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Lower Tortonian scaphopods from the Korytnica clays, southern slopes of the Holy Cross Mts

ABSTRACT: An assemblage of scaphopods, the richest in Poland, occurs in the Lower Tortonian *Pleurotoma* clays outcropped in the environs of Korytnica on southern slopes of the Holy Cross Mts. All in all, this assemblage includes thirteen species, that is, four hitherto known from this locality and nine others, four of which are here described as new ones. This is one of the richest assemblages of these molluscs in the Miocene of Europe and in the number of species yields only to some Miocene localities of Italy. *Dentalium (Antalis) fossile* Schroeter and *Fustiaria (Episiphon) miocaenica* (Boettger) are most frequent species at Korytnica. The present paper contains paleontological descriptions of particular species, along with characteristics of their life environment. This assemblage has also been compared with those from other Miocene localities and a considerable similarity has been found to the scaphopods of the Vienna Basin, of the environs of Pleven, Bulgaria, and of the environs of Kostej, Transylvania.

INTRODUCTION

The present paper, discussing the molluscs of the class Scaphopoda coming from the Lower Tortonian *Pleurotoma* clays of Korytnica, is a successive result of the writer's studies on the faunal assemblage of this locality. These deposits are outcropped in the vicinity of the village Korytnica, on southern slopes of the Holy Cross Mts, 24 km SSW of Kielce.

The occurrence of scaphopods at Korytnica has already been stated by the first explorers of the local fauna (Pusch 1837, Eichwald 1853, Hörnes 1856). All of them recorded the presence of conspicuously large shells of *Dentalium badense* Partsch. In addition, the species *Dentalium entalis* Linnaeus was mentioned from this locality by Pusch and Hörnes. Later, four species: *Dentalium michelotti* Hörnes, *Dentalium badense* Partsch, *Dentalium fossile raricostatum* Sacco and *Fustiaria jani* (Hörnes)

were described from Korytnica by Friedberg (1928a). In addition to the last-named species, *Dentalium vitreum* Schroeter is mentioned by Kowalewski (1930).

During his field studies, the writer found at Korytnica a considerably richer assemblage of scaphopods, including a total of thirteen species. Of the species hitherto mentioned from this locality, *Dentalium entalis* Linnaeus and *Dentalium vitreum* Schroeter are absent from this assemblage. In the writer's opinion, the presence of these species is here problematic and the supposition may be expressed that these names were given by previous researchers to fragmentary shells of *Dentalium fossile* Schroeter devoid of ornamentation. This is the more probable as the last-named species was neither by Pusch nor Hörnes mentioned by name, which seems strange, since it is very common at Korytnica.

Acknowledgements. The writer's heartfelt thanks are extended to Dr. N. H. Ludbrook, Toorak Gardens, South Australia for kindly sending in a few of her works on scaphopods of Austrialia and to Dr. G. F. Laghi, University of Modena, Italy for the xerocopies of Caprotti's works on scaphopods and for information on the situation of some of the Miocene localities in Italy.

The writer feels also indebted to L. Łuszczewska, M. Sc., for taking all photographs of scaphopods presented in the paper (Pls 1—6).

THE KORYTNICA SCAPHOPODS AND THEIR LIFE ENVIRONMENT

As is known from Radwański's studies (1964, 1969, 1970), a few bays deeply indenting the land were formed in the southern part of the Holy Cross Mts during the Lower Tortonian sea transgression. The bay of Korytnica, which joined the open sea by a few narrow inlets, was one of them. It had a varied, rocky shore composed of Jurassic limestones. Parts of well-preserved littoral structures, stretching along the then coastline, are visible even now. A series of sediments, several scores of meters thick, was deposited in the western part of this bay, *i.e.* in the Korytnica aquenum. This series is composed of the following (bottom to top) structures:

— silts and clays, known as *Pleurotoma* clays;
— sands and marly sandstones with *Heterostegina costata* d'Orbigny;
— lithothamnian limestones.

The lowermost of these members, about 30 m thick, has for a long time been famous for its excellently preserved and strongly varying fossils, which include Korytnica in the rank of Europe's most interesting Miocene faunal localities.

The clayey bottom and undoubtedly large number of microorganisms, present in the deposit, provided very favorable conditions to the

life of scaphopods in the Korytnica aquenum. The shells of these molluscs are now met with practically in the entire profile of *Pleurotoma* clays and, in addition, in the entire area of this aquenum. The frequency of individual species of the scaphopods is, however, considerably varied. Some of them, *e.g., Dentalium dentale* Linnaeus and *Dentalium (Antalis) angusticostatum* sp.n. are a great rarity, while others as, *Dentalium (Antalis) fossile* Schroeter and *Fustiaria (Episiphon) miocaenica* (Boettger) are very common.

Specific geological conditions of the present area of Korytnica aquenum, expressed in the occurrence of *Pleurotoma* clays observed directly on the surface of a sizeable part of this territory (Fig. 1) with a simultaneous complete lack of natural sections, exert a decisive influence on the manner of collecting fossils in this locality. Large-size specimens are collected directly from the soil of the local arable land, whereas obtaining the entire stock of smaller forms requires washing considerable samples of deposit. Among the scaphopods, found by the writer in the fields, there were only the shells of *Dentalium (Antalis) badense* Partsch, *Dentalium (Antalis) fossile* Schroeter and *Dentalium (Antalis) angusticostatum* sp.n. All the remaining species were found only in the material obtained by washing. Although met with in almost each sample taken, the tuskshells were more abundant and differentiated in three of them (the places of sampling are shown in Fig. 1 in which they are designated *A, B* and *E*). The first two of them, were taken from the uppermost part of the *Pleurotoma* clays, sample *A* in a place situated about 200 m north of Mt. Łysa, while sample *B* north-west of the village Karsy. Both these, already described (Bałuk & Jakubowski 1968, Bałuk 1971), localities are known for their vast wealth of fossils, among which remarkable is the presence of bivalved gastropods of the genus *Berthelinia* Crosse and many species of chitons. Sample *E* comes from the northern slope of Mt. Łysa and represents a deposit accumulated in a direct contact with the zone of littoral structures (Kowalewski 1930, Radwański 1969) and, therefore, corresponding to the coastal facies of Korytnica clays (Friedberg 1928b; Radwański 1964, 1969). A list of the species of scaphopods found in particular localities is shown in Table 1.

Although the Korytnica clays seem to form a uniform complex, their particular parts differ in a slightly various lithological development. In the lower parts of the profile, the deposit is more clayey, while its upper parts frequently contain silts, which in extreme cases may even be loose. These slight differences are, however, reflected in the faunal composition, particularly so in that of scaphopods. Thus, *Dentalium (Antalis) badense* Partsch occurs almost exclusively in lower parts of the profile, in a typically clayey deposit. It is as a rule accompanied by the occurrence of individual corals of the genus *Flabellum* Lesson. The places in which the shells of these scaphopods were found are marked

in Fig. 1. The species *Dentalium (Dentalium) subprismaticum* sp. n., *Dentalium (Antalis) mutabile* Hörnes, *Fustiaria (Episiphon) jani* Hörnes and *Dentalium (Antalis) badense* Partsch are met with in coastal deposits (sample *E*) crowded with the shells of *Ostrea* cf. *frondosa* de Serres. In addition to the oysters, they are accompanied by many corals of the

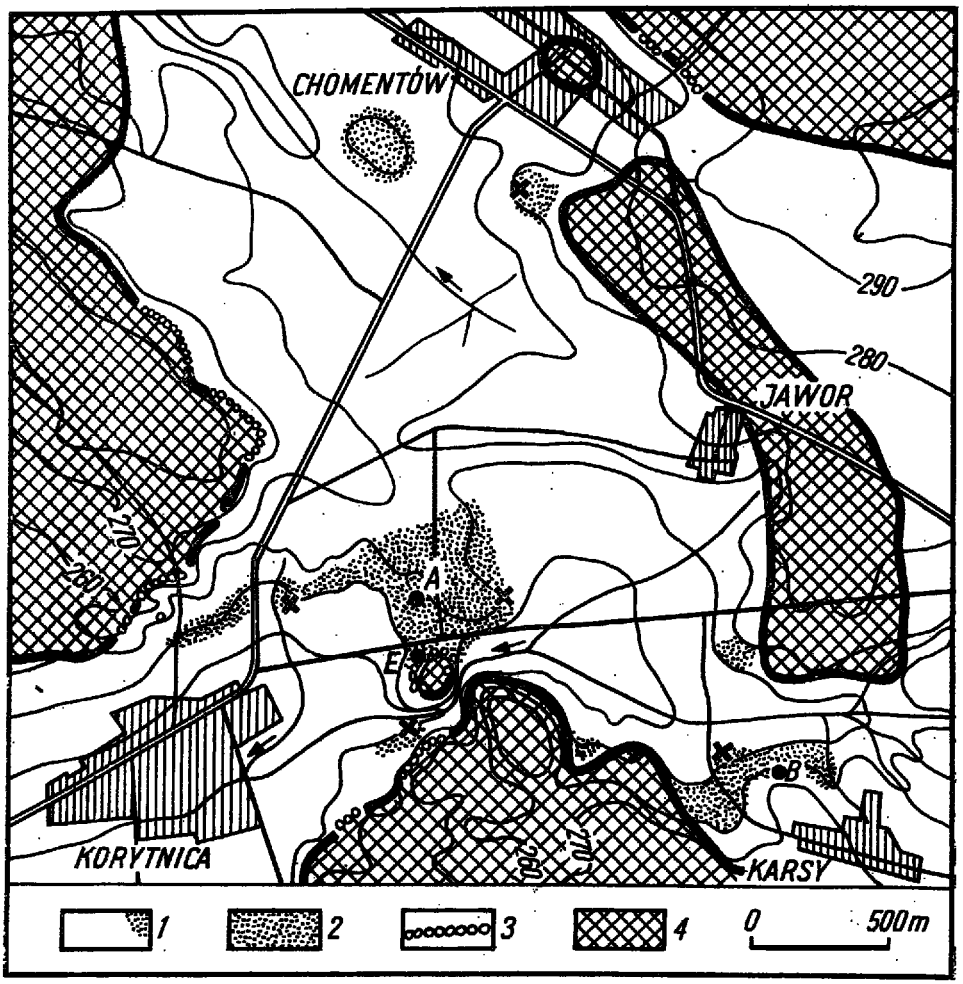

Fig. 1

Locality map of the scaphopod-bearing samples (*A, B, E*) from the Korytnica clays, and paleogeographic situation of the region during the Lower Tortonian time (*cf.* Radwański 1969, Figs 25 and 31)

1 marine area of the Korytnica aquenum during the Lower Tortonian transgression, *2* present-day outcrops of the *Pleurotoma* clays situated beneath the overlying Tortonian deposits and Quaternary cover, *3* preserved fragments of the Lower Tortonian littoral structures, *4* land (or island) areas along the Lower Tortonian seashores; marked by cross are places yielding *Dentalium (Antalis) badense* Partsch

genera *Dendrophyllia* Blainville, *Balanophyllia* S. Wood and *Discotrochus* Milne-Edwards & Haime, as well as by cirripeds of the genera *Balanus* da Costa and *Scalpellum* Leach. Among the species of scaphopods, mentioned from this locality, the first occurs only in it, the next two of them being here abundant and in other places occurring only sporadically. A mass occurrence of *Fustiaria (Episiphon) miocaenica* (Boettger) is connected with silty deposits of the upper part of the profile. *Dentalium (Antalis) korytnicense* sp. n. and *Dentalium (Dentalium) dentale* Linnaeus may also be met with only in these same deposits. These specimens are usually accompanied by a definite faunal assemblage, in which, in addition to molluscs, noteworthy are the corals of the genera *Stylocora* Reuss, *Tarbellastraea* Alloiteau and *Porites* Link. Many cirripeds *Creusia* Leach occur in the coralla of the two last-named genera (*cf.* Bałuk & Radwański 1967). In addition to species closely connected with a definite type of deposit, there are also forms met with everywhere, including *Dentalium (Antalis) fossile* Schroeter, as well as *Entalina tetragona* (Brocchi).

The observations discussed above allow one to conclude that the distribution of particular species of scaphopods over the aquenum depended primarily on the type of deposit on the sea bottom. On the other hand, it seems that the problem of differences in depth was not important in this respect, since the entire complex of *Pleurotoma* clays undoubtedly represents shallow-water deposits (*cf.* Radwański 1969). As a matter of fact, this is a well-known feature, observed in many Recent seas. The occurrence of particular coastal species of scaphopods in waters varying in depth from several scores to slightly more than 100 m was found by Henderson (1920) in the Gulf of Mexico and the Caribbean Sea and by Stork (1934) in the Adriatic Sea.

