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WACŁAW BAŁUK & ANDRZEJ RADWAŃSKI

Free-living bryozoans from the Korytnica Clays (Middle Miocene; Holy Cross Mountains, Central Poland)

ABSTRACT: The free-living bryozoans occurring commonly in the Middle Miocene (Badenian) Korytnica Clays (southern slopes of the Holy Cross Mountains, Central Poland) are represented by the three species, viz.: *Cupuladria vindobonensis* BAŁUK & RADWAŃSKI, *Reussirella haidingeri* (REUSS), and *Lunulites androsaces* MANZONI. All of them are studied in regard with their taxonomy, and some morphological features (number of kenozoidal chambers in *Cupuladria vindobonensis,* coverage of zooecia by a calcareous lamina in *Reussirella haidingeri*) are discussed as important for recognition of the variability within these species. The colony regeneration is presented in all the three species, and this is primarily important for *Cupuladria vindobonensis* in which it is thought to have been responsible for the survival of the species within particular biotopes of the Korytnica Basin.

INTRODUCTION

Since the previous publication on the colony regeneration and life habitat of the free-living bryozoans from the Middle Miocene (Badenian) Korytnica Clays, developed on the southern slopes of the Holy Cross Mountains, Central Poland (BAŁUK & RADWAŃSKI 1977), it appeared that the two species which have exemplified these events, viz. „*Cupuladria canariensis* (BUSK)" and „*Cupuladria haidingeri* (REUSS)", represent obviously the taxa of another systematic position.

The aim of this paper is to present the Korytnica free-living bryozoans (*see* Text-fig. 1) in their new taxonomic frames, and to indicate some morphological features which have a bearing upon the taxonomy. The latter problem concerns primarily the species *Cupuladria vindobomensis* BAŁUK & RADWAŃSKI in which some features have recently been postulated by CADÊE (1979, 1981) as taxonomically important at the infraspecific level. Moreover, supplemented are the previous data on the colony regeneration, the meaning of which for the survival of the species will also be discussed. In the systematic account, the spectrum of free-living bryozoans from the Korytnica Basin is extended for the species *Lunulites androsaces* MANZONI, 1869.

The three investigated species belong, accordingly with the newly proposed systematical status (BAŁUK & RADWAŃSKI 1984), to the three different genera and families of the cheilostome bryozoans. Their

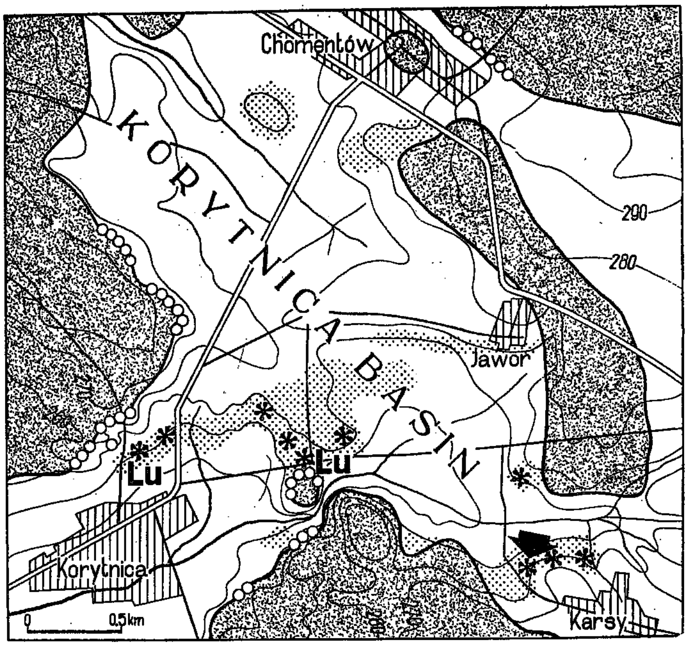


Fig. 1. Paleoenvironmental sketch of the Korytnica Basin, to supplement the previous data on the distribution of free-living bryozoans (*cf.* BAŁUK & RADWAŃSKI 1977, Text-fig. 1)

Indicated are: marine area of the Korytnica Basin during the Middle Miocene (Badenian) transgression (*blank*) and present-day outcrops of the Korytnica Clays (*stippled*); preserved fragments of littoral structures (*circled*); land or island areas along the seashore (*hachured*)

Asterisked are the sampling areas that yielded the investigated free-living bryozoans, *Cupuladria vindobonensis* BAŁUK & RADWAŃSKI and *Reussirella haidingeri* (REUSS); marked **Lu** are the occurrence sites of *Lunulites androsaces* MANZONI

Arrowed is the sampling area of *Cupuladria vindobonensis* BAŁUK & RADWAŃSKI reported [under the name of *C. canariensis* (BUSK)] by COOK (1965b, p. 199)

common feature is in the free-living mode of life, and this often implies the use of a handy term which could cover them all. It was formerly kept usually as „the lunulitiform bryozoans" and often understood in a broader range to cover also the other families (*see* LAGAAIJ 1953, GREELEY 1967, CADÉE 1975, COOK & CHIMONIDES 1978). Recently, it has been introduced informally, as „the lunulite bryozoans" or shortened as simply as „the lunulites" by COOK & CHIMONIDES (1983), to cover only the families under investigation (Cupuladriidae, Discoporellidae, and Lunulitidae, as understood in this paper).

TAXONOMY OF THE LUNULITE BRYOZOANS

The taxonomy of the investigated lunulite bryozoans concerns the three families (Cupuladriidae, Discoporellidae, and Lunulitidae), everyone of which is respresented by one genus and one species (of *Cupuladria*, of *Reussirella*, and of *Lunulites*, respectively).

Basic problems and/or misunderstandings in these bryozoans have formerly been displayed either by the whole families (as in the Cupuladriidae), or by particular genera (as in the Discoporellidae). Within the family Cupuladriidae, the best known is primarily the „*Cupuladria canariensis* group" of species, as named by COOK (1965a), and supplemented by CADÊE (1975), which has recently been isolated by the authors (BAŁUK & RADWAŃSKI 1984) from other „groups" and recognized as the only one to represent the genus *Cupuladria* CANU & BASSLER, 1919.

Within specimens referred to the „index" species of the discussed group, *Cupuladria canariensis* (BUSK, 1859), the authors distinguished (BAŁUK & RADWAŃSKI 1984) a separate species, *Cupuladria vindobonensis* BAŁUK & RADWAŃSKI, 1984, to which all specimens of *Cupuladria* from the Korytnica Basin are to be attributed.

The internal structure of the colonies in the species *haidingeri* of REUSS (1847), and in a few species of other groups distinguished by COOK (1965a) has been recognized (BAŁUK & RADWAŃSKI 1984) as different than in *Cupuladria*, and substantial for the creating a separate

Table 1

Cupuladriidae LAGAAIJ, 1952	Discoporellidae BAŁUK & RADWAŃSKI, 1984	
Cupuladria CANU & BASSLER, 1919	Reussirella BAŁUK & RADWAŃSKI, 1984	Discoporella d'ORBIGNY, 1852
Zoaria free in adult stages Zooecia with asymmetrical vibracula, distal to each zooecium		
Vicarious vibracula sometimes present in some species	Vicarious vibracula not stated	
Central zooecia open	Central zooecia closed by a calcareous lamina	
Vestibular arch absent	Vestibular arch present	
Cryptocyst simple, without spinules	Cryptocyst incomplete, with spinules, sometimes joined	Cryptocyst complete, with two rows of opesiules
Kenozoidal chambers arranged in series oblique to the sole of the basal pad	Kenozoidal chambers absent	
Underside sectored, with pores	Underside with alternating grooves and ridges, tuberculate	

Diagnostic features of the investigated cupuladriid and discoporellid bryozoans from the Korytnica Clays genus, *Reussirella* BAŁUK & RADWAŃSKI, 1984, with the species *Reussirella haidingeri* (REUSS, 1847) as the type. The genus *Reussirella* appears to be related to the genus *Discoporella* d' ORBIGNY, 1852, more closely than to *Cupuladria*, and thus these two genera have been joined (BAŁUK & RADWAŃSKI 1984) into a separate family, the Discoporellidae BAŁUK & RADWAŃSKI, 1984.

