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Short communication

Gastropod egg capsules preserved on an Early Cretaceous ammonite from Daghestan, Russia

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ABSTRACT

Tiny, circular objects preserved in the form of rims have been detected on an Early Cretaceous (early Aptian) ammonite from Daghestan, Russia. They are preserved on the body chamber portion of the mould, where they occur either as isolated rims or, more commonly, as structures closely neighbouring with each other. Comparisons with similar Recent and fossil structures indicate that they are remnants of gastropod egg capsules preserved as attachment bases, and most probably were produced by neritimorph gastropods. The egg capsules were deposited within an empty ammonite body chamber where the gastropods found a site sheltered against potential scavengers and predators. The occurrence of only attachment bases indicates, that the egg capsules may have hatched. Although they are preserved in the form of iron oxides, during fossilization the originally organic egg capsules underwent pyritization followed by later weathering. This is the first record of this kind from the Lower Cretaceous.

1. Introduction

Most Recent gastropods lay their eggs enclosed in protective capsules that, having passed through the oviduct, are attached to firm or hard substrates (e.g., Rawlings 1999; Przeslawski 2004; Aktipis et al., 2008; Bigatti et al., 2010; see Roche et al., 2011). Egg capsules differ in composition, shape and size depending on the gastropod group (e.g., Soliman 1987; Rawlings 1999). However, due to the organic composition of most gastropod egg capsules (e.g., Soliman 1987; Hawkins and Hutchinson 1988; Rawlings 1999), their fossil record is poor and very patchy, being known only from a few localities. The oldest known come from Lower Jurassic (Hettangian) deltaic deposits of Poland (Zatoń et al., 2009), and the youngest putative gastropod egg capsules are known from Miocene limnic to swamp deposits of the Czech Republic (Mikuláš and Dvořák 2001). In between, there are only records from marine Lower Jurassic (Pliensbachian) deposits of Germany (Kaiser and Voigt, 1977, 1983) and the uppermost Cretaceous (Maastrichtian) of the Netherlands (Zatoń et al., 2013). Certainly there may be many more occurrences of gastropod egg capsules in the fossil record, but due to their small size and very simple appearance, they usually are unnoticed by collectors. However, the search for such fossils is important because from them we can gain valuable information concerning gastropod reproductive behavior and its potential evolutionary changes through time.

Here we report on intriguing structures preserved on an ammonite from the Lower Cretaceous of Daghestan, Russia. Based on their size, morphology, arrangement and occurrence, they are hypothesized to represent the remnants of gastropod egg capsules. This is the first record of this kind from the Lower Cretaceous.

2. Material and methods

The fossils investigated are preserved on the internal mould of an Early Cretaceous, small-sized (43 mm in diameter) ammonite microconch *Deshayesites dechyi* (Papp). The specimen was collected from lower Aptian deposits outcropping in the neighborhood of Levashi village in Daghestan, Russia (Fig. 1, see also Bogdanova and Mikhailova 2004). The lower Aptian deposits consisting of sandstones and sandy clay containing shells of *Prochelonicera* sp. and *Pseudocrioceras waageni* overlie upper Barremian sandstones with *Matheronites ridzewskyi* and are overlain by a breccia-conglomerate horizon with mixed fauna representing several zones of the lower and middle Aptian (Kakabadze et al., 1978; Bogdanova et al., 1979). The specimen of *Deshayesites dechyi* comes from the upper part of the lower Aptian deposits consisting of a 0.2 m thick sandy

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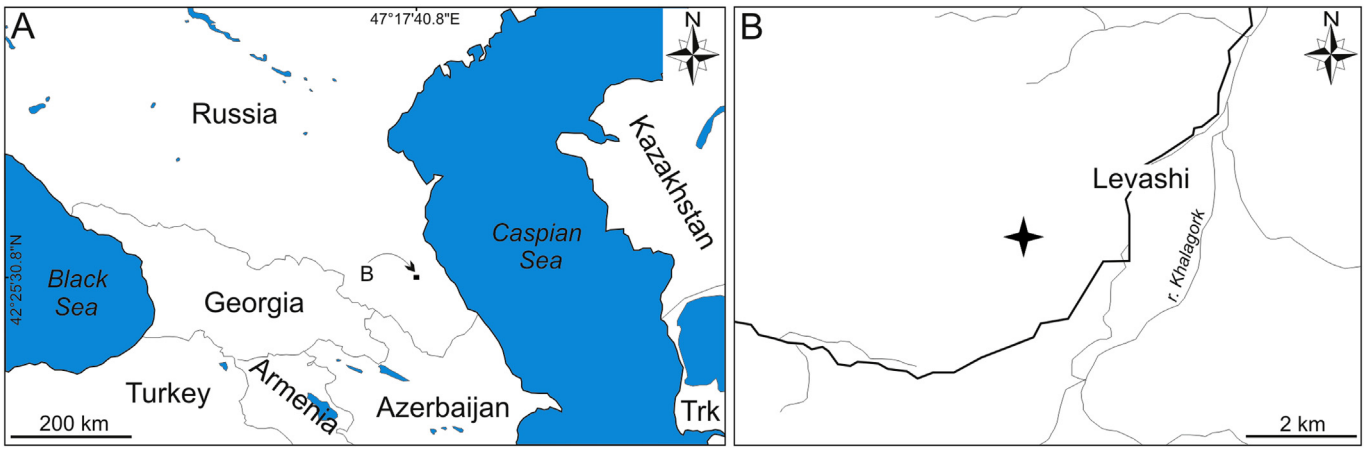

Fig. 1. Sketch-maps showing the location of the site near the village of Levashi in Daghestan, Russia where the egg capsule-bearing ammonite was found. Trk – Turkmenistan.

limestone with abundant shells of *Deshayesites* ammonites. Stratigraphically, these deposits represent the *Deshayesites deshayesi* Zone (see Bogdanova and Mikhailova 2004).

