

**DESCRIPTION OF THE LARVA OF *ACANTHAGRION*
QUADRATUM SELYS, WITH A KEY TO THE KNOWN LARVAE
OF THE GENUS (ZYGOPTERA: COENAGRIONIDAE)**

R. NOVELO-GUTIÉRREZ

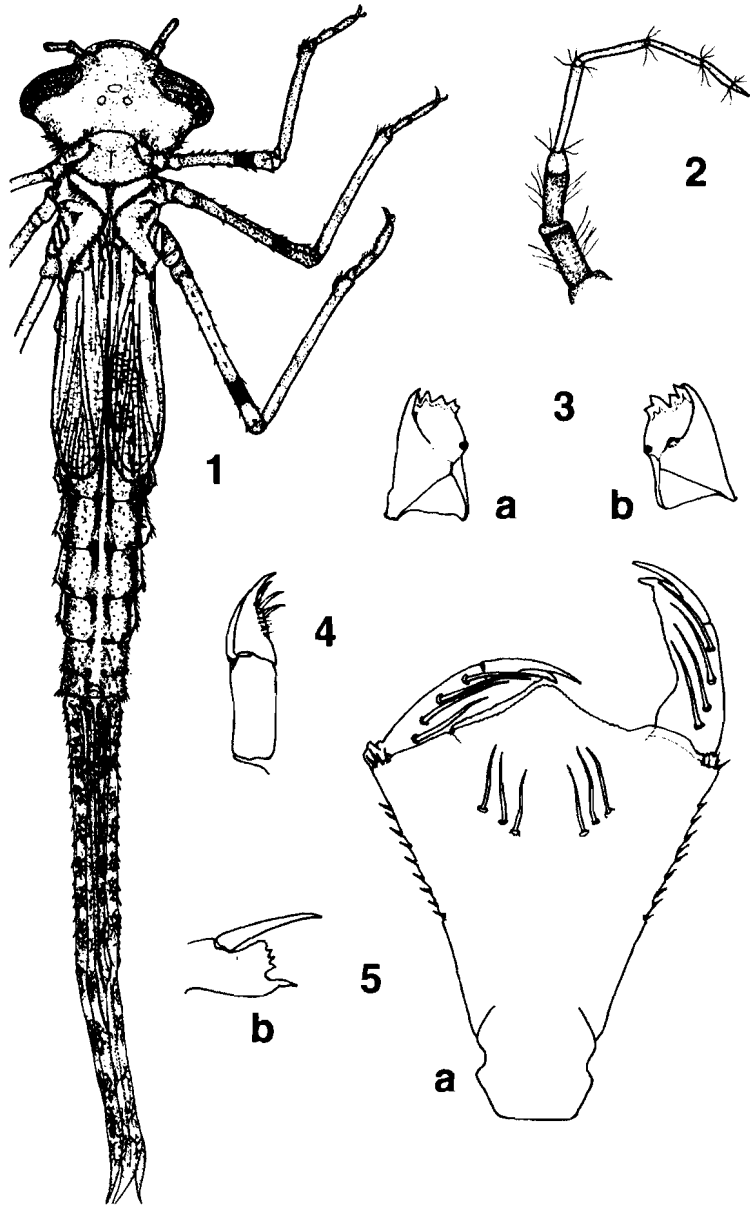
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The larva is described, illustrated, and compared with other described congeneric larvae. *A. quadratum* is distinguished from all others by possessing 3 premental setae, 4 setae on labial palp, and caudal lamellae 8-10 times longer than their widest part. A key to the 9 known congeneric larvae is provided

