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Diverse sclerozoan assemblages encrusting large bivalve shells from the Callovian (Middle Jurassic) of southern Poland

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ABSTRACT

A diverse sclerozoan assemblages consisting of both encrusting and boring biota are described from the large limid bivalves *Ctenostreon* from the Callovian hardground setting of Zalas in southern Poland. At least 27 encrusting and seven bioerosion taxa are reported here, which makes this assemblage not only one of the most diverse in the Middle Jurassic, but the richest in encrusting taxa from the Callovian. The encrusters consist of cryptic biota of which sedentary polychaetes and cyclostome bryozoans dominate with respect to both species number and abundance. The bioerosion traces are dominated by tiny pits referred to the ichnogenus *Oichnus*, probably made by some soft-bodied biota in the present case, followed by the borings of acrothoracican barnacles (*Rogerella*). The first colonizers of the bivalve shells probably were borers as they only occur in the host shells. The encrusting pioneers presumably were oysters and oyster-like bivalves, followed by opportunistic serpulid/sabellid polychaetes and cyclostome bryozoans. The last colonizers were calcisponges and thecideide brachiopods. In comparison to the only known Late Callovian shallow and reef-associated, tropical sclerozoans of Israel, the assemblage from the open-marine, deeper setting of Poland is much richer in encrusting taxa. Such a surprising high encruster diversity in the marine northern paleolatitude may have resulted from the deeper and calmer environment with a both reduced sedimentation rate and algal cover, and without any significant salinity changes, the factors that are thought to have impacted the tropical and shallow-marine sclerozoans from Israel.

1. Introduction

Sclerozoans are animals that inhabit hard substrates of any kind (lithic or biogenic) through encrustation, boring and nestling behavior (Taylor and Wilson, 2002, 2003). Fossil marine sclerozoans were diverse during the Phanerozoic and the oldest are Cambrian (e.g., Palmer, 1982; Taylor and Wilson, 2003). Those with calcitic skeletons were easily fossilized. Those with aragonitic skeletons or fully soft-bodied either left recognizable traces by boring activities or were preserved by bioimmuration or epibiont shadowing (e.g., Taylor, 1990; Palmer et al., 1993; Taylor and Wilson, 2003). Even though sclerozoans are well known from the whole Phanerozoic, knowledge about their community structure within narrower time-intervals (e.g., in stages) is still incomplete due to their patchy distribution resulting from uneven occurrences of suitable hard substrate.

The Jurassic was an important period for sclerozoan communities. During this time their diversity and abundance significantly increased, which was largely a result of the increase in lithic carbonate hard substrates (e.g., hardgrounds) and thick carbonate skeletons of various sessile organisms (e.g., Palmer, 1982; Stanley and Hardie, 1998; Taylor and Wilson, 2003). The significant increase in diversity and abundance of borers (e.g., Palmer, 1982; Wilson, 2007) is also linked to an increase in predation pressure on the benthic communities during the Mesozoic Marine Revolution (Vermeij, 1977; Aberhan et al., 2006). Recently the increase in grazing bioerosion has been suggested as an important factor in diminishing brachiopod abundance during the Jurassic (Radley, 2010). Finally, during the Middle Jurassic the modern succession patterns of cryptic sclerozoans were established (Wilson, 1998). However, despite many investigations, our knowledge of Jurassic sclerozoan communities is still far from complete. So far the largest amount of comprehensive data comes from biogenic and lithic substrates of the Bajocian–Bathonian (Middle Jurassic) ages (e.g., Palmer and Fürsich, 1974, 1981; Taylor, 1979; Palmer and Wilson, 1990; Fürsich et al., 1994; Wilson and Palmer, 1994; Wilson et al., 1998; Zatoń et al., 2011). We know much less about Early Jurassic sclerozoan community composition and paleoecology (Voigt, 1968; Sequeiros and Mayoral, 1980; Hary, 1987; Johnson and McKerrow, 1995). Data on Late Jurassic encrusting and boring communities exists as well (e.g. Gruszczyński, 1986; Pisera, 1987; Machalski, 1998; Insalaco, 1999; Radwańska and Radwański, 2003; Radwańska, 2004; Krawczyński, 2008; Schlögl et al., 2008; Hara and Taylor, 2009). However, with some exceptions (e.g., Schlögl et al.,

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2008), they are not as comprehensive as those of the Middle Jurassic mentioned above, and they focus on specific problems and individual animal groups.

The present study concentrates on the latest Middle Jurassic (Callovian) sclerozoan communities. The Callovian is an interesting interval of the Middle Jurassic as during this time there were widespread condensation deposits and a global sea-level rise (Norris and Hallam, 1995; Wierzbowski et al., 2009), although some authors (Dromart et al. 2003a, b) even place the onset of an ice-age at the end of this time interval. It is also during the Callovian that modern encrusting communities began to develop (Zatoń and Vinn, 2011). However, unlike the preceding stages of the Middle Jurassic, the Callovian is poorly known with respect to encrusting and boring assemblages. So far only one locality (Israel) has been thoroughly studied in order to recognize the structure and composition of Callovian sclerozoan communities (Feldman and Brett, 1998; Wilson et al., 2008, 2010; Vinn and Wilson, 2010).

