LABIOBAETIS (EPHEMEROPTERA: BAETIDAE): NEW STATUS, NEW NORTH AMERICAN SPECIES, AND RELATED NEW GENUS[1]

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ABSTRACT: *Labiobaetis* Novikova and Kluge is raised to generic rank and includes 27 nominal species, including most of those previously considered in the *Baetis propinquus*, *Baetis atrebatinus*, and *Baetis molawinensis* species groups, which are known, respectively, from North America, Eurasia, and the Orient. The genus represents a clade evidently derived near the base of the *Baetis* complex. *Labiobaetis apache*, n. sp. is based on larvae studied from Utah and Arizona, and is distinguished by profuse spinelike setae on the legs and body. Notes on the habitat of *L. apache* and comments on the western North American species are given. An illustrated key to the larvae of all six species of *Labiobaetis* in North America is provided. A new, closely related genus, *Cymulabaetis*, presently consists of two species from northern Africa and eastern Europe, respectively. *Labiobaetis* and *Cymulabaetis* preliminarily appear to represent sister lineages.

The *Baetis propinquus* species group as defined by Morihara and McCafferty (1979a), the *B. atrebatinus* species group as defined by Müller-Liebenau (1969, 1973), and the *B. molawinensis* species group as defined by Müller-Liebenau (1984a) form a distinct grouping of species distributed in North America, Eurasia, and the Orient, respectively (see also Morihara and McCafferty 1979b; Müller-Liebenau 1981, 1982, 1984b; Müller-Liebenau and Hubbard 1985). The larvae in this grouping share the possession of the apomorphic femoral villopore found only in *Baetis* and certain other closely related baetid genera, considered the "*Baetis* complex" by Waltz and McCafferty (1987a). *Acentrella* Bengtsson, *Baetiella* Ueno, *Baetis* Leach, *Barbaetis* Waltz and McCafferty, *Heterocloeon* McDunnough, *Liebebiella* Waltz and McCafferty, *Platybaetis* Müller-Liebenau, and *Pseudocloeon* Klapalek sensu auctt. are also included in this complex. The importance of the villopore in understanding the generic relationships of the Baetidae was discussed by McCafferty and Waltz (1990), and those species lacking it have been removed from *Baetis* (see, e.g., Waltz and McCafferty 1987b). Although species in the *propinquus*, *atrebatinus*, and *molawinensis* groups traditionally have been considered in *Baetis*, Morihara and McCafferty (1979a) showed that they are defined by unique apomorphic characteristics not found in other *Baetis*, and

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thus they form a monophyletic grouping. Novikova and Kluge (1987) gave subgeneric rank to this grouping within *Baetis* under the name *Labiobaetis*, and we now consider it to constitute a genus. Two species that have been considered in the *atrebatinus* species group by some workers but that do not actually possess larval apomorphies that define *Labiobaetis* are placed in a new genus (see below).

Genus *Labiobaetis*, NEW STATUS

The reasons we recognize *Labiobaetis* as a genus are as follows. We consider its relative phylogenetic position to be near the base of the *Baetis* complex because the villopore is only poorly developed, being rudimentary or absent, for example, on the fore- and midlegs of many species. Also, the plesiomorphic sclerotized plate between the bases of the male forceps is retained to various degrees in this clade. In *Baetis* sensu stricto and some other more remotely derived genera in the complex, the villopore has become well established and the genital plate has been lost. The recognition of relatively later derived clades as genera in this latter lineage mandates the additional recognition of the genus *Labiobaetis*, if indeed a phylogenetic classification is sought for the Ephemeroptera as discussed by McCafferty (1991). Larvae of *Labiobaetis* are best defined by the unique, synapomorphic excavation of the maxillary palps (Fig. 14) (only weakly developed in two Oriental species). Also, the presence of a distal lobe on the antennal scapes (Fig. 12) (not apparent in one Oriental species and slightly developed in one other) is evidently another important larval apomorphy, which delineates this group.

Müller-Liebenau (1984a) provided a synopsis of the larval characteristics that are associated with this genus, and a first key to the Holarctic genera of Baetidae, including *Labiobaetis*, is being prepared for publication by Waltz and McCafferty.