SYSTEMATIC DESCRIPTION

Class **Scaphopoda** Bronn, 1862
Family **Dentaliidae** Gray, 1847
Genus *DENTALIUM* Linnaeus, 1758
Subgenus *DENTALIUM* sensu stricto
Dentalium (Dentalium) michelottii Hörnes, 1856
(Pl. 6, Fig. 1)

1856. *Dentalium Michelottii* Hörn.; M. Hörnes, pp. 654—655, Pl. 50, Fig. 33.
1897. *Dentalium Michelottii* Hörn.; F. Sacco, pp. 96—97, Pl. 7, Figs 84—86.
1910. *Dentalium Michelottii* Hörn.; S. Cerulli-Irelli, p. 23, Pl. 3, Figs 1—2.
1928. *Dentalium Michelottii* Hoern.; W. Friedberg, p. 559, Pl. 36, Figs 22—23.
1954. *Dentalium michelottii* Hörn.; L. Strausz, p. 39, Pl. 9, Fig. 171.
1960. *Dentalium (Dentalium) michelottii* Hoernes; B. Strachimirov, p. 224, Pl. 52, Figs 15—16.
1961. *Dentalium (Dentalium) Michelottii* Hoernes; E. Caprotti, p. 352, Pl. 19, Figs 7—8.

Material. — Three fragmentary shells.

Dimensions. — The length of the largest fragment — 6.0 mm, the largest diameter of shell — 2.2 mm.

Description. — Shell tubelike, externally hexagonal in transverse section (Pl. 6, Fig. 1b). Six longitudinal, sharp ribs run on the surface of shell along the margin and disappear in the terminal part of shell (*cf.* Friedberg 1928a, Pl. 36, Figs 22—23). At the first glance, the surface of shell between ribs seems to be quite smooth, but it is covered with closely spaced, delicate, longitudinal striae, visible only when viewed magnified. No apical orifice is preserved in any of the specimens found.

Remarks. — *Dentalium (Dentalium) michelottii* Hörnes is undoubtedly one of the rarest scaphopods in the Korytnica clays. This species has hitherto been described from this locality only by Friedberg (1928a, 1938). Outside of Korytnica, its presence was also found only in the sands of the environs of Bogucice (Friedberg 1907, Liszka 1933).

Dentalium (Dentalium) subprismaticum sp. n.
(Pl. 6, Figs 2—7)

Holotype: the specimen presented in Pl. 6, Fig. 6, lodged in the writer's collection (numbered *BkK-S06*).

Type horizon: Lower Tortonian (Badenian).

Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mts.

Derivation of name: subprismaticum — after a similarity to the shell of *Dentalium prismaticum* Seguenza, from which it, however, conspicuously differs in size.

Diagnosis. — Shell medium-sized, polygonal (usually octogonal) in transverse section, number of primary ribs is eight (rarely seven or nine).

Material. — Thirty fragmentary shells.

Dimensions. — The largest fragment (established as the holotype):

length	—	10 mm
diameter in the posterior part of shell	—	2.8 mm
diameter in the anterior part of shell	—	3.2 mm

Other specimen (Pl. 6, Fig. 2):

the smallest diameter at the apical orifice	—	0.7 mm

Description. — In the apical part, the shell ornamented by eight longitudinal ribs, five of them on the ventral and only three on the dorsal half. In this part of shell, all ribs are sharp so that its external outline of transverse section is starlike. The number of ribs is variable, one of the specimens displaying nine ribs (six on the ventral half) and another only seven (four on the ventral half). In a further part of shell, ribs diminish and the external outline of shell becomes polygonal in transverse section (Fig. 2). Yet smaller, secondary ribs appear between the primary ribs which run over the entire length of shell. The secondary ribs do not appear simultaneously. They are first observed on the dorsal part where primary ribs are more widely spaced. One or two and exceptionally three or even four secondary ribs appear between each two primary ribs. The surface of shell between ribs is densely and finelly striated. The apical orifice is provided with a short pipe (Pl. 6, Fig. 2).

Remarks. — The specimens described above cannot be assigned to any of hitherto known species. Although in the shape of shell and developement and number

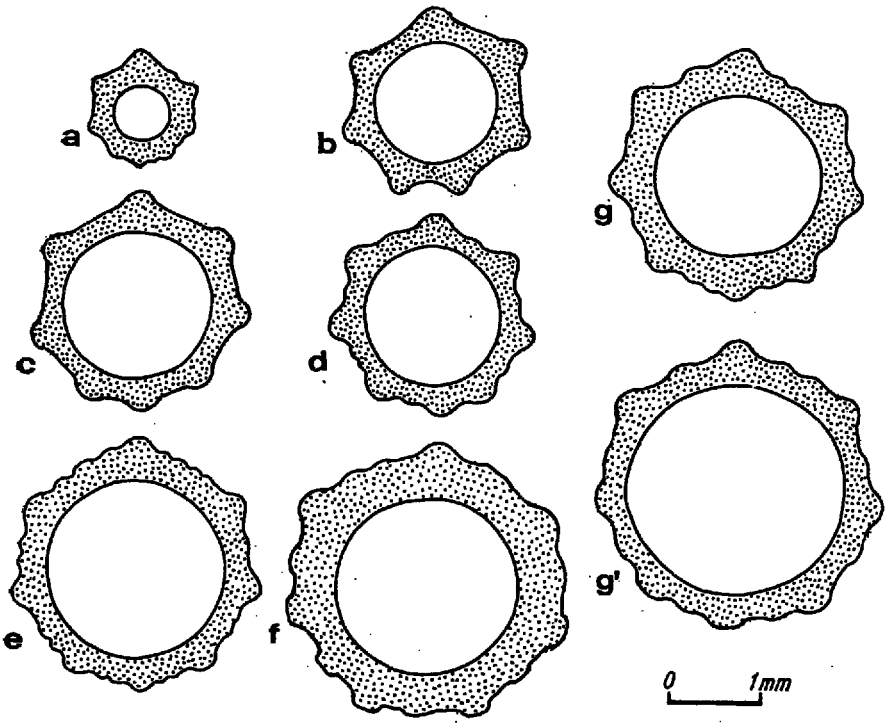

Fig. 2

Transverse sections of *Dentalium (Dentalium) subprismaticum* sp. n. (*g, g'* correspond to the holotype)

of ribs they resemble *Dentalium prismaticum* Seguenza, they decidedly differ from it in smaller dimensions and a thinner wall of shell. *Dentalium prismaticum* Seguenza reaches 60 mm in length and, at the anterior aperture, 7 mm in diameter (*cf.* Fantinet 1959, Pl. 5, Figs 1—5). A certain similarity may also be observed when comparing the specimens of *Dentalium subprismaticum* sp. n. with *Dentalium inaequale* Bronn. The development of both primary and secondary ribs and the appearance of the surface of shell between ribs are identical in the specimens of the two species. In addition to the size of shell, the number or ribs and, consequently, a different external outline of shell in transverse section, make up a fundamental difference between them. The outline of *Dentalium inaequale* Bronn is hexagonal and *Dentalium subprismatum* sp. n. as a rule octagonal in transverse section.

Subgenus *ANTALIS* H. Adams & A. Adams, 1854
Dentalium (Antalis) badense Partsch *in* Hörnes, 1856
(Pl. 2, Figs 1—3)

1856. *Dentalium Badense* Partsch; M. Hörnes, pp. 652—653, Pl. 50, Fig. 30.
1897. *Entalis badensis* (Partsch) et var.; F. Sacco, pp. 107—108, Pl. 9, Figs 17—30.
1917. *Entalis badensis* (Partsch); M. Cossmann & A. Peyrot, pp. 19—20, Pl. 1, Figs 12—13, 16.
1925. *Dentalium (Entalis) badense* Partsch var. *borealis* Kautsky; F. Kautsky, pp. 53—54, Pl. 5, Fig. 12.

1928. *Dentalium badense* Partsch; W. Friedberg, pp. 557—558, Pl. 36, Figs 17—19.
1947. *Dentalium (Fissidentalium) badense* Partsch; A. F. Tauber, p. 301, Abb. 7, Figs 8—10.
1959. *Dentalium badense* Partsch *in* Hoernes; F. Seifert, pp. 26—27, Pl. 1, Figs 1—3.
1960. *Dentalium badense* Partsch; T. Báldi, p. 57, Pl. 1, Fig. 5.
1960. *Dentalium (Entalis) badensis* Partsch *in* Hoernes; B. Strachimirov, pp. 225—226, Pl. 52, Figs 19—20.
1968. *Dentalium badense* Partsch *in* Hoernes; L. B. Rasmussen, pp. 77—79, Pl. 7, Figs 2 and 4.

Material. — Twenty-five specimens.
Dimensions. — The largest specimen (Pl. 2, Fig. 2):

length	— 50.0 mm
diameter at the apical orifice	— 2.8 mm
diameter at the anterior aperture	— 7.0 mm

Other specimens:

the smallest diameter at the apical orifice	— 2.0 mm
the largest diameter at the anterior aperture	— 9.5 mm

Description. — Shell large, thick-walled, slightly flattened dorsoventrally in transverse section. Its surface ornamented by many longitudinal ribs varying in thickness. In the apical part, the number of ribs amounts to nine or ten and increases in further parts as secondary ribs appear with the growth of shell. On the largest two specimens identical in diameter (about 9 mm), this number amounts to 34 and 45. Secondary ribs appear at a varying distance from the apex and differ in number (two to five) between each pair of primary ribs. The apical orifice is provided with a not very deep V-shaped notch situated near the ventral side.

Remarks. — The specimens of *Dentalium (Antalis) badense* Partsch *in* Hörnes, found at Korytnica, do not depart in their appearance from those described from other Neogene localities in Europe, except only for their somewhat smaller dimensions. Although relatively rare in the Korytnica clays, the shells of this species, conspicuous by their size, were recorded by all explorers who dealt with this locality fossils (Pusch 1837, Eichwald 1853, Hörnes 1856, Kontkiewicz 1882, Friedberg 1928a, Kowalewski 1930). Outside of Korytnica, this species was found in the Tortonian of Poland also at Zgłobice (Friedberg 1907, 1928a), in the environs of Małoszów (Michalski 1884, Kowalewski 1930, Krach 1947), at Benczyn (Krach 1950) and in the environs of Andrychów (Krach 1957).

Dentalium (Antalis) fossile Schroeter, 1783
(Pl. 1, Figs 1—5)

1856. *Dentalium pseudo-entalis* Lam.; M. Hörnes, p. 656, Pl. 50, Fig. 35.
1897. *Antale fossile* (Schröt.) et var. *raricostata* Sacco; F. Sacco, pp. 99—100, Pl. 8, Figs 22—41.
1910. *Dentalium (Antale) fossile* Schröt.; S. Cerulli-Irelli, p. 24, Pl. 3, Fig. 5.
1917. *Dentalium (Antale) raricostatum* Sacco; M. Cossmann & A. Peyrot, pp. 11—12, Pl. 1, Figs 23, 24, 27—31.
1928. *Dentalium fossile* Schröt. var. *raricostata* Sacco; W. Friedberg, pp. 558—559, Pl. 36, Figs 20—21.
1938. *Dentalium fossile* Gmelin; V. Stchepinsky, pp. 50—51, Pl. 5, Figs 12—13.
1959. *Dentalium (Antale) fossile* Schroeter; D. Fantinet, pp. 43—44, Pl. 5, Fig. 7.
1960. *Dentalium raricostatum* (Sacco); T. Báldi, pp. 55—56, Pl. 1, Figs 2a—2b.
1960. *Dentalium (Antale) crux* Boettger; B. Strachimirov, p. 224, Pl. 52, Fig. 17.
1968. *Dentalium (Antale) crux* Boettger; L. Hinculov, p. 155, Pl. 39, Fig. 13.

