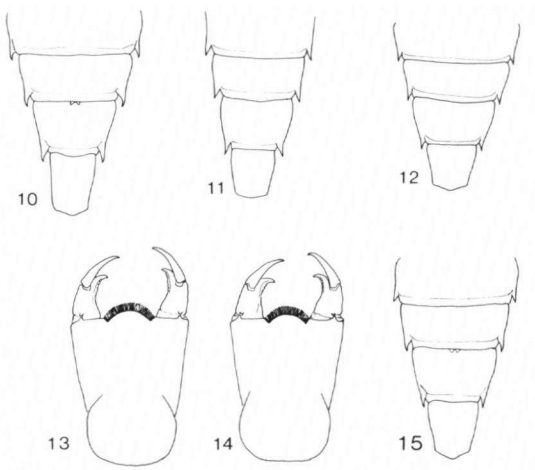
M e a s u r e m e n t s (mm). – Total length 32.5; – abdomen 21.5; – width of head over the eyes 5.8; – posterior femur 9; – segment 9 (ventral) 2.25; – segment 10 (ventral) 2.6; – lateral spines on 7-9 (measured ventrally on the inner margin) 0.5, 0.6, 0.75 respectively. – Dorsal hooks

on 3-9 (dorsal margin): 0.55, 0.95, 1.1, 1.25, 1.5, 2.0, 2.15; – (inferior margin): 0.35, 0.45, 0.45, 0.5, 0.65, 0.8, 1.0.

PHYLLOGOMPHOIDES LUISI GONZÁLEZ & NOVELO, 1990

Figures 6, 9B, 11, 13, 23, 29

Material. – 2 exuviae (1 ♂, reared; 1 ♀). MEXICO: Morelos, Río Sabinos, km 18.3 Rt 95, 5 km S Acatlipa, 23-III-85, R. Novelo leg., 1 ♂ (as ultimate instar larva), 1 ♀ (exuviae). – Deposited in author's collection.



Figs 10-15. Details of the morphology of *Phyllogomphoides duodentatus* (Fig. 10), *P. luisi* (Figs 11, 13), *P. pacificus* (Fig. 12) and *P. suasus* (Figs 14, 15): (10-12, 15): abdominal segments 7-10, showing the shape of lateral spines [11, 12: ♂, – 10, 15: ♀]; – (13-14) prementum, dorsal aspect.

DESCRIPTION. – Exuviae yellowish-brown, abdominal segment 10 reddish-brown; body as stated for the genus.

Head and thorax as in *P. duodentatus*, except: internal branch of left mandible with 6 cusps (Fig. 23), that of right mandible with 3-4 cusps. Ligula without slight concavity in middle of its anterior border; end hook gradually incurved but not angularly as in *P. duodentatus* (Fig. 13).

Abdomen similar to that of *P. duodentatus* but lateral spines in 7-9 straight and divergent, not incurved (Fig. 11); apices of dorsal hooks of segments 8 and 9 reaching basal 0.38 and 0.47 of segments 9 and 10 respectively (Fig. 6). Female gonapophyses 0.08 as long as sternite 9; internal borders irregular, apices acute (Fig. 9B). Male gonapophyses vestigial (absent). Caudal appendages: Epiproct yellowish-brown throughout; cerci dark, reddish-brown; paraprocts mostly reddish-brown, apices yellow. Proportions: cerci 0.86, epiproct 1.0, paraprocts 1.0.

Measurements (mm). – Total length 28.5 (♂), 30.0 (♀); – abdomen 20.5 (♂), 21.0 (♀); – width of head over the eyes 5.2 (♂, ♀); – posterior femur 4.1 (♂), 4.5 (♀); – segment 9: 2.25 (♂), 2.15 (♀); – segment 10: 2.25 (♂), 2.27 (♀); – lateral spines on 7-9: 0.35, 0.45, 0.50 (♂), 0.25, 0.40, 0.50 (♀). – Dorsal hooks on 3-9 (dorsal margin): 0.85, 0.90, 1.0, 1.20, 1.50, 1.75, 2.0 (♂), 0.85, 1.0, 1.0, 1.15, 1.50, 1.75, 2.10 (♀); – (inferior margin): 0.35, 0.30, 0.30, 0.40, 0.60, 0.75, 0.85 (♂), 0.30, 0.25, 0.25, 0.40, 0.50, 0.75, 0.85 (♀).

