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NORBERT VÁVRA

A littoral bryozoan assemblage from the Korytnica Clays (Middle Miocene; Holy Cross Mountains, Central Poland)

ABSTRACT: Bryozoa from the Middle Miocene (Badenian) deposits of the Korytnica Basin, Holy Cross Mountains (Central Poland) are reviewed. The new material having been collected on a coastal slope in an area with preserved littoral structures shows characteristic patterns for depth distribution, on the basis of which approximate bathymetric estimations are given. Indicated is also the presence of some species important for paleogeographical considerations (*Bobiesipora fasciculata*), and tropical implications (*Steginoporella manzonii*).

INTRODUCTION

Bryozoa from the Middle Miocene (Badenian) deposits of the Korytnica Basin have not yet been studied extensively. COOK (1965) mentioned from this area the ecologically important genus *Cupuladria*, which subsequently subjected to a thorough investigation by BAŁUK & RADWAŃSKI (1977b)*. The latter authors described also boring ctenostomate bryozoans from the gastropod shells (BAŁUK & RADWAŃSKI 1979); realizing that the Neogene deposits of Europe have yielded only rather poor material of Ctenostomata unitil now, this paper must be regarded as a very important contribution to our knowledge of Ctenostomata in general.

LOCALITY AND STRATIGRAPHY

The Korytnica Basin developed during the Middle Miocene (Badenian) transgression onto the southern slopes of the Holy Cross Mountains in Central Poland. The sedimentary sequence includes the famous fos-

* A revision of the „*Cupuladria*" species from the Korytnica Clays, supplemented by a report on another free-living species, *Lunulites androsaces* MANZONI, is presented by BAŁUK & RADWAŃSKI (1984) in the same issue of the journal.

siliferous Korytnica Clays, and the overlying marly sands and lithothamnian limestones (*see* BAŁUK & RADWAŃSKI 1977). The bryozoan-bearing sediment is the oyster lumachelle replete with diverse fossils, and which is regarded as a littoral facies of the Korytnica Clays (BAŁUK & RADWAŃSKI 1977a, p. 93).

The bryozoan samples come from an area with well preserved littoral structures (*see* Text-fig. 1). Increasing numbers of the samples (*O, 1, 2,* to *7*) indicate increasing depth, the samples having been collected on the coastal slope (*see* BAŁUK & RADWAŃSKI 1977a, Text-figs 2 and 4—5).

The bryozoan samples were collected at the localities from which also material for the study of the calcareous nannoplankton (MARTINI 1977) had been taken (*cf.* Text-fig. 1).

The exact correlation of the Korytnica sequence with other localities in the Paratethys is given by MARTINI (1977, Text-fig. 3), who showed by the study of the calcareous nannoplankton that the Korytnica sequence corresponds to the uppermost part of the NN 5 (Sphenolithus heteromorphus Zone) and approximately to the lower half of the NN 6 (Discoaster exilis Zone), according to the standard nannoplankton zona-

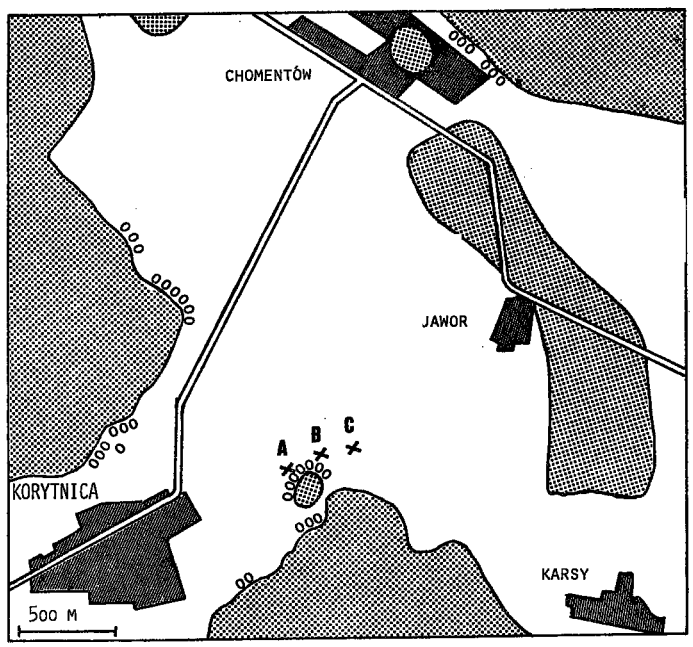


Fig. 1. Paleoenvironmental sketch of the Korytnica Basin (*adopted from:* BAŁUK & RADWAŃSKI, 1977, Text-fig. 2, *and* MARTINI, 1977, Text-fig. 1)

Indicated are: marine area during the Middle Miocene (Badenian) transgression (*blank*), preserved littoral structures (*circled*), land or island areas (*stippled*)

Bryozoan localities (crossed): **A** — samples No. O and 1 (sample *9* of MARTINI 1977); **B** — samples No. 2, 3, 4 (sample *10* of MARTINI 1977); **C** — samples No. 5, 6, 7 (sample *15* of MARTINI 1977)

tion. This means that the material under investigation corresponds to the uppermost part of the upper Lagenid Zone and to the lower part of the Spiroplectammina Zone (regional zones in the Austrian part of the Central Paratethys, as established by GRILL (1941).

The material described in this paper is kept in the collections of the Institute of Geology, University of Warsaw.

SYSTEMATIC ACCOUNT

Practically, all species presented below are well known from the Paratethys, and thus descriptions of their morphology are omitted, and only a few more or less general remarks are given.

