Some New and Exciting Angiosperm Fruits from the Early Permian of the Fore-Urals (Russia)

by
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In the Early Permian (Kungurian) regions of the Fore-Urals (Russia), a fair amount of different and novel multiple angiospermous fruits were recovered: *Matvèevofructa bardaensis* nov. gen. n. sp., *Permofructa multipla* nov. gen. n. sp., *Sylvafructa aggregata* nov. gen. n. sp. and *Uralofructa magnoliformae* nov. gen. n. sp. All of them can be considered aggregate fruits or follicetum enveloping several hardened seeds. Some of them can be correlated with today's composite fruitlets that show a clustered character, some others have many similarities with extant Magnolias, and for the remaining, comparisons are difficult.

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Early Permian aggregated fruits

A landscape of the former Angara continent with some aggregated fruits; on the **upper side** from **left to right** – *Sylvafructa aggregata,* a red *Permofructa multipla* and *Matvèevofructa bardaensis.* On the **lower side** sprout some *Uralofructa magnoliformae*, supposed cones of a Magnoliaceae progenitor.

Introduction

Although the whole Cisuralian Permian period has been studied for about 200 years, most research works have been done on marine stratigraphy and, only in some cases, on terrigenous sediments. Some places pertain to the older Artinskian stage and lay especially around the small hamlet of Arti, from which the whole period took its name.
This is valid for Panteleykovo near Arti (Sverdlovsk Oblast). There, the Artinskian outcrop consists of alternating sandstones, siltstones and argillites. Or on the street from Manchazh till Ckekmash, inside a mainly abandoned waste disposal site. From the slightly younger Kungurian period, a basionym of the nearby laying city of Kungur, the best specimen are found in the Aleksandrovskoe section between Pridannikova and Achit, near the city of Krasnoufimsk, the Mazuevka site near the Sylva River, about 12 km northeast of Suksun, and especially the both classic fossil sites Chekarda, about 20 km east of Klyuchiki, and Matvéevo (Lyswa district), about 15 km south-west of Kormovishche. Here finest grained gray to yellow terrigenous siltstones crop out in diverse beds. The conservation is unique, and all the details of the insects and the plants, including their filigree parts, are maintained.

Matvèevofructa nov. gen. WACHTLER & PERNER 2020

Etymology

It is from the Early Permian locality of Matvèevo in the Russian Fore-Urals and the Latin word "fructus", meaning fruit.

Diagnosis

The fruit are mainly rounded and connected with a short stalk to the tree.

Matvèevofructa bardaensis nov. gen. n. sp. WACHTLER & PERNER 2020

Holotype

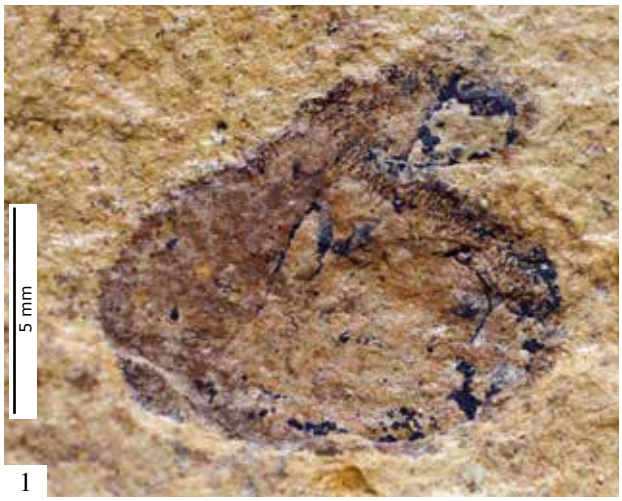
MAT 43, Matvèevo (Collection Wachtler, Dolomythos, Innichen, Italy

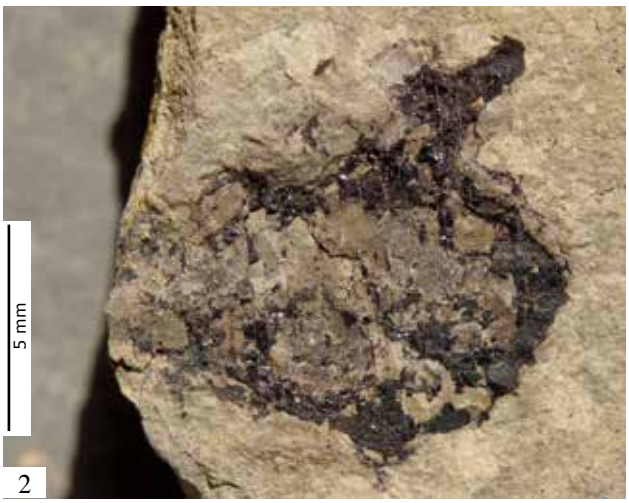
Etymology

The name is from the Barda River, which flows through Matvèevo.

