

The Adult Stage of Three Central American *Baetodes* (Ephemeroptera: Baetidae) with Notes on the Genus

by

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Adults of *Baetodes tritus*, *B. velmae* and *B. deficiens* from Panama and eggs of *B. tritus* and *B. velmae* are described and illustrated. *Pseudocloeon arawak* is transferred to *Baetodes*. Generic characters of *Baetodes* are discussed and additional nymphal characters are given.

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Baetodes is a genus of distinctive and widely distributed mayflies found in rivers and streams from northern Argentina to the southwestern United States. The genus was described from Brazilian nymphs by Needham and Murphy (1924) and at present 28 species are known. Nymphs are common in collections of lotic aquatic insects from the Neotropics and the taxonomy of the genus is based largely on this stage. Only 3 species are known from the adult stage: Traver (1943) described the male imago and female subimago of *Baetodes spinifer* (as *Baetodes spiniferum*) from Venezuela and Koss (1972) described *B. edmundsi* from the imago and *B. arizonensis* from the subimago stage. For a review of the literature on *Baetodes*, see Cohen and Allen (1978).

In this paper, I describe the imagines of two Central American species, *Baetodes tritus* Cohen and Allen, 1972, and *B. velmae* Cohen and Allen, 1978, which I reared from nymphs collected in the Río Chiriqui at Fortuna, the Institution de Recursos Hydraulicos y Electrificación (IRHE) camp at Hornitos, Chiriqui Province, in western Panama. I also describe the subimago of *B. deficiens* Cohen and Allen, 1972, which I collected and associated with mature nymphs at another locality, also on the Río Chiriqui. These rearings, along with those of Koss (1972), provide diagnostic information which can be used to distinguish the adult of *Baetodes* from the numerous other species of two-winged Baetidae in the Neotropics. Rearings also show that Traver's (1943) description of *B. spinifer* was the first description of adult *Baetodes*, and that *Pseudocloeon arawak*, (Traver, 1943), described from one male imago from Venezuela, is also *Baetodes*.

Also included herein are illustrations of mouthparts and other nymphal

characters of the Panamanian species of *Baetodes*. These characters were not given in the original descriptions since they were thought not to be useful for species determination (Cohen and Allen, 1978). However, they are included here to provide consistency with the publications of Mayo (1972, 1973) and to provide data for phylogenetic analysis which can be used by workers on other genera of the Baetidae.

