3RD INTERNATIONAL MEETING OF EARLY-STAGED RESEARCHERS IN PALAEONTOLOGY

KRASIEJÓW (OPOLE VOIVODESHIP, POLAND),
MAY 18 – 21, 2018

FIELD GUIDE

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ABOUT THE CONFERENCE LOGO

Logo designed by Klaudia Kardynał.
As you may know, Poland is divided into sixteen districts named voivodeships – in view of the fact that the conference will be held in the Opole region, we have decided to create a logo to reflect this, as in previous years. The logo illustrates the contours of Opole Voivodeship, filled in with the local colours, yellow and blue. In addition, it depicts the local ‘VIP’, the dinosauriform *Silesaurus opolensis* that was unearthed from Upper Triassic strata.

EDITORS

DOROTA KONIETZKO-MEIER, ELENA JAGT-YAZYKOVA,
JOHN JAGT, ELŻBIETA M. TESCHNER

PATRONAGE

PATRONAT HONOROWY

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Laboratory of Palaeobiology and Evolution
Department of Biosystematics
Faculty of Natural Sciences and Technology
University of Opole

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Dawid Mazurek and Kamil Gruntmejer

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City Tour

OPOLE CITY TOUR

Wiktoria Wojtkiewicz

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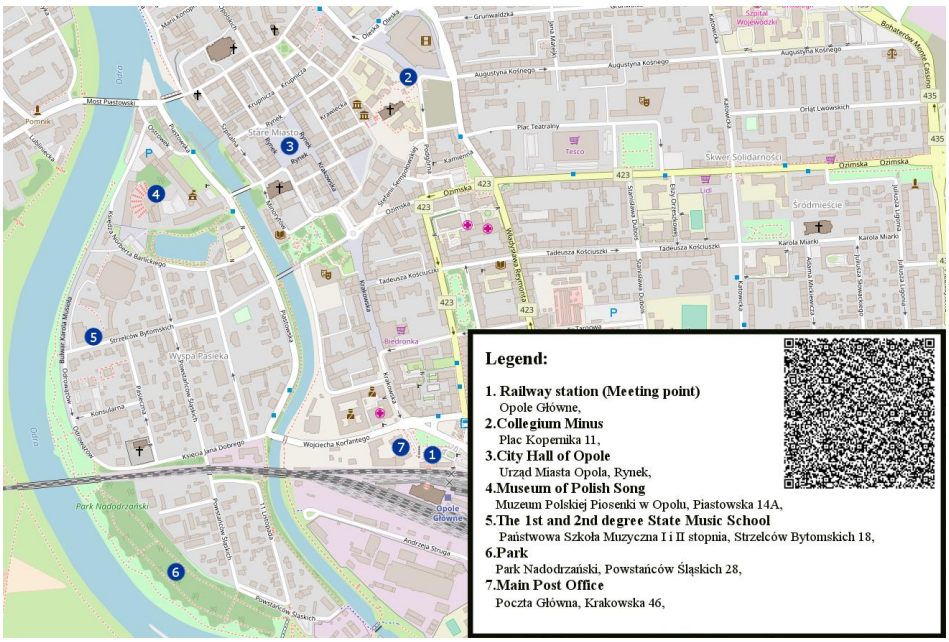


Before the official start of the conference, we recommend a short trip around Opole city centre. It will take you through the charming corners of Pasieka island lying in the heart of the city. It is on its premises that the Odra River park is located, where you can walk along the river bank. As Opole is called the Capital of Polish Song, a visit to the amphitheatre in which every year the most prestigious National Polish Song Contest Festival is organised is planned. Right next to it stands the Piast Tower, which is a small remnant of the Piast Castle - one of the historical rulers of Poland. For those who will be interested, there is an opportunity to climb up the tower. Along the Młynówka Canal, also referred to as Opole Venice, will provide just a short break before our visit of the market square in a lookout tower at the Town Hall. However, as befits a palaeontological conference, we will also visit the Museum of the University of Opole, where a permanent exhibition devoted to fossils can be viewed in one of the halls and prof. Elena

Yazykova will guide you through this. During the whole trip, we encourage you to explore urban palaeontology looking for fossils right under your noses. To this end we will visit the Main Post Office, where you can find many interesting samples. But, in general, we invite you to look carefully along the entire route. Maybe this time you will make a new discovery? The trip is estimated to last around 2-3 hours.

Meeting point – Main Railway Station (Opole Główne) 1 pm

Icebreaker Party venue

PALAEONTOLOGICAL MUSEUM IN KRASIEJÓW – OLD SCHOOL

Sylwia Widawska

Association of Fans of Krasiejów, ul. Sporacka 19, 46-040 Krasiejów, Poland; e-mail:info@krasiejow.pl

The building of "Old School" where the paleontological exhibition of a local museum is hosted (photo: SW).

The Palaeontological Museum in Krasiejów is located in the "Old school" building in the centre of the village. The school was built in 1904 and served as an eight-class educational institution until 1964, when a new school was established in the south-west of the village. Only younger children went there until the 1990s. Later, the building was left empty for many years and it was not used at all. At present, the seat of the Association of Fans of Krasiejów and the Social and Cultural Association of Germans in Opole Silesia, the Public Library, the Common Room, the Palaeontological Museum and the historical exhibition are located here. The museum was opened when the school building had been restored and adapted to the conditions the museum requires. This was made possible thanks to voluntary work by members of the Association of Fans of Krasiejów and financial resources from the Voivodship Environmental Protection Fund, Marshall's Office in Opole, Town and Community Office of Ozimek and EU funds. The director of the Museum of Opole Silesia, Mrs. Krystyna Lenart-Juszczewska, made a significant contribution to the creation of the museum. It was officially opened on January 21, 2005, a year before the Palaeontological Pavilion in JuraPark.

The exhibition was organised by the Association of Fans of Krasiejów and the Museum of Opole Silesia. It was arranged by Marek and Maciej Mikulski and the decorative setting was prepared by Krzysztof Książkiewicz from the University of Opole.

Material on exhibit at the museum was borrowed from the collections of the University of Opole. They are fossils of Triassic animals (about 220 million years old) discovered on the site of the former clay pit at Krasiejów (collar bones, skulls, jaw bones, limbs and vertebrae belonging to the species *Metoposaurus krasiejowensis* and *Paleorhinus* sp., plus bony plates of *Stagonolepis olenkae*). The museum also has thematic charts showing the history of palaeontological discoveries and the rise of animal groups in geological times.

The museum offers various gadgets and souvenirs for sale:

- Commemorative coins, postcards, candlesticks.
- Mugs and beer glasses with images of prehistoric animals.
- Popular science book by Jerzy Dzik & Tomasz Sulej "The first Polish dinosaur".
- Publication of Magdalena Moj "Krasiejów. Photographs of contemporary collective memory".
- CD with the film by Teresa Kudyba and Mariusz Przygoda entitled "Dinosaurs from Krasiejów".
- Area maps.

Museum objects are under care of the Association of Fans of Krasiejów; this is an organisation that was founded by the villagers in 2000.

Its goal is:
• promoting values of the oldest village in Ozimek community, its geographical
environment, history, present and future, and palaeontological discoveries,
• stimulation of social activities by inhabitants of Krasiejów,
• co-operation with local government bodies,
• cultural activities,
The Association of Fans of Krasiejów manages its own website: www. krasiejow.p..

Conference venue

JURAPARK IN KRASIEJÓW

Anna Jończyk, Anna Szymutko, Piotr Urbanowski*, Sabina Zaręba and Mateusz Wojczyk

*Opole University, Department of Biosystematics, ul. Oleska 22, 45-052 Opole, Poland; Science and Entertainment Park Krasiejów, ul. 1 Maja 10, 46-040 Krasiejów; *e-mail: piotrurbanowski1@gmail.com*

View on the educational path in JuraPark with the real-size reconstructions of dinosaurus (photo: AJ).

JuraPark in Krasiejów is the largest park of dinosaurs in Europe and maybe in the world. It is one of the few places that combine entertainment with science. The reason why the Delta Association, owner of JuraPark, decided to open the facility in Krasiejów was the Palaeontological Pavilion, an object managed by the University of Opole, where the remains of animals from 220 million years ago are located. The Palaeontological Pavilion was opened in 2006, four years prior to the opening of JuraPark. JuraPark is an example of co-operation between a state university and a private company which mutually support each other so that knowledge of prehistory is passed on to as many people as possible. JuraPark, covering an area of almost 40 hectares, is a great example of the development of post-mining land, where tourists and scientific objects blend into the natural surroundings.

The Time Tunnel

If you wish to experience a unique time travel with us, we invite you to board a special train, which will take you into the Time Tunnel.

The entrance to Time Tunnel, to go through the tunnel you have to take a train visible on the photo (photo: AJ).

The adventure begins by witnessing the most important moments in the formation of the Universe and our Solar System.

