

## REVISIONS TO *PLAUDITUS CESTUS* AND *P. GLOVERI* (EPHEMEROPTERA: BAETIDAE)<sup>1,2,3</sup>

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**ABSTRACT:** Two species of the North American genus *Plauditus* (Ephemeroptera: Baetidae), *P. cestus* and *P. gloveri*, are shown to be apotypic sister species. All type specimens associated with both species were re-examined. Certain published larval character descriptions and figures are corrected; for example, mouthpart morphology is shown to be essentially similar in both species. Intraspecific variability is discussed based on previously reported variants and new variants of *P. cestus*, especially from New York and Wisconsin. Consistently reliable characteristics for diagnosing larvae of the two species are given, including both structural and color pattern differences. Species distributional ranges are updated.

The baetid genus *Plauditus* Lugo-Ortiz and McCafferty (1998a) includes several North American species that had been considered either in the original but incorrect American concept of *Pseudocloeon* Klapálek (e.g., Traver 1935), or as certain *Baetis* Leach species without hindwings and lacking a developed median caudal filament as larvae (McCafferty and Waltz 1990). *Plauditus* is closely related to the genera *Acentrella* Bengtsson and *Heterocloeon* McDunnough (R. D. Waltz, pers. comm.). The essential differentiation of the type of *Plauditus* from other North American *Baetis* complex genera, including *Acentrella*, *Baetis*, *Barbaetis* Waltz and McCafferty, *Heterocloeon*, and *Pseudocloeon* (as *Labiobaetis* Novikova and Kluge) can be found in Lugo-Ortiz and McCafferty (1998a). Several species of *Plauditus* are among the most poorly documented Baetidae in North America at this time.

Two species of *Plauditus*, *P. cestus* (Provonsha and McCafferty) and *P. gloveri* McCafferty and Waltz, form a relatively apotypic species pair, which is apparent from their common possession of a combination of relatively apomorphic character states in the larval stage. These character states include antennae that are shortened to one to two times the length of the head capsule (highly unusual for Baetidae in general); a labial palp segment 3 that is distinctly broadened apically (Fig. 5 [Lugo-Ortiz and McCafferty 1998b] and Fig. 6 [McCafferty and Waltz 1998]); and a tarsal claw with an outer, convex margin that is somewhat straight basally and medially, combined with the absence of a distinct distal curvature (see Fig. 8 [Lugo-Ortiz and McCafferty 1998b] and Fig. 7 [McCafferty and Waltz 1998]).

When using the most recent comprehensive North American generic key to mayflies (Edmunds and Waltz 1996), *P. cestus* larvae will key to *Barbaetis*

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because of their very short antennae (about the same length as the head capsule); however, key users should keep in mind that *P. cestus* significantly differs from *Barbaetis benfieldi* Kennedy because the median caudal filament of the latter is well developed. Also when using this key, *Plauditus gloveri* larvae, which have somewhat longer antennae (up to twice the head capsule), along with larvae of other *Plauditus* species, could alternatively be placed as *Acentrella* or *Baetis* lacking hindwingpads and developed median caudal filament.

Examinations of newly available larval samples of *P. cestus* as well as a careful re-examination of both of the holotypes and all paratypes associated with *P. cestus* and *P. gloveri* have shed new light on some similarities, differences, and variability regarding the two species. These data are important to note for workers needing to identify these species because the two species are now known to be sympatric in at least the Appalachian area of eastern North America and can be shown to be morphologically cryptic to a significant degree. With respect to adults, only those of *P. cestus* are described (Provonsha and McCafferty 1982), and therefore that stage does not contribute to analyses herein.

