Early Permian Ferns from the Fore-Urals

by
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Abstract

Pteridophyta are frequently found in the Early Permian floras (Artinskian-Kungurian) of the Russian Fore Urals, but an unambiguous determination is not possible for all. Many fronds look like ferns, but due to the fact that sporangia were never found another classification, the highly interesting group of Paleoangiosperms is suggested. In this publication, only those ferns were included whose sterile fronds and fertile parts were known. The most common pteridophyte is represented by *Convexocarpus distichus* with its characteristic synangia that can be compared with coeval *Scolecopteris* or *Asterotheca* ferns from Permian fossil sites in Europe. Completely different feature generating separate fertile and sterile fronds – a feature of extant Osmundaceae – is recorded in *Sylvopteris conspicua, Lomatopteris superba* or *Todites uralica* comb. nov. The *Corsinopteris dicranophora* probably belong to the Marattiales.

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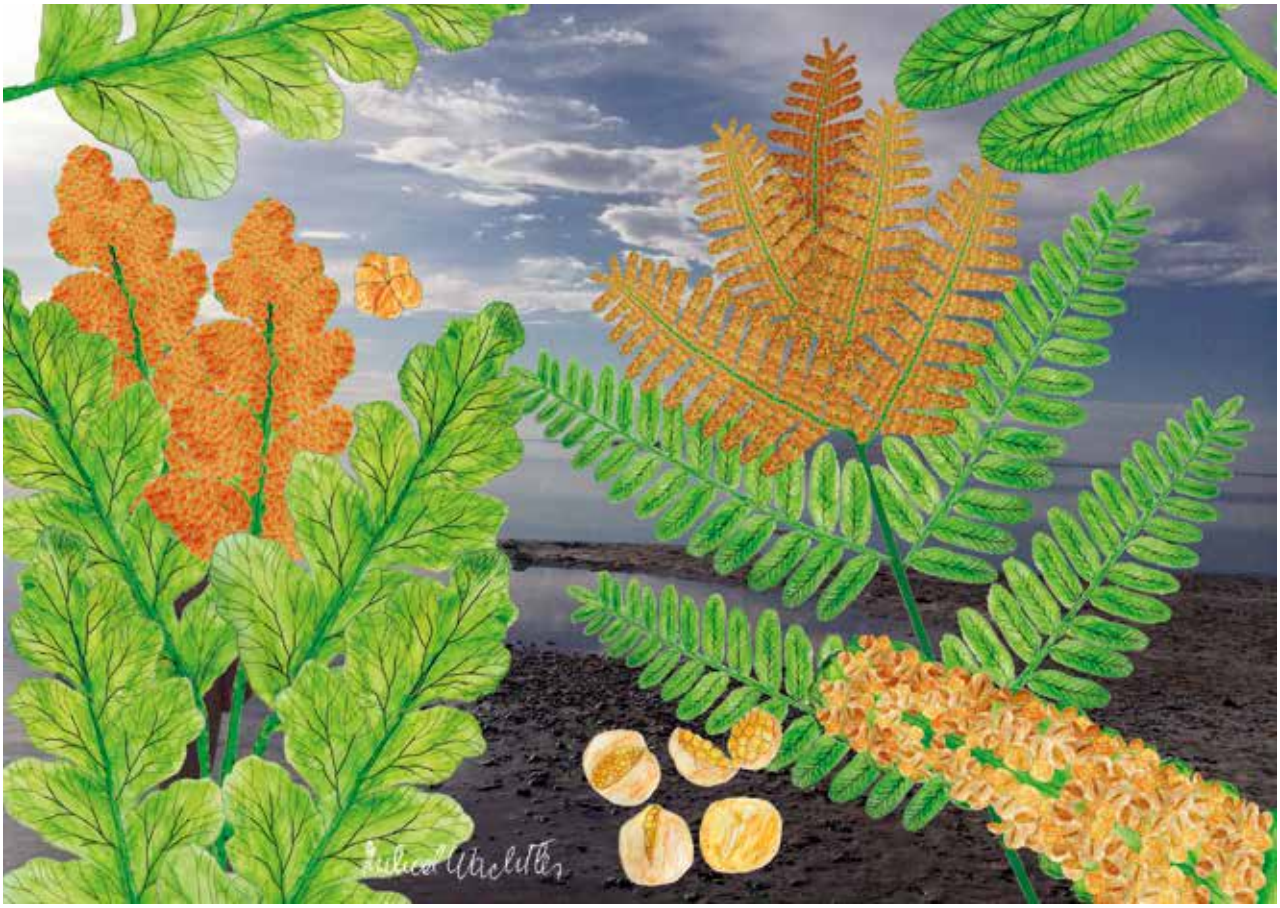