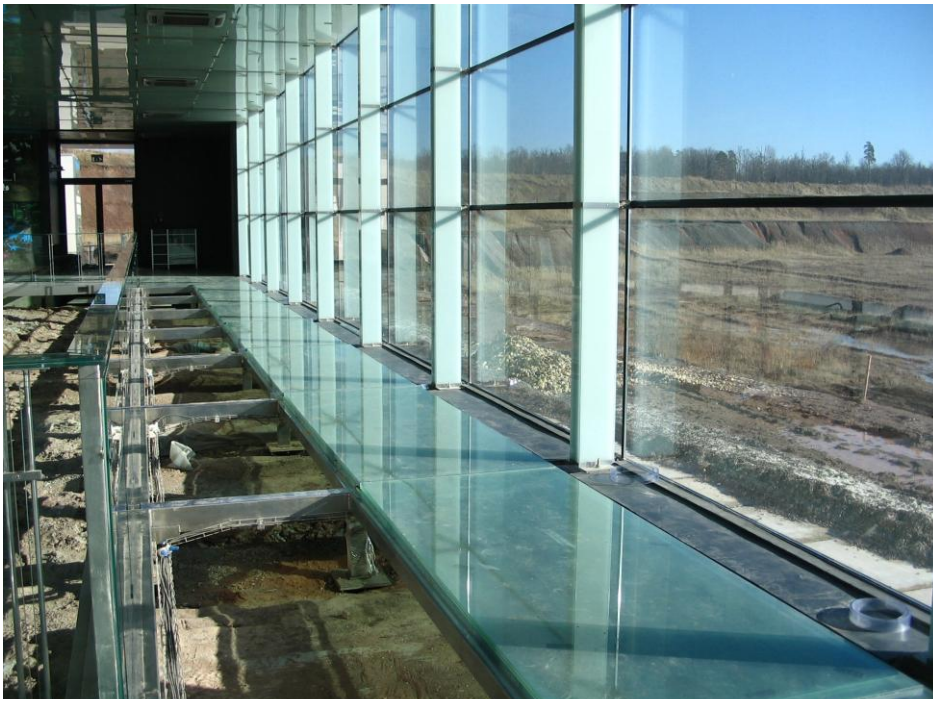
You will be witnesses of the birth of our planet and its first forms of life. We will present to you the inhabitants of the depths of Palaeozoic seas and the rise of life on land. We will let you feel the breeze generated by the wings of *Meganeura* and see continental drift: all in an amazing scenery inside a 3D cinema with a length of 300 metres!
This unusual spectacle ends with the greatest disaster in Earth history and with hopeful words "… but life still goes on".
After an unforgettable journey in the Time Tunnel, you will continue your tour by walking among prehistoric creatures along a specially prepared educational path.

Educational path

Along the educational path in JuraPark there are over 250 animal models that present in excess of 60 species. The models have been set chronologically; therefore visitors, during the journey through Triassic, Jurassic, and Cretaceous, will be able to see how life on Earth evolved. All reconstructions were made by scientists, artists and technicians employed by Delta Association. All models were created based on the latest research and at natural size, varying from less than a metre to over 60 metres in length. Reconstructions are presented in a gentle manner, without aggressive scenes and bloodshed. In addition to models each species is provided with an illustrated information board and characterised in three languages (Polish, English and German).

Pavilion – real palaeontology

The Palaeontological Pavilion in Krasiejów secures the largest fossils of Triassic amphibians and reptiles in Europe that can be seen through a glass floor. The exhibition entitled "The World of the Opole Dinosaur" is of an "*in situ*" nature. As a result of a catastrophe 252 million years ago, over 90% of all living creatures died on Earth. The scientific site of Krasiejów is one of the few places in the world where remains of animals that developed following this terrible catastrophe are preserved. What amazes visitors the most is the number of preserved remains: hundreds of skulls and other bones gathered in a small space. It is the only museum in the world that stands on top of an active palaeontological site. One can see here the reconstruction of the skeleton of the oldest predinosaur *Silesaurus opolensis* made by sculptor Marta Szubert. Walking on glass panes, you can see well-preserved specimens, just as nature left them almost 220 million years ago.



A view of the inside of the pavilion at Krasiejów Jurapark, with an exhibit of *in-situ* Late Triassic vertebrate remains, mostly metoposauroids. Visible through the glass wall is a portion of the quarry. The pavilion belongs to Opole University (photo: DKM).

For palaeontologists, a mobile platform moving above the fossil field was designed. In the season, from July to September, you can look at the work of palaeontologists. This is an interesting tourist and educational attraction. The pavilion received the most important architectural distinction in the country - SARP Award for the best object - by GoczołowieArchitekci and OvoGrąbczewscyArchitekci realised in Poland in 2006 and the prestigious "Polish Cement in Architecture" for the best implementation with the use of concrete technology.

Prehistoric aquarium

The planktonic foram-shaped oceanarium will take you to the prehistoric oceanic depths, dominated by huge Devonian armoured fish and various Mesozoic marine reptiles. Thanks to modern 3D technologies, you will be facing a majestic *Basilosaurus*, take a close look at *Liopleurodon*, and a clash with a 20-m *Carcharodon megalodon* will surely result in goose bumps.
If you have enough courage, we will take you with a bathyscaphe for an underwater adventure. Diving among powerful mosasaurs will be a lifetime experience!

Food and fun

After exhausting fun and time travel, you can partake in the gastronomy of JuraPark, located in the park's yard. You need to replenish your strength and quench your thirst, and before continuing to eat and travel to the unknown, consume a warm and tasty meal. You can compose your own dinner set. Apart of small snacks, such as burgers, chips and salads, the chef recommends traditional dinners as well as grilled dishes, for instance trout, freshly caught from the pond at a nearby farm.
All dishes served in JuraPark are prepared from natural products on site by qualified kitchen staff. With a meal you can sit under the shelter and barbecue grill, while in the courtyard in the shade of the parasol you can enjoy your meal, being outdoors, in the fountains and close to nature.
For the youngest tourists of JuraPark, a playground with an area of 3,000 m^2 has been prepared. There are devices such as fleeting, 12-m slides, which are safe for children and of high standard. A much deeper playground is also a labyrinth with a wooden structure prepared for the youngest tourists with lots of attractions for slides and elements for climbing. In addition, the youngest, like palaeontologists, can find the skeleton of a dinosaur in the sand.
On the beach you can buy ice cream, drinks and various bathing accessories. The artificial swimming pool, with clean water, can be used by the youngest guests as well as by adults. There is also a separate zone for watersport equipment, such as kayaks. When taking a bath, you can always rely on the watchful eyes of professional rescuers.
Being on the beach you can take a comfortable sun bed, and a folded parasol will protect the tourist from hot weather and sunlight. Near the beach there is also an Amusement Park, which includes a Pirate Ship and mini cars that are offered to younger tourists.

Science and Human Evolution Park

Part of the exhibition in a Science and Human Evolution Park (photo: AJ).

Since 2014, opposite one of the best three pairs of dinosaurs in Poland, the Park of Science and Evolution of Man has been created. The interactive museum allows us to learn about history in an interesting

way. Thanks to the fact that each person has their own guide, he or she can explore at their own pace without fear that the group will escape.
If you decide to explore the park, the first thing that will strike you is the futuristic look of the building. The greatest attraction for children and adults is the large mammoth mascot, which every year can boast of a large photo gallery.
What will make this museum stand out from others?
There is extremely advanced technology everywhere, which can be noted when entering the waiting room. A room full of interactive games makes the time pass by, waiting for the first ferry that will take us on a journey in time. A special helmet equipped with an audioguide, at the very beginning informs us that it will be an amazing adventure that will provide you with a lot of experience and a lot of knowledge. Finishing the trip, we come to the hall where all exhibits are characterised by a high level of authenticity. Before leaving the building, it is worth buying some souvenirs that will remind you of this journey in time.
Good news for teachers, because you can organise educational camps, or learn through play. You do not have to worry about accommodation or food. The Park of Science and Human Evolution has a cafe where you can eat and accommodation for an entire tour coach, or 55 people.

Field trip

UPPER SILESIAN MUSCHELKALK

Adam Bodzioch

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Stop 1. Strzelce Opolskie (active quarry): the Lower Muschelkalk Sea

At the active quarry of Strzelce Opolskie, the Lower Muschelkalk (Middle Triassic; late Anisian, Pelsonian to Illyrian) is exposed. The section includes the uppermost part of the Gogolin Formation, the Górażdże Formation, the highly fossiliferous Dziewkowice Formation (the so-called Terebratula Beds) and the Karchowice Formation, which are in the centre of palaeontological focus. The Dziewkowice Formation represents an off-barrier facies, formed in the deepest part of the Upper Silesian part of the Muschelkalk basin. The rich fossil assemblage consists of brachiopods (mainly terebratulids, dominated by

Coenothyris), molluscs (mainly bivalves represented by dozens of genera, e.g. *Enantiostreon*, *Prospondylus*, *Plagiostoma*) and echinoderms (mainly crinoids, e.g., *Silesiacrinus*, *Holocrinus*). Occasionally, however, other invertebrates can be found, as well as remains of vertebrates. The Karchowice Formation represents reef facies (unique in the Middle Triassic) that formed during regression of the Lower Muschelkalk sea.

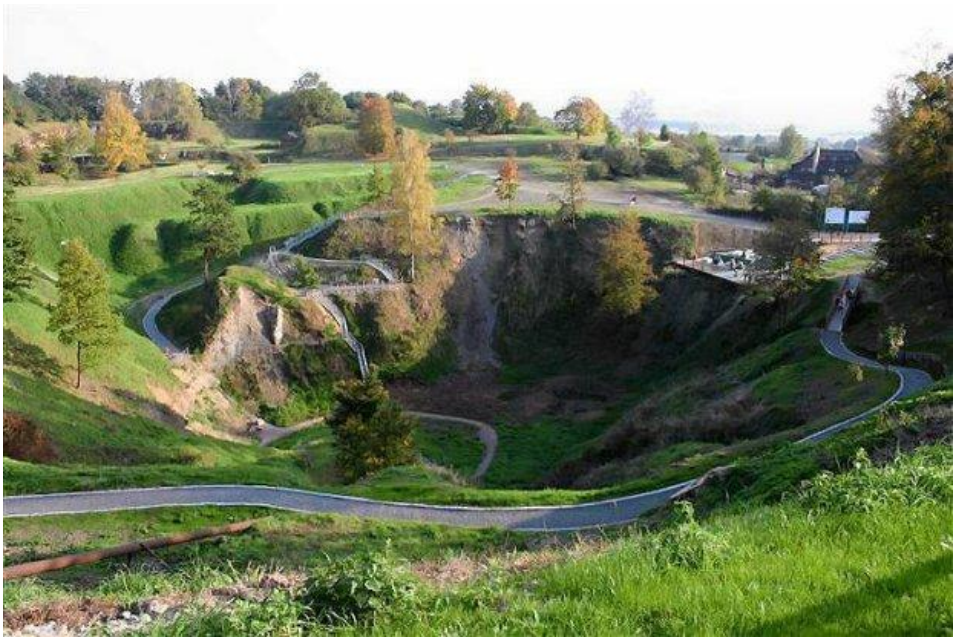
At the active quarry of Strzelce Opolskie with the Lower Muschelkalk exposed (photo: EY).