Description

Fruit: Holotype MAT 43 as well as MAT 383 consist of a fruit that is 10 mm long and 12 mm wide; the short stalk is 3 mm long. From the outer appearance, it is not clear if it can considered a mature syconium that contains numerous one-seeded druplets as in today's figs (ficus) or *Cornus kousa,* or it is a seed covered by an aril, similar to the recent cherries, almonds or plums. MAT 383 resembles more of a multi-seeded fruit.





***Matvèevofructa bardaensis* nov. gen. n. sp. (Kungurian, Early-Middle Permian)**

1. Fruit attached on a stipe (Designed holotype MAT 43);
2. Fruit (MAT 383); All Matvèevo, Coll. Wachtler

Permofructa nov. gen. WACHTLER & PERNER 2020

Etymology

It is from the Permian period of the Urals and Latin fruit.

Diagnosis

The elongated fruit incorporates many small rounded seeds.

***Permofructa multipla* nov. gen. n. sp. (Kungurian, Early-Middle Permian)**

1. Fruit with an apical depression, evidencing many seeds on the basal part (Designed holotype MAT 365); 2. Fruit (MAT 573) all Matvèevo; 3. Other fruit from Chekarda (CHEK 189); Coll. Wachtler, Dolomythos Museum, Italy.

Permofructa multipla nov. gen. n. sp. WACHTLER & PERNER 2020

Holotype

MAT 365, Matvèevo (Collection Wachtler, Dolomythos, Innichen, Italy

Etymology

It is from the raspberry-like aggregation of the fruits.

Diagnosis

The fructification is characterised by a hollow depression on the upper part. The fruit contains many seeds.

Description

Fruit: Holotype MAT 365 has a length of 1.5 cms and a width on the basal side of 1.2 cms. MAT 573 is 2.5 cm long and 1.6 cm wide. The fruit is composed of many seeds that are slightly elongated and about 0.2 cm long. MAT 365 especially has the form of an aggregate fruit composed of numerous drupelets. It seems that the fruitlets separate from the central core when dropped off, leaving the hollow depression at the base.

Sylvafructa nov. gen. WACHTLER & PERNER 2020

Etymology

It is from the Sylva River (Russian: Сылва), a river in the Sverdlovsk Oblast and Perm Krai in Russia, where the main fossil sites are located.

Diagnosis

The elongated fruits contains many visible and hardened seeds.

Sylvafructa aggregata nov. gen. n. sp. WACHTLER & PERNER 2020

Holotype

MAT 345, Matvèevo (Collection Wachtler, Dolomythos, Innichen, Italy

Etymology

It is from the Latin word "aggrego", meaning put together.

Description

Fruit: Holotype MAT 345 has a length of 2.1 cms and a width of 1.4 cms on the apical side and is symmetrically heart-shaped. The individual seeds are circular and reach a size of 0.2 cms. A thin but tough skin covers the fruit, allowing it to shine through quite a number of hard, smooth and rounded seeds. Also, CHEK 26 from the Chekarda locality has about the same size as that of the holotype. From the appearance, it can be regarded as a multiple fruit. It is difficult to establish whether during their origin, they stay as clusters of fruiting flowers or an inflorescence or the fruit develops from the merging of several ovaries of single flowers. MAT 577 has a length of 4.1 cms and a width of 2.2 cm on the apical side and is slightly different from the other two. It seems that the part connecting the stalk to the tree was additionally fossilised. Also, the single seeds are circular and reach a diameter of 2–3 mms.

Uralofructa nov. gen. WACHTLER & PERNER 2020

Etymology

It is from the Ural region in Russia, where the main fossil sites are situated

Diagnosis

There are multiple fruits that originate from a stout peduncle; The rounded seeds are distributed on the outer side of the bracts.