Therefore, in order to fill the gap, we provide here comprehensive data on the sclerozoan communities preserved on the shells of the large bivalve *Ctenostreon* occurring within a Callovian hardground setting in southern Poland. To the best of our knowledge, this is the first such study on sclerozoans of this interval outside the Tethys (see Wilson et al., 2008, 2010).

2. Geological setting

2.1. Location and characteristics of the studied section

The sampled section is exposed in a quarry located at the Zalas village. The Zalas quarry is about 8 km south of Krzeszowice and about 30 km west of Kraków in southern Poland (Fig. 1). This region is within the southern part of the Kraków–Częstochowa Upland where the main structural units are Mesozoic dominated by Jurassic deposits that are well exposed. Paleozoic rocks underlie the Mesozoic strata in this region. The lower part of the working Zalas Quarry exposes Lower Permian rhyodacites as a laccolith (e.g., Lewandowska and Rospondek, 2003; Nawrocki et al., 2005); these rocks are the main subject of quarry exploitation. The topmost part of the laccolith is eroded and discordantly overlain by transgressive Jurassic deposits with topographic relief on the order of several meters (Giżejewska and Wieczorek, 1976) (Fig. 2A).

The Jurassic deposits begin with about 7.5 m of near-shore marine sands dated as earliest Callovian (Herveyi Chron) on the basis of the occurrence of *Macrocephalites* ammonites (Matyja, 2006). The sands are rich in marine fossils and in their upper part silicified wood also occurs (Giżejewska and Wieczorek, 1976; Tarkowski, 1989; Matyja, 2006). Within the sands, quartzose sandstones and conglomerates occur (Matyja, 2006). The environment of sand deposition is interpreted as a near-shore, close to a beach (see Matyja, 2006).

The sands are overlain by sandy crinoidal limestones intercalated with quartz–pebble conglomerate and shelly layers in their lower part. The ammonites found indicate the Early Callovian age (Koenigi and Calloviense chrons), and the overall rich fossil content shows that they were deposited in a shallow sublittoral environment. The top of the crinoidal limestones is erosive and bear signs of both chemical and physical erosion. Limonitic coating and abundant encrusting fauna indicate it was a hardground (Giżejewska and Wieczorek, 1976; see also Dembicz and Praszkier, 2007). Depressions in the top of the crinoidal limestones are filled with a nodular layer, consisting of numerous clasts, derived from underlying crinoidal limestone (Fig. 2A). The clasts, shells and molds occurring there show ferruginous coating and encrustation. They also show features of chemical corrosion and erosional truncation indicating their redeposition (Giżejewska and Wieczorek, 1976; Dembicz and Praszkier, 2007). Both the hardground and nodular layer are topped by a

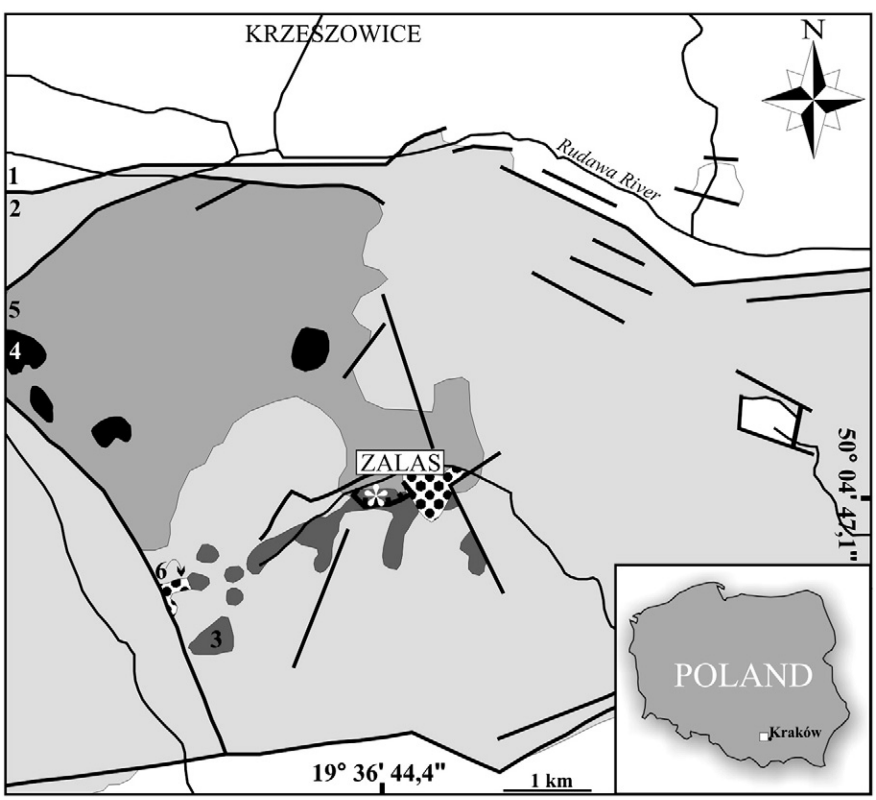

Fig. 1. A geological sketch-map of the Zalas environs (simplified after Nawrocki et al., 2007). 1. Cenozoic mudstones, 2. Mesozoic deposits, 3. Permian rhyodacite domes and rhyolitic, trachytic and andesitic dykes, 4. Permo-Carboniferous basaltic lavas and trachyandesite sills, 5. Upper Carboniferous conglomerates, 6. Lower Carboniferous mudstones. Asterisk indicates the location of the Zalas quarry.