It consists of biohermal limestone built by hexactinellid sponges (*Hexactinoderma* and *Silesiaspongia*) and scleractinian corals (e.g., *Pamiroseris*, *Eckastrea*, *Voltzeia*), accompanied by taxonomically highly diverse molluscs (especially gastropods, such as *Worthenia*, *Coelocentrus*, *Euomphalus*, *Loxonema*, *Naticopsis* or *Omphaloptycha*), echinoderms (especially rare are Muschelkalk echinoids, such as *Triadocidaris*) and brachiopods (including unique *Tetractinella*). Both sponges and corals of the Karchowice Formation are the oldest Mesozoic representatives of their orders. Similarly, the reefs themselves are also the oldest Mesozoic sponge-coral reefs.

Stop 2. Góra św. Anny (National Geopark): Cenozoic volcano, Middle Triassic, Cretaceous

The Geopark has been founded here at the unique site of an ancient caldera. Volcanic formations are represented by basaltic and pyroclastic rocks, which cut older rocks. Near the surface, we can observe the same lithostratigraphical units of the Middle Triassic as at Stop 1, and, moreover, blocks of Lower and Upper Cretaceous sandstones and marls, respectively. The spatial relationships between all outcropping formations evidenced that the volcano was formed at the surface built of Cretaceous rocks. According to radiometric data, this occurred in the Late Pliocene, 27 myr ago. 15 myr ago, during the last eruption, the volcano cone collapsed and formed a caldera, which has been eroded since then.

Reef facies of the Karchowice Formation, including a sponge bioherm, its talus and both under- and overlying deposits, are well visible near the contact with basaltic rocks. Currently, Upper Cretaceous marls are poorly exposed in the western part of the main “volcano” outcrop, but it is worth mentioning that their fossil content includes mainly echinoids (e.g., *Micraster*, *Echinocorys*) and bivalves (e.g., *Inoceramus*).



The view on the Geopark (photo: AB).

Field trip/Conference venue

KRASIEJÓW – A LATE TRIASSIC PARADISE FOR PALAEONTOLOGISTS

Kamil Gruntmejer[1,2,*] and Dorota Konietzko-Meier[1,3]

*[1]University of Opole, Department of Biosystematics, ul. Oleska 22, 45-052 Opole, Poland; [2]University of Opole, European Centre of Palaeontology, ul. Oleska 48, 45-052 Opole, Poland; [3]University of Bonn, Steinmann Institute, Nussallee 8, 53115 Bonn, Germany; *e-mail:gruntmejerkamil@gmail.com*

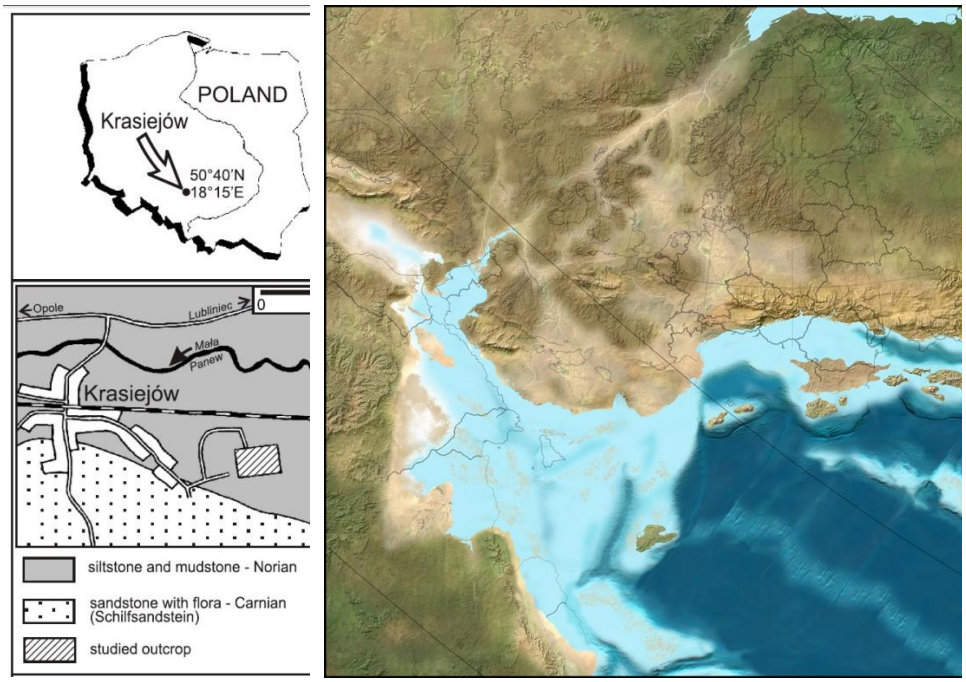
Probably every palaeontologist has heard about Krasiejów, and especially about 'Jurapark' – the largest European science, amusement and touristic object dedicated mainly to dinosaurs. Here, the visitors (and especially you!) can marvel at life-size models of prehistoric creatures, beginning from the Triassic and extending into the Cretaceous. In 'The Science and Human Evolution Park' you can also investigate the evolutionary process that led from our ancestors to modern humans. However, Krasiejów is famous for something else … Krasiejów is a small village some 20 kilometres east of Opole, and in recent years, it has rapidly become a mecca for lovers of palaeontology from all over the world. The prime reason is the sheer abundance of accumulated fossil vertebrates on the grounds of old brickworks for which claystone was excavated in an open-cast mine (Dzik & Sulej, 2007). If you have never heard in media about 'the oldest dinosaur in the world' – currently the dinosauromorph *Silesaurus opolensis*, large archosaurs *Stagonolepis olankae* or *Polonosuchus silesiacus*, temnospondyls *Metoposaurus krasiejowensis* or *Cyclotosaurus intermedius*, and 'the biggest flying Triassic reptile' *Ozimek volans* – this place is beckoning you to pay a visit! Moreover, there also is a palaeontological museum with exhibits of fossils and skeletal reconstructions of vertebrates from Krasiejów, and during the summer, visitors can experience what makes palaeontologists tick at digs near the pavilion. Of course, the conference participants are obliged to dig with us too. Due to these tourist attractions and primarily because of the palaeontological excavations, young researchers from around the world visit Krasiejów every year.

Part of the exhibition of 'JuraPark' in Krasiejów (photo: KG).

Palaeontological stand

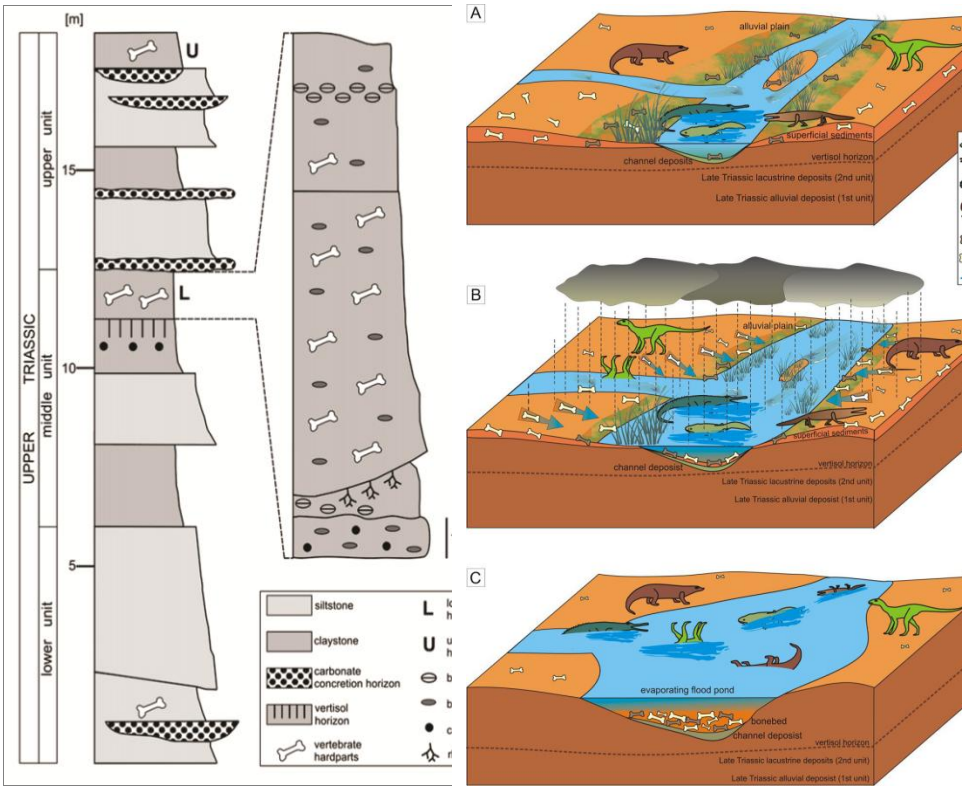
At the present day Silesia is completely different from the situation during the Late Triassic. During that time, this area was situated much further south on the globe, under warm, subtropical climatic conditions and impact of monsoon rains. Because of these circumstances air temperatures were very similar to those of the present-day Mediterranean basin, with merely two seasons; a rainy and dry one. Under such conditions, rivers swelled during the wet season and extended far beyond their beds, whereas in periods of drought they almost disappeared and marsh and swamp areas decreased in size. Occasionally, rainfall was very intense which locally led to flooding. Just

as a result of one of such floods, the extensive accumulation of fossil bones came into being in what is now Krasiejów (Gruszka & Zieliński, 2008). The rapid rise of flood waters washed out skeletal remains from neighbouring areas, and transported them to their final site of burial. During transportation and prior to deposition, material was segregated, intermingled and often damaged as well (Bodzioch & Kowal-Linka, 2012).



Position of the Krasiejów site within Poland (left) and location of Europe during the Late Triassic (from Gruszka & Zieliński, 2008).

