

ON A NEW GENUS OF MAY-FLIES  
(EPHEMEROPTERA, BEHNINGIIDAE)\*

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O. A. Chernova and O. Ya. Baikova

- Department of Entomology, Moscow State University, Moscow, and Pacific Institute of Fisheries and Oceanography, Khabarovsk
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Until recently the family Behningiidae has included only the single genus *Behningia* Lestage, 1929. The type of this genus is *Behningia ulmeri* Lestage, 1929, established and named from a detailed description, made by Ulmer (1924), of a larva from the Volga. Fourteen years later a second species of the genus was described, also from the larva, collected in this case in the Dnestr, and named *Behningia lestagei* Mot. et Băc. (Motas and Băcesco, 1938); the describers of this species expressed the opinion that the genus *Behningia* belonged to a separate family Behningiidae. Simultaneously with the paper by the Rumanian authors, new material in the Behningiidae was described in the USSR from the Amur—one larva and, particularly important, two adult specimens (males). The description of this Far Eastern material demonstrated the unique structure of *Behningia*, not only of the larva but of the imago; on this basis the separate family Behningiidae was established (Chernova, 1938). In 1955 cast skins of *Behningia* larvae and adult females were found in Poland, in the Warta (Keffermüller, 1957). In recent years some larvae and, in addition, some adult females were once again collected in the Amur. The data enumerated here point to the scarcity of this group of may-flies and also demonstrate its extremely wide distribution.

The description of the new family Behningiidae has aroused some comment in the literature. The structure of *Behningia*, its phylogenetic relationships, and its position in the classification of the Ephemeroptera have been discussed. For instance, Lestage (1938) stated that a separate family should not be established for this genus and that *Behningia* belongs to the true Oligoneuriidae. Motas and Băcesco (1940), in a later work, joined in this opinion stating that the family Oligoneuriidae should be divided into two subfamilies — the Oligoneuriinae and Behningiinae. Demoulin (1952, 1955) accepted the Behningiidae as a separate family and discussed its close relationship to the Palingeniidae and Oligoneuriidae. In his latest system of classification Demoulin places the Behningiidae in the superfamily Palingenioidea which includes, in addition, the modern Palingeniidae and the extinct Jurassic MesepheMERIDAE (Demoulin, 1958). Thus, he no longer considers our family to be close to the Oligoneuriidae.

Very recently we received the new work of Edmunds and Traver (1959), in which the authors examine all the

members of the Behningiidae known to date and describe a new genus *Dolania* from larvae collected in the southeastern United States, in the Savannah River. In addition, in this paper Edmunds and Traver discuss the question of the systematic position of the Behningiidae in the order, placing it in the superfamily Ephemeroidea. We believe their conclusion to be nearer to the truth.

The new, third genus described below differs considerably from both *Behningia* and *Dolania*; for this reason the characterization of the family on the basis of the larval phase should be correspondingly changed.

*Protobehningia* Chernova, gen. nov.

Larva. Body very narrow and of almost constant width throughout; length of body 7 times width of mesothorax. Anterior end short; abdomen  $3\frac{1}{2}$  times longer than head and thorax combined (Fig. 1). Head rounded, retracted, enclosed almost halfway by sides of prothorax; ocelli lying anterior to compound eyes. Labrum thin and short; more developed mandibles with strongly sclerotized margins and dentate; grinding surface absent on inner margin; between outer teeth and inner process is a bifurcate process with sharp teeth (Fig. 2, a, b); maxillary lobe extended, narrowing apically and terminating in a sharp tooth; maxillary palp three-segmented (Fig. 2, c); hypopharynx trilobate, outer margin of its median lobe excavate; labium small and with well-developed inner and outer lobes separated from one another; labial palp three-segmented, the division between 2nd and 3rd segments very indistinct and visible only in microscopical preparations (Fig. 2, d). Anterior legs located as in *Behningia*, laterally to labium as "gnathopods" applied closely to head; middle and hind legs of similar structure, but very short; no compact or widened hind legs; claws present on all pairs of legs; coxae strongly developed on all legs (Fig. 2, e, f, g). All abdominal segments long and narrow, convex, their lateral margins with flat projections possessing even outer margins; all gill filaments plumose; the first pair single, the remaining six pairs double; gills held