The generic content and anatomical differences in these two families, the Cupuladriidae and the Discoporellidae, have recently been discussed (BAŁUK & RADWAŃSKI 1984) when studying the contemporaneous (Middle Miocene, Badenian) materials from the Vienna Basin. The diagnostic features of these families are therefore repeated in this paper (*see* Table 1) without further comments.

The taxonomic position and understanding of the third investigated family, the Lunulitidae, is the same as given by LAGAAIJ (1952) and BASSLER (1953) whose diagnoses are fully acceptable.

SYSTEMATIC ACCOUNT

Family **Cupuladriidae** LAGAAIJ, 1952

The family Cupuladriidae is understood the same as definied by LAGAAIJ (1952), to include only the genus *Cupuladria* CANU & BASSLER. Rejected are (BAŁUK & RADWAŃSKI 1984) the statements of BASSLER (1953) who included the Cupuladriidae to the Membraniporidae, and of CHEETHAM & SANDBERG (1964) and COOK (1965a) who extended the range of the family to contain also the genus *Discoporella.*

DIAGNOSIS (*given by* BAŁUK & RADWAŃSKI 1984): Zoaria free in adult stages; zooecia with asymmetrical vibracula, distal to each zooecium. Vicarious vibracula sometimes present in some species. Central zooecia open, without closures by a calcareous lamina. Zooecia rounded, and vestibular arch not developed. Cryptocyst simple, in the form of a narrow ledge, without spinules. Kenozoidal chambers arranged in series running obliquely to the sole of the basal pad; number of kenozoidal chambers variable. Underside sectored, with pores.

Genus *Cupuladria* CANU & BASSLER, 1919
Type species: *Cupuladria canariensis* BUSK, 1859*

DIAGNOSIS: The same as for the family (*see* BAŁUK & RADWAŃSKI 1984).

SPECIES INCLUDED: *Cupuladria canariensis* (BUSK, 1859); *C. monotrema* (BUSK, 1884); *C. biporosa* CANU & BASSLER, 1923; *C. surinamensis* CADÉE, 1975; *C. vindobonensis* BAŁUK & RADWAŃSKI, 1984.

* In references, it is BUSK (1859a).

Cupuladria vindobonensis BAŁUK & RADWAŃSKI, 1984
(Plates 1—4)

HOLOTYPE: The specimen illustrated by BUSK (1859b, Pl. 13, right picture of Fig. 2d).

DIAGNOSIS (*given by* BAŁUK & RADWAŃSKI 1984): Cupuladriid species distinguished by their basal sectors, the majority of which are long, with pores ranging usually between 6 and 12, and their maximum range observed 2 to 20 in a sector; the number of kenozoidal chambers variable, usually from one to three or four; vicarious vibracula not definitely stated.

SYNONYMY: Given by BAŁUK & RADWAŃSKI (1984).

MATERIAL and its DISCUSSION: Numerous regenerated colonies of variable size, attaining about 5 mm in diameter (Pls 2—3; and BAŁUK & RADWAŃSKI 1977, Pls 1—3). Fragments of larger, not regenerated colonies (indicating about 11 mm diameter of the primary colony) are exremely rare (*see* Pl. 1; *and* BAŁUK & RADWAŃSKI 1977, Pl. 2, Fig. 5). Some colonies of the smallest size have regenerated from such fine fragments as composed of only one or two zooids which survived the breakage of their primary colony (Figs 1—4 in Pls 2—3; *cf.* BAŁUK & RADWAŃSKI 1977, p. 148 and Pl. 1, Figs 1—3). All the colonies, as observed in the sections or along the broken edges, display pronouncedly the kenozoidal chambers within the basal pads varying in their number from one to eight in a series; the shape of particular chambers changes from place to place (*see* Pl. 1, Figs 1c, 2c, 3c, and Pl. 4, Figs 1—3). The number of kenozoidal chambers in a series (or, number of „layers", as named by COOK 1965a, b, and CADÉE 1979) is a function of the thickness of the basal pad. The kenozoidal chambers are formed during the colony growth by a „scaled" accretion of the basal pad. The individual growth lamellae („scales") are deposited obliquely to the colony base, and thus the number of kenozoidal chambers in a series beneath a zooecium/vibraculum couple remains more or less constant, and evidently lesser than the number of zooecium/vibraculum couples within a given file (radius) of the upper side of the colony (*see* Text-fig. 2; *cf. also* TAVENER-SMITH 1973, Fig. 1).

The study of the distribution of kenozoidal chambers within the basal pad shows that their diverse number is more or less constant within a colony, and does not depend directly on the size of the colony. The smallest colonies have one chamber in a file, but this occurs also in larger colonies. Fragments of larger size, which bear one (Pl. 4, Fig. 1) or two chambers (Pl. 1, Fig. 1) in a series, cannot be regarded as belonging to juvenile colonies. The thickness of the basal pad which has to contain the kenozoidal chambers is not therefore thought to have been a function solely of the ontogenic age. In many colonies it was also dependant on the local biotope conditions featured by an extremely high ecological heterogeneity (cf. HOFFMAN 1979). The specimens with a different thickness of the basal pad, and thus a different number of kenozoidal chambers are regarded as the ecotypes of no taxonomical value (BAŁUK & RADWAŃSKI 1984).

A distinction between the present-day forms with one kenozoidal chamber and those ancient ones with a greater number, and a bunching them into separate subspecies, as postulated by CADÉE (1979, 1981), is not to be accepted (BAŁUK & RADWAŃSKI 1984). It may also be noted that in other species of the genus the number of kenozoidal chambers is commonly known as variable (*see* the reference data *in* BAŁUK & RADWAŃSKI 1984) and this feature has never been used for acceptable taxonomical purposes.

The maximum number of kenozoidal chambers (eight in a series) corresponds to that known in other species of the genus, the type species including (*see* WATERS 1921, Pl. 29, Fig. 1).

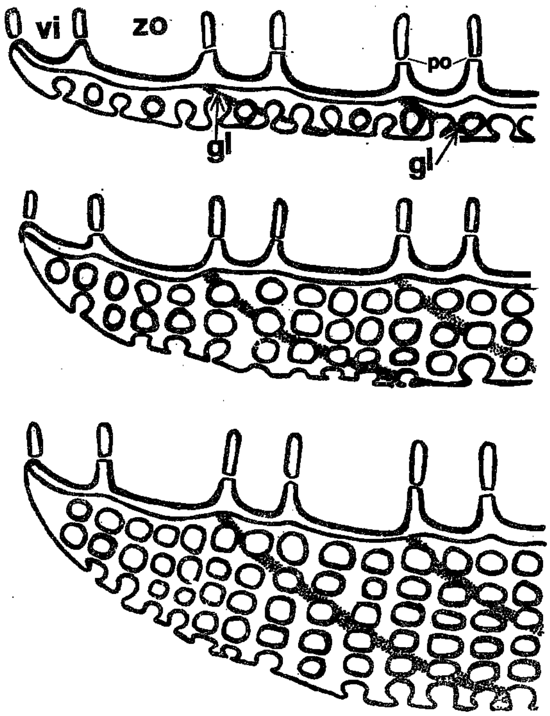


Fig. 2

Distribution of kenozoidal chambers within the basal pad in colonies of *Cupuladria vindobonensis* BAŁUK & RADWAŃSKI; the drawings correspond to the specimens presented in Pl. 4, Figs 1—3
zo — zooecium, **vi** — vibraculum, **gl** — growth lamellae within the basal pad, **po** — pores

