

Revision of Permosialidae (Insecta: Palaeomanteida) from the Uppermost Lower and Lower Middle Permian of European Russia

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Received September 15, 2022; revised October 25, 2022; accepted October 26, 2022

Abstract—The generic and species composition of Permosialidae (Insecta: Palaeomanteida) from the uppermost Lower and lower Middle Permian of European Russia is discussed. *Permosialis defurcata* Martynova, 1952, *P. brevifurcata* Martynova, 1952, *P. bifasciata* Martynov, 1933, *P. cauleoides* Martynova, 1952, *P. marmorata* Martynova, 1952, *P. immaculata* Martynova, 1952 and *P. fasciata* Martynova, 1952 (all from the Lower Kazanian of Soyana in the Arkhangelsk Region) are synonymized under *P. paucinervis* Martynov, 1928 from the coeval deposits of Tikhie Gory in Tatarstan. *Permosialis quadriramosa* Martynova, 1952 from Soyana is synonymized under *Palaeomantopsis furcatella* Martynov, 1928 from Tikhie Gory. *Palaeomantopsis furcatella*, *Permosialis paucinervis*, *P. perfecta* Martynova, 1952, and *P. latiformis* Martynova, 1952 (the latter two from Soyana) are redescribed. *Permosialis vizzya* sp. nov. from Upper Kungurian of the Vorgashor coal field and *P. martynovae* sp. nov. from Soyana are described as new.

Keywords: Insecta, Palaeomanteida, Permosialidae, Lower and Middle Permian, Russia

DOI: 10.1134/S003103012302003X

INTRODUCTION

This paper deals with the revision of representatives of the family Permosialidae (Insecta: Palaeomanteida) from the upper Lower–lower Middle Permian of European Russia. The family is known from the Permian and Triassic of Eurasia, South Africa, and Australia (Riek, 1968; Novokshonov and Zhuzhgo, 2004; Rasnitsyn and Dijk, 2011; Rasnitsyn and Aristov, 2013). *Permosialis paucinervis*, the first representative of the family Permosialidae, was described by A.V. Martynov in the order Megaloptera (Martynov, 1928). In the same work, another species, *Palaeomantopsis furcatella*, which we also attributed to Permosialidae, was assigned to Miomoptera incertae sedis (Martynov, 1928).

Later, the family Permosialidae was assigned to the order Megaloptera (Martynov, 1933; Martynova, 1952, 1962), to insects of unclear position (Carpenter, 1992), or to order Palaeomanteida (=Miomoptera) (Rasnitsyn, 1980; 2002; Rasnitsyn and Aristov, 2013; Novokshonov and Zhuzhgo, 2004).

With this work, we begin the revision of the family, which is necessary because of contradictions in

its taxonomy, when almost every specimen was initially described as a new species. This was followed by a more measured approach, but the former taxonomy remained in common use and caused chaos in the understanding of genera and species. Certainly, isolated wings comprise the largest part of the material, which, together with impoverished venation, demands a formal approach to the identification of genera and species, and simple and clear diagnoses of taxa.

In doubtful cases, one has to take into account not only the actual wing morphology, but also the origin of the fossil (geography and age); it is assumed that specimens of similar origin are more likely to be conspecific, even despite some morphological differences. Such deviations from the standard paleontological procedure were only permitted when absolutely necessary, when the alternative is the description of individual specimens, rather than what we understand to be species.

In connection with the approach described, it seemed logical to start with some chronological and geographical commonality and, in particular, with the richest and earliest description of the Late Kungurian–Early Kazanian material of the northeast of European Russia, especially since this includes most

[†] Deceased.

of the type specimens, and the taxonomy of the corresponding species is the most confused.

SYSTEMATIC PALEONTOLOGY

Order Palaeomanteida

Family Permosialidae Martynov, 1928

Genus *Permosialis* Martynov, 1928

Permosialis paucinervis Martynov, 1928

Plate 8, figs. 1–9

Permosialis paucinervis: Martynov, 1928, p. 94, pl. 8, figs. 4, 5, pl. 15, fig. 3; Martynova, 1952, p. 229; Carpenter, 1992, p. 501.

Permosialis bifasciata: Martynov, 1933, p. 74, figs. 9; Martynova, 1952, p. 234; 1962, p. 269, text-fig. 843, syn. nov.

Permosialis defurcata: Martynova, 1952, p. 230, text-fig. 25, syn. nov.

Permosialis brevifurcata: Martynova, 1952, c. 230, text-fig. 26, syn. nov.

Permosialis cauleoides: Martynova, 1952, c. 233, text-fig. 29; Novokshonov and Zhuzhgov, 2004, p. 177, syn. nov.

Permosialis marmorata: Martynova, 1952, c. 234, text-fig. 30; Novokshonov and Zhuzhgov, 2004, c. 177, syn. nov.

Permosialis immaculata: Martynova, 1952, c. 235, text-fig. 31; Novokshonov and Zhuzhgov, 2004, p. 177, syn. nov.

Permosialis fasciata: Martynova, 1952, p. 236, text-fig. 32; Novokshonov and Zhuzhgov, 2004, p. 177, syn. nov.

H o l o t y p e. Specimen illustrated by: Martynov, 1928, pl. 8, fig. 5, pl. 15, fig. 3; Russia, Tatarstan, right bank of the Kama River at the Tikhiye Gory Pier, Tikhie Gory locality; Middle Permian, Kazanian Stage, Lower Kazanian Substage, Baitugan Formation, *Lingula* Beds. Holotype not found, probably lost; the interpretation of the species is based on the original description and illustration.