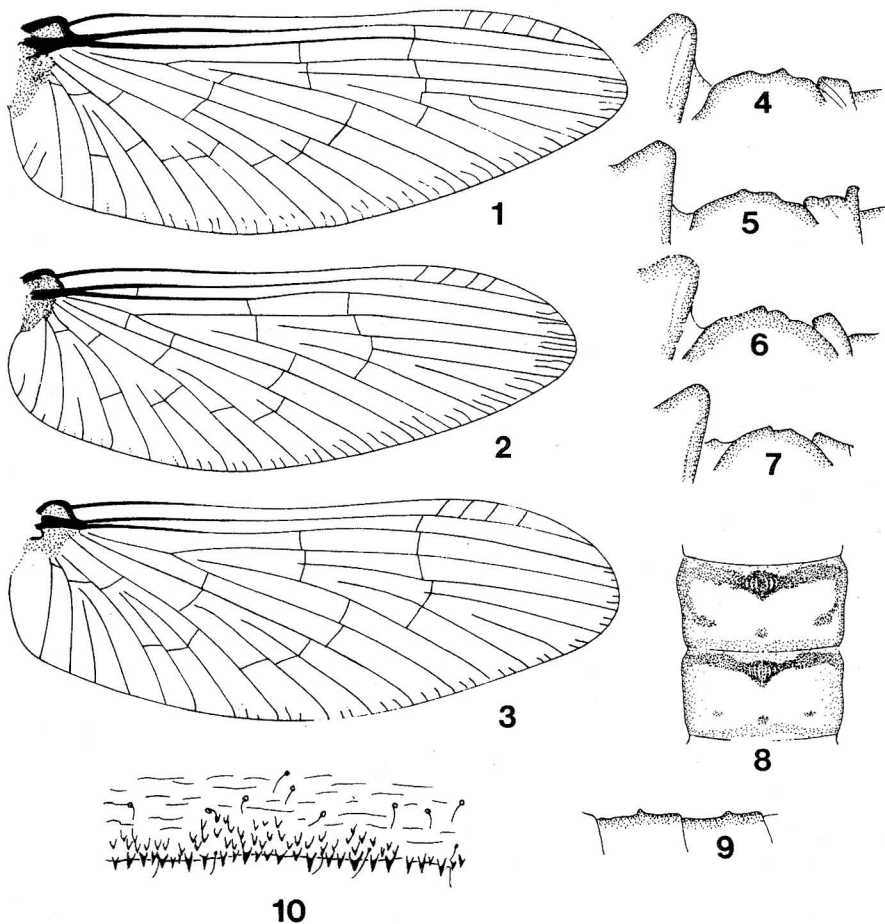


Fig. 1-9: *Baetodes*, imago: 1-3, Wings: 1, *B. tritus*; 2, *B. velmae*; 3, *B. deficiens*. 4-7, metanota (lateral view): 4, *B. velmae*; 5, *B. tritus*; 6, *B. deficiens*; 7, *B. arawak*. 8-9, abdominal terga 3-4 of *B. tritus*: 8, dorsal view; 9, lateral view.

Fig. 10: *B. velmae*, mature nymph, apical edge of abdominal tergum 5.

Baetodes tritus Cohen and Allen, 1972

Fig. 1, 5, 8, 9, 11, 14, 16, 31-36, 38, 40, 43

Baetodes tritus Cohen and Allen, 1972: 133; Cohen and Allen, 1978: 267.

Male imago. Length: body, 7.4 mm; fore wings, 7.6 mm. Head yellowish brown, darker at base of antennae; base of ocelli black; antennae yellow. Turbinate eyes yellowish brown, dark brown at base, medially contiguous; diameter 1.5 times length of stalk. Thorax yellow, washed with orange-brown; metascutellum scarcely projecting (Fig. 5); legs yellow, orange-brown at joint of femora and tibiae, femora with a brown spot in basal third; fore tibiae twice length of fore femora (tarsi missing). Wing (Fig. 1) hyaline, veins yellow. Abdomen yellowish brown, dark brown markings on terga 2-9 (Fig. 8); tergum 1 with strong median tubercle on apical margin (Fig. 5), terga 2-5 with minute tubercle in middle of segments on dorsal midline (Fig. 9); terga 8 and 9 with minute tubercle near apical margin on midline. Genitalia as in Fig. 11, subgenital plate and base of forceps dark yellowish brown, apex of forceps paler. Cerci brown.

Female subimago. Length: body, 6.2 mm; fore wings, 7.5 mm. Head, body and abdomen yellowish brown, marked with brown as in male imago. Wing opaque smoky yellow, veins dark yellowish brown. Abdominal tubercles on terga 2-5 more prominent than in male imago; tergum 1 without tubercle.

Mature nymph. Mouthparts as in Fig. 31-36; labrum with sclerotized lateral margins on ventral surface (Fig. 36); right mandible with prosthema reduced, a row of fine setae on inner margin of incisors (Fig. 32). Basal segments of antennae as in Fig. 16. Metanotum with small hind wing pads as in Fig. 40. Abdomen with apical margins of terga on each side of tubercles thickly spiculate (Fig. 14); paraproct as in Fig. 38. Other characters and color patterns as described by Cohen and Allen (1972, 1978).

Egg. Chorion obscured by an adhesive layer but showing evenly spaced vesicles as in *Baetodes velmae* (Fig. 43). Micropylar openings not found. The presence of adhesive layers and the lack of micropylar openings on eggs from nymphs and subimagines has also been found among European *Baetis* (Kopelke and Müller-Liebenau 1982).

Specimens examined. 1 male imago (reared with nymphal exuvia and subimago skin), PANAMA: Chiriqui Province, Fortuna (8°44'N:82°15'W), 1050 m, Río Chiriqui, 9, 11.XII.1977, R. W. Flowers; 1 female subimago (reared, with nymphal exuvia), same locality and collector, 6.XII.1977; 47 nymphs, same locality and collector, 26.XI/14.XII.1977; 6 nymphs, same locality, 18.V.1978, C. W. O'Brien; 8 nymphs, PANAMA: Chiriqui Province, Fortuna, small tributary of Río Chiriqui, 29.XI.1977, R. W. Flowers; 3 nymphs, PANAMA: Chiriqui Province, Boquete, small stream, 24.XI.1977, R. W. Flowers; 1 nymph, PANAMA: Chiriqui Province, Río Caldera, Bajo Lino at 1064 m, 17.XII.1977, R. W. Flowers.

