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TRACES OF THE ACTIVITY OF BOTTOM ORGANISMS ON THE SHELLS OF THE JURASSIC OSTREIFORM PELECYPODS OF POLAND

Abstract. — Traces of the destructive activity of plants and animals, belonging to six species and tests of nine animals settled on pelecypod shells are described. The animals belong to the Foraminifera (two species), Annelida (five species) and Bryozoa (two species).

INTRODUCTION

During the studies on ostreiform pelecypods from the Jurassic of Poland, an abundant epifauna and traces of the destructive activity of plants and animals preserved in the form of canals and orifices varying in shape and size, were observed on their shells.

The material studied comes from the Mesozoic deposits of the margin of the Holy Cross Mountains, Western Pomerania (Czarnogłowy, Świętoszewo) environs of Kutno (Łęczyca), Radom (Wierzbica) and Tomaszów Mazowiecki (Brzostówka). It includes the deposits ranging from the Bajocian-Bathonian to the Lower Volgian inclusively.

Of the epifauna, the most numerous are the Annelida Polychaeta and Bryozoa. The latter are frequently preserved in the form of an impression of zoarium, on which only initial stages are visible as two tubes budding from a disclike ancestrula. The Foraminifera occur sporadically and are represented by few individuals. Two species identified represent two different families. The organisms which destroy shells of pelecypods are of the vegetal (Algae, Fungi) or animal (Sarcodina, Cirripedia, Pelecypoda) origin. Few destructions in the form of subsurface canals without outer apertures, were made during the animals' life time and most destructions with outer apertures — posthumously.

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Stratigrafical and facial conditions

Covering the stages between the Bajocian-Bathonian and the Lower Volgian inclusively, the ostreiform pelecypods have an extensive stratigraphic range. These formations are also marked by a considerable facial variability. The lowermost ones are developed in the form of gray, black or brown ore-bearing clays, intercalating thicker beds of brown-gray clayey limestones. These deposit abound in the ostreiform fauna which is, however, relatively monotonous. Few shells of *Liostrea* reveal traces of the destructive activity of cirripeds and tests of foraminifers are attached to some other shells of this genus.

The higher Jurassic horizons (Oxfordian and Kimeridgian), are developed in a similar, calcareous-marly and clayey facies. Ostreiform pelecypods occur in them in vast accumulations, frequently forming aleoctryonic beds (Holy Cross Mts.), or smaller, discontinuous lumachelle intercalations, in clayey marls or limestones which are frequently oölitic (Western Pomerania). In the deposits of these stages there occur numerous traces of the destructive activity of bottom organisms. Epifauna is also richly represented. The traces of boring organisms and organisms settled on the shells of ostreiform pelecypods belong to various groups of animals and plants. The last-named are represented by algae and fungi and the sessile organisms by the Foraminifera, Annelida-Polychaeta and Bryozoa.

The Lower Volgian deposits are developed mostly as clayey marls, gray clays with mica (environs of Tomaszów Mazowiecki) or oölitic and clayey marls and limestones (Western Pomerania). The shells of ostreiform pelecypods form, in these deposits, lumps of lumachelles and are the main component of the shell detritus. A rich but monotonous bryozoan epifauna and tubes of annelids, encrusting or filling valves, were identified in these deposits.

Palaeoecological conclusions

The traces of organisms boring the shells of ostreiform pelecypods may constitute an additional criterion characterizing environmental conditions, determining the depth of a water basin, its insolation, oxygen content and temperature.

For their processes of photosynthesis, algae, which bore canals in the valves of pelecypods, need sunlight and for this reason they may occur only in the basins whose depth does not exceed 200 m (Mägdefrau, 1937,

p. 64). It has also been found that the further the distance from the shore and the greater the depth of a water basin, the smaller becomes the percentage of shells with traces of the activity of algae. These observations also provide evidence that bored shells occur on its original bed and, therefore, are autochtonous in character, whereas an decreasing part of bored shells may testify under such conditions to their allochthonous character. This might be an additional index of the occurrence of strong bottom currents (Roger & Fatton, 1968, p. 17).

Of considerable importance seems, however, to be the determination of the vegetal origin of the traces of boring. This problem has not so far been ultimately solved (Mägdefrau, *l.c.*). As follows from the latest elaborations of this subject, both the size and trace of the borings might be a decisive criterion of the origin of these traces. Algae bore irregular canals with a large diameter, whereas traces left by fungi occur in the form of regular and symmetrically runing canals with usually considerably smaller transverse section (Roger & Fatton, *l.c.*, p. 20). On the basis of the traces of the vegetal origin, described in the present paper, algae should be responsible for the traces determined as *Calcideletrix flexuosa* (Mägdefrau), whereas regular canals determined as *Chaetophorites gomontoides* Pratje and *Ch. tenuis* Mägdefrau should be ascribed to fungi.

The traces of a boring pelecypod of the genus *Gastrochaena* Spengler may be an index of temperature. The studies have shown that this pelecypod bores canals in a chemical manner. Organisms of this type are very rarely met with in cold waters. In the material collected, *Gastrochaena* are known only from three cases and, therefore, the conclusion may be drawn that the water basin in which this genus lived, was probably marked by a relatively high temperature.

The examples cited above enable the determination of this water basin as not exceeding a depth of 200 m, well insolated and aerated, with strong currents and relatively high temperature. Such conditions are characteristic of a sublittoral zone and under such conditions oölites were formed abundantly occurring in deposites in which the ostreiform pelecypods are preserved as an additional index of the environmental conditions of a marine basin.

TRACES OF LIFE-TIME DESTRUCTIONS ON THE SHELLS OF PELECYPODS

Genus *Dictyoporus* Mägdefrau, 1937

Dictyoporus nodusus Mägdefrau, 1937

(Pl. I, Fig. 1)

1937. *Dictyoporus nodusus* Mägdefrau; K. Mägdefrau, Lebensspuren fosiller..., p. 55, Pl. 2, Fig. 10.

1962. *Dictyoporus nodosus* Mägdefrau; W. Häntzschel, Trace fossils..., p. 230, Fig. 144–5.

1965. *Dictyoporus nodosus* Mägdefrau; H. Pugaczewska, Les organismes sédentaires..., p. 75, Pl. 1, Fig. 1.

Material. — Few traces in the form of canals intersecting each other and forming a reticulum with meshes varying in size.

Description. — Traces of destruction found on a few shells of the ostreiform pelecypods occur in the form of subsurface canals variously intersecting each other and presenting themselves as a reticulum with meshes varying in size and shape. Canals are slightly extended at intersection points. Their very small transverse diameter amounts to 0.06–0.08 mm. They have no outer apertures and for this reason are believed to be formed during organism's life-time. These parasites might have penetrated to the pallial cavity between pallium fold and valve. With the growth of the organism they were subsequently covered with new layers of the shell, secreted by the pallial surface. These destructions are ascribed to the activity of the Sarcodina.