Description (Figs. 1a–1i). The forewing is relatively narrow (2.1–2.3 times as long as wide). The anterior margin of the forewing is convex. The costal area at the base of RS is wider than the subcostal area. Branches of SC are commensurate in length with the distance between them; the last fork of SC is short (no longer or slightly longer than the width of the costal area). R is simple, with an S-curved apex. RS with three branches. The first fork of RS is located immediately posterior of the mid-wing (in specimen PIN, no. 94/798, closer to its distal third), distal to the forks of M and CuA. The stem of RS_{1+2} is not sharply curved and hump-shaped; its length varies (one and a half times longer than RS_1 in the holotype, equal to RS_1 in the type of *P. cauleoides*). The fork RS_{1+2} is short, accounting for less than a third of the total

length of RS. M splits into two branches near the mid-wing (slightly more basal in the holotype, slightly more distal in specimen PIN, no. 94/798). CuA is forked into two branches slightly basal to middle of wing; fork of CuA not narrowed at the base. CuP is slightly S-curved. A_1 is simple, A_2 has two or three branches. Coloration in the form of two transverse bands of variable width, passing through the stem of RS (usually through its basal half, less often through its middle) and through the stem of RS_{1+2} , and not entering the costal field; the base of the wing is always light, the apex may be darkened (coloration was not preserved in the holotype). In specimen PIN, no. 3353/801 (Fig. 1g), the apex of the wing is darkened, but the venation is identical.

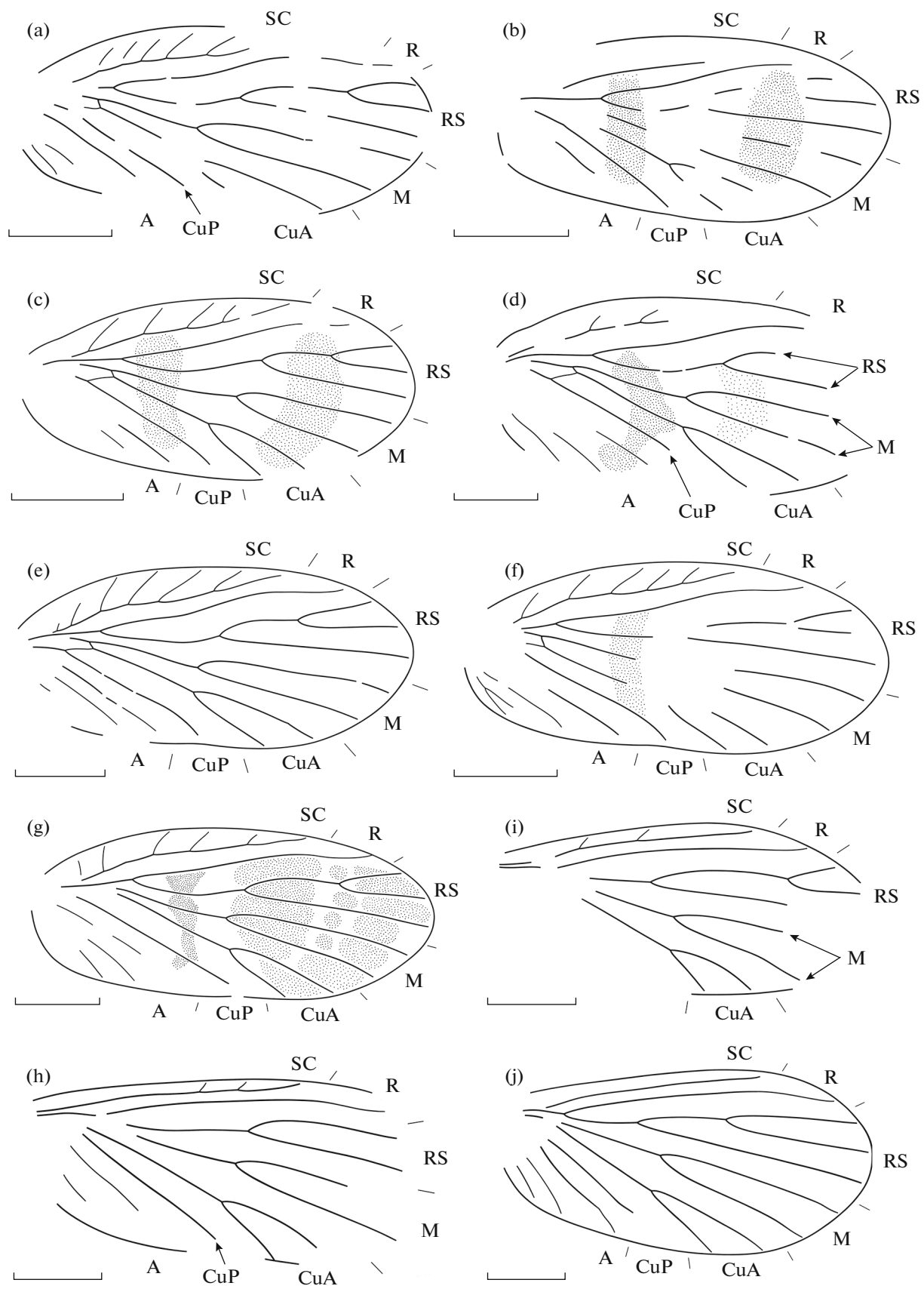
The hind wing is relatively narrow (2.3 times as long as wide), and differs from the anterior wing in a straight anterior margin, narrow costal and subcostal areas, and a straight SC with few short oblique branches. R is simple; RS has three branches, with the first fork located slightly basal or slightly distal to the mid-wing. Fork RS_{1+2} is short, less than a third of the length of RS. M is subdivided into two branches near the middle of the wing (basal to it in the type of *P. brevifurcata*, distally in the *P. defurcata* type), the fork of RS_{1+2} is short. The fork of CuA is short, there are two anal veins. Coloration is missing or not preserved.

