

## Further notes on Chinese Cordulegastridae (Insecta: Odonata: Anisoptera)

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Zool. Med. Leiden 68 (9), 15.vii.1994: 87-96, figs. 1-13.— ISSN 0024-0672.

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**Key words:** Cordulegastridae; Anisoptera; Odonata; East Palaearctic; China; Lieftinck.

After the description of new species of Cordulegastridae from China by Zhou (1988) and Zhu & Han (1992), additional specimens have been described by van Pelt (1993) and Lohmann (1993). In this paper additional material of *Anotogaster cornutifrons* Lohmann, 1993, is reported upon. *Neallogaster lieftincki* Lohmann, 1993, is synonymized with *Cordulegaster jinensis* Zhu & Han, 1992. Some further comments are made on Lohmann's paper. A single male from Tsingtau (Ch'ing-tao, Shantung, NE China) is described as *Cordulegaster orientalis* spec. nov., being the sole representative of the *C. boltonii* (Donovan, 1807) species-group in the East Palaearctic.

### Introduction

In recent papers (Zhou, 1988; Zhu & Han, 1992) two new species of Cordulegastridae from China are described. Zhou described *Anotogaster sakaii* from the Zhejiang province (E China) and Zhu & Han described *Cordulegaster jinensis* from Shanxi. Van Pelt (1993) associated a single female from the collection of the late Dr M.A. Lieftinck with *C. jinensis*, and redescribed 19th century material of *C. lunifera* Sélys, 1878, and *C. pekinensis* Sélys, 1886. Lohmann (1993) described several new species of *Anotogaster* and *Neallogaster lieftincki*. Lohmann's descriptions are compared with the descriptions given by Zhu & Han and by van Pelt. Additional material of *Anotogaster cornutifrons* Lohmann, 1993 is reported upon. A single male from Tsingtau (Ch'ing-tao, Shantung, NE China) is described as a new species.

### *Anotogaster* Sélys, 1854

*Anotogaster* Sélys, 1854: 82-83; Fraser, 1929: 84-85; Lohmann, 1992: 11.

*Anotogaster* is characterized by the absence of an anal triangle in the hind wings of the males and the strongly reduced auriculae on the second abdominal segment of the males. These characters are considered to be related to each other (Carle 1983: 65). An additional characteristic is the yellow suffusion on the wing bases, especially in the females. Since this character is shared with Chinese *Cordulegaster*, single females are hard to identify. The genus *Anotogaster* is still very much in need of a revision.

### *Anotogaster cornutifrons* Lohmann, 1993 (figs 1-3)

*Anotogaster cornutifrons* Lohmann, 1993: 281-282, figs 12, 14.

*Anotogaster sieboldii kuchenbeiseri*; van Pelt 1993: 275 (tentative identification).

Material.— **China**, Shaanxi. Three females, labelled: "Central China South Shensi", 4.vi.1936 (teneral), 3.vii.1936, 9.vii.1936, "E. Suenson, spec. A" (written in black); "Museum Leiden, ex verz. M.A. Lief-tinck" (printed in black).

Description.— Head (fig. 1) as described by Lohmann.

Anterior margin of pronotum in the two adult specimens partly yellow, small medio-lateral spots and yellow stripes at the posterior margins. In the teneral female these yellow spots are somewhat larger.

Synthorax (fig. 2) as described by Lohmann, with fold at middle of posterior margin of stripe on mesepimeron and small dorso-lateral spot on metepisternum.

Abdomen as described by Lohmann, but the shape of the yellow marking on the first abdominal segment differs: the teneral specimen (fig. 3) has this much smaller than it is in Lohmann's female (1993: fig. 13). In the adult females it is only vestigial (fig. 2).

Dimensions (in mm).— "4.vi." female: total length including ovipositor 85.0; length abdomen including ovipositor 64.0; span of hind wings 116.0; length fore wing 53.5; length hind wing 55.0. "3.vii." female: total length including ovipositor 93.0; length abdomen including ovipositor 70.0; span of hind wings 120.0; length fore wing 54.0; length hind wing 55.0. "9.vii." female (apices of fore wings and right hind wing missing): total length including ovipositor 91.0; length abdomen including ovipositor 69.0; span of hind wings >115.0; length fore wing >53.0; length hind wing 53.5.