INTRODUCTION

The neotropical genus *Acanthagrion* Selys, 1876 comprises 40 known species (VON ELLENRIEDER & LOZANO, 2008), *A. inexpectum* Leonard and *A. quadratum* Selys occur in Mexico (GONZÁLEZ-SORIANO & NOVELO-GUTIÉRREZ, 2007). The genus was redefined by VON ELLENRIEDER & LOZANO (2008), who diagnosed the larvae from those of *Oxyagrion* by their markedly lanceolate caudal lamellae, with width/length ratio 0.18 or less, and longer than abdomen (1.02 or more). Despite the speciose nature of the genus, larvae of only eight species (20% of genus) have been described: *A. ascendens* Calvert (GEIJSKES, 1941), *A. adustum* Williamson and *A. indefensum* Williamson (GEIJSKES, 1943), *A. fluviatile* De Marmels (DE MARMELS, 1990), *A. apicale* Selys (DE MARMELS, 1992), *A. hildegarda* Gloger (MUZÓN et al. 2001), *A. vidua* Selys (DE MARMELS, 2007), and *A. aepiohum* Tennessen (LOZANO et al., 2007). WESTFALL & MAY (1996) keyed the larva of *A. quadratum*, providing some figures, but did not include a description. I provide here a full description of the larva of *A. quadratum*, encompassing variability of material from several localities. Based on comparison with descriptions of other larvae of *Acanthagrion* a key to all their described larvae is provided.



Figs 1-5. *Acanthagrion quadratum*, details of larval morphology: (1) last instar larva, dorsal view; - (2) right antenna, lateral view; - (3) mandibles, ventrointernal view: (a) right mandible, (b) left mandible; - (4) right maxilla, ventral view; - (5) labium: (a) prementum, dorsal view, (b) detail of labial palp, frontal view.

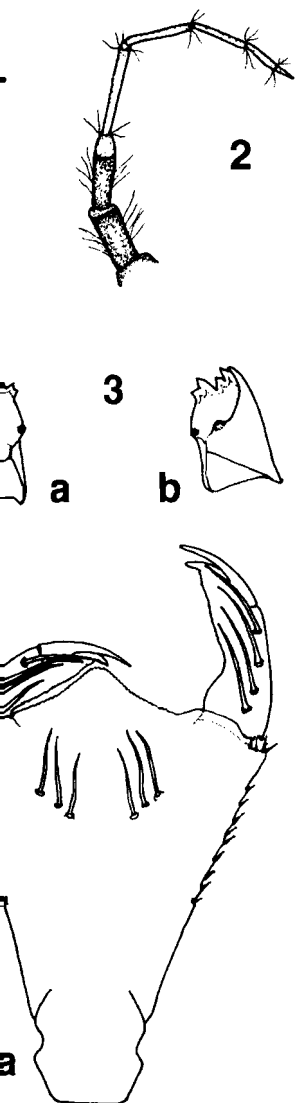
Material. - 8 exuviae (5 ♂, 3 ♀ n (19 ♂, 10 ♀). MEXICO: Veracruz: Los Tu W, 18 m), 31-V-1984, H. Velasco leg. (1 ♂). N, 95°03'816 W, pond, 20 m), 24-VIII-198 "Los Tuxtlas", Laguna Azul (18°35'363 N 4 ♀); Catemaco, Coxcoapan, Ejido López 2003, R. Arce leg. (1 ♂). Sayula, Almagr J.A. Gómez leg. (1 ♂). Xalapa, Botanical 1991, R. Novelo leg. (2 ♂). Tlapacoyan, VII-2002, R. Novelo leg. (2 ♀), same data (19°28'278 N, 96°47'197 W, lagoon, 930 (1 ♀); same data but 19-VIII-2008, B. Bru Atezca (20°48'293 N, 98°44'535 W, lagoo data but 12-II-1994 (1 ♂); same data but Pago-Pago (22°05'996 N, 99°09'143 W, st ta Fe (22°07'800 N, 99°12'082 W, stream nacimiento Río Coy (21°46'339 N, 99°03 2 ♀). Puebla: Xicotepec de Juárez (20°15' leg. (1 ♂, 1 ♀). Querétaro: Arroyo Seco, VII-1998, R. Novelo leg. (2 ♂). All depos A.C., Xalapa (IEXA).