Measurements in mm: forewing length 9.0–13.5 (in holotype – 11), hindwing (holotypes of *P. brevifurcata* and *P. defurcata*)—11–13.

Remarks. The hindwings of *P. brevifurcata* Martynova, 1952 (Fig. 1i; Pl. 8, fig. 9) and *P. defurcata* Martynova, 1952 (Fig. 1h; Pl. 8, fig. 8) we assign to the same species, since their features, in our opinion, are comparable: fork RS_{1+2} is short, fork M is near the mid-wing. It is also important that *P. paucinervis* absolutely dominates in the Lower Kazanian deposits of the northeast of European Russia, and the hindwings assigned to this species also make up the majority of the hindwings collected here. The considered wings differ in the location of the transverse veins in the costal region and in the mutual position of the main forks, but these differences do not exceed what is known for the forewings of *P. paucinervis*.

We retain *P. latiformis* described from the hind wing along with the previous species as a separate species due to the long first fork RS_{1+2} (see below for details).

Fig. 1. Representatives of the genus *Permosialis*, (a–g) forewings of *P. paucinervis* Martynov, 1928: (a) holotype, Tikhie Gory locality (drawing over the photograph of A.V. Martynov); (b) specimen PIN, no. 2334/41 (holotype of *P. bifasciata* Martynov, 1933); (c) specimen PIN, no. 94/798 (holotype of *P. cauleoides* Martynova, 1952); (d) specimen PIN, no. 94/186(192) (holotype of *P. marmorata* Martynova, 1952); (e) specimen PIN, no. 117/2579 (holotype of *P. immaculata* Martynova, 1952); (f) specimen PIN, no. 117/2651 (holotype of *P. fasciata* Martynova, 1952); (g) specimen PIN, no. 3353/801; (h–j) hindwings: (h, i) *P. paucinervis*: (h) specimen PIN, no. 117/1316 (holotype of *P. defurcata* Martynova, 1952); (i) specimen PIN, no. 117/1756 (holotype of *P. brevifurcata* Martynova, 1952); (j) *P. latiformis* Martynova, 1952, holotype PIN, no. 117/1153; Soyana locality. Scale bar 3 mm.



V.G. Novokshonov and L.V. Zhuzhgov, when revising representatives of the genus *Permosialis* from Soyana, mentioned only two species: *P. perfecta* and *P. cauleoides*, and considered two other Soyana species as junior synonyms of *P. cauleoides*: “+ *P. immaculata* O. Mart. + *P. fasciata* O. Mart.” (Novokshonov and Zhuzhgov, 2004). *P. marmorata*, *P. bifasciata*, *P. defurcata*, *P. brevifurcata*, and *P. latiformis* were not mentioned.

Occurrence. Tatarstan and Arkhangelsk Region; Middle Permian, Kazanian Stage, Lower Kazanian Substage

Material. Apart from the holotype, specimens nos. 2334/41 (holotype *P. bifasciata* Martynov, 1933), 94/798 (holotype of *P. cauleoides* Martynova, 1952), 94/186(192) (holotype of *P. marmorata* Martynova, 1952), 117/2579 (holotype of *P. immaculata* Martynova, 1952), 117/2651 (holotype of *P. fasciata* Martynova, 1952), 3353/801, forewings; 117/1316 (holotype of *P. defurcata* Martynova, 1952), 117/1756 (holotype of *P. brevifurcata* Martynova, 1952), hindwings; all specimens, except for the holotype, are from Soyana (Arkhangelsk Region; Ivagora Formation).

Permosialis latiformis Martynova, 1952

Plate 8, fig. 10

Permosialis latiformis: Martynova, 1952, p. 231, text-fig. 27.

Holotype. PIN, no. 117/1153, imprint of the hind wing; Russia, Arkhangelsk Region, Soyana locality; Middle Permian, Kazanian Stage, Lower Kazanian Substage, Ivagora Formation.

Description (Fig. 1j). The hindwing is relatively wide (twice as long as wide). R is simple, RS with three branches, the first fork located noticeably basal to the mid-wing. The fork of RS_{1+2} is long, almost half the length of RS. M forks into two branches in front of the middle of the wing. The fork of CuA is short, there are three anal veins. No coloration is known.

Measurements in mm: hindwing length 14.

Comparison. This species is most similar to *P. paucinervis*, from which it differs in a wider wing and a long fork RS_{1+2} . In *P. paucinervis*, the hindwing is narrower (the length is 2.3 times the width), fork RS_{1+2} is short (Figs. 1h, 1i; pl. 8, figs. 8, 9).

Remarks. The described hindwing is similar to the forewing of *P. perfecta* Martynova, 1952 in having a long fork RS_{1+2} (see below). The absence of a pattern on the hindwing, which is at rest hidden below the forewing is normal and in itself should not serve as an obstacle to attributing it to the same species. However, the original ocellate pattern of the forewings of *P. perfecta*, which is rare in permosialids, may indicate some isolation of this species, therefore we consider it premature to assign the hind wing of *P. latiformis* to it on the sole base of the long fork RS_{1+2} .