Remarks.— Lohmann described this taxon after material collected by E. Suenson in 1936, which was forwarded to Liefstinck, who identified it as '*Anotogaster* spec. nov.?' in 1938. The material here described has not been studied by Lohmann. Since all material of this taxon collected by E. Suenson might have come from only one locality, these specimens might belong to the same series as the type material. They differ from Lohmann's description especially in the shape of the yellow marking on the first abdominal segment. They do not have the pronotum surrounded by yellow, as Lohmann described, but with markings similar to those in *Anotogaster antehumeralis* Lohmann, 1993. These differences are considered intraspecific variability. The record of *A. sieboldii kuchenbeiseri* Förster, 1899 from Shanxi by Zhu (1991) might also refer to this taxon.

Lohmann named this taxon after the shape of the frons. This taxon differs from *A. sieboldii* (?) *kuchenbeiseri* in the yellow and black portions on the head (fig. 4), the shape of the stripes on the mesepimeron and metepisternum, the larger abdominal markings and the presence of a yellow marking on the first abdominal segment (fig. 5).

Discussion.— In the adult specimens the ground colour of head, thorax and abdomen is black, and the wings have a yellow suffusion from the bases to the discoidal cell; in the teneral female the ground colour is light reddish brown and the wings are completely hyaline. Van Pelt (1993: 275) assumed that the intensity and extension of the light and dark (reddish) brown markings might be (partly) due to the state of preservation. Now these characters appear to vary with the age of the insect when collected. Therefore one has to be cautious in using these characters for taxonomic purposes.

*Cordulegaster* Leach, 1815

*Cordulegaster* Leach 1815: 136; Sélys, 1858: 327; van Pelt, 1993: 268.

*Neallogaster*; Asahina, 1988: 32-33; Lohmann, 1992: 11 [partim]; Lohmann, 1993: 282-284.

*Thecagaster* Sélys, 1854: 84; Lohmann, 1992: 10 [partim].

Van Pelt (1993: 268, 275) assumed that Chinese *Cordulegaster* might belong to a separate, yet to be described supraspecific taxon, including *C. lunifera* Sélys, 1878, *C. jinensis* Zhu & Han, 1992 and *C. pekinensis* Sélys, 1886. As diagnostic features are assumed: anal triangle present (normally with four cells), frons shaped similarly as in *Anotogaster*, yellow suffusion on bases of wings present, especially in females (van Pelt, 1993: 275). All specimens considered to belong to this species-group are moderately sized (males: length abdomen including appendages (in mm): 50.0-57.0; females: length abdomen including ovipositor: 53.0-61.0).

*Cordulegaster jinensis* Zhu & Han, 1992

*Cordulegaster jinensis* Zhu & Han, 1992: 18-21, figs 1-7; van Pelt, 1993: 274-276, figs 16-18, 43-44, 46.

*Thecagaster jinensis*; Lohmann, 1992: 12.

*Neallogaster lieftincki* Lohmann, 1993: 282-284, figs 18, 20. **Syn. nov.**

**Remarks.**— This species was described by Zhu & Han after a series of specimens collected in Shanxi, Central China. Van Pelt associated a single female from the collection of Dr Lieftinck with this taxon. Lohmann (1993) does not refer to any recently published Chinese papers, and has apparently not compared his specimen of "*Neallogaster lieftincki*" with the newly described material. An analysis of the data published by Zhu & Han (1992), van Pelt (1993) and Lohmann (1993) gives the following results: 1) ground colour in Lohmann's male brown (a matter of age); 2) abdominal segment two with small, segment three without dorsobasal spot in Lohmann's male (as in the male type of *C. jinensis*, while females appear to have a larger spot on two and a tiny spot on three); 3) frons with black bar restricted to the upper part of the anterior side (as in the male type, while in the female it is larger, covering this side almost completely); 4) post- and anteclypeus differing in colouration [van Pelt (1993: 274) erroneously described these as 'black' and 'yellow', respectively; in fact, this female has a yellow postclypeus and a black anteclypeus (cf. van Pelt, fig. 16)]; 5) Lohmann's specimen has the last three segments including appendages missing, so a comparison of the shape of the appendages of the two taxa is impossible; 6) unfortunately, Lohmann fails to give any (wing) dimensions. Most probably the two taxa are conspecific and the differences found sexually linked, since in all cordulegastrids the females have larger yellow markings than the males.