Uralofructa magnoliformae nov. gen. n. sp. WACHTLER & PERNER 2020

Holotype

MAT 355, Matvèevo (Collection Wachtler, Dolomythos, Innichen, Italy

Etymology

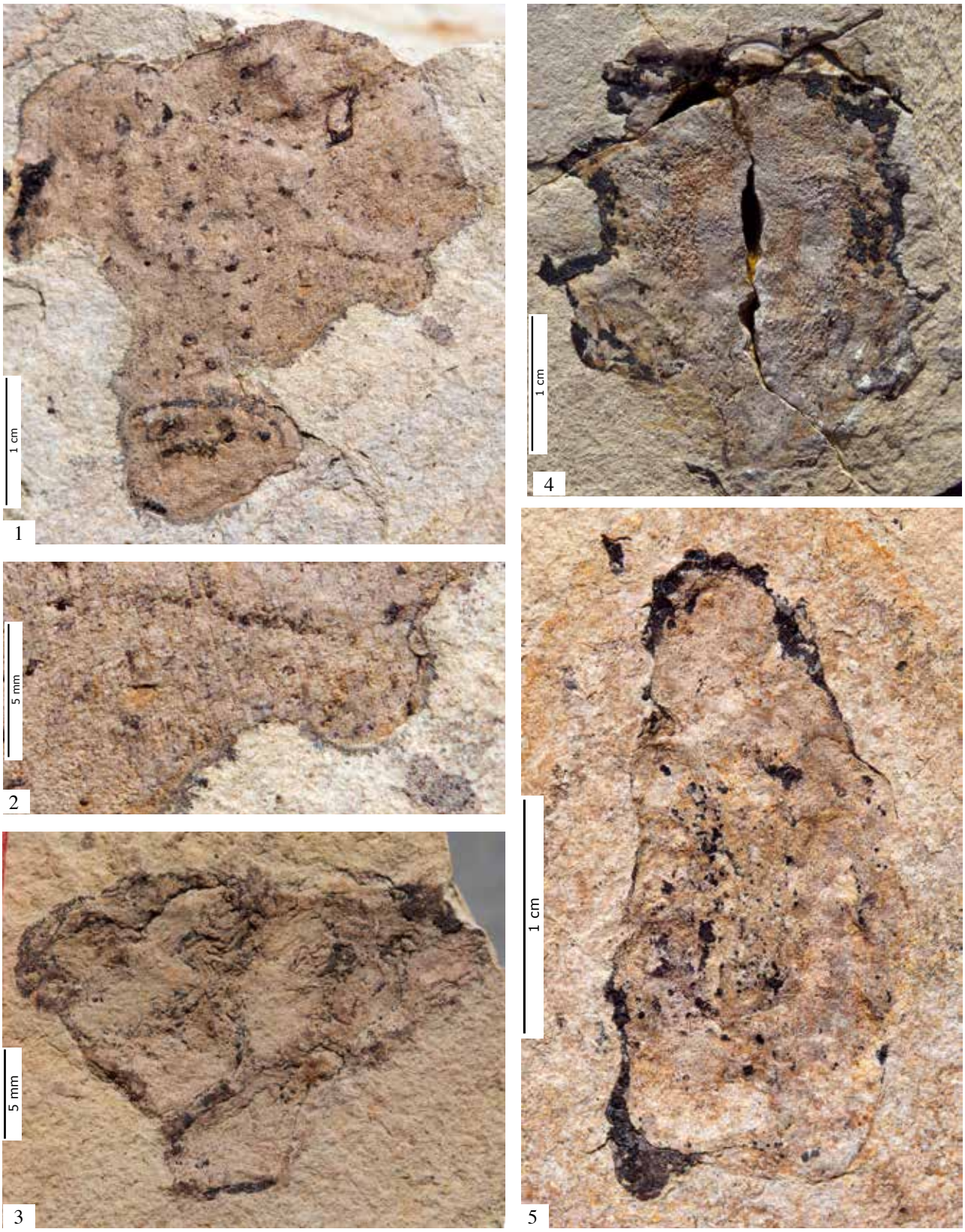
The name is due to their similarity with the cones of Magnolia.

Description

Fruit: The reproductive organs are cone-like, sitting on a stout peduncle, consisting of densely settled multiple fruits and are elongated or ovoid (Holotype MAT 355 is 25 mm long, CHEK 311 is 85 mm long and 35 mm wide). Some cones (CHEK 205 is 50 mm long and 35 mm wide; MAT 406 is 19 mm long and 12 mm wide) can also be a result of aborted floral shoots released into the soil after or during the blooming period. Other cones (MAT 364, MAT 376, MAT 679 and CHEK 214) probably represent partially decomposed multiple fruits. Also, they usually have a stout peduncle. Each segmented bract is rectangular to

***Sylvafructa aggregata* nov. gen. n. sp. (Kungurian, Early-Middle Permian)**

1. Fruit evidencing the seeds (Designed holotype MAT 345, Matvèevo); 2. Fruit (CHEK 26) Chekarda, Coll. Wachtler; 3. Oval fruit composed of many seeds (MAT 577); 4. Fruit (MAT 589); Matvèevo and Chekarda, Coll. Wachtler, Dolomythos-Museum, Innichen, Italy.



