# Callipterid pteridosperms from the Early Permian of Ukraine

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In terrigenous rocks of the early Permian age, below the limestone P6, of the Western Donets Basin two new pteridosperm species have been identified. One of them had phyllosperms with seed scars situated near the base and in the middle part of a pinnule, at the ends of vein-like off-shoots. Its foliage consists of dichotomously branched pinnate to tripinnate fronds, sphenopteroid pinnules and intercalary pinnae and pinnules. The foliage is very variable. Immature, semi-mature, and mature pinnae and pinnules are known. These plants grew probably along the margins of floodplain lakes. The name *Raminervia mariopteroides* gen. et sp. n. is proposed here for them. The second species, *Dichophyllum cuneata* sp. n., is characterized by pinnate to bipinnate fronds with a dichotomy of the primary rachis, broadly wedge-shaped pinnules and similarly shaped intercalary pinnules. Plants of the species probably grew on elevated lots of the floodplain and on the alluvial-lacustrine plain.

Key words: pteridosperms, natural genus, Early Permian, Ukraine, paleoecology.

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## Introduction

Fossil plants with callipterid foliage were earlier included in the form-genus *Callipteris*. The appearance of the genus was maintained as a marker for the Carboniferous-Permian boundary on the first and second Congresses on Carboniferous Stratigraphy (Jongmans 1928; Jongmans & Gothan 1937). Although several species of *Callipteris* have been subsequently reported from the Stephanian (Nemejc 1951; Havlena 1958; Doubinger 1979; Kozur 1978, 1984; Kerp 1988) the callipterids continue to play an important role in the Late Paleozoic stratigraphy.

The genus *Callipteris* in its traditional meaning included species with alethopteroid, sphenopteroid, and flabelliform pinnules. They were classified together only because of the shared presence of intercalary pinnules and probably the genus is a highly heterogenous group. Moreover, the name *Callipteris* Brongniart 1849 is a junior homonym of *Callipteris* Bory 1804, a genus of extant ferns, and must be abandoned (Kerp 1986). As a result of detailed studies of the callipterids a reclassification of these pteridosperm has appeared necessary (Kerp 1988; Kerp & Haubold (1988). The genus *Autunia* Krasser 1919 was emended by Kerp (1988) to include some vegetative and reproductive organs earlier attributed to *Callipteris*. *Autunia*, with two species included, *A. conferta* (Sternberg 1826) and *A. naumannii* (Gutbier 1849) Kerp 1988, was classified in the Peltaspermaceae Thomas 1933. Better known species from western and central Europe were transferred to callipterid form-genera *Rhachiphyllum* Kerp 1988, *Lodevia* Haubold & Kerp 1988, *Arnhardtia* Haubold & Kerp 1988, *Dichophyllum* Elias *ex* Andrews 1941, and *Gracilopteris* Kerp, Naugolnykh, & Haubold 1991 (the latter name introduced by Kerp *et al.* 1991 to replace *Sphenocallipteris* Haubold & Kerp 1988 which is a junior homonym of *Sphenocallipteris* Kryshtafovich & Novik 1947). The informal term 'callipterid' was proposed in descriptions of fossil foliage (Kerp & Haubold 1988).

## Fossil callipterids in the Donets Basin

Fossil plants with callipterid foliage from the Donets Basin were first investigated by Stschegolev (1960, 1965). The plant remains were found in greenish- grey siltstones and claystones below the limestones $P_6$, between the coal seams $p_4$ and $p_5$. The best outcrops of this part of the sequence are in the valley on the west side of the Lugan River Reservoir near the Luganskoje village, Donetsk County. The fossil plant assemblage consists of *Autunia naumannii*, *Odontopteris lingulata* (Göppert 1841) Schimper 1869, *Sphenopteris germanica* Weiss 1872, *Pecopteris arcuata* Halle 1927 and the form previously described as *Callipteris* aff. *zbyšoviensis* Augusta var. *microphylla* Stschegolev 1960. According to Stschegolev (1965) the high number of hypautochthonous *Callipteris* fossils there is a result of the expansion of these plants from the uplands into the lowlands. These changes of the lowland vegetative cover are considered to mark the beginning of the Permian floristic stage. On this basis Stschegolev (1965, 1975) placed the Carboniferous-Permian boundary below the limestone $P_6$, between the coal seams $p_4$ and $p_5$. According to Inosova & Schvartsman (1970; also Inosova *et al.* 1976) a prominent change in palynological assemblages indicates that the boundary is located between limestones $Q_7$ and $Q_8$. The part of the sequence between limestones $P_5$ and $Q_7$ is correlated with the *Daixina bosbytauensis-D. robusta* Zone of the fusulinid standard by Davydov (1990).

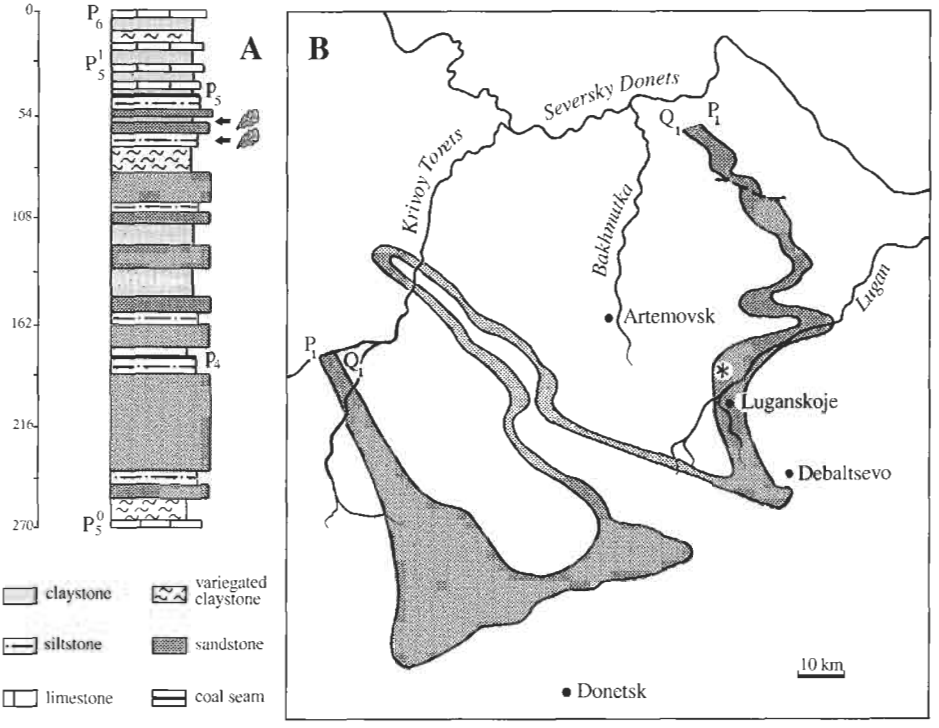


Fig. 1. ❑A. Rock column of the stratigraphic interval between $P_5^0$ and $P_6$ limestones at the west bank of the Lugan river reservoir near Luganskoje. ❑B. Schematic map of the Western Donets Basin, Ukraine, showing the structural plan of the limestones $P_1$ and $Q_1$. The locality of fossil callipterids indicated with asterisk.