**Distribution.**— The locality of Lohmann's specimen (Lüliang Shan, 37°10'N 111°50'E) is 80 km N of the type locality of *C. jinensis* (Lingshi, 36°25'N 111°46'E), and situated in the same river valley (Fen Ho river). The exact locality of Suenson's female is unknown. I have not been able to find any more detailed references on his expedition (see also Lieftinck, 1939: 294).

**Discussion.**— Lieftinck (1939) described new Gomphidae from China on the base of material present in the Museum Koenig at Bonn (e.g. from the expedition of H. Köne, 1936) and material collected by E. Suenson (also 1936). Since the two collectors

worked in the same area over at least a short period of time (as the collecting data show), they might have come across each other and might have exchanged information on collecting sites. However, I cannot connect the Lüliang Shan with 'S. Shensi', since the former is in the centre of the Shanxi province, while the latter must be near the Qin Ling (Tsingling Shan) in the S of the now called Shaanxi province (W of Shanxi). The two specimens are therefore not collected at the same locality. The female was probably not caught in association with *Anotogaster cornutifrons*, since it is labelled "15.vi.", while none of Suenson's 'spec. A' was collected on that date.

Lieftinck identified Köne's male as '*Allogaster* spec. nov.' in 1938. The labels on Suenson's female suggest that Lieftinck saw this specimen much later (1958), although he had identified Suenson's 'spec A' in 1938. Probably he never compared his female with Köne's male. This is probably the reason that he did not recognize the conspecificity of the male and the female specimens he had seen, apart from the sexual dimorphism and the limited amount of material.

It remains uncertain whether this taxon is specifically distinct from *C. pekinensis*.

#### *Cordulegaster lunifera* Sélys, 1878

*Cordulegaster luniferus* Sélys, 1878: 691-692; McLachlan, 1896: 368; Fraser, 1929: 121-123, pl x, fig. 14.

*Cordulegaster luniferus pekinensis*; McLachlan, 1896: 368 [partim]; Fraser, 1929: 121-123 [partim].

*Cordulegaster luniferous*; Needham, 1930: 106.

*Neallogaster luniferus*; Asahina, 1988: 32-33.

*Neallogaster lunifera*; Lohmann, 1992: 11.

*Neallogaster lunifera pekinensis*; Lohmann, 1993: fig. 19.

*Cordulegaster lunifera*; van Pelt, 1993: 269-272, figs 1-12, 24-33, 35-37, 39-40.

Remarks.— Van Pelt redescribed nearly all known specimens of this taxon, and showed that material associated by McLachlan with *Cordulegaster pekinensis* Sélys, 1886 (doubting its specific status) was in fact not conspecific with that taxon, but more similar to *C. lunifera*. Lohmann (1993: fig. 19) figured the abdomen of a single male, treating it as *Neallogaster lunifera pekinensis*, without describing the specimen in the text. The caption of his figure reads: "*N. lunifera pekinensis* (Fraser) [sic!] (Xiao Lu, China, S. Oberthur leg. 1956)". His figure does not fit the original description of *Cordulegaster pekinensis* Sélys, 1886 with regard to the abdominal markings. Lohmann probably compared his specimen only with descriptions in Fraser (1929). Unfortunately, he did not figure the appendages in detail. The locality 'Xiao Lu', is believed to be the same as that of some of the McLachlan specimens, 'Siao-Lou'. Although the abdominal markings are somewhat larger than in the McLachlan specimens, this specimen is considered to be conspecific with McLachlan's 'Siao-Lou' material, and therefore treated here as *C. lunifera*.

#### *Cordulegaster orientalis* spec. nov. (figs 6-13)

Material.— China, Shantung: Ch'ing-tao (= Qing-dao), one male (RMNH). With labels: "Tsingtau" (written); "China Tsingtau, ex Mus. Stockholm 1947" (written); "*Cordulegaster not luniferus* det. M.A. Lieftinck (cpd. with types Mus. Paris)" (written in Lieftinck's hand); "Museum Leiden ex verz. M.A. Lieftinck" (printed in black).