Biology. *Baetodes tritus* was moderately common at Fortuna. It was collected from rocks in moderate to fast current, although it seemed to avoid extremely fast water. *B. tritus* was collected from two localities outside Fortuna, both in disturbed habitats.

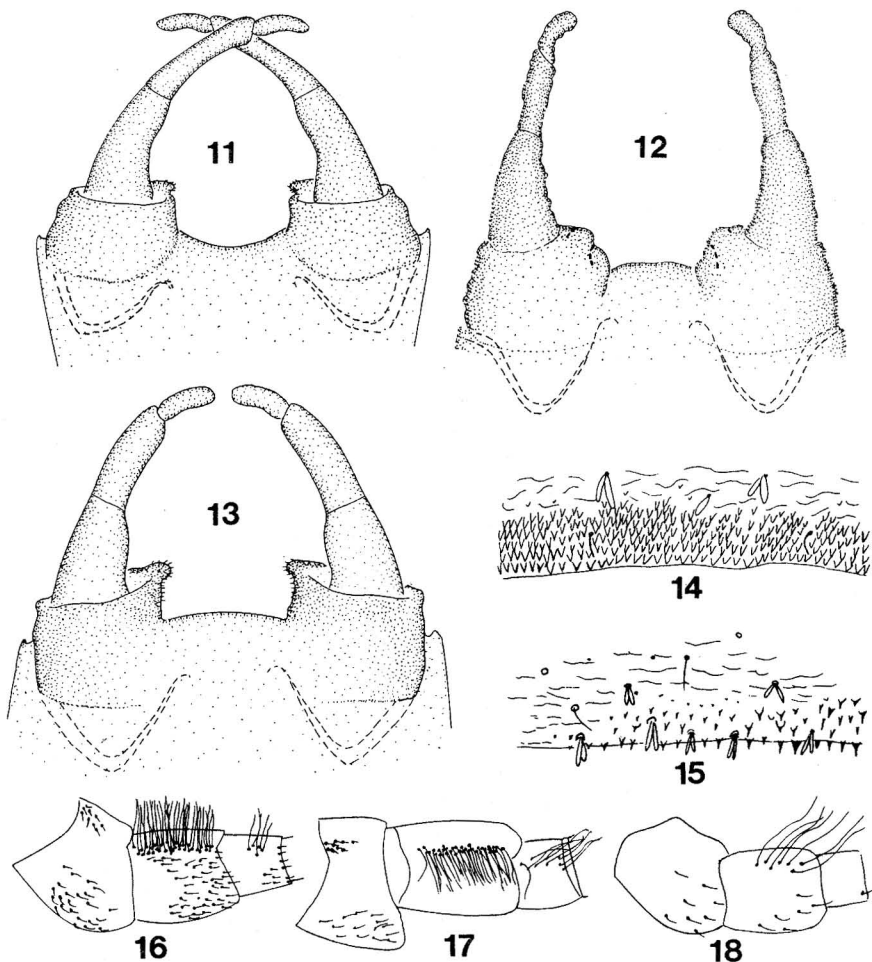


Fig. 11-13: *Baetodes*, male genitalia: 11, *B. tritus*; 12, *B. deficiens* (dissected from mature subimago); 13, *B. velmae*.

Fig. 14-18: *Baetodes*, mature nymph. 14-15, apical edge of abdominal tergum: 14, *B. tritus*; 15, *B. deficiens*. 16-18, basal segments of antenna: 16, *B. tritus*; 17, *B. velmae*; 18, *B. deficiens*.

Baetodes velmae Cohen and Allen, 1978

Fig. 2, 4, 10, 13, 17, 25-30, 42, 44

Baetodes velmae Cohen and Allen, 1978: 267.