During the last 15 years a lot of fossil callipterids have been collected by A.K. Stschegolev and the author from the locality near Luganskoje village. The fossil plant material provides new data on the morphology of these types of callipterid foliage. This provides an insight into local palaeoecological conditions and contributes towards a better understanding of the early Permian phytogeography.

The collection is stored in the Natural History Museum of Ukraine, Kiev (abbreviated GM MPC, collection No 2216).

## Taxonomic descriptions

Order Callistophytales Meyen 1984

Incertae familiae

Note on anatomical terminology: In the callipterid fronds described below immature entirely margined pinnae bear thick pronounced 'midveins', which correspond to axes of mature pinnae, and densely distributed 'lateral veins' that became midveins of pinnulae later in frond ontogeny. To avoid confusion, I introduce here the terms 'pre-axes' and 'pre-midveins' for these structures, respectively.

Genus *Raminervia* gen. n.

Type species: *Raminervia mariopteroides* sp. n.

Derivation of the name: Latin ramus (offshoot) and nervus (vein), which refer to peculiarities of the ovule attachment.

**Diagnosis**. — Fronds dichotomously branched, pinnate to tripinnate. Pinnae alternating. Intercalary pinnae are situated on the primary rachis between the penultimate order pinnae. Intercalary pinnae are analogous to the ultimate order pinnae. Intercalary pinnules are situated on the penultimate order rachis between the ultimate order pinnae. Intercalary pinnules resembling other pinnules. Pinnules sphenopteroid. Phyllosperms are (enlarged/prolonged) fertile pinnules. Ovules are situated near the base and in the middle part of the phyllosperms. Ovules are attached to the lamina and situated at the ends of vein-like offshoots. The vein-like offshoots emerge from the base of the midvein and from the base of the basal lateral veins. Seeds and polliniferous organs are unknown.

**Remarks**. — *Raminervia* gen. n. and the natural genus *Tinsleya* Mamay 1966 are both established for fronds of callipterid foliage with ovuliferous pinnules. Such pinnules are referred to as phyllosperms (Meyen 1984). *Raminervia* differs from *Tinsleya* in the position of the seed scars which are situated in *Raminervia* near the base and in the middle part of the phyllosperms. Ovules of *Tinsleya* are either attached apically or marginally to slightly modified 'normal' pinnules.

**Species assigned**. — Only the type species.

## *Raminervia mariopteroides* sp. n.

Figs 2–5.

Holotype: Fragment of a penultimate order pinna with semi-mature and mature pinnules, GM MPC 2216/4, Fig. 2C

Type horizon: Claystone bed 4 from the interval between the limestones $P_5$ and $P_6$; Asselian, Early Permian.

Type locality: Valley on west bank of the Lugan River reservoir, Luganskoje, Western Donets Basin, Ukraine.

Derivation of the name: The species name refers to a general resemblance to pinnules of *Mariopteris*.

**Diagnosis**. — Fronds dichotomously branched, pinnate. Primary rachis bifurcates into two equal rachises with alternating pinnate pinnae. Fronds are tripinnate above the bifurcation. Pinnae of the external side of the forked rachis are larger and more strongly developed than pinnae of the internal side. Rachises straight, longitudinally striated. Penultimate and ultimate order pinnae are oval to oblong-oval with oval apices. Immature and semi-mature pinnae vary from entirely margined to lobed and incised. Pre-axes of the immature entirely margined pinnae are robustly pronounced and thick; after reaching approximately 3/4 of the pinnae length they bifurcate. The pre-axes have 3–4 lateral pre-midveins on the every side. Pre-midveins bifurcate 1–2 times near their base or in the middle part. Pinnules are oval- to wedge-shaped, three to five-lobed, narrow at the bases, widened in the middle part, with wide-oval apices, decurrent, and

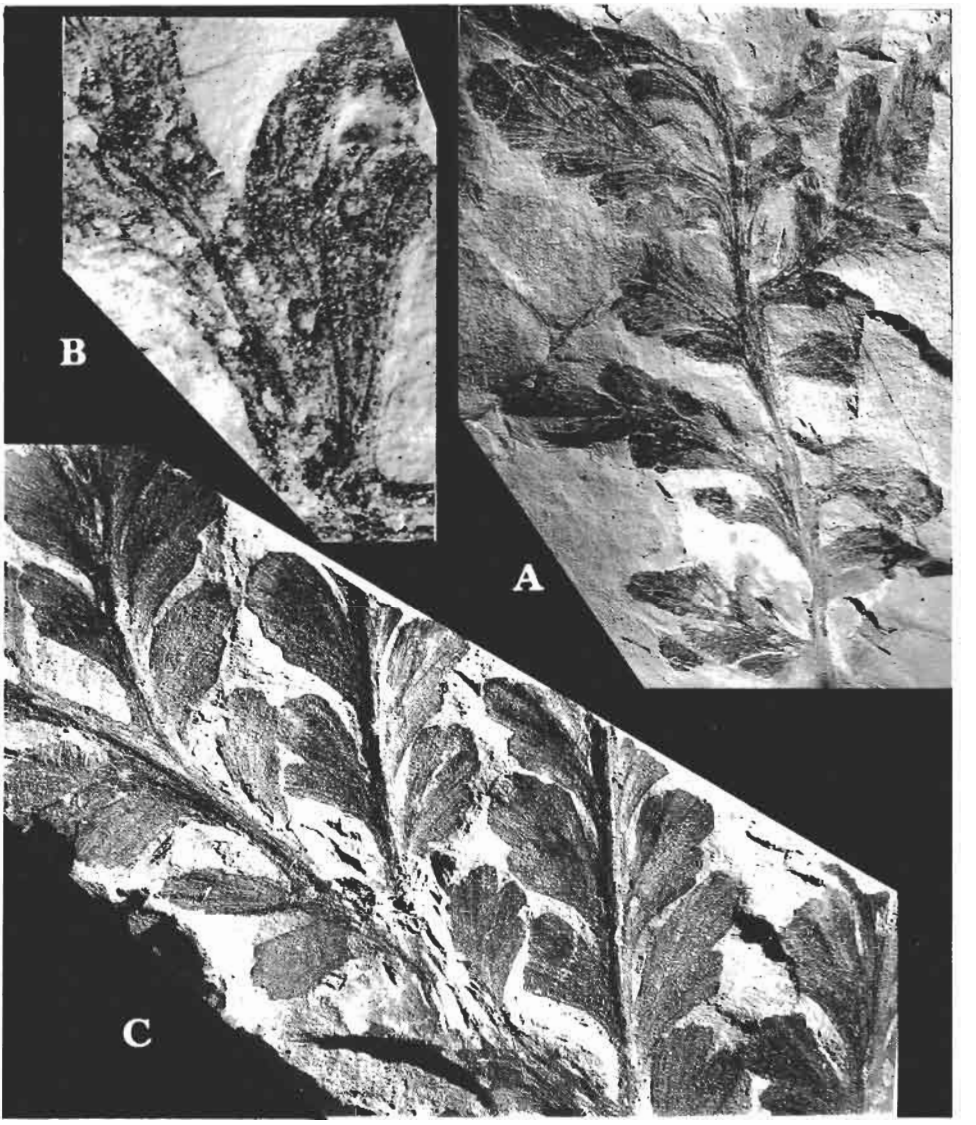


Fig. 2. *Raminervia mariopteroides* gen. et sp. n., Early Permian claystone between coal seams $P_4$ and $P_5$ (below limestone $P_6$), Luganskoje, Donets Basin. ❑A. Fragment of a ultimate order pinna with seed-bearing pinnules (phyllosperms), paratype GM MPC 2216/10, × 1.5. ❑B. Detail of A, the phyllosperm with seed scars, × 7. ❑C. Fragment of a penultimate order pinna with semi-mature and mature pinnules, holotype GM MPC 2216/4, × 2.5.

