WYCIECZKI TERENOWE

A NEW EXCEPTIONALLY PRESERVED LATE JURASSIC ECOSYSTEM (OWADÓW-BRZEZINKI, CENTRAL POLAND) AND ITS GEOLOGICAL BACKGROUND

NOWY, WYJĄTKOWO ZACHOWANY PÓŹNOJURAJSKI EKOSYSTEM (OWADÓW-BRZEZINKI, CENTRALNA POLSKA) I JEGO TŁO GEOLOGICZNE

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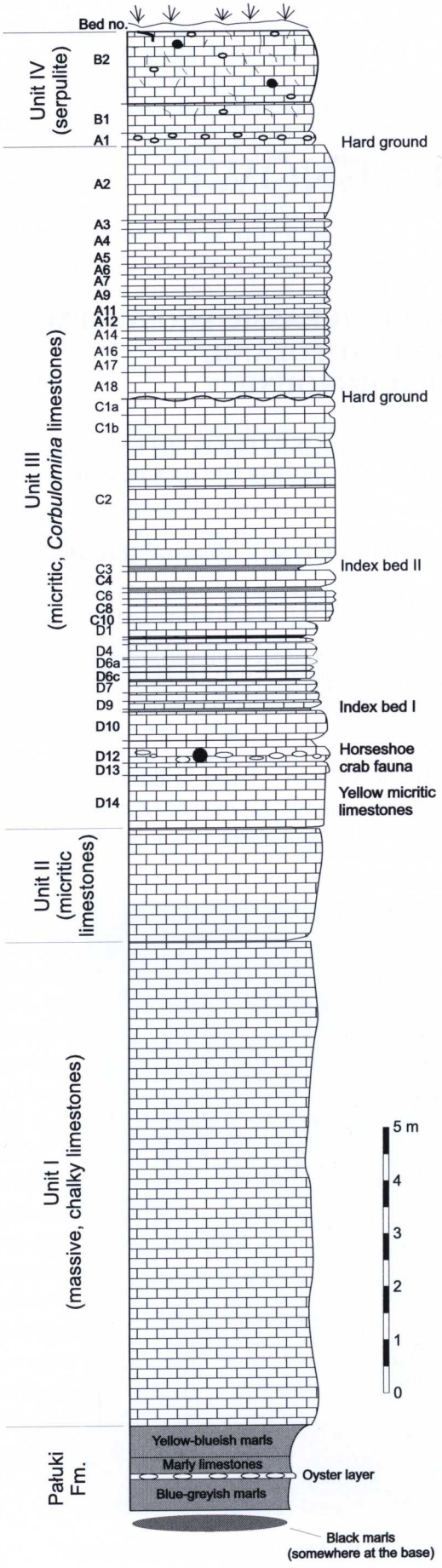
Unusually well preserved fossils of latest Jurassic (Middle Volgian = latest Middle or early Late Tithonian) – the terrestrial and marine organisms – have been recently discovered (Kin *et al.*, 2013) at the paleontological site in Owadów-Brzezinki quarry (Fig. 1), located about 19 km southeast of To-

Fig. 1. Panoramic view of the highest level of exploitation in the Owadów-Brzezinki quarry; number of rock-units of the Sławno Limestone Member are indicated



maszów Mazowiecki (central Poland). At the moment, the Owadów-Brzezinki quarry is the only place in extra-Carpathian Poland where the Middle Volgian strata are available for the study (the classic locality Brzostówka within the Tomaszów Mazowiecki town limits is infilled; quarries in Pomerania are flooded).

Deposits exposed in the Owadów-Brzezinki quarry are limestones of the Sławno Limestone Member which belong to the Kcynia Formation. They are subdivided into four successive units (Fig. 2):

Unit I is composed of indistinctly laminated, very thick-bedded, fine-grained, chalky limestones (~9.1 m in total thickness) with *Deltoideum delta* and *Zaraiskites zarajskensis*.

