

## Description of a new *Sinorogomphus* from Northern Laos (Odonata: Chlorogomphidae)

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*Sinorogomphus hiten* sp. nov. is described and illustrated from both sexes (holotype ♂ : Laos, Oudomxay province [20°36'14" N, 102°3'21" E, 1075 m a.s.l.], deposited in the National Science Museum, Tokyo, Japan). This is also a first record of the genus from Laos. The new species is easily differentiated from the other congeners in the male by its characteristic anal appendages, i.e. a moderately obtuse ventral spine on cerci and conspicuous paired bifurcate dorsal spines on epiproct, and by the undeveloped valvulae vulvae in the female. Additionally we briefly mention our observations of the species in the field.

**Keywords:** Odonata; dragonfly; *Sinorogomphus*; *hiten*; new species; Laos

### Introduction

The genus *Sinorogomphus*, which was separated from *Chlorogomphus* by Carle (1995) with *S. nasutus* (Needham) as its type species, includes about eight species from South China, including Hainan Island, Taiwan and Vietnam.

During our continuous odonate researches in Laos, we encountered an interesting species of *Sinorogomphus* near Oudomxay (sometimes spelled “Udom Xay”), in the northern part of the country that represented a first record of the genus from Laos. Later examination revealed this species to be undescribed. Here, we describe this species and provide field observations.

### *Sinorogomphus hiten* sp. nov. (Figures 1, 2, 3)

*Chlorogomphus* sp. Yokoi & Souphanthong 2004: 54, 57, figure 13 (records and brief ecology).

### Etymology

The species name “hiten” is the Japanese noun, meaning the religious imaginary holy people who fly around and admire Buddha and Amida in Buddhism.

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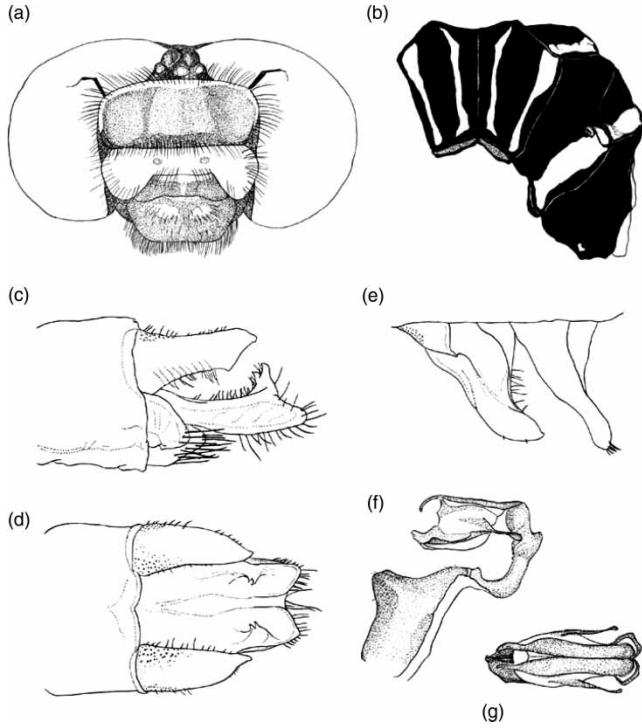


Figure 1. *Sinorogomphus hiten* sp. nov. male holotype: (a) head; (b) synthorax; (c) terminalia, lateral view; (d) same, dorsal view; (e) anterior lamina and posterior hamulus, lateral view; (f) vesica spermalis; lateral view; (g) same; ventral view.

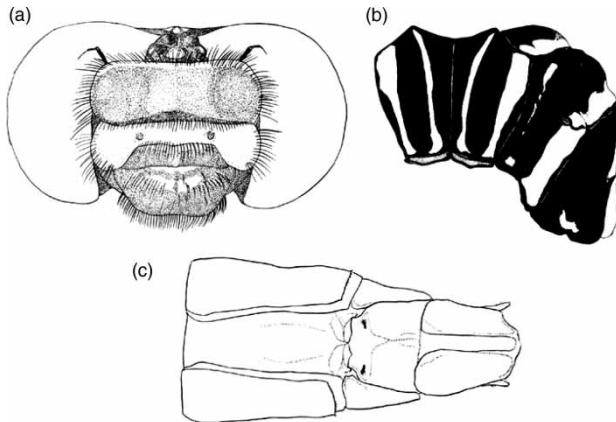


Figure 2. *Sinorogomphus hiten* sp. nov. female paratype: (a) head; (b) synthorax; (c) abdominal S8-S10, including valvulae vulvae; ventral view.

