Cretaceous Research 31 (2010) 350–363

Contents lists available at ScienceDirect

Cretaceous Research

journal homepage: www.elsevier.com/locate/CretRes

Apodid sea cucumbers (Echinodermata: Holothuroidea) from the Upper Turonian of the Isle of Wolin, NW Poland

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A R T I C L E I N F O

Article history:
Received 18 May 2008
Accepted in revised form
15 March 2010
Available online 18 March 2010

Keywords:
Apodida
Holothuroidea
Echinodermata
Upper Cretaceous
Turonian
Wolin
Pomerania
Poland

A B S T R A C T

A diverse holothurian fauna from the Upper Turonian of the Isle of Wolin (northwestern Poland), is described and assessed with respect to palaeoecology, palaeobiology and evolutionary diversification. The fauna was recovered from chalk and partly silicified chalk. A stratigraphic re-assessment of all available biostratigraphic literature permits assignment to the *Subprionocyclus neptuni* ammonite zonal age (late Turonian). The majority of the holothurian fauna consists of apodid, aspidochirotid, and elasipodid species. The part of the fauna described here consists of sclerite species of three different Recent families of the Apodida. Two new forms, *Calcancora venusta* sp. nov. and *Rigaudites ernsti* sp. nov. (Synaptidae: Rynkatorpinae), are described, figured and discussed.

1. Introduction

With the exception of the Maastrichtian (Reich, 2002b, 2003a, b, c, d), only scarce data exist on fossil holothurians from the Upper Cretaceous (Reich, 1997a, 2002a, 2004). Počta (1886, pp. 11–12, fig. 8) was the first to report sclerites of sea cucumbers ("? *Psolus*") from Upper Turonian sediments of Koštice near Louny (formerly Koschtitz near Laun), Bohemian Cretaceous Basin, Czech Republic. Later, short notes on, or figures of Turonian holothurians were published (see detailed list in the appendix), a.o., from the Isle of Wolin by Deecke (1895, p. 43), Mecklenburg (Schacko, 1897, p. 289), Bohemia by Frič (1893, p. 61, 113, fig. 150) and Hinterlechner (1901, p. 473), and Surrey, England, by Upton (1917, p. 115). Müller (1912) described a myriotrochid holothurian wheel from the Turonian of Westphalia, northern Germany, erroneously as the diatom *Actinoclava frankei* gen. et sp. nov. (= *Hemisphaeranthos frankei*).

The occurrences of Turonian holothurian ossicles were additionally confirmed by Gilliland (1993, p. 11, figs. 9–10, 13) from the Chalk of Kent, England, unfortunately without detailed stratigraphic information. Sadeddin and Saqqa (1997) and Sadeddin and Al-Tamimi (2006) recorded the first non-European holothurians from Turonian sediments of Jordan.

Deecke (1895, p. 43) mentioned "Holothurienrädchen" [= holothuroid wheels] from the chalk limestones of Lubin, Isle of Wolin (formerly Lebbin, Isle of Wollin, Eastern Pomerania) for the first time from our study area. 100 years later, Reich (1995, p. 685) mentioned new discoveries of holothurian sclerites from the Upper Turonian of Kępa (former Kamp, Isle of Wolin), which included 18 paraspecies of the Dendrochirotida, Aspidochirotida, Elasipodida, and Apodida (Reich, 2000), amongst which *Pravuscucumis deeckei* Reich, 2001 appears to be a possible biostratigraphic marker for the Upper Turonian in Mecklenburg and Pomerania. Herein, we will supplement the systematic description of Upper Turonian holothurians from NW Poland, beginning with apodid holothurians. Six (para)species of three different families will be described, among which two of them are newly introduced.

2. Geological setting and previous research

The island of Wolin is located in the Odra River mouth, north of Szczecin (Fig. 1). There, Turonian strata were exposed in several

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0195-6671/$ – see front matter
doi:10.1016/j.cretres.2010.03.001

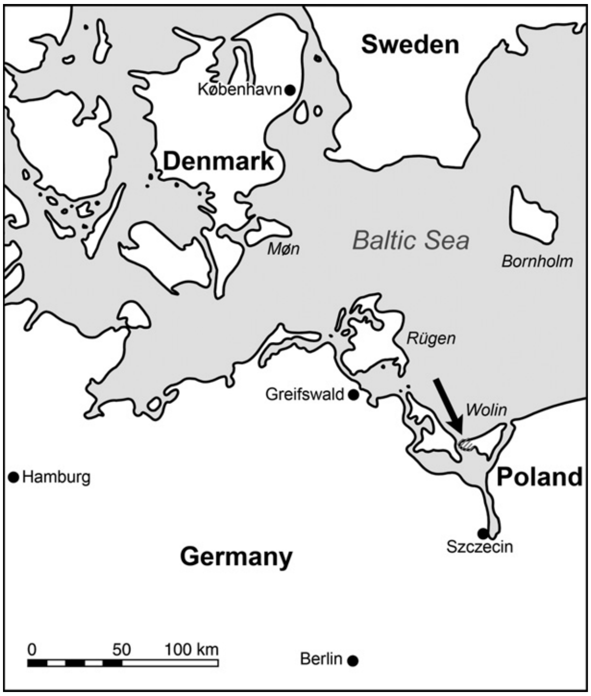

Fig. 1. Map showing the southern Baltic Sea coast with the Isle of Wolin (arrow and grey lines mark the investigated area).

