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A Hybrid Male in the Genus *Ophiogomphus* (Odonata: Gomphidae)

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Abstract. A gomphid male from west-central Wisconsin (Eau Claire County, North Fork Eau Claire River, 11 June 1994, K. J. Tennessen leg) with characters that are intermediate between *Ophiogomphus carolus* Needham, 1897 and *Ophiogomphus rupinsulensis* (Walsh), 1862 is described and illustrated. The specimen appears to be a hybrid based on intermediate character states of 1) color pattern (slightly closer to *O. carolus*), 2) hamule morphology (shaped slightly more like those of *O. carolus*), and 3) anal appendage morphology (slightly more like those of *O. rupinsulensis*).

Introduction

The dearth of recorded hybrid specimens of Odonata indicates that hybridization in this order of insects is rare (Corbet 1999, p. 492 and Table A.11.12), although Donnelly (2000, 2008) speculated that hybridization might be more widespread than has been suspected, at least in certain groups. In North America, only five hybrid specimens in the family Gomphidae have been reported (Tennessen 1982; Donnelly 1998, 2000, Manolis 2006), four of which are in the genus *Ophiogomphus* Selys, 1854. I collected a mature male *Ophiogomphus* in west-central Wisconsin that appears to be the result of a cross between *O. carolus* Needham and *O. rupinsulensis* (Walsh). The purpose of this paper is to describe and illustrate the intermediate character states, bringing this specimen on record for future comparisons.

Material and Methods

I collected the proposed hybrid specimen in Wisconsin, Eau Claire County, North Fork Eau Claire River, 44.7292°N, -90.6427°W, 11 June 1994 and preserved it using the acetone method (Needham, Westfall and May 2000). The specimen has been deposited in the Florida State Collection of Arthropods (FSCA), labeled “*Ophiogomphus* [*carolus* x *rupinsulensis* hybrid].” At the same locality and same day, I also collected a single male of *O. carolus* and several males of *O. rupinsulensis*. For comparative purposes, I examined over 150 males of each species in the FSCA: *O. carolus* from ON, NB, ME, MI, NY, WV, WI and *O. rupinsulensis* from ON, QC, IN, KY, MI, MN, NY, OH, PA, TN, VA, WV, WI. Measurements were made with a Wild stereomicroscope and morphological details drawn with aid of a camera lucida.