Occurrence. — The traces of this type are known from the rostra of the Cretaceous belemnites, from the shells of Recent pelecypods and brachiopods. The material described comes from the Lower Volgian of Brzostówka (environs of Tomaszów Mazowiecki) and was found on the shells of *Liostrea virguloides* (Lewiński, 1922).

TRACES OF POSTHUMOUS DESTRUCTIONS ON THE VALVES OF PELECYPODS

Genus *Calcideletrix* Mägdefrau, 1937
Calcideletrix flexuosa Mägdefrau, 1937
(Pl. I, Fig. 2; Pl. II, Fig. 2)

1937. *Calcideletrix flexuosa* Mägdefrau, K. Mägdefrau, Lebensspuren fossiler..., p. 57, Pl. 4, Fig. 4.
1962. *Calcidelatrix flexuosa* Mägdefrau; W. Häntzschel, Trace fossils..., p. 228, Fig. 142, 4.
1965. *Calcideletrix flexuosa* Mägdefrau; H. Pugaczewska, Les organismes sédentaires..., p. 76, Pl. 1, Fig. 3.

Material. — Few traces in the form of arborescently branched canals varying in thickness.

Description. — Destruction traces developed in the form of arborescently branched subsurface canals. Outer outlet round, about 0.15 mm in diameter, leading to the main canal and side branchings which are parallel to the outer surface of valve. The further the distance from the aperture, the narrower become the canals whose terminal branchings are 0.02 mm in diameter. In the process of fossilization, the canals are subject to secondary, sometimes considerable enlargement (Pl. II, Fig. 2). The destruction of this type is ascribed to the activity of algae or fungi. (Mägdefrau, 1937, p. 63).

Occurrence. — Known from the rostra of the Cretaceous belemnites of Germany (environs of Hannover) and Poland (Mielnik on the Bug). The specimens described occur on the valves of *Exogyra virgula*, Defrance, 1820 from the Lower Kimeridgian of Sobków and *Nanogyra nana* (Sowerby, 1822) from the Lower Kimeridgian of Gruszczyn (north-western margin of the Holy Cross Mts.).

Genus *Chaetophorites* Pratje, 1922
Chaetophorites gomontoides Pratje, 1922
(Pl. III, Fig. 12)

p. 58, Pl. 4, Fig. 7; Pl. 6, Figs. 1, 2, 5, 6.
1937. *Chaetophorites gomontoides* Pratje; K. Mägdefrau, Lebensspuren fossiler...,

Material. — Few traces preserved in the form of straight canals deviating laterally from the main canal.

Description. — Destruction traces in the form of subsurface canals parallel or oblique to the outer surface of shell. Outer aperture leading to the main canal from which short, lateral canals run frequently alternately. Diameter of canals uniform, amounting to about 0.16 mm over the entire length. Some of the branchings have a slightly larger transverse section which is caused by their being filled with calcite during fossilization. In the case under study, lateral canals deviate from the main one at a right angle. The cases are known, however, in which the angle they form with the main canal is more or less acute, mostly 45° (Mägdefrau, 1937, Pl. 6, Figs. 1, 5, 6). Desctructions on *Ch. gomontoides* are of a vegetal origin and are ascribed to the boring activity of algae.

Occurrence. — So far known from the rostra of the Liassic belemnites and shells of pelecypods of Western Germany (Erlangen, Baden, Neumarkt, Hirschau). The specimen described here was found on a shell of *Nanogyra nana* (Sowerby, 1822) from the Lower Kimeridgian of Wierzbica (environs of Radom).

Chaetophorites tenuis Mägdefrau, 1937
(Pl. II, Fig. 4)

1937. *Chaetophorites tenuis* Mägdefrau; K. Mägdefrau, Lebensspuren fossiler..., p. 60, Pl. 6, Fig. 8.

Material. — Numerous traces of boring organisms in the form of fine, interrupted main and lateral canals.

Description. — Boring canals with a characteristic trace. The main canal and lateral canals which deviate from it at an angle of about 60° have a very small transverse section amounting to 2 to 5 microns. Lateral canals appear simultaneously subsequently continuing as straight, single branchings running for a certain distance. The main canal produces lateral branchings at certain, constant intervals usually amounting to 0.3 mm. Sometimes, distances between lateral canals are larger but usually uniform on one and the same main canal. The deepening of canals is the next stage of their development. The process of penetrating inside the shell starts in fine, subsurface canals. It takes place simultaneously in three canals at certain, definite intervals. As a result, the main canal and lateral ones become much thicker and their trace interrupted. A very complex picture results from a mass appearance of similar small canals in the limited area of a pelecypod's shell and from an varying trace of these canals. Stellate notches caused by intersections of too canals running in opposite directions occur frequently. The interpretation of a manner of branching the main canals and of their trace has so far encountered considerable difficulties (Mägdefrau, *l.c.*, p. 60.). Their occurrence is ascribed to the activity of algae.

Occurrence. — Known from rostra of belemnites and shells of pelecypods of the Jurassic and Cretaceous of Germany. In Poland, they occur on many shells of pelecypods of the genus *Exogyra* from the Lower Kimeridgian of the margin of the Holy Cross Mountains.

Genus *Simonizapfes* Codez, 1957

Simonizapfes elongata Codez, 1957

(Pl. II, Fig. 1; Pl. III, Fig. 8)

1954. *Zapfella patei* Saint-Seine; R. Saint-Seine, Existence de Cirripèdes..., p. 447–449, Pl. 20, Figs. 1, 5.
1957. *Simonizapfes elongata* Codez; J. Codez, Révision des Cirripèdes acrothoraciques fossiles..., p. 705, Pl. 37, Figs. 2–4.
1962. *Simonizapfes* Codez; W. Häntzschel, Trace fossils..., p. 231.

Material. — Abundant traces of boring preserved in the form of oval orifices on many valves of the Ostreidae.

Description. — Elongate orifices usually contracted conspicuously on one side, defined as an anterior side and rounded on the other, that is, posterior side. The length of orifices on the valve described varies within limits of 0.4 and 1.5 mm and their width 0.2 and 0.8 mm resp. The largest depth amounts to 1.5 mm. This hollow is shaped like a bent tube which turns anteriorly under the surface of shell after reaching a definite depth. In the case under study, the largest depth of the chamber bored amounts to about 2 mm. As follows from literature the largest length of a surface outlet may reach 2.3 mm with the width coming to 0.6 mm. The length of chamber fluctuates within limits of 2 and 4.5 mm its width — 0.5–1.0 mm. (Codez, 1957, p. 705). These traces are interpreted as borings of cirripeds.

