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作品名稱　**Microfossil association of the Štíty locality**

得獎獎項　一等獎

國　　家　**Czech Republic**

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關鍵詞　**Bohemian Cretaceous Basin、Foraminifera、Ostracoda**

作者照片

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Annotation

My thesis focuses on studying Cretaceous microfossil specimens from the excavation of the former brickworks in Štíty, especially foraminifera. In the theoretical part, I have covered the structure of the Bohemian Cretaceous Basin area, especially the Bystřice Lithofacial Development. I have also processed previous paleontological research from the locality. Emphasis was placed on field research and subsequently on the laboratory research of the site.

I have examined the present state of the location and gathered samples of silt clay containing a wide variety of fossils. I have acquired the microfossils, determined them, and ordered them systematically. The most important part of the thesis is the systematic and palaeoecological processing of the collection of microfossils from the locality.

The thesis continues the research of the last year of SOČ, where I have gathered a collection of fossilized macrofauna, flora, and ichnofauna.

1 INTRODUCTION

The town of Štíty is an important paleontological locality in northern Moravia. In 42. year of SOČ, I worked on the project Fossil association of Štíty – locality (Bystřice Lithofacial Development the Bohemian Cretaceous Basin), in which I researched mainly macrofossils and ichnofossils. In this thesis, I will only deal with microfossils, especially foraminifera.

2 THE AIM OF THE THESIS

The presented thesis aims to:

- evaluate the current state of the site after the end of mining the brick clay,
- describe the former mining area,
- in the research part of the thesis to study the available professional literature dealing with the geological structure and paleontological finds in the vicinity of Štíty and the Czech Cretaceous Basin, also to study articles published about Nysa Kłodzko Graben,
- focus on the fieldwork and sampling directly on the site,
- create a comprehensive collection of microfossils, subject it to further research,
- compare the findings with samples published in the literature,
- create a comprehensive collection of microfossils, determine them, and make tables from their photographs.

3 DESCRIPTION OF THE LOCALITY

3.1 Information about the locality

The town of Štíty lies within the north-eastern parts of the Czech Republic, nearby the Poland border. The altitude of the town center is 450 m above sea level. The locality is a part of Nysa Kłodzka Graben included in the Bohemian Cretaceous Basin (Figure 1).

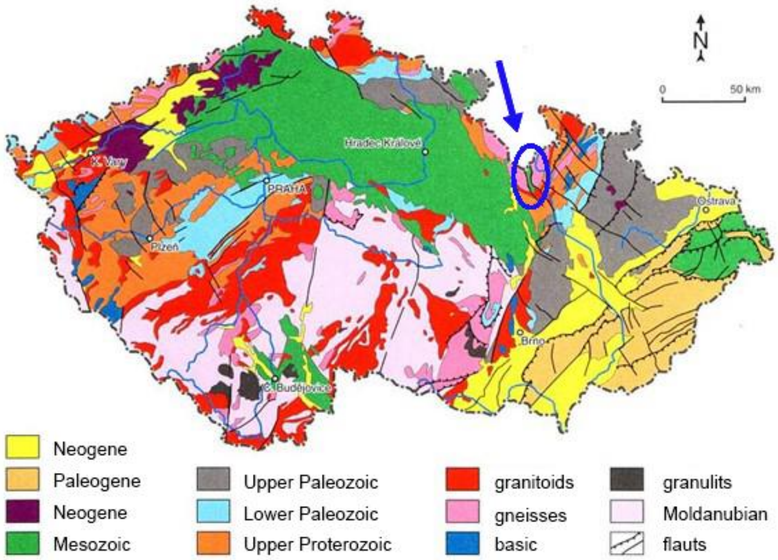


Figure 1 Simplified geological map of the Czech Republic[1].

3.2 Present state of the locality

The following photo documentation (Figures 2 and 3) shows the current state of the paleontological site. Clay Mining has been gradually reduced since the 1990s and stopped in 2004. The centre of the pit is flooded, surrounded by mounds of clay or sandstone. The site is heavily overgrown with ruderal, forest-steppe, and wetland vegetation making it difficult to collect paleontological material.

[1]MOTLÍK, Martin *Geologická mapa České republiky* [online]. In: [cit. 2021-04-26]. https://sites.google.com/a/12zscv.cz/geologie-ceske-republiky/home/geologicka-mapa-ceske-republiky

Figure 2 Northern view spring 2019 (photo author).

Figure 3 Lake view (photo author).

3.3 Bohemian Cretaceus Basin

The Bohemian Cretaceous Basin lies within the northern half of the Czech Republic with 14,600 km^2. It is the largest preserved sedimentation area, which today extends from Dresden to north-western Moravia. The original extent was much larger, but a significant part of the basin succumbed to Cretaceous erosion. It connected the vast European continental basins in the northwest with the Tethys Ocean in the southeast.

The subsoil of the Czech Cretaceous basin consists of rocks of the Bohemian Massif. The crystalline rocks of the Lower Proterozoic surrounding units of the Krušné hory, Kutná Hora, Svratka, Orlicko-Kladsko and Krkonoše-Jizera are represented in the subsoil of the marginal parts. These are metamorphic and wrinkled and migmatites.

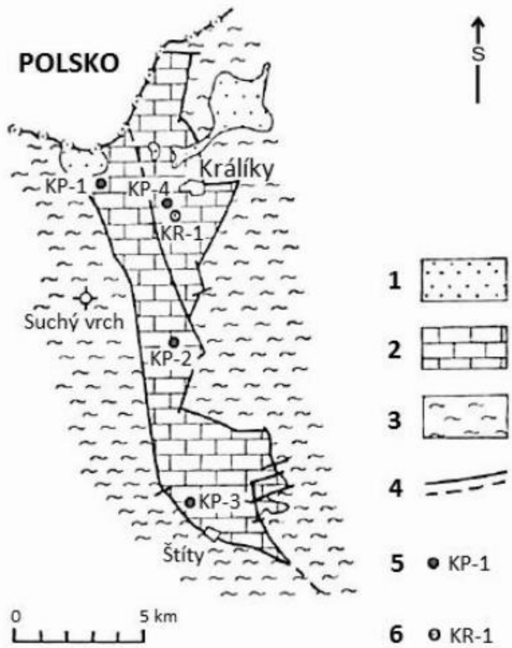
Based on the four structural boreholes KP-1 to KP-4 and the borehole KR-1 it was possible to compare and evaluate in detail Upper Cretaceous sediments, which exceed the thickness up to 700 m. Depending on the content of basic components and other sedimentary features, it was possible to single out five sedimentary phases characterized by specific paleogeographic conditions. Correlation with chronostratigraphic units. Microfossils were obtained from navigable sediments of the upper parts of the profiles.

3.4 Petrographic characteristics

We can identify three types of rocks in brickyard:

1. Siltstone + silt: mined raw material grey in colour, with brownish sandy laminates. They contain fragile macrofossils and a large number of microfossils, including foraminifera.

2. Pelosiderite concretions: mining "waste" with spherical loaf shape and diameter around 5-20 cm. Silt and clay accumulated around grains just as pearls do. Reinforced with siderite, they perfectly preserve



macrofossils, ranging from plants to mollusc and chordates, to whom I have dedicated my previous work.

3. Sandstone: forms large benches within the siltstone layers with a thickness of around 50 cm. In the pit, there are large piles of sandstone boulders because they were considered a mining waste. They contain many ichnofossils.

Figure 4 The geological situation around Štíty (adapted according to Valečka, 1988).

Explanations: 1 - Cenozoic; 2 - Upper Cretaceous; 3 - Orlicko-Kladsko crystallinicum; 4 – flauds; 5, 6 – boreholes.

4 FOSSILS[2]

Within my research, I collected siltstone samples for the subsequent study of microfossils. Foraminifers are the most abundant, although there is also a large variety of Ostracoda, Porifera, Echinoidea, and teeth.

4.1 Foraminifera[3] [4]

4.1.1 General characteristics

Foraminifers are single-celled marine organisms with characteristic predominantly solid shells called tests, which are morphologically highly variable. At present, over 40,000 species are known, of which 4,000 are recent species.

Based on their lifestyle, we distinguish:

1. Benthic foraminifers: usually inhabit sand buried in the ocean floor (endofauna) or actively move on the surface of sediments (epifauna).
2. Planktonic foraminifers: are a significant part of the zooplankton. They float freely in the water and are intolerant to reduced salinity. They are often in a symbiotic relationship with algae, thus making them most common at a depth of 50 meters. Below 300 meters, their diversity decreases.

4.1.2 Tests

The first foraminifers with shells appeared in the Early Cambrian. The Typical size of a test varies between 0.1 and 1 mm, although some can even reach up to 10 cm. For their large abundance and variety, tests of foraminifers are invaluable for palaeoecological reconstructions. They are also significant limestone-forming organisms, especially in nummulitic limestone.

Depending on the material and structure we distinguish:

1. Agglutinated tests – foraminifers selectively attach foreign particles onto a tectin layer for additional protection. These consist of grains of sand, sponge spicules, and shells of other organisms.
1. Calcareous tests – they are formed by calcite or aragonite, which the foraminifers produce by themselves. According to the coarseness and structure of the walls, we distinguish microgranular, porcelaneous, and hyaline subtypes.

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[2] SKUPIEN, Petr a Lucie MĚCHOVÁ. *Základy stratigrafie a paleontologie* [online]. Vysoká škola báňská – Technická univerzita Ostrava, Hornicko-geologická fakulta: Institut geologického inženýrství. Dostupné z: http://geologie.vsb.cz/paleontologie/Default.htm

[3] SCHEINER, Filip. *Foraminifery a jejich potenciál pro paleoekologickou a biostratigrafickou interpretaci*. 2013. Bakalářská práce. Univerzita Karlova, Přírodovědecká fakulta, Ústav geologie a paleontologie. Vedoucí práce Holcová, Katarína.

[4] HAŠKOVÁ, Barbora. *Foraminifery české křídy z lokality Březno*. Praha, 2012. Diplomová práce. Univerzita Karlova, Přírodovědecká fakulta, Ústav geologie a paleontologie. Vedoucí práce Holcová, Katarína.

Early foraminifers had unilocular tests with only a single chamber. This chamber later developed into the proloculus, capable of producing more chambers. These chambers increase in size and are separated by septa (or sutures, if visible on the surface). Foraminifer tests can bear more than a wide variety of arrangements. The most basic ones are graphicly described in Figure 5.

Foraminifers have a variety of openings in the shell for communication with an environment. They consist of pores for pseudopodia and apertures. The placement and number of apertures are of great importance in the taxonomical system.

The chambers can create a row (uni-, bi-, triserial), enrolled alignment in a spiral plane (planispiral), and enrolled spatially in a helix (trochospiral). Spiral tests can be involute - the chambers overlap, or evolute -all chambers are visible.