#### INTRASPECIFIC VARIABILITY

It has generally been considered that the presence of a dark band encompassing abdominal segment 5 in *P. cestus* was diagnostic (Provonsha and McCafferty 1982, McCafferty and Waltz 1998). Indeed, the vast majority of *P. cestus* larvae that have been examined fit this typical pattern; however, there are significant variants. Lugo-Ortiz and McCafferty (1998b) described an additional color pattern variant of *P. cestus* from South Carolina that had only a poorly developed segment 5 band, which was especially weak on the sternum. The latter authors also indicated the existence of an immature larval variant of *P. cestus* from South Carolina that almost entirely lacked the segment 5 band but possessed a well-developed band on segment 9. Besides color pattern variability in *P. cestus*, these observations established that *P. cestus* and *P. gloveri* are both present in South Carolina. Actually, the two variants of *P. cestus* mentioned above were taken in the same sample from South Carolina (Edgefield Co., Double Branch of Horn Cr., VI-3-1997, deposited in the Purdue Entomological Research Collection [PERC]). Although this was not made apparent in the previous work, it is significant. In addition, the variant of *P. cestus* that was referred to as immature by Lugo-Ortiz and McCafferty (1998b) is actually quite mature, with well-developed but light wingpads.

We have recently examined mature larvae of *P. cestus* from New York (Catskill Mountains, lot #667, deposited with EcoAnalysts collections, Moscow, ID—no other data readily available) that had both a moderately developed segment 5 band and a well-developed segment 9 band. This observation adds another color pattern variant for *P. cestus* in a state where both typical *P.*

*cestus* larvae and *P. gloveri* larvae had already been found (Jacobus and McCafferty 2001).

Finally, with respect to abdominal tergal color variants of *P. cestus*, we have recently examined mature larvae of *P. cestus* from Wisconsin (Dunn Co., Hay R., X-6-1998, deposited in PERC) that show a well-developed segment 5 band in addition to a somewhat less developed segment 9 band. This represents one more pattern variant of *P. cestus* larvae.

Medial abdominal tergal dots that are present in *P. gloveri* (Fig. 9 [McCafferty and Waltz 1998]) are not typical of *P. cestus* larvae; however, as indicated by Lugo-Ortiz and McCafferty (1998b), they are present in some larvae of *P. cestus*.

The maxillary palps of *P. cestus* were described as not reaching the apex of the galealaciniae (Fig. 5 [Lugo-Ortiz and McCafferty 1998b]), and this was previously considered to be a notable difference between *P. cestus* and *P. gloveri*, whose maxillary palps extend markedly beyond that apex of the galealaciniae in specimens examined (Fig. 2 [McCafferty and Waltz 1998]). One of the Indiana paratypes of *P. cestus* has maxillae with palps as long as those typical of *P. gloveri*. Amongst numerous other larval specimens of *P. cestus* from various localities in North America, we have observed an entire range of intermediate palp lengths.

In Figure 6 of Lugo-Ortiz and McCafferty (1998b), the apical margin of labial palp segment 3 is shown as truncate. After examining additional labia of this species, however, we discovered that the apex of this palp varies from strictly truncate to slightly pointed apicolaterally and slightly rounded apicomediaally, as has been shown for the labial palps of *P. gloveri* (Fig. 5 [McCafferty and Waltz 1998]). This would apparently preclude the use of the labial palp for differentiating between the two species.

The antennal length in *P. gloveri* has been observed to vary roughly from about one and one-half the head capsule to approximately twice the head capsule. Because we have had only a limited number of specimens of *P. gloveri* to examine, however, the variation may turn out to be greater than here reported, and we can not be sure that antennal length is relatively consistent through larval development.

#### INTERSPECIFIC SIMILARITIES

*Plauditus cestus* and *P. gloveri* are similar in generic characteristics as well as those that differentiate the pair from other *Plauditus* as discussed above. In addition, the current study has revealed that certain morphological traits that previously would have been considered differences between the two species, based on published figures and descriptions, are not in fact valid.

