

Fig. 1. Stonefly wings of the family Palaeonemouridae: (a) *Palaeotaeniopteryx perlonga* sp. nov., forewing fragment, holotype PIN, no. 3700/78, Novo-Aleksandrovka locality; (b) *P. distalis* sp. nov., wing fragment, holotype PIN, no. 3700/74, Novo-Aleksandrovka locality; (c) *Palaeonemoura proximalis* sp. nov., forewing fragment, holotype PIN, no. 3286/7, Chepanikha locality; (d) *P. furcata* sp. nov., forewing, holotype PIN, no. 3695/4, Galevo locality; (e) *P. lepida* sp. nov., forewing fragment, holotype PIN, no. 3700/87, Novo-Aleksandrovka locality. Scale bars 2 mm in all figures.

Explanation of Plate 9

- Fig. 1.** *Palaeotaeniopteryx perlonga* Sinitshenkova, sp. nov., holotype PIN, no. 3700/78, Novo-Aleksandrovka locality, $\times 19.5$.
Fig. 2. *Palaeonemoura furcata* Sinitshenkova, sp. nov., holotype PIN, no. 3695/4, Galevo locality, $\times 10$.
Fig. 3. *Palaeonemoura lepida* Sinitshenkova, sp. nov., holotype PIN, no. 3700/87, Novo-Aleksandrovka locality, $\times 12$.
Fig. 4. *Palaeonemoura petaloidea* Sinitshenkova, sp. nov., holotype PIN, no. 3700/73, Novo-Aleksandrovka locality, $\times 14.5$.
Fig. 5. *Palaeonemoura apicalis* Sinitshenkova, sp. nov., holotype PIN, no. 3700/93, Novo-Aleksandrovka locality, $\times 10$.
Fig. 6. *Palaeonemoura remota* Sinitshenkova, sp. nov., holotype PIN, no. 3700/84, Novo-Aleksandrovka locality, $\times 12$.
Fig. 7. *Palaeonemourisca novojilovi* Sinitshenkova, gen. sp. nov., holotype PIN, no. 4991/1, Prokoshevo locality, $\times 11$.

Palaeonemoura lepida Sinitshenkova, sp. nov.

Plate 9, fig. 3

E t y m o l o g y. From Latin *lepidus* (elegant).

H o l o t y p e. PIN, no. 3700/87, part and counterpart of forewing fragment; Novo-Aleksandrovka locality; Upper Permian, Upper Tatarian.

D e s c r i p t i o n (Fig. 1e). Imago. The forewings are narrow; the costal field is wide; c–sc is very long and enters C very proximad of the tip of SC, which enters R proximad of r–rs. There is one crossvein in the pterostigmal field; crossveins are absent in the costal field. The RS fork is narrow and long, nearly six times as long as the RS stalk; rs–m is situated slightly distad of r–rs.

M e a s u r e m e n t s, mm. Forewing fragment length in holotype, 8, full length, about 10; forewing fragment length in paratype, 12.8, full length, about 13.

C o m p a r i s o n. It clearly differs from all other species in its larger size and narrower wings. *P. lepida* sp. nov. is similar to *P. zwicki* in having a very long c–sc entering C very distad of the SC tip; however, it clearly differs from the latter species in the absence of crossveins from the costal field.

M a t e r i a l. In addition to the holotype, paratype PIN, no. 3700/72, part and counterpart of forewing fragment from the same locality.

Palaeonemoura petaloidea Sinitshenkova, sp. nov.

Plate 9, fig. 4

E t y m o l o g y. From Latin *petaloideus* (petal-like).

H o l o t y p e. PIN, no. 3700/73, part and counterpart of fore- and hindwings; Novo-Aleksandrovka locality; Upper Permian, Upper Tatarian.

