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UPPER JURASSIC NERINEACEAN GASTROPODS FROM THE HOLY CROSS MTS (POLAND)

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Twenty five species and subspecies of the Upper Jurassic nerineaceans including one new genus (*Lewinskia* gen. n.), 3 new species (*Elatioriella sanctacrucensis* sp. n., *Fibuloptygmatis mieronicensis* sp. n., and *Phaneroptyxis sulejovensis* sp. n.), and 2 new subspecies (*Cossmannea desvoidyi baltovensis* subsp. n., *C.d. karczewskii* subsp. n.) are erected. The nerineaceans inhabited mostly shallow water carbonate depositional environments. Nerineacean beds formed under the optimum ecological conditions and slow sedimentation rate.

K e y w o r d s: Nerineacean gastropods, taphonomy, paleoecology, shell ontogeny, taxonomy, biostratigraphy, Oxfordian, Kimmeridgian, Central Poland.

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INTRODUCTION

The nerineacean gastropods from the margins of the Holy Cross Mts (Góry Świętokrzyskie) have for long been investigated (Siemiradzki 1894; Karczewski 1959, 1960, 1965; Wieczorek 1974, 1975*a*), and the list of the recognized species is given by Malinowska (1970). The nerineaceans from other regions of Poland were studied by Zeuschner (1849), Siemiradzki (1894), Wójcik (1914), and Dmoch (1970, 1971).

The present paper gives the results of the study of morphology and paleoecology of the nerineacean gastropods derived from the Middle Oxfordian to Upper Kimmeridgian deposits cropping out in the Holy Cross Mts margins (fig. 1). The conclusions are based upon the author's own material (over 4,000 specimens) collected during a few years of the fieldwork, mainly in the vicinity of Sulejów (over 2,000 specimens). Most investigated specimens are incomplete, with their apical parts lacking and the shells more or less abraded. Nevertheless, the shell internal structu-

res are usually quite clear; they were studied in some 2,000 axial sections. The internal structures are commonly diagenetically deformed. Collapse structures (pl. 5: 1—9) are often observed, and they manifest in an anomalous position of the whorls relative to the original shell wall.

The investigated nerineacean collection comprises over 40 species in total; only the new or poorly known taxa are described here. The documentary part of the collection is housed at the Museum of the Insti-

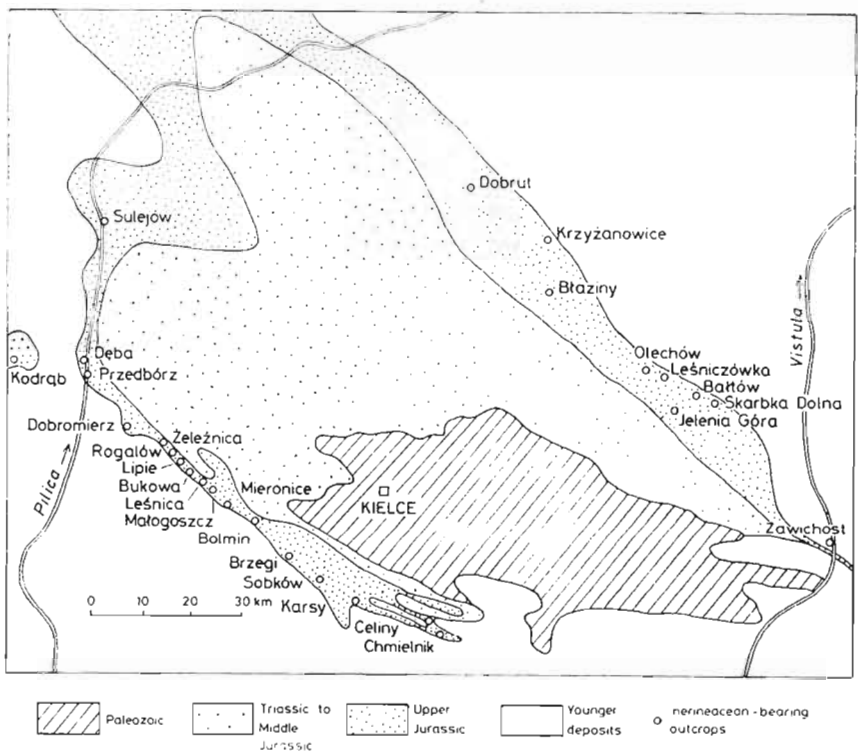


Fig. 1. Geological sketch of the Holy Cross Mts.

tute of Geological Sciences of the Polish Academy of Sciences, Cracow (abbreviated as ZNG Kr); the rest of the collection is housed at the Institute of Geology of the Jagiellonian University, Cracow.

The present paper follows the taxonomic arrangement given for the nerineaceans by Pchelintsev (1960, 1965). However, this gastropod group comprising the families Tubiferidae, Nerineidae, Nerinellidae, and Itieridae, is here regarded as a suprafamily (viz. Nerineacea), which is consistent with the tradition, since the order Murchisoniata proposed by Pchelintsev (1965) does not appear enough justified (cf. Djalilov 1975). The new families erected by Pchelintsev (1963, 1965) are therefore referred to at the subfamilial level. Some other modern authors (e.g. Sohl 1965, Fischer 1969, Sirna 1968) follow the arrangement proposed by

Fold formula			internal-structural pattern	Genera
numeral	numeral–literal	literal–numeral		
0000	–	–		Pseudonerinea Aptyxiella
1000	C	C	C	Contortella
0100	P	P	P	Cryptoplocus Conoplocus
0010	L	L	L	? Nerinella
1100	CP	CP	P, C	Turbinea
1010	1C, 1L	C, L	C, L	Cossmannea Aphanotaenia
1110	1C, 1P, 1L	C, P, L	P, C, L	Nerinea Endiatrochelus Phaneroptyxis
1111	1C, 1P, 1L, 1B	C, P, L, B	P, C, L, B	Elatioriella
2110	2C, 1P, 1L	C_1, C_2, P, L	P, C_2, C_1, L	Nerinella
2111	2C, 1P, 1L, 1B	C_1, C_2, P, L, B	P, C_2, C_1, L, B	Fibuloptygmatis
2120	2C, 1P, 2L	C_1, C_2, P, L_1, L_2	P, C_2, C_1, L_2, L_1	Ptygmatis
2130	2C, 1P, 3L	C_1, C_2, P, L_1, L_2, L_3	P, C_2, C_1, L_3, L_2, L_1	Lewinskia Bactroptyxis

Fig. 2. Fold formulae and general patterns of the nerineacean shell internal structures for the genera recorded in the Upper Jurassic of the Holy Cross Mts margins.

Cox (1949, 1954); the resulting inconveniences have been considered in a preceding paper (Wieczorek 1975*a*).

Acknowledgements. — This study was accomplished in the Institute of Geology of the Polish Academy of Sciences under the supervision of Dr. L. Teller to whom the author is deeply grateful for his help during the work. Thanks are also due to Dr. L. Karczewski, Professor W. Krach, Professor J. Kutek, and Professor H. Makowski for their helpful remarks. Dr. M. Barker, Polytechnic Institute at Portsmouth, and Dr. N. Sohl, U.S. Geological Survey, Washington, are gratefully acknowledged for making available comparative collections.

Terminology. — The morphological terminology proposed by Cox (1960) is used in the present paper, except for the term "labial fold" which is here used instead of "palatal fold". The internal structures are described in terms of Cox' (1954) formula but a modified literal-numeral formula introduced by Delpey (1939) is used for detailed description of the folds. The following abbreviations are used: C — columellar fold, P — parietal fold, L — labial fold, and B — basal fold.

To describe more complex internal structures, an expanded formula is used, taking into account minor folds of the second and third orders (see description of *Ptygmatis bruntrutana*). The swellings of shell walls which do not form any distinct folds are here called flexures (F); e.g. F_c is the symbol of a flexure at the columella. Diverse formulae describing internal structures of the investigated nerineacean shells are shown in fig. 2.

The following biometrical indices are used:

PA — pleural angle
AA — apical angle
SA — sutural angle
n — whorl number
H_n — total height of n whorls
D — maximum shell diameter
D_o — maximum diameter of axial hole
h — whorl height
$h_{n-1}/_d$ — height to width ratio of the penultimate whorl
d_{min}/d_{max} — whorl concavity index (measured at whorls with concave walls)
d_{max}/d_{min} — whorl convexity index (measured at whorls with convex walls)
h_f — fold height

The term "whorl inside index" is meant as the ratio of whorl inside cross-section area to the total whorl section.

Except of those indicated, all the measurements given in the description were taken at the penultimate whorls. All the linear measurements are given in millimeters, and the angular measurements in degrees.

REMARKS ON NERINEACEAN STRATIGRAPHIC DISTRIBUTION IN THE HOLY CROSS MTS

Northeastern margin of the Holy Cross Mts. — The Upper Jurassic stratigraphy of this region is presented by Samsonowicz (1932), Dąbrowska (1953, 1957), Dembowska (1953), and Pożaryski (1948). The ammonite fauna is poor and hence, the stratigraphy is very imprecise in this area; the so far recognized units "Astartian" and "Rauracian" can be

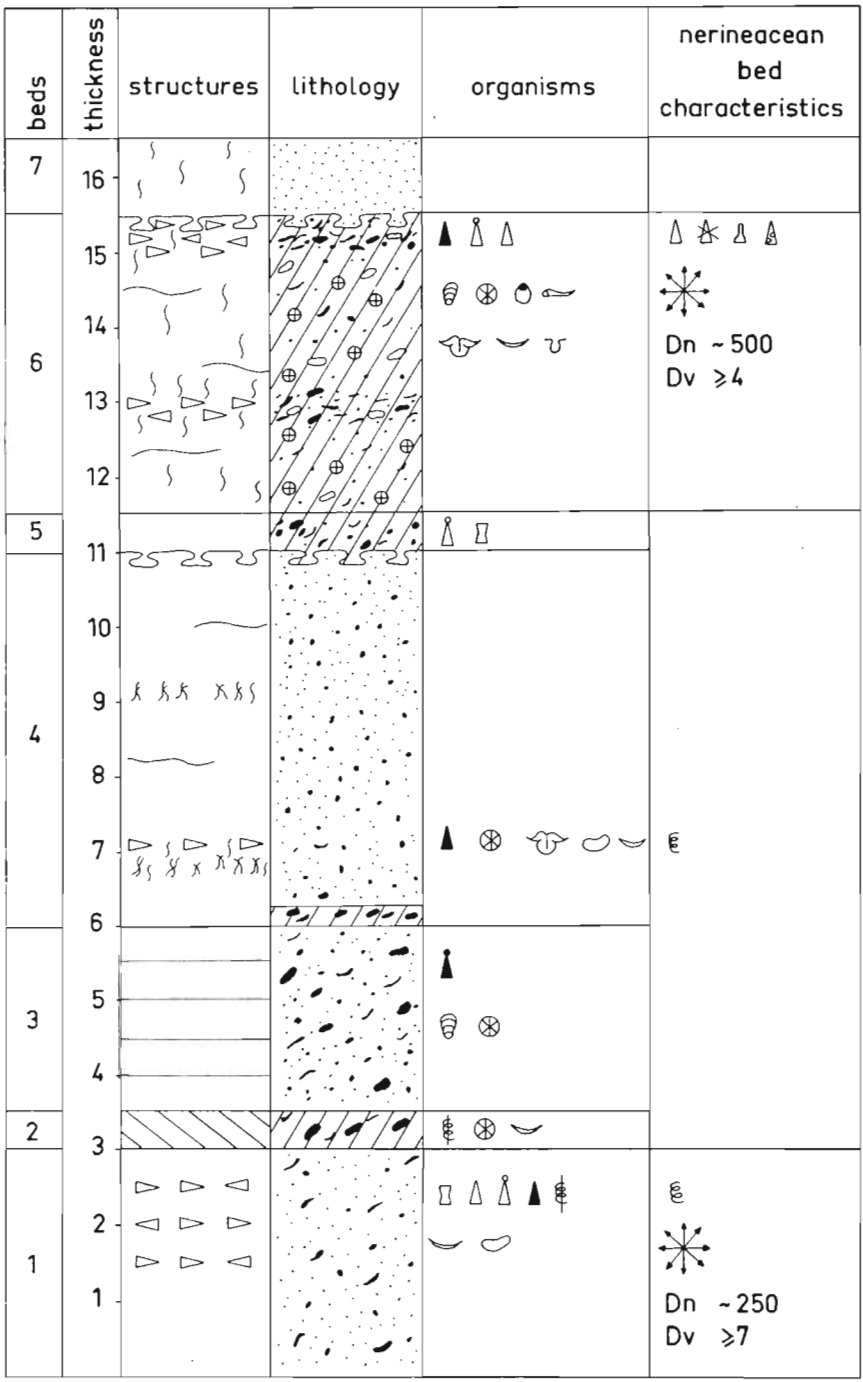
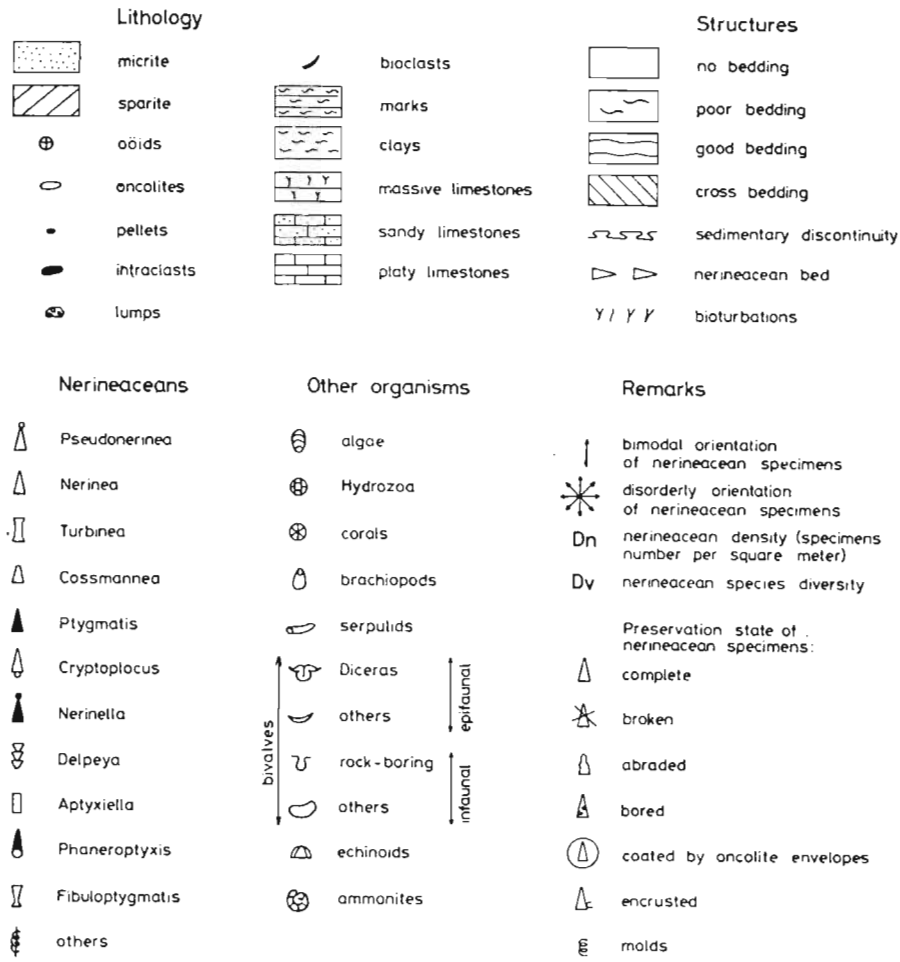


Fig. 3. "Astartian" deposits at Błaziny.



Explanations to figs. 3, 4, 5, 8.

only approximately correlated with the ammonite zones. The oldest nerineacean-bearing strata occur at Bałtów-Zarzecze (Roniewicz and Roniewicz 1971) and are assigned to the Middle Oxfordian (*Gregoryceras transversarium* Zone). They yield abundant assemblage including *Elatioriella sanctacrucensis* sp.n., *Cossmannea desvoidyi baltovensis* subsp.n. *Nerinella* cf. *gurovi*, and *Nerinella ornata* which have not been recorded in any younger strata. The nerineaceans occur also very abundantly in the "Astartian" deposits at Dobrut (for the geological section see Dembowska 1953), Błaziny (fig. 3), and Skarbka (for the geological section see Liszkowski 1976). The most common species are there *Ptygmatis bruntrutana*, *Ptygmatis pseudobruntrutana*, and *Cryptoplocus depressus*; less common are *Turbinea contorta*, *Sculpturea incisa*, and *Cossmannea desvoidyi desvoidyi*. The nerineaceans have also been recorded in the Upper Kimmeridgian deposits of Krzyżanowice area where *Cryptoplocus pyramidalis* and *Cossmannea desvoidyi karczewskii* subsp.n. occur abundantly.

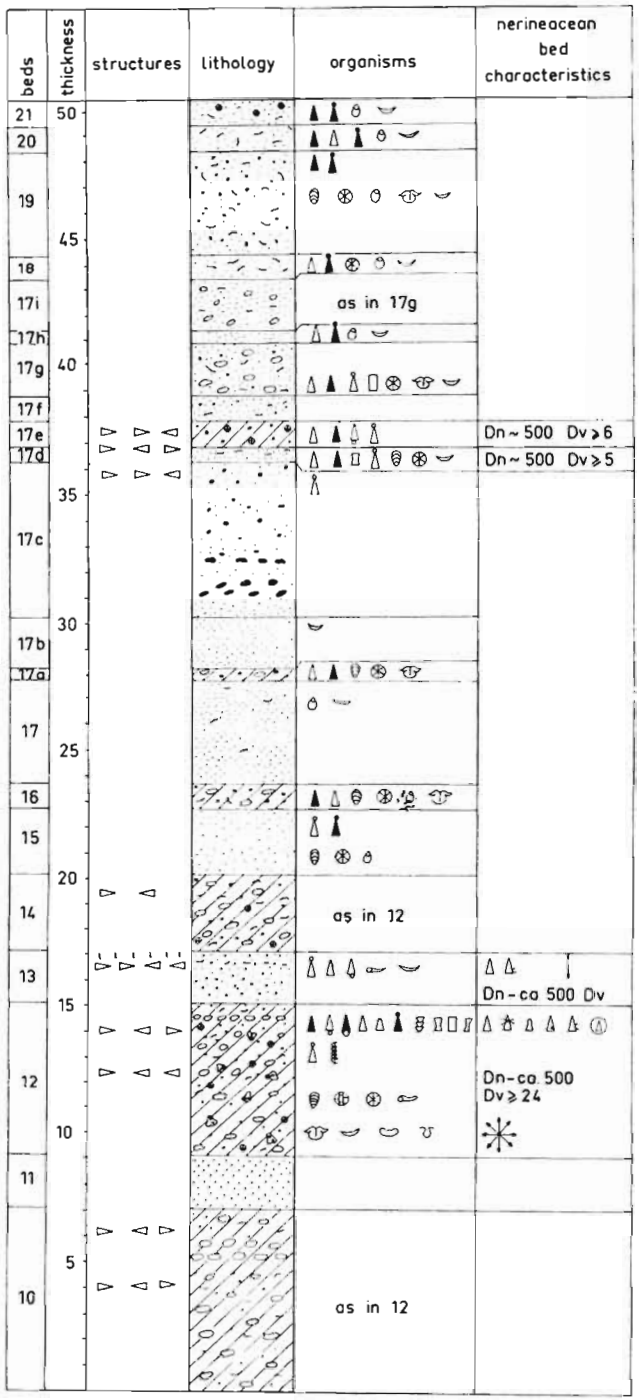


Fig. 4. Deposits and fossil assemblage of the Lower Kimmeridgian section at Sulejów; see also Barczyk (1961), Wieczorek (1975b).

Northwestern margin of the Holy Cross Mts. — The nerineacean gastropods occur very commonly in the Upper Oxfordian to Lower Kimmeridgian strata exposed at Sulejów (for the geological section see fig. 4, Barczyk 1961, Wieczorek 1975b). In that area, *Bactroptyxis* aff. *crebriplicata* and ?*Nerinella* sp. have been recorded in the Upper Oxfordian (*Idoceras planula* Zone). An exceptionally rich nerineacen assemblage has been found in the Lower Kimmeridgian (*Sutneria platynota* Zone and the lowermost part of *Ataxioceras hypselocyclum* Zone), with *Ptygmatis bruntrutana*, *Ptygmatis pseudobruntrutana*, *Cryptoplocus depressus*, *Phaneroptyxis sulejovensis* sp.n., *Cossmannea desvoidyi desvoidyi*, *Lewinskia varioplicata*, *Nerinea fallax*, *Pseudonerinea clytia*, and *Fibuloptygmatis* sp. represented most abundantly. The upper Lower Kimmeridgian deposits (the upper part of *Ataxioceras hypselocyclum* Zone, and *Katroliceras divisum* Zone) comprise the nerineaceans only sporadically, mostly *Nerinella* aff. *satagea*.