Material. — About 500 specimens.
Dimensions. — The largest specimen (Pl. 1, Fig. 3):

length	— 35.0 mm
diameter at the apical orifice	— 1.2 mm
diameter at the anterior aperture	— 3.4 mm

Other specimens:

the smallest diameter at the apical orifice	— 0.25 mm
the largest diameter at the anterior aperture	— 3.8 mm

Description. — Shell medium-sized, shaped like a bent tube round in transverse section. At the apex, the surface of shell is at first quite smooth. At a small distance from it, there appear 12 to 16 delicate, longitudinal ribs. Further on, a secondary rib and, rarely, even two appear between each two primary ribs. The secondary ribs soon become almost equal in width to the primary ones. Thus, the number of all ribs ornamenting the shell usually amounts to 26 to 32. All of them become wider and wider and, at the same time, less and less conspicuous. Inter-costal spaces become narrower and narrower, finally disappearing at all and the shell becomes almost completely smooth (*cf.* Fig. 3). The place in which the ribbing disappears is,

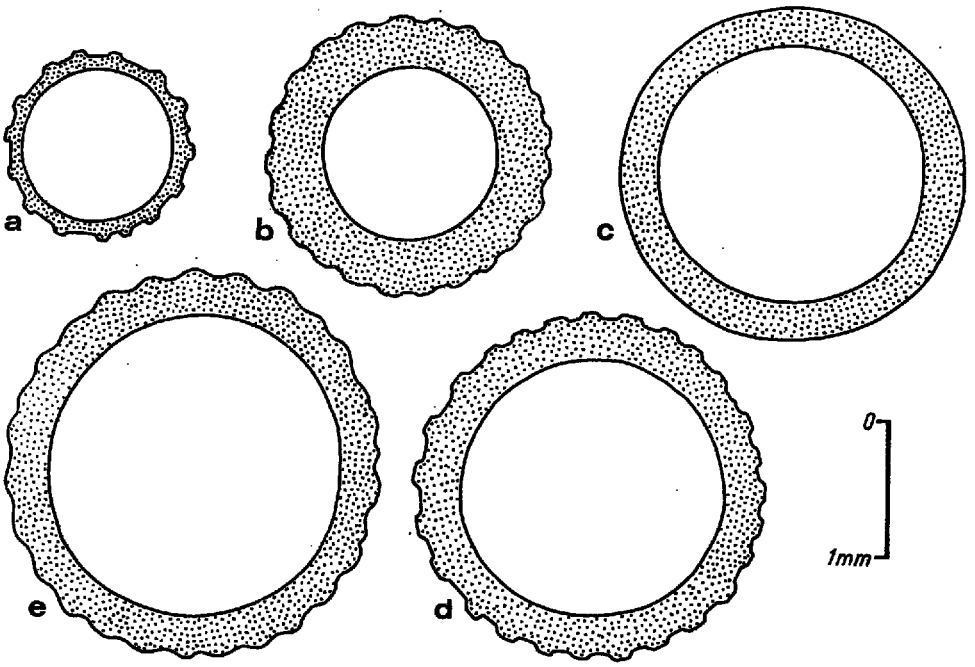

Fig. 3

Transverse sections of *Dentalium (Antalis) fossile* Schroeter

however, variously situated in particular specimens and consequently, the length of the ribbed part is variable. This is very distinct when compared in selected, extremely varying specimens (Pl. 1, Figs 3—4). Apical orifice simple, rarely with a short pipe.

Remarks. — Similar specimens, coming from the same locality, have already been described by Friedberg (1928a) and Kowalewski (1930) under the name of *Dentalium fossile* Schröt. var. *raricostata* Sacco. In the writer's opinion, the distinction of this variety is groundless. Although very sketchy, the diagnosis formulated by Sacco (1897) seems to concern the specimens in which secondary ribs occur only rarely.

Specimens, not differing from those found at Korytnica, were described by Hörnes (1856) from the Vienna Basin (Baden, Steinabrunn) under the name of

Dentalium pseudo-entalis Lam. Shells, differing from the Korytnica specimens only in slightly larger dimensions, but not departing from them either in shape or character of ornamentation (of which the writer could convince himself by a direct comparison of the specimens), were described by Báldi (1960, 1961) from the Tortonian of Hungary as *Dentalium raricostatum* (Sacco). Precisely the same concerns the specimens from the Tortorian of Bulgaria (environs of Pleven), described by Strachimirov (1960) as *Dentalium (Antale) crux* Boettger. In the present writer's opinion, it seems beyond any doubt that this same species of scaphopod, only differently determined by various researchers, occurs in all the localities mentioned above and, in addition, in the environs of Kostej and Lapugy, Transylvania. It is a from difficult to determine and this may probably explain the meaning of the specific name introduced by Boettger: *crux*, that is, torment. It is worth mentioning that in all the localities mentioned above the deposits are similarly developed and contain very similar faunal assemblages.

In the case of the specimens from other localities, in particular from the Miocene of Italy and France, the supposition may only be expressed concerning their conformability. For the illustrations contained in the monographs (*cf.* Sacco 1897, Cossmann & Peyrot 1917) are not easily legible and using them as a basis is unreliable.

Dentalium (Antalis) fossile Schroeter from the Tortonian of Poland, assigned after Friedberg to Sacco's variety discussed above, has hitherto been mentioned from Bogucice (Friedberg 1928a, Liszka 1933), Małoszów (Krach 1947) and Benczyn (Krach 1950). Scaphopods from Niskowa were also mentioned under this same name (Friedberg 1928a, Skoczylasówna 1930, Bałuk 1970), but these specimens do not belong here and should be identified as *Dentalium (Antalis) dentale* Linnaeus.

Dentalium (Antalis) dentale Linnaeus, 1766
(Pl. 3, Figs 1—3)

?1856. *?Dentalium fossile* Linn.; M. Hörnes, p. 657, Pl. 50, Fig. 36.
1897. *Antale? dentale* (L.) var. *sexdecimcostata* Sacco; F. Sacco, p. 104, Pl. 8, Figs 74—75.
1928. *Dentalium fossile* Schröt. var. *raricostata* Sacco; W. Friedberg (partim).
1959. *Dentalium (Antale) dentale* Linné; D. Fantinet, pp. 46—48, Pl. 8, Fig. 1.
1961. *Dentalium (Antalis) dentale* Linneo; E. Caprotti, pp. 353—354, Pl. 20, Fig. 2.

Material. — Eight specimens (fragmentary shells only).

Dimensions. —

Length of the largest fragment	—	3.3 mm
The smallest diameter at the apical orifice	—	0.3 mm
The largest diameter at the anterior aperture	—	1.2 mm

Description. — Shell small-size and, judging by the fragments found, relatively strongly bent. Thirteen to sixteen longitudinal ribs form its ornamentation. Between the ribs, the surface of shell is covered with many, closely spaced, fine striae. On a specimen (Pl. 3, Fig. 3) representing a fragment of the anterior part of shell, one of the striae, situated between the ribs, is slightly more strongly developed. Apical orifice simple, or bearing a short pipe.

Remarks. — Although the material available is exceptionally scarce and consists of the fragments of young individuals only, assigning it to the species *Dentalium (Antalis) dentale* Linnaeus does not seem to arouse any doubts. The specimens from Korytnica are in complete conformity with the forms described by Fantinet (1959) and Caprotti (1961). Of the specimens from the Neogene of Italy and

which were described by Sacco (1897), the most similar to the Korytnica forms are the individuals assigned by him to the variety *sexdecimcostata*. Other specimens, illustrated by the last-named author, in particular the typical form and var. *astensis* seem to be different. However, Sacco's very indistinct figures do not entitle one to explicit statements.

Dentalium (Antalis) dentale Linnaeus has not so far been recorded in any of the Miocene localities of Poland. However, as the writer has recently been able to find, specimens very similar to those here described abundantly occur at Niskowa, but so far they were (Friedberg 1928a, Skoczylasówna 1930, Bałuk 1970) erroneously determined. This species was not also mentioned from the Vienna Basin. However, the supposition may here be expressed that it includes the specimens encountered at Pötzleinsdorf and described by Hörnes (1856) as *Dentalium fossile* Linn.

At present, *Dentalium (Antalis) dentale* Linnaeus lives in the Mediterranean Sea (Stork 1934, Riedl 1963).

Dentalium (Antalis) mutabile Hörnes, 1856
(Pl. 3, Figs 4—9)

1856. *Dentalium mutabile* Doderlein, M. Hörnes, p. 654, Pl. 50, Fig. 32.
1897. *Antale novemcostatum* (Lk.) et var.; F. Sacco, pp. 102—104, Pl. 8, Figs 59—70.
1917. *Dentalium (Antale) mutabile* Doderlein; M. Cossmann & A. Peyrot, p. 11, Pl. 1, Figs 34—35.
1928. *Dentalium novemcostatum* Lam. var. *mutabilis* Dod.; W. Friedberg, p. 560, Pl. 36, Figs 24—25.
1938. *Dentalium novemcostatum* v. *mutabilis* (Doderlein); V. Stchepinsky, pp. 51—52, Pl. 15, Figs 14—15.
1949. *Dentalium (Antale) novemcostatum* Lamarck; G. Ruggieri, pp. 91—92, Pl. 2, Fig. 7.
1959. *Dentalium novemcostatum* Lamarck f. *mutabile* Doderlein; F. Seifert, p. 28, Pl. 2, Fig. 7.
1960. *Dentalium novemcostatum mutabilis* Dod.; T. Báldi, pp. 56—57, Pl. 1, Fig. 3.
1960. *Dentalium (Antale) novemcostatum* var. *mutabilis* (Doderlein *in* Hoernes); B. Strachimirov, p. 225, Pl. 53, Fig. 1.
1963. *Dentalium (Antale) novemcostatum mutabile* Doderlein; M. Atanacković, p. 81, Pl. 15, Fig. 10.

Material. — A hundred specimens (fragmentary shells only).
Dimensions. — The largest specimen (Pl. 3, Fig. 8*a*):

length	— 15.5 mm
diameter in the posterior part of shell	— 1.7 mm
diameter in the anterior part of shell	— 2.4 mm

Other specimens:

the smallest diameter at the apical orifice	— 0.4 mm
the largest diameter at the anterior aperture	— 3.0 mm

Description. — The surface of shell is ornamented by conspicuous, longitudinal ribs whose number in the apical part amounts in all specimens to ten (Fig. 4). In this part of shell, the surface between ribs is smooth, but subsequently a few fine striae, one of which gradually increases and turns into a secondary rib, appear between each two ribs. One or two more secondary ribs appear in the same manner in a further part of shell. Apical orifice simple. Neither slit, nor pipe are observed in any of the specimens.

Remarks. — Here assigned specimens are in complete conformity with forms described from the Vienna Basin (Hörnes 1856, Sieber 1959), of which the writer could convince himself when comparing them with specimens from Vöslau. A constant number of primary ribs is a characteristic feature of the specimens from

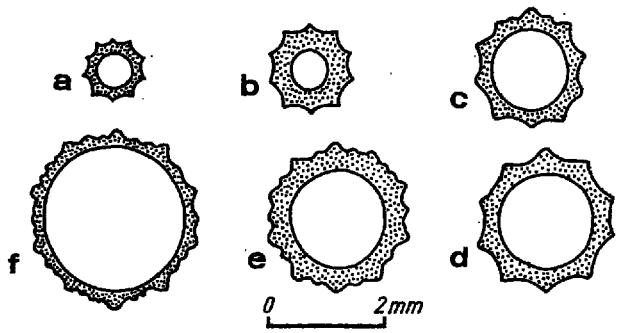

Fig. 4

Transverse sections of *Dentalium (Antalis) mutabile* Hörnes

Korytnica, whereas on the whole this number fluctuates within limits of eight and eleven.

Dentalium (Antalis) mutabile Hörnes has not so far been mentioned by any of the authors from the Korytnica clays. On the other hand, this species is known in Poland from other localities, that is, Gliwice Stare (Quitzow 1921, Friedberg 1928a, Krach 1954), Bogucice (Friedberg 1907, 1928a, 1938, Liszka 1933), Gaszowice (Krach 1939), Małoszów (Michalski 1884, Krach 1947), Benczyn (Krach 1950) and Brzeźnica (Krach 1960).

Dentalium (Antalis) angusticostatum sp. n.
(Pl. 1, Figs 6—8)

Holotype: the specimen presented in Pl. 1, Figs 7*a—b*, lodged in the writer's collection (numbered *BkK-S26*).

Type horizon: Lower Tortonian (Badenian).

Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mts.

Derivation of name: angusticostatum — after a characteristic appearance of its longitudinal ribs.

Diagnosis. — Shell ornamented by eight or nine narrow, sharp ribs, which in the apical part resemble thin lists.

Material. — Five specimens (fragmentary shells only).

Dimensions. — The longest fragment (established as the holotype):

length	—	27.5 mm
diameter at the posterior part of shell	—	2.1 mm
diameter at the anterior part of shell	—	3.9 mm

Other specimens:

the smallest diameter in the posterior part of shell	—	1.0 mm
the largest diameter in the anterior part of shell	—	4.6 mm

When complete, the specimens probably reach about 60 to 70 mm in length.

Description. — Shell large-sized, round in transverse section. Its surface ornamented by sharp, narrow, longitudinal ribs. In the anterior part, the ribs are more prominent and even look like thin lists; further on, they gradually become weaker

and finally disappear (Fig. 5). The surface of shell between ribs, initially smooth, displays with growth one to five slight, longitudinal striae occurring between each two ribs. The terminal section of shell is almost completely smooth with only slightly visible, disappearing ribs and striae. Apical orifice not preserved in any of the specimens found.

