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the Nymphal Stages***
(Ephemeroptera: Ephemerellidae)

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***Ephemerella* (*Cincticostella*): A Revision of
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The following treatment includes a characterization of the subgenus *Cincticostella*, a description, or diagnosis, of the nymphal stages, a key to the nymphs, and the known distributional limits of each species. *Ephemerella* (*Cincticostella*) *orientalis* Tshernova, 1952, whose nymph is unknown is included with complete synonymy and known distribution.

Grateful appreciation is expressed to Professors Kazimitzu Kato and Valentina Zaydman, California State University, Los Angeles, for translating parts of the papers by Imanishi (1940) and Tshernova (1972), respectively.

SUBGENUS CINCTICOSTELLA ALLEN

nigra-group Imanishi 1938: 33.

Cincticostella Allen 1971: 513; Tshernova 1972: 614 (= *Asiatella*).

Asiatella Tshernova 1972: 611.

Imanishi (1938) placed *E. nigra* Uéno, 1928, in the *nigra*-group of the genus *Ephemerella* and Allen (1971) erected the subgenus *Cincticostella* for *E. nigra* and five other species. He transferred *E. levanidovae* Tshernova, 1952, and described *E. castanea*, *E. delicata*, *E. imanishii*, and *E. insolta*. Tshernova (1972) described the genus *Asiatella* to include *E. nigra*, *E. femorata* Tshernova, 1972, *E. orientalis*, *E. levanidovae*, and *E. tshernovae* Bajkova, 1962, to this taxon. In the same paper, as a footnote, she synonymized *Asiatella* with *Cincticostella* and placed *E. imanishii* as a junior synonym of *E. tshernovae*.

Cincticostella is confined to southeast and eastern Asia. *Ephemerella boja* n. sp., *E. gosei* n. sp., and *E. insolta* are known from Thailand; *E. castanea* from Korea; *E. delicata* from Japan and Manchuria; *E. femorata* from Vietnam; *E. levanidovae* and *E. orientalis* from Russia; *E. nigra* from Japan; and *E. tshernovae* from Japan, Korea, and Russia. The number of described species in the subgenus is ten.

The species of *Cincticostella* are all known from the nymphal stage except *E. orientalis* which was described from male and female sub-

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imagoes. *Ephemerella nigra* is the only species known from the nymph and the male imago.

Nymphal Stage.—Body flattened ventrally, convex dorsally. Head round to quadrangular; genae often truncate; maxillae without apical canines, with apical tuft of setae; maxillary palpi well developed, vestigial, or absent. Fore femora with band of transverse spines near middle; denticles on tarsal claws variable in number. Anterolateral corners of prothorax produced anteriorly; mesothorax expanded laterally in anterior portion. Abdominal terga with paired dorsal submedian tubercles; abdominal segments 7-9 with or without well developed posterolateral projections; abdominal terga 3-7 with lamellate, imbricated gills. Caudal filaments shorter than body.

On the basis of nymphal characters two groups of related species are recognized. *Ephemerella insolta*, *E. boja*, and *E. femorata* form the *insolta*-group. These species are characterized by possessing suboccipital head tubercles, and the second and third pairs of femora are enlarged with serrated margins and/or protuberances. The *nigra*-group includes *E. nigra*, *E. castanea*, *E. delicata*, *E. gosei*, *E. levanidovae*, and *E. tshernovae*. These species are without head tubercles and the second and third pairs of femora are narrow, not enlarged, and the margins are entire. *Ephemerella orientalis* cannot be placed to species-group until the nymphal stage is discovered.

The characters most useful for distinguishing the species of *Cincticostella* nymphs are as follows: (1) the number and degree of development of the paired dorsal abdominal tubercles; (2) the degree of expansion, the presence or absence of marginal serrations, and the presence or absence of spines and tubercles on the anterior surfaces of the middle and hind femora; (3) the degree of development of the posterolateral projections on abdominal segments 7-9; (4) the shape of the genae; (5) the color patterns on the head and body; and (6) the relative lengths of the body and caudal filaments.