DESCRIPTION: Exuviae and lar (alcoholic specimens); larva slen (epiproct and paraproct).

Head. - Almost twice as br men, occipital margin widely cor short, stout, stiff setae, remaine long, with roughly circular pale s of compound eye one third the l (Fig. 2), the third segment the lon 1.0, 0.75, 0.60, 0.40, 0.20; scape a of antenna creamy pale. Mandib crest, with following formula (ser 5 y a. Ventral pad of hypopharyr a row of long setae, posterior ma nia (Fig. 4) with six teeth, the th the ventroapical tooth the larges the most internal one a mere sp and dorsal teeth; maxillary palp setae on its external surface. Lab ching basal half of mesosternum

ACANTHAGRION QUADRATUM SELYS, 1876

Figures 1-9



Morphology: (1) last instar larva, dorsal view; (2) antenna, dorsal view; (3) mandible, (a) right mandible, (b) left mandible; (4) prementum, (a) prementum, dorsal view, (b) detail of prementum.

Material. — 8 exuviae (5 ♂, 3 ♀ reared), 22 last instar larvae (14 ♂, 8 ♀), 29 younger larvae (19 ♂, 10 ♀). MEXICO: Veracruz: Los Tuxtlas: Balzapote, Río Máquinas (18°37'27" N, 95°05'31.2" W, 18 m), 31-V-1984, H. Velasco leg. (1 ♂); Rancho Dr. Moreno, road to Playa Escondida (18°34'741 N, 95°03'816 W, pond, 20 m), 24-VIII-1984, R. Novelo leg. (5 ♂, 3 ♀); Estación de Biología Tropical "Los Tuxtlas", Laguna Azul (18°35'363 N, 95°05'607 W, 176 m), 27-VIII-1988, R. Novelo leg. (7 ♂, 4 ♀); Catemaco, Coxcoapan, Ejido López Mateos (18°26'510 N, 94°57'902 W, river, 174 m), 02-XII-2003, R. Arce leg. (1 ♂). Sayula, Almagres (17°48'333 N, 94°54'369 W, lagoon, 30 m), 20-III-1999, J.A. Gómez leg. (1 ♂). Xalapa, Botanical Garden (19°30'745 N, 96°56'619 W, pond, 1337 m), 08-V-1991, R. Novelo leg. (2 ♂). Tlapacoyan, Ixtacuaco (20°01.957 N, 97°07.014 W, stream, 115 m), 10-VII-2002, R. Novelo leg. (2 ♀), same data but 30-III-2003 (2 ♂, 2 ♀). Emiliano Zapata, Miradores (19°28'278 N, 96°47'197 W, lagoon, 930 m), 22-II-1997, R. Arce leg. (1 ♀); same data but 11-I-1998 (1 ♀); same data but 19-VIII-2008, B. Brug and R. Novelo leg. (1 ♂). Hidalgo: Molango, Laguna de Atezca (20°48'293 N, 98°44'535 W, lagoon, 1294 m), 13-III-1988, R. Novelo leg. (3 ♂, 1 ♀); same data but 12-II-1994 (1 ♂); same data but 06-IV-1997 (1 ♂, 2 ♀). San Luis Potosí: Micos, cascadas Pago-Pago (22°05'996 N, 99°09'143 W, stream, 154 m), 25-VII-1990, R. Novelo leg. (3 ♂, 1 ♀); Santa Fe (22°07'800 N, 99°12'082 W, stream, 224 m), 24-VI-1998, R. Novelo leg. (1 ♂); Ciudad Valles, nacimiento Río Coy (21°46'339 N, 99°03'602 W, stream, 138 m), 06-VII-2004, R. Novelo leg. (6 ♂, 2 ♀). Puebla: Xicotepac de Juárez (20°15'804 N, 97°57'739 W, pond, 1167 m), 20-V-1987, R. Novelo leg. (1 ♂, 1 ♀). Querétaro: Arroyo Seco, El Nogal (21°20'759 N, 99°32'673 W, stream, 642 m), 23-VII-1998, R. Novelo leg. (2 ♂). All deposited at Colección Entomológica del Instituto de Ecología, A.C., Xalapa (IEXA).

