

THE LARVA OF *PROGOMPHUS BELLEI* KNOPF & TENNESSEN (ANISOPTERA: GOMPHIDAE)

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Larvae of *P. bellei* are very similar morphologically to the other eastern U.S. *Progomphus* spp., *alachuensis* Byers and *obscurus* (Ramb.). Lateral spines are present on abdominal segments 5-9, dorsal hooks are present on segments 1-9, and lateral brown markings are present on the abdomen. *P. bellei* larvae are distinct in having a longer dorsal hook on the ninth abdominal segment (0.45-0.60 mm vs. 0.17-0.40 mm in *alachuensis* and *obscurus*), and longer cerci (1.10-1.37 mm vs. 0.80-1.10 in *alachuensis* and *obscurus*). Also, the fourth antennal segment of *bellei* is about 1/3 the length of the third segment (0.31-0.36), whereas this ratio is greater in *obscurus* (0.37-0.47).

INTRODUCTION

In the original description of *Progomphus bellei* (KNOPF & TENNESSEN, 1980), we stated that the species had been reared and the larva would be described later. Since then I have collected additional specimens of *P. bellei* and have studied variation in certain characters. The larva of *P. bellei* is herein described, and characteristics are given by which it can be distinguished from larvae of *P. alachuensis* Byers and *P. obscurus* (Rambur).

DESCRIPTION

Material. — UNITED STATES, Florida: Leon Co., Silver Lake, 25-III-1985, 11 final instars, 9 F-1 instars, KJT; — Calhoun Co., Juniper Creek, Hwy 20, 18-III-1974, 1 final instar, KJT; — Liberty Co., Mystic Lake, Hwy 12, S of Bristol, 17-III-1973, 1 reared, KJT & K.W. Knopf (emerged in lab April 1973).

FINAL INSTAR. — **Measurements** (in mm): Total length 27-33; — head width 4.8-5.6; — hind femur length 2.9-3.3; — abdomen length 16-20; — abdomen width 5.4-6.8.

Similar in form and size to other North American species of the genus (Fig. 1).

H e a d: Anterodorsal stout setae longer anteriorly. Antennae half maximum head width; antennal segment 3 about 3 times length of recurved segment 4 (range 2.8-3.2), with long setae. Prementum (Fig. 2) about 1.6 times as long as wide, sides nearly parallel; venter flat but dorsal surface convex in lateral view; ligula obtuse-angular, with 2 rows of long, flat setae that are longer in dorsal row (0.18-0.22 mm) than in ventral row (0.06-0.10 mm); palpal lobes without teeth or dorsal setae, tips blunt with 1 long hairlike seta on ventral surface; movable hook as long as base of palpal lobe; 12-16 scattered setae on dorsal surface of prementum, 2 long hairlike setae on venter near anterior margin.

T h o r a x: Dorsum nearly devoid of setae. Front femora enlarged, bearing dense tuft of stout setae on lateral surface; meso-coxae closer together than fore- or hind-coxae. Wing pads divergent, tips overlie posterior margin of abdominal segment 4, long setae on margins. Subapical, ventral seta on outer hind tarsal claw.

A b d o m e n. — Mean ratio length to maximum width 3.0 (range 2.8-3.3). Dorsal color pattern usually as in Figure 1, but varies from fainter and less extensive to darker and more extensive; brown markings present along lateral margins in all specimens examined.

Dorsal hooks on segments 1-9, those on 1 and 2 elongate knobs, on 3-9 flatter and triangular; lengths of dorsal hooks on 5-9 are (in mm): 5: mean 0.26 (range 0.21-0.32), — 6: 0.29 (0.23-0.34), — 7: 0.35 (0.26-0.42), — 8: 0.42 (0.36-0.47),