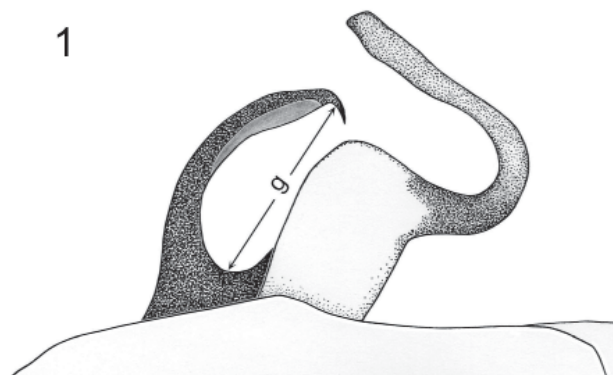


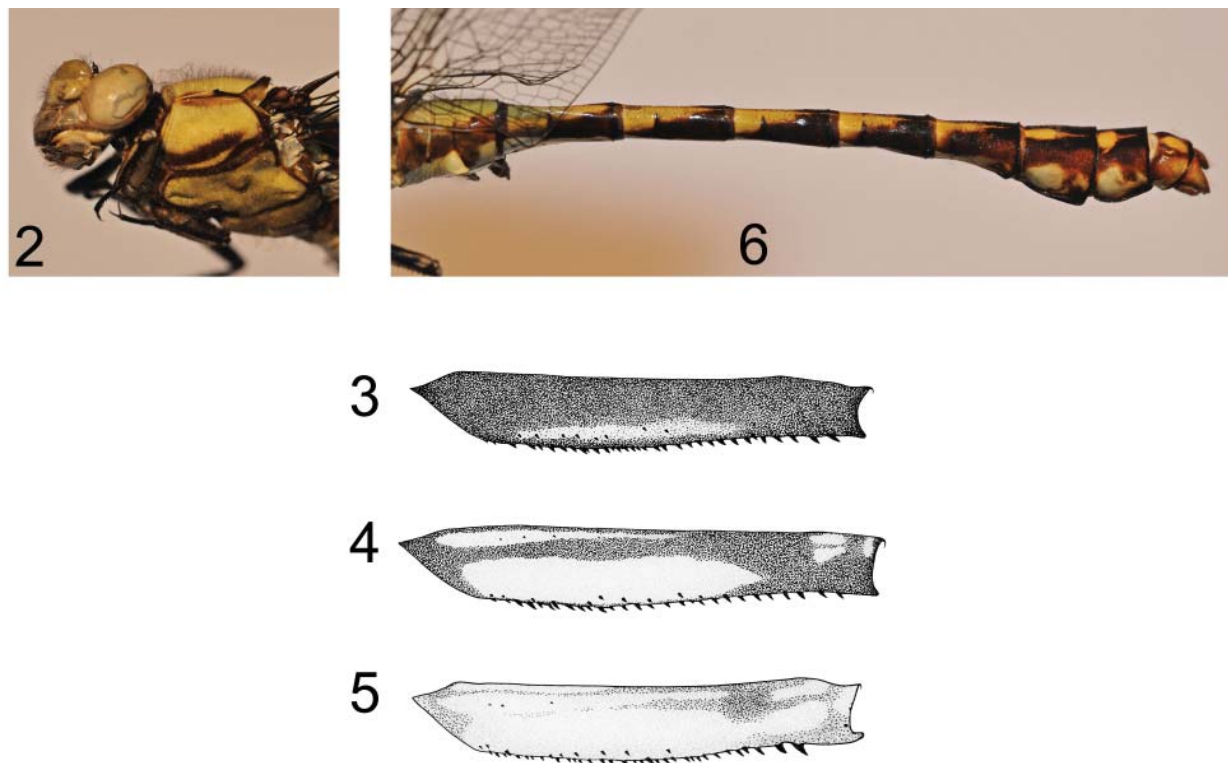
Figure 1. Hamules of *Ophiogomphus carolus* in lateral view, showing measure of “gap” length (g) of anterior hamule.

The “gap” length of the anterior hamule was measured as shown in Fig. 1. The following description of the purported hybrid treats mainly those characters deemed intermediate between *O. carolus* and *O. rupinsulensis* but also some characters in which the hybrid matches one of the two species. Abbreviations: S = abdominal segment (e.g., S2 = abdominal segment 2); L = length; W = width.

Results

Description of supposed hybrid male *Ophiogomphus*. Head: Vertex black, as in *O. carolus* vs. brown in *O. rupinsulensis*. Thorax: Mesepisternum with light brown mid-dorsal stripe and fully developed dark brown antehumeral and humeral stripes (diffusely connected at upper end); mesepimeron with narrowly developed dark brown stripe above spiracle; suture between metepisternum and metepimeron with light but distinct brown stripe, paler and narrower anteriorly, slightly darker and wider (ca. 0.35 mm) posteriorly; metepimeron with light brown mark antero-ventrally. Hind femur partly pale but black apically and with full-length black stripe; hind tibia pale on extensor surface; hind tarsus black. Costa proximal to nodus yellow on anterior margin, light brown on dorsal margin.