Cyclostomata

Idmidronea sp.

Two poorly preserved specimens from sample 3 show the alternating rows of peristomes and on the dorsal face the well developed kenozooecia.

Tervia irregularis (MENEGHINI, 1845)

1845. *Idmonea irregularis;* MENEGHINI, p. 128.
1977. *Tervia irregularis* (MENEGHINI, 1845); VÁVRA, pp. 35—36.

A few fragments from sample *1* can be attributed to this well-known and widespread species; one of them even shows rests of a rather short ovicell (gonozooid) on the dorsal side of a bifurcation.

This species typically occurs at greater depths (down of 65 m), what explains why it is so rare in the material under investigation.

The species is reported to occur from the Eocene to the Recent. The Miocene material is known from Austria, Czechoslovakia, Hungary, Rumania, and France. The species is common in the recent faunas of deeper areas of the Mediterranean Sea, the Atlantic, the Pacific, and the Indian Ocean (HARMELIN 1976).

MATERIAL: sample *1* (3 specimens), sample *3* (1 specimen), sample *4* (1 specimen).

Mecynoecia pulchella (REUSS, 1848)
(Pl. 1, Fig. 1)

1848. *Cricopora pulchella* m.; REUSS, p. 40, Pl. 6. Fig. 10.
1970. *Mecynoecia* (?) *pulchella* REUSS 1869; VOIGT & FLOR, pp. 67—68, Pl. 15, Figs 13—17.
1977. *Mecynoecia pulchella* (REUSS, 1848); VÁVRA, pp. 41—42.

A few fragments of more or less poorly preserved zoaria of this common Miocene species could be found among the Korytnica material.

The species is reported to occur from the Eocene to the Miocene. The Miocene material is known from Austria, Czechoslovakia, and the Ukraine (Soviet Union).

MATERIAL: sample *1* (4 specimens), sample *2* (2 specimens), sample *3* (4 specimens).

Ybselosoecia typica (MANZONI, 1878)
(Pl. 1, Figs 2—3)

1878. *Filisparsa typica* MANZ.; MANZONI, p. 10, Pl. 8, Fig. 30.
1934. *Ybselosoecia typica* MANZONI, 1877; CANU & LECOINTRE, pp. 162—163, Pl. 31, Figs 6—8.

Different well preserved fragments of this widespread species show the morphological characteristics typical of this form. One tiny fragment from sample 3 seems to be the basal part of a very fragile zoarium (Pl. 1, Fig. 3).

The species is reported to occur from the Eocene to the Miocene. The Miocene material is known from Austria, France, and the Ukraine (Soviet Union).

MATERIAL: sample *1* (5 specimens), sample *2* (4 specimens), sample *3* (11 specimens), sample *4* (3 specimens), sample *5* (3 specimens), sample *6* (? 1 specimen).

? *Pseudofrondipora davidi* MONGEREAU, 1970

Three small fragments of zoaria can possibly be attributed to this species. Comparison with authentic material from the Badenian of the Vienna Basin however could not confirm the determination: larger and better preserved zoaria from Korytnica would be necessary to make sure that both forms are identical.

MATERIAL: sample *2* (1 specimen), sample *3* (1 specimen), sample *4* (1 specimen).

Hornera sp. div.

The determination of specimens of this genus at the species level is known to be rather difficult if only tiny fragments are available; the Korytnica material is unfortunately in a very poor state of preservation, what makes specific determinations nearly impossible. Among the richer material of sample 3 two specimens could be determined as *Hornera striata* and *Hornera frondiculata*.

