

## FURTHER CONTRIBUTIONS TO THE SPATULATE CLAWED BAETIDAE (EPHEMEROPTERA)<sup>1</sup>

W. P. McCafferty, R. P. Randolph<sup>2</sup>

**ABSTRACT:** The formal new name, *Camelobaetidius kickapoo*, n. sp., is given for *Camelobaetidius* sp. 1 of McCafferty and Davis. The species is described from the lower Rio Grande between Texas and the Mexican states of Chihuahua and Coahuila, but it has also been taken in northwestern Colorado and the Gila River in Arizona. It is unique in North and Central America in having an intermediate number of denticles on the spatulate claws in both early and late instar larvae. *Camelobaetidius warreni* is shown to possess larval forecoxal osmobranchiae, and *C. sinaloa* is shown to be a new junior synonym of *C. musseri*. A revised key to the known larvae of the species of *Camelobaetidius* in North and Central America is given to express new and recent findings.

Recent important work dealing with the Western Hemisphere mayfly genus *Camelobaetidius* Demoulin that has appeared since the original work of Traver and Edmunds (1968) has included foremost the synoptic treatment of the North and Central American fauna by Lugo-Ortiz and McCafferty (1995). Our continuing research on the genus in North America and the recent examination of larval material upon which original descriptions were based has led to the discovery of certain discrepancies in the literature regarding the most ubiquitous species north of Mexico, *C. warreni* (Traver and Edmunds). In addition, our survey of a multitude of collections of *Camelobaetidius* from North America has also confirmed the uniqueness on the continent of a species previously referred to as *Camelobaetidius* sp. 1 by McCafferty and Davis (1992), McCafferty et al. (1993), and Lugo-Ortiz and McCafferty (1995). This species was not named previously because mature larvae were not known. One newly studied population, however, contains early to middle-instar larvae associated with ultimate instar larvae. This population thus confirms that larval characters previously thought to be diagnostic are consistent through the development of the larvae and allows the formal naming of the species previously known as *C. sp. 1 sensu* McCafferty and Davis herein. Finally, our study has also revealed an additional species synonym involving what has been known as *C. sinaloa* (Allen and Murvosh). We provide evidence for that herein, and we also provide corrected and updated character information for the identification of North American species, including a revised larval key to species.

<sup>1</sup> Received September 25, 1999. Accepted March 16, 2000.

<sup>2</sup> Department of Entomology, Purdue University, West Lafayette, IN 47907.

***Camelobaetidius kickapoo* McCafferty, NEW SPECIES**

*Camelobaetidius* sp. 1 McCafferty and Davis, 1992:207.

**Material examined.** HOLOTYPE: Larva: Texas, Presidio Co., Rio Grande, 13 miles downstream from Presidio, VI-28-1977, J. R. Davis, deposited in the Purdue Entomological Research Collection (PERC). PARATYPE: larva, Texas, Brewster Co., Rio Grande at Santa Elena Canyon, IX-28-1977, J. R. Davis (PERC), some mouthparts slide-mounted in Euparal. Additional larval material has been examined from Colorado, Moffat Co., Yampa R, Echo Park, Dinosaur National Monument, VII-16-1991 (in the C. P. Gillette Museum of Arthropod Diversity, Fort Collins, Colorado), from Texas, Val Verde Co., Rio Grande at Foster Ranch near Langtry, V-2-1977 (in the private collection of J. R. Davis, Austin, Texas), and from Arizona, Greenlee Co, Gila R just upstream from San Francisco R confluence, IX-17-1997, K. Palmer and R. Williams (in the EcoAnalysts collection, Moscow, Idaho).

**Etymology.** The species is named for the Native American Kickapoo tribe and is a noun in apposition.

**Diagnosis.** *Camelobaetidius kickapoo* is unique in North and Central America in that it possesses an intermediate number of claw denticles (13-18, often with 16). Other species have denticles in the range of 5-10 or 30-45. Segment 2 of the labial palps has a small medial point, approaching that of *C. waltzi* McCafferty in North America, and also *C. penai* (Traver and Edmunds) from Argentina and *C. anubis* (Traver and Edmunds) from Brazil. The dorsal submarginal row of labral setae is variable, sometimes with a large gap between the medial seta and the three or four lateral setae, similar to *C. mexicanus* (Traver and Edmunds) and *C. variabilis* Wiersema in North America, and sometimes with a narrower gap between the medial and lateral setae, similar to *C. waltzi* in North America. Such variability has also been observed between the left and right side of the labrum on the paratype larva. No coxal osmobranchiae are present in the new species.