A number of *Labiobaetis* species from the Orient remain unknown as adults (see Müller-Liebenau and Hubbard 1985); however, on the basis of known and provisionally placed adults, this stage of *Labiobaetis* either possesses hindwings with two longitudinal veins and a very weakly developed or absent costal process, or they lack hindwings. (Thus, all larvae also have narrow hindwing pads except for a few species in the Oriental region that lack hindwing pads.) In addition, known adults have short, apically rounded terminal segments on the male forceps and a variously developed sclerotized plate between the base of the forceps. The reduction of the costal process and the loss of the hindwings themselves are apomorphic character states; however, they are not unique to *Labiobaetis*, being homoplasies associated with size reduction in general that have occurred in many diverse lineages of baetids (see, e. g., McCafferty and Waltz 1990). The degree to which the short terminal segments of male genitalia may be found throughout the genus remains to be known, but we expect this characteristic to be consistent.

The larval stage of three species of *Labiobaetis* from the Sunda Islands (Müller-Liebenau 1981) and one species from India (Gillies 1949) remain unknown. The placement of these species, which are asterisked in the species composition list below, requires substantiation with reared larvae at a future time. There is little doubt, however, that *Baetis calcaratus,* although also known only in the adult stage, should be placed in *Labiobaetis* because of its detailed resemblance to *Labiobaetis* species for which the larvae are well known (see Keffermüller 1972).

Labiobaetis, as defined here, includes the following species: *L. apache* n. sp. (North America); *L. atrebatinus* (Eaton) n. comb. (type species of the genus from Eurasia); *L. borneoensis* (Müller-Liebenau) n. comb. (E. Malaysia); *L. calcaratus* (Keffermüller) n. comb. (Eurasia); *L. dardanus* (McDunnough) n. comb. (North America); *L. desertus* (Novikova and Kluge) n. comb. (Kazakhstan); *L. difficilis* (Müller-Liebenau) n. comb. (W. Malaysia); *L. diffundus* (Müller-Liebenau) n. comb. (W. Malaysia); *L. ephippiatus* (Traver) n. comb. (North America); *L. frondalis* (McDunnough) n. comb. (North America); **L. fulmeki* (Ulmer) n. comb. (Sunda Islands); *L. geminatus* (Müller-Liebenau and Hubbard) n. comb. (Sri Lanka); *L. longipalpus* (Morihara and McCafferty) n. comb. (North America); *L. molawinensis* (Müller-Liebenau) n. comb. (Philippines); *L. moriharai* (Müller-Liebenau) n. comb. (W. Malaysia); *L. multus* (Müller-Liebenau) n. comb. (W. Malaysia); **L. necopinatus* (Müller-Liebenau) n. comb. (Sunda Islands); *L. neglectus* (Navas) n. comb. (Algeria); *L. numeratus* (Müller-Liebenau) n. comb. (W. Malaysia); *L. operosus* (Müller-Liebenau) n. comb. (W. Malaysia); *L. ordinatus* (Müller-Liebenau and Hubbard) n. comb. (Sri Lanka); **L. palmyrae* (Gillies) n. comb. (India); *L. propinquus* (Walsh) n. comb. (North America); *L. pulchellus* (Müller-Liebenau and Hubbard) n. comb. (Sri Lanka); *L. sumigarensis* (Müller-Liebenau) n. comb. (Philippines); *L. tricolor* (Tshernova) n. comb. (Eurasia); and **L. ulmeri* (Müller-Liebenau) n. comb. (Sunda Islands).