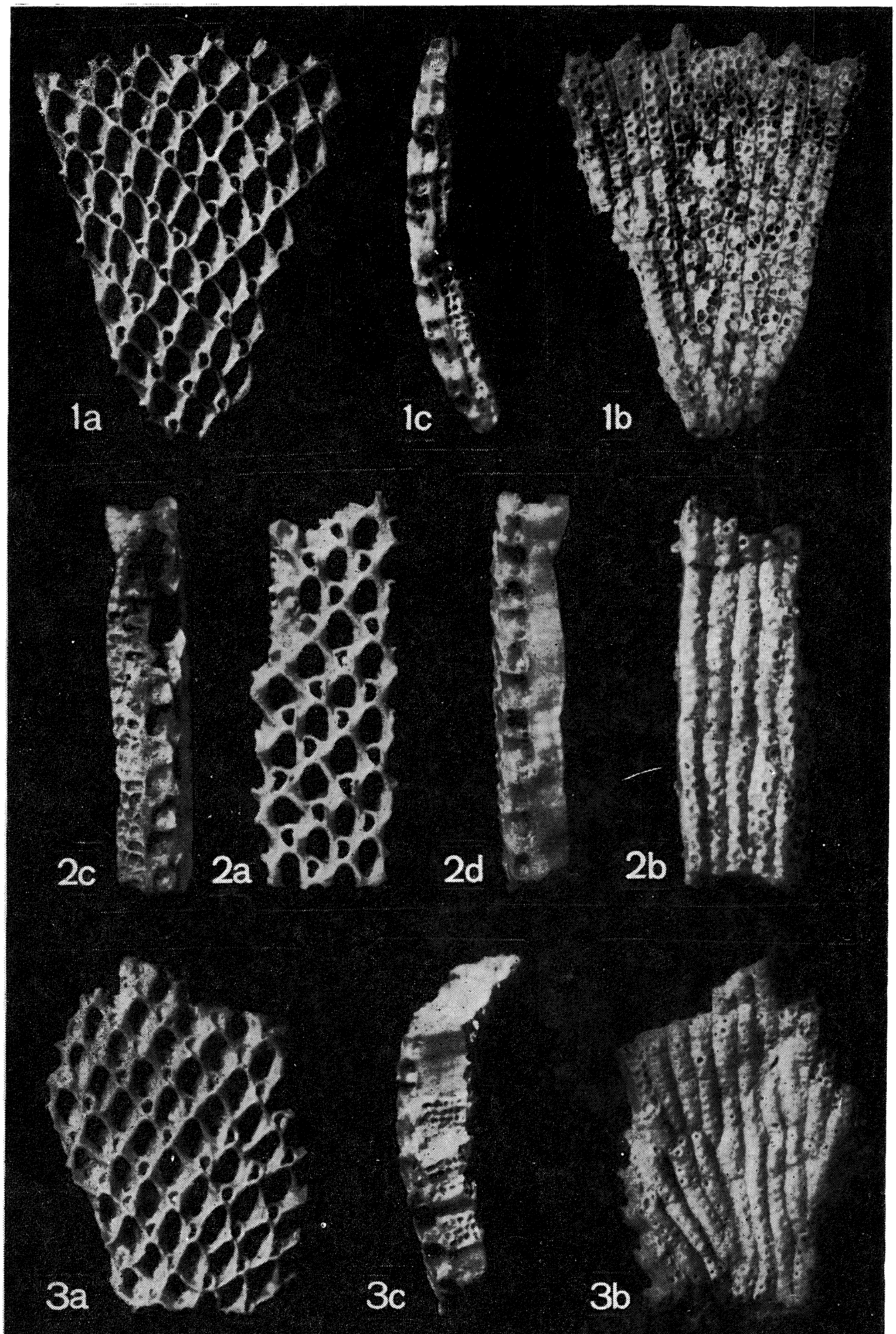
REMARKS: The investigated specimens coincide with those included into the synonymy of the species (*see* BAŁUK & RADWAŃSKI 1984).

The number of kenozoidal chambers is often greater than displayed by specimens from the contemporaneous deposits of the Vienna Basin, where it ranges from one (chambers usually elongated vertically) to three or four (BAŁUK & RADWAŃSKI 1984).

PLATE 1

Cupuladria vindobonensis BAŁUK & RADWAŃSKI, 1984

1-3 — Fragments of larger, not regenerated colonies displaying a variable number of kenozoidal chambers in a series; 1a, 2a, 3a — frontal views; 1b, 2b, 3b — basal views; 1c, 2c-d, 3c-d — side views (*1c* taken along the right side of *1a*; *2c* taken along the left side of *2a*; *2d* along the sectorline, right side of *2a*; *3c* taken along the right side of *3a*)
Specimen in Fig. 1 displays one kenozoidal chamber at the colony margin (up in the photo) and 2 through 3 towards the center of the colony; specimen in Fig. 2 displays 2 through 3, and that in Fig. 3 displays 4 through 6 kenozoidal chambers in a series