loosely spaced. Semi-mature pinnules are entirely margined with crenulate lateral margins. Midveins are thin, decurrent at the basis. They reach up to 1/2 or 2/3 of the length of pinnules and then bifurcate. Lateral veins are thin, sparse, decurrent and bifurcate one or two times. The bifurcation of the lateral veins is usually situated near the midvein.

Intercalary pinnules resembling the other pinnules are situated on the penultimate order rachis between the ultimate order pinnae. Intercalary

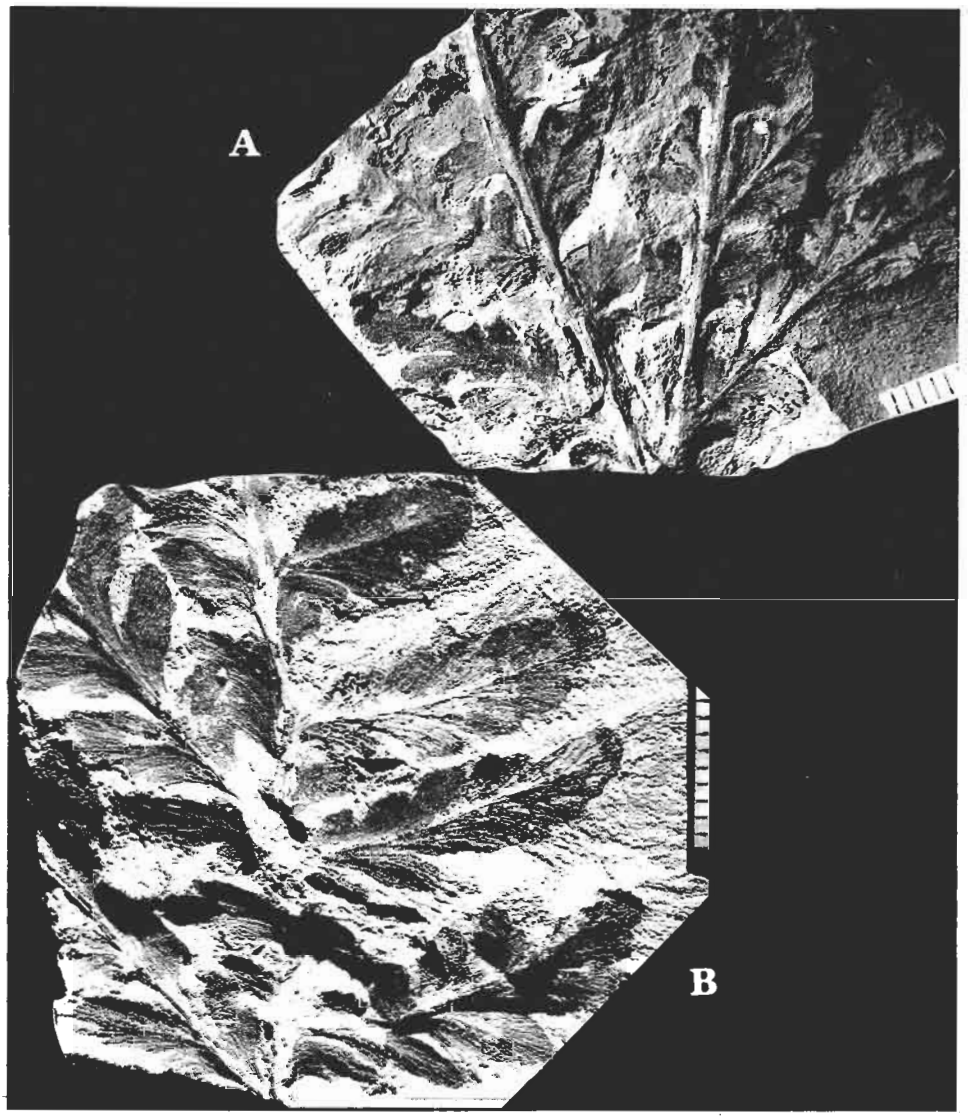


Fig. 3. *Raminervia mariopteroides* sp. n., Early Permian, Luganskoje, Donets Basin. ❑A. Fragment of a small frond of a juvenile plant with the dichotomous primary rachis, paratype GM MPC 2216/6, × 2. ❑B. Portion of a frond above bifurcation of the primary rachis with penultimate order pinnae better developed on the external than internal side, paratype GM MPC 2216/3, × 2.

pinnae analogous to ultimate order pinnae are situated on the primary rachis between the penultimate order pinnae.

Phyllosperms are large, well developed, strongly lobed pinnules which bear roundish and round-oval seed scars near the base and in their middle part. Ovules were attached to the lamina and situated at the ends of the vein-like offshoots. The vein-like offshoots emerge from the base of the midvein and from the base of the basal lateral veins.