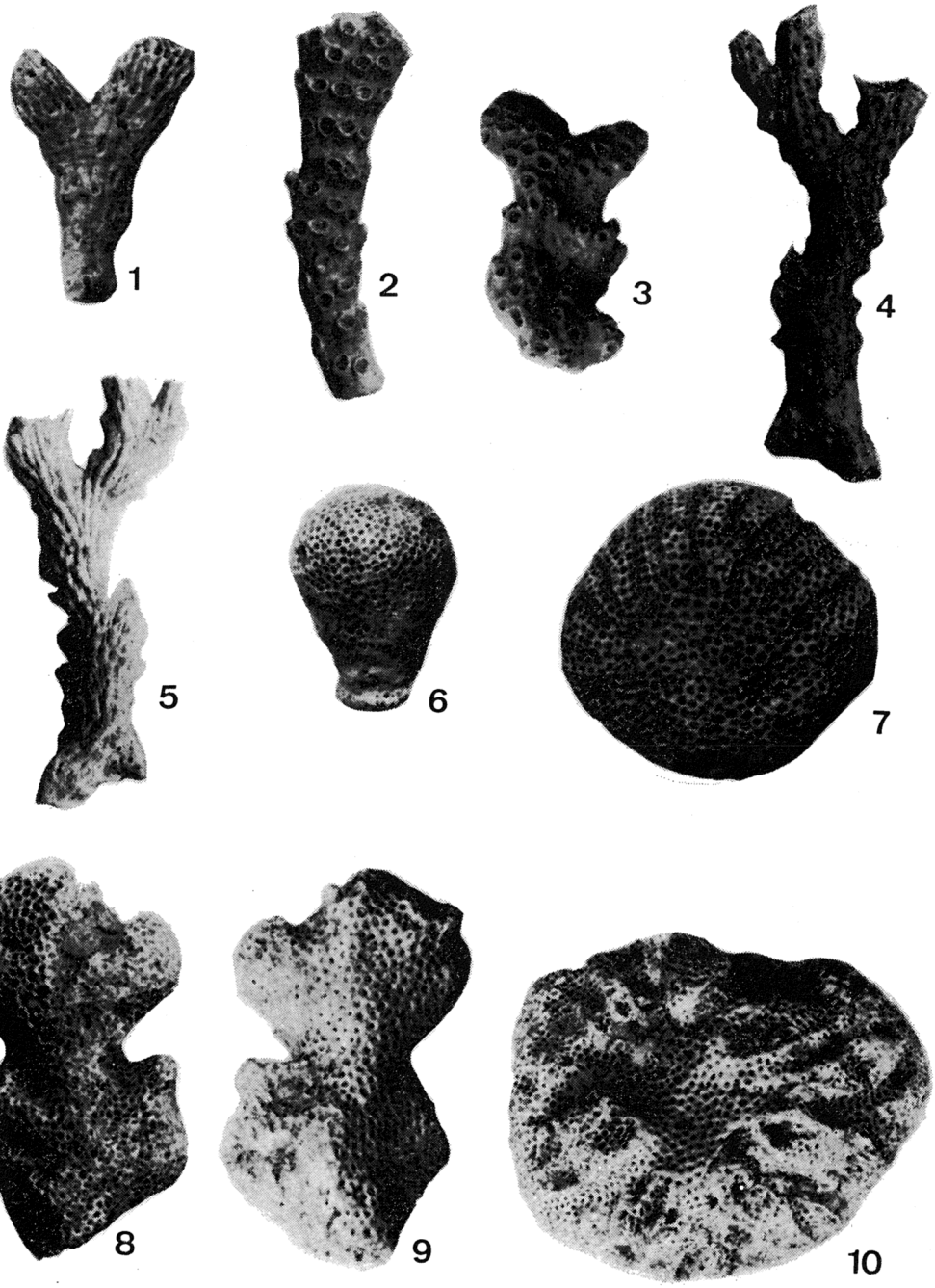
According to the opinion of all authors, the Horneridae are typical forms of greater depths. CANU & BASSLER (1920, p. 796) stated that *Hornera* lives at "variable but always very great depths. At 30 to 100 meters one may hope to find some examples, but it is at greater depths, from 100 to 300 meters these animals find the most favorable conditions for their development".

MATERIAL: sample *1* (1 specimen), sample *2* (2 specimens), sample *3* (24 specimens), sample *4* (4 specimens), sample *5* (4 specimens), sample *6* (1 specimen), sample *7* (1 specimen).

PLATE 1

Cyclostomata from the littoral facies of the Korytnica Clays

1 — *Mecynoecia pulchella;* sample *3*, x 7.5
2 — *Ybselosoecia typica;* sample *3*, x 8.5
3 — *Ybselosoecia typica:* basal part of zoarium; sample *3*, x 8.5
4—5 — *Hornera verrucosa echinata:* 4 — frontal view, 5 — dorsal view; sample *3*, x 8
6 — ? *Tetrocycloecia* sp.; sample *3*, x 9.5
7 — *Lichenopora* sp.; sample *3*, x 9.5
8—9 — *Bobiesipora fasciculata*: 8 — frontal view, 9 — dorsal view; sample *3*, x 10
10 — *Bobiesipora fasciculata;* basal part of zoarium; sample *3*, x 8.5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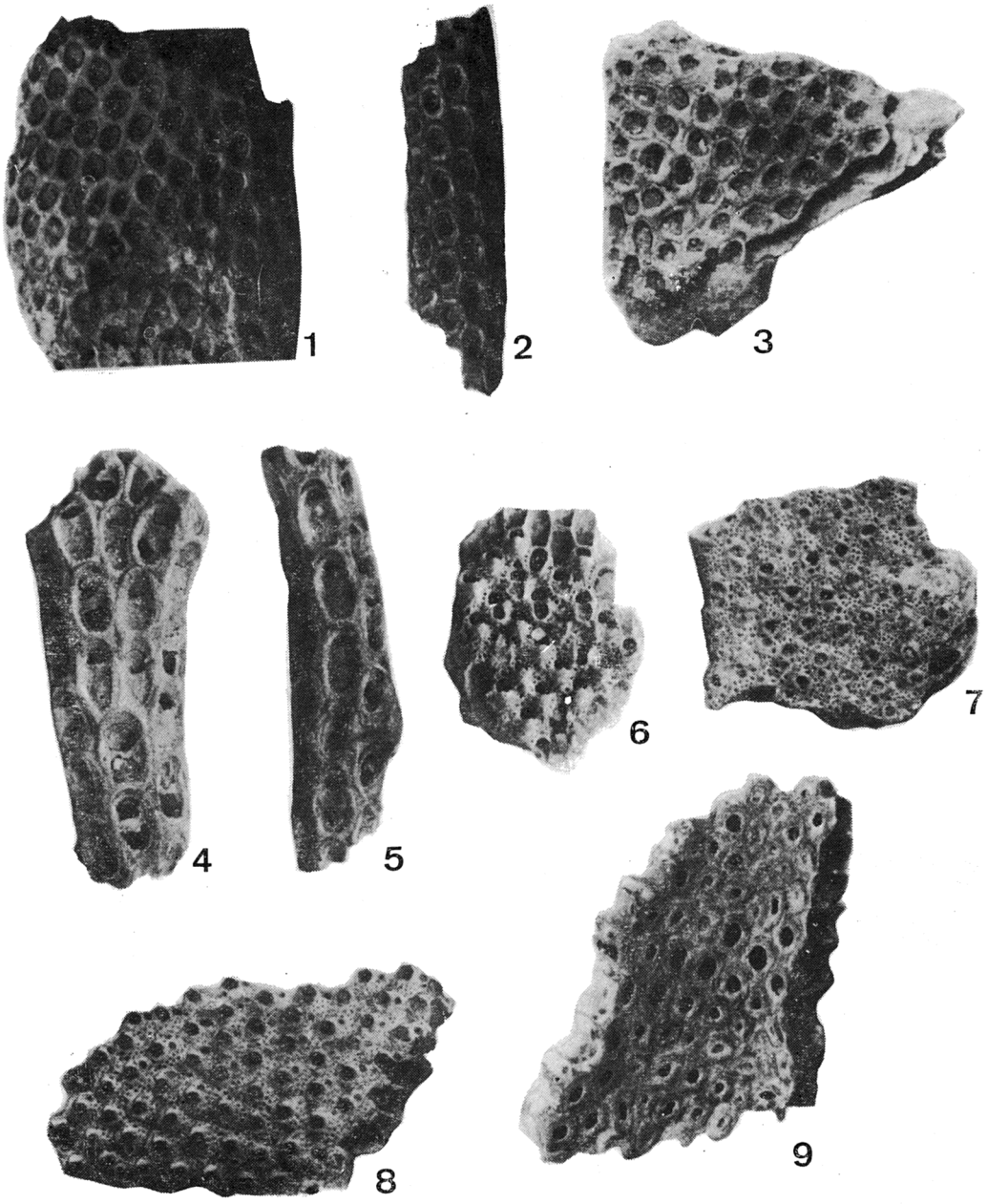