1a
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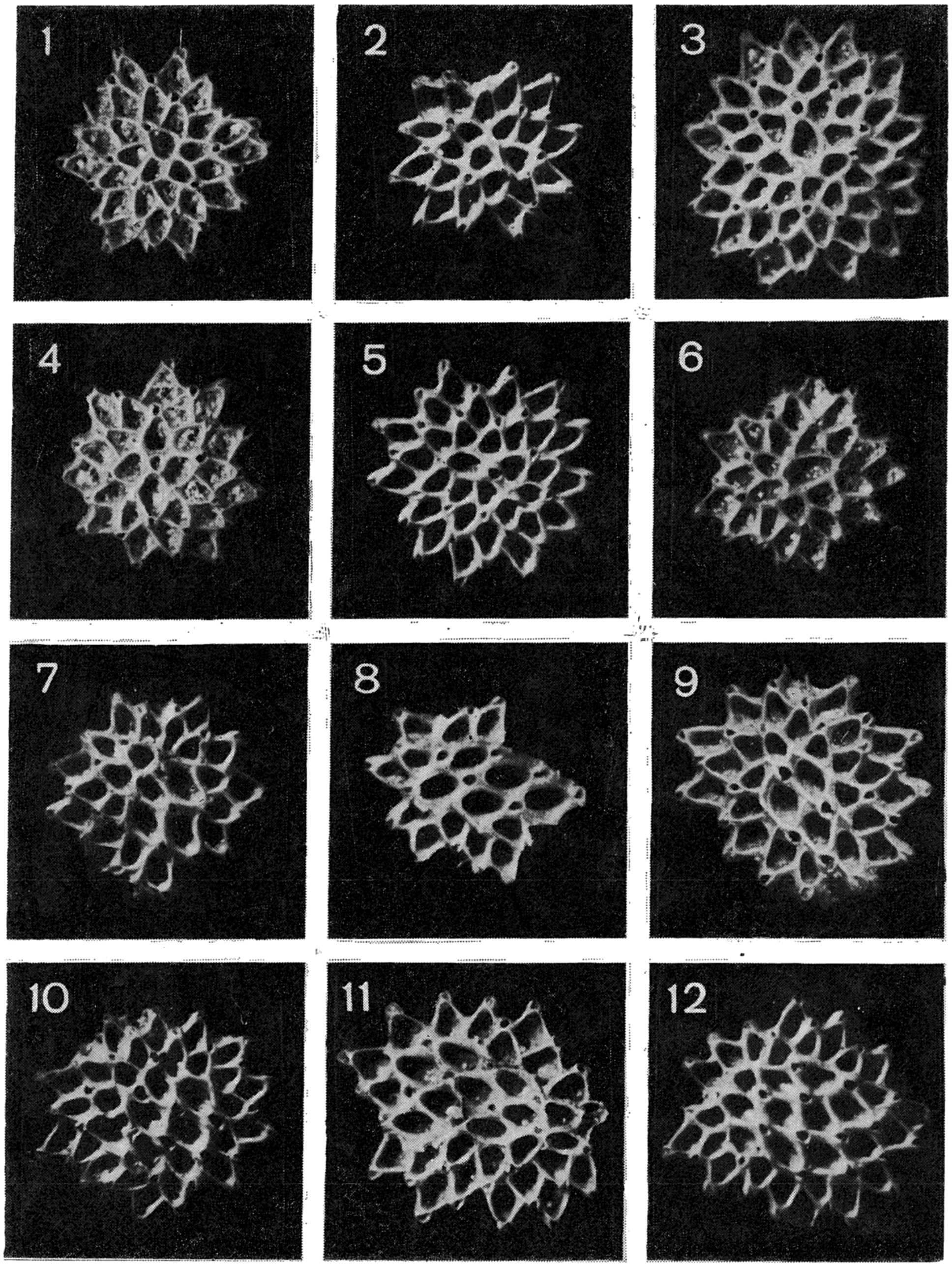
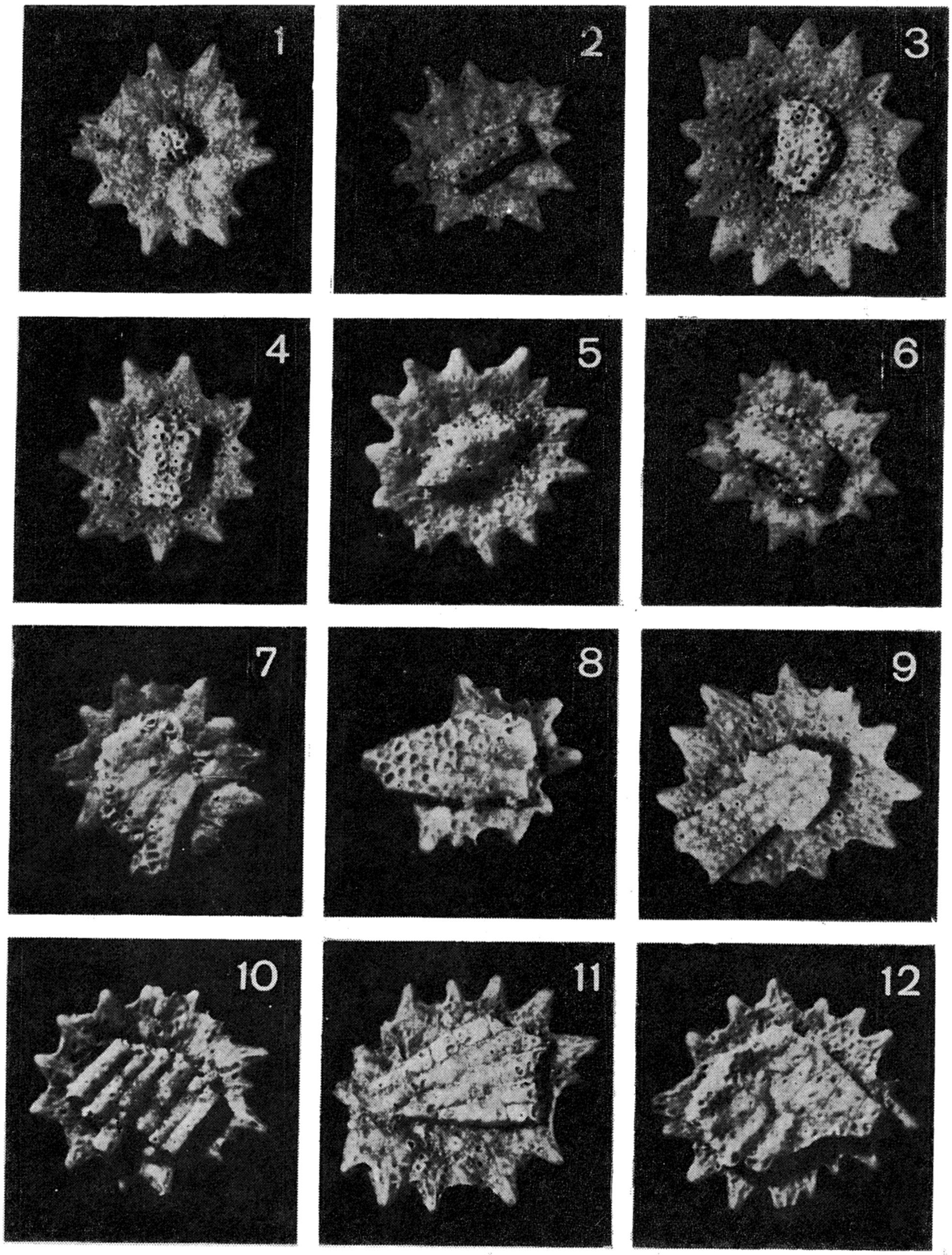


Cupuladria vindobonensis BAŁUK & RADWAŃSKI, 1984

1-12 — Small, regenerated colonies, to show the shape and size of the primary colonies: frontal views of colonies presented in Pl. 3, Figs 1—12

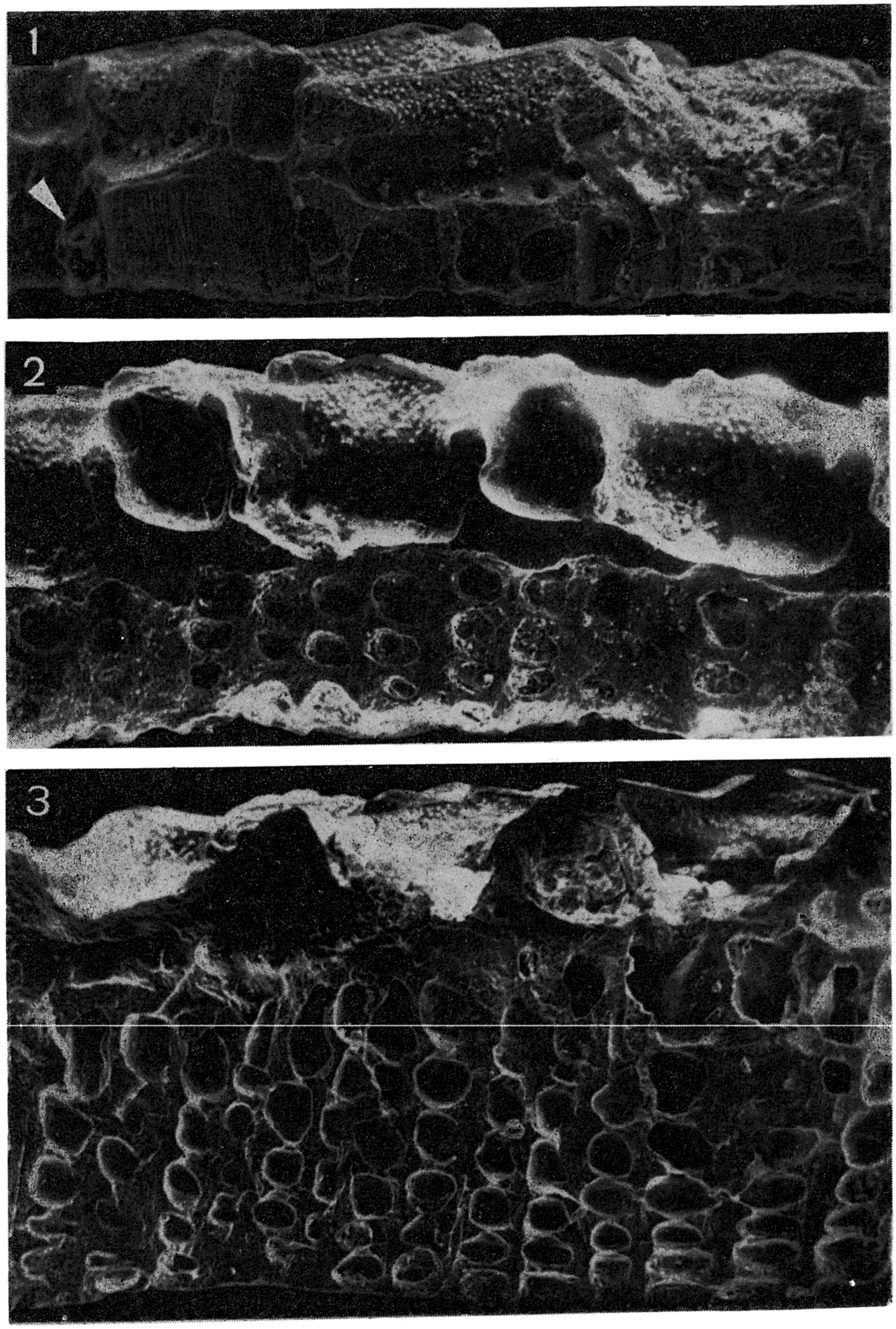
All figures x 15; taken by ŁUSZCZEWSKA, M. Sc., and by K. ZIELIŃSKA