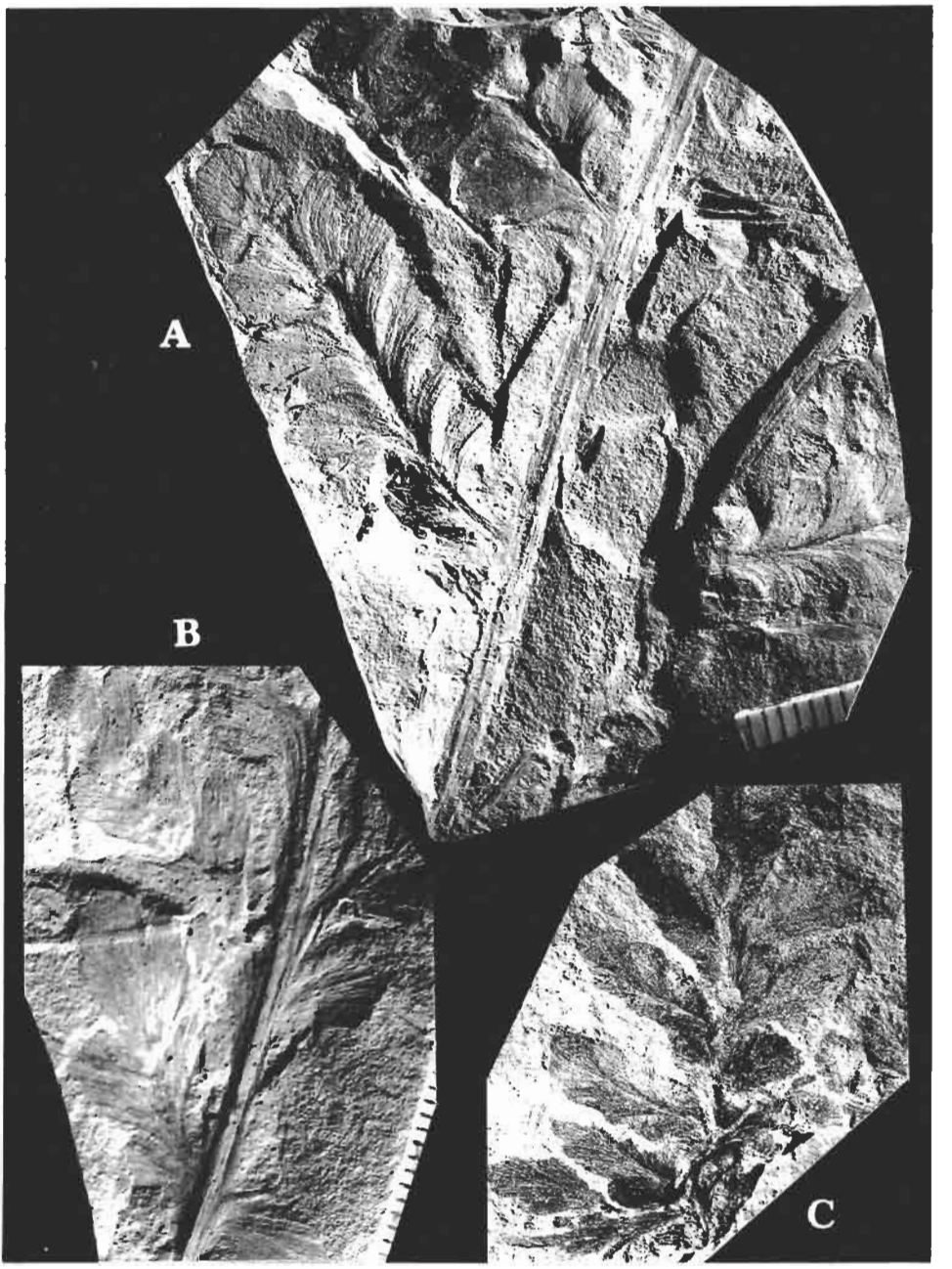


Fig. 4. *Raminervia mariopteroides* sp. n., Early Permian, Luganskoje, Donets Basin. ❑A. Portion of a frond with semi-mature pinnules on the ultimate order pinna of the external side of the forked primary rachis, specimen GM MPC 2216/8, × 2.5. ❑B. Fragment of the ultimate order pinna with large mature pinnules, paratype GM MPC 2216/9, × 2. ❑C. Apical part of an immature pinna, GM MPC 2216/5, × 2.2.

Polliniferous organs are unknown.

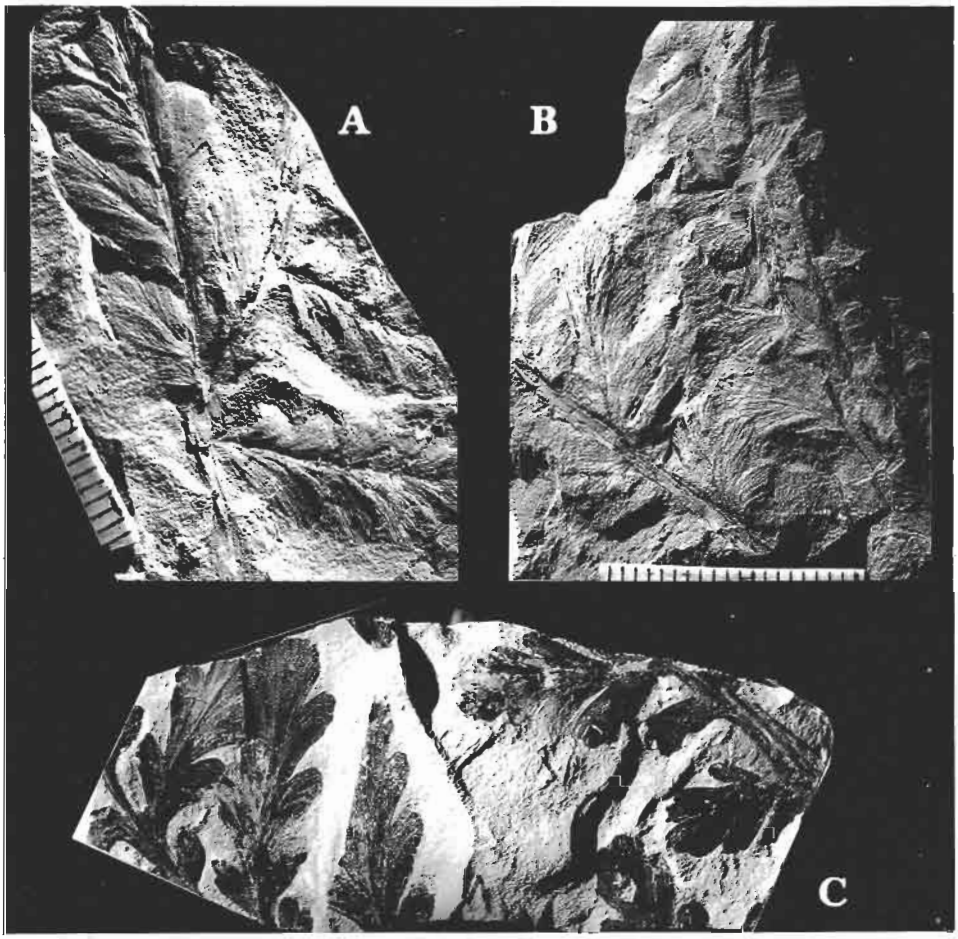


Fig. 5. *Raminervia mariopteroides* sp. n., Early Permian, Luganskoje, Donets Basin. ❑A. Portion of a frond above bifurcation of the primary rachis with pinnae better developed on the external than on internal side, specimen GM MPC 2216/7, × 2. ❑B. Fragment of a frond with a dichotomous primary rachis, specimen GM MPC 2216/17, × 2. ❑C. Fragment of penultimate order pinnae with semi-mature ultimate order pinnae, specimen GM MPC 2216/16, × 1.5.

**Material**. — 58 specimens, including one pinna with fertile pinnules. The most informative are phyllosperms with seed scars GM MPC 2216/10 (Fig. 2A); fragment of a small frond of a juvenile plant with the dichotomously branched primary rachis GM MPC 2216/6 (Fig. 3A); portion of a frond above the bifurcation of the primary rachis with stronger developed pinnae of the penultimate order on the external side GM MPC 2216/3, the internal side bears less developed pinnae (Fig. 3B); fragment of an ultimate order pinna with large mature pinnules GM MPC 2216/9 (Fig. 4B).