Occurrence. — The borings described were found on a shells of *Nanogyra nana* (Sowerby, 1822) from the Lower Kimeridgian of Gruszczyn (north-western margin of the Holy Cross Mts.). Similar destructions, known from the Sinemurian to the Portlandian inclusively, occur on the rostra of the Jurassic belemnites, on the shells of the Ostreidae and other pelecypods and gastropods, on the skeletons of crinoids and corals from France and England. As follows from literature, they are common, but so far they have never been found in the Kimeridgian. In the Portlandian they have been discovered on one only specimen of *Ostrea expansa* in Charente-Maritime (Codez, 1957, p. 706).

Family **Gastrochaenidae** Gray, 1840
Genus *Gastrochaena* Spengler, 1783
(Pl. II, Figs. 3*a*, *b*; Pl. III, Figs. 5, 7)

1952. *Gastrochaena* Spengler; C. Dechaseaux, Classe des Lamellibranches..., p. 313.
1965. *Gastrochaena* sp. Spengler; A. Radwański, Addit. Notes on Miocene . . . , p. 171, Pl. 2, Figs. 3–6.
1968. *Gastrochaena* Spengler; J. Roger & E. Fatton, Les organismes perforants..., p. 37.

Material. — Few traces of boring in the form of orifices and canals varying in length.

Description. — The borings preserved have the form of a canal open at both ends. The larger, inlet orifice is oval or round in outline and 3.2 mm in diameter, the smaller, 8-shaped, with a longer diameter equalling 1.8 mm and shorter — 1 mm. The canal has smooth walls and in only one case part of the tube produced by the pelecypod and a transverse septum separating siphons are preserved (Pl. II, Fig. 3*a*). The canal is short, in the case under study its length amounts to 4.5 mm. The body chamber is not preserved; it probably remained in the substratum to which the bored valve was attached. Similar chambers were swollen in a macelike manner in its initial part in which shells were preserved of the genus *Gastrochaena* (Radwański, 1966, Pl. 2, Figs. 3–6). Boring pelecypods of this genus had a capability of dissolving chemically the calcareous substance of a shell or rock which served as their habitat. Figs. 5, 7 in Pl. III present initial stages of the boring activity of *Gastrochaena*.

Occurrence. — Known from the Jurassic to the Recent from many traces on the valves of different pelecypods, as well as on corals and the Miocene erratic pebbles of Chełmek (environs of Cracow), Korytnica, Wymysłów, etc. The traces described were also found on valves of *Nanogyra nana* (Sowerby, 1822) from the Lower Kimeridgian of Gruszczyn (north-western margin of the Holy Cross Mts.) and of *Liostrea delta* (Smith, 1817) from the Lower Kimeridgian of Czarnogłowy (Western Pomerania).

EPIFAUNA

FORAMINIFERA

Family **Polymorphinidae** d'Orbigny, 1839
Subfamily **Webbinellinae** Rhumbler, 1904
Genus *Bullopora* Quenstedt, 1856
Bullopora rostrata Quenstedt, 1858
(Pl. III, Figs. 1, 2)

1858. *Bullopora rostrata* Quenstedt; Fr. A. Quenstedt, Der Jura, p. 580, Pl. 73, Fig. 28.
1962. *Bullopora rostrata* Quenstedt; C. G. Adams, Calcareous adherent..., p. 157, Pl. 24, Fig. 4.
1964. *Bullopora rostrata* Quenstedt; A. R. Loeblich, Jr. & H. Tappan, Sarcodina chiefly "Thecamoebians"..., p. C. 535, Fig. 420, 1*a–d*.
1965. *Bullopora rostrata* Quenstedt; H. Pugaczewska, Les organismes sédentaires..., p. 79. Pl. 3, Fig. 1*a–b*.

Material. — Two specimens preserved on valves of ostreiform pelecypods, one of them in the form of a limonitized inner mould.

Description. — Test consisting of uniserial chambers with a smooth outer surface and oval in shape. Chambers, disposed rectilinearly or along an arcuate line, connected with each other by short, tubular necks. They rapidly increase in size with the growth of the test. The first of the seven chambers preserved is about 0.3 mm in transverse diameter and more globular, while the same diameter of the last chamber increases to about 0.6 mm and, at the same time, this chamber elongates increasing its longitudinal diameter to 1.1 mm. The necks which connect chambers, at first short (0.1 mm), elongate to reach 0.3 mm near the last chamber. As shown by studies, a rapid increase in the size of chambers is a character of microspherical forms, while in macrospheric ones, chambers increase only slightly with the growth of the test or their size even does not change at all (Loeblich & Tappan, 1964, p. 535).

Occurrence. — Germany: on the rostra of belemnites from the Lower Jurassic to the Malm inclusively. In Poland, this species was described (Pugaczewska, 1961, 1965) from the Bathonian of Trzebionka (Chrzanów District), also from the rostra of belemnites, from the Callovian of Wrzosowa (Częstochowa District) and from the Upper Cretaceous of the environs of Mielnik on the Bug. The material here described comes from the ore-bearing beds of Łęczyca (Kutno District) where it was found on a shell of *Catinula knorri* (Voltz, 1828) and *Exogyra virgula* (Defrance, 1820) from the Lower Kimeridgian of Wierzbica (near Radom).

Family **Nubeculariidae** Jones, 1875
Subfamily **Nubeculariinae** Jones, 1875
Genus *Nubeculinella* Cushman, 1930
Nubeculinella bigoti Cushman, 1930

(Pl. I, Fig. 3; Pl. III, Fig. 3)

1962. *Nubeculinella bigoti* Cushman; C. G. Adams, Calcareous adherent..., p. 162–163, Pl. 22, Figs. 1–7.
1964. *Nubeculinella bigoti* Cushman; A. R. Loeblich Jr. & H. Tappan, Sarcodina chiefly "Thecamoebians"..., p. 447, Figs. 339, 1, 2.

Material. — Numerous tests of a many chambered foraminifer attached to shells of ostreiform pelecypods.

Description. — Test consisting of several uniserial chambers closely adhering to each other. Chamber height, somewhat larger than width, amounts, in the youngest chamber preserved, to about 0.2 mm and in the oldest to 0.4 mm. Chambers outlined like irregularly square vesicles, slightly higher near an S-shaped lateral wall of test. Test sometimes semicircular, more frequently S-shaped. Its surface is smooth, sutures between chembers being only slightly concave. With the growth of valve, chamber height increases relatively insignificantly, that is over a strech covered by 20 chambers the height increased only twofold. As follows from literature, the proloculus is surrounded by the first and subsequently second chamber over a space of between a half and one and a half of a whorl. The second chamber elongates and continues growing rectilinearly. In many cases, the test may grow outside the substratum (Loeblich & Tappan, 1964, p. 447). A specimen shown in Pl. III, Fig. 3 has a destroyed outer wall which allows one to see thick inner septa separating the chambers.