Early Permian Osmundaceae

Left: *Sylvopteris conspicua*; and **right:** *Lomatopteris superba*, two ferns belonging to the Osmundaceae with their fertile and sterile parts

Introduction

Paleozoic fern remains are found all over the Northern hemisphere, but they are often of limited informative value; fertile and sterile frond cannot be connected. This is valid for the Artinskian-Kungurian fern floras of the Fore-Urals, where in some places like Matvéevo, about 15 km south of Lyswa, and Chekarda, about 20 km north-east of Krasnoufimsk, we encounter superb but only fragmentary preserved fern-pinnulas of Kungurian age, or in other places like the Mazuevka site near the Sylva River, about 12 km northeast of Suksun, or Artinskian Panteleykovo in the direction to Arti's bigger fronds.– However, due to the coarse sandy siltstones, less conserved slabs often do not allow to study the characteristics of the sporangia well.

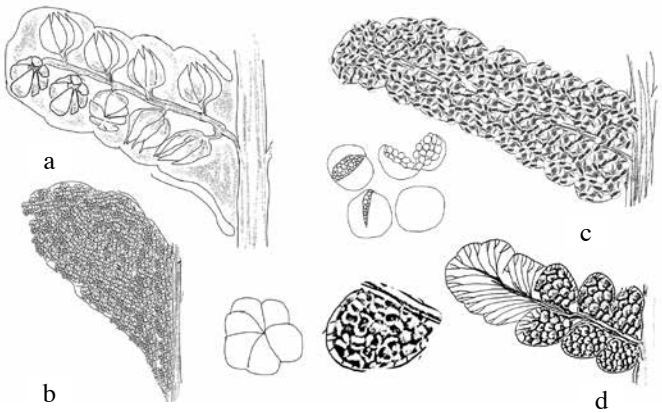
The first Pteridophyta from the former Angaraland were studied by the Russian palaeobotanist, Mikhail Dmitrievich Zalessky (1918, 1934, 1937), who introduced new genera and species such as *Dicranopteris regia* (invalid name because *Dicranopteris* or forked fern is an extant genus of tropical ferns of the family Gleicheniaceae) (Bernhardi, 1805), *Sclеropteris pristina, Odontopteris artipinnata, Stenopteris permensis* based on similar Paleozoic ferns from Europe including *Sylvopteris conspicua* or *Lomatopteris superba*. Unfortunately, his drawings are sometimes rudimentary to compare them with the reality, but his publication was a milestone in the spreading of knowledge about the Permian floras from Russia.

Another voluminous research we must thank is by the Russian palaeontologist, Serge V. Naugolnykh, who in his various works described the Filicales amongst other plants from the Early Permian Ural region (2013, 2014, 2016).

Convexocarpus distichus (Naugolnykh, 1995)