***Uralofructa magnoliformae* nov. gen. n. sp. nov. gen. n. sp. (Kungurian) cones**

1–2. Multiple fruit with detail of one single seed (Designed holotype MAT 355); 3–4. Cones with several seeds (MAT 364 and CHEK 214); 5. Mature cone with bracts and some isolated seeds (MAT 679). Kungurian (Coll. Wachtler, Dolomythos-Museum)

Magnolia cones

1–4. Diverse growth stages and seed development of *Magnolia virginiana;* 5–6. Adult cones of *Magnolia grandiflora* (the last one has been cut in the middle)

polygonal and is about 10 mm in diameter (MAT 355, MAT 364 and MAT 212). On some bracts, several rounded till elongated seeds of about 5 mm diameter are attached.

Discussion

In the Early Permian Fore-Urals, we encounter many different types of fruit, such as the samaras from maple ancestor *Sylvella alata*, ash progenitor *Sadovnikovia belemnoides*, elms like *Matvéeva perneri, Uralosamara palaeozoica* resembling today's Ulmus alata and birch-samara *Samzalesskya triquetra* (Wachtler, 2017, 2020; Naugolnykh, 2007). We have oak-acorn *Craspedosperma bardaeanum*, leafy involucres like hazelnut-resembling *Nucifructa primaeva*. Also, several important items of evidence from the Asteraceae, such as *Naugolnykhia matvéevoi* and *Asteroforma nicolaswachtleri* with their presumed parachutes *Pappusperma,* are found. Easy to distinguish, big kernels with fruit pulp *Bardocarpus aliger* are omnipresent in the Early Permian sediments. In today's plant kingdom, most fruits are simple and develop from a single carpel or a compound ovary. However, some fruits with robust seed coats and kept together by a peel or by forming a follicetum are recorded. Apart from these, we also encounter multiple or aggregated inflorescences that have all the conditions to coalesce together, forming an aggregate fruit after maturation. These types of fruits today are classified as clusters of several separate carpels of one single, apocarpous gynoecium like the raspberries, where each unit is a single carpel.
However, they can also represent multiple fruits originating from separate flowers and representing inflorescence. These two multi-ovary fruit types can appear nearly identical in form; raspberry (*Rubus idaeus*) is an example of an aggregate of drupes where the single fruitlets are crowded pressing against one another on a raised thalamus. It resembles mostly the multiple fruit mulberry, but the differences between the two are considerable. Compound fruits are found today, especially in the Annonaceae (Soursop family), which are heart-shaped, holding many round protuberances. In the strawberries (*Fragaria*), the minute achenes are buried as small specks on a fleshy edible thalamus. Other examples of aggregate follicles are the Magnoliaceae. When the flower matures, the thalamus elongates so that the aggregate fruit looks like a bunch of fruits. Especially the described *Uralofructa magnoliformae* has many resemblances with today's Magnolias, particularly if brought in connection with the Early Permian flower, *Geraschia wachtleri*. The outside from the follicles hanging rounded seeds have no differences with the extant ones.
Even more difficult is the interpretation for *Sylvafructa aggregata* and *Permofructa multipla*. Although some are tempted to think, upon superficial examination of a strawberry fruit, this is probably to exclude due to delicateness of their pulp. The source of these fruits must be a robust seed and a preservation capable involucrum, such as the chambered seed head of extant lotus, loculicidal capsules from the Celastraceae (*Euonymus*) or the capsule from *Silene latifolia* resembling in some aspects *Sylvafructa aggregata* (MAT 589). A good example could also be an open capsiconum fruit of extant Liquidambar-resembling *Neuburgosperma radiata,* whose juvenile fruits were found in the Early Permian layers of Chekarda (Wachtler, 2020).

Contributions

Thomas Gerasch, Martin Dammann, Thomas Perner, Nicolas Wachtler and Michael Wachtler made fossil specimens available. Michael Wachtler analysed the data, made the drawings, photos and wrote the paper. Thomas Perner supported the work financially.

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