DESCRIPTION: Exuviae and last instar larvae (Fig. 1) yellow to dark brown (alcoholic specimens); larva slender with very long and narrow caudal lamellae (epiproct and paraproct).

Head. — Almost twice as broad as long and wider than thorax and abdomen, occipital margin widely concave, cephalic lobes rounded and covered with short, stout, stiff setae, remainder of head smooth; compound eyes wider than long, with roughly circular pale spots on dark background (Fig. 1), dorsal length of compound eye one third the length of occipital area. Antennae 7 segmented (Fig. 2), the third segment the longest; relative length of antennomeres: 0.50, 0.80, 1.0, 0.75, 0.60, 0.40, 0.20; scape and basal 0.80 of pedicel light brown, remainder of antenna creamy pale. Mandibles (Fig. 3) with molar teeth but lacking molar crest, with following formula (*sensu* Watson 1956): L 1+2 3 4 5 0 a b, R 1+2 3 4 5 y a. Ventral pad of hypopharynx subrectangular, anterior margin straight with a row of long setae, posterior margin widely convex, smooth. Maxilla: galeolacinia (Fig. 4) with six teeth, the three dorsal teeth large and moderately incurved, the ventroapical tooth the largest, the remaining two ventral teeth the smallest, the most internal one a mere spine, a row of stiff setae preceding both ventral and dorsal teeth; maxillary palp incurved, sharply pointed, with some stiff long setae on its external surface. Labium: prementum-postmentum articulation reaching basal half of mesosternum; prementum (Fig. 5a) longer than its widest

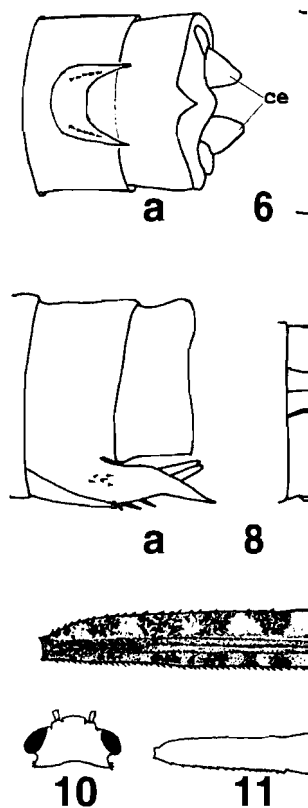
part, lateral margins moderately divergent on basal half, then strongly divergent at apical half and with a row of 10-11 spiniform setae; three long and stout premental setae to each side of midline; ligula prominent, triangular, its border finely serrulate with closely set minute claviform setae on apex; labial palp (Fig. 5a) with four long and stout setae, its apical lobe divided into a squarely truncate dorsal branch composed of four small teeth (Fig. 5b) of which the dorsal one is obtuse and with minute denticles, and a ventral branch with a well-developed end hook; internal margin of palp finely serrated; movable hook long and sharply pointed.

T h o r a x . — Pronotum trapezoidal, posterolateral margins moderately angular with a row of short robust setae, its posterior margin straight at middle. Anterior and posterior wing pads reaching basal 0.40 and 0.60 of abdominal segment 5, respectively. Legs pale with a subapical dark ring on femora (Fig. 1), short (e.g., hind legs scarcely reaching posterior margin of abdominal segment 8); dorsal and ventral borders and anterior (external) surface of femora with rows of spiniform setae; external surface of tibiae with sparse, long, delicate setae, internal surface with sparse spiniform setae, apical ends of tibiae with tridentate, scalelike setae. Two rows of short, stout, stiff setae on ventral surface of tarsi, claws with a pulvilliform empodium.

