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DESCRIPTION OF THE LARVA OF *NEURAESCHNA COSTALIS* (BURMEISTER), WITH NOTES ON ITS BIOLOGY, AND A KEY TO THE GENERA OF BRAZILIAN AESHNIDAE LARVAE (ANISOPTERA)

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The larva is described and figured, based on various instars and on the exuviae of a reared specimen. It is the first larva described for the genus. The habitat, laboratory observations on the larval stage, and the affinities with other aeshnid larvae are discussed. A generic key to the larvae of Brazilian Aeshnidae is appended.

INTRODUCTION

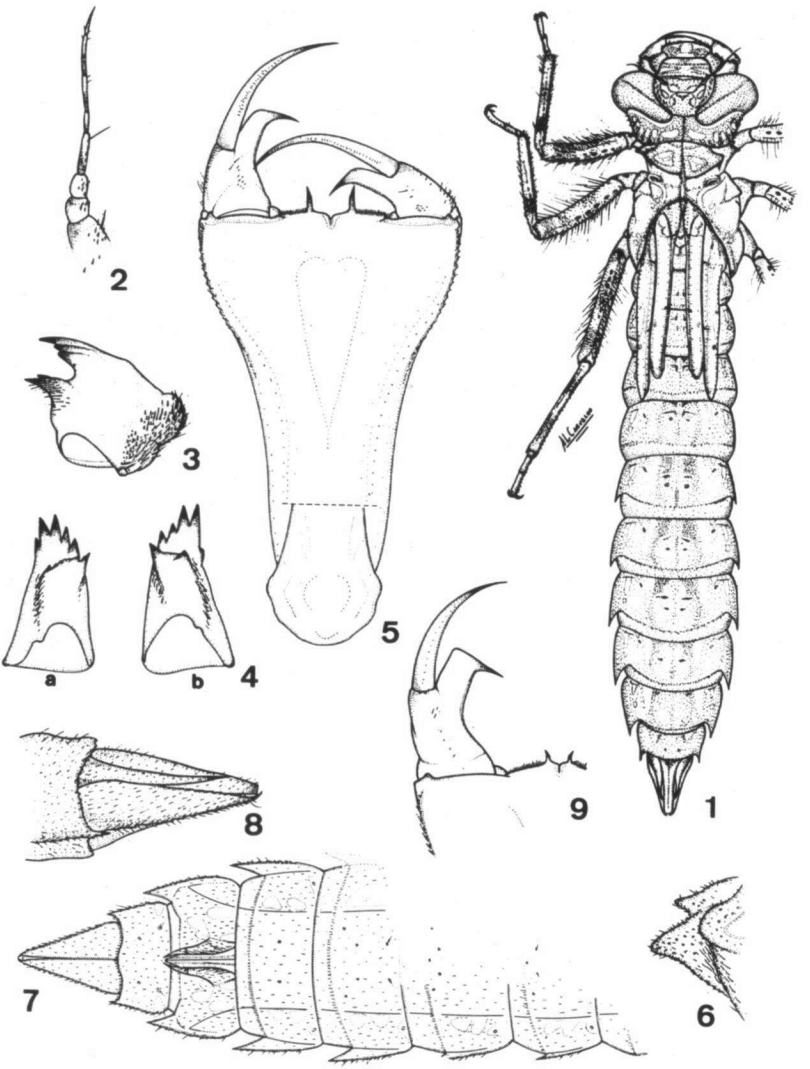
The genus *Neuraeschna* Hagen, 1867 includes 9 described species (DAVIES & TOBIN, 1985), the majority of which are endemic to the Amazon basin. This is one of the less known groups of Neotropical dragonflies. The pertaining literature consists merely of faunal lists, nomenclatural remarks, and species descriptions, some of which (*N. inarmata* Kimmins, *N. mina* Wllmsn & Wllmsn, *N. rostrifera* Martin) are based on single specimens. The only field observations reported are those on the *N. claviforcipata* Martin and *N. mina* habitats in northern Brazil, and notes on the crepuscular activity of *N. dentigera* Martin and *N. harypa* [sic] Martin during warming flights in British Guiana (WILLIAMSON & WILLIAMSON, 1930). This lack of information on the biology of these species is surely due to the difficulties in finding both adults and larvae. The latter were never cited, and probably never found. Even adults are poorly represented in collections (KIMMINS, 1951).

Neuraeschna costalis (Burmeister, 1839) is the most widespread species of the genus, and the most common in collections, being reported from the Guianas to southeastern Brazil. Adults are usually seen in warmer months (rainy season), within or in the vicinity of primary forests, where they fly at dusk, as other Gynacanthini do (SANTOS, 1981).