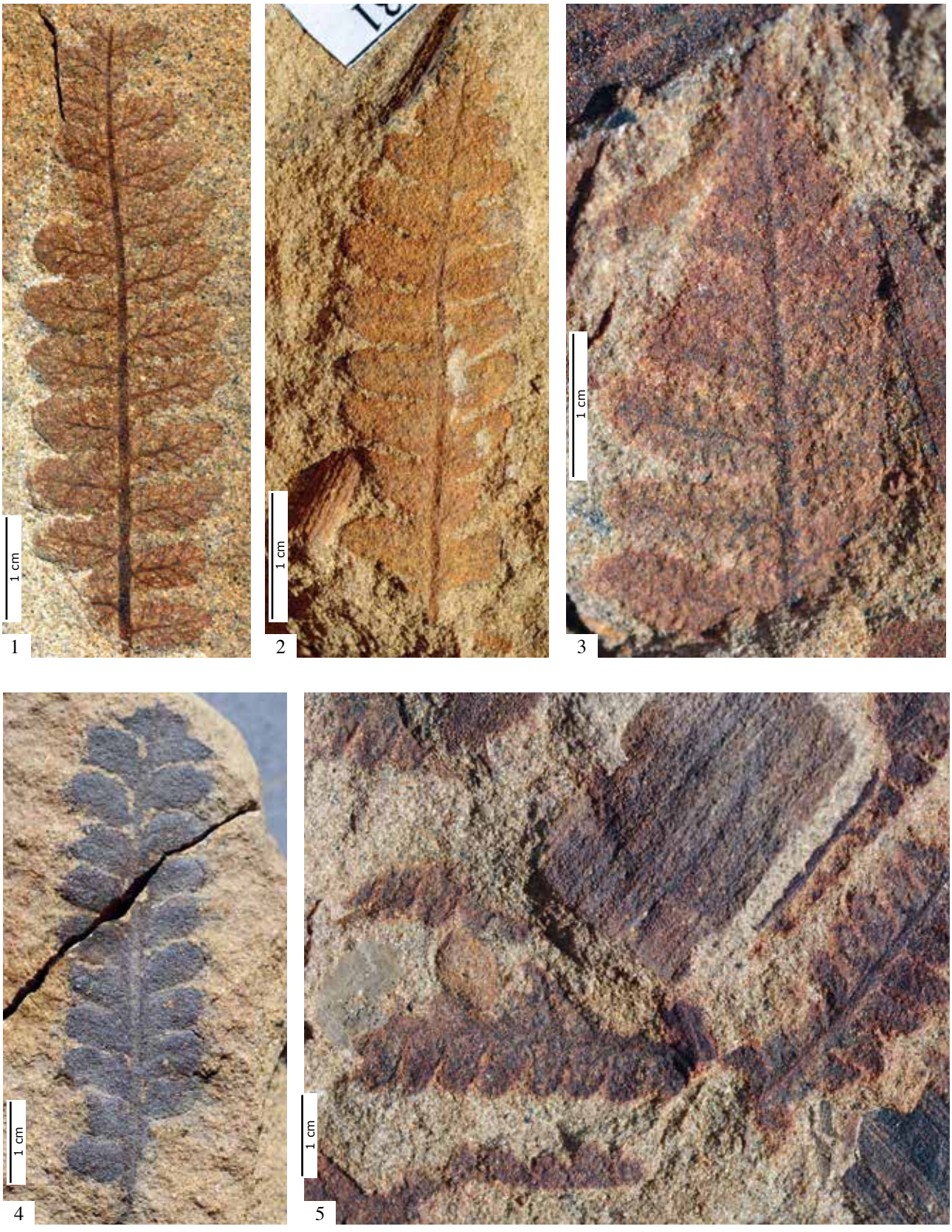
Probably the most common and, due to their conspicuous sporangia, easily recognisable fern is *Convexocarpus distichus*, although entire fronds have never been found. The whole fronds were probably bi- till tri-pinnate with lateral branchlets in an opposite or alternate attachment. The sterile leaflets are slightly elongated, with one main venation reaching the pinnule apex. The strong main vein forks into subtle lateral veins, which divide further only once towards the end of the apex. The fertile fronds were similar to the sterile ones in size. The single fertile pinnula was equipped with eight to nine synangia situated on the underside of the leaflets and attached to the basal part of the lateral veins. The synangia are radially symmetrical, positioned close to each other in two parallel rows extending along the mid-vein of fertile pinnule. Each synangium consists of eight or, less often, nine or ten sporangia, which are fused by the basal margins almost throughout the length, except for the apical part. The central part of the synangium contained the receptacle, providing attachment for sporangia. The synangia are often preserved lying on one side, and therefore, only four sporangia located on the side of the synangium turned towards the observer are seen. If they are pressed from the upper side, eight to ten sporangia can be observed (Wachtler, 2017).