**Description**. — The fragment of the small dichotomously branched pinnate frond is up to 4 cm long (Fig. 3A). The bifurcation angle is 35°. The pinnae are alternately inserted at angles of 35–50° to the rachis. Immature

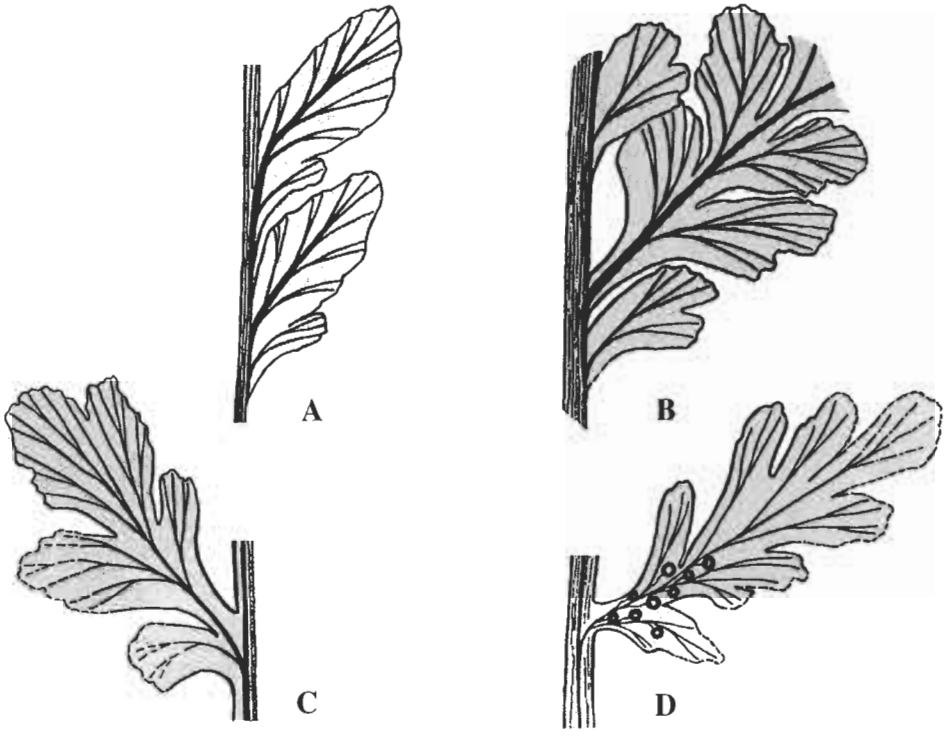


Fig. 6. Drawings of *Raminervia mariopteroides* sp. n. pinnae and pinnules. ❑A. Immature entirely margined pinnae of the ultimate order; drawn after the specimen GM MPC 2216/7 (Fig. 5A), × 2.5. ❑B. Semi-mature pinnules; drawn after the holotype GM MPC 2216/4 (Fig. 2C), × 2. ❑C. Mature pinnule; drawn after the paratype GM MPC 2216/9 (Fig. 4B), × 2.5. ❑D. Phyllosperm with seed scars; drawn after the paratype GM MPC 2216/10 (Fig. 2A), × 2.

penultimate order pinnae vary in length from 1–2 cm to 10–12 cm. Pinnae are 1–2 cm long, entirely margined with crenulate or lobed lateral margins (Figs 3B, 4C). Pinnae are from 2.5–3 cm to 7–12 cm long; they bear immature and semi-mature ultimate order pinnae (Figs 3A, 3B).

Immature ultimate order pinnae vary in length from 0.4–0.6 cm to more than 4–5 cm. Pinnae 0,4– 0,6 cm long can be fused to 1/3 or 2/3 of their length, entirely margined, oval, decurrent with oval apices (Fig. 3A). Pinnae 0.7–1 cm long are closely spaced, fused at the base, entirely margined, oblong-oval and oval. Lateral margines of the pinnae may be straight or slightly convex (Figs 3A, 4A). Pinnae from 1 to 3 cm long are loosely spaced, oval or oval-rhombic, from crenulate to lobed, with distinct basal lobe, widened in the middle part, decurrent, with oval apices (Figs 3B, 5A).

Mature ultimate order pinnae are more than 4–5 cm long and 1–1.5 cm wide. They bear semi-mature and mature pinnules.

Pinnules are 8–12 mm long and 4.5–5 mm wide (Fig. 2C) and loosely spaced, wedge-shaped, decurrent. Semi-mature pinnules 8–10 mm long are entirely margined with crenulate lateral margins. Mature pinnules, 11–12 mm long and more, are usually lobed. Mature pinnules of adult

Fig. 7. Restoration of *Raminervia mariopteroides* sp. n. frond; upper part based on specimens illustrated on Figs 3A–B and 4A, C, lower inferred from analogy with dichotomously branched frond of *Dichophyllum cuneata* sp. n. (Fig. 9A).

plants (Fig. 4B), 22–28 mm long and 15 mm wide, are strongly lobed with the loosely spaced basis lobe.

Phyllosperms (Fig. 2A) are 25–30 mm long and 8–12 mm wide and bear 8–10 seed scars. Seed scars, up to 0.8–0.9 mm in diameter, are situated at the ends of the slightly undulate vein-like offshoots which are 1 to 2 mm long.

**Remarks**. — The new species shows some resemblance to *Rhachiphyllum schenkii* (Heyer 1884) Kerp 1988, *Lodevia nicklesii* (Zeiller 1898) Haubold & Kerp 1988, and *L. luganica* (Boyarina & Stschegolev 1989) transl. herein. It differs from *R. schenkii* in its dichotomously branching primary rachis, wedge-shaped pinnules, the absence of subsidary veins and less dense venation in mature pinnules. From *L. nicklesii* and *L. luganica* the new species differs in having wedge-shaped pinnules, more pronounced midvein, bifurcating lateral veins, and thin laminae of pinnules.

The presence of oval structures, up to 0.8–0.9 mm in diameter, is crucial for the proposed interpretation of *R. mariopteroides* as a fertile callipterid. Their rounded shape, a concavity in the center and a scar at the margin, as well as connection with the vein-like offshoots and concentration near the base and in the middle part of pinnules, indicate that these are seed scars and not glandular bodies or fungal infections.

**Distribution**. — Only the type locality.

Pteridosperms incertae sedis

Genus *Dichophyllum* Elias *ex* Andrews 1941

Type species: *Dichophyllum moorei* Elias *ex* Andrews 1941.

## *Dichophyllum cuneata* sp. n.

Figs 8–9.

*Callipteris* aff. *zbyšoviensis* Augusta var. *microphylla* Stscheg.; Stschegolev 1960: Pl. 1: 2.

Holotype: Portion of a frond above bifurcation of the primary rachis with semi-mature pinnules GM MPC 2216/11 (Fig. 8A).

Type horizon: Mudstone bed from the interval between the limestones $P_5$ and $P_6$, Asselian, Early Permian.

Type locality: Valley on the west bank of the Lugan River reservoir, Luganskoje, Western Donets Basin, Ukraine.

Derivation of the name: The species name is derived from Latin cuneatus (wedge-shaped) and refers to the pinnule shape.

**Diagnosis**. — Fronds pinnate with a dichotomously branched primary rachis. Fronds are bipinnate to tripinnate above the bifurcation. Pinnae of the external side of the forked rachis are larger and better developed than pinnae of the internal side. Primary rachis longitudinally striated.

