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BIVALVIA OF THE POLISH MIDDLE JURASSIC AND REMARKS ON THEIR PALEOECOLOGY

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Sixty Middle Jurassic species of Bivalvia from Poland including a new one (*Goniomya rudnikensis* sp. n.) are described and their occurrence in profile and dependence on environment are considered. It has been stated that epifaunal suspension-feeders to infaunal suspension-feeders ratio in one of the investigated profiles (Łęczyca) from the Polish Lowlands is comparable to that of the Lower Oxford Clay in England; the deposit-feeders are less numerous in the Polish profile. Ornamentation variability and anisometric growth changes as well as changes of hinge structure during ontogeny in some investigated bivalves have been noticed.

Key words: Bivalvia, Middle Jurassic, paleoecology, taxonomy, Poland.

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INTRODUCTION

The collection here described was assembled during the 1958—1968 field works prospecting for fossils in exposures of the Middle Jurassic of Poland. Bivalves are the main component of macrofauna in the Polish Middle Jurassic deposits. They occur in all facies, from the Lower Bajocian to the Upper Callovian. The bivalves described here were collected together with other mulluscs. So far the present author has described belemnites (Pugaczewska 1961, 1965), and 19 species of bivalves of the following families: Spondylidae (Pugaczewska 1968), Ostreidae (1971) and Trigoniidae (1976, 1977). Present paper contains the descriptions of remaining 60 species, previously not considered.

Besides the taxonomy, some paleoecological interpretations of the examined fauna are also included. They are, however, limited by the character of the material collected mainly for faunistic purposes.

Bivalvia here described come from the following regions and sites (fig. 1, Table 1): the Polish Lowlands (Łęczyca) — 49 species, the northern region

of the Kraków-Częstochowa Uplands (Rudniki, Włodowice, Kłobuck, Kierszula, Teofilów, Jaworzniki, Kamienica Polska) — 27 species, the southern region of the Kraków-Częstochowa Upland (Żar Mountain near Ogrodzieniec, Balin, Piła Kościelecka) — 9 species, Łuków near Siedlce (the glacial exotic) — 4 species, Bachowice near Wadowice in the Carpathians (the tectonic exotic) — 8 species. In the present paper 60 species are described including a new one: *Goniomya rudnikensis* sp.n. These bivalves are much diverse systematically and represent four subclasses: Palaeotaxodonta (representing six congeneric species), Pteriomorphia (three orders, six superfamilies, nine families, three subfamilies, fifteen genera, eighteen species), Heterodonta (one order, four superfamilies, four families, three subfamilies, eight genera, fourteen species), Anomalodesmata (one order, two superfamilies, five families, six genera, twenty two species). In all, 19 families and 30 genera have been recognized. Most of the species belong to the four families: Astartidae — 10 species, Pholadomyidae — 9 species, Pleuromyidae — 8 species, Nuculidae — 6 species. The remaining families include 1—4 species each.

The richest collection of the Middle Jurassic bivalves comes from the Polish Lowlands, Łęczyca site, where the most complete profile is exposed. Out of 60 species recognized in Poland as much as 49 have been found in this region and 25 of them occur in no other exposure in Poland. In other regions, of discontinuous sedimentation, the bivalve fauna is much less diversified.

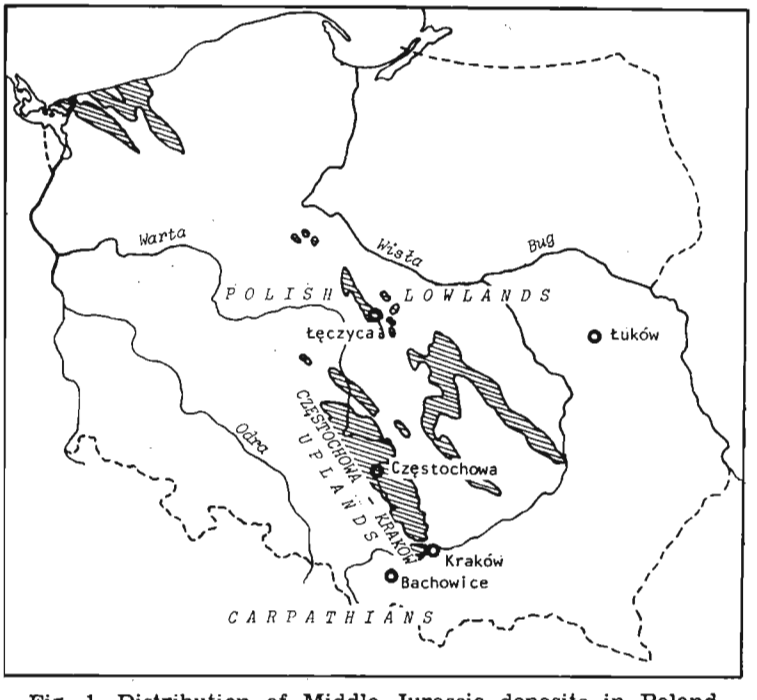


Fig. 1. Distribution of Middle Jurassic deposits in Poland.

Some of the species have wide geographic and stratigraphic distribution in Poland whilst others occur only at one stratigraphical horizon or site. *Bositra buchii* (Roemer), *Oxytoma inaequivalvis* (Sowerby), *Meleagrinella echinata* (Smith), *Camptonectes lens* (Sowerby), *Lima duplicata* Sowerby and less common representatives of Pholadomyidae and Pleuromyidae are abundant in the regions in question, whereas *Palaeonucula strigilata* (Goldfuss), *P.* cf. *oxfordiana* (Roeder), *P. menkei* (Roemer), *Plagiostoma* cf. *semicircularis* Goldfuss, *Astarte* cf. *meeki* Stanton, *Eriphyla elegans* (Sowerby), *Pleuromya calceiformis* (Phillips) and *Thracia lata* (Goldfuss) are known only from the Kuiavian of Łęczyca.

The Middle Jurassic of Poland has been the subject of numerous geological and paleontological monographs. For the regions discussed here the most important ones are those describing not only stratigraphy but lithologic differentiation of the sediments as well. These are: Krach 1934, 1951, Makowski 1952, Różycki 1953, Książkiewicz 1956, Znosko 1957, 1958, Kopik 1956, Kopik and Znosko 1968, Dayczak-Calikowska 1967.

The systematics adopted here is that proposed by McCormick and Moore (1969).

The material studied is housed at the Institute of Paleobiology of the Polish Academy of Sciences, Warsaw (abbr. ZPAL).

The photographs have been made by E. Wyrzykowska from this Institute.

The following abbreviations are used in the systematic part: H — height, L — length, I — inflation, C — convexity, H/L — height index, Rn — number of ribs.

MATERIAL

The bivalves described here are abundant and much varied taxonomically but only about 400 specimens are preserved well enough to be examined in detail.

The richest collections of bivalves come from the clayey-silty arenaceous deposits of the Upper Kuiavian and the sideritic silty arenaceous sediments of the Upper Bathonian of Łęczyca (the Polish Lowlands).

The bivalves, particularly those which occur as single individuals (e.g. Pholadomyidae and Pleuromyidae), are generally well-preserved. Both moulds and shells are complete, rarely damaged or deformed. Occasionally they are cracked but their concentric and radial ornamentations are well-preserved. The bivalves occurring in coquina like Astartidae, Nuculidae, or *Bositra buchii* (Roemer), are sometimes difficult to prepare, frequently cracked. Oysters and representatives of Pectinacea are usually found as more or less incomplete single valves with well-preserved orna-

mentation and details of internal morphology. It is difficult to excavate the oysters and trigonids or the oysters and *Meleagrinella* from shell beds cemented by siderite, in Upper Kuiavian siderite beds. The oysters and *Meleagrinella* which form the Lower Bathonian coquina of silty-arenaceous cement are better preserved.

In general the state of preservation of the bivalves from Bathonian deposits is comparatively good though in the collection single valves predominate. The fossils from the Lower Callovian beds of hard, dolomitic sandstones are usually poorly preserved and difficult to prepare. The bivalve fauna is abundant in the, so called, Nodular Bed of the Upper Callovian. The fossils found here are usually poorly preserved, cracked and crushed but defineable and measurable.

The northern region of the Kraków-Częstochowa Uplands is second as to the abundance of bivalve fauna. The sandstone conglomerate with clayey intercalations of the Lower Bajocian contains bivalve fauna which is relatively poorly preserved and consists of fragments of thin valves of Pectinacea as well as few limids and astartids. Despite this, however, the material can be examined because the characteristic ornamentation and shell outlines have been preserved. In the clays of the Kuiavian, valves and shells are preserved with the details of external and internal morphology. The richest collections of bivalves come from the clayey and clayey-arenaceous sediments of the Bathonian. Preservation of the specimens is generally good, shells and inner casts are complete, only occasionally deformed, with well-preserved ornamentation. The valves of Pectinacea are usually more damaged and often cracked, their ornamentation, however, is well-preserved.

Bivalves from the sandy-calcareous sediments of the Lower Callovian and from the nodular layer of the Upper Callovian are poorly preserved. The valves of *Bositra*, *Oxytoma*, *Meleagrinella* and few Limidae and Pholadomyidae which occur here, are often damaged, mainly due to compaction.

In the southern region the bivalve fauna is scarce. Mainly the bivalves from the sandy limestones of the Upper Bathonian have been examined. The specimens are generally well-preserved, not deformed. The size, outline and inflation of the shells and moulds are easy to discern.

A very well-preserved fauna, the bivalves included (Makowski 1952), is found in the Upper Callovian clays of Łuków near Siedlce. All of the bivalve shells are complete with well-preserved ornamentation, and details of their internal morphology visible on the open shells.

Bivalves from Bachowice near Wadowice (the Carpathians) occur mainly in sands and sandy-calcareous deposits of the Bajocian. They are numerous and well-preserved. Numerous *Bositra buchii* (Roemer) are difficult to prepare but easy to define thanks to their characteristic and well-preserved ornamentation.

MIDDLE JURASSIC SEDIMENTS IN THE EXPOSURES EXAMINED AND THEIR BIVALVE CONTENTS

1. The Polish Lowlands: Łęczyca

The Lower Bajocian (Sonninia sowerbyi, Otoites sauzei, Stephanoceras humphriesianum, Teloceras blagdeni zones) sediments are medium- to fine-grained sandstones which pass upwards in clayey siltstones with numerous bivalves: *Modiolus*, *Inoceramus*, *Bositra*, *Oxytoma*, *Meleagrinella*, *Maccoyella*, *Camptonectes*, *Lima*, *Tancredia*, *Ostrea* and *Trigonia*. The shell-beds that are often found here may be monospecific (*Bositra buchii*) or polyspecific (oysters, trigonids or *Meleagrinella*).

The Lower Kuiavian (Strenoceras subfurcatum, Garantiana garantiana and G. tetragona zones) sediments include sandy siltstones, silty-clayey shales and sandy-clayey siltstones. At the G. garantiana Zone appear intercalations of sandy clays as well as clayey and silty black shales, and at the G. tetragona Zone — interbeddings of brown sideritic sandstones. Bivalves occur mainly in the clayey and clayey-silty beds of the garantiana Zone. Apart from the genera known from the Lower Bajocian the following ones are found here: *Grammatodon*, *Plagiostoma*, *Pseudolimea*, *Myoconcha*, astartids in small amounts, and *Pholadomya*, *Gresslya* and others. Astartids usually form shell beds.

The Middle Kuiavian (Parkinsonia subarietis, P. parkinsoni, P. schloenbachi) deposits embrace black clayey siltstones, black clays with muscovite, which contain piritized plant remains, traces of worms and numerous bivalves. The bivalve fauna includes the species known from the lower horizons of the Jurassic as well as the species of the genera: *Astarte*, *Prorokia*, *Eriphyla*, *Pholadomya* and *Palaeonucula*. At the P. subarietis Zone occur monospecific shell beds of *Bositra*, as well as polyspecific, e.g. *Ostrea-Meleagrinella*, *Ostrea-Serpula*, *Ostrea-Trigonia* ones. They appear on the surfaces of the silty-clayey strata. Astartids and nuculids occur usually in clusters. Upwards, the P. parkinsoni Zone contains black or grey clayey shales, still with polyspecific coquinas, and the shaly facies contains monospecific shell beds of *Bositra buchii* (Roemer). The P. schloenbachii Zone is developed differently. In its lower part, clayey and sandy sediments alternate, and upward there are grey, medium- to fine-grained sandstones with muscovite and siltstones. There appear numerous sideritic and silty-sideritic intercalations as well as insets of dolomitic sandstones and sideritic marls. The bivalve fauna is less frequent and consists of *Pholadomya*, *Gresslya*, *Trigonia*, *Ostrea*, *Palaeonucula*, *Oxytoma* and others. Oysters and nuculids occur in large beds. *Ostrea-Serpula* bed is presented in fig. 2.

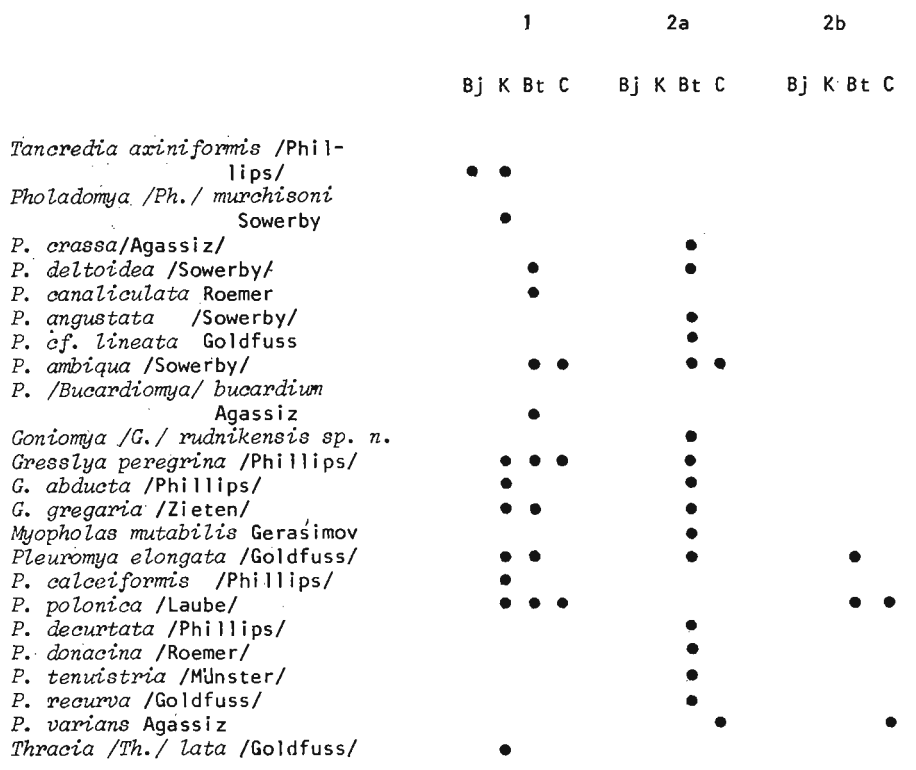
The Upper Kuiavian (Parkinsonia ferruginea, P. compressa, Oxycerites yeovilensis, Asphinctites tenuiplicatus) begins with siderite beds with

Table 1

Distribution of the described species

Species	Polish Lowlands				Kraków - Częstochowa Uplands							
					Northern region				Southern region			
	1				2a				2b			
	Bj	K	Bt	C	Bj	K	Bt	C	Bj	K	Bt	C
Palaeonucula hammeri /Defrance/		•	•									
P. strigilata /Goldfuss/		•	•									
P. variabilis/Sowerby/	•	•	•			•	•					
P. cf. oxfordiana /Roeder/		•										
P. ornati /Quenstedt/			•									
P. menkei /Roemer/		•										
Grammatodon /G./ concinnus /Phill/		•	•				•	•				
Musculus /M/ pulcherrimus /Roemer/			•									
Modiolus /M/ lonsdalei /Morris et Lycett/	•	•	•									
M. cuneatus /Sowerby/		•					•				•	
Pinna /P./ cf. buchii Koch et Dunker		•					•					
Inoceramus /Mytiloides/ amygdaloides Goldfuss	•	•										
Bositra buchii /Roemer/	•	•	•		•	•	•				•	
Oxytoma /O./ inequivalvis /Sowerby/	•	•	•	•	•	•	•	•			•	•
Maleagrinella echinata /Smith/	•	•	•	•	•	•	•	•				
Maccoyella cf. moorei /Etheridge/	•	•										
Camptonectes /C./ rushdenensis /Lycett/	•	•	•									
C. richei Dechaseaux		•	•									
C. lens /Sowerby/	•	•	•	•	•	•	•	•			•	•
Placunopsis cf. radians/Morris et Lycett/			•									
Lima /L./ duplicata Sowerby	•	•	•	•	•	•	•	•			•	•
Plagiostoma cf. semicircularis Goldfuss		•										
Limatula gibbosa /Sowerby/					•						•	
Pseudolimea duplicata /Münster/		•									•	•
Mactromya depressa /Phillips/			•									
Unicardium sp.			•									
Myoconcha sp.		•										
Astarte /A./ pulla Roemer		•	•									
A. minima Phillips		•										
A. cf. meeki Stanton		•										
A. robusta Lycett		•	•									
A. fimbriata Walton			•									
A. /Leckhamptonia/ cf. aytonesis /Lycett/			•									
Neocrassina striato-costata Goldfuss			•									
Prorokia meriani /Greppin/	•	•										
Eriphyla depressa /Münster/	•	•			•	•						
E. elegans /Sowerby/		•										

Bj Bajocian, K Kulavian, Bt Bathonian, C Callovian



clayey intercalations. Upward, beds of black clayey shales alternate with three beds of siderite. Rich fauna of cephalopods and bivalves occurs in the black clayey shales. Apart from the genera known from the Middle Kuiavian there occur: *Catinula*, *Liostrea*, *Meleagrinella*. Oysters are usually found in large beds, and, together with *Meleagrinella* they compose polyspecific coquinas. In the sediments with the sideritic cement the *Ostrea-Meleagrinella* and *Ostrea-Trigonia* beds are still frequent. Black noncalcareous clayey shales with muscovite dominate in the upper parts. In the clayey shales occur intercalations of siderites and spherosiderites. The bivalve fauna of the clayey sediments is identical to that from the lower horizon of the Upper Kuiavian.