The following key will serve to distinguish the known nymphs of the species of *Cincticostella*. Illustrations are not included but reference is made to previously published figures which are enclosed in parentheses in the couplets. That is, (Allen 1971: fig. 11) in couplet 1 makes reference to "New Asian *Ephemerella* with notes (Ephemeroptera: Ephemerellidae). Canad. Ent. 103: 512-528."

KEY TO THE NYMPHS OF EPHEMERELLA (CINCTICOSTELLA)

1. Middle and hind femora expanded and margins serrate; head with suboccipital tubercles (Gose 1969: fig. 23; Tshernova 1972: fig. 5) *insolta*-group, 2
- Middle and hind femora narrow, and margins entire (Allen 1971: fig.

- 9); head without suboccipital tubercles (Allen 1971: fig. 13) *nigra*-group, 4
- 2 (1). Abdominal terga with paired submedian tubercles on segments 1-10 (Allen 1971: fig. 18); fore femora with median band of tubercles (Allen 1971: fig. 12); head, body and legs with numerous pale spots (Allen 1971: fig. 14) *insolta*
- Abdominal terga with paired submedian tubercles on segments 2-10 (Gose 1969: fig. 23) or 4-9 (Tshernova 1972: fig. 5); fore femora without a median band of tubercles; head, body and legs without pale spots 3
- 3 (2). Head quadrangular; abdominal terga with paired submedian tubercles on segments 2-10 (Gose 1969: fig. 23); known distributional limits Thailand *boja*
- Head round; abdominal terga with paired submedian tubercles on segments 4-9 (Tshernova 1972: fig. 5); known distributional limits Vietnam *femorata*
- 4 (1). Head with three pale maculae on frons (Gose 1969: fig. 43); maxillae without palpi (Gose 1969: fig. 44); known distributional limits Thailand *gosei*
- Head without pale maculae on frons; maxillae with palpi; known distributional limits Manchuria, Korea, Japan, and Russia 5
- 5 (4). Head with truncate genae (Tshernova 1952: fig. 78); middle and hind femora with an anterior longitudinal ridge *levanidovae*
- Head with round genae (Allen 1971: fig. 13); middle and hind femora without a longitudinal ridge 6
- 6 (5). Abdominal terga with paired submedian tubercles on segments 2-9 (Allen 1971: figs. 16-17); caudal filaments more than 70% as long as body (Imanishi 1940: fig. 18) 7
- Abdominal terga with paired submedian tubercles on segments 5-9; caudal filaments less than 50% as long as body (Imanishi 1940: fig. 17) *tshernovae*
- 7 (6). Abdominal terga with dark sublateral stripes along line of submedian tubercles (Imanishi 1940: fig. 18); body short, less than 7 mm in length *delicata*
- Abdominal terga unicolorous, often with a pale median stripe, without sublateral dark stripes; body moderately long, more than 9 mm in length 8
- 8 (7). Abdominal tubercles on segments 2-4 distinct and sharp (Allen 1971: fig. 17); body reddish-brown; known distributional limits Korea *castanea*
- Abdominal tubercles on segments 2-4 barely discernible (Allen 1971: fig. 16); body dark brown to black, often with pale median longitudinal stripe; known distributional limits Japan *nigra*

***Ephemerella* (*Cincticostella*) *boja*, new species**

Ephemerella TEA Gose 1969: 132.

This species was described and figured, but not named, from nymphs collected in Thailand. *Ephemerella boja* is a distinctive species with a

quadrangular head and well developed posterolateral projections on segments 7-9.

Nymph.—Length: body 11.0-12.0 mm; caudal filaments 7.0-8.0 mm. General color brown. Head quadrangular; maxillary palpi small, two segmented. Thoracic nota without tubercles or ridges; prothorax much wider than head; anterior surface of femora smooth, without protuberances; fore femora small, margins entire; middle and hind femora broadly expanded laterally, margins serrate; tarsal claws with 3-4 denticles. Abdominal segments 3-9 with well developed posterolateral projections; terga 2-10 with paired submedian tubercles; tubercles small on terga 2-3, well developed on 4-10; segments 7-9 with well developed posterolateral projections. Caudal filaments brown (rewritten from Gose, 1969).

Holotype nymph.—The specimen from which figure 23 in Gose was illustrated (Nature and Life in Southeast Asia, vol. VI, 1969) from Chanta Buri, Thailand, 20-VI-61, no other data, is designated as the type of the species. The other nymphal paratopotype is designated as a paratype.