With respect to the labrum, it may have been assumed from Figure 1 of *P. cestus* by Lugo-Ortiz and McCafferty (1998b) compared to Figure 1 of *P. gloveri* by McCafferty and Waltz (1998) that the shape of the labrum and the

dorsal labral setal pattern differ in the two species. The shape differences in the labra figured are to a large degree related to slide mounting differences, and the true shape of the labrum of either species is essentially similar to that shown for *P. gloveri* by McCafferty and Waltz (1998). In Figure 1 of Lugo-Ortiz and McCafferty (1998b), the pair of long submarginal setae that occur about midway between the midline and lateral margin of the labrum were not drawn. In Figure 1 of McCafferty and Waltz (1998), the pair of submedian setae were not drawn. Re-examination of the slides upon which the latter two figures were based indicated that the setal pattern is the same in the two species and that both mentioned sets of submarginal setae are present. Because of the dorsal convexity of the labrum, it is difficult if not impossible to have both sets or even one seta of each set in focus simultaneously under the high magnification that is required. Also, the length of the submarginal setae nearest the midline is variable among individuals of both species. In some labra these submedian setae reach beyond the anterior labral margin, but in other labra they are shorter and therefore more difficult to detect.

In Figure 4 of Lugo-Ortiz and McCafferty (1998b) of the planate mandible of *P. cestus*, the medial margin of the fused incisor is smooth. This may have been interpreted as a significant difference from the comparative margin shown for *P. gloveri* (Fig. 4 [McCafferty and Waltz 1998]), which is serrate. However, close examination of the planate mandibles of material of *P. cestus*, including the types, has indicated that this margin is indeed also consistently serrate. This is apparently characteristic of most or all *Plauditus*.

McCafferty and Waltz (1998) figured the midleg of *P. gloveri*, showing a dorsal femoral setal row that was weakly developed in the basal half of the femur. Lugo-Ortiz and McCafferty (1998b) figured the non-comparative foreleg of *P. cestus*, showing a well-developed dorsal femoral setal row for the entire length of the femur. The midleg feature mentioned is essentially consistent for the mid- and hindlegs of both species, with only some variability in the degree of development of the basal armature. The foreleg feature mentioned is also consistent for both species.

#### INTERSPECIFIC DIFFERENCES

Certain of the characters discussed above and with which previous attempts have been made to diagnose *P. cestus* from *P. gloveri* cannot be used as such because we have herein demonstrated their similarity in both species. In the same respect, those characters that we have shown to be variable in *P. cestus* may not be used consistently for species diagnosis, although some of these latter characteristics can be used with some lesser degree of confidence as ancillary diagnostic characteristics, such as the common presence of segment 5 banding in *P. cestus* and the presumed common lack of such in *P. gloveri*. There are, however, certain characteristics that appear to be consis-

tently useful at least for the diagnosis of relatively mature larvae, and especially unbleached specimens of such.

Relative antennal length of *P. cestus* has been found to be consistently shorter than that of *P. gloveri* (about subequal with head capsule compared to one and one-half to two times the head capsule, respectively). The sub-basal cross-band shading on at least the fore- and midfemora of *P. cestus* (Fig. 8 [Provonsha and McCafferty 1982] and Fig. 7 [Lugo-Ortiz and McCafferty 1998b]) compared with the dark dot/dash pattern found on at least the fore- and midfemora of *P. gloveri* (Fig. 6 [McCafferty and Waltz 1998]) has proven consistent. The short, somewhat thick, median V-shaped shading on the abdominal tergum 2 of *P. gloveri* (Fig. 8 [McCafferty and Waltz 1998]) compared to the lack of such a mark on *P. cestus* (Fig. 8 [Provonsha and McCafferty 1982] and Figs. 9-11 [Lugo-Ortiz and McCafferty 1998b]) has proven consistent but may be subject to fading. Abdominal segment 7 of *P. gloveri* is at least somewhat shaded compared to adjacent segments but this may be difficult to detect, as pointed out by McCafferty and Waltz (1998), whereas *Plauditus cestus* lacks shading or banding on segment 7. *Plauditus cestus* consistently has a distinctive, dark, wide band in the distal half of the cerci (Fig. 8 [Provonsha and McCafferty 1982]), whereas *P. gloveri* lacks such a band, instead either having three, lighter, narrower bands or having no banding apparent on the cerci (probably due to rapid fading in preserved material).