The Lower Bathonian (Procerites sp.) begins with a silty-clayey sediments. Upper horizons are composed of clayey shales and sideritic sandstones which are known as the complex of Rock Borer Beds (Znosko 1957). The northern part of the region is mainly built of sideritic and dolomitic sandstones, whereas the southern part is dominated by clayey sandstones and siltstones with sandstone intercalations. These sediments contain large shell beds of *Ostrea-Meleagrinella*. In the central part of the Lower Bathonian, which is called Clayey-arenaceous shales (Znosko 1957), there are dark-grey, clayey-arenaceous limy shales with muscovite, with piritic

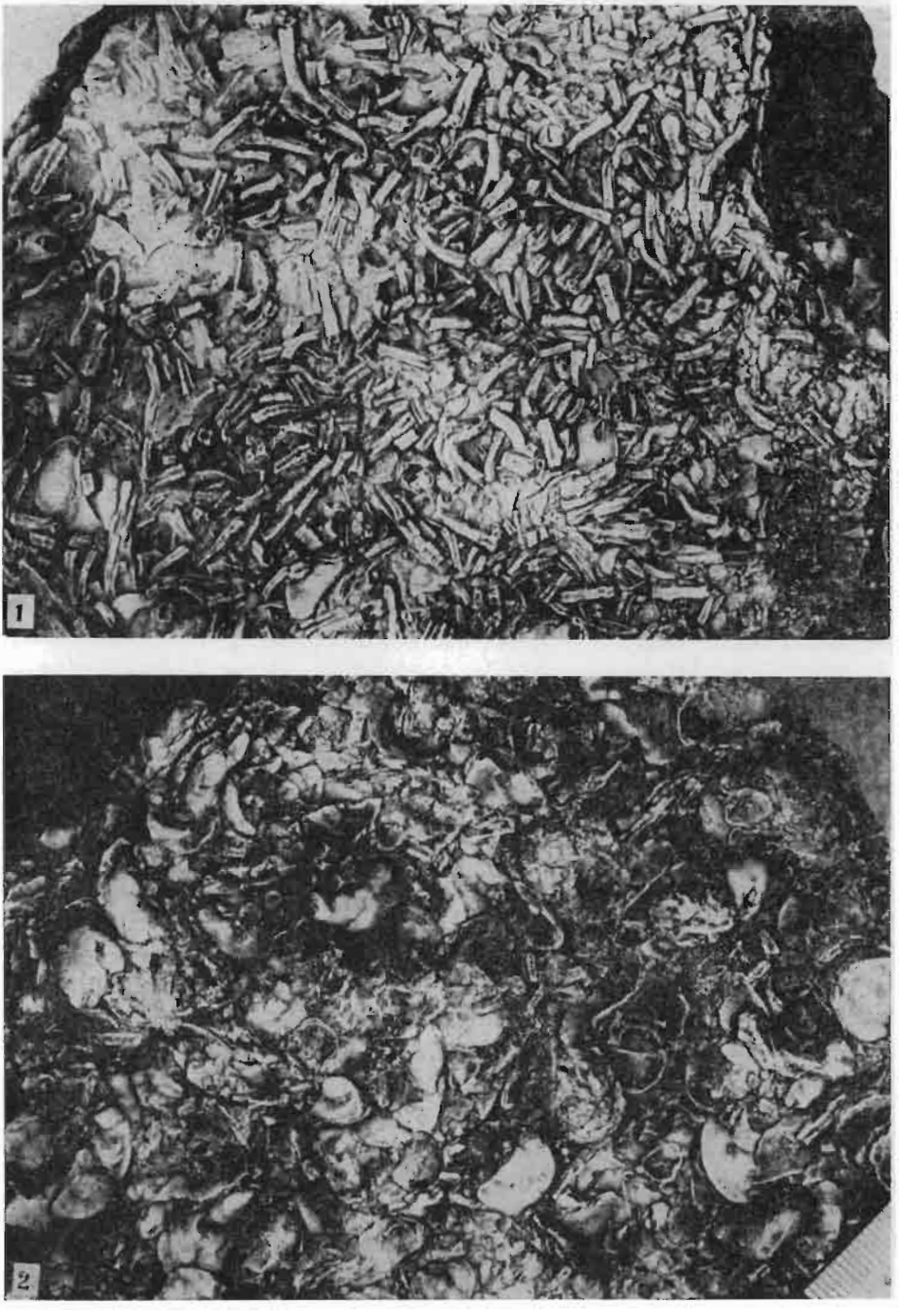


Fig. 2. Clusters of (1) *Serpula tetragona* Sowerby (ZPAL Mo. XII/68) and (2) *Ostrea acuminata* Sowerby (ZPAL Mo. XII/69). Kuiavian, Łęczyca, ×1.

or sideritic concretions. The shales pass upwards into siltstones with dolomitic sandstones. The clayey-arenaceous Shales contain large beds of *Ostrea-Meleagrinella* cemented by sandy sediments. The highest layer of the Lower Bathonian, known as the Lower Siltstone Bed, is composed of noncalcareous, clayey-arenaceous siltstones, usually dark-grey or black. These sediments contain relatively great number of bivalves, mainly *Oxytoma*, *Meleagrinella*, *Pleuromya*, which usually occur in monospecific coquinas.

The Middle Bathonian (Morrisiceras morrisi, Cadomites bremeri) can be divided in its lower part into two different horizons: the Lower Sandstone Bed and the Sandy-Silty Bed (Znosko 1957). Bivalves are more numerous in the sandy-silty sediments. The following genera are found here: *Nucula*, *Grammatodon*, *Lima*, *Oxytoma*, *Modiola*, *Astarte*. *Astarte* is the genus represented by a small number of species. *Nucula* and *Astarte* occur usually in shell beds.

The Upper Bathonian (Oecotraustes heterocostatus, O. paradoxus, Clydoniceras discus) in its lowest part is composed of dark-grey arenaceous-clayey sediments or black noncalcareous siltstones with muscovite and intercalations of grey noncalcareous fine-grained sandstones with muscovite. These sediments are known as the Middle Silty Bed (Znosko 1957). In its central part the Upper Bathonian consists of grey, occasionally clayey sandstones with muscovite. It contains concretions of pirite and wood fragments. In the uppermost part of the Upper Bathonian the facies is different and consists of grey and black clayey sands, noncalcareous clayey-arenaceous siltstones with muscovite or clays and clayey shales. This level is known as the Upper Siltstone Bed (Znosko 1957). In the eastern part of the region occur brown-green chloritic sandstones with ferruginous oolite and, in places, dolomitic sandstones. Silty sandstones occur in the south of the region. Bivalves are scarce here and occur mainly in the clayey-arenaceous sediments and siltstones. They belong to the following genera: *Astarte*, *Neocrassina*, *Grammatodon*, *Unicardium*, *Mactromya*, *Pholadomya*, *Pleuromya*, *Camptonectes*, *Lima*, *Modiolus*.

In the Bathonian the bivalve species are more diverse than at the lower stages. Mytilidae (*Musculus*, *Modiolus*), Lucinacea (*Unicardium*, *Myoconcha*), *Lima*, *Grammatodon* and others are common here. Relatively numerous bivalves occur in the clayey-arenaceous siltstones of the Lower Bathonian. The *Ostrea-Meleagrinella* shell beds, which occur lower in the profile, continue in the shaly facies.

The Lower Callovian (Macrocephalites typicus, Sigaloceras calloviense) is known as the, so called, dolomitic layer, composed of hard, grey dolomitic sandstones or calcareous dolomites and medium- to fine-grained sandstones with poor fauna of cephalopods and bivalves. Higher, the sediments change into marly-arenaceous limestones and form the, so called, glauconitic layer. Bivalves occur in sandstones and belong to the genera: *Oxy-*

toma, *Meleagrinella*, *Camptonectes*, *Lima*, *Pholadomya*, *Pleuromya*, *Gresslya* and *Ostrea*.

The Upper Callovian (Kosmoceras jason, K. pollux, K. duncani) forms the, so called, Nodular Bed (Znosko 1957) in which there are irregular fragments of arenaceous limestone, phosphatic concretions, oolitic marls and fragments of ferruginous oolite. The bivalve fauna occurs in the lower part of the bed and includes the species known from the Lower Callovian.

The most numerous families in the Łęczyca profile are: Nuculidae (6 species), Astartidae (10 species), Pholadomyidae (5 species), Pleuromyidae (3 species), trigonids and oysters (18 species: Pugaczewska 1971, 1976).

2. The Kraków-Częstochowa Uplands

Due to facies differentiation the Kraków-Częstochowa Uplands may be divided into two regions: A) The Northern Region, with certain lithologic homogeneity and continuous sedimentation, and B) the Southern Region with great lithologic diversity, numerous traces of discontinuity in sedimentation, and stratigraphic gaps. The Middle Kuiavian is the oldest stratigraphic horizon here (Różycki 1953).

A. The Northern Region

The Lower Bajocian (Sonninia sowerbyi, Otoites sauzei, Stephanoceras humphriesianum, Telocera blagdeni) sediments are developed as sands and sandstones with intercalations and concretions of clayey siderites as well as limonitic sands in the Częstochowa area. Comparatively rich and diversified (7 species) bivalve fauna occurs in the clayey intercalations of the two highest ammonite zones. *Oxytoma* occurs all over the region in different proportions. *Eriphyla* occurs in Teofilów, *Meleagrinella* and *Camptonectes* in Rudniki; *Meleagrinella*, *Lima* and *Limatula* in Włodowice. In the sandstones *Bositra buchii* (Roemer) may be found.

The Lower Kuiavian (Garantiana garantiana, G. tetragona) is developed in the sediments of Ore Bearing Clays (Znosko 1957), sandstones with clay intraclasts and sandy clays with oolitic influx. The bivalve fauna and, among others, mass *Megateuthis giganteus* (Schlotheim) occur in the Garantiana garantiana and G. tetragona Zones. In Strenoceras subfurcatum Zone a break in the sedimentation is observed. In the ore-bearing clays the bivalves are relatively diversified (8 species). Apart from the species of the Lower Bajocian the new ones — nuculids and pleuromyids are found here. All over the region occur representatives of *Oxytoma*, in Teofilów — *Eriphyla* and *Pleuromya*, in Rudniki — *Meleagrinella*, *Camptonectes*, and few *Gresslya*, in Włodowice — *Meleagrinella* and *Lima*.

The Middle Kuiavian (Parkinsonia subarietis, P. parkinsoni, P. schloenbachi) in its lower and middle parts is composed of dark-grey clays and

clayey shales. Its lower part contains concretions of clayey ammonite-rich siderite. Upwards, the sediments pass into a silty clayey-sandy unit which continues to the uppermost Middle Kuiavian. Bivalves occur in clayey--shaly sediments all over the region and represent the species known from the Lower Kuiavian.

The Upper Kuiavian (Parkinsonia ferruginea, P. compressa, Oxycerites yoevilensis, Asphinotites tenuiplicatus) is represented by the clayey-shaly sediments with intercalations of clayey oolitic siderites. In the area of Częstochowa, in the P. ferruginea Zone occur dark grey clays with the bivalve detritus of the genera known from the Lower Kuiavian, and *Palaeonucula* in Kierszula site. In the P. compressa Zone there are beds of siltstones and sandstones as well as thin intercalations of siderite with numerous ammonites.

The Lower Bathonian (Procerites sp.) is represented mainly by dark grey, sandy clays, clayey-sandy shales and siltstones, with intercalations of siderites and spherosiderites. Bivalves occur in the clayey-sandy deposits and clayey shales. *Palaeonucula* and *Oxytoma* still occur in Kierszula; *Oxytoma* continues to the Callovian. In Rudniki occur: *Oxytoma*, *Meleagrinella*, *Camptonectes*, *Grammatodon*, *Pholadomya*, *Gresslya*, *Pleuromya*. In Włodowice — *Oxytoma*, *Pleuromya*, *Meleagrinella*, *Pholadomya* and *Lima*. In Kamienica Polska — *Oxytoma* and *Gresslya*.

The Middle Bathonian (Morrisiceras morrisi, Cadomites bremmeri) deposits are composed of dark grey sandy clays with spherosiderites, siltstones and microgranular sandstones. In the Middle Bathonian clays (Morrisiceras morrisi Zone) *Goniomya rudnikensis* sp.n. in Rudniki has been found. *Pholadomya* and *Pleuromya*, *Grammatodon* and *Gresslya* still occur here. In Jaworzniki occurs *Pholadomya ambiqua* (Sowerby) which passes into the Callovian. In Włodowice other species of *Pholadomya* and *Pleuromya* appear. The sediments in Kamienica Polska still contain *Oxytoma* and *Gresslya*.

The Upper Bathonian (Oecotraustes heterocostatus, O. paradoxus, Clydoniceras discus) is represented by ore-bearing sediments. These deposits, 40 metres thick, are composed mainly of brown and dark-grey sandy clays with clayey siderites. In the upper part (O. paradoxus) clayey and a silty-sandy deposits appear. In the uppermost Bathonian, near Częstochowa, the sediments are composed of brown marly clays and limestones, and constitute the so called Częstochowa limy oolite, with numerous ammonites. Near Zawiercie deposits of O. paradoxus Zone thin down to 0.25 metre. Bivalves occur in the clayey sediments of the Cydoniceras discus Zone. In Kłobuck and Teofilów there is *Pleuromya*; in Rudniki — *Pholadomya*, *Pleuromya*, *Myopholas*, *Pinna*; in Włodowice — *Pholadomya*, *Pleuromya*, *Lima*.

The Bathonian deposits are the richest source of bivalves in the Częstochowa area. Bivalves are most numerous in ore-bearing clays and in the

clayey-silty-sandy sediments of the Oecotraustes paradoxus Zone. These sediments have provided 24 bivalve species of the families: Nuculidae, Pholadomyidae, Pleuromyidae and Pectinacea.

The Lower Callovian (Macrocephalites typicus, Sigaloceras calloviense) is composed of grey or brown, sandy ferruginous limestones or dolomites and calcareous sandstones, flints and marly intercalations. Nodular glauconitic limestones form the uppermost layer. Oolite contents grows upwards in the profile. In the area between Wieluń and Częstochowa oolitic limestones are rare, whereas the Zawiercie and Łazy area is dominated by oolitic sediments. The bivalve fauna comes mainly from the nodular limestones. *Pholadomya* occurs in Jaworzniki, *Grammatodon* in Rudniki, *Pleuromya* and *Lima* in Włodowice.

The Upper Callovian (Kosmoceras jason, K. pollux, K. duncani) deposits are developed as the so called Nodular Bed, composed of phospatic concretions. This layer is overlayed by a stromatolite horizon and glauconitic marls. In the area of Zawiercie the Nodular Bed passes upwards into marly sediments with numerous oolites. Scarce bivalves of the genera known from the Lower Callovian are found in the Nodular Bed. In Kłobuck, *Plicatula pateroides* Rollier (Pugaczewska 1968) occurs. In all, 7 species have been determined from the Callovian sediments assigned to: Pectinacea, Pholadomyacea, Limidae and Astartidae.

B. The Southern Region

The Middle Kuiavian (Parkinsonia subarietis, P. parkinsoni, P. schloenbachi) is the oldest part of the Middle Jurassic in this region. It is developed typically in Niegowice (South of Zawiercie) and consists of conglomerates, marls and oolitic clays with siderites. From these deposits scarce fauna, mainly of the genus *Pleuromya*, has been determined in the Żar Hill near Ogrodzieniec. To the South of the region the beds are thinner and thinner, with frequent sedimentation discontinuities which, in the Olkusz area, comprise the Upper Kuiavian and the Middle Bathonian.

The Upper Bathonian (Oecotraustes heterocostatus, O. paradoxus, Clydoniceras discus) is well developed in the Olkusz area as the, so called, Parczów Conglomerate, which consists of dolomites, clays and fine quartz, and in its upper part, of clayey limestones. It contains a small number of bivalves and brachiopods. The Ogrodzieniec area lacks sediments of the Upper Bathonian. To the South of the region there appears a facies of oolitic limestones, best known in Balin near Chrzanów, containing rich fauna of the Upper Bathonian (Laube 1867). Most of the bivalves found in the southern region come from these sediments. For example, *Modiolus*, *Pseudolimea*, *Pleuromya* occur here. In red ferruginous clays in Piła Kościelecka near Chrzanów *Camptonectes*, *Lima*, *Limatula* and *Pleuromya* have been found.

The Lower Callovian (Macrocephalites typicus, Sigaloceras calloviense) sediments displayed oolitic limestones. *Pseudolimea* and *Pleuromya* still occur in Balin. *Camptonectes*, *Lima*, *Limatula* and *Pleuromya* were determined from clayey-ferruginous deposits of Piła Kościelecka. The Upper Callovian (Kosmoceras jason, K. pollux, K. duncani) is often incomplete, with sedimentation discontinuities. In Balin there are thick beds of glauconitic marls with phosphorites. The fauna is sparse there. The bivalve genera known from the Lower Callovian occur both in Balin and in more clayey beds in Piła Kościelecka (*Pleuromya*).

On the whole, in the southern region 9 species, belonging to Mytilidae, Limidae, Pectinacea and Pleuromyidae have been found, most of them being from the Bathonian limestones.

3. Eastern Poland: Łuków

The Jurassic sediments of Łuków were brought from the North in the form of glacial erratics. In the clays of the Upper Callovian (Kosmoceras pollucinum and Oecoptychius refractus zones) fauna occurs in the concretions of clayey sideritic limestones. It consists of abundant specimens and species of different systematic groups, and contains, among others, foraminifera, cephalopods, bivalves. The bivalves (Nuculidae, Astartida and Pholadomyidae), which occur here, are represented by four species of the genera: *Palaeonucula*, *Neocrassina*, *Eriphyla* and *Pholadomya*. Bivalves are not numerous.

4. The Carpathians: Bachowice

In Bachowice bivalves occur in tectonic exotics of the Middle Jurassic (which comprises the deposits from the Upper Bajocian up to the Callovian) and those of the Upper Jurassic.

The Bajocian (Parkinsonia parkinsoni) is developed in the sandy facies. Bivalves *Eriphyla*, *Pholadomya*, *Pleuromya* come from black oolitic sandstones. In white, limy or fine-grained sandstones with flora remains *Bositra*, *Astarte* and *Ostrea* occur. Numerous oysters occur also in sandstone conglomerates. Higher, *Meleagrinella*, *Camptonectes* and bivalves of the genera *Variamussium*, *Entolium*, *Modiola*, *Cucullaea*, *Gervillia*, *Lucina* and *Clavotrigonia* occur which are not described here but are mentioned by Książkiewicz (1956). *Pleuromya*, the species described here, occurs in dark sandstones.

The Lower Bathonian (Phylloceras kudernaischi and Calliphylloceras cf. disputabilis) is developed as sandstones with bivalves, intercalated by marls with sideritic concretions. *Bositra* and *Pleuromya* have been described here.

The Callovian contains the calcareous sediments, rich in crinoids,

brachiopods and ammonites. In places ferruginous concretions and marly shales with *Bositra buchii* (Roemer) occur. Fine phylloceratids and brachiopods suggest the Upper Callovian or the lowest Oxfordian.

Eight species of Pectinacea, Pholadomyacea and Astartidae have been described from the Bachowice site. They come mainly from the sandy and sandy-calcareous sediments of the Bajocian. *Bositra buchii* occurs in masses both in the sandstones of the Lower Bathonian and in the marly shales of the Callovian, and forms coquinas of shells and valves. The Bachowice exposure is one of the richest in the whole of the Middle Jurassic, especially when one takes into account the numerous trigonids, oysters, *Gervillia* and *Cuculea*, which were mentioned by Książkiewicz (1956).

REMARKS ON PALEOECOLOGY

Duff's (1975) trophic categories with regard to the mode of life and the kind of environment bivalves inhabit have been accepted in the present paper (Table 2).

The bivalves described here belong to: suspension-feeders, which feed by filtering food particles suspended in water, and deposit-feeders, which take organic material from the sediment. The suspension-feeders belong to the epifauna or infauna, and deposit-feeders represent the infauna.

A. In the material described the epifaunal suspension-feeders are represented by Pectinacea (*Bositra, Oxytoma, Meleagrinella, Camptonectes, Placunopsis*), Pteriacea (*Inoceramus*), Mytilacea (*Musculus, Modiolus*), Pinnacea (*Pinna*), Limacea (*Lima, Plagiostoma, Limatula, Pseudolimea*), Carditacea (*Myoconcha*), and Ostreacea (*Liostrea, Catinula, Nanogyra*: Pugaczewska 1971). The epifaunal suspension-feeders lived free or burrowed or attached with one of the valves or the byssus to plants, rocks, or other objects, throughout life or only for a certain period.