Unit II ~2.2 m thick, is represented by thin-bedded, micritic limestones with poor fauna (small brachiopods, shrimps), with occasional distinctive parallel lamination. A mass occurrence of calcareous polychaete tubes is encountered in a single horizon.

Unit III ~12.8 m thick, is developed as well bedded micritic limestones consisting mostly of beds several centimetres in thickness which split into thin flags, and marly intercalations. A few thicker limestone beds (D_{14}, C_2 and A_2; see Fig. 2) attain from about 1m to even 2 m in thickness; they are known in the lowermost, the middle and the uppermost parts of the unit. Some marly layers in the succession have the correlation value and are treated as index beds (index beds I and II). The detailed correlation of the particular sections (A, C, D) makes possible distinction of large number of beds in the unit – each of them marked with letter referred to the particular section and the following number. The most characteristic faunal feature of the unit is the mass occurrence of small shelled bivalves *Corbulomina obscura* (in the past attributed to the genus *Corbula*) – treated formerly as indicative of the so-called "Purbeckian" facies (*cf.* Kutek, 1994, and earlier papers cited therein). Highly fossiliferous strata in the lower part of the unit (D_{13}, D_{12}) yielded unusually well preserved and interesting marine and terrestrial fossils. Numerous specimens of horseshoe crabs (Fig. 3), remains of various fishes (Fig. 4) and marine reptiles, rare ammonites, decapod crustaceans, land insects (dragonflies, beetles, grasshoppers – Fig. 5) and pterosaurs are found in this level.

Unit IV ~1.7 m thick, is exposed at the top of quarry. It is developed as organodetrital limestones rich in *Nanogyra* oysters, bryozoans and serpulids, which often form small bioherms; ammonites are sometimes encountered. The lower boundary of the unit is marked by well developed omission surface encrusted with oysters and with very dense burrows attaining about 0.4–0.5 cm

Fig. 2. Lithological succession of the Sławno quarry

Fig. 3. Articulated horseshoe crab exoskeleton – *Crenatolimulus* sp. nov.

in diameter and ranging into the underlying limestones of unit III down to about 0.6 m below the surface. The unit IV was called "the serpulite" in older geological literature (Lewiński, 1923). Younger Jurassic limestones are not exposed in the quarry, and their lithological character is poorly known (Kutek, 1994).

In general, first three units (I, II and III) of the Kcynia Fm. represent continuous transition from the offshore to the nearshore, perhaps even lagoonal setting, whereas the unit IV bears evidence of a return to more open marine conditions.

Grey (yellowish when weathered) marls and marly clays with ammonites and oysters of the Pałuki Formation occur below the described deposits of the Kcynia Formation. The uppermost part of these deposits (~2.5 m) has been temporarily accessible in the bottom of the quarry; a thin (about 0.1 m in thickness) marly layer crowded with oysters, ammonites, and brachiopods occurs about 1 m below the top of the unit.

The biostratigraphical interpretation of the deposits from the Owadów-Brzezinki quarry is based on the study of Kutek [(1994 and older papers cited therein including the older monographs of Michalski (1890), and Lewiński (1923)], who recognized the deposits of the upper part of the Scythicus Zone, corresponding to the Zaraiskensis Subzone, in the Volgian section of Brzostówka at Tomaszów Mazowiecki. The correlation of the Middle Volgian deposits of the Brzostówka section with those of the Owadów-Brzezinki is evident because of the lithological similarity of the sections and similarity of ammonites. The oldest deposits of the Owadów-Brzezinki section, representing the topmost part of the marly clays of the Pałuki Formation, yielded abundant ammonites of the genus *Zaraiskites*. Some of them are similar to *Zaraiskites regularis* Kutek, some newly discovered show fairly wide interspaces between sheaves of neigbouring virgagatome ribs which indicate their close relation with a younger ammonite assemblage of the *Zaraiskites zarajskensis* (Michalski) – *Z. pilicensis* (Michalski) type. These features suggest the proximity of the boundary between the *regularis* horizon and the *zarajskensis* horizon sensu Kutek (1994). The younger ammonite assemblage occurring in the lower part of the Sławno Limestone Member of the Kcynia Formation (unit I) is represented mostly by *Zaraiskites zarajskensis* (Michalski) indicative of the *zarajskensis* horizon sensu Kutek (1994). The ammonites found in unit III and IV bear general resemblance to representatives of *Zaraiskites zarajskensis* and they were also treated as indicative of the *zarajskensis* horizon by Kutek (1994). It should be remembered, however, that some of these ammonites