D e s c r i p t i o n (Fig. 2a). Imago. The forewing is slightly longer and wider than the hindwing; it is wide in its apical third and 2.6 times as long as its maximum width. In the forewing, c–sc is short and enters C proximad of the tip of SC, which enters R at the level of r–rs. The pterostigma is darkened and has one long crossvein; crossveins are absent from the costal field. The RS stalk is very short, five times shorter than the fork. The only rs–m starts from R at the level of r–rs and enters MA distad of M fork. Crossveins r–rs and rs–m form a nearly straight line. M branches approximately at the wing midlength; CuA branches very proximad of the RS fork and distad of the M fork. CuP enters the wing margin distad of the M fork.

M e a s u r e m e n t s, mm. Forewing length, 6.5, maximum width, 2.5; hindwing fragment length, 5.2, full length; about 6.

C o m p a r i s o n. It clearly differs from other species in its forewing being widened in its apical third, very short RS stalk, and r–rs and rs–m arranged in a straight line.

M a t e r i a l. Holotype.

Palaeonemoura duplicata Sinitshenkova, sp. nov.

E t y m o l o g y. From Latin *duplicatus* (duplicate).

H o l o t y p e. PIN, no. 3700/80, part and counterpart of a small fragment of the forewing; Novo-Aleksandrovka locality; Upper Permian, Upper Tatarian.

D e s c r i p t i o n (Fig. 2b). Imago. In the forewing, the SC tip enters R at the level of distal r–rs. The RS fork is 2.7 times as long as its stalk, and the only rs–m starts from R proximad of r–rs. M branches slightly basad of rs–m.

M e a s u r e m e n t s, mm. Forewing fragment length, 4; full length, about 8.

C o m p a r i s o n. In SC entering R at the level of r–rs and in its size, *P. duplicata* sp. nov. is similar to *P. petaloidea* sp. nov. and *P. riparia* sp. nov., from which it clearly differs in rs–m appearing very proximad of r–rs.

M a t e r i a l. In addition to the holotype, paratype PIN, no. 3700/91, part and counterpart of forewing fragment from the same locality.

Palaeonemoura riparia Sinitshenkova, sp. nov.

E t y m o l o g y. From Latin *riparius* (coastal).

H o l o t y p e. PIN, no. 3700/88, part and counterpart of forewing without its base; Novo-Aleksandrovka locality; Upper Permian, Upper Tatarian.

D e s c r i p t i o n (Fig. 2c). Imago. In the forewing, c–sc is short and enters C slightly proximad of the SC tip, which enters R at the level of r–rs. The RS fork is almost twice as long as its stalk. The only rs–m enters MA distad of the M fork. Crossveins r–rs and rs–m form a nearly straight line. The pterostigma is darkened and has one long crossvein; there is at least one crossvein in the costal field. CuA branches almost at the level of the M fork.

M e a s u r e m e n t s, mm. Forewing fragment length, 8.1; full length, about 9.

C o m p a r i s o n. *P. riparia* sp. nov. is similar to *P. petaloidea* sp. nov. in the position of c–sc in relation to the SC tip, SC entering R at the level of r–rs as well as r–rs and rs–m arranged in almost a straight line. However, *P. riparia* sp. nov. differs in its larger size, longer RS stalk, and CuA branching much proximally. The latter character distinguishes *P. riparia* sp. nov. from other known species of *Palaeonemoura*.

M a t e r i a l. Holotype.

Palaeonemoura apicalis Sinitshenkova, sp. nov.

Plate 9, fig. 5

E t y m o l o g y. From Latin *apicalis* (apical).

H o l o t y p e. PIN, no. 3700/93, positive impression of a nearly complete forewing; Novo-Aleksandrovka locality; Upper Permian, Upper Tatarian.

D e s c r i p t i o n (Fig. 2d). Imago. In the forewing, c–sc is short and enters C proximad of the SC tip, which enters R slightly distad of r–rs. The pterostigma is dark-