B. Among the infaunal suspension-feeders the following feeding groups were present:

i) The non-siphonate suspension-feeders represented by three superfamilies: Arcacea (*Grammatodon*), Trigoniacea (see Pugaczewska 1976, 1977), and Crassatellacea (*Astarte, Neocrassina, Prorokia, Eriphyla*). The bivalves of this group had no siphons and penetrated the sea floor using the strong foot. It is suggested that the shell outline, more or less rounded, with relatively high inflation and a well developed ornamentation could limitate depth of the burrowing into the sediment;

ii) The siphonate suspension-feeders represented by Pholadomyacea (*Pholadomya, Goniomya, Gresslya, Myopholas, Pleuromya*) had more or less elongated siphons. Some of them had also rich ornamentation. Judging from the length of siphons, these bivalves probably lived deeper in the sediment than those of the previous group. Also in this case, shell orna-

Table 2

Life habits of examined Dogger bivalves (after Duff 1978, modified)

Genera and feeding groups	EPIFAUNAL				INFAUNAL					Systematic position
	Swimming	Free-living or cemented	Bysally attached	Pendent	Non-siphonate	Short siphonate	Long siphonate	Mucus-tube feeders	Mobile	
Deposit feeders										
Palaeonucula									○	Nuculacea
Suspension-feeders										
Grammatodon					○				○	Arcacea
Musculus			○							Mytilacea
Modiolus			○							Mytilacea
Pinna			○							Pinnacea
Inoceramus				○						Pteriacea
Bositra				○						Pectinacea
Oxytoma				○						Pectinacea
Meleagrinella				○						Pectinacea
Maccoyella			○							Pectinacea
Camptonectes			○							Pectinacea
Placunopsis		○								Pectinacea
Lima	○		○							Limacea
Plagiostoma	○		○							Limacea
Limatula	○		○							Limacea
Pseudolimea	○		○							Limacea
Liostrea		○								Ostreacea
Catinula		○								Ostreacea
Nanogyra		○								Ostreacea
Trigonia					○				○	Trigoniacea
Myophorella					○				○	Trigoniacea
Vaugonia					○				○	Trigoniacea
Macromya							○	○		Lucinacea
Unicardium							○	○		Lucinacea
Myoconcha			○							Carditacea
Astarte					○				○	Crassatellacea
Neocrassina					○				○	Crassatellacea
Prorokia					○				○	Crassatellacea
Triphyla					○				○	Crassatellacea
Tancredia						○				Tellinacea
Pholadomya							○			Pholadomyacea
Goniomya							○			Pholadomyacea
Gresslya							○			Pholadomyacea
Myopholas							○			Pholadomyacea
Pleuromya							○			Pholadomyacea
Thracia							○	○		Pandoracea

mentation (some *Pholadomya* or *Myopholas*) or high inflation (e.g. *Gresslya*) might influence their ability to penetrate into the sediment;

iii) The mucus-tube feeders are poorly represented in the material described. To this group belong representatives of Lucinacea (*Mactromya*, *Unicardium*) and Pandoracea (*Thracia*). *Thracia* was occasionally regarded as an infaunal siphonate suspension-feeder (Wright 1973). The infaunal mucus-tube-feeders lived deep below the sediment surface. The inhalent and exhalent currents, produced by the cilia of the anterior adductor muscle and the gills, flew through their mucus-lined tubes which reached to the surface (Duff 1978).

C. The infaunal deposit-feeders are represented here by one genus, *Palaeonucula*. The contemporary *Nucula* were considered among others by Yonge (1939) and their mode of feeding may be regarded similar to that of the fossil Nuculidae. They lived just beneath the sediment surface and could make slow rotary movements in search of food which was collected by labial palps. *Palaeonucula* species, as integripalliata, have no siphons and the weak inhalent current is drawn directly through the sediment (Duff 1978: 19).

DISTRIBUTION OF THE BIVALVE FEEDING GROUPS WITHIN THE MIDDLE JURASSIC SEDIMENTS OF THE POLISH LOWLANDS

The most complete data on the distribution of the bivalve feeding groups come from the site Łęczyca, Polish Lowlands, the Middle Jurassic sediments of which are most complete.

Lower Bajocian

The silty-clayey facies of the higher part of the Lower Bajocian (Stephanoceras hunphriesianum and Teloceras blagdeni zones) contains a diverse bivalve fauna. The following groups occur here: epifaunal suspension-feeders: i) 'pendent' forms (*Inoceramus*, *Bositra*, *Oxytoma*, *Meleagrinella*); ii) bysally attached forms (*Modiolus*, *Maccoyella*, *Camptonectes*, *Lima*); iii) cemented forms (Ostreidae); infaunal suspension-feeders: i) non-siphonate forms (*Prorokia*, *Eriphyla*, Trigoniidae); ii) short siphonate forms (*Tancredia*); as well as infaunal deposit-feeders represented only by one genus (*Palaeonucula*).

Kuiavian (the Upper Bajocian)

In the Lower Kuiavian bivalves of various feeding groups occur in the clayey and silty-clayey sediments of the zones Strenoceras subfurcatum and Garantiana garantiana. The sediments are dominated by 'pendent' epifaunal suspension-feeders (*Bositra*, *Oxytoma*, *Meleagrinella*). The byss-

ally attached *Modiolus*, *Camptonectes*, *Lima*, *Plagiostoma*, *Pseudolimea*, *Myoconcha* and the cemented Ostreidae are also numerous. The infaunal suspension-feeders are represented by the non-siphonate (*Astarte*, *Prorokia*, *Eriphyla*, Trigoniidae, *Grammatodon*), the short siphonate (*Tancredia*), and the long-siphonate forms (*Pholadomya*, *Gresslya*). Some deposit-feeders (*Palaeonucula*) are also found here.

In the Middle Kuiavian, in the silty-clayey facies of Parkinsonia subarietis Zone there are numerous infaunal suspension-feeders, first of all the non-siphonate ones (*Astarte*, *Prorokia*, *Eriphyla*, *Grammatodon*). The clayey shales of Parkinsonia parkinsoni Zone are dominated by 'pendent' epifaunal suspension-feeders (*Bositra*, *Oxytoma*, *Meleagrinella*), and the clayey sideritic sediments — by long-siphonate infaunal suspension-feeders (*Pholadomya*, *Gresslya*, *Pleuromya*) and mucus tube-feeders (*Thracia*). Still numerous are the non-siphonate bivalves (Astartidae, Trigoniidae). Of epifaunal suspension-feeders, the cemented ones (Ostreidae) are abundant in the sediments of this zone. The sandy and marly-sideritic sediments of Parkinsonia schloenbachi Zone contain a rather poor bivalve fauna. It consists mainly of non-siphonate infaunal suspension-feeders (Trigoniidae), and cemented epifaunal suspension-feeders (Ostreidae). In more silty sediments infaunal deposit-feeders (*Palaeonucula*) are numerous. The long siphonate infaunal suspension-feeders are represented by Pholadomyidae.

In the Upper Kuiavian the bivalve fauna occurs mainly in the black clayey shales of Parkinsonia ferruginea and P. compressa zones. There are mainly cemented epifaunal suspension-feeders (Ostreidae) or the 'pendent' ones (*Inoceramus*, *Bositra*, *Oxytoma*, *Meleagrinella*). Of the infaunal suspension-feeders, numerous are non-siphonate bivalves (Trigoniidae, *Astarte*, *Eriphyla*, *Grammatodon*). The clayey shales of the Oxycerites yeovilensis Zone still contain 'pendent' epifaunal suspension-feeders (*Bositra*, *Oxytoma*, *Meleagrinella*) and the cemented ones (Ostreidae).

Bathonian

In the Lower Bathonian clayey-sandy shales (Procerites sp.), bivalves are still diverse; the 'pendent' epifaunal suspension-feeders (*Bositra*, *Oxytoma*, *Meleagrinella*) dominate and the cemented ones (Ostreidae) also occur. Higher, in the silty-clayey sediments with siderites, occur infaunal deposit-feeders (*Palaeonucula*), non-siphonate suspension-feeders (*Grammatodon*, Trigoniidae, *Astarte*, *Neocrassina*, *Eriphyla*), and a few long-siphonate ones (*Gresslya*). Of the epifaunal suspension-feeders, the byssally attached ones (*Modiolus*, *Camptonectes*, *Lima*) occur here.

The silty-sandy and dolomitic facies of the Middle Bathonian (Morrisiceras morrisi and Cadomites bremeri zones) contain fewer non-siphonate infaunal suspension-feeders (*Astarte*, *Neocrassina*, *Eriphyla*), while new long-siphonate species appear. The epifaunal suspension-feeders are re-

presented by numerous byssally attached bivalves (*Musculus, Modiolus, Camptonectes, Lima*).

In the Upper Bathonian, in the clayey-sandy sediments and black siltstones of Oecotraustes heterocostatus and O. paradoxus zones bivalves are less numerous. They are represented by non-siphonate infaunal suspension-feeders (*Astarte, Neocrassina, Eriphyla, Grammatodon*, Trigoniidae) and long-siphonate forms (*Pholadomya, Pleuromya*). Higher, in the Clydoniceras discus Zone 'pendent' epifaunal suspension-feeders (*Bositra, Oxytoma, Meleagrinella*) and the byssally attached ones (*Modiolus, Camptonectes*) are added to the fauna in the facies of claystones and clayey shales.

In the Lower Callovian, in the grey, medium- and micro-grained sandstones of Macrocephalites typicus Zone, the bivalve fauna is relatively poorly represented, mainly by byssally attached epifaunal suspension-feeders (*Camptonectes, Lima*). 'Pendent' (*Oxytoma, Meleagrinella*) and cemented bivalves (Ostreidae) are scarce. Higher, in the more silty and clayey-sandy sediments of Sigaloceras calloviense Zone occur non-siphonate infaunal suspension-feeders (*Eriphyla*, Trigoniidae) and the long-siphonate forms (*Pholadomya, Gresslya, Pleuromya*).

In the Upper Callovian sandy limestones with ferruginous oolithes, and in the glauconitic marls, bivalves are grouped mainly in the Kosmoceras jason Zone. They belong to bysally attached epifaunal suspension-feeders (*Camptonectes, Lima*), the 'pendent' ones (*Oxytoma*), and to infaunal non-siphonate suspension-feeders (Trigoniidae, *Eriphyla*) and to the long-siphonate forms (*Pholadomya, Pleuromya*).

The review presented above confirms the opinion that there is a close relationship between the environment and the type of bivalve fauna (Duff, 1975, 1978; Hallam 1975; Fürsich 1975, 1977, 1981, and others). To support this view let us compare briefly bivalve fauna from the Bajocian-Callovian of the Polish Lowlands basin and that from the Callovian of English basin in which Oxford Clay was deposited. The relatively monotonous, silty-clayey Middle Jurassic sediments of the Polish Lowlands, similarly to the poorly diversified sediments of the English Oxford Clay, are interbedded with shaly, calcareous or ferruginous sediments. Both units contain numerous coquina horizons, such as the multispecific oyster meleagrinella or oyster-serpulid coquinas as well as the monospecific ones of *Bositra buchii, Nucula* sp. or *Astarte* sp. Oyster-serpulid coquinas are composed of valves of *Liostrea acuminata* and tubes of *Serpula* (*Tetraseptula*) *tetragona*. The coquinas lie on the surfaces of the silty-clayey sediments in various parts of the profile. It has been found that in the oyster-serpulid coquinas the serpulids occur at the bottom of the layer, just as in the Lower Oxford Clay (Hallam 1975). The conditions in which the fine-grained, silty layers with abundant *Bositra buchii* were formed, allow one to suppose that waters of the basin could be stagnant and therefore poorly

aerated. Inclusions of scattered pyrite and the lack of a burrowing benthos could support such a supposition. However, as Hallam (1975: 38) concludes, though the pyritic inclusions point to the anaerobic conditions "resulting from the activities of sulphate-reducing bacteria, but such conditions commonly obtain within a wide variety of fine-grained sediments which were deposited in oxygenic waters". The sufficient aeration of the water in the sedimentary basin of the Polish Lowlands Dogger is confirmed by the occurrence of a diverse foraminifer faunas (Garbowska *et al.* 1978) and suspension-feeder bivalves, which require for their existence constant supply of organic-rich and well aerated water. Another fact confirming the correctness of this view is the significant rise in the number of the sessile annelids (Duff 1975: 475).

When compared in terms of feedeing groups, the considered Dogger faunas of Poland and England are as follows: the Dogger bivalves of Poland equally represent the infaunal and epifaunal groups (17 genera each), however, proportions between the feeding groups are markedly unequal. Only *Palaeonucula* belongs to the deposit-feeders, whereas the remaining 34 genera are the suspension-feeders. The similar proportions appear within the bivalves of the Lower Oxford Clay (Duff 1978: 18). Greater differences exist among the Polish and English short-siphonate bivalves belonging to the infaunal suspension-feeders. They are represented by five genera in the Lower Oxford Clay, while Dogger deposits in Poland supplied only one representative of this group — *Tancredia*.

THE ROLE OF SHELL ORNAMENTATION AS EXEMPLIFIED BY THE SELECTED BIVALVE SPECIES

In epifaunal bivalves the shell ornamentation as well as the projecting umbonal ridges greatly influence the process of aeration and feeding by creating whirls and micro-currents which draw fresh water with food particles and remove waste particles. The basic role of ornamentation, however, is to strengthen the shell (Kauffman 1969: 148).

The material examined provided a variety of shell ornamentation. Pectinacea and, to a smaller degree, Limacea are especially diversified in this respect. Within the first subclass the following genera should be mentioned: *Meleagrinella*, *Camptonectes*, *Placunopsis*, within the second one — *Limatula* and *Pseudolimea* as the examples (pls. 19, 21—25). The genera mentioned above represent epifaunal suspension-feeders of different habits: swimming or byssally attached (*Limatula*, *Pseudolimea*, some Pectinidae), byssate in all stages of life (*Camptonectes*), 'pendent' or byssally attached to the sea floor (*Meleagrinella*, *Bositra*), free-living (some Pectinidae), or cemented (*Placunopsis*, Spondylidae and Ostreidae, see: Pugaczewska 1968, 1971).

The shell ornamentation is an important diagnostic feature of species.

It consists of concentric lines, striae, ribs or growth lamellae, and of, often superposed on them, radial lines, striae and ribs. In the case of superposition a specific reticulate ornamentation is formed. At the crossing points of reticulation, nodes and spines appear. The concentric elements are the result of the continuous growth of the shell and are normally produced by the pallial margin cells. The radial elements are produced by special cells of the pallial margin due to their increassed secretion. Most often both valves are identically ornamented, e.g. *Pseudolimea duplicata* (pl. 18: 9; 24: 4—5). In numerous cases, however, e.g. in bivalves lying on the sea floor or attached to various sea floor objects, the ornamentation is different on each of the valves (*Meleagrinella* — pls. 19—21, *Camptonectes* pls. 24, 25; Ostreidae: Pugaczewska 1971; Spondylidae: Pugaczewska 1968). In the case of attached valves ornamentation is usually present only on their free parts, raised above the substrate, e.g. in Ostreidae.

With growth of the bivalve some elements of shell ornamentation may disappear or appear in later growth stages, e.g. the radial striae of the second, or further, orders in Pectinacea.

The inferred adaptive role of infaunal bivalves' ornamentation may be illustrated by Astartidae and Pholadomyidae. A well developed ornamentation is present in forms burrowing at small depths: suborbicular shells of astartids under consideration are usually ornamented by thickened and protruding concentric ribs. Such bivalves are supposed to live just beneath the sediment-water interface (Duff 1978: 17). It can be assumed that the prominent ornamentation stabilized the bivalve in the sediment at a small depth. Of the bivalves which burrow deeply in the sediment only few have distinct ornamentation, e.g. *Myopholas* or some species of *Pholadomya*. In such cases, radial ribs, running obliquely from the umbo to the ventral margin, that is, conformably to the longer shell axis, might have been a kind of adaptation which facilitated the penetration of poorly consolidated sediment. Most of the bivalves with strong ribs having reached a safe depth might fix themselves with their ribs in preferred position. Other representatives of Pholadomyacea are, however, poorly ornamented (*Pholadomya*) or have no ornamentation at all (*Gresslya*). It is not excluded that this is an adaptation to deeper penetration of the sediment, but such a direct depth/ornamentation relation can not be inferred from the paleontological data alone.

As a rule, the shell ornamentation becomes more complicated with growth, there appear nodes, spines or lamellae. It happens, therefore, that the ornamentation is different in different parts of the valve. In *Meleagrinella echinata*, the central part of the left valve is ornamented by radial striae with a relatively even surface, a small number of second-order striae, and thin, concentric striae (pl. 21: 1 *a*, *c*). On the adventral and lateral parts of the valve the radial ribs are thicker, spiny and cut by

broad protruding growth lamellae (pl. 21: 1*a*, *b*; 2 *a*, *c*). *Camptonectes* (*C.*) *reshdenensis* is another example of variable ornamentation of left and right valves in their different parts: the adumbonal part of the left valve has reticulate ornamentation that passes toward margin into a lamellar one (pl. 24: 1*a*—*b*), whereas the right valve is ornamented in its subumbonal part by densely spaced growth striae, and the remaining surface by short protruding lamellae (pl. 25: 1*a*—*b*). In *Placunopsis* cf. *radians* (pl. 25: 2 *a*—*b*), the radial ribs of the adumbonal part of the free valve have uneven edges, in intervals there are thin concentric striae and short thin, slightly undulated radial micro-ribs. Radial ribs and concentric striae form a reticulation. With growth this ornamentation becomes more complex as its elements thicken. Where the radial ribs cross the concentric striae, distinct nodes appear. Fine nodes appear at the crossing of the striae and micro-ribs. The number of micro-ribs per interval increases from four in the subumbonal part to six at the margins of the valve.

The ornamentation becomes more complex when the second-order radial ribs appear as a result of intercalation (in *Pseudolimea duplicata* — pl. 18: 9), and the dichotomy (in *Camptonectes* (*C.*) *lens* — pl. 24: 2, pl. 25: 3). The ornamentation changes of the final growth stage, reflected in the presence of densely-spaced growth lines and striae, are well illustrated by *Pseudolimea duplicata* (pl. 21: 1 *a*—*b*).

Some bivalves have micro-ornamentation in form of fine nodes, e.g. right valves of *Meleagrinella echinata* (pl. 25: 2 *a*—*b*). The role of micro-ornamentation could be to strengthen the shell.

While attempting to explain the role of ornamentation one should stress the role of high radial ribs. Apart from strengthening the shell such ornamentation may also have other functions. The radial ribs or folds form a folded zigzag commissure. By increasing the amplitude of the commissure, the sensory area of the mantle margin expands thus increasing sensitivity of the organism. Moreover, the zigzag commissure functions as a sieve preventing bigger inorganic particles from getting into the pallial cavity. In the material examined the commissure of increased amplitude occurs in *Pseudolimea duplicata* (pl. 24: 4 *b*, pl. 22: 1 *a*—*b*). Such shell structure is an adaptation of the organism to life in muddy environment as well as in environment of strong turbulence and sedimentation. This problem has earlier been discussed by the present author (Pugaczewska 1971: 210) for the Jurassic oysters *Arctostrea* and *Alectryonia*.

Primary function of big, sharp nodes and longer or shorter spines, seen on the valve surface, was, possibly, to support sensory receptors of the pallial margin, or to stabilize the shell on the ground, and also to strengthen the valves (Kauffman 1969: 142). In the material examined the nodes and spines are well seen on the left valve of *Meleagrinella echinata* (pl. 21: 1—4). In this case they could support the sensory epithelium as well as strengthen the, usually thin, valves.