Cupuladria vindobonensis BAŁUK & RADWAŃSKI, 1984

1-12 — Small, regenerated colonies, to show the shape and size of the primary colonies: basal views of colonies presented in Pl. 2, Figs 1—12

All figures × 15; taken by L. ŁUSZCZEWSKA, M. Sc., and by K. ZIELIŃSKA



Cupuladria vindobonensis BAŁUK & RADWAŃSKI, 1984

1-3 — Vertical sections through the colonies, to show the number and shape of kenozoidal chambers (in Fig. 1 arrowed is the chamber of the next row); *SEM* micrographs, taken × 100

The number of pores within a sector of the underside, varying usually between 6 and 12, and with the observed range from 2 to 20, agrees also with that reported in the reference data, the maximum number of twenty including (COOK 1965b, p. 199; CADÉE 1975, p. 325, *and* 1979, p. 446). This number for the Vienna Basin specimens is usually 6 to 12, with the observed range 2 to 18 (BAŁUK & RADWAŃSKI 1984).

The regeneration of colonies in *Cupuladria vindobonensis* BAŁUK & RADWAŃSKI is known as well pronounced both in the specimens from the Korytnica Basin (*see* BAŁUK & RADWAŃSKI 1977, Pls 1—3), and from the Vienna Basin (BAŁUK & RADWAŃSKI 1984, Pl. 2, Fig. 2 and Pl. 3, Fig. 1). In the present-day specimens it was recognized by DARTEVELLE (1935) in materials from Madeira, and from the Algerian coast, western Mediterranean (DARTEVELLE 1935, Pl. 19, Figs 1—2; reillustration *in* LAGAAIJ 1963, Pl. 25, Fig. 5; for synonymic attribution to this species *see* BAŁUK & RADWAŃSKI 1984).

OCCURRENCE: In Poland, the species was reported, under the name of *C. cannariensis*, from the Korytnica Basin (COOK 1965*b*, p. 199, at Karsy; BAŁUK & RADWAŃSKI 1977) and the Carpathian Foredeep at Benczyn (MAŁECKI 1951; LAGAAIJ 1963, Text-fig. 15*a*).

In the Vienna Basin the species has been reported, also under the name of *C. canariensis* from diverse Middle Miocene (Badenian) deposits (MANZONI 1877, CANU & BASSLER 1925, LAGAAIJ 1963, DAVID & POUYET 1974, VÁVRA 1977, CADÉE 1979), and it has recently been revised by the authors (BAŁUK & RADWAŃSKI 1984) when introducing the specific name of *vindobonensis*. In other Central Paratethys basins it is known from the Transylvanian Basin (MANZONI 1877, COOK 1965b). Reports on other Neogene till Recent occurrences in Europe and overseas are indicated by BAŁUK & RADWAŃSKI (1984).

Family **Discoporellidae** BAŁUK & RADWAŃSKI, 1984

The family Discoporellidae was established by the authors (BAŁUK & RADWAŃSKI 1984) to comprise the genera *Discoporella* d'ORBIGNY, 1852 and *Reussirella* BAŁUK & RADWAŃSKI, 1984.

DIAGNOSIS (*given by* BAŁUK & RADWAŃSKI 1984): Zoaria free in adult stages; zooecia with asymmetrical vibracula, distal to each zooecium. Vicarious vibracula not stated. Central zooecia closed by a calcareous lamina. All zooecia with vestibular arch well developed. Cryptocyst with spinules or completely covering the opesium. Kenozoidal chambers absent within the basal pad. Underside with alternating grooves and ridges, tuberculate.

Genus *Reussirella* BAŁUK & RADWAŃSKI, 1984
Type species: *Reussirella haidingeri* (REUSS, 1847)

DIAGNOSIS (*given by* BAŁUK & RADWAŃSKI 1984): Discoporellid genus bearing the incomplete cryptocyst provided with spinules, sometimes joined over the opesium.

SPECIES INCLUDED: *Reussirella haidingeri* (REUSS, 1847); *R. reussiana* (MANZONI, 1869); *R. multispinata* (CANU & BASSLER, 1923); *R. doma* (d'ORBIGNY, 1853); *R. oweni* (GRAY, 1828).

Reussirella haidingeri (REUSS, 1847) (Plates 5—6)

ORIGINAL DESIGNATION: Two specimens illustrated, under the name „*Lunulites Haidingeri*, m." by REUSS (1847, Pl. 7, Figs 26—27).

LECTOTYPE: The specimen designated by DAVID & POUYET (1974, p. 101), and kept in the collection of the Naturhistorisches Museum in Vienna (Geologisch-Paläontologische Abteilung; Catalogue Number *1867. XL. 315/1*), illustrated by BAŁUK & RADWAŃSKI (1984, Pl. 4, Fig. 1a—1b).

SYNONYMY: Given by BAŁUK & RADWAŃSKI (1984).

MATERIAL and its DISCUSSION: Numerous colonies, the majority of which are fragmented to a variable extent (*see* Pls 5—6; *and* BAŁUK & RADWAŃSKI 1977, Pl. 4). Regeneration is displayed primarily by smaller colonies, the smallest of which is composed of 4 zooids of the primary colony, and 12 zooids of the first regeneration-rim (BAŁUK & RADWAŃSKI 1977, Pl. 4, Figs 1a—1b). Fragments of larger colonies, indicating about 20 mm of the primary diameter, do not show regeneration (*see* e.g. Pl. 5, Fig. 2).

Colonies with some zooecia covered by a calcareous lamina are not common, and were formerly (BAŁUK & RADWAŃSKI 1977) unknown in the Korytnica material. The covered zooecia are usually distributed patchily in the near-to-center part of the colony, more or less distant to its margin (Pl. 5, Figs 1—2). The central zooecia are wholly covered only in the regenerated specimens in which evident is the attribution of such zooecia to the primary colony (Pl. 6, Figs 2—3). In one colony which regenerated around a fragment having the margin of the primary colony, this margin remained not regenerated (Pl. 6, Fig. 1). Some colonies bear traces of a predatory attack upon the primary, or possibly upon the newly-regenerated colonies (Pl. 6, Fig. 1).