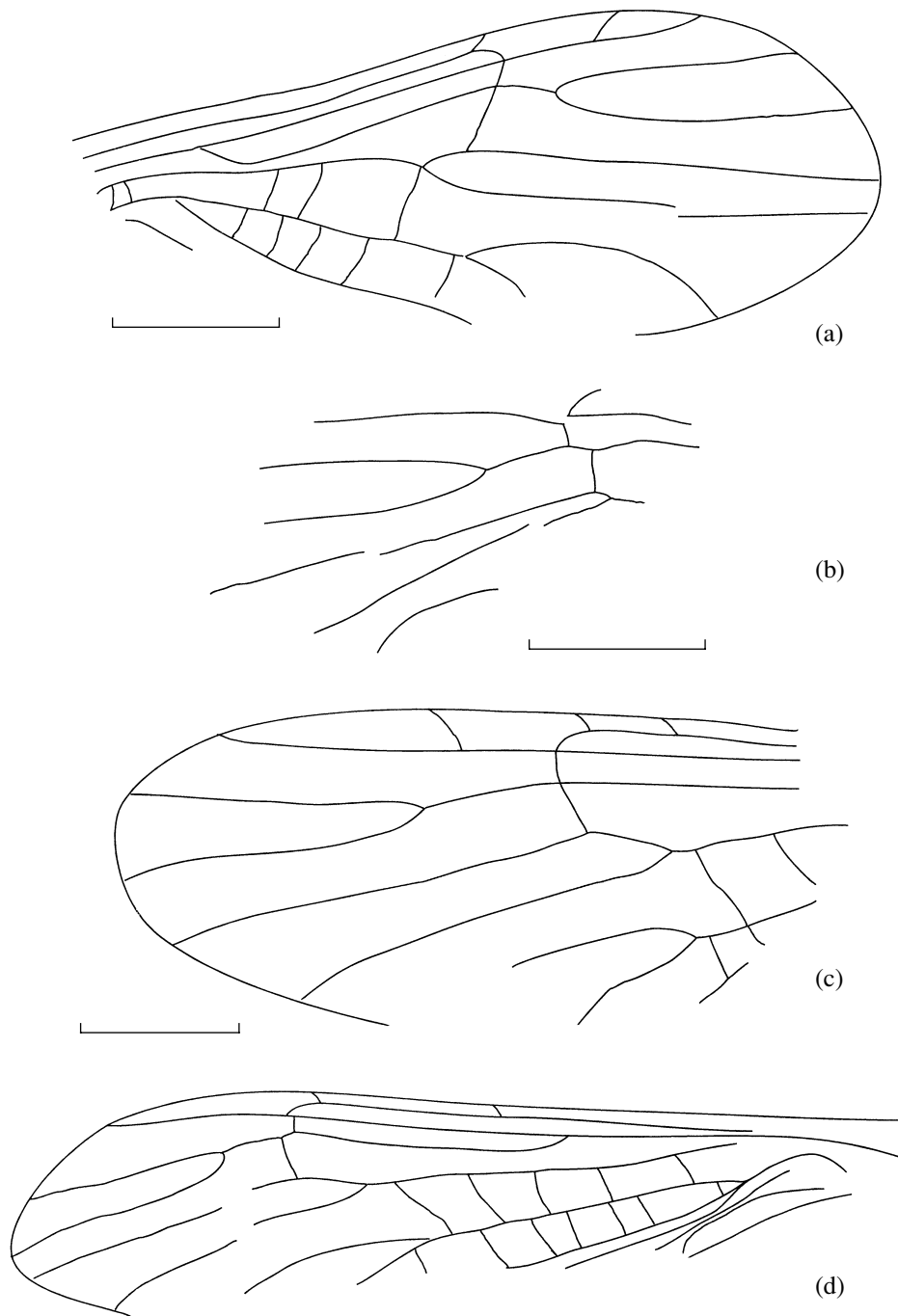


Fig. 2. Stonefly forewings of the genus *Palaeonemoura* from the locality of Novo-Aleksandrovka: (a) *P. petaloidea* sp. nov., holotype PIN, no. 3700/73, (b) *P. duplicata* sp. nov., forewing fragment, holotype PIN, no. 3700/80, (c) *P. riparia* sp. nov., forewing fragment, holotype PIN, no. 3700/88, (d) *P. apicalis* sp. nov., holotype PIN, no. 3700/93.

ened and devoid of any crossveins; there is at least one crossvein in the costal field. RS starts from R slightly basad of the wing midlength. The RS fork is almost 1.5 times as long as its stalk, the only rs-m starts from RS distal of r-rs and enters MA very distad of the M fork, which is situated quite beyond the wing midlength. Crossveins r-rs and rs-m appear in the api-

cal third of the wing. There are six crossveins between M and CuA; not less than four crossveins are developed between CuA and CuP.