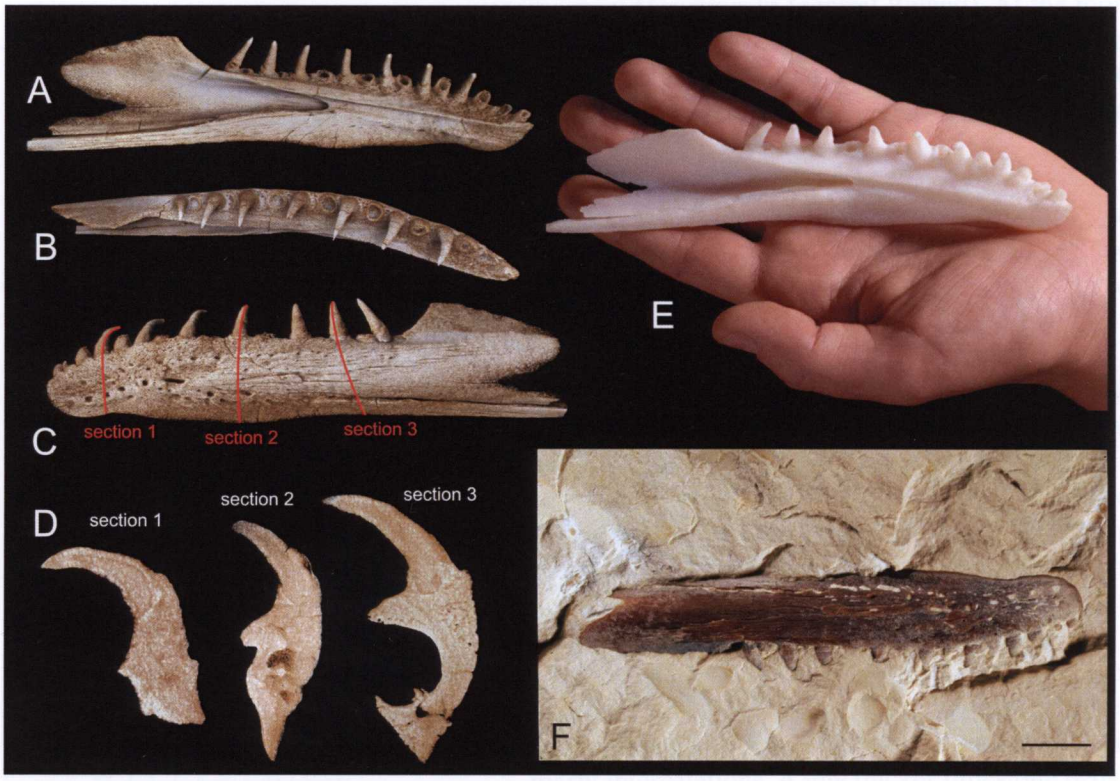


Fig. 4. Dentary bone of actinopterygian fish *Furo* sp.: A–C. Reconstruction of 3-D "virtual fossil" – the same specimens after digital processing and analysis of tomographic data. D. Sections; E. 3-D printed model. F. Specimen in piece of limestone

The X-ray microcomputed tomography (XMT), a non-destructive technique, is used in order to elucidate details of internal structure of the specimens from unit III and provides data for further investigations. Three dimensional reconstructions allow taxonomical verification; a possibility of 3-D printing gives the opportunity for work with a model in any desired scale, without a need of preparation, cutting, and a risk of damaging the specimen.

show loosely spaced fairly strong ribs on the inner whorls which suggest that they may correspond already to the earliest representatives of the genus *Virgatites* – the species *Virgatites gerassimovi* Mitta. If such interpretation appeared correct it would indicate the presence of the lowermost part of the Virgatus Zone – the next Subboreal zone of the Middle Volgian.