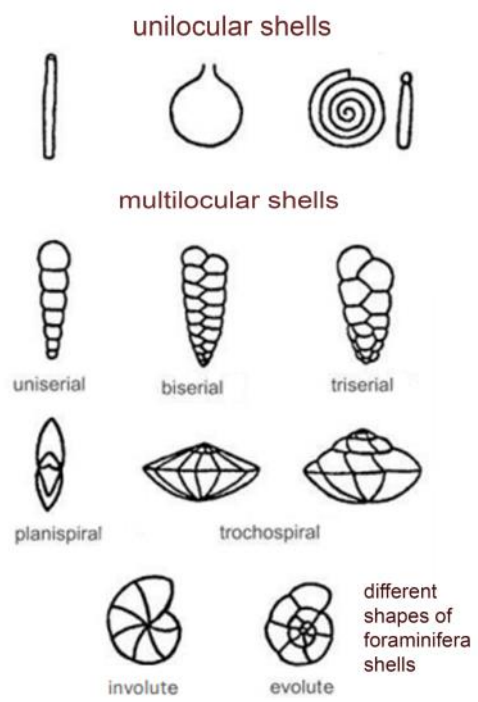

Figure 5 Types of foraminiferal shells (Pokorný 1992, edited).

Foraminifers grow new chambers periodically. The initial chamber (proloculus) is formed first, then the following chambers of different shapes (postembryonic). They are long tubular, irregular, spherical, teardrop-shaped, saddle-shaped, cylindrical, triangular, square, prismatic, and more. The volume of successive chambers usually increases. Young individuals, therefore, have a lower number of chambers than adults.

4.1.3 Reproduction

The reproduction of benthic foraminifers is haplo-diplophasic, characterized by alternating two stages with specific dimorphism:

1 Macrospheric generation: larger proloculus formed during haploid reproduction, and a megalospheric shell is formed.
2 Microspheric generation: sexual reproduction of the diploid generation tends to form a smaller proloculus.

These generations alternate irregularly but mostly lack the sexual cycle.

4.1.4 Diet

Foraminifers procure food with their pseudopodia. Some species with large apertures can pull food directly into the shell. Methods of obtaining food include grazing or symbiosis with algae, suspension filtration, and even predation of arthropods and other foraminifera.

4.2 Other fossils

4.2.1 Porifera[5]

The sponges have been known since the Lower Cambrian and occur in all geological periods. Their bodies are full of pores, and channels, allowing for inner water circulation and nutrition. The inner is skeleton formed by elastic fibres or spicules. The spicules divide according to size and function into macrosclerites, the support of the body, and microsclerites, which have a filling function. We distinguish three classes:

- *Hexactinellida* – siliceous, occurring in cold the deep-water environment.
- *Calcarea* – calcareous, warm shallow-water sponges.
- *Desmospongia* – keratinous, the most diverse.

Sponges create porifer cliffs with rock-forming significance forming spongolites.

4.2.2 Ostracoda[6]

The ostracods are small crustaceans. They first appeared in Cambrian. They most often occur as benthic forms of shallow marine waters. They are widely used in biostratigraphy and paleogeography. Ostracods have separate sexes, although parthenogenesis is very common. The body of an ostracod is concealed between two valves. The valves are variously sculpted - from smooth to tiled ornaments. However, they usually do not exceed the size of 2 mm. External distinguishing features for the identification of seashells are shown in Figure 17. Ostracods feed mainly on smaller organisms, organic detritus, or the remains of dead bodies.

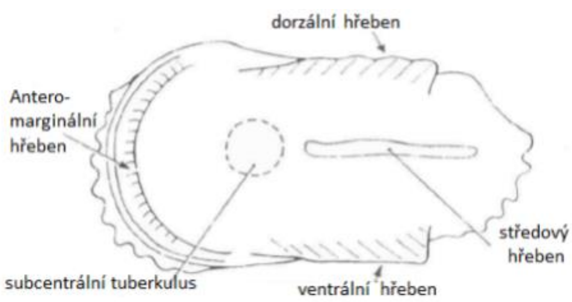

Figure 6 External features of cstracods.

4.2.3 Echinoidea[7]

Sea urchins have a characteristic calcareous skeleton surrounding internal organs. Sea urchins have a radially symmetrical five-fold body. The mouth is on the underside and contains Aristotles lantern. The skeleton composes of calcareous plates. The surface of the skeleton is covered by spines, which sit articulated on tubercles. The most important urchins for the locality are Micraster and Clypeaster.

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[5] SKUPIEN, Petr a Lucie MĚCHOVÁ. *Základy stratigrafie a paleontologie* [online]. Vysoká škola báňská – Technická univerzita Ostrava, Hornicko-geologická fakulta: Institut geologického inženýrství. Dostupné z: http://geologie.vsb.cz/paleontologie/Default.htm

[6] HOUDKOVÁ, Markéta. *Ostrakodi české křídové pánve – stav výzkumu a inventarizace sbírky prof. Pokorného*. 2013. Bakalářská práce. Univerzita Karlova, Přírodovědecká fakulta, Ústav geologie a paleontologie. Vedoucí práce Pipík, Radovan.

[7] SKUPIEN, Petr a Lucie MĚCHOVÁ. *Základy stratigrafie a paleontologie* [online]. Vysoká škola báňská – Technická univerzita Ostrava, Hornicko-geologická fakulta: Institut geologického inženýrství. Dostupné z: http://geologie.vsb.cz/paleontologie/Default.htm

4.2.4 Mollusca

Mollusca is a phylum of invertebrates ranging from gastropods and bivalves to cephalopods. I covered their characteristics in detail in my macrofossil research in the year 2019/20 SOČ.

4.2.5 Chordata[8]

Chordates are multicellular organisms with a perfectly developed body that is bilaterally symmetrical. The chordates probably evolved at the beginning of the Cambrian. Findings of teeth of sharks, fish, and sea reptiles are typical for the marine environment of the Bohemian Cretaceous Basin.

5 METHODOLOGY

The whole project divided into field and laboratory research.

5.1 Collecting information

In the theoretical part of my research, I studied contributions from geological proceedings dealing about Štíty locality and theses published on:

http://www.geology.cz/sbornik - Journal of Geological Sciences

https://www.researchgate.net/ - science publications

https://journals.muni.cz/gvms/about - Journal of Geological research in Moravia and Silesia

From the theses and journals available at Charles University in Prague and Palacký University in Olomouc, I created a timeline regarding research in the locality.

In 1931, Dr. Jaroš discussed a treatise in which he identified 67 fossil species from the brickyard.

Koverdynsky (1956) mentions in a short article the findings of fossils, rare and mostly small, ostracod shells, and plant fragments.

Litzmannová, Novotná, and Svobodová (1979) followed with a survey devoted to micropaleontological research. They came up with three different associations:

1. Turonian-Coniacian age (1 sample):

dominant *Lenticulina* (LAMARCK), less common *Arenobulimina preslii* (REUSS), *Globotruncana linneiana* (D´O RBIGNY), *Globotruncana* sp., *Globorotalites* sp.

2. probable Coniacian age (3 samples):

Dorothia sp., *Haplophragmoides* sp., *Trochammina* sp., *Ammobaculites* sp., *Glomospira* sp., *Ammodiscus* sp.

[8] SKUPIEN, Petr a Lucie MĚCHOVÁ. *Základy stratigrafie a paleontologie* [online]. Vysoká škola báňská – Technická univerzita Ostrava, Hornicko-geologická fakulta: Institut geologického inženýrství. Dostupné z: http://geologie.vsb.cz/paleontologie/Default.htm

3. Coniacian age – the highest quality and quantity (3 samples):

Globotruncana marginata (REUSS), *Verneuilina munsteri* (REUSS), *Lenticulina* sp., *Globotruncana cretacea* (D´ORBIGNY), *Pleurostomella bicornis* (REUSS), *Frondicularia* sp., *Gaudryina bronii* (REUSS), *Marginulina bullata* (REUSS), *Globotruncana angusticarinata* (D´ORBIGNY), *Globotruncana* cf. *linneiana* (D´ORBIGNY), *Globorotalites Turonianicus* (KAEVER), *Reophax* cf. *minutus* (LOEBLICH et TAPPAN), *Arenobulimina* sp., *Plectina* sp., *Dorothia oxycona* (REUSS), *Vaginulinopsis* sp., *Ammodiscus* sp., *Globotruncana coronata* (BOLLI), *Frondicularia goldfusi* (REUSS), *Arenobulimina d´orbignyi* (REUSS), fragments of ostracods, cephalopods, sea urhins, and *Bryozoa.*

In 1988, Valečka published a contribution about the sedimentology in Králíky Graben. Upper Cretaceous sediments have five sedimentation phases with the well-distinguished lithological unit and paleogeographic conditions.

The foraminiferous association was evaluated by Hercogová (1985) as Coniacian. The highest samples belong to Santonian, based on the findings of the species Cibicides excavatus (Brotzen), Fissurina orbignyana (Seguenza), Neoflabellina santonica (Koch), Spiroplectammina baudouiniana (d´Orbigny) and Eggerellina sp. However, this is only associated with boreholes KP-1 and KP-2, not with Štíty.

In 2003, Gába published New Finds of Fossils from Štíty. In the Vertebrate Remnants section, Gába mentions the tooth of the shark Oxyrrhina angustidens. The found well-preserved shark tooth measuring 3.5 x 1.5 mm was identified by Trbušek.

5.2 Basis for the systematic part

I used various internet sources for inclusion in the paleontological system, in particular:

WoRMS – World Register of Marine Species [online].
http://www.marinespecies.org

The Foraminifera.eu Project. Foraminifera Gallery – illustrated catalog [online].
http://www.foraminifera.eu

BELLIER, Jean-Pierre, Robert MATHIEU a Bruno GRANIER. *Short Treatise on Foraminiferology: (Essential on modern and fossil Foraminifera)* [online]. Laboratoire de Micropaléontologie, Université Pierre et Marie Curie, 2010.
http://paleopolis.rediris.es/cg/BOOKS/CG2010_B02/index.html

Pforams@mikrotax: Introduction to the Mesozoic Database [online]. [cit. 2021-3-14].
https://www.mikrotax.org/pforams/

LOEBLICH, JR., Altred R. a Helen TAPPAN. *Foraminiferal Genera and Their Classification*. II. New York: Springer Science+Business Media New York, 1988. ISBN 978-1-4899-5762-7.

5.3 Laboratory

5.3.1 Gathering samples

Figure 7 Home laboratory equipment

In December 2019 and March 2020, siltstone samples were removed from the northern wall about 15 m below the top of the clay pit in a depth of 0.5 m to prevent contamination of the material with recent organisms.

5.3.2 Sample processing at home

In a stainless pot with a volume of 2 litres, I boiled siltstones of smaller dimensions (diameter up to 7 cm) with water and baking soda ($NaHCO_3$). I gathered fine sediment, which I was able to process with clean water through a set of kitchen sieves with holes of 125 µm and nylon stockings (Figure 7). This way, I got rid of the dust, and after drying the flooded filtrate, I was able to separate the microfossils from the rest of the sediment using just a binocular microscope, Advance ICD 10x - 160x, and a needle.

5.3.3 Sample processing at the laboratory

Figure 8 FRITSCH SPARTAN 3

To verify the processing at home, and to expand my experience with professional equipment, I was able to access the FRITSCH SPARTAN 3 vibrating sieve (Figure 8) with meshes of sizes 1000 µm, 500 µm, 250 µm, 125 µm, and 62.5 µm, at the Department of Geology of Palacký University together with RNDr. Lehotský. I ordered the sieve samples according to their specific size. The vibration sieving was not successful, probably because of the short sieving time and required further refinement. Due to the enclosure caused by the Covid-19, it was no longer possible to redo the experiment.

