

Revision of the Baetidae (Ephemeroptera) of Korea (1) Historical Review, *Acentrella* Bengtsson and *Baetiella* Uéno

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ABSTRACT: A taxonomic revision of the Baetidae was conducted based on comprehensive examinations of larval and adult materials from Korea. A historical review and revision of *Acentrella* and *Baetiella* were provided in this paper. Larval and known adult stages of *Acentrella gnom* (new distributional record), *A. sibirica* (new distributional record), and *Baetiella tuberculata* were described, figured, and photographed with SEM.

Key words : Ephemeroptera, Baetidae, *Acentrella*, *Baetiella*, description, revision, Korea

INTRODUCTION

Baetidae or small minnow mayflies (Ephemeroptera) are widespread being found on all the continent and many islands but wanting from New Zealand (Edmunds *et al.*, 1976). They frequently and abundantly occur in streams, ponds, and other typical lotic and lentic habitats. Over 500 species of baetids have been described from the world; 154 species have been known from North and Middle America (McCafferty and Waltz, 1990); and 51 species have been known from Northeast Asia (Bae, 1995). These numbers are equivalent to about one fourth of all the known mayflies in the region or subregion, but it may be overestimated because of narrow typological species concept (McCafferty and Waltz, 1990). Color variations have been frequently applied in describing the species.

Baetidae is a taxonomically difficult group of mayflies because of their small size and lack of characters especially in their adult stages. There are still many places where the baetid fauna has not been investigated.

Baetidae, as a taxonomic group of mayflies, was established by Leach (1815), but its restricted concept has been well defined since Eaton's (1885) monograph as Section 9 of the genera (Type of *Baetis*).

The larvae of Baetidae (Figs. 1-2) possess stream-lined and minnowlike body, relatively long antennae, which are two or more times as long as head width, hypognathous mouthparts (Figs. 3-5), relatively long and narrow glossae and paraglossae, gills on abdominal segments 1-7, 1-5, or 2-7, and two or three caudal filaments which possess rowed setae on both sides of terminal filament and those on only mesial side of cerci in most species (Edmunds *et al.*, 1976). The larvae lack or possess only weakly developed posterolateral projections on abdominal segments 8-9 that may distinguish them from most other Pisciforma mayflies (Edmunds *et al.*, 1976; McCafferty, 1991).

The adults (Figs. 6-8) are also well characterized by the enlarged turbinate eyes in male, reduced venation of fore and hindwings, reduced penes, and two caudal filaments. The veins of MA₂ and MP₂ of forewings (Fig. 8) always detached basally from their respective stems, and hindwings are greatly reduced or sometimes absent (Edmunds *et al.*, 1976).

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The eggs of Baetidae possess tageniform micro-pyle in common which is located at about midway between the equator and one pole (Koss and Edmunds, 1974).

Since Leach (1815) created *Baetis* and *Cloeon*, Eaton (1885) grouped *Centroptilum* Eaton and *Callibaetis* Eaton together with *Baetis* and *Cloeon*. Spieth (1933), with a detailed morphological examination, recognized three lineages of the Baetidae, *Callibaetis* lineage, *Baetis-Pseudocloeon* lineage, and *Centroptilum-Cloeon* lineage, and regarded the former most primitive.

In the Palaearctic region, Müller-Liebenau (1969, 1973) revised European *Baetis*; Novikova and Kluge (1987) and Kluge and Novikova (1992) revised Palaearctic baetids; and Waltz and McCafferty (1987), McCafferty and Waltz (1990), and Waltz *et al.* (1994) revised many genera of the Holarctic Baetidae. In addition, there have been many more revisionary works treated genera and species of the Baetidae.

According to a catalog of the Ephemeroptera (Hubbard, 1990), there were 44 recent genera (2 fossil genera) and 17 subgenera in valid in Baetidae, but some more genera and subgenera have been created since then.

In Northeast Asia, McLachlan (1875) and Eaton (1885) reported *Cloeon dipterum* (Linnaeus) from Japan for the first time, and Takahashi (1924, 1929), Uéno (1928, 1931a, b), Imanishi (1930, 1937, 1940), Matsumura (1931), and Gose (1965, 1980) described Japanese baetids. Kazlauskas (1963), Bajkova (1968), Kluge (1983), Tshernova *et al.* (1986), Novikova (1987), and Kluge and Novikova (1992) described or revised Far East Russian baetids. Uéno (1935) and Imanishi (1940) reported Manchurian baetids.