EPHEMERELLA (CINCTICOSTELLA) CASTANEA Allen

Ephemerella castanea Allen, 1971: 514.

Nymph.—Length: body 10.0-11.0 mm; caudal filaments 7.0-8.0 mm. General color reddish-brown with dark brown markings. Head without occipital tubercles; maxillary palpi with moderately developed palpi. Thoracic nota without tubercles or ridges. Abdominal terga 2-9 with paired submedian tubercles; tubercles on segments 2-4 small and sharp, always discernible; tubercles on segments 5-9 moderately developed. Caudal filaments brown with dark brown annulations at apex of each segment.

Distribution.—South Korea, Kwang Nung and Seoul.

EPHEMERELLA (CINCTICOSTELLA) DELICATA Allen

Ephemerella "nay" Imanishi 1940: 206; Tshernova 1952: 274.

Ephemerella delicata Allen 1971: 517.

Nymph.—Length: body 5.5-7.0 mm; caudal filaments 5.5-7.0 mm. General color light brown to reddish brown and dark brown. Abdominal terga with paired submedian tubercles on segments 2-9; tubercles small on segments 2-4 and 9, well developed on segments 5-8; abdominal terga with dark submedian longitudinal stripes along line of submedian tubercles, pale medially and laterally, and with brown lateral maculae on segments 2-8. Caudal filaments with light thick setae on every second segment (rewritten from Imanishi 1940).

Distribution.—Kamo River, Kyoto, Yanashiro Prefecture, Japan, and Botankoshu, Sekito-ga, Manchuria.

Remarks.—The following discussion is rewritten from Imanishi (1940): "Japanese specimens have white line on thorax, but these are absent on Manchurian collections. Abdominal markings are distinct on specimens from Manchuria, and indistinct or barely discernible on the Japanese. This species is almost identical to *E. nigra* in form and color, and the only difference is the smaller size and emergence is

slightly later than *E. nigra* in Japan. The adult is unknown (adult probably smaller than *E. nigra*) and nymph is not as common as *E. nigra*."

EPHEMERELLA (CINCTICOSTELLA) FEMORATA Tshernova

Asiatella femorata Tshernova 1972: 611, 614 (= *Cincticostella*).

Nymph.—Length: body 12.0 mm; caudal filaments 5.0 mm. General color light brown. Head with paired suboccipital tubercles; genae rounded; maxillary palpi reduced in size, two segmented. Thoracic nota without tubercles or ridges; prothorax broadly expanded laterally; anterior surface of fore femora without protuberances, dorsal margin with small protuberances; middle and hind femora broadly expanded laterally; middle femora with apical serrations; hind femora with apical and dorsal serrations; femora, tibiae and tarsi margined with setae; tarsal claws with 2 denticles. Abdominal terga with paired submedian tubercles on segments 4-9, tubercles increase in length on posterior segments; segments 7-8 with well developed posterolateral projections. Caudal filaments dark brown at base (rewritten from Tshernova 1972).

Distribution.—Red River (Song Koi), Back Thai, North Vietnam.

Ephemerella (Cincticostella) gosei, new species

Ephemerella TEB Gose 1969: 135.

This species, along with *E. boja*, was described and figured, but not named, by Gose (1969) from nymphs collected in Thailand.

Nymph.—Length: body 6.0-7.0 mm; caudal filaments 3.0-4.0 mm. General color dark brown. Head round; frons with pale markings mesad to compound eyes and pale marking over median ocellus; genae truncate; maxillary palpi absent. Thoracic nota without tubercles or ridges; tarsal claws with 6 denticles. Abdominal terga 2-9 with paired submedian tubercles; tubercles small on terga 2-3, better developed on 4-9. Caudal filaments light brown (rewritten from Gose 1969).

Holotype nymph.—The specimen from which figure 38 was illustrated (Nature and Life in Southeast Asia, vol. VI, Gose 1969) from Chanta Buri, Thailand, 20-VI-61, no other data, is designated as the type of the species.

EPHEMERELLA (CINCTICOSTELLA) INSOLTA Allen

Ephemerella insolta Allen 1971: 516.