Material. Holotype.

Permosialis perfecta Martynova, 1952

Plate 9, figs. 1, 2

Permosialis perfecta: Martynova, 1952, p. 232, text-fig. 28; Novokshonov and Zhuzhgov, 2004, p. 177.

Holotype. PIN, no. 117/1772, forewing imprint part; Russia, Arkhangelsk region, location Soyana; Middle Permian, Kazanian Stage, Lower Kazanian Substage, Ivagora Formation.

Description (Figs. 2a, 2b). The forewing is wide (1.9–2.0 times as long as wide). The anterior margin of the forewing is convex. The costal area at the base of RS is wider than the subcostal area. The branches of SC are longer than the distance between them, the last fork of SC is short (no longer or slightly longer than the width of the costal area). R is simple, with a slightly curved apex. RS has three branches. The first fork of RS is located near the mid-wing, on the same level as the forks of M and CuA. The stem of RS_{1+2} is short, without a hump. The fork of RS_{1+2} is long, making up more than a third of the total length of RS. M splits into two branches near the mid-wing. CuA forks into two branches near the mid-wing; the fork of CuA is narrowed at the base. CuP is straight, curved at the apex. The wing membrane is dark, the coloration is in the form of small light bordered spots.

Measurements in mm: forewing length 15–18.

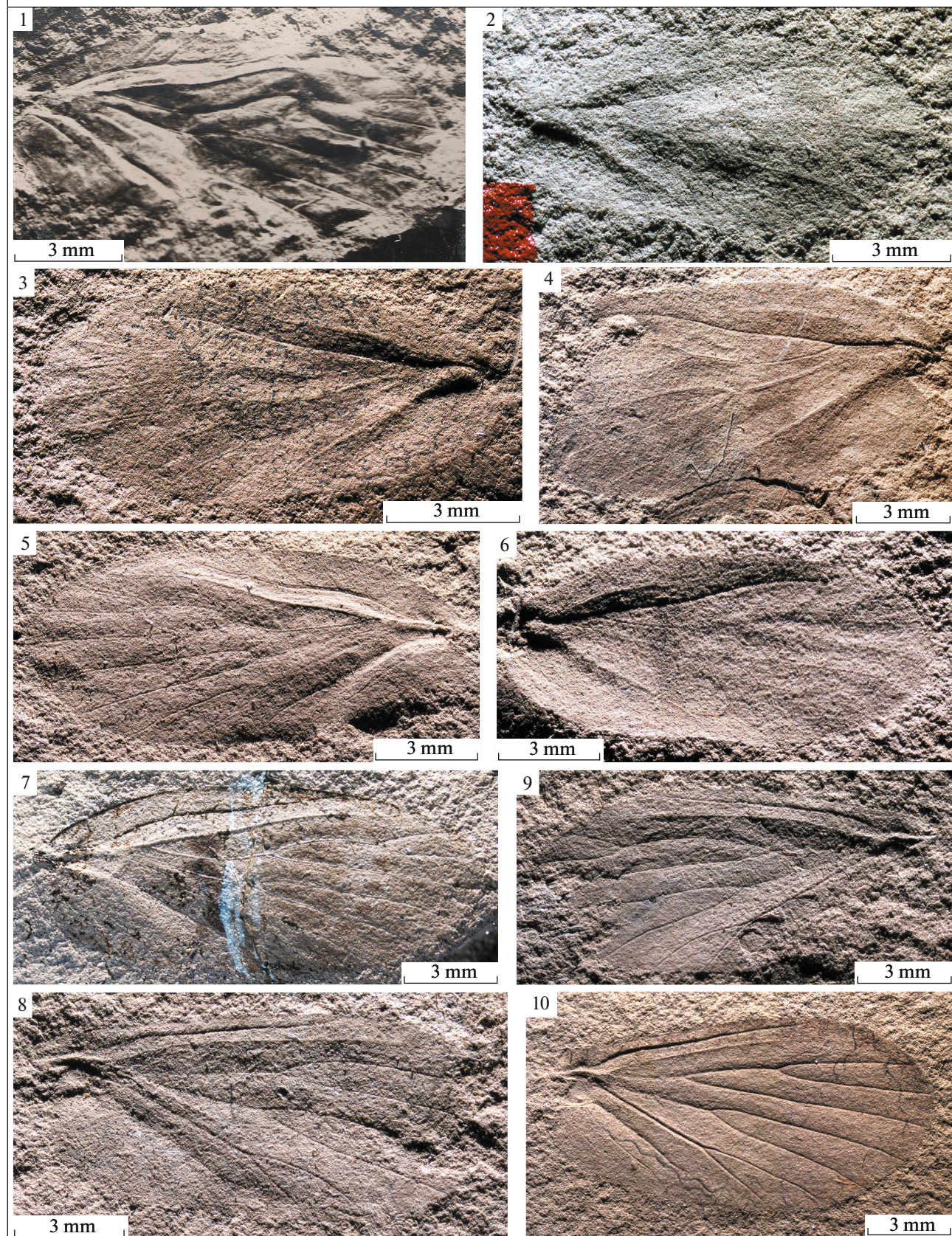
Comparison. The redescribed species is most similar to *P. paucinervis* from the Soyana locality, from which it differs in the long fork RS_{1+2} , the narrow fork CuA, and the coloration in the form of rimmed spots. In *P. paucinervis*, the fork of RS_{1+2} is short, the fork of CuA is not narrowed at the base, and the coloration is in the form of stripes.