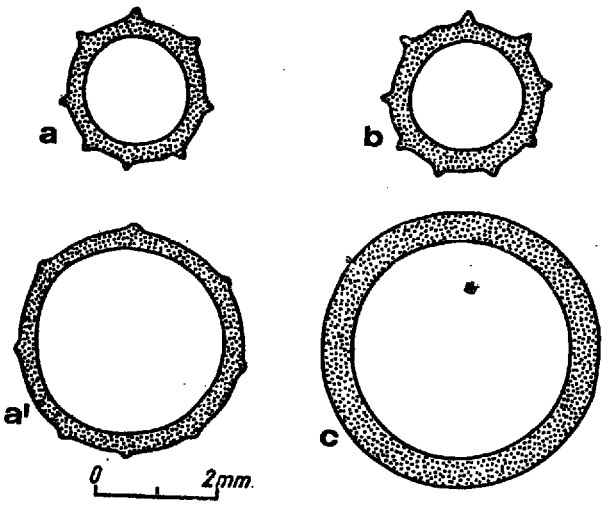

Fig. 5

Transverse sections of *Dentalium (Antalis) angusticostatum* sp. n. (*a, a'* correspond to the holotype)

Remarks. — No species to which the specimens from Korytnica discussed above could be assigned has ever been found by the writer in the available literature concerning both fossil and Recent scaphopods. For this reason he erects for them a new species, *Dentalium (Antalis) angusticostatum* sp. n. It is not unlikely that specimens from the Tortonian of Bulgaria, described by Strachimirov (1960) under the name of *Dentalium (Dentalium) inaequale* var. *rotundatior* Sacco, 1897, should also be assigned to this species. Unfortunately, Strachimirov's illegible illustration (*cf.* Strachimirov 1960, Pl. 52, Fig. 14), does not allow one to find a complete conformity. In the writer's opinion, the Bulgarian specimens are undoubtedly erroneously determined. The shells of *Dentalium (Dentalium) inaequale rotundatior* Sacco are hexagonal in transverse section in the posterior part and subround but with a distinct hexagonal outline in the apertural part. In addition, they have only six primary ribs, between which numerous secondaries occur (*cf.* Sacco 1897; Moroni 1956, p. 12, Pl. 1, Figs 72—74).

A fragment of a specimen found by Docent A. Radwański at Szokolya, Hungary is also assigned by the writer to the newly erected species.

Dentalium (Antalis) korytnicense sp. n.
(Pl. 2, Figs 4—6)

Holotype: the specimen presented in Pl. 2, Figs 4*a*—c, lodged in the writer's collection (numbered *BkK-S28*).

Type horizon: Lower Tortonian (Badenian).

Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mts.

Derivation of name: korytnicense — after the locality Korytnica.

Diagnosis. — Shell small-sized, ornamented by 7—10 longitudinal ribs, three of which always run along the dorsal side, and remaining ones—along the ventral side.

Material. — Seventy-five specimens.

Dimensions. — The largest specimen, established as the holotype:

length	—	3.7 mm
diameter at the apical orifice	—	0.4 mm
diameter at the anterior aperture	—	1.3 mm
arc	—	0.2 mm

Other specimens:

the smallest diameter at the apical orifice (Pl. 2, Fig 6)	—	0.2 mm
the largest diameter at the anterior aperture	—	1.5 mm

Description. — Shell small-sized. At the apex, shell is round in transverse section and in a further part angular. Longitudinal ribs, running along the entire shell, make up the ornamentation. Initially, at the apex, the ribs are very slight and hardly visible at all. Further on, they rapidly become very prominent and near the anterior aperture they become weaker (Fig. 6). The variable number of ribs is mostly eight or nine, but there are also exceptional specimens with either seven or ten ribs (Fig. 7). The ribs are very characteristically distributed over the

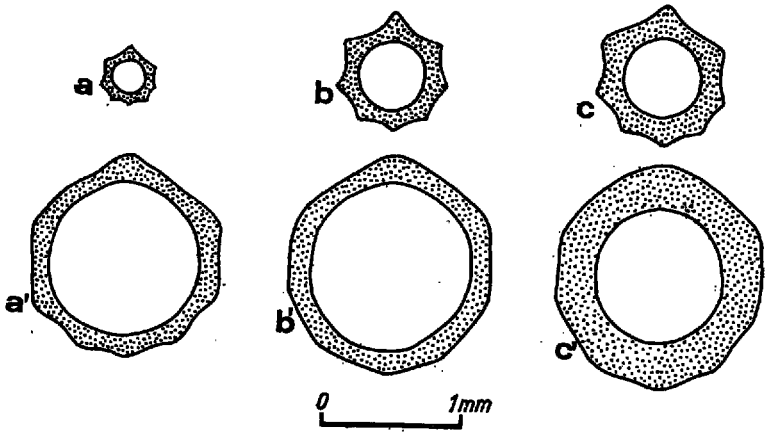

Fig. 6

Transverse sections of the three specimens of *Dentalium* (*Antalis*) *korytnicense* sp. n. showing a fainting of longitudinal ribs at the anterior part of the shell (*a*, *a'* correspond to the holotype)

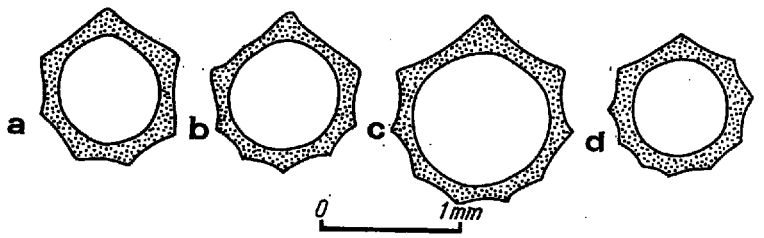

Fig. 7

Transverse sections of *Dentalium (Antalis) korytnicense* sp. n., showing varying number of longitudinal ribs

surface of shell. Three ribs always run on the dorsal and the remaining ones occur on the ventral side. For this reason the distances between particular ribs are larger on the dorsal side. Of the dorsal ribs the central one is usually situated nearer one of the lateral ones and hence an asymmetrical outline of the shell in transverse section. The surface of shell between ribs is usually smooth, with only growth lines marked on it. Sometimes, however, delicate, longitudinal striae are also visible. Some of them are more prominent and may, therefore, be considered as secondary ribs. Apical orifice simple, without any slit or tube.

Remarks. — No description of a species to which the above described specimens from Korytnica might be assigned, has ever been found by the writer in the available literature on both fossil and Recent scaphopods. For this reason he erects for them a new species. Assigning this species to an appropriate genus is a separate and very difficult problem. In this respect, there are two possibilities: to assign it either to the genus *Entalina* Monterosato 1872, or to the subgenus *Antalis* H. Adams & A. Adams, 1854, which occurs within the genus *Dentalium* Linnaeus, 1758. Unfortunately, it is not in all cases that the two forms may be correctly distinguished on the basis of the shell alone, since fundamental differences between them consist in their different anatomies, in particular the structure of the foot and radula (Emerson 1962). Here described specimens have been assigned by the writer to the subgenus *Antalis*, but their small dimensions and a conspicuously different development of the shell on its dorsal and ventral sides arouse certain doubts concerning the correctness of such a standpoint.

Genus *FUSTIARIA* Stoliczka, 1868
Subgenus *EPISIPHON* Pilsbry & Sharp, 1897
Fustiaria (Episiphon) jani (Hörnes, 1856)
(Pl. 5, Figs 1—5)

1856. *Dentalium Jani* Hörn.; M. Hörnes, pp. 657—658, Pl. 50, Fig. 37.
1897. *Fustiaria Jani* (Hörn.); F. Sacco, pp. 112—113, Pl. 10, Figs 24—27.
1917. *Fustiaria Jani* (Hoernes); M. Cossmann & A. Peyrot, pp. 17—18, Pl. 1, Figs 46—49.
1928. *Fustiaria Jani* Hoern.; W. Friedberg, pp. 561—562, Pl. 36, Figs 28—29.
1947. *Dentalium (Laevidentalium) jani* Hoern.; A. F. Tauber, p. 301, Abb. 7, Figs 5—7.
1956. *Dentalium jani* Hoernes; M. A. Moroni, p. 122, Pl. 12, Figs 69—70.
1960. *Fustiaria jani* (Hoern.); T. Báldi, p. 55, Pl. 1, Fig. 4.
1960. *Fustiaria jani* (Hoernes); B. Strachimirov, p. 226, Pl. 52, Fig. 21.
1962. *Dentalium (Fustiaria) jani* Hörn.; E. Caprotti, pp. 95—96, Pl. 16, Fig. 8.
1968. *Fustiaria (Fustiaria) jani* (Hoernes); E. Robba, pp. 503—504, Pl. 9, Fig. 5.

Material. — Eighty specimens, mostly fragmentary shells.

Dimensions. — The largest specimen:

length	—	15.0 mm
diameter in the posterior part of shell	—	1.4 mm
diameter in the anterior part of shell	—	1.8 mm

Other specimens:

the smallest diameter at the apical orifice	—	0.3 mm
the largest diameter at the anterior aperture	—	1.9 mm

Description. — Shell small-sized, in the form of a slightly bent tube somewhat laterally flattened and, consequently, elliptically outlined in transverse section. Closely spaced annular swellings form the ornamentation. Their width is variable, but in younger specimens they are always considerably narrower than in the adults. In

shells to 0.5 mm in diameter, 20 to 30 annular swellings occur per 1 mm of length, while in the adults there are only ten or even less of them. In young specimens, the apical orifice is simple, whereas in older ones shell is strongly truncated posteriorly and provided with a very short pipe (Pl. 5, Fig. 5).

Remarks. — The species under study is undoubtedly among the most common scaphopods met with in the Neogene deposits of Europe. A decided majority of all explorers (*cf.* synonymy) assign it to *Fustiaria* Stoliczka, 1868, a taxon considered as an independent genus or as a subgenus within the genus *Dentalium* Linnaeus, 1758. Recently, some of them (Robba 1968) assign it even to the subgenus *Fustiaria* sensu stricto. In doing so, all of them base their considerations on the character of the ornamentation of shell. Such a standpoint is not, however, completely correct, since it disregards the development of the apical part of shell. Forms belonging to *Fustiaria* Stoliczka have on their ventral side a very long and narrow slit in the apical part of shell. On the other hand, such a structure of shell have not been given by any of the researchers, describing Hörnes' species under study. Likewise, no such structure may be observed on their illustrations. The studies on the shells of this species found at Korytnica have convinced the writer that the structure of the apical orifice was quite different (*cf.* description). It is, therefore, for this reason that this species should be assigned to *Episiphon* Pilsbry & Sharp, 1897. Incidentally, the taxonomic position of this taxon is variously understood. According to Ludbrook (1960), *Episiphon* Pilsbry & Sharp, much the same as *Fustiaria* Stoliczka, are subgenera within *Dentalium* Linnaeus. On the other hand, Emerson (1962) extends the range of *Fustiaria* Stoliczka, recognizing it as an independent genus and including in it, as one of the subgenera, *Episiphon* Pilsbry & Sharp.

Outside of Korytnica, this species has not so far been known in Poland. At Korytnica, it was recorded by Friedberg (1928a, 1938) and Kowalewski (1930).

No representative of the subgenus *Episiphon* Pilsbry & Sharp lives recently in European seas. Forms with shells similar to those of the Neogene species *Fustiaria (Episiphon) jani* (Hörnes), are at present met with in warm seas, e.g., *Episiphon sowerbyi sowerbyi* Guilding, 1834, which occurs in the coastal parts of the Gulf of Mexico (Henderson 1920).

Fustiaria (Episiphon) miocaenica (Boettger, 1901)
(Pl. 4, Figs 1—12)

1901. *Pulsellum miocaenicum* sp. n.; O. Boettger, p. 182, No. 567.
1934. *Siphonodentalium (Pulsellum) miocaenicum* (Boettger); A. Zilch, p. 279, Pl. 22, Fig. 27.

Material. — About 1,000 specimens.

Dimensions. — The largest specimen:

length	—	15.5 mm
diameter at the apical orifice	—	1.0 mm
diameter at the anterior aperture	—	1.3 mm
arc	—	0.8 mm

Other specimens:

the smallest diameter at the apical orifice	—	0.15 mm
the largest diameter at the anterior aperture	—	1.4 mm
the largest length of pipe	—	2.8 mm

Description. — Shell small-sized, shaped like a moderately curved and slightly flattened laterally tube. The surface of shell completely smooth and lustrous. Growth

lines almost completely invisible. Sometimes, irregularly distributed encircling grooves are marked which correspond to the position of aperture during a periodical growth arrest (Pl. 4, Fig. 12*a*). The margin of aperture is slightly oblique to the axis of shell and the dorsal part of aperture is shoved forward. In very young individuals, the apical orifice is simple (Pl. 4, Fig. 1), in somewhat older ones the posterior end of shell is sharply truncated and provided with a thin-walled pipe (Pl. 4, Figs 11*a*—*b*), which, however, is not always preserved. The length of pipe is variable, but on the whole not exceeding 0.5 mm and specimens with pipes longer than 2.0 mm are unique (Pl. 4, Fig. 9).