As suggested by Fig. 8 (Provonsha and McCafferty 1982) and Figs. 9-11 (Lugo-Ortiz and McCafferty 1998b) compared to Figs. 8-9 (McCafferty and Waltz 1998), the reduced median caudal filament of *P. cestus* is more attenuate than that of *P. gloveri*. After examining numerous specimens of *P. cestus*, however, we do not recommend that the median caudal filament be used for diagnosis; any specific differences possibly associated with this structure are very subtle and therefore too easily misinterpreted much of the time.

#### SPECIFIC RANGES

*Plauditus cestus* is herein reported from Wisconsin for the first time (see above, under Intraspecific Variability) and it had been previously reported from Colorado, Idaho, Illinois, Indiana, Iowa, Kentucky, Missouri, North Carolina, New York, Ontario, South Carolina, and Vermont (Provonsha and McCafferty 1982, McCafferty et al. 1993, Klubertanz 1995, Sarver and Kondratieff 1997, Lugo-Ortiz and McCafferty 1998b, Randolph and McCafferty 1998, Pescador et al. 1999, and Jacobus and McCafferty 2001). *Plauditus gloveri* is currently known from New York, South Carolina, and Texas (McCafferty and Waltz 1998, Jacobus and McCafferty 2001). We expect the latter species to occur in at least certain areas intermediate between these latter three states.

## LITERATURE CITED

- Edmunds, G. F. and R. D. Waltz.** 1996. Ephemeroptera. pp. 126-163. In: Merritt, R. W. and K. W. Cummins (eds.). An introduction to the aquatic insects of North America, Third Edition. Kendall/Hunt, Dubuque, Iowa.
- Jacobus, L. M. and W. P. McCafferty.** 2001. The mayfly fauna of New York state (Insecta: Ephemeroptera). J. New York Entomol. Soc. 109: 47-80.
- Klubertanz, T. H.** 1995. Survey of Iowa mayflies (Ephemeroptera). J. Kans. Entomol. Soc. 68: 20-26.
- Lugo-Ortiz, C. R. and W. P. McCafferty.** 1998a. A new North American genus of Baetidae (Ephemeroptera) and key to *Baetis* complex genera. Entomol. News 109: 345-353.
- Lugo-Ortiz, C. R. and W. P. McCafferty.** 1998b. New larval variants and distributional records for *Plauditus cestus* (Ephemeroptera: Baetidae). Gr. Lakes Entomol. 31: 201-204.
- McCafferty, W. P. and R. D. Waltz.** 1990. Revisionary synopsis of the Baetidae (Ephemeroptera) of North and Middle America. Trans. Am. Entomol. Soc. 116: 769-799.
- McCafferty, W. P. and R. D. Waltz.** 1998. A New species of the small minnow mayfly genus *Plauditus* (Ephemeroptera: Baetidae) from South Carolina. Entomol. News 109: 354-356.
- McCafferty, W. P., R. S. Durfee, and B. C. Kondratieff.** 1993. Colorado mayflies (Ephemeroptera): an annotated inventory. Southwest. Natural. 38: 252-274.
- Pescador, M. L., D. R. Lenat, and M. D. Hubbard.** 1999. Mayflies (Ephemeroptera) of North Carolina and South Carolina: an update. Florida Entomol. 82: 316-332.
- Provonsha, A. V. and W. P. McCafferty.** 1982. New species and previously undescribed larvae of North American Ephemeroptera. J. Kans. Entomol. Soc. 55: 23-33.
- Randolph, R. P. and W. P. McCafferty.** 1998. Diversity and distribution of the mayflies (Ephemeroptera) of Illinois, Indiana, Kentucky, Michigan, Ohio, and Wisconsin. Bull. Ohio Biol. Surv., New Ser. 13: vii + 1-188.
- Sarver, R. and B. C. Kondratieff.** 1997. Survey of Missouri mayflies with the first description of adults of *Stenonema bednariki* (Ephemeroptera: Heptageniidae). J. Kans. Entomol. Soc. 70: 132-140.
- Traver, J. R.** 1935. Part II: Systematic. pp. 237-739. In: Needham, J. G., J. R. Traver and Y-C. Hsu (eds.). The biology of mayflies. Comstock Publ., Ithaca, NY.