The sections (or, broken edges) of the colonies (Pl. 5, Figs 1c and 2c; Pl. 6, Fig. 3c) show a variable extent of the zooecia, and the absence of any kenozooidal chambers. The zooecia in some, rather smaller and thus younger colonies reach almost the lower surface of the colony (Pl. 5, Fig. 1c and Pl. 6, Fig. 3c). In larger colonies the zooecia do not reach that surface (Pl. 5, Fig. 2c), the latter case corresponds to that in a specimen from the Vienna Basin, presented by MANZONI (1877, Pl. 16, Fig. 54).

REMARKS: The investigated specimens coincide well with those from Steinebrunn in the Vienna Basin for which REUSS (1847) established the species. The synonymy of the species, as well as a discussion upon the taxa „*denticulata*" of

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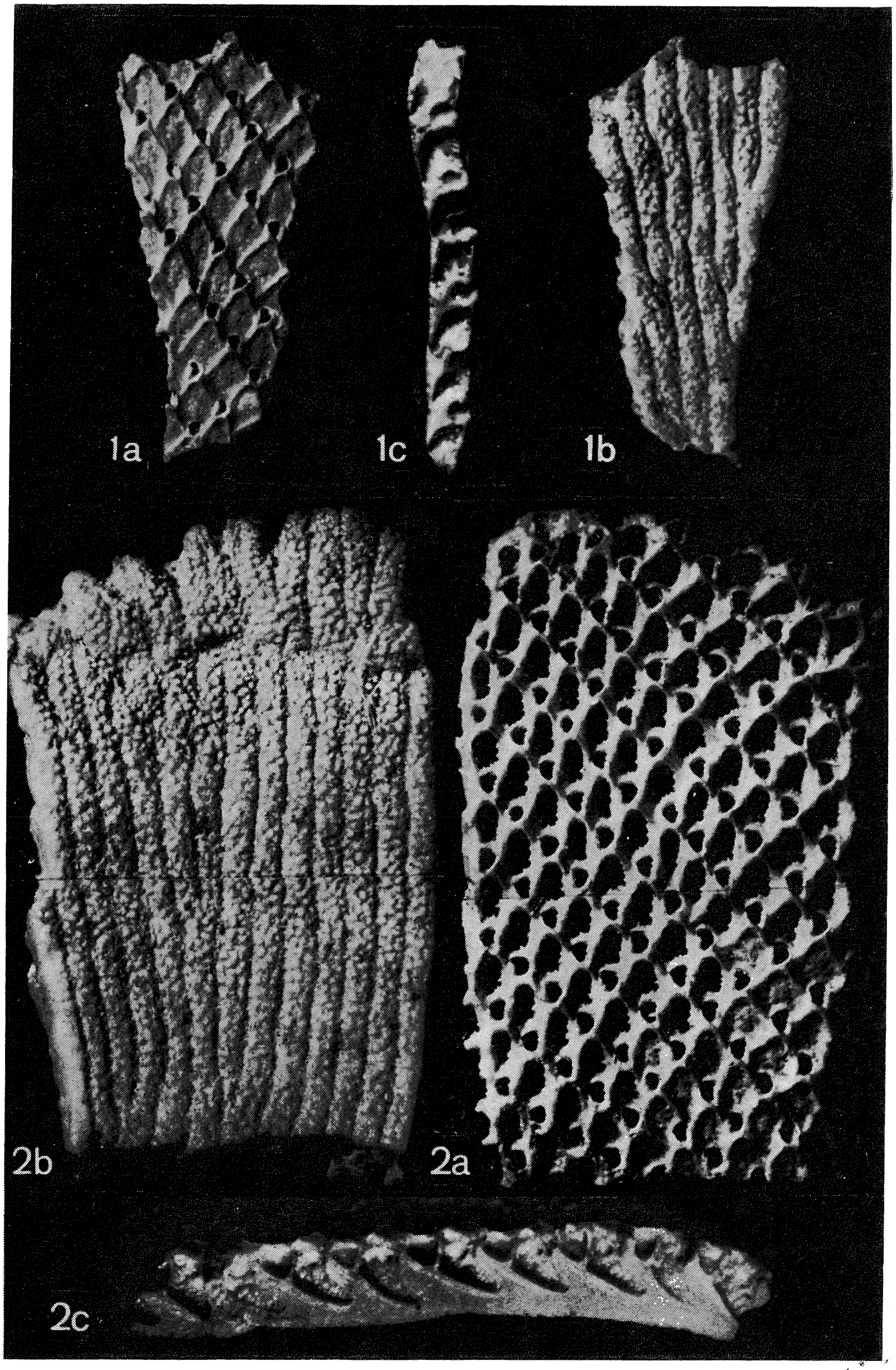
PLATE 5

Reussirella haidingeri (REUSS, 1847)

1 — Fragment of the median part of colony with all the zooecia covered by a calcareous lamina: 1a — frontal view; 1b — basal view; 1c — side view (taken along the right side of *1a*), to show the shape and extent of zooecia reaching almost the lower surface of the colony

2 — Fragment of large colony, to show the zooecia covered by a calcareous lamina in the near-to-center part of the colony, and the well developed spinules: 2a — frontal view (covered zooecia in a patchy area, *at lower right*); 2b — basal view; 2c — side view (taken along the right side of *2a*), to show the zooecia not reaching the lower surface of the colony

All figures × 15; taken by L. ŁUSZCZEWSKA, M. Sc.


1a
1c
1b
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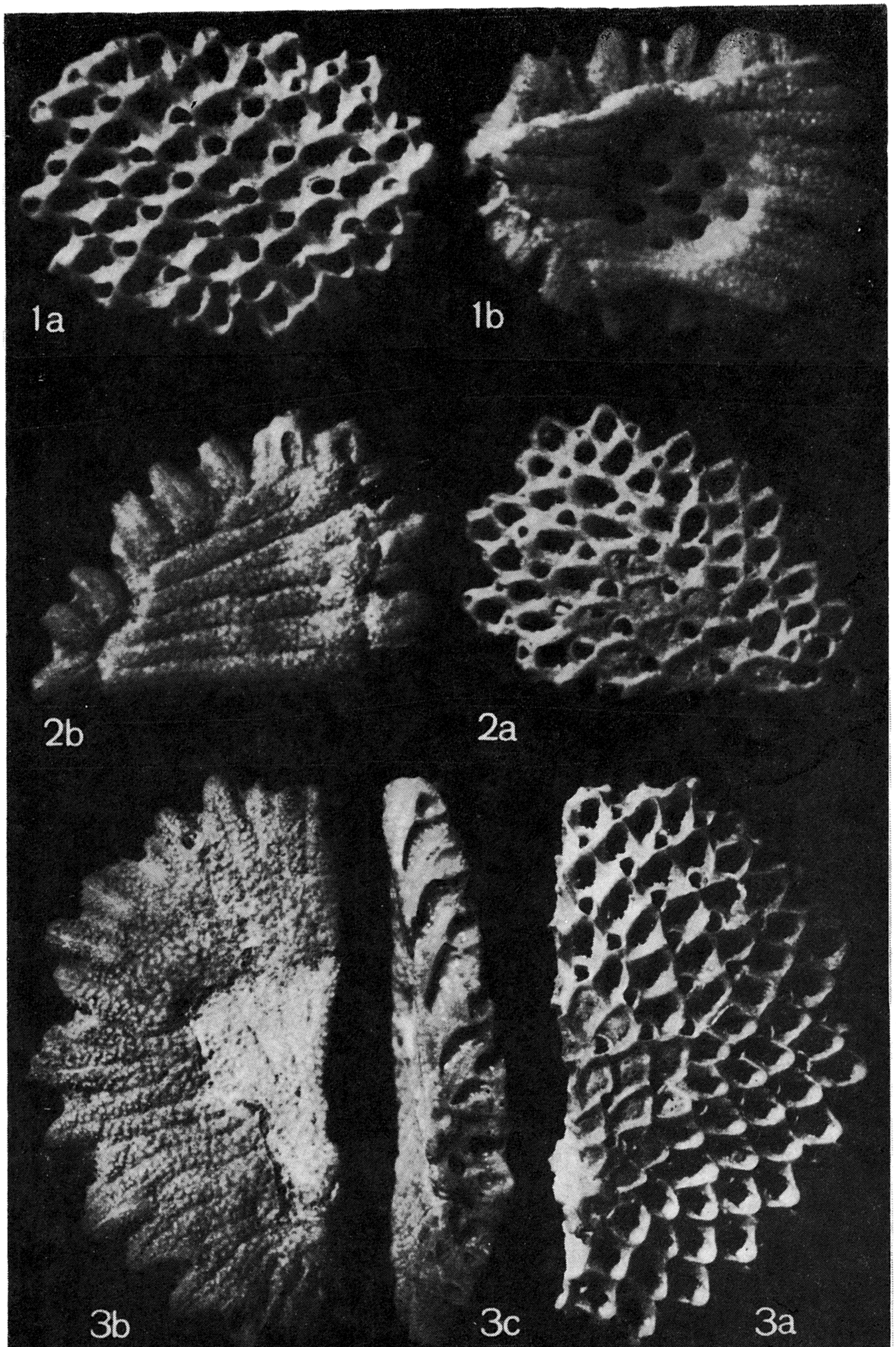
2c


