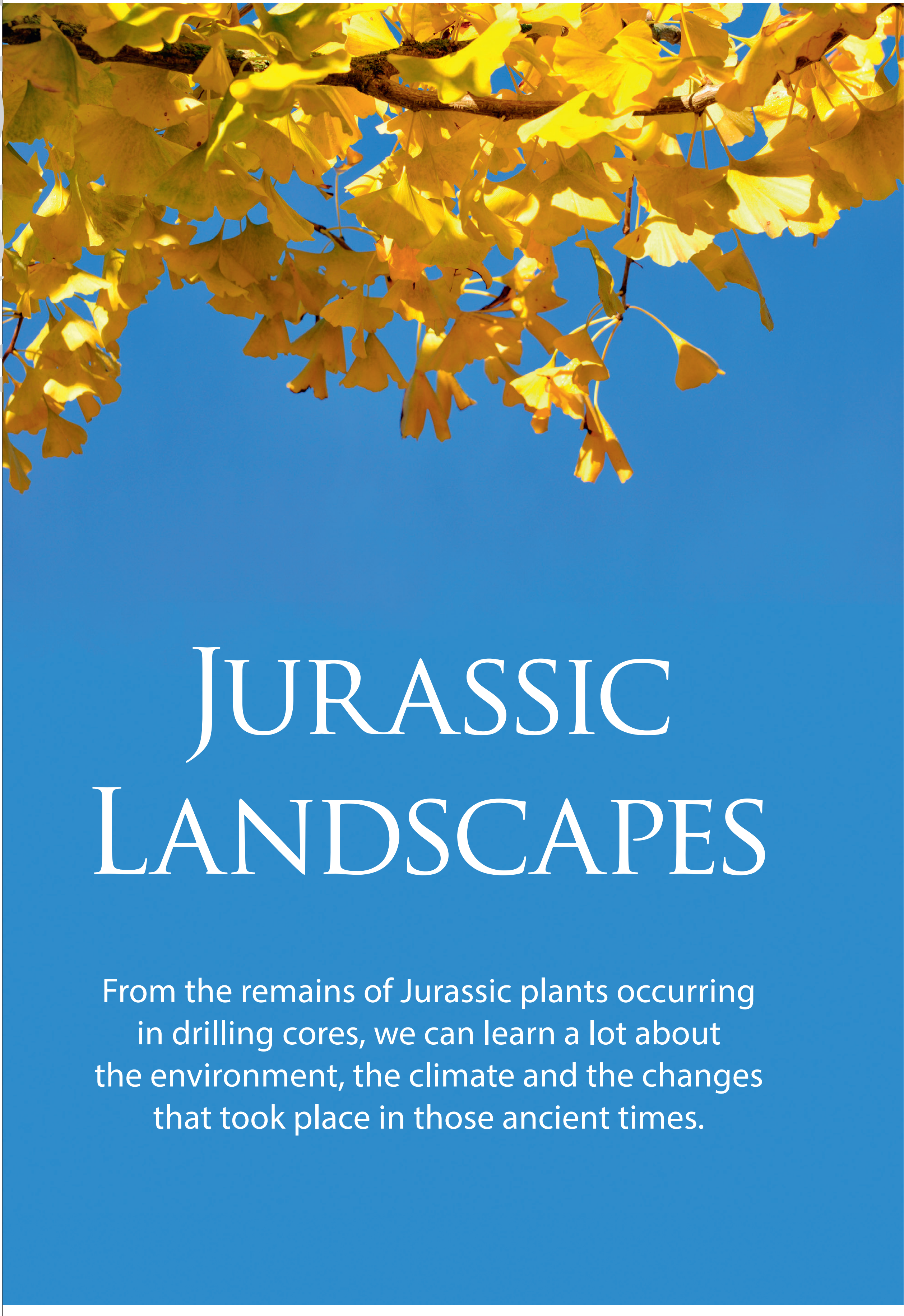
INSIGHT



Jurassic Landscapes

From the remains of Jurassic plants occurring in drilling cores, we can learn a lot about the environment, the climate and the changes that took place in those ancient times.