Southwestern margin of the Holy Cross Mts. — In this region, the nerineaceans occur most abundantly in Chalky Limestones member attributed by Kutek (1968) to the Oxfordian/Kimmeridgian boundary sequence (the upper part of *Idoceras planula* Zone and the lower part of *Sutneria platynota* Zone). The species *Ptygmatis bruntrutana*, *Ptygmatis pseudobruntrutana*, *Cryptoplocus depressus*, *Elatioriella bernardiana*, *Lewinskia varioplicata*, *Fibuloptygmatis* sp., *Pseudonerinea clytia*, *Aphanotaenia* aff. *strigillata* and others have been recorded in Chalky Limestone member

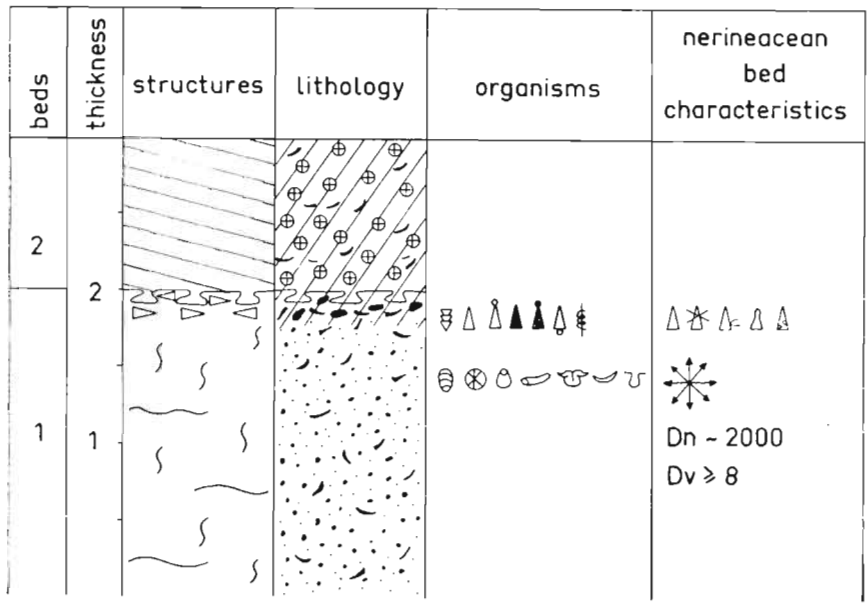


Fig. 5. A part of the Lower Kimmeridgian section at Przedbórz; boundary of the Chalky Limestone member (bed 1) and the overlying deposits (bed 2).

cropping out at Przedbórz (fig. 5), Bukowa (for the geological section see Roniewicz and Roniewicz 1971), and Małogoszcz (for the geological section see Kutek 1968). The so-called Lower Oolite assigned by Kutek (1968) to the lower part of *Ataxioceras hypselocyclum* Zone and exposed in the vicinity of Sobków and Karsy yields the nerineaceans attributed to *Lewinskia varioplicata*, *Nerinella episcopalis* and *Nerinnella* aff. *satagea*. In turn, the so-called Upper Oolite (the upper part of *Ataxioceras hypselocyclum* Zone, according to Kutek 1968) exposed at Mieronice contains *Lewinskia varioplicata*, *Nerinea fallax*, and *Fibuloptygmatis mieronicensis*. *Cossmannea desvoidyi desvoidyi* occurs rather commonly in the Staniewice Lumachelle of *Katroliceras divisum* Zone (Kutek 1968). A rich collection of *Ptygmatis bruntrutana* derived from Oncolitic-Platy Limestone member exposed at Kodrąb (for the geological section see Kutek 1968) and representing the beds transitional from *Sutneria platynota* to *Ataxioceras hypselocyclum* Zones.

The nerineacean distributional patterns are largely facies controlled and hence, merely the local stratigraphic ranges can be determined in particular exposures. The total stratigraphic ranges cannot be determined with more precision than to a stage or substage level because of the rarity of ammonites in the nerineacean-bearing strata. This is consistent with the conclusions of Pchelintsev (1965), and Karczewski (1960, 1973).

TAPHONOMY AND PALEOECOLOGY

The Upper Jurassic deposits cropping out in the Holy Cross Mts margins represent mostly the limestone, marly, and shaly facies. The nerineaceans occur mainly in the limestones (chalky limestones, oncolitic-lumpy limestones, pelletal limestones, oolitic limestones) of Late Oxfordian and Early Kimmeridgian age. Their shells form commonly large accumulations called as the "nerineacean beds".

Nerineacean beds. — The nerineacean beds are here meant as rock bodies displaying very high density of nerineacean shells (pls 1—3). They range from a few to some tens centimeters in thickness and can usually be traced continuously at a distance of at least some hundreds meters up to a few kilometers. Their lower and upper boundaries are quite distinct as a rule (pl. 2: 2). Considerably bioturbated zones (figs 2—4) and sedimentary discontinuities of "soft-bottom" type occur very commonly both at the base and top of the beds.

The nerineacean shells may represent some tens percent of the fossil assemblage of a bed, becoming sometimes its only significant component. The nerineacean associations include commonly a few to a dozen or so species (associations of so high species diversity have been recorded exclu-

sively in the oncolitic-lumpy limestones at Sulejów), with a single or a couple of species dominant. Beds dominated by far by a single species (representing over 90% of the total number of nerineacean specimens) occur very rarely; this is the case of the bed with *Psudonerinea clytia* at Sulejów. In addition to the nerineaceans algae (*Marinella, Solenopora*), corals, hydrozoans, bivalves (*Diceras, Trichites, Liostrea*), and serpulids may also considerably contribute to the nerineacean beds.

In some beds, density of the nerineacean shells is very high and attains usually a few tens to some hundreds specimens per square meter. There is no evidence for size sorting of the specimens (pl. 3). The shells lie parallel to the bed surfaces but they do not show any prevalent orientation (figs 6B, 7A, 7C; pl. 2: 1; pl. 3: 1). Distinctly oriented shells have been recorded merely in two nerineacean beds, namely the bed with *Pseudonerinea clytia* at Sulejów (fig. 6A; pl. 1: 1) and the bed with *Elatioriella sanctacrucensis* sp.n. at Bałtów (fig. 7B; pl. 3: 2). In both cases, the shell apices point to the opposite directions what suggests the wave nature of the orientation (Nagle 1967, Seilacher 1973). Any evidence for current orientation of the shells has not been found. One has, however, to keep in mind that a shell orientation may be disturbed by life activities of burrowing organisms (Toots 1965). The lack of any apparent shell orientation in the upper part of the bed with *Elatioriella sanctacrucensis* (fig. 7C; pl. 3: 1) may be due to the bioturbation by crabs, the burrows of which occur here and there in that part of the bed.

The nerineacean shells and their associated fossils are commonly more or less abraded and fragmented; the only well preserved fossils are those contained by micritic and pelletal limestones. Many shells are bored by algae, fungi, sponges (mostly *Clionolithes* Clarke = *Olkenbachia* Soll; Häntzschel 1962; Wieczorek 1975*a*), polychaetes (*Trypanites*), or bival-

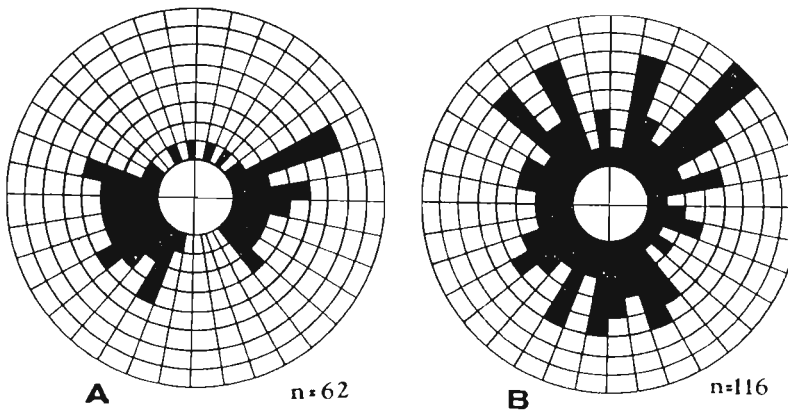


Fig. 6. Specimen orientation in nerineacean beds; angular sectors of 10°; ▼ — a single measurement, n — number of measurements *A* directional orientation in a bed with *Pseudonerinea clytia*, Sulejów, Lower Kimmeridgian (cf. fig. 4, bed 13; pl. 1: 1). *B* random orientation, Przedbórz, Lower Kimmeridgian (cf. fig. 5: bed 1).

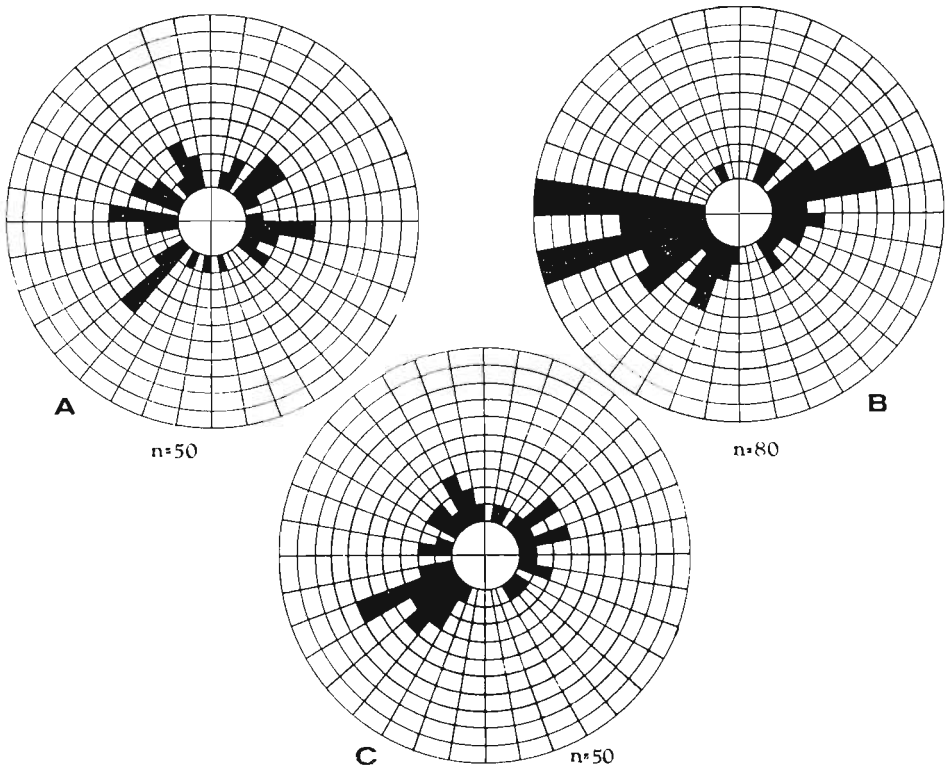


Fig. 7. Specimen orientation in a bed with *Elatioriella sanctacrucensis*, Bałtów, Middle Oxfordian; angular sectors of 10°; ▼ — a single measurement, n — number of measurements. *A* random orientation at the bed base, *B* directional orientation in the middle of the bed (pl. 3: 2), C random orientation at the bed top (pl. 3: 1).

ves—*Lithophaga* or *Gastrochaena* (pl. 4: 1, 2, 4). Sometimes, a few distinct boring generations can be recognized (pl. 4: 1) which points to an early lithification of the internal sediments (Goldring and Kaźmierczak 1974). External surfaces of the shells are also commonly encrusted by serpulids, the bivalves—*Diceras* (pl. 4: 3), *Liostrea*, *Exogyra*, corals, hydrozoans, and algae (*Marinella*, *Solenopora*). The serpulids encrust also the umbilical walls and the whorl insides. The nerineacean shells derived from chalky and oncolitic-lumpy limestones show frequently oncolitic coatings (pl. 1: 2; pl. 4: 1, 2, 4) encrusted sometimes by the serpulids or bivalves, and bored (see also Kutek and Radwański, 1965).

Origin of the nerineacean beds. — The above presented characteristics of the nerineacean beds suggest that these shell accumulations are autochthonous or almost autochthonous fossil assemblages formed under conditions of very slow sedimentation. The shell preservation state and orientation may indicate their transportation prior to the final burial but nevertheless, any transport of the shells outside the gros environment inhabited originally by the nerineacean gastropods seems impro-

bable. As shown by investigation of the modern shallow-water habitats, shells are merely locally transported even during storm periods, and the taphocoenoses resemble closely the original biocoenoses in both their distribution and composition (Johnson 1965; Warme 1969). Furthermore, there is no evidence for any considerable erosion at the base of the nerineacean beds what demonstrates that storms were rather insignificant for their formation. One may conclude that the nerineacean shells underwent final burial close to their original habitats. This is supported by the similarity of intraskeletal to surrounding sediments, and by the apparent specificity of some nerineacean assemblages for particular lithofacies. The high nerineacean density in the beds cannot be regarded only as a relative enrichment of the deposit in fossils caused by a low sedimentation rate; the nerineaceans occur merely sporadically or even are absent at all from strata separating the beds. The nerineacean beds are therefore to be related to the ecological optimum conditions for those organisms, established during the periods of slow sedimentation.

As indicated e.g. by the co-occurrence of nerineaceans, corals and the bivalves *Diceras*, most nerineacean genera lived probably epifaunally (Awad 1952; Delpey 1937; Vogel 1968) and were able to settle only stable substrate areas. The epifaunal mode of life of the nerineaceans is also suggested by rather common occurrence of their shells encrusted during the growth by serpulids (pl. 4: 5), hydrozoans (Delpey 1937), or the bivalves *Sauvagesia* (Vogel 1968). The observations on the present-day carbonate sedimentary environments (Persian Gulf, Great Bahama Bank) show clearly that benthic organisms attain large abundances only in the areas with very slow sedimentation and more or less consolidated bottom sediments (Seibold 1973; Shinn 1969); apart from the early lithification processes, bottom sediments may also be stabilized by organic film (Bathurst 1967). One may suppose that because of the epifaunal mode of life of the nerineaceans, stable substrate availability made a necessary condition for mass occurrence of those gastropods. However, not all the stable-bottom surfaces discernible in the investigated geological sections were actually settled by the nerineaceans and hence some other ecological factors are also to be taken into account. The nerineacean mass occurrences show that these were opportunistic organisms (Levinton 1970) gaining a prevalence in numerical abundance under their optimum ecological conditions. The single-species beds recorded here and there in the investigated area were probably related in their origination to the habitat variability (Sanders 1969; Bretsky and Lorenz 1969).

Those factors responsible for the mortality of large nerineacean associations can hardly be unequivocally recognized. One may suppose that changes in substrate nature (decreased consolidation) and an increase in water turbidity due to the increase in sedimentation rate played here important roles. In fact, these factors appear harmful for epifaunal or-

ganisms as a rule (Thayer 1975). Some beds could be suddenly buried during a storm, which is indeed a common cause for mass mortality of benthic organisms (Brongersma-Sanders 1956). It is noteworthy that all the fossils associated with the nerineacean beds do also disappear at their upper limits.

Nerineaceans and facies. — The Upper Jurassic deposits of the Holy Cross Mts margins accumulated in a shelf basin far away of the coastline. At the Oxfordian/Kimmeridgian boundary, this region was a large carbonate bank resembling the modern Bahama Bank (fig. 8; Kutek 1969; Roniewicz and Roniewicz 1971). Cross-stratified oolites without any autochthonous organic remains were deposited in high-turbulence environments. One may claim that the unstable substrate at the oolite shoals made the environment unsuitable for settlement by benthic organisms (cf. Newell *et al.* 1959; Purdy 1963, 1964). In less turbulent habitats seawards of the oolite shoals, oolitic deposits without cross-stratification

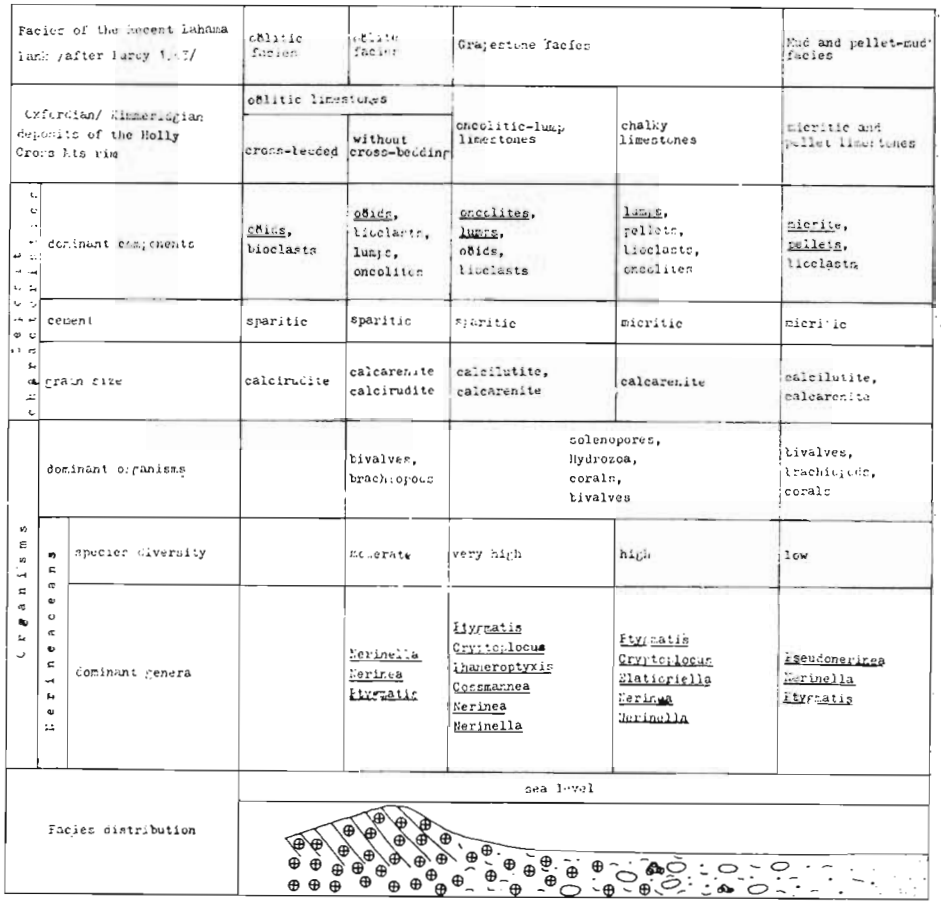


Fig. 8. Facies characteristics of Oxfordian/Kimmeridgian boundary in the Holy Cross Mts margins: based partly upon the data presented by Kutek (1968).

accumulated. In this case, discontinuous sedimentation is documented with (i) abundance of burrows, (ii) sedimentary discontinuities, and (iii) evidence for micritization of the ooids and fossil remains. The fauna of this lithofacies is dominated by bivalves (*Pholadomya, Pleuromya, Mytilus*), brachiopods (terebratulids and rhynchonellids), and nerineaceans. The algae *Marinella* are also common, and corals occur sporadically. Chalky and oncolitic-lumpy limestones without any distinct sedimentary structures formed under conditions of moderate water energy. The rich fossil assemblages of these facies comprises algae (*Marinella, Solenopora*), hydrozoans, corals (there are some patches, but never true reef structures: Roniewicz 1966; Kutek 1969), bivalves (mostly *Diceras*, *Trichites*, *Liostrea*, *Lima*), and gastropods (nerineaceans and *Acteonina*). The fossils show commonly oncolitic coatings and various borings. Micritic and pelletal limestones with less abundant fauna, or non-fossiliferous at all, accumulated in quiet-water habitats (lagoons or central part of the bank).

Somewhat different nerineacean assemblages are specific for particular lithofacies. The most abundant and diverse assemblages occur in the chalky and oncolitic-lumpy limestones. The oolitic limestones show much poorer nerineacean associations, whereas there are merely a few nerineacean species in the micritic and pelletal limestones. The nerineacean genera vary in degree of their dependence upon lithofacies. The genus *Ptygmatis* occurs commonly in all the carbonate lithologies which demonstrates that it is only weakly controlled by lithofacies. It is however noteworthy that the largest specimens of *Ptygmatis bruntrutana* occur in the chalky and oncolitic-lumpy limestones where this species represents usually half the total number of the nerineacean gastropods. *Nerinea* and *Nerinella* are also fairly independent of lithofacies all though they seem to be dominant in the oolitic limestones. In turn, *Pseudonerinea* occurs abundantly exclusively in the micritic and pelletal limestones. The genera *Fibuloptygmatis*, *Elatioriella*, *Cossmannea*, *Phaneroptyxis*, and *Cryptoplocus* occur mostly in the chalky and oncolitic-lumpy limestones; while *Lewinskia* and *Aphanotaenia occur* abundantly in the chalky and oncolitic-lumpy limestones and in the oolitic deposits as well.

The nerineacean distributional patterns at the Upper Jurassic carbonate bank of the Holy Cross Mts margins were controlled mainly by water turbulence, substrate type, and sedimentation rate. High turbulence, unstable substrate, or rapid sedimentation made the environment inaccessible for the nerineacean gastropods. One can hardly find out any distinct correlation between the water-energy level and the complexity of nerineacean shell internal structures. There is, however, some evidence to support a claim that quiet-water environments were preferred by the nerineaceans lacking any folds inside the shell (*Pseudonerinea*) and the shells of those genera displaying complex internal structures (*Ptygmatis*) were thinner-walled there.