\*In the composition of this paper the work was shared in the following manner between the authors: the collaborator from the Pacific Institute of Fisheries and Oceanography, O. Ya. Baikova, collected the material, studied the habitat, and established the family relationships of the species; O. A. Chernova described the genus and species.

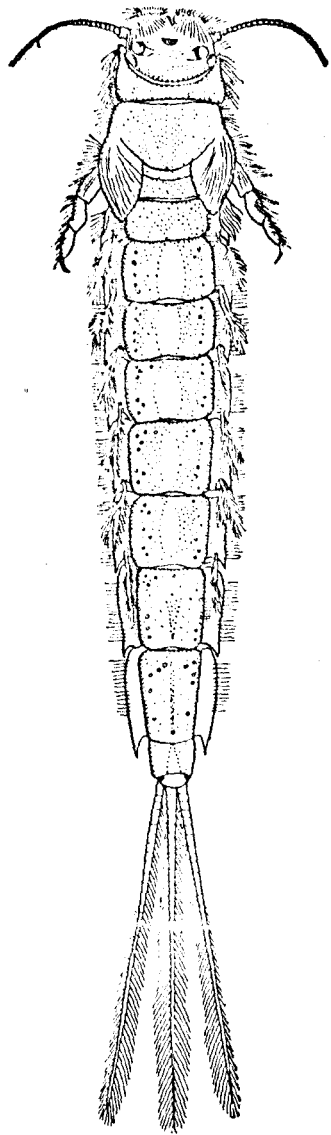


Fig. 1. Protobehningia asiatica, g. n., sp. n., larva from above. (Figure by O. A. Chernova).

along abdomen; setae situated in a straight line along sides of all abdominal tergites where a break occurs between dorsal and lateral surfaces of tergites; caudal filaments (cerci and paracerci) equal in length.

Imago. The winged phase is unknown, but it is possible to gain an idea of it from the rudimentary wings of the larva, which display numerous transverse and separated longitudinal veins (Fig. 3); the branching point of M is located almost at the base of the wing, proximally to the branching point of RS, this being characteristic of Behningia and Dolania\*; on the basis of an interpretation of venation given by Demoulin (1952) it may be noted that in the forewing MA branches off at the same level as MP, the basal parts of the veins situated behind MP are

not visible, and the intercalary veins between CuA and CuP are 8 in number and connected together by cross-veins; the hind wing is well developed, with SC and R proceeding parallel to the apex, and RS being four-branched; basal sections of other veins are not visible behind the basal part of R; the median and distal sections of, apparently, the three medial branches and CuA are distinctly visible; there are few distinct cross-veins in the hind wing; the anal field of both wings consists of large cells.

Type of genus: Protobehningia asiatica, sp. n.

Composition and distribution of the genus. One species, the type of the genus, found in the lower reaches of the Ussuri River.

Protobehningia asiatica Chernova, sp. n.