Remarks. — Here assigned specimens from Korytnica are quite identical with those described by Boettger (1901) from Kostej and Lapugy in Transylvania. So far, these localities are the only places of this species occurrence.

At present, forms very similar to *Fustiaria (Episiphon) miocaenica* (Boettger) live in warm seas, e.g.: *Episiphon sowerbyi pelliceri* Henderson, 1920, abundantly occurs in the region of the Gulf of Mexico (Henderson 1920) and *Episiphon bordaensis* Cotton & Ludbrook, 1938 — at southern coasts of Australia (Cotton & Ludbrook, 1938).

Family **Siphonodentaliidae** Simroth, 1894
Genus *ENTALINA* Monterosato, 1872
Entalina tetragona (Brocchi, 1814)
(Pl. 5, Figs 6—8)

1856. *Dentalium tetragonum* Brocc.; M. Hörnes, pp. 655—656, Pl. 50, Fig. 34.
1897. *Entalina tetragona* (Br.); F. Sacco, p. 114, Pl. 10, Figs 47—53.
1938. *Dentalium tetragonum* Brocc.; W. Friedberg, pp. 43—44, Fig. 7.
1947. *Entalina tetragona* Brocc.; A. F. Tauber, p. 301, Abb. 7, Figs 1—4.
1957. *Dentalium tetragonum* Brocc.; W. Krach, p. 39, Pl. 1, Fig. 2.
1960. *Entalina tetragona* (Brocc.); T. Báldi. p. 58, Pl. 1, Fig. 6.
1960. *Pulsellum (Entalina) tetragona* (Brocchi); B. Strachimirov, p. 227, Pl. 53, Fig. 2.
1961. *Entalina tetragona* (Brocchi); E. Caprotti, pp. 356—357, Pl. 20, Figs 7—8.
1968. *Entalina tetragona* (Brocchi); E. Robba, p. 505, Pl. 39, Fig. 6.

Material. — Twelve specimens.

Dimensions. — The longest specimen:

length	—	8.0 mm
diameter at the apical orifice	—	0.3 mm
width at the anterior aperture	—	1.1 mm

Other specimens:

the smallest diameter at the apical orifice	—	0.2 mm
the largest diameter at the anterior aperture	—	1.4 mm

Description. — Shell small-sized, rather strongly curved. In young specimens, the outline of shell at the very apex is rounded in transverse section, but it is already not very far from the apex that it takes a pentagonal shape. In the adults, the outline of shell in transverse section becomes trapezoidal (Fig. 8) as a result of the disappearance of a ridge which runs over the middle of the dorsal side of shell. Longitudinal riblets make up the ornamentation. At first, five very delicate ribs appear at the apex and run further along the ridge on the shell. Two of them, running along the ridges on the ventral side of shell, are more prominent. A rib, running along the ridge through the middle of the dorsal side is the least prominent and separates distinctly only in the younger part of shell. The surface of shell

between the ridges is at first flat and further somewhat convex and ornamented by numerous, longitudinal riblets, which almost do not differ at all from those running along the ridge. The number of ribs increases with the growth of shell. A total number of ribs on the largest grown specimen amounts to 28. Apical orifice simple.

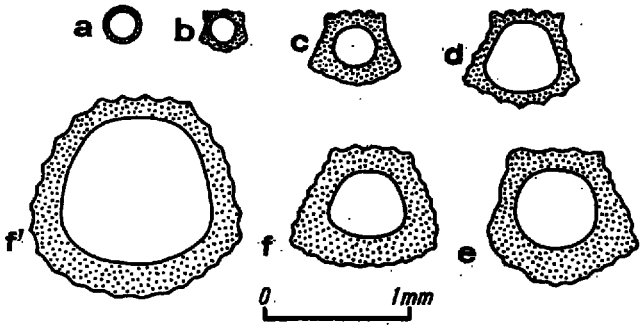

Fig. 8

Transverse sections of *Entalina tetragona* (Brocchi); *f*, *f'* correspond to the same specimen

Remarks. — The specimens from Korytnica are in complete conformity with those, described by Friedberg (1938) from Grudna Dolna and seem also not to depart from those described from the Vienna Basin.

On the basis of a single specimen, the species *Dentalium (Entalina) anomalum* Cossmann & Peyrot was described from the Miocene of Aquitaine by Cossmann & Peyrot (1917). In the opinion of these authors, it is supposed to differ from Brocchi's species. The difference they specify do not seem, however, to be great, but without a direct comparison of the specimens it is difficult to express one's opinion on this species' conformity with the specimens from Korytnica.

The species *Entalina quinquangularis* (Forbes), which perhaps should be considered as a descendant of the species *Entalina tetragona* (Brocchi), lives now in European seas (Benthem Jutting 1926, Stork 1934, Riedl 1963). The views on the mutual relationship of the two species vary among the researches of the scaphopods. Describing *Entalina quinquangularis* (Forbes) from the Adriatic Sea, Stork (1934) excludes from the synonymy the species *Dentalium tetragonum* Brocchi, 1814. Quite different is the view of Emerson (1962), who, presenting *Entalina tetragona* (Brocchi) as a type species of *Entalina* Monterosato, considers it as identical with Forbes' species mentioned above.

The species *Entalina tetragona* (Brocchi) has not so far been known from Korytnica. On the other hand, it happened to be found at Wieliczka (Reuss 1867), Bogucice (Liszka 1933), Grudna Dolna (Friedberg 1938) and Andrychów (Krach 1956).

Genus *CADULUS* Philippi, 1844
Subgenus *DISCHIDES* Jeffreys, 1867
Cadulus (Dischides) fibula (Boettger, 1906)
(Pl. 5, Figs 14—15)

1897. *Discides bifissus* (S. Wood) (an *Discides politus* (S. Wood); F. Sacco, p. 115, Pl. 10, Figs 56—58.

1906. *Gadila fibula* n. sp.; O. Boettger, p. 212, No. 713.

1917. *Siphonodentalium (Dischides) subpolitum* nom. mut.; M. Cossmann & A. Peyrot, pp. 29—30, Pl. 2, Figs 8—10.
1928. *Siphonodentalium bifissum* S. Wood; W. Friedberg, p. 562, Pl. 36, Fig. 30.
1934. *Cadulus (Gadila) fibula* (Boettger); A. Zilch, p. 278, Pl. 22, Fig. 24.

Material. — Twenty-eight specimens.

Dimensions. — The largest, complete specimen:

length	—	7.0 mm
diameter at the apical orifice	—	0.4 mm
diameter at the anterior aperture	—	0.8 mm

Other specimens:

the smallest diameter at the apical orifice	—	0.3 mm
the largest diameter at the anterior aperture	—	0.9 mm

Description. — Shell small, shaped like a slightly inflated and somewhat dorsoventrally flattened tube. The largest diameter of shell occurs somewhat before the apertural rim. The surface of shell is quite smooth, with only hardly discernible, fine growth lines marked on it. Anterior aperture slightly constricted, with its margin somewhat oblique to the axis of shell. Apex cut by two wide, V-shaped lateral slits, one on each side. Due to these slits, the apical rim consists of two lobes, of which the ventral one is longer.

Remarks. — Here assigned specimens seem to be in a complete conformity with forms described by previous authors (*cf.* synonymy).

The species has not so far been known from Poland. It was described by Friedberg (1928a) from Volhynia and Podolia.

Cadulus (Dischides) bifissum (S. Wood), which probably may be considered as a descendant of the Miocene species *Cadulus (Dischides) fibula* (Boettger), lives now in European seas (Mediterranean, Eastern Atlantic). The differences between the two species mostly amount to a stronger constriction of the aperture and narrower slits observed in the Recent species (*cf.* Emerson 1962, Pl. 80, Fig. 3).

Cadulus (Dischides) ornatus sp. n.
(Pl. 5, Figs 9—13)

Holotype: the specimen presented in Pl. 5, Fig. 10, lodged in the writer's collection (numbered *BkK-S54*).

Type horizon: Lower Tortonian (Badenian).

Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mts.

Derivation of name: ornatus — after an ornamented surface of its shell.

Diagnosis. — The surface of shell covered with closely spaced, fine, longitudinal striae.

Material. — Twenty-five specimens.

Dimensions. — The largest complete specimen, established as the holotype:

length	—	5.6 mm
diameter at the apical orifice	—	0.3 mm
diameter at the anterior aperture	—	0.7 mm
arc	—	0.5 mm

Other specimens:

the largest diameter at the anterior aperture	—	0.9 mm

Description. — Shell small, shaped like a slightly inflated and very slightly dorsoventrally flattened tube. The largest diameter of shell occurs somewhat before the apertural rim. The surface of shell ornamented by numerous, closely spaced,

fine, longitudinal riblets (or striae). The ornamentation usually appears at a small distance from apex and disappears close to the apertural rim. Anterior aperture slightly constricted, with its margin oblique to the axis of shell. The dorsal part of aperture is shoved forward. Apex cut by two, wide, *V*-shaped, lateral slits, one on each side and, consequently, the apical rim consists of two lobes, of which the ventral one is longer.

Remarks. — As compared with the above described, the species *Cadulus (Dischides) ornatus* sp. n. has an ornamented and more strongly curved shell. The presence of two lateral slits at its apex is a character decisive as to assigning this species to the subgenus *Dischides* Jeffreys, 1867, although no longitudinal sculpture (Emerson, 1962, p. 478) has hitherto been found in the representatives of this subgenus. *Striocadulus* Emerson, 1962, an only subgenus of the genus *Cadulus* Philippi, 1844, having a longitudinal striation, differs in considerably larger dimensions of shell and a simple apical orifice without lateral slits.

A COMPARISON WITH OTHER SCAPHOPOD ASSEMBLAGES FROM THE MIOCENE OF EUROPE

In the faunal communities, which lived in the Miocene seas of Europe, scaphopods were common animals. In principle they lived everywhere, where the sea bottom was composed of clay, silt or fine sand and where the water had an adequately high degree of salinity. This is the reason why their shells are relatively frequently met with in this age deposits. However, the scaphopods on the whole make up a secondary element of faunal assemblages, concerning the number of both species and individuals. Only exceptional are the localities in which the scaphopods are a predominant element. Of such localities we can name in fact only the clays from Višnjica, Yugoslavia (*cf.* Luković 1922) and the sandy marls from Szokolya, Hungary (*cf.* Báldi 1961). The former contain exceptionally abundant shells of *Dentalium (Antalis) badense* Partsch. At Szokolya, sandy marls with many scaphopods, termed by Báldi (1961) Pteropod-Dentalian marls, overlay *Pleurotoma* clays.

In a vast majority of localities, scaphopod assemblages are only slightly differentiated, which is expressed in a relatively small number of species. The localities, in which the assemblages consist of ten or more species, are also among the exceptional ones. The greatest variability of these animals is always observed in the deposits of the facies of *Pleurotoma* clays.

The presence of scaphopods in the Tortonian deposits of Poland was found in many localities (*cf.* Table 1 and Fig. 9). However, such a rich and varied assemblage as that at Korytnica have never been found elsewhere. The number of species in particular localities always fluctuates between one and four only. These are mostly species, which also occur at Korytnica, but *Dentalium vitreum* Schroeter was also found in addition to them.