6 SYSTEM

kingdom: *Chromista*

infrakingdom: *Rhizaria*

phylum: *Foraminifera* (*Foraminiferida*)

6.1 class: Globothalamea

subclass: *Rotaliana*

Order: *Rotaliida*

superfamily: *Chilostomelloidea* BRADY

family: *Gavelinellidae* HOFKER

genus: *Gavelinella* BROTZEN

Gavelinella thalmanni (BROTZEN, 1936)

The test of G*avelinella thalmanni* is planispiral, spiral side evolute, umbilical side involute, granular calcareous perforated walls, Turonian – Maastrichtian.

Plate 1, sample 1

Gavelinella sp.

Other samples of *Gavelinella* are not sufficiently well preserved for further determination.

Plate 1, sample 2–5

family: *Globorotalitidae* LOEBLICH & TAPPAN

genus: *Globorotalites* BROTZEN

Globorotalites subconicus (MORROW, 1934)

The structure of *the Globorotalites subconicus* test is trochospiral, planoconvex, the spiral part is flattened or slightly convex, the umbilical side is strongly convex, calcareous, smooth surface, perforated, Coniacian – Maastrichtian.

Plate 2, sample 1–3

superfamily: *Discorboidea* EHRENBERG

family: *Cancrisidae* CHAPMAN, PARR & COLLINS

genus: *Gyroidinoides* BROTZEN

Gyroidinoides nitida (REUSS, 1884)

The structure of the test *Gyroidinoides nitida* is trochospiral, planoconvex, with a flat, evolute spiral side and a convex, involute umbilical side. Umbilicus is characteristically partially covered by the last chambers. Smooth calcareous surface, granular, Turonian.

Plate 2, sample 4–5

Gyroidinoides sp.

The shape of the test shows a similar structure to others from the genus *Gyroidinoides*.

Plate 2, sample 6

superfamily: *Turrilinoidea* CUSHMAN

family: *Turrilinidae* CUSHMAN

genus: *Praebulimina* HOFKER, 1953

Praebulimina sp.

The genus *Praebulimina* forms an oval inflated test, chambers stacked triserially close to each other, the last chamber pronounced, calcareous walls, fine perforation, smooth, opaque.

Plate 5, sample 3

suborder: *Globigerinina*

superfamily: *Globotruncanoidea* BROTZEN

family: *Globotruncanidae* BROTZEN

genus: *Globotruncana* CUSHMAN

Globotruncana linneiana (D'ORBIGNY, 1839)

Globotruncana linneiana forms a round slightly trochospiral test, almost flat, umbilicus occupies one 1/4-1/2 diameter of the concave umbilical side. Individual chambers are mostly flattened and with very wide keels, 5-6 chambers. Calcareous wall perforated, coarse, Santonian – Maastrichtian.

Plate 4, sample 9–11

genus: *Marginotruncana* HOFKER

Marginotruncana angusticarenata (GANDOLFI, 1942)

Marginotruncana angusticarenata forms a trochospiroconvex test, the chambers gradually increase in size, 5-8 chambers in the last thread, pronounced umbilicus, flat chambers with smaller keels, calcareous perforated wall, Turonian – Coniacian.

Plate 3, sample 1–2

Marginotruncana coronata (BOLLI, 1945)

Marginotruncana coronata, in the last thread 6-9 chambers, most pronounced umbilicus, chambers rounder than those of *M. angusticarenata*, thicker double keels, smoother wall, Coniacian – Campanian.

Plate 3, sample 3–4

Marginotruncana marginata (REUSS, 1845)

Marginotruncana marginata, in the last thread 5-8 chambers, chambers round, very thin sutures, calcareous perforated wall, Turonian – Santonian.

Plate 3, sample 5–12

family: *Rugoglobigerinidae* SUBBOTINA

genus: *Archaeoglobigerina* PESSAGNO

Archaeoglobigerina cretacea (D'ORBIGNY, 1814)

Archaeoglobigerina cretacea forms a slightly convex trochospiral Test, chambers significantly rounder, rapid increase from the proloculus, 4-6 chambers in the last thread, a wide umbilicus occupies 1/4-1/2 of diameter, minimal keels, calcareous, Turonian – Campanian.

Plate 4 sample 1–8

superfamily: *Heterohelicoidea* CUSHMAN

family: *Heterohelicidae* CUSHMAN

family: *Planoheterohelix* GEORGESCU & HUBER

Planoheterohelix globulosa (EHRENBERG, 1840)

Planoheterohelix globulosa has a very small proloculus (~10 μm) followed by 11-16 rapidly growing round chambers, biserial, calcareous granular wall, Cenomanian – Maastrichtian.

Plate 1, sample 6

subclass: *Textulariana*

Order: *Textulariida*
suborder: *Textulariina*
family: *Eggerellidae* CUSHMAN
genus: *Marssonella* CUSHMAN
Marssonella oxycona (REUSS, 1860)

Marssonella oxycona forms a conical test, the chambers are slightly more horizontally arranged, rapidly enlarging, around 5 chambers in one thread, the walls agglutinated, Turonian – Maastrichtian.
Plate 5, sample 1–2

Order: *Lituolida*
suborder: *Lituolina*
family: *Lituolidae* BLAINVILLE
genus: *Ammobaculites* CUSHMAN, 1910
Ammobaculites sp.

The genus *Ammobaculites* forms an elongated test, the first chambers are narrowly spiral, further chambers are loose, agglutinated, and coarse wall.
Plate 4, sample 12–14

suborder: *Verneulinina*
family: *Verneuilinidae* CUSHMAN
genus: *Verneuilina* D'ORBIGNY
Verneuilina sp.

The *genus Verneuilina* forms a triserial test with a base of an equilateral triangle, sharp edges, agglutinated.
Plate 5, sample 11–15

genus: *Gaudryina* D'ORBIGNY 1839
Gaudryina sp.

The genus *Gaudryina* forms an elongated triserial test, later chambers gradually pass into a biserial arrangement, rounded, walls agglutinated.
Plate 5, sample 8-10

Order: *Loftusiida*
suborder: *Ataxophragmiina*
family: *Ataxophragmiidae* SCHWAGER
genus: *Arenobulimina* CUSHMAN
Arenobulimina dorbignyi REUSS, 1845

Arenobulimina dorbignyi is trochospiral, the chambers have a triangular shape, a simple aperture in the basal position, sutures recessed and curved, Coniacian.
Plate 5, sample 6–7

Arenobulimina preslii REUSS,1845

Arenobulimina preslii has a little trochospiral test, stockier, chambers pear-shaped, simple aperture, Turonian – Maastrichtian.
Plate 5, sample 4–5

6.2 class: Tubothalamea

Order: *Spirillinida*

family: *Ammodiscidae* REUSS

subfamily: *Ammodiscinae* REUSS

genus: *Ammodiscus* REUSS

Ammodiscus cretaceus (REUSS, 1845)

The test of *Ammodiscus cretaceus* begins with a globular proloculus followed by a second chamber that is planispirally evolutically wrapped around the proloculus, forming a symmetrical disk. Agglutinated wall, aperture at the end of the second chamber, Turonian – Maastrichtian.

Plate 6, sample 1

Ammodiscus minimus HOFKER, 1966

Ammodiscus minimus is formed in the same way as *A. cretaceus*, significantly smaller, distinctive proloculus, Maastrichtian.

Plate 6, sample 2–3

subfamily: *Usbekistaniinae* VYALOV

genus: *Glomospira* RZEHAK

Glomospira sp.

The spherical proloculus of the genus *Glomospira* is followed by a second elongated chamber, only two chambers are formed, agglutinated.

Plate 6, sample 4–6

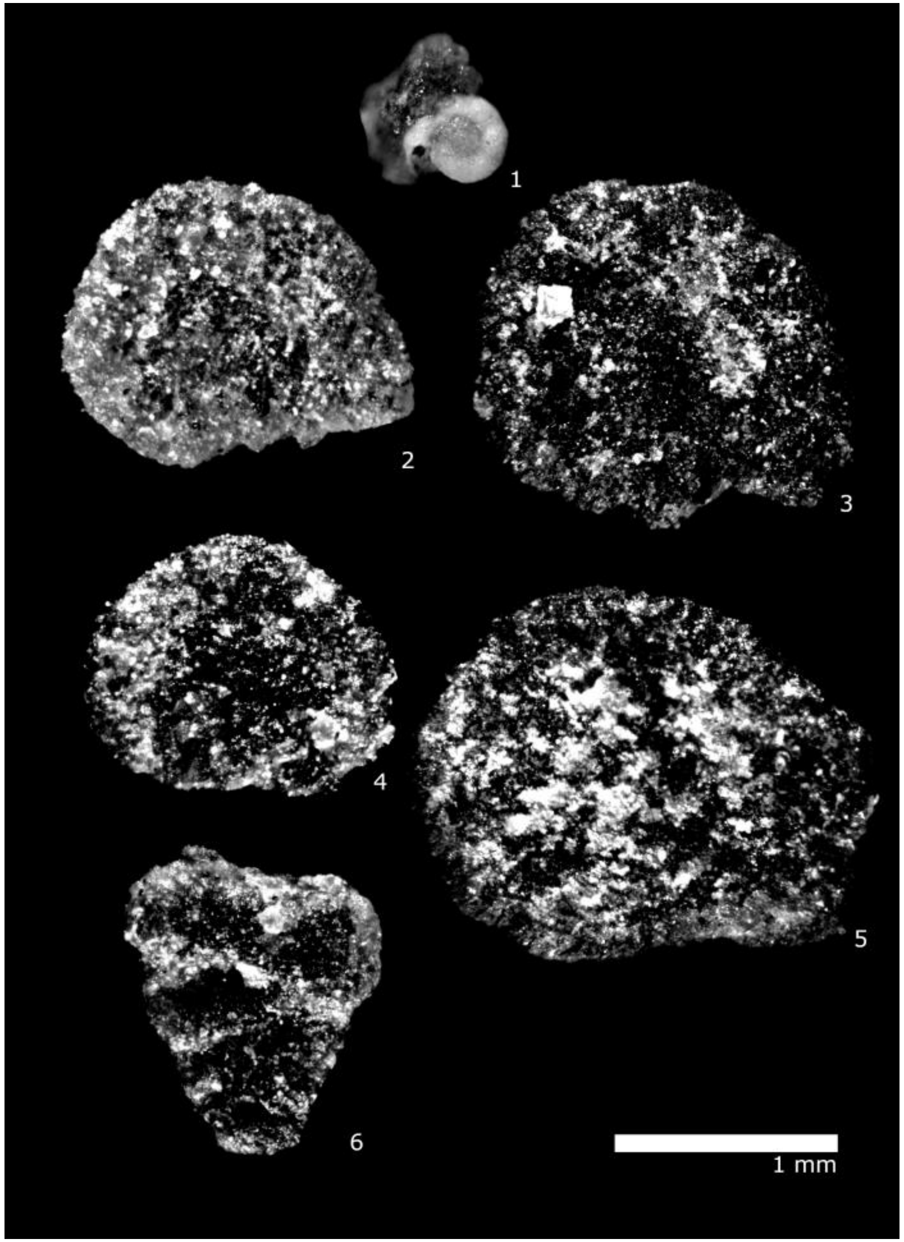

Plate 1 *Gavelinella* cf. *thalmanni* (1), *G.* sp. (2-5), *Planoheterohelix globulosa* (6).

