

New and Little Known Blattinopsidae (Insecta: Blattinopsida) from the Middle Permian of Russia

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Abstract—The fauna of the insect order Blattinopsida in the Soyana and Tikhie Gory localities (Middle Permian of Russia) is discussed. *Glaphyrophlebia iva* sp. nov. from Soyana is described, *G. subcostalis* (Martynov, 1928) from Soyana and *G. rossica* (Martynov, 1930), nom. ressur. from Tikhie Gory are redescribed, and *G. rossica* is removed from synonymy with *G. subcostalis*.

Keywords: Insecta, Blattinopsida, Blattinopsidae, Middle Permian, Russia

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INTRODUCTION

The small Paleozoic order Blattinopsida includes one family and two genera: *Blattinopsis* Giebel, 1867 and *Glaphyrophlebia* Handlirsch, 1906, with 12 and 15 species respectively, occurring in the Late Carboniferous and the Early and early Middle Permian [Hörschemeyer, Stapf, 2001; Beckemeyer, 2013; Aristov, 2015, and present work; other genera placed in the family (Hörschemeyer and Stapf, 2001; Béthoux and Jarzembowski, 2010), in our opinion, require additional substantiation to be attributed to Blattinopsidae]. The order Blattinopsida was recognized relatively recently (Rodendorf, 1977); before that, and often even now, the family Blattinopsidae was included in the orders Protoblattodea or Protorthoptera (Osnoy, 1962; Carpenter, 1992; Hörschemeyer and Stapf, 2001, etc.). This group, together with another small Late Paleozoic order Caloneurida, occupies an important position at the roots of the very large lineage Cimiciformes + Scarabaeiformes or Paraneoptera + Oligoneoptera in the Martynov-Rodendorf system (Rasnitsyn, 1980a; Rasnitsyn, 2002).

The first representatives of the order Blattinopsida appear in the Upper Carboniferous and are known from deposits of North America and Europe (Hörschemeyer and Stapf, 2001; Rasnitsyn, 2002). In the Asselian deposits of Germany, the diversity of Blattinopsida increases, comprising 10% of insect remains (Hörschemeyer, 1999). In the synchronous deposits of the Czech Republic and in Kungurian localities of the United States and Russia, Blattinopsida are repre-

sented by single species (Kukalová, 1965; Beckemeyer, 2013; Aristov, 2015), accounting for less than 1% of insect remains (Beckemeyer and Hall, 2007; our data). In the Roadian, or more correctly, the Ufimian (Lozovsky et al., 2009) deposits of Russia, the relative proportion of blattinopsids to all other insects increases. It ranges from 12% (Inta Formation of the Vorkuta Group of the Pechora basin) to 22% (Tyul'ino locality). Their diversity is also increased there (unpublished data). In the lower part of the Kazanian, the abundance and diversity of the order decreased; more recent representatives are unknown. Below we consider the insect fauna of the Russian localities of this age (Soyana and Tikhie Gory). Two species of Blattinopsidae are known in the former, and one species in the latter. In both localities, Blattinopsidae account for less than 1% of insect remains. For more detail on the stratigraphy and paleontological characteristics of Soyana and Tikhie Gory see Naugolnykh (2015) and Naugolnykh and Ponomarenko (2010) respectively.

The Early-Late Kazanian boundary shows a significant change in insect faunas. Among the phytophagous orders that appeared in the Carboniferous (Caloneurida, Hypoperlida, Dictyoneurida, Mischopterida, Diaphanopterida, and Blattinopsida), 47% of families became extinct at this level, including Blattinopsidae, the only family of the order. The rest of the orders, except for Caloneurida and Hypoperlida, are represented after Early Kazanian by single finds (Rasnitsyn et al., 2015). Perhaps this is due to climate aridization

and a change in burial environments from coastal-marine to inland (Shcherbakov, 2008).

At the same border, there is a significant renewal of the flora composition (S.V. Naugolnykh, pers. comm., 2019). The last relictual representative of the large *Calamites gigas* Brongniart, 1828, which had xerophilic adaptations and was most likely a phreatophyte, a plant with a deep root system, using groundwater as a source of moisture, completely disappear (Naugolnykh, 2005). The species diversity of the hygro- and hydrophilic horsetail genera *Paracalamites* Zalessky, 1932 and *Paracalamitina* Zalessky, 1934 (for the taxonomic status and ecological preferences of the latter genus, see Zalessky, 1934 and Naugolnykh, 2002) and ferns (Esaulova, 1986) decreases. The species diversity of peltasperms and ginkgophytes is noticeably reduced. At the same time, their abundance relative to the overall decrease in diversity increases (for analytical data see: Esaulova, 1986, p. 43, text-fig. 9).