Male imago. Length: body, 4.2-5.7 mm; fore wings 5.6-5.7 mm. Head orange-brown, base of ocelli black, antennae pale yellow with brown spot at tip of scape. Turbinate eyes orange (brick red in living animal), separated medially by

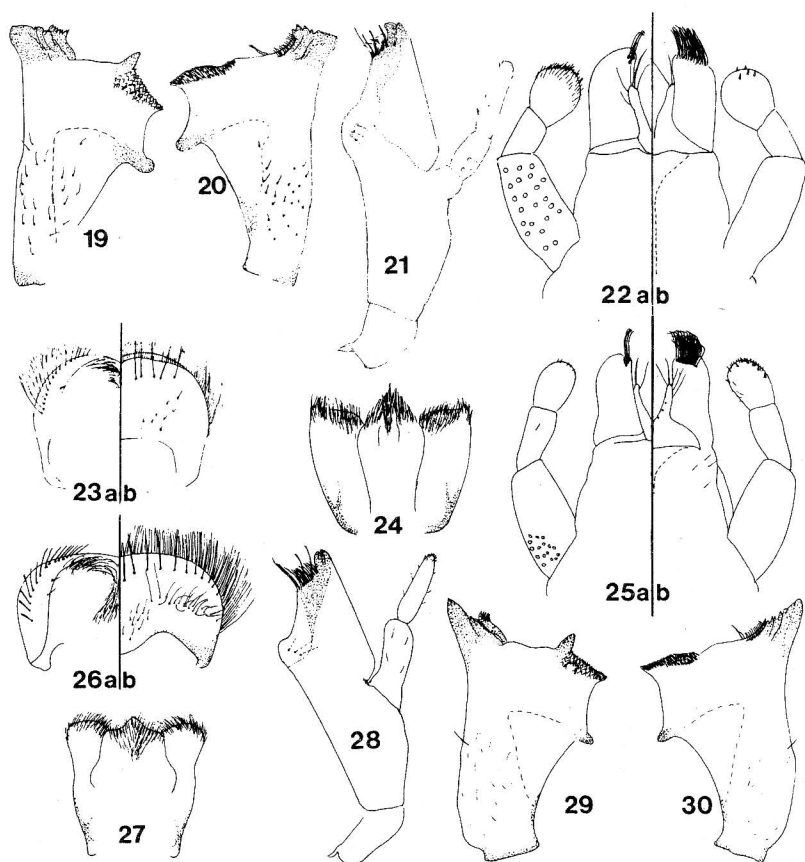


Fig. 19-30: *Baetodes*, mouthparts of mature nymph: 19-24, *B. deficiens*; 25-30, *B. velmae*. Left mandible (19, 29), right mandible (20, 30), maxilla (21, 28), labium (22, 25: a, dorsal view; b, ventral view), labrum (23, 26: a, ventral view; b, dorsal view), hypopharynx (24, 27).

width of median ocellus, diameter slightly greater than height. Thorax dark reddish brown; metascutellum scarcely projecting (Fig. 4); legs pale yellow, femora washed with brown and with a dark brown spot just before apex. Fore leg: tibiae 1.5 times length of femora, tarsi $\frac{1}{2}$ length of tibiae; tarsal segments in order of decreasing length: 2, 3, 4, 5, 1. Meso- and metathoracic legs: tibiae subequal to femora, tarsi $\frac{1}{2}$ length of tibiae; tarsal segments 1 = 4, 3, 2. Wings (Fig. 2) hyaline, veins opaque white. Abdominal terga brown with pale yellow transverse apical band on segments 2-7; minute median tubercles on apical margins of terga 2-6. Sterna brown, segments 1-5 paler apically. Genitalia as in Fig. 13; brown, forceps paler. Cerci pale yellow.

Female imago. Length: body, 4.5-4.6 mm; fore wings, 5.7-5.8 mm. Head yellowish brown, eyes and bases of ocelli black. Thorax dark purplish brown; legs pale yellow, femora ringed at apex and streaked in basal third with purplish

brown; wing veins amber. Color pattern of abdomen as in male; tergum 10 yellowish brown; small median tubercles on apical margins of terga 2-6. Cerci yellowish brown.