Explanation of Plate 8

Figs. 1–9. *Permosialis paucinervis* Martynov, 1928: (1) holotype, Tikhie Gory locality (photo by A.V. Martynov); (2) specimen PIN, no. 2334/41 (holotype of *P. bifasciata* Martynov, 1933); (3) specimen PIN, no. 94/798 (holotype of *P. cauleoides* Martynova, 1952); (4) specimen PIN, no. 94/192 (holotype of *P. marmorata* Martynova, 1952); (5) specimen PIN, no. 117/2579 (holotype of *P. immaculata* Martynova, 1952); (6) specimen PIN, no. 117/2651 (holotype of *P. fasciata* Martynova, 1952); (7) specimen PIN, no. 3353/801; (8) specimen PIN, no. 117/1316 (holotype of *P. defurcata* Martynova, 1952); (9) specimen PIN, no. 117/1756 (holotype of *P. brevifurcata* Martynova, 1952); Soyana locality; (1–7) forewings, (8, 9) hindwings.

Fig. 10. *Permosialis latiformis* Martynova, 1952, holotype PIN, no. 117/1153, hindwing; Soyana locality.

Plate 8



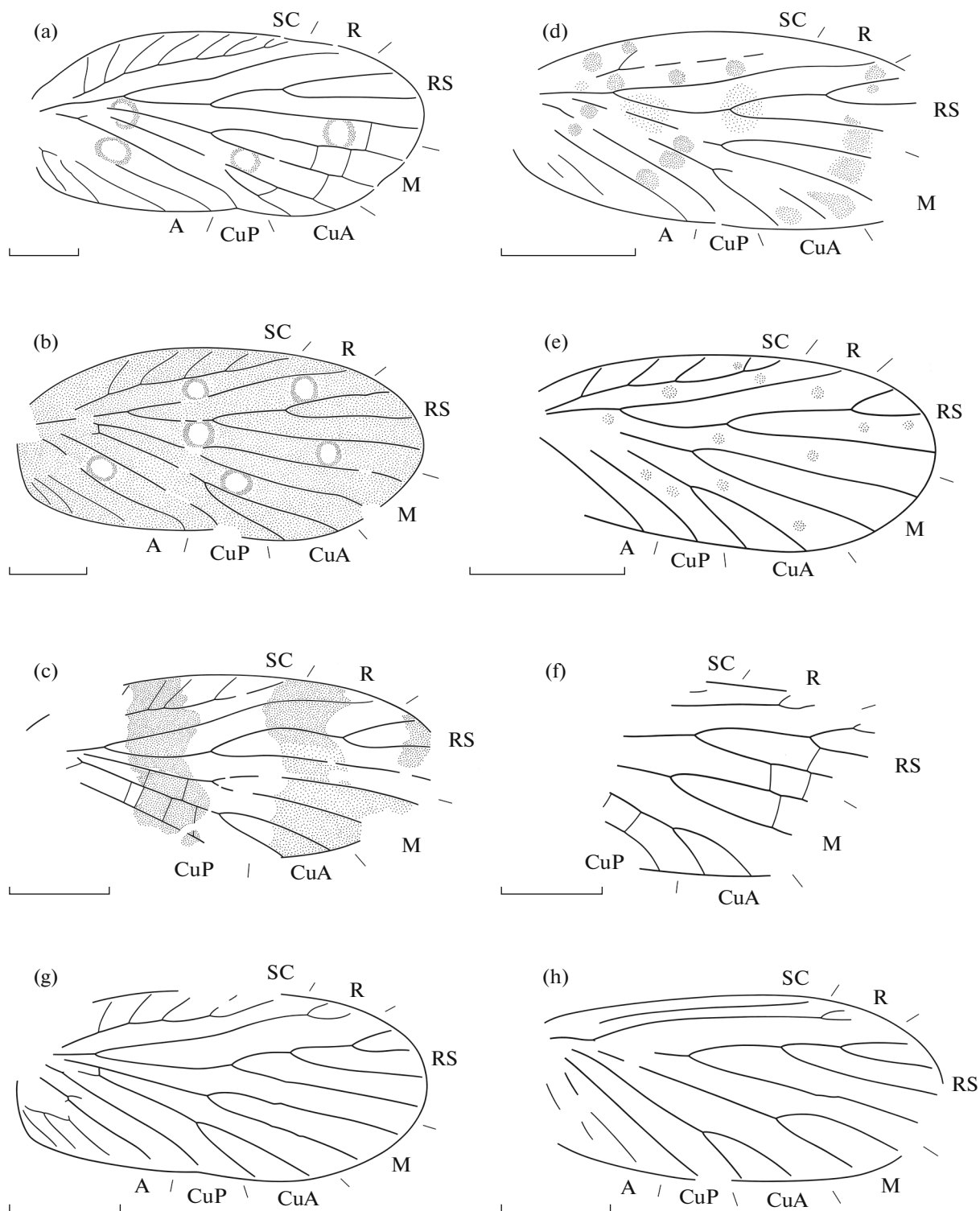
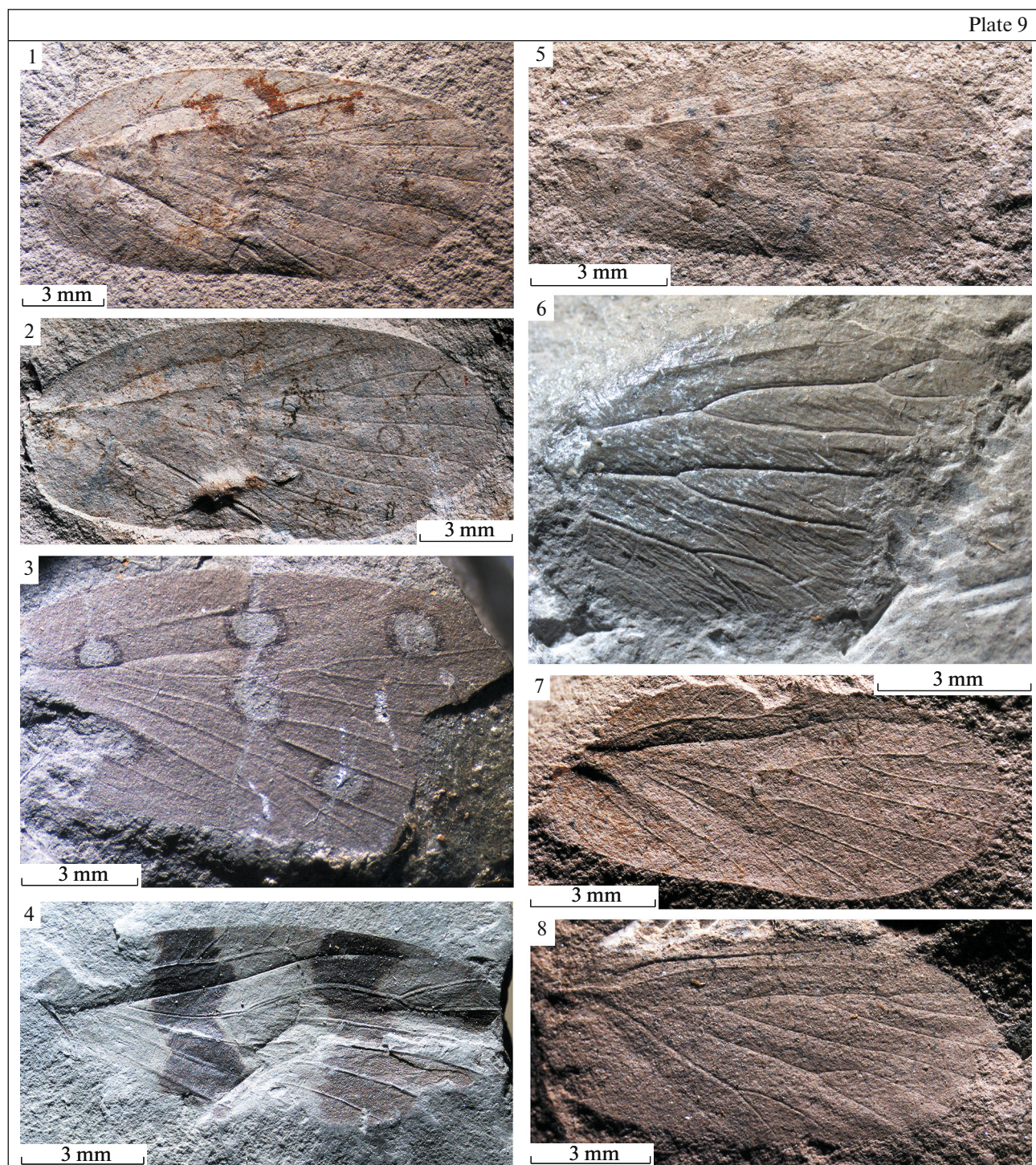