We do not recognize *L. tricolor* as a junior synonym of *L. propinquus,* as was designated by Novikova and Kluge (1987). This is because, as pointed out by Morihara and McCafferty (1979a), there exists a clinal but distinct difference in the development of the apicomedial corner of the basal portion of the male forceps in these two species, albeit they are very similar sister species as shown cladistically by Morihara and McCafferty (1979a). Keffermüller (1972) studied the variability of this structure in *L. tricolor,* and, among the range of variability of some 330 males examined, she did not show any forceps with an apicomedial corner as well developed as in *L. propinquus.*

Labiobaetis apache, new species

Larval description. Body length: 5-6 mm; cerci: 2.5-3.0 mm. Head: Intra-antennal process present, parallel-sided between antennal bases. Antennal scape and pedicel with fine setae and sharp, robust setae dorsally and ventrally; scape with distal lobe. Labrum (Fig. 1) with one medial seta and 7-11 submarginal setae, submarginal setae slender, tapering distally, two submarginal setae nearest medial seta nearly contiguous; marginal setae bifurcate; dorsally with fine setae and setal bases. Right mandible (Fig. 2) incisors 3(1)+3 or apparently 3(2)+3, the latter reflecting an additional spur on the reduced tooth of the outer incisor in some individuals, possibly a bifurcate condition; prostheca prominent, base recessed into mandible; plane of mandible between incisor bases and molar region arched and scabrate. Left mandible (Fig. 3) incisors 3(1)+3; prostheca prominent; plane of mandible between incisor bases and molar region arched; process of molar region slightly elevated. Maxillae with two-segmented palps, ratio of segment 1 to segment 2 = 4:5; apex of palps exceeding apex of galealacineae; palps excavated distally. Hypopharynx typical of other Baetidae, heavily setate; lingua with distal tuft. Labium (Fig. 4) with palps three segmented; segment 2 strongly expanded distally, with medially expanded lobe; lobe with four or five strong dorsal setae and many scattered, smaller setae; base of segment 3 subequal to one-half distal width of segment 2; paraglossae medial width subequal to twice medial width of glossae, with three rows of apical setae; glossae with three strong distal setae and 10-11 medial setae and simple row of ventral setae.

Thorax: Hindwingpads present. Legs (Fig. 5) each with villopore, villopores most developed on hindlegs, poorly developed on fore- and midlegs; all legs strongly setate with sharp, spinelike setae on all surfaces; forelegs slightly shorter than mid- or hindlegs.

Abdomen: Terga with fine setae and many scales; scale bases angulate; scales slightly longer than wide, ovoid; posterior marginal spine length subequal to width; fine setae between spines; robust, spinelike setae present proximal to pleural suture. Gills asymmetric, ovoid, with margins mostly smooth, and basally with scattered fine setae; serrations of gill margin increasing in frequency toward distal margin of gills, and with fine, interspersed setae; gill surfaces also with fine setae. Male sternite 9 (Fig. 6) with weakly developed lobes (see Morihara and McCafferty 1979a: Figure 9 for comparison) and with 8-11 spines between lobes. Paraprocts with numerous spines (>30), and profusion of spines distally; spine length subequal to twice basal width. Terminal filament ca. 0.6x-0.75x length of cerci.