DESCRIPTION

Figures 1-8

Material — F-3, F-2, F-1 and ultimate instars of 1 ♀ larva: Campo dos Escoteiros-Citrolândia, Magé, Rio de Janeiro, Brazil, 12-XII-87 (moultings: 18-XII-87, 2-I-88, 18-I-88, emergence: 19-II-



Figs 1-8. *Neuraeschna costalis*, ♀ ultimate instar (1) dorsal view; — (2) antenna; — (3) right mandible, dorsal view; — (4) mandibles, inner view, a: right, b: left; — (5) labium, inner view of prementum; — (6) prothoracic pleural processes, dorsal view; — (7) abdomen, ventral view; — (8) caudal appendages, lateral view. — Fig. 9. F-4 instar: distal portion of labium, left side.

-88), A.L. Carvalho leg. — 2 larvae (F-4, F-2), same locality, 7-XI-87 and 28-XI-87 resp., K. Tanizaki leg.

Body elongate, particularly the abdomen, scantily covered with short setae. Ground colour ochraceus, with ill defined pattern (Fig. 1).

Head pentagonal with antero-lateral angles occupied by compound eyes. Antenna 7-segmented, with third and sixth segments longest, and nearly of same size (Fig. 2). Length of segments: 0.52, 0.52, 0.91, 0.50, 0.79, 0.93, 0.64 mm. Labium very long when folded, reaching posteriorly to level of third coxae; prementum goblet-shaped, narrow in basal two-thirds (Fig. 3). Median border with two long sharp-pointed teeth, one on each side of median cleft, and flanked by short fringes of piliform setae only on external sides. Labial palps incurved, pointed, inner margin finely serrate, small setae present on lateral margins dorsally. Movable hooks long, curved inward, sharp-pointed, and armed with smaller setae dorsally disposed in a row (Fig. 3). Maxillae with galea simple and hairy, lacinia with seven large curved teeth. Mandibles with conspicuous lateral prominence, armed with short, curved spines and setae which are directed forward (Fig. 4). Mandibular formula:

$$\frac{\text{L } 1234\text{ y- ab}}{\text{R } 1234\text{ y aa' (m1, 2, 3, 4?) b}}$$ (Fig. 5) incisor teeth 3 and 4 of both mandibles approximately same height, thus differing from the common pattern of the family (WATSON, 1956).

Prothoracic pleuron with a pair of prominent and obtuse processes on lower margin (Fig. 6). Synthorax as wide as prothorax. Wing-cases nearly parallel, reaching to end of third abdominal segment. Legs long, marked with ill-defined dark bands. External surface of femora marked basally with a row of black spots. Femora covered with long hairs at level of carinae (Fig. 1).

Table I

Neuraeschna costalis ♀, measurements (in mm) of the four oldest instars (75% ethanol)

Parameter	F-0	F-1	F-2	F-3
Total length	50.85	43.21	32.15	24.28
Width of head (max.)	9.23	7.75	5.85	4.74
Length of head	6.61	5.24	3.85	2.81
Width of prementum (max.)	6.50	5.02	4.00	3.03
Length of prementum	11.29	9.01	6.81	5.11
Length of antenna	4.85	3.76	2.15	1.63
Length of wing-cases	10.83	4.56	2.22	0.89
Length of hind femora	7.64	5.81	4.44	3.40
Length of hind tibiae	7.52	5.59	4.22	3.11
Length of abdomen	34.88	30.44	22.46	16.99
Width of abdomen (seg. 6)	9.00	7.64	5.85	4.37
Length of anal pyramid	4.10	3.42	2.74	1.63
Length of ♀ gonapophyses	3.42	2.05	1.11	0.52

Abdomen slender, widest on segments 6 and 7. Lateral spines present on abdominal segments 5-10. Female gonapophyses reaching beginning of segment 10 (Fig. 7). Epiproct truncate, almost as long as paraprocts, with a ridge along the median dorsal surface. Cerci long, but distinctly shorter than other anal appendages (Fig. 8).

Measurements (mm): cf. Table I.