The Subboreal ammonites of the genus *Zaraiskites* occur in the Russian Platform area together with Boreal ammonites of the genera *Dorsoplanites* and *Pavlovia.* This makes correlation possible between the Boreal Panderi Zone and the Subboreal Scythicus Zone, and more precisely between the upper part of the Scythicus Zone – the Zarajskensis Subzone known from the Owadów-Brzezinki quarry and the upper part of the Boreal Panderi Zone (Kutek, 1994; Rogov, 2014). Consequently it gives also the arguments for the existence of the direct connection between the Polish and the Russian seas at the end of the Jurassic. Much more complicated is the correlation between the Subboreal zonation and the Tethyan one. A crucial problem is the occurrence of the genus *Pseudovirgatites* in the Polish sections which could make possible the correlation of the lower part of the Zarajskensis Subzone (the *regularis* horizon) with Upper Tithonian (Kutek, Zeiss, 1988; Kutek; 1994, and earlier papers cited therein with special attention to data showing the distribution of *Pseudovirgatites* in the Upper Tithonian in the Carpathian-Balkan areas – see *e.g.* Kutek, Wierzbowski, 1986). On the other hand, Rogov (2004, 2013, 2014) presented another correlation between the Subboreal and Tethyan zonations using some ammonites found in the Russian sections (oppeliids, as well as forms interpreted by him as corresponding to the German genus *Danubisphinctes*). He believes that the Panderi Zone (= Scythicus Zone) corresponds either in its lower part to the Lower (Middle) Tithonian, and in its upper part (including the Zarajskensis Subzone) to the Upper Tithonian (Rogov, 2004), or that the whole stratigraphical interval of the Panderi Zone (= Scythicus Zone) correlates with the Ponti Zone of the uppermost Lower (and Middle) Tithonian (Rogov, 2013,

Fig. 5. Grasshopper wing *Pycnophlebia* sp.

2014). The currently undertaken detailed study of the ammonite succession in the Owadów-Brzezinki quarry may yield new data in that matter.

The palaeontological uniqueness of the new locality at Owadów-Brzezinki lies in its close stratigraphical relationship to two famous *Fossil-Lagerstätte* localities – Solnhofen and Nussplingen, in southern Germany, but also in the fact that it is a few millions years younger. Marine and terrestrial creatures lived and died during the Late Jurassic at Solnhofen (Early Tithonian, Hybonotum Chron), and at Nussplingen (latest Kimmeridgian, Beckeri Chrone) as well as in Owadów-Brzezinki (Zarajskensis Subchron of the Scythicus Chron – ?earliest Virgatus Chron), under closely related environmental conditions. Marine and terrestrial organisms from all the localities are very similar to each other and allow to conduct comparative paleontological studies at a previously unattainable level of taxonomic resolution. The recent identification of new species of dragonflies (family Eumorbaeschnidae) and grasshoppers (family Prophalangopsidae), previously known from the Solnhofen area only, is an example (Fig. 5).

The Owadów-Brzezinki Quarry may be regarded as a new "taphonomic window" into the latest Jurassic World as it represents a kind of "palaeontological supplement" to the previously known record of the other *Fossil-Lagerstätten*. Although the fossil organisms found at Owadów-Brzezinki resemble those from the Bavarian locality of Solnhofen, both faunas derived from basically different biogeographic provinces of the latest Jurassic. Whereas Solnhofen yielded ammonites of the Tethyan affinities which can be easily correlated with the Tithonian, the latest Jurassic ammonite faunas of central and north-western Poland belong to the classic palaeontological localities of the Volgian. One may thus expect, that non-ammonite organisms from Owadów-Brzezinki may show affinities to those of the Boreal Realm.

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