Fig. 2. Representatives of the genera *Permosialis* and *Palaeomantopsis*: (a–g) forewings: (a, b) *Permosialis perfecta* Martynova, 1952: (a) holotype PIN, no. 117/1772; (b) specimen PIN, no. 3353/808; Soyana locality; (c) *P. vizzya* sp. nov., holotype PIN, no. 1631/503; Vorgashor Coal Field; (d) *P. martynovae* sp. nov., holotype PIN, no. 3353/811; Soyana locality; (e) *P. punctimaculosa* Novokshonov et Rasnitsyn, 2001, male forewing reconstruction based on paratypes PIN, nos. 4987/57 and 4987/60; Chekarda locality; (f–h) *Palaeomantopsis furcatella* Martynov, 1928: (f) holotype PIN, no. 2065/23(32); Tikhie Gory locality; (g) specimen PIN, no. 3353/807; (h) specimen PIN, no. 117/1444(2652), hindwing (holotype of *Permosialis quadriramosa* Martynova, 1952); Soyana locality. Scale bar 3 mm.



Explanation of Plate 9

Figs. 1, 2. *Permosialis perfecta* Martynova, 1952: (1) holotype PIN, no. 117/1772, (2) specimen PIN, no. 3353/808, forewings; Soyana locality.

Fig. 3. *Permosialis ualentovae* Novokshonov et Zhuzhgova, 2004, holotype PIN, no. 1366/349, Kityak locality.

Fig. 4. *Permosialis vizzya* sp. nov., holotype PIN, no. 1631/503, Vorgashor Coal Field.

Fig. 5. *Permosialis martynovae* sp. nov., holotype PIN, no. 3353/811, Soyana locality.

Figs. 6–8. *Palaeomantopsis furcatella* Martynov, 1928: (6) holotype PIN, no. 2065/23, forewing, Tikhie Gory locality; (7) specimen PIN, no. 3353/807, forewing, (8) specimen PIN, no. 117/1444, hindwing (holotype of *Permosialis quadriramosa* Martynova, 1952); Soyana locality.