BIOLOGY

The larvae of *N. costalis* were collected in a small extension of preserved primary forest, surrounded by deforested lowland areas, neighboring a mountain chain covered with native forest. Adults were not found there so far. The aquatic habitats lie deep in the woods, a region covered with thick vegetation and of difficult access, formed by temporary brooklets and nearby small ponds, rich in allotrophic organic matter. During periodic samplings in this region, aimed at others studies, two specimens were found. Since then, a number of excursions have yielded but one specimen. The odonate fauna of the region is rather varied, and the following Aeshnidae species have been collected: *Anax concolor* Brauer, *Coryphaeschna adnexa* (Hagen), *C. perrensi* (McLachlan), *Gynacantha bifida* Rambur, *G. nervosa* Rambur and *Triacanthagyna ditzleri* Williamson. Odonate larvae are scarce in the inner woods, except for the libellulid *Orthemis cultriformis* Calvert. Due to flooding of the entire region, the rainy season causes the aquatic habitats to merge. Shortly after these periods it is possible to find, in inner woods brooklets, species typical of small open-country ponds, like *G. nervosa.*

The single larva reared in the laboratory was kept in a small styrofoam box, filled with water from the collecting place, and fed daily with mosquito larvae, earthworms and small fish. It moulted three times until emergence of the female adult in the night of February 19, 1988. The larval moultings were accomplished in the night/dawn period. The resulting exuviae were fixed in 75% ethanol. The F-1 and F-2 instars lasted 14 and 16 days, respectively, whereas the ultimate instar lasted 32 days, the last 13 of which were spent without feeding, and with the body partially out of water.

DISCUSSION

Among the Neotropical genera of Aeshnidae, a striking affinity can be noticed between the larvae of *N. costalis* and those of *Staurophlebia,* with 2 hitherto described immature forms: *S. reticulata* (Burmeister) (GEIJSKES, 1959) and *S. bosqui* Navas (BACHMANN, 1963). They share a set of characters which distinguish them from all other known Aeshnidae immatures. These are: external surface of mandibles robust, armed with spines and setae; molar crest of right mandible with marked teeth between the teeth *a* and *b;* labium with slender palpi;

a large tooth on each side of the median cleft at the anterior margin of prementum, and without piliform setae on internal border of it (between the teeth and the median cleft); third and sixth antennal segments of about same size; femora with a dorsal longitudinal row of black spots; tenth abdominal segment with lateral spines. Some of these characters were assumed by BACHMANN (1963) as diagnostic for *Staurophlebia.* The labium of *N. costalis* shows some overall similarity with that of some *Coryphaeschna* species, such as *C. ingens* (Rambur), *C. perrensi* (McLachlan) and *C. viriditas* Calvert. The narrowed palpi, typical of developed larvae, seem to be derived from the truncated form, as shown by ontogenetic evidence (Carvalho, in prep.). See e.g. the F-4 larvae of *N. costalis* (Fig. 9). Probably the sharp tooth at each side of the median cleft in *N. costalis* and those of *Coryphaeschna* species are not homologous, for there are no piliform setae on internal border of prementum, between the teeth and the median cleft of the former; which also occurs in *Gynacantha gracilis* (Burmeister) (SANTOS, 1973).

Although detailed information about immature stages of many non-Neotropical genera is not available, it is possible, by means of the descriptions examined, to notice the similarity between *Neuraeschna, Staurophlebia* and the Oriental *Tetracanthagyna,* e.g. *T. bakeri* Campion & Laidlaw (NEEDHAM & GYGER, 1937). The tenth abdominal segment bears a pair of lateral spines, and the labium shows a similar structure, although the prementum of *T. bakeri* lacks developed teeth on the sides of the median cleft. The tubercles of the head and thorax of *T. bakeri* seem to be disposed as in *Staurophlebia,* besides small dorsal hooks are present on the same abdominal segments (9-10).

KEY TO THE GENERA OF BRAZILIAN AESHNIDAE LARVAE

There are few papers on the identification of larval neotropical Aeshnidae. They are incomplete and based, in part, on non-reared larvae, misidentified through supposition (e.g. CALVERT, 1956[1]). Due to the lack of adequate keys for South America, keys to the North American genera are currently used to identify anisopteran larvae (e.g. NEEDHAM & WESTFALL, 1955; GLOYD & WRIGHT, 1959). The key presented here is almost totally based on reared

[1] Some of these errors are as follows: (a) Part of the material used for the description of the larva of *Coryphaeschna l. luteipennis* (Burm.) collected in Nova Teutonia, SC (p. 204, figs 538, 587), must be assigned to *Limnetron debile* (Karsch), described by SANTOS (1970), through reared material; — (b) The larva of *Coryphaeschna perrensi* (McL.), described on p. 209 (figs 593, 602), is to be referred to as *Gynacantha gracilis* (Burm.), described by SANTOS (1973); — (c) His description of the larva of *Coryphaeschna viriditas* v. (p. 210), comes to a conclusion with reports on variations found in the material: "If these differences indicate that more than one species is involved, I know of no other imago to which they might be referred". This doubt was not pointless, since larvae of *C. perrensi* were among this material.

specimens of many species of the 9 Brazilian genera. The species utilized are given between parentheses in the key, below each genus. Descriptions of other South American species were also examined. There are in this region 3 other genera of Aeshnidae (*Subaeschna* Martin, *Racenaeschna* Calvert and *Allopetalia* Selys), all with unknown larvae. However, the present key can be used for most countries, since these genera are poor in species (4 in total), all with restricted distribution.