Mature nymph. Mouthparts as in Fig. 25-30; labrum with sclerotized lateral margins on ventral surface (Fig. 26); right mandible with prosthema reduced, a row of fine setae on inner margin of incisors (Fig. 30). Basal segments of antennae as in Fig. 17. Metanotum with small hind wing pads (Fig. 42). Abdomen with apical margins of terga with sharp denticles (Fig. 10); paraproct as in Fig. 39. Other characters and color patterns as described in Cohen and Allen (1978).

Egg. Chorion with numerous evenly spaced adhesive vesicles (Fig. 44). Micropylar openings not found.

Specimens examined. 1 male imago, PANAMA: Chiriqui Province, Fortuna (8°44'N; 82°15'W), 1050 m, 1.XII.1977, R. W. Flowers; 1 male imago (reared, with nymphal exuvia), PANAMA: Chiriqui Province, Fortuna, tributary of Río Chiriqui, 2.XII.1977, R. W. Flowers; 1 male imago, same locality and collector, 3.XII.1977; 5 male subimagos (reared with nymphal exuvia), PANAMA: Chiriqui Province, Fortuna, Río Chiriqui, 7, 9.XII.1977, R. W. Flowers; 1 male subimago, PANAMA: Chiriqui Province, Fortuna, at mercury vapor light, 26.XI.1977, R. W. Flowers; 1 male subimago (reared with nymphal exuvia), PANAMA: Chiriqui Province, Río Caldera at Bajo Lino, 1064 m, 17.XII.1977, R. W. Flowers; 1 female imago (reared, with nymphal exuvia and subimaginal skin), PANAMA: Chiriqui Province, Fortuna, Río Chiriqui, 7.XII.1977, R. W. Flowers; 3 female subimagos (reared, with nymphal exuvia), same locality and collector, 6-9.XII.1977; 1 female subimago (reared, with nymphal exuvia), PANAMA: Chiriqui Province, Fortuna, tributary of Río Chiriqui, 26.XI.1977, R. W. Flowers; 59 nymphs, PANAMA: Chiriqui Province, Fortuna, Río Chiriqui, 26.XI/13.XII.1977, R. W. Flowers; 2 nymphs, PANAMA: Chiriqui Province, Fortuna, tributary of Río Chiriqui, 4.XII.1977, R. W. Flowers; 19 nymphs, PANAMA: Chiriqui Province, stream, Boquete, 24.XI.1977, R. W. Flowers; 11 nymphs, PANAMA: Chiriqui Province, Río Caldera at Bajo Lino, 1064 m, 17.XII.1977, R. W. Flowers; 3 nymphs, PANAMA: Chiriqui Province, Río David, Rovira Arriba, 638 m, 18.XII.1977, R. W. Flowers; 2 nymphs, PANAMA: Chiriqui Province, stream, Alto Lino, 1246 m, 18.XII.1977, R. W. Flowers; 3 nymphs, PANAMA: Chiriqui Province, Río Chiriqui Viejo, near Bambito, 1581 m, 21.XII.1977, R. W. Flowers; 9 nymphs, PANAMA: Coclé Province, El Valle, Río Anton below falls, 600 m, 19.IX. 1982, R. W. Flowers, D. Habeck, C. Bennett.

Biology. *Baetodes velmae* was one of the most common mayflies in the Río Chiriqui at Fortuna and in other streams and rivers in the Cordillera de Talamanca in Chiriqui Province, both in undisturbed forest and in agricultural areas. It was abundant in cobble in very strong current; it was also found in slower deeper parts of the river clinging to the sides of large boulders. In one stream which was almost choked with the hulls of coffee beans, *B. velmae* was common. Imagines emerged in early morning and two were taken at light.

***Baetodes deficiens* Cohen and Allen, 1972**

Fig. 3, 6, 12, 15, 18, 19-24, 39, 41

Baetodes deficiens Cohen and Allen, 1972: 126; Cohen and Allen, 1978: 259; Mayo, 1972: 236 (*bellus*).