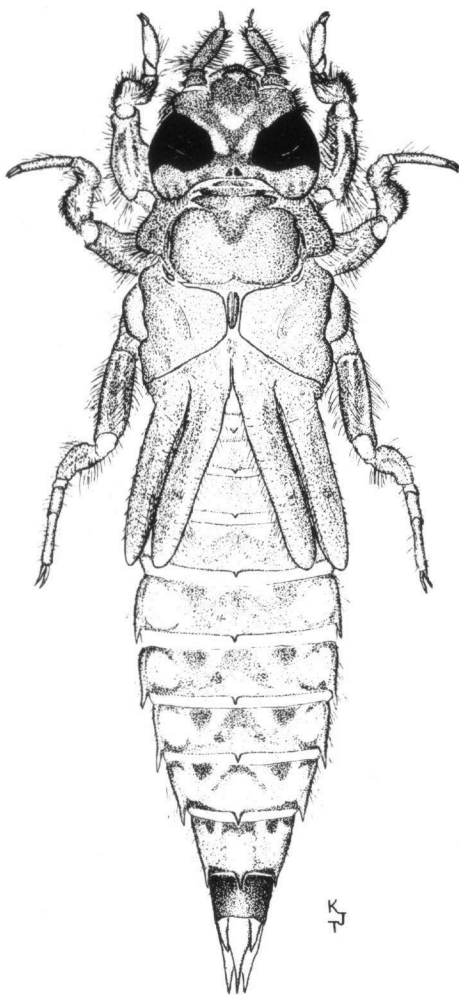


Fig. 1. *Progomphus bellei* larva, dorsal view.

— 9: 0.51 (0.45-0.60).

Lateral spines present on segments 5-9, those on 7 usually slightly divergent (less often divergent on 5, 6, and 8); spines progressively longer on posterior segments except spine on 9 shorter than on 8 (mean ratio of spine on 9 to spine on 8 = 0.78, range 0.70-0.85); lengths of spines on 5-9 are (in mm): 5: mean 0.47 (range 0.37-0.58), — 6: 0.63 (0.58-0.69), — 7: 0.68 (0.60-0.78), — 8: 0.68 (0.58-0.79), — 9: 0.53 (0.45-0.58).

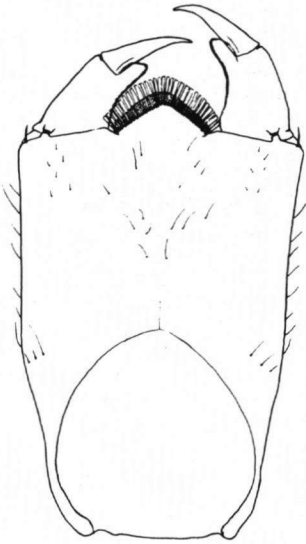


Fig. 2. Prementum of *P. bellei* larva, dorsal view.

Segment 8 about 3/4 as long as 9; length of 9 about 2/3 its maximum width (range 0.63-0.68); ventral longitudinal sutures on segments 2-8. Cerci about 1.2 mm long (range 1.10-1.37 mm), approximately half as long as epiproct (0.46-0.55); tips of paraprocts usually even with tip of epiproct, occasionally surpassing or rarely shorter than epiproct.

COMPARISON WITH *P. OBSCURUS* AND *P. ALACHUENSIS*

The larvae of the North American species of *Progomphus* are exceedingly similar morphologically. Larvae of *P. borealis* McLachlan (western: AZ, CA, CO, ID, NM, OR, TX, UT, Mexico) possess posterolateral spines on abdominal segments 3-9 (KENNEDY, 1917), whereas spines are present only on segments 5-9 in the three eastern species. BYERS (1939) stated that differentiating characters for *P. alachuensis* and *P. obscurus* do not exist. I found that larvae of these species and *P. bellei* can be separated using four characters. Because *P. alachuensis* and *P. bellei* are basically restricted to Florida (*alachuensis* is endemic and *bellei* is recorded from North Carolina), I compared them with larvae of *P. obscurus* mainly from Florida. *P. obscurus* is widely distributed, though mainly eastern: AL, AR, CO, FL, GA, IL, IN, IA, KS, KY, LA, MD, MA, MI, MS, MO, NB, NJ, NY, NC, OH, OK, PA, SC, TN, TX, VA, WV, WI, WY. It is highly variable in size and other characteristics.

COLOR PATTERN. — In *P. alachuensis* the brown pattern on the dorsum of the abdomen is medial, with no brown marking on the lateral margins, either dorsally or ventrally. In *P. obscurus* and *P. bellei* (Fig. 1), some brown marking is present medially and also along the lateral margins, usually dorsally and ventrally; variation in color pattern of the latter two species does not allow their separation. NEEDHAM & HART (1901) gave an illustration of the entire larva of *P. obscurus*,

and NEEDHAM (1941) showed abdominal color patterns for *P. obscurus* and *P. alachuensis*.