Cheilostomata from the littoral facies of the Korytnica Clays

1 — *Biflustra savarti savarti;* sample *3*, x 10
2 — *Biflustra savarti texturata;* sample *6*, x 10
3 — *Ramphonotus appendiculatus;* sample *3*, x 8
4 — *Steginoporella manzonii;* sample *3*, x 8.5
5 — *Steginoporella manzonii;* sample *3*, x 8.5
6 — *Ubonula* cf. *endlicheri;* sample *1*, x 8.5
7 — unidentified; sample *3*, x 8.5
8—9 — *Schizoporella geminipora:* 8 — frontal view, 9 — dorsal view; sample *3*, x 8.5

Hornera verrucosa echinata BOBIES, 1958
(Pl. 1, Figs 4—5)

1958. *Hornera verrucosa echinata* nov. subspec.; BOBIES, pp. 128—129, Pl. 1, Figs 1—2.

Among the fragments of *Hornera* in sample 3 one specimen shows all characteristics of this subspecies established by BOBIES (1958). Especially the typical protuberances on the nervi of the dorsal face are well preserved.

The species is known from the Austrian Miocene and from Poland (Miecnow, according to BOBIES 1958).

MATERIAL: sample 3 (1 specimen).

Polyascosoecia coronopus CANU & BASSLER, 1922

1848. *Idmonea cancellata* GOLDF.; REUSS, pp. 46—47, Pl. 5, Figs 25—27, and Pl. 6, Fig. 33.
1922. *Polyascosoecia coronopus*, new species; CANU & BASSLER, pp. 124—127, Text-fig. 37, and Pl. 20, Figs 1—8.
1955. *Reteporidea reussi* nov. spec.; KÜHN, pp. 234—235, Pl. 1, Fig. 3, and Pl. 2, Fig. 4.
1977. *Reteporidea coronopus* (CANU & BASSLER, 1922); VÁVRA, pp. 59—60.
1984. *Polyascosoecia coronopus* CANU & BASSLER, 1922; VOIGT, pp. 407—410, Pl. 7, Figs 8—13.

This species is rather common in the Miocene deposits of the Paratethys and of other areas. On the basis of a thorough study of the morphology of the ovicells (gonozooids), VOIGT (1984) proved that *Polyascosoecia* is not a synonym of *Reteporidea* but still a valid genus.

MATERIAL: sample 1 (1 specimen), sample 3 (1 specimen), sample 4 (1 specimen).

? *Tetrocycloecia* sp.
(Pl. 1, Fig. 6)

A number of more or less globular-shaped zoaria (one specimen from sample 3 being perhaps best described as club-shaped) shows the morphology being known for the genera *Tetrocycloecia* and *Heteropora*. No well preserved brood chambers being available, there are no closer determinations possible; only one of the specimens in sample 5 shows traces of something which once might have really been a brood chamber.

The genus *Tetrocycloecia* is known from the Badenian deposits of the Central Paratethys from different localities, and thus it does not seem improbable the investigated zoaria can also be attributed to this genus.

MATERIAL: sample 2 (3 specimens), sample 3 (10 specimens), sample 4 (4 specimens), sample 5 (2 specimens).

Lichenopora sp.
(Pl. 1, Fig. 7)

Zoaria of this genus are rather common in some of the Korytnica samples. The state of preservation is however so poor that often it is not possible to decide if the fascicles are biserial or not. Nevertheless, a form with small — to medium-sized central area and biserial fascicles seems to be rather abundant. This could correspond to *Lichenopora mediterranea*, a form being known also from recent faunas (see e.g. CANU & BASSLER 1929, pp. 561—563, Pl. 90, Figs 1 and 3).

Moreover, the forms with predominant uniserial fascicles can be found in the investigated material (*i.a.* one specimen from sample *2*, and one from sample *5*).

MATERIAL: sample *1* (2 specimens), sample *2* (1 specimen), sample *3* (27 specimens), sample *4* (8 specimens), sample *5* (3 specimens), sample *6* (1 specimen), sample *7* (1 specimen).

