

A NEW FOSSIL GENUS AND SPECIES OF THE FAMILY  
HEXAGENITIDAE (EPHEMEROPTERA) FROM THE  
SOUTHERN EUROPEAN PART OF THE USSR  
AND ITS CONNECTION WITH RECENT  
EPHEMEROPTERA

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Only two genera have been included in the family Hexagenitidae, *Hexagenites* Scudder and *Ephemeropsis* Eichwald, of which the first is known from the Upper Jurassic of Bavaria and the other from Transbaikalia and Mongolia.

In the years 1966-1967 the Southern Ukrainian geologic expedition of the "Kievgeologiya" Trust carried out drilling operations in combustible shales of the Rotmistrovka and Boltysk depressions of Cherkasskoye Province in the Ukraine in the vicinity of Smela on the northwestern slope of the Ukrainian Shield. The geologist Yu. I. Selin found wings and nymphs of Ephemeroptera among other faunistic and floristic remains in core samples from various depths. It was immediately apparent that Ephemeroptera remains belonged to the family Hexagenitidae. Their discovery may be said to be sensational; it was unexpected and is interesting because it is a connecting link between two such widely separated regions as Western Europe and East Asia.

On closer examination of the discovery it was found that it represented a new genus and species. The material consists of partly preserved fore and hind wings and separate abdominal segments of nymphs with poorly preserved gills (a total of 7 specimens from the Rotmistrovka depression).

The Rotmistrovka and Boltysk depressions have been geologically and paleontologically investigated, a cadastral survey has been made and, according to a written communication from Yu. I. Selin, the specimens sent to us from the Rotmistrovka depression came from beneath Cenomanian chalk. On the basis of the mode of occurrence and the paleontological data it was put as Hauterivian or Barremian. Paleontological data on the Boltysk depression have been evaluated in an article (Vasil'yev and Selin, 1970), in which the authors date the whole of the productive strata containing fauna and flora in both depressions as Early Cretaceous, i. e., they regard both depressions as of the same age.

The present article contains only a description of the wings and discussion of the systematic position. The nymphs should be the subject of a special article. There is no doubt that the nymphal remains belong to the Hexagenitidae.

G. Demoulin has written many articles on members of the family Hexagenitidae from the Upper Jurassic of Bavaria. The Belgian ephemeropterologist, having reexamined the types of several species

described long ago by various authors, reduced the number of species. He considered that the genus *Paedephemera* Handlirsch was a synonym of *Hexagenites* and, consequently, he also liquidated the family Paedephemeridae, reducing it to a synonym of Hexagenitidae, and he left in the latter family only the one genus *Hexagenites* with the single species *H. cellulusus* (Hagen). One of the species of Paedephemera, namely *P. schwertschlagerei* (Handlirsch), was found to belong to the family Siphonuridae, and he established the new genus *Olgisca* for it (Demoulin, 1970).

Two species of *Ephemeropsis*, *E. trisetalis* Eichwald and *E. martynovae* Tshernova, are known in Asia from a number of places in Transbaikalia and Mongolia (Chernova, 1961). The 1961 paper was prepared from collections made in 1959, on the basis of relatively incomplete material that was probably not a good sample of a fore wing even without the other wing lying on it. It was for this reason that the paper did not show the complete wing venation of *E. trisetalis* and that the wing of another species (*E. martynovae*), which did not have a second wing superimposed on it, was reproduced. Later, in 1961, the senior of the authors was able to visit the "Baysa" exposure on the Vitim River and to collect quite a large amount of additional material of *E. trisetalis*.

The present article contains an illustration of the complete venation of the fore wing of *E. trisetalis*, which is essential for comparison with the newly described genus.

There is actually so much material of *E. trisetalis* that it merits future monographic treatment. All the parts of the body collected together will yield an excellent representation of this very important extinct mayfly.

The new genus described is the third genus in the family Hexagenitidae and the fourth species. Apart from the geologic aspect, the material is of interest for the system and phylogeny of the order Ephemeroptera.

The authors are deeply indebted to Yu. I. Selin, who presented the material for study, and they name the new species after him.

## HEXAGENITIDAE

*Ephemeropsis trisetalis* Eichwald, 1884.

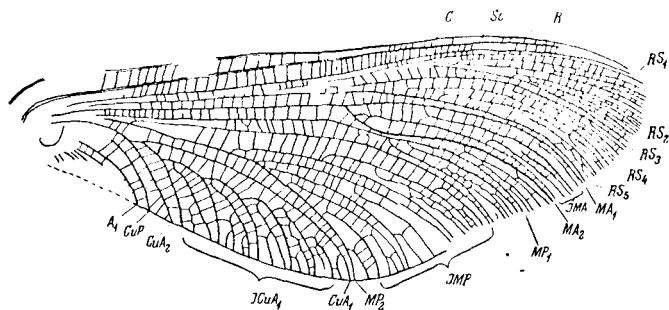


Fig. 1. *Ephemeroptera trisetalis* Eichwald. Fore wing.  
PIN collection, No. 1989/692. Location: Vitim River, Baysa.  
Upper Jurassic.