quarries near the small villages of Lubin (Lebbin), Wapnica (Kalkofen), Kępa (Kamp) and Wicko (Vietzig) in the southwestern part of the island (Fig. 2), where the white Turonian limestones were quarried mostly for Portland cement production (e.g. Kowalewski, 1887; Deecke, 1907). Today, only the small abandoned quarry near Kępa exhibits some exposures, while the other quarries are now back-filled or flooded. For more than 150 years, these favourable exposures stimulated palaeontologic investigation of the succession (e.g. Gumprecht, 1846, pp. 463–464; Borchardt, 1850; v. Hagenow and Borchardt, 1850; v. Hagenow, 1864, p. 82). The first monographic approach was presented by Behrens (1878), who mainly listed and described sponges, bivalves, brachiopods and echinoderms, and who correctly dated the strata as Turonian in age, following Schlüter (1876, p. 475, footnote). Deecke (1907, pp. 79–81) added some data, specifically on bryozoans, ostracods and foraminifers, and Keilhack (1914) listed the fauna from Behrens (1878). Later, echinoderms (Böhm, 1920; Nietsch, 1921), molluscs (Wolansky, 1932) and especially foraminifers (Franke, 1925, 1928; Brotzen, 1942; Alexandrowicz, 1966) were treated in detail.

Although numerous new species were established from material of the area – making it a classical Upper Cretaceous locality in Pomerania – the area faded from view, and only a few recent studies have been undertaken (e.g. Alexandrowicz, 1967; Cieśliński and Wyrwicka, 1976; Jaskowiak-Schoeneichowa, 1979; Borówka et al., 1999; Cedro, 1999).

In contrast to the number of palaeontologic accounts, lithostratigraphic descriptions are very limited. Behrens (1878) presented lithologic details and an overview of the quarried successions of Lubin and Wapnica. He was able to roughly subdivide the section into three parts and demonstrated the equal development in both localities, which are only c. 1 km apart. Alexandrowicz (1967) described a section in Kępa, which is only few hundreds of metres distant from Wapnica. Lithologic data from all three sections give an impression of the formerly accessible rock units. The lower part of the succession consists of dark, partly sandy marls (Alexandrowicz, 1967) with $CaCO_3$ contents of only c. 30 % (Keilhack, 1914), which yielded fragments of thin inoceramids (Unger, 1860). At the base, pyrite is very common, and has been quarried (Unger, 1860). Higher up-section, marls without pyrite occur, which progressively grade into greyish-white flintless chalk with abundant pyrite concretions in the lower part. It appears that, towards the upper part of the unit, the carbonate content increases.

A main interval with inoceramids is followed by an acme occurrence of irregular echinoids (Behrens, 1878), before a sharp facies change towards chalk with platy flints occurs (Behrens, 1878, p. 10; Kutscher, 1974). Interestingly, the lowermost part of the flint-bearing unit yields light grey flints, which, to our observation, represent partly silicified chalk. The literature suggests that the previously exposed Turonian section may have reached a thickness of c. 40 m, the larger part of which is the flint-bearing chalk. According to Alexandrowicz (1967), c. 17–18 m of Turonian sediments were accessible at the time of this study, of which presumably only the lower part of the flint-bearing unit was exposed. During our last visit in 2001, the quarry walls had progressively deteriorated and detailed logging of the section was no longer possible, but the interval with the platy flints is still well recognisable. Several samples were taken between 1992 and 2001 for this investigation. Additional samples were taken from the grey, partly silicified chalk at the base of the flint-bearing unit.

2.1. Biostratigraphy

After an initial imprecise dating of the Lubin sequence as "Sénonian" by d'Orbigny (1853), Schlüter (1876) and Behrens (1878) declared a late Turonian age for the sequence. It was interpreted to correspond with the 'Scaphitenschichten' of Germany (*Scaphites* Beds, see discussion and problems in Prescher, 1963) of a middle late Turonian age (c. the interval of the *Hyphantoceras* Event to the base of the Erwitte Formation, see Fig. 3). However, the faunal assemblages listed and partly figured (Wolansky, 1932, inoceramids; Nietsch, 1921, irregular echinoids; Alexandrowicz, 1967, foraminifers) permit a more precise correlation.

2.1.1. Inoceramids

The inoceramid fauna of Pomerania was presented mainly by Wolansky (1932), who stated that dark marls were exposed at the base of the Turonian successions in the area of Lubin, which were no longer accessible during the conclusion of her studies. From these deepest and thus oldest parts of the succession, *Mytiloides labiatus* is recorded, which provides evidence for an early Turonian age of the lowermost sediments. Upsection, in the lower part of the flintless chalk, inoceramid debris and inoceramids become more frequent. From this level, (in part large) *I. lamarcki* Parkinson were reported and interpreted to reflect a middle Turonian age. However, this taxon likewise occurs in upper Turonian strata of NW Germany (Wood and Ernst, 1998), and its exclusive occurrence alone yields no biostratigraphic data more precise than middle to upper Turonian. The mention of "large" *I. lamarcki* is rather suggestive of an early late Turonian age, where large *I. lamarcki lamarcki*, *I. lamarcki stuemckei* and *I. hercules*-like inoceramids are not uncommon (see discussion in Walaszczyk in Niebuhr et al., 1999). A number of inoceramid taxa: *I. hoepeni* [*I.* (*Striatoceramus*) aff. *hoepeni* Heinz; see Walaszczyk, 1992 for discussion], *I. perplexus* Whitfield [mentioned as *I.* (*Crioceramus*) aff. *undulatus* (Mantell) and *I. vancouverensis* Shumard], *I. stuemckei* Heinz (*I. lamarcki stuemckei*) and *I. hercules* Heinz, have been listed and figured by Wolansky (1932) (her original assignment in brackets).

Compared to the known ranges of the taxa in NW Germany and Poland (Walaszczyk, 1992; Wood and Ernst, 1998), a lower (not lowermost) Upper Turonian age is assumed for the entirety of the inoceramids. While the *lamarcki*-bearing interval might be early