In Korea, Imanishi (1940) reported *Baetiella japonica* na [= *Baetiella tuberculata* (Kazlauskas)], *Baetis thermicus* Imanishi, and *Baetis nla*. Yoon and Bae (1988) added *Cloeon dipterum*, *Baetis* KUa, and *Baetiella japonica* (Imanishi). There are only four nominal species and two undetermined species known to Korean peninsula (see Bae *et al.*, 1994).

As many previous baetid workers have pointed out, there are taxonomic problems in the family with its generic limitation; and comprehensive phylogenetic studies covering the family have not been conducted (McCafferty and Waltz, 1990;

McCafferty, 1991). As mentioned above, although many species of Baetidae have been described, those species concepts are not always clear due to the lack of characters or prevalence of variations. In Northeast Asia, for example, 23 and 30 species of Baetidae were described from Japan and Russia, respectively, but only 2 species are in common in those countries (see Bae, 1995).

The purpose of this study is to review and describe previously known and unknown species of Baetidae from Korean peninsula. Descriptions of the taxa, taxonomic discussions of related species, known habitat and ecology, and larval and adult identification keys will be provided with line-drawings and SEMs. *Acentrella* and *Baetiella* will be treated in this paper; and other genera will be treated elsewhere in a series.

MATERIALS AND METHODS

Numerous larval and adult materials, collected throughout South Korea since 1980s are used for this study. Part of them were reared in the field or lab. Reference materials from Far East Russia and Japan are also examined. All the materials are deposited at Seoul Women's University (SWU).

The initials used in material examined are as follows: A (adult), M (male adult), F (female adult), S (subimago), Ms (male subimago), Fs (female subimago), L (larva), and E (egg); SL (Seoul), KW (Kangwön-do), CCB (Ch'ungchöngbuk-do), CCN (Ch'ungchöngnam-do), KB (Kyöngsangbuk-do), KN (Kyöngsangnam-do), CLB (Chöllabuk-do), CLN (Chöllanam-do), and CJ (Cheju-do).

TAXONOMY

Acentrella Bengtsson

Acentrella frequently has been regarded as synonym of *Baetis* or a subgenus of *Baetis* (Müller-Liebenau, 1969; Edmunds *et al.*, 1976; Morihara and McCafferty, 1979; Novikova and Kluge, 1987). Waltz and McCafferty (1987) recognized the genus as a distinct monophyletic group. *Acentrella* is closely allied to Palaearctic and Oriental *Baetiella* Uéno (Waltz and McCafferty, 1987).

Labial palpi (Figs. 3–4) of *Acentrella* are relatively small and their terminal segments are round and not well articulated from the 2nd segments. This character may distinguish them from the larvae of *Baetiella*. Among Korean baetids, the larvae of *Acentrella* can be easily distinguished from other genera by relatively broad thorax and relatively short caudal filaments (shorter than body length) (Fig. 1). Because the adult of *Acentrella* has not been well defined (Waltz and McCafferty, 1987; McCafferty and Waltz, 1990), it is hard to diagnose the adult of the genus (see description in Waltz and McCafferty, 1987).

***Acentrella gnom* (Kluge), 1983
(Fig. 3)**

Pseudocloeon gnom Kluge: 1983: 63.

Baetis (*Acentrella*) *gnom* (Kluge): Tshernova *et al.*, 1986: 134.

Acentrella gnom (Kluge): Waltz and McCafferty, 1987: 560.

Mature Larva. Dimensions (mm): Body length 3.00–3.20; antennae 0.80; forefemora, foretibiae & foretarsi 0.50, 0.45 & 0.30; midfemora, midtibiae & midtarsi 0.50, 0.35 & 0.27; hindfemora, hindtibiae & hindtarsi 0.45, 0.27 & 0.17; terminal filament 0.90; cerci 1.75. General body color brown. **Head.** Head broader than prothorax, without markings. Antennae pale, ca. 1/4x length of body. Maxillary palpi (Fig. 3) 2-segmented; segments 1 as long as segments 2. Labial palpi (Fig. 3) 3-segmented; terminal segments apically round.

Thorax. Color brown, without distinct markings. Hindwingpads rudimentary. Legs light brown, with maculae on femora; articulations dark brown; forelegs longest and hindlegs shortest; all legs with single row of long and fine setae along outer margin of femora, tibiae, and tarsi; claws with denticles. **Abdomen.** Abdominal terga light brown; terga 2–8 with paired, small, brown spots; terga 9–10 white, without markings. Gills 1–7 single, pale, with slightly developed trachea; gills 1 smallest and oval; gills 2–7 somewhat elongated. Terminal filament well developed, 1/2x length of cerci.

Male Adult. Unknown.

Female Adult. Unknown.