Description.— Head (fig. 6) with labium ochreous; maxillae with posterior half black; labrum yellow, anteriorly bordered with black, especially at the antero-lateral corners, posterior half narrowly bordered with dark reddish brown, virgule completely but narrowly black; anteclypeus black with margin near base of labrum yellow; postclypeus yellow with posterior margin narrowly bordered with black which also covers the two impressions; frons yellow with narrow basal black stripe extending laterally along the margins of the eyes, a rather small black bar just below the median part of frontal crest; occipital triangle yellow with narrow black lines along eyes, rear side yellow with black stripe at median part of ventral margin; hairs on the frons black, those on crest of occipital triangle yellowish brown; rear side of head black with a yellow stripe along eyes reaching dorsally the bending in the hind margin of the eyes.

Synthorax (fig. 7) with antehumeral stripes shaped as in most cordulegastrids, e.g. *C. boltonii* (Donovan, 1807), humeral spot distinct, stripe on mesepimeron with a slight bend at middle of hind margin, metepisternum with well-developed and entire stripe, with an additional transverse spot just below the spiracle; anterior margin of stripe on metepimeron deeply incurved, dorsal part of stripe being much broader than middle and lower parts.

Legs and ventral parts of synthorax damaged by scavengers, middle pair of legs missing, anterior pair only with coxae and trochanters present, of which the coxae are in part yellow, posterior pair black.

Wings as in *C. boltonii*, right fore wing broken at nodus, right hind wing with hind margin near median supplemental vein missing, left hind wing with extreme apex missing; anal triangle in both hind wings with five celles, nodal index in fore wings (within braces the primary, thick ones): 12-(7,1)17/18(1,6)-12; in hind wings 14-(6,1)11/11(1,5)-13; pterostigma reddish brown, length in fore wing ca. 3.8 mm, ca. 4 mm in hind wing, in left fore wing with 3.5 cells below, right with only 2.5 cells, in both hind wings with 4 cells below. Cux: 2, one crossvein in triangle, no crossvein in supratriangle, anal loop with four celles in both hind wings. All veins black, except for costa which is anteriorly yellow. Costa reddish brown dorsally near (yellow) costal plate only. Membranula greyish white.

Abdomen (figs 8-9) with yellow markings resembling specimens of *C. boltonii* intermediate of subspecies *boltonii* and *immaculifrons* (Sélys, 1850): segment one with *C. boltonii*-like spot near postero-ventral margin, extending anteriorly along the ventral suture and dorsally up to ca.  $\frac{2}{3}$  of the segments height, there again extending anteriorly, an additional spot anteriorly of this last mentioned extension is present; segment 2 with dorsally a rather narrow anterior band, extending but little before the jugal suture but occupying the complete auriculae and the area anteriorly of these, apical lunules well-developed, narrowly disconnected at dorsal carina, narrowly connected with postero-ventral spot near hind margin; segment 3 damaged at left side of anterior half, yellow anterior band connected dorsally except for its extreme anterior and posterior margins, extending laterally to the anterior margin and reaching the ventral suture along which it extends posteriorly almost reaching the segments hind margin, apical lunules present, little extended anteriorly, not connected at the dorsal carina; segment 4 with anterior band occupying ca.  $\frac{1}{4}$  of the segments length, connected at dorsal carina except for its anterior and posterior margin, lower-

ing antero-ventrally and reaching the ventral suture, but restricted ventrally of its anteriormost part, apical lunules smaller than on segment 3, less extended anteriorly and ventrally, more broadly disconnected dorsally; segment 5 with yellow colouration in all aspects somewhat restricted compared with segment 4 and anterior band less connected dorsally; segment 6 with a continuation of this trend resulting in the complete separation at dorsal carina of anterior markings; segment 7 posteriorly broader than anteriorly, anterior spots broader than on the preceding segment, somewhat notched at dorso-lateral part of its hind margin, apical lunules reduced to narrow stripes; segment 8 wider than the other segments (except one and two), with the anterior spots placed more anteriorly than in preceding segments, antero-ventrally almost reaching the segments anterior margin, posterior margin of this spot somewhat notched, apical lunules vestigial; segment 9 black with small spots present only at extreme base near dorso-lateral part of anterior margin, extending posteriorly only at its lower half; segment 10 and appendices completely black.