A b d o m e n . — Cylindric, light brown, with a distinct network of traqueoles clearly visible by transparency, segments 2-10 with a thin pale middorsal line gradually widening on 8-10, a narrow reddish brown stripe to each side of pale middorsal line (Fig. 1). Segments 1-10 gradually narrowing posteriorly, 1-8 with a lateral carina which bears a row of spiniform setae on 4-8, increasing in number and robustness posteriorly; surface of tergites 5-10 densely covered with minute spiniform setae which are large and stout on 10, mainly on its posterior margin. Sternites 1-10 with a longitudinal, central, wide, creamy pale band; a short, narrow, longitudinal, dark midline on apical margin of sternites 1-7. Male gonapophyses sharply pointed, in ventral view widely divergent, reaching basal 0.30 the length of sternite 10, with a row of 4-5 spiniform setae on ventral margin, intermingled with some long, white, delicate setae (Fig. 6). Female gonapophyses yellow (Fig. 7), exceeding posterior margin of sternite 10, lateral valvae sharply pointed (Fig. 7a) with a ventral row of 4-5 robust spiniform setae increasing in size and robustness posteriorly, apices slightly divergent in ventral view (Fig. 7b), central valvae slightly shorter than lateral valvae. Male cerci as in Figures 6 and 8. Caudal lamellae (epiproct and paraprocts) with a complex color pattern, slender and extraordinarily long, 0.77 the length of the rest of the body (Fig. 1), 8-10 times longer than their widest part, lanceolate, apex acuminate and sometimes with a very short filament (Fig. 9), with a longitudinal carina along basal 0.53 on both sides of lamellae, which bears a row of 20-22 spiniform setae on external carina and 10-11 spiniform setae on internal carina of paraprocts, carinae on both sides of epiproct with a row of 13-14 spiniform setae; dorsal and ventral margins

of paraprocts with a row of spiniform setae on basal remainder of margins on epiproct sparse, white, delicate setae; no lateral carinae and ventral row

M e a s u r e m e n t s (in mm; average (excluding caudal appendages) 9.8-13.5; width of head 2.7-2.9, [2.8] (N=13); hind tibiae 1.5-1.8, [1.6] (N=6); paraprocts 7.0-7.7, [7.3] (N=12)



Figs 6-13. Details of the morphology of *A. adustum* and *A. vidua*. Fig. 6: *A. adustum*, male cerci: (a) ventral view, (b) dorsal view. Fig. 7: *A. adustum*, female gonapophyses: (a) lateral view, (b) ventral view. Fig. 8: *A. vidua*, male cerci: (a) dorsal view, (b) laterodorsal view. Fig. 9: *A. adustum*, caudal lamellae: (a) left epiproct; (b) left paraproct; (c) right epiproct; (d) right paraproct. Fig. 10: *A. adustum*, male gonapophyses: (a) lateral view, (b) ventral view. Fig. 11: *A. adustum*, left paraproct; — (12) distal end of paraproct. Fig. 13: *A. adustum*, male cerci: (a) dorsal view, (b) laterodorsal view. (Fig. 6 from KES (1943), Fig. 12 from DE MARMONTE (1943))