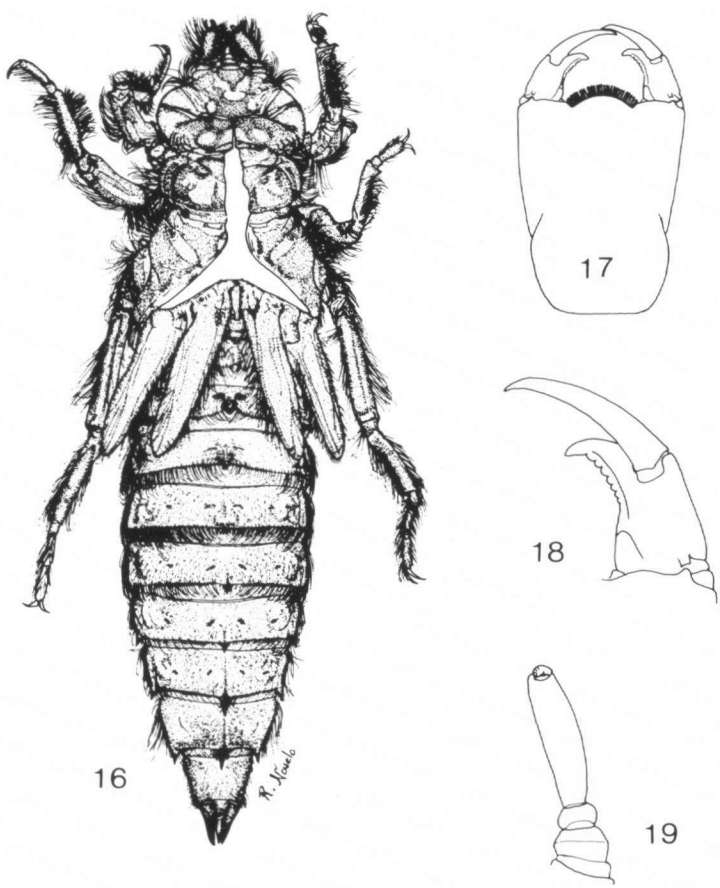
PHYLLOGOMPHOIDES PACIFICUS (SELYS, 1873)

Figures 7, 9C, 12, 16-19, 22, 31

Material. – 5 exuviae (2 ♂, 3 ♀), 2 ♀. MEXICO: Morelos, Río Sabinos, km 18.3 Rt 95, 5 km S Acatlipa, 15-VII-85, R. Novelo leg., 2 ♀ (exuviae); – 7-VII-87, R. Novelo leg., 1 ♂ (exuvia); – Temilpa Viejo, 15-I-87, R. Novelo leg., 1 ♀ (ultimate instar larva); – 24-VII-87, R. Novelo leg., 1 ♀ (ultimate instar larva, reared); – 26-III-87, R. Novelo leg., 1 ♂ (ult. instar larva, reared), 1 ♀ (ult. instar larva). – Deposited in author's collection.

DESCRIPTION. – Exuviae yellow to brownish, larvae yellowish-brown to reddish-brown, body enlarged and tapering caudad (Fig. 16).

Head and thorax as in preceding species except: internal branch of left



Figs 16-19. *Phyllogomphoides pacificus*: (16) dorsal aspect of the last ♂ exuviae; – (17) prementum, dorsal view; – (18) right palp, dorsal view; – (19) left antenna, dorsal view.

mandible with 6-8 cusps (Fig. 22), that of right mandible with 4 cusps. Ligula and end hook as in *P. luisi* (Figs 17-18).

A b d o m e n mostly as in *P. duodentatus* except: lateral spines in 7-9 straight and divergent (Fig. 12); bases of dorsal hooks on 8-9 generally not forming a dorsal ridge (Fig. 16); apices of dorsal hooks of 8-9 reaching the basal 0.20 and 0.25 of segments 9 and 10 respectively (Fig. 7). Gonapophyses of female 0.10 as long as sternite 9; internal border as in Fig. 9C, apices rounded. Caudal appendages dark, reddish-black, except the tip of paraprocts which are reddish--yellow, heavily setose, acutely-pointed at apex. Proportions: Paraprocts 1.0, epiproct 0.96, cerci 0.87.

M e a s u r e m e n t s (mm). – Total length 28 (♂), 31 (♀); – abdomen 19 (♂), 21.5 (♀); – width of head over the eyes 5.2 (♂, ♀); – posterior femur 4 (♂), 4.5 (♀); – segment 9: 1.85 (♂), 1.8 (♀); – segment 10: 2.1 (♂), 2 (♀); – lateral spines on 7-9: 0.25, 0.45, 0.45 (♂), 0.3, 0.55, 0.55 (♀). – Dorsal hooks on 3-9 (dorsal margin): 0.5, 0.75, 0.8, 0.9, 1.1, 1.5, 1.7 (♂), 0.51, 0.75, 1.0, 1.0, 1.25, 1.6, 2.0 (♀); – (inferior margin): 0.35, 0.2, 0.2, 0.2, 0.35, 0.65, 0.75 (♂), 0.35, 0.2, 0.2, 0.2, 0.5, 0.6, 0.75 (♀).