High specific diversity of the nerineacean gastropods (over 40 species) recorded in the Upper Jurassic strata of the Holy Cross Mts margins is probably related to the long-term persistence (Middle Oxfordian to Lower Kimmeridgian) of shallow-water carbonate facies in this area. During the Kimmeridgian, the carbonate bank disappears replaced by the marly facies; the nerineaceans become then much less abundant and represented merely by *Nerinella*, *Nerinea*, and *Cossmannea*. In turn, the latter three genera accompanied also by *Cryptoplocus* occur commonly in the Upper Kimmeridgian deposits at Krzyżanowice represented by organogenic sandy limestones pointing to a distinct shallowing of the sea; the terrigenous influx resulted in very low species diversity of this abundant nerineacean assemblage.

The analyses of nerineacean distribution in the Upper Jurassic deposits all over the area of Poland shows clearly that abundant and diverse nerineacean assemblages occur exclusively in the shallow-water bahamites (fig. 9). Merely a few specimens of *Nerinea* and *Ptygmatis* are repor-

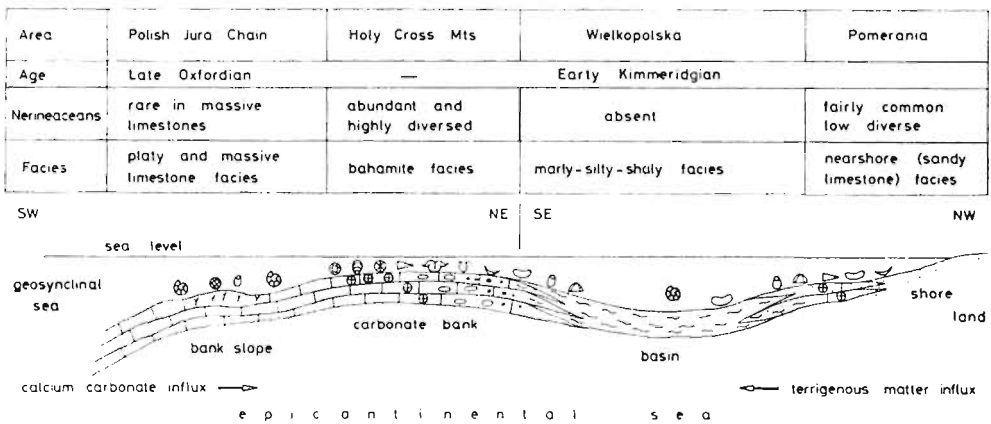


Fig. 9. Dependence of the nerineacean gastropods and other organisms upon the Upper Jurassic facies in Poland.

ted from deeper-water facies as exemplified by the massive limestones of the Cracow Uplands (Siemiradzki 1894, 1903). The nearshore facies of the Jurassic sea (Czarnogłowy and Kłęby, West Pomerania) yield fairly abundant nerineacean assemblages representing a dozen or so species mostly of the genera *Nerinea* and *Nerinella*. Interestingly, there are no representatives of *Phaneroptyxis*, *Cryptoplocus*, *Fibuloptygmatis*, and others common in the Holy Cross region; furthermore, *Ptygmatis* occurs very sporadically. This impoverishment of nerineacean fauna may be related to the habitat instability (Bretsky and Lorenz 1968) consisting mainly in salinity fluctuations and terrigenous influx (Dmoch 1970). The nerineaceans are absent at all from the marly facies of the western Central

Poland. It is also to be noted that the nerineaceans occur abundantly in the undoubtedly shallow-water Tithonian Śtramberk-type limestones, Carpathians (Zeuschner 1849, Wójcik 1914).

The same relationship of the nerineaceans to shallow-water carbonate facies can also be demonstrated in other geographic regions, not only in the Upper Jurassic (Pchelintsev 1931, 1965; Sirna 1968; Ziegler 1965), but also in the Middle Jurassic (Arkell 1931; Fischer 1969) and the Cretaceous (Delpey 1939; Carbone, Praturlon and Sirna 1971; Pchelintsev 1953). The apparent crisis underwent by the nerineaceans during the Callovian was correlated to the expansion of terrigenous facies in the epicontinental seas caused by some paleogeographic and possibly also paleoclimatic changes. The nerineaceans migrated southwards at that time, and their sporadic occurrences are reported from the Tunisia (Cox 1965), Israel (Reiner 1968; Hirsch 1976), Caucasus (Pchelintsev 1965), and Utah, United States (Sohl 1965); a few specimens of *Bactroptyxis* are reported from Balin, Southern Poland (Laube 1867), which locality appears as the northernmost Callovian nerineacean-bearing one. The nerineaceans migrated again northwards in the Upper Jurassic when the shallow-water carbonate facies spread all over the epicontinental Europe. In fact, the northern ranges of nerineacean gastropods and shallow-water carbonates are coincident in the Upper Jurassic (Ziegler 1965; Hallam 1969). The nerineaceans occur, however, very rarely on the Oxfordian shallow-water limestones in England (e.g. Fürsich 1976), due probably to fluctuations in water salinity and temperature under the conditions of land proximity (Hallam 1969, 1975).

No doubt that the nerineacean were thermophilic; they co-occur with corals, calcareous algae, and thick-shelled bivalves as a rule. The nerineacean shells are as thick as those of the present-day subtropical gastropods (Graus 1971). The calcification index exceeds 2.0 in some Florida gastropods (Graus op.cit). A similar or even higher calcification index is shown by the nerineaceans. The climatic zonation was probably less distinct in the Jurassic than today (Hallam 1969, 1975) but nevertheless, one may suppose that the geographic distribution of the nerineacean gastropods was largely controlled by climatic factors.

The Upper Oxfordian and Lower Kimmeridgian nerineaceans from the Mesozoic margin of the Holy Cross Mts are among the richest in species in Europe. They are only slightly less differentiated, especially in the subfamily Ptygmatisinae and family Itieridae, than those of the Mediterranean region (Jura, Crimea, cf. Pchelintsev 1965). Similar spectrum is present in the Upper Jurassic nerineaceans from the East margin of the Paris Basin (Levasseur 1934), those from the region of Hannover being less differentiated (Credner 1863).

SHELL ONTOGENY

The nerineacean shell ontogeny can hardly be studied in detail because of the poor preservation state of the juvenile whorls. Nevertheless, the investigated material permits recognition of considerable changes in both external and internal characteristics of the shell in ontogeny.

There is a distinct allometry in nerineacean growth at the early ontogenetic stages. Most shell parameters (e.g. angular measurements of the spiral, whorl height to diameter ratio, axial hole diameter) undergo then considerable changes. Later on, the shell grows almost isometrically, except of the whorl concavity or convexity index, suture development, and shell ornamentation. The siphonal furrow grows progressively in size during ontogeny.

The nerineacean shell internal structure shows also considerable changes in ontogeny. In most species, the shell internal structure increases continuously in complexity at the early to adult ontogenetic stages. The earliest preserved whorls display simple internal structures; any folds are lacking at all or at most, there are merely some slight swellings of the shell walls forming subsequently (at the successive whorls) more or less distinct folds.

The succession in appearance of particular folds remains poorly known so far. One may only assess that in the genera exhibiting merely three folds (*Nerinea, Nerinella*), the labial fold (L) develops at the beginning, while the columellar (C) and parietal (P) folds appear a little later. A similar pattern of the early development of the shell internal structure is also typical of some nerineaceans with complex internal structure (e.g. *Lewinskia varioplicata:* Wieczorek 1974). Other folds appear successively in those species: C_2, L_1 and L_3 in *Lewinskia varioplicata,* C_2, L_2 in *Ptygmatis*, C_2, B in *Fibuloptygmatis.*

This increase in complexity of the shell internal structure takes place over several whorls. The fold shapes and sizes are then changed; in some forms (e.g. *Ptygmatis*), the main folds are split into subordinate ones of the second or even third order. The fold morphology remains almost constant at a few last whorls of the adults.

The shell internal structure becomes gradually but rapidly simplified at the very last whorl or in the distal portion of the penultimate one. Both the subordinate and main folds disappear at that developmental stage. The shell walls (especially the whorl base decrease in thickness towards the aperture. The simplification of shell internal structure at the last whorl occurs in all the investigated specimens irrespective to their developmental stage (fig. 10; and Wieczorek 1974). This indicates that the changes in internal structure of the last whorl of a shell reflect the mode of shell growth. This interpretation is indeed confirmed by the wall structure preserved in some specimens (fig. 11*a*) permitting a reconstruction

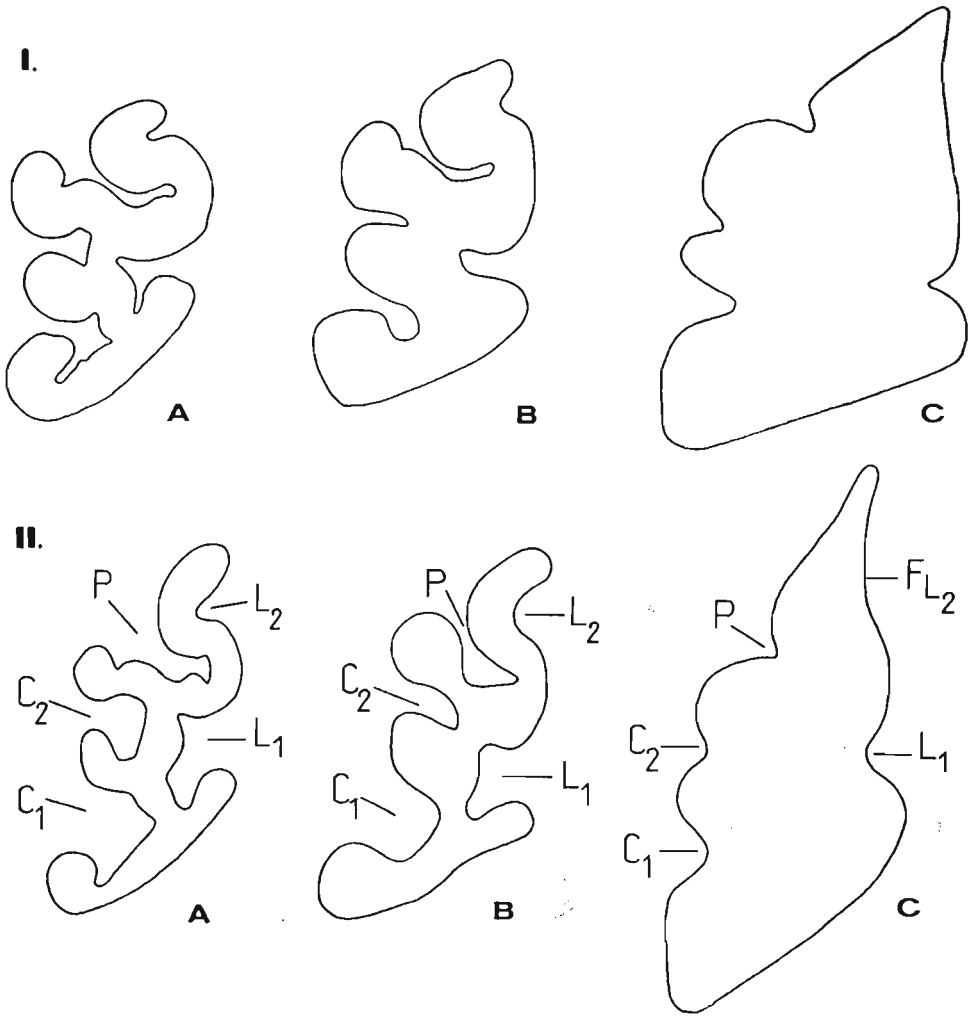


Fig. 10. Last whorl inside in *Ptygmatis bruntrutana* (Thurmann): I. juvenile specimen, ZNG KR A-I-66/134, II. entirely grown up specimen, ZNG KR A-I-66/22; *A* early part of the final whorl, *B* middle part of the final whorl, C apertural part of the final whorl.

of the changes in internal structure of the last whorl induced by the formation of successive growth layers (fig. 11*b*). There are no swellings at the external growth layers, while flexures and folds appear at the more and more internal growth layers. The external growth layers were originally formed at the shell aperture (actually, they made up the shell lip at the respective developmental stages), whereas the internal growth layers were formed each successive one further away from the aperture. Therefore, the number of growth layers, thickness of the shell wall, and complexity of the shell internal structure increase gradually at the last whorl with the increase in distance from the aperture.

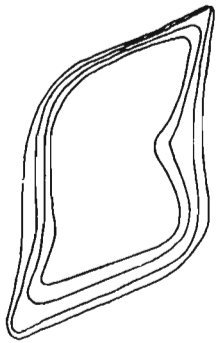


Fig. 11*a*. Internal structure of whorl walls in *Cossmannea desvoidyi desvoidyi* (d'Orbigny); the most distinct growth layers are indicated.

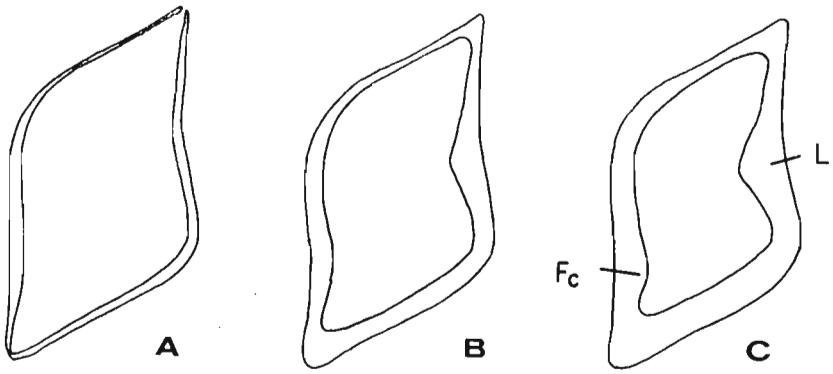


Fig. 11*b*. Main developmental stages of the internal structure of the last whorl in *Cossmannea desvoidyi desvoidyi* (d'Orbigny), related to the growth of successive layers (A-C) of the whorl wall.

Some nerineaceans show, however, a different ontogenetic pattern from that presented above. There is only a single columellar fold at the earliest konwn developmental stages of *Aptyxiella rupellensis*, disappearing at a few last whorls. Similarly, there are two folds, viz. columellar and labial ones (fig. 12), at the earliest konwn whorls of *Cryptoplocus*; the columellar fold may disappear at the later ontogenetic stages. Interestingly, this process can be observed even in large-sized specimens of *Cryptoplocus* (fig. 13a,b).

One is not always able to recognize the final inhibition of nerineacean shell growth. This is commonly reflected in gastropods by a swe-

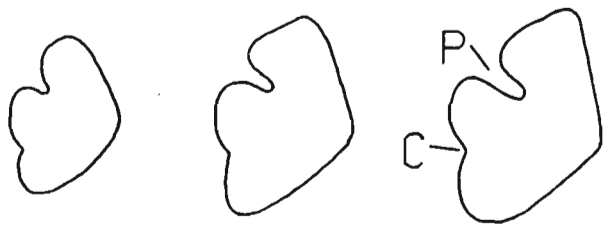


Fig. 12. Successive whorl insides at the early stages of a juvenile specimen of *Cryptoplocus* sp.; ×16.

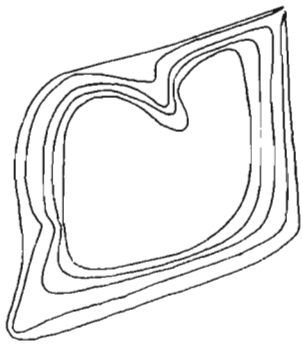


Fig. 13*a*. Internal structure of whorl walls in *Cryptoplocus depressus* (Voltz); the most distinct growth layers are indicated.

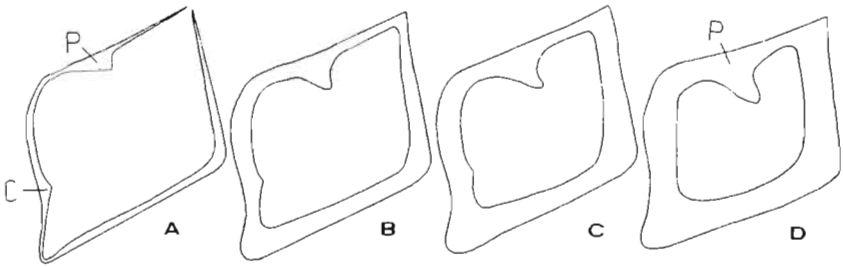


Fig. 13*b*. Main developmental stages of the internal structure of the last whorl in *Cryptoplocus depressus* (Voltz), related to the growth of successive layers (A-D) of the whorl wall.

lling and turning out of the outer lip, development of apertural processes (Cox 1960), and uncoiling of the shell. Some nerineaceans show a trend to uncoil the shell, as demonstrated by the less close attachment of the last whorl to the penultimate one than in the case of any earlier whorl (pl. 8: 4). The very last whorl displays in those forms a much larger or smaller height, larger diameter, and larger diameter of the axial hole. Any changes in the shell internal structure have not been recorded in specimens inhibited finally in their growth, except of some anomalous swellings at the internal walls of the whorls. However, the calcium carbonate could form secondarily (at the last growth stages or after its final inhibition) in the

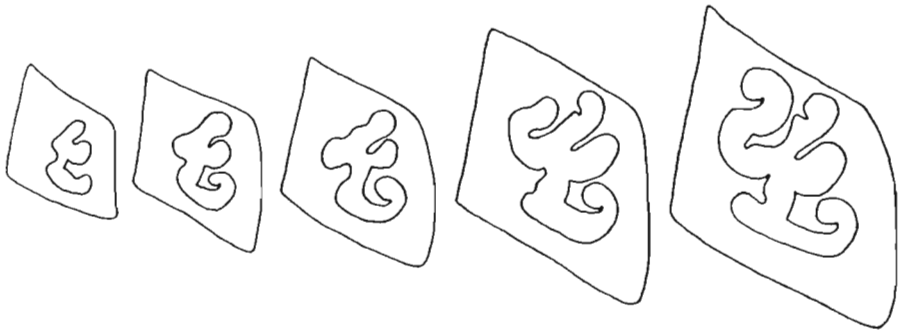


Fig. 14. Anomalous internal structure of the early whorls in *Ptygmatis bruntrutana* (Thurmann), Sulejów, Lower Kimmeridgian; ZNG KR A-I-66/33, ×7.5.

shell apical parts (Cox 1960; Andrews 1974). This is indicated by the apparent thickening of the apical shell walls and the accompanying modifications of the shell internal structure (fig. 14); the secondary nature of the latter features seems obvious when the earliest whorls of the juveniles are compared to the analogous parts of the adult shells.

Taking into account the data presented herein and in the previous papers (Wieczorek 1974, 1975*a*), one may conclude that the opinion of Pchelintsev (1931) on the constancy of the nerineacean shell internal structure throughout the ontogeny should be rejected. In the present author opinion, the pattern of fold development in nerineacean ontogeny as presented by Delpey (1939) and thereafter by Termier and Termier (1952) seems doubtful. This pattern is based mostly upon the ontogeny of *Polyptyxis schiosensis* (Pirona), in which species the following fold succession was recognized: C_1, P, L, C_2, P. However, the changes in shell internal structure of the specimen illustrated by Delpey (1939; fig. 106) are most probably of a secondary nature. In fact, the axial sections given for *Polyptyxis schiosensis* by Delpey (1939; pl. 9: 6—8), Berthou and Termier (1972—73; pl. 3: 1—4), or Berthou (1973; pl. 60; 1—4) show somewhat different internal structure of the shell. The specimen on which recognition of the general developmental pattern was based displays very thick walls of the early whorls. One may therefore suppose that the formation of its internal structure is modified by the secondary calcium carbonate filling in part the earliest whorls.

SYSTEMATIC PALEONTOLOGY

Superfamily **Nerineacea** Zittel, 1873
Family **Tubiferidae** Cossmann, 1895
Subfamily **Pseudonerineinae** Pchelintsev, 1965
Genus *Pseudonerinea* Loriol, 1980
Pseudonerinea clytia (d'Orbigny, 1850)
(pl. 6: 1—3)

1931. *Pseudonerinea clytia* (d'Orbigny); Pchelintsev: 171.
For other synonymy see Dietrich 1925:112

Material. — Ten specimens.
Dimensions:

ZNG Kr	n	H_n	h_{0-1}/d	D	PA	SA
A-I-66/1	10	68	0.8	16	13	75

Description. — Spiral angles decrease in ontogeny (AA approximates 20°, PA ranges from 13° to 16°), whereas whorl height to diameter ratio increases from 0.6 at the early developmental stages up to 0.7—0.8 at the last whorls. The last few whorls are slightly convex. Whorl inside index approximates 0.7.

Occurrence. — Poland: Sulejów, Przedbórz, Skorków — Lower Kimmeridgian; Leśniczówka — "Astartian". France and USSR (Crimea): "Rauracian".

