

**TWO NEW LOWER CRETACEOUS DRAGONFLY LARVAE
FROM NORTHEASTERN CHINA
(ANISOPTERA)**

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2 larvae from the Yixian Formation are described. One of these has morphological similarities with the 'ultimate larval instars of *Sona nectes*', and the other one is of "cordulegastrid"-type. The relationships of the 'ultimate instars of *S. nectes*' and its young larvae are outlined and their identity is addressed. The "cordulegastrid"-like larva provides new data on the early evolution of the taxa involved.

INTRODUCTION

With at least 8 described species, the Early Cretaceous dragonfly imagines and larvae of northeastern China provide very valuable evidence on the odonate diversity during the Late Mesozoic (REN, 1994; REN et al., 1995; REN & GUO, 1996; ZHANG, 1999a, 1999b; HUANG & NEL, 2001; ZHANG & ZHANG, 2001; LI & REN, 2002). Nevertheless, till now, studies on the larvae were fewer than those on the adult material. The most common Mesozoic forms are aeschnidiid larvae, which are widely distributed in North China (ZHANG, 1999a; ZHANG & ZHANG, 2001; FLECK et al., 2002). In addition, some 'hemeroscopid' larvae have been discovered in great number in the Lower Cretaceous of Beijing (HUANG & NEL, 2001); they are probably conspecific with the adult *Hemeroscopus baissicus* (HUANG & LIN, 2001). The new material described herein comes from the Yixian Formation, Lower Cretaceous, in Huangbanji-gou, Beipiao City, Liaoning province, China, representing new elements in the famous Jehol fauna, preserved near the Feathered Bird Layer.

LARVA OF THE "ULTIMATE LARVAL INSTARS OF *SONA NECTES*"-TYPE
(SENSU PRITYKINA, 1986)

Figures 1a-b, 2a

SYSTEMATIC PALAEOONTOLOGY. — Clade: Cavilabiata Bechly, 1996
Family: uncertain

Material. — 1 ♂ (NIGP 133695), almost complete, without counterpart: Lower Cretaceous Yixian Formation; western Liaoning prov., NE China.

DESCRIPTION. — **Male.** — Body elongate; head contracted forwards. Eyes of moderate size, in posterior-lateral position; spoon-shaped mask partly visible, rather short prementum armed with median line, very broad at apex, with a median anterior hollow. Legs rather short, femora, tibiae and tarsi bearing two dense rows of strongly developed spines; ca 30 very short spines in each row on femora; also a row of femoral setae/spines visible; ca 15-20 strongly developed spines in each row on tibiae, somewhat comb-like, of sharply pointed shape, and gradually terminally contracted; tarsal spines similar to those of tibiae; tarsi three-jointed, third joint widened at apex; claws rather thin and elongate, perhaps armed with an inner tooth. Wing sheaths not well parallel, sword-shaped and with a clearly visible longitudinal vein, forewing sheaths reaching anterior margin and hindwing sheaths mid part of the 4th abdominal segment. Abdomen rather elongate, covered with setae, and armed with a posterior row of comb-like setae, width of abdomen gradually increasing (broadest at the level of segments 6 and 7); segments 1-9 of similar length; length of 10th abdominal segment ca one third of that of the 9th. Male projection semicircular. Cerci very small; epiproct incompletely preserved; paraproct armed along outer ridge, much contracted after base, probably rather short and pointed.

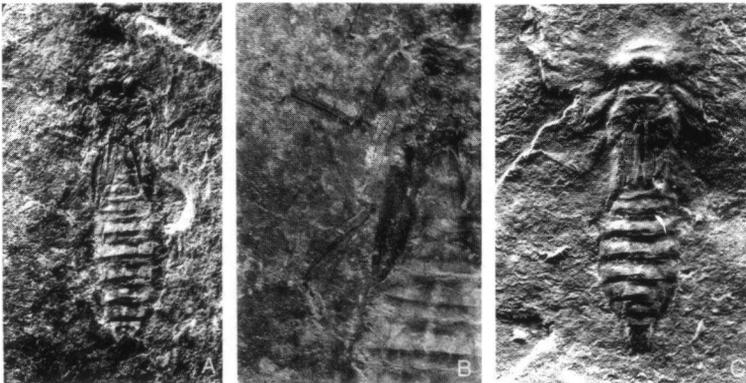


Fig. 1. Photographs of: (A) the "ultimate larval instars of *Sona nectes*"-type larva (NIGP 133695), general view; — (B) same, enlargement of the left legs; — (C) "cordulegastrid"-type larva (NIGP 133696), general view.

Measurements (in mm). — Total preserved length 41.6, width (at level of 6th abdominal segment) 10.2; length of head 6.6, width 6.3; hind wing sheath 11.3; fore tibiae 4.7, tarsi 2.8, claw 1.3; middle femora 5.8, tibiae 4.9; hind tibiae 6.4.