REMARKS ON THE GROWTH OF BIVALVES

The shell height, length and convexity increase during growth of the organism at the same or different rates.

Changes in the growth rate are usually related to the environmental changes, or to periodic physiological changes of the organism, e.g. reproduction. In the material examined one may observe bivalves in which, during their ontogenesis, occurred a change of ornamentation or in the mode of the shell growth. This may be illustrated by the following examples:

1. The shell of a young specimen of *Neocrassina* (*N. striatocostata*) is much inflated and ornamented by eight concentric ribs, angularly bent near the posterior margin. The shell of an adult bivalve lacks ribs and has only fine growth lines. Its inflation diminishes considerably (pl. 29: 9 *b*).

2. *Pleuromya donacina* exemplifies variable growth rates of height and width. The length ratio in the juvenile stage is about 2.5, while in the adult stage it diminishes to 1.6. This change leads to a change in the shell outline from elongated to rounded (pl. 34: 7). A contrary change, from rounded in juvenile stage to elongated in the adult occurs in *Pleuromya calceiformis*. When the distal part elongates during growth, other changes must occur, e.g. the umbo, medially placed in juvenile stage, is placed anteriorly later on (pl. 34: 3).

3. Another type of growth changes is present in *Meleagrinella echinata*. The right valves of this species show a clear variability of a few morphological features during ontogenesis (pl. 20: 1 *a*—*c*, 5 *a*—*c*). The valve outline changes from suborbicular to asymmetrically elongated with the overgrowth of the antero-dorsal lobe (pl. 20: 1 *ab*—5 *ab*), the ventral margin bends gradually outward and, consequently, a concentric fold appears on the internal surface of the valve (pl. 20: 5 *a*, *b*). During growth the byssal notch below the anterior ear enlarges and deepens (pl. 20: 5 *b*). The posterior adductor muscle scar, shallow at the beginning, deepens, and by the end of the development is enclosed by elevated edges. The hinge also undergoes distinct growth changes. The cardinal plate initially narrow, with a shallow resilifer, broadens considerably, the resilifer deepens and by the end of the growth process has an outline of a big triangular area (pl. 20: 1 *c*—5 *c*). The valve ornamentation, the size of ears, location and length of the hinge margin, and location of the umbo undergo smaller changes. Distinct concentric furrows on the external surface of the valves mark three growth stages of the organism (pl. 20: 5 *b*).

As observation of the contemporary bivalves proves, the shell morphology is influenced by the environment and the mode of life. One may, therefore, suppose that the examples discussed above illustrate certain changes in the environment and mode of life of the bivalves during their ontogenesis. The examples include representatives of three groups:

a) Epifaunal suspension-feeders, living on the sea-floor or above it, most of which were byssally attached in some stages of development (*Meleagrinella*). It is possible that *M. echinata* was 'pendent' at the beginning, and by the end of its development lived free on the bottom. This may be suggested by thickening of the shell with age; b) Infaunal non-siphonate suspension-feeders, embedded in the sediment just beneath its surface (*Neocrassina*). The loss of ornamentation by the end of growth, and more flattened shell may suggest that the bivalve moved into slightly deeper layers of the sediment (*Neocrassina striatocostata*); c) Infaunal siphonate suspension-feeders which represent the bivalves burrowed deeply in the sediment. It is highly probable that they could live at different depths in different growth stages. This is suggested by the change in shell outline, e.g. in *Pleuromya donacina* and *Pl. calceiformis*. By the end of development the former lived probably at a smaller and the latter at a greater depth in the sediment.

DESCRIPTIONS

Class **Bivalvia** Linnaeus, 1758
Subclass **Palaeotaxodonta** Korobkov, 1954
Order **Nuculoida** Dall, 1889
Superfamily **Nuculacea** Gray, 1824
Family **Nuculidae** Gray, 1824
Genus *Palaeonucula* Quenstedt, 1930

Palaeonucula hammeri (Defrance, 1825)
(pl. 15: 8 a—b)

1825. *Nucula hammeri* Defrance: 217.
1834—40. *Nucula Hammeri* Defrance; Goldfuss: 154, pl. 125: 12 (*non* pl. 25: 1).
1973. *Nucula eudore* d'Orbigny; Romanov: 25, pl. 18—20 (here synonymy).

Material. — Six shells in different growth stages: ZPAL Mo. XII/81—86. Measurements (in mm):

H	L	I	H/L
8—13	10—17	6.5—8	0.6—0.8

Remarks. — The Liassic and "Lower-Oolithian" (Unter-Oolithe) specimens from Württemberg (Goldfuss 1834: pl. 25: 1a—f) differ from *N. hammeri* Defrance in having more elongated shells with umbos placed terminally on the posterodorsal margin and wider, more rounded anteroventral margin (*fide*: Loriol 1897: 115).

Occurrence. — Poland, Polish Lowlands: Lower Kuiavian-Lower Bathonian. USSR (Moldavia): Upper Bajocian, FRG: Oxfordian.

Palaeonucula strigilata (Goldfuss, 1840)

(pl. 15: 1 a—b, 2—3)

1834—40. *Nucula strigilata* Goldfuss: 153, pl. 124: 18 a—c.

Material. — Four shells and two valves: ZPAL Mo.XII/70—75.
Measurements (in mm):

H	L	I	H/L
8.5—10	10—12	5.5—8.5	0.75—0.85

Remarks. — The species may be distinguished from the related ones by deeper and wider depression below the umbo and by angular valve shape (see also *P. ornati* and *P. variabilis*).

Occurrence. — Poland, Polish Lowlands: Kuiavian. Tyrol: "Unter Oolithe".

Palaeonucula variabilis (Sowerby, 1824)

(pl. 15: 4—7)

1898—1900. *Nucula variabilis* Sowerby; Greppin: 98, pl. 9: 2, 2a.
1973. *Nucula variabilis* Sowerby, 1819; Romanov: 19, pl. 1: 28 (here synonymy).

Material. — Five well-preserved shells and numerous deformed ones: ZPAL Mo.XII/76—80.
Measurements (in mm):

H	L	I	H/L
8.5—11	11—15	5—8	0.73—0.78

Remarks. — The considered specimens differ from Moldavian ones in having more centrally placed umbos, more arched ventral margin and in height index (compare: Romanov 1973: 29, pl. 1: 28). They may be distinguished from the Swiss specimens by lower more ventral inflation (compare: Greppin 1899: 98, pl. 9: 2a). The Polish specimens are slightly bigger than the previously mentioned ones. In contrast with Moldavian specimens (Romanov 1973: 29), anterodorsal margin of Polish specimens is longer than posterodorsal margin (pl. 15: 4—7). From *P. strigilata* (Goldfuss) the species differ in lack of angularity in the shape of the upperposterior part of the shell, umbos more distant from the posterior margin and in more oval shape of the adductor muscle scars.

Occurrence. — Poland, Polish Lowlands: Upper Bajocian-Lower Bathonian; Central Uplands (Kierszula near Częstochowa): Upper Kuiavian-Lower Bathonian. USSR (Moldavia, Turkmenia): Upper Bajocian. Switzerland: Upper Bajocian. SE England, FRG: Bajocian-Bathonian.

Palaeonucula cf. *oxfordiana* (Roeder, 1802)

(pl. 16: 1—2)

Material. — Several somewhat damaged shells: ZPAL Mo. XII/87—99.
Measurements (in mm):

H	L	I	H/L
7—10	10—12	6—8	0.7—0.83

Remarks. — The specimens here described resemble most *Nucula oxfordiana* Roeder from the Lower Calcareous Grit (Upper Oxfordian) from Scarborough, Cambridgeshire (Arkell 1929: 34, pl. 1: 2, 2a). They have similar oblique shells, similarly placed umbos, posterior margin almost vertical and distinct concentric folds (pl. 16: 1 a—c, 2). They differ from English specimens in slightly greater length, lower inflation of the shell, slightly less height and greater apical angle.

Occurrence. — Poland, Polish Lowlands: Kuiavian.

Palaeonucula ornati (Quenstedt, 1858)
(pl. 16: 3—4)

1858. *Nucula ornati* Quenstedt: 504, pl. 67: 22—23; pl. 72: 33; 582, pl. 73: 49—50.
1952. *Nucula ornati* Quenstedt; Makowski: 5, pl. 5: 1 (here synonymy).

Material. — Eight shells, two well preserved. ZPAL Mo. XII/106—107.
Measurements (in mm):

H	L	I	H/L
8—9	10—12	6—8	0.75—0.8

Remarks. — The specimens considered here resemble *P. strigilata* (Goldfuss) in shell sizes and positions of umbos. They differ from the specimens of *P. strigilata* in more rounded outline of the shell, wider and more convex umbos, shorter and more arched ventral margin and in less noticeable angularity of the anteroventral margin (pl. 16: 3a), as well as in clear concentric ornamentation.

Occurrence. — Poland, Polish Lowlands: Lower Bathonian; glacial exotic bloc of Łuków: Upper Callovian. USSR and West Europe: Bathonian-Lower Oxfordian.

Palaeonucula menkei (Roemer, 1836)
(pl. 15: 9 a—b)

1836. *Nucula Menkei* Roemer: 98, pl. 6: 8, 10.
1863. *Nucula Menkei* Roemer; Lycett: 44, pl. 39: 2; pl. 40: 12.
1973. *Nucula menkei* Roemer; Romanov: 34, pl. 2: 1—3 (here synonymy).

Material. — A few slightly damaged shells: ZPAL Mo. XII/46—48.
Measurements (in mm):

H	L	I	H/L
13—15	17—20	6—19	0.72—0.75

Remarks. — In contrast with *P. strigilata* (Goldfuss) and *P. ornati* (Quenstedt) the shell surface of the considered specimens has only regular, very thin growth lines. The height index of the Polish specimens is similar to that of specimens from Moldavia (Romanov 1973: pl. 2: 1—3). The Polish specimen has shell features of an individual in gerontic stage apart from closely-packed concentric striae along the ventral margin, it has also short radial ribs (pl. 15: 9a).

Occurrence. — Poland, Polish Lowlands: Upper Kuiavian. Portugal, France: Sekvanian, Virgulian. FRG: Portlandian. USSR, Moldavia: Lower Kimmeridgian. SE-England: Bathonian-Lower Callovian.

Subclass **Pteriomorphia** Beurlen, 1944
Order **Arcoida** Stoliczka, 1871
Superfamily **Arcacea** Lamarck, 1809
Family **Parallelodontidae** Dall, 1898
Subfamily **Grammatodontinae** Branson, 1942
Genus *Grammatodon* Meek et Hayden, 1861

Grammatodon (*Grammatodon*) *concinnus* (Phillips, 1829)
(pl. 33: 1 a—b)

1829. *Cucullaea concinna* sp. nov., Phillips: pl. 5: 9, 31.
1834—1840. *Arca concinna* Goldfuss: 148, pl. 123: 6.
1853. *Cucullaea concinna* Phill.; Morris and Lycett: 50, pl. 5: 7.
1973. *Cucullaea concinna* (Phillips, 1829); Romanov: 43, pl. 3: 1—3.
1978. *Grammatodon* (Grammatodon) *concinnus* (Phillips, 1829); Duff: 36, pl. 2: 7, 11—17, 19.

Material. — Two slightly deformed shells: ZPAL Mo. XII/108—109.
Measurements (in mm):

H	L	I	H/L
21—23	34.5—39	37—39	0.56—0.6

Remarks. — The Polish specimens differ from the specimens described in literature in greater measurements and greater (8) number of radial ribs in anterior area of the shell (pl. 33: 1b) (compare: Quenstedt 1858: pl. 67: 16).

Occurrence. — Poland, Polish Lowlands: Middle Kuiavian-Lower Bathonian; Central Uplands (Rudniki near Częstochowa): Bathonian-Callovian. USSR, Crimea, Turkmenia: Bathonian-Callovian; the region between the Prut and Dniestr rivers: Bajocian-Middle Callovian. GDR (Mecklenburg), FRG: Lower Bathonian-Upper Callovian. France, Swiss: Callovian-Oxfordian. England: Bathonian-Callovian.

Order **Mytiloida** Férrusac, 1822
Superfamily **Mytilacea** Rafinesque, 1815
Family **Mytilidae** Rafinesque, 1815
Subfamily **Crennelinae** Adams et Adams, 1857
Genus *Musculus* Röding, 1798
Musculus (*Musculus*) *pulcherrimus* (Roemer, 1836)
(pl. 17: 5 a—b)

1836. *Modiola pulcherrima* Roemer: 94, pl. 4: 14, 14 a.
1834—1840. *Mytilus Pulcherrimus* Roemer; Goldfuss: 177, pl. 131: 9 a—b.
1853. *Mytilus pulcherrimus* Roemer, 1836; Morris and Lycett: 38, pl. 4: 12, 12a.

Material. — Left valve embedded in rock: ZPAL Mo. XII/96.
Measurements (in mm):

H	L	C (convexity)	H/L
16	14	6	0.7

Remarks. — The Polish specimen differs from the English one in higher length index (0.5 see: Morris and Lycett, 1853: 38), from the German specimen in less numerous (about 30) and thicker radial ribs (see: Roemer, 1836, pl. 4: 14). These differences fall within the limits of individual variability.

Occurrence. — Poland, Polish Lowlands: Middle Bathonian (Łęczyca). FRG: Portlandian. England: Bathonian.

Subfamily **Modiolinae** Keen, 1958

Genus Modiolus Lamarck, 1799

Modiolus (*Modiolus*) *lonsdalei* (Morris et Lycett, 1853)

(pl. 17: 6, pl. 31: 7)

1853. *Mytilus Lonsdalei* Morris and Lycett: 40, pl. 4: 3.
1898—1900. *Modiola* cf. *Lonsdalei* Morris and Lycett; Greppin: 104, pl. 9: 8.
1961. *Modiola lonsdalei* (Morris and Lycett); Sibiriakova: 108, pl. 14: 4, 5.

Material. — Right valve: ZPAL Mo. XII/97 and a few fragments.

Remarks. — The Polish specimen differs from the specimen from the Upper Bajocian of the Bâle region in less length in relation to height (16 mm:41 mm), and in more posteriorly placed keel (pl. 17: 6) (compare: Greppin 1899: 104, pl. 9: 8). Similar differences may be observed between the Polish specimen and the specimens from Turkmenia (compare: Sibiriakova 1961: 108, pl. 14: 4—5). Greppin (1899) mentions the presence of radial striae on the Swiss specimen. On the Polish specimen the similar striae are seen only on the upper surface of the ventral part of the keel.

Occurrence. — Poland, Polish Lowlands: Bajocian-Middle Bathonian. Switzerland, FRG, England: Bajocian-Bathonian.

Modiolus (*Modiolus*) *cuneatus* (Sowerby, 1818)

(pl. 17: 1—2)

1953. *Modiola cuneata* Sow.; Różycki: 26, 31, 43.
1973. *Modiolus cuneata* (Sowerby, 1818); Romanov: 100, pl. 9: 7—10 (here synonymy).

Material. — Two specimens, one slightly damaged: ZPAL Mo. XII/92—93.

Occurrence. — Poland, Polish Lowlands: Upper Kuiavian, Central Uplands: Upper Bathonian. England, France, Switzerland, USSR (Turkmenia, the region between the Prut and Dniestr rivers): Bajocian-Bathonian.

Superfamily **Pinnacea** Leach, 1819

Family **Pinnidae** Leach, 1819

Genus *Pinna* Linnaeus, 1758

Pinna (*Pinna*) cf. *buchii* Koch et Dunker, 1837

(pl. 27: 2 a—b)

Material. — Fragments of subumbonal valve parts: ZPAL Mo. XII/151, 151a.

Remarks. — Cross-section of the valve semicircular, valve thickness about 2.5 mm. Cross-section outline of the valve, the presence of radial ribs of I and II orders, wide ribs-interspaces as well as growth lines and striae forming reticulate ornamentation resemble those of the specimens *Pinna buchii* Koch et Dunker from Swiss Upper Bajocian (Greppin 1898: 99, pl. 13: 3—4).

This species, under the synonymous name *Pinna nitis* Zieten, 1830, is mentioned by Różycki as occurring in the Upper Bathonian, Rudniki near Częstochowa (Różycki 1953: 41—42).

Occurrence. — Poland, Polish Lowlands: Upper Kuiavian, Central Uplands (Rudniki): Upper Bathonian.

Order **Pterioida** Newell, 1965
Suborder **Pteriina** Newell, 1965
Superfamily **Pteriacea** Gray, 1847
Family **Inoceramidae** Giebel, 1852
Genus *Inoceramus* Sowerby, 1814
Subgenus *Mytiloides* Brongniart, 1834
Inoceramus (*Mytiloides*) *amygdaloides* Goldfuss, 1834
(pl. 17: 3—4)

1834—1840. *Inoceramus amygdaloides* Goldfuss: 110, pl. 115: 4.
1961. *Mytiloides amygdaloides* (Goldfuss, 1834); Sibiriakova: 79, pl. 10: 1—2.
1975. *Inoceramus* (*Mytiloides*) *amygdaloides* Goldfuss, 1834; Pugaczewska *in*: Birkenmajer and Pugaczewska: 60, pl. 2: 1—2.

Material. — Two interior casts of shells: ZPAL Mo. XII/94—95.

Remarks. — Height of the specimens is about 10 mm and 16 mm, length 7 mm and 9 mm, inflation 5 mm and 10 mm. Posterior adductor muscle scar rounded of a diameter about 2 mm. Umbos acute, bent. Concentric ornamentation. These features are similar to those of the specimens in synonymy.

Occurrence. — Poland, Polish Lowlands: Bajocian-Lower Kuiavian. USSR, SE Caucasus: Lower-Upper Aalenian, Crimea: Upper Liassic. FRG, England: Upper Liassic. Spitsbergen: Upper Liassic-Aalenian.

Superfamily **Pectinacea** Rafinesque, 1815
Family **Posidoniidae** Frech, 1909
Genus *Bositra* Gregorio, 1886
Bositra buchii (Roemer, 1836)
(pl. 15: 11; pl. 26: 4)

1836. *Posidonia buchii* Roemer: 81, pl. 4: 8.
1965. *Bositra buchii* (Roemer); Cox: 50, pl.: 1.
1978. *Bositra buchii* (Roemer); Duff: 52, pl. 4: 3—6, 8, 10, 14 (here synonymy).

Material. — Numerous valves in coquinas: ZPAL Mo. XII/91.

Remarks. — The largest specimen examined is of subequal length and height — 9—10 mm. The shape and measurements distinguish it from the Middle-Callovian specimens from the Moscow and Briańsk areas, the largest of which has a height of 17 mm and length of 23 mm (Gerasimov 1955), as well as from the specimens from the region between the Prut and Dniestr rivers, which are 20 mm high and 34.5 mm long (Romanov 1973). Other characteristic features of the species, apart from high variability of measurements, are, high variability of valve shapes, varying positions of umbos, from median to anterior, and varied ornamentation formed of irregular, dense concentric striae.

Because of the high variability individual morphotypes used to be regarded as belonging to different species.

Occurrence. — Poland, Polish Lowlands and N of Central Uplands: Bajocian-

-Upper Bathonian; S of Central Uplands: Bathonian; tectonic exotic bloc of Bachowice: Bathonian-Callovian. West Europe, USSR, North America: Upper Aalenian--Callovian. Tanganyika: Bajocian. Kenya: Upper Callovian.