Pinnules broadly flabelliform, wedge-shaped, with a narrow base, decurrent. Apices wide, semi-rounded, margins usually crenulate. Immature pinnnules closely spaced, usually fused at the base, and with crenulate apices. Semi-mature and mature pinnules loosely spaced, incised into 3–5 wedge-shaped segments with straight lateral margins and obtuse, crenu-

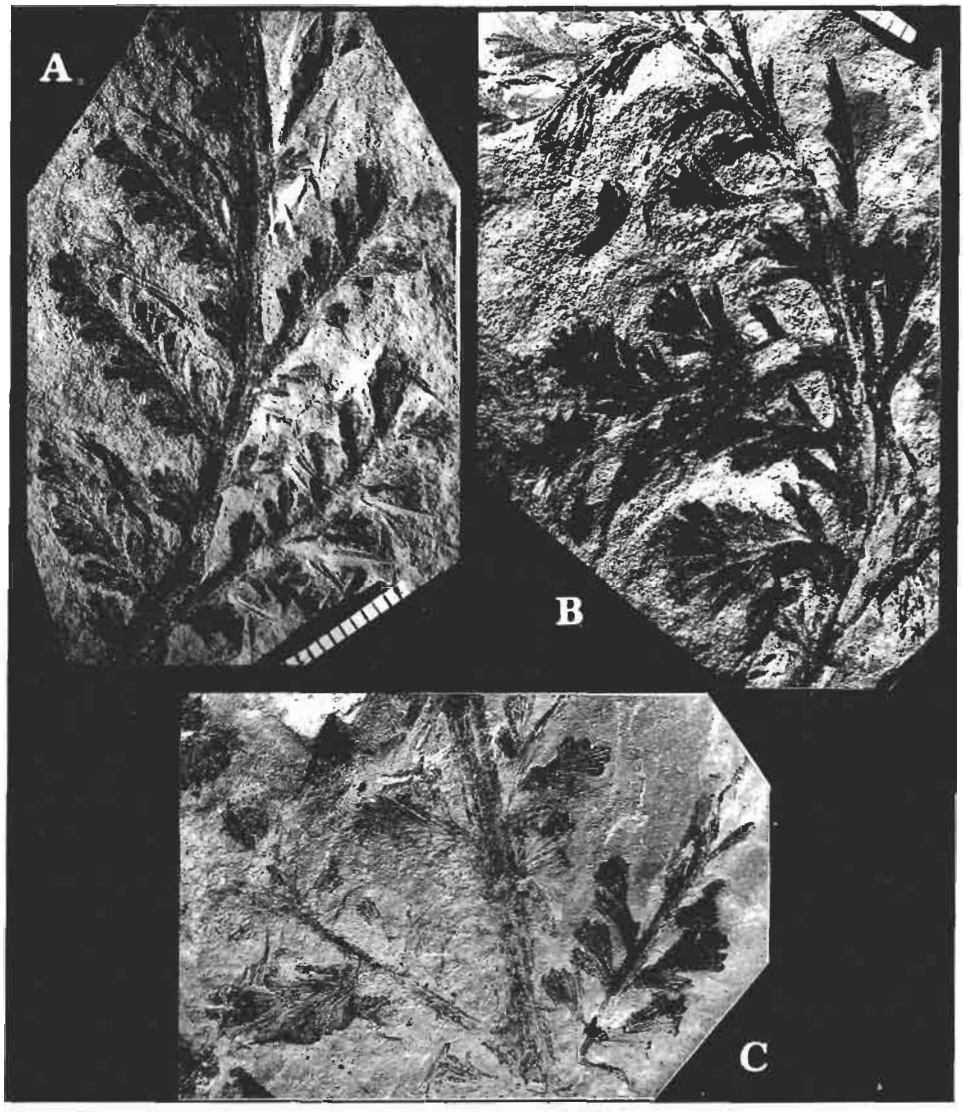


Fig. 8. *Dichophyllum cuneata* sp. n., Early Permian mudstone between coal seams $P_4$ and $P_5$, Luganskoje, Donets Basin. ❑A. Portion of a frond above the bifurcation of the primary rachis with semi-mature pinnules, holotype GM MPC 2216/11, × 1.8. ❑B. Apical part of a forked rachis with semi-mature ultimate order pinnae, paratype GM MPC 2216/12 × 2. ❑C. Portion of a frond above the bifurcation of the primary rachis with pinnae better developed on the external than on internal side, GM MPC 2216/13, × 1.8.

late or grooved apices. The midvein bifurcates near the pinnule base. Each lateral vein enters an individual segment and bifurcates 1–2 times.

Intercalary pinnules are similar to other pinnules.

**Material**. — 5 specimens. Along with the holotype the most informative is the apical part of a forked rachis with semi-mature ultimate order pinnae GM MPC 2216/12 (Fig. 8B).