ANTENNAE. — Although neither BYERS (1939) nor NEEDHAM (1941) found differences between *P. obscurus* and *P. alachuensis* in the relative lengths of antennal segments 3 and 4, my measurements showed that in *P. bellei* the ratio is significantly different, although there is some overlap:

	Mean ratio	Range (mm)	Standard error	N
<i>bellei</i>	0.34	0.31-0.36	0.02	13
<i>alachuensis</i>	0.38	0.34-0.41	0.01	13
<i>obscurus</i>	0.42	0.37-0.47	0.03	27

KENNEDY (1917) stated that the fourth antennal segment is 1/3 to 1/5 as long as the third segment in *P. obscurus* compared to "nearly one-half as long" in *P. borealis*. But KENNEDY later (1921) gave this ratio as "nearly one-half" in *P. obscurus* final instars from Texas. The ratio for five larvae of *P. borealis* from Arizona that I measured was 0.38-0.42, which is within the range I found for *P. obscurus*.

DORSAL HOOKS/LATERAL SPINES. — BYERS (1939) stated that the differences in length of the dorsal hooks between *P. obscurus* and *P. alachuensis* were "not sufficiently distinct" to be used as key characters. My measurements of dorsal hooks on abdominal segments 5-9 revealed significant differences in mean length among the three species. *P. bellei* is distinct from *P. alachuensis* with no overlap for hook length on segment 9 (Fig. 3). *P. obscurus* is somewhat intermediate and overlaps both species for hook length on segments 5-8, but the hook on 9 is distinctly shorter than in *P. bellei*. Two other characters

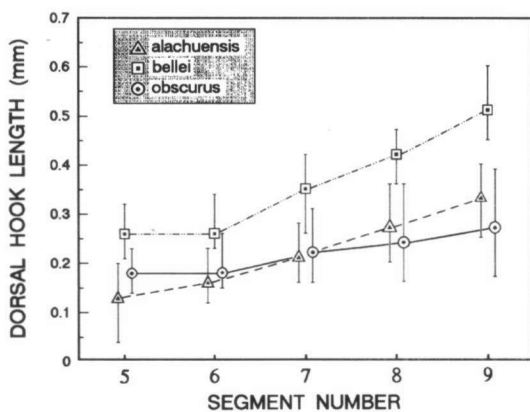


Fig. 3. Dorsal hook length, abdominal segments 5-9 in *P. alachuensis*, *P. bellei* and *P. obscurus*; vertical lines indicate range.

were found that make further separation of these species possible. First, the ratio of dorsal hook length on segment 6 vs. 9 will separate most *P. obscurus*, at least from *P. alachuensis*. The ranges in this ratio (with means in parentheses) were: *alachuensis* 0.38-0.58 (0.49), — *bellei* 0.44-0.69 (0.57), — *obscurus* 0.60-0.96 (0.79). Similar differences were obtained for the dorsal hook on segment 7 (means of 0.59, 0.70, and 0.84, respectively). Secondly, the ratio of the dorsal hook length to lateral spine length for each segment from 5-9 yielded a unique curve for each species (Fig.4). The curves reflect the comparatively greater lengths

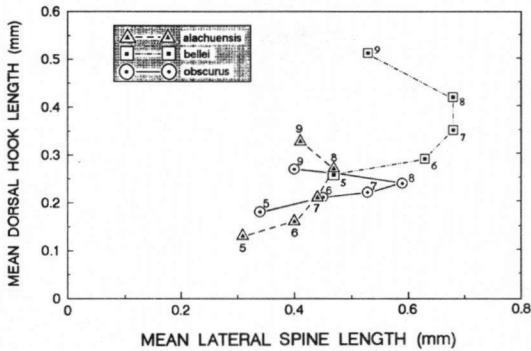


Fig. 4. Mean dorsal hook length plotted against mean lateral spine length in *P. alachuensis*, *P. bellei* and *P. obscurus*; numbers refer to abdominal segments.