This explains why entire skeletons with proper anatomical arrangement of all elements are rare at Krasiejów. However, the rapid process of bone bed accumulation meant that interspersed bones of various animal species are now very numerous. Remains of large-sized vertebrates are present in both upper and lower claystone horizons (bone beds). These two levels are separated by a several layers of claystones and siltstones with thin veins of carbonate concentration. The lower bone-bearing horizon is situated about 10 metres below ground surface and is still exploited for fossils. The upper horizon is at two metres below ground level, and has already been exploited within the limits of the Krasiejów bone bed.



(left) Schematic lithostratigraphic log of the Krasiejów site; **(right)** Schematic model illustrating how the lower bone-bearing bed might have formed (after Bodzioch & Kowal-Linka, 2012).

The age of the Late Triassic rocks and the fossils in Krasiejów is still debated. Stratigraphical data suggests sedimentation during the early Norian (Szulc *et al*., 2015a, b), while biochronological data indicate the late Carnian (Dzik & Sulej, 2007; Lucas, 2015). Generally, the view is that the claystones at Krasiejów were not laid down earlier than latest Carnian (230-225 million years ago, myr) and no later than middle Norian (220-210 Ma) (Gruszka & Zieliński, 2008). As far as the geological time scale is concerned, this is merely a narrow age range difference, but from the point of view of the evolution of terrestrial Triassic vertebrates it does make quite a difference!

Plants and invertebrates

The alkaline environment of water during sedimentation process explains why fossils of plants are very rare in Krasiejów (Dzik, 2003). Large accumulations of oospores (spore cells) indicate that green algae occupied inland waters whereas the land was covered mostly by large horsetails and ferns in wetlands, while in drier areas conifers could

develop. The fauna of small aquatic invertebrates was dominated mainly by bivalves (very common and numerous moulds), especially by a single genus and species, *Silesunio parvus* (Skawina & Dzik, 2011). Apart from bivalves, fossils of a cycloid crustacean e.g., *Opolanka decorosa*, ostracods and phyllopods were found in Krasiejów (Olempska, 2004; Dzik, 2008). Of other animals, only a few specimens of Coleoptera (beetles) were found (Dzik & Sulej, 2007).

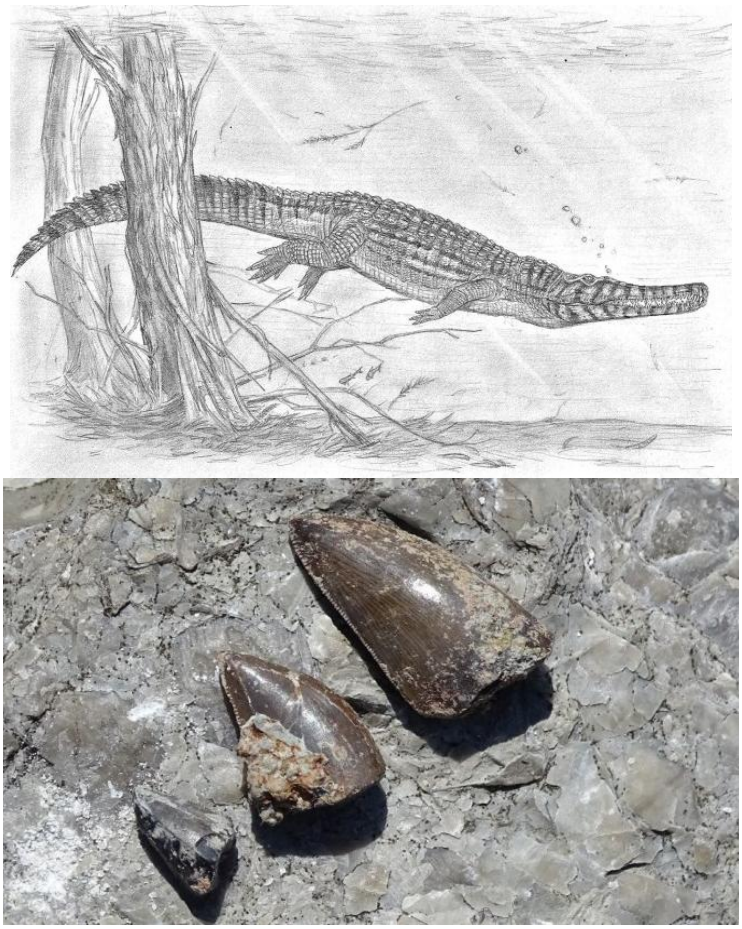
Vertebrates

Metoposaurus is the commonest large vertebrate of the Upper Triassic bone bed in Krasiejów. The most popular, and the best researched, of its skeletal remains are vertebrae (Sulej, 2007; Konietzko-Meier *et al*., 2013, 2014), skulls (Sulej, 2002, 2007; Konietzko-Meier and Wawro, 2007; Gruntmejer *et al*., 2016; Konietzko-Meier *et al*., 2018) and long bones (Sulej, 2007; Konietzko-Meier and Klein, 2013; Teschner *et al*., 2017). Metoposaurids were huge, around 2-3 metres in length, fully aquatic temnospondyls. This amphibian was generally a bottom dweller predator, as evidenced by strongly, dorso-ventrally flattened body (Sulej, 2002). However, the most recent studies indicate that metoposaurids were also actively swimming hunters (Konietzko-Meier *et al*., 2013; Fortuny *et al*., 2017; Konietzko-Meier *et al*., 2018). For air, they had to regularly resurface and the main mode of locomotion (swimming) was via the long and laterally flattened tail. The most characteristic feature of their skull is the location of the orbits, which were situated in the anterior skull region, near the nostrils. Such placement of the orbits helped this aquatic predator in its search for prey and during swimming in the murky waters (Sulej, 2007). Metoposaurids had a cosmopolitan distribution during the Late Triassic. Their fossils are known from Africa, North America, India and Europe. European species are represented by *Metoposaurus diagnosticus* from Germany, *Metoposaurus algarvensis* from Portugal and *Metoposaurus krasiejowensis* (previously described by Sulej as a subspecies, *Metoposaurus diagnosticus krasiejowensis*) from Poland.

Reconstruction of *Metoposaurus krasiejowensis* (drawing by Jakub Kowalski), and a skull at the Opole University Museum (photo: KG).

Phytosaurs are the second commonest group of large vertebrates at the palaeontological site of Krasiejów. *Paleorhinus* sp. (see Dzik, 2001) was a 3,5-m-long, semi-aquatic predator, closely similar in shape to extant gavials or crocodiles. Its skull was narrow, markedly elongated and possessed numerous, sharply pointed teeth adapted for a

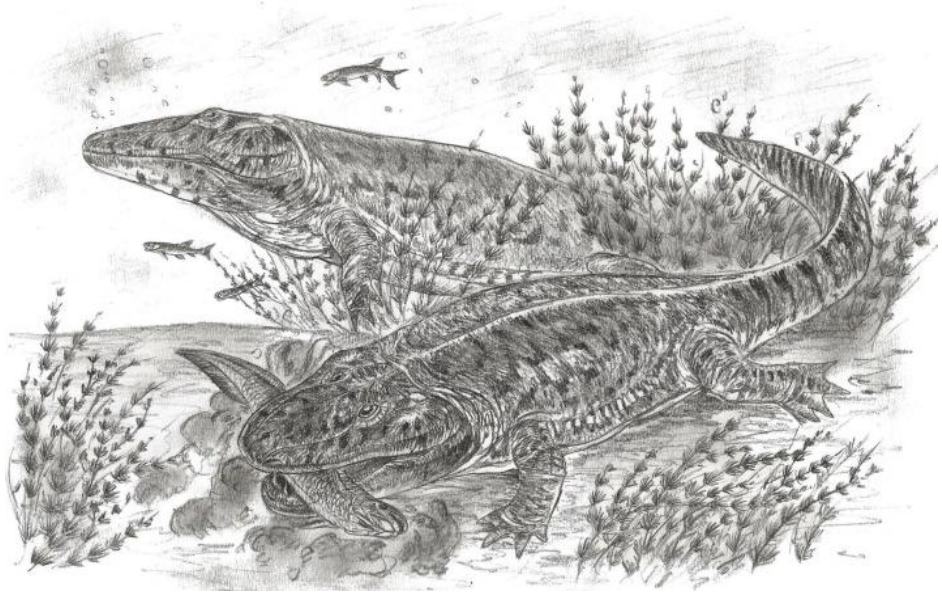
piscivorous habit. Features differentiating phytosaurs from Krasiejów from extant crocodylomorphs include the weak construction of the pelvis in the former, and the development of a secondary palate and a shift of the nostrils to the forehead (Dzik, 2001). The long jaws, slender body and extension of epiphyses in caudal vertebrae suggest that *Paleorhinus* was a fast and active predator in the freshwater ecosystems.



Reconstruction of *Paleorhinus* sp. (drawing by Jakub Kowalski); and its teeth (photo: KG).

Capitosaurid temnospondyls are the largest and top predators in freshwater ecosystems of Krasiejów. *Cyclotosaurus intermedius* (Sulej & Majer, 2005) was a 3,5-m-long amphibian. Cyclotosaurid behaviour must have been similar to that of extant crocodiles and alligators – these predators hunted on small vertebrates near the water's edge. In contrast to metoposaurids, cyclotosaurids did not possess lateral sulci on their skull surface, which was adapted for a predatory life style both in the water and in terrestrial habitats. The location of the orbits in the posterior

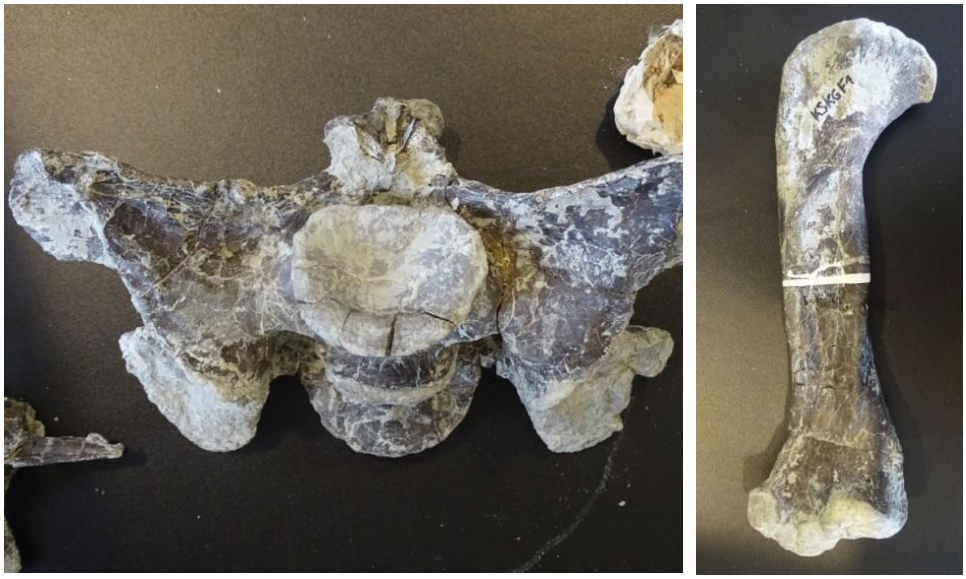
part of the skull and closure of the otic notch during evolution made capitosaurids hunt efficiently, from ambush, and exert a strong biting force (Fortuny *et al*., 2012).