**Distribution.** The species is currently known from northwest Colorado; far west Texas; eastern Arizona; far northeastern Mexico.

**Remarks.** Only the Peruvian species *C. cayumba* (Traver and Edmunds) has claw denticles similar in number to those of *C. kickapoo*. We have not studied the type material of *C. cayumba*, but have seen additional material from South America that agrees with the description of the larvae by Traver and Edmunds (1968). We do not presume, however, a close relationship from this similarity in denticle number, which could easily have resulted from homoplasy. Based on the shape of the labial palps, one might deduce that *C. kickapoo* and *C. waltzi* are closely related North American species, perhaps additionally related to certain South American species that also express a medially pointed labial palp segment 2 (see diagnosis above). The probable sister species *C. kickapoo* and *C. waltzi* currently appear to be separated geographically, with *C. kickapoo* being a mainly southwestern species, and *C. waltzi* being a plains species ranging from eastern Nebraska (Kubertanz and Jones 1999) to southwestern Indiana (McCafferty and Klubertanz 1994) to south-

eastern Texas (Wiersema and McCafferty 1999).

Although larvae of *C. kickapoo* were secured from the Rio Grande from the Texas side, the localities cited above along the Rio Grande are shared by the Mexican states of Chihuahua and Coahuila. *Camelobaetidius kickapoo* and *C. warreni* have both been taken from the upper Green River. We have seen larvae of *C. warreni* from the Green River, Daggett County, Utah, not far from the vicinity of the Colorado record for *C. kickapoo* (see McCafferty et al. 1993), and we expect that *C. kickapoo* will be found in this part of Utah. We have seen both *C. kickapoo* and *C. musseri* (Traver and Edmunds) from the Gila River in Arizona. Although *C. kickapoo* has been taken from the lower Rio Grande, it has not been found in the Rio Grande drainage in New Mexico nor have any other *Camelobaetidius* (McCafferty et al. 1997).

### LARVAL DIAGNOSIS

Certain species of *Camelobaetidius* are known to possess coxal osmobranchiae. These are short, single, fingerlike filaments that have been referred to as gills by some authors. The term osmobranchia appears more appropriate than gill to us, because we have noted relative hypertrophy in these structures that suggests some osmoregulatory role and which may explain the sometimes difficult task in detecting these structures in some specimens.

In couplet 2 of the key to larvae of North and Central American species of *Camelobaetidius* given by Lugo-Ortiz and McCafferty (1995), the presence or absence of forecoxal osmobranchiae were used to separate *C. similis* Lugo-Ortiz and McCafferty (osmobranchiae present) from *C. waltzi*, *C. mexicanus*, and *C. warreni* (Traver and Edmunds) (osmobranchiae absent). In the larval key given by Traver and Edmunds (1968), the forecoxal osmobranchiae were not used; however, Traver and Edmunds (1968) indicated in their monograph that these structures had been encountered in larvae from Brazil, Uruguay, and Panama, but were absent in other material they had examined (which could be taken to include those larvae studied from North America).

*Camelobaetidius warreni* was described from California, but is now known from Costa Rica (Lugo-Ortiz and McCafferty 1995) to Saskatchewan (McCafferty and Randolph 1998), and is the most widely distributed species of *Camelobaetidius* in North America, having been taken from most western USA states (e.g., McCafferty et al. 1997). We have recently encountered considerable material from the West that agree with the previous published concepts of *C. warreni*, except for the presence of forecoxal osmobranchiae. We examined the paratype larval material from California (deposited at PERC) upon which the original description of the species was based and found that forecoxal osmobranchiae were indeed present, although they had neither been mentioned in the original description nor had they been depicted with the foreleg (figure 25 of Traver and Edmunds [1968]). We also re-examined all of the

larval material of *C. warreni* that had been reported by Lugo-Ortiz and McCafferty (1995) and consistently found forecoxal osmobranchiae present.