Measurements, mm. Forewing length, 9.5.

Comparison. It sharply differs from other species in the distal position of the RS and M forks and in rs-m being developed distad of r-rs.

Remarks. The position of SC distad of r-rs was earlier indicated as a characteristic feature of the genus *Palaeotaeniopteryx* (Sinitshenkova, 1987). The examination of a vast amount of material from Novo-Aleksandrovka prompts the revision and broadening of generic diagnoses. The presence of a long RS stalk, which is longer than its fork, remains a distinctive feature of *Palaeotaeniopteryx*. Taking into account the considerable variability of stonefly wing venation, the position of SC proximad of r-rs as well as at the level or slightly distad of r-rs should be added to the diagnosis of the genus *Palaeonemoura*.

Material. In addition to the holotype, paratype PIN, no. 3700/95, positive impression of a forewing fragment from the same locality.

Palaeonemoura remota Sinitshenkova, sp. nov.

Plate 9, fig. 6

Etymology. From Latin *remotus* (remote).

Holotype. PIN, no. 3700/84, part and counterpart of a nearly complete forewing; Novo-Aleksandrovka locality; Upper Permian, Upper Tatarian.

Description (Fig. 3a). Imago. In the forewing, c-sc is short and enters C at the level of the SC tip, which enters R slightly distad of r-rs. The pterostigma is darkened and has one long crossvein; the costal field is free of crossveins. The RS fork is twice as long as its stalk; rs-m starts from RS proximad of r-rs and enters MA noticeably distad of the M fork. Crossveins r-rs and rs-m are situated slightly distad of the wing midlength. The only rs-m starts from RS proximad of r-rs and distad of the point of M branching. CuA bifurcates considerably distad of the M fork, CuP enters the posterior margin of the wing noticeably distad of the M fork. There are not less than seven crossveins between M and CuA, and not less than four between CuA and CuP.

Measurements, mm. Forewing fragment length, 8; its full length, about 9.

Comparison. In the position of SC distad of r-rs, *P. remota* sp. nov. gets closer to *P. apicalis* sp. nov.; only these two species of *Palaeonemoura* possess this feature. *P. remota* sp. nov. differs well from *P. apicalis* sp. nov. in rs-m situating proximad of r-rs.

Material. In addition to the holotype, paratypes PIN, no. 3700/85 and 3700/77, parts and counterparts of forewing fragments from the same locality.

Palaeonemoura abdita Sinitshenkova, sp. nov.

Etymology. From Latin *abditus* (hidden).

Holotype. PIN, no. 3695/5, positive impression of a well-preserved fragment of the anterior margin of forewing; Udmurtiya, the Kama River right bank cliff, 6.4 km downstream of Galevo pier, near triangulation sign 168.6; Upper Permian, Lower Tatarian.

Description (Fig. 3b). Imago. In the forewing, c-sc enters C noticeably proximad of the SC tip, which enters R proximad of r-rs; there is a distinct crossvein in the pterostigmal field and two additional crossveins in the costal field. The RS stalk is short, less than one-third of the fork. The only rs-m starts from RS proximad of r-rs.

Measurements, mm. Forewing fragment length, 8; its full length, about 11–12.

Comparison. In the relative position of the SC tip, r-rs, and rs-m, *P. abdita* sp. nov. is close to *P. lepida* sp. nov., from which it clearly differs in the proximal position of c-sc and in the presence of two crossveins in the costal field.

Material. Holotype.

Genus *Palaeonemourisca* Sinitshenkova, gen. nov.

Etymology. From the genus *Palaeonemoura*.

Type species. *P. novojilovi* sp. nov.