Remarks. *P. perfecta* differs from *P. paucinervis* also in terms of characters that Novokshonov and Zhuzhgova (Novokshonov and Zhuzhgova, 2004) consider, not without reason, to be characteristic of females of the species they considered (larger size and wider costal field). However, the fundamentally different coloration of the wings (ocellate spots in *P. perfecta* and transverse stripes in *P. paucinervis*) does not allow us to consider them, respectively, females and males of the same species (in *P. punctimaculosa* Novokshonov et Rasnitsyn, 2001, the model species used by these authors to illustrate sexual dimorphism in permiosialids, the coloration of males and females is the same).

Ocellate spots are also known in *P. ualentovae* Novokshonov et Zhuzhgova, 2004 (Pl. 9, fig. 3), described from the Middle Permian locality of Kityak in Kirov Region of Russia (Novokshonov and Zhuzhgova, 2004).

Material. In addition to the holotype, specimen PIN, no. 3353/808 (Fig. 2b; pl. 9, figs. 2) from the type locality.

Permiosialis vizzya Aristov et Rasnitsyn, sp. nov.

Plate 9, fig. 4

Etymology. From the Komi-Permyak *vizzya* (with stripes).

Holotype. PIN, no. 1631/503, forewing part and counterpart; Russia, Komi Republic, Vorgashorskoye Field, well VK-1349, deep 487 m; Lower Permian, Kungurian (Aristov et al., 2021), Pechora Group, Lekvorkuta Formation, Rudnitskaya Subformation.

Description (Fig. 2c). The forewing is narrow (2.5 times as long as wide). The anterior margin of the forewing is convex. The costal area at the base of the RS is probably slightly wider than the subcostal area. The branches of SC are arranged irregularly, the last fork of SC is short (no longer or slightly longer than the width of the costal field). R is simple, with a strongly S-curved apex. RS is with three branches. The first fork of RS is located before the mid-wing, at the same level as the forks of M and CuA. The stem of RS_{1+2} is long (longer than the trunk of RS), sharply arched towards the wing anterior margin. The fork of RS_{1+2} is short, less than a third of the total length of RS. M splits into two branches near the mid-wing. CuA splits into two branches near the middle of the wing; the fork of CuA is not narrowed at the base. CuP is straight. Coloration in the form of two wide stripes reaching the wing anterior margin, and of spots at the wing apex.

Measurements in mm: forewing length 10.5.

Comparison. The new species is most similar to *P. paucinervis* Martynov, 1928, from which it differs in the stem of RS_{1+2} long (longer than RS trunk) and arched towards the wing anterior margin, and in col-

oration with stripes reaching the wing anterior margin. In *P. paucinervis*, stem of RS_{1+2} is shorter than the stem of RS, and coloration does not reach the anterior margin of the wing.

Material. Holotype.

Permiosialis martynovae Aristov et Rasnitsyn, sp. nov.

Plate 9, fig. 5

Etymology. In honor of O.M. Martynova.

Holotype. PIN, no. 3353/811, forewing, part imprint; Russia, Arkhangelsk Region, Mezensky District, bank of the Soyana River near Mount Sheimo, locality Soyana; Middle Permian, Kazanian Stage, Lower Kazanian Substage, Ivagora Formation.

Description (Fig. 2d). The forewing is narrow (about 2.3 times as long as wide). The anterior margin of the forewing is convex. The costal area at base of RS 1.6 times wider than the subcostal area. R is simple, with an S-curved apex. RS is with three branches. The first fork of RS is located near the mid-wing slightly distal to the forks of M and CuA. The stem of RS_{1+2} is slightly longer than that of RS, slightly arched towards the wing anterior margin. The fork of RS_{1+2} is short, less than a third of the total length of RS. M forks into two branches before the mid-wing. Cu forks into two branches before the mid-wing, the CuA fork is not narrowed at the base. CuP is slightly S-curved. Coloration in the form of spots of different width and intensity, forming three indistinct oblique rows before the RS base, before its first fork, and before of the wing apex.

Measurements in mm: forewing length 10.2.

Comparison. In mottled coloration and size, the new species is most similar to the male of *P. punctimaculosa* Novokshonov et Rasnitsyn, 2001 from Chekarda (Russia, Perm Region; Lower Permian, Kungurian), from which it differs in the straight SC and coloration consisting of spots of various sizes. In the male of *P. punctimaculosa*, the SC is S-shaped curved, the apex of R is straight, and the coloration is in the form of small spots of the same size (Novokshonov and Rasnitsyn, 2001, text-figs. 1b; 2b; here: Fig. 2e).

Material. Holotype.

Genus *Palaeomantopsis* Martynov, 1928

Palaeomantopsis furcatella Martynov, 1928

Plate 9, figs. 6–8

Palaeomantopsis furcatella: Martynov, 1928, p. 83, pl. 11, figs. 4.

Permiosialis quadriramosa: Martynova, 1952, p. 229, text-fig. 24, syn. nov.

Holotype. PIN, no. 2065/23(32), forewing part and counterpart; Russia, Tatarstan, right bank of the Kama River, near the Tikhie Gory pier, Tikhie Gory

locality; Middle Permian, Kazanian Stage, Lower Kazanian Substage, Baitugan Formation, *Lingula* Beds.