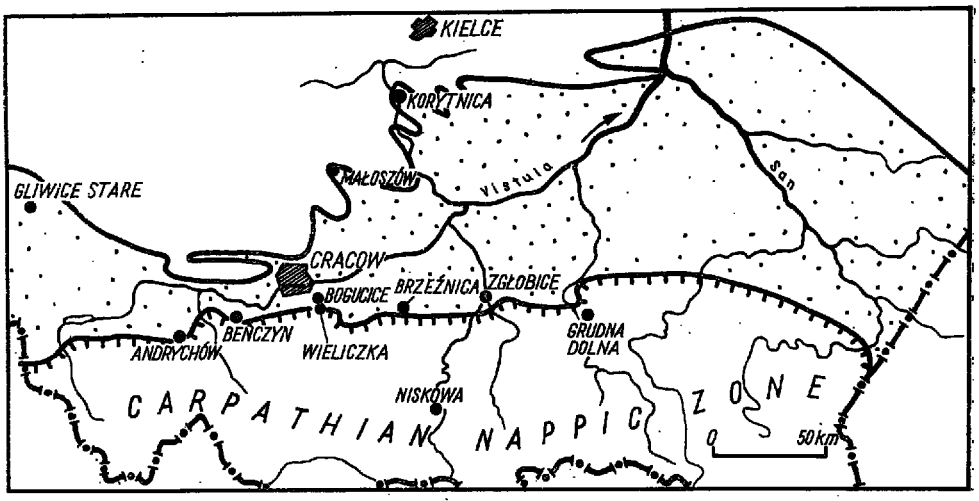

Fig. 9

Locality map of the scaphopod-bearing localities in the Tortonian deposits of Southern Poland (referenced bibliography given in explanation of Table 1)

Stippled is the area of the fore-Carpathian depression; two localities are situated within the Carpathian nappic zone

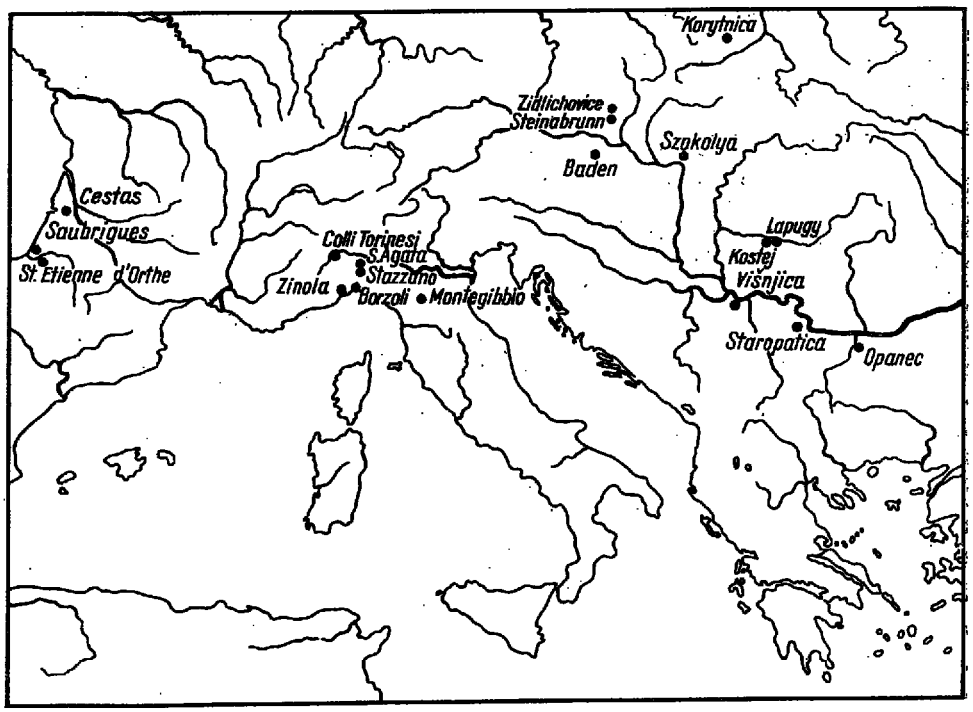

Fig. 10

The most important localities of the scaphopod fauna in the Miocene deposits of Europe

Compiled on the data presented by: Hörnes (1856), Procházka (1893), Sacco (1897), Boettger (1901, 1906), Cossmann & Peyrot (1917), Sieber (1953), Strachimirov (1960), Báldi (1961)

The Tortonian of Poland is closely related paleogeographically with the Miocene of the Vienna Basin or, more broadly speaking, with the Miocene of the Vienna type, in which, *i.a.* also the Miocene of Bohemia, Hungary, Transylvania and Western Bulgaria is included. This relationship is reflected in a great similarity of faunal assemblages (*cf.* also Bałuk 1971), including the similarity of the scaphopods (Table 2 and Fig. 10). Among all localities of the Vienna-type Miocene, the scaphopod assemblage from Korytnica is the most strongly differentiated and includes thirteen species. Apart from new species, all the remaining ones

Table 1

Scaphopods from the Korytnica clays and their occurrence in other Tortonian localities in Poland

Species	Sampling localities of the Korytnica clays at Korytnica and Karsy /cf. Fig.1/: A	B	E	Gliwice Stare	Mazosze	Andrychów	Benosyn	Bogucice	Wieliczka	Bresnica	Zgłobice	Niskowa	Grudna Dolna
Dentalium /Dentalium/ michelottii Hörnes	.	.	+	.	.	.	.	+	.	.	.	.	.
Dentalium /Dentalium/ subpriscatticum sp.n.	.	.	+	.	.	.	.	.	.	.	.	.	.
Dentalium /Antalis/ badense Partsch . . .	.	.	+	.	+	+	+	.	.	.	+	.	.
Dentalium /Antalis/ fossile Schroeter . .	+	+	.	.	+	.	.	+	.	.	.	.	.
Dentalium /Antalis/ dentale Linnaeus . . .	+	.	.	.	.	.	.	.	.	.	.	+	.
Dentalium /Antalis/ mutabile Hörnes . . .	.	.	+	+	+	.	+	+	.	+	.	.	.
Dentalium /Antalis/ sexangulostatum sp.n.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dentalium /Antalis/ korytnicense sp.n. . .	+	+	.	.	.	.	.	.	.	.	.	.	.
Fustiaria /Episiphon/ jani /Hörnes/ . . .	+	.	+	.	.	.	.	.	.	.	.	.	.
Fustiaria /Episiphon/ miocenica /Boettger/	+	+	.	.	.	.	.	.	.	.	.	.	.
Entalina tetragona /Brocchi/	+	.	+	.	.	+	.	+	+	.	.	.	+
Cadulus /Dischides/ fibula /Boettger/ . .	+	+	.	+	.	.	.	.	.	.	.	.	.
Cadulus /Dischides/ ornatus sp.n.	+	+	.	.	.	.	.	.	.	.	.	.	.
Other species				1	–	1	1	–	1	–	–	1	–
Total number of species				3	3	3	3	4	2	1	1	2	1

The data for particular localities (*cf.* Fig. 9) taken from the referenced papers (Reuss 1867; Michalski 1884; Friedberg 1907, 1928a, 1938; Quitzow 1931; Kowalewski 1930; Skoczylasówna 1930; Liszka 1933; Krach 1947, 1950, 1954, 1957, 1960; Bałuk 1970)

are known from other localities of the Vienna Miocene (Hörnes 1856, Sieber 1959). The greatest similarity occurs between the assemblages from Korytnica and Kostej, Transylvania, which contain seven common species as compared to a total of twelve species known at all from Kostej. The assemblages from Baden, Szokolya, Lapugy and Opanec have each five or six species in common with that from Korytnica. Of the list shown in Table 2, it is obvious that all assemblages of scaphopods from the Miocene of the Vienna type are similar to each other. Here, we may generalize and state that this is an assemblage very characteristic of the deposits of this part of European Miocene sea.

Table 2

Scaphopods from the Korytnica clays and their occurrence in more important Miocene localities in Europe

Species of the Korytnica assemblage	Vienna type of the Miocene									Northern Italy						Aquitaine				NW Germany	
	Zdiichovice	Steinabrunn	Pötzleinsdorf	Baden	Szokolya	Kostej	Lapugy	Opanac	Staropatics	Colli Torinesi	Zinola	St. Agata	Stazzano	Borzoli	Montegibbio	Saubrigues	Saint Etienne	Payrère	Cestas	Hoeretogen	Hemmoor
Dentalium /Dentalium/ michelottii Hörnes	+	•	•	+	•	+	•	•	+	+	+	+	+	+	•	•	•	•	•	+	+
Dentalium /Dentalium/ subpriscatiocum sp.n.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Dentalium /Antalis/ badense Partsch	+	+	•	+	+	+	+	+	+	+	•	•	•	•	•	+	•	•	•	+	+
Dentalium /Antalis/ fossile Schroeter	•	+	?	+	+	+	+	+	•	•	+	+	+	•	+	+	•	•	•	•	•
Dentalium /Antalis/ dentale Linnaeus	•	•	?	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Dentalium /Antalis/ mutabile Hörnes	+	+	+	•	+	•	•	+	•	•	•	+	•	+	•	•	•	+	•	•	+
Dentalium /Antalis/ angusticostatum sp.n.	•	•	•	•	/?/	•	•	?	•	•	•	•	•	•	•	•	•	•	•	•	•
Dentalium /Antalis/ korytnicense sp.n.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Fustiaria /Episiphon/ jani /Hörnes/	•	+	•	+	+	+	+	+	+	•	+	+	+	+	+	+	+	•	•	•	•
Fustiaria /Episiphon/ miocaenica /Boettger/	•	•	•	•	•	+	+	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Entalina tetragona /Brocchi/	+	•	•	+	+	+	+	+	•	+	+	•	+	+	+	•	•	•	•	•	•
Cadulus /Dischides/ fibula /Boettger/	•	•	•	•	•	+	•	•	•	•	•	•	•	•	•	•	•	•	+	•	•
Cadulus /Dischides/ ornatus sp.n.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Other species	1	1	–	3	2	5	3	3	1	15	10	12	9	8	9	5	7	4	3	4	3
Total number of species	5	5	3	8	7	12	8	9	4	13	14	16	13	12	12	8	8	5	4	6	6

The data for particular localities (*cf.* Fig. 10) taken from the referenced papers (Hörnes 1856; Procházka 1893; Sacco 1897; Boettger 1901, 1906; Cossmann & Peyrot 1917; Kautsky 1925; Sieber 1953; Seifert 1959; Báldi 1980; Strachimirov 1966)

The comparison of the scaphopods from Korytnica with the Miocene assemblages of Northern Italy (Table 2) reveals that here the similarity is considerably smaller. The assemblages, described from North Italian localities (Sacco 1897), are much more strongly differentiated. The number of species in the most important of them is higher and fluctuates between twelve and sixteen, but the number of species common with Korytnica amounts only to three or four, although a total number of common forms amounts to seven. On the other hand, the Miocene of Northern Italy contains numerous species which are completely absent from the Vienna Miocene. A considerable difference in scaphopod assemblages of these areas gives ample evidence for the lack of a broad connection between both aquena of the Miocene sea.

Much less analogies occur with the comparison of the assemblage under study with those described from the Miocene of Aquitaine (*cf.* Cossmann & Peyrot, 1917). From this area only five species are common with those occurring at Korytnica, their number in particular localities fluctuating between one and three.

The comparisons presented above seem to indicate that assemblages connected with definite aquena may be distinguished from the scaphopods which lived in European Miocene seas. Particularly strongly differentiated are the assemblages of the Vienna and Italian Miocene. Each assemblage contains species which are characteristic only of it, as well as forms which are common in all assemblages, that is, cosmopolitan ones. The latter include, for instance, *Fustiaria (Episiphon) jani* Hörnes, *Dentalium (Antalis) mutabile* Hörnes and *Dentalium (Antalis) badense* Partsch. The two last-named species are also known from the Miocene of Northern Germany and Denmark (Kautsky 1925, Seifert 1959, Anderson 1964, Rasmussen 1968).

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ŁÓDKONOGI Z IŁÓW KORYTNICKICH

(Streszczenie)

W dolnotortońskich iłach pleurotomowych okolic Korytnicy występuje bogaty zespół łódkonogów, których skorupki spotyka się w obrębie całego profilu iłów. Szczególnie liczne i najbardziej zróżnicowane zespoły łódkonogów znaleziono w trzech próbkach (*por.* fig. 1 oraz tab. 1).

W skład zespołu łódkonogów z Korytnicy (*por.* fig. 2—8 oraz pl. 1—6) wchodzi ogółem 13 gatunków; obok 4 dotychczas znanych stąd gatunków (*por.* Friedberg 1928a) znaleziono 9 dalszych, z których 4 są dla nauki nowe: *Dentalium (Dentalium) subprismaticum* sp. n., *Dentalium (Antalis) angusticostatum* sp. n., *Dentalium (Antalis) korytnicense* sp. n., oraz *Cadulus (Dischides) ornatus* sp. n. Częstość występowania poszczególnych gatunków łódkonogów w iłach korytnickich jest bardzo różna. Skorupki niektórych, jak np. *Dentalium (Antalis) dentale* Linnaeus czy *Dentalium (Antalis) angusticostatum* sp. n., stanowią duże rzadkości, inne zaś, jak *Dentalium (Antalis) fossile* Schroeter czy *Fustiaria (Episiphon) miocaenica* (Boettger), są niezmiernie pospolite. Zauważono, że występowanie szeregu gatunków jest ściśle związane z określonym wykształceniem litologicznym iłów.

Opisany zespół jest najbogatszym spośród znanych w tortonie Polski (*por.* fig. 9 oraz tab. 1). Pod względem liczby gatunków przewyższa on także wszystkie znane zespoły ze stanowisk miocenu typu wiedeńskiego, natomiast pod względem składu

wykazuje względem nich uderzające podobieństwo (*por.* fig. 10 oraz tab. 2). W innych rejonach europejskiego miocenu (*por.* tab. 2) zespoły łódkonogów były odmienne, chociaż obok gatunków właściwych dla poszczególnych akwenów żyły tam także formy kosmopolityczne.