Paleozoic fern-fronds from Euramerican fossil sites with these features were described as *Scolecopteris* (Perner & Wachtler, 2013). Beginning from the Permian over the Triassic, they were further classified as *Asterotheca* (Wachtler, 2016). Due to their similarities with *Convexocarpus,* some assumptions suggest a genealogical relationship. A classification in one of the today's existing fern groups is difficult. Often, they were compared with the Marattiaceae, such as the *Angiopteris* or *Marattia* (Naugolnykh, 2014), widespread in the tropics around the world, but their synangia seems to be too different. Also, their natural extant tropical habitat is in net



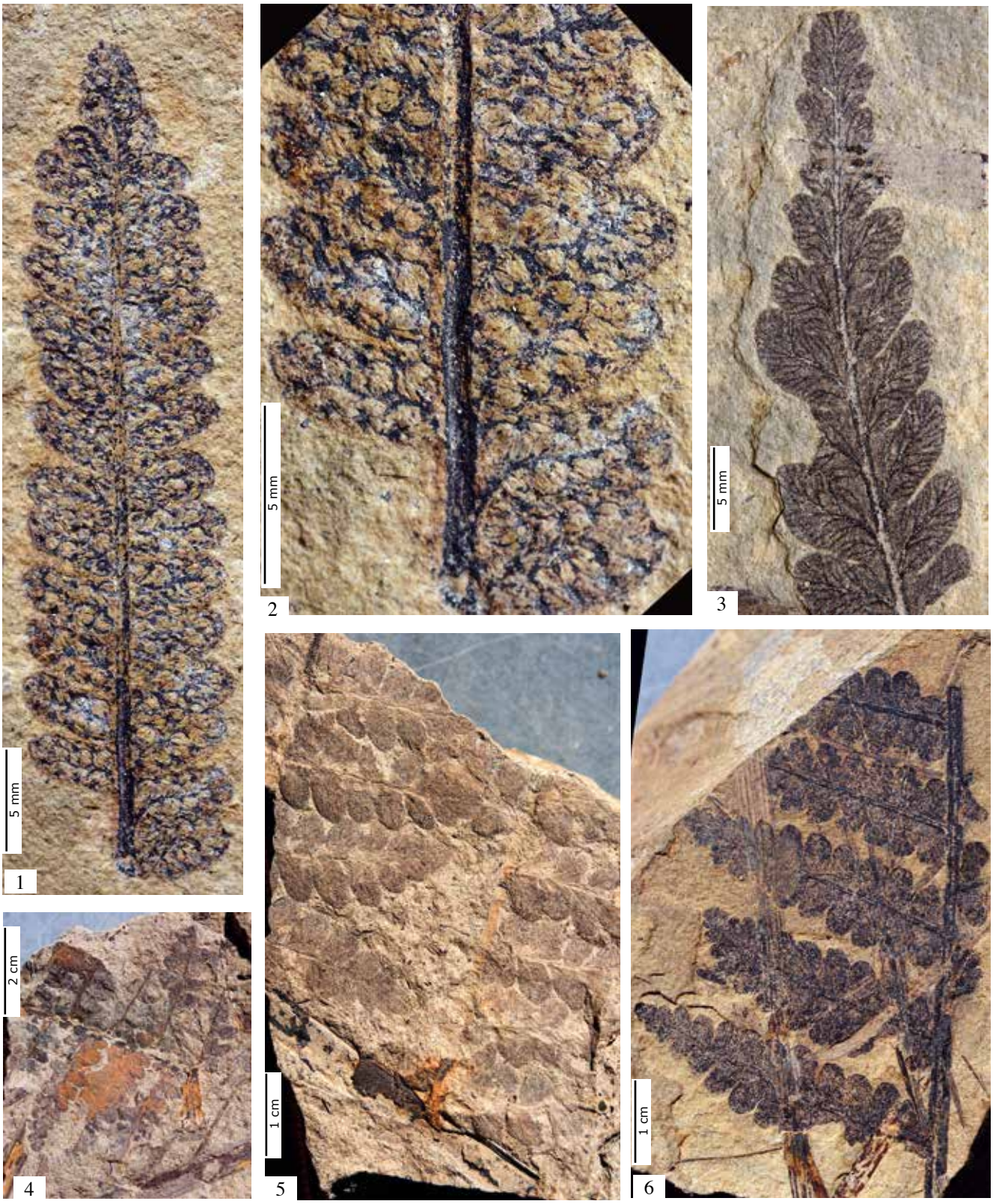
Angaran ferns and their sporangia

a. *Convexocarpus distichus; b. Sylvopteris conspicua; c. Lomatopteris superba; d. Todites uralica.*



