

A New Mayfly Species of the Extant Genus *Neophemera* from the Eocene of North America (Insecta: Ephemera = Ephemeroptera: Neophemeridae)

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Abstract—A new mayfly species *Neophemera antiqua* sp. nov. (Neophemeridae) is described from the Eocene of North America (the Republic locality). This is a first fossil find of the genus *Neophemera*, and the oldest record of the family Neophemeridae.

INTRODUCTION

Dr W.C. Wehr from the Burke Museum of Natural History and Culture, Seattle, Washington, USA (UWBM) kindly presented to me for study three insect specimens from the Klondike Mountain Formation near Republic, Washington: one nymph determined as a stonefly, and two mayfly nymphs. One mayfly nymph (UWBM, 57158) was previously reported as Heptageniidae *incertae generis* ("? *Stenonema* or *Heptagenia*;" Lewis and Wehr, 1993). The specimen (part and counterpart) is rather poorly preserved, allowing confirmation but without delineation. The second, well preserved mayfly nymph (UWBM, 76324) belongs to a new species of the family Neophemeridae. The third nymph (UWBM, 57138), misidentified as a stonefly, is in fact a mayfly, possessing three caudal filaments, the paracercus being less distinct than the cerci in the impression, long forewing pads and short hindwing pads (Fig. 1a). This fragmentarily preserved specimen can be identified up to order only; it is not conspecific with either of the above-mentioned ones.

The small family the Neophemeridae comprises three genera and 12 species occurring in the Nearctic and Oriental Regions (Edmunds *et al.*, 1979; Bae and Mc Cafferty, 1998). Up to the present only one fossil neophemerid species was known, *Potamanthellus rubiensis* Lewis from the Oligocene (or terminal Eocene) of the Rubi River Basin, Montana, USA (Lewis, 1977). The genus *Potamanthellus* Lestage is now restricted to the Oriental Region. The genus *Neophemera* is reported here for the first time in the fossil state, this find being the oldest record of the Neophemeridae.

Living *Neophemera* species occur in the eastern Nearctic and western Palearctic regions, in contrast to *Potamanthellus*, now restricted to central and eastern Asia. The former distribution of the family was essentially unlike the modern one. In the western Palearctic where neophemerids are now absent, one Eocene spe-

cies was already found assigned to the genus *Potamanthellus*. This phenomenon was explained by the isolation in the Cretaceous and Early Paleogene of the western part of North America (faunistically associated with Asia) from the eastern part (associated with Europe). It was assumed that two extant phyletic lineages within Neophemeridae had separated due to the geographical isolation of their ancestors, the *Potamanthellus* lineage on the Asiamerican land and the *Neophemera*+*Ochernova* lineage on the Euramerican land (Bae and McCafferty, 1998). However, a new find of fossil *Neophemera* in the western Nearctic conflicts with this hypothesis, once more demonstrating how unreliable the paleobiogeographic constructions based on the present-day distribution of the group are. This find shows that in the Paleogene both phyletic lineages of the family occurred in western North America (where Neophemeridae now became extinct), and that there are no reasons to associate their separation with the isolation of Asiamerica and Euramerica.

The fossil insects from the Republic locality originate from the Middle Eocene lake deposits filling the Republic graben, Washington, and belonging to the Lower Klondike Mountain Formation (Wolfe and Wehr, 1987, 1991). These insects were collected along with a rich leaf flora (Wolfe and Wehr, 1987, 1991; Wehr and Schorn, 1992), freshwater crustaceans, and freshwater and anadromous fishes (Wilson, 1978; Joseph, 1986). Composition of the flora indicates that the sediments were formed in a mountain lake under a humid and warm climate.

Of 16 insects orders reported from the Republic locality (Lewis, 1992; Wehr and Barksdale, 1996), five include water dwellers: Ephemeroptera, Odonata, Plecoptera, Hemiptera, and Trichoptera. However, if the record of Plecoptera is based only on the above-mentioned specimen, this order should be excluded from the list. The Odonata are represented with imagoes only. There are no water dwelling forms among the