Reconstruction of *Cyclotosaurus intermedius* (drawing by Jakub Kowalski).

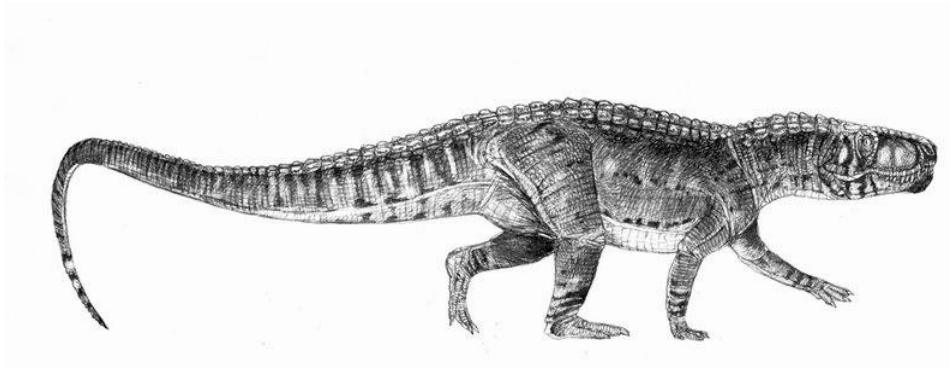
Skeletal remains of aetosaurs represented by the genus *Stagonolepis* were found in the lower and upper bone beds at Krasiejów (Dzik, 2003; Dzik & Sulej, 2007). *Stagonolepis* was a herbivorous, 3,5-m-long archosaur with a heavily armoured body, covered by osteoderms, which played a protective role against attacks of large predators. At first, the osteroderm morphology of the Polish aetosaur appeared to indicate its conspecificity with a Scottish species, *Stagonolepis robertsoni*. Later studies of the skull anatomy have shown this conclusion to be erroneous – cranial material was described as a new species – *Stagonolepis olenkae* (Sulej, 2010). Subsequent descriptions of new skull material have proposed the synonymy of *Stagonolepis robertsoni* and *Stagonolepis olenkae*, suggesting sexual dimorphism to be the cause of some differences (Antczak, 2016).

The skull of *Stagonolepis* was small, equipped with conical teeth, a horny beak on the mandible and a fleshy snout on the toothless, upturned and laterally expanded upper jaw (premaxilla) (Sulej, 2010). Jaw morphology and tooth shape suggest that *Stagonolepis* used its snout to poke around amongst rhizomes and in the muddy bottom, in search of small invertebrate prey (Small, 2002, Desojo *et al*., 2013).



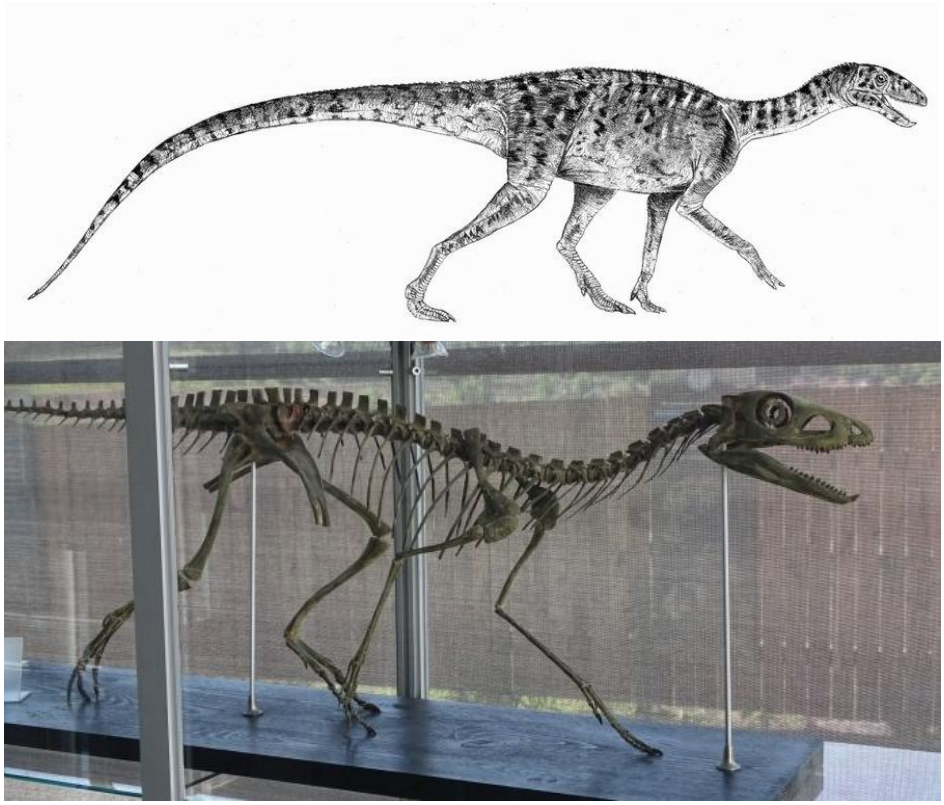
Bones of *Stagonolepis olenkae*: vertebrae (on the left) and femur (on the right) (photo: KG).

The largest, terrestrial predator from Krasiejów was a 4-m-long rauisuchian, *Polonosuchus silesiacus* (Dzik, 2003; Sulej, 2005; Brusatte *et al*., 2009). This archosaur was a seasoned hunter, specialising mainly in chasing armoured aetosaurs. The Polish *Polonosuchus* is a smaller relative of the German genus *Teratosaurus* and the North American *Postosuchus*. At Krasiejów, rauisuchian remains are very rare, and so far only a few single skeletal remains, including vertebrae, teeth and skull fragments have been found. The connection between skull bones at its anterior part were elastic and mobile, which made that teeth slipped from the herbivores osteoderms of victims during biting, to penetrate the soft tissues between them. Similarly to the North American rauisuchian, it is also possible that *Polonosuchus* could have been an ambush predator that went for smaller, yet faster animals.



Reconstruction of *Polonosuchus silesiacus* (drawing by Jakub Kowalski).

The most unique and precious find in the Krasiejów bone beds are the fossils of the small dinosauromorph, *Silesaurus opolensis*. *Silesaurus* was a small, 2-m-long, agile herbivore, an intermediate form between archosaurs and dinosaurs.



Reconstruction of *Silesaurus opolensis* (drawing by Jakub Kowalski), and life-size skeleton model in the palaeontological pavilion at Krasiejów (photo: KG).

The construction of its hind legs and pelvis and the open-work structure of the cervical vertebrae constitute features that are typical of the dinosaur lineage. On the other hand, skull morphology and tooth shape are characteristically archosaur. The accumulation of skeletal remains which belonged to several individuals suggests that *Silesaurus* lived in herds. During feeding the partially edentulous mandible with a horny beak at its end was used (Dzik, 2003). Both its agility and life in a herd helped in spotting larger, yet slower, predators and in running from them. It is difficult to imagine that this small and inconspicuous species is closely related to the majestic, herbivorous ornithischian dinosaurs from the Jurassic and Cretaceous.

These are not the only residents of the Late Triassic world of Krasiejów. The freshwater reservoirs and rivers were inhabited by large

ganoid and dipnoan fishes, as evidenced by numerous finds of scales, teeth or larger fragments of the skeleton. In terrestrial environments many smaller vertebrates coexisted with larger ones, e.g., reptiles such as sphenodonts or protorosaurids *Ozimek volans* (Dzik & Sulej, 2016), and perhaps small mammals.

What other secrets are still hidden in Krasiejów?

The residents of the wetlands of Krasiejów presented above undoubtedly comprise but a small portion of the biota that lived here more than 200 million years ago. Between the first publication on the palaeontological treasures of Krasiejów (Dzik *et al*., 2000) and today, almost 18 years have passed; nw finds are still being made to document further inhabitants of these settings. Now it is certain that Krasiejów and environs during the Late Triassic period was full of life, comprising mammals, sharks, small lizards, protorosaurs, dwarf temnospondyls, and a whole lot of yet unidentified skeletal elements which are awaiting publication. The sheer number of fossils and their unique nature (on a European scale) have turned Krasiejów into the largest bone bed of the Upper Triassic across Europe and the one that is most valued by research institutes abroad.

References

Antczak, M., 2016. Late Triassic aetosaur (Archosauria) from Krasiejów (SW Poland): new species or an example of individual variation? *Geological Journal,* **51**: 779–788.

Bodzioch, A. & Kowal-Linka, M., 2012. Unravelling the origin of the Late Triassic multitaxic bone accumulations at Krasiejów (S Poland) by diagenetic analysis. *Palaeogeography*, *Palaeoclimatology*, *Palaeoecology* **346-347**, 25-36.

Brusatte S. L., Butler, R. J., Sulej, T. & Niedźwiedzki, G., 2009. The taxonomy and anatomy of rauisuchian archosaurs from the Late Triassic of Germany and Poland. *Acta Palaeontologica Polonica*, **54** (2): 221–230.