PHYLLOGOMPHOIDES SUASUS (SELYS, 1859)

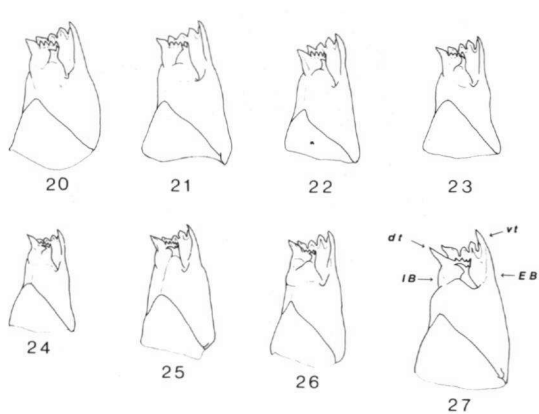
Figures 8, 9D, 14-15, 21, 30

M a t e r i a l. – 2 exuviae (♂, ♀, reared). MEXICO: San Luis Potosí, Huichihuayan; 23-VI-90, R. Novelo leg., 1 ♂, 1 ♀ (as ultimate instar larvae). – Deposited in author's collection.

DESCRIPTION. – Exuviae yellowish-brown, abdominal segment 10 reddish--brown, body as stated for the genus.

H e a d and t h o r a x as in preceding species except: internal branch of right mandible with 5-7 cusps (Fig. 21). Ligula and end hook as in *P. luisi* (Fig. 14).

A b d o m e n similar to that of *P. duodentatus* but lateral margins of 8-9 and tergite 10 with some long setae; lateral spines on 7 more or less straight, 8-9 slightly incurved (Fig. 15). Female gonapophyses 0.6 as long as sternite 9; internal border al-



Figs 20-27. Internal view of the left mandibles, showing the teeth's shape of internal and external branches: (20) *Phyllogomphoides duodentatus*; – (21) *P. suasus*; – (22) *P. pacificus*; – (23) *P. luisi*; – (24) *P. andromeda*; – (25) *P. undulatus*; – (26) *P. cristatus*; – (27) *P. major*; – [IB: internal branch; – EB: external branch; – dt: dorsal tooth; – vt: ventral tooth].

most straight, apices rounded (Fig. 9D). Caudal appendages: in the male colored as follows: basal half of epiproct and paraprocts pale brown, apical half yellow; cerci reddish-brown on basal 0.50, thence the following 0.30 yellow and the apical 0.20 reddish-brown; female's epiproct yellowish-brown throughout; cerci dark, dark brown at basal 0.65, reddish-brown at apical 0.35; paraprocts mostly reddish-brown, apices yellowish-brown.

Measurements (mm). – Total length 30 (♂), 31 (♀); – abdomen 20 (♂), 22 (♀); – width of head over the eyes 5.3; – posterior femur 4.5 (♂), 5 (♀); – segment 9: 2.2 (♂), 2.1 (♀); – segment 10: 2.25 (♂, ♀); – lateral spines on 7-9: 0.35, 0.5, 0.55 (♂), 0.25, 0.55, 0.55 (♀); – dorsal hooks on 3-9 (dorsal margin): 0.85, 1.0, 1.25, 1.25, 1.6, 1.8, 2.0 (♂), 0.75, 1.0, 1.2, 1.25, 1.55, 1.95, 2.15 (♀); – (inferior margin): 0.25, 0.25, 0.25, 0.4, 0.6, 0.8, 0.8 (♂), 0.25, 0.2, 0.2, 0.35, 0.55, 0.6, 0.75 (♀).

DISCUSSION

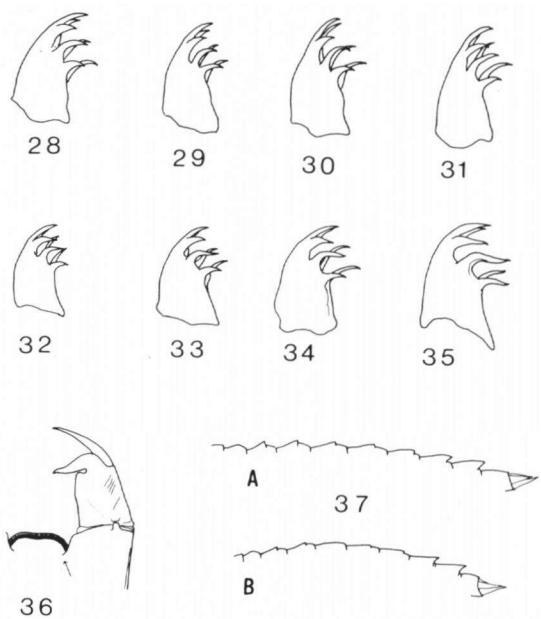
The larvae of *P. luisi* and *P. pacificus* are morphologically the most closely related ones of the four species here treated. This similarity agrees with that observed by GONZÁLEZ & NOVELO (1990) with the respective adults. Both larvae are similar in stature and general coloration. They agree in premental structures and in the shape of the lateral spines of the abdomen. However, *P. luisi* is easily distinguished by the more produced dorsal hooks and in having the female gonapophyses sharply-pointed (Fig. 9B); the latter are rounded in *P. pacificus* (Fig. 9C). Both species occur sympatrically in the Pacific slope.