Bobiesipora fasciculata (REUSS, 1848)
(Pl. 1, Figs 8—10)

1848. *Apsendesia fasciculata* m.; REUSS, p. 40, Pl. 6, Fig. 8.
1978. *Bobiesipora fasciculata* (REUSS, 1848); VÁVRA, pp. 229—235, Pl. 1, Figs 1—8, and Pl. 2, Figs 1—6.

This strange and very rare species has been described only from the Miocene deposits of Austria. The Korytnica material is therefore the first proof of its occurrence outside the Austrian Tertiary. The material from sample *3* includes a number of the typical basal parts of the zoaria and also a very fine branch (*see* Pl. 1, Figs 8—10).

MATERIAL: sample *2* (1 specimen), sample *3* (9 specimens), sample *4* (7 specimens), sample *5* (3 specimens), sample *6* (1 specimen).

Cheilostomata

Biflustra savarti savarti (SAVIGNY-AUDOUIN, 1826)
(Pl. 2, Fig. 1)

1826. *Flustra savartii;* SAVIGNY-AUDOUIN, p. 240, Pl. 10, Fig. 10.
1974. *Biflustra savarti* (SAV.-AUD., 1826): DAVID & POUYET, p. 99.

Only one zoarium of this widespread subspecies could be found in the Korytnica material. The subspecies is reported to occur primarily in the Miocene (Austria, Czechoslovakia (?), France, Portugal, Tunesia, United States) and in the Pliocene (the Netherlands, Portugal, Tunesia), but it also appears in the Oligocene and even in the Lutetian (*see* CANU & BASSLER 1920, p. 101). Its recent distribution includes the Atlantic Ocean, the Indian Ocean, the Red Sea, and the Pacific off Australia. In the Red Sea, zoaria of this subspecies have been brought up from depths of 18—54 m (CANU & BASSLER 1920). The subspecies seems to have not yet been reported from the Mediterranean Sea.

MATERIAL: sample *3* (1 specimen).

Biflustra savarti texturata (REUSS, 1848)
(Pl. 2, Fig. 2)

1848. *Vaginopora texturata* m.; REUSS, p. 73, Pl. 9, Fig. 1.
1974. *Biflustra savarti* forme *texturata* (REUSS, 1848); DAVID & POUYET, pp. 99—100, Pl. 3, Fig. 6.
1977. *Biflustra savarti texturata* (REUSS, 1848); VÁVRA, p. 77.

Only tiny fragments and one small part of a zoarium of this subspecies could be recognized in the Korytnica material.

The subspecies is known from the Austrian Miocene and from Poland (Wieliczka); a find from Czechoslovakia is doubtful.

MATERIAL: sample *2* (4 tiny fragments), sample *6* (1 specimen).

Ramphonotus appendiculatus (REUSS, 1848) (Pl. 2, Fig. 3)

1848. *Cellepora appendiculata* m.; REUSS, p. 96, Pl. 11, Fig. 22.
1974. *Ramphonotus appendiculata* (REUSS, 1848); DAVID & POUYET, pp. 108—109, Pl. 1, Figs 2 and 6.

Though the specimen from sample *3* is a little unusual in its appearance due to a rather high degree of calcification there is no doubt in respect to its determination. This species has been found not only in the Miocene deposits of Austria but also in Hungary and Poland (Miechów), and in the Oligocene of Germany.

MATERIAL: sample *3* (1 specimen).

Steginoporella manzonii DAVID & POUYET, 1974 (Pl. 2, Figs 4—5)

1974. *Steginoporella manzonii* nov. sp.; DAVID & POUYET, pp. 126—127, Pl. 4, Figs 2—3.
1979a. *Steginoporella manzonii* DAVID & POUYET, 1974; POUYET & DAVID, p. 786, Text-fig. 3, and Pl. 4, Fig. 7.

Nearly all of the zoaria from Korytnica show the granulation of the rim of the zooecia typical of this species. One of the specimens from sample *3* shows in addition to all the morphological details characteristic of this species also a *B*-zooecium, thus proving, contrary to the statement by DAVID & POUYET (1974), the occurrence of dimorphism in this species. The *B*-zooecium is situated at the proximal end of two rows of *A*-zooecia (*see* Pl. 2, Fig. 4).

According to POUYET & DAVID (1979b), recent species of *Steginoporella* show a wide bathymetrical distribution as a consequence of great adaptability. The genus occurs in tropical and subtropical regions, and only a few species spread in temperate areas if warm currents were able to transport the larvae.

The species *Steginoporella manzonii* has been reported to occur in the Miocene deposits of Austria, Czechoslovakia, and the Ukraine (Soviet Union).

MATERIAL: sample *2* (3 specimens), sample *3* (8 specimens).

Cellaria fistulosa auct.

1962. *Cellaria fistulosa* auctt. (non LINNE 1758); GAUTIER, pp. 71—7
1974. *Cellaria fistulosa* auct.; DAVID & POUYET, pp. 132—135.

This well-known and widespread form shows a great variability in its morphology, but the Korytnica material seems to fit really well to all other material usually described by different authors under this name.

The species has been found in many Miocene faunas, those from Poland including. In respect to the older literature one should perhaps be a little careful, because modern taxonomic studies seem necessary. In recent faunas, *Cellaria fistulosa* is found in all seas except of the polar regions.

MATERIAL: sample *1* (17 specimens), sample *2* (10 specimens), sample *3* (43 specimens), sample *4* (7 specimens), sample *5* (9 specimens).

Umbonula cf. *endlicheri* (REUSS, 1848)
(Pl. 2, Fig. 6)

A rather small fragment of a zoarium shows nearly all morphological characteristics typical of this species. Slight devations which might be very well within the range of specific variability are the reason for inserting „cf.".