Occurrence. — A species known from the Upper Jurassic deposits of Europe. In France, it occurs in the Oxfordian. In Poland, it is known from the valves of *Exogyra virgula* (Defrance, 1820) from the Lower Kimeridgian of Sobków (south-western margin of the Holy Cross Mts.).

ANNELIDA

Family **Serpulidae** Bermeister, 1837
Subfamily **Filograninae** Rioja, 1923
Genus *Sarcinella* Regenhardt, 1961
Sarcinella sarcinella Regenhardt, 1961

(Pl. III, Fig. 4)

1961. *Sarcinella sarcinella* Regenhardt; H. Regenhardt, Serpulidae (*Polychaeta sedentaria*)..., p. 29, Pl. 1, Fig. 6.

Material. — Very numerous specimens attached to shells and filling all spaces between them; occurring in a mass.

Description. — Tubes occurring in bunches clustered together more or less closely, but never cemented with each other. They are round in transverse section which reaches 1.5 mm. Diameter of inner canal about 0.8 mm. Tube surface devoid of ornamentation. In the bunch described, tubes reach about 3 cm in length, their number exceeding 70. They are usually rectilinear, only some of them are S-shaped or form loosely twisted whorls. This species resembles two others, that is, *S. socialis* and *S. filosa,* in a similar trace of smooth tubes and differ from them in smaller dimensions of transverse sections.

Occurrence. — Known from the Upper Cretaceous (Coniacian) of the environs of Villedieu in France. Polish specimens come from the Lower Volgian of the environs of Tomaszów Mazowiecki (Brzostówka) from the shells of *Exogyra michalskii* Lewiński, 1922 and *Ex. decipiens* Lewiński, 1922.

Genus *Glomerula* Nielsen, 1931
Glomerula gordialis (Schlotheim, 1820)
(Pl. III, Fig. 10)

1965. *Serpula (Cycloserpula) gordialis* (Schlotheim, 1820); H. Pugaczewska, Les organismes sédentaires..., p. 82, Pl. 6, Fig. 1*a–b*.
1961. *Glomerula gordialis* (Schlotheim, 1820); H. Regenhardt, Serpulidae (Polychaeta sedentaria)..., p. 26, Pl. 1, Fig. 2.
1967. *Glomerula gordialis* (Schlotheim, 1820); H. Pugaczewska, Serpulidae from..., p. 180, Pl. I, Figs. 5–10; Pl. 2, Fig. 4; Pl. 3, Fig. 1. (vide synonymy).

Material. — Numerous, variously twisted tubes, attached to valves of various genera of ostreiform pelecypods.

Description. — Tubes single, long, with a outer surface, varying in thickness with the growth between 0.2 and 1.0 mm. In the case under study, the transverse section of the canal of tube measures 0.7 mm. Tubes are variously twisted. Younger stages have a rectilinear or meandering trace older are represented by bundle-like or trochospiral forms. Particular whorls of a bundle-like tube are loose and are neither cemented with pelecypod shells, or fused with each other.

Occurrence. — Common from the Lias through the Danian, they occur on various shells and other skeletal forms. In Poland they were recorded in a Dano-Montian boring at Boryszew. Recently, found by the present writer on valves of *Exogyra reniformis* Goldfuss, 1834 from the Lower Kimeridgian of Czarnogłowy (Western Pomerania), and on valves of *Liostrea explanata* (Goldfuss, 1834) from deposits transitional from the Bajocian to the Bathonian of Łęczyca (Kutno District).

Subfamily **Serpulinae** Rioja, 1923
Genus *Serpula* Linnè, 1758
Subgenus *Tetraserpula* Parsch, 1956
Serpula (Tetraserpula) tetragona Sowerby, 1829

(Pl. III, Fig. 9)

1956. *Serpula (Tetraserpula) tetragona* Sowerby; K. Parsch, Die Serpulidenfauna..., p. 223, Pl. 21, Fig. 14.

Material. — Many straight or variously bent tubes, cemented to shells of ostreiform pelecypods, sometimes loose in their terminal part. Frequently filling the inside of valves. Mass occurrence.

Description. — Tubes varying in length, rectangular, in transverse section measuring 1.7 mm, cemented to the shell. Tube canal slightly smaller in diameter which amounts to 1.3 mm. Four, symmetrically distributed, rounded keels run along the tube, separated by more or less deep furrows. In the place of occurrence of keels, tube wall is twice as thick. Fine, concentrical growth lines and irregularly spaced transverse folds are visible on the surface of tube. These folds form swellings on keels and are separated by narrow grooves. On some specimens, a double ring is formed probably in the vicinity of tube aperture. Terminal ring has a somewhat smaller diameter amounting to 1.5 mm. In some cases, tubes are cemented with each other in their initial part which is indicated by a single wall separating them. With the growth, tubes detach themselves, adding a lacking wall and continuing their further growth independently. Transverse section of the tubes fluctuates within limits of 1 and 2.5 mm. Sometimes longitudinal furrows become shallower or may even disappear at all (Parsch, 1956, p. 224).

Occurrence. — Known from the spongy facies from the Dogger through Malm of Western Germany. In Poland, they occur abundantly in the Bajocian-Bathonian ore-bearing clays of Łęczyca, where they are frequently cemented to valves of *Liostrea acuminata* (Sowerby, 1816).

Serpula (Tetraserpula) quinquangularis Goldfuss, 1831

(Pl. II, Fig. 7; Pl. III, Fig. 6)

1831. *Serpula quinquangularis* Goldfuss; A. Goldfuss, Petrefecta Germaniae p. 230, Pl. 68, Fig. 8*a–c*.
1956. *Serpula (Tetraserpula) quinquangularis* Goldfuss; K. Parsch, Die Serpulidenfauna..., p. 224, Pl. 19, Fig. 9; Pl. 20, Fig. 13; Pl. 21, Fig. 25.

Material. — Few tubes cemented to shells of ostreiform pelecypods.

Description. — Tubes cemented with their entire bottom surface and with the growth changing their thickness from 0.2 to 2.2 mm. Transverse section of tube canal amounts to 1.5 mm. A bilaterally flattened testaceous layer, increasing tube diameter to 3 mm, is formed at the base. Outer surface of tube uneven. Fine, undulating growth lines, disappearing with age, are visible in its younger parts. A dorsal middle keel with an undulated crest runs along the tube. Below, lateral keels are developed with a smooth outer surface. Tubes of this species frequently forms many whorls, variously bent and overgrowing younger parts of the tube (Pl. II, Fig. 7).

Occurrence. — A species known from the Kimeridgian clays of France and from the Dogger through the Malm of North-western Germany. In Poland, it was found in the Lower Kimeridgian marly deposits of Czarnogłowy (Western Pomerania) where it occurs on valves of *Nanogyra nana* (Sowerby, 1822).