DISCUSSION. — The new specimen shows similarities with the "ultimate larval instars of *Sona nectes*", described by PRITYKINA (1986), viz. typical structures of femora, tibiae and tarsi bearing two well-developed rows of spines; wing sheaths; forked claws very long but not very strong. This larva has probably close relationships with the so-called ultimate instar larvae of *S. nectes*. However, the paraprocts of the latter are rather slender, straight, and without a distinct contracted section and their head shapes are also different.

The Lower Cretaceous *Sona nectes* and the monotypic extinct Sonidae, erected by PRITYKINA (1986), are based on ca 300 adult and larval specimens from western Mongolia. The holotype is a well-preserved young larva. However, the correspondence between the young larva, the ultimate larval instars, and the imagines has been recently questioned (BECHLY et al., 1998; FLECK et al., 2002). At least two different types of larvae and imagines occur in this West Mongolian outcrop.

The identity of the young and ultimate instar *Sona nectes* larvae is discussed below:

- (1) Femora, tibiae and tarsi of the "ultimate instars of *Sona nectes*" have two developed rows of spines, unlike the long hair fringes occurring on the tibiae and tarsi of the typical young *S. nectes*. No comparable case of similar morphological differences between young and ultimate instars is known in an extant anisopteran (FLECK et al., 2002). Moreover, similar comb-like hairs are also present on the tibiae and tarsi of the Lower Cretaceous 'hemeroscopid' larvae (PRITYKINA, 1977; HUANG & NEL, 2001). Such structures occur in the hundred 'hemeroscopid' larvae specimens of all stages we could examine. The main difference between the alleged larvae of *Hemeroscopus baissicus* and the alleged larvae of young *Sona nectes* instars concerns their masks, i.e. the 'hemeroscopid' larvae have a spoon-shaped mask of the 'libelluloid' type, while *S. nectes* has a flat mask, of the 'aeshnoid' type (HUANG & NEL, 2001; HUANG & LIN, 2001).
- (2) The abdomen of the "ultimate instars of *Sona nectes*" is almost parallel-sided between segments five to eight, unlike the widely increased abdominal segments in the young *S. nectes* instars, which could be related to taphonomy (FLECK et al., 2002). The structures of the two last abdominal segments in the young stage larvae also differ from those in a nearly complete specimen of the "ultimate instars of *Sona nectes*" (PRITYKINA, 1986: 174, fig. 8), but they are similar to those of another alleged ultimate instar larva (PRITYKINA, 1986: 174, fig. 11) and to our new specimen. Therefore, the specific identity of the alleged ultimate instar larvae described by Pritykina needs confirmation.
- (3) The rather short and forked claws of the "ultimate instars of *Sona nectes*" differ from the elongate and fused claws of the young instars (PRITYKINA, 1986). No similar important differences are known in extant dragonfly larvae (FLECK et al., 2002).

- (4) The paraprocts of the "ultimate instars of *Sona nectes*" are straight, instead of being somewhat forceps-shaped as in the young stages (PRITYKINA, 1986).
- (5) The epiproct of the ultimate instars is very short and truncated at apex instead of the pointed epiproct of the young larva (PRITYKINA, 1986: p. 174, fig. 8).
- (6) The wing sheaths of "ultimate instars of *Sona nectes*" only reach the base of the 4th abdominal segment, as apparent from the line drawing and plate, but the original author stated that it reaches almost to the end of the 4th segment. She also described the young larvae with wing sheaths extending at most to the middle of 4th segment (PRITYKINA, 1986), thus the length of wing sheaths cannot be used to separate the young larvae from the so-called ultimate instars. Considering the general wing sheath length in Anisoptera, it is too short for an ultimate instar, and the evidence that our new specimen represents an ultimate instars larva is lacking.

Neither the larva of the "ultimate larval instars of *Sona nectes*"-type as described here, nor the numerous adults described from the Yixian Formation of NE China (REN, 1994; REN et al., 1995; REN & GUO, 1996; ZHANG & ZHANG, 2001; LI & REN, 2002), resemble the alleged *S. nectes* adult. This is consistent with the hypothesis that the young *S. nectes* larvae, the so-called ultimate instars, and perhaps the imago are not conspecific.

The new Chinese specimen provides too limited features to ascertain its exact systematic position. However, it has a spoon-shape mask, a widened, apically protruded prementum, and a not very elongate mask, which exclude affinities with the Aeshnoptera. The aeschnidiid prementum is long, and thin, their claws are well developed, and their legs very slender. Therefore, the new specimen is not an Aeschnidiidae. Its structures resemble those of a hemeroscopid or a libelluloid larva, of the epiproctophoran type. The new larva is armed with rows of spines on its legs instead of the typical comb-like hairs of the hemeroscopid larvae. However, our knowledge of the hemeroscopid larvae is only based on those attributed to *H. baissicus*, therefore a closer affinity of our larva to the Hemeroscopiidae remains a possibility.