Traver and Edmunds (1968) did not mention coxal osmobranchiae, or coxal gills, in their description of *C. zenobia* (Traver and Edmunds), which is now known as a junior synonym of *C. warreni*, but our examination of paratype larvae of *C. zenobia* held at PERC revealed the presence of the forecoxal osmobranchiae. Traver and Edmunds (1968) gave a tentative designation of *C. cepheus* (Traver and Edmunds) to larvae from Idaho. The latter name has also proven to be a synonym of *C. warreni* (Lugo-Ortiz and McCafferty 1995). The larval material identified as *C. cepheus* by Traver and Edmunds is also held at PERC, and our examination of it confirmed that it too has forecoxal osmobranchiae. In larvae associated with other known synonyms of *C. warreni*, i.e., *C. navis* Allen and Chao from New Mexico and *C. trivialis* Allen and Chao from Arizona and New Mexico, Allen and Chao (1978) did not mention coxal osmobranchiae, or gills. Although we have not been able to examine original larval material associated with these latter two names, we assume the forecoxal osmobranchiae are present, based on all of our other observations.

This confirmation of the presence of forecoxal osmobranchiae in *C. warreni* is of considerable importance in the determination of North and Central American species of *Camelobaetidius*, because there has been, until now, a strong possibility of misidentifying the common species *C. warreni* as either *C. similis*, *C. variabilis*, or an unnamed species if a user is relying entirely on statements and figures by Traver and Edmunds (1968) or the key by Lugo-Ortiz and McCafferty (1995). These corrections and new observations regarding these species are reflected in the new key provided herein (see below).

We have made one other discovery that has direct bearing on larval diagnosis in North and Central America. Recently, we have had access to considerable new material of *Camelobaetidius* from Mexico. Mexican specimens would key to either *C. musseri* (Traver and Edmunds) or *C. sinaloa* (both with larval spatulate claws having 30-40 denticles and thus distinct from other North and Central American species known as larvae). However, it was particularly difficult to consistently distinguish between the two using the color pattern characterization given in the Lugo-Ortiz and McCafferty (1995) key. Populations often appeared to be mixed. Allen and Murvosh (1987) had based their *C. sinaloa* on two larvae taken at Sinaloa, Mexico, and indicated that they were similar to *C. musseri* and *C. salinas* Allen and Chao, and could be distinguished from *C. salinas* by lacking submedian markings on the abdominal terga; they did not state any characterization for differentiating their larvae from those of *C. musseri*. *Camelobaetidius salinas* was placed as junior subjective synonym of *C. musseri* by Lugo-Ortiz and McCafferty (1995) because the larval differences cited by Allen and Chao (1978) for *C. salinas* reflected intraspecific variability. Nonetheless, Lugo-Ortiz and McCafferty (1995) retained *C. sinaloa* and believed that the two could be distinguished by the pres-

ence of dark posterior borders on abdominal terga 1-9 in *C. sinaloa*, as per the figure given by Allen and Murvosh (1987), and as was reflected by couplet 7 in the Lugo-Ortiz and McCafferty key.

We have examined series of paratype larvae of *C. musseri* from the type locality population as well as other populations in Mexico (deposited at PERC), and found that the dark posterior borders indicated by Allen and Murvosh (1987) for *C. sinaloa* are present in most larvae of *C. musseri*. Paratype larvae of *C. musseri* show considerable variability both with respect to marginal shading on the abdominal terga and submedian maculation, which is present in some individuals and absent in others. On this basis, it is obvious that the two names refer to the same species, and we therefore place *C. sinaloa* as a junior subjective synonym of *C. musseri*, new synonym.

We offer the following updated key to the North and Central American species of *Camelobaetidius* species in the larval stage that takes into account all of the above observations as well as new species descriptions herein and elsewhere (Wiersema 1997) since Lugo-Ortiz and McCafferty (1995). Careful inspection is necessary for accurate claw denticle counts and the observation of coxal osmobranchiae. Furthermore, it should be kept in mind that precise inspection of the chetotaxy of the labrum and form of the labium require slide mounting and high magnification.

**Revised key to the known North and Central American middle to late instar larvae of *Camelobaetidius***

- 1 Claws with 5-20 denticles ..... 2
- 1' Claws with 30-45 denticles ..... 7
  
- 2 Claws with 5-10 denticles ..... 3
- 2' Claws with 13-20 denticles ..... *C. kickapoo*
  
- 3 Forecoxal osmobranchiae present ..... 4
- 3' Forecoxal osmobranchiae absent ..... 6
  
- 4 Midcoxal osmobranchiae present ..... *C. variabilis*
- 4' Midcoxal osmobranchiae absent ..... 5
  