Diagnosis. Imago. In the forewing, SC enters R slightly distad of r-rs; additional crossveins present in costal field. Pterostigma darkened, lacking crossveins or having one crossvein. RS three-branched, RS stalk short, almost three times as short as the RS fork. M branches very proximad of r-rs, additional rs-m absent, CuA two-branched, CuP simple, two anal veins straight and long and nearly parallel to CuP and anal margin of wing.

Species composition. Two new species.

Comparison. It clearly differs from *Palaeonemoura* and *Palaeotaeniopteryx* (winged stages are known only for these genera of the family) in the three-branched RS.

Palaeonemourisca novojilovi Sinitshenkova, sp. nov.

Plate 9, fig. 7

Etymology. In the memory of N.I. Novojilov, a paleontologist who collected fossil insects in Permian deposits of Udmurtiya.

Holotype. PIN, no. 4991/1, part and counterpart of very well preserved nearly complete forewing; Udmurtiya, the village of Prokoshevo, borehole 9, depth 4.6–4.8 m; Upper Permian, Lower Tatarian.

Description (Fig. 3c). Imago. In the forewing, c-sc is short and enters C slightly proximad of the SC tip; the apical third of SC is situated noticeably closer to the costal margin of the wing rather than to R. The pterostigma is colored, the color pattern is distributed along R up to the SC tip; the RS and MA branches are bordered with the color pattern from the wing apex to rs-m. The pterostigmal field is free of crossveins. RS is three-branched, its anterior branch bifurcates approximately at the midlength, a short crossvein links the anterior branch of RS and R near the tip. The M branches are slightly curved; the only rs-m enters RS at the level of r-rs. CuA branches slightly basad of M;