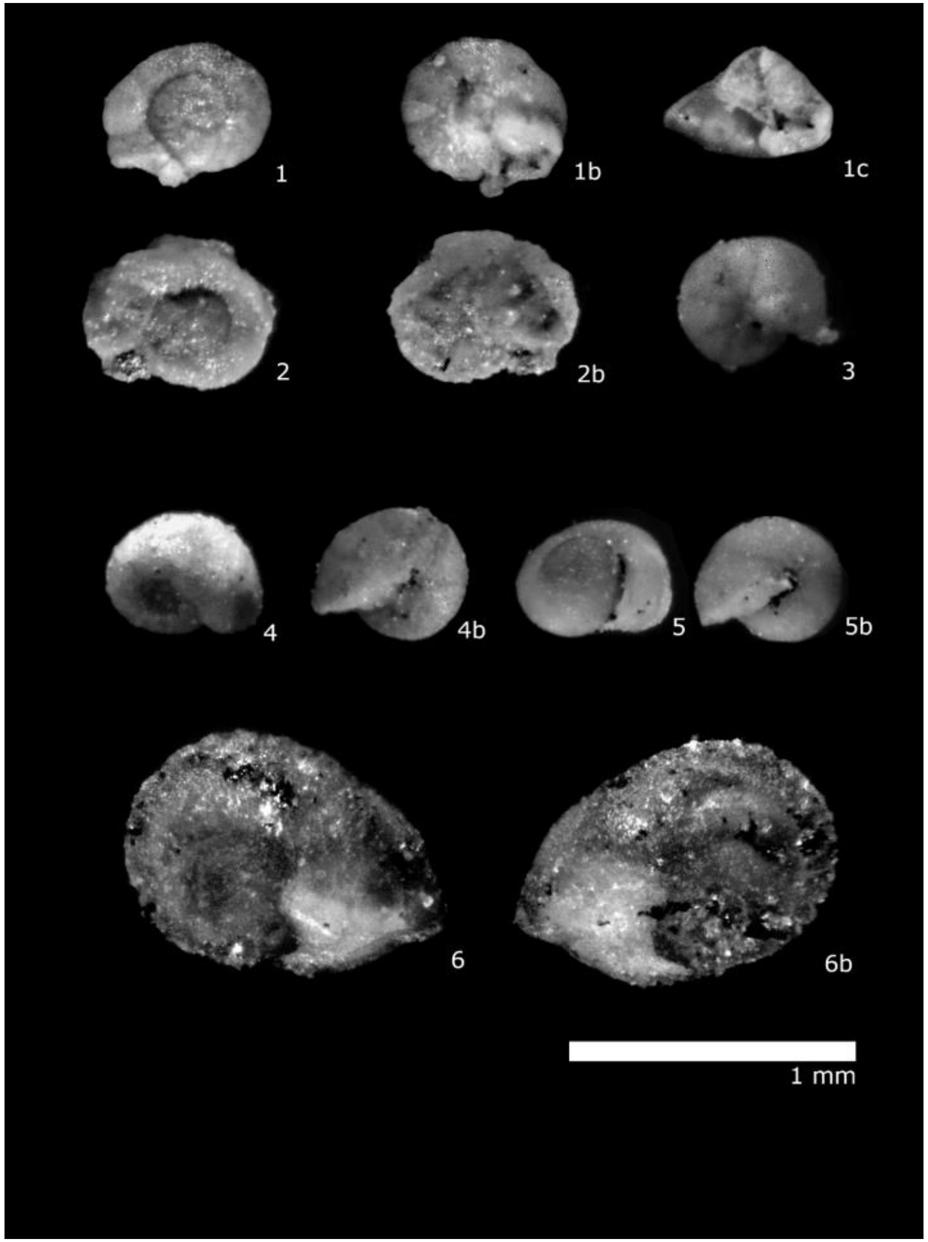

Plate 2 *Globorotalites subconicus* (1 spiral side, 1b umbilicus, 1c side view, 2, 2b, 3), *Gyroidinoides nitida* (4, 5 spiral s. 4b, 5b umbilicus) *G.* sp. (6 spirl s, 6b umbilicus).

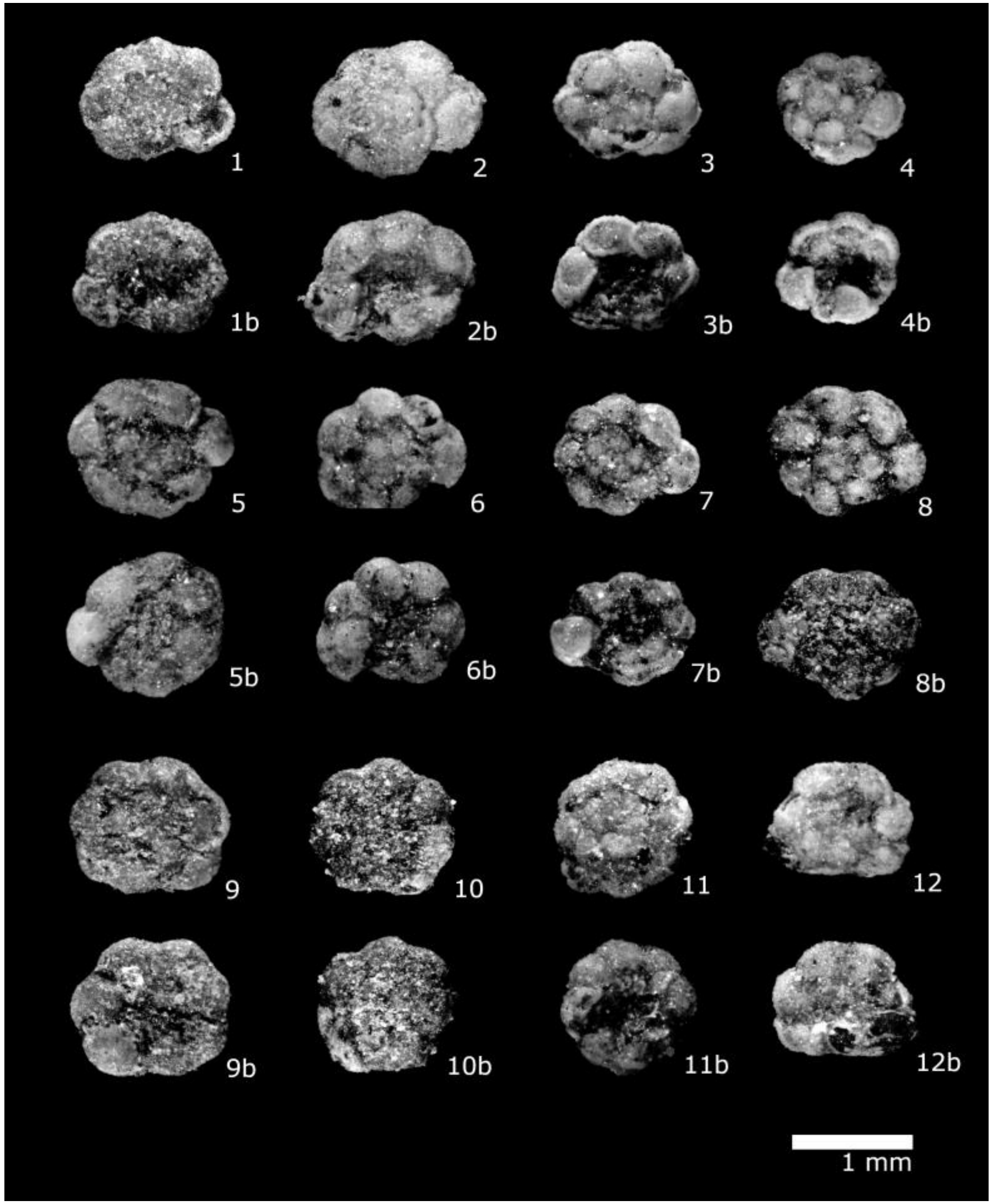

Plate 3 *Marginotruncana angusticarenata* (1-2), *M. coronata* (3-4), *Marginotruncana marginata* (5-12) xb - umbilicus.

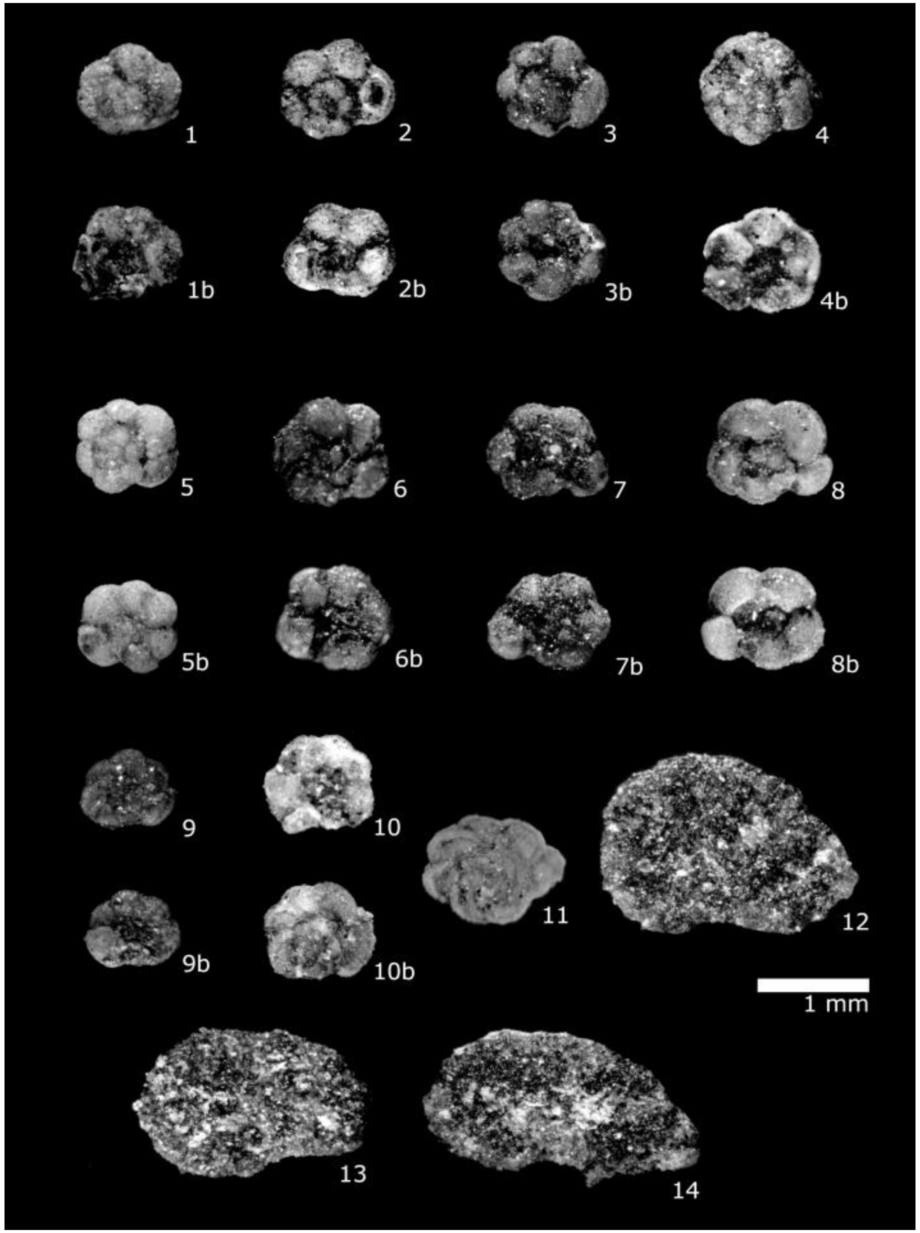

Plate 4 *Archaeoglobigerina cretacea* (1-8), *Globotruncana linneiana* (1-3), xb - umbilicus.