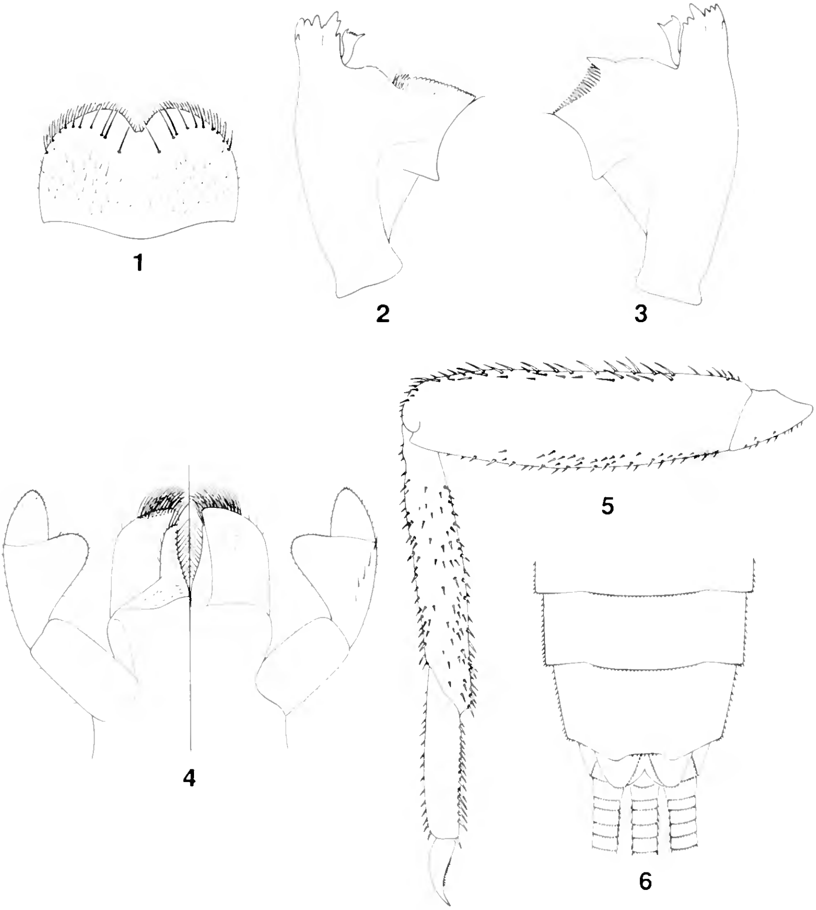
Material. HOLOTYPE: male larva (in alcohol), Arizona: Apache Co., straight S of St. John's, 12 July, 1967, R. & D. Koss, deposited in the Purdue Entomological Research Collection (PERC), West Lafayette, Indiana. PARATYPES: 40 larvae, same data as holotype and 6 larvae, Utah: Wayne Co., Capitol Reef National Park, Pleasant Creek, 5 August, 1993, J. F. MacDonald, deposited in PERC; 39 larvae, same data as holotype, deposited in the California Academy of Science, San Francisco; and 39 larvae, same data as holotype, deposited in the National Museum of Natural History, Washington, D.C.

Etymology. This new species is named after the Apache tribe of native American southwestern peoples, who historically occupied northern Mexico, Arizona, New Mexico, and Texas.

Diagnosis. *Labiobaetis apache* is a uniformly colored species without strongly contrasting color patterns. The body is covered with numerous distinct, spinelike setae. The prominent bristles of the legs (Fig. 5), thoracic sterna, and lateral margins of the abdominal terga (Fig. 6) are diagnostic of this new species. It differs from the presumably closely related *L. propinquus* in having more numerous submarginal setae on the labrum (Fig. 1), numerous sharp, robust setae covering the body as mentioned above, and in body coloration. See below for a key to the larvae of all North American species of *Labiobaetis.*

DISCUSSION

Labiobaetis apache was recently collected in Utah by J. F. MacDonald from a fast flowing, cold water stream, less than six inches deep (lacking con-

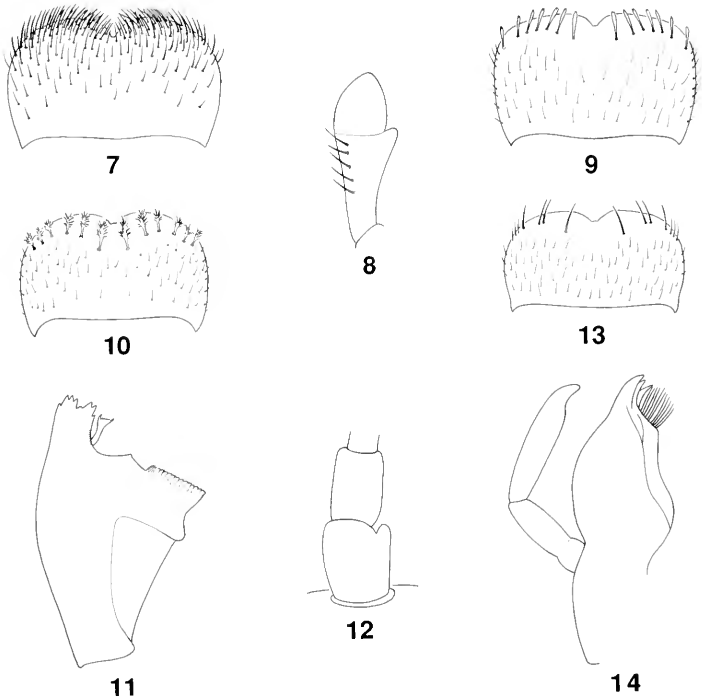


Figs. 1-6. *Labiobaetis apache* n. sp. larva. 1. Labrum. 2. Right mandible. 3. Left mandible. 4. Labium (left-ventral/right-dorsal). 5. Hindleg. 6. Posterior abdominal sterna (male).