The imago and the nymphs have been described previously (Chernova, 1961; Meshkova, 1961). The venation of the fore wing of No. 1989/692 is depicted in Fig. 1 (drawing) and Fig. 5 (photograph). The wing has very profuse venation. There are many crossveins and intermediate veins which are fairly long; they are particularly plentiful on the terminal margin. The tornus lies in the middle of the hind wing near  $MP_2$ .

Twinning of the veins is expressed in many places around the terminal margin; it is also clearly manifested on the anal margin:  $MP_2$  is converged with  $CuA_1$  and the veins in the loops of the cubital field are also converged in pairs. C, Sc and R are distinct; it is only right at the apex that they have not been preserved. On impression No. 1989/692 RS is basally crumpled, which is the case in almost all specimens. We therefore give a separate illustration of the wing base from specimen No. 1668/1, in which the origin of RS is clearly apparent ( $RS_1$  and  $RS_3$ ), where the two veins are connected with a group of small cells in the wing base (Fig. 2, a). The branch  $RS_5 - RS_3$  is indistinctly apparent in Fig. 1; all that is clear is that the branching of these two veins is nearer the wing base by comparison with the branching in *E. martynovae* Tshern. (Chernova, 1961, Fig. 7); the position of this branch is basad of the first medial fork, whereas in *E. martynovae* it lies beyond fork MA. There are some differences between these two species in the first medial field. *E. trisetalis* has two long intermediate veins and two shorter ones. *E. martynovae* has two long ones, another one which is half the length of those, and a fourth which is quite short and marginal. The two characters indicated are further confirmation of the distinctness of these two species.

The genus *Ephemeroptera* is characterized by the branch of the anterior median vein; it is not symmetrical, the posterior branch of media ( $MA_2$ ) extends obliquely downwards, bends and then clearly converges with an intermediate vein. The postmedial field is very broad, with 5-6 intermediate veins, between which there are fairly long marginal veins. Most of the intermediate veins are connected with  $MP_2$ . The branch  $MP_2$  is converged with  $CuA_1$ .  $CuA$  branches and an intermediate vein most probably extends from  $CuA_1$ , giving rise to a looplike fork and beyond it to a series of successive loops, of which *E. trisetalis* has

5 and *E. martynovae* 4 (not 3 as was stated in the previous paper) (Chernova, 1961: 864).  $CuP$  is slightly converged with  $A_1$  near the wing margin.

The hind wing has previously been described and illustrated (Chernova, 1961). It is more than half as long as the fore wing. Twinning of the veins is well expressed.

The fore wing is 43 mm long and 17 mm wide at the level of the median fork.

Material from the collections of the Paleontological Institute, USSR Academy of Sciences, No. 1989/692, positive impression of right fore wing.

Location: Transbaikalia. Buryat ASSR. Sosnovy-Ozernyy District, left bank of the Vitim River, below the mouth of the Baysa River, layer 2, 1961.

**Comment.** Some variability has been noted in the position of the main intermediate vein in the cubital fork. This vein does not always arise some distance away from the branching point, but sometimes directly from the branching point (Fig. 2, b-f).

#### HEXAMEROPSIS Tshernova et Sinitshenkova, gen. n.

**Type-species** *H. scilini* Tshernova et Sinitshenkova, sp. n. The southern Ukraine, (Lower Cretaceous).

The size of this mayfly is practically the same as that of *Hexagenites*. The wing venation is profuse. The fore wing is triangular and the anal margin of the wing is shorter than the terminal margin, as in *Hexagenites*. The longitudinal veins of the wing ( $MA$  and  $CuA_1$ ) are curved in their apical half. Twinning of the veins is apparent in some places, but it is weaker than in *Ephemeroptera* and *Hexagenites*. The fork of  $MA$  on the fore wing is not symmetrical as in *Ephemeroptera*. The post medial field has not been preserved, but it would appear to be not so broad as in *Ephemeroptera*. There are only 3 recurring looplike forks in the cubital field, within each of which there is a crossvein (Fig. 6). The anal veins are weakly curved.