Family **Oxytomidae** Ichikawa, 1958

Genus *Oxytoma* Meek, 1864

Oxytoma (*Oxytoma*) *inequivalvis* (Sowerby, 1819)

(pl. 18: 1, 3, 8; pl. 19: 1)

1819. *Avicula inequivalvis* sp. n.: J. Sowerby: 78, pl. 244: 2, 3.
1975. *Oxytoma* (*Oxytoma*) *inaequivalvis* (J. Sowerby); Pugaczewska *in*: Birkenmajer and Pugaczewska: 61, pl. 3: 1—6.
1978. *Oxytoma* (*Oxytoma*) *inequivalve* (J. Sowerby); Duff: 54, pl. 4: 7, 9, 11, 13, 15—19, 21—23 (here synonymy).

Material. — Four well-preserved specimens and numerous damaged ones: ZPAL Mo. XII/69, 166—167, 176.

Remarks. — Height of the specimens from 8 mm to 18 mm. Left valves have from 16 to 25 radial ribs respectively. A characteristic feature is high individual variability as to valve shapes, number, convexity and distribution of I order ribs, and concentric ornamentation. Ornamentation consists of lines, concentric striae and more or less protruding growth lamellae.

Occurrence. — A cosmopolitan species occurs from the Liassic up to tne Kimeridgian.

Genus *Meleagrinella* Whitfield, 1885

Meleagrinella echinata (Smith, 1817)

(pl. 23: 4; pl. 22: 2—3; pl. 21: 1—4; pl. 20: 1—5; pl. 19: 2—3)

1961. *Meleagrinella echinata* (Smith); Sibiriakova: 70, pl. 8: 13—15.
1961. *Meleagrinella echinata* (Smith); Ronchetti and Sestini: 120, pl. 10: 11—12.

Material. — Numerous valves, including five right and three left well-preserved ones: ZPAL Mo. XII/154—161.

Measurements (in mm):

	H	L	C	Rn
Left valves:	10—20	9—18	4—7	40
Right valves:	8—15	8.5—13	1.5—3	14—25

Remarks. — In right valves preserved spherical prodissoconchs of a diameter about 1/3 mm. The valves have characteristic features of the successive growth stages, among others: posterior adductors muscle scars move towards the ventral margin and deepen; thin, radial striae appear on them; pallial line moves away from the ventral margin, its discontinuity becomes well seen (pl. 19: 3), the shape of the right valves changes from rounded to oblique-ovate with elongated lobe-like posteroventral and anterodorsal margins; a thickened, geniculated ventral margin appears (pl. 20: 5a—b), byssal notch below the anterior ear deepens (pl. 20: 5c).

Occurrence. — Poland, Polish Lowlands: Bajocian-Callovian; N of Central Uplands (Rudniki, Włodowice): Bajocian-Callovian; tectonic exotic bloc of Bachowice: Bajocian. Western Europe: Bajocian-Callovian. USSR, Crimea, Turkmenia, Mangyshlak: Upper Bajocian-Callovian. Spitsbergen: Toarcian-Bajocian. Tanganyika: Callovian. Afghanistan: Bajocian-Callovian.

Genus *Maccoyella* Etheridge, 1892

Maccoyella cf. *moorei* (Etheridge, 1892)

(pl. 18: 5)

Material. — Two left valves in different growth stages: ZPAL Mo. XII/168—169. Measurements (in mm):

H	L	C	Rn
5.5—8	4.5—6.5	2—3	30

Description. — Valves small, thickened, convex. Umbos prosogyrate, small, protruding and overhanging the hinge margin. Hinge margin long (3.5—5.5 mm) (pl. 18: 5). Ligament area long, wide, concave. Ligament pit triangular, oblique. Tooth-like outgrowth 0.4—1 mm high, placed on the hinge margin closer to the anterior margin. Ears small, posterior ear slightly larger than anterior. Numerous radial ribs of subquadrate cross-section at the ventral margin, irregularly spaced.

Remarks. — The features of the described specimens place them between *Meleagrinella* and *Maccoyella*. The specimens resemble most *Maccoyella moorei* (Etheridge), from the Upper Jurassic and the Lower Cretaceous of Australia (Cox 1961: 15, pl. 1: 9—14, pl. 2: 1—3), mainly due to the structure of the hinges and the presence of a tooth-like outgrowth. An intermediate nature of the features of *Meleagrinella* and *Maccoyella* has been discussed by Brunnschweiler (1960: 41).

Occurrence. — Poland, Polish Lowlands: Bajocian-Kujavian.

Family **Pectinidae** Rafinesque, 1815

Genus *Camptonectes* Agassiz, 1864

Camptonectes (*Camptonectes*) *rushdenensis* (Lycett, 1863)

(pl. 24: 1 a—b; pl. 23: 1 a—c, 2 a—b; pl. 25: 1 a—b)

1863. *Pecten Rushdenensis* Lycett: 33, pl. 33: 4 a—c.
1961. *Camptonectes rushdenensis* (Lycett, 1863); Sibiriakova: 94, pl. 12: 5—6.
1973. *Camptonectes rushdenensis* (Lycett, 1863); Romanov: 77, pl. 6: 7—10.

Material. — One right, two complete left valves, as well as a few damaged ones: ZPAL Mo. XII/147, 148, 178.

Remarks. — The Polish specimens differ from those mentioned in synonymy in greater measurements. Height of the examined right valve is 25 mm, and that of the Turkmenia specimen — 15 mm (Sibiriakova 1961). The species is rare — ten specimens have been found so far.

Occurrence. — Poland, Polish Lowlands: Upper Bajocian-Lower Bathonian. USSR (Moldavia, W. Turkmenia): Upper Bajocian-Lower Bathonian. England: Upper Bathonian-Lower Callovian.

Camptonectes (*Camptonectes*) *richei* Dechaseaux, 1936

(pl. 23: 3 a—b)

1936. *Camptonectes Richei* Dechaseaux: 32, pl. 4: 12—13, 15; pl. 5: 1—2.
1961. *Camptonectes richei* Dechaseaux; Sibiriakova: 93, pl. 12: 2—4 (here synonymy).

Material. — Two left valves: ZPAL Mo. XII/149—150.

Remarks. — The number of concentric striae per one mm decreases from eight in the umbo area to four at the ventral margin. The striae become more and more protruding and thickened (pl. 23: 3a—b). Density of radial striae is 5/1 mm. Apical

angle about 90° (in the case of Turkmenia specimens — 93°: Sibiriakova 1961: 93), *C. richei* differs from the related species *C. rushdenensis* in less diversified ornamentation and the presence of radial striae, it may be distinguished from *C. lens* by the domination of concentric striae as well as the absence of reticulate ornamentation.

Occurrence. — Poland, Polish Lowlands: Kujawian-Bathonian. France: Bajocian--Bathonian. USSR (W Turkmenia): Bathonian.

Camptonectes (*Camptonectes*) *lens* (Sowerby, 1818)
(pl. 24: 2, 3 a—b; pl. 25: 3)

1818. *Pecten lens* J. Sowerby: 3, pl. 205: 2—3.
1934. *Camptonectes lens* Sow.; Krach: 11, pl. 11: 3, 15.
1955. *Camptonectes lens* (Sowerby, 1818); Gerasimov: 116, pl. 26: 5—7.
1977. *Camptonectes lens* (Sowerby); Andreeva: 40, pl. 11: 3—5.

Material. — Three left valves and a few fragments: ZPAL Mo. XII/162—164.

Remarks. — Some of the radial striae on side surfaces of the valves are dichotomous (pl. 25: 3). In subumbonal areas of the valves radial striae are thinner and growth lines more closely spaced than in the ventral parts. Density of the striae decreases from 8/1 mm to 4/1 mm. Surfaces of the striae covered by fine granules. Growth lines and radial striae cross to form reticulation (pl. 24: 3b). Height of the Polish specimens is generally less (16—40 mm) than that described in literature (70 mm — Sibiriakova 1961).

Occurrence. — Poland, Polish Lowlands: Bajocian-Callovian, N of Central Uplands (Rudniki): Bajocian-Callovian; S of Central Uplands (Piła Kościelecka): Upper Bathonian-Callovian; tectonic exotic bloc of Bachowice: Bajocian. Middle and West Europe: Upper Bathonian-Kimmeridgian. USSR: Bajocian-Oxfordian. India, Africa: Bajocian-Oxfordian. Australia: Liassic-Kimmeridgian.

Family **Terquemiidae** Cox, 1964
Genus *Placunopsis* Morris et Lycett, 1853
Placunopsis cf. *radians* Morris et Lycett, 1853
(pl. 25: 2 a—b)

Material. — One specimen: ZPAL Mo. XII/68.

Remarks. — The Polish specimen resembles English *Placunopsis radians* (Morris et Lycett 1853: 7, pl. 1: 10) in a rounded shape of the valves, their slight convexity and reticulate ornamentation. The Polish specimen differs from the English one in more complex ornamentation: short radial striae in ribs interspaces and nodes on intersections of concentric and radial elements (pl. 25: 2a—b). It is possible that the Polish specimen represents a new species. *Placunopsis radians* Morris et Lycett is a species rarely found in the English Bathonian (Minchinhampton).

Occurrence. — Poland, Polish Uplands: Bathonian.

Superfamily **Limacea** Rafinesque, 1815
Family **Limidae** Rafinesque, 1815
Genus *Lima* Bruguière, 1797
Lima (*Lima*) *duplicata* Sowerby, 1820
(pl. 26: 1 a—b; pl. 27: 1; pl. 22: 4—6)

1898—1900. *Lima (Radula) duplicata* Sowerby; Greppin: 137, pl. 13: 10.
1951. *Radula duplicata* Sow.; Krach: 343, pl. 12: 1.
1961. *Lima duplicata* Sowerby, 1829; Sibiriakova: 94, pl. 12: 7—8.

Material. — Five specimens preserved in rock: ZPAL Mo. XII/144—146, 176—177.

Remarks. — Height of the examined specimens is 29 mm, length up to 32 mm (pl. 26: 1a, pl. 27: 1). The number of radial ribs up to 25. Umbos acute, bent, the apical angle — 92—95°.

Occurrence. — Poland, Polish Lowlands, N of Central Uplands (Włodowice): Bajocian-Callovian; S of Central Uplands (Piła Kościelecka): Upper Bathonian-Callovian. Western Europe: Bajocian-Callovian. USSR (Crimea, Turkmenia): Bathonian--Callovian.

Genus *Plagiostoma* Sowerby, 1814
Plagiostoma cf. *semicircularis* Goldfuss, 1840
(pl. 26: 2 a—b)

Material. — One interior mould of right valve: ZPAL Mo. XII/143.

Remarks. — Oblique-trigonal outline of the specimen, bent umbo and concentric folds make it similar to the specimens of *Lima semicircularis* Goldfuss (1840: 83, pl. 101: 6) from the Bathonian of Bayeux. From specimens of *Pl. semicircularis* of Middle Jurassic from the Cracow region (Krach, 1951: 336, pl. 11: 1—2) the examined specimen differs in higher umbo and greater convexity. This species occurs from the Liassic up to the Callovian of Europe.

Occurrence. — Poland, Polish Lowlands: Kuiavian.

Genus *Limatula* Wood, 1839
Limatula gibbosa (Sowerby, 1818)
(pl. 17: 7 a—b)

1834—1840. *Lima gibbosa* Desh.; Goldfuss: 86, pl. 102: 10 a—b.
1934. *Lima (Limatula) gibbosa* (Sowerby); Stoll: 20, pl. 2: 12.
1973. *Limatula gibbosa* (Sowerby, 1814); Romanov: 89, pl. 7: 7.

Material. — Interior mould of shell with fragments of valve: ZPAL Mo. XII/98

Remarks. — Height of the specimen equals to 28 mm, inflation 17 mm. About 20 ribs. Anterior and posterior surface of the shell, without radial ornamentation, is covered with growth lines and folds.

Occurrence. — Poland, N of Central Uplands (Włodowice): Bajocian, S of Central Uplands (Piła Kościelecka): Upper Bathonian. USSR (Turkmenia, Uzbekistan, the region between the Prut and Dniestr rivers): Middle Callovian. FRG: Bathonian. Switzerland, England: Bajocian.

Genus *Pseudolimea* Arkell, 1932
Pseudolimea duplicata (Münster, 1835)
(pl. 27: 5—6; pl. 18: 9; pl. 24: 4—5; pl. 22: 1)

1834—1840. *Limea duplicata* Münster; Goldfuss: 103, pl. 107: 9a—c.
1965. *Pseudolimea duplicata* (J. de Sowerby); Cox: 64, pl. 8: 8.
1973. *Lima duplicata* Münster, 1835; Yamani: 108, pl. 4: 13 (here synonymy).

Material. — Several valves: ZPAL Mo. XII/147—150.

Remarks. — Height and length subequal — about 12 mm, convexity about 4 mm. 15—17 radial ribs. Very thin inter-ribs between the ribs. On the side surface of the main ribs one can see 3—4 radial striae (pl. 18: 9, pl. 21: 1). At the hinge margin this taxodontic teeth.

Occurrence. — Poland, Polish Lowlands: Kuiavian; S of Central Uplands (Balin): Bathonian-Callovian. Switzerland, France: Bajocian-Callovian. Africa (Kenya, Tanganyika): Toarcian-Upper Oxfordian.

Subclass **Heterodonta** Neumayr, 1884
Order **Veneroida** Adams et Adams, 1856
Superfamily **Lucinacea** Fleming, 1828
Family **Mactromyidae** Cox, 1929
Genus *Mactromya* Agassiz, 1843
Mactromya depressa (Phillips, 1829)
(pl. 28: 1—5)

1854. *Unicardium depressum* Phill. sp.; Morris and Lycett: 133, pl. 14: 10.
1973. *Mactromya depressum* (Phillips 1829); Romanov: 123, pl. 12: 23—24 (here synonymy).

Material. — Seven shells and a few interior moulds: ZPAL Mo. XII/99—105.
Measurements (in mm):

H	L	I	H/L
16—21	19—24.5	13—17	0.84—0.85

Remarks. — The Polish specimens differ from the English ones only in slightly more elongated posterior margin of the shell (Morris and Lycett 1854: 133, pl. 14: 10). The Polish specimens differ from the Moldavian ones in less angular outline of the shell (Romanov, 1973: 123, pl. 12: 23—24).

Occurrence. — Poland, Polish Lowlands: Middle Bathonian. England: Bajocian--Bathonian. USSR: Lower parts of Middle Callovian (the region between the Prut and Dniestr rivers).

Genus *Unicardium* d'Orbigny, 1850
Unicardium sp.
(pl. 16: 5—6)

Material. — Three valves: ZPAL Mo. XII/124—126.
Measurements (in mm):

H	L
12—19	12.5—19.5

Remarks. — Valves ovate-triangular. Umbos rounded, prominent, bent inward, submedial, prosogyrate (pl. 16: 5—6). Main tooth in left valve thickened, boss-like (pl. 16: 6), in right valve low, elongated (pl. 16: 5b). Nymph narrow, elongated. Concentric ornamentation of irregular thickened striae.

Occurrence. — Poland, Polish Lowlands: Middle Bathonian.

Superfamily **Carditacea** Fleming, 1820
Family **Permophoridae** van de Poel, 1859
Subfamily **Myoconchinae** Newell, 1957
Genus *Myoconcha* Sowerby, 1824
Myoconcha (*Myoconcha*) sp.
(pl. 27: 7—8)

Material. — Two valves of young individuals: ZPAL Mo. XII/152—153.
Measurements (in mm):

H	L	C
7—11	3.5—5	2—4

Remarks. — Valves high, modioliform. Anterior end narrow, rounded, posterior wide (pl. 27: 7—8). In the hinge area one can see wide depression and traces of tubercular, tooth-like elements.

Occurrence. — Poland, Polish Lowlands: Kuiavian.

Superfamily **Crassatellacea** Férussac, 1822
Family **Astartidae** d'Orbigny, 1844
Genus *Astarte* Sowerby, 1816
Astarte (*Astarte*) *pulla* Roemer, 1836
(pl. 29: 5—6)

1836. *Astarte pulla* Roemer: 113, pl. 6: 27.
1973. *Astarte pulla* Roemer; Romanov: 106, pl. 10: 6—11 (here synonymy).

Material. — A few damaged shells and two almost complete ones: ZPAL Mo. XII/1—2.
Measurements (in mm):

H	L	I
6—7	6.5—9	4—4.5

Remarks. — It differs from the similar *Astarte minima* Phillips in smaller number of concentrical ribs, more rounded outline of the shell and higher inflation.

Occurrence. — Poland, Polish Lowlands: Middle Kuiavian-Upper Bathonian: tectonic exotic bloc of Bachowice: Bajocian. FRG: Bathonian. USSR (Crimea, Caucasus, W. Turkmenia): Bathonian.

Astarte (*Astarte*) *minima* Phillips, 1835
(pl. 29: 13)

1961. *Astarte minima* Phillips; Sibiriakova: 115, pl. 15: 17—19 (here synonymy).

Material. — Three shells: ZPAL Mo. XII/3—5.

Remarks. — Height of the shell — about 7 mm — is a little less than its length. Inflation comparatively high — 5 mm. 12—14 concentric ribs. They are high, thickened, of rounded upper edges (pl. 29: 13 a—b).

Occurrence. — Poland, Polish Lowlands: Kuiavian; tectonic exotic bloc of Bachowice: Bajocian. USSR (Moldavia, Crimea), Switzerland, England, France: Bajocian-Bathonian.

Astarte (*Astarte*) cf. *meeki* Stanton, 1899
(pl. 29: 1)

Material. — Two right valves: ZPAL Mo. XII/23, 23a.

Remarks. — The specimens resemble most *Astarte meeki* Stanton described by Imlay (1967: 82, pl. 5: 1—6). Outline rounded. Height equals to 5 mm a little less than length. Umbos submedial, slightly prosogyrate, rounded. 23 concentric ribs. Ribs--interspaces increase with growth of the valve. Deep concentric groove separates younger part of the valve which is covered with thin striae adjoining one another. The lower part is covered with ribs less densely spaced (pl. 29: 1). In outline and proportions the Polish specimens resemble the American ones, but differ from them in smaller measurements, relatively greater number of ribs, less excentrical location of the umbo. The American specimens are about 15 mm high and have 35—42 ribs.

Astarte meeki Stanton can be found in numerous exposures of Wyoming and Idaho in the sediments "Twin Creek Limestone" (Imlay 1967).

Occurrence. — Poland, Polish Lowlands: Kuiavian.

Astarte (*Astarte*) *robusta* Lycett, 1863
(pl. 15: 11—12)

1863. *Astarte robusta* Lycett: 74, pl. 25: 6, 6a.

Material. — Two shells: ZPAL Mo. XII/6—7.

Remarks. — The Polish specimens resemble the English ones in triangular outline of the shell, considerably prosogyrate umbos, and ornamentation — both species have thin radial striae (pl. 15: 11—12). The Polish specimens differ in slightly smaller measurements and smaller number of ribs (twelve while the English specimen has sixteen).

Occurrence. — Poland, Polish Lowlands: Kuiavian-Lower Bathonian. England: Lower Bathonian.

Astarte (*Astarte*) *fimbriata* Walton *in* Lycett, 1863
(pl. 15: 14)

1863. *Astarte fimbriata* Walton; Lycett: 77, pl. 40: 34—34a.
1961. *Astarte fimbriata* Lycett, 1863; Sibiriakova: 115, pl. 15: 20—21.

Material. — Seven shells: ZPAL Mo. XII/8—14.