Brusatte, S. L., Butler, R. J., Mateus, O. & Steyer, J. S., 2015. A new species of *Metoposaurus* from the Late Triassic of Portugal and comments on the systematics and biogeography of metoposaurid temnospondyls. *Journal of Vertebrate Paleontology,* **e912988**, 1-23.

Desojo, J. B., Heckert, A. B., Martz, J. W., Parker W. G., Schoch, R R., Small, B. J., & Sulej, T., 2013. Aetosauria: a clade of armoured pseudosuchians from the Upper Triassic continental beds. In: Nesbitt, S. J., Desojo, J. B., Irmis, R. B., (Eds.), Anatomy, Phylogeny, and Palaeobiology of Early Archosaurs and Their Kin. In: Special Publications of the Geological Society of London, **379**, 203–239.

Dzik, J., Sulej, T., Kaim, A., & Niedźwiedzki, R., 2000. Późnotriasowe cmentarzysko kręgowców lądowych w Krasiejowie na Śląsku Opolskim. *Przegląd Geologiczny*, **48**, 226–235.

Dzik, J., 2001. A new *Paleorhinus* fauna in the early Late Triassic of Poland. *Journal of Vertebrate Paleontology* **21**, 625-627.

Dzik, J., 2003. A beaked herbivorous archosaur with dinosaur affinities from the early Late Triassic of Poland.*Journal of Vertebrate Paleontology* **23**, 556-574.

Dzik, J., 2008. Gill structure and relationships of the Triassic cycloid crustaceans. *Journal of Morphology* **269**, 1501-1519.

Dzik, J., & Sulej, T., 2007. A review of the early Late Triassic Krasiejów biota from Silesia, Poland. *Palaeontologia Polonica* **64**, 3-27.

Dzik, J., & Sulej, T., 2016. An early Late Triassic long-necked reptile with a bony pectoral shield and gracile appendages. *Acta Palaeontologica Polonica*, **61**(4), doi:10.4202/app.00276.2016

Fortuny, J., Marcé-Nogué, J., Gil, L. & Galobart, Á., 2012. Skull mechanics and the evolutionary patterns of the otic notch closure in capitosaurs (Amphibia: Temnospondyli). *The Anatomical Record*, **295**, 1134–1146.

Fortuny, J., Marcé-Nogué, J. & Konietzko-Meier, D., 2017. Feeding with Late Triassic metoposaurids: a 3D Finite Element Analysis approach. *Journal of Anatomy*, **230**(6), 752–765. doi:10.1111/joa.12605.

Gruntmejer, K., Konietzko-Meier, D. & Bodzioch, A., 2016. Cranial bone histology of *Metoposaurus krasiejowensis* (Amphibia, Temnospondyli) from the Late Triassic of Poland. *PeerJ* 4, e2685. doi:10.7717/peerj.2685.

Gruszka, B. & Zieliński, T., 2008. Evidence for a very low-energy fluvial system: a study from the dinosaur-bearing Upper Triassic rocks of southern Poland. *Geological Quarterly*, **52**(3), 239-252.

Konietzko-Meier, D. & Wawro, K,. 2007. Mandibular dentition in the Late Triassic temnospondyl amphibian *Metoposaurus*. *Acta Palaeontologia Polonica* **52**: 213–215.

Konietzko-Meier, D., Bodzioch, A. & Sander, P.M., 2013. Histological characteristics of the vertebral intercentra of *Metoposaurus diagnosticus* (Temnospondyli) from the Upper Triassic of Krasiejów (Upper Silesia, Poland). *Transactions of the Royal Society of Edinburgh*, *Earth and Environmental Science* **103**, 237-250.

Konietzko-Meier, D. & Klein, N., 2013. Unique growth pattern of *Metoposaurus diagnosticus krasiejowensis* (Amphibia, Temnospondyli) from the Upper Triassic of Krasiejów, Poland. *Palaeogeography Palaeoclimatology Palaeoecology* **370**: 145–157.

Konietzko-Meier, D., Danto, M., & Gądek, K., 2014. The microstructural variability of the intercentra among temnospondyl amphibians. *Biological Journal of the Linnean Society*, **112**, 747–764. doi:10.1111/bij.12301.

Konietzko-Meier, D., Gruntmejer, K., Marcé-Nogué, J., Bodzioch, A., & Fortuny, J., 2018. Merging cranial histology and 3D-computational biomechanics: a review of the feeding ecology of a Late Triassic temnospondyl amphibian. PeerJ 6:e4426.

Lucas, S., G. 2015. Age and correlation of the Late Triassic tetrapods from southern Poland. *Annales Societatis Geologorum Poloniae*, 85, 627–635. doi:10.14241/asgp.2015.024.

Olempska, E., 2004. Late Triassic spinicaudatan crustaceans from southwestern Poland. *Acta Palaeontologica Polonica*, **49**(3):429–442.

Skawina, A. & Dzik., J., 2011. Umbonal musculature and relationships of the Late Triassic filibranch unionoid bivalves. *Zoological Journal of the Linnean Society* **163**, 863–883.

Small, B. J., 2002. Cranial anatomy of *Desmatosuchus haplocerus* (Reptilia: Archosauria: Stagonolepididae). *Zoological Journal of the Linnean Society*, **136**, 97–111.

Sulej, T., 2002. Species discrimination of the Late Triassic temnospondyl amphibian *Metoposaurus diagnosticus*. *Acta Palaeontologica Polonica*, **47**, 535–546.

Sulej, T., 2005. A new rauisuchian reptile (Diapsida: Archosauria) from the Late Triassic of Poland. *Journal of Vertebrate Paleontology* **25**, 78-86.

Sulej, T., 2007. Osteology, variability, and evolution of *Metoposaurus*, a temnospondyl from the Late Triassic of Poland. *Palaeontologia Polonica* **64**, 29-139.

Sulej, T., 2010. The skull of an early Late Triassic aetosaur and the evolution of the stagonolepidid archosaurian reptiles. *Zoological Journal of the Linnean Society* **158**, 860-881.

Sulej, T., & Majer, D., 2005. The temnospondyl amphibian *Cyclotosaurus* from the Upper Triassic of Poland. *Palaeontology* **48**, 157-170.

Szulc, J., Racki, G., & Jewuła, K. 2015a. Key aspects of the stratigraphy of the Upper Silesian middle Keuper, southern Poland. *Annales Societatis Geologorum Poloniae*, 85, 557–586. doi:10.14241/asgp.2015.039.

Szulc, J., Racki, G., Jewuła, K., & Środoń, J. 2015b. How many Upper Triassic bone-bearing levels are there in Upper Silesia (southern Poland)? A critical overview of stratigraphy and facies. *Annales Societatis Geologorum Poloniae*, 85, 587–626.

Teschner, E. M., Sander, P. M., & Konietzko-Meier, D., 2017. Variability of growth pattern observed in *Metoposaurus krasiejowensis* humeri and its biological meaning. Journal of Iberian Geology. doi:10.1007/s41513-017-0038-y.

Field trip

DIVERSE PALAEONTOLOGICAL CONTENT OF TURONIAN STRATA IN THE OPOLE AREA

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Scientific studies of Cretaceous marls and limestones in the Opole area (Fig. 1) are linked closely to the development of the cement industry (since the 1850s), ever since the introduction of the first types of Portland Cement.

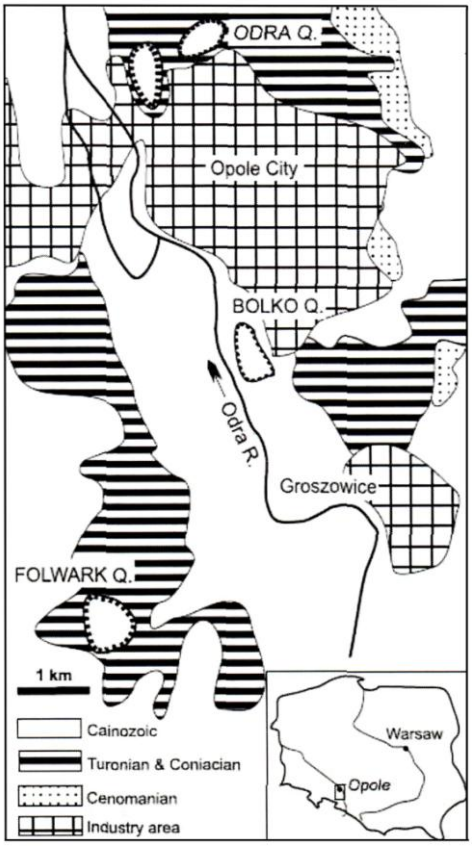


Fig.1. Map of the Opole area (southwest Poland), showing the Odra (both disused and currently exploited), Bolko (disused/flooded) and Folwark quarries (from Mazurek, 2008; after Niedźwiedzki & Kalina, 2003).