Serpula (Tetraserpula) quadrilatera Goldfuss, 1831
(Pl. II, Fig. 6)

1831. *Serpula quadrilatera* Goldfuss, A. Goldfuss, Petrefacta Germaniae, p. 230, Pl. 68, Fig. 9*a–c*.

1956. *Serpula (Tetraserpula) quadrilatera* Goldfuss;; K. Parsch, Die Serpulidenfauna..., p. 224, Pl. 19, Fig. 11; Pl. 21, Fig. 13.

Material. — A specimen attached to a right valve of *Nanogyra nana* and a few other on valves of *Liostrea delta.*

Description. — Tubes cemented with their entire, bilaterally extended wall. Transverse diameter of a tube amounting to 4 mm and that of its inner canal — to 2 mm. Tube surface uneven, strongly weathered and, consequently, with distinct laminae of the outer parabolic layer. Dorsal keel not very high, with a straight, nonfolded trace, visible only in early growth stages. In later stages, it frequently disappears. Dorsal side flattened. Sometimes, a longitudinal, wide furrow is formed in this place. Bilaterally longitudinal keels with a smooth surface occur on the ventrolateral surface of the tube. Transverse section of the tube, rectangular in younger stages takes a pentagonal shape in older — ones as a result of the disappearance of the dorsal keel. Shape of tube varying, mostly twisted to form a flat spiral.

Occurrence. — Doggerian ferruginous deposits and Dogger through Malmian where it is recorded from the spongy facies of South-western Germany (Walkererde). In Poland, it was found on a specimen of *Nanogyra nana* (Sowerby, 1822), from the Lower Kimeridgian deposits of Czarnogłowy (Western Pomerania) and on many valves of *Liostrea delta* (Smith, 1817) from these same beds and the same locality.

BRYOZOA

Order **Cyclostomata** Busk, 1852
Family **Diastoporidae** Gregory, 1899
Genus *Stomatopora* Bronn, 1825
Stomatopora dichotoma (Lamouroux, 1821)
(Pl. I, Fig. 6)

1939–40. *Stomatopora dichotoma* Lamouroux; M. Orieux, Étude de quelques..., p. 3–13, Pl. 1, Figs. 1–4; Pl. 2, Figs. 1–4; Pl. 3, Fig. 1–6; Pl. 4, Figs. 1–6.
1953. *Stomatophora dichotoma* (Lamx); R. Bassler, Bryozoa, p. 43, Figs. 14, 1.
1965. *Stomatophora dichotoma* (Lamouroux); H. Pugaczewska, Les organismes sédentaires..., p. 85, Pl. 8, Fig. 2.

Material. — A few complete zoaria and some single branches.

Description. — A dichotomous zoarium about 11 mm in diameter. Particular branches diverge at a certain angle, forming a polygonal system. Diameter of zoecial tubes, increasing with individual age, fluctuates between 0.2 and 0.3 mm. A rounded aperture 0.09 mm in diameter usually occurs at the base of newly branched tubes. Near aperture, the zoecial tube slightly thicknes and rises. Aperture surrounded by a thickened ring. Zoecia varying in length between 0.4 and 0.7 mm. Surface of zoecia smooth, with fine, concentric growth lines visible sometimes.

Occurrence. — A species known from the Lower Lias and described from the rostra of belemnites, tests of echinoids and shells of brachiopods of England, France and Poland. The specimen described was found on a shell of *Alectryonia gregarea* (Sowerby, 1816) from the Lower Kimeridgian of Wierzbica near Radom.

Genus *Berenicea* Lamouroux, 1821
Berenicea parvitubulata Gregory, 1896
(Pl. I, Figs. 4, 5; Pl. III, Fig. 11)

1969. *Berenicea parvitubulata* Gregory; L. J. Pitt & H. D. Thomas. The Polyzoa of some..., p. 35, Pl. 1, Fig. 2; Pl. 2, Figs. 1–3; Pl. 3, Fig. 2.

Material. — A few fully developed zoaria and some impressions of destroyed zoecia.

Description. — Zoarium attaching to the shell disclike or fanlike in shape, with conspicuous initial stages. Zoarium diameter varying from 2 to 8.5 mm. Creeping zoecia closely adhere to each other, while those growing in them more or less stick out in terminal parts of a colony. Zoecial tubes cylindrical, with an unevenly convex upper wall devoid of sculpture. Insignificantly increasing with age, their thickness amounts to about 0.15 mm and length varies between 0.3 and 0.7 mm. Aperture round, about

0.06 mm in diameter. Incipient stages of a colony in the form of a disclike ancestrula about 0.03 mm in diameter and two budding zoecial tubes slightly larger in transverse diameter (Pl. I, Figs. 4, 5) are visible on the destroyed zoarium.

Occurrence. — A species known from the Cornbrash deposits of England (Rushden, Northamptonshire). In Poland, zoaria of this species were found on valves of *Ex. virgula* (Defrance, 1820) from the Lower Kimeridgian of Sobków (North-western margin of the Holy Cross Mts.), as well as on a valve of *Exogyra michalskii* Lewiński, 1922, from the Lower Volgian of Brzozówka near Tomaszów Mazowiecki.

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HALINA PUGACZEWSKA

ŚLADY DZIAŁALNOŚCI ORGANIZMÓW DENNYCH NA SKORUPKACH MAŁŻÓW OSTRYGOWATYCH Z JURY POLSKI

Streszczenie

W pracy opisano 15 organizmów, w tym 6 niszczących skorupki ostryg oraz 9 przytwierdzających się do nich. Materiał pochodzi z utworów jurajskich Polski i występuje głównie w iłach rudonośnych bajosu-batonu Łęczycy (pow. Kutno), oraz w marglach i wapieniach dolno-kimerydzkich obrzeżenia Gór Świętokrzyskich i Pomorza Zachodniego.

Ślady niszczącej działalności organizmów dennych wykształcone w postaci kanalików i komór można podzielić na przyżyciowe i pośmiertne. Pierwsze z nich charakteryzują się brakiem ujść na zewnątrz, drugie zaopatrzone są w otworki zewnętrzne. Przypisuje się ich powstanie działalności zarówno roślin (algi, grzyby) jak i zwierząt (pierwotniaki, wąsonogi, małże).

Organizmy przytwierdzające się do muszli ostryg należą do Foraminifera, Annelida (Polychaeta) i Bryozoa. Z otwornic opisano *Bullopora rostrata* Quenstedt i *Nubeculinella bigoti* Cushman. Annelida reprezentowane są przez 5 gatunków: *Sarcinella sarcinella* Regenhardt, *Glomerula gordialis* (Schlotheim), *Serpula (Tetraserpula) tetragona* Sowerby, *Serpula (Tetraserpula) quinquangularis* Goldfuss, *Serpula (Tetraserpula) quadrilatera* Goldfuss. Z mszywiołów oznaczono 2 gatunki: *Berenicea parvitubulata* Gregory i *Stomatopora dichotoma* (Lamouroux).