Supplementary description. — Shells oblique-triangular 6—8 mm in height. Height and length subequal. Maximal inflation in half of the shell height closer to the posterior margin, equals to 4—5 mm. Umbos small, slightly prosogyrate. Escutcheon long, narrow and shallow lunula of a heart-like shape, wide and deep. Escutcheon and lunula surrounded by thickened ridges (pl. 15: 14b). Ribs highest in half of the shell height, angularly bent near the posterior and anterior margins. Elongated node at the bending point of the ribs (pl. 15: 14a). Intervals between the ribs widen from the umbo towards the middle of the shell height, where their width is 1 mm, and become narrower while approaching the ventral margin.

Remarks. — The described specimens are similar to the English ones from the Bathonian (Lycett, 1863: 77, pl. 40: 34). They differ slightly from the specimen of the Turkmenian Bathonian in a more oblique shape and more posterior location of maximal inflation (Sibiriakova, 1961: 115, pl. 15: 20—21).

Occurrence. — Poland, Polish Lowlands: Lower Bathonian. England and USSR (Turkmenia): Bathonian.

Astarte (*Leckhamptonia*) Cox et Arkell, 1948
Astarte (*Leckhamptonia*) cf. *aytonensis* (Lycett, 1863)
(pl. 15: 4)

Material. — One specimen: ZPAL Mo. XII/15.

Remarks. — The specimen is 6 mm long, trapezoidal in outline. Hinge margin almost rectilinear, subquadrate pattern of concentric ribs. It differs from the English specimen from the Bathonian in almost four times smaller length (Lycett, 1863: 78, pl. 40: 13).

Occurrence. — Poland, Polish Lowlands: Bathonian.

Genus *Neocrassina* Fischer, 1886
Neocrassina (*Neocrassina*) *striatocostata* (Goldfuss, 1840)
(pl. 15: 9—10)

1834—1840. *Astarte striato-costata* Münster; Goldfuss: 192, pl. 134: 18.
1896—1901. *Astarte trembiazensis* Loriol: 69, pl. 4: 24—26.
1952. *Astarte striato-costata* Goldfuss; Makowski: 9, pl. 5: 2.

Material. — Two shells and one left valve: ZPAL Mo. XII/20—22.

Remarks. — Subequal length and height of 15—16 mm. Maximum inflation (5 mm) located in the middle-upper part of the shell. Concentric ribs, eight in number, are found only on the upper half of the shell. Near the posterior margin the ribs bent almost at a right angle (pl. 15: 9b). The Polish specimens differ from those mentioned in the synonymy in slightly greater measurements, and from the specimens described by Loriol (1901) and Makowski (1952) in angular pattern of the ribs.

Occurrence. — Poland, Polish Lowlands: Middle Bathonian; glacial exotic bloc of Łuków: Upper Callovian. France, Switzerland: Oxfordian. USSR, FRG, England: Bathonian-Callovian.

Genus *Prorokia* Boehm, 1893
Prorokia meriani (Greppin, 1899)
(pl. 31: 3)

1899. *Astarte Meriani* Greppin: 87, pl. 8: 9.

Material. — Shell fragments and one right valve: ZPAL Mo. XII/58.

Remarks. — Valve outline subquadrate. Growth lines cut at certain intervals by furrows. The valve length is 12 mm, height 9 mm, convexity about 4 mm. The Polish specimen differs from the Swiss one in the absence of a wide, oblique keel. The related species *P. fontenellensis* Imlay (1967) and *P. rustica* (Lycett, 1863) have shorter valves of an almost quadrate outline without concentric furrows.

Occurrence. — Poland, Polish Lowlands: Lower Bajocian-Kuiavian. Switzerland: Upper Bajocian.

Subfamily **Eriphylinae** Chavan, 1952
Genus *Eriphyla* Gabb, 1864
Eriphyla (*Eriphyla*) *depressa* (Münster, 1840)
(pl. 29: 2—3; pl. 18: 2)

1834—1840. *Astarte depressa* Münster; Goldfuss: 192, pl. 134: 14.
1898—1900. *Astarte depressa* Goldfuss; Greppin: 83, pl. 8: 11.
1952. *Astarte depressa* Münster; Makowski: 11, pl. 1: 13.

Material. — One right and two left valves and several fragments: ZPAL Mo. XII/16, 17, 17a.

Remarks. — Valves rounded, relatively flat, of subequal length and height — about 4.5 mm. Umbos small, submedial. 18—19 concentric ribs. In the upper half of the valves the ribs closely spaced, on the remaining surface more distant from one another (pl. 29: 2b, 3; pl. 18: 2).

Occurrence. — Poland, Polish Lowlands, N of Central Uplands (Teofilów): Bajocian-Kuiavian; glacial exotic bloc of Łuków: Upper Callovian; tectonic exotic bloc of Bachowice: Bajocian. GDR: Bathonian, Callovian. England, FRG, Switzerland: Bajocian-Bathonian.

Eriphyla (*Eriphyla*) *elegans* (Sowerby, 1816)
(pl. 29: 7—8)

1858. *Astarte elegans* Sowerby; Quenstedt: 445, pl. 61: 3.
1898—1900. *Astarte elegans* Sowerby; Greppin: 84.

Material. — One right and one left valve: ZPAL Mo. XII/18—19.

Remarks. — The Polish specimens differ from the ones mentioned in the synonymy in having lower umbos and in measurements. The species differs from *E. depressa* (Münster) in more elongated subquadrate valves, greater length in relation to height, thinner and more numerous ribs (20) of the same shape on the whole valve (pl. 29: 8).

Occurrence. — Poland, Polish Uplands: Kuiavian. FRG, Switzerland: Upper Bajocian.

Superfamily **Tellinacea** Blainville, 1814
Family **Tancrediidae** Meek, 1864
Genus *Tancredia* Lycett, 1850

Tancredia axiniformis (Phillips, 1829)
(pl. 16: 7—8)

1854. *Tancredia axiniformis* Phill. sp.; Morris and Lycett: 93, pl. 13: 6 a—b.
1973. *Tancredia axiniformis* (Phillips, 1829); Romanov: 121, pl. 12: 13—14 (here synonymy).

Material. — Three right and two left valves: ZPAL Mo. XII/127—131.

Remarks. — The Polish specimens are 12 mm high and 19 mm long.

Occurrence. — Poland, Polish Lowlands: Lower Bajocian-Upper Kuiavian. England: Bajocian-Bathonian. USSR: (W. Turkmenia, the region between the Prut and Dniestr rivers): Upper Bajocian-Bathonian.

Subclass **Anomalodesmata** Dall, 1889
Order **Pholadomyoida** Newell, 1965
Superfamily **Pholadomyacea** Gray, 1847
Family **Pholadomyidae** Gray, 1847
Genus *Pholadomya* Sowerby, 1823

Pholadomya (*Pholadomya*) *murchisoni* Sowerby, 1827
(pl. 30: 1 a—c)

1827. *Pholadomya murchisoni* Sowerby: 87, pl. 545: 1—3.
1955. *Pholadomya murchisoni* Sowerby, 1827; Gerasimov: 81, pl. 11: 7.
1973. *Pholadomya murchisoni* Sowerby, 1827; Romanov: 137, pl. 14: 6.

Material. — Seven specimens: ZPAL Mo. XII/24—30.

Remarks. — The examined specimens are among the biggest representatives of the genus *Pholadomya* Sowerby. Their height equals to 115 mm, length — 105 mm, inflation — 100 mm. All of them have constant number of nine radial ribs. Two biggest ribs occur on the anterior surface of the shell. Towards the posterior margin the ribs become lower and narrower, and the last ones do not reach the ventral margin (pl. 30: 1a—c).

The described specimens differ from the ones mentioned in the synonymy in greater measurements, height and width of the ribs.

Occurrence. — Poland, Polish Lowlands: Kuiavian; tectonic exotic bloc of Bachowice: Bajocian; glacial exotic bloc of Łuków: Callovian. FRG, USSR (Turkmenia): Bajocian-Callovian.

Pholadomya (*Pholadomya*) *crassa* (Agassiz, 1842)

(pl. 31: 7)

1961. *Pholadomya crassa* Agassiz, 1842; Sibiriakova: 143, pl. 23: 3 (here synonymy).

Material. — One shell: ZPAL Mo. XII/31.

Remarks. — The examined specimen is 46 mm high, 58 mm long. Its inflation equals to 36 mm. On the shell surface there are 6 radial ribs of which three anterior ones are highest and longest while the remaining ones are short and thin. The surface of the ribs is uneven (pl. 31: 7). In comparison with the specimen from the Bathonian of Causasus the Polish specimen has smaller measurements and different details of ornamentation.

Occurrence. — Poland, N of Central Uplands (Włodowice): Bathonian. USSR (Caucasus): Bathonian. Dagestan: Callovian. England, Switzerland, Portugal: Bajocian-Bathonian.

Pholadomya (*Pholadomya*) *deltoidea* (Sowerby, 1827)

(pl. 32: 7)

1863. *Pholadomya deltoidea* Sow.; Lycett: 86, pl. 42: 4.

Material. — Five interior moulds of shells with partially preserved valves: ZPAL Mo. XII/32—36.

Measurements (in mm):

H	L	I
43—58	53—68	40—48

Supplementary description. — Umbos strongly bent inward. Eight radial ribs. Two anterior ones thin, short, arch-like. The remaining six ones placed on the side surface of the shell; they are high and they reach the ventral margin. The shell covered with concentric growth lines and folds. Ribs-intervals up to 6 mm wide.

Remarks. — Individual variability of *Pholadomya* (*P.*) *deltoidea* involves the elongation of the posterior margin of the shell, the number of ribs and the width

of intervals. The Polish specimens differ from the English one in smaller measurements and constant width of intervals. The intervals of the English specimen get narrower towards the posterior end of the shell.

Occurrence. — Poland, Polish Lowlands; N of Central Uplands (Włodowice): Middle Bathonian. England: Bathonian-Lower Callovian.

Pholadomya (Pholadomya) canaliculata Roemer, 1836
(pl. 31: 1)

1836. *Pholadomya canaliculata* Roemer: 129, pl. 15: 3.
1934. *Pholadomya canaliculata* Roemer; Stoll: 15, pl. 2: 25.

Material. — One shell: ZPAL Mo. XII/37.

Remarks. — The Polish specimen is 23 mm high, 33 mm long, its inflation is 18 mm. Outline ovate, of higher anterior margin. Ten radial ribs run obliquely to the ventral margin. The first two ones arch-like. The width of the intervals decrease towards the posterior end of the shell.

Occurrence. — Poland, Polish Lowlands: Middle Bathonian. GDR: Middle Callovian (Mecklenburg). FRG: Rauracian.

Pholadomya (Pholadomya) angustata (Sowerby, 1819)
(pl. 31: 6)

1961. *Pholadomya angustata* (Sowerby, 1819); Sibiriakova: 145, pl. 24: 3 (here synonymy).

Material. — Four shells: ZPAL Mo. XII/38—41.

Remarks. — Shell height — 30 mm, length — 40—50 mm, inflation about 25 mm. 14—15 radial ribs. The width of intervals changes from 4 mm in the anterior part to 4.5 mm in the posterior part of the shell (pl. 31: 6a). Concentric treads and striae, most distinct on the posterior surface of the shell, make the surface of the ribs uneven (pl. 31: 6a—b). The Polish specimens differ from the Turkmenian ones in smaller measurements and greater number of ribs.

Occurrence. — Poland, N of Central Uplands (Rudniki): Bathonian. England, Switzerland, Hungary, USSR (Turkmenia), E Africa: Liassic-Callovian.

Pholadomya (Pholadomya) cf. *lineata* Goldfuss, 1840
(pl. 31: 3)

Material. — Two incomplete shells: ZPAL Mo. XII/42—43.

Remarks. — The Polish specimens are 23—27 high, 29—32 mm long, their inflation, maximal in the anterior part of the shell, equals to 17—20 mm. Umbos placed subterminally on the anterior part of the shell, prominent, bent inward. 13 ribs run from the umbo towards the posterior end of the shell. They are straight except for the first two arch-like ones (pl. 31: 3). The side surface of the shell is covered with numerous, protruding growth striae. The described specimens resemble the specimen from the Upper Jurassic of Solothurn in Switzerland (Goldfuss, 1840: 268, pl. 156: 4a—b). The only difference is lower and more convex anterior margin of their shells.

Occurrence. — Poland, N of Central Uplands (Rudniki): Bathonian.

Pholadomya (Pholadomya) ambiqua (Sowerby, 1819)
(pl. 32: 6)

1834—1840. *Pholadomya ambiqua* Sow.; Goldfuss: 267, p. 156: 1 a—c.

Material. — Four specimens with partially preserved valves: ZPAL Mo. XII/59—62.

Remarks. — Height of the Polish specimen equals to 37—51 mm, length to 40—60 mm, inflation 30—42 mm. 7—8 radial ribs, five of which are placed on the central surface of the shell, and the remaining three run obliquely towards the posterior area. The ribs are long, high and slightly sinuous (pl. 32: 6).

Occurrence. — Poland, Polish Lowlands: Middle Bathonian-Lower Callovian; N of Central Uplands (Jaworzniki): Bathonian-Lower Callovian. FRG, England: Liassic--Bathonian.

Pholadomya (Bucardiomya) cf. *bucardium* Agassiz, 1842
(pl. 32: 1)

Material. — Four interior moulds of shells: ZPAL Mo. XII/63—66.

Remarks. — The height of the examined specimens 33—38 mm, length 31—37 mm, inflation 25—32 mm. 7—8 radial ribs noticeably thickened and high in the ventral margin area (pl. 32: 1). The Polish specimens resemble the specimen of *Ph. (Bucardiomya) bucardium* Agassiz from the Middle Bathonian in an ovate-triangular outline of the shell, the absence of escutcheon, sharp radial ribs and a convex anterior margin of the shell.

Occurrence. — Poland, Polish Lowlands: Middle Bathonian.

Genus *Goniomya* Agassiz, 1841
Goniomya (Goniomya) rudnikensis sp. n.
(pl. 31: 2; pl. 32: 4)

Holotype: ZPAL Mo. XII/36, pl. 31: 2.

Type horizon: Middle Bathonian: Morrisiceras morrisi Zone.

Type locality: a quarry near Rudniki village, Częstochowa region.

Derivation of the name: the name connected with Rudniki village.

Diagnosis. — Medium-sized valve, elongated. Umbo acute, small, strongly bent inward, prosogyrate. Ornamentation of divergent V-shaped ribs joined by horizontal riblets. The whole surface of the valve covered with numerous, small nodes arranged linearly.

Material. — One right and one left valve: ZPAL Mo. XII/56—57.

Measurements of the holotype (in mm):

H	L	Rn
29.0	ca 32.0	30

Description. — Umbos placed in 1/3 of shell behind the anterior margin. Anterior margin high, convex, posterior margin lower, narrow, elongated. Posterodorsal margin obliquely sloping down, slightly depressed below the umbo. Ventral margin rectilinear. Numerous V-shaped ribs occur below the dorsal margin and are joined by short horizontal riblets. Anterior divergent ribs have a shape of elongated S, posterior ones slightly arch-like. The ribs on the umbo numerous, thin, low. Rib-

-interspaces narrower than the ribs. During growth they thicken quickly, the width of intervals increases and becomes almost twice the width of the ribs at the ventral margin. In posterior areas of the valves the intervals stay narrow (pl. 31: 2a, pl. 32: 4a). During growth the horizontal ribs elongate and the last of them occupy the whole of the central part of the valves, being parallel to the ventral margin. Side ribs join with horizontal ones at an obtuse angle. Growth lines and folds are well developed mainly on the posterior part of the valves (pl. 31: 2a). The whole valve surface covered with micro-ornamentation consisting of vertical and horizontal rows of nodes (pl. 32: 4b). Elongated hinge area shaped as a low triangle enclosed by a thickened margin. In front of the umbo there is a depressed lunula enclosed along its whole length by a sharp edge. Escutcheon placed behind the umbo enclosed by a ridge which is rounded except for its sharp subumbonal part (pl. 31: 2b).

Remarks. — The described species differs from the known species of the genus *Goniomya* mainly in a granulous micro-ornamentation covering the valve surface, in S-like oblique anterior ribs, considerable elongation of horizontal ribs during growth, more distinct lunula and escutcheon as well as in considerable inequilaterality of the valves.

Occurrence. — As for the holotype.

Family **Ceratomyidae** Arkell, 1934
Genus *Gresslya* Agassiz, 1843
Gresslya peregrina (Phillips, 1819)
(pl. 33: 3 a—b; pl. 26: 3)

1863. *Gresslya peregrina* Phillips; Lycett: 79, pl. 36: 2, 2a—b.
1929—1937. *Gresslya peregrina* (Phillips); Arkell: 319, pl. 43: 7, 7a.
1969. *Gresslya peregrina* (Phillips); Cox: 841, F 18 2a, b.

Material. — Three shells and a few interior moulds: ZPAL Mo. XII/110—116. Measurements (in mm):

H	L	I	H/L
29—30	36—42	20—25	0.83—0.7

Remarks. — On one of the specimens a distinct furrow is seen running near the margin from the umbo towards the posterior area of the right, larger valve (pl. 33: 3b). Its length and depth are characteristic of the species. Another distinctive feature of the species is micro-ornamentation consisting of densely spaced, small nodes which form thin, vertical lines, 7—8 per 1 mm on the umbo and 6 per 1 mm on the central part of the valve (pl. 26: 3). From the related *G. abducta* (Phillips) the described species differs in having an umbo more distant from the anterior margin, longer and deeper furrow on the right valve, lower inflation of the shell and different micro-ornamentation.

Occurrence. — Poland, Polish Lowlands: Kuiavian-Callovian; N of Central Uplands (Kamienica Polska): Upper Bathonian. England: Upper Bathonian-Kimmeridgian. France: Callovian.

Gresslya abducta (Phillips, 1835)
(pl. 33: 4—5)

1898—1900. *Gresslya abducta* Phillips sp.; Greppin: 56, pl. 6: 3.
1934. *Gresslya abducta* Phillips sp.; Stoll: 14, 45, 47.

Material. — A several specimens: ZPAL Mo. XII/117—120.
Measurements (in mm):

H	L	I	H/L
34—42	44—57	27—32	0.77—0.73

Remarks. — A furrow running from the umbo towards the posterior area of the right valve is short and relatively shallow. Micro-ornamentation consists of irregularly spaced nodes, densely covering the whole surface of the shell. During growth of the valve the nodes elongate horizontally and change, at the ventral margin, into thin, oblique treads.

Occurrence. — Poland, Polish Lowlands: Upper Kuiavian; N of Central Uplands (Rudniki, Kamienica Polska): Bathonian. Switzerland: Upper Bajocian. England, France, FRG, GDR, USSR: Upper Bathonian.

Gresslya gregaria (Zieten, 1830)
(pl. 33: 6—7)

1830. *Lutraria gregaria* Zieten: 85, pl. 64: 1 a—c.
1836. *Lutraria gregaria* Merian; Roemer: 124, pl. 8: 11.
1969. *Gresslya gregaria* (Zieten); Cox: 841, F 18: 2c.

Material. — Three interior moulds of shells and several fragments: ZPAL Mo. XII/121—123.
Measurements (in mm):

H	L	I	H/L
30—40	37—55	19—26	0.8—0.72

Remarks. — A comparatively wide furrow running from the umbo of the right valve towards the posterior area.

Occurrence. — Poland, Polish Lowlands: Kuiavian-Bathonian; N of Central Uplands (Rudniki, Kamienica Polska): Bathonian. FRG: Inferior Oolite.