In the hind wing (Fig. 4) the apical portion has been preserved (No. 2990/2) but its length may tentatively be regarded as at least half the length of the fore wing. The crossveins are smaller than in

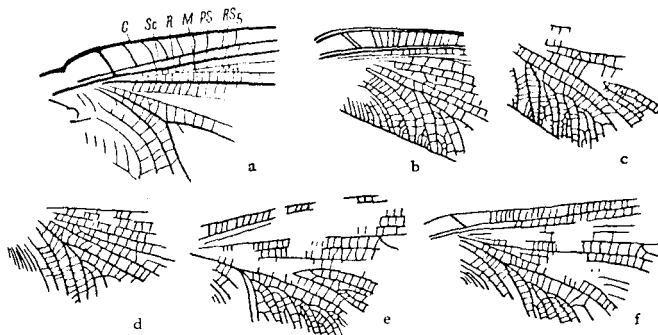


Fig. 2. *Ephemeroptera trisetalis* Eichwald. Basal portion of fore wing.

PIN collection. a—No. 1668/1, Vitim River, Baysa; b—No. 3145/1155, Mongolia, Anda-Khuduk; c—No. 3145/524, Mongolia, Anda-Khuduk; d—No. 3145/306, Mongolia, Anda-Khuduk; e—No. 3145/528, Mongolia, Anda-Khuduk; f—No. 1668/152, Vitim River, Baysa. Upper Jurassic.

*Ephemeroptera*. The fork MA is regular and the medial branches MA<sub>1</sub> and MA<sub>2</sub> diverge uniformly. There are many intermediate marginal veins. (Fig. 7).

*Hexameropsis selini* Tshernova et Sinitshenkova, sp. n.

Two poorly preserved superimposed fore wings (Figs. 6-7). We give separate illustrations of the right and left wings (Fig. 3). The anal margin of the wing is considerably shorter than the terminal margin, by practically one third. CuA<sub>1</sub> emerges at the terminal margin behind the tornus. There are one long intermediate vein and one short one in the fork MA (Fig. 3, a). The loops in the cubital field are gentle; the third loop is wider than the previous one around the wing margin (Fig. 3, b).

Dimensions: Length of fore wing 20.0 mm, width on the level of the median fork 9.0, length of anal margin 9.0, length of terminal margin 13. The length of the incomplete hind wing is 9.0 mm; the total length would be approximately 10 mm.

Material from the collection of the Paleontological Institute, USSR Academy of Sciences. Holotype No. 2990/1, two superimposed fore wings. Paratype No. 2990/2, positive and negative impressions of hind wing, Yu. I. Selin.

**Location:** Ukraine, Cherkasskoye Province, near the town of Smela, on the northwestern slope of the Ukrainian Shield, Rotmistrovka depression, bore 10463, depth 182 m.

**Comment.** We have no doubt that the new genus described belongs to the family Hexagenitidae. The wing has the characteristic fork of CuA and intermediate veins in the cubital field, forming 3 loops. In addition, the hind wing is at least half as long as the fore wing.

The genus described is distinguished from *Ephemeroptera* by lesser size, the considerably shorter anal margin of the wing, the sparser venation, the almost total absence of twinning of the veins and the lesser number of looplike intermediate veins in the

cubital field of the fore wing. The hind wing of *Hexameropsis* is half as long as the fore wing, whereas in *Ephemeroptera* it is clearly more than half as long as the fore wing.

It is distinguished from *Hexagenites* by the irregular shape of the first medial fork, and by the number and nature of the looplike intermediate veins in the cubital field of the fore wing. *Hexagenites* has 4 sharply curved looplike veins, which are clearly to be seen on a photograph of *Hexagenites wayenberghi* Scudder (Demoulin, 1967, Pl. 1, Fig. 2). The twinning of the veins on the terminal margin is better expressed in *Hexagenites* and is clearly to be seen in the cubital field.

*Hexameropsis selini* Tshernova et Sinitshenkova, gen. n., sp. n. is a more progressive form than *Ephemeroptera* and *Hexagenites* (reduction of the hind wing and of the number of loops in the cubital field), which is in good agreement with its discovery in later deposits belonging to the Lower Cretaceous.

#### THE CONNECTION BETWEEN THE FAMILY HEXAGENITIDAE AND THE RECENT EPHEMEROPTERA

The *Hexameropsis* wings here described were collected together with remains of the abdominal segments of nymphs, the gill leaflets of which are similar to those of *Ephemeroptera*.

We ought to emphasize the connection between members of the Hexagenitidae and the Recent Siphonuridae and recall that back in 1961 it was pointed out that the morphoecological type of *Ephemeroptera* nymphs associated with existence in shallows overgrown with vegetation was of a siphonurid habit. This connection is not disputed, but there is some disagreement concerning the relative degree of their affinity (Chernova, 1961: 866). The structure of the body, the legs, the lamellate gills and the strongly pubescent caudal filaments are very similar in the nymphs of the Hexagenitidae and Siphonuridae. *Stackelbergisca sibirica* Tshernova, a member of the Recent family Siphonuridae, has been described from the remains of wings and nymphs from the Middle Jurassic, i. e., from earlier

