A MAYFLY (EPHEMEROPTERA, LEPTOPHLEBIIDAE) FROM FOSSIL RESIN OF CRETACEOUS DEPOSITS IN THE POLAR REGIONS OF SIBERIA

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In 1970 an expedition of the Paleontological Institute, USSR Academy of Sciences, consisting of V. V. Zherikhin and I. D. Dukacheva, collected a large number of specimens of fossil resin (retinite) in the basin of the Khatanga River (Taymyr National District). Among the insects which these specimens contained were several mayflies which were sent to me for identification. These fossil resins, known as 'amber', in which inclusions of mayflies are found, are of Cretaceous age and are known mineralogically as retinites. Inclusions of other insects and mayflies in retinites were not previously known at all in our country. All the pieces are of very small size and only small insects were found in them. Out of a total of nine samples, two were found to contain whole mayflies, and the others contained only separate parts, mainly wings. The seven remains and the two practically whole specimens belong to the Recent family Leptophlebiidae.

LEPTOPHLEBIIDAE

Peters, Edmunds, 1964: 225-253: 1970: 157-240; Chernova, 1970: 136.

A phylogenetic diagram of 29 genera of the Eastern Hemisphere based on an analysis of plesiomorphous and apomorphous structural features is given in the extensive treatments of the family by Peters and Edmunds. These authors have combined the various genera into separate groups, but have not as yet established any supergeneric taxa (tribes or subfamilies).

Given the existing diversity of venation, the greater or lesser development of the hind wing or its complete loss and the very differing structure of the genital appendages and larvae in members of the different genera or their groups, it will probably become necessary to establish and define various other taxa-subfamilies, tribes or subtribes.

When we examined the holotype of Cretoneta zherichini in retinite the first thing which we noted was the similarity of the genital appendages to those of the recently described nymph of Mesoneta (Chernova, 1969: 158), namely similarity in the primitive nature of the styliger.

This and some other considerations which we shall set out below prompted us to place the imago from retinite and the Jurassic Mesoneta nymph in the same group. The imago definitely belongs to the family Leptophlebiidae. Consequently, the family Mesonetidae previously established by the author (Chernova, 1969: 158) should be included in the family Leptophlebiidae as a special extinct subfamily Mesonetinae, which now comprises two genera. The winged stage of the Mesonetinae was previously unknown. It is described below from retinite for the first time.

Subfamily MESONETINAE Tshernova, 1969 (status n.)

Chernova 1969: 158 (Mesonetidae). Demoulin, 1969: 2 (Ametropodidae, Mesonetinae).

Description. Imago ♂. Compound eyes touching on vertex, not divided into two parts; facets on lower, very small part of the eye smaller in size. Ocelli well developed. Pronotum short, with a large notch in middle of posterior margin. Fore wing with weakly expressed tornal spot on posterior margin. Fork MA little more than half the length of basal part of median vein (their ratio 5 : 8). Basal part of MP_2 basally linked to MP_1. Cubital field very narrow; it incorporates only two small intercalary veins unrelated to CuA and one oblique marginal vein (Fig. 1, a). There are very few cross veins in the cubital field. CuP is curved, A_1 is practically straight. Hind wing well developed, with many longitudinal veins and cross-veins, which are not apparent in the holotype. Costal margin with a very small projection; its anterior margin was apparently coupled to the anal margin of the hind wing, since these margins are correspondingly folded. The styliger consists of two large, weakly fused parts. Paracercus short.

Nymph. Small head with slightly elongated anterior margin. Thorax very short, 1/3 length of abdomen. Metathorax especially short, half length of 1st abdominal segment. Legs short and narrow, femora of all legs longer than tibiae, tibiae of same length as tarsi (excluding claw). Abdomen with short, broad segments. Seven pairs of short leaf-like solitary gills without noticeable tracheation and with slightly thickened anterior margins, located along the sides of the abdomen. Rudiments of genital appendages of ♂ nymph with segmented styliger and two lobes of penis projecting far beyond styliger. Three densely pubescent caudal filaments, their length less than half that of the body. Cerci pubescent on inner side, paracercus pubescent on both sides.