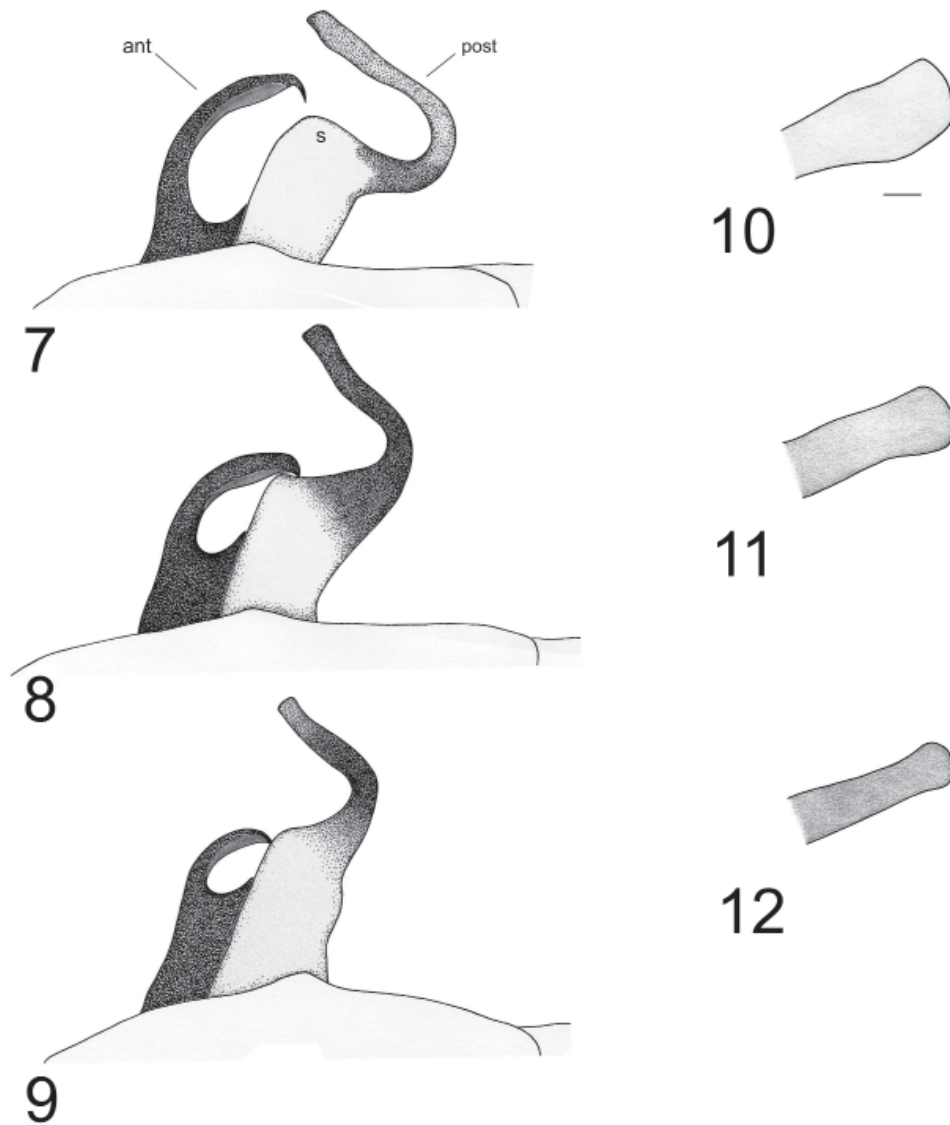
Abdomen: S2–S9 patterned with conjoined black and brown markings set off from yellow-tan markings, flanges of S8 and S9 black, S10 mostly orange tan. Anterior hamule with posterior arm elongate, arm forming angle of slightly less than 90° with shoulder of hamule. Cercus 1.75 mm long, in lateral view blunt-tipped, dorso-apical corner square; epiproct about 0.2 mm shorter than cercus, in lateral view with dorso-lateral arm at 0.68 length, apex tapered, ventral margin strongly convex in basal fourth, straight in posterior 0.75. Cercus in dorsal view blunt-tipped, rounded; epiproct in ventral view with square notch.



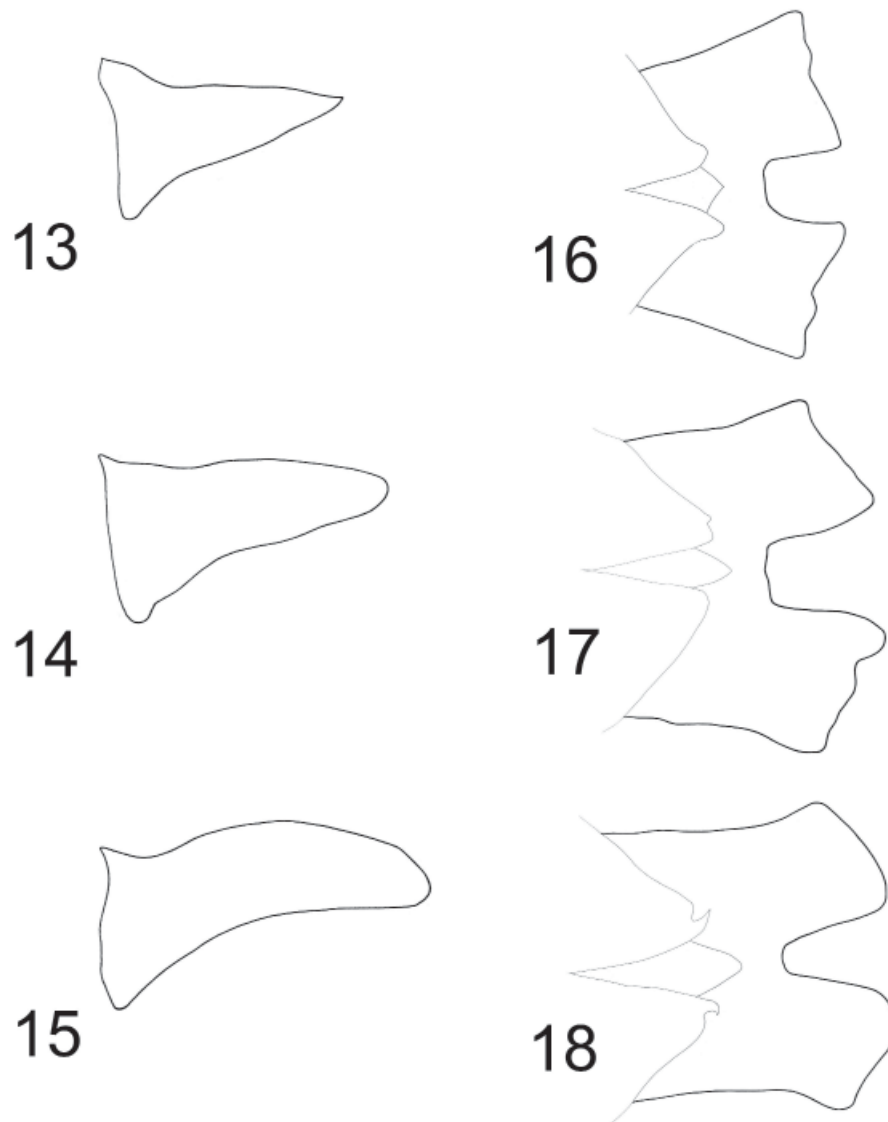
Figures 2–6. Color pattern of thoracic structures of *Ophiogomphus* species. 2) Thorax of *O. carolus* x *rupinsulensis* hybrid, dorso-lateral view. Figs. 3–5. Hind femur, lateral view: 3) *O. carolus*, 4) *O. carolus* x *rupinsulensis*, 5) *O. rupinsulensis*. 6) Abdomen of *O. carolus* x *rupinsulensis* hybrid, dorso-lateral view.