ГАЛИНА ПУГАЧЕВСКА

СЛЕДЫ ЖИЗНЕДЕЯТЕЛЬНОСТИ ДОННЫХ ОРГАНИЗМОВ НА СТВОРКАХ УСТРИЦ ИЗ ЮРЫ ПОЛЬШИ

Резюме

В работе описано 15 организмов, в том числе 6 разрушающих створки устриц и 9 прикрепляющихся к ним. Материал был собран из юрских отложений Польши, прежде всего из рудоносных глин байосо-батского возраста окрестности Лэнчицы (повят Кутно), а также из мергелей и известняков нижнекимериджского возраста мезозойского обрамления Свентокшиских Гор и западного Поморья.

Следы деструктивной деятельности донных организмов, выраженные в форме ходов, можно разделить на прижизненные и посмертные. Первые характеризуются отсутствием наружных отверстий, у вторых отверстия имеются. Возникновение этих следов объясняется деятельностью растений ,водоросли, грибы) или животных (Sarcodina, Cirripedia, Pelecypoda).

Организмы, прикрепляющиеся к створкам устриц, принадлежат к Foraminifera, Annelida (Polychaeta) и Bryozoa. Из фораминифер описаны *Bullopora rostrata* Quenstedt и *Nubeculinella bigoti* Cushman. Кольчатые черви представлены 5 видами: *Sarcinella sarcinella* Regenhardt, *Glomerula gordialis* (Schlotheim), *Serpula (Tetraserpula) tetragona* Sowerby, *Serpula (Tetraserpula) quinquangularis* Goldfuss, *Serpula (Tetraserpula) quadrilatera* Goldfuss. Из мшанок определены два вида: *Berenicea paryitubulata* Gregory и *Stomatopora dichotoma* (Lamouroux).

PLATES

Plate I

Fig. 1. *Dictyoporus nodusus* Mägdefrau; traces of destruction in the form of irregularly intersecting canals on a valve of *Liostrea virguloides* (Lewiński); Lower Volgian, Brzostówka (Z. Pal. U. W. No V. IV/1); ×20.

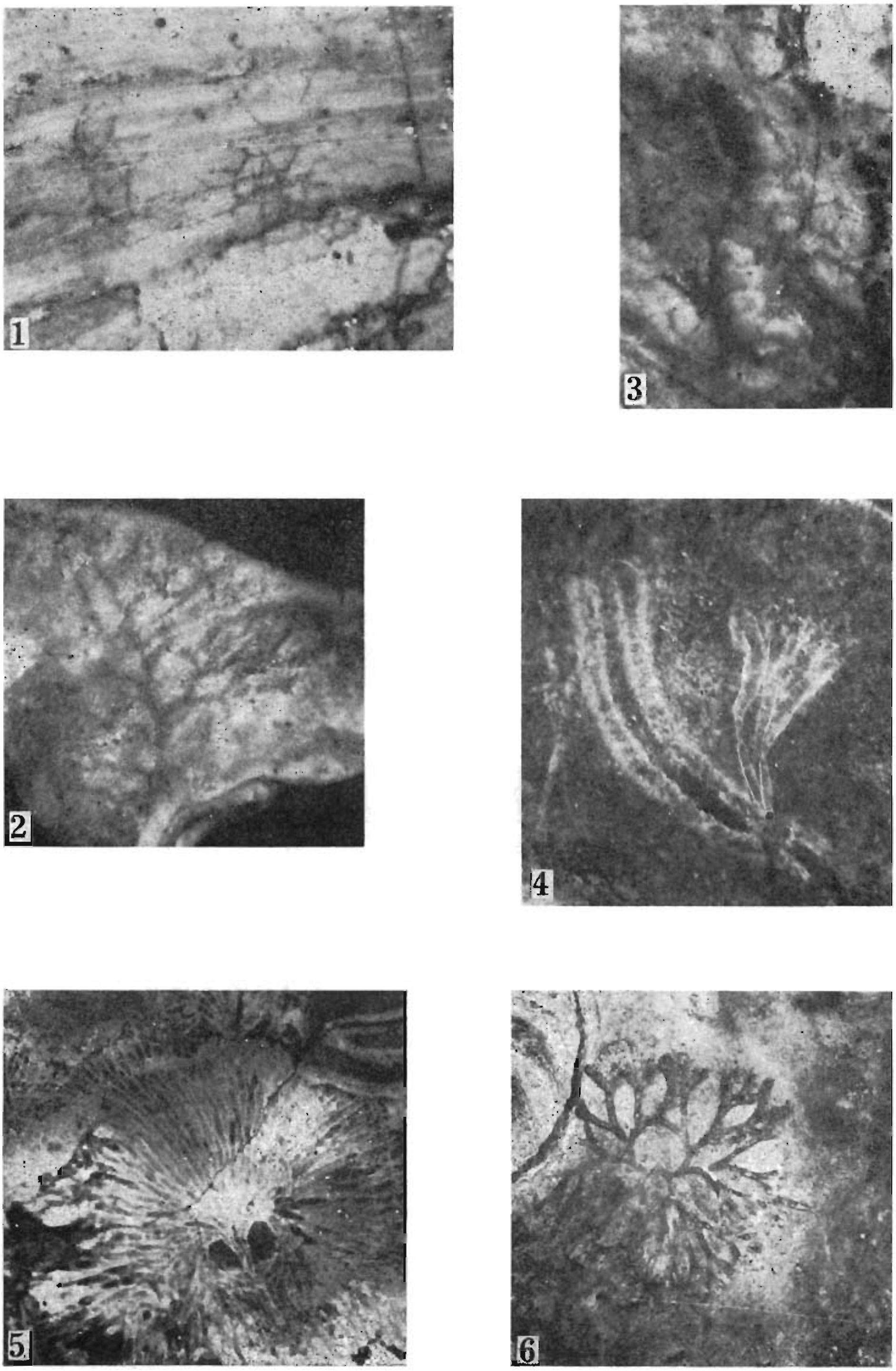
Fig. 2. *Calcideletrix flexuosa* Mägdefrau; traces of destruction in the form of rootlike, branched canals on a valve of *Exogyra virgula* (Defrance); Lower Kimeridgian, Sobków (Z. Pal. U. W. No V. IV/2); ×20.

Fig. 3. *Nubeculinella bigoti* Cushman; a multichamber foraminifer attached to a valve of *Ex. virgula* (Defrance); Lower Kimeridgian, Sobków (Z. Pal. U. W. No V. IV/3); ×20.

