Unique fossil deposits in Sławno, dating back 148 million years

Window on an Ancient World

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Dr. Błażej Błażejowski, one of the discoverers of the unique Sławno deposits, studies Foraminifera and microfossils, as well as paleoclimatic and paleoenvironmental change.

Academia: You discovered one of the world's most fascinating paleontological sites in a quarry in Sławno near Opoczno. It can be easily compared to the most famous site at Solnhofen in Bavaria. How do such discoveries come about?

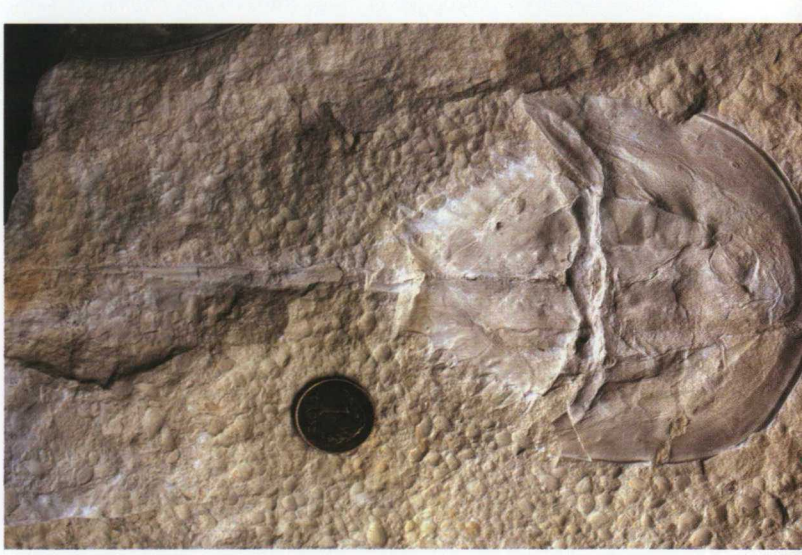
Błażej Błażejowski: First of all, you need to survey the area; you need to get out of the lab, travel to the site as the excavations are ongoing. You need to be aware that even in places concealing the most fascinating fossils – such as Solnhofen – you can spend several days there without finding anything. You need to know what to look for, how and where, and you need a good dose of luck. The quarry had already been known in Poland, as fossils had been extracted from it by researchers from the University of Warsaw. Still, excavation in the northern direction revealed younger formations and layers. We have been observing a gradual change to the sedimentation regime, from deep- and mid-sea levels to extremely shallow environments with parts of terrain emerging out of the waters.

When we spoke last June, you were hoping that by now some new discoveries will have been made at the site. Have there been?

We conducted another two-week-long dig using funding from sponsors, and we're currently applying for a grant for the next three years. It is a unique location, and it has generated a lot of interest worldwide. We recently published a paper in the journal Lethaia *on the subject. Our site is the closest equivalent (in stratigraphic terms) of the most famous late Jurassic fossil site in Solnhofen in southern Germany, dating back approx. 150 million years. The Sławno site is 148 million years old. The two million year difference, and the relatively small paleogeographical distance separating the two sites, make it possible to closely follow evolutionary trends and the rate of speciation among a wide variety of aquatic and land organisms. One particularly exciting element of the fauna fossils found at the site are insects, including fragments of a previously unknown dragonfly species. It was first described by the discoverer of this site, Dr. Adrian Kin, who sadly passed away a few months ago. He first started visiting the location seven years ago; I soon joined him, and for a number of years we travelled there together, inventing numerous excuses to keep the discovery hidden. We wanted to study it as much as possible before letting anyone in on the secret, but most of all we needed to make sure that nothing would get damaged. Today, there is an entire interdisciplinary team working onsite. I'm a paleobiologist from the PAS Institute of Paleobiology, Prof. Andrzej Wierzbowski works at the Polish National Geological Research Institute, Prof. Bronisław Matyja is with the University of Warsaw, Dr. Hubert Wierzbowski with the PAS Institute of Geological Sciences, and Dr. Marcin Binkowski is a specialist in computed microtomography at the University of Silesia.*

People always assume that paleontologists and paleobiologists have such great lives: always on holiday, easy and fun work...

We are out there using pickaxes, hammers, crowbars, day in, day out, often for many years.



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The collection of merostomata found in Sławno is unique: in just a few weeks researchers discovered over a hundred extremely well-preserved specimens, including some with legs intact – something totally unexpected

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Over the holidays, I held camps for students there, and we worked for two weeks without a break. They swapped places every few days, while I was there for the entire fortnight, and towards the end I'd run out of energy even to show them what they came to dig. Still, if it's your passion, it doesn't matter that it's a hard toil; it's still incredibly rewarding, a bit like going for a hike. When you know there's a chance of finding fossils, you'll swing the pickaxe from dawn until dusk. You head out first thing in the morning, and depending on the weather, dig for six or even eight hours. After a few hours in the summer heat, you have no energy left for anything, and all you want to do is lie down and go to sleep. We know people at a local school, and stay there on camping mattresses.

What a romantic job... So once you've made a discovery, how do you study it?

It depends on the finding. We found beautifully-preserved dental bones of vertebrates, for example pterosaurs. They are extremely fragile, difficult to prepare, and of course priceless. You need a wealth of experience in order to prepare and conserve them. The task is made much easier by computer microtomography. We have a very different problem when it comes to studying extinct species of merostomata (horseshoe crabs). Because of their chitin carapaces they are rarely preserved as fossils, making the collection found in Sławno all the more special. I recently read a paper in a well-regarded journal, devoted entirely to a single fossilized horseshoe crab found in the US. In the meantime, in just a couple of weeks we discovered over a hundred extremely well-preserved specimens; some even had their legs intact. That was something totally unexpected. The animals' carapaces had been discovered in just a few locations around the globe, while we have a collection of specimen fossilized right here at home, making it possible for us to study the evolution of these extraordinary animals. The present-day species can even be described as living fossils - descendants of ancient horseshoe crabs, whose appearance has barely changed over millions of years. We are able to examine them closely and study them to evaluate whether there have really been no evolutionary changes over the years. We have described at least two new species of the animals; in fact over 70% of the fossils discovered at Sławno are species new to science. There are also families and genera previously only seen at Solnhofen.

