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A Jurassic Highway Linking Different Worlds

The site of one of Poland's most significant paleontological discoveries of the early twenty-first century is situated in the unassuming village of Owadów-Brzezinki – now the site of a geopark.

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The extensive excavations at the Owadów-Brzezinki paleontological site have recently marked their tenth anniversary. This remarkable quarry in the Sławno municipality (Opoczno district, Łódź province, central Poland) is actively mined by the company Nordkalk, extracting rock material from the youngest Jurassic layer, the Tithonian. The site is undeniably one of the pivotal discoveries in Polish research on the Jurassic, and continues to turn up surprising finds.

The birth of paleontology as a recognized scientific discipline is inextricably linked to the discovery of Jurassic rock formations in Western Europe, such as the Solnhofen limestone and the cliffs of Dorset. There, the Jurassic rocks came to be prominently exposed thanks to extensive industrial mining and natural erosion over the years, revealing plentiful and well-preserved fossils. These conditions spurred local scientists to make significant advances in the nineteenth and twentieth centuries. Prior to the discovery of Owadów-Brzezinki, Poland hadn't had a site of this magnitude, which made our insight into the evolution and biodiversity of many groups of Jurassic life forms more fragmentary than that of our Western colleagues.

A Discovery of Extraordinary Importance

In 2005, Adrian Kin found the first horseshoe crab fossil at the quarry site. This was an extraordinary discovery, as horseshoe crab fossils are extremely rare in the fossil record due to their chitinous, unmineralized skeleton. This signaled that we were dealing with a unique site where the sedimentary conditions were exceptionally well suited for preservation – a *Lagerstätte*, or site with an accumulation of perfectly preserved fossils.

Owadów-Brzezinki is the only non-Carpathian site in Poland providing insight into Tithonian rocks. The exposure represents a record of regression and transgression – the gradual retreat of the sea and its return, with a local dry-climate episode. This is visible

Entrance gate to the Geopark Owadów-Brzezinki in the municipality of Sławno

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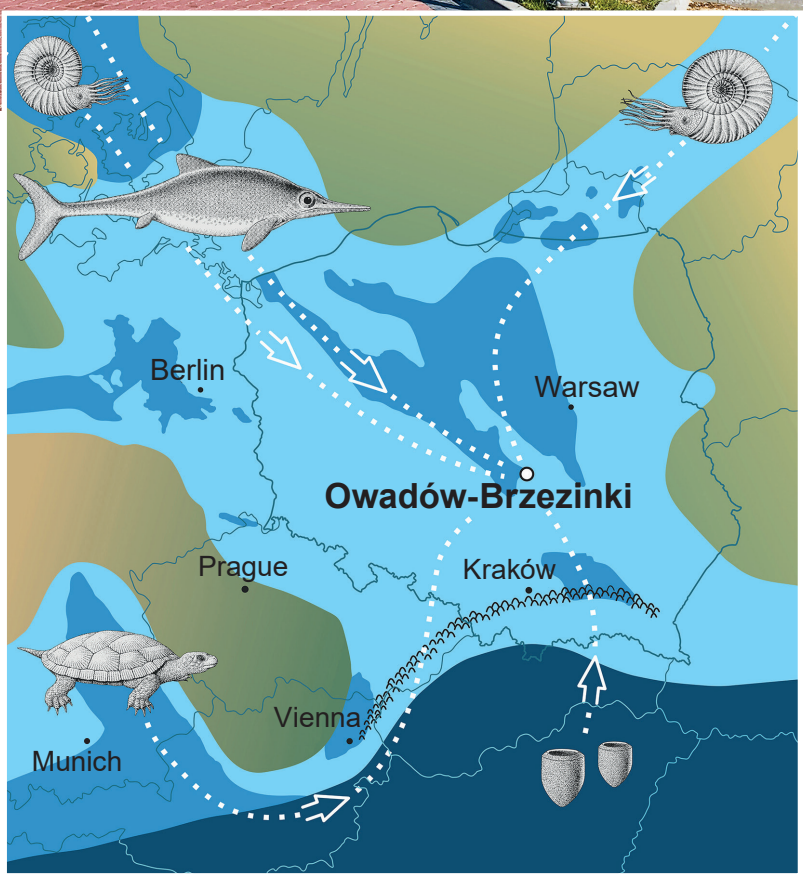
in the appearance of the rocks, as the darker marlstone rocks of the Pałuki Formation transition into the light, massive limestones of the two lower units of the Kcynia Formation. The maximum regression, or retreat of the sea, can be observed thanks to the presence of slab limestones, similar to the famous Solnhofen lithographic limestones, which are the richest fossil horizon. The succession of different rocks can be interpreted as gradual changes in the environment from fully marine to lagoonal.

Studying the fossils from the Owadów-Brzezinki quarry shows that the area of today's Poland was a kind of paleogeographic "hub" at that time, where animals and plants from the warm southern seas (the Tethys Ocean) encountered and intermingled with those from cooler northern waters. Moreover, specimens representing fauna similar to those discovered in world-famous Western European exposures, as well as taxa found in Russia and the east, are also found in this area. This makes the site extremely valuable for correlative and comparative studies.