Larva. Outgrowths of anterior margin of head not projecting laterally, covered with blunt bristles; lateral margin of head with very small impression at level of antennae; bases of antennae ventral, 1st segment not visible from above, the long 2nd segment projects beyond lateral margin of head; labium extending along entire anterior margin of head, its anterior margin provided with long setae; mandibles strong asymmetrical - apex of inner projection of right mandible strongly drawn out; inner margin of maxilla bearing a row of long bristles and a row of stout, shorter spinose bristles; at base of apical tooth there is an additional small tooth; division between 2nd and 3rd maxillary palpal segments visible only in microscopical preparations; palpiger well developed; inner and outer lobes of labium almost equal in size; almost entire surface of labial palp covered with rows of long bristles; most bristles are equally thick for their entire length and have a blunt apex; longest bristles are found at base of 1st palpal segment; these bristles are pale and seen best of all in transmitted light. Anterior margin of prothorax strongly concave, the anterior angles reaching upper parts of compound eyes, their lateral surfaces bearing long bristles. Anterior leg flattened, with a large coxa and broad, flat femur, on which long bristles are arranged; tibia and tarsus fused; the margins between these sections may be made out on comparison with the middle and hind legs; furthermore there is a row of bristles at this point in dorsal view; inner margin of anterior legs bearing short bristles; middle and hind legs with a distinctly articulated tarsus; claw of third pair of legs strongest, acute and curved; hind legs especially strongly armed with sharp strong spines similar to the thorns of plants. Abdominal segments above lateral projections strongly flattened laterally, the gill filaments with their flat surfaces applied

\* We noted a similar venation characteristic in one species of Asthenopus (Campsurinae) from S. America (Demoulin, 1955: 29).