Superior appendages (figs 10-11) basally broad, slowly tapering towards the (missing) apices, lateral margin slightly curved; basal teeth strong and robust, extending ventrally beyond dorsal margin of base of inferior appendage, posterior teeth only visible in dorsal view, strongly developed and touching each other over about half of their lengths. General shape of appendages resembles that of *C. princeps* Morton, 1916, which has, however, its posterior teeth widely separated, not touching.

Inferior appendage (fig. 12) about as long as broad, with lateral margins straight as in all species of the *C. boltonii* group, hind margin notched medially, teeth at the postero-lateral corners present.

Dimensions (in mm).— Total length including appendages 71.5; length abdomen including appendages 56.0; span of hind wings 89.0; length fore wing 42.0; length hind wing 40.5.

Remarks.— This specimen was found in the collection of the late Dr M.L. Lief-tinck. He had compared it with the type specimen of *C. lunifera* Sélys, 1878, in the MNHN, and concluded that both were not conspecific. It is easily distinguished from all East Palaearctic taxa by the quadrate shape of the inferior appendage, a character only present in West Palaearctic cordulegastrids (Nearctic cordulegastrids not taken into account). It resembles the European *C. boltonii* in many characters. In fact, it possesses all apomorphic characters of imagines separating the monophyletic *C. boltonii* species-group from other cordulegastrids (shape of the superior appendages; anal triangle normally with five celles; the (possible) presence of a humeral spot). It therefore belongs to this species-group. It cannot be associated with one of the known representatives of this group, so the possibility of a locality error is excluded.

I have not been able to find more material of this taxon. Since most, if not all, woodland between Beijing and Shanghai has been chopped away and is now cultivated, this species might be restricted to the hilly areas in the Shangtung province: the Lu Shan and Meng Shan (< 1080 m asl) and the Tai Shan (1500 m asl). It is not impossible that this species is threatened in its existence or even has already become extinct.

Etymology.— This is the oriental representative of its species-group. In fact, it is the easternmost Palaearctic cordulegastrid with an anal triangle.

Discussion. The discovery of an East Palaearctic representative of the *C. boltonii*

species-group suggests that other representatives of this species-group might occur on the immense Asian continent. The description of *Cordulegaster vanbrincki* Lohmann, 1993 (which should have been named *vanbrinckae*, since Dr Janny M. van Brink was a woman!) from North Iran supports this theory. The species-group is supposed to have once inhabited most of the Palaearctic. The two stocks might have become separated during one of the periods of marked aridity in Central Asia (Ham-brey & Harland, 1981: 148).

Little is known on the habitat preference of Chinese cordulegastrids. Taxa of the *C. boltonii* species-group prefer small, swift running and well-oxygenated brooks (including those in lowlands) with plenty of mud to allow females to oviposit. These brooks often have their spring areas in hilly or mountainous woodland areas. Fraser's observation on the habitat preference of *Anotogaster nipalensis* (1929: 90: "a situation very similar to ones favoured by *Cordulegaster boltonii*"), suggests that the representatives of *Anotogaster* and the *C. boltonii* species-group have the same habitat preference. Since no *Anotogaster* has been reported from Shantung until now, the two species-groups might exclude each other. If this is true, no representatives of the *C. boltonii* species-group might be found in regions inhabited by *Anotogaster* (most of China including the extreme West and Szechwan, and the southern flanks of the Himalayas) because of competitive exclusion, resulting in a disjunct distribution of the *C. boltonii* species-group.

Van Pelt (1993: 275) supposed that Chinese *Cordulegaster* (except *C. orientalis*) form a separate species-group. The taxa of this supposed supraspecific taxon have been found in the mountainous areas, ranging from N of Peking through Shanxi and S Shaanxi to the mountains W of the Red Basin. This mountain range forms a transitional zone between the eastern lowlands and the regions of Inner Mongolia and Tibet. In this mountain range spring brooklets might be present, which would be consistent with the hypothesis, that the representatives of this species-group are restricted to the spring areas of (mountain) brooklets (van Pelt, 1993: 276).