Family **Myopholadidae** Cox, 1964
Genus *Myopholas* Douvillé, 1907
Myopholas mutabilis Gerasimov, 1955
(pl. 31: 5)

1955. *Myopholas mutabilis* Gerasimov: 86, pl. 11: 4 (here synonymy).
Material. — One valve: ZPAL Mo. XII/67.
Measurements (in mm):

H	L	H/L	Rn
27.0	46.0	0.57	17

Remarks. — The Polish specimen has measurements, shell outline and ornamentation similar to those of the specimen described by Gerasimov (1955). To his description we may add that the shell of *M. mutabilis* is inequivalve, the right valve being larger than the left one and overlapping the latter along the dorsal margin.

Maximum inflation runs in the posterior part of the shell from the umbo towards the ventral margin. Other species of the genus *Myopholas* have different number of ribs and different width of intervals (Arkell, 1935 — in the work of 1929—1937).

Occurrence. — Poland, N of Central Uplands (Rudniki): Uppermost Bathonian. USSR (Moscow region): Volgian-Berriasian.

Family **Pleuromyidae** Dall, 1900

Genus *Pleuromya* Agassiz, 1842

Pleuromya elongata (Goldfuss, 1836)

(pl. 34: 9)

1836. *Lutraria elongata* sp. nov., Münster; Goldfuss: 258, pl. 153: 2 a—c.
1961. *Pleuromya elongata* (Goldfuss, 1836); Sibiriakova: 157, pl. 28: 3—4.
1973. *Pleuromya elongata* (Goldfuss, 1836); Romanov: 153, pl. 19: 3—6.

Material. — Two valves and several moulds: ZPAL Mo. XII/44, 44a.
Measurements (in mm):

H	L	I	H/L
23—29	44—55	17—23	0.52—0.53

Remarks. — Growth changes of the examined species mainly in the form of thickened growth striae in the final growth stages.

Occurrence. — Poland, Polish Lowlands: Upper Kuiavian-Upper Bathonian; N of Central Uplands (Teofilów), S of Central Uplands (Góra Żar near Ogrodzieniec): Bathonian; tectonic exotic bloc of Bachowice: Bajocian and Bathonian. USSR: Upper Bajocian (Moldavia), Bathonian (Western Turkmenia). France, FRG: Bajocian--Bathonian.

Pleuromya calceiformis (Phillips, 1829)

(pl. 34: 3 a—b)

1863. *Myacites calceiformis* (Phillips); Lycett: 80, pl. 42: 1.
1929—1937. *Pleuromya calceiformis* (Phillips); Arkell: 324, pl. 44: 12.
1965. *Pleuromya calceiformis* (Phillips); Cox: 132, pl. 20: 9.

Material. — One shell: ZPAL Mo. XII/45.
Measurements (in mm):

H	L	I	H/L
30.0	60.0	20.0	0.5

Remarks. — The surface of the shell is covered with lines, growth striae and microgranulation which is radially arranged in the upper part to the shell and irregularly concentric on the remaining surface. The granules are closely-packed and fine near the umbo, and sparser, larger, protruding on the remaining surface (pl. 34: 3a—b). The Polish specimen resembles most the one from the English Oxfordian (Arkell 1934), from which it differs in slightly smaller measurements. From the specimen of the Upper Oxfordian of Tanganyica (Cox 1965) it differs in having more oblique anterodorsal margin and less rounded umbos. This species of wide geographical and stratigraphic distribution occurs sporadically.

Occurrence. — Poland, Polish Lowlands: Upper Kuiavian. SE England: Upper Vesulian, Bathonian, Lower Callovian, Upper Oxfordian. Tanganyika: Upper Oxfordian.

Pleuromya polonica (Laube, 1867)
(pl. 30: 1 a—c; 34: 1 a—b)

1934. *Pleuromya polonica* (Laube 1867); Stoll: 14, pl. 1: 43.
1973. *Pleuromya polonica* (Laube 1867); Romanov: 155, pl. 19: 7—9 (here synonymy).

Material. — Two shells and a few interior moulds: ZPAL Mo. XII/46—48, 138—142.

Measurements (in mm):

H	L	I	H/L
15—25.5	30—46	11—20	0.5—0.55

Remarks. — On the surface of two shells there is microornamentation in the form of fine radial granulation. Similar ornamentation has been found on the specimen from Mecklenburg (Stoll 1834) and Balin (Laube 1867).

Occurrence. — Poland, Polish Lowlands: Kuiavian-Callovian, S of the Central Uplands (Balin, Piła Kościelecka): Upper Bathonian-Callovian. USSR (Turkmenia, Popilany, Moldavia, the region between the Prut and Dniestr rivers): Upper Bathonian-Lower, Middle Callovian. GDR: Middle Callovian.

Pleuromya decurtata (Phillips, 1829)
(pl. 34: 6 a—b)

1829. *Amphidesma decurtatum* sp. nov.: Phillips, pl. 7: 11.
1834—1840. *Lutraria decurtata* Goldfuss: 257, pl. 153: 3.
1961. *Pleuromya decurtata* (Phillips, 1829); Sibiriakova: 154, pl. 27: 4—6 (here earlier synonymy).

Material. — Two interior moulds of shell: ZPAL Mo. XII/49—50.

Measurements (in mm):

H	L	I	H/L
16—24	32—37	14—16	0.5—0.65

Remarks. — The Polish specimens are in accordance with those included to synonymy.

Occurrence. — Poland, N of the Central Uplands (Włodowice): Bathonian. England, France, USSR (Turkmenia): Bathonian. FRG: "Unter Oolithe".

Pleuromya donacina (Roemer, 1836)
(pl. 34: 7—8)

1836. *Lutraria donacina* Roemer: 124, pl. 9: 14.
1961. *Pleuromya donacina* (Roemer); Sibiriakova: 161, pl. 29: 5—6.

Material. — Three specimens: ZPAL Mo. XII/51—53.

Measurements (in mm):

H	L	I	H/L
15.0	24.0	10.5	0.62

Remarks. — The Polish specimens are in accordance with those included in synonymy.

Occurrence. — Poland, N of the Central Uplands: Bathonian (Włodowice, Kłobuck). USSR (W Turkmenia), W Germany: Bathonian.

Pleuromya tenuistria (Münster, 1836)

(pl. 32: 5; pl. 34: 5)

1834—1840. *Lutraria tenuistria* Münster; Goldfuss: 257, pl. 153: 2.

1973. *Pleuromya tenuistria* (Goldfuss); Romanov: 151, pl. 18: 5—6 (here earlier synonymy).

Material. — Two shells: ZPAL Mo. XII/54, 54a.

Measurements (in mm):

H	L	I	H/L
20.0	30.0	16.0	0.66

Remarks. — The examined specimens are in accordance with those included to synonymy. One can see microornamentation characteristic of the species consisting of granules arranges in thin oblique lines (pl. 32: 5).

Occurrence. — Poland, N of the Central Uplands (Włodowice): Bathonian. FRG: Bajocian. USSR (Moldavia): Upper Bajocian; (Turkmenia): Lower Bathonian. France: Bajocian-Bathonian.

Pleuromya recurva (Goldfuss, 1836)

(pl. 31: a—b)

1834—1840. *Lutraria recurva* Goldfuss: 257, pl. 152: 15.

Material. — One right valve: ZPAL Mo. XII/55.

Remarks. — The height of the specimen is about 22 mm, length about 35 mm, convexity 12 mm. The height index — 0.62.

Occurrence. — Poland, N of Central Uplands (Rudniki): Bathonian. FRG: Bathonian (Bavaria).

Pleuromya varians Agassiz, 1842

(pl. 27: 3 a—b, 4 a—b)

1896—1901. *Pleuromya varians* Agassiz; Loriol: 75, pl. 11: 6.

1861. *Pleuromya varians* Agassiz; Sibiriakova: 158, pl. 28: 7—8 (here earlier synonymy).

Material. — Six interior moulds of shells: ZPAL Mo. XII/70—75.

Measurements (in mm):

H	L	I	H/L
13—21	22—30	9—18	0.56—0.7

Remarks. — The Polish specimens are in accordance with those included to synonymy. High individual variability involves mainly changes of the shell length

in relation to height, what is illustrated by the significant differences in the height index.

Occurrence. — Poland, N of the Central Uplands (Włodowice) and S of the Central Uplands (Piła Kościelecka): Callovian. USSR (Western Turkmenia): Callovian. France. Switzerland: Oxfordian.

Superfamily **Pandoracea** Rafinesque, 1815
Family **Thraciidae** Stoliczka, 1870
Genus *Thracia* Leach *in* Sowerby, 1823
Thracia (*Thracia*) *lata* (Goldfuss, 1840)
(pl. 15: 10 a—b)

1834—1840. *Sanquinolaria lata* Goldfuss: 281, pl. 160: 2.
1973. *Thracia lata* (Goldfuss, 1839); Romanov: 135, pl. 14: 3—5 (here earlier synonymy).

Material. — One interior mould of shell: ZPAL Mo. XII/90.

Remarks. — The examined specimen has a height of 26 mm, slightly greater length, inflation of 13.5 mm, the height index about 1.

Occurrence. — Poland, Polish Lowlands: Middle-Upper Kuiavian. Switzerland, USSR (Moldavia, Western Turkmenia): Upper Bajocian-Lower Bathonian. FRG: Liassic-Bajocian.

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HALINA PUGACZEWSKA

MAŁŻE ŚRODKOWOJURAJSKIE POLSKI I UWAGI O ICH PALEOEKOLOGII

Streszczenie

Małże opracowane w niniejszej pracy pochodzą z osadów środkowej jury Polski Pozakarpackiej od dolnego bajosu (poziom *Stephanoceras humphriesianum*) do górnego keloweju włącznie (poziom *Kosmoceras jason*, *K. pollux* i *K. duncani*). Materiały do pracy zostały zebrane w latach 1958—1968 w czasie prac terenowych na Niżu Polskim (Łęczyca), Wyżynie Krakowsko-Częstochowskiej (Jaworzniki, Kierszula, Teofilów, Kłobuck, Kamienica Polska, Rudniki, Włodowice — północna część regionu, oraz Ogrodzieniec (Góra Żar), Balin, Piła Kościelecka — południowa część regionu), w Łukowie koło Siedlec oraz w Bachowicach koło Wadowic na Przedgórzu Karpat.

Materiał, w większości w dobrym stanie zachowania, pochodzi głównie z osadów kujawu i batonu Niżu Polskiego. W pozostałych regionach Polski jest on znacznie uboższy i w gorszym stanie zachowania. Częste są nagromadzenia małżów w postaci muszlowców ostrygowo-meleagrinellowych, ostrygowo-trygoniowych czy ostrygowo-serpulowych, które występują głównie w środkowym kujawie Niżu Polskiego (*Parkinsonia subarietis*) i kontynuują się do dolnego batonu (*Procerites* sp.). W łupkach ilastych, w różnych poziomach środkowej jury, występują nagromadzenia skorupek *Bositra buchii* (Roemer), najliczniej na Niżu Polskim i w północnej części regionu Wyżyny Krakowsko-Częstochowskiej. W muszlowcach małże są zwykle w gorszym stanie zachowania, często połamane, zwykle trudne w całości do wypreparowania z twardego osadu, prawie zawsze zachowują się tylko skorupki, muszle należą do rzadkości. Do szczegółowego opracowania użyto ponad 400 okazów.

Z nielicznymi wyjątkami małże nie stanowią form przewodnich dla określonych poziomów stratygraficznych, ale zespoły ich są charakterystyczne dla określonych facji. Ich rozwój, sposób życia i pobieranie pokarmu uzależnione są od środowiska. Wpływ środowiska powoduje wykształcenie się różnych przystosowań w budowie części miękkich organizmu jak i budowie, zarysie, wielkości muszli. Ze względu na sposób życia wyróżnia się 2 podstawowe kategorie małżów: małże epifaunalne — żyjące na dnie morskim lub nad dnem oraz infaunalne — żyjące w osadzie. Ze względu na sposób pobierania pakarmu małże należą do grupy pobierającej cząstki organiczne z zawiesiny wodnej oraz do grupy filtrującej pokarm z osadu. W kolekcji polskiej do tej drugiej grupy należy tylko jeden przedstawiciel, *Palaeonucula* z 6 gatunkami, zaś wszystkie pozostałe małże reprezentują grupę pierwszą, tzn. pobierające pokarm z zawiesiny wodnej.

Ze względu na miejsce bytowania zespół małżów żyjących na dnie lub ponad nim obejmuje następujące grupy: 1) małże przytwierdzające się jedną ze skorupek do trwałych obiektów dna morskiego, jak Ostrygi (*Liostrea*, *Catinula*, *Nanogyra*) cemen-

tujące się lewą skorupką oraz *Placunopsis*, cementujący się skorupką prawą; 2) małże przytwierdzające się byssusem, jak *Musculus, Modiolus, Pinna, Camptonectes, Lima, Plagiostoma, Limatula, Pseudolimea, Myoconcha*, które przytwierdzają się do stałych obiektów, oraz małże przytwierdzające się do obiektów dryfujących, jak *Inoceramus, Bositra, Oxytoma, Meleagrinella.*

Małże żyjące w osadzie można podzielić, ze względu na posiadanie krótkich czy długich rurek syfonalnych, lub też ich brak, na: 1) małże nie posiadające syfonów, które żyły tuż pod powierzchnią osadu otwierając otwory inhalacyjne i exhalacyjne bezpośrednio do wody. Należą tu aktywnie, szybciej lub wolniej penetrujące osad małże rodzajów: *Grammatodon, Trigonia, Myophorella, Vaugonia, Astarte, Neocrassina, Prorokia* i *Eriphyla*; 2) małże o krótkich syfonach, które żyły płytko w osadzie, wystawiając krótkie rurki syfonalne do granicy osad—woda. W polskim materiale grupę tę reprezentuje rodzaj *Tancredia*; 3) małże o długich rurkach syfonalnych, najliczniej reprezentowane w kolekcji, żyjące głęboko w osadzie dennym z syfonami wysuwanymi nad powierzchnię osadu. Należą tu: *Mactromya, Unicardium, Pholadomya, Goniomya, Gresslya, Myopholas, Pleuromya* i *Thracia* (łącznie 22 gatunki).

Te same cechy przystosowawcze małżów związane z trybem życia odgrywają niekiedy różną rolę w grupie epifaunalnych czy infaunalnych małżów. Na przykład ornamentacja skorupek dla małżów epifaunalnych stanowi wzmocnienie cienkich zwykle i delikatnych ich skorupek, zaś dla małżów infaunalnych ornamentacja guzkowa lub żeberkowa może warunkować głębokość penetrowania osadu, stanowiąc pewne utrudnienie w szybkim zagłębianiu się w dno. Małże o silnie wypukłych skorupkach z grupy infaunalnej zapewne zagrzebywały się płycej, zaś o skorupkach spłaszczonych bocznie mogły szybciej i głębiej drążyć osad. Niekiedy przystosowawczy charakter do środowiska może przejawiać się odmiennie nawet u przedstawicieli tego samego rodzaju. W warunkach burzliwych środowiska litoralnego, o znacznym falowaniu, intensywnym naświetleniu małże rodzaju *Lima* o muszlach spłaszczonych przytwierdzają się byssusem w szczelinach skalnych po nienaświetlonej stronie skały, zaś inni przedstawiciele tego rodzaju o silnie uwypuklonych skorupkach, mogą sami uwalniać się i, poruszając skorupkami, swoiście pływać. Adaptacją małżów do silnego falowania wód w strefie litoralnej przytwierdzających się jedną ze skorupek, jest znaczne pogrubienie skorupek. W ten sposób przeciwstawiają się one niszczącemu działaniu silniejszych prądów. Małże żyjące w zamulonym środowisku dennym, o znacznej zawartości klastycznych cząstek nieorganicznych zaadaptowały swe muszle wytwarzając wysokie żebra promieniste o ząbkowanym brzegu przywentralnym. Tak powstały brzeg zygzakowaty lub sfałdowany (*Pseudolimea duplicata* (Münster)) wielokrotnie zwiększał powierzchnię sensoryczną brzegu płaszcza a dodatkowo jeszcze zabezpieczał jamę płaszczową przed przenikaniem do niej większych cząstek nieorganicznych, działając na podobieństwo sita.

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EXPLANATIONS OF PLATES 15—34

Plate 15

Łęczyca near Kutno

1. *Palaeonucula strigilata* (Goldfuss), shell ZPAL Mo. XII/70: *a* in dorsal view, *b* right valve view, Kuiavian.
2. Same species, valve ZPAL Mo. XII/71, internal view of left valve, Kuiavian.
3. Same species, valve ZPAL Mo. XII/72, internal view of right valve, Kuiavian.
4. *Palaeonucula variabilis* (Sowerby), shell ZPAL Mo. XII/76: *a* dorsal view, *b* right valve in external view, Upper Bajocian.
5. Same species, valve ZPAL Mo. XII/77, internal view of left valve, Upper Bajocian.
6. Same species, right valve ZPAL Mo. XII/78, internal view, Lower Bathonian.
7. Same species, left valve ZPAL Mo. XII/79: anterior muscle scar and anterior part of hinge visible, Lower Bathonian.
8. *Palaeonucula hammeri* (Defrance), shell ZPAL Mo. XII/81: *a* dorsal view, *b* right valve view, Kuiavian.
9. *Palaeonucula mankei* (Roemer), shell ZPAL Mo. XII/46: *a* right valve in external view, *b* dorsal view, Upper Kuiavian.
10. *Thracia lata* (Goldfuss), shell ZPAL Mo. XII/90: *a* in dorsal view, *b* left valve in external view, Kuiavian.
11. *Bositra buchii* (Roemer), valve ZPAL Mo. XII/91, concentric ornamentation visible, Bajocian.

1—9 ×2; *10* ×1.5; *11* ×3

Plate 16

Łęczyca near Kutno

1. *Palaeonucula* cf. *oxfordiana* (Roeder), shell ZPAL Mo. XII/87: *a* right valve view, *b* dorsal view of shell, Kuiavian.
2. Same species, shell ZPAL Mo. XII/88, umbo strong shifted posteriorly, Kuiavian.
3. *Palaeonucula ornati* (Quenstedt), shell ZPAL Mo. XII/106: *a* right valve view, *b* dorsal view, Kuiavian.
4. Same species, shell ZPAL Mo. XII/107: concentric folds well developed, Kuiavian.
5. *Unicardium* sp., left valve ZPAL Mo. XII/124: *a* external view, ×1.5, *b* internal view, ×3, Middle Bathonian.
6. Same species, right valve ZPAL Mo. XII/125, hinge well developed is visible, Middle Bathonian.
7. *Tancredia axiniformis* (Phillips), right valve ZPAL Mo. XII/127 in external view, keel well developed, Upper Kuiavian.
8. Same species, left valve ZPAL Mo. XII/128 in internal view, Upper Kuiavian.
9. Same species, right valve ZPAL Mo. XII/129 in internal view, Upper Kuiavian.