There are two genera in the subfamily: Mesoneta Br., Redt., Gangl., known only from a nymph from the Upper Lias of Siberia, and the new genus described from the winged stage from the Upper Cretaceous (Coniacian stage) from the polar regions of Siberia.

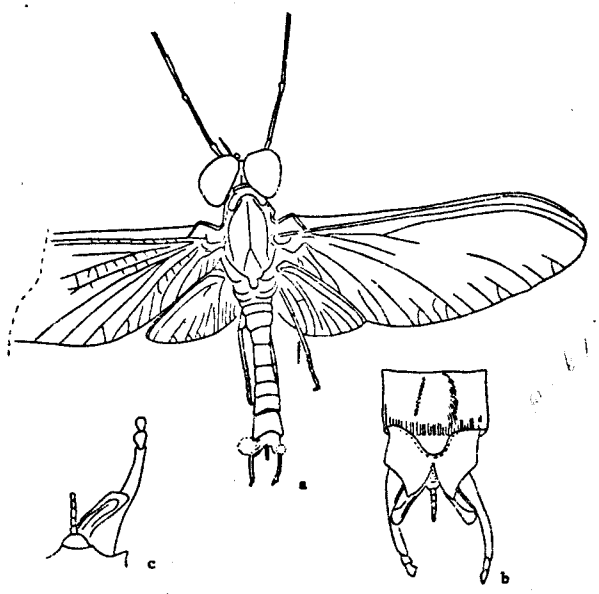

Fig. 1. Cretoneta zherichini Tshernova, gen. n., sp. n. ♂. a) General appearance of the fossil, b) genital appendages from below, c) paracercus and right part of genital appendages from above. Coll. PIN (Paleont. Inst.), No. 3130/4, Yantardakh on the Kheta River, Khatanga River basin, Taymyr National District, Upper Cretaceous.

The subfamily is distinguished from other members of the Leptophlebiidae (subfamily Leptophlebiinae) by the narrow cubital field and by the eyes of the male, which are not divided into two parts.

CRETONETA O. Tshernova, gen. n.

Type-species. C. zherichini Tshernova, sp. n.

Imago ♂. Compound eyes longer than broad when seen from above. Scutellum very large, round, appearing flat and sharply protruding.* Cross-veins plentiful on the fore wing; they are evidently present in the costal field and in the fields of the radial sector, and are merely not apparent, but should be there. In the fork of the median vein MA_1 is strongly curved; IMP and MP_2 are linked to MP_1 at a single point near the wing base (Fig. 2). On the hind wing (Figs. 3 and 4) in the female a weak projection of the costal margin is to be seen. Fore legs long, their preserved basal part more than half the length of the body. Tarsi of hind legs 4-segmented. Lobes of penis projecting far beyond margin of styliger, diverging sideways, their common base not apparent. Genital forceps 3-segmented with a long, thin basal segment and two small terminal segments (Fig. 1, b and c). Cerci not preserved.

The nymph is unknown. The species is sharply distinguished from Mesoneta by its smaller size. Other differences cannot be noted until data have been obtained on the structure of the imago of Mesoneta.

Cretoneta zherichini Tshernova, sp. n.

Holotype No. 3130/4, Taymyr National District, Yantardakh on the Maymecha River, a tributary of the Kheta River, which flows into the Khatanga River basin, collection of V. V. Zherikhin and I. D. Sukacheva, 1970. Polar regions of Siberia, entire insect without cerci.