Male subimago. Length: body, 3.5-3.6 mm; fore wings, 3.8-3.9 mm; cerci ca. 10.5 mm. Head reddish brown, turbinate eyes yellowish brown, base of ocelli black,

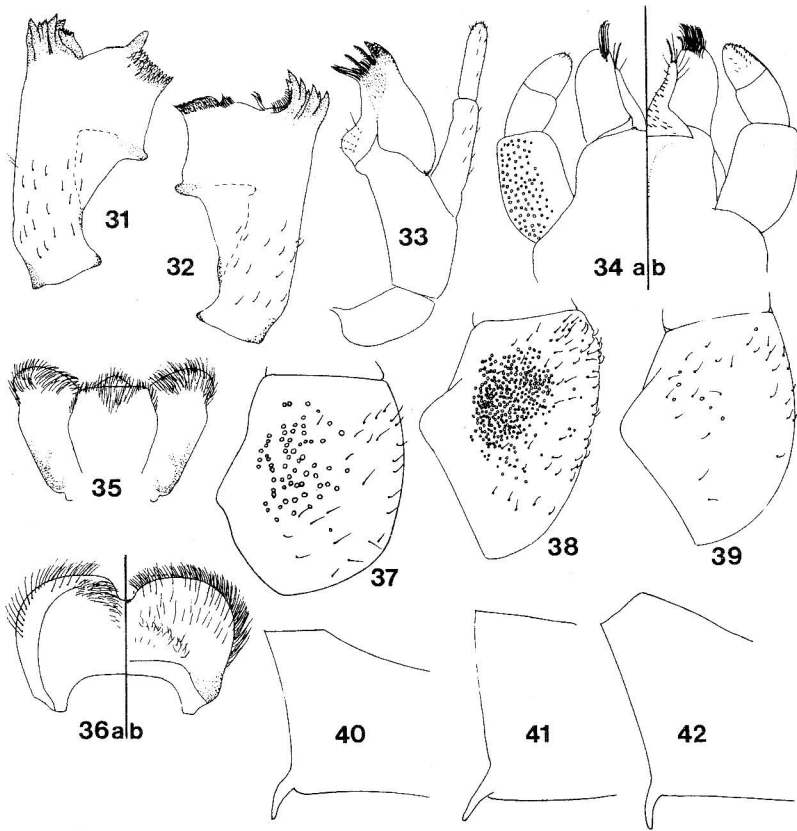


Fig. 31-42: *Baetodes*, mature nymph: 31-36, mouthparts of *B. tritus*; 31, left mandible; 32, right mandible; 33, maxilla; 34 labium (a, dorsal view; b, ventral view); 35, hypopharynx; 36, labrum (a, ventral view; b, dorsal view). Fig. 37-39, paraproct: 37, *B. deficiens* (X400); 38, *B. tritus* (X200); 39, *B. velmae* (X400). Fig. 40-42, hind wing pad: 40, *B. tritus*; 41, *B. deficiens*; 42, *B. velmae*.

antennae yellow. Thorax dark yellowish brown, pleura with dark brown streaks behind prothorax and above mesocoxae; wing opaque white, venation as in Fig. 3; metanotum as in Fig. 6. Abdomen yellow; terga 1-3 dark brown; terga 4-9 dark brown markings as illustrated in Cohen and Allen, 1978, Fig. 28; terga 8 and 9 washed with brown; sterna pale yellowish brown, sternum 1 washed with brown, sterna 2-6 with pale lateral brown patches; genitalia pale yellow, partially expanded imago genitalia with subimago exuvia removed shown in Fig. 12. Cerci pale yellow.

Mature nymph. Mouthparts as in Fig. 19-24; basal segments of antennae as in Fig. 18. Metanotum with small hind wing pads (Fig. 41). Abdomen with apical margins of terga and paraprocts as in Fig. 15, 37. Other characters and color patterns as described by Cohen and Allen (1972, 1978).

Specimens examined. 2 male subimagines, PANAMA: Chiriqui Province, Río Chiriqui, east of Caldera at power station, 334 m, at light, 18.XII.1977; R. W. Flowers; 2 nymphs, same locality and collector, 19.XII.1977; 1 nymph, PANAMA: Chiriqui Province, Fortuna, tributary of Río Chiriqui, 1050 m, 29.XI.1977, R. W. Flowers.

Baetodes arawak (Traver) comb. n.

Fig. 7.

Pseudocloeon arawak Traver, 1943: 90.

This species, described by Traver from one male imago and one male subimago is transferred to *Baetodes* because the genitalia (figured by Traver 1943) and the metascutellum (Fig. 7) agree with characters diagnostic of adult male *Baetodes*, as discussed below.

Baetodes spinifer Traver, 1943

Baetodes spiniferum Traver, 1943: 94.