***Convexocarpus distichus*, Artinskian ferns from Panteleykovo in the direction to Arti**

1-2. Sterile pinnulas (ARTI 06 Coll. Gerasch, ARTI 31); 3-5. Fertile pinnulas (ARTI 34, ARTI 24, ARTI 23); Coll. Dolomythos, Arti, Artinskian



***Convexocarpus distichus*, ferns from Early Permian (Kugurian), Fore Urals, Russia**

1-2. Fertile pinnae with detail of the synangial structure (MAT 51); 3. Sterile pinnula with strong veins on the single pinnulas (MAT 529); 4-6. Several parts of fronds (MAT 260, 484), Matvéevo, Kungurian (Early Permian) Coll. Perner & Wachtler, Museum Dolomythos

Early Permian (Kungurian) Angaran pteridophyta: the fern *Convexocarpus distichus* was widespread, characterised by its eight to ten (normally nine) synangia on each leaflet.

contradiction with the moderate climate of the Early Permian Angaraland.

Sylvopteris conspicua (Zalessky 1937)

A characteristic but enigmatic fern from these localities is represented by *Sylvopteris conspicua.* It was often cited in literature as *Pecopteris anthriscifolia* (Naugolnykh, 2013), but when in 1918 M. D. Zalessky introduced this name for Middle Permian filicales from the Kousnetzk basin in Russia (Plate 33, 34, 35), he used this morphogenus for widespread Carboniferous-Permian ferns in the Northern hemisphere. After that, Zalessky (1937) described and drew a fern from Chekarda, introducing the new genera and species name, *Sylvopteris conspicua.* A similar fern was later sometimes indicated as *Ovopteris* sp. (Naugolnykh, 2013).
Because *Pecopteris* is a common genus of leaves that first appeared in the Devonian period, flourished in the Carboniferous and vanished in the Permian along with various other sporangia forms, it will here be proposed to reutilise the name, *Sylvopteris conspicua* from Zalessky (1937).

Sometimes the sori, when compared with those of Carboniferous *Oligocarpia* (Radczenko, 1955), help trace connections with today's leptosporanigate fern-family of the Gleicheniaceae. Should also be given the impression that their circular sori correspond to *Oligocarpia* so is this a misapprehension. They are circular and reach 1–1.5 mm in diameter but are formed of many radially symmetrical dwarfish sporangia, which are fused at the basal margins except for the apical part.
In that, they resemble single *Convexocarpus distichus* synangia, but they are positioned close to each other in two parallel rows extending along the midvein in this case, and they form aggregated and irregularly spread clusters on the pinnula (MAT 622). The sterile fronds are tri-pinnate, with the pinnules fused at their bases, with acute apices and a pinnate venation. The well-pronounced midvein reaches the apex, whereas the lateral veins diverge in alternating order. The pinnulas of the last order hold four or five pairs of lateral veins that dichotomize.

***Sylvopteris conspicua,* Artinskian ferns from Panteleykovo in the direction to Arti**

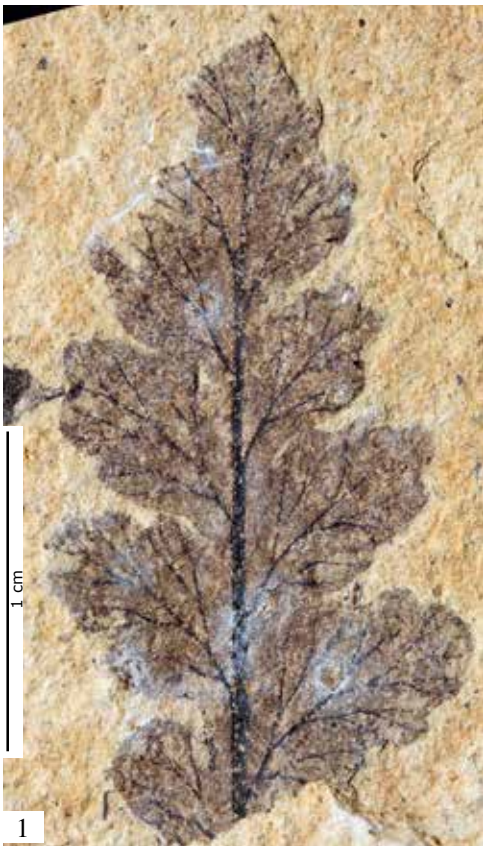
1-3. Several pinnae and pinnulas ARTI 31, 14, 08); Coll. Dolomythos, Arti, Artinskian