MATERIAL: sample *1* (1 specimen).

Schizoporella geminipora (REUSS, 1848)
(Pl. 2, Figs 8—9)

1848. *Vaginipora geminipora* m.; REUSS, p. 74, Pl. 9, Figs 3—4.
1974. *Schizoporella geminipora* (REUSS, 1848); DAVID & POUYET, pp. 158—159, Pl. 8, Fig. 4.
1977. *Schizoporella geminipora* (REUSS, 1848); VÁVRA, pp. 117—118.

Fragments of zoaria of this species are especially abundant in sample 2. This is one of the very few species of *Schizoporella* which can be identified without any difficulties. The morphological characteristics have been summarized by DAVID & POUYET (1974). All fragments in the Korytnica material show more or less curved basal surfaces. Though no complete "hollow cylinders", a zoarial type which is rather common in this species at some localities, were found in the investigated material, all fragments show zooecia with typical holes of variable size in their basal walls. These characteristics can be compared with the picture of the basal wall of an *Onychocella* described by VOIGT (1956) who interpreted this form as having an overgrown alga. If this interpretation is also accepted for *Schizoporella geminipora* (*see e.g.* VÁVRA 1981), then the rich abundance of this species in sample 2 evidences that this material corresponds to the "phytal zone", indicating thus the photic zone and being therefore of great bathymetric value.

This species ranges from the Eocene (?) to the Miocene. In the Miocene deposits it is especially abundant in Austria (Eggenburgian and Badenian), but it also occurs in Czechoslovakia, Poland (Miechów, Wieliczka), Rumania, and the Soviet Union.

MATERIAL: sample *1* (12 specimens), sample *2* (95 specimens), sample *3* (15 specimens), sample *4* (3 specimens), sample *5* (4 specimens), sample *6* (1 specimen).

Porella cervicornis (PALLAS, 1766)

1766. *Millepora cervicornis;* PALLAS, p. 252.
1962. *Porella cervicornis* (PALLAS) 1766; GAUTIER, pp. 204—206.
1977. *Porella cervicornis* (PALLAS, 1766); VÁVRA, pp. 139—140.

This well-known species shows a great variety of its appearance depending upon the degree of calcification, as described (*e. g.* by GAUTIER (1962). This species is very common in many localities of the recent Mediterranean fauna. It is to be found in depths from 30 to 120 m with an optimum between 40 and 60 m (GAUTIER 1962).

Fossil material attributed to this species has been reported from many parts of Europe: Miocene of Austria, Czechoslovakia, France, northern Germany, Italy, Poland (Wieliczka), Portugal, Rumania; Pliocene of Belgium, the Netherlands, Portugal and Italy.

MATERIAL: sample *0* (5 specimens), sample *1* (45 specimens), sample *2* (12 specimens), sample *3* (108 specimens), sample *4* (37 specimens), sample *5* (26 specimens), sample *6* (22 specimens), sample *7* (4 specimens).

Margaretta cereoides (ELLIS & SOLANDER, 1786)

1786. *Cellaria cereoides;* ELLIS & SOLANDER, p. 26, Pl. 5, Figs B-E.
1974. *Margaretta cereoides* (ELLIS & SOLANDER, 1786); DAVID & POUYET, pp. 196—197, Pl. 10, Fig. 7.

A few fragments in poor state of preservation belong to this well-known species. It has been reported to occur in the ancient deposits of Oligocene (Germany, Italy, Poland), Miocene (Austria, Czechoslovakia, France, Poland, Rumania), and Pliocene age (Italy, North Africa, Central America). Its recent occurrences include: Mediterranean Sea, Red Sea, Pacific and the tropical and subtropical parts of the Atlantic (VÁVRA 1977).

GAUTIER (1962) reports this species to occur between 10 and 45 meters, being especially abundant on the stems of *Posidonia*, on different algae and in caves. The depth distribution (GAUTIER 1962, p. 337, Fig. 63) shows the corresponding maxima of abundance: one for the caves and two separate maxima for *Posidonia* habitats.

MATERIAL: sample *1* (4 specimens), sample *4* (1 specimen).

Sertella sp.

Comparatively common is the Korytnica material are rather large fragments of the reticulate colonies of the genus *Sertella*. Though some of the fragments are large enough to show twenty or even more fenestrulae and though even basal parts of the colonies are preserved, the general state of preservation is very poor: neither ovicells nor avicularia can be studied. Therefore no attempt of a specific determination is justified, and all numerous parts of these zoaria can only be determined as "*Sertella* sp.".

The genus *Sertella* is one of the elements of the bryozoan fauna of the coralligenous biocoenose, being the richest circumlittoral Mediterranean community (RYLAND 1970). STACH (1936) regarded the retepore colonies as a category of their own: „adapted for life in regions where wave action currents are strong". But only a few of the European species occur in very shallow water; the "Challenger"-expedition collected them from depths of few meters down to 1 000 m, whereas the "Siboga"-expedition at depths less than 50 m (RYLAND 1970).

MATERIAL: sample *0* (3 specimens), sample *1* (9 specimens), sample *2* (45 specimens), sample *3* (92 specimens), sample *4* (25 specimens), sample *5* (18 specimens), sample *6* (9 specimens).

Adeona polystomella (REUSS, 1848)

1848. *Sschara polystomella* m.; REUSS, p. 70, Pl. 8, Figs 27—28.
1974. *Adeona polystomella* (REUSS, 1848); DAVID & POUYET, pp. 200—201, Pl. 6, Fig. 2.