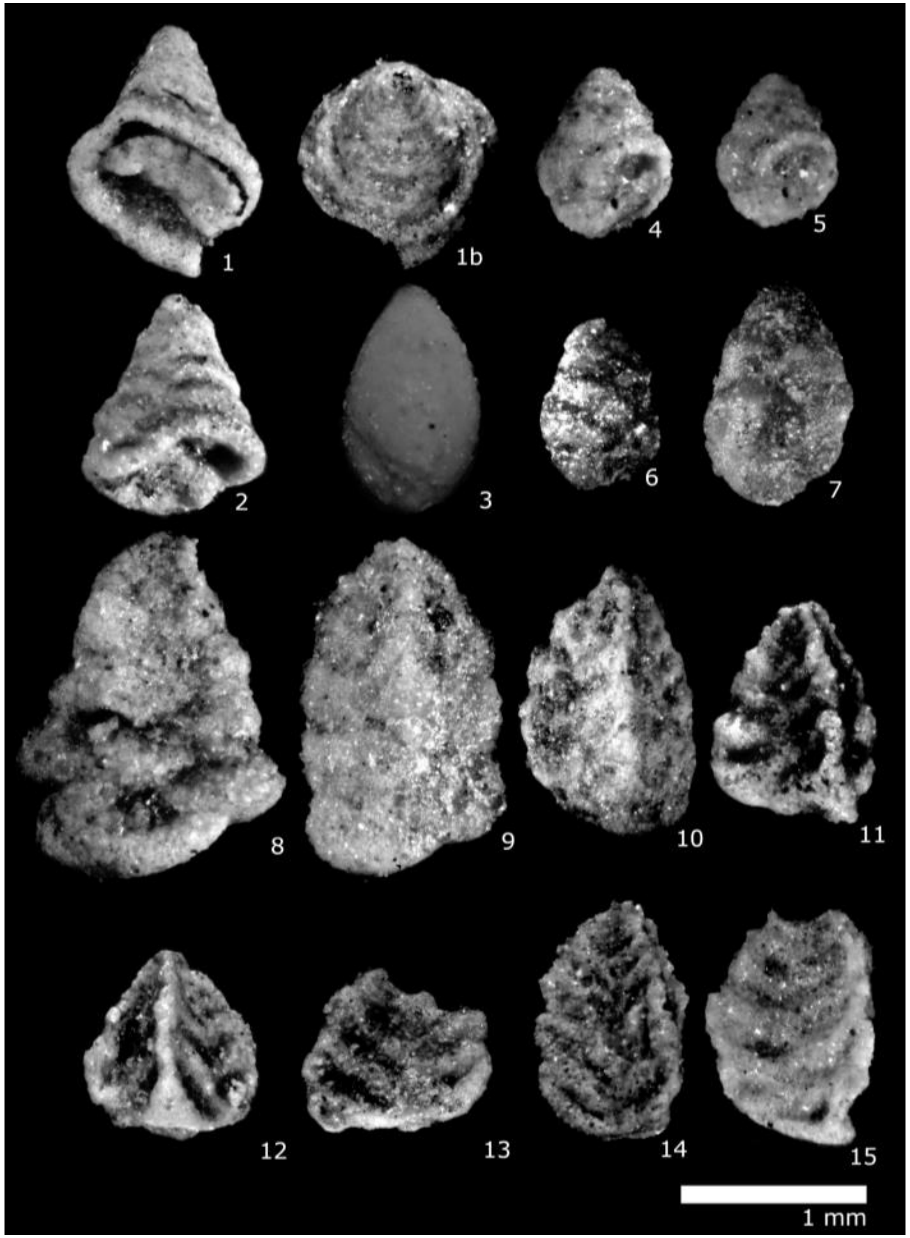

Plate 5 *Marssonella oxycona* (1, 1b view from above, 2), *Praebulimina* sp. (3), *Arenobulimina preslii* (4-5), *A. dorbignyi* (6-7), *Gaudryina* sp. (8-10), *Verneuilina* sp. (11-15).

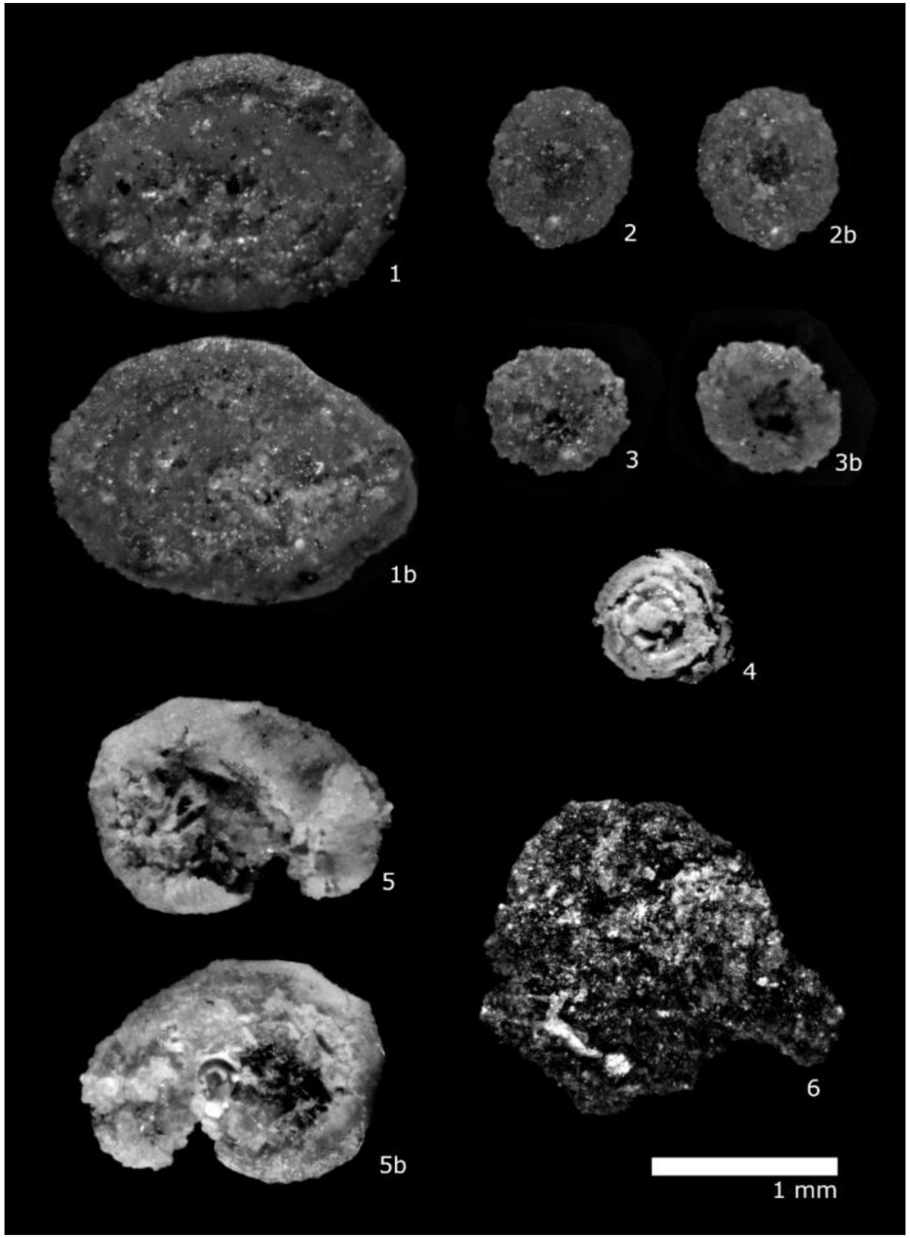

Plate 6 *Ammodiscus cretaceus* (1), *A. minimus* (2-3), *Glomospira* sp. (4-6).

6.3 class: Nodosariata

order: *Nodosariida*

family: *Nodosariidae* EHRENBERG

genus: *Laevidentalina* LOEBLICH & TAPPAN, 1986

Laevidentalina sp.

The genus *Laevidentalina* forms a uniserial elongated test with a pronounced curvature, the last chamber significantly rounded, calcareous, smooth, sometimes hyaline.
Plate 7, sample 1–3

genus: *Nodosaria* (*Dentalina*) D'ORBIGNY

Nodosaria vertebralis (BATSCH, 1791)

Nodosaria vertebralis forms a straight elongated uniserial test, the chambers gradually increase, the surface is significantly ribbed, hyaline, Cenomanian – present.
Plate 7, sample 9–12

Nodosaria sp.

The shape of the test shows a similar structure to others from the genus *Nodosaria*.
Plate 7, sample 7–8

genus: *Pyramidulina* FORNASINI, 1894

Pyramidulina sp.

The *genus Pyramidulina* forms a curved uniserial test, the chambers are distinguishable, weaker ribbing, calcareous walls.
Plate 7, sample 16–20

genus: *Frondicularia* DEFRANCE IN D'ORBIGNY

Frondicularia angulosa ORBIGNY

Frondicularia angulosa forms a flattened test, a pronounced oval proloculus, the chambers are wide, arrow-shaped, smooth calcareous walls.
Plate 8, sample 8–20

Frondicularia angusta (NILSSON, 1826)

Frondicularia angusta is characterized by a much more elongated and slender shell than other species, sutures sharply shaped into a "V", Turonian – Coniacian.
Plate 8, sample 1–4

Frondicularia goldfussi REUSS, 1860

Frondicularia goldfussi forms a test similar to a rhomboid with rounded walls. The sides touching the proloculus are shorter, sutures like a letter V, smooth calcareous walls, Cenomanian – Coniacian.
Plate 8, sample 7

Frondicularia cordai REUSS, 1844

Frondicularia cordai forms a flattened test, similar to *F. goldfussi*, but the tes is significantly more rounded, the suture passes into arches, the vacant lot significantly protrudes from the test, smooth calcareous walls, Coniacian.
Plate 8, sample 5–6

order: *Polymorphinida*

family: *Ellipsoidinidae* SILVESTRI
genus: *Ellipsoglandulina* SILVESTRI
Ellipsoglandulina sp.

The *genus Ellipsoglandulina* forms a shorter test, the last chamber is very distinct, occupying up to 2/3 of the total size, smooth calcareous.
Plate 7, sample 4-5

genus: *Nodosarella* RZEHAK
Nodosarella sp.