The egg capsules were investigated using a binocular microscope and SEM TESCAN // VEGA with BSE detector at the Paleontological institute of the Russian Academy of Sciences in Moscow. The fossils were inspected in an uncoated state in low vacuum conditions at 30 kV. Images were generated using backscattered electrons (BSE). Data on the elemental composition of the preserved structures were obtained using the SEM-coupled energy dispersive spectroscopy detector (EDS).

The material is housed at the Moscow State University Museum, Russia, abbreviated MSU 120/3.

3. Results

The structures investigated are preserved on an internal mould of the ammonite *Deshayesites dechyi*. They occur on 2/3 of the preserved part of the body chamber, being confined to its right side (Fig. 2A–B). The fossils are visible mainly on the lateral part of the mould; however, some also occur on its ventro-lateral side as well as on the umbilical slope. There seem to be hundreds of preserved structures, but the exact number is uncertain due to their variable state of preservation.

The structures are preserved in the form of more or less circular attachment bases. Their width along the shortest axis ranges from 0.47 to 0.64 mm (mean = 0.59 mm, $n = 15$), and their length along the longest axis ranges from 0.54 to 0.67 mm (mean = 0.61 mm, $n = 15$). The attachment bases are exclusively preserved in the form of rings with thickened (up to 0.088 mm in width), irregular rims (Figs 2C, 3A-C). The EDS analysis indicated that they are preserved as iron oxides (Fig. 4). Inside the rings, only the carbonate surface of the mould is preserved (Fig. 4). The structures discussed mainly occur as dense clusters (up to 70 specimens/cm^2) with particular basal rings attached to each other (Fig. 3A–C). Some, however, are preserved as isolated rims but being still close to the neighbouring ones (Fig. 2C).

4. Discussion

4.1. Identity of the fossils

The structures preserved on the internal mould of an ammonite from the Lower Cretaceous of Daghestan are intriguing and thus it is first needed to compare them to any other potentially similar fossils. The shape and occurrence of the structures on the ammonite mould may remind the pits or "pearls" known from many different ammonoids and considered as traces of parasitoses (see De Baets et al., 2011). Such structures, however, occur as convex swellings ("pearl") on the inner side of the shell wall, or concave depressions (pits) on the mould (see De Baets et al., 2011). The structures investigated here are not concave so only superficially may remind the pits mentioned above. Thus, they are not a sign of parasitosis infesting the ammonite. The outline and size of the preserved structures investigated may also remind the attachment bases (holdfasts) of a problematic fossil with possible cnidarian affinities called *Sphenothallus* which encrusted hard substrates. However, *Sphenothallus* had phosphatic mineralogy, ranged from Cambrian to Carboniferous, had long tubular projections, and was attached to the substrate with an entire attachment base (see e.g., van Iten et al., 1992; Vinn and Kirsimäe 2015). Thus, based on clear differences and stratigraphic discrepancy, the sphenothallid hypothesis is rejected. Some tiny (c. 400 μm in diameter), encrusting foraminifers, like those illustrated by Zatoń et al. (2011, fig. 6A) attached to the Callovian bivalve shells, may be considered as superficially similar. However, unlike the structures described here, they would certainly be preserved in the form of entire calcitic test bases on the ammonite mould. Thus, from taphonomic point of view, this hypothesis is also rejected. The dense arrangement of circular structures investigated may also remind the zooaria of some anascan cheilostome bryozoans (e.g., Taylor and McKinney 2006). However, the calcitic mineralogy and different morphology and organization of zooecia make the structures investigated here completely dissimilar to bryozoan colonies.

Although different than any potentially similar structures and fossils listed above, those investigated here are most similar to remnants of some gastropod egg capsules, especially those produced by neritimorphs. As with Recent neritimorph egg capsules (e.g., Adegoke et al., 1969; Pechenik 1982; Soliman 1987; Rawlings 1999; Przeslawski 2004; Aktipis et al., 2008; Kano and Fukumori 2010; Bigatti et al., 2010; see Roche et al., 2011 for a review; Fig. 3F), those described here were produced *en masse* on hard substrate in the form of aragonitic ammonite shell. Like the egg capsules of Recent neritimorphs (Fig. 3F; see also Adegoke et al., 1969; Fischer 1980; Kano et al., 2001; Kano and Fukumori 2010), the Cretaceous capsules were also deposited in rows, close to each other. Their shape is also very similar, as the capsules produced by neritimorphs may be more or less circular to elliptical in outline (e.g., Adegoke et al., 1969; Kano and Fukumori 2010). The most important feature, however, is the architecture of the egg capsules.