### *Specimens studied*

Holotype ♂ (specimen no. NSMT-I-Od 0008) Laos, Oudomxay province, along road from Oudomxay to Louang Phabang, crossing mountain stream in forests (20°36'14" N, 102°3'21" E, 1075 m a.s.l.), 1 May 2009 leg. A. Sasamoto, paratype 1 ♀ (specimen no. NSMT-I-Od 0009), 2 May 2009 leg. N. Yokoi, deposited in the National Science Museum, Tokyo, Japan; Paratypes

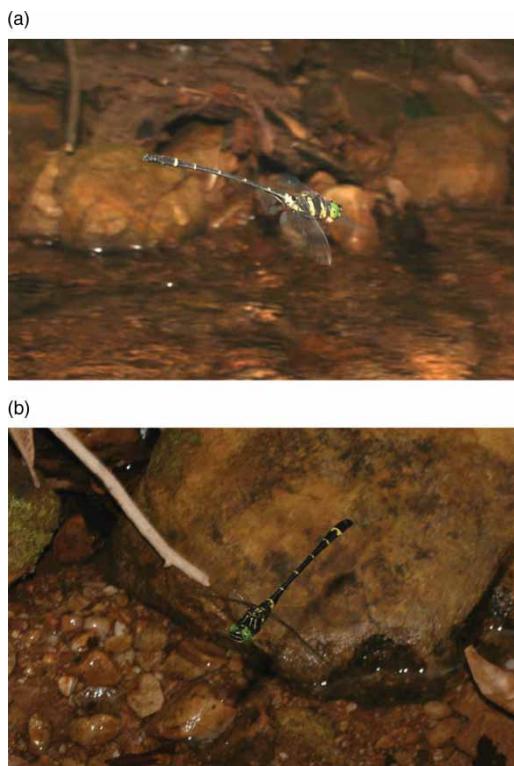


Figure 3. *Sinorogomphus hiten* sp. nov.: (a) a male patrolling the territory over the stream; (b) a female coming to oviposition site on a shallow flowing stream. Oudomxay province, N. Laos, 2 May 2009. Photos by N. Yokoi.

2 ♀ same locality, 9 May 2004, 2 ♀, same locality, 12 May 2004 leg. N. Yokoi, 9 ♂ 3 ♀, same locality, 1–5 May 2009 leg. A. Sasamoto, N. Yokoi & T. Teramoto, deposited in the authors' private collections.

### **Diagnosis**

A moderately obtuse ventral spine on each cercus and conspicuous paired bifurcated dorsal spines on the epiproct (Figure 1c, d) in males easily separate this species from other congeners, most of which have deeply bifurcate cerci or lack any erect spines on the epiproct, e.g. the cerci of *S. nasutus* (Needham, 1930) (including subspecies, *S. n. satoi* (Asahina, 1995)), *S. suzukii* (Oguma, 1926) and *S. tunti* (Needham, 1930) are deeply bifid (Zhang & Tong, 2010), and those of *S. kitawakii* (Karube, 1995), *Chlorogomphus shanicus* Wilson, 2002 and *C. gracilis* Wilson et Reels, 2001 (the latter two species probably belong in *Sinorogomphus*) lack such a moderate spine. The epiproct in other known males of *Sinorogomphus* bear bifid apices, but not spines proximal to the apices.

Female identification should be carefully checked against other congeneric females by the combination of undeveloped valvulae vulvae and the general maculation pattern (Figure 2b). *Sinorogomphus infuscatus* (Needham, 1930) and *S. montanus* Chao, 1999 were described based only on females and so far the males remain unknown. The former species, according to the original description, has heavily infuscated wings, tinted brown on the basal half, and a larger number of postnodal crossveins (16 in the Fw and 17 in the Hw) than in any specimens of *S. hiten*. *Sinorogomphus montanus* has ventral yellow markings of abdominal S2 extending along

the posterior half, and the valvulae vulvae with obtusely protruded tips, whereas *S. hiten* has the corresponding marking covering only the anterior half of ventral S2 and the apex of the valvulae vulvae indistinct (Figure 2c).