All this could have contributed to the extinction of Blattinopsida. In any case, no Blattinopsids are known from any Upper Permian localities, including the largest, Isady (Severodvinian Stage of the Vologda Region, Russia) and Belmont (Changhsingian Stage of New South Wales, Australia). At the same time, representatives of some orders that had been considered extinct after the Middle Permian were found in these localities (Aristov et al., 2013).

SYSTEMATIC PALEONTOLOGY

Order Blattinopsida

Family Blattinopsidae Bolton, 1925

Genus *Glaphyrophlebia* Handlirsch, 1906

Glaphyrophlebia subcostalis (Martynov, 1928)

Plate 10, figs. 1–5

Sindonopsis subcostalis: Martynov, 1928, p. 61, pl. 12, fig. 3; Handlirsch, 1937, p. 120.

Sindonopsis reducta: Martynov, 1928, p. 61, pl. 7, fig. 7; Handlirsch, 1937, p. 120; synonymized by: Rasnitsyn, 1980b, p. 40; Hörschemeyer and Stapf, 2001, p. 85.

Glaphyrophlebia subcostalis: Rasnitsyn, 1980b, p. 40; Rasnitsyn, 2002, p. 108, text-fig. 110b, 110c; Hörschemeyer and Stapf, 2001, p. 85; Golubev et al., 2007, p. 232.

Holotype. PIN, no. 2050/18; the distal half of the hindwing, part; Arkhangelsk Region, right bank of the Soyana River, 56–60 km upstream the mouth; Middle Permian, Kazanian Stage, Lower Kazanian Substage, Iva-Gora Beds.

Description (Figs. 1a–1e). Small insects with wide front wings (front wing length is 2.7 times its width). The forewing has a precostal lobe (expansion of the base of the costal field, separated from the rest of it by a fold). The wing anterior edge is convex to its middle, then slightly concave. The wing apex is shifted towards its anterior margin. The costal area at the base of RS is 0.77 of the costal area width. SC with simple anterior branches, ends at mid-wing, its apex sharply

curved anteriorly, parallel to the branches. The stem of R before and after the RS base is S-shaped. RS begins immediately behind the basal third of the wing, extends from R with one stem, comb-like backward, with five to six simple main branches and 10–13 terminations. M_5 flows into CuA after its splitting into branches; M is simple, with a short terminal fork, at the middle of the wing not parallel to its posterior margin. CuA begins to branch before the confluence with M_5 ; the posterior branch (branching off before the confluence with M_5) is simple or with two branches, not parallel to the stem of CuA. The anterior branch is unevenly split, with 13–14 branches. CuP is weakly curved towards the posterior wing margin. The anal region is lanceolate, slightly convex, separated from the remigium (main part of the wing) by a deep flexible fold along CuP, i.e., transformed into a clavus as defined by Gorochov (2004). A_1 has a short blind branch at the base facing forward and with a short terminal fork, A_2 has several branches, with 13–15 terminations. The crossveins are simple and form a double row of cells between A_1 and A_2 . The coloration forms a dark stripe along the apex and the posterior margin; the clavus is entirely darkened. The nodal line is slightly curved, clearly visible as a thin fold from R to CuA.

The anterior margin of the hindwing is concave at the base, then slightly convex, with a rounded apex. The subcostal area is very narrow, SC terminates before the mid-wing, with a few simple, gently sloping anterior branches. R has a slight S-shaped curve, behind the SC apex with short, frequent, straight anterior branches. RS lacks its base (unless it was at the very base of the wing; visible double base of M in specimen figured in Fig. 1e, is probably an individual deviation, most likely an anastomosis of the branches). RS is S-shaped, comb-like backward, its border with M is not clear, RS + M with nine or more main branches, some branches extending to the posterior edge of the wing have terminal forks. CuA is gently curved at the base, further straight, comb-like backward, with four to five slender posterior branches. CuP is weakly S-shaped, simple or with a short, thin, blind branch in the cubital field. A_1 is S-shaped, with thin, partly blind posterior branches. A_2 is simple, curved towards the wing hind margin. A_3 (jugal vein) is with posterior comb of thin branches. The crossveins are simple; the coloration is present along the wing apex and hind margin.