Fig. 4. *Berenicea parvitubulata* Gregory; initial part of a colony with two zoecial tubes budding from ancestrula and attached to a shell of *Ex. michalskii* Lewiński; Lower Volgian, Brzostówka (Z. Pal. U. W. No V. IV/4); ×20.

Fig. 5. *Id.*; a zoarium with a fanlike system of zoecial tubes, the origin of a colony visible; the same horizon, locality and substratum (Z. Pal. U. W. No V. IV/4); ×6.

Fig. 6. *Stomatopora dichotoma* (Lamx.); a zoarium with a polygonal trace of zoecial tubes on a valve of *Alectryonia gregarea* (Sowerby); Lower Kimeridgian, Wierzbica (Z. Pal. U. W. No V. IV/5); ×3.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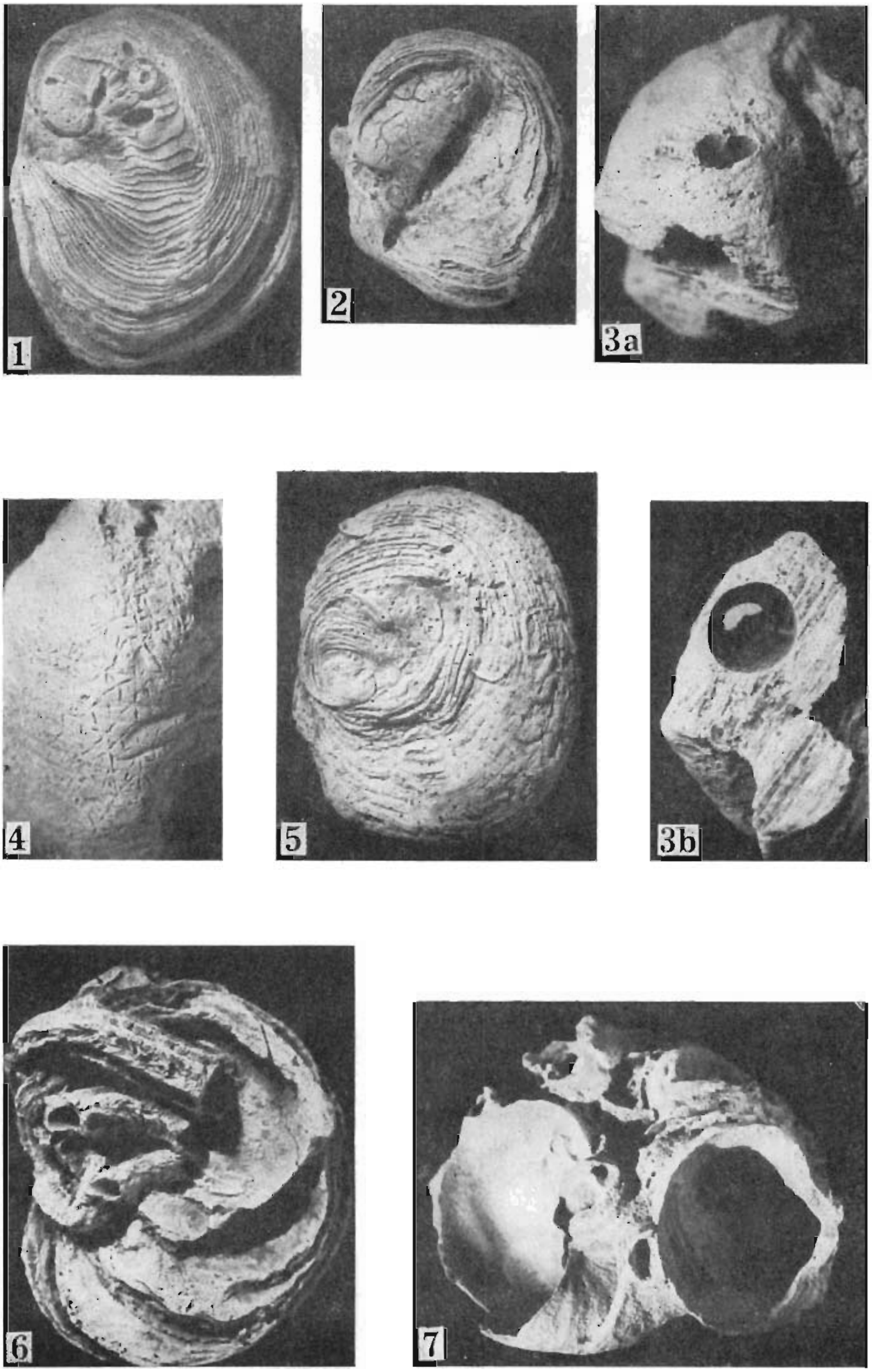
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Plate II

Fig. 1. *Simonizapfes elongata* Codez; traces of boring, left by a cirriped, in the form of elongate apertures on a valve of *Nanogyra nana* (Sowerby); Lower Kimeridgian, Gruszczyn (Z. Pal. U. W. No V. IV/6); ×3.

Fig. 2. *Calcideletrix flexuosa* Mägdefrau; rootlike, branched canals extended in the process of fossilization on a valve of *Nanogyra nana* (Sowerby); Lower Kimeridgian, Gruszczyn (Z. Pal. U. W. No V. IV/7); ×3.

Fig. 3a, b. *Gastrochaena* sp. a canal bored chemically by a pelecypod on a valve of *Nanogyra nana* (Sowerby): *a*, aperture with an intersiphonal septum visible, *b*, inlet aperture; Lower Kimeridgian, Gruszczyn (Z. Pal. U. W. No V. IV/8); ×5.

Fig. 4. *Chaetophorites tenuis* Mägdefrau; traces of destruction in the form of discontinuous, boring canals on a shell of *Exogyra virgula* Defrance; Lower Kimeridgian, Oleszno (Z. Pal. U. W. No V. IV/9); ×5.

Fig. 5. Traces of destruction in the form of round apertures with uneven margins, sometimes folled with lumps of Recent lichens. Visible are also traces of *Simonizapfes elongata* and a tube of *Glomerula gordialis*. Shell of *Nanogyra nana* (Sowerby); Lower Kimeridgian, Gruszczyn (Z. Pal. U. W. No V. IV/10); ×3.

Fig. 6. *Serpula* (Tetraserpula) *quadrilatera* Goldfuss. Tube rectangular in transverse section, cemented to a shell of *Nanogyra nana* (Sowerby); Lower Kimeridgian, Czarnogłowy (Z. Pal. U. W. No V. IV/11); ×3.

Fig. 7. *Serpula* (Tetraserpula) *quinquangularis* Goldfuss overgrowing cemented left valves of *Nanogyra nana* (Sowerby); Lower Kimeridgian, Czarnogłowy (Z. Pal. U. W. No V. IV/12); ×2.