#### Acknowledgements and abbreviations

I wish to thank Dr B. Kiauta for kindly presenting me some literature, and Dr E. Gittenberger, J. van Tol and C.H.J.M. Fransen (all NNM) for their useful comments on draft versions of this paper. Abbreviations: RMNH: Nationaal Natuurhistorisch Museum (formerly Rijksmuseum van Natuurlijke Historie), Leiden, the Netherlands; MNHN: Museum Nationale d'Histoire Naturelle, Paris, France.

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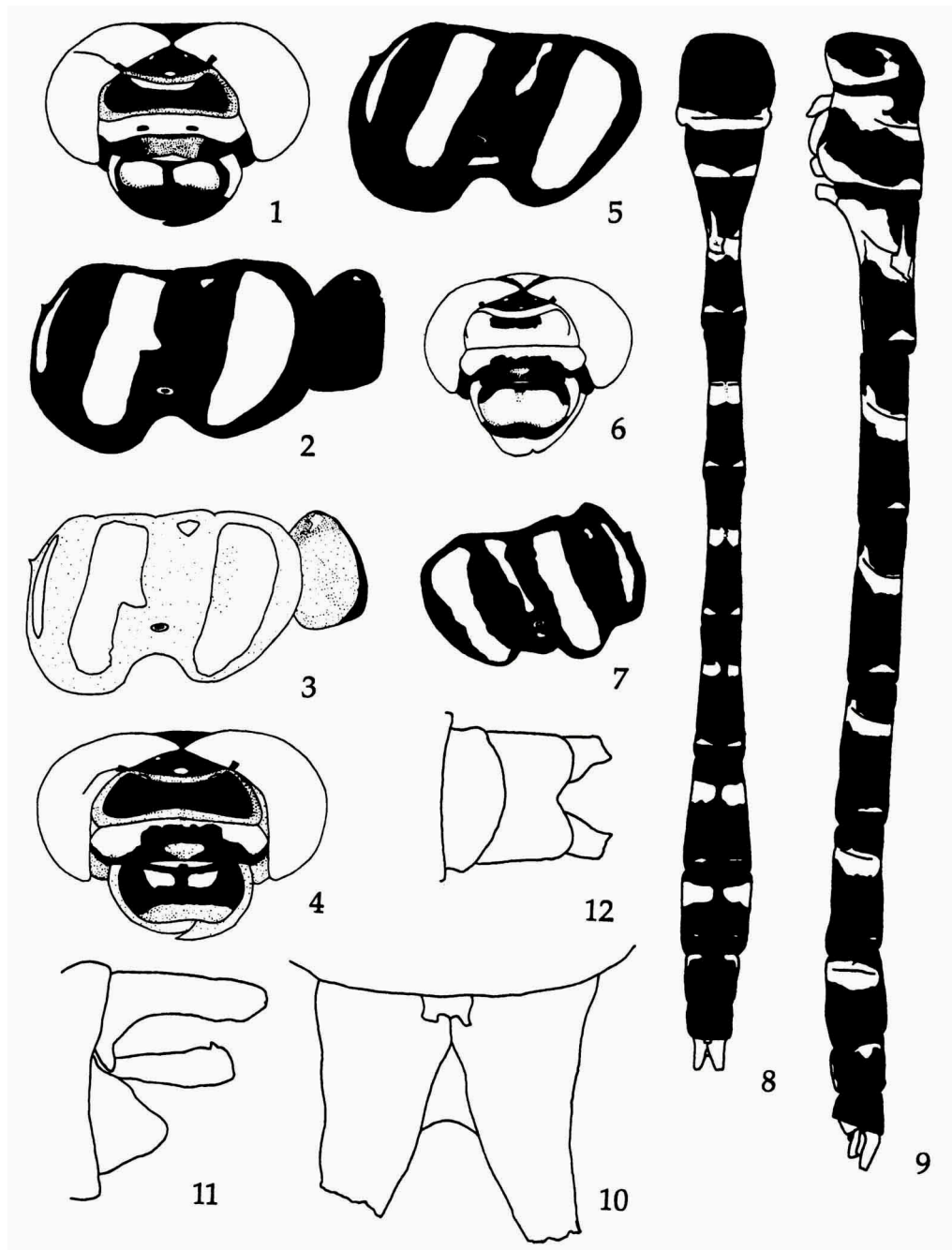
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Received: 18.ii.1994