Family **Nerineidae** Zittel, 1873
Subfamily **Nerineinae** Pchelintsev, 1960

Genus *Nerinea* Defrance, 1825
Nerinea fallax Thurmann, 1862
(fig. 15; pl. 6: 4)

1862. *Nerinea fallax* Thurmann: 92, pl. 7: 36.

Material. — Thirty specimens
Dimensions:

ZNG Kr	n	H_n	h_{0-1}/d	D	PA	SA
A-I-66/7	6	65	0.73	22	9	67
A-I-66/8	6	65	0.68	20	9	66
A-I-66/5	6	60	0.67	21	9	67
A-I-66/9	9	74	0.74	17	8	65

Description. — Shell rather large, turriculate, slender. Whorls high, slightly concave (with a convexity at the midheight ornamented with 5 fine spiral ribs; two central ribs more distinct than the others. Suture at a conspicuous sutural roll

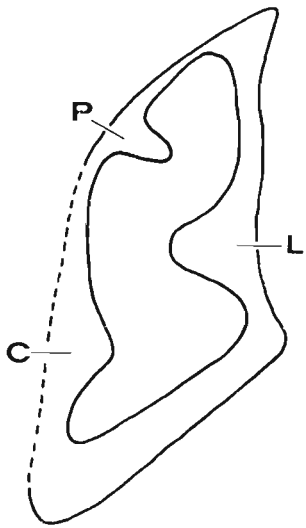


Fig. 15. Whorl cross-section in *Nerinea fallax* Thurmann, Sulejów, Lower Kimmeridgian; ZNG KR A-I-66/8, ×1,5.

formed by both the adjacent whorls. Sutural roll asymmetrical, as its upper part covered with a dozen or so nodes is much larger than the lower one. Shell base slightly concave, covered with concentric ribs, separated by a distinct keel from the flank of the last whorl. Aperture ended with a fairly long siphonal furrow. Whorl insides constricted by 3 folds:

C — wide at the base, asymmetrical, h_f approximates 1 mm;
P — slightly bent, long, h_f approximates 3 mm;
L — located much below the midheight of a whorl, large, h_f approximates 3 mm.

Whorl inside index approximates 0.5. At the last whorl, folds are much less distinct and the inside index is much higher.

Remarks. — The external characteristics (and especially, convexity at the whorl midheight) and biometrical indices justify the assignment of the investigated spe-

cimens to *N. fallax*. The internal structure of the species has not been so far recognized.

Occurrence. — Poland: Sulejów, Bukowa, Skorków — Lower Kimmeridgian. Switzerland: Sequanian.

Genus *Turbinea* Pchelintsev, 1965
Turbinea contorta (Buvignier, 1852)
(fig. 16)

1934. *Nerinella turriculata* (d'Orbigny); Levasseur: 291, text-fig. 23, pl. 17: 4.
1961. *Nerinea contorta* Buvignier; Krjaczkova: 7, pl. 1; 7, 8.
1965. *Nerinea contorta* Buvignier; Pchelintsev: 26, fig. 10.
1970. *Nerinella turriculata* (d'Orbigny); Dmoch: 48, pl. 3; 1—4.
For other synonymy see: Dietrich 1925: 48.

Material. — Nineteen fragmented, mostly distorted specimen.

Description. — Shell large-sized, very long, with PA close to 5°. Whorls very high, with the height to diameter ratio decreasing from over 1.0 at the early stages down to some 0.6 at the last whorl; considerably concave, with d_{min}/d_{max} approximating 0.65 in the central part of the shell. Suture at a very high asymmetrical sutural roll (its lower part is considerably larger than the upper one); sutural angle close to 75°. Whorls covered with some spiral ribs and very densely spaced growth lines. Shell base concave, separated by a distinct keel from the flank of the last whorl. As judged from the axial sections, aperture high and narrow, ended with a fairly long siphonal furrow. Whorl insides constricted by an indistinct fold C and a right-angle triangular fold P of 1 mm in height.

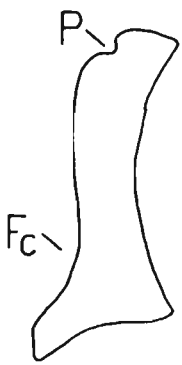


Fig. 16. Whorl inside in *Turbinea contorta* (Buvignier), Sulejów, Lower Kimmeridgian, ZNG KR A-I-66/10, ×2.

Remarks. — Specimens of *Turbinea contorta* are sometimes attributed to *Nerinea turriculata* (see synonymy); the latter name is *nomen nudum* (Dietrich 1925).

Occurrence. — Poland: Sulejów — Lower Kimmeridgian; Błaziny — "Astartian". France, Switzerland and USSR (Crimea): "Rauracian".

Genus *Cossmannea* Pchelintsev, 1931
Cossmannea desvoidyi desvoidyi (d'Orbigny, 1850)
(fig. 11*a*, *b*; pl. 7: 1, 4; pl. 8: 1, 6)

1970. *Cossmannea desvoidyi* d'Orbigny; Dmoch: 45, pl. 2: 4—6.
For other synonymy see: Dietrich 1925: 49.

Material. — Almost 100 specimens.

Dimensions:

ZNG Kr	n	H_n	h_{0-1}/d	D	PA	SA
A-I-66/12	13	190	0.65	41	10	72
A-I-66/13	6	108	0.69	46	14	72
A-I-66/16	5	130	0.55	52	12	70
A-I-66/17	8	127	0.63	40	15	72

Description. — Shell very large-sized, turriculate. Whorls fairly high: height to diameter ratio approximates 0.55—0.60 at the early stages (at $h_s = 5$—10 mm), 0.65—0.70 at the middle developmental stages (at $h_s = 10$—20 mm), less than the latter value at the final stages. Whorls distinctly concave in the central part of the shell (d_{min}/d_{max} close to 0.80), somewhat more flat at both the early and late stages (d_{min}/d_{max} exceeds 0.85). The maximum concavity displaced upwards at the late whorls. Suture at a distinct sutural roll, symmetrical at the early whorls, asymmetrical at the late ones. Early whorls ornamented with 5—6 spiral ribs; further on, the ornamentation disappears. Growth lines densely spaced. Shell base slightly convex, separated clearly from the flank of the last whorl. Aperture wide rhomboidal, ended with a short siphonal furrow. Axial hole very narrow. At the late whorls, whorl insides constricted by a distinct and wide, somewhat asymmetrical fold L approximating 1.5—2.0 mm in height, and a wide columellar flexure (F_c) ranging up to 1 mm in thickness. Whorl inside index approximates 0.5. As judged from the insides of successive whorls, siphonal furrow develops progressively in ontogeny.

Occurrence. — Poland: Sulejów — Lower Kimmeridgian; Dobrut — Oxfordian/Kimmeridgian boundary. France: "Rauracian" — Portlandian. FRG: Kimmeridgian.

Cossmannea desvoidyi baltovensis subsp.n.

(fig. 17; pl. 6: 5*a*, *b*; pl. 7: 5)

Holotypus: specimen ZNG Kr A-I-66/18, pl. 6: 5*a*, *b*.

Stratum typicum: Middle Oxfordian (*Gregoryceras transversarium* Zone).

Locus typicus: Bałtów.

Derivatio nominis: after the type locality Bałtów.

Diagnosis. — Shell very large-sized, almost cylindrical in shape; whorls smooth, flat; axial hole narrow; fold formula F_cL.

Material. — Eight specimens.

Dimensions:

ZNG Kr	n	H_n	h_{0-1}/d	D	PA	SA
A-I-66/18	5	128	0.58	50	6	70

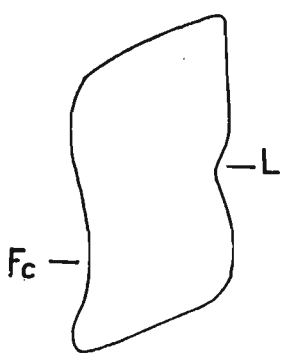


Fig. 17. Whorl inside in *Cossmannea desvoidyi baltovensis* subsp. n. holotype; Bałtów, Middle Oxfordian; ZNG KR A-I-66/18, ×1,3.

Description. — Shell very large-sized, almost cylindrical in shape. Whorls fairly high, flat, tending to a regular arrangement at the late stages. Shell base slightly convex, rather clearly separated from the flank of the last whorl. Axial hole of some 5 mm in diameter constricted by siphonal whorl portions. Whorl insides constricted by an asymmerical fold L located a little below the midheight of a whorl (h_f approximates 1.5—2.0 mm) and a wide but indistinct flexure F_c at the lower part of the columellar wall of a whorl.

Remarks. — The investigated specimens differ from *Cossmannea desvoidyi desvoidyi* in their smaller pleural angle, flat whorls, fold L shape, and whorl inside shape.

Occurrence. — Poland: Bałtów — Middle Oxfordian (*Gregoryceras transversarium* Zone).

Cossmannea desvoidyi karczewskii subsp.n.

(fig. 18; pl. 7: 2, 3)

1960. *Nerinea desvoidyi* d'Orbigny; Karczewski: 20, fig. 3, pl. 6: 78.

Holotypus: specimen illustrated by Karczewski (1960: pl. 6: 7).

Stratum typicum: Upper Kimmeridgian.

Locus typicus: Podmalenie by Krzyżanowice.

Derivatio nominis: in honor of Dr L. Karczewski, eminent student of the nerineacean gastropods.

Diagnosis. — Shell turriculate; whorls concave; well developed fold C; weakly developed triangular fold L.

Material. — Twenty four specimens.

Dimensions:

ZNG Kr	n	H_n	h_{0-1}/d	D	PA	SA
A-I-66/20	4	80	0.5	41	ca. 15	75

Description. — Shell fairly large-sized, turriculate. Whorls smooth, concave, low. Suture at a distinct sutural roll. Shell base slightly concave, separated clearly from the flank of the last whorl. Axial hole narrow. Whorl insides constricted by a distinct and well developed fold C of some 2 mm in height, and an obtuse triangular fold L of 0.5 mm in height.

Remarks. — The specimens collected at Podmalenie and attributed previously by Karczewski (1960) to *Cossmannea desvoidyi* are here recognized for a new subspecies, as they differ from the nominative subspecies in their larger pleural angle

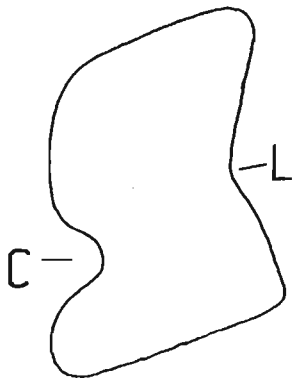


Fig. 18. Whorl inside in *Cossmannea desvoidyi karczewskii* subsp. n., Podmalenie by Krzyżanowice. Upper Kimmeridgian, ZNG KR A-I-66/20, ×2.

and better developed columellar fold; there are also some differences in fold L morphology.

Lewiński (1902) assigned the nerineaceans from Podmalenie to the species *Cossmannea gosae* (Roemer) which is here considered as synonymous with *C. desvoidyi* (cf. Geiger 1901).

Occurrence. — Poland: Podmalenie by Krzyżanowice — Upper Kimmeridgian.

Subfamily **Ptygmatisinae** Pchelintsev

Genus *Ptygmatis* Sharpe, 1849

Ptygmatis bruntrutana (Thurmann, 1832)

(figs 10, 14, 19—21; pl. 8: 2—5, 7)

1965. *Ptygmatis subbruntrutana*; Pchelintsev: 55, pl. 20: 4*a*, *b*.
1974. *Ptygmatis bruntrutana* (Thurmann); Krivic, 204, fig. 18*a*, *b*, *c*.

Material. — A thousand specimens.

Dimensions:

ZNG Kr	n	H_n	h_{0-1}/d	D	PA	SA
A-I-66/30	10	58	0.34	27	20	75
A-I-66/26	9	57	0.40	27	15	81
A-I-66/31	15	62	0.38	22	13	77
A-I-66/23	9	44	0.42	20	18	78

Description. — Internal structure. At the late developmental stages where the shell internal structure attains its maximum complexity, whorl insides constricted by 5 folds, at least 4 of which are composite (fig. 19).

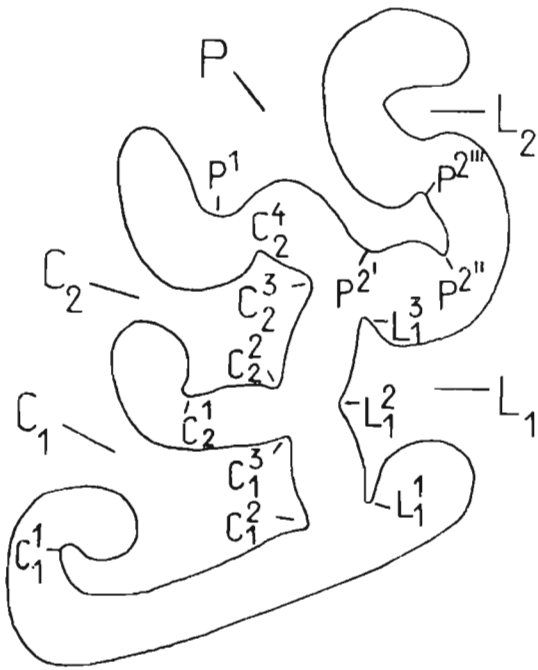


Fig. 19. Whorl inside in *Ptygmatis bruntrutana* (Thurmann), Sulejów, Lower Kimmeridgian; ZNG KR A-I-66/26, ×10.7.

Internal structure of *Ptygmatis bruntrutana* at its maximum complexity

main folds	2[d] order folds	3[d] order folds
C_1	C_1^1, C_1^2, C_1^3	—
C_2	$C_2^1, C_2^2, C_2^3, C_2^4$	—
P	P^1, P^2	$P^{2'}, P^{2''}, P^{2'''}$
L_1	L_1^1, L_1^2, L_1^3	—
L_2	—	—

The folds can be characterized as follows:

C_1 — irregular polygonal in shape, with h_f close to 3 mm; among its subordinate folds, C_1^1 is the largest, slightly bent upwards; C_1^2 and C_1^3 weakly developed;

C_2 — irregular polygonal in shape, considerably constricted at the base, with h_f of some 2 mm; its subordinate folds in from of indistinct swellings at the polygon angles;

P — long, ranging over 3 mm in height, with a wide base; split at the base into 2 subordinate folds; P^1 wide, symmetrical, with h_f of 1 mm; P^2 elongate, running at some 70° to the external whorl-wall, split into 3 folds of third order;

L_1 — located at the lower part of a whorl, with h_f of some 2 mm; split into 3 subordinate folds, among which L_1^1 is the largest one;

L_2 — simple, located high at the upper part of a whorl, with h_f of 1 mm.

Whorl inside index approximates 0.2.

Ontogeny. The shell changes from conical (AA ranges from 30 to 40°) to turriculate (PA ranges from 10 to 20°) in shape during the ontogeny. The whorl convexity increases a little and the axial hole becomes more and more wide in ontogeny (except of the central part of the shell where it remains constant in diameter). Simultaneously, the shell internal structure increases in complexity (fig. 20). At

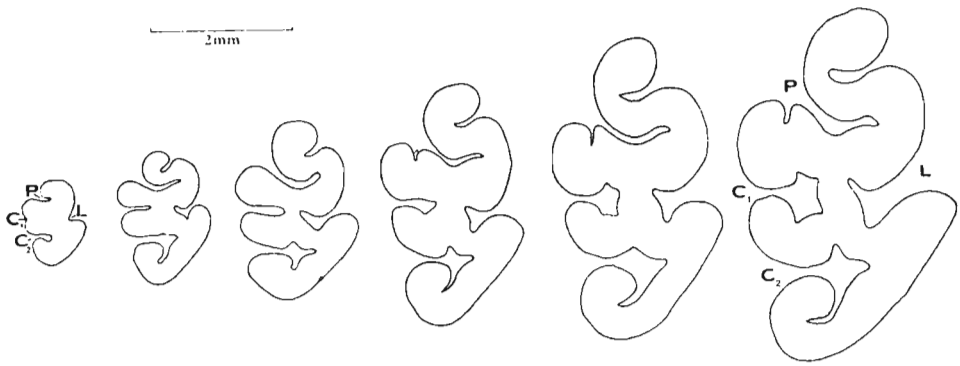


Fig. 20. Successive whorl insides in *Ptygmatis bruntrutana* (Thurmann), Sulejów, Lower Kimmeridgian, ZNG KR A-I-66/34.

the earliest preserved whorl, 4 folds occur, namely the folds C_1, C_2, P, and L. The folds C_1, P, and L are less than 0.2 mm in height, and the fold C_2 is very weakly developed (it is less than 0.1 mm in height). Later on, the fold L_2 appears and the other folds form their subordinate folds; the second order folds appear in the fold C_1 at first and thereafter, in the folds L_1, P, and C_2, successively. Because of its considerable development and distinctness of its subordinate folds, the fold C_1 becomes very complex in shape. The size and shape of particular folds change at the successive whorls; and the third order folds appear in the fold P. The second order folds become somewhat less distinct (especially in the fold C_1). The maximum

complexity of the shell internal structure achieved, there are no significant changes in fold morphology at a few last whorls of the shell. The internal structure undergoes considerable changes but at the penultimate whorl and especially, at the final one. The subordinate folds disappear gradually at those whorls and the main folds diminish. The fold L_2 disappears close to the aperture. Such a simplification of the internal structure occurs in all the investigated specimens, irrespective to their ontogenetic stage (fig. 10, pl. 8: 3—5, 7). Internal structure of the early whorls is commonly modified due to their partly fill with the secondary calcium carbonate (fig. 14).

In specimens exceeding 8—10 cm in height, one can recognize some characteristics that may point to the final inhibition of the shell growth; these are: the shell uncoiling, morphological uniqueness of the last whorl, increase in diameter of the axial hole (pl. 8: 4, 5).

Intraspecific variability. The pleural angle ranges from 9° to 26° but it approximates most commonly 12—17°. There is also a variation in whorl height to diameter ratio, axial hole diameter, and whorl convexity. The second order folds vary in both number and shape (fig. 21).

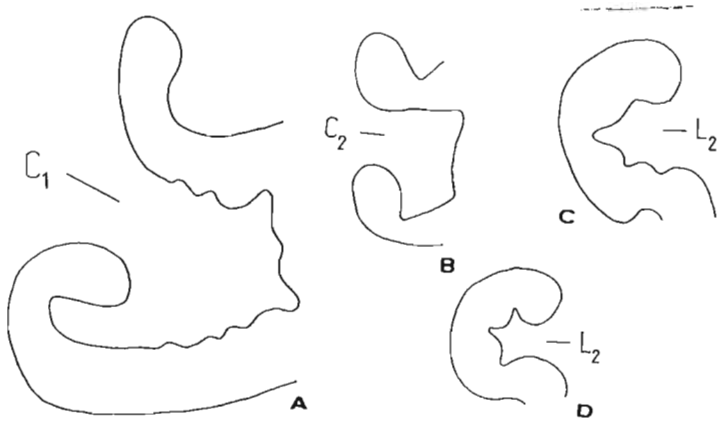


Fig. 21 Fold morphology in *Ptygmatis bruntrutana* (Thurmann): *A* anomalous development of the lower columellar fold, ×10, *B* upper columellar fold, ×8.4, *C*, *D* upper labial fold, ×8.4.

Remarks. — The specimens recognized by Pchelintsev (1965) for the new species, *Ptygmatis subbruntrutana*, show all the characteristics typical of the juveniles of *P. bruntrutana*.

Occurrence. — Poland: Sulejów, Kodrąb, Przedbórz, Bukowa, Skorków, Małogoszcz (Mała Brogowica) — Lower Kimmeridgian; Dobrut, Błaziny-Oxfordian/Kimmeridgian boundary. France, USSR (Crimea): "Rauracian = Sequanian". FRG: Kimmeridgian.

Ptygmatis pseudobruntrutana (Gemmellaro, 1865)

1972b. *Ptygmatis pseudobruntrutana* (Gemmellaro); Dvali: 5, pl. 2: 1.
1974. *Ptygmatis pseudobruntrutana* (Gemmellaro); Krivic: 206, fig. 19*a*, *b*, *c*.

For other synonymy see: Sirna 1968: 166.

Material. — Some fifty specimens.

Dimensions:

ZNG Kr	n	H_n	h_{0-1}/d	D	PA	SA
A-I-66/40	10	50	0.43	23	15	75
A-I-66/41	8	44	0.30	22	18	85
A-I-66/42	10	41	0.30	19	12	80

Remarks. — The specimens collected in the Holy Cross Mts margins do not differ in their internal structure from the type material from the Upper Tithonian of Italy (e.g. Sirna 1968: pl. 2: 13); however, their shell base is less markedly separated from the flank of the last whorl because of the weaker development of the keel. The shell internal structure of *P. pseudobruntrutana* resembles very closely that of *P. bruntrutana*.

Occurrence. — Poland: Sulejów, Przedbórz, Leśnica-Kościółek — Lower Kimmeridgian; Dobrut, Błaziny, Skarbka — Oxfordian/Kimmeridgian boundary. France: "Sequanian". Italy (Sicily): Tithonian.