Asst. Prof. Maria Barbacka (PhD, DSc)
is a paleobotanist who deals with Mesozoic fossil plants, mainly from the Jurassic period found in Poland, Hungary, Germany and Alaska. She focuses mainly on taxonomy and paleoecology and uses interdisciplinary methods to reconstruct Jurassic ecosystems.

maria.barbacka@gmail.com

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Maria Barbacka

Władysław Szafer Institute of Botany, Polish Academy of Sciences, Kraków
Hungarian Natural History Museum Botanical Department, Budapest

Jadwiga Ziaja

Władysław Szafer Institute of Botany, Polish Academy of Sciences, Kraków

In Cianowice, 20 km north-west of Kraków, a core sample was drilled 600 m deep. The locality is situated within the Małopolska Block, near the Krzeszowice Graben and the Kraków-Lubliniec Suture Zone. This zone lies on the border of two tectonically active regions: the Małopolska Block and the Upper Silesian Block. Shale and sandstone were found in some of the sediments from the part of core from a depth of 265.5–244.5 m. This points to a terrestrial origin of this section of the core, with numerous fresh water lakes or a meandering river. The sediments lack typical indicators that might allow us to determine their exact age. Instead, the age was determined as Lower or Middle Jurassic on the basis of lithological structures and correlations with neighboring areas. Above this section, there are limestones with ammonite fauna, which indicates a marine transgression (sea entry) into the studied area. Due to the presence of ammonites, the age of the sediments was estimated as the Upper Batonian-Oxfordian (Middle-Upper Jurassic).

Diversity

In 2014 Grzegorz Pieńkowski studied the terrestrial portion of the profile (a 21-meter long section of the core) in details in terms of sedimentology and recognized 5 lithological-sedimentological successions corresponding to different types of environment: 1. alluvial cone, 2. river succession with floodplain and canals, 3. lake succession, 4. river succession with floodplain, and 5. canal succession.

This part of the profile contains accumulations of fossil leaf remains belonging to particular successions. In total, there are 96 leaf fragments which can be identified in terms of species on 27 core fragments measuring 7 cm in diameter. In total, 20 species were identified, of which the vast majority were bennettitaleans, an extinct group from the Mesozoic Era (10 species). In addition to them, there are ferns (1 species), seed ferns (also extinct by the end of the Mesozoic – 2 species), cycads (1 species), ginkgophytes (3 species – during the Mesozoic this group was large and taxonomically diverse, now only one species is known: *Ginkgo biloba*), and conifers (3 species).

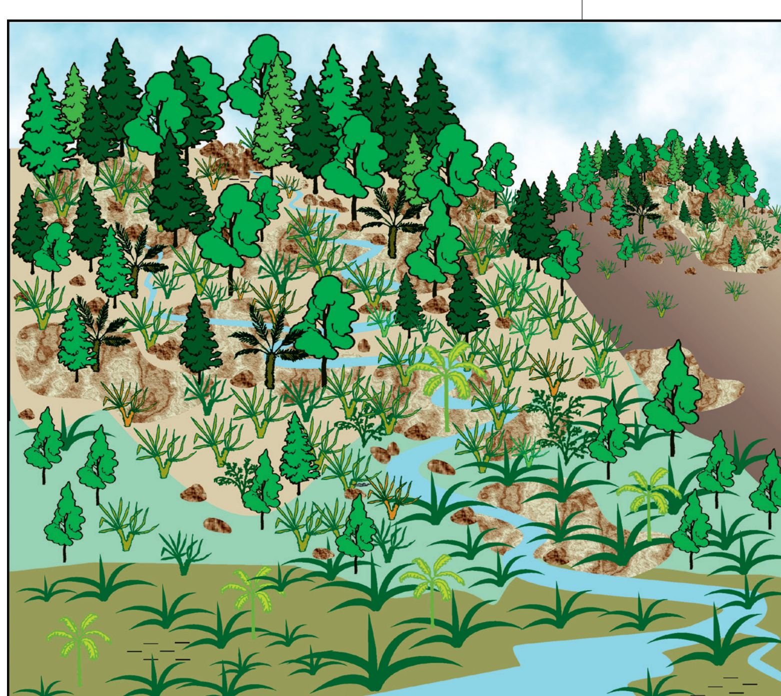
Material

The leaves are very well preserved. The organic matter coalified during fossilization, but the cuticle remained. This is a layer consisting of lipids, cellulose and pectin synthesized by epidermal cells, which covers all plant organs, protecting them from external conditions and mechanical damage. The plant cuticle is an extremely durable material, and if the fossil was well-preserved, it can be chemically treated and examined under a microscope. Because it adhered tightly to the epidermis throughout the plant's lifetime, the external structure of the epidermis, including the outlines of cells, stomata, hairs, glands and other structures are visible on it. Studying cuticles from the plants found in Cianowice helped to determine species and to draw conclusions about their living conditions.