spicuous vegetation), at approximately 1,900 m elevation [for more habitat details see McCafferty and MacDonald (1994)]. Most specimens were collected near the stream margin. The exact elevation at which the Arizona material was taken in the Little Colorado River south of St. John's was not recorded.

As pointed out by McCafferty and MacDonald (1994), *Chloroterpes inornata* is also found in the same locations that the new species described here has been taken. The distribution pattern shown by *C. inornata* includes much of the Colorado Plateau but not the Great Basin, and this may also prove to be the case for *L. apache*. This may in part explain why it has not been taken in Utah previously, since much of the historical collecting in that state has been in the Great Basin area.

With the addition of *L. apache*, there are now six nominal species of *Labiobaetis* in North America, at least three of which are western. The figure



Figs. 7-14. *Labiabaetis* larvae. Figs. 7-8. *L. Longipalpus*. 7. Labrum. 8. Labial palp. Fig. 9. B. *frondalis*, labrum. Figs. 10-11. *L. ephippiatus*. 10. Labrum. 11. Right mandible (redrawn from Soluk 1981). Figs. 12-14. *L. propinquus*. 12. Antennal base. 13. Labrum. 14. Maxilla.

of a labium of *"Baetis* sp." from California that was provided by Day (1956: Fig. 3:26h) is referable to *Labiobaetis.* It possibly represents a new species, or any one of the known western species: *L. apache, L. dardanus* (see Soluk 1981), which is known from the Northwest as far south as Utah and Colorado (Durfee and Kondratieff 1994), and *L. propinquus* a widespread, somewhat ubiquitous species (Berner and Pescador 1988) that, in the West, has recently been reported from Colorado and was previously known from New Mexico (see McCafferty *et al.* 1993).

A close relationship of *L. apache* and *L. propinquus* may be assumed on the basis of similarities in their larvae (see key below). If this is the case, the as yet undescribed adults of *L. apache* may also key out near *L. propinquus* when using the adult key provided by Morihara and McCafferty (1979a).

KEY TO THE LARVAE OF NORTH AMERICAN SPECIES OF *LABIOBAETIS*

1. Labrum with submarginal setae similar to other, relatively dense, dorsal labral setae in form and arrangement (Fig. 7); labial palp segment 2 not expanded medially (Fig. 8) . . . . *L. longipalpus*

Labrum with few regularly spaced dorsal setae and with submarginal setae distinct from these in form and arrangement (Figs. 1, 9, 10, 13); labial palp segment 2 well developed as in Figure 4 2

2. Labrum with submarginal setae spatulate (Fig. 9), often fringed apically . . . *L. frondalis*

2′. Labrum with submarginal setae not as above (Figs. 1, 10, 13) 3

3. Labrum with submarginal setae branched as in Figure 10 4

3′. Labrum with submarginal setae simple (Figs. 1, 13) 5

4. Right mandible with abrupt prominence between incisor and molar region (Fig. 11) . . . . *L. ephippiatus*

4′. Right mandible without abrupt prominence between incisor and molar region, this area being more similar to Figure 2 . . . . *L. dardanus*

5. Distinct spinelike setae on legs (Fig. 5), thoracic sterna, and pleural margins of abdomen (Fig 6); labrum submarginal setal formula 1+7-11 (Fig. 1); maxillary palp exceeding apex of galealaciniae . . . . *L. apache*

5′. Body without armature as above; labrum submarginal setal formula 1+2-7 (Fig. 13); maxillary palp extending nearly to apex of galealaciniae (Fig. 14) . . . . *L. propinquus*

Cymulabaetis, new genus

We define this genus as having adults and larvae generally similar to those of *Labiobaetis* except for a unique combination of larval traits, i.e., a labrum with a row of branched submarginal setae, non-excavated maxillary palps, and non-lobed antennal scapes. The larval femora also appear to be broader than is typical of *Labiobaetis.*

We include in this genus: *C. balcanicus (*Müller-Liebenau and Soldán), n. comb. from Bulgaria and Greece (which we designate as the type of the genus); and *C. cleopatrae* (Thomas and Soldan), n. comb. from Egypt.