Subfamily **Cryptoplocinae** Pchelintsev, 1960

Genus *Cryptoplocus* Pictet et Campiche, 1861

Cryptoplocus depressus (Voltz, 1836)

(fig. 13*a*, *b*, pl. 9: 1—3, 5—6)

1960. *Cryptoplocus depressus* (Voltz); Karczewski: 41, pl. 11: 4, 5.
1960. *Cryptoplocus succedens* Zittel; Karczewski: 43, pl. 10: 5, 6.
1960. *Cryptoplocus cingulatus* Zittel; Karczewski: 40, pl. 9: 11.
1965. *Cryptoplocus depressus* (Voltz); Pchelintsev: 71, pl. 12: 1*a*, *b*.

For other synonymy see: Dietrich 1925: 99.

Material. — Some two hundred specimens.

Dimensions:

ZNG Kr	n	H_n	h_{0-1}/d	D	PA	SA
A-I-66/50	10	82	0.32	40	21	80
A-I-66/51	13	79	0.32	35	24	82
A-I-66/49	9	80	0.30	46	21	81

Description. — Internal structure. At the late developmental stages, whorl insides are constricted by an asymmetrical, slightly rounded at the top fold P running at some 45° to the external whorl wall; its h_f approximates 3.5 mm. In some specimens (fig. 13*b*), a minute, low conical, wide based fold C occurs. Whorl inside index approximates 0.4.

Ontogeny. The shell changes from conical (AA close to 35°) to slender-conical (PA close usually to 20—24°) in ontogeny. At the same time, the axial hole increases regularly in diameter, and the siphonal furrow grows progressively in size (it is poorly developed at the early whorls).

The changes in shell internal structure observed commonly in large-sized specimens (pl. 9: 1.5) result in part from the secondary modifications. There are two folds (namely, the folds C and P) at the earliest preserved whorls. Later on, the fold C disappears, whereas the other grows progressively in size.

Remarks. — The specimens assigned by Karczewski (1960) to *Cryptoplocus cingulatus* Zittel and to *C. succedens* Zittel show all the features of *C. depressus* and hence, are here included into the synonymy of the latter species.

Occurrence. — Poland: Sulejów, Skorków — Lwów Kimmeridgian Dobrut — Oxfordian/Kimmeridgian boundary. France and Switzerland: "Sequanian".

Cryptoplocus pyramidalis (Münster *in* Goldfuss, 1844)
(pl.9:4)

1968. *Trochalia pyramidalis* (Münster in Goldfuss); Sirna: 167, pl. 2: 8—9; pl. 3: 1, 2, 9 (with synonymy).

Material. — Ten specimens.

Dimensions:

ZNG Kr	n	Hn	h_{0-1}/d	D	PA	SA
A-I-66/53	7	55	0.28	32	28	77
A-I-66/52	6	80	0.25	ca 55	ca 25	80

Occurrence. — Poland: Podmalenie by Krzyżanowice — Upper Kimmeridgian. FRG: Kimmeridgian. France: Kimmeridgian — Portlandian.

Family **Nerinellidae** Pchelintsev, 1960
Subfamily **Nerinellinae** Pchelintsev, 1965

Genus *Nerinella* Sharpe, 1849
Nerinella cf. *gurovi* Lapkin, 1959
(fig. 22)

Material. — Three specimens.

Description. — Shell small, turriculate, with PA of some 10—12°. Whorls flat or slightly concave, with the height to diameter ratio close to 0.6. At the late developmental stages, whorl insides constricted by 4 folds. These are:

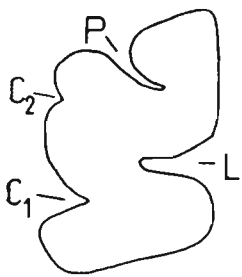


Fig. 22. Whorl inside in *Nerinella* cf. *gurovi* Lapkin, Bałtów, Middle Oxfordian, ZNG KR A-I-66/58, ×12.5.

C_1 — located low at the columella, narrow and minute (h_f close to 0.4 mm);
C_2 — weakly developed 0.1—0.2 mm in height;
P — long, somewhat curved, with h_f approximating 0.8 mm;
L — located below the midheight of a whorl, well developed, symmetrical, 0.7—0.8 mm in height.

The fold L is the only one at the early whorls.

Remarks. — The investigated specimens do not differ in their biometrical indices and in the shell internal structure from the type material (cf. Lapkin 1959). Their preservation state makes, however, impossible recognition of the external details and hence their assignement to *N. gurovi* is tentative.

Occurrence. — Poland: Bałtów — Middle Oxfordian.

Nerinella aff. *satagea* (Loriol, 1874)
(fig. 23; pl. 10: 1, 2)

Material. — Two specimens.

Dimensions:

ZNG Kr	n	Hn	h_{0-1}/d	PA	SA
A-I-66/59	5	35	0.8	4	70

Description. — Shell very long and narrow. Whorls flat or very slightly concave, covered with 5—6 spiral, weakly nodose ribs. Sutural roll indistinct, whorls poorly separated. Whorl insides constricted by 3 folds, namely:

C — minute, with h_f of 0.7 mm;

P — very short, running at some 45° to the external whorl-wall, h_f approximates 0.5 mm;

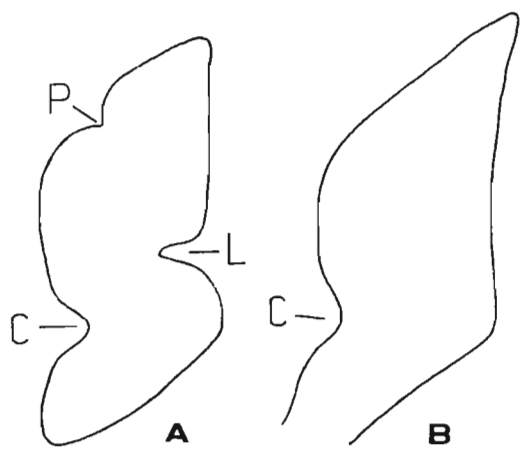


Fig. 23. Whorl insides in *Nerinella* aff. *satagea* (Loriol), Sobków, Lower Kimmeridgian, ZNG KR A-I-66/60, ×5.4. *A* penultimate whorl, *B* final whorl.

L — well developed, narrow, distinctly widened at the base, located below the mid-height of a whorl, h_f close to 1.5 mm.

The fold C is the only one present at the last whorl.

Remarks. — The investigated specimens differ from those described by Cossmann (1898) in their much lower whorl height to diameter ratio.

Occurrence. — Poland: Sulejów, Kodrąb — Lower Kimmeridgian.

? *Nerinella* sp.
(fig. 24; pl. 10: 3)

Material. — A single specimen.

Description. — Shell cylindrical in shape, with slightly concave, high whorls (height to diameter ratio approximates 1.0). Whorl insides constricted by an almost symmetrical fold L located at the midheight of a whorl and approximating 1 mm in height.

Remarks. — The shell shows many features typical of *Nerinella*. However, its preservation state makes impossible recognition of its external ornamentation in de-

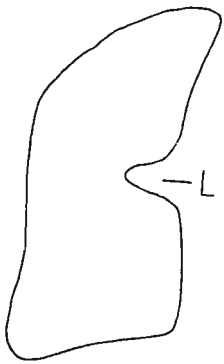


Fig. 24. Whorl inside in ?*Nerinella* sp., Sulejów, Upper Oxfordian; ZNG KR A-I-66/61, ×8.

tail: furthermore, shell internal structure of this type has so far not been recorded in the genus *Nerinella*. Therefore, even the generic attribution cannot be made with certainty.

Occurrence. — Poland: Sulejów — Upper Oxfordian.

Genus *Lewinskia* gen.n.

Type species: *Nerinella? varioplicata* Wieczorek, 1974.

Derivatio nominis: in honour of Jan Lewiński, eminent student of the Upper Jurassic of the Holy Cross Mts margins.

Diagnosis. — Shell turriculate, with concave, stair-like arranged whorls. Whorl surface covered with spiral ribs. Sutural roll conspicuous, asymmetrical. Shell base slightly concave, separated by a keel form the flank of the last whorl. Aperture high, ended with a fairly long siphonal furrow. Folds formula at the maximum complexity of the shell internal structure is 2130. Fold L_2 split into 2—3 subordinate ones; the other folds simple.

Species assigned: *Nerinella? varioplicata* Wieczorek, 1974, *Nerinella jollyana* (d'Orbigny, 1850).

Remarks. — *Lewinskia* gen. n. resembles closely *Nerinella*. Sharpe in its external morphology. The only difference is the stair-like arrangement of whorls in the former genus. There are, however, distinct differences between the two genera in their internal structures. The species of *Nerinella* show in general 3 simple folds (there are merely 2 folds or even a single one in some species; see e.g. Pchelintsev 1965), whereas the species assigned to *Lewinskia* display 6 folds, a single composite one (L_2) including.

The ontogeny of *Lewinskia varioplicata* (Wieczorek, 1974) may, however, indicate that the internal structure typical of *Lewinskia* developed from pattern characteristic for *Nerinella*. Hence, *Lewinskia* is here attributed to the subfamily Nerinellinae. One should, however, keep in mind that *Lewinskia* achieves the same complexity in its shell internal structure as does the genus *Bactroptyxis* of the subfamily Bactroptyxisinae.

In addition to the type species, *Nerinella jollyana* (d'Orbigny) can also be assigned to the newly established genus. In fact, it resembles *Lewinskia varioplicata* in its external morphology and differs from the latter species only in less complex internal structure (cf. d'Orbigny 1850: 115, pl. 266: 1—4). One may suppose that *Nerinella jollyana* is ancestral to *Lewinskia varioplicata*. This is supported by its earlier appearance in the stratigraphic record (*N. jollyana* has been reported from the "Rauracian", while *L. varioplicata* appears for the first time in the lowermost Kimmerid-

gian) and the similarity of its internal structure to that typical of the early ontogenetic stages of *L. varioplicata*.

Occurrence. — Poland and France: Upper Jurassic (Oxfordian to Lower Kimmeridgian).

Lewinskia varioplicata (Wieczorek, 1974)

(figs 25, 26; pl. 10:4—6)

1974. *Nerinella? varioplicata* Wieczorek: 407, pl. 1: 1—6; pl. 2: 1—6.

Material. — Some two hundred specimens.

Dimensions:

ZNG Kr	n	Hn	h_{0-1}/d	D	PA	SA
A-I-66/62	6	55	0.83	13	5	70
A-I-66/63	7	43	0.76	9,5	5	70
A-I-66/64	9	57	0.74	11	6	70

Description. — *Ontogeny.* A few main ontogenetic stages showing successively more and more complex internal structure can be recognized in *Lewinskia varioplicata* (fig. 25; pl. 10: 5, 6 and the data presented in Wieczorek 1974). The literal-numeral formulae for these stages are as follows:

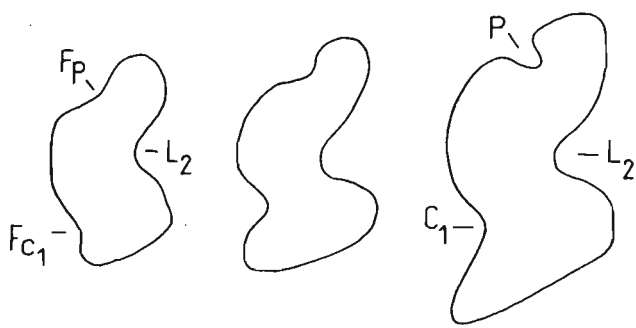


Fig. 25. Whorl insides at the earliest preserved, successive ontogenetic stages of *Lewinskia varioplicata* (Wieczorek), Sulejów, Lower Kimmeridgian; ZNG KR A-I-66/72, ×24.

I — F_C, F_P, L_2
II — C_1, P, L_2
III — C_1, C_2, P, F_L, L_2, F_L
IV — C_1, C_2, P, L_1, L_2, L_3
V — C_1, C_2, P, L_1, L_2, (L_2^1, L_2^2), L_3
VI — C_1, C_2, P, L_1, L_2, (L_2^1, L_2^2, L_2^3), L_3

The maximum complexity achieved at the 6th developmental stage persists over a few late whorls. At the penultimate whorl and especially, at the final one, the internal structure undergoes a rapid simplification. The fold formula is C_1, P, F_{L_2} at the aperture.

Intraspecific variability. There is a variation in the shell internal structure of *Lewinskia varioplicata* (cf. fig. 26). The upper portion of the fold C_1 is sometimes distinctly curved. The folds C_2 and P vary in their width and inflection. The folds L_1 and L_2 vary in their distinctness; this is especially clear in the fold L_2 displaying also a variation in development of its 2—3 subordinate folds.

Occurrence. — Poland: Sulejów, Przedbórz, Bukowa, Skorków, Małogoszcz (Mała Brogowica), Mieronice, Sobków, Karsy — Lower Kimmeridgian.

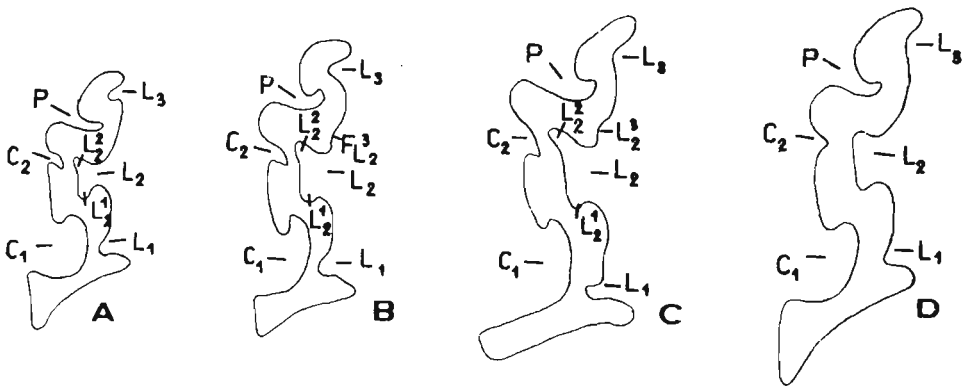


Fig. 26. Whorl inside in various specimens of *Lewinskia varioplicata* (Wieczorek); ×3: *A* Karsy, Lower Kimmeridgian, ZNG KR A-I-66/65; *B* Sulejów, Lower Kimmeridgian; ZNG KR A-I-66/66 *C* Bukowa, Lower Kimmeridgian, ZNG KR A-I-66/67; *D* Bukowa, Lower Kimmeridgian; ZNG KR A-I-66/68.

Lewinskia aff. *varioplicata* (Wieczorek, 1974)

(fig. 27; pl. 10: 7)

Material. — A single specimen.

Dimensions:

ZNG Kr	n	Hn	h_{0-1}/d	D	PA	SA
A-I-66/73	4	42	0.7	1.5	10	70

Description. — Shell narrow turriculate, with slightly concave whorls. Shell ornamentation unrecognizable. Whorl insides constricted by 5 folds; these are:

C_1 — very wide, with h_f close to 1 mm;

C_2 — asymmetrical, fairly wide, h_f approximates 0.6 mm;

P — wide, curved, with h_f of some 2 mm;

L_1 — minute, slightly asymmetrical, h_f approximates 0.5 mm;

L_2 — well developed, large and wide, located at the midheight of a whorl, with h_f close to 2 mm.

There is also flexure F_L high at the labial wall of a whorl.

Remarks. — This specimen differs from *L. varioplicata* in its larger pleural angle and details of the shell internal structure. The folds C_2 and P are better developed

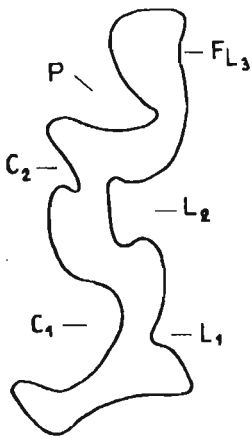


Fig. 27. Whorl inside in *Lewinskia* aff. *varioplicata* (Wieczorek), Sulejów, Lower Kimmeridgian, ZNG KR A-I-66/73, ×5.

and much wider in *Lewinskia* aff. *varioplicata* than in *L. varioplicata*. In contrast to the latter species, the fold L shows but indistinct subordinate folds and the fold L_3 is marked merely by a slight swelling in the investigated specimen.

Occurrence. — Poland: Sulejów — Lower Kimmeridgian.

Genus *Aptyxiella* Fischer, 1885
Aptyxiella rupellensis (d'Orbigny, 1850)
(fig. 28)

For the synonymy: see Dietrich 1925: 96.

Material. — Four specimens.

Description. — Internal structure. At the earliest preserved developmental stages, whorl insides constricted by a minute fold L of 0.3 mm in height. At the last stages, whorl inside is close to rectangular, with the fold L lacking.

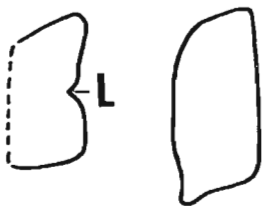


Fig. 28. Whorl insides in *Aptyxiella rupellensis* (d'Orbigny), Bałtów, Middle Oxfordian; ZNG KR A-I-66/74; left-central part of the shell; ×12.5, right-final part of the shell; ×5.

Occurrence. — Poland: Bałtów — Middle Oxfordian; Sulejów — Lower Kimmeridgian. FRG: Kimmeridgian. France: "Rauracian — Sequanian". USSR (Crimea);

Genus *Contortella* Pchelintsev, 1965
Contortella sp.
(fig. 29; pl. 10: 8)

Material. — Two specimens.

Dimensions:

ZNG Kr	n	Hn	H_{0-1}/d	D	PA	SA
A-I-66/75	3	21	0,5	16	ca 10°	ca 75°

Description. — Shell turriculate, with low, concave whorls (d_{min}/d_{max} approximates 0.8) covered with numerous fine ribs. Sutural roll conspicuous, symmetrical. Shell base flat, separated by a keel from the flank of the last whorl. Whorl insides very large, constricted only by a fold C, somewhat asymmetrical and approximating 0.2—0.3 mm in height.

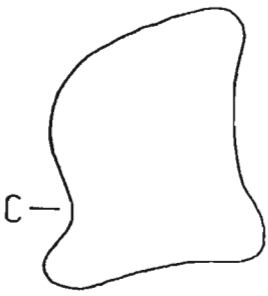


Fig. 29. Whorl inside in *Contortella* sp., Sulejów, Lower Kimmeridgian; ZNG KR A-I-66/75, ×5.

Remarks. — These specimens resemble closely *Contortella ornata* Pchelintsev, 1965, from the Valanginian of Crimea (Pchelintsev 1965; 94, pl. 24: 10) but they show less conspicuous sutural roll and less concave whorls.

Occurrence. — Poland: Sulejów — Lower Kimmeridgian.

Subfamily **Elatioriellinae** Pchelintsev, 1965

Genus *Elatioriella* Pchelintsev, 1965

Elatioriella sanctacrucensis sp.n.

(figs 30, 31; pl. 10: 9—11)

Holotypus: specimen ZNG Kr A-I-66/76, pl. 10: 9.

Stratum typicum: Middle Oxfordian (*Gregoryceras transversarium* Zone).

Locus typicus: Bałtów by Ostrowiec Świętokrzyski.

Derivatio nominis: after the Latin name of the Holy Cross Mts.

Diagnosis. — Shell long and narrow, with high, slightly convex whorls covered with 5 spiral nodose ribs. Non-ornamented furrow located high at whorl surface. Shell base slightly convex. Fold formula at the maximum complexity of the shell internal structure is 1111.

Material. — Fifteen specimens.

Dimensions:

ZNG Kr	n	Hn	H_{0-1}/d	D	PA	SA
A-I-66/76	7	45	0.9	9,5	ok. 5°	65

Description. — Shell long and narrow, with high, slightly convex whorls. Non-ornamented furrow of some 1.5 mm in width located high at whorl surface. Whorl surface covered with 5 spiral nodose ribs and numerous growth lines. Sutural roll distinct, approximating 0.2—0.3 mm in width. Shell base slightly convex, separated clearly from the flank of the last whorl. Siphonal furrow fairly long. At the maximum complexity of the shell internal structure, whorl insides constricted by 4 folds, namely:

C — located very low at the columella, narrow, inflected upwards with h_f approximates 1.5 mm;

P — narrow, slightly curved, running at some 70° to the external whorl-wall, h_f approximates 1.5 mm;

L — composite, split into 2 second order folds, with L^2 much larger than L^1, h_f approximates 2 mm;

B — minute but wide, with h_f close to 0.3 mm.