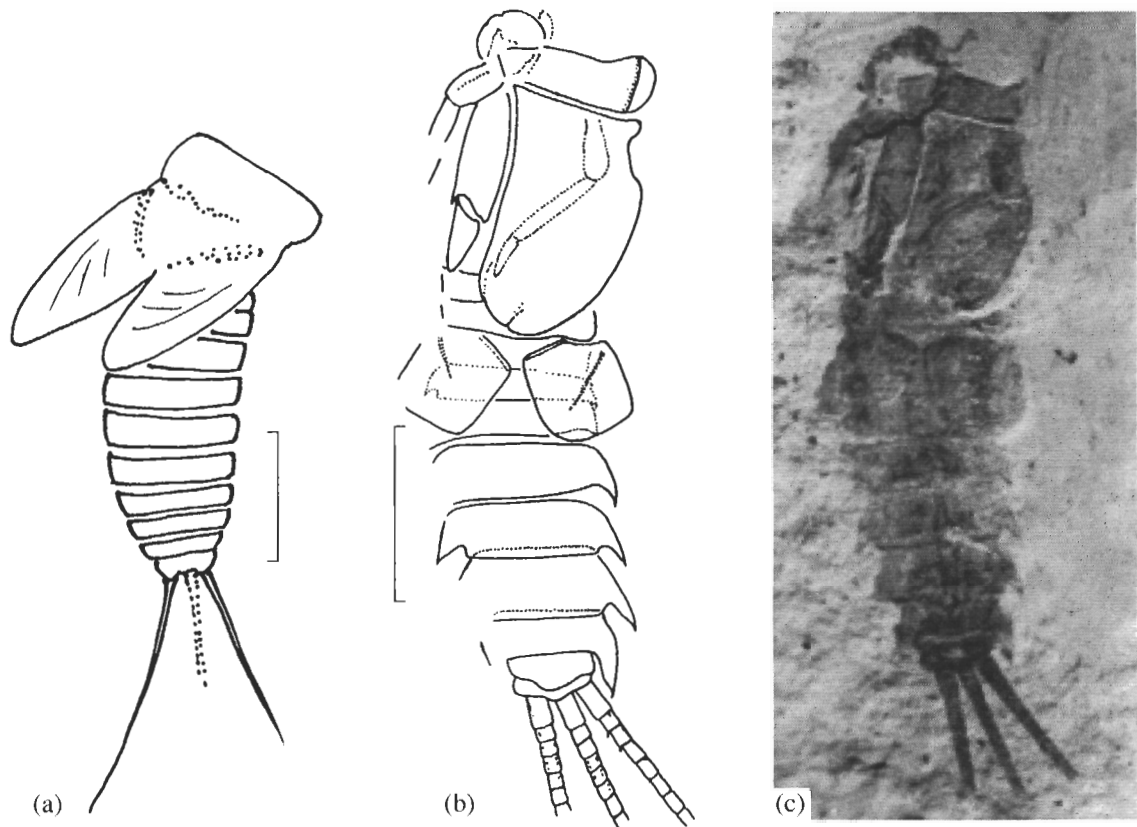


Fig. 1. Mayflies from the Eocene of Republic (North America): (a) Ephemeroptera inc. fam., nymph, specimen UWBM, 57138; (b, c) *Neophemera antiqua* sp. nov., nymph, holotype UWBM, 76324 AO307B: (b) structural details, (c) habitus, $\times 11.7$. Scale unit 2 mm.

families of Coleoptera and Diptera given in the list. Thus, aquatic insects are not diverse in this locality. The nymphs of living *Neophemera* inhabit slow or moderately fast rivers, often occurring on submerged tree roots and trunks, more rarely under large flat stones in rapid currents or in moss (Edmunds *et al.*, 1979; Bae and McCafferty, 1998). The nymph of Heptageniidae from Republic shows the typical reophilous habitus, characteristic of the members of this family as a whole. So far as both identifiable mayfly nymphs belong to reophilous groups and are represented by unique finds, these remains are most probably taphonomically allochthonous, the more so that mayflies are quite stenobiotic and develop only in the water bodies favourable to aquatic insects in general.

SYSTEMATIC PALEONTOLOGY

Family Neophemeridae Traver, 1935

Genus *Neophemera* McDunnough, 1925

Neophemera antiqua Sinitshenkova, sp. nov.

Etyymology. From Latin *antiquus* (old).

Holotype. UWBM, 76324 AO307B, well preserved positive impression of a nymph from dorsal side

(fore and middle leg almost complete; all three caudal filaments lacking apical portions); locality nr. Republic, Washington, USA; Eocene, Lower Klondike Mountain Formation.

Description (Figs. 1b, 1c). A nymph. The pronotum is almost four times as wide as long medially, with the lateral margins conspicuously dilated, anterolateral angles formed into small acuminate processes, and anterior margin lacking submedian tubercles. The anterior angles of the mesonotum are provided with small rounded processes, its anterior margin lacks submedian tubercles. The fore legs are short, the middle ones are considerably longer and broader. The plates of operculate gills are subquadrate with the posterolateral angles rounded and the diagonal ridge well developed; they almost completely cover the fourth and fifth segments. The abdominal segments are short, 3.4 times as wide as long, without median processes at the posterior margin; the posterolateral angles of the sixth-ninth segments are developed into strong spines, on the sixth and seventh ones being nearly half segment long, on the eighth and ninth ones surpassing the next segment. The cerci bear small spinules, but no long hairs.

Measurements (mm): body length of the nymph lacking head, 7.3; estimated total body length, ca. 8.5.

Comparison. Distinct from the living species of the genus in the shorter pronotum with moderately dilated lateral margins, smaller rounded process at the anterolateral angles of the mesonotum, and absence of median processes at the posterior margins of the abdominal segments.

Remarks. The species is assigned to the genus *Neophemera* based on the presence of processes at the anterolateral angles of the pronotum, of a diagonal rib at the gill opercula, and the absence of lateral setal rows on the caudal filaments; however, it can easily be distinguished from all the living species by the above-mentioned characters.

Material. Holotype.

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