Material Examined. 5L, 2Ms & 2Fs (reared): KG, Ch'ongpyöng, Chojong Cr. at Kyongchun Hwy Br., VIII–24–1994, Y.J. Bae (SWU); 4L: KG, Kapyöng, Kapyöng Cr. at railroad Br., IX–6–1992, Y.J. Bae & S.J. Lee (SWU).

Remarks. The larvae of *A. gnom* can be easily distinguished from other species of *Acentrella* and *Baetiella* by the presence of well developed terminal filament. Larvae were found in the lower reaches of tributaries of the Han River, which are medium-sized (5–6th order stream) and moderately polluted. They inhabited in the riffle areas of the streams.

***Acentrella sibirica* (Kazlauskas), 1963
(Figs. 1, 4 & 6)**

Pseudocloeon sibiricum Kazlauskas, 1963: 589; Kluge, 1980: 566.

Baetis (*Acentrella*) *sibiricus* (Kazlauskas): Tshernova *et al.*, 1986: 135.

Acentrella sibirica (Kazlauskas): Waltz and McCafferty, 1987: 560.

Pseudocloeon japonica (Imanishi): Yoon and Bae, 1988: 114 (misidentification).

Mature Larva. Dimensions (mm): Body length 3.30; antennae 0.90; forefemora, foretibiae & foretarsi 0.67, 0.50 & 0.35; midfemora, midtibiae & midtarsi 0.67, 0.50 & 0.32; hindfemora, hindtibiae & hindtarsi 0.62, 0.37 & 0.30; cerci 2.30. General body (Fig. 1) color brown. **Head.** Vertex with irregular symmetrical brown markings. Antennae pale, ca. 1/3x length of body. Maxillary palpi (Fig. 4) 2-segmented; segments 1 1/2x length of segments 2. Labial palpi (Fig. 4) 3-segmented; terminal segments not clearly articulated with segments 2; terminal segments apically round. **Thorax.** Thorax (Fig. 1) relatively broad. Legs light brown; articulations brown; femora with single row of long setae along posterior margin; tibiae with single row of long setae dorsally; hindtibiae with additional row of short setae along posterior margin; tarsi with single row of long setae dorsally; claws brown, with 7–10 denticles. **Abdomen.** Terga (Fig. 1) 1–8 with paired brown spots. Gills 1–7 oval. Cerci brown, 2/3x length of body; terminal filament rudimentary.

Male Adult. Dimensions (mm): Body length

4.00; antennae 0.57; longitudinal diameter of compound eye 0.50; cross diameter of compound eye 0.37; distance between compound eyes 0.07; height of dorsal compound eye 0.27; forefemora 0.75; foretibiae 1.27; foretarsal segments 1, 2, 3, 4 & 5 0.05, 0.50, 0.40, 0.22 & 0.12; midfemora 0.60; midtibiae 0.70; midtarsi 0.37; hindfemora 0.60; hindtibiae 0.70; hindtarsi 0.37; forewing length 4.10; forewing width 1.40; forceps segments 1, 2 & 3 0.10, 0.22 & 0.05; cerci 6.40. General body color brown. **Head.** Dorsal eyes yellow; height of dorsal eyes ca. 1/2x width of dorsal eyes; distance between compound eyes ca. 1/5x cross diameter of a compound eye; ventral eyes black and round. Ocelli yellow, dome-shaped, with circumferential dark brown stripe. Antennae 3-segmented; segments 1

and 2 brown; segments 3 light yellow. **Thorax.** Color brown with irregular longitudinal dark brown line. Forewings transparent; veins white. Hindwings absent. Legs light brown; coxae dark brown; femora brown. **Abdomen.** Abdomen light brown; segment 9–10 brown. Forceps (Fig. 6) light brown; segments 2 2.0x length of segments 1; segments 3 1/2x segments 1; inner sides of segments 1 apically hollow.

Female Adult. Unknown.

Material Examined. 6L: KG, Kapyŏng, Kapyŏng Cr. at Mŏkdong Br., X-6-1985, Y.J. Bae (SWU); 1L: KG, Kapyŏng, Chojong Cr. at Daewŏn-ri, IX-24-1978 (SWU); 3L: KG, Kapyŏng, Chojong Cr. at Ch'ŏngpyŏng, VI-12-1983, Y.J. Bae (SWU); 2L & 1M (with larval exuvium, reared): KW, Yangyang, Sŏrak Mt. at Osaek, VI-20, 21-1995, Y.J. Bae (SWU); 1L: KW, Hongchŏn, tributary of Hongchŏn R. at P'ungchŏn, IX-20-1994, Y.J. Bae & S.K. Namgung (SWU); 1L: KW, Wŏnju, Ch'iak Mt., VII-11-1994, Y.J. Bae (SWU); 1L: CCB, Chechŏn, Wŏral Mt. at Songgye, VIII-11-1995, Y.J. Bae (SWU); 9L: KB, Taegu, Kumho R. at Pullo Br., IV-28-1992 (SWU); 1L: KB, Taegu, Omok Cr. at Hwaryong Br., IV-29-1992 (SWU); 150L: KB, Ullŭng-do, Chŏdong and Taeha, VIII-2, 3-1983, Y.J. Bae (SWU); 1L: CLN, Yŏsu, Tolsando, II-12-1982, J.U. Byun (SWU); 2L: CJ, Sŏguipo, Kangjŏng Cr. at 1st Kangjŏng Br., V-26-1996, Y.J. Bae (SWU).