1a
1b
2b
2a
3b
3c
3a

CONRAD and „vandenheckei" of MICHELIN, sometimes identified or synonymyzed with the species in older references, has recently been presented elsewhere (BAŁUK & RADWAŃSKI 1984).

The colosures of central zooecia by a calcareous lamina in the investigated specimens are identical with those pictured for the specimens both from the Vienna Basin (*see* REUSS 1847, Pl. 7, Fig. 26c; MANZONI 1877, Pl. 16, Fig. 54; BAŁUK & RADWAŃSKI 1984, Pl. 4, Figs 1—3, Pl. 5, Figs 1—3, Pl. 6, Figs 1—3, Pl. 10, Figs 1—4), and the North Sea Basin (*see* BUGE 1973, Pl. 6, Fig. 3; CADÉE 1977, Pl. 1, Fig. 2*a*). The zooids covered by a calcareous lamina are interpreted to have functioned as a passive excurrent chimney, in the same way as in some present-day lunulite bryozoans (*see* COOK 1979; CHIMONIDES & COOK 1981, p. 212).

The regeneration of colonies in *Reussirella haidingeri* (REUSS) has formerly been reported only from the Korytnica Basin (BAŁUK & RADWAŃSKI 1977, Pl. 4, Figs 1—6) and the Vienna Basin (BAŁUK & RADWAŃSKI 1984, Pl. 4, Fig. 4, Pl. 6, Fig. 1).

OCCURRENCE: In Poland, the species in known from the Korytnica Basin (BAŁUK & RADWAŃSKI 1977) and the Carpathian Foredeep at Benczyn (MAŁECKI 1951).

In the Vienna Basin the species is reported both from the Eggenburgian (VÁVRA 1977) and Badenian deposits (REUSS 1847, MANZONI 1877, CANU & BASSLER 1925, DAVID & POUYET 1974, VÁVRA 1977, BAŁUK & RADWAŃSKI 1984). In other Central Paratethys basins it is known from the Pannonian and Transylvanian basins (MANZONI 1877). Raports on other occurrences in the Neogene deposits of Europe are indicated by BAŁUK & RADWAŃSKI (1984).

Family **Lunulitidae** LAGAAIJ, 1952
Genus *Lunulites* LAMARCK, 1816
Type species: *Lunulites radiata* LAMARCK, 1816
Lunulites androsaces MANZONI, 1869
(Plate 7)

HOLOTYPE: The specimen illustrated, under the name „*Lunulites androsaces*, ALL.", by MANZONI (1869, Pl. 2, Figs 18 and 18').

SYNONYMY: Given by BAŁUK & RADWAŃSKI (1984).

PLATE 6

Reussirella haidingeri (REUSS, 1847)

1 — Regenerated colony: regeneration rim developed all around a triangular fragment of the primary colony except of its margin: 1a — frontal view; 1b — basal view, to show a trace (etching or drilling) of the predator

2 — Fragment of the regenerated colony (broken edge at the bottom), the primary piece of which bears most of its zooecia covered by a calcareous lamina: 2a — frontal view, 2b — basal view

3 — Half of the regenerated colony, the primary piece of which bears all its zooecia covered by a calcareous lamina: 3a — frontal view; 3b — basal view; 3c — side view, to show a disruption in size and shape of zooecia of the both parts (primary and regenerated) of the colony

All figures × 15; taken by K. ZIELIŃSKA (Figs 1—2), and by L. ŁUSZCZEWSKA, M. Sc. (Fig. 3)

MATERIAL: Over a dozen of fragmented colonies (Pl. 7, Figs 2—4), the morphological features of which coincide well with those displayed by the specimens included into the synonymy presented in the revision of the species (BAŁUK & RADWAŃSKI 1984). One small colony (Pl. 7, Fig. 1) is regenerated from an angular fragment composed of 13 zooecia.

REMARKS: The species has long been commonly regarded (*see* BAŁUK & RADWAŃSKI 1984) as established by MICHELOTTI (1838). A documentation offered by MICHELOTTI (1838, p. 191, Pl. 7, Fig. 2) can hardly be however accepted as picturing any *Lunulites*. MICHELOTTI himself (1838), followed by MANZONI (1869, 1877), attributed this species to ALLIONI, whose designation (ALLIONI 1757, pp. 16—17) of "*Madrepora Androsaces*" is still more nebulous. Consequently, it was indicated (BAŁUK & RADWAŃSKI 1984) that the first adequate documentation was given just lately by MANZONI (1869, p. 28, Pl. 2, Figs 18 and 18') and this very author was recognized as the creator of the species.

The regeneration of colonies in *Lunulites androsaces* MANZONI has formerly been known only in one small specimen from Immendorf in the Vienna Basin (BAŁUK & RADWAŃSKI 1984, Pl. 12, Fig. 1).

OCCURRENCE: The species has not been formerly reported either from the Korytnica Basin or any other locality in Poland.