Traver's description and figure indicate that her assignment of this species is correct. Like *Baetodes velmae*, *B. tritus*, and *B. edmundsi*, imagines of *B. spinifer* have abdominal tubercles, indicating that the nymph, still unknown, probably has well developed dorsal abdominal spines.

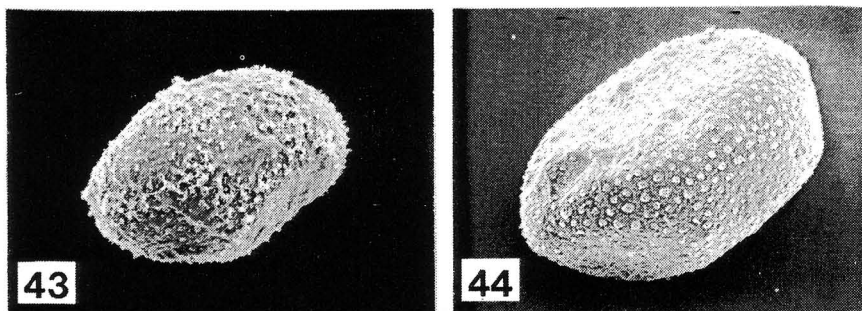


Fig. 43-44: *Baetodes*, egg: 43, *B. tritus* (from subimago, X550); 44, *B. velmae* (from imago X715).

DISCUSSION

Based on comparisons of the adult stages now known for seven species of *Baetodes* (*arawak*, *arizonensis*, *deficiens*, *edmundsi*, *spinifer*, *tritus* and *velmae*), the following characters appear to separate adult male *Baetodes* from all other

known genera of Neotropical two-winged Baetidae: 1) male genitalia have a mesal projection on first segment of forceps (Fig. 11-13); 2) the metanotal scutellum is not prominent (Fig. 4-7); 3) the tibiae of the male fore leg 1.5 to 2 times the length of the femora. Females can sometimes be associated with males on the basis of color pattern; they can also be placed in *Baetodes* by the condition of the metascutellum.

The character of the hind margin of the wing cited by Koss (1972) and Edmunds et al. (1978): "subparallel to the costal margin" is not as apparent in *B. tritus* as in *B. velmae*, *B. deficiens* (Fig. 2, 3), *B. edmundsi*, and *B. arizonensis* (Koss 1972). Also, in some small undescribed *Baetodes* adults from Panama, the hind margin of the wing is smoothly curved throughout its length. This character, then, is not applicable to all adult *Baetodes*, although it may be useful in some cases as confirmation of an identification.

Even less useful as a generic character is the length of the intercalary veins. They are relatively short – subequal in length to the space between members of a pair – in *B. arizonensis* and *B. edmundsi* (Koss 1972) and *B. dificiens* (Fig. 3); Edmunds et al. (1978) use this character in their key to genera. As Figs. 1, 2 show, however, *B. velmae* and *B. tritus* have intercalaries considerably longer than the space between them.

Mayo (1972) provided a generic diagnosis of *Baetodes* nymphs. The nymphs of *B. deficiens*, *B. tritus* and *B. velmae* conform to this diagnosis in all particulars. Several characters widely used by other workers on Baetidae were not examined by Mayo and a few of these may have potential phylogenetic significance. The labrum of *Baetodes* has heavily sclerotized lateral margins on the ventral surface. This condition is also found in *Moribaetis ellenae* (Mayo) but seems to be otherwise quite rare in the Baetidae. The paraprocts of *Baetodes* are weakly sclerotized and lack the marginal spines characteristics of many baetids. All *Baetodes* nymphs examined have small but distinct hind wing pads.

Baetodes is a highly specialized Neotropical genus whose relationships with other Baetidae are not yet clear. It is worth noting that in Africa and Southeast Asia there are baetids whose nymphs closely resemble *Baetodes* in general appearance and some even have such "*Baetodes*-like" structures as coxal gills and dorsal abdominal spines. However, mouthparts, abdominal gills and other characters show that these Old World baetids are more closely allied with *Pseudocloeon* s.s. (see Müller-Liebenau, 1981, 1982), and are only distantly related to *Baetodes*. The unusual body form of *Baetodes* has thus arisen more than once in Baetidae.

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