Remarks: This species has been incorrectly known as either *Pseudocloeon japonica* (Imanishi) (see Yoon & Bae, 1988) or *Baetiella japonica* Ima-

nishi (see Yoon, 1995) in Korea. The materials from Korea which were identified as *B. japonica* and used in Waltz and McCafferty (1987) are actually *Acentrella*. Based on our examinations of baetid materials from Korea and Far East Russia, we corrected the above misidentification. *Baetiella tuberculata* is the only known representative of *Baetiella* in Korea. Imanishi's (1940) *Baetiella* nX is most probably identical with *A. sibirica*. Kazlauskas (1963) and Bajkova (1968) synonymized *Baetiella* nX (or nx) with *Acentrella fenestrata* (Kazlauskas), but Kluge (1980) corrected Bajkova's (1968) identification of male adult of *A. fenestrata* as *A. sibirica*. Larvae of *A. sibirica* occur in the riffle areas of the lower reaches of moderately polluted streams.

Baetiella Uéno

Baetiella is a Palaearctic and Oriental genus of Baetidae that has been frequently classified as *Pseudocloeon* Klapálek because of the lack of hindwings in adults. The generic concept of *Baetiella* was revalidated by Waltz and McCafferty (1985, 1987) based on phylogenetic interpretations.

Terminal segments of labium (Fig. 5) of *Baetiella* are distinctly coniform and well articulated which may distinguish them from *Acentrella*. Among Korean baetids, larvae of *Baetiella* possess relatively longer cerci comparing with those of *Acentrella*.

The adults of *Baetiella* possess forewings (Fig. 8) with paired marginal intercalaries and often with distinctively pigmented areas adjoining and including the crossveins. Hindwings of adult in Korean *Baetiella* are absent.

Baetiella tuberculata (Kazlauskas), 1963 (Figs. 2, 5, 7 & 8)

Baetiella japonica na: Imanishi, 1940: 227.

Pseudocloeon (*Baetiella*) *tuberculatum* Kazlauskas, 1963: 586.

Baetiella nosegawaensis Gose, 1965: 218 (synonymized by Kluge, 1983).

Baetis (*Baetiella*) *tuberculatus* (Kazlauskas): Tshernova *et al.*, 1986: 134.

Baetiella tuberculata (Kazlauskas) Waltz & McCafferty, 1987: 563.

Pseudocloeon japonica na (Imanishi): Yoon & Bae,

1988: 115.

Mature Larva. Dimensions (mm): Body length 3.00~5.00; antennae 1.10~1.50; forefemora, foretibiae & foretarsi 0.87, 0.75 & 0.42; midfemora, midtibiae & midtarsi 0.80, 0.75 & 0.37; hindfemora, hindtibiae & hindtarsi 0.90, 0.67 & 0.32; cerci 4.00~5.10. General body (Fig. 2) color brown. **Head.** Vertex (Fig. 2) with 3~4 pairs of symmetrical brown markings. Antennae pale, ca. 1/3x length of body. Maxillary palpi (Fig. 5) 2-segmented. Labial palpi (Fig. 5) 3-segmented; terminal segments apically conical. **Thorax.** Pronotum (Fig. 2) with 2 pairs of dark brown markings medially; mesonotum with irregular light markings. Legs articulations brown; claws brown, with denticles and paired long terminal setae. **Abdomen.** Abdominal segment 1~9 (Fig. 2) with paired brown spots; segment 1~7 with tubercles at posteromedian margin. Gills 1~7 pale; trachea not visible. Cerci longer than body length.