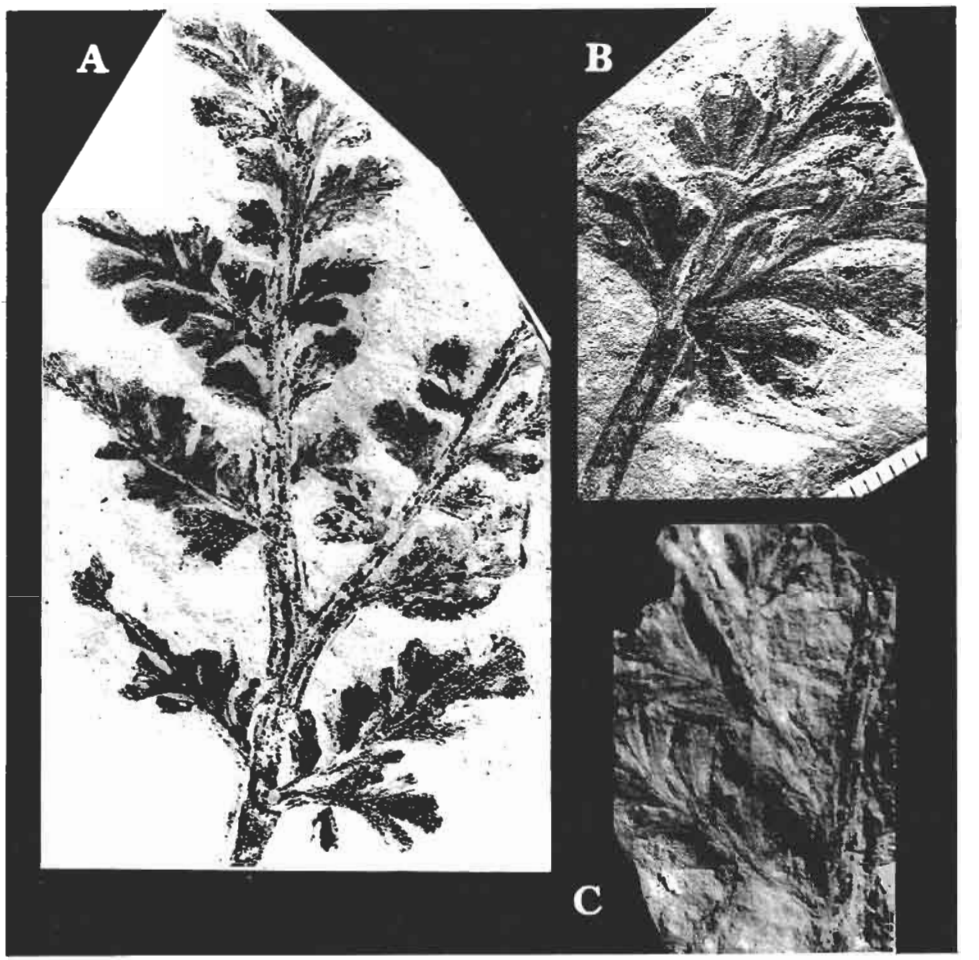


Fig. 9. *Dichophyllum cuneata* sp. n., Early Permian, Luganskoje, Donets Basin. ❑A. The specimen figured by Stschegolev (1960: Pl. 1:2); fragment of a dichotomously branched bipinnate frond, × 1.2. ❑B. Fragment of a pinna with mature pinnules, GM MPC 2216/14, × 1.8. ❑C. Fragment of pinna with mature pinnules, GM MPC 2216/15, × 1.

**Description**. — The most complete fragment of the dichotomously branched pinnate frond is up to 12 cm long (Fig. 9A). The angle of the fork is 40°. The primary rachis bears ultimate order pinnae below and above the bifurcation. The pinnae are alternately inserted at angles of 40–50° to the rachis. Immature ultimate order pinnae are 1–1.8 cm long and 0.4–0.7 cm wide. They vary from being lobed (Fig. 8C) to incised on the segments (Fig. 8B). Pinnae are 0.8–3 cm long and 0.3–1 cm wide, bear immature and semi-mature pinnules (Fig. 8A–B).

Immature pinnules are 1.5–3 mm long and 0.5–0.7 mm wide, closely spaced, usually fused at the base (Fig. 8B). Semi-mature pinnules are 4–6 mm long and 3.5–4.5 mm wide, loosely spaced, incised into 3–5 lobes (Fig.

8A). Mature pinnules are 7–13 mm long and 6–13 mm wide, incised up to the base of the pinnules into the loosely spaced segments (Fig. 9B–C).

**Remarks**. — The specimen described as *Callipteris* aff. *zbyšoviensis* Augusta var. *microphylla* Stscheg. by Stschegolev (1960) is considered to be conspecific with *D. cuneata*. This is the most complete fragment of a frond showing its structure.

The new species is included in *Dichophyllum* because of its flabelliform pinnules, with segments fused only basally. *D. cuneata* sp. n. differs from other species of the genus in its broadly idealy wedge-shaped pinnules and wedge-shaped segments.

*D. cuneata* sp. n. shows some resemblance to *Callipteris zbejsoviensis* Augusta 1937, the species not attributed to any valid genus by Kerp & Haubold (1988), and *Lodevia nicklesii*. The wedge-shaped pinnules with narrow bases and straight lateral margins, pinnules incised to the base into 3–5 wedge-shaped segments with straight lateral margins, and the bifurcation of midveins near the pinnule base make it different from *C. zbejsoviensis*. From *L. nicklesii* the new species differs in broadly flabelliform shape of pinnules with wide, semi-rounded apices, in pinnules being incised to the base, wedge-shaped segments with straight lateral margins, and in bifurcation of the midvein near the pinnule base.

**Distribution**. — Only the type locality.

## Palaeoecology

The palaeoecological interpretations presented below are based on the fossil plant material from the Western Donets Basin. The most important occurrences are found in the upper part of the sequence between the limestones $P_5^0$ and $P_6$. The plant remains occur in grey and greenish-grey claystones and siltstones. Apart from the plant fossils, numerous imprints of lacustrine bivalves occur there (personal communication by N.L.Maslo).

The bed No. 4 is richest in plant fossils. They occur in a greenish-grey claystone. The claystone is up to 45 cm thick, vaguely laminated, massive, with a faint rupture. Abundant *Raminervia mariopteroides* remains were found in the lower part of the bed No. 4. Relatively scarce plant remains of *Rhachiphyllum schenkii*, *Autunia conferta*, *Lodevia nicklesii* and rare *Pecopteris bredovi* Germar 1845, *P.* sp., *Sphenopteris fayoli* Zeiller 1888 have been found together with *Raminervia mariopteroides* in the upper part of this bed. A few other claystone horizons, up to 20–25 cm thick, contain only the remains of *Raminervia mariopteroides*. Other fossil plant assemblages from various claystone, siltstone, and fine-grained sandstone beds, containing *Lodevia nicklesii*, *Autunia naumannii*, and relatively scarce remains of *Dichophyllum cuneata* sp. n., *Lodevia suberosa* (Sterzel 1918) Haubold & Kerp 1988, *L. luganica*, *Autunia conferta*, represent mixed assemblages.

Relatively good preservation of *Raminervia mariopteroides* specimens as large fragments of fronds and pinnae in claystone suggests that the

material did not undergo a long transport. The claystone is interpreted as a lacustrine-floodplain deposit. The thin lamina with relatively thin veins of *Raminervia mariopteroides* leaves suggests that the plants grew on margins of floodplain lakes under moderately humid conditions. *R. mariopteroides* apparently dominated in the floodplain vegetation and may have formed near marginal lacustrine-floodplain monospecific plant communities. *Autunia naumannii*, *A. conferta*, *Dichophyllum cuneata*, *Lodevia nicklesii*, *L. suberosa*, and *L. luganica*, which occur also in siltstones and fine-grained sandstones, were spread more widely, both on elevated parts of the floodplain and on less humid parts of the alluvial-lacustrine plain. Usually the presence of large frond parts in claystones and minute pinnae fragments in more coarsely grained rocks apparently correspond to a variation in energy of depositional environment and distance of transport. *Autunia naumannii*, *A. conferta*, *Dichophyllum cuneata*, *L. suberosa*, and *L. luganica* had relatively thick laminae and veins of their leaves which may suggest their realtively dry habitat. The lamina of *Lodevia nicklesii* was rather thin. *Rhachiphyllum schenkii*, also having thin pinnules, probably grew near the floodplain lakes, like *R. mariopteroides*, since hypoautochtonous plant remains of *R. schenkii* occur only in claystones of a lacustrine-floodplain origin.

Probably some morphological features of ovuliferous organs are related to life conditions of pteridosperms. *Raminervia mariopteroides* with seed-bearing pinnules and

*Rhachiphyllum schenkii* with the sterile pinnules, which Kerp (1988) compared with those of *Tinsleya texana* Mamay 1966, are generally believed to live in more humid conditions than *Autunia conferta* and *A. naumannii* which both have petiolate broadly flabelliform megasporophylls.

Such megasporophylls with strong ribs were obviously rigid and, consequently, better protected the ovules in dry conditions on elevated areas of the floodplain and alluvial-lacustrine plain.