Imago ♂. Length ratio of femur of fore leg to tibia 13.0 : 11.0 and correspondingly, length of 1st tarsal segment 10.0. Length ratio of parts of hind leg: femur 10.0, tibia 10.5, tarsus 8.5 (tarsal segments: 2.0, 1.5, 1.3, 2.5, claw 1.0). Basal segment of genital forceps slender, very weakly broadened basally, more than 3 times as long as the last 2 segments combined. Lobes of penis uniformly dilated, with a blunt distal end from which an indistinct process extends upward. Paracercus consisting of 5-6 segments. Eyes dark amber in color, slightly transparent (they may possibly have been cleared by the resin and have lost their natural color). Occiput, entire thorax and 1st abdominal segment dark brownish, shiny. A narrow light stripe extending along the median line of the mesonotum terminates before the scutellum in a small light expansion. Scutellum practically black. Wing membrane transparent, all veins light and poorly apparent. Legs entirely light and transparent; only femora of fore legs not transparent, light cinnamon-brown. Abdomen transparent from 2nd to 7th segments, 8th-9th tergites brownish. Genital forceps and paracercus light. Mesosternum dark brownish, apical sternites of abdomen brown, all remaining sternites light.

Body 4.5 mm long, wing 4 mm.

Imago ♀. Allotype No. 3130/11, poorly preserved body. The insect is trapped in a drop of resin. Only the venation on the posterior half of the left wing is well indicated (on a small chipped fragment). To judge by the size of the body and by the venation, by the characteristic narrow cubital field, the female apparently belongs to the same genus and species as the male. However, there are the following differences: wing broader than in male, tornus

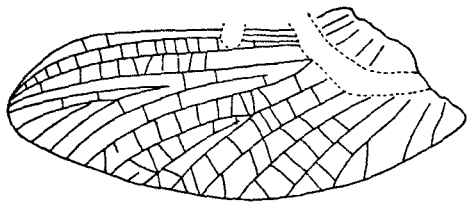

Fig. 2. Cretoneta zherichini Tshernova, gen. n., sp. n., fore wing with crumpled basal part. Coll. PIN (Paleont. Inst.), No. 3130/5, Yantardakh on the Kheta River, Khatanga River basin, Taymyr National District, Upper Cretaceous.

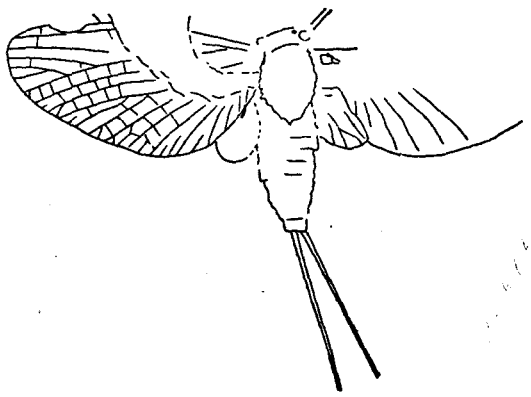

Fig. 3. Cretoneta zherichini Tshernova, gen. n., sp. n., ♀. Coll. PIN (Paleont. Inst.), No. 3130/11, Yantardakh on the Kheta River, Khatanga River basin, Taymyr National District, Upper Cretaceous.

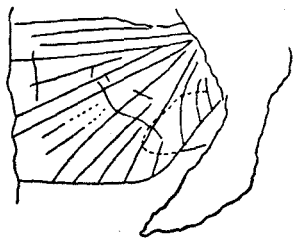

Fig. 4. Cretoneta zherichini Tshernova, gen. n., sp. n., basal part of fore wing. Coll. PIN (Paleont. Inst.), No. 3130/12, Yantardakh on the Kheta River, Khatanga River basin, Taymyr National District, Upper Cretaceous.

weakly expressed. It is possible that the shape of the wing has not been accurately conveyed, since it does not lie in a single plane. Hind wings crumpled, abdomen lacking distinct contours. Two caudal filaments (Fig. 3).

Body 3 mm long, wing 4 mm, length of incomplete cerci 3 mm.

In addition to the allotype there is another ♀ No. 3130/12 lacking distinct body contours and with the basal part of the wing preserved, shown in Fig. 4. In both females only one intercalary vein is to be seen in the cubital field.