- 5 Labrum with second seta from center in dorsal submarginal line smaller and offset basally compared to adjacent setae (see Fig. 6, Lugo-Ortiz and McCafferty [1995]) ..... *C. warreni*
- 5' Labrum with second seta from center in dorsal submarginal line similar in size and level of origin with adjacent submarginal setae ..... *C. similis*
  
- 6 Labium with second segment of palps pointed (Fig. 5, McCafferty and Klubertanz [1994]) ..... *C. waltzi*
- 6' Labium with second segment of palps rounded ..... *C. mexicanus*
  
- 7 Claws with 40-45 denticles ..... *C. kondratieffi*
- 7' Claws with 30-39 (usually 30-35) denticles ..... *C. musseri*

Although our revised key has utilitarian value, we strongly suggest that original descriptions and diagnoses of species also be consulted for confirmation of other characteristics not covered by the simplified couplets. The following published distributions of the species included (all citations above) may also be of some assistance in diagnosis but must remain ancillary to morphological characterization: *C. kickapoo* (Arizona, Colorado, Texas, northern Mexico, and ?Utah); *C. kondratieffi* Lugo-Ortiz and McCafferty (Central America); *C. mexicanus* (Kansas, northern and southern Mexico, and Texas); *C. musseri* (Arizona, Central America, southern and northern Mexico, Nevada, and New Mexico); *C. similis* (northern and southern Mexico); *C. variabilis* (northern Mexico, Oklahoma, and Texas); *C. waltzi* (Indiana, Iowa, Nebraska, and Texas); *C. warreni* (Arizona, California, Central America, Colorado, Idaho, southern and northern Mexico, New Mexico, Oregon, Saskatchewan, South Dakota, and Utah).

#### ACKNOWLEDGMENTS

We thank J. R. Davis, Austin, Texas, and G. Lester, Moscow, Idaho, for providing specimens for study. Funding for this research was provided in part by NSF grant DEB-9901577, and the paper has been assigned Purdue ARP Journal No. 16103.

#### LITERATURE CITED

- Allen, R. K. and E. S. M. Chao. 1978. Mayflies of the Southwest: new species and records of *Dactylobaetis* (Ephemeroptera: Baetidae). Pan-Pac. Entomol. 54: 300-304.
- Allen, R. K. and C. D. Murvosh. 1987. New Baetidae from the southwestern United States and northern Mexico (Ephemeroptera: Insecta), with notes. Can. Entomol. 11: 1095-1099.
- Klubertanz, T. H. and D. M. Jones. 1999. Adults of *Camelobaetidium waltzi* (Ephemeroptera: Baetidae), with field notes. Entomol. News 110: 173-176.
- Lugo-Ortiz, C. R. and W. P. McCafferty. 1995. Taxonomy of the North and Central American species of *Camelobaetidium* (Ephemeroptera: Baetidae). Entomol. News 106: 178-192.
- McCafferty, W. P. and J. R. Davis. 1992. New and additional records of small minnow mayflies (Ephemeroptera: Baetidae) from Texas. Entomol. News 103: 199-209.
- McCafferty, W. P. and T. H. Klubertanz. 1994. *Camelobaetidium* (Ephemeroptera: Baetidae) in Indiana and Iowa: new species and range extension. Proc. Entomol. Soc. Wash. 96: 37-43.
- McCafferty, W. P. and R. P. Randolph. 1998. Canada mayflies: a faunistic compendium. Proc. Entomol. Soc. Ontario 129: 47-97.
- McCafferty, W. P., R. S. Durfee, and B. C. Kondratieff. 1993. Colorado mayflies (Ephemeroptera): an annotated inventory. Southwest. Natural. 38: 252-274.
- McCafferty, W. P., C. R. Lugo-Ortiz, and G. Z. Jacobi. 1997. Mayfly fauna of New Mexico. Gr. Basin Natural. 57: 283-314.
- Traver, J. R. and G. F. Edmunds, Jr. 1968. A revision of the Baetidae with spatulate-clawed nymphs (Ephemeroptera). Pac. Insects 10: 629-677.
- Wiersema, N. A. 1998. *Camelobaetidium variabilis* (Ephemeroptera: Baetidae), a new species from Texas, Oklahoma and Mexico. Entomol. News 109: 21-26.
- Wiersema, N. A. and W. P. McCafferty. 1999. *Americabaetis* (Ephemeroptera: Baetidae) from Texas: first USA record and adult description of *A. pleturus*. Entomol. News 110: 36-38.