What conditions needed to be met so that so many species could be fossilized, including whole specimens of horseshoe crabs?

Very specific conditions; we are working on describing them. Several of the preserved fully-articulated organisms with a very low fossilization potential (such as merostomata and insects) show that the conditions were extremely favorable. One of the features would have been gentle yet fast sedimentation.

What did the land look like during the late Jurassic? How has it changed?

The recently-discovered fauna associations in Sławno existed in a lagoon environment with limited access to an open basin and near land. It's a similar environment to that at Solnhofen, although the Sławno lagoon was located in the eastern reaches of the epicontinental sea; we can suppose that the lagoon was almost completely isolated from it by a barrier which is yet to be identified. The proximity to open sea is indicated by the occasional presence of rare ammonites. It was likely to have been very shallow, as confirmed by numerous emerging sedimentation structures, home to swarms of insects and pterosaurs.

How did they evolve, and how were they preserved? Are you able to define that?

Yes, using the ever-popular ammonites. They are preserved frequently, but we have discovered forms that are either new to science, or that were previously only seen in northern and western Europe, and no one expected to find them in Poland. Ammonites are excellent indicators of era, since their phenotype varies as they evolve. They have been found in many different layers which can be dated very precisely. They are also extremely useful in the biostratigraphy of microfossils. We study all findings carefully, especially the most interesting ones, such as insects. For example, we have a wing of a late-Jurassic grasshopper, the largest of its kind. A similar animal had been found at Solnhofen, although its wings were much smaller.

Is it the same species?

No; ours is a new species, although they are of the same genus. There is about two million years between them.

What has been your most fascinating discovery?

I always enjoy studying merostomata, although insects and pterosaur bones are also very important. Really, it's the beginning of our adventure at this location. We have already found dozens of vertebrate bones, and we want to continue excavations for a few more years.

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The wing of a late--Jurassic grasshopper, the largest of its kind – representing a species new to science

At Solnhofen, dozens of people are working every day looking for fossils, and yet in Sławno we have already accumulated more merostomata specimens than they have discovered over two centuries. On the other hand, of course they do have eight more or less complete specimens of the Archaeopteryx.

But you also found flying reptiles, didn't you?

Yes; we have pterosaur bones and teeth. There are other vertebrates: ray-finned fish and cartilaginous fish, the latter including sharks. We also have fragments of bones and teeth, which are extremely important for our geochemical research. Our next aims are to reconstruct the conditions and course of sedimentation on the basis of paleoecological analysis of fossils, and to analyze selected aspects of the geochemistry of limestone from Sławno. Detailed identification and analysis of the previously undescribed succession of fauna fossils from the region, and analysis of changes to the composition of oxygen and carbon isotopes of carbonate mollusc shells and phosphate fish teeth, should help us learn about the conditions and changes to the paleoenvironment (including paleoclimatic changes). The location provides a window on the world from just under 150 million years ago. It is an excellent companion site to Solnhofen, as the difference of two million years makes it possible to study different aspects of evolution of merostomata, insects and other animals.

You also discovered the remains of an aquatic reptile, an ancestor of the tuatara.

That's right; we have a dental bone. They are also living fossils. Last year, while Adrian was still with us, we discovered a location where numerous bone fragments have been found, including those of sphenodons. We also found a number of fossilized insects. During excavations last August, sadly no longer with Adrian, we discovered dragonflies, mayflies, grasshoppers and beetles. The first description of a dragonfly wing is about to be published in Acta Palaeobiologica Polonica *as a collaboration between Adrian Kin and a paleobiologist from Germany. Originally, the dragonfly was to be named after Darwin; however, the name will commemorate its discoverer (*Eumorbaeschna adriankini*).*

Shouldn't the site be protected somehow?

Journalists ask us occasionally why we the quarry hasn't been closed; the truth is that we really need the support of the Finnish owners, and they have been very supportive of us and our research. They have put quarrying work on hold for the next two years in the location where we uncovered the most valuable fossils; they will start again in a couple of years, which is just as well, since it would cost us around a million zlotys to remove the 50 meter layer of rock.

Is there a prospect that in the future machines will be able to scan soil in search of fossils, so that major excavations are no longer required?

For now that's completely unrealistic; it takes a great deal of effort and expense to use computed microtomography to scan a 10 cm fragment of rock, never mind deep deposits. During excavation work, we revealed a tiny fragment of bone, which we suspected originated from a sphenodon. We prepared the fragment, but we didn't want to disturb it too much, so we used microtomography to examine it more closely and look at its 3D structure. This is something we wouldn't have been able to do before. We get a 3D printout which is so precise that we can dissect it and observe structures within bones. That's an incredible advance!

Interview by **Patrycja Dołowy**

For technical reasons the English version of this text is being published without having yet received final acceptance from the author.

Further reading:

Kin A., Gruszczyński M., Martill D., Marshall J., Błażejowski B. (2012). Palaeoenvironment and taphonomy of a Late Jurassic (Late Tithonian) Lagerstätte from central Poland. *Lethaia*, 45(3).

Kin A., Błażejowski B., Binkowski M. (2012). 'Polish Solnhofen': a long-awaited alternative?! *Geology Today*, 28(3): 92–95.