Comparison with *O. carolus* and *O. rupinsulensis*. The dark brown lateral stripes on the thorax of the hybrid male and the black extensor surface of the hind tarsus were similar to *O. carolus*. The yellow extensor surface of the hind tibia of the hybrid was similar to that of *O. rupinsulensis* (tibiae completely black in *O. carolus*). Intermediate color pattern characters were: the light brown mid-dorsal mesepisternal stripe (Fig. 2), the bi-colored hind femur (Fig. 3–5), and the light brown posterior surface of the costa. The patterning on the abdomen (Fig. 6) is similar to that of *O. carolus* except the dark markings contrast less with the pale areas than in typical *O. carolus*.

The anterior hamule of the hybrid was intermediate in shape (Fig. 8), as the arm was shorter than in *O. carolus* (Fig. 7) but longer than in *O. rupinsulensis* (Fig. 9); the “gap” length of the anterior hamule did not overlap between *O. carolus* (0.90–1.06 mm) and *O. rupinsulensis* (0.50–0.67 mm), whereas the value for the hybrid fell in between the two species at 0.74 mm. The posterior hamule was similar to that of *O. carolus* in the broadly developed “shoulder,” however the arm was not widely divergent and the angle between the arm and the shoulder was nearly 90°, both characters fitting *O. rupinsulensis*



Figures 7–12. Details of hamules of *Ophiogomphus* species. Figs. 7–9. Anterior and posterior hamules, lateral view (“ant” = anterior hamule, “post” = posterior hamule, “s” = shoulder of posterior hamule): 7) *O. carolus*, 8) *O. carolus* x *rupinsulensis* hybrid, 9) *O. rupinsulensis*. Figs. 10–12. Hamule tips, ventro-lateral view inclined from rear: 10) *O. carolus*, 11) *O. carolus* x *rupinsulensis*, 12) *O. rupinsulensis* (scale line = 0.1 mm).



Figures 13–18. Anal appendages of *Ophiogomphus* species. Figs. 13–15. Left cercus, dorsal view: 13) *O. carolus*, 14) *O. carolus* x *rupinsulensis* hybrid, 15) *O. rupinsulensis*. Figs. 16–18. Epiproct, ventral view: 16) *O. carolus*, 17) *O. carolus* x *rupinsulensis*, 18) *O. rupinsulensis*.

more than *O. carolus* (Fig. 7–9). The width and shape of the tip of the posterior hamule of the hybrid was also intermediate (Fig. 11 vs. Fig. 10 and 12).