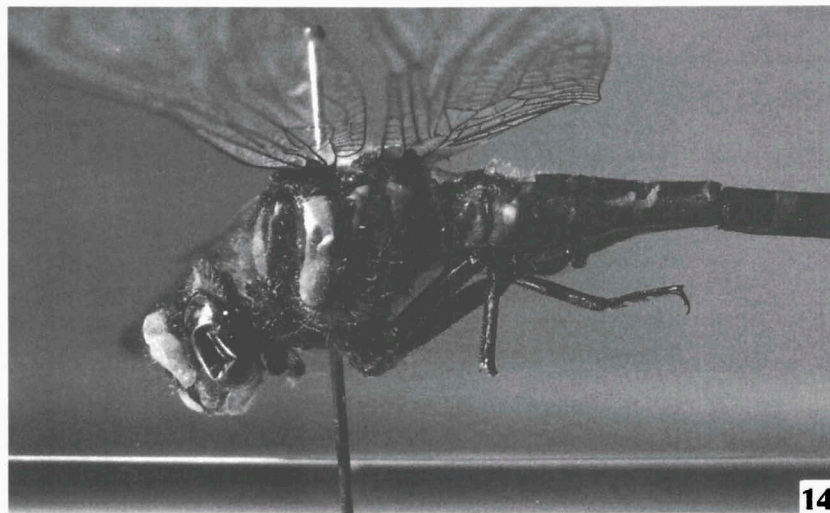
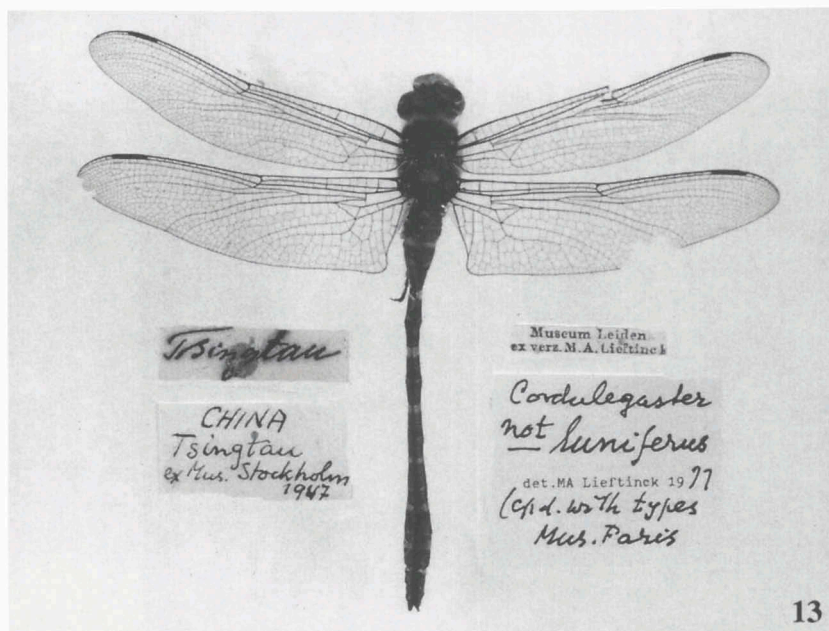
Accepted: 18.ii.1994

Edited: C. v. Achterberg





Figs 1-3. *Anotogaster cornutifrons* Lohmann, 1993; 1, "9.vii. female" head in anterior view; 2, "3.vii. female" thorax and first abdominal segment in left lateral view; 3, "4.vi. female" thorax and first abdominal segment in left lateral view. Figs 4-5. *Anotogaster sieboldii* (?) *kuchenbeiseri* Förster, 1899; ♀, "Suisapa, 1000 m asl, Lichuan Distr., W. Hupeh, China, 27.vii.1948, leg. Gressitt & Djan, RMNH, ex coll. M.A. Lieftinck"; 4, head in anterior view; 5, thorax in left lateral view. Figs 6-12. *Cordulegaster orientalis* spec. nov., ♂, holotype; 6, head in anterior view; 7, thorax in right lateral view; 8, abdomen in dorsal view; 9, abdomen in left lateral view; 10, appendages in dorsal view; 11, appendages in left lateral view; 12, inferior appendage in ventral view.



Figs. 13-14. *Cordulegaster orientalis* spec. nov., ♂, holotype; 13, habitus; 14, thorax in left lateral view.