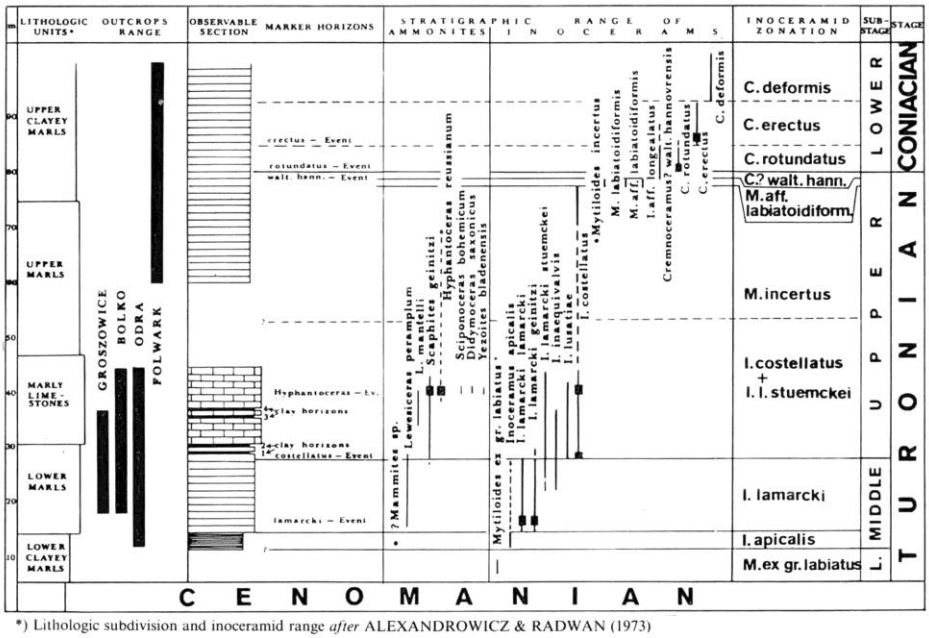
In 1841, Friedrich Adolf Roemer was the first to come up with the proper age assignment of these rocks, by equating the so-called 'Opole Cretaceous' with the Chalk Marl in Great Britain. The same author (F.A. Roemer, 1841, 1864) studied some fossils from the German Cretaceous, compared them with material from the Opole Cretaceous, and described twenty-one species from so-called 'scaphite beds' of the latter area. One of the most influential papers on the geology (and palaeontology) of Silesia is *Geologie von Oberschlesien* by Ferdinand Roemer (1870), who outlined the lithostratigraphy of Cretaceous strata in Opole, distinguishing sands and sandstones, calcareous marls and calcareous sandstones with muscovite. Later, German scholars visited

these outcrops, and recorded various species of macrofossils (sponges, echinoids, ammonites). Of particular note was a paper by Leonhard (1898), who illustrated the geology of the region in a much more professional way, in particular the rocks of Turonian age. He distinguished between grey sandy-marly clays with pyrite nodules but barren of fossils, marly limestones with *Inoceramus brongniarti*, and beds with *Scaphites geinitzi*, as well as those with *Inoceramus cuvieri*.
According to Leonhard, the Cenomanian was developed here only in a sandy facies and most of the fossils and sections described by the Roemer brothers were exclusively from the scaphite beds. In the upper part of the interval with *Inoceramus brongniarti* he noted two marly layers with the brachiopod *Terebratulina gracilis*. The start of the twentieth century did not contribute much to our knowledge of the palaeontology of the Cretaceous in the area, but numerous new boreholes did enable a better understanding of the lithological column. Palaeontological studies were resumed by the publication of a paper by Wegner (1913), who described a few dozen species of sponge, coral, bryozoan, cephalopod, crinoid and others, some of them representing the only specimens ever to have been recorded from the area – this may be due either to improper classification and sampling or to a loss of outcrops from which this material had been collected. Much more recently, in 1960, Biernat presented a geological map of the city of Opole. Some macro- and microfossils were also described, and the lithological zonation was corrected. As far as the biostratigraphy of Turonian strata is concerned, the *Inoceramus labiatus* Zone (exclusively on the basis of microfossils) was distinguished, as were the zones of *I. lamarcki* and *Scaphites geinitzi*.Other high-ranking papers include that by Aleksandrowicz (1974).
Following analysis of borehole cores and extensive outcrop sampling, the following lithological scheme could be presented (Figs 2, 3):
1. Sands and sandstones (Cenomanian);
2. Lower clayey marls (lower-middle Turonian);
3. Lower marls (middle Turonian);
4. Marly limestones (upper Turonian);
5. Upper marls (upper Turonian);
6. Upper clayey marls (upper Turonian-lower Coniacian).

NOTE: At the Odra quarry, only units 2, 3 and 4 are exposed to date. Units 2-6 were referred to as the Prószków Formation.

An attempt at synthesis of all current data on the Opole Cretaceous was made by Tarkowski (1991), who focused on biostratigraphy and macrofaunas. A more workable biozonation can be found in a subsequent paper (Tarkowski, 1996). The macrofaunal assemblages described in these papers are in need of re-evaluation and additional

comments. Independent work on biozonations was done by Walaszczyk (1988, 1992), who presented clear divisions based on well-known inoceramid taxa (Fig. 2).



*) Lithologic subdivision and inoceramid range *after* ALEXANDROWICZ & RADWAN (1973)

Fig.2. Lithostratigraphy, ammonite and inoceramid bivalve ranges and inoceramid biostratigraphy of Turonian strata in the Opole area (see Fig. 1; from Walaszczyk, 1988).

Kędzierski (1995) discussed microfaunas, and recently detected lower Turonian strata at Odra quarry (see Kędzierski, 2008; Fig. 3), while Kędzierski & Uchman (2001) presented an outline of ichnofossil assemblages (ichnofabrics). Bieńkowska et al. (2015) noted the occurrence of fish remains-bearing ichnotaxon *Lepidenteron lewesiensis*.

Olszewska-Nejbert (2007) recorded irregular echinoids from the upper part of the section exposed at the Odra quarry, noting numerous specimens of *Micraster* and *Echinocorys*. Jagt & Salamon (2007) found bourgueticrinid crinoids. Świerczewska-Gładysz (2012) revisited ventriculitid sponges, while Świerczewska-Gładysz & Jurkowska (2013) described rare lyssacinosid sponges. Kin & Niedźwiedzki (2012) described some of the largest ammonites from Poland, assigned to the genera *Lewesiceras* and *Pachydesmoceras*. The most recent additions also include two notes on fossil arthropods: a record of a calanticid cirripede, *Cretiscalpellum striatum* (Jagt & Mazurek, 2010) and of an erymid decapod *Enoploclytia leachii* (Jagt et al., 2015).

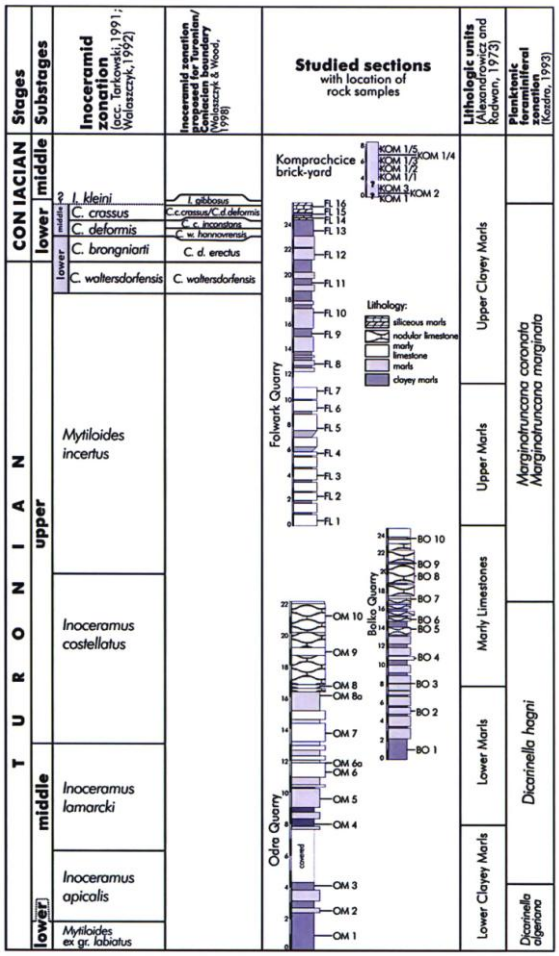


Fig.3. Inoceramid biozones, lithostratigraphy and planktonic foraminiferal biostratigraphy of Turonian-Coniacian strata in the Opole area (see Fig. 1; from Kędzierski, 2008).

Ongoing investigations by one of us (DM), following his unpublished MSc thesis (Mazurek, 2008), have resulted in the recognition of a number of first occurrences and some taxa rarely noted from Opole, in the following groups: asteroids, ophiuroids, cheilostome bryozoans, serpulid annelids, mussels, oysters and boring bivalves.

Vertebrates

At the Odra quarry (all Turonian; Figs 2, 3) and at other outcrops in the Opole area (Folwark and Bolko quarries; Cenomanian-Coniacian), fish remains are quite abundant, but usually of small size (and thus easily overlooked) and often undiagnostic, which explains why the ichthyofauna is rather poorly known.

limb bone (Fig. 5). In 2009 one of us (DM) collected a specimen that may represent sea turtle material.

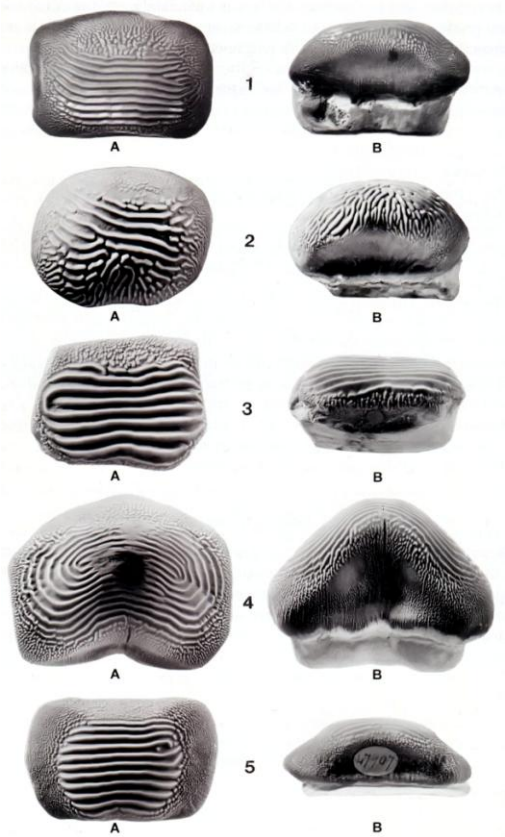


Fig. 4. Teeth of ptychodontid sharks, as follows: *Ptychodus decurrens* (1), *P. oweni* (2), *P. polygyrus* (3), *P. concentricus* (4) and *P. marginalis* (5) (after Longbottom & Patterson, 2002).