Plate III

Fig. 1. *Bullopora rostrata* Quenstedt; a foraminifer attached to a valve of *Exogyra virgula* Defrance with oval chambers arranged in a row; Lower Kimeridgian, Wierzbica (Z. Pal. U. W. No V. IV/13); ×20.

Fig. 2. The same species; a specimen attached to a valve of *Catinula knorri* (Voltz); Bajocian-Bathonian, Łęczyca, (Z. Pal. U. W. No V. IV/14); ×2.

Fig. 3. *Nubeculinella bigoti* Cushman; a partly destroyed test of a foraminifer attached to a valve of *Ex. virgula* (Defrance); Lower Kimeridgian, Gruszczyn (Z. Pal. U. W. No V. IV/15); ×20.

Fig. 4. *Sarcinella sarcinella* Regenhardt; tubes arranged in bunches; Lower Volgian, Brzostówka (Z. Pal. U. W. No V. IV/16); nat. size.

Figs. 5 and 7. Oval apertures bored by the pelecypod *Gastrochaena* Spengler in shell of *Liostrea delta* (Smith); Lower Kimeridgian, Czarnogłowy, (Z. Pal. U. W. No. V. IV/17–18); nat. size.

Fig. 6. *Serpula* (Tetraserpula) *quinquangularis* Goldfuss; tubes with an undulated dorsal keel cemented on a shell of *Nanogyra nana* (Sowerby); Lower Kimeridgian, Czarnogłowy, (Z. Pal. U. W. No V. IV/19); ×3.

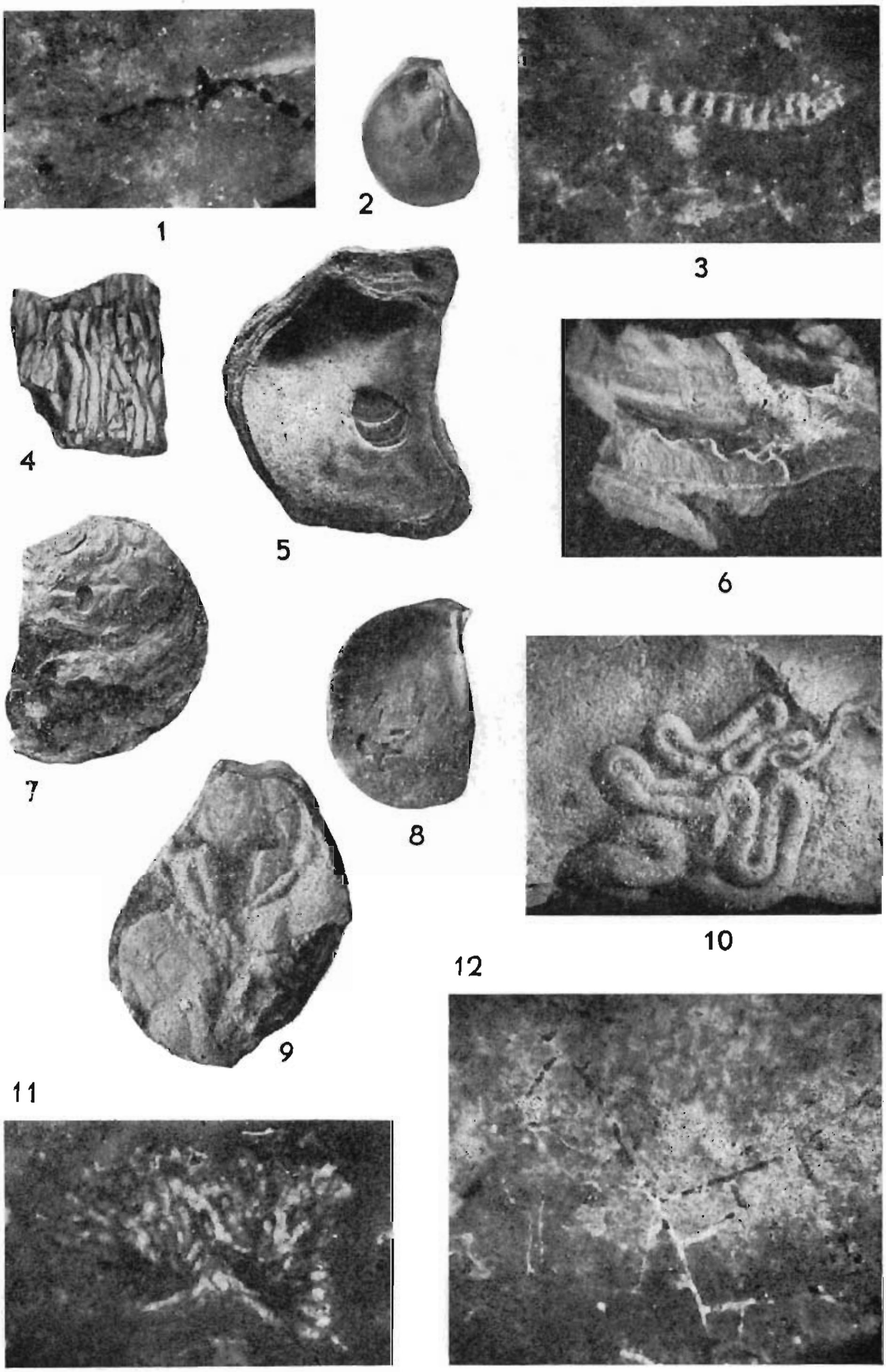
Fig. 8. *Simonizapfes elongata* Codez; elongate traces of boring, left by a cirriped on a shall of *Catinula knorri* (Voltz); Bajocian-Bathonian, (Z. Pal. U. W. No V. IV/20); ×2.

Fig. 9. *Serpula* (Tetraserpula) *tetragona* Sowerby; tubes quadrangular in transverse section, on a shell of *Liostrea acuminata* (Sowerby); Bajocian-Bathonian, Łęczyca, (Z. Pal. U. W. No V. IV/21); ×3.

Fig. 10. *Glomerula gordialis* (Schlotheim); round tubes twisted in a bundle and meandering, cemented to a shell of *Ex. reniformis* Goldfuss; Lower Kimeridgian, Czarnogłowy, (Z. Pal. U. W. No V. IV/22); ×5.

Fig. 11. *Berenica parvitubulata* Gregory; a zoarium cemented to a valve of *Ex. virgula* (Defrance); Lower Kimeridgian, Sobków, (Z. Pal. U. W. No V. IV/23); ×20.

Fig. 12. *Chaetophorites gomontoides* Pratje; traces of boring in the form of straight canals on a shell of *Nanogyra nana* (Sowerby); Lower Kimeridgian, Wierzbica, (Z. Pal. U. W. No V. IV/24); ×20.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