Ontogeny. The earliest developmental stages are unknown. Judging from the preserved fragments, one may suppose that the shell is needle-like at the earliest stages, with the whorls almost flat. The shell internal structure changes markedly in ontogeny (fig. 30, 31; pl. 10: 10, 11). At the earliest preserved whorls (fig. 30*A*), the

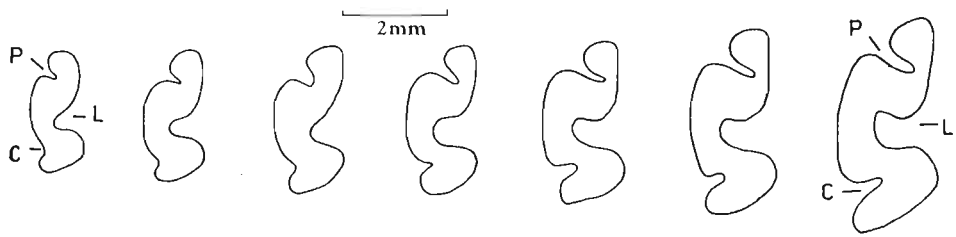


Fig. 30. Successive whorl insides at the early developmental stages of *Elatioriella sanctacrucensis* sp. n., paratype; Bałtów, Middle Oxfordian; ZNG KR A-I-66/78.

whorl insides are constricted by 3 folds, namely a poorly developed but wide fold C, a wide but short fold P, and a wide and simple fold L. At the later ontogenetic stages, the folds change in both their shapes and sizes. The fold L becomes inflected upwards and thereafter, splits into 2 subordinate folds. At the penultimate whorl and especially, at the final one, the folds gradually disappear.

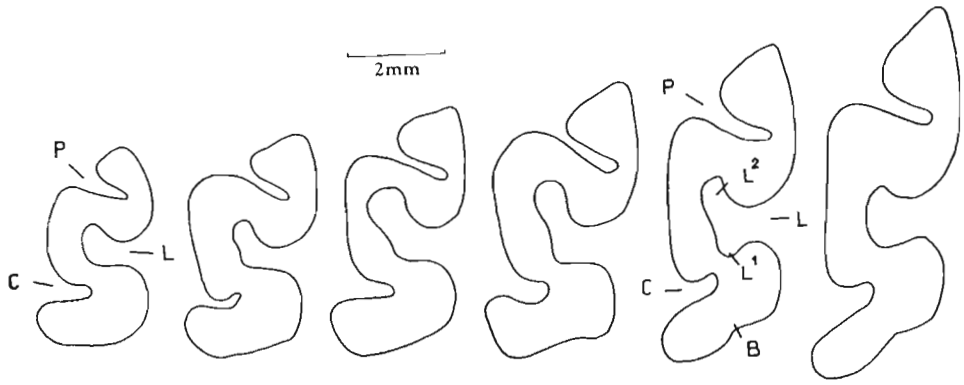


Fig. 31. Successive whorl insides at the late developmental stages of *Elatioriella sanctacrucensis* sp. n., paratype; Bałtów, Middle Oxfordian; ZNG KR A-I-66/77.

Remarks. — The newly established species differs from *Elatioriella elatior* (d'Orbigny) in its less distinct ornamentation and more complex internal structure. There is no fold B in the latter species, whereas its fold L is simple and symmetrical (cf. d'Orbigny 1850: 125, pl. 270: 1—4).

Occurrence. — Poland: Bałtów — Middle Oxfordian (*Gregoryceras transversarium* Zone).

Elatioriella bernardiana (d'Orbigny, 1850)

(pl. 10: 13)

1925. *Endiatrachelus? bernardianus.* d'Orbigny; Dietrich: 93 (with synonymy).
1972 *a. Auroraella bernardiana* (d'Orbigny); Dvali: 33, pl. 6: 6, 6*a*; pl. 7: 1, 1*a*.

Material. — Seventy specimens.

Dimensions:

ZNG Kr	n	Hn	h_{0-1}/d	D	PA	SA
A-I-66/80	6	52	0.80	12	8°	63°

Description. — Shell long and narrow, with high whorls convex at the midheight. Whorl surface ornamented with 5 spiral nodose ribs and 4—5 intercalated fine, usually smooth ribs. Early whorls less convex than the late ones; they show also more nodose main ribs and less distinct intercalated ones. Non-ornamented band of some 2—3 mm in width located high at a whorl. Growth lines inclined at a dozen or so degrees to the shell axis, inflected considerably to the right in the upper part of a whorl, reach at 40—50° the narrow sutural roll. Shell base high and flat, covered with numerous concentric ribs, separated clearly from the flank of the last whorl. Aperture high, extended to from a long siphonal furrow. At the last developmental stage, whorl insides constricted by 3 folds:

C — wide, indistinct, with h_f close to 1 mm;

P — narrow, slightly curved, of some 2.5 mm in height;

L — asymmetrical, with its upper limb more steeply inclined to the shell axis than the lower one, h_f approximates 2 mm.

Whorl inside index approximates 0.5. The internal structure is much simpler and the inside area is much larger at the final whorl.

Remarks. — Generic attribution of *E. bernardiana* has so far not been ultimately recognized. The nineteenth century authors (d'Orbigny 1850; Zittel 1873; Loriol in Loriol and Baurgerat 1886, Cossmann 1898) assigned it to *Nerinea*; Dietrich (1925) assigned it with reservations to *Endiatrachelus*; and Pchelintsev (1965) assigned it to *Auroraella*. The present author is, however, of the opinion that this species appears most closely related to the species within *Elatioriella* Pchelintsev, 1965; this assignement is suported by the occurrence of a non-ornamented band in the upper part of the whorls, clear separation of the shell base, whorl convexity, and internal-structural pattern, all these characteristics shared with other representatives of the latter genus.

Occurrence. — Poland: Bukowa, Skorków — Lower Kimmeridgian. France: "Rauracian" — Kimmeridgian.

Subfamily **Bactroptyxisinae** Pchelintsev, 1965
Genus *Bactroptyxis* Cossmann, 1896
Bactroptyxis aff. *crebriplicata* (Zittel, 1873)

(fig. 32; pl. 11: 5)

Material. — Three specimens.

Dimensions:

ZNG Kr	n	Hn	h/d	PA	SA
A-I-66/82	13	50	0.9	3	65

Description. — Shell cylindrical, with very numerous, flat and high whorls. Whorl walls very thin (0.1—0.2 mm in thickness). At the maximum complexity of the shell internal structure, whorl insides constricted by 6 folds:

C_1 — located very low at the columella, with h_f of some 0.7 mm, split into 2 subordinate folds; C_1^1 very narrow, directed towards the base, with h_f of 0.5 mm; C_1^2 wider, triangular, somewhat inflected upwards, with h_f of 0.2—0.3 mm;

C_2 — located a little above the midheight of a whorl, triangular, with h_f of some 0.5 mm;

P — displaced considerably towards the shell axis, very narrow, running at some 40° to the external whorl-wall;

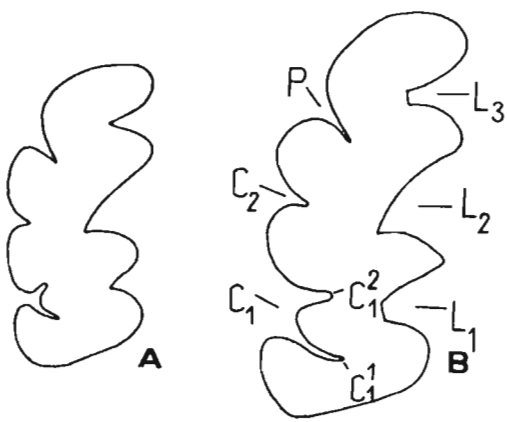


Fig. 32. Whorl insides in *Bactroptyxis* aff. *crebriplicata* (Zittel), Sulejów, Lower Kimmeridgian; ZNG KR A-I-66/ZZ, ×12.5: *A* the earliest preserved whorl, *B* final part of the shell.

L_1 — located very low, asymmetrical, blunt, with h_f of 0.5 mm;
L_2 — strongly developed, beak-shaped, located at the midheight of a whorl, with h_f approximating 0.7 mm;
L_3 — somewhat asymmetrical, blunt, with h_f close to 0.5 mm.

At the early whorls (fig. 32*A*), the folds L_1 and L_3 are pointed, and the second order folds of the fold C_1 are indistinct.

Remarks. — The investigated specimens resemble closely *Bactroptyxis crebriplicata* described from the Tithonian by Zittel (1873) and Janicke (1970) but they differ from the latter species in the internal structure, mostly in the columellar folds.

Occurrence. — Poland: Sulejów — Upper Oxfordian.

Subfamily **Auroraellinae** Pchelintsev, 1965

Genus *Endiantrachelus* Cossmann, 1898

Endiantrachelus subcylindricus (d'Orbigny, 1850)

(fig. 33)

1934. *Nerinea subcylindrica* d'Orbigny; Levasseur: 185, fig. 11.

For other synonymy see: Dietrich 1925: 94.

Material. — Two specimens.

Description. — Whorl insides constricted by 3 folds:
C — short, wide at the base, with h_f of some 1.5 mm;
P — long and narrow, runing at 45° to the external whorl-wall, with some 3 mm in height;
L — located a little below the midheight of a whorl, rectangular in shape, with h_f of some 3.5 mm.

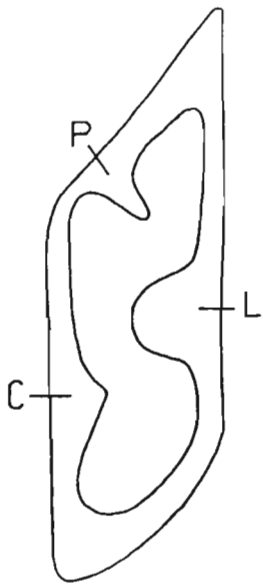


Fig. 33. Whorl cross-section in *Endiatrachelus subcylindricus* (d'Orbigny), Sulejów, Lower Kimmeridgian; ZNG KR A-I-66/83, ×2,2.

Whorl inside index approximates 0.6.

Occurrence. — Poland: Sulejów — Lower Kimmeridgian. France and Switzerland: "Rauracian" — Kimmeridgian.

Family **Itieridae** Cossmann, 1896
Subfamily **Phaneroptyxisinae** Pchelintsev, 1965

Genus *Phaneroptyxix* Cossmann, 1896, emend. Pchelintsev, 1965

Phaneroptyxis sulejovensis sp.n.

(fig. 34; pl. 11: fig. 3, 4*a*, *b*)

Holotypus: specimen ZNG Kr A-I-66/84, fig. 34, pl. 11: 4*a*, *b*.

Stratum typicum: Lower Kimmeridgian (*Sutneria platynota* and *Ataxioceras hypselocyclum* Zones boundary).

Locus typicus: Sulejów on Pilica.

Derivatio nominis: after the type locality, Sulejów.

Diagnosis. — Shell oval turriculate, with high whorls convex in their upper portions. Early whorls nodose, late whorls smooth. Aperture high and narrow. Fold formula 1110.

Material. — Some two hundred specimens.

Dimensions:

ZNG Kr	n	Hn	h_{0-1}/d	D	PA	SA
A-I-66/85	7	145	0.64	46	18	72
A-I-66/86	9	104	0.65	36	16	75

Description. — Shell large-sized, oval turriculate, with each whorl covering half the preceding one. Whorls somewhat convex in their upper parts. Early whorls ornamented each with 7—9 tubercles, late whorls smooth; a few earliest whorls show also 4 spiral ribs. Growth lines densely spaced, inclined at a dozen or so degrees to the shell axis. Sutural roll (1 mm in width) distinct, inclined at some 120° to the labial whorl-wall. A crest occurs at the boundary of sutural roll and whorl wall.

The final whorl oval, gently concave at the midheight. Shell base inclined at 50° to the shell axis, grading gently into the flank of the last whorl. Aperture high and elongate, ended with a fairly long siphonal furrow. 2 folds occur at the internal lip, and a single at the external one. Axial hole of some 5 mm in diameter, encircled by a siphonal fasciole. At the late developmental stages, whorl insides constricted by 3 folds:

C — slightly asymmetrical, fairly narrow, with h_f close to 3 mm;

P — narrow, somewhat inflected, h_f approximates 2.5 mm;

L — very large (h_f attains 5 mm), asymmetrical, with its upper limb almost normal to the whorl wall, and the lower one inclined at some 50°.

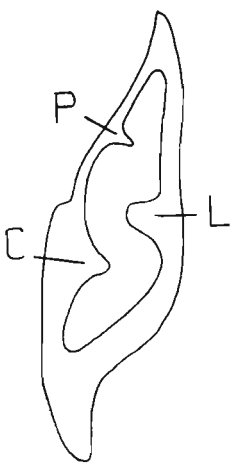


Fig. 34. Whorl cross-section in *Phaneroptyxis sulejovensis* sp.n. Sulejów, Lower Kimmeridgian; holotype, ZNG KR A-I-66/84, ×2.

Whorl wall attains usually 2—3 mm in thickness, except of the much thinner top wall (0.5 mm). Whorl inside index approximates 0.5. Fold size and wall thickness decrease markedly at the very last whorl.

Axial hole develops regularly over all the whorls of a shell. Judging from the successive whorl cross-sections, one may claim that the siphonal furrow appears already at the earliest whorls. The lower portion of siphonal furrow moves away from the shell axis and hence, the top wall of a whorl (consistent in morphology with the base of the preceding whorl) shows a peculiar concavity.

Ontogeny. Shell changes from conical (AA ranges from 35° to 40°) to turriculate (PA approximates 16—21°) in shape in ontogeny. The ratio of whorl height to its diameter increases from 0.4 at the early whorls to 0.60—0.65 at the late ones. Suture is almost horizontal at the early ontogenetic stages, while it becomes markedly inclined relative to the shell axis at the late stages. The whorls become convex in their upper parts and smooth in ontogeny. The folds change their shape from the early to late ontogenetic stages; the early internal structure remains, however, unknown, as the early whorls are usually filled partly up with the secondary calcium carbonate.

Remarks. — The newly erected species differs in its more slender shape, larges whorl height to diameter ratio, and smoothness of the last whorls from *Phaneroptyxis moreana* (d'Orbigny) as described and illustrated by d'Orbigny (1850: 100, pl. 257: 2), Peters (1855: 351, pl. 13: 5—7), Gemmellaro (1871: 22, pl. 3: 6, 7), Schlosser (1882: 82, pl. 12: 2—3), Cossmann (1896, 1898: 14, pl. 2: 1—2), Levasseur (1934: 286, fig. 13), Veselinovic (1965: 255, pl. 3: 1—3), and Sirna (1968: 169, pl. 3: 3, 11; pl. 4: 1, 3). The specimens of the latter species described and illustrated by Credner (1863: 175, pl. 4: 10) and Loriol and Lambert (1893: pl. 2: 5) are as slender as these *P. sulejovensis* sp.n. but they show much more conspicuous ornamentation.

Occurrence. — Poland: Sulejów — Lower Kimmeridgian (*Sutneria platynota* and *Ataxioceras hypselocyclum* Zones boundary).

Genus *Fibuloptygmatis* Pchelintsev, 1965

Fibuloptygmatis sp.

(pl. 12: 2*a*, *b*, 3)

Material. — Some sixty specimens.

Dimensions:

ZNG Kr	n	Hn	h_{0-1}/d	D	PA	SA
A-I-66/92	6	45	0.5	24	25	70

Description — see Wieczorek 1975.

Occurrence. — Poland: Sulejów, Skorków, Bukowa — Lower Kimmeridgian; Dobrut — Oxfordian/Kimmeridgian boundary.

Fibuloptygmatis mieronicensis sp.n.

(fig. 35: pl. 12: 1, 4)

Holotypus: specimen ZNG A-I-66/96, fig. 35, pl. 12, fig. 4.

Stratum typicum: Lower Kimmeridgian (*Ataxioceras hypselocyclum* Zone).

Locus typicus: Mieronice by Małogoszcz.

Derivatio nominis: After the type locality Mieronice.

Diagnosis. — Shell turriculate, with considerably concave whorls and prominent sutural roll. Siphonal furrow long. Shell base slightly convex, separated by a di-

stinct keel from the last whorl flank. Fold formula 2111. Fold L inflected upwards, fold P truncated at its midlength.

Material. — Five specimens.

Dimensions:

ZNG Kr	n	Hn	h_{0-1}/d	D	PA	SA
A-I-66/96	6	94	0.42	ca 50	18	78
A-I-66/97	4	53	0.44	43	20	76

Description. — Shell large-sized, turriculate, with fairly low, considerably concave whorls (d_{min}/d_{max} approximates 0.75). Maximum whorl concavity occurs at one fifth of a whorl height. Sutural roll prominent, asymmetrical, with its upper part better developed and more sharply separated from a whorl flank than the lower part. Whorl ornamentation unknown. Shell base slightly convex, inclined at 55° to the shell axis. Judging from the cross-sections of a few last whorls, one may suppose that the aperture is rhomboidal in shape, extending downards in the form of a fairly long siphonal furrow.

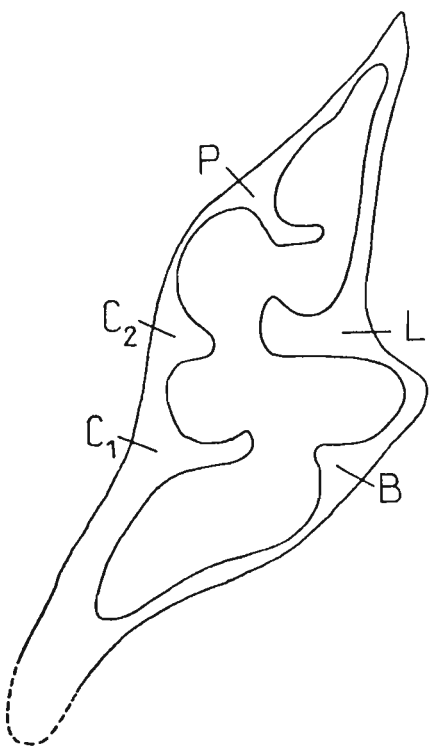


Fig. 35. Whorl cross-section in *Fibuloptygmatis mieronicensis* sp. n., holotype; Mieronice, Lower Kimmeridgian; ZNG KR A-I-66/96, ×2.

At the maximum complexity of the shell internal structure, whorl insides constricted by 5 folds:

C_1 — long and narrow, with its end inflected upwards (h_f approximates 5.5 mm);

C_2 — short, wide-based, with h_f of some 3 mm;

P — long, with h_f of some 5 mm, running at 45° to the external whorl-wall at the beginning, truncated at the midlength and thereafter, inclined at some 100° to the external whorl-wall;

L — long, somewhat inflected upwards, with a fairly narrow base and h_f of some 5 mm;

B — short, wide-based, with h_f of some 2 mm.

Remarks. — The investigated specimens differ from those determined here as *Fibuloptygmatis* sp. in their lower whorl height to diameter ratio, more concave whorls, shape of the folds P and L, and whorl inside shape. Furthermore, the newly established species shows more distinctly the stair-like arrangement of whorls and the external whorl-wall appears almost parallel to the shell axis.

F. mieronicensis sp.n. differs from *Fibuloptygmatis mosae* (d'Orbigny) in the considerably concave whorls and more slender shell shape. The whorl concavity makes it also different from *F. costulata* (Loriol).

Occurrence. — Poland: Mieronice, Gołuchów, Leśna Góra — Lower Kimmeridgian (*Ataxioceras hypselocyclum* Zone).

Family uncertain
Genus *Aphanotaenia* Cossmann, 1898
Aphanotaenia aff. *strigillata* (Cerdner, 1873)
(pl. 11: 1, 2)

Material. — Nine specimens.

Dimensions:

ZNG Kr	n	Hn	h_{0-1}/d	D	PA	SA
A-I-66/98	6	30	0.88	8	9	72
A-I-66/99	6	35	0.86	9	7	70

Description. — Shell small-sized, slender, turriculate, with numerous, high and flat, stair-like arranged whorls. Whorls ornamented each with some 20 elongate tubercles at its upper part. Shell base convex. Aperture elongate, ended with a short siphonal furrow. Whorl insides constricted by 2 folds:

C — very distinct, asymmetrical, located below the midheight of a whorl, with h_f of 1 mm;

L — similar in both the shape and height to the fold C, but slightly wider, located at the midheight of a whorl, sometimes inflected upwards.

In some specimens, another columellar fold appears indistinctly at a few last whorls.

Remarks. — The Upper Jurassic specimens from the Holy Cross Mts differ from the type material of *Aphanotaenia strigillata* described by Credner (1873: 169, pl. 3: 7*a*, *b*) in their weakly developed upper columellar fold; actually, that fold is absent from most investigated specimens.

It may be emphasized that the representatives of *Aphanotaenia* lack any sutural roll and hence, their attribution to the subfamily Nerineacea may be doubtful (cf. Cossmann 1898).

Occurrence. — Poland: Sulejów, Przedbórz—Lower Kimmeridgian.

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JÓZEF WIECZOREK

GÓRNOJURAJSKIE NERINEE Z OBRZEŻENIA GÓR ŚWIĘTOKRZYSKICH

Streszczenie

W pracy opisano 25 gatunków bądź podgatunków ślimaków z nadrodziny Nerineacea występujących bardzo licznie w utworach górnej jury (środkowy i górny oksford oraz kimeryd) obrzeżenia Gór Świętokrzyskich. Wyróżniono jeden nowy rodzaj, *Lewinskia* gen. n., 3 nowe gatunki — *Elatioriella sanctacrucensis* sp. n., *Fibuloptygmatis mieronicensis* sp. n., *Phaneroptyxis sulejovensis* sp. n. oraz 2 podgatunki — *Cossmannea desvoidyi baltovensis* subsp. n i *Cossmannea desvoidyi karczewskii* subsp. n.