Male Adult. Dimensions (mm): Body length 3.80~4.50; antennae 0.70; longitudinal diameter of compound eye 0.42; cross diameter of compound eye 0.42; distance between compound eyes 0.10; height of dorsal compound eye 0.30; forefemora 0.90; foretibiae 1.17; foretarsal segments 1, 2, 3, 4 & 5 0.07, 0.50, 0.37, 0.25 & 0.12; midfemora 0.62; midtibiae 0.65; midtarsal segments 1, 2, 3, 4 & 5 0.02, 0.07, 0.05, 0.07 & 0.17; hindfemora 0.62; hindtibiae 0.75; hindtarsal segments 1, 2, 3, 4 & 5 0.05, 0.10, 0.05, 0.04 & 0.15; forewing length 4.00~4.30; forewing width 1.50; forceps segments 1, 2 & 3 0.10, 0.20 & 0.04; cerci 12.00. General body color light yellow. **Head.** Dorsal compound eyes orange; height of dorsal eye slightly shorter than width of dorsal eye; distance between compound eyes ca. 1/4x cross diameter of a compound eye; longitudinal diameter as long as cross diameter; ventral eyes black. Ocelli yellow, dome-shaped, with circumferential dark brown stripe. Antennae 3-segmented, brown; segments 2 darker. **Thorax.** Color yellow, without markings. Forewings (Fig. 8) transparent; longitudinal veins white; crossveins brown and thick. Legs pale; articulations brown; femora brown; claws brown. **Abdomen.** Abdominal terga pale, without markings. Forceps (Fig. 7) light, arched; basal segments with a distinct process apicomediaally; segments 2 2.0x

length of segments 1; segments 3 2/5x length of segments 1. Cerci pale, 3x length of body.

Female Adult. Dimensions (mm): Body length 3.00~3.60; antennae 0.50~0.60; forefemora 0.65; foretibiae 0.75 foretarsal segments 1, 2, 3, 4 & 5 0.05, 0.05, 0.07, 0.05 & 0.20; midfemora 0.65; midtibiae 0.62; midtarsal segments 1, 2, 3, 4 & 5 0.07, 0.02, 0.02, 0.02 & 0.20; hindfemora 0.57; hindtibiae 0.50; hindtarsal segments 1, 2, 3, 4 & 5; 0.07, 0.02, 0.02, 0.02 & 0.20; forewing length 4.30; forewing width 1.70; cerci 8.80~9.50. General body color light brown. **Head.** Compound eyes black. Ocelli brown, dome-shaped, with circumferential dark brown stripe. Antennae 3-segmented, brown; segments 2 darker. **Thorax.** Color light brown, without distinct markings. Forewings transparent; veins brown; crossveins brown and thickened. Legs pale; articulations dark brown; femora brown; claws brown. **Abdomen.** Abdomen light brown, without markings. Cerci 2.5x length of body.

Material Examined. 3L: KG, Namyangju, Wangsuk Cr. at Kwangnŭng, X-13-1995, Y.J. Bae (SWU); 10L, 3F: KG, Kapyŏng, Sudong Cr., VI-11, VII-5, 9-1993, IX-11-1993, Y.J. Bae (SWU); 1L: KG, Chojong Cr. at Imcho Br., VII-4-1993, Y.J. Bae, E.M. Kim (SWU); 1L: KG, Kapyŏng, Myŏngji Mt., VI-10-1995, Y.J. Bae (SWU); 3L: KG, Kapyŏng, Todae-ri, X-6-1985, Y.J. Bae (SWU); 1F: KG, Kapyŏng Cr., VI-13-1993, J.I. Kim (SWU); 2L & 11F: KG, Kapyŏng Cr., VII-25, VIII-20, IX-29-1994, Y.J. Bae (SWU); 1L: KG, Yumyŏng Mt., VI-10-1995 (SWU); 6L: KW, Chiak Mt., Chupo Cr. at Okjŏn, V-4, VII-3-1996, Y.J. Bae, S.J. Lee (SWU); 5F: KW, Chiak Mt. at Sangwŏngol, VI-5-1992, Y.J. Bae (SWU); 16L, 3F & 1Ms (reared): KW, Sŏrak Mt. at Osaek, VI-19-21-1995, Y.J. Bae (SWU); 2L: KW, Hongsŏng, Taegi Mt., VI-24-1986, D.J. Chun (SWU); 1M, 19F & 5L: KW, Inje, Pangtae Cr., V-16-18-1996, Y.J. Bae (SWU); 1L: KW, Hongchŏn, tributary of Hongchŏn R. at P'unghŏn, IX-20-1994, Y.J. Bae, S.K. Namgung (SWU); 5M & 94F: CCB, Chechŏn, Wŏrak Mt. at Tŏkjugol, V-29-30-1987, VI-24-1994, Y.J. Bae (SWU); 1L: CCB, Chechŏn, Pongyang, Nomok, VIII-22-1995, Y.J. Bae (SWU); 2L, CCB, Yŏngchun, Namchŏn, IX-19-1994, Y.J. Bae (SWU); 2L & 11F: CCN, Kongju, Kyeryong Mt., VII-11, 18-1995, Y.J. Bae, J.H. Whang (SWU); 1L: KB, Munkyŏng, Mungyŏng-