The cercus tip of the hybrid specimen in lateral view was blunt, resembling that of *O. rupinsulensis*; in dorsal view the cerci were slightly curved inward and rounded at the tips (Fig. 14), more closely resembling those of *O. rupinsulensis* (Fig. 15) than *O. carolus* (Fig. 13). The epiproct in lateral view resembled *O. carolus*. In ventral view, the epiproct of the hybrid (Fig. 17) was shaped more like *O. carolus* (Fig. 16) than *O. rupinsulensis* (Fig. 18), although the lateral process was slightly less developed and the medio-distal arm was more produced apically, thus appearing slightly intermediate between the two species.

Total length and hind wing length of the hybrid male were greater than the largest *O. carolus* male measured (Table 1) but fit within the size range of *O. rupinsulensis*. Hind femur length and head width of the hybrid male were at the upper end of the size range for *O. carolus* but fit well within the ranges for *O. rupinsulensis* (Table 1).

Table 1. Size of *Ophiogomphus carolus* and *O. rupinsulensis* males* (mm). *Measurements of *O. carolus* and *O. rupinsulensis* based exclusively on specimens available to author.

	Total L	Hind Wing L	Hind Femur L	Head W
<i>carolus</i> (N = 152)	40.0–46.5	23.0–26.5	5.5–6.3	6.5–7.2
<i>rupinsulensis</i> (N = 165)	44.0–54.5	25.5–32.0	5.65–6.9	6.9–8.0
hybrid male	49.5	28.2	6.3	7.1

Discussion

Ophiogomphus carolus and *O. rupinsulensis* are sympatric over a broad geographic range, from Nova Scotia south to Virginia and west to Minnesota and southwestern Ontario (Donnelly 2004). The locality where I collected the hybrid male in Eau Claire County is at the southwestern edge of the range for *O. carolus* in Wisconsin. The lower Eau Claire River at the confluence of the North and South Forks supports a fairly large population of *O. rupinsulensis* whereas *O. carolus* is rare. As differences in population size can result in males of a more common species coming into contact with a female of a rarer species (Reyer 2008), it is possible that the hybrid male was the result of a male of *O. rupinsulensis* mating with a female of *O. carolus*.

Taking the hybrid specimen through the *Ophiogomphus* key in Needham, Westfall and May (2000) is problematic. In couplet 4, if one determines the light mid-dorsal brown stripe as “well-developed,” the specimen would go to couplet 7. As the cerci are not inflated and are only very slightly longer than the epiproct, one would proceed to couplet 8. The yellow external carina on the tibiae would then lead to couplet 9 in which *O. australis* Carle and *O. incurvatus* Carle are distinguished; neither choice would be correct. On the other hand, if the light mid-dorsal brown stripe were considered “vestigial” in couplet 4, one would go to couplet 5. Based on three male characters (tibia with extensor surface yellow, cerci not markedly acuminate, and lateral processes of epiproct at 3/4 length vs. 1/2 length), the specimen would then key to *rupinsulensis* in couplet 6 (brown antehumeral and humeral stripes present and lateral process on the epiproct obtuse). Details of the hamules and epiproct, however, would show that this determination was not a good fit. In the *Ophiogomphus* key presented by Walker (1958), the specimen would go to couple 7 but would fit *O. rupinsulensis* in epiproct shape and *O. occidentis* Hagen in color pattern.

The only previous mention of hybridization between *O. carolus* and *O. rupinsulensis* are Donnelly's reports (1998, 2000) of two females (one from Maine, one from Massachusetts) that were intermediate between these two species. The specimen I describe here is the first male reported from such a probable cross. Discovery of this male indicates that these two species, which often occur together, might hybridize more frequently than has been realized. Two females of *O. rupinsulensis* collected in Maine by S. W. Dunkle (housed in FSCA) have the hand written note “copulation marks by *O. carolus* male,” further indication that tandem mistakes between these species occur.

The male *Ophiogomphus* hybrid reported by Manolis (2006) apparently resulted from a cross between *O. bison* Selys and *O. morrisoni* Selys. The intermediate character states that I report here for the Wisconsin hybrid are largely similar to those Manolis found in his California specimen, both in color pattern and morphological details. It is possible that there are hybrid specimens in collections that have gone unrecognized. Hybrid specimens are somewhat difficult to detect, especially between species that are highly morphologically similar. Close examination of specimens of sympatric gomphid species is warranted.

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I thank Bill Mauffray and Bob DuBois for allowing me to examine specimens of *Ophiogomphus carolus* and *O. rupinsulensis* in the collections they manage. Nick Donnelly and Dennis Paulson graciously took the time to critique the initial draft and offered helpful comments that improved the manuscript.

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