The genus *Nodosarella* forms spherical chambers, significantly inflated, pronounced sutures, uniserial, calcareous walls, finely perforated, smooth.
Plate 7, sample 6

Order: *Hormosinana*
family: *Reophacidae* CUSHMAN
genus: *Reophax* MONTFORT
Reophax sp.

The *genus Reophax* forms a uniserial test, the chambers quickly grow in size, a rough agglutinated surface.
Plate 7, sample 13–15

Order: *Vaginulinida*
family: *Vaginulinidae* REUSS
subfamily: *Lenticulininae* CHAPMAN, PARR & COLLINS
genus: *Lenticulina* LAMARCK
Lenticulina rotulata (LAMARCK, 1804)

Lenticulina rotulata has a planispiral arrangement of chambers, wide triangular to trapezoidal chambers, pronounced rounded sutures, calcareous hyaline walls, smooth surface, Turonian – to this day.
Plate 9, sample 1–5

Lenticulina sp.

Due to diversity, the genus *Lenticulina* could not be accurately classified into other species.
Plate 9, sample 6–14

subfamily: *Vaginulininae* REUSS
genus: *Vaginulina* D'ORBIGNY
Vaginulina sp.

The genus *Vaginulina* has a uniserial test, similar to the genus *Nodosaria*, but laterally flattened and more massive, wide chambers, pronounced sutures, calcareous wall, smooth.
Plate 10, sample 1–2

Plate 7 *Laevidentalina* sp. (1-3), *Ellipsoglandulina* sp. (4-5), *Nodosarella* sp. (6), *Nodosaria* sp. (7-8), *N. vertebralis* (9-12), *Reophax* sp. (13-15), *Pyramidulina* sp.(16-20).

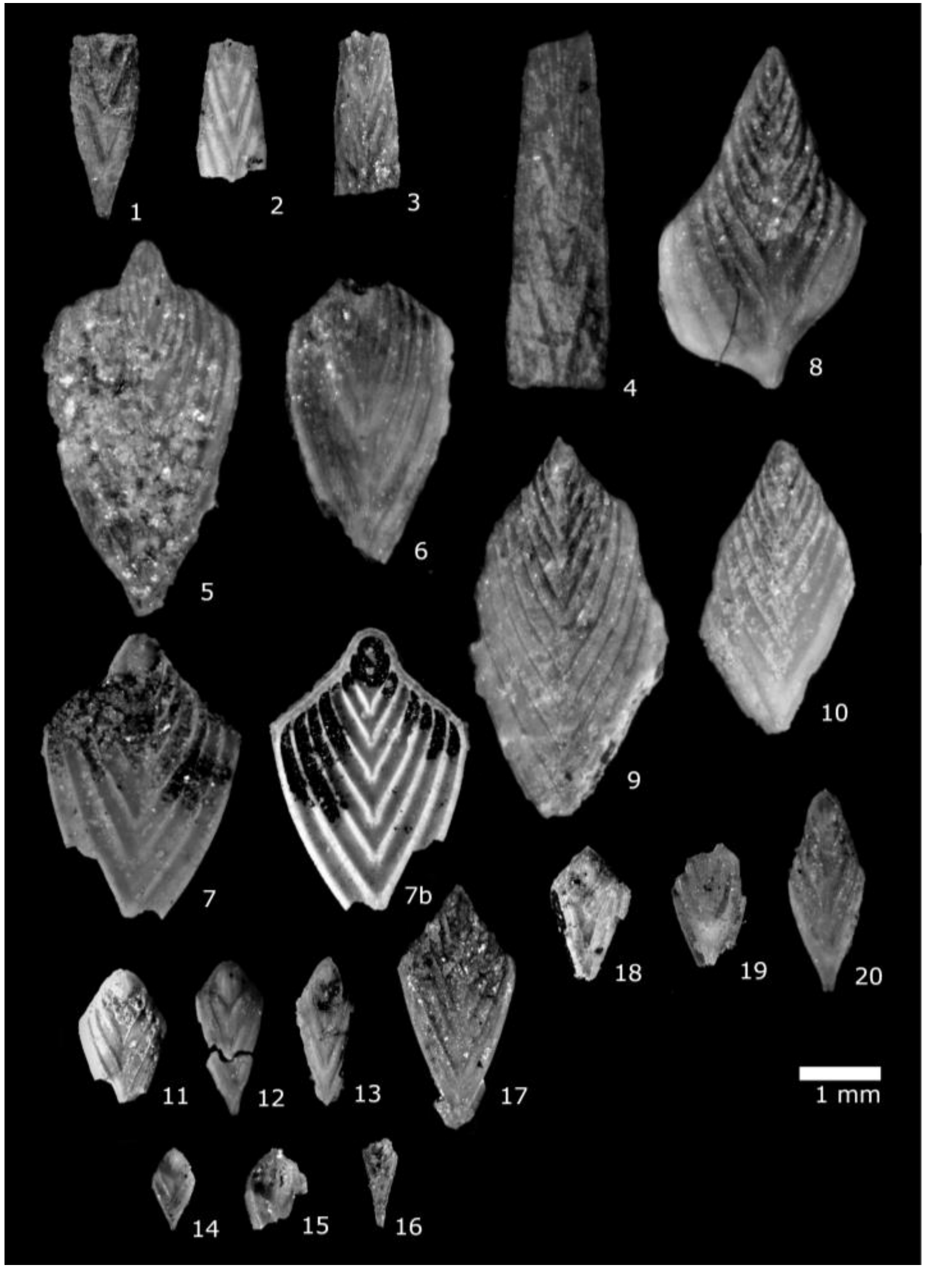

Plate 8 *Frondicularia angusta* (1-4), *F. cordai* (5-6), *F. goldfussi* (7), *F.* cf. *angulosa* (8-20).

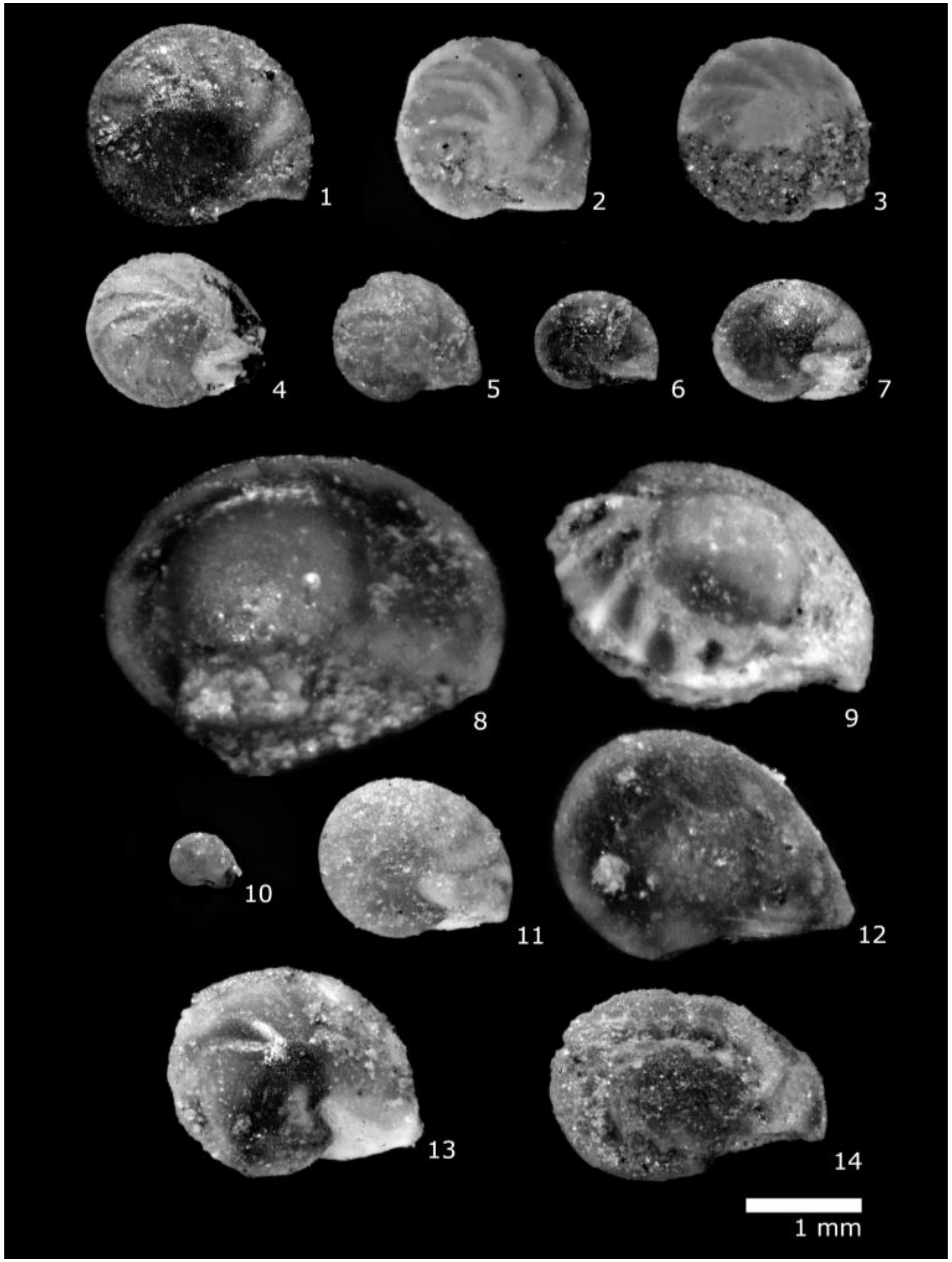

Plate 9 *Lenticulina rotulata* (1-5), *Lenticulina*. sp. (6-14).