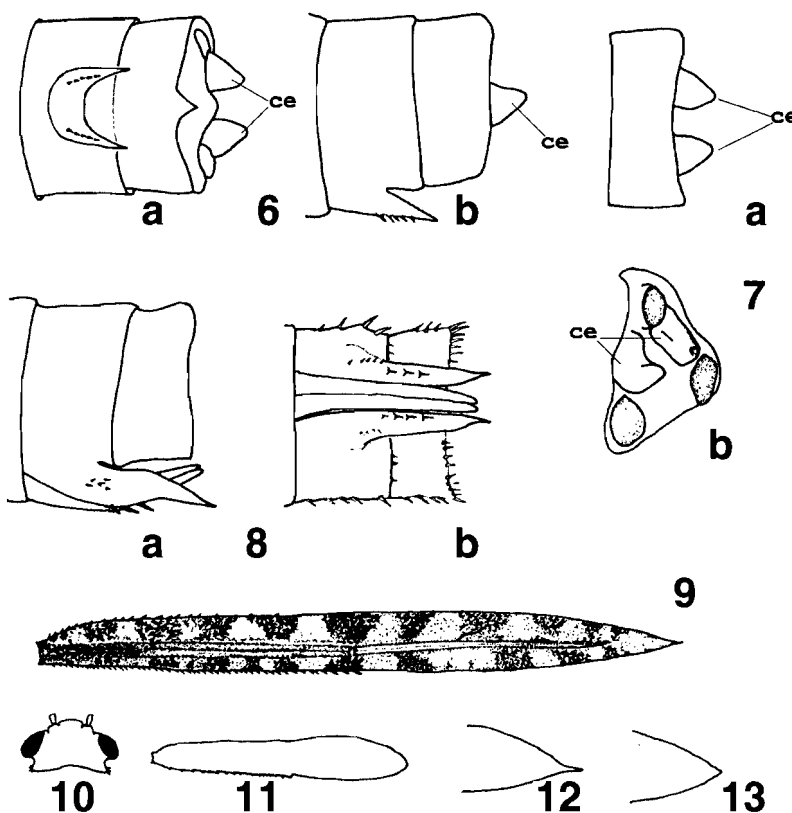
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 tively, spiniform setae on basal 0.52 on dorsal and ventral margins of epiproct,
 remainder of margins on epiproct and paraprocts mostly smooth, with some
 sparse, white, delicate setae; nodus hardly visible, but delimited by apical end of
 lateral carinae and ventral row of spiniform setae on paraprocts.

Measurements (in mm; average in square brackets). — Only last instar larvae: Total length
 (excluding caudal appendages) 9.8-13.9, [11.6] (N=13); abdomen 6.4-9.5, [7.8] (N=13); maximum
 width of head 2.7-2.9, [2.8] (N=13); hind femur (dorsal) 2.4-2.7, [2.5] (N=13); epiproct 6.7-7.5, [7.1]
 (N=6); paraprocts 7.0-7.7, [7.3] (N=12); nodus on epiproct at basal 51.4-54.2, [53.1] (N=6); nodus



Figs 6-13. Details of the morphology of *Acanthagrion* spp. larvae. Figs 6-9: *A. quadratum*, Figs 10-11: *A. adustum*, Fig. 12: *A. vidua*, Fig. 13: *A. ascendens*: (6) abdominal segments 9-10, showing male gonapophyses and cerci: (a) ventral view, (b) lateral view; — (7) abdominal segment 10 showing male cerci: (a) dorsal view, (b) laterodorsal view; — (8) abdominal segments 9-10, showing female gonapophyses: (a) lateral view, (b) ventral view; — (9) left paraproct, external lateral view; — (10) head; — (11) left paraproct; — (12) distal end of paraproct; — (13) idem. — [Figs 10-13 redrawn from GEIJSKES (1943), Fig. 12 from DE MARMELS (2007) and Fig. 13 from GEIJSKES (1941)].

on paraproct at basal 50-54.3, [52.7] (N=12).

REMARKS. — *Acanthagrion* spp. inhabit in both lotic and lentic water bodies. GEIJSKES (1941) reported larvae of *A. ascendens* in rice fields and ditches, and those of *A. adustum* and *A. indefensum* from the aquatic plant *Cabomba aquatica* Aubl. (GEIJSKES, 1943). DE MARMELS (1990) found larvae of *A. fluviatile* on grasses in a flooded savannah, and those of *A. apicale* in a stagnant pool (DE MARMELS, 1992). MUZÓN et al. (2001) recorded *A. hildegarda* from streams, while DE MARMELS (2007) collected larvae of *A. vidua* “in stagnant and slowly flowing water”. *Acanthagrion quadratum* inhabits open areas in both lotic and lentic systems; when in lotic systems they are usually found closely associated to roots of herbaceous riparian vegetation growing in backwaters. Larvae usually climb on emergent grasses and aquatic phanerogams.