### ***Description of holotype male***

#### *Head*

Labium ochre yellow; labrum shining black with a pair of rhomboid yellow spots on medial part (Figure 1a); anteclypeus black with dark yellow medially; postclypeus wholly yellow with a pair of small pits; antefrons hairy and projected dorsally, slightly elevated along medial third, black with narrow yellow margin along dorsal edge, vertex and occipital triangle black with ocular tubercle about half as high as its width; medial angle of compound eye almost touching each other.

#### *Thorax*

Prothorax black with yellow spots as follows: a semicircular spot on medial part of posterior lobe and two triangular spots on anteroventral and posteroventral borders. Synthorax (Figure 1b) hairy, black with yellow markings as follows: mesepisternum with two pairs of stripes, a narrow, gradually undulate, elongate medial stripe notched above and forming a slanted “T” at upper end; a slightly broader humeral stripe gently curved on dorsal half, widened on ventral half, then continuing to yellow patch on mesinfraepisternum; dorsal carina and mesepimeron black; metepisternum with broad yellow stripe, narrowly interrupted posterior to metastigma; metinfraepisternum with broad yellow spot posteriorly; metepimeron with a small spot near the ventroposterior corner; ventral part of synthorax with yellow margin bordering metepimeron. —Legs with fine hairs on coxa to femur, the latter bearing numerous small spines; tibia and tarsus with brushed hairs; legs black with yellow markings; fore leg with yellow on exterior surface of coxa, interior of trochanter, and basal femur; middle leg with yellow on the exterior of coxa; hind leg entirely black. —Wings entirely hyaline, venation black; nodal index Ax 22/19 in Fw, 17/17 in Hw, with thickened veins at Ax 1 and Ax 8 (right) /Ax 7 (left) in Fw; Ax 8 thickened in both Hw; Px 12/13 in Fw, 15 in Hw; median spaces with two cross-veins in both wings; triangles of both wings two-celled; anal loop eight-celled in right Hw and 11-celled in left Hw; Pt black, 3.1 mm in Fw and 3.5 mm in Hw, overlaying 2.5–3 cells in both wings.

#### *Abdomen*

Basally thick and hairy, then constricted at S3, subsequently slender but gradually widening around S7 and S8; general coloration black with yellow markings on terga; S1 with broad lateroventral spot, expanding posteriorly to ventral yellow marking on S2; posterior half of S2 with broad dorsal spot with dorsomedial triangular notch on anterior edge; S3 to S7 with a pair of dorsal small semicircular spots near distal border of segment, each successively becoming gradually larger toward distal segments; S8 with distal annular marking irregularly expanded laterally; S9 with a pair of tiny spots ventrolaterally near distal border; S10 entirely black. —Anal appendages (Figure 1c, d); cerci granulate dorsally and basally thick then gradually tapering, with a moderately developed obtuse spine ventrally on about apical third, acutely sharpened at apex; epiproct about 1.5 as long as cerci, rugose laterally, gently curved in lateral view, with a blunt apex and, at about 2/3 its length, a dorsal triangular projection, bearing two sharp spines each directed anteriorly at their apex; epiproct in dorsal view bilobate with its distal side broadly emarginate.

Accessory genitalia; anterior lamina (Figure 1e) broad at base, thinning at the edge, its apex bluntly pointed and curved posteroventrally; posterior hamulus (Figure 1e) broad basally,

becoming narrow distally, twisted obliquely posteromedially. Basal segment of vesica spermalis (Figure 1f, g) with a pair of ventral tubercles; second segment with a small dorsal protuberance; distal segment as shown in Figure 1f, g.

#### *Measurements (mm)*

Total length 74.8; length of abdomen excl. appendages 57.0; length of Hw 41.5.

#### *Description of a paratype female*

##### *Head*

Maculation pattern (Figure 2a) similar to male but pair of yellow spots on labrum larger and almost approximate; inner angles of compound eyes more widely separated than in male; yellow margin on dorsal edge of postcylpeus broader and more pronounced; occipital triangle with dark yellow spot in centre.

##### *Thorax*

Thoracic maculation as in male, but yellow stripes slightly broader than those of male (Figure 2b); mesepimeron with irregular continuous markings reminiscent of thin stripe; spot on metepimeron larger, in the form of an inverted comma. —Wing; membrane hyaline as in male and basally tinged dark orange until Ax1; nodal index Ax 21/22 in Fw, 18 in Hw, with thickened veins Ax 1 and Ax 7 (right) /Ax 8 (left) in Fw, same Ax 9 (right) /Ax 8 (left) in Hw; Px 12/13 in Fw, 14/15 in Hw; triangles in Fw three-celled (right) and two-celled (left); both three-celled in Hw; anal loop 15-celled (right) and 14-celled (left); Pt black, 3.2 mm in Fw and 4.0 mm in Hw, overlying 2.5–3 cells in both wings.