Lomatopteris superba (Zalessky, 1937)

Another type of fern is represented by *Lomatopteris superba*. It was described and drawn (page 53) in 1937 by Zalessky from a single specimen from Matvèevo. Although the drawing is not accurate, the outer form of the leaflets corresponds to each other approximately. On the apical part, the single pinnules are about 15 mm long and five mm wide. They are elongated and rounded apically and seat strongly asymmetrical with the basal side fused partially with the rachis. The midrib is exocentrally placed, the lateral veins fork twice, in which the anterior branch dichotomizes one time more. More basally, they build segmented smaller pinnules. The fertile pinnules resemble the sterile fronds, but the entire lamina is covered by abaxially positioned sporangia. The sporangia of *Lomatopteris superba* are closely pressed together, but their aggregation does not seem to reach a soral organisation in comparison with *Convexocarpus distichus.* The small single sporangium is pyriform in length and rounded in shape. In that, they can be regarded as having similarities with today's Osmundaceae.

Todites uralica nov comb. (Zalessky, 1937; Naugolnyck, 2002)

Several fern-fronds were additionally incorporated in the formal species *Pecopteris uralica* (Naugolnykh, 2013). Also, here it will be proposed to transfer them to *Todites uralica* due to the fact that the aggregation and blueprint of the sporangia correspond to the Osmundaceae. They are randomly distributed across the leaflet surface, and they are large and contain a large number of spores. Some *Todites* ferns were just described from the Middle Permian of the Eastern Russian platform and the Pechora River as *Todites lobulatus, Todites emarginatus* and *Todites coronatus* (Naugolnykh, 2002). Fertile and sterile pinnulas are mainly equal and alternating. The sterile linguiform leaflets with a rounded apex evidence a midvein that passes along the pinnula with slight curves but do not reach the margin. From