Most species from Cianowice have thick cuticles, which indicate rather dry soil conditions, intense sunlight or wind. It can be assumed that all these factors could have occurred together, especially because the stomata in almost all species are strongly protected. The guard cells of most leaves from Cianowice are surrounded by subsidiary cells with papillae (cuticle rod-shaped protuberances on epidermal cells often performing protective role, along with other functions not fully known). In stomata these papillae overhang the aperture and regulate the pit size by tightening up and closing or opening it. This mechanism indicates

Dr. Jadwiga Ziaja (PhD)
is a palynologist who studies spores and pollen grains of Mesozoic plants, mainly of the Jurassic. Based on the palynological analysis of rocks, she tracks climate and environmental changes in the studied areas, as well as describes and identifies spores and pollen grains in situ, which is important in establishing botanical relationships between fossil plants.

j.ziaja@botany.pl



Reconstruction of the Jurassic paleoenvironment of Cianowice based on sedimentological, paleobotanical and palynological studies

AGNIESZKA SOJKA

variable conditions and at least some transient periods of drought when closed stomata protect the leaf from excessive evaporation. Some species have papillae on the entire surface of the leaf blade. Studying the cuticles helped reconstruct the environment in which the plants lived.

In addition to macroflora, some of the samples were palynologically tested for sporomorphs (spores and pollen grains), and 19 taxa were identified. Most of the sporomorphs belonged to ferns, whose spores were definitely the most numerous in the settlement. In addition there was small amount of pollen grains belonging to conifers and seed ferns, and sporadically cycads and bennettitaleans. ginkgophyte pollen grains were not found at all.

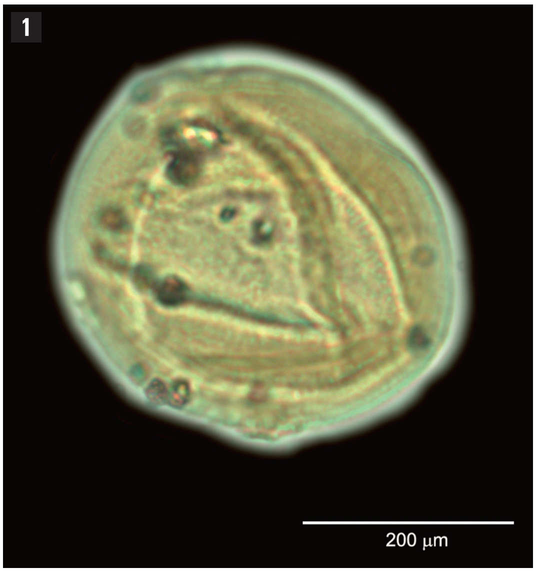
Environment

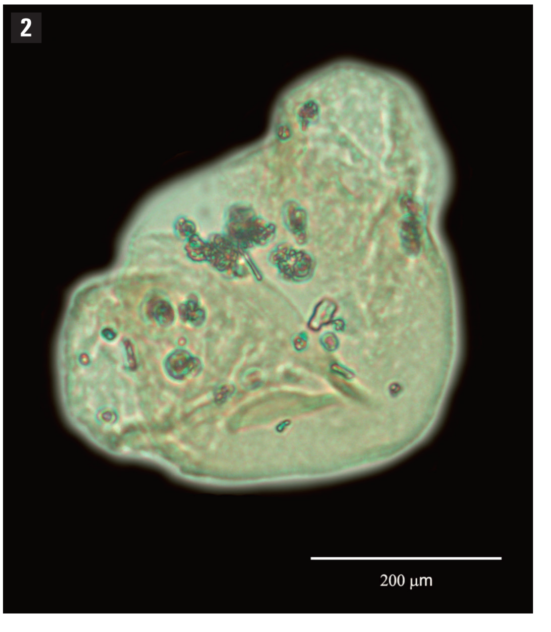
Studying changes in the taxonomical composition of the plant assemblage corresponding with lithological-sedimentological successions, we expected to find out whether certain species were connected only to specific habitats, and how they tolerated environmental changes. By analyzing the species composition in subsequent stratigraphical levels (from oldest to youngest), we can trace the changes in ecosystems that have occurred in this area over a long time.