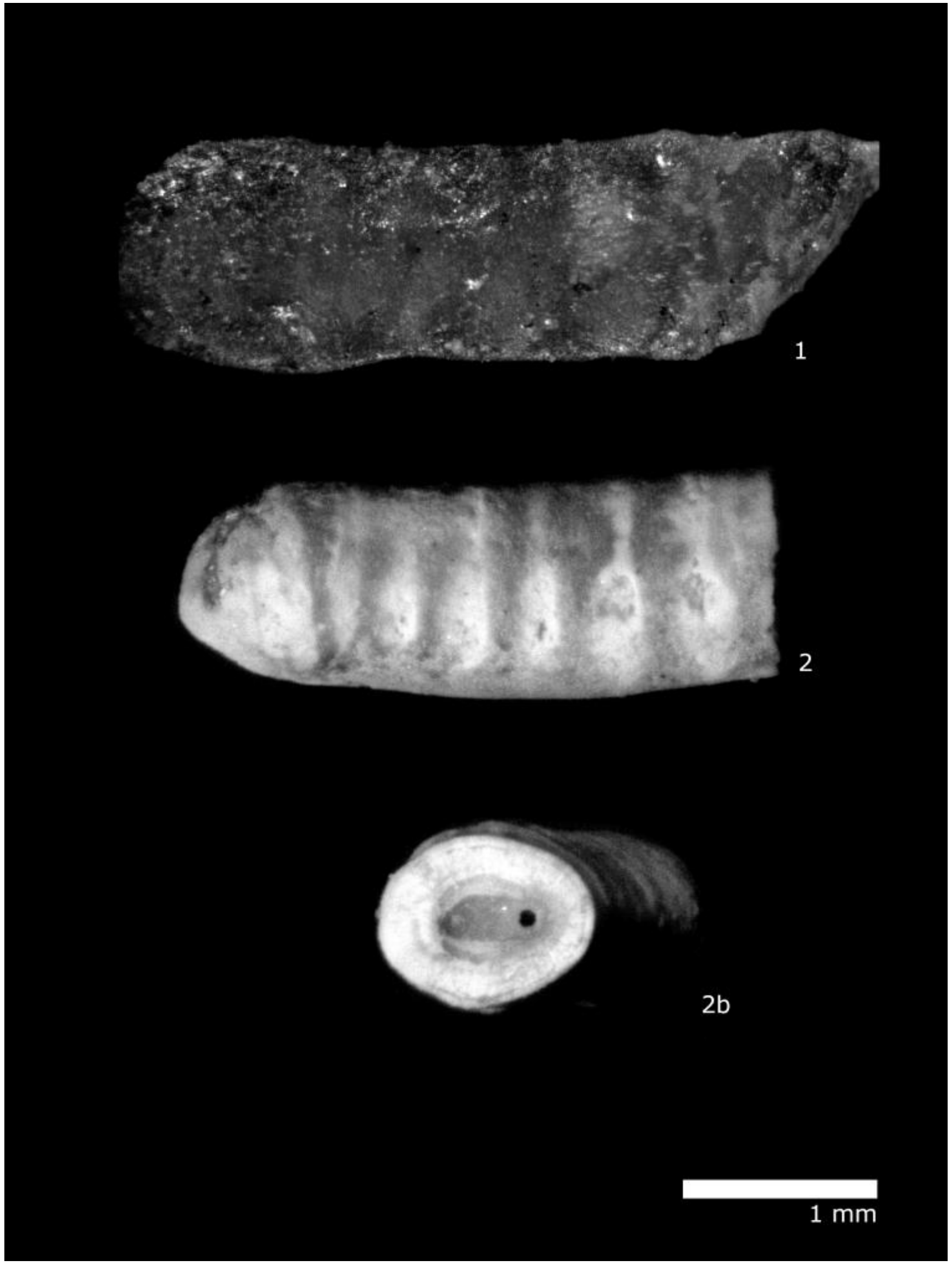

Plate 10 *Vaginulina* sp. (1-2, 2b view from above).

7 OTHER MICROFOSSILS

In addition to foraminifera, other groups of organisms have been found in the association of microfossils. These are sponge spicules, representatives of seashells, fragments of sea urchins, and teeth of vertebrates, which are included in the following tables. Juvenile gastropods, fragments of bivalves, and parts of plant bodies were also found.

7.1 Porifera

Several skeletal elements of sponges were also present in the filtrates. These are mostly spicules, which have already been described by Počta (1885). The spicules have reticular branching, so they are most likely to be classified as siliceous sponges - Plate 11.

7.2 Ostracoda

The microfossil association also includes a seed shrimp community. The overall shape is identifiable. I was not able to identify individual species yet - plate 12.

7.3 Echinoidea

There were a considerable number of fragments of sea urchins in the filtrates. Complete spines were not found; however, both their distal (pointed) and basal parts are represented in the fragments. The Plate 13, Figures 1-5 show the spine tips, Figures 6-11 their middle parts.
Figures 12-14 show the basal parts with a typical extension and the joint area through which the spine rests on the skeleton of the sea urchin. The sculpture is given by fine growths which form rows along the entire length of the spine.
In addition to the spines, it was also possible to identify skeletal plates with a characteristic warty surface (Table 13, Figures 15 and 16).

7.4 Chordata

Remains of fish-like vertebrates, especially teeth, were also found in the siltstone. It is possible to identify the teeth of a shark of the genus Cretolamna with a characteristic shape (Fig. 1, 1b).

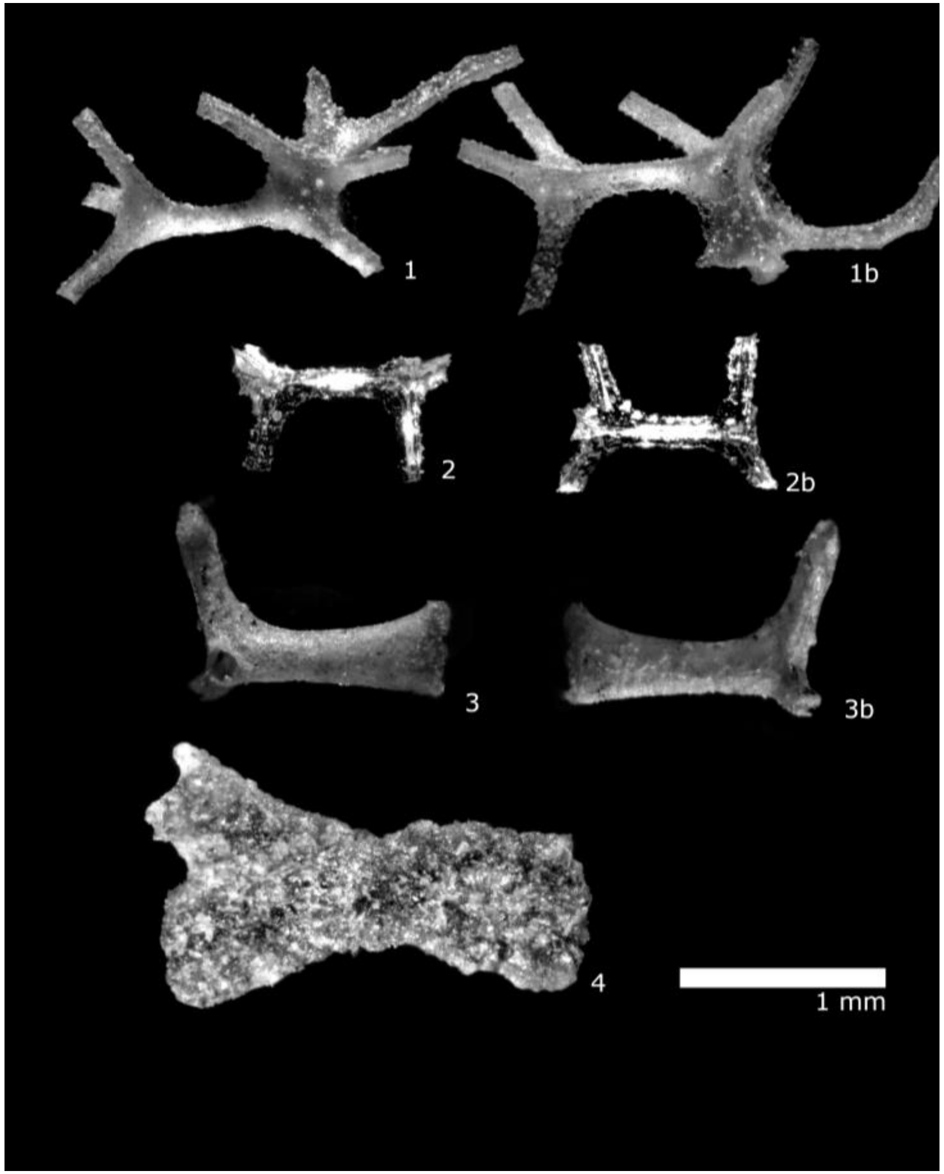

Plate 11 *Porifera*.

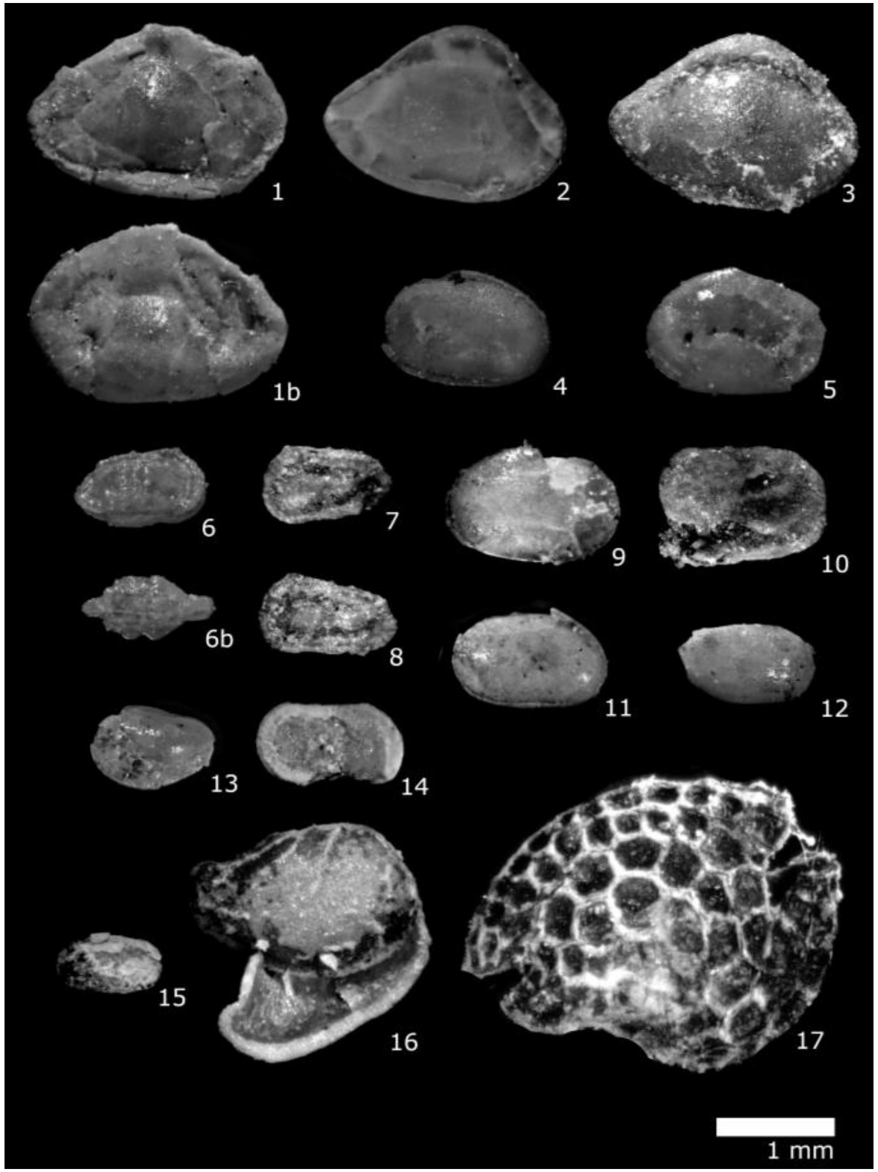

Plate 12 Different kinds of ostracods.