Material. In addition to the holotype ♂ and allotype ♀, the following finds were made in the same locality: No. 3130/5, a wing with crumpled basal part; No. 3130/6 poorly preserved abdomen with two fore wings and one crumpled hind wing; No. 3130/7, fore wing, torn in the middle; No. 3130/8, several poorly preserved abdominal segments; No.

*The scutellum of the only known species of this genus differs sharply from that of the following genera: in Chorotepes the scutellum is sharply acuminate, in Habrophlebia it is small, rounded and convex upward, in Paraleptophlebia and Leptophlebia it is smaller, although rounded, and does not protrude to the same extent.

3130/9, head of male and fore leg; No. 3130/10, poorly preserved head of female with right fore wing; No. 3130/12, basal part of fore wing (cross veins not apparent) and contour of hind wing.

The species has been named after the paleoentomologist V. V. Zherikhin who has collected Cretaceous insects in retinite in the polar regions of the Urals.

It is a far more complicated matter to make a systematic evaluation of a fossil form than of a Recent form, since mayflies are only partly preserved in the fossil state (for example, the mouthparts, which are extremely important for systematics, are not preserved in nymphs). It is for this reason that descriptions of fossils are always briefer than those of Recent insects. Furthermore, finds of additional material in better condition may supplement our knowledge and make it possible to establish new relationships and to alter the position of the taxon in the system. This was the situation with the genus Mesoneta of which Demoulin wrote (Demoulin, 1969: 1); the same applied to species of the Hexagenetidae and Paedephemeridae from the Solenhofen shales. Repeated investigation of the type material of these Jurassic mayflies has resulted in modification of views on their taxonomic composition, reduction of the number of species and genera and even suppression of the family (Demoulin, 1970: 6-7).

It is quite in order to make changes in the systematics of fossil remains when they are further investigated and close attention should be paid to such changes.

No proof is needed that the mayflies from retinite belong to the family Leptophlebiidae: ample evidence is provided by the description and the illustrations. All that may be foreseen is objection to the establishment of the special subfamily; and, in particular, care must be taken to remove doubt concerning the connection between the imago described and the nymph of Mesoneta and to demonstrate this connection.

Before the Mesonetinae were distinguished as a special subfamily and placed in the family Leptophlebiidae many publications on this family in all zoogeographic regions were consulted (Demoulin, 1968: 263-270, Needham, Traver and Hsu, 1935: 504-555 and many others*). Although the veins in the cubital field of the fore wing are developed to varying degrees in the numerous genera of the family, the cubital field remains broad in all without exception, whereas in Cretoneta it is very narrow; no other species of the Leptophlebiidae has such a cubital field. At the same time the remaining venation does not have any particular specific features. A small number of cross veins in the cubital field is found among many genera of the Recent Leptophlebiidae.

With regard to the nymphs of Mesoneta, I am even more convinced than before that these nymphs are completely unrelated to the genus Ametropus, although Demoulin adheres to his former opinion and places Mesoneta in the family Ametropodidae (Demoulin, 1969: 2). Mesoneta does not have long claws or strongly shortened tibiae, or eyes located on the anterior margin of the head, as in Ametropus. Furthermore, before Cretoneta had been found I had noted the similarity between the rudiments of the genital appendages and those of the Leptophlebiidae. Demoulin considers this unimportant and not of phylogenetic significance. I consider it impossible to ignore the fact that there is similarity in the rudiments of the genital appendages between the Mesoneta nymph and the Leptophlebiidae. I am well acquainted with the nymph and the imago of Ametropus, which is a genus rare in Western Europe and of which I have many specimens, and I am unable to see any similarity between them and Mesoneta. I doubt whether Dr. Demoulin has been able fully to study the structure of the genus Ametropus.