Nymph.—Length: body 5.0-6.0 mm; caudal filaments 4.0-5.0 mm. General color light brown to brown with numerous small pale spots on head, body and legs. Head with paired suboccipital tubercles; genae rounded; maxillary palpi present, but reduced in size. Thoracic nota with ridges; femora expanded laterally and with spines and protuberances; tarsal claws with 5-8 denticles. Abdominal terga 1-10 with well developed paired submedian tubercles; segments 7-9 without posterolateral tubercles. Caudal filaments brown.

Distribution.—The species is known only from the type series collected from Chiangmai, Thailand.

EPHEMERELLA (CINCTICOSTELLA) LEVANIDOVAE Tshernova

Ephemerella levanidovae Tshernova 1952: 274; Tshernova 1958: 76; Edmunds 1959: 545; Allen 1971: 516; Tshernova 1972: 612.

Nymph.—Length: body 12.0 mm; caudal filaments 10.0 mm. General color brown. Head without occipital tubercles; genae truncate; maxillae with well developed palpi. Thoracic nota without tubercles or ridges; femora of middle and hind legs with longitudinal ridge on anterior surface; tarsal claws with 6 denticles. Abdominal terga 5–8 with well developed tubercles, tubercles small on other segments. Caudal filaments with spines on every segment (rewritten from Tshernova 1952).

Distribution.—This species is known only from the type series collected from the Hor River in eastern Russia.

EPHEMERELLA (CINCTICOSTELLA) NIGRA Uéno

Ephemerella nigra Uéno 1928: 44; Imanishi 1937: 325; Uéno 1950: 128 (male genitalia); Edmunds 1959: 546; Bajkova 1962: 204; Allen 1971: 513; Tshernova 1972: 611.

Chitonophora (?) *nigra* Uéno 1931: 224.

Nymph.—Length: body 9.5–11.5 mm; caudal filaments 7.0–8.0 mm. General color dark brown to black. Head without occipital tubercles; genae round; maxillary palpi well developed. Thoracic nota without tubercles or ridges. Abdominal terga 2–9 with paired submedian tubercles; tubercles on segments 2–4 barely discernible; tubercles on segments 5–9 moderately developed. Caudal filaments brown.

Distribution.—This species has been reported from several localities on the Island of Honshu, Japan.

EPHEMERELLA (CINCTICOSTELLA) ORIENTALIS Tshernova

Ephemerella orientalis Tshernova 1952: 279; Tshernova 1958: 75; Tshernova 1972: 612.

This species was described from a male imago collected in the vicinity of the Amur River in eastern Russia and the nymphal stage has not been associated at this time. Tshernova (1972) placed *E. orientalis* in *Cincticostella* (as *Asiatella*) with the following statement, "The imago described by me as *E. orientalis* Tshern. (Tshernova, 1952: 279, table XIV, fig. 99) due to the structure of the genital appendages is very close to *E. nigra* Uéno and by all means belongs to the genus *Asiatella*."

Distribution.—The adult of this species was described from Sudhuhynshi Preserve, USSR and records of additional specimens have not been published.

EPHEMERELLA (CINCTICOSTELLA) TSHERNOVAE Bajkova

Ephemerella "nax" Imanishi 1940: 205; Tshernova 1952: 274.

Ephemerella tshernovae Bajkova 1962: 203; Tshernova 1972: 612, 614 (= *imanishii*).

Ephemerella imanishii Allen 1971: 517.

Ephemerella tshernovae nymphs are easily distinguished from those of the other species in the *nigra*-group as they possess paired submedian tubercles only on segments 5-9.

Nymph.—Length: body 10.0-11.0 mm; caudal filaments 4.0 mm. General color reddish brown to dark brown with purple to purple black markings. Abdominal terga with large paired submedian tubercles on segments 5-9; abdomen with posterolateral projections on segments 4-9; poorly developed on 4-6, well developed on 7-9; abdominal terga with short heavy setae; abdominal segment 9 with concave lateral margins. Caudal filaments less than one-half body length; caudal filaments with heavy setae around each segment (rewritten from Imanishi 1940).

Distribution.—This species is reported by Imanishi (1940) from Gifu Prefecture, Japan, and four localities in Korea.

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