Sharks usually occur as isolated teeth or tooth crowns, whereas teleosts (the commonest group of osteichthyans) can be collected as isolated teeth, scales or bones, or in concentrations in connection with trace fossils (in particular *Lepidenteron lewesiensis*; see Jurkowska & Uchman, 2013; Bieńkowska-Wasiluk *et al*., 2015), burrows (i.e., bottom current resedimentation) or residues/regurgitates of piscivorous animals.
Leonhard (1898) described three shark species, *Hybodus dentatus*, *Notidanus microdon* and *Ptychodus mammillaris*, and also found some unidentified corprolites and vertebrae. Ganoids recorded are all pycnodonts: *Coelodus complanatus*, *Coelodus cretaceus* and *Ganoideorum*? sp., while teleosts noted include *Enchodus halocyon*, *Osmeroides lewesiensis*, *Beryx zippei*, *Beryx* sp., *Saurocephalus marginatus* and *Protosphyraena ferox*.
Osteichthyans have virtually remained unrecorded since then, whereas Niedźwiedzki & Kalina (2003) dealt with sharks from Opole, recording mainly ptychodontids, e.g., *Ptychodus latissimus*, *Ptychodus polygyrus*

and *Ptychodus mammillaris*. Other sharks are represented as well, and include, according to those authors, anacoracids (*Squalicorax* sp.), mitsukurinids (*Scapanorhynchus raphiodon*), alopiids (*Paranomotodon angustidens*) and unidentified cretoxyrhinids.

Ptychodus was a shell-crushing shark (Fig. 4). At the Odra quarry, accumulations of such teeth also occur; the Lower Marls, especially the lower part of that unit, have yielded a sample of mainly *P. mammillaris* teeth, which maybe linked to the common occurrence of small-sized inoceramid taxa and heteromorph ammonites here. Higher up section, *P. latissimus* and *P. polygyrus* also occur, associated with their preferred food items, i.e., large inoceramids. Other shark remains found recently comprise mainly cretoxyrhinid teeth, as well as numerous other lamniforms. A few unidentifiable shark coprolites (or intestinal fillings; see Hunt et al., 2015) have been collected as well; these appear to be fairly common in the Lower clayey marls, in particular below two prominent limestone levels (Fig. 3).

Recently, Sachs *et al*. (2012) reported on the rediscovery of most of the reptile material described from Opole in the nineteenth century by Leonhard, as well as some other material collected by that author. The collection is composed of teeth belonging to polycotylid plesiosaurians and a russellosaurine mosasauroid and a single purported plesiosaurian.

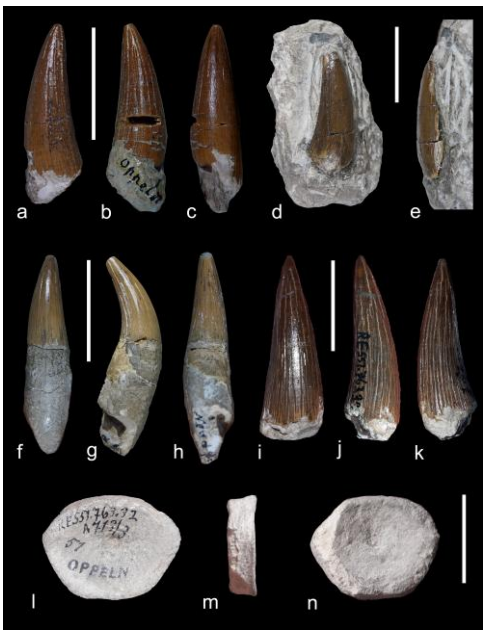


Fig.5. Teeth of polycotylid plesiosaurians (f-h) and a purported plesiosaurian limb bone (l-n) (Sachs *et al*., 2018).

References

Alexandrowicz, S.W., 1974. Kreda opolska. *In*: Rutkowski, J. (ed.). Przewodnik XLVI Zjazdu PTG, Opole, 12-14 września 1974, 29-38.

Bieńkowska-Wasiluk, M., Uchman, A., Jurkowska, A. & Świerczewska-Gładysz, 2015. The trace fossil *Lepidenteron lewesiensis*: a taphonomic window on diversity of Late Cretaceous fishes. *Paläontologische Zeitschrift* 89, 795-806.

Biernat, S., 1960. Budowa geologiczna kredy opolskiej. *Biuletyn Instytutu Geologicznego* 152, 173-241.

Hunt, A.P., Lucas, S.G., Milàn, J., Lichtig, A.J. & Jagt, J.W.M., 2015. Vertebrate coprolites from Cretaceous chalk In Europe and North America and the shark surplus paradox. *In*: Sullivan, R.M. & Lucas, S.G. (eds). Fossil Record 4. *New Mexico Museum of Natural History and Science Bulletin* 67, 63-68.

Jagt, J.W.M., Jagt-Yazykova, E.A. & Kijok, R., 2015. Notes on turonian decapod crustacean body fossils and ichnotaxa from Odra Nowa Quarry, Opole (Southwest Poland). *Nature Journal* 48, 101-113.

Jagt, J.W.M. & Mazurek, D., 2011. A calanticid cirripede from the middle Turonian of the Opole Cretaceous Basin. *Nature Journal* 43, 117-122.

Jagt, J.W.M. & Salamon, M.A., 2007. Late Cretaceous bourgueticrinid crinoids from southern Poland – preliminary observations. *Scripta Geologica* 134, 61-76.

Jurkowska, A. & Uchman, A., 2013. The trace fossil *Lepidenteron lewesiensis* (Mantell, 1822) from the Upper Cretaceous of southern Poland. *Acta Geologica Polonica* 63, 611-623.

Kędzierski, M., 1995. Stratygrafia turonu i koniaku okolic Opola na podstawie nanoplanktonu wapiennego. *Przegląd Geologiczny* 43, 406-408.

Kędzierski, M., 2008. Calcareous nannofossil and inoceramid biostratigraphies of a Middle Turonian to Middle Coniacian section from the Opole Trough of SW Poland. *Cretaceous Research* 29, 451-467.

Kędzierski, M. & Uchman, A., 2001. Ichnofabrics of the Upper Cretaceous marlstones in the Opole region, southern Poland. *Acta Geologica Polonica* 51, 81-91.

Kin, A. & Niedźwiedzki, R., 2012. First record of the puzosiine ammonite genus *Pachydesmoceras* from the Middle and Upper Turonian of Poland. *Cretaceous Research* 33, 15-20.

Kutyba, J., 1977. Ślady życia organizmów w osadach turonu okolic Opola. *Zeszyty Naukowe AGH*, *Geologia* 3, 61-66.

Leonhard, R., 1898. Die Fauna der Kreideformation in Oberschlesien. *Palaeontographica* 44, 11-70.

Longbottom, A.E. & Patterson, C., 2002. Fishes. *In*: Smith, A.B. & Batten, D.J. (eds). *Fossils of the Chalk*. Palaeontological Association, Field Guides to Fossils, no. 2 (second edition, revised and enlarged), 296-324, pls 62-63. The Palaeontological Association, London.

Mazurek, D., 2008. *Paleoekologia i biostratygrafia utworów turonu (górna kreda) kamieniołomu Odra w Opolu*. Uniwersytet Opolski, Wydział Przyrodniczo-Techniczny, Katedra Biosystematyki, Zakład Palebiologii, Opole (Praca magisterska), 84 pp., pls 1-5.

Niedźwiedzki, R. & Kalina, M., 2003. Late Cretaceous sharks in the Opole Silesia region (SW Poland). *Geologia Sudetica* 35, 13-24.

Olszewska-Nejbert, D., 2000. Late Cretaceous (Turonian-Coniacian) irregular echinoids of western Kazakhstan (Mangyshlak) and southern Poland (Opole). *Acta Geologica Polonica* 57, 1-87, pls 1-32.

Roemer, F., 1870. *Geologie von Oberschlesien*, xxiv + 587 pp. Nischkowsky, Breslau.

Roemer, F.A., 1840-1841. *Die Versteinerungen des norddeutschen Kreide-Gebirges*, iv + 145 pp., 16 pls. Hahn'sche Hofbuchhandlung, Hannover.

Roemer, F.A., 1864. Die Spongitarien des Norddeutschen Kreide-Gebirges. *Palaeontographica* 13, 1-63.

Sachs, S., Jagt, J.W.M., Niedźwiedzki, R., Kędzierski, M., Jagt-Yazykova, E. & Kear, B.P., 2018. Turonian marine amniotes from the Opole area in southwest Poland. *Cretaceous Research* 84, 578-587.

Świerczewska-Gładysz, E., 2012. Late Turonian and Early Coniacian ventriculitid sponges (Lychniscosida) from Opole Trough (southern Poland) and their palaeoecological significance. *Annales Societatis Geologorum Poloniae* 82, 201-224.

Świerczewska-Gładysz, E. & Jurkowska, A., 2013. Occurrence and paleoecological significance of lyssacinosid sponges in the Upper Cretaceous deposits of southern Poland. *Facies* 59, 763-777.

Tarkowski, R., 1991. Stratygrafia, makroskamieniosci i paleogeografia utworów górnej kredy niecki opolskiej. *Zeszyty Naukowe AGH*, *Geologia* 51, 1-156.

Tarkowski, R., 1996. Inoceramid biostratigraphy in the Turonian of the Opole Trough (southwestern Poland). *Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg* 77, 489-501.

Walaszczyk, I., 1988. Inoceramid stratigraphy of the Turonian and Coniacian strata In the environs of Opole (southern Poland). *Acta Geologica Polonica* 38, 51-61, pls 1-8.

Walaszczyk, I., 1992. Turonian through Santonian deposits of the Central Polish Uplands: their facies development, inoceramid paleontology and stratigraphy. *Acta Geologica Polonica* 42, 1-122, pls 1-48.

Wegner, R.N., 1913. Tertiaer und umgelagerte Kreide bei Oppeln. *Palaeontographica* 60, 175-274.

NOTES

ABOUT THE CONFERENCE LOGO

Conference logo designed by Klaudia Kardynał.
As you may know, Poland is divided into sixteen districts named voivodeships – in view of the fact that the conference will be held in the Opole region, we have decided to create a logo to reflect this, as in previous years. The logo illustrates the contours of Opole Voivodeship, filled in with the local colours, yellow and blue. In addition, it depicts the local 'VIP', the dinosauriform *Silesaurus opolensis* that was unearthed from Upper Triassic strata.