The derivation of the name *Cymulabaetis is* from the Latin, cymula, diminutive of young sprout, combined with *Baetis,* as an allusion to the phylogenetic branch represented by the genus, as discussed below.

The two species placed in *Cymulabaetis* were previously classified in *Baetis* and have been considered to belong to the *atrebatinus* species group by Müller-Liebenau and Soldán (1981) and Thomas and Soldán (1989). As indicated above, they possess a number of characteristics found in *Labiobaetis.* For example, submarginal setae of the labrum appear to be similar to those of the North American species *L. ephippiatus* (Fig. 10), and the hindwings and male genitalia of *C. balcanicus* (the only one of the two known as an adult) are similar to those of known *Labiobaetis* adults. These species, however, have been problematic because the larvae of both lack the excavation of the maxillary palp and the lobe of the scape and therefore presently do not fit previous definitions of the *atrebatinus* group (or our definition of *Labiobaetis).*

It appears highly probable that *Cymulabaetis* shares a recent common ancestor with *Labiobaetis,* evidenced by possible synapomorphic reduction of the costal process in the hindwings and reduced apical segment of the male forceps. General similarities in mandibles, labium, and tergal armature may have also evolved in a recent common ancestor. Unlike *Baetis* sensu stricto, the plesiomorphic sclerotized genital plate has been retained just as it has been retained variously in *Labiobaetis.* From this, it would appear that *Cymulabaetis* represents an early offshoot from the lineage that led to *Labiobaetis,* i.e., the species involved do not share the further synapomorphies of the maxillary palps and antennae found in *Labiobaetis.* We speculate that the branched submarginal setae on the labrum of *Cymulabaetis* represent a convergence with *L. ephippiatus,* related perhaps to some feeding, tactile, or cleaning function. Supportive of this speculation is the fact that the labral condition is not identical: the branched setae in *L. ephippiatus* are much fewer in number and appear to be relatively larger in size.

There is, of course, also the posssibility that the excavated maxillary palps and the lobe of the scapes have been secondarily lost in *C. balcanicus* and *C. cleopatrae,* and these species are simply anomalous members of *Labiobaetis.*

We obviously do not know which of the two possibilities discussed above regarding *C. balcanicus* and *C. cleopatrae* is correct. Either possibility, however, indicates that, with respect to constructing a phylogenetic classification, they should not be classified as *Baetis* sensu stricto. Therefore, it appears to us that an interim practical classificatory position must be taken until such time that more conclusive cladistic analysis is possible. To include *C. balcanicus* and *C. cleopatrae* in *Labiobaetis* (even as a subgenus) would not allow a clear universal definition of this widespread genus as larvae; nonetheless, this may eventually be necessary. In the meantime, therefore, we have taken the only alternative remaining, i.e., to place them in a separate genus that could, if necessary, be synonymized with *Labiobaetis* in the future or placed as a subgenus within it.

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BOOK RECEIVED AND BRIEFLY NOTED

PLANTHOPPERS. THEIR ECOLOGY AND MANAGEMENT. R.F. Denno and T.J. Perfect, eds. 1994. Chapman & Hall. 799 pp. $85.00 hdbk.

This volume summarizes what is known about planthopper ecology and biological control. Its contents include host-plant relationships of planthoppers; planthopper/plant interactions; life history strategies and reproductive biology; population dynamics and migration; interactions of planthoppers with predators, parasitoids, and vectored plant viruses; structure of planthopper communities; ecological approaches to planthopper management including biological control, the genetics of host-plant adaptation, varietal resistance, and insecticide resistance.