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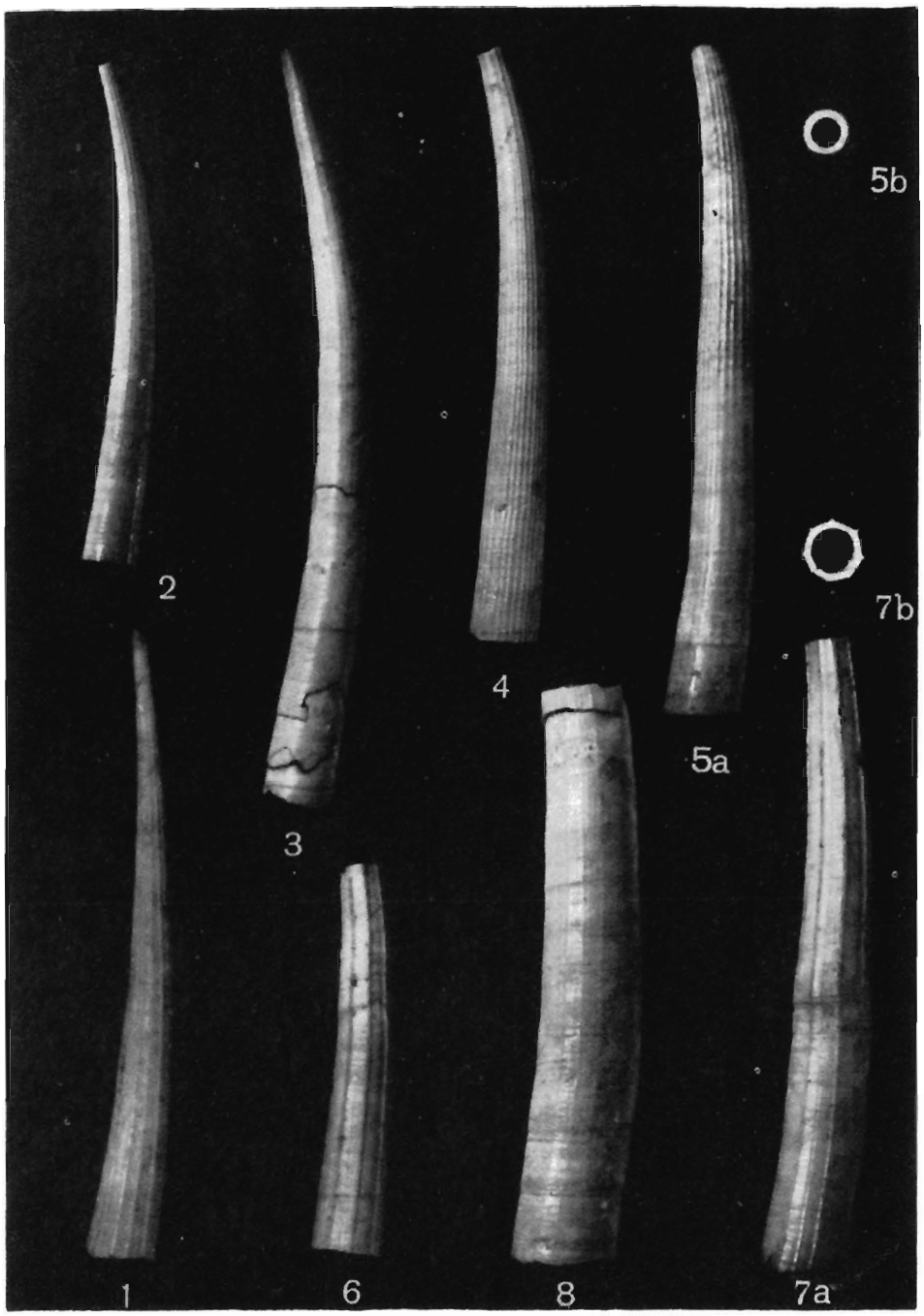
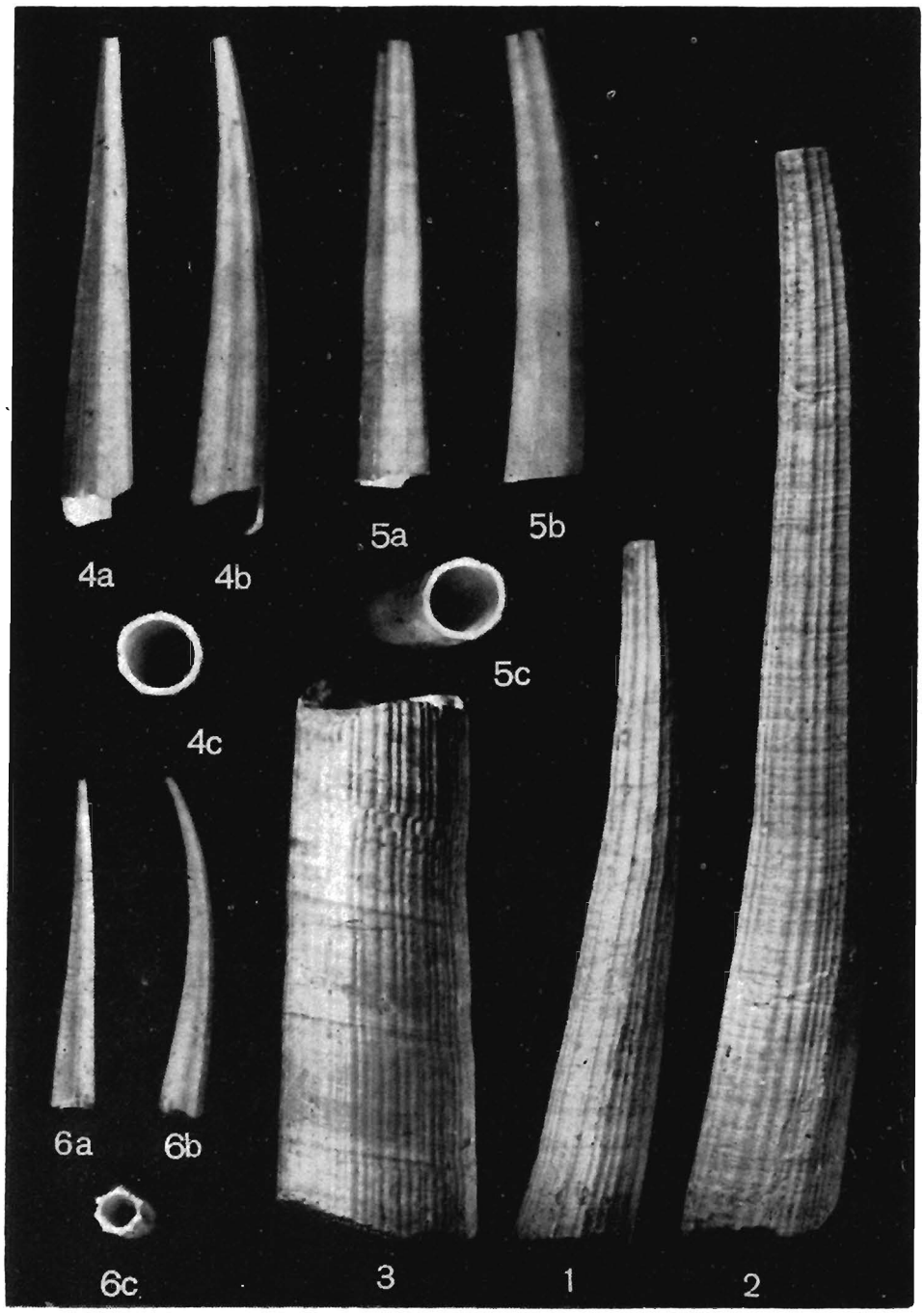
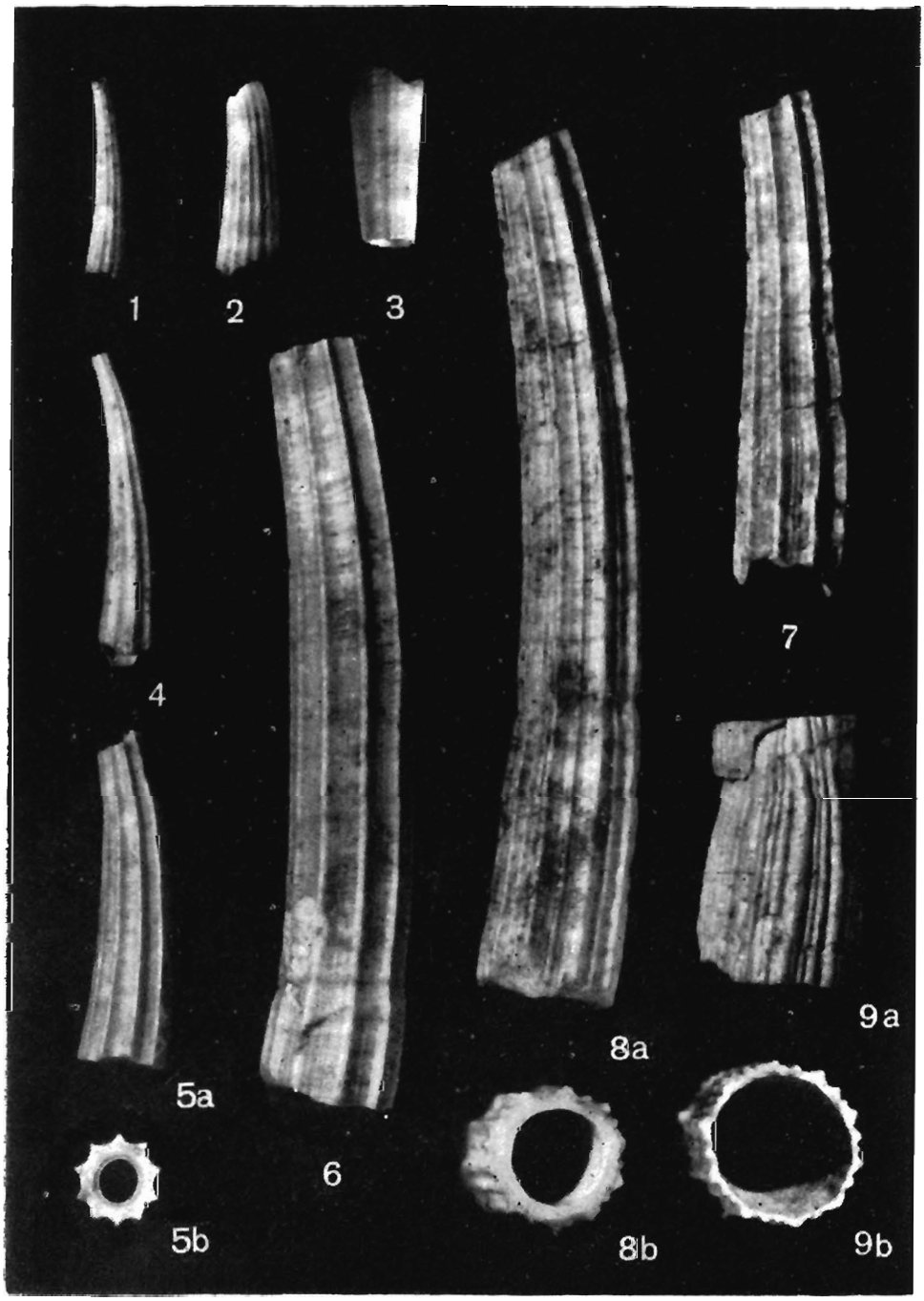


1-5 — *Dentalium (Antalis) fossile* Schroeter; *1—4, 5a* side view, *5b* transverse section.
6-8 — *Dentalium (Antalis) angusticostatum* sp. n.; *6, 7a, 8* side view, *7b* transverse section (*7* presents the holotype).
Fig. 1 × 8, Figs 2—8 × 3; taken by L. Łuszczewska, M. Sc.