Description (Figs. 2f–2h). The forewing anterior margin is slightly convex. The costal field near the RS base is 1.6 time wider than the subcostal field. The SC branches are nearly equal to the distance between them, the last fork of SC is short (no longer or slightly longer than the width of the costal area). R is with a short fork; RS originates in the basal quarter of the wing, with four branches. The first fork of RS is located near the mid-wing slightly distal to the forks of M and CuA. M forks into two branches near the mid-wing. CuA forks into two branches at the same level as the M fork or slightly basal. The anterior margin of the hind wing is slightly convex; the costal area at the mid-wing is slightly wider than the subcostal field. SC ends before the wing distal third; R with a short fork. RS originates in the basal quarter of the wing, with four branches. M forks into two branches near the border of the distal third of the wing. CuA forks into two branches before the mid-wing. CuP is slightly S-curved; the first anal vein is with two branches; the second vein is simple. Coloration on the wings is absent (possibly not preserved).

Measurements in mm: forewing length 12–15 (specimen PIN, nos. 3353/807 and 2065/23(32), correspondingly), hindwing (specimen PIN, no. 117/1444(2652))—11.

Occurrence. Tatarstan and Arkhangelsk Region; Middle Permian, Kazanian Stage, Lower Kazanian Substage.

Material. Apart from the holotype, specimens PIN, no. 3353/807, part imprint of a forewing, and 117/1444(2652), part and counterpart of a hindwing (holotype *Permosialis quadriramosa* Martynova, 1952); both from the Soyana locality (Arkhangelsk Region; Ivagora Formation).

ACKNOWLEDGMENTS

The authors are grateful to A.G. Ponomarenko (Paleontological Institute, Russian Academy of Sciences) and V.D. Ivanov (St. Petersburg State University) for important remarks and suggestions on the text of the manuscript.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

- Aristov, D.S., Rasnitsyn, A.P., and Naugolnykh, S.V., New Blattinopsidae (Insecta: Blattinopsida) in the Permian of the Pechora Basin (Komi Republic, Russia) in the context of landscape and vegetation evolution, *Paleontol. J.*, 2021, vol. 55, no. 6, pp. 641–649.
- Carpenter, F.M., *Superclass Hexapoda, Treatise on Invertebrate Paleontology, Pt R: Arthropoda 4*, vols. 3–4, Boulder, Colorado: Geol. Soc. Am., Univ. Kansas Press, 1992.
- Martynov, A.V., Permian fossil insects of northeastern Europe, in *Tr. Geol. Mus. Akad. Nauk SSSR* (Trans. Geol. Mus. USSR Acad. Sci.), 1928, vol. 4, pp. 1–118.
- Martynov, A.V., Perm fossil insects of the Arkhangelsk region. Part II. Neuroptera, Sialidae and Coleoptera, with a description of two new beetles from Tikhie Gory, in *Tr. Paleozool. Inst. Akad. Nauk SSSR* (Trans. Paleozool. Inst. USSR Acad. Sci.), 1933, vol. 2, pp. 63–96.
- Martynova, O.M., Permskie setchatokrylye SSSR (Permian Neuroptera of the USSR), in *Tr. Paleontol. Inst. Akad. Nauk SSSR* (Trans. Paleontol. Inst. USSR Acad. Sci.), 1952, vol. 40, pp. 197–237.
- Martynova, O.M., Order Megaloptera. Sialidae, in *Osnovy Paleontologii: Chlenistonogie—trakheinye i kheliterovye* (Fundamentals of Palaeontology. Arthropoda, Tracheata and Chelicerata), Rodendorf, B.B., Ed., Moscow: Akad. Nauk SSSR, vol. 9, 1962, pp. 269–270.
- Novokshonov, V.G. and Rasnitsyn, A.P., A new species of insects of the order Palaeomanteida = Miomoptera from the Lower Permian of Chekarda (Perm Region), *Vestn. Perm. Univ. Ser. Geol.*, 2001, no. 3, pp. 110–114.
- Novokshonov, V.G. and Zhuzhgova, L.V., Discussion of the system and phylogeny of the order Palaeomanteida (=Miomoptera) with description of new representatives of the genus *Permosialis* Mart. from the Late Permian of Kirov Region and Triassic of Kyrgyzstan, *Paleontol. J.*, 2004 vol. 38, no. 2, pp. 173–184.
- Rasnitsyn, A.P., Order Palaeomanteida Handlirsch, 1906, in *Trans. Paleontol. Inst. USSR Acad. Sci. "Historical development of the class Insecta"*, Rodendorf, B.B. and Rasnitsyn, A.P., Eds., 1980, vol. 175.
- Rasnitsyn A.P. Order Palaeomanteida Handlirsch, 1906, in *History of Insects*, Rasnitsyn A.P. and Quicke, D.L.J., Eds., Dordrecht: Kluwer Acad. Publ., 2002, pp. 161–164.
- Rasnitsyn, A.P. and Aristov, D.S., New fossil insects (Insecta: Caloneurida, Hypoperlida, Palaeomanteida, Jurinida) from the Middle and Upper Permian of European Russia, *Paleontol. J.*, 2013, vol. 47, no. 7, pp. 678–704.
- Rasnitsyn, A.P. and van Dijk, D.E., The first Gondwanan *Epimastax* from the Lopingian of KwaZulu-Natal, South Africa (Insecta: Palaeomanteida = Miomoptera: Permosialidae), *Afr. Invertebr.*, 2011, vol. 52, no. 1, pp. 207–209.
- Riek, E.F., Undescribed fossil insects from the Upper Permian of Belmont, New South Wales (with an appendix listing the described species), *Rec. Austral. Mus.*, 1968, vol. 27, no. 15, pp. 303–310.

Translated by S. Nikolaeva