Measurements in mm: The forewing length 10–11, hindwing length 8–9.

Material. Apart from the holotype, specimen PIN, no. 2050/19 (holotype of *Sindonopsis reducta* Martynov, 1928) and specimens nos PIN, no. 3353/198, 200, 203 and 210 from the same locality.

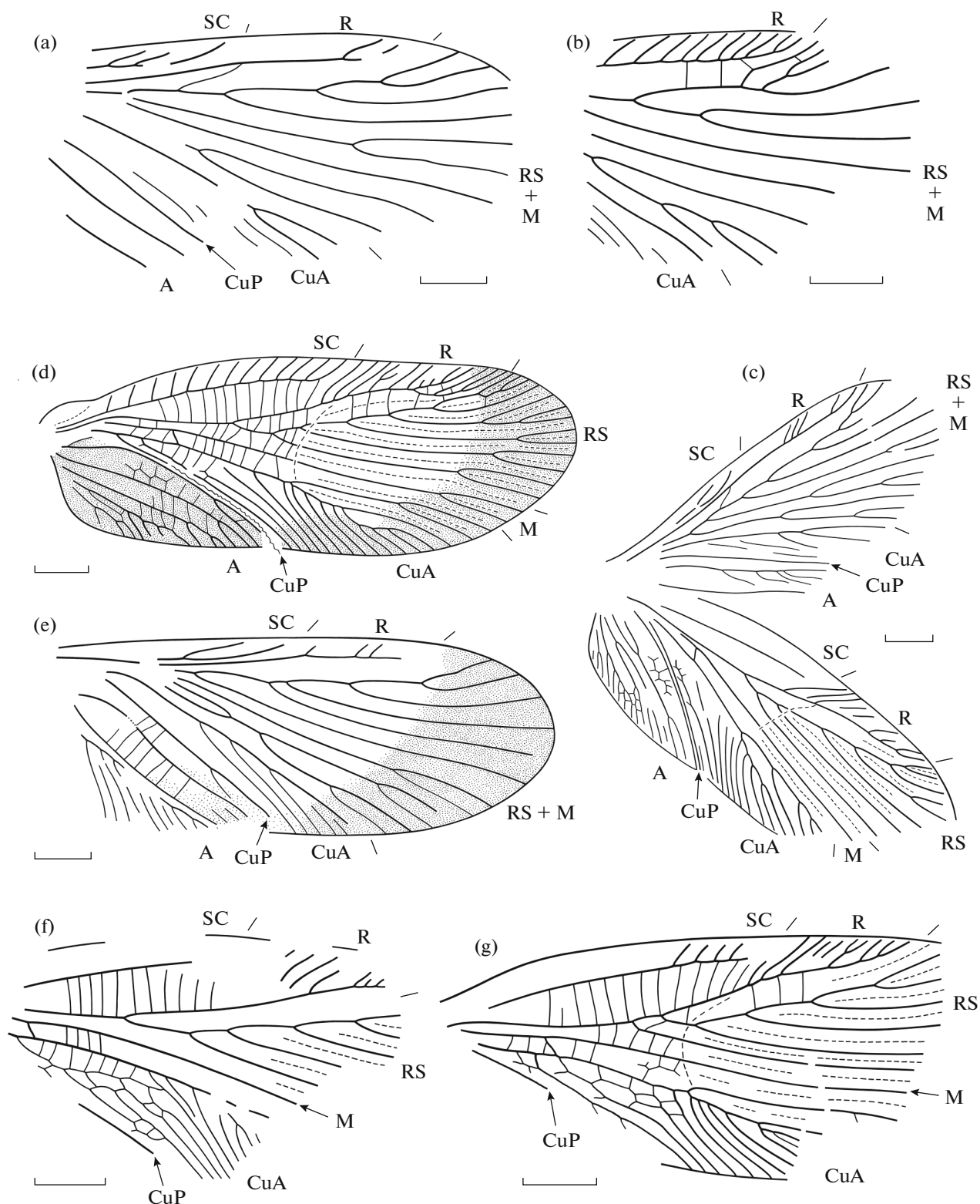
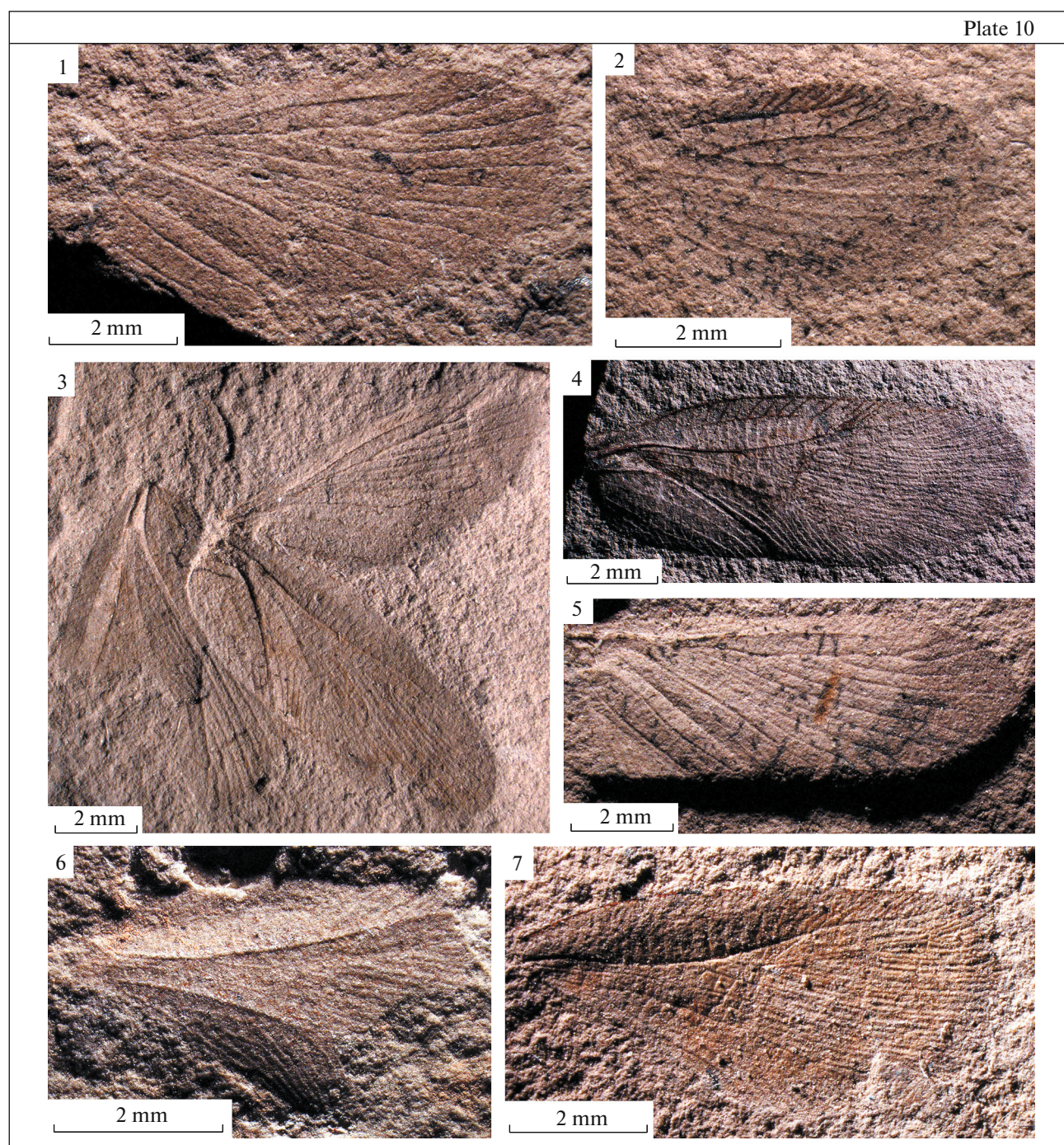