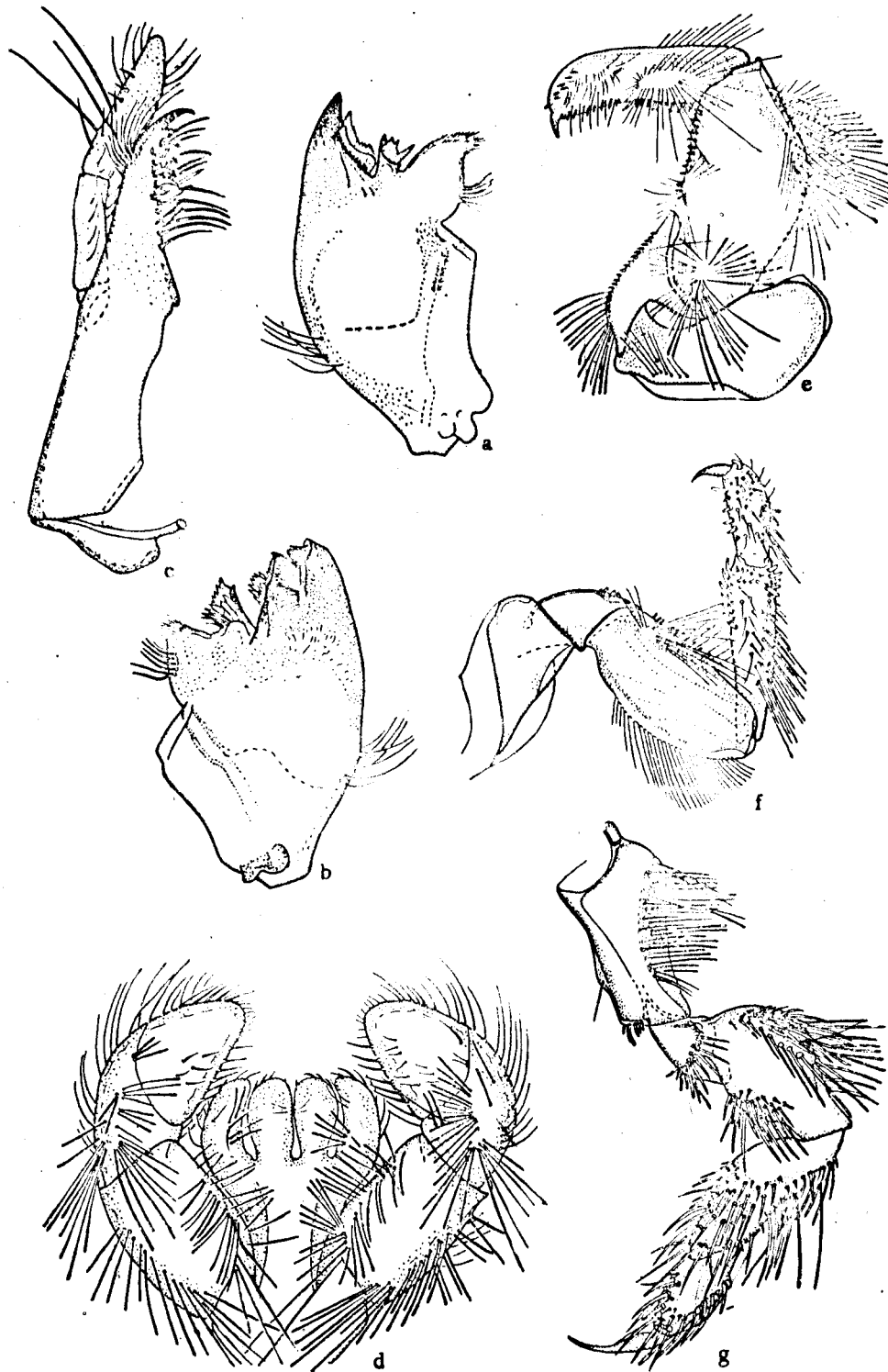


Fig. 2. *Protobehningia asiatica*, g. n., sp. n. a) Right mandible from below; b) left mandible from below; c) maxilla from below; d) labium from below; e) fore-leg from below; f) middle leg from below; g) hind leg from below. (Figures by O. A. Chernova).

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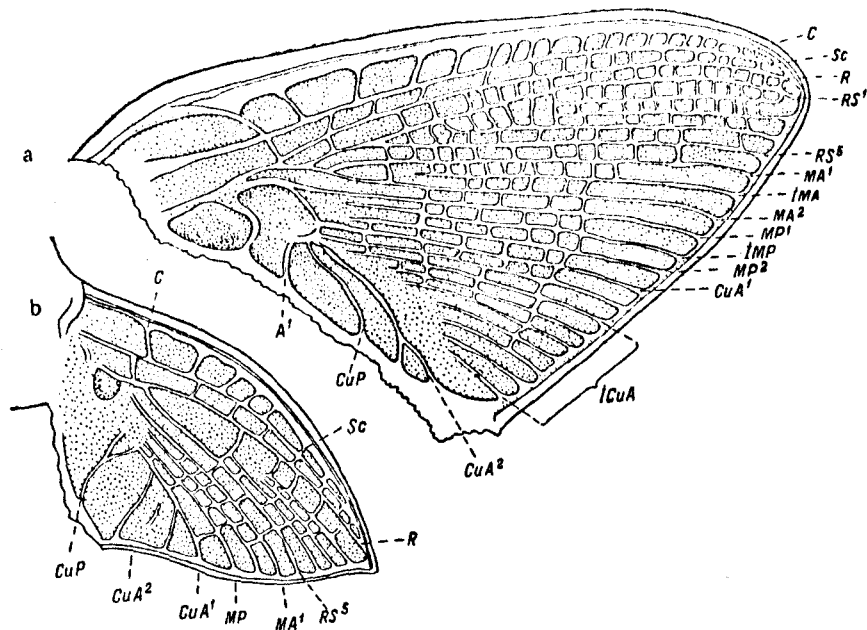


Fig. 3. *Protobehningia asiatica*, g. n., sp. n., rudiments of fore and hind wings of larva. (Figures by O. A. Chernova).

against these raised sides in such a manner that in dorsal view the sides of the gill filaments are visible; upper branch of each gill shorter than lower one; first gill filament single, its base formed like a short, broad handle from which emerge a plumose rod and long filaments arranged along sides of this handle. Each caudal filament fringed with setae which are shorter at basal part of filament; paracercus is most heavily fringed, the setae distributed on either side; cerci are fringed on inner side, their outer side bearing setae only on apical part; segmentation of caudal filaments barely perceptible.