LARVA OF "CORDULEGASTRID" TYPE

Figures 1c, 2b

SYSTEMATIC PALAEOLOGY. — Clade: Cordulegastrida Bechly, 1996
Family: uncertain

Material. — 1 ♂ (NIGP 133696), with a relative three-dimensional preservation, almost complete, without counterpart: Lower Cretaceous, Yixian Formation; western Liaoning prov., NE China.

DESCRIPTION. — **Male.** — Body elongate; head short; eyes big and located laterally. Folded mask partly visible, spoon-shaped; prementum with a middle line, with a row of at least nine setae on each side, labial palps developed, triangular in shape, very large and broad, their inner margins armed with irregular teeth not very sharply pointed and not very long. Legs rather short and strong; femora with two ridges and the

tibiae with one; tarsi three-jointed, the third joint contracted at apex; strong claws well developed at base and very sharply pointed at apex. Wing sheaths rather parallel, with a longitudinal vein clearly visible, fore- and hind wing sheaths reaching to the middle of the 3rd abdominal segment. Abdomen armed with posterior comb-like setae, and with numerous, irregularly distributed lateral setae, other parts of abdomen with small setae; abdominal width distinctly increasing towards the 7th segment and narrow from 8th to 10th; the 8th and 9th abdominal segments slightly contracted in length, and armed with distinct lateral spines; 10th abdominal segment armed with small lateral spines, it is distinctly contracted in length and width, (width about half that of the 9th). Male projection triangular. Cerci small and pointed at apex; epiproct spine-like with a median ridge; paraprocts probably not very long but longer than epiproct, slightly curved and contracted from base, with a median ridge.

Measurements (in mm). — Preserved length of body 44.5; width (at level of the 6th and 7th abdominal segments) 12.0; length of hind wing sheath 11.0; length of fore femora 6.0; of fore tibiae 5.2; of middle femora 6.4; of middle tibiae ca 3.0; of hind tibiae 6.5; length of the 7th abdominal segment 3.3, 8th 2.8, 9th 2.3, 10th 1.3; length of epiproct 2.8.

DISCUSSION. — We attribute this specimen to the Cordulegastrida Bechly, 1996 on the basis of the following features (BECHLY, 1996):

- (1) Mask with premental setae; labial palps well developed, very large and armed with pointed irregular teeth along their inner margins. These characters are typical of

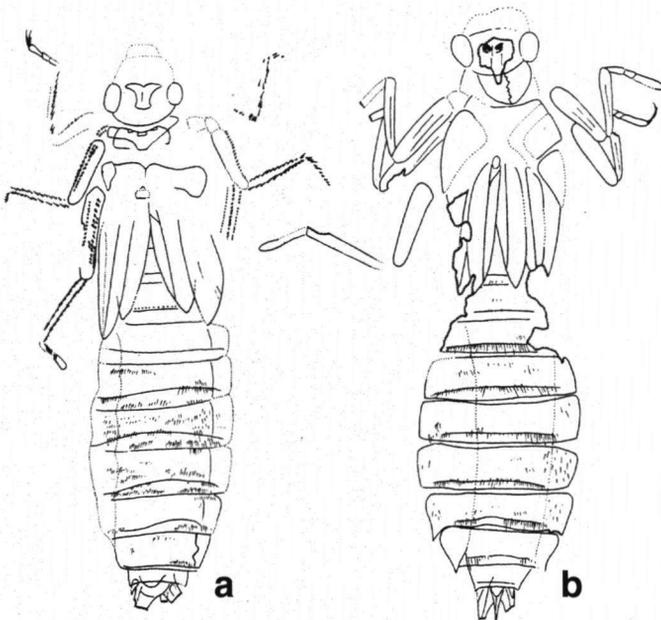


Fig. 2. Camera-lucida drawings of: (a) the "ultimate larval instars of *Sona nectes*"-type larva (NIGP 133695); — (b) the "cordulegastrid"-type larva (NIGP 133696).

Cavilabiata Bechly, 1996. The mask of our specimen is partly overlapped by its head and its shape is not clearly visible, but it is typically spoon-shaped. The mask is very close to those of extant Cordulegastridae, the only difference being its not very sharp labial teeth.

- (2) The eye shape strongly resembles that of extant Cordulegastridae.
- (3) The elongate abdomen, armed with spines on segments 8 and 9, the elongated and attenuate anal pyramid, with a long epiproct-process and long paraprocts, and with small cerci that are shorter than half the length of the ventral margin of the 10th abdominal segment strongly resembles those of extant Cordulegastrida (BECHLY, 1996).

It is not possible to give a more precise determination within this clade that comprises the modern Zoraenidae Lohmann, 1992 and Cordulegastridae Hagen, 1875. Nevertheless, this clade is still unknown from the Mesozoic, though it was obviously present then, since the representatives of the Brachystigmata Bechly, 1996, a sister group of the Cordulegastrida, are recorded from the Upper Jurassic and Lower Cretaceous.

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