Fig. 1. Representatives of Blattinopsidae from the Middle Permian of Russia (a–e) *Glaphyrophlebia subcostalis* (Martynov, 1928): (a) holotype PIN, no. 2050/18, forewing, (b) specimen PIN, no. 2050/19 (holotype of *Sindonopsis reducta* Martynov, 1928), forewing, (c) specimen PIN, no. 3353/198, forewing and hindwing; (d) reconstruction of a forewing based on specimen PIN, nos. 3353/203 and 210; (e) specimen PIN, no. 3353/200, hindwing; Soyana locality; (f) *Glaphyrophlebia rossica* (Martynov, 1931), nom. ressur., holotype PIN, no. 2295/113; Tikhie Gory locality; (g) *Glaphyrophlebia iva* sp. nov., holotype PIN, no. 2455/128, forewing; Soyana locality. Scale bar (a, b, d–g) 1 mm; (c) 2 mm.



Explanation of Plate 10

Figs. 1–5. *Glaphyrophlebia subcostalis* (Martynov, 1928): (1) holotype PIN, no. 2050/18, forewing; (2) specimen PIN, no. 2050/19, forewing; (3) specimen PIN, no. 3353/198, forewing and hindwing; (4) forewing; (5) specimen PIN, no. 3353/200, hindwing; Soyana locality; Middle Permian.

Fig. 6. *Glaphyrophlebia rossica* (Martynov, 1931), nom. ressur., holotype PIN, no. 2295/113; Tikhie Gory locality; Middle Permian.

Fig. 7. *Glaphyrophlebia iva*, sp. nov., holotype PIN, no. 2455/128, forewing; Soyana locality; Middle Permian.

Glaphyrophlebia rossica (Martynov, 1931), nom. ressur.

Plate 10, fig. 6

Sidon rossicum: Martynov, 1931, p. 154, fig. 4.

Glaphyrophlebia rossicum: Carpenter, 1966, p. 70; synonymized with *Glaphyrophlebia subcostalis*: Rasnitsyn, 1980b, p. 40.

Holotype. PIN, no. 2295/113; Tatarstan, Mendeleevo district, right bank of the Kama River near the Tikhiye Gory pier, Tikhiye Gory locality; Middle Permian, Kazanian Stage, Lower Kazanian Substage, *Lingula* Beds of the Baitugan Formation.

Description (Fig. 1f). Small insects. The anterior margin of the forewing is convex in the middle. The costal area at the RS base is 1.2 times as wide as the subcostal area; SC terminates before mid-wing. The R stem is straight up to the base of RS, then slightly S-shaped. RS begins in the basal third of the wing, extends from R with one stem, comb-like backward, with more than five branches. M_5 flows into CuA after its division into branches, M is simple up to the distal third of the wing, at the middle of the wing it is not parallel to its posterior margin. CuA begins to branch before the confluence with M_5 , with more than 10 endings; its posterior (branching off before the confluence with M_5) branch is comb-like forward, runs parallel to the stem of CuA. The CuP base is straight. The transverse veins are simple and form a double row of cells in the medial area and in the area between the branches of CuA.

Measurements in mm: The forewing length is ca. 8.

Remarks. *G. rossica* was synonymized with *G. subcostalis* (Martynov, 1928) by Rasnitsyn (1980b). The redescription of these species showed that the posterior branch of CuA in *G. subcostalis* is simple in all the numerous specimens (while in *G. rossica*, this branch is comb-like, see above). Together with the finding of these species at different localities, this allows us to remove *G. rossica* from synonymy with *G. subcostalis*.

Material. Holotype.

Glaphyrophlebia iva Aristov et Rasnitsyn, sp. nov.

Plate 10, fig. 7

Etymology. From the Iva-Gora Locality (=Soyana).

Holotype. PIN, no. 2455/128, incomplete forewing, counterpart; Arkhangelsk Region, right bank of the Soyana River 56–60 km upstream of the mouth; Middle Permian, Kazanian Stage, Lower Kazanian Substage, Iva Gora Beds.

Description (Fig. 1g). Small insects. The anterior margin of the forewing is slightly concave at the base, further slightly convex. Costal area at base of RS 1.5 times narrower than subcostal area; SC terminates before mid-wing. The stem of R before and after the bases of the RS is slightly S-shaped; R with nine anterior branches, ending in front of the distal third of the wing. RS begins at the border of the basal third of the wing, extends from R by two stems, the anterior one is regularly comb-like backward, with five main branches, the posterior one to the distal third of the wing is simple. M is simple up to distal third of wing, parallel to its posterior margin near wing middle. M_5 flows into CuA after its splitting into branches. The anterior branch of CuA is simple up to the nodal line, the posterior branch is not parallel to its stem, with multiple forks; altogether CuA with more than

10 branches. CuP is straight in the middle. The crossveins are simple. The nodal line has the appearance of a slight depression, otherwise resembling *G. subcostalis*.

Measurements. The forewing length is ca. 10.

Comparison. The new species is closest to *G. subcostalis* (Martynov, 1928) from the Soyana locality, from which it differs by RS arising from R by two stems. In *G. subcostalis*, RS branches off from R with one stem (see above).

Material. Holotype.

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