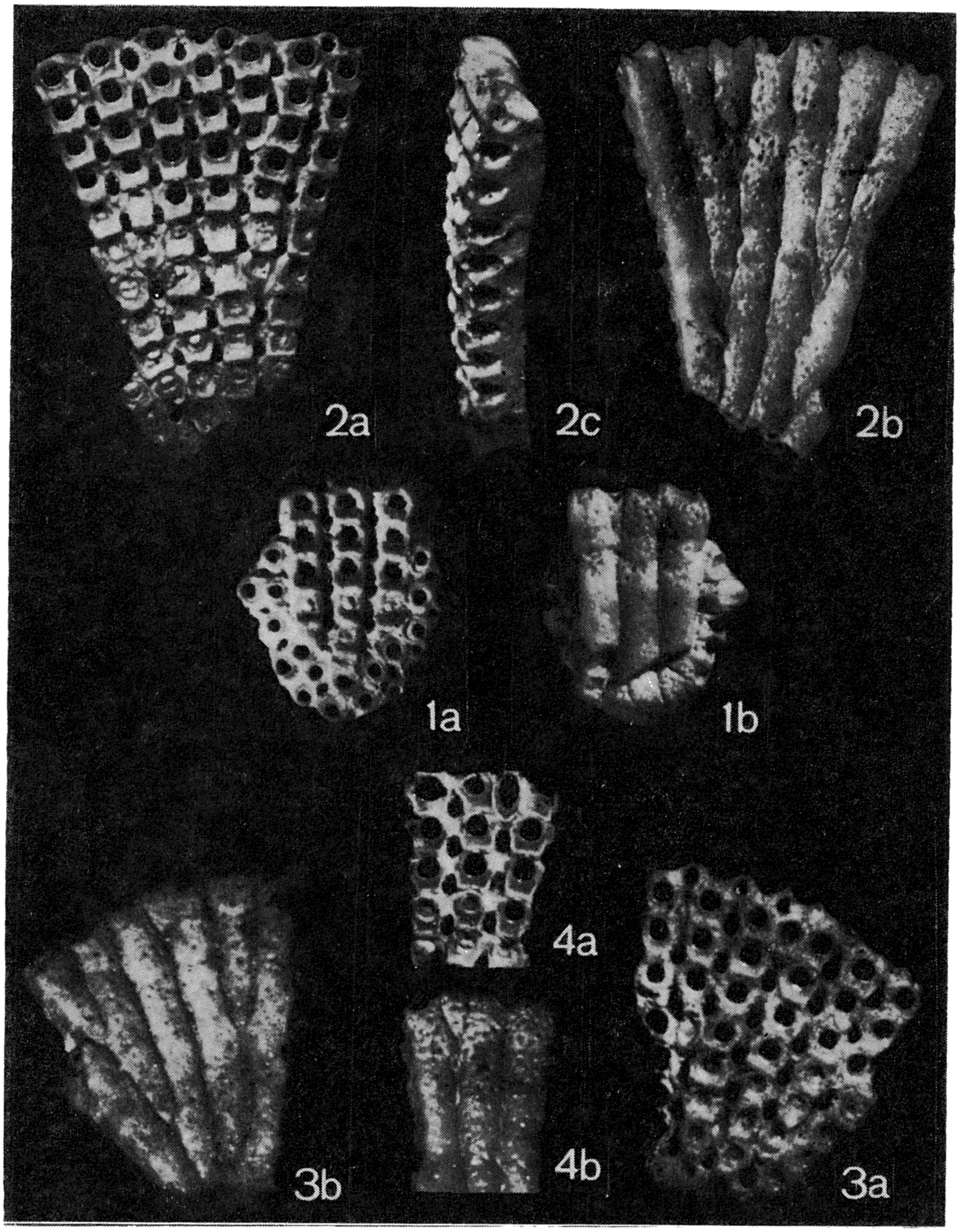
In the Vienna Basin the species is known from two localities (Baden and Immendorf) within the Middle Miocene (Badenian) deposits (MANZONI 1877, DAVID & POUYET 1974, VÁVRA 1977, BAŁUK & RADWAŃSKI 1984). In other countries it is also known from the Miocene and Pliocene deposits of Italy (*see* MANZONI 1869, 1877), and Miocene of France (*see* VIGNEAUX 1949, DAVID & POUYET 1974). Its whole stratigraphic range and geographic distribution seem to be confined to the Neogene of Europe (*see* LAGAAIJ 1963, Text-fig. 18).

REGENERATION OF THE COLONIES

The regeneration of the colonies of free-living bryozoans from the Korytnica Basin is well displayed by all the three investigated species, viz. *Cupuladria vindobonensis* BAŁUK & RADWAŃSKI, *Reussirella haidingeri* (REUSS), and *Lunulites androsaces* MANZONI.

The regeneration is primarily best pronounced in *Cupuladria vindobonensis* BAŁUK & RADWAŃSKI in which the majority of colonies underwent the damage and regeneration. It is therefore thought that for this very species there existed in Korytnica Basin a situation comparable to that of some present-day populations of free-living bryozoans which are even entirely composed of regenerated colonies (*see* COOK & CHIMONIDES 1983, p. 568). The regeneration is consequently regarded as providing an important means for colony reproduction (MARCUS & MARCUS 1962; BOARDMAN & CHEETHAM 1973, p. 173), and this certainly may be assumed as responsible for the survival of the discussed species in many of its habitats, for instance in the Korytnica Basin.

The damage of colonies of all the free-living bryozoans in the Korytnica Basin was supposedly caused by either predacious or accidental activity of various benthic animals, primarily of holothurians and hermit



Lunulites androsaces MANZONI, 1869

1 — Small, regenerated colony with some zooecia of the primary colony covered by the cryptocyst: 1a — frontal view, 1b — basal view

2 — Fragment of larger colony with the near-to-center zooecia covered by the cryptocyst: 2a — frontal view, 2b — basal view, 2c — side view (taken along the right side of *2a*)

3-4 — Fragments of colonies, to show the shape and extent of the avicularia: 3a, 4a — frontal view; 3b, 4b — basal view

All figures × 15; taken by K. ZIELIŃSKA (Fig. 1), and by L. ŁUSZCZEWSKA, M. Sc. (Figs 2—4) crabs (*see* BAŁUK & RADWAŃSKI 1977) which living commonly in the environment became the most important factor dangerous for persistence of both the discussed *Cupuladria* species and the other free-living bryozoans. If it is apparent that the predacious and other destructive activities of the benthic animals upon the free-living bryozoans (*see* LAGAAIJ 1963; GREELEY 1967; CADÉE 1975; BAŁUK & RADWAŃSKI 1977, 1984) are almost identical in both ancient and present-day conditions, the regeneration images in the colonies are well comparable to those known in other invertebrates, *e.g.* in the fungiid corals (*see* BOSCHMA 1925, Pl. 8, Figs 93—96, in *Halomitra philippinensis* STUDER).

NOTES ON THE LIFE HABITAT

Within the Korytnica Basin (*cf.* Text-fig. 1), when the deposition of the Korytnica Clays continued, the environmental conditions were controlled by the topography of an inundated valley which became a shallow bay during the Middle Miocene (Badenian) transgression (RADWAŃSKI 1969, BAŁUK & RADWAŃSKI 1977). The clay material from the nearby shores was transported primarily by currents, whilst sedimentation from suspension was subordinate. The gradual filling of the bay with clays resulted in a successive shallowing of the basin, the original depth of which was about 60 to 40 meters. The investigated lunulite bryozoans come primarily from the uppermost part of the clay sequence that originated on the bottom densely overgrown by seagrasses, at the depth of a few meters, and thus much smaller than reported for the present-day biotopes of the cupuladriids (*see* BAŁUK & RADWAŃSKI 1977, 1984). It is therefore thought that in an ancient protected area of the Korytnica Basin, the cupuladriids and discoporellids were more tolerant to the bathymetry than they are in the hitherto recognized present-day conditions (*see* also discussion on the ecological evolution of the cupuladriids by HOFFMAN 1979).

The tropical and/or subtropical climatic requirements of all the three investigated free-living cheilostome bryozoans, *Cupuladria vindobonensis* BAŁUK & RADWAŃSKI, *Reussirella haidingeri* (REUSS), and *Lunulites androsaces* MANZONI, as well as their biogeographic affinites have been summarized in the formerly given approaches (BAŁUK & RADWAŃSKI 1977, 1984).

Institute of Geology
of the University of Warsaw,
Al. Żwirki i Wigury 93,
02-089 Warszawa, Poland

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