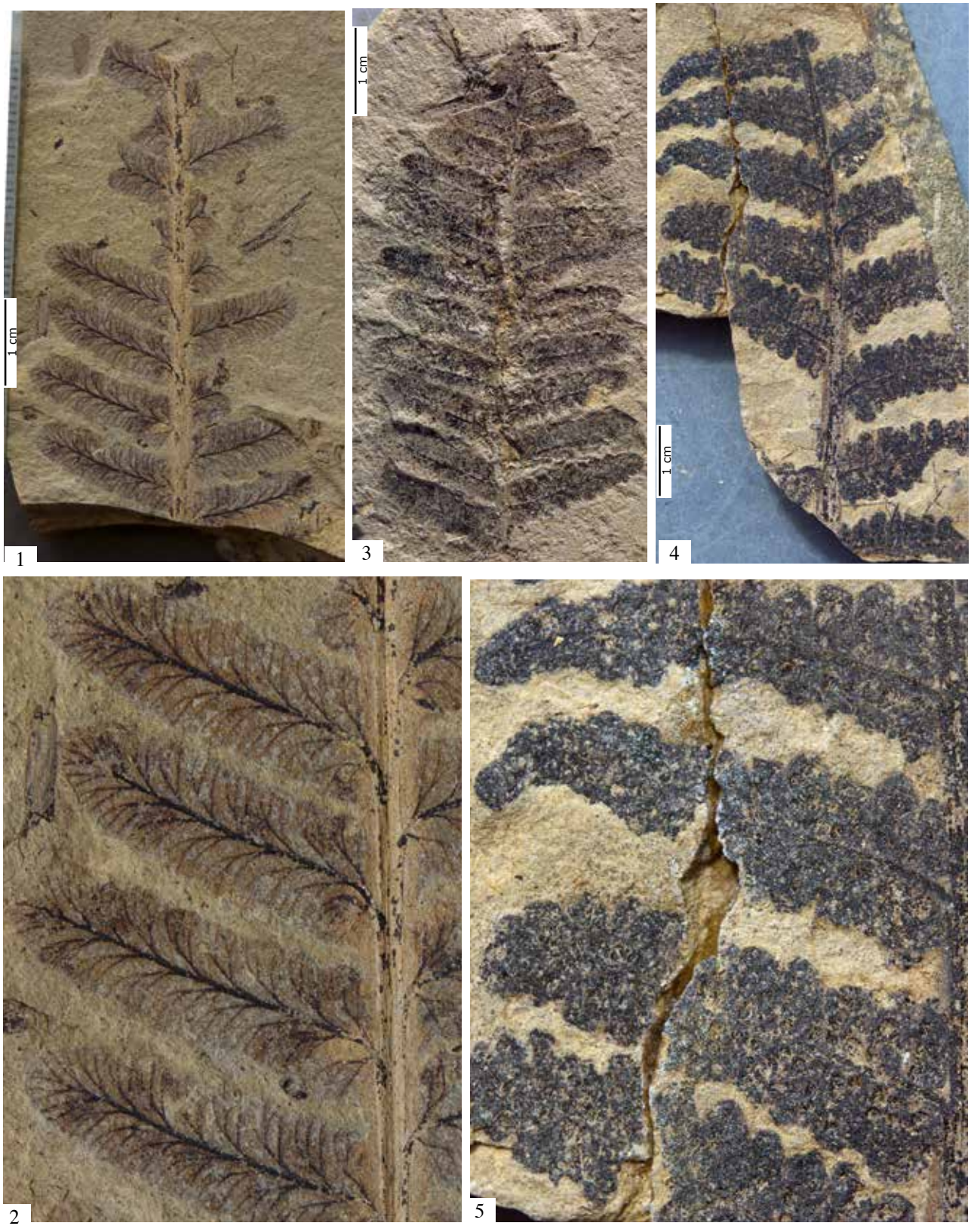


***Sylvopteris conspicua* – ferns from Early Permian (Kugurian), Fore-Urals, Russia**

1. Pinna of the last order showing the venation of the fragile leaflets well (MAT 277); 2. Apical part of a frond (MAT 278); 3. Fertile pinnula (MAT 622); 4. Detail of the fertile leaflet showing the circular clustered sori (MAT 622); Matvéevo, Kungurian (Early Permian) Coll. Dolomythos

***Todites uralica* nov comb. – ferns from Early Permian (Kugurian), Fore Urals, Russia**

1-2. Fertile pinna with sporanga (CHEK 31); 3-4. Sterile pinnula (MAT 784, MAT 265, Matvèevo); 5. Fertile pinnula with sporangia (CHEK 114, Chekarda); Kungurian (Early Permian) Coll.Wachtler, Dolomythos, Innichen, Italy



***Lomatopteris superba* – ferns from Early Permian (Kugurian), Fore-Urals, Russia**

1–2. Sterile pinna evidencing the venation of the leaflets (CHEK 116); 3. Fertile frond (CHEK 204, Chekarda); 4–5. Fertile pinnula with the densely arranged sporangia (MAT 518); Matvéevo, Kungurian (Early Permian) Coll.Wachtler, Dolomythos, Innichen, Italy

Unknown ferns, belonging to the Osmundales (MAT 519, Matvèevo)

the midvein diverge several lateral veins that dichotomize close to the base.
The fertile leaflets hold their sporangia free and separately but often they are arranged in compact clusters. The sporangia are small, round to ovoid, so that each fertile pinnule generate about 70–100 sporangia. Although the pinnulas are similar to those of *Convexocarpus distichus,* the differences between their fertile parts are obvious. In *Convexocarpus*, they form clusters of sori in two rows, while in *Todites uralica*, they hold many elliptical till spherical sporangia covering the whole blade. Therefore, a classification in some eu- till lepto-sporangiate filicales is justified. In the Early Permian Fore Urals, we additionally encounter ferns with sporangia aggregated on certain pinnae that we can see in MAT 519. There the fertile pinnae have almost lost their foliar nature and form tassels. Interestingly, the sporangia hang there and are partially pyriform in shape.

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