Wykazano, że w rozwoju ontogenetycznym budowa wewnętrzna muszli ulega u większości gatunków stopniowej i stałej komplikacji. Odmienny sposób ontogenezy stwierdzono jedynie u *Cryptoplocus* Pictet et Campiche, 1861 oraz *Aptyxiella rupellensis* d'Orbigny, 1852. Uzasadniono, że upraszczanie budowy wewnętrznej obserwowane w ostatnim skręcie ma charakter wzrostowy i jest charakterystyczne dla wszystkich stadiów ontogenezy muszli. Jako cechy ostatecznego zakończenia wzrostu muszli można wskazać — przejawy rozwijania się muszli, zmiany morfologii ostatniego skrętu oraz anomalne zgrubienia ścianek. Z końcowymi etapami wzrostu muszli należy ponadto wiązać zapełnianie wierzchołkowej części muszli przez wtórny węglan wapnia.

U wielu okazów rozpoznano struktury kolapsyjne stanowiące rezultat diagenetycznej modyfikacji budowy wewnętrznej muszli. Obecność tych struktur utrudnia, a niekiedy uniemożliwia identyfikację taksonomiczną okazów.

Przedyskutowano zależność nerinei od czynników facjalnych. Najliczniejsze zespoły nerinei występują w utworach pogranicza oksfordu i kimerydu, reprezentujących osady rozległej płycizny na której miała miejsce sedymentacja węglanowa. W różnych facjach wykazujących znaczne analogie do współczesnych osadów płycizn bahamskich występują nieco odmienne zespoły nerinei. W wapieniach kredowatych i onkolitowo-grudkowych, w których nerinee są najsilniej zróżnicowane występują głównie przedstawiciele rodzajów *Ptygmatis*, *Cryptoplocus*, *Phaneroptyxis*, *Cossmannea*, *Elatioriella*, *Nerinea*, *Nerinella*, *Lewinskia*. W wapieniach mikrytowych i gruzełkowych zespół nerinei jest znacznie uboższy i reprezentowany głównie przez *Pseudonerinea*, *Nerinea* i *Nerinella*. Wapienie oolitowe zawierają natomiast dość liczne

formy z rodzajów *Nerinea*, *Nerinella* i *Ptygmatis*. Brak jest natomiast nerinei w osadach oolitowych wykazujących przekątne warstwowanie.

Nerinee występują bardzo często w dużych nagromadzeniach — ławicach, które w większości stanowią rezultat stopniowej akumulacji muszli w okresach wolnej sedymentacji. W takich okresach panowały sprzyjające warunki ekologiczne dla rozwoju nerinei, a istotne znaczenie przy tym zdają się mieć zmiany konsolidacji podłoża związane głównie z procesami wczesnej lityfikacji osadów.

W obrębie płycizn rozmieszczenie nerinei kontrolowane było głównie przez czynniki hydrodynamiczne, charakter podłoża i szybkość sedymentacji. O rozprzestrzenieniu geograficznym nerinei decydowały natomiast czynniki klimatyczne, zmiany zasolenia oraz dopływ materiału terrygenicznego i batymetria.

Wskutek dużej zależności występowania nerinei od facji przydatność tych organizmów dla celów szczegółowej stratygrafii jest niewielka.

EXPLANATIONS OF THE PLATES 1—12

Plate 1

1. Bed with *Pseudonerinea clytia* (d'Orbigny), Sulejów, bed 13, Lower Kimmeridgian, top view; directional specimen orientation; ZNG KR A-I-66/124, ×0.5.
2. Nerineacean bed, Sulejów, bed 10, Lower Kimmeridgian, horizontal section: abundant macrooncolites, sections through *Fibuloptygmatis* sp. and *Ptygmatis bruntrutana* (Thurmann); ZNG KR A-I-66/126, ×0.5.

Plate 2

1. Nerineacean bed, Błaziny, bed 5, "Astartian", horizontal section: sections through *Ptygmatis bruntrutana* (Thurmann), *P. pseudobrutrutana* (Gemmellaro), Pseudonerinea sp., and *Nerinea* sp.; ZNG KR A-I-66/128, ×0.4.
2. Bed with *Elatioriella sanctacrucensis* sp. n. Bałtów, Middle Oxfordian, vertical section, ZNG KR A-I-66/129, ×0.5.

Plate 3

Bed with *Elatioriella sanctacrucensis* sp. n. Bałtów, Middle Oxfordian, vertical sections: 1 upper part of the bed, random specimen orientation, ZNG KR A-I-66/130; 2 middle part of the bed, directional specimen orientation, ZNG KR A-I-66/131; ×0.35.

Plate 4

1, 2, 4. Axial sections through nerineacean shells forming oncolite nuclei; bivalve borings; Sulejów, Lower Kimmeridgian: 1 *Lewinskia varioplicata* (Wieczorek), ZNG KR A-I-66/112, ×1.5; 2 *Ptygmatis bruntrutana* (Thurmann), ZNG KR A-I-66/114, ×10; 4 *Ptygmatis bruntrutana* (Thurmann), ZNG KR A-I-66/113, ×1.5.

3. *Diceras* encrusting a shell of *Cryptoplocus depressus* (Voltz), Sulejów, Lower Kimmeridgian, ZNG KR A-I-66/98, ×1.
5. Section through *?Dorsoserpula triferulata* Partsch inbetween successive whorls of *Cryptoplocus depressus* (Voltz), Sulejów, Lower Kimmeridgian; the serpulid encrusted the base of a specimen still in growth; ZNG KR A-I-66/107, ×1.

Plate 5

Collapse structures in nerineacean shell internal structures, axial sections; 5 — Mieronice, Lower Kimmeridgian; all the other — Sulejów, Lower Kimmeridgian: 1. *Ptygmatis bruntrutana* (Thurmann), ZNG KR A-I-66/115, ×2; 2. *Phaneroptyxis* sp., ZNG KR A-I-66/116, ×1; 3. *Cryptoplocus* sp. ZNG KR A-I-66/117, ×1; 4. *Ptygmatis pseudobruntrutana* (Gemmellaro), ZNG KR A-I-66/118, ×1; 5. *?Nerinea fallax* Thurmann, ZNG KR A-I-66/119, ×1; 6. *Ptygmatis bruntrutana* (Thurmann); ZNG KR A-I-66/120, ×1; 7. *Phaneroptyxis* sp. ZNG KR A-I-66/121, ×2; 8. *Cryptoplocus* sp.: compaction deformations are also apparent, ZNG KR A-I-66/122, ×1; 9. *Cryptoplocus depressus* (Voltz), ZNG KR A-I-66/123, ×1; (figs 1 and 7×2, all others ×1)

Plate 6

Pseudonerinea clytia (d'Orbigny), Lower Kimmeridgian

1. External view, Sulejów, ZNG KR A-I-66/1.
2. Axial section, Bukowa, ZNG KR A-I-66/4.
3. Mould, Sulejów, ZNG KR A-I-66/2.

Nerinea fallax, Thurmann, Sulejów, Lower Kimmeridgian

4. Axial section, ZNG KR A-I-66/6.

Cossmannea desvoidyi baltovensis subsp.n., Bałtów, Middle Oxfordian

5. *a* external view; *b* axial section; holotype, ZNG KR A-I-66/18a.
all ×1

Plate 7

Cossmannea desvoidyi desvoidyi (d'Orbigny), Sulejów, Lower Kimmeridgian

1. Axial section, ZNG KR A-I-66/13.
4. External view, ZNG KR A-I-66/12.

Cossmannea desvoidyi karczewskii subsp.n., Podwalenie by Krzyżanowice, Upper Kimmeridgian

2. Axial section, ZNG KR A-I-66/20.
3. External view, ZNG KR A-I-66/21.

Cossmannea desvoidyi baltovensis subsp.n., Bałtów, Middle Oxfordian

5. Internal mould, paratype, ZNG KR A-I-66/19.
all ×1

Plate 8

Cossmannea desvoidyi desvoidyi (d'Orbigny), Lower Kimmeridgian, Sulejów

1. Axial section, ZNG KR A-I-66/15.
6. External view, ZNG KR A-I-66/16.

Ptygmatis bruntrutana (Thurmann), Lower Kimmeridgian

2. External view, Sulejów, ZNG KR A-I-66/32.
3. Axial section, Przedbórz, ZNG KR A-I-66/23.
4. Axial section, Sulejów, ZNG KR A-I-66/25.
5. Axial section, Sulejów, ZNG KR A-I-66/22.
7. Axial section, Sulejów, ZNG KR A-I-66/24.

all ×1

Plate 9

Cryptoplocus depressus (Voltz), Sulejów, Lower Kimmeridgian

1. Adult specimen, axial section; ZNG KR A-I-66/47.
2. Juvenile specimen, axial section; ZNG KR A-I-66/45.
3. Juvenile specimen, axial section; ZNG KR A-I-66/46.
5. Adult specimen, axial section; ZNG KR A-I-66/44.
6. External view; ZNG KR A-I-66/48.

Cryptoplocus pyramidalis (Münster), Podmalenie by Krzyżanowice, Upper Kimmeridgian

4. Axial section, ZNG KR A-I-66/52.

fig. 3 ×2, others ×1

Plate 10

Nerinella aff. *satagea* (Loriol), Lower Kimmeridgian

1. Axial section, Sobków, ZNG KR A-I-66/60, ×1.
2. Axial section, Sulejów, ZNG KR A-I-66/59, ×1.

?*Nerinella* sp., Sulejów, Upper Oxfordian

3. Axial section, ZNG KR A-I-66/61, ×1.

Lewinskia varioplicata (Wieczorek), Lower Kimmeridgian

4. External view, Sulejów, ZNG KR A-I-66/68, ×1.
5. Last whorls of an adult specimen in the axial sexion, Bukowa, ZNG KR A-I-66/72, ×2.
6. Axial section, Bukowa, ZNG KR A-I-66/132, ×1.

Lewinskia aff. *varioplicata* (Wieczorek), Sulejów, Lower Kimmeridgian

7. Axial section, ZNG KR A-I-66/73, ×1.

Comtortella sp. Sulejów, Lower Kimmeridgian

8. Axial section, ZNG KR A-I-66/75, ×2.

Elatioriella sanctacrucensis sp.n., Bałtów, Middle Oxfordian

9. External view, holotype, ZNG KR A-I-66/76, ×2.
10. Axial section, paratype, ZNG KR A-I-66/77, ×1.
11. Axial section, paratype, ZNG KR A-I-66/78, ×1.

Elatioriella bernardiana (d'Orbigny), Bukowa, Lower Kimmeridgian

12. Axial section; ZNG KR A-I-66/80, ×1.
13. External view; ZNG KR A-I-66/81, ×2.

Plate 11

Aphanotaenia aff. *strigillata* (Credner), Sulejów, Lower Kimmeridgian

1. Axial section, ZNG KR A-I-66/133.
2. Axial section, ZNG KR A-I-66/134:

Phaneroptyxis sulejovensis sp.n., Sulejów, Lower Kimmeridgian

3. External view, ZNG KR A-I-66/86.
4. *a* axial section, *b* external view, holotype, ZNG KR A-I-66/85*a*, *b*.

Bactroptyxis aff. *crebriplicata* (Zittel), Sulejów, Upper Oxfordian

5. Axial section, ZNG KR A-I-66/82.

fig. 5 ×2, others ×1

Plate 12

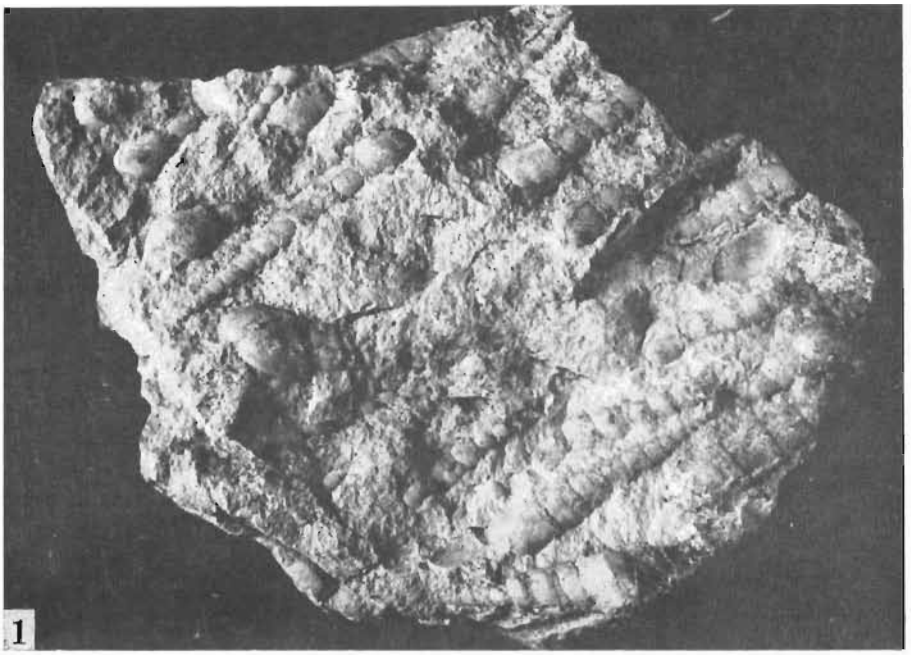
Fibuloptygmatis mieronicensis sp.n., Mieronice, Lower Kimmeridgian

1. Axial section, paratype, ZNG KR A-I-66/97;
4. Axial section, holotype, ZNG KR A-I-66/96.

Fibuloptygmatis sp., Sulejów, Lower Kimmeridgian

2. *a* axial section, *b* external view, ZNG KR A-I-66/93.
3. Axial section, A-I-66/93.

all ×1



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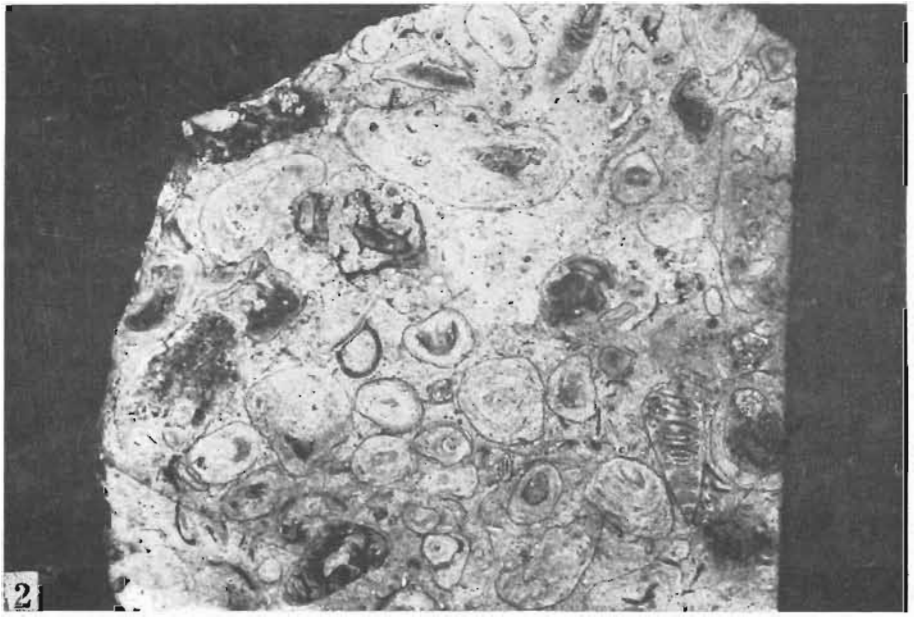

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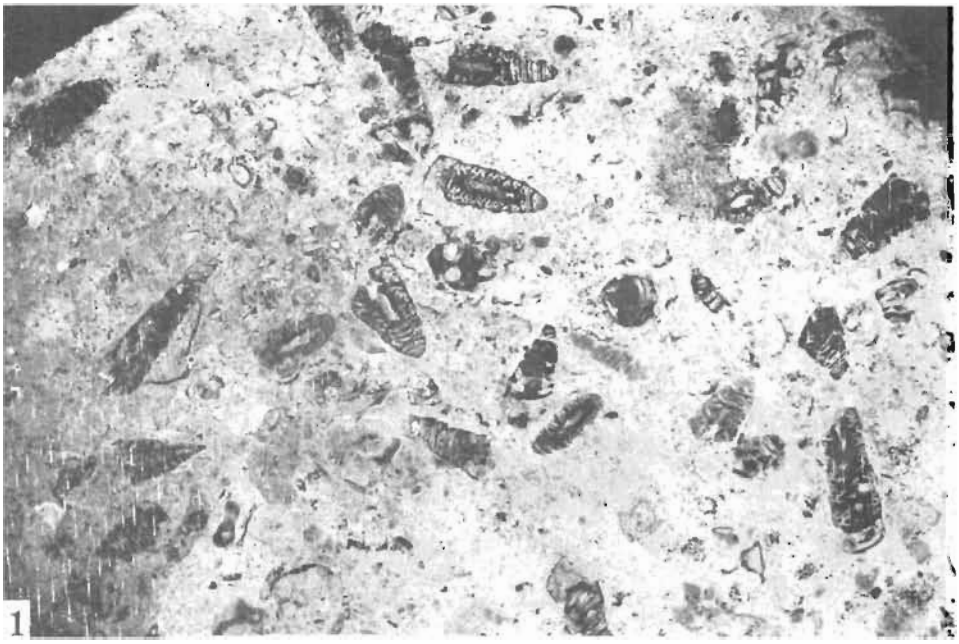

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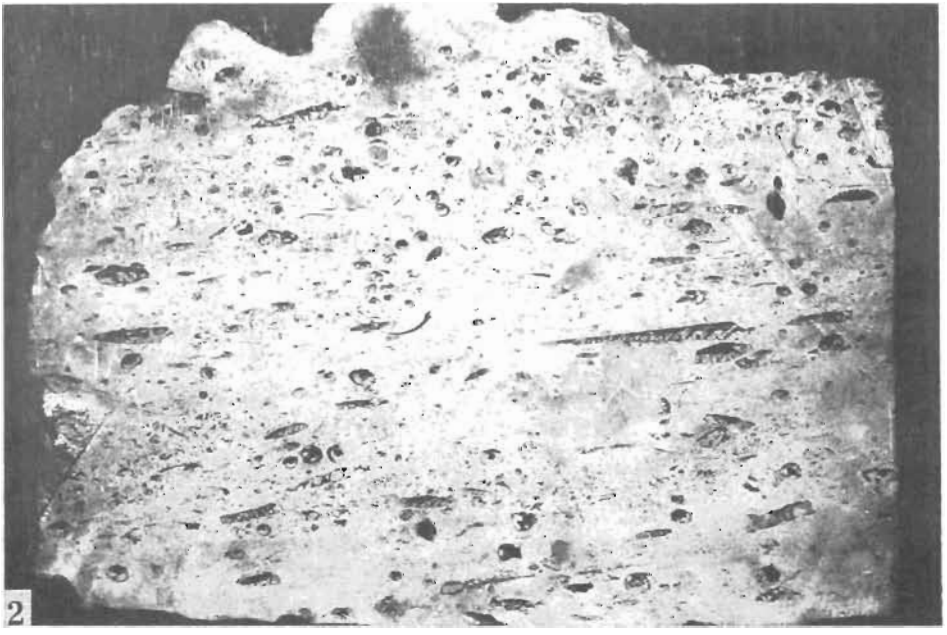

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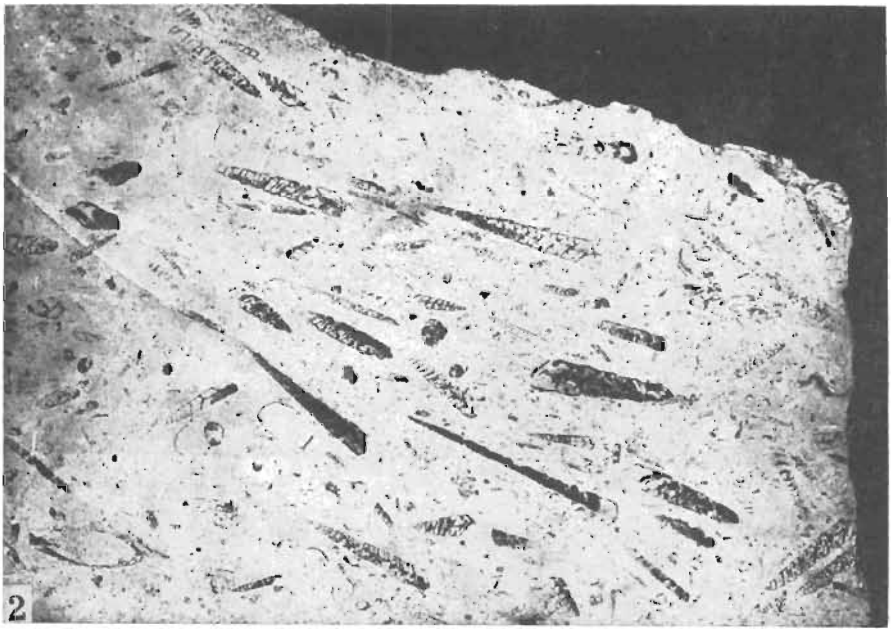
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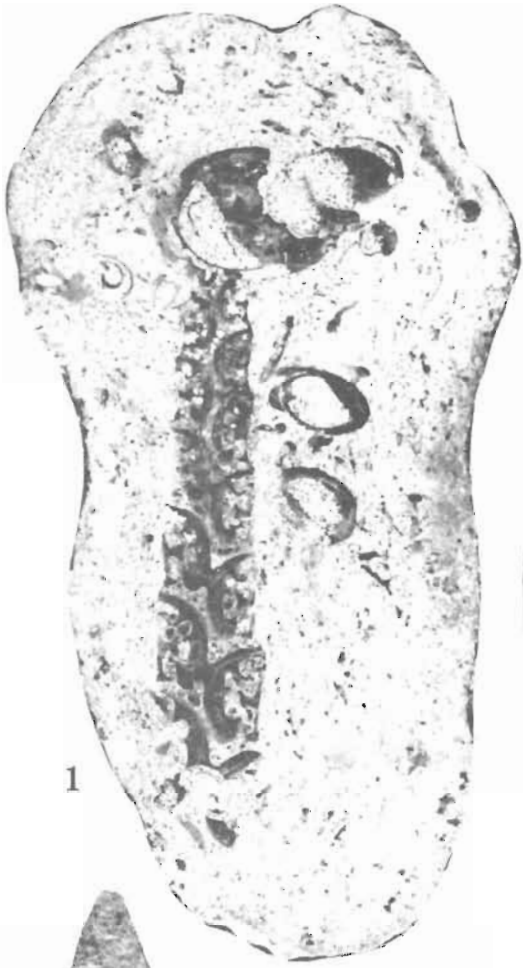