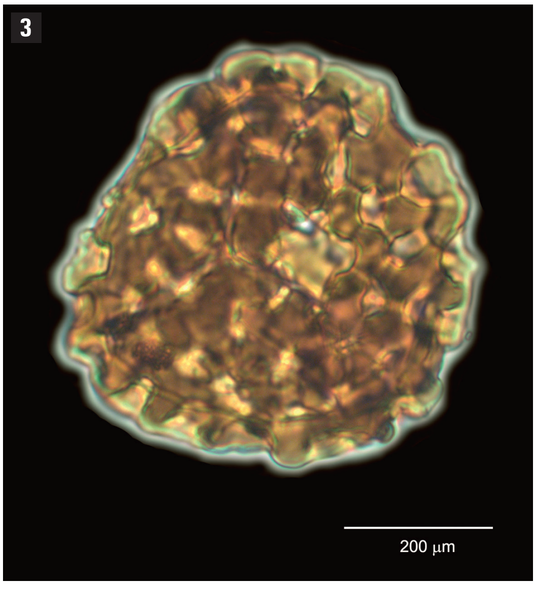
Examining plant remains and their distribution on individual specimens (core fragments) led us to the following conclusions:

1. The leaves on the specimens are small. A small specimen can contain up to a dozen leaf fragments, mostly pinnate. This indicates poor soil conditions, and the cuticle structure suggests water scarcity or strong sunlight.
2. The density of leaf fragments indicates their transport (mainly by water) to the sedimentary basin, where they later fossilized.
3. The transport did not occur rapidly or over a long distance, because fragments of compounded leaves were not significantly damaged or fragmented.
4. While the leaves are mostly bennettitaleans, ginkgophyte, and conifers, the sporomorphs are mostly ferns. There were only sporadic small fragments of fern fronds found (only 2), while hardly any bennettitaleans or ginkgophyte pollen grains were found in the sediment.

These observations were used to reconstruct the hypothetical environment along with its plant cover. We present them as a slope of a low hill from which a small river ran down to the foot of the hill. The river in some sections (successions 2 and 4) was still a meandering river with smaller or larger marshes. At times, with a larger inflow of water, the river spilled over and even created a lake with wetland coastal areas (succession 3). The marshes and the lake at the foot of the hill acted as a sedimentary basin, to which leaves from the slope







GLOSSARY

Ammonite: an extinct group of cephalopods. They are very important guiding fossils, because on their basis one can determine the age of the rocks in which they occur.

Ammonite fauna: all ammonites occurring in a given area.

Fossilization: a process during which the remains of organisms become fossils.

Lithology: a set of rock features and properties that can be observed with the naked eye.

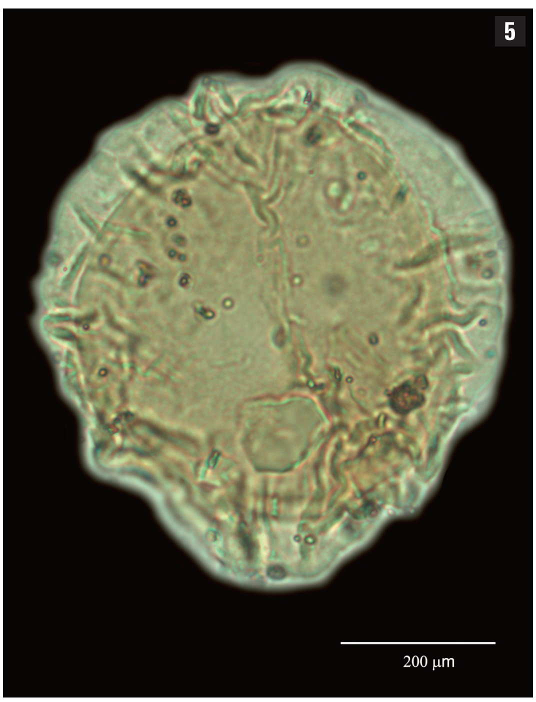
Sedimentology: the science of determining the environment in which sedimentary rocks formed.