saejae, VIII-12-1983, Y.J. Bae (SWU); 1L: KN, Miryang, Kaji Mt., V-27-1982 (SWU); 1L: CLB, Kimje, Moak Mt. at Kõmsansa, IX-30-1984 (SWU); 1L: CLB, Chiri Mt. at Samgõri, VI-22-1982 (SWU); 1L: CLN, Changsõng, Naejang Mt. at Paegyangsa, V-29-1983, Y.J. Bae (SWU); 40F & 1M: CLN, Kurye, Chiri Mt. at Piagol, VI-7, VI-26-1996, Y.J. Bae, S.Y. Park (SWU); 2L & 51F: CLN, Chiri Mt. at Talgung, VI-25-1986, Y.J. Bae (SWU).

Remarks. Larvae of this species commonly occur in the riffle areas of clean mountain streams clinging on the rocks.

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국문적요 : 한국산 꼬마하루살이과 (하루살이목)의 분류학적 재검토. (1) 역사적 고찰, *Acentrella* 및 *Baetiella*. 박선영, 배연재, 윤일병¹(서울여대 생물학과, ¹고려대 생물학과) 한국산 꼬마하루살이과의 유충 및 성충표본에 대한 종합적인 검토를 통하여 분류학적 재검토를 실시하였다. 이 논문에서는 역사적 고찰, *Acentrella* 및 *Baetiella*속을 수록하였다. *Acentrella gnom* (미기록종), *A. sibirica* (미기록종) 및 *Baetiella tuberculata*에 대하여 유충 및 알려진 성충을 그림 및 주사전자현미경사진과 함께 기재하였다.