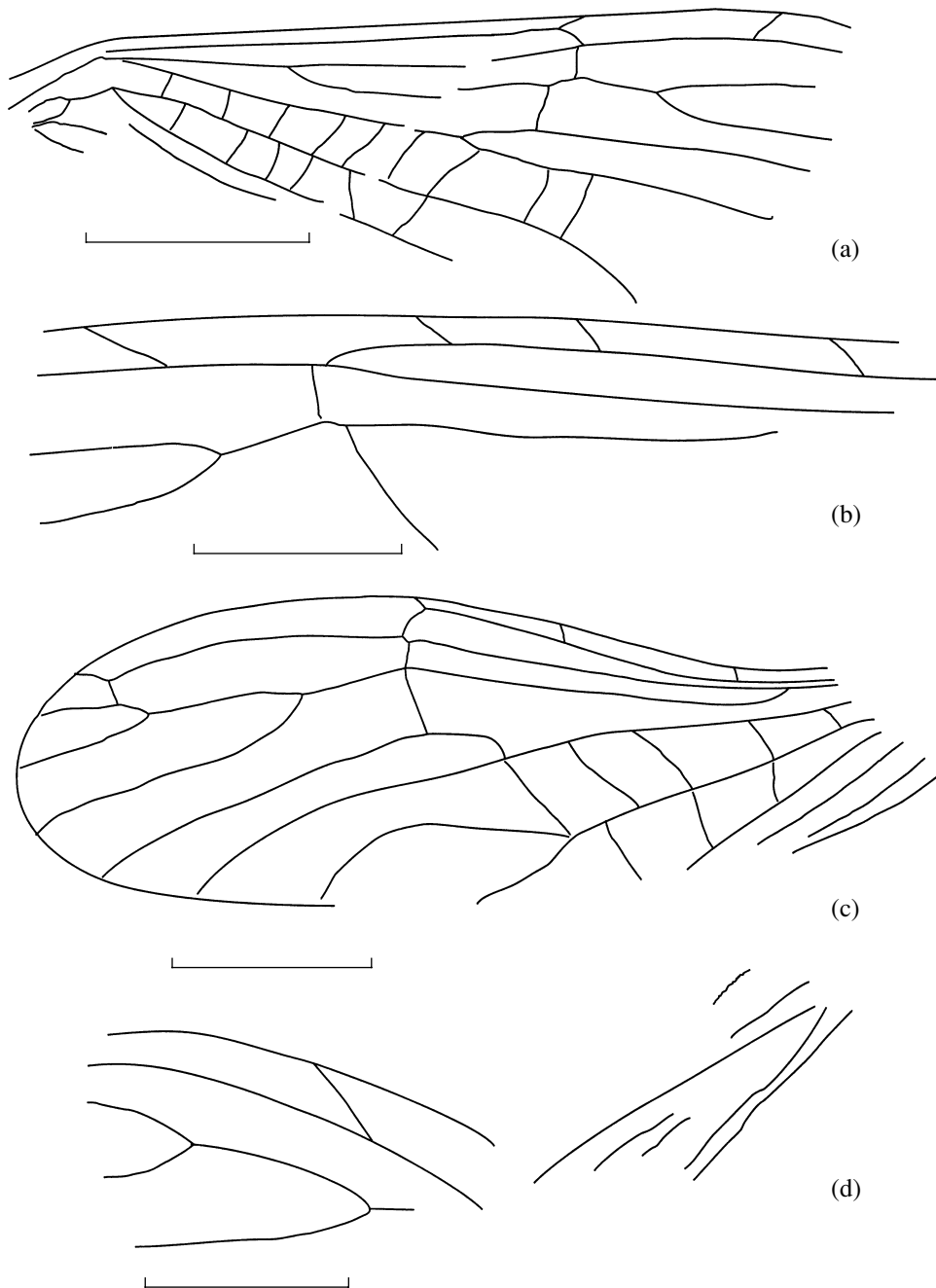


Fig. 3. Stonefly wings of the family Palaeonemouridae: (a) *Palaeonemoura remota* sp. nov., forewing fragment, holotype PIN, no. 3700/84, Novo-Aleksandrovka locality; (b) *P. abdita* sp. nov., forewing fragment, holotype PIN, no. 3695/5, Galevo locality; (c) *Palaeonemourisca novojilovi* gen. et sp. nov., forewing, holotype PIN, no. 4991/1, Prokoshevo locality; (d) *P. subita* sp. nov., wing fragment, holotype PIN, no. 3700/71, Novo-Aleksandrovka locality.

there are seven crossveins between M and CuA, other crossveins (one or two) are linking the posterior branch of M with the arched anterior branch of CuA; there are also seven crossveins between CuA and CuP.

Measurements, mm. Forewing fragment length, 9.5; its full length, about 11.

Material. Holotype.

Palaeonemourisca subita Sinitshenkova, sp. nov.

Etymology. From Latin *subitus* (unexpected).

Holotype. PIN, no. 3700/71, part and counterpart of a forewing fragment; Novo-Aleksandrovka locality; Upper Permian, Upper Tatarian.

Description (Fig. 3d). Imago. There is one thin, long crossvein in the pterostigmal field. The RS branches are slightly downcurved basally.

Measurements, mm. Wing fragment length, 8; its full length, about 11.

Comparison. It clearly differs from the type species in the presence of a crossvein in the pterostigmal field.

Remarks. In spite of the presence of only a small wing fragment, its description is quite sensible, since a distinct three-branched RS occurs very rarely in representatives of the Palaeonemouridae.