DISCUSSION

Due to the shape of the larval head PESSACQ et al. (2005) considered the species *A. adustum*, *A. fluviatile* and *A. indefensum* to be related. I agree, and these species may conform a natural group sharing other features such as antennae 6-segmented, one premental setae, and caudal lamellae with apex nearly rounded. A second group of four apparently closely related species includes *A. ascendens*, *A. apicale*, *A. aepiolum* and *A. vidua*, sharing among other characters the combination of 2 or 2+1 premental setae and 4 palpal setae. *A. hildegarda* and *A. quadratum* do not appear to be closely related to any of the other species mentioned.

Nevertheless, the larva of *A. quadratum* shares some features as follows: antennae 7-segmented and cephalic lobes rounded (*apicale*, *ascendens*, *hildegarda*, *vidua*); palpal setae 4 (*adustum*, *aepiolum*, *apicale*, *ascendens*, *indefensum*, *fluviatile*, *vidua*); premental setae 3 (*hildegarda*); shape of caudal lamella (*adustum*, *indefensum*, *fluviatile*).

A key to the larvae known to date is presented here based exclusively upon the descriptions provided in literature; no specimens were closely examined except those of *A. quadratum*.

KEY FOR THE KNOWN LARVAE OF ACANTHAGRION

- 1 Posterior lobes of head angled and beset with spines (Fig. 10); one large premental seta on each side of midline; antennae 6-segmented; caudal lamellae with the apex nearly rounded (Fig. 11) 2
- 1' Posterior lobes of head rounded (Fig. 1); two or more large premental setae on each side of midline; antennae 7-segmented (sometimes 6 in *A. aepiolum*); caudal lamellae with apex acuminate or prolonged into a short terminal filament (Figs. 9, 12) 4
- 2 Posterior margin of head almost straight; nodus on lateral lamella (paraproct) at basal 0.55; total length of full-grown larva excluding caudal lamellae 11.5-13 mm *adustum*
- 2' Posterior margin of head concave; nodus on lateral lamellae (paraproct) at basal 0.57 or more; total length of full-grown larva excluding caudal lamellae less than 10.5 mm 3

- 3 Scape and pedicel of antenna nearly equal; nodus on paraproct at basal 0.58, less than 0.55, respectively 3
- 3' Scape clearly shorter than pedicel, scape of antennomeres pale; nodus on paraproct and dorsal series respectively 4
- 4 Premental setae 2 or 2+1 (two setae lateral each side of midline; palpal setae 4) 4'
- 4' Premental setae 3 or more; palpal setae 4 5
- 5 Nodus not reaching basal 0.50 the length of head 5'
- 5' Nodus beyond basal 0.50 the length of head 6
- 6 Caudal lamellae with tips prolonged into a filament; length of caudal lamellae; 3rd antennomere reaching well beyond posterior margin of abdomen 6'
- 6' Caudal lamellae with tips short and acuminate; at basal 0.48 the length of caudal lamellae; gonapophyses reaching to just behind posterior margin of abdomen 7
- 7 Nodus at basal 0.53 the length of caudal lamellae 7'
- 7' Nodus at basal 0.60 the length of caudal lamellae 8
- 8 Palpal setae 5-6 8'
- 8' Palpal setae 4.....

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I thank Dr R. ARCE-PÉREZ for collecting the larva of *A. quadratum*. Drs N. VON ELLENRIEDER helped me with literature. Special thanks are due to J. MUZÓN, who improved substantially the final manuscript.

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both lotic and lentic water bodies. *ascendens* in rice fields and ditches, and the aquatic plant *Cabomba aquatica* (1990) found larvae of *A. fluviatile* of *A. apicale* in a stagnant pool (DE recorded *A. hildegarda* from streams, of *A. vidua* "in stagnant and slow-habits open areas in both lotic and usually found closely associated to in backwaters. Larvae usually erogams.