Due to the great structural changes which occur in some species during larval development (Carvalho, in prep.), larvae or exuviae in the last 3 instars should be preferably used for identification.

1 Median lobe of prementum with a developed and acute spine on each side of the median cleft, distinctly longer than the fringe of piliform setae. Blade of palpal lobe with a well developed end-hook 2

Median lobe of prementum without spines or with blunt ones, like tubercles, on the sides of the median cleft, never longer than the fringe of piliform setae. Blade of palpal lobe with or without a developed end-hook 5

2 Lateral spines present on abdominal segment 10. Dorsal surface of the femora marked basally with a longitudinal row of black spots. Mandibles with a conspicuous lateral prominence armed with spines 3

Abdominal segment 10 without lateral spines. Dorsal surface of the femora without a longitudinal row of black spots. Mandible without lateral prominence 4

3 Upper surface of the head and thorax tuberculate. Small dorsal hooks on abdominal segments 9 and 10 ..... ***Staurophlebia*** (*reticulata*)

Upper surface of the head of the head and thorax without tubercles. No abdominal dorsal hooks ..... ***Neuraeschna*** (*costalis*)

4 Hind angles of the head angulate. Blade of palpal lobe narrowed toward tip, without a row of setae dorsally. Apical third of the femora marked with black spots, forming a dark ring ..... ***Coryphaeschna*** (*perrensi, viriditas* [?])

Hind angles of the head rounded. Blade of palpal lobe squarely truncated, with a row of small setae dorsally. Femora without black spots forming a dark ring ..... ***Gynacantha*** (*gracilis*)

5 Labium when folded reaching distinctly to the level of the third coxae. Lateral spines present only on abdominal segments 7 to 9. Male larvae with the basal tubercle of the epiproct truncate or concave at the apex ..... ***Anax*** (*amazili, concolor*)

Labium when folded reaching to the level of the second coxae. Lateral spines present on abdominal segment 6. Male larvae with the basal tubercle of the epiproct pointed or blunt at the apex 6

6 Blade of palpal lobe with a row of well developed setae dorsally, the longest (the distals) of which are as long as the width of the blade, or longer..... 7

Blade of palpal lobe lacking setae dorsally, or with very small ones not disposed in a row. If there are some scattered developed setae, palpal lobes lack developed end-hooks 8

7 Palpal lobe with a well developed end-hook. Row of setae not robust, very unequal in length, diminishing to very small ones at proximal end of row. Abdominal segment 5 without lateral spines ..... ***Gynacantha***
(*adela, bifida, interioris, membranalis, mexicana, nervosa*)

Palpal lobe without, or with a poorly developed, end-hook. Row of setae strongly developed, libellulid-like, nearly uniform in length (at least the 4 distals). Lateral spines present on abdominal segment 5 ..... ***Triacanthagyna***
(*caribbea, ditzleri, septima*)

8 Lateral spines present on abdominal segment 5. Median lobe of prementum with a short, but developed, blunt spine on each side of the median cleft ..... ***Limnetron***
(*debile*)

Abdominal segment 5 without lateral spines. Median lobe of prementum without spines or with very small ones, like tubercles.....9

9 Cerci slightly longer than the epiproct. Epiproct with two developed lateral spines at the apex ..... ***Castoraeschna***
(*castor, januaria, longfieldae* [?])

Cerci each as long as the epiproct, or shorter. Epiproct with the apex variable 10

10 Cerci nearly as long as the epiproct. Epiproct with the apex truncate, without a ridge along the median dorsal surface ..... ***Coryphaeschna***
(*adnexa, luteipennis*)

Cerci distinctly shorter than the epiproct. Epiproct with a ridge along the median dorsal surface, and with the apex pointed, or with 1 or 2 shallow clefts, forming 2 or 3 short spines ..... ***Aeshna***
(*bonariensis, cornigera, peralta, punctata*)

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