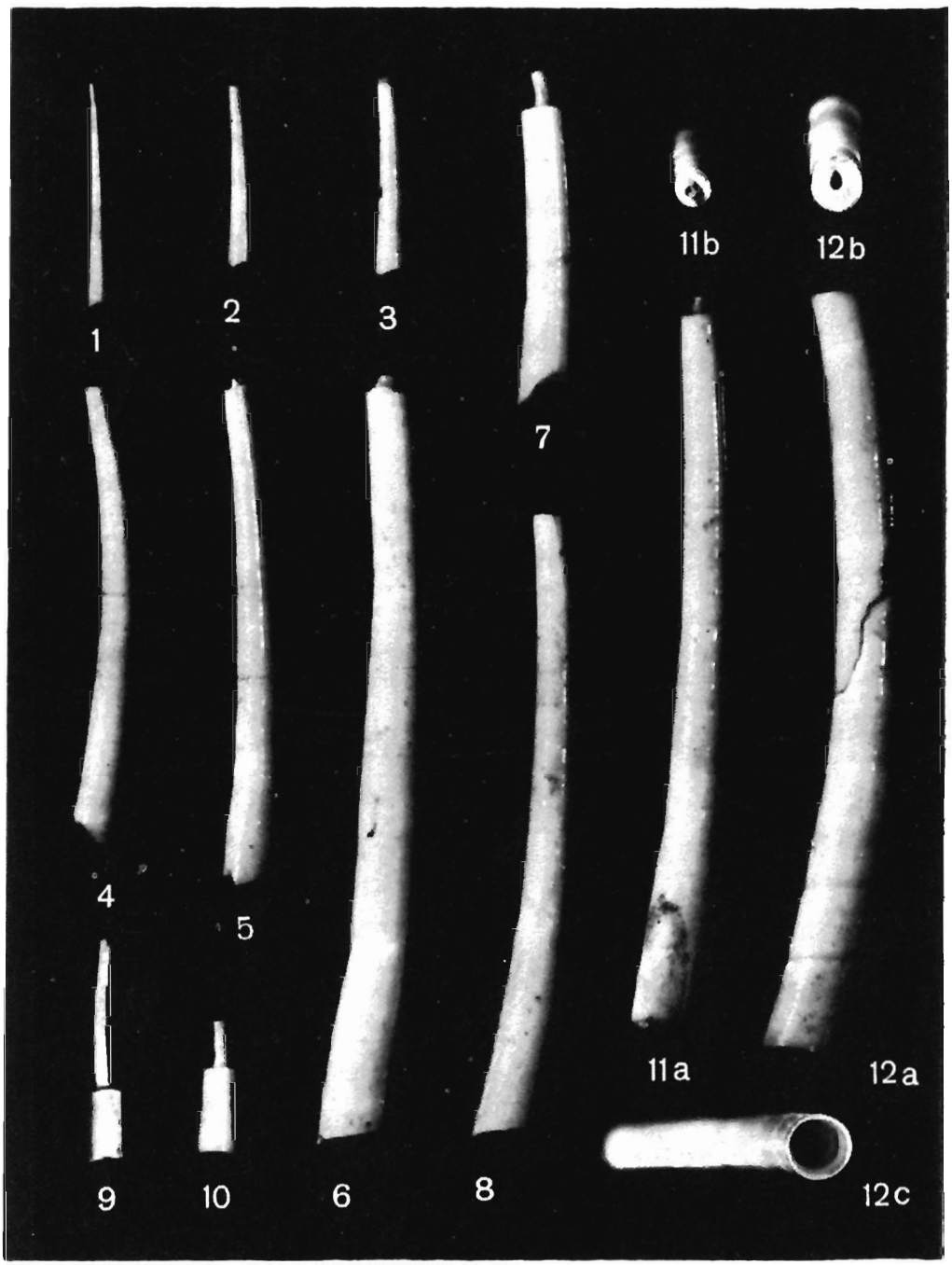


1-3 — *Dentalium (Antalis) badense* Partsch *in* Hörnes; side view.
4-6 — *Dentalium (Antalis) korytnicense* sp. n.; *4b*, *5b*, *6b* side view; *4a*, *6a* dorsal view, *5a* ventral view, *4c*, *5c*, *6c* transverse section (*4* presents the holotype).
Figs 1—3 × 3, Figs 4—6 × 8; taken by L. Łuszczewska, M. Sc.

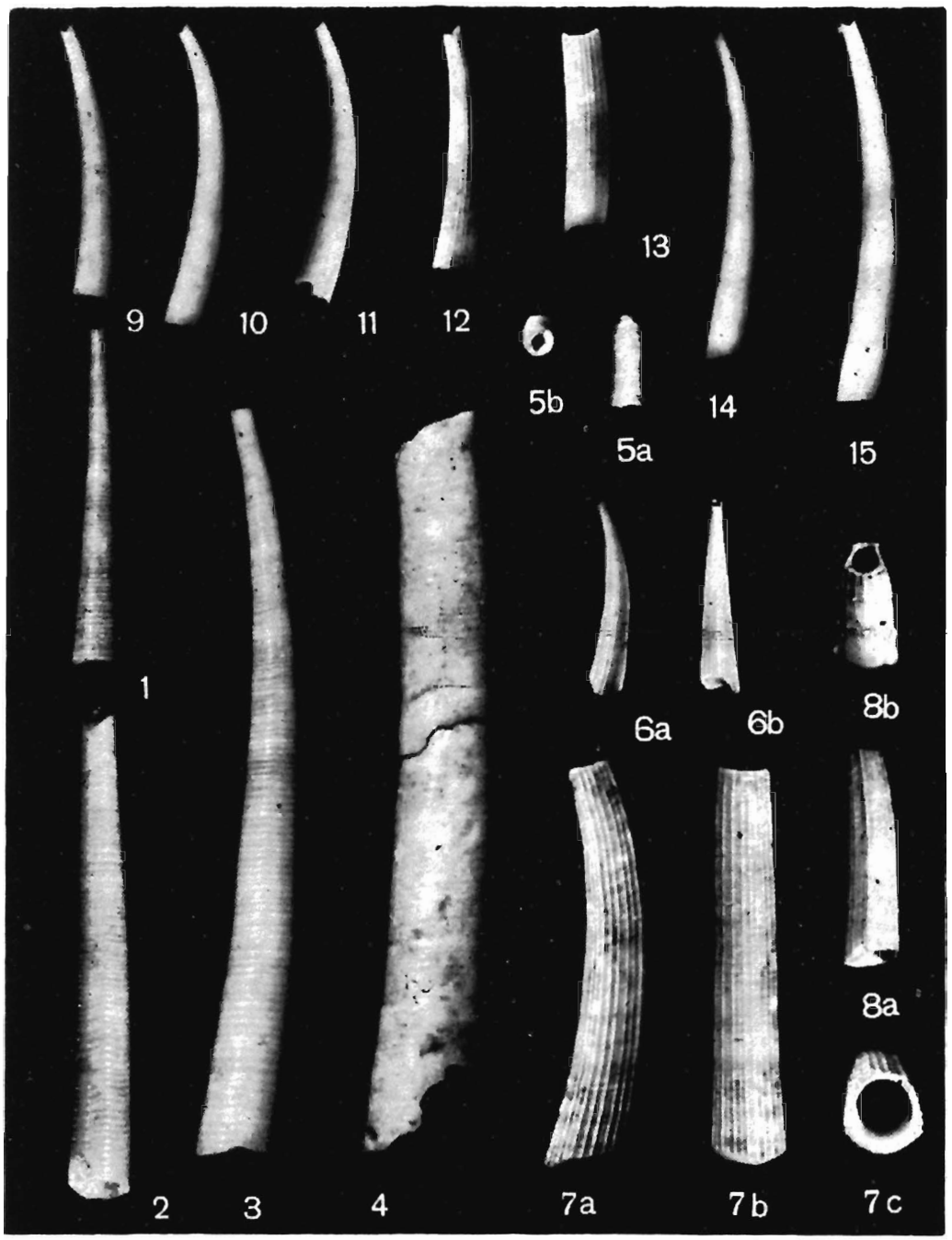


1-3 — *Dentalium (Antalis) dentale* Linnaeus; *1, 2* side view, *3* dorsal view.
4-9 — *Dentalium (Antalis) mutabile* Hörnes; *4, 5a, 6, 7, 8a, 9a* side view, *5b, 8b* transverse section, *9b* apertural view.

All figures X 8; taken by L. Łuszczewska, M. Sc.

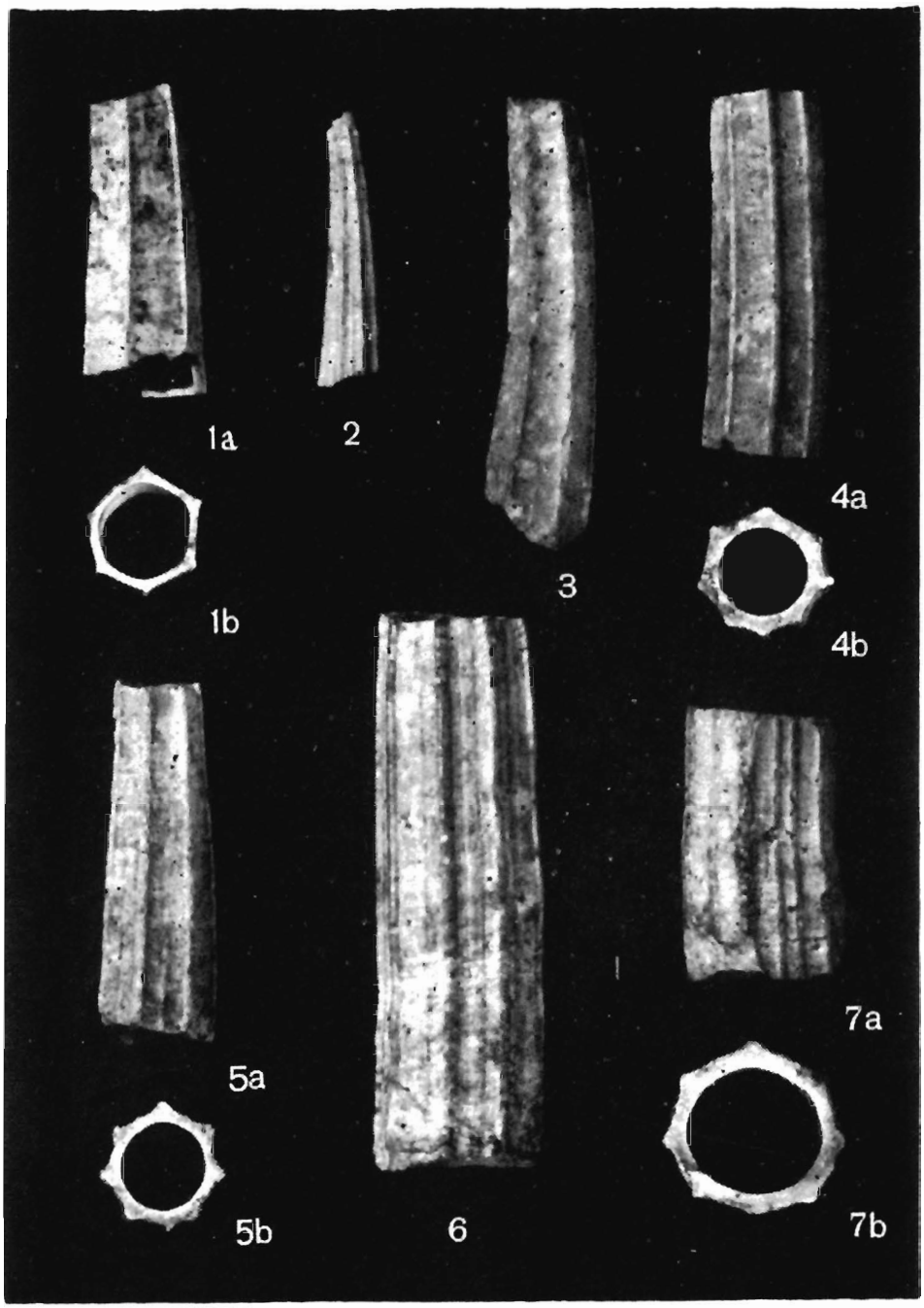


Fustiarta (Episiphon) miocaenica (Boettger)
1—10, 11a, 12a side view, *11b, 12b* apical view, *12c* apertural view
All figures × *8; taken by L. Łuszczewska, M. Sc.*



1-5 — *Fustiaria (Episiphon) jani* (Hörnes); *1—4*, *5a* side view, *5b* apical view.
6-8 — *Entalina tetragona* (Brocchi); *6a*, *7a* side view, *6b*, *7b* dorsal view, *8a* ventral view, *7c*, *8b* transverse section.
9-13 — *Cadulus (Dischides) ornatus* sp. n.; side view (*10* presents the holotype).
14-15 — *Cadulus (Dischides) fibula* (Boettger); side view.

All figures × *8; taken by L. Łuszczewska, M. Sc.*



1 — *Dentalium (Dentalium) michelottii* Hörnes; *1a* side view, *1b* transverse section.
2—7 — *Dentalium (Dentalium) subprismaticum* sp. n.; *2, 3, 4a, 5a, 6, 7a* side view, *4b, 5b, 7b* transverse section (*6* presents the holotype).

All figures × *8; taken by L. Łuszczewska, M. Sc.*