검색어 : 하루살이목, 꼬마하루살이과, *Acentrella*, *Baetiella*, 기재, 분류학적 재검토, 한국

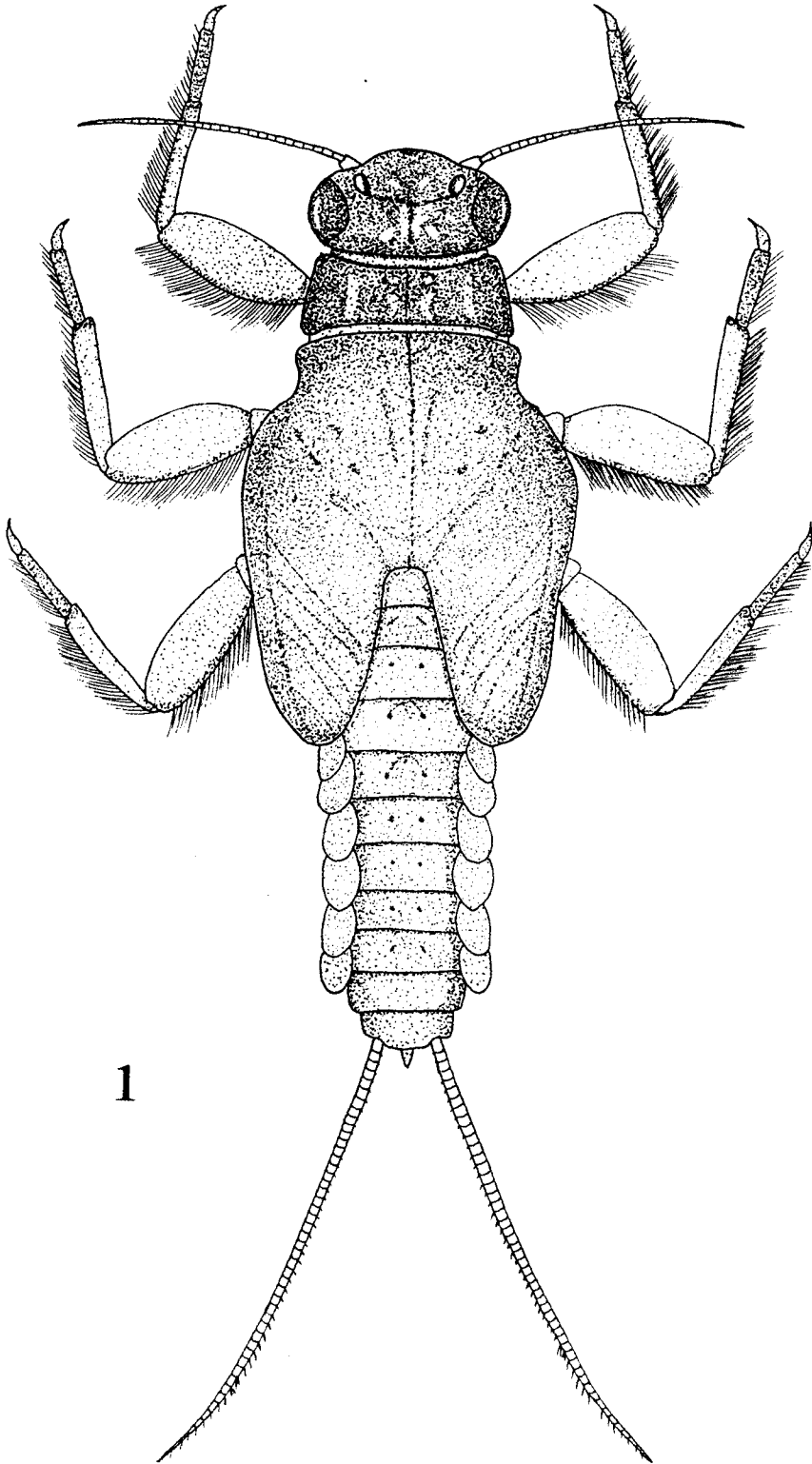
FIGURE LEGENDS

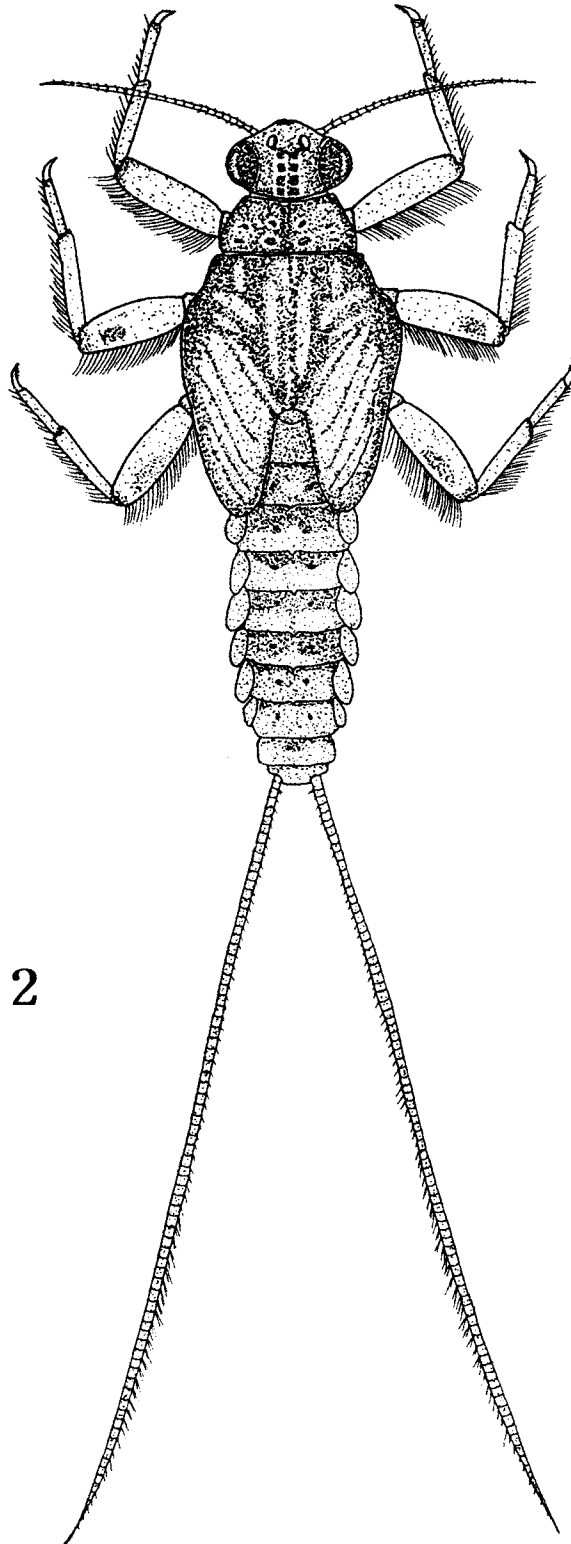
Fig. 1. Larval habitus of *Acentrella sibirica*.