Kerp (1988) described similar conditions of growth of plants with callipterid foliage in the Early Permian of the Saar-Nahe area. According to him, *Autunia conferta* grew under relatively dry conditions on elevated sandy lake margins and river banks. In opposition to *A. conferta*, *Rhachiphyllum schenkii* had very thin pinnules which may indicate a more humid habitat, and seem to be a member of a hygrophilous vegetation..

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## References


Davydow, V.I. (Давыдов, В.И.) 1990. Зональное деление гжельского яруса в Донбассе и Предонецком прогибе по фузулинидам. In: Т.Н. Богданова, Э.М. Бугрова, (eds) *Проблемы современной микропалеонтологии*, 52–69. Наука, Ленинград.

Doubinger, J. 1979. Aperqu general des flores du Stephanien B, C et D(?) dans les bassins houillers de la France. *C.R. 8ieme Congress International de stratigraphie et de geologie Carbonifere, Moskou 1975* **2**, 141–146.

Havlena, V. 1958. Das Grundproblem der Grenze Karbon-Perm in der Tschechoslowakei. *C. R. 4ieme Congress pour l'avancement des etudes de Stratigraphie et de geologie du Carbonifere, Heerlen 1958* **1**, 277–285.

Inosova, K.I., Schvartsman, E.G. (Иносова, К.И., Шварцман, Е.Г.) 1970. Основные этапы изменения спорово-пыльцевого состава в верхнем карбоне и нижней перми. In: С.В. Семихатова (ed.) *Проблемы стратиграфии карбона*, 149–156. Наука, Москва.

Inosova, K.I., Kruzina, A.H., & Schvartsman, E.G. (Иносова, К.И., Крузина, А.Х., Шварцман, Е.Г.) 1976. *Атлас микроспор и пыльцы верхнего карбона и нижней перми Донецкого бассейна*, 1–176. Недра, Москва.

Jongmans, W.J. 1928. Congress pour l'étude de la stratigraphie du Carbonifere dans les differents centres houillers de l'Europe. *C.R. 1ième Congress pour l'avancement des études de Stratigraphie et de géologie du Carbonifere, Heerlen 1927* **1**, 1–48.

Jongmans, W.J. & Gothan, W. 1937. Betrachtungen über die Ergebnisse des Zweiten Kongresse für Karbonstratigraphie. *C. R. 2ieme Congress pour l'avancement des etudes de Stratigraphie et de geologie du Carbonifere, Heerlen 1935* **1**, 1–40.

Kozur, H. 1978. Bemerkungen zum Vorkommen der Gattung *Callipteris* Brongniart in Karbon. *Verhandlungen der Geologischen Bundesanstalt, Wien* **2**, 11–22.

Kozur, H. 1984. Carboniferous-Permian boundary in marine and continental sediments. *9th International Congress of Carboniferous Stratigraphy and Geology, Washington and Champaign-Urbana 1979* **2**, 577–586.

Kerp, J.H.F. 1986. The generic name *Callipteris* Brongniart (Foss.) reconsidered – withdrawal of proposal to conserve *Callipteris*. *Taxon* **35**, 370–371.

Kerp, J.H.F. 1988. Aspects of Permian palaeobotany and palynology. X. The West- and Central European species of the genus *Autunia* Krasser emend. Kerp (Peltaspermaceae) and the form-genus *Rhachiphyllum* Kerp (callipterid foliage). *Review of Palaeobotany and Palynology* **54**, 249–360.

Kerp, J.H.F. & Haubold, H. 1988. Aspects of Permian palaeobotany and palynology. VIII. On the reclassification of the western and central European species of the form-genus *Callipteris* Brongniart 1849 *non* Bory 1804. *Review of Palaeobotany and Palynology* **54**, 135–150.

Kerp, J.H.F., Naugolnykh, S.V., & Haubold, H. 1991. *Gracilopteris*, a new name for *Sphenocallipteris* Haubold et Kerp. *Review of Palaeobotany and Palynology* **69**, 369–370.

Mamay, S.H. 1966. *Tinsleya*, a new genus of seed-bearing callipteroid plants from the Permian of North-Central Texas. *US Geological Survey Professional Paper* **523E**, 1–15.

Meyen, S.V. 1984. Basic features of gymnosperm systematics and phylogeny as evidenced by the fossil record. *Botanical Review* **50**, 1–111.

Němejc, F. 1951. K vyskytu Callipteridu obzoru sloji rosicko-oslavanskych a k otazce stari tohovo slojeveho pasma. *Sbornik Ustředního Ústavu Geologického* **18**, 425–436.

Stschegolev, A.K. (Щеголев, О.К.) 1960. До питания про межу карбону та перми в Доневскому бассейни (за даними викопной флори). *Геологичний Журнал* **20**, 1, 47–57.

Stschegolev, A.K. (Щеголев, О.К.) 1965. Флора на рубеже карбона перми в Донецком бассейне. In: Д.Л. Степанов, П.П. Тимофееев (eds) *Геология угленосных формаций и стратиграфии карбона СССР*, 234–243. Наука, Москва.

Stschegolev, A.K. 1975. Die Entwicklung der Pflanzenbedeckung im Suden des Europäischen Teils der UdSSR, vom Ende des Mittelkarbons bis zum Perm. Umfang und Gliederung des oberen Karbons (Stefan). *Septieme Congres International de Stratigraphie et de Geologie du Carbonifere* **4**, 275–280.

## Анотація

Вивчені рештки викопних рослин виявлені в ранньопермських відкладах Західного Донбасу. Викопний матеріал зібран в аргілітових та алевролітових відкладах озерного і алювіально-озерного генезису в інтервалі розрізу між вапняками $P^0_5$ та $P_6$. Описано один природний рід *Raminervia* gen. n. та два види – *Raminervia mariopteroides* sp. n. і *Dichophyllum cuneata* sp. n.

Рід *Raminervia* характеризується філоспермами, які при основі та в середній частині несуть насінні рубці. До кожного рубця підходить відгалуження жилки. Листи *Raminervia mariopteroides* дихотомічно-перисті тричі перисто-складні, з дихотомією головної осі, сфеноптеридними лопатевими пір'ячками та проміжними елементами останнього та передостаннього порядку. Пір'я і пір'ячки морфологічно різноманітні, що обумовлено різними стадіями росту листа. Листи *Dichopyllum cuneata* діхотомічно-перисті двічі перисто-складні, з дихотомією головної осі, широко клиновидними пір'ячками, розсіченними на сегменти майже до основи, та з проміжними елементами останнього порядку.

Виходячи із морфологічних і тафономічних ознак рослинних решток та з генезису порід, рослини виду *R. mariopteroides* росли по берегам заплавних озер, утворюючи озерно-заплавні фітоценози, а представники виду *D. cuneata* були розповсюджені на підвищених ділянках заплави та алювіально-озерної рівнини.

## Streszczenie

Praca zawiera opis dwu nowych gatunków permskich paproci nasiennych o liściach typu *„Callipteris"* (nazwa ta jest młodszym synonimem rodzaju dzisiejszych paproci i w paleobotanice paleozoiku nie może być używana). Jeden z tych gatunków stanowi podstawę do wydzielenia nowego naturalnego rodzaju *Raminervia*.