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apicale, *ascendens*, *indefensum*, *fluvia-*
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KEY OF ACANTHAGRION

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12) 4
ateral lamella (paraproct) at basal 0.55; total
11.5-13 mm *adustum*
lamellae (paraproct) at basal 0.57 or more;
ellae less than 10.5 mm 3

- 3 Scape and pedicel of antenna nearly of the same length, darker than remainder antennomeres; nodus on paraproct at basal 0.58, less than 20 and 10 spines on prenodal ventral and dorsal series respectively *fluviatile*
- 3' Scape clearly shorter than pedicel, scape dark, pedicel pale with a dark, subapical ring, remainder of antennomeres pale; nodus on paraproct at basal 0.57, 20 and 15 spines on prenodal ventral and dorsal series respectively *indefensum*
- 4 Premental setae 2 or 2+1 (two setae large, the third one a half the length of the others or less) to each side of midline; palpal setae 4 5
- 4' Premental setae 3 or more; palpal setae 4 or more 8
- 5 Nodus not reaching basal 0.50 the length of caudal lamellae 6
- 5' Nodus beyond basal 0.50 the length of caudal lamellae 7
- 6 Caudal lamellae with tips prolonged into a terminal filament (Fig. 12); nodus at basal 0.42 the length of caudal lamellae; 3rd antennomere twice as long as scape; female gonapophyses reaching well beyond posterior margin of abdominal segment 10 *vidua*
- 6' Caudal lamellae with tips short an acute not prolonged into a terminal filament (Fig. 13); nodus at basal 0.48 the length of caudal lamellae; 3rd antennomere not twice as long as scape; female gonapophyses reaching to just behind posterior margin of segment 10 *ascendens*
- 7 Nodus at basal 0.53 the length of caudal lamellae *apicale*
- 7' Nodus at basal 0.60 the length of caudal lamellae *aepiolum*
- 8 Palpal setae 5-6 *hildegarda*
- 8' Palpal setae 4 *quadratum*

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A COMPARATIVE INVESTIGATION OF THE ANTENNAL SENSILLA IN

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A fine structural overview of the antennal sensilla of dragonflies (Gomphidae), *Aeshna cyanea* (Aeshnidae), *Zygoptera* and *Cordulegaster boltonii* (Cordulegasteridae) is presented. The sensilla are typically located on the lateral surface of the antenna in all four species. These sensilla are divided into two types: shallow sensilla and deeply sunken sensilla. The shallow sensilla show features typical of thermo-hygroreceptors, while the deeply sunken sensilla have convoluted cavities. It is suggested that the shallow sensilla are the main sensilla on the antenna, while the deeply sunken sensilla are the coeloconic sensilla of dragonflies. The finding of pore tubules in *O. f. f.* in the suborder Anisoptera, are re-

INTRODUCTION

“The face of a dragonfly is practically flat. Indeed, dragonflies are represented by a flat face (Rebora, 1999). In this regard, the sensilla on the face are poorly investigated. An early overview of the sensilla of dragonflies (Zygoptera and Zygoptera species (Selys, 1876) and the presence of coeloconic sensilla located on the face of dragonflies (Rebora & ODENDAHL, 2004) considered the role of these sensilla in speed perception and flight control. Recently, a fine structural investigation of the antennal sensilla of dragonflies (Gomphidae), *Aeshna cyanea* (Aeshnidae), *Zygoptera* and *Cordulegaster boltonii* (Cordulegasteridae) is presented. The sensilla are typically located on the lateral surface of the antenna in all four species. These sensilla are divided into two types: shallow sensilla and deeply sunken sensilla. The shallow sensilla show features typical of thermo-hygroreceptors, while the deeply sunken sensilla have convoluted cavities. It is suggested that the shallow sensilla are the main sensilla on the antenna, while the deeply sunken sensilla are the coeloconic sensilla of dragonflies. The finding of pore tubules in *O. f. f.* in the suborder Anisoptera, are re-

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