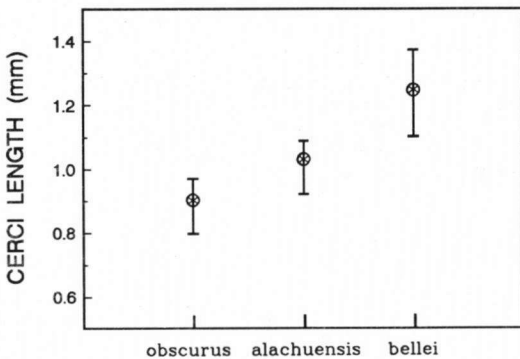


Fig. 5. Length of cerci in *P. alachuensis*, *P. bellei* and *P. obscurus*; vertical lines indicate range.

of the hooks and spines in *P. bellei*.

CERCI/EPIPROCT.

Length of cerci was distinctly longer in *P. bellei* than in *P. obscurus* and *P. alachuensis* (Fig. 5). The length of the cerci compared to the length of the epiproct yielded the following ratios (means in parentheses): *alachuensis* 0.37-0.44 (0.41), — *bellei* 0.46-0.55 (0.50), — *obscurus* 0.38-0.44 (0.41). This ratio can be used to distinguish *P. bellei* reliably, but not the other two species.

DISCUSSION

Summarizing, the above comparisons show that *P. bellei* is similar to *P. alachuensis* in: (1) ratio of length of antennal segments 3 and 4; — and (2) ratio of dorsal hook lengths on abdominal segments 6 and 9. It is similar to *P. obscurus* in dorsal abdominal color pattern.

P. bellei stands apart from the other two species in: (1) ratio of dorsal hook to lateral spine length on abdominal segments 5-9 (Fig. 4); — and (2) higher ratio of cerci to epiproct length (0.46-0.55).

P. alachuensis and *P. obscurus* are difficult to distinguish. A combination of several characters will separate most individuals: (1) lateral brown markings on dorsum of abdomen present in *obscurus*, absent in *alachuensis*; — (2) dorsal hook on segments 5 and 6 closer in length to that on segment 9 in *obscurus* (0.52-0.94 for ratio of segment 5 to 9, 0.60-0.96 for ratio of 6 to 9) than in *alachuensis* (0.13-0.50 for ratio of 5 to 9, 0.38-0.58 for ratio of 6 to 9). Larger samples will undoubtedly uncover greater variability in these characters than reported here, and the following key may require emendation.

In the key, LS = lateral spines, and DH = dorsal hook on abdomen.

KEY TO *PROGOMPHUS* LARVAE OF NORTH AMERICA

- 1 LS on segments 3*-9; DH of segments 7 and 8 absent or small, 0.10 mm or less in length; western *borealis*
 – LS on segments 5-9; DH of segments 7 and 8 larger, at least 0.15 mm long; mostly eastern 2
 2 Cerci 1.10-1.37 mm long, about half length of epiproct (ratio 0.46-0.55); DH and LS of segment 9 long, 0.45-0.60 mm; length of antennal segment 4 about 1/3 length of segment 3 (0.31-0.36) *bellei*
 – Cerci 0.80-1.10 mm long, about 2/5 length of epiproct (ratio 0.37-0.44); DH and LS of segment 9 shorter, 0.17-0.49 mm; length of antennal segment 4 greater than 1/3 length of segment 3 (0.34-0.47) 3
 3 Lateral margins of abdomen without dark markings; DH of segment 6 about half as long as DH of segment 9 (ratio 0.38-0.58) *alachuensis*
 – Lateral margins of abdomen with dark markings dorsally and usually ventrally; DH of segment 6 at least 2/3 as long as DH of segment 9 (ratio 0.60-0.96) *obscurus*

KNOPF & TENNESSEN (1980) speculated that *P. bellei* was more closely related to *P. alachuensis* than to the other North American species based on adult morphology. My study of larval morphology indicated that these two species and *P. obscurus* are all very closely related. The difficulty encountered in trying to separate larvae of *P. alachuensis* and *P. obscurus* indicates they are closer to each other than either is to *P. bellei*.

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* BELLE (1991) reported that some *P. borealis* larvae have a lateral spine on abdominal segment 2.