Diversity of Fossils

A defining feature of the Owadów-Brzezinki site is the presence of perfectly preserved arthropod fossils. Among the most impressive are representatives of the order Xiphosura, better known as horseshoe crabs. Their discovery is exceptional not only within Poland,



Paleogeographic map of Europe at the end of the Jurassic (about 148 million years ago)

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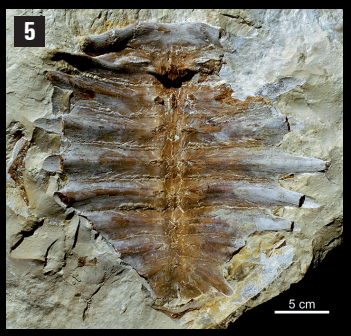

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Photo 1
Skeleton of an ichthyosaur
Photo 2
Brachiopods
Photo 3
Ammonite *Virgatopavlovia*
Photo 4
Lobster-like crustaceans *"Mecochirus"*
Photo 5
Carapace of a cryptodire turtle
Photo 6
Tooth of a plesiosaur
Photo 7
The on-site museum displays life-sized replicas of animals that once roamed the local seas and islands during the late Jurassic period

but also globally. For context, the United States as a whole can boast only a few well-preserved specimens of Jurassic horseshoe crabs, whereas this single Polish site has yielded over 300, all perfectly preserved. Intriguingly, studying the morphology of these fossils has revealed that they all represent juvenile individuals.

The prevailing hypothesis explaining this selective preservation suggests that brief periods of hypoxia (low oxygen) or even anoxia (no oxygen), coinciding with abrupt salinity shifts, triggered algae blooms. These blooms clogged the gill chambers of horseshoe crabs, leading to the widespread demise of younger individuals in particular. To capture the remarkable evolutionary persistence of these creatures, which are still around today, the discoverers of the new species *Limulus darwini*, Kin and Błażejowski, introduced the concept of "stabilomorphism." This term describes the morphological consistency of an organism (taxonomically confined to the genus level) across time and space. Stabilomorphism results from a highly specialized adaptive strategy that significantly diminishes the need for diverse phenotypic variations – that is, variations reflecting environmental influences on their structure. This new definition, aimed at genus-level animals and plants that have weathered at least one major extinction or biotic crisis and survived to modern times, offers a precise and verifiable alternative to the vague notion of "living fossils."

Decapods, particularly the lobster-like crustaceans called *Mecochirus*, form another large group of arthropods at the site. Their remains are frequently found,

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with their existence further documented by numerous trace fossils, such as burrows they left behind. Occasionally, with a bit of luck, one can even discover burrows still housing their original architects.

By far the most abundant vertebrates found at the site are primitive ray-finned fishes. These are mostly known from small, fragmentary fossils abundant in slab limestones. Larger fish bones are also found, belonging to predatory species like caturoids and orthocormids, reminiscent of barracudas and tarpons, or to pyknodonts, which fed on hard prey and resemble some modern reef fishes in body shape. Another highlight of the site is an ichthyosaur from the ophthalmosaur family, *Cryopterygius kielanae* (or *Undorosaurus kielanae*, according to Zverkov), with some of the most complete remains found in Poland. This medium-sized ichthyosaur shares characteristics with boreal specimens (living in northern seas) discovered on Spitsbergen in the Svalbard archipelago and the European part of Russia. Noteworthy marine reptile fossils also include cryptodire turtles, represented by *Owadowia borsukbialynickae*, showing affinities with turtles from Germany originating from warm southern seas, and newly found plesiosaur teeth, likely belonging to the Cryptoclididae family, akin in form to well-documented specimens from Great Britain. Additionally, fossils of terrestrial vertebrates, mainly crocodylomorphs from the atoposaur family, suggest these nimble creatures spent most of their lives on land, unlike their contemporary relatives. Pterosaur bone fragments have also been unearthed, albeit rarely.

A significant indicator of the site's proximity to land is the presence of insects – another group rare in the Polish fossil record. These insects, including beetles, crickets, and dragonflies, may have been carried into the water basin by wind or water, or perhaps attracted from inland by plant life near the shores.

The mission of Geopark Owadów-Brzezinki

The Owadów-Brzezinki site holds immense value not only for its contributions to science but also for its role in geoeducation. The establishment of the Owadów-Brzezinki Geoeducational Center, also known as Geopark Owadów-Brzezinki, marks a significant achievement. Here, both locals and visitors have the opportunity to learn about the fascinating geological history of the area. Operated under the auspices of the Institute of Paleobiology of the Polish Academy of Sciences, the geopark ensures that the exhibits and educational materials adheres to the highest scientific standards. With a variety of engaging infographics and detailed models of Jurassic-era creatures, the geopark serves as a captivating destination for those eager to learn, especially sparking curiosity among young future paleontologists. This project stands as a prime example of how collaboration between local governments, businesses, and the scientific community can foster educational growth, economic development, and enhanced civic engagement. ■

Photo 8
Remains of a small terrestrial crocodylomorph

Photo 9
Excavation work underway in the Owadów-Brzezinki quarry

Further reading:

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