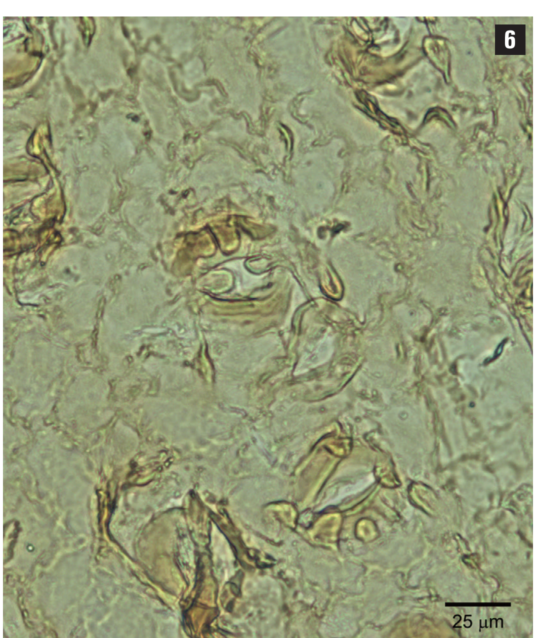
Lithological-sedimentological succession: successive layers of sedimentary rocks, whose features and properties point to the formation in specific environmental conditions.

Taxon: a scientifically classified group of organisms in a taxonomic unit (such as a genus or order) of any rank.

Taxonomy: the science dealing with the classification of organisms.

MARIAN SZEWCZYK





were carried by the river current (drilling at Cianowice 2 passes through layers of this basin). The slope was rather dry, which is why the plants growing there (mainly seed ferns, bennettitaleans, ginkgophytes, and conifers) were somewhat stunted (in other areas plants of the same species grew much larger). Ferns most likely grew on the plain at the foot of the hill.

The disproportion between the sporomorphs and leaf remains was most likely due to the wind that carried the pollen grains outside the sedimentary basin, while heavier spores, falling from ferns straight into the wetlands, accumulated in a larger amount in the sedimentary basin. We should note that the drill core passes through a small part of the area and gives a slightly distorted image, although such large accumulation of fossils allows us to make conclusions regarding the environment.

Changes to the plant assemblage on the hypothetical slope were relatively insignificant and would most likely have been caused by the microclimate associated with flowing or standing water. The first lithological-sedimentalogical succession, the alluvial cone, had the fewest coniferous plant remains. The vegetation of the 2nd (river) succession was the most abundant and had the most diverse species. At that time, all of the groups of plants described in Cianowice were present here, including ferns, seed ferns, bennettitaleans (dominant), cycads, ginkgophytes, and conifers. In the 3rd (lake) succession there were only a few seed ferns, bennettitaleans, (most diverse) and ginkgophytes. The 4th succession (flood plain) again had a relatively lush vegetation, including ferns, seed ferns, bennettitaleans (dominant) and ginkgophytes, while the 5th (canal) succession was poorer in species with only one species of seed ferns, bennettitaleans, ginkgophytes and conifers.

During the succession transitions, not only did plant groups appear or disappear, there were also changes to the species as well, with only 2 of all 20 species making it through 3 successions. Some appeared in two successions, and some only in a single one. This demonstrates that even the slightest changes to the environment at the foot of the hill had some influence on the microclimate and the species composition of the plant assemblage. However, despite the microclimatic changes, the topography, the rise of the terrain did not change. This is evidenced by the fact that all successive species were similarly adapted to the dry conditions in which they grew (on the reconstructed slope).

The site in Cianowice is one example of how one can use sedimentological and paleobotanic data (leaves and sporomorphs) to study living and environmental conditions.

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Fig. 1.
Classopollis torosus (Reissinger) Couper pollen grain belonging to the coniferous family

Fig. 2.
Bisaccate pollen grain of a seed fern or coniferous plant

Fig. 3.
Klukisporites variegatus Couper, fern spore

Fig. 4.
Fragment of the core with bennettitalean leaf remains: 16 – *Ptilophyllum sirkennethii* Watson et Sincock, 17 – *Ptilophyllum okribense forma ratchiana* Doludenko et Svanidze

Fig. 5.
Callialasporites dampieri (Balme) Dev. pollen grain belonging to the coniferous family

Fig. 6.
Bennettitalean cuticle *Otozamites parallelus* Philips, with stoma and visible papillae around the stoma

Further reading:

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