Coloration of larva pale, uniformly pale yellow, the abdomen lighter below; the black eyes and ocelli and distinct, reddish-golden tufts of setae on anterior margin sharply stand out on pale head; margins of abdominal tergites somewhat darker where setae are located; surface of each tergite in addition with a row of very minute round spots devoid of pigment; on lower surface the reddish-golden spines on legs are the most brightly colored; setae on abdomen pale. Caudal filaments and their setae white

Length of not fully grown larvae 12.5 and 14 mm; length of caudal filaments 5.5 and 6 mm.

**Material.** Lower course of the Ussuri River, July 10 (2 larvae) and 11 (1 larva), 1958, collected by O. Ya. Balkova. The type of the species is preserved in the collection of the Zoological Institute of the Academy of Sciences, USSR, in Leningrad.

**Ecology.** Two larvae were caught in a plankton net at a depth of 6 m and a water temperature of 21.5°C; the third larva was caught at the surface of the water. In the diet of the larvae were found antennae and setae of copepod crustaceans, the head of a tentipede and a few filamentous algae; there was no plant

debris. These data (together with the absence of grinding areas on the mandibles!) enable us to suppose that the larvae of *Protobehningia* are predatory. The unique structure of the legs, which are short, bent, and provided with spines, is clearly unsuitable for swimming purposes.

Until recently the way of life and ecology of *Behningiidae* larvae remained poorly known. In their work Edmunds and Traver (1959) first reported accurate observations on the behavior of live larvae. It appears that these larvae have the ability to burrow quickly into sand, the large anterior projections on the head, provided with strong bristles, serving as the principal organ by means of which the larva sinks into the substrate; the elongated maxillary and labial palps and the anterior pair of legs are then directed forward and help in the digging. All these data were obtained through direct observations of live larvae placed in a glass vessel with water and sand. Our previous assumption concerning the nectonic way of life of *Behningia* larvae was based on the structure of the hind legs, which are flattened and partly paddle-shaped, and also on indirect evidence (the collection of larvae in deep water with a plankton net). In the larvae of *Dolania americana* similar hind legs serve as coverings for the gills when moving through sand. The structure of the legs of *Protobehningia asiatica* Chern., sp. n., fully supports the idea of a burrowing way of life in deep sand; this is indicated not only by the presence of strong, bristle-bearing projections on the head but especially by the long, smooth, worm-like body and strong, bristle-bearing legs. It should also be pointed out that the expansion of the abdominal tergites and the formation of a unique lateral groove on the abdomen, in which the gills are located, are also excellent adaptations for the movement of the larva within sand. The

predatory way of life (the most probable food are tendipedid larvae) also fully accords with a habitat in sandy bottoms.

KEY TO THE GENERA BASED ON THE LARVAE

- 1 (2). Total length seven times width; very narrow, abdominal segments long; middle and hind legs short, not reaching beyond end of second abdominal segment; all legs bearing claws; gill filaments located at sides of abdomen . . . . .  
 . . . . . Protobehningia, gen. nov.
- 2 (1). Total length almost three times width (at mesothorax); abdominal segments short and broad; hind legs long, reaching almost to ninth abdominal segment; all legs devoid of claws; gill filaments located on venter of abdomen . . . . .  
 . . . . . 3.
- 3 (4). Hind coxae approximately half as long as femora; outer surface of hind femur with dense hair-like bristles; outer margin of mandibles weakly rounded; paraglossae long and narrow, considerably longer than wide . . . . .  
 . . . . . Behningia Lestage.
- 4 (3). Hind coxae about 4/5 as long as femora; outer surface of hind with sparse bristles; outer margin of mandibles sharply angular; paraglossae short and broad, wider than long . . . . .  
 . . . . . Dolania Edmunds and Traver.

SUMMARY

In 1958, in the lower reaches of the Ussuri River, the junior writer found three larvae of a remarkable may-fly which belongs to an unknown genus of Behningiidae. Its differences from the other genera are given above in the key.

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