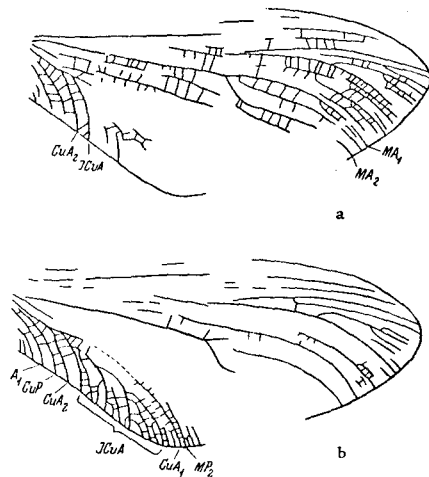


Fig. 3. *Hexameropsis selini* Tshernova et Sinitshenkova, gen.n., sp.n.

a—left fore wing; b—right fore wing. PIN coll., No. 2990/1. Ukraine, Cherkasskoye Province, near the town of Smela, Rotmistrovka depression. Lower Cretaceous.

layers of Jurassic deposits than the finds of members of the Hexagenitidae (Chernova, 1967). The nymphal type of the Siphonuridae and the Hexagenitidae was formed long ago; a proportion of siphonurid nymphs still retain this primitive habit. At the same time members of the Hexagenitidae have distinctive wing venation in the imaginal stage and a relatively large hind wing, while the females have an "ovipositor". These characters indicate the marked specificity of the family Hexagenitidae; we consider that this is a special extinct branch sharing a common origin with the Siphonuridae.

KEY FOR IDENTIFICATION OF GENERA AND SPECIES OF THE FAMILY HEXAGENITIDAE

Imago

- 1 (4). Very large mayflies. Length of fore wing 35-43 mm. Length of fore wing more than 2.5 times its width. Tornus located in the middle of the hind wing, or otherwise the length of the anal margin equals the length of the terminal margin. Twinning of veins strongly expressed. Numerous crossveins and intermediate marginal veins. Late Jurassic (Early Cretaceous?). . *Ephemeropsis* Eichwald.
- 2 (3). Five looplike forks in cubital field. Branching point of  $RS_5 - RS_3$  located toward the base from the first median fork. Apex of hind wing strongly extended. Length of fore wing 40-43 mm. . . . . *E. trisetalis* Eichwald.
- 3 (2). Four looplike forks in cubital field. Branching point  $RS_5 - RS_3$  nearer the wing tip than the first medial fork. Apex of hind wing less extended. Length of fore wing 35 mm. . . . . *E. martynovae* Tshernova.

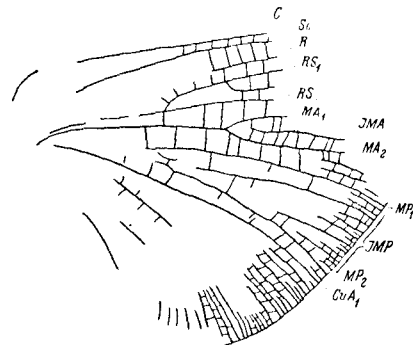


Fig. 4. *Hexameropsis selini* Tshernova et Sinitshenkova, gen.n., sp.n. Hind wing.

PIN coll., No. 2990/2, Ukraine, Cherkasskoye Province, near the town of Smela, Rotmistrovka depression. Lower Cretaceous.

- 4 (1). Mayfly of medium size. Length of fore wing 19-22 mm. Length of fore wing only twice its width. Length of anal margin one third length of entire posterior margin or equal to half length of terminal margin. Twinning of veins weakly expressed. Relatively fewer crossveins.
- 5 (6). Median fork normal,  $MA_1$  and  $MA_2$  uniformly diverging. Twinning of veins forming four looplike forks to be seen in cubital field. Late Jurassic. . . . . *Hexagenites* Scudder.
- 6 (5). Median fork not symmetrical,  $MA_2$  extending from  $MA_1$  obliquely downwards, then perceptibly bending. Twinning of veins not expressed in cubital field. The intermediate veins form three looplike forks, one of which is wider than the others. Early Cretaceous. . . *Hexameropsis* Tshernova et Sinitshenkova, gen. n.

SUMMARY

The article contains a description of a single new genus and species, *Hexameropsis selini* Tshernova et Sinitshenkova, gen. n., sp. n., from the Lower Cretaceous of the southern Ukraine, which is the third genus in the family Hexagenitidae and only the fourth species. A depiction of the complete venation of the fore wing of *Ephemeropsis trisetalis* Eichwald is given for the first time.

It has been concluded on the basis of a comparison of the venation of all three genera of the Hexagenitidae that the new genus *Hexameropsis* is a more progressive form, which is in good agreement with its discovery in later deposits belonging to the Lower Cretaceous.

A key is presented for identification of the genera *Ephemeropsis* Eichw., *Hexagenites* Scud. and *Hexameropsis*, gen. n.

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