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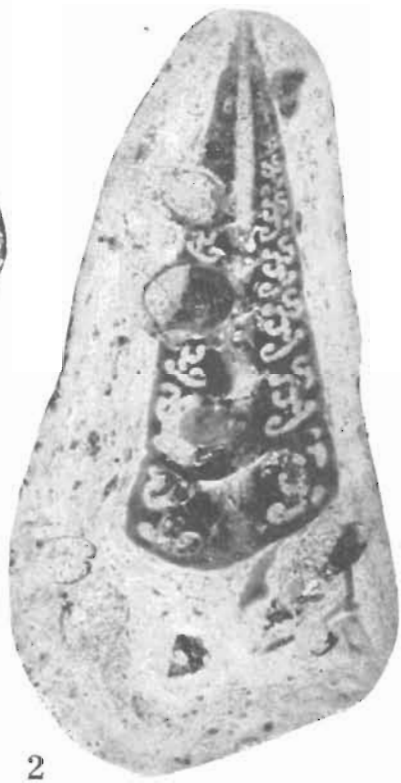

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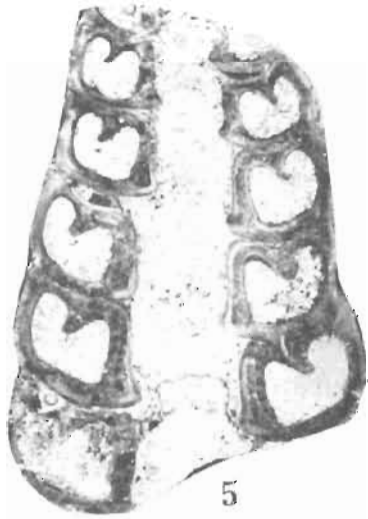

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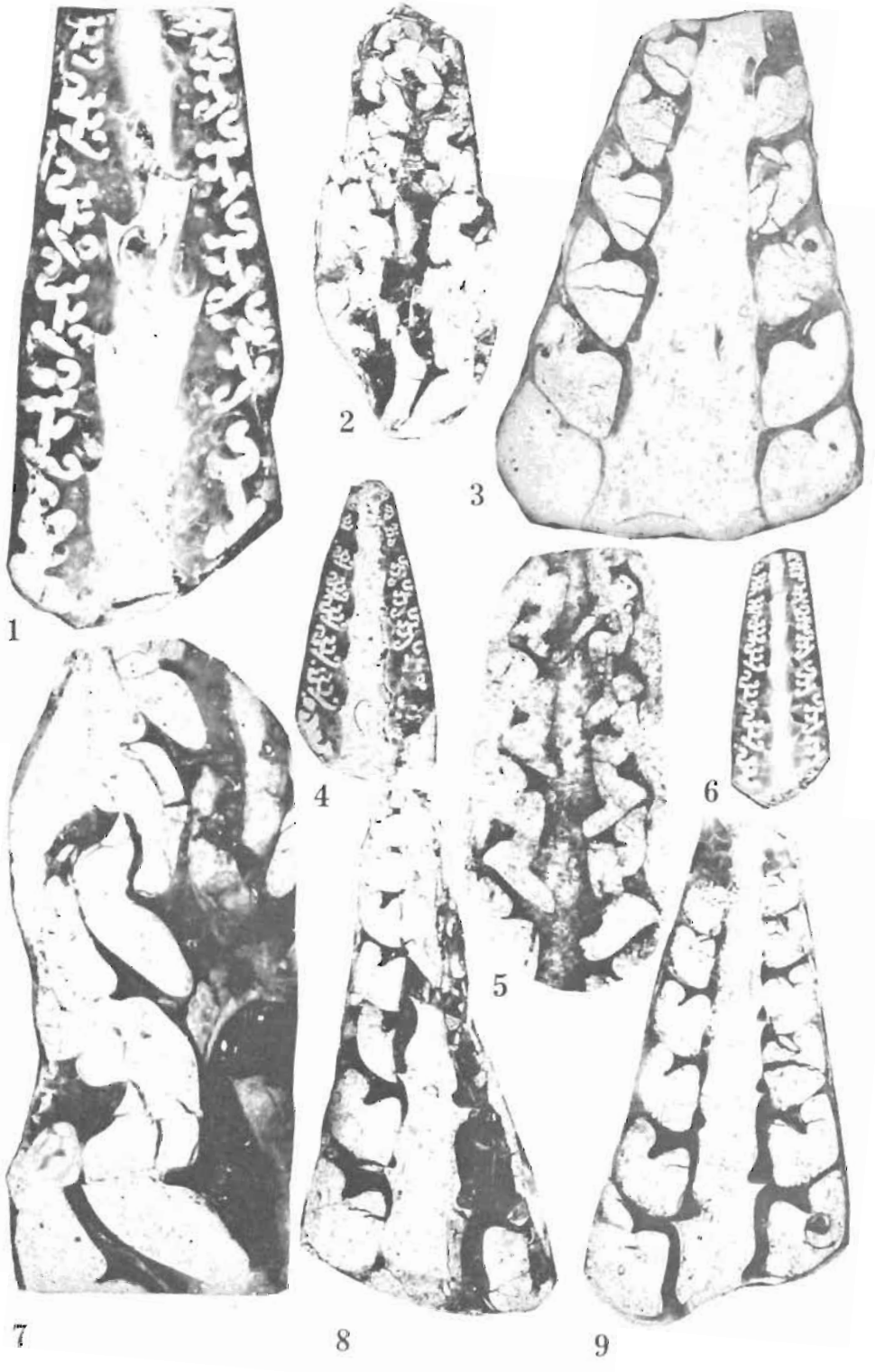
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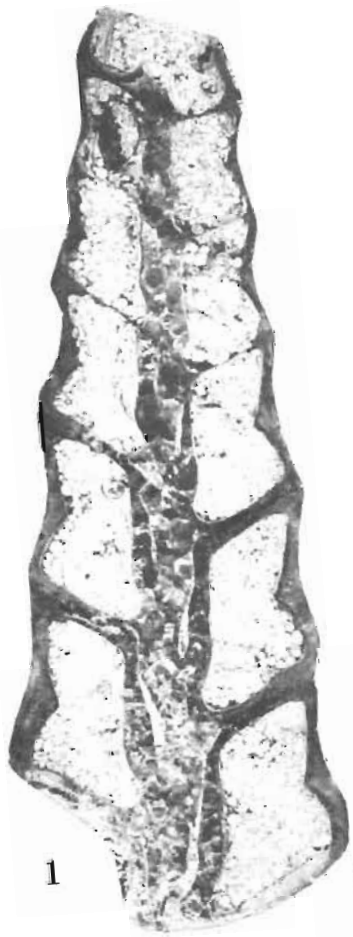
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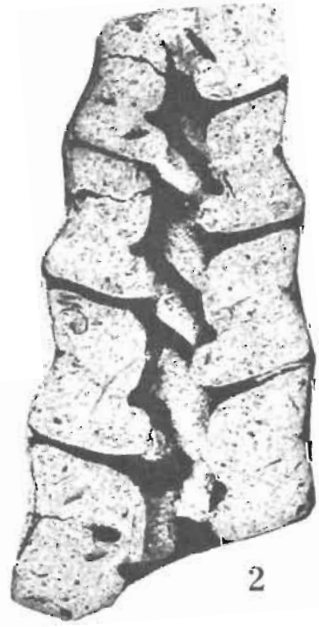
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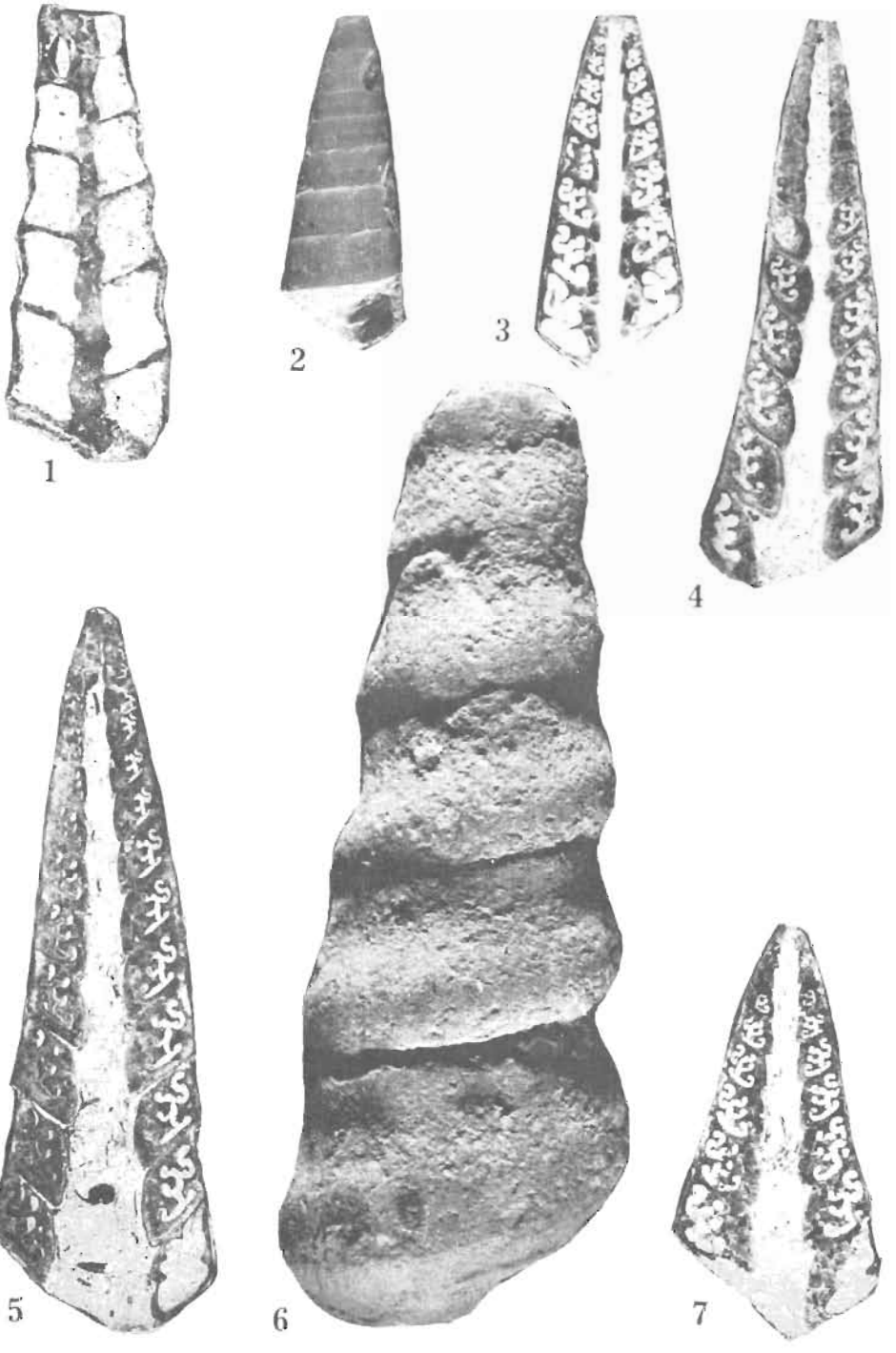
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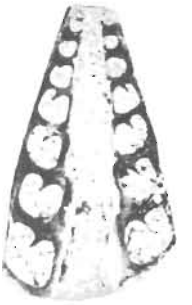

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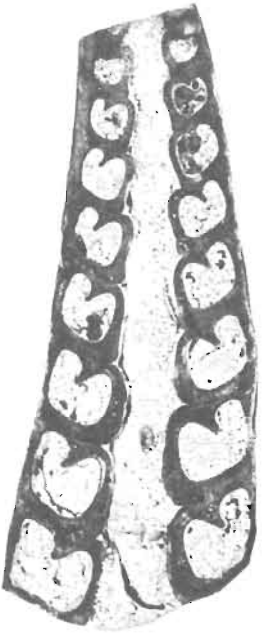

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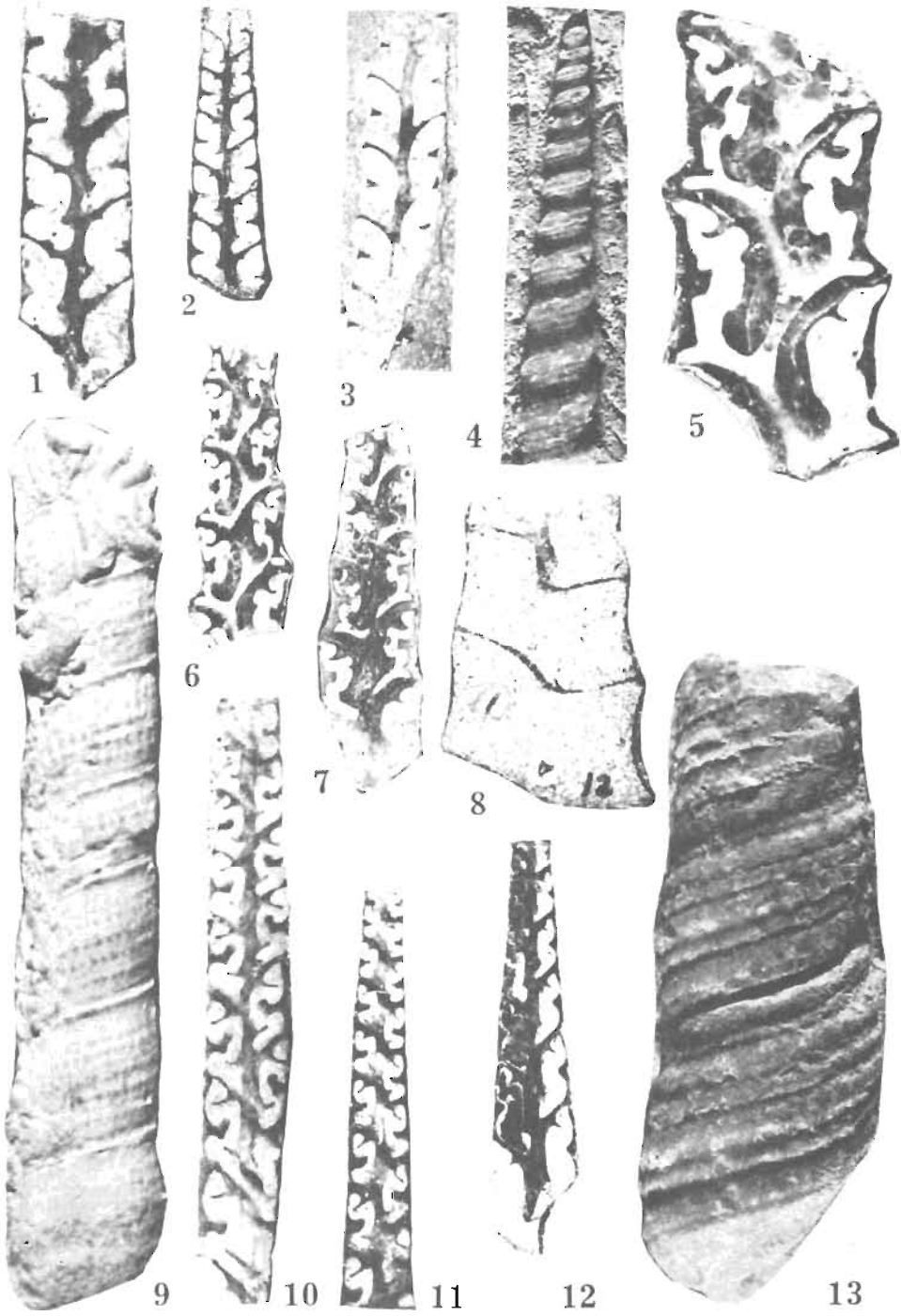
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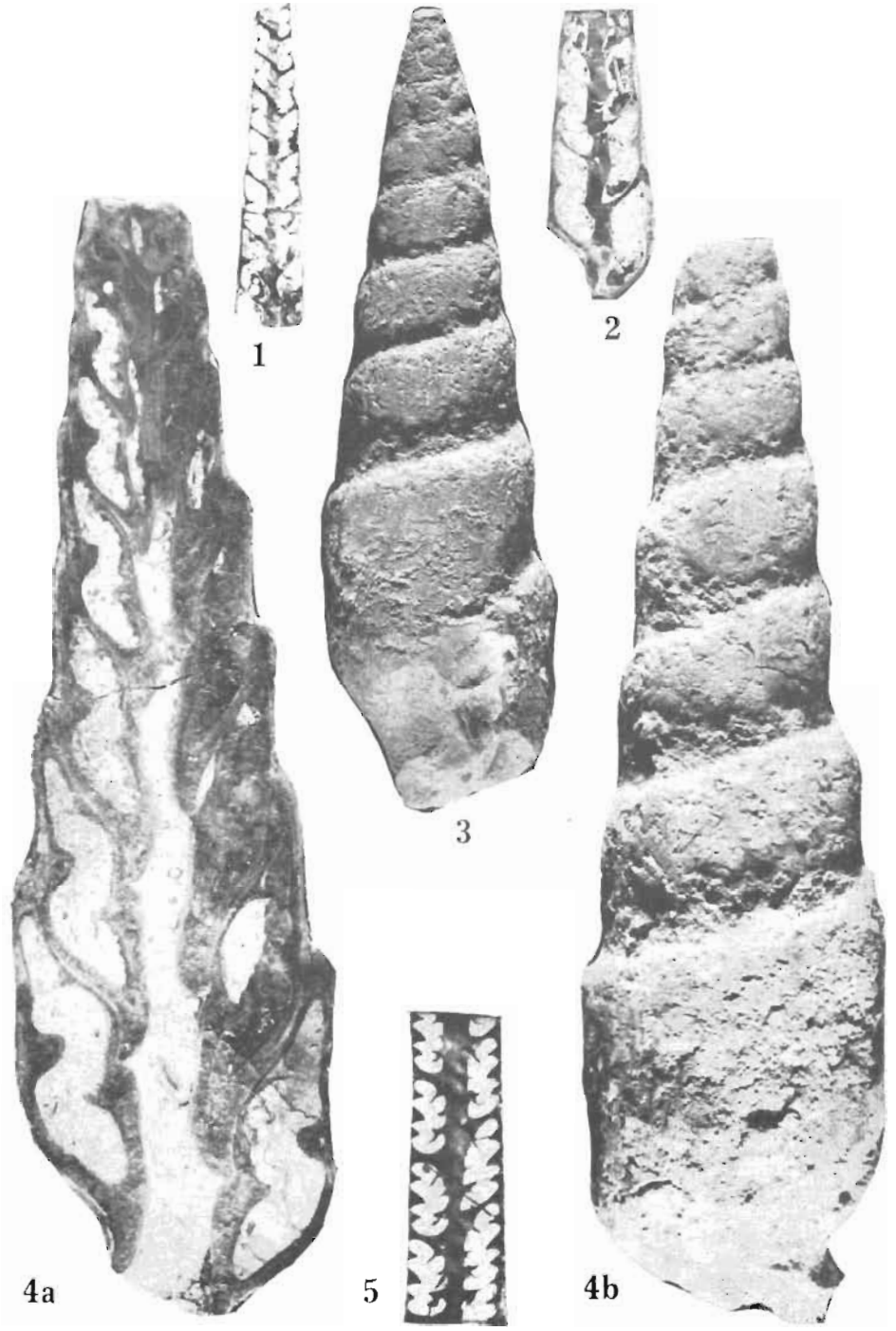
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