Identification key to stonefly wings of the family Palaeonemouridae

- 1(4) RS three-branched.....*Palaeonemourisca* gen. nov.
 2(3) One thin and long crossvein in pterostigmal field. Wing length, about 11 mm.....*P. subita* sp. nov.
 3(2) Pterostigmal field free of crossveins. Wing length, about 13 mm.....*P. novojilovi* sp. nov.
 4(1) RS two-branched.
 5(10) RS stalk considerably longer than its fork.....
*Palaeotaeniopteryx* Sharov, 1961
 6(7) SC entering R noticeably distad of r-rs. Wing length, about 7 mm.....*P. distalis* sp. nov.
 7(6) SC entering R almost at level noticeably proximad of r-rs.
 8(9) SC entering R almost at level of r-rs. Wing length, about 6.5 mm.....*P. elegans* Sharov., 1961
 9(8) SC entering R noticeably proximad of r-rs. Wing length, about 6 mm.....*P. perlonga* sp. nov.
 10(5) RS stalk considerably shorter than its fork.....
*Palaeonemoura* Sharov, 1961
 11(22) SC entering R proximad of r-rs.
 12(17) Crossvein(s) present in pterostigmal field.
 13(14) Two crossveins in pterostigmal field, c-sc long. Wing length, 9–10 mm.....*P. zwicki* Sinitsh., 1987
 14(13) One crossvein in pterostigmal field.
 15(16) c-sc very long and entering C very distad of SC tip. Wing length, about 13 mm.....*P. lepida* sp. nov.
 16(15) c-sc short and entering C proximad of SC tip. Wing length, 11–12 mm.....*P. abdita* sp. nov.
 17(12) Pterostigmal field free of crossveins.
 18(19) Two transverse rs-m present. Wing length, 8.4 mm.....
*P. altaica* Sharov, 1961
 19(18) Only one transverse rs-m present.
 20(21) r-rs and rs-m arranged in one line. Wing length, 8.3 mm.....
*P. clara* Sharov, 1961
 21(20) rs-m situated proximad of r-rs. Wing length, 8.3 mm.....
*P. proximalis* sp. nov.
 22(11) SC entering R distad or at level of r-rs.
 23(24) Two rs-m present, two crossveins developed near wing apex. Wing length, about 5.5 mm.....*P. finitima* Sinitsh., 1992

24(23) Only one rs-m present, one crossvein developed in pterostigmal field.

25(28) SC entering R distad of r-rs.

26(27) Additional crossveins developed in costal field, rs-m situated distad of r-rs, c-sc entering C proximad of SC tip. Wing length, 9.2 mm.....*P. apicalis* sp. nov.

27(26) Costal field free of additional crossveins, c-sc entering C at level of SC tip. Wing length, about 9 mm.....
*P. remota* sp. nov.

28(25) SC entering R at level of r-rs.

29(32) Transverse r-rs and rs-m arranged in a line.

30(31) CuA branching almost at level of M fork; additional crossveins developed in costal field. Wing length, about 8 mm.....
*P. riparia* sp. nov.

31(30) CuA branching distad of M fork; costal field free of additional crossveins; forewing broadened in its apical third. Wing length, 6.5 mm.....*P. petaloidea* sp. nov.

32(29) rs-m situated proximad of r-rs.

33(34) c-sc long, two additional crossveins developed in costal field. Wing length, about 10 mm.....*P. furcata* sp. nov.

34(33) Costal field free of crossveins. Wing length, about 7 mm.....*P. duplicata* sp. nov.

ACKNOWLEDGMENTS

I am grateful to D.E. Shcherbakov (Paleontological Institute, Russian Academy of Sciences) for his help in taking photographs. This work has been supported by the Russian Foundation for Basic Research, project no. 01-04-48925.

REFERENCES

1. A. V. Gomankov, "Flora and Stratigraphy of the Tatarian Stage in the East European Platform," Doctoral Dissertation in Geology and Mineralogy (Geol. Inst. Russian Acad. Sci., Moscow, 2002).
2. A. V. Gomankov and S. V. Meyen, "Tatarinovo Flora," Tr. Geol. Inst. Akad. Nauk SSSR **401**, 1–174 (1986).
3. N. D. Sinitshenkova, "Historical Development of Stoneflies," Tr. Paleontol. Inst. Akad. Nauk SSSR **221**, 1–143 (1987).
4. N. D. Sinitshenkova, "Two New Insect Species (Insecta: Dicytoneyrida-Palaeodictyoptera, Perlida-Plecoptera) from the Late Permian of Southern Mongolia: New Taxa of Fossil Invertebrates of Mongolia," Tr. Sovm. Sov. Mongol. Paleontol. Eksped. **41**, 98–101 (1992).
5. A. G. Sharov, "Order Plecoptera," in *Paleozoic Insects of the Kuznetsk Basin*, Ed. by B. B. Rohdendorf *et al.* (Akad. Nauk SSSR, Moscow, 1961), pp. 225–234 [in Russian].