P. suasus and *P. duodentatus* occur in the eastern part of Mexico. Nevertheless, *P. suasus* shows great resemblance with the two Pacific species in the following: (1) ligula convex throughout without central concavity on its anterior border; – (2) end hook gradually incurved; – (3) segments 9 and 10 almost equal in length; – and (4) coloration rather reddish-brown. *P. duodentatus* exhibits features that place it nearer to the South American congeners: (1) a small concavity just at middle of anterior border of ligula; – (2) end hook more angularly incurved; – (3) lateral spines on 7-9 incurved and slightly upturned. Further the larva of *P. duodentatus* is the largest of the four here described; it has the best developed dorsal hooks (Figs 1, 5).

BELLE (1970) established the larval features for the genus *Phyllogomphoides* based on the species *P. fuliginosus* and *P. major*. Later on he (BELLE, 1982) further characterized the larvae defining three sections: (1) *fuliginosus* + its nearest allies (South American); – (2) the *cristatus* group + *andromeda* group + *undulatus* group (South American); – (3) *semicircularis* + its nearest allies (predominantly Central American).

Summarizing, the existence of two evolutive lineages seems to be evident:

SOUTH AMERICAN LINEAGE. – Species share the following characters: (1) prementum widened laterally at the middle; – (2) ligula small, its width shorter than the base of palp articulation; this base projecting its internal margin into



Figs 28-37. Details of the morphology of *Phyllogomphoides duodentatus* (Fig. 28), *P. luisi* (Fig. 29), *P. suasus* (Fig. 30), *P. pacificus* (Fig. 31), *P. andromeda* (Fig. 32), *P. undulatus* (Fig. 33), *P. cristatus* (Fig. 34), *P. major* (Figs 35-36, 37A) and *P. fuliginosus* (Fig. 37B): (28-35) right laciniae, ventral view, showing the teeth's shape; – (36) prementum [arrow indicates the projection of the palp's base into the dorsal ligula's area]; – (37) dorsal outlines of abdomen, showing the reduced dorsal hooks on abdominal segments 2-7. – [Figs 36-37 redrawn from BELLE, 1970].

the dorsal ligula's area (Fig. 36); – (3) scale-like setae of ligula short; – (4) end hook of palp sharply-pointed; – (5) internal margin of palp smooth or with a few blunt teeth; – (6) lateral spines on abdominal segments 7-9 incurved.

This lineage comprises sections 1 and 2 of BELLE (1982). He defined his groups on labial characters, mainly those of the palpi. However, some additions must be made to this grouping. The species of section 1 show a tendency towards reduction of the dorsal hooks (mainly on 3-7) (Fig. 37); the ligula exhibits a concavity at the middle of its anterior border; the dorsal teeth of both internal and external branches of mandibles are notably enlarged (Fig. 27); the laciniae of the maxillae have teeth strongly incurved (Fig. 35). Species of section 2 are similar in the lacinia's teeth shape to species of section 1 (except *P. andromeda*) (Figs 32-34), but in the structure of mandibles are more like those of section 3 (see Figs 24-26).

MIDDLE AMERICAN LINEAGE. – Species share the following characters: (1) sides of prementum strictly straight; – (2) ligula large, its width greater than the base of palp articulation; internal margin of this base does not project into the dorsal ligula's area (Figs 2, 13, 14, 17); – (3) scale-like setae of ligula long; – (4) end hook of palp bluntly-pointed; – (5) internal margin of palp crenate; – (6) lateral spines on abdominal segments 7-9 usually straight and divergent.

This lineage corresponds to section 3 of BELLE (1982).

From my experience with odonate larvae, I emphasize that species belonging to the same genus are often very similar, making their separation usually difficult.

Larvae of species of section 1 of BELLE (1982) are quite different from the remaining species of *Phyllogomphoides*, suggesting a further separation of the species of sections 2 and 3 into a new genus at least, as BELLE (1984) suggested.

Finally, if we maintain the present taxonomic scheme, and if we consider South America as the center of origin of *Phyllogomphoides*, we may expect to find the most primitive forms in this subcontinent, and we may suppose that species further from this center will be more evolved. Following this criteria, we could speculate that synapomorphies for the larvae of *Phyllogomphoides* would be those listed under the Middle American Lineage.

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