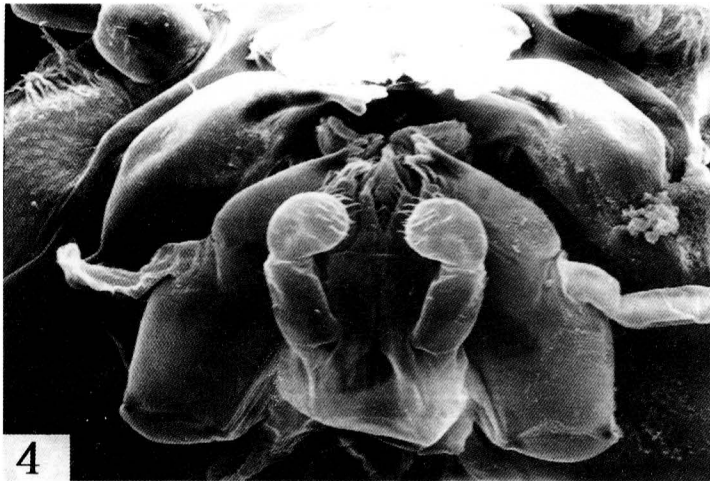
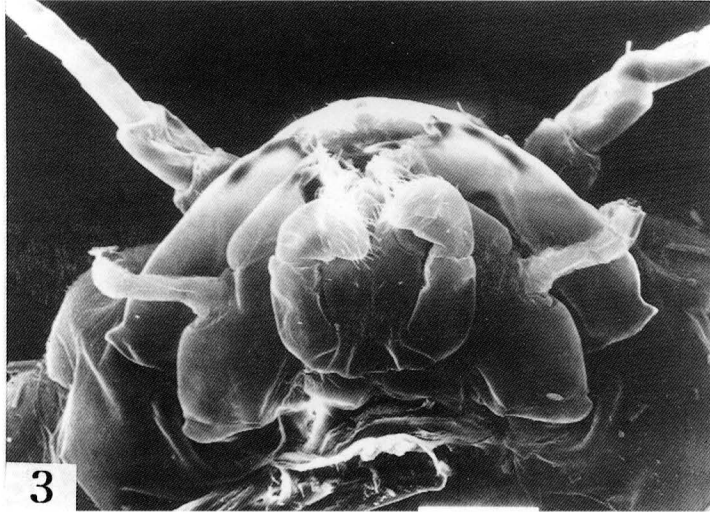
Fig. 2. Larval habitus of *Baetiella tuberculata*.

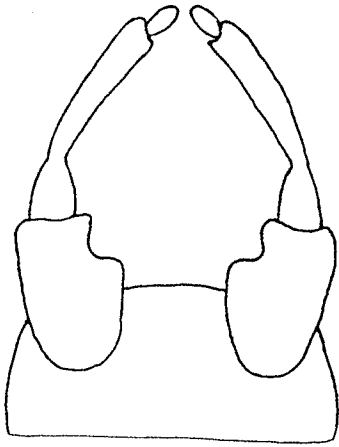
Figs. 3-5. SEMs of larval mouthparts (bar=100 μ m). (3) *A. gnom.* (4) *A. sibirica.* (5) *B. tuberculata.*

Figs. 6-8. Line-drawings of adult parts. (6) Male genitalia of *A. sibirica.* (7) Male genitalia of *B. tuberculata.* (8) Forewing of *B. tuberculata.*

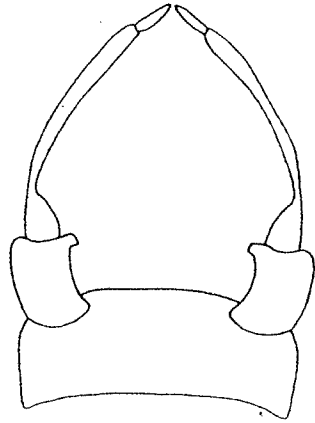




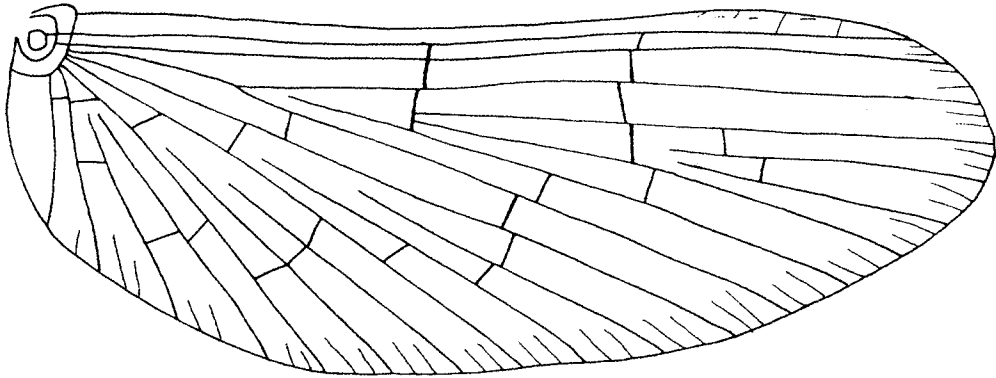




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