1—4, 7—9 ×2; *6* ×3

Plate 17

Łęczyca near Kutno

1. *Modiolus* (*Modiolus*) *cuneatus* (Sowerby), valve of young specimen ZPAL Mo. XII/92, Upper Kuiavian, ×1.
2. Same species, mould of a shell ZPAL Mo. XII/93: *a* in anterior view, *b* left valve, Upper Kuiavian.
3. *Inoceramus* (*Mytiloides*) *amygdaloides* Goldfuss, mould of a shell ZPAL Mo. XII/94: *a* right valve view, *b* posterior view of a specimen, *c* dorsal view, Lower Kuiavian.
4. Same species, a mould of shell ZPAL Mo. XII/95 of young specimen, Lower Kuiavian.
5. *Musculus* (*Musculus*) *pulcherrimus* Roemer, left valve ZPAL Mo. XII/96: *a* latero-ventral view, ×2, *b* lateral view, ×5, Middle Bathonian.
6. *Modiolus* (*Modiolus*) *lonsdalei* (Morris and Lycett), right valve ZPAL Mo. XII/97 in external view, Lower Bathonian.
7. *Limatula gibbosa* (Sowerby), shell ZPAL Mo. XII/98: *a* view of left valve, *b* anterior view of shell, Upper Kuiavian.

2, *6—7* ×1.5; *3—4* ×2

Plate 18

Łęczyca near Kutno

1. *Oxytoma* (*Oxytoma*) *inequivalvis* (Sowerby), shell ZPAL Mo. XII/69: *a* view of left valve, *b* view of right valve, Upper Kuiavian, ×1.
2. *Eriphyla* (*Eriphyla*) *depressa* (Münster), right valve of young specimen ZPAL Mo. XII/17, Bajocian, ×4.
3. *Oxytoma* (*Oxytoma*) *inequivalvis* (Sowerby), valve ZPAL Mo. XII/166: *a* external view, ×3, *b* hinge view, Upper Kuiavian, ×5.
4. *Mactromya depressa* (Phillips), left valve ZPAL Mo. XII/99 in hinge view, Middle Bathonian, ×4.
5. *Meleagrinella* cf. *Maccoyella moorei* (Etheridge), valve ZPAL Mo. XII/168: hinge with tooth-like protuberance visible, Upper Kuiavian, ×5.
6. *Vaugonia compta* (Lycett), right valve ZPAL Mo. XII/169: *a* external view, oblique additionale striae on posterior valve area are visible, *b* internal view, wide and low posterior tooth is visible, Upper Kuiavian, ×3.
7. *Modiolus* (*Modiolus*) *lonsdalei* (Morris and Lycett), posterior fragment of valve ZPAL Mo. XII/97a: concentric ornamentation visible, Upper Kuiavian, ×2.
8. *Oxytoma* (*Oxytoma*) *inequivalvis* (Sowerby), left valve ZPAL Mo. XII/167: hinge visible, Upper Kuiavian, ×5.
9. *Pseudolimea duplicata* (Münster), fragment of valve ZPAL Mo. XII/148: on the side of ribs of I order thin riblets visible, in intervals also ribs of II order visible, Upper Kuiavian, ×10.

Plate 19

Łęczyca near Kutno, Upper Kuiavian

1. *Oxytoma* (*Oxytoma*) *inequivalvis* (Sowerby), left valve ZPAL Mo. XII/176: internal view of valve, on adductor muscle scar *Bullopora rostrata* cemented, ×5.

2. *Meleagrinella echinata* (Smith), right valve ZPAL Mo. XII/174: *a* external view, ×3; *b* fragment of valve surface, ×30; *c* enlarged fragment, ×300 microornamentation of valve surface well visible.
3. Same species, left valve ZPAL Mo. XII/175, on internal surface of valve discontinuous mantle line and posterior adductor muscle scar reniform in shape are visible, ×5.

Plate 20

Meleagrinella echinata (Smith)
Łęczyca near Kutno, Upper Kuiavian

1—5. Right valves in different growth stages ZPAL Mo. XII/169—173: *a* external view; *b* internal view, *c* growth changes of hinge, all figs. ×3, 5 *c* ×10.

Plate 21

Meleagrinella echinata (Smith)
Łęczyca near Kutno, Upper Bajocian

1—5. Left valves ZPAL Mo. XII/157—161: *a* differentiation of ornamentation is visible, ×2; *b* details of ornamentation, ×6.

Plate 22

1. *Pseudolimea duplicata* (Münster), valve of adult specimen ZPAL Mo. XII/150: *a* concentration of growth lines near ventral margin is visible, ×2, *b* valve more enlarged, ×10.
2. *Meleagrinella echinata* (Smith), fragment of valve ZPAL Mo. XII/155: *a* external view, ×2, *b* fragment of valve more enlarged, ×6.
3. Same species, fragment of valve ZPAL Mo. XII/156; *a* example of variability of ornamentation, ×2, *b* enlarged fragment of valve, ×6.
4. *Lima* (*Lima*) *duplicata* Sowerby, fragment of valve ZPAL Mo. XII/146: *a* external view, ×2, *b* fragment of valve more enlarged, ×6.
5. Same species, fragment of valve ZPAL Mo. XII/176: *a* example of differentiation of ornamentation in this species, ×2; *b* details of ornamentation, ×6.
6. Same species, fragment of valve ZPAL Mo. XII/176a: *a* external view, ×2; *b* details of ornamentation visible, ×6.

Plate 23

Łęczyca near Kutno, Upper Bajocian

1. *Camptonectes* (*Camptonectes*) *rushdenensis* (Lycett), right valve ZPAL Mo. XII/147: *a* external view, ×2, *b* ornamentation in postero-ventral part of valve, ×9, *c* ornamentation in antero-ventral part of valve, ×9.
2. Same species, right valve ZPAL Mo. XII/148: *a* external view, ×2, *b* antero-ventral ornamentation of valve, ×9.

3. *Camptonectes* (*Camptonectes*) *richei* Dechaseaux, left valve of adult specimen ZPAL Mo. XII/149: *a* external view, ×2, *b* middle fragment of the valve, ×9.
4. *Meleagrinella echinata* (Smith), right valve ZPAL Mo. XII/154, well developed ornamentation is visible, ×9.

Plate 24

1. *Camptonectes* (*Camptonectes*) *rushdenensis* (Lycett), left valve ZPAL Mo. XII/165: *a* external view, ×2, *b* middle part of valve, ×9.
2. *Camptonectes* (*Camptonectes*) *lens* (Sowerby), left valve of adult specimen, ZPAL Mo. XII/162, ×3.
3. Same species, left valve ZPAL Mo. XII/163: *a* external view, ×2, *b* a fragment of valve more enlarged, ×9.
4. *Pseudolimea duplicata* (Münster), valve ZPAL Mo. XII/149: *a* external view, ×2, *b* valve fragment more enlarged, ×9.
5. Same species, valve ZPAL Mo. XII/150: *a* external view, ×2, *b* enlarged lateral fragment of valve, radial ornamentation not developed, ×9.

Plate 25

Łęczyca near Kutno, Upper Kuiavian

1. *Camptonectes* (*Camptonectes*) *rushdenensis* (Lycett), right valve ZPAL Mo. XII/178: *a* external view, ×2; *b* changes of ornamentation are visible; concentric striae under umbo with growth stages are as concentric lamellae developed, ×4.
2. *Placunopsis* cf. *radians* (Morris and Lycett), valve ZPAL Mo. XII/68: *a* external surface of valve visible, ×3; *b* details of complicated ornamentation are visible, ×10.
3. *Camptonectes* (*Camptonectes*) *lens* (Sowerby), fragment of valve ZPAL Mo. XII/ /162, details of ornamentation well visible, ×10.

Plate 26

Łęczyca near Kutno, Upper Kuiavian

1. *Lima* (*Lima*) *duplicata* Sowerby, shell of adult specimen ZPAL Mo. XII/144: *a* left valve visible, *b* dorsal view of shell.
2. *Plagiostoma* cf. *semicircularis* Goldfuss, right valve ZPAL Mo. XII/143, *a* dorsal view, *b* external view.
3. *Gresslya peregrina* (Phillips), valve fragment ZPAL Mo. XII/111, ornamentation in form of fine granulation in linear arrangement is visible.
4. *Bositra buchii* (Roemer) in cluster ZPAL Mo. XII/91.

1—2, *4* ×1; *3* ×5

Plate 27

1. *Lima* (*Lima*) *duplicata* Sowerby, left valve ZPAL Mo. XII/145 in external view, Łęczyca near Kutno, Upper Kuiavian, ×1.5.

2. *Pinna* (*Pinna*) cf. *buchii* Koch and Dunker, shell fragment ZPAL Mo. XII/151: *a* in lateral view, *b* keel of different ornamentation, Łęczyca near Kutno, Upper Kuiavian, ×2.
3. *Pleuromya varians* Agassiz, mould of young specimen ZPAL Mo. XII/132: *a* dorsal view, *b* lateral view, Piła Kościelecka in region of Kraków, Callovian, ×1.5.
4. Same species, mould of adult specimen ZPAL Mo. XII/133: *a* dorsal view, well-flattened umbones visible, *b* left valve, concavity of ventral margin visible, Piła Kościelecka in region of Kraków, Callovian, ×1.5.
5. *Pseudolimea duplicata* (Münster), valve ZPAL Mo. XII/147 in external view, fine ribs of II order are well visible. Łęczyca near Kutno, Upper Kuiavian, ×2.
6. Same species, valve of adult specimen ZPAL Mo. XII/148, ribs of I order visible, Łęczyca near Kutno, Upper Kuiavian, ×1.5.
7. *Myoconcha* sp., valve of juvenile specimen ZPAL Mo. XII/152 in hinge view, Łęczyca near Kutno, Upper Kuiavian, ×8.
8. Same species, valve of juvenile specimen ZPAL Mo. XII/153 in external view, irregular folds visible, Łęczyca near Kutno, Upper Kuiavian, ×8.

Plate 28

Mactromya depressa (Phillips)
Łęczyca near Kutno, Middle Bathonian

1. Right valve ZPAL Mo. XII/99: hinge view,
2. Left valve ZPAL Mo. XII/100: hinge view,
3. Shell in posterior view ZPAL Mo. XII/101: growth striae visible,
4. Shell ZPAL Mo. XII/102: *a* dorsal view, *b* right valve view, *c* left valve view,
5. Shell of adult specimen ZPAL Mo. XII/103: *a* dorsal view, *b* right valve view,

1—2 ×4; *3* ×1.5; *4—5* ×2

Plate 29

Łęczyca near Kutno

1. *Astarte* (*Astarte*) cf. *meeki* Stanton, external view of the right valve ZPAL Mo. XII/23, Upper Kuiavian.
2. *Eriphyla* (*Eriphyla*) *depressa* (Münster), valve ZPAL Mo. XII/16: *a* internal, *b* external view, Lower Kuiavian.
3. Same species, right adult valve ZPAL Mo. XII/17 in external view, Lower Kuiavian.
4. *Astarte* (*Leckhamptonia*) cf. *aytonensis* (Lycett), external view of right valve ZPAL Mo. XII/15, Bathonian, ×3.
5. *Astarte* (*Astarte*) *pulla* Roemer, left valve ZPAL Mo. XII/1; *a* internal, *b* external view, Upper Kuiavian.
6. Same species, shell ZPAL Mo. XII/2: *a* external, *b* anterior view, Upper Kuiavian.
7. *Eriphyla* (*Eriphyla*) *elegans* Münster, right valve ZPAL Mo. XII/18: *a* internal, *b* external view, Lower Kuiavian.
8. Same species, left ZPAL Mo. XII/19 in external view, Lower Kuiavian.
9. *Neocrassina* (*Neocrassina*) *striato-costata* (Goldfuss), shell ZPAL Mo. XII/20: *a* left valve in external view, *b* shell in dorsal view, Lower Bathonian.

10. Same species, left valve ZPAL Mo. XII/21, hinge view, Lower Bathonian.
11. *Astarte* (*Astarte*) *robusta* Lycett, left valve ZPAL Mo. XII/6, hinge view, Lower Bathonian.
12. Same species, shell ZPAL Mo. XII/7, right valve in external view, Upper Kuiavian.
13. *Astarte* (*Astarte*) *minima* Phillips, shell ZPAL Mo. XII/3: *a* right valve in external view, *b* shell in anterior view, Upper Kuiavian.
14. *Astarte* (*Astarte*) *fimbriata* Walton, shell ZPAL Mo. XII/8: *a* right valve in external view, *b* shell in anterior view, Lower Bathonian.

2—3, 7—10 ×2; *others* ×4

Plate 30

1. *Pholadomya* (*Pholadomya*) *murchisoni* Sowerby, shell of adult specimen ZPAL Mo. XII/24: *a* dorsal, *b* anterior, *c* right valve views, Łęczyca near Kutno, Upper Kuiavian, nat. size.

Plate 31

1. *Pholadomya* (*Pholadomya*) *canaliculata* Roemer, shell ZPAL Mo. XII/37, left valve in external view, Łęczyca near Kutno, Middle Bathonian.
2. *Goniomya rudnikensis* sp. n., holotype, left valve ZPAL Mo. XII/56: *a* external view, *b* dorsal view, Rudniki near Częstochowa, Middle Bathonian.
3. *Pholadomya* (*Pholadomya*) cf. *lineata* Goldfuss, shell ZPAL Mo. XII/42, external view of right valve, Rudniki near Częstochowa, Upper Kuiavian.
4. Same species, shell ZPAL Mo. XII/43: *a* right valve view, *b* shell in dorsal view, Rudniki near Częstochowa, Upper Kuiavian.
5. *Myophylas mutabilis* Gerasimov, left valve ZPAL Mo. XII/67, Rudniki near Częstochowa, Uppermost Bathonian.
6. *Pholadomya* (*Pholadomya*) *angustata* (Sowerby), shell ZPAL Mo. XII/38: *a* left valve in external view, *b* shell in dorsal view, Rudniki near Częstochowa, Upper Kuiavian.
7. *Pholadomya* (*Pholadomya*) *crassa* (Agassiz), shell ZPAL Mo. XII/31: *a* left valve in external view, *b* shell in dorsal view, Włodowice near Zawiercie, Bathonian.

1, 3, 5—7 ×1; *2, 4* ×1.5

Plate 32

1. *Pholadomya* (*Buccardiomya*) cf. *buccardium* Agassiz, shell ZPAL Mo. XII/63 viewed from right valve, Łęczyca near Kutno, Middle Bathonian.
2. Same species, shell ZPAL Mo. XII/64, viewed from left valve, Łęczyca near Kutno, Middle Bathonian.
3. *Prorokia meriani* (Greppin), right valve ZPAL Mo. XII/58: *a* denticulated ventral margin of the valve is visible, *b* external view, Łęczyca near Kutno, Middle Kuiavian.
4. *Goniomya rudnikensis* sp. n., paratype, right valve ZPAL Mo. XII/57: *a* external view, ×2, *b* valve fragment, ×10, Rudniki near Częstochowa, Middle Bathonian.

5. *Pleuromya tenuistria* (Münster), valve fragment ZPAL Mo. XII/54, oblique striae visible, Włodowice near Zawiercie, Bathonian.
6. *Pholadomya (Pholadomya) ambiqua* (Sowerby), left valve ZPAL Mo. XII/59, external view, Łęczyca near Kutno, Middle Bathonian.
7. *Pholadomya (Pholadomya) deltoidea* (Sowerby), left valve ZPAL Mo. XII/32, external view, Łęczyca near Kutno, Middle Bathonian.

1—2, 6—7 ×1; *3, 5* ×3

Plate 33

1. *Grammatodon (Grammatodon) concinnus* (Phillips), shell ZPAL Mo. XII/108: *a* left valve view, *b* dorsal view, Łęczyca near Kutno, Kuiavian.
2. *Mactromya depressa* (Phillips), right valve ZPAL Mo. XII/104: *a* external view, *b* dorsal view, lunula narrow, Łęczyca near Kutno, Middle Bathonian.
3. *Gresslya peregrina* (Phillips), shell ZPAL Mo. XII/110: *a* left valve visible, *b* view on anterior part of shell, Łęczyca near Kutno, Kuiavian.
4. *Gresslya abducta* (Phillips), shell ZPAL Mo. XII/117 in anterior view, Łęczyca near Kutno, Kuiavian.
5. Same species, shell ZPAL Mo. XII/118 in view on left valve, Łęczyca near Kutno, Middle Kuiavian.
6. *Gresslya gregaria* (Zieten), shell ZPAL Mo. XII/121: *a* viewed on left valve, *b* on dorsal side, narrow furrow posteriorly of the umbo visible, Rudniki near Częstochowa, Bathonian.
7. Same species, mould of shell ZPAL Mo. XII/122, umbones, strongly bent inward and adductor muscle scarce are visible, Rudniki near Częstochowa, Bathonian.

1, 3—6 ×1; *2* ×2; *7* ×1.5

Plate 34

1. *Pleuromya polonica* (Laube), shell ZPAL Mo. XII/46: *a* shell in dorsal view, *b* left valve view, Łęczyca near Kutno, Upper Kuiavian.
2. Same species, shell ZPAL Mo. XII/47: *a* dorsal view, *b* right valve in external view, Łęczyca near Kutno, Upper Kuiavian.
3. *Pleuromya calceiformis* (Phillips), shell ZPAL Mo. XII/45: *a* shell in dorsal view, *b* left valve in external view, Łęczyca near Kutno, Upper Kuiavian.
4. *Pleuromya recurva* (Goldfuss), valve ZPAL Mo. XII/55: *a* right valve in external view, *b* right valve in internal view, Rudniki near Częstochowa, Bathonian.
5. *Pleuromya tenuistria* (Münster), shell ZPAL Mo. XII/54: *a* dorsal view of the shell, *b* left valve view, Włodowice near Zawiercie, Bathonian.
6. *Pleuromya decurtata* (Phillips), shell ZPAL Mo. XII/49: *a* dorsal view, *b* right valve view, Włodowice near Zawiercie, Bathonian.
7. *Pleuromya donacina* (Roemer), shell ZPAL Mo. XII/51, in dorsal view, Włodowice near Zawiercie, Bathonian.
8. Same species, left valve ZPAL Mo. XII/52 in external view, Włodowice near Zawiercie, Bathonian.
9. *Pleuromya elongata* (Goldfuss), shell ZPAL Mo. XII/44: *a* dorsal view of the shell, *b* left valve in external view, Łęczyca near Kutno, Upper Kuiavian.

1, 3—5 ×1; *2, 6, 9* × 1.5; *7—8* ×2


1a


1b


2


3


4a

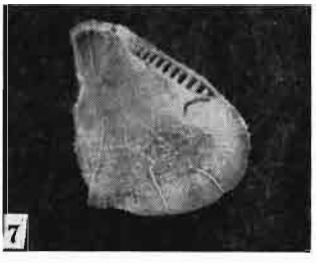

8a


8b


5


6


4b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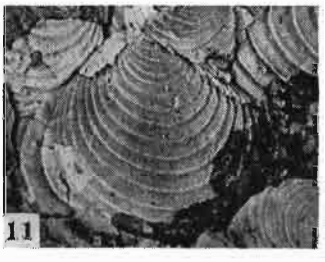
9a


9b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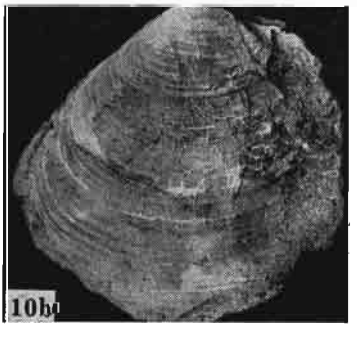
10a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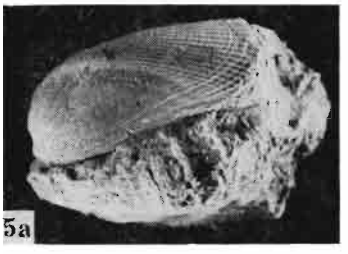
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