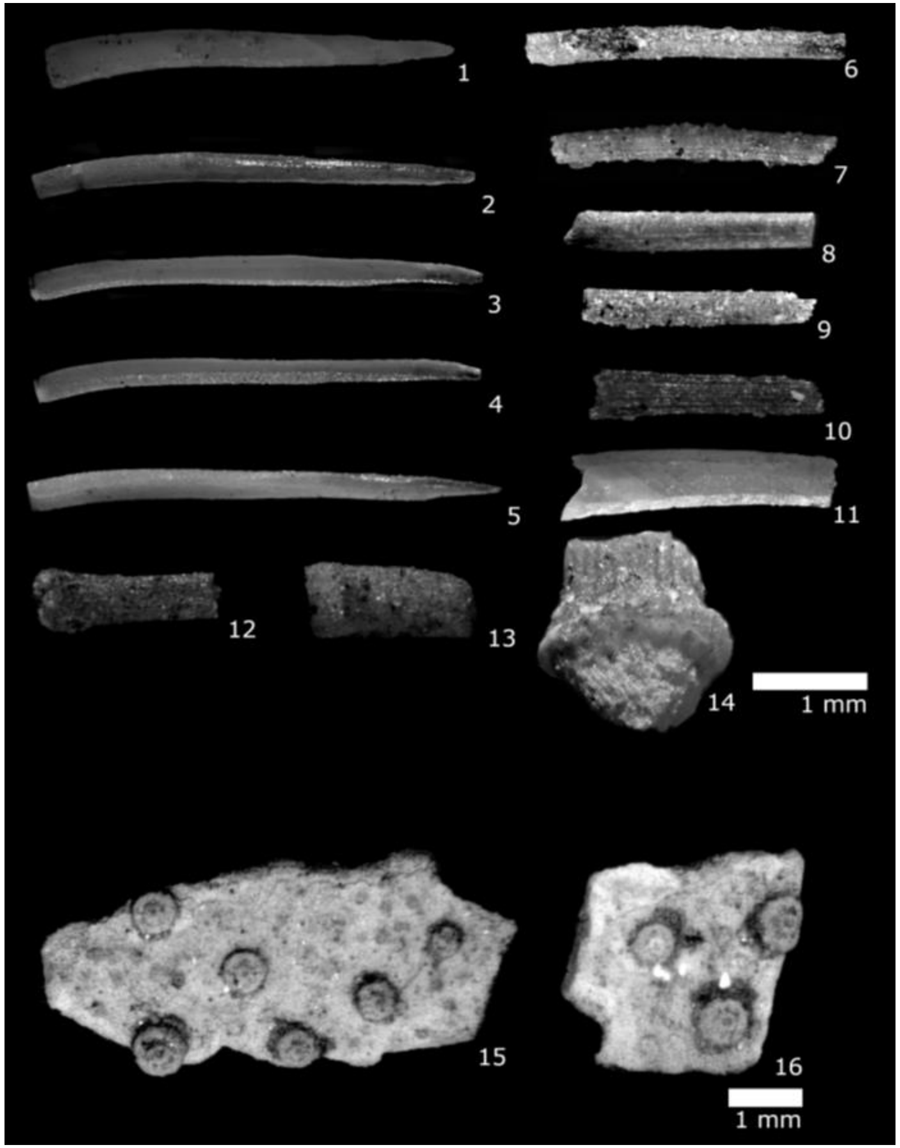

Plate 13 Spines (1-5), spine fragments (6-9), spine fragments with joints (10-14), skeletal plates (15-16).

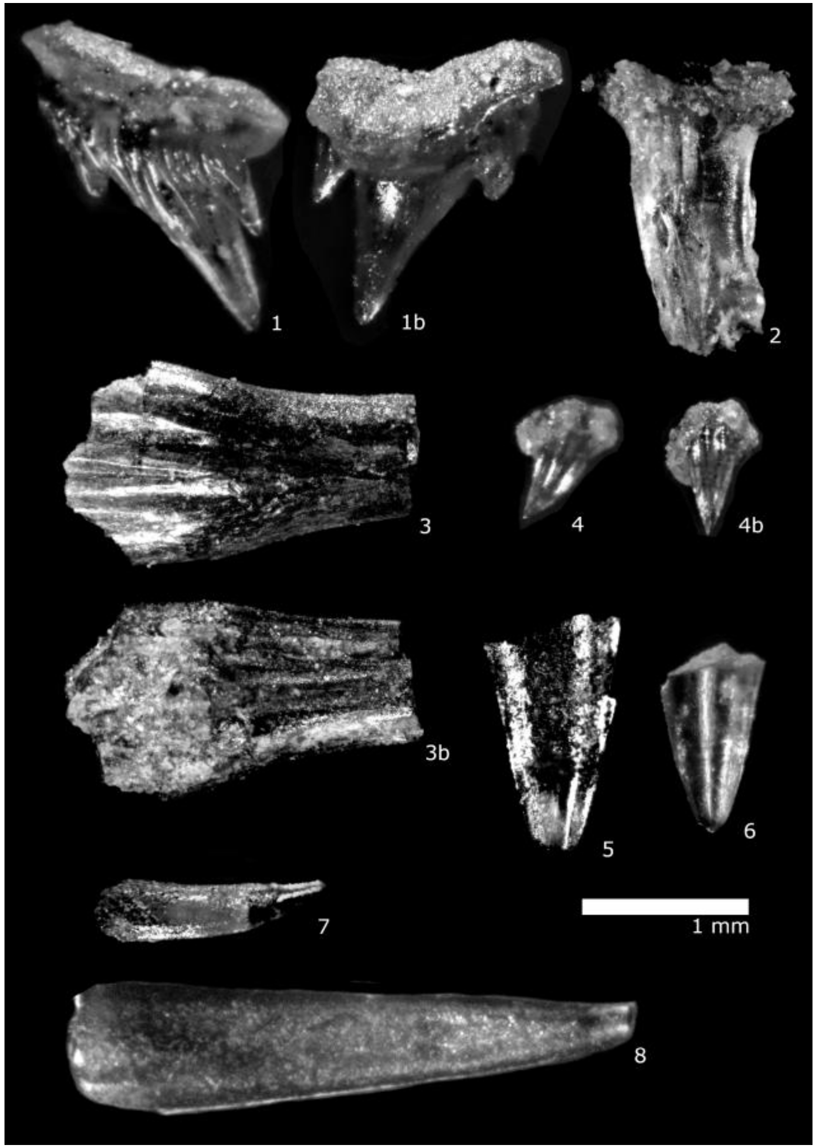

Plate 14 Various kinds of found teeth.

8 CONCLUSION[9]

The aim of the project was to study the Cretaceous fossil microfauna from the excavation of a former brickyard in the town of Štíty. Emphasis was placed on the field and subsequently on laboratory research of the site. The most important part of the thesis was the systematic and paleoecological processing of the collection of microfossils.

The geomorphological unit Nysa Kłodzko Graben forms in the territory of the Czech Republic the subunit Králíky Graben ending in Štíty Graben. According to previous paleontological research, the sediments in the vicinity of Štíty belong to Coniacian (89.8-86.3 Ma) and Bystrice lithofacial development.

My research builds on five previously published theses. The aim was to evaluate the condition of the site after the end of brick clay mining. The site is heavily overgrown with ruderal, forest-steppe, and wetland vegetation, making access to the specimens considerably more difficult.

During my research since 2018, I created a collection of fossils, which consists of macrofauna, flora, and ichnofauna. These fossils come from three types of rocks: siltstone, pelosiderite concretions, and sandstone. My recent collection is supplemented mainly by benthic and planktonic foraminifers, which I obtained through sieving the siltstone. It was confirmed that the specimens found are typical representatives of marine fauna belonging to the Upper Cretaceous Coniacian. The paleoecological characteristics of the environment correspond to a nutrient-rich shallow-water environment, occasionally disturbed by storm waves.

I mainly used my own diagnostic and documentation technology. I regularly took samples in the field and their initial analysis since June 2019, followed by the creation of a collection with a wide range of fossils. I continued with laboratory research, subsequent identification, and systematic processing of specimens.

To verify my research, I used expert consultations with:

RNDr. Tomáš Lehotský, Ph. D. from the Department of Geology, Faculty of Science, Palacký University in Olomouc, and the National History Museum in Olomouc;

RNDr. Zdeňk Gába from the Museum of National History in Šumperk;

RNDr. Miroslav Bubík, CSc. from the Czech Geological Survey.

In the following Table 7, I present an overview of micropaleontological findings from the published literature compared to my collection.

[9] JANDERKA Aleš. *Asociace fosilií z lokality Štíty: Bystřický litofaciální vývoj České křídové pánve.* Šumperk, 2020. Práce SOČ, 42. ročník. Gymnázium Šumperk. Vedoucí práce Lehotský, Tomáš.

Table 1 An overview of micropaleontological findings from the published literature compared to my collection.

Literature	My findings
Foraminifera	
Ammobaculites sp.	✓
Ammodiscus sp.	✓
Arenobulimina sp.	✓
Arenobulimina d´orbignyi REUSS	✓
Arenobulimina preslii REUSS	✓
×	*Archaeoglobigerina cretacea* D'ORBIGNY
×	*Ammodiscus cretaceus* REUSS
×	*Ammodiscus minimus* HOFKER
×	*Ellipsoglandulina* sp.
Frondicularia sp.	✓
Frondicularia goldfusi REUSS	✓
×	*Frondicularia angusta* NILSSON
×	*Frondicularia angulosa* ORBIGNY
×	*Frondicularia cordai* REUSS
Gaudryina bronii REUSS	✓
×	*Gavelinella* sp.
Globotruncana sp.	✓
Globotruncana linneiana D'ORBIGNY	✓
×	*Globotruncana bulloides* VOGLER
Globorotalites sp.	✓
Globorotalites Turonianicus KAEVER	?
×	*Globorotalites subconicus* MORROW
Glomospira sp.	✓
×	*Gyroidinoides nitidus* REUSS
×	*Gyroidinoides subconica* VASILENKO
Haplophragmoides sp.	✓
×	*Haplophragmoides bulloides* BEISSE
×	*Laevidentalina* sp.
Lenticulina sp.	✓
×	*Lenticulina rotulata* LAMARCK
Marginotruncana angusticarenata GANDOLFI	✓
Marginotruncana coronata BOLLI	✓
Marginotruncana marginata REUSS	✓
Marginulina bullata REUSS	×
Marsonella sp.	✓
Marsonella oxycona REUSS	✓
×	*Nodosarella* sp.
×	*Nodosaria vertebralis* BATSCH
Planoheterohelix globulosa EHRENBERG	✓
Plectina sp.	×
Pleurostomella bicornis REUSS	×
×	*Praebulimina* sp.
×	*Pyramidulina* sp.
Reophax cf. *minutus* LOEBLICH ET TAPPAN	?
✓	*Reophax* sp.
×	*Textularia* sp.
Trochammina sp.	×
Vaginulinopsis sp.	✓
×	*Vaginulina* sp.
Verneuilina muensteri REUSS	✓
Porifera	
?	Not determined yet.
Ostracoda	
Lithistida	Not determined yet.
Echinoidea	
Hemiaster of. *Regulusanus* D´ORBIGNY	?
Hemiaster cf. *lacunosus* GOLDFUSSI	?
Micraster cf. *breviporus* AGASSIZ	✓
Pisces	
Oxyrhina angustidens REUSS	Different kinds of teeth (*Cretolamna*)
Plantae	
Geinitzia reichenbachii	✓

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This study focuses on the collection of Cretaceous microfossil specimens from the former brickworks in Stity. The collection of fossils, which consists of macrofauna, flora, and ichnofauna. The fossils come from siltstone, pelosiderite concretions, and sandstone. This is a really hard work and good study.