##### *Abdomen*

S1 and S2 robust and densely covered with hairs dorsally and ventrally; S3 constricted ventrally as in male, gradually becoming slender to anterior portion of S7; subsequently widening laterally from posterior S7 to S8, but narrowing again at S9 to S10; yellow markings on S1–S3 broader than in male, forming oblique band, which connects to other side dorsodistally; maculation patterns on S4–S8 almost same as, but slightly broader and clearer than those of male, especially markings on S8 which extend anterolaterally; S9 and S10 entirely black; cerci short, about half the length of S10; valvulae vulvae short and excavated at the centre (Figure 2c); sternite of S10 protruded posteriorly beyond lamina subanalis.

#### *Measurements (mm)*

Total length 77.0; length of abdomen excl. appendages 59.5; length of Hw 46.3.

#### *Variation*

##### *Male*

Ax 19–24 in Fw and 15–19 in Hw, Px 10–12 in Fw and 11–14 in Hw; triangle consisting of two cells in both wings of all specimens; anal loop 8–11 cells. Variation in maculation pattern is

minor, except for presence of pale rudimentary marking on mesepimeron in some individuals and variability in size of spot on S8.

Measurements (mm), total length 71–78, abdominal length 52–59, length in Hw 40–43.

### *Female*

Markings on thoracic mesepimeron more pronounced and larger in younger specimens, but tend to disappear in mature specimens; spots of metepimeron variable, sometimes broken into several tiny ones in young specimens; in mature specimens wings membrane tinged slightly brown generally and basal yellow patches expanded to level of Arc; variations of Ax 21–27 in Fw and 18–21 in Hw, Px 11–13 in Fw and 13–16 in Hw; triangle consisting of 2–4 cells in Fw, 3–5 in Hw; anal loop consisting 12–16 cells. The apical marking on abdominal S8 fading in older specimens.

Measurements (mm), total length 71–78, abdominal length 53–61, length in Hw 42–47.

### ***Ecological observations***

We researched at the mountain stream for several sunny or slightly cloudy days in May. Males were on territory, slowly coursing up and down the stream, from 0.5 to 3 m above water's surface (Figure 3a). They were active only during sunshine, and disappeared when cloudy. Females oviposited in sandy bottomed slow-flowing streams by successively rising and lowering and touching the tip of the abdomen over the water's surface (Figure 3b). We observed a flying female with an accumulated clump of eggs on the abdominal tip.

### **Remarks**

Recent research in semitropical and tropical Asia, especially from Indo-Chinese regions, has revealed several new species of *Chlorogomphus sensu lato* (e.g. Karube, 1995). These discoveries indicate a rich diversity for this group and pose the questions of how they evolved and how they coexist with allied species.

By adapting his unique methodology, Carle (1995) published a new classification system of *Chlorogomphus sensu lato* and divided it into two subfamilies, Chloropetalinae and Chlorogomphinae, the latter of which was split into three tribes, Chlorogomphini, Eorogomphini and Sinorogomphini. However, Karube (2002), based on the structure of penile organ and analysis of mitochondrial DNA, proposed an alternative to Carle's (1995) system; he generally downgraded the status of higher taxa, as "Chlorogomphidae" to a subfamily under Cordulegastridae and "Chloropetalinae" to a tribe. However, recent molecular research has again tended to treat Chlorogomphidae as a good family, separate from Cordulegastridae (Carle, Kjer & May, 2008; Ware, May & Kjer, 2007). So the classification of higher taxa of this group remains as yet unresolved and requires additional research.

Among all chlorogomphids, *Sinorogomphus* is unique in the following combination of characters: the Hw triangle cell with costal side longer than proximal side, abdominal S3 rather constricted, and the abdomen much longer than the Hw. Although the status of the taxon is not consistent among researchers, being regarded as a genus (Carle, 1995; Chao, 1999; Wang, 2007) or a subgenus (Wilson, 2002; Zhang & Tong, 2010), current molecular analysis seems to support recognition as a full genus (Ware et al., 2007). In this paper, we used the originally described genus rank of *Sinorogomphus*, considering the above-mentioned characteristics. After obtaining enough material of this group, the exact status can be expected to be revealed in the future.

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