The solitary leaf-like gills of Mesoneta are not a character which can hinder the placing of this genus in the family Leptophlebiidae. The first gill filament is solitary and leaf-like in members of the Ethiopian genus Adenophlebioides (Peters and Edmunds, 1964, Fig. 124; Peters and Edmunds, 1970, Fig. 298). This filament is 'elytroid', it covers the converged gills of other segments. Admittedly, there are no general links between this extremely specialized African genus and Mesoneta. What is important is that solitary gill plates are found in the Leptophlebiidae, even if exceptionally. Furthermore, in Adenophlebioides sp. the posterolateral angles of the 6th-9th segments are drawn out into mucrones (Peters and Edmunds, 1970, Fig. 3).

Let me now set out the arguments on the basis of which I related the imago of Cretoneta to the nymph of Mesoneta. Among the Recent genera of the Leptophlebiidae there are some forms with a divided styliger. The structure of the styliger of the Mesoneta larva, which has a plate that is not completely fused, is similar to the styliger of Cretoneta, on which a deep incision is developed. To demonstrate this convincingly I give illustrations of the rudiments of the genital appendages of the nymph and imago of Leptophlebia vespertina (L.) (Fig. 5, a, and 5, b) from which it is apparent that the plate of the styliger is notched in the nymph, as in the imago. In addition to the styliger, the lobes of the penis, which project beyond the margin, diverge sideways and are devoid of teeth, are similar in Cretoneta and Mesoneta.

Furthermore, the imago of Cretoneta and the nymph of Mesoneta are closer in geological age than the mayfly from retinite to Recent mayflies. Approximately 70-80 million years elapsed between the Coniacian stage of the Upper Cretaceous and the Upper Lias, and 100 million years between the Upper Cretaceous and the Cenozoic. This is also an additional argument in favor of converging the new form with the nymph of Mesoneta.

In conclusion I should like also to reply to the criticism of Demoulin, in the same article in which he writes of Mesoneta (Demoulin, 1969: 4), concerning Epeoromimus beybienkoi Tshern. which he places in the family Baetidae. The drawing of the rudiments of the hind wings indicates clearly that the hind wing is at all events at least half as long as the fore wing, and this is not a distortion due to fossilization (in that case the adjacent rudiments of the anterior wings would also be modified) and it is not an error in preparation of the illustration, since an illustration is prepared in the following manner: the contours of the future outline are touched up on a large pale photograph of the stone and as this is being done the specimen is examined under a binocular microscope. The illustration is then transferred to tracing paper and subsequently to paper. Dr. Demoulin bases his conclusions on the poor quality of the photograph in my article and regards the illustration as inaccurate. I believe that the nymph of E. beybienkoi does not belong to the family Baetidae. Another reason for not placing it there is that the head is directed forward, which is never the case in the Baetidae.

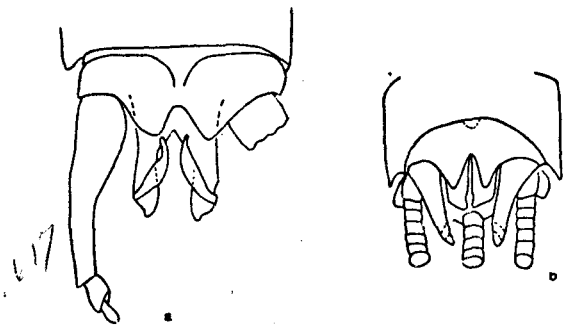

Fig. 5. Leptophlebia vespertina (L.). a) Genital appendages of ♂ imago, b) rudiments of nymphal genital appendages. Moscow Province, Chashnikovo.

*I am deeply indebted to Professor J. Traver, W. L. Peters, G. F. Edmunds, G. Demoulin and many other ephemeropterologists who have regularly sent me their publications essential to my research.

SUMMARY

The article contains a description of one new genus and species from fossil resin (retinite) of Cretaceous age from the polar regions of Siberia. The new genus and species Cretoneta zherichini are placed together with the Jurassic nymph Mesoneta Br., Redt., Gangl. in the family Leptophlebiidae, in the subfamily Mesonetinae (status n.).

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