A comparatively well preserved zoarium from sample *3* shows the morphology typical of this species, even the two different types of zooecia being distinctly discernible. Another fragment from this sample is a part of an old zoarium

with high degree of calcification, showing closed zooecia, whereas the third specimen remains rather dubious. A tiny fragment from sample *1* can also be attributed to this species though its state of preservation is rather poor.

The species *Adeona polystomella* has been described from the Eocene deposits of Italy, the Miocene of Austria, Czechoslovakia, France, and the Ukraine (Soviet Union), as well as from the Pliocene deposits of Italy, Greece (Rhodes), and Portugal.

Two species of this genus, showing rather similar morphology, are to be found in the recent fauna of the Mediterranean Sea; they are living between 20 and 120 m, being the most abundant from 30 to 50 m (GAUTIER 1962, p. 220).

MATERIAL: sample *1* (1 specimen), sample *3* (3 specimens, one of which is doubtful).

„Celleporidae" auct.

In all samples from Korytnica there occur small, mostly globular zoaria which can be attributed without any doubt to this group. A poor state of preservation of the surfaces of these zoaria prevents any closer determination.

MATERIAL: sample *1* (3 specimens), sample *2* (9 specimens), sample *3* (27 specimens), sample *4* (11 specimens), sample *5* (16 specimens), sample *6* (6 specimens), sample *7* (5 specimens).

Unidentified forms

Among the material studied there have been some forms which could not be identified because of various reasons. This additional material includes, for instance, one specimen of *Umbonula* (sample *4*, very poor preservation, and no determination at the species level possible). Two specimens (samples 3, and 6) which show a remarkable similarity to heavily calcified zoaria of *Cryptosula*, correspond rather well to a picture given by BOBIES (1957, Pl. 9, Fig. 17), but strong calcification seems to have changed the shape of the apertures to a great extent. Another example is given by the fragment of a bifoliate zoarium (Pl. 2, Fig. 7) which cannot be attributed to any genus because the ovicells are lacking.

All these discussed specimens have partly been included when counting the species numbers (as given in Text-fig. 2).

ECOLOGICAL INTERPRETATION

The total number of all more or less well determined taxa in each of the samples studied (a very few not well preserved or dubious forms are omitted) indicates (Text-fig. 2) a distinct maximum of taxa diversity for sample *3*.

The percentage of specimens in the samples for some of the more common species shows (Text-fig. 3) a distinct maximum for sample *3* in such taxa as *Cellaria fistulosa, Porella cervicornis, Sertella* sp., and „Celleporidae"; the same result is also valid for other species. One species only, *Schizoporella geminipora,* has a very remarkable maximum in sample *2*.

According to the general data about the vertical distribution of the Bryozoa (*e.g.* RYLAND 1970) in the continental shelf areas, this distribution is usually far from being uniform. The best data available for the

Mediterranean indicate, according to GAUTIER (1962), maximum for species diversity at depths between 20 and 80 m with a peak at 40 m.

For a few species occurring at Korytnica the detailed data in respect to their bathymetrical distribution are available. The species *Porella cervicornis* in the Mediterranean area is to be found in depths from 30 to 120 m with an optimum between 40 and 60 m (GAUTIER 1962). The species *Margaretta cereoides* (being very rare in the material studied) never occurs below 50 m; *Cellaria fistulosa* can be found between 30 and 80 m; for *Cellaria salicornioides* a distinct maximum for its vertical distribution is given as 40 m (GAUTIER 1962, p. 330, and Fig. 49). There are also some forms in the Korytnica material which do not give any bathymetrical information, as e.g. *Steginoporella* which, according to POUYET & DAVID (1979b), shows a wide vertical distribution as a consequence of its great adaptability. Forms which can be expected to indicate greater depths, like the genus *Ramphonotus* (for *R. minax* the maximum is 100 m) are extremely rare in the material studied (*e.g.* only one specimen of *R. appendiculatus* in all the eight samples). A little embarrassing and disappointing in this respect is the fact that the genus *Hornera* shows the highest numbers of specimens in the material from sample *3* like other species: for this genus one should have expected an increase of its abundance with increasing depth.

The genus *Polyascosoecia,* which according to the present author's experience, has also prefered "greater depths" fits rather well in this respect, because only 3 specimens were found in all the samples studied. Nevertheless, these considerations seem to justify an approximate depth of sedimentation for sample *3* of perhaps 30—50 m. The latter value is almost twice greater than that evidenced by BAŁUK & RADWAŃSKI (1977a, pp. 100—101).

Sample *2,* showing the sharp maximum for *Schizoporella geminipora* (*see* Text-fig. 3) seems to correspond to the „phytal zone". A species of the Cheilostomata *(Onychocella propinqua)* showing only partial calcification of its basal walls, has already been interpreted by VOIGT (1956) as having an overgrown alga, and thus regarded as an indicator of the phytal in the Maastrichtian at Kunrade (Netherlands). The same fact was also reported for another species of this genus (VOIGT 1956, p. 103).

The same conclusion is justified for *Schizoporella geminipora,* a species always showing a distinctly curved basal surface with holes of varying size in the basal wall of each zooecium (*see* Pl. 2, Fig. 9); the Austrian material from the Lower Miocene (Eggenburgian) deposits shows even well-preserved zoaria shaped like hollow cylinders (VÁVRA 1981, p. 279).

Summarizing the results reported above, the investigated bryozoan assemblage form Korytnica shows a distinct distribution pattern depending upon the depth of sedimentation. Sample *2* corresponds to the

„phytal zone", sample *3* represents the optimum of taxa diversity, being perhaps equivalent to depth of 30—50 m.

These above results must be regarded at least in one respect with some caution: the one or the other species might very well depend in its depth distribution on availability of special substrates, a fact which had unfortunately to be neglected in all these considerations.

In respect to paleoclimatological considerations the occurrence of the genus *Steginoporella* in the Korytnica material is important, because according to POUYET & DAVID (1979a, b) this genus is found mainly in the tropics.

COMPARISON WITH OTHER BRYOZOAN FAUNAS

At the present state of knowledge only a few remarks in this respect seem justified.

The most outstanding feature of the investigated bryozoan fauna from Korytnica is the fact that many of the typical Paratethys species have not been discovered in these samples. Among the Cheilostomata, the encrusting forms like *Onychocella angulosa* or *Calpensia gracilis*, and the great variety of *Schizoporella* species should be expected to occur. There are also no cribrimorphs in the material studied.

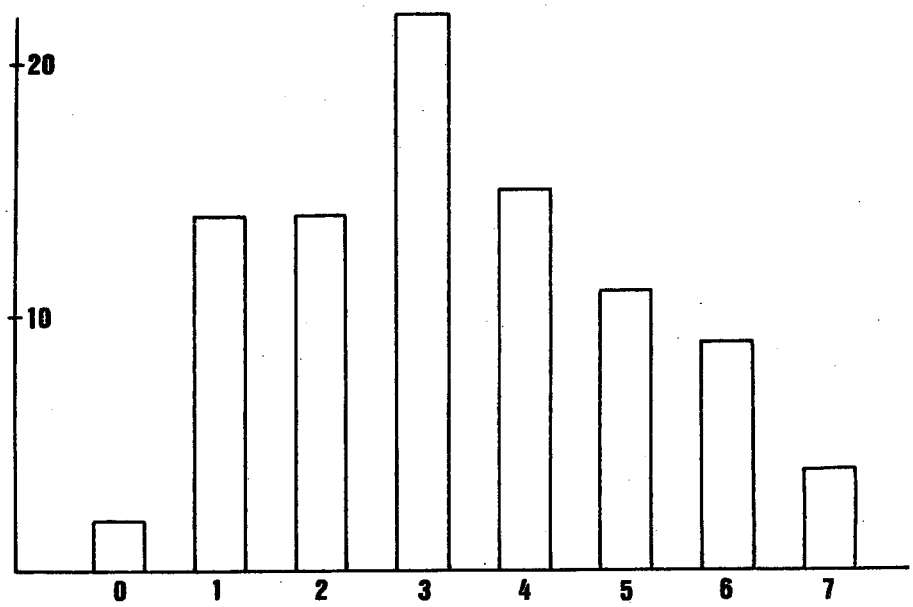

Fig. 2. Taxa diversity for the Korytnica samples studied
Ordinate: number of taxa for each sample; Abscissa: sample number

An outstanding "positive" feature of the Korytnica material is a rather rich material of *Bobiesipora fasciculata*, a species having not been reported outside Austria.

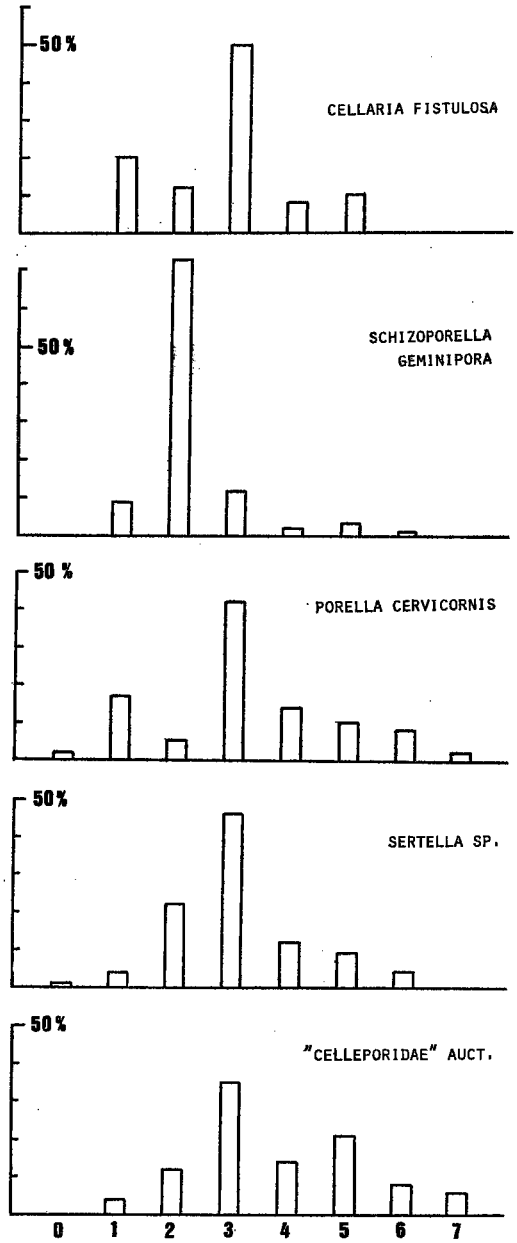

Fig. 3. Frequency of some taxa in the Korytnica samples studied

Ordinate: percentage (total number of fragments of zoaria for each taxon in all samples equals 100%); Abscissa: sample number

But, before drawing any general conclusions at the present state of knowledge one should better wait for more material from other areas of the Korytnica Basin.

Institut für Paläontologie
der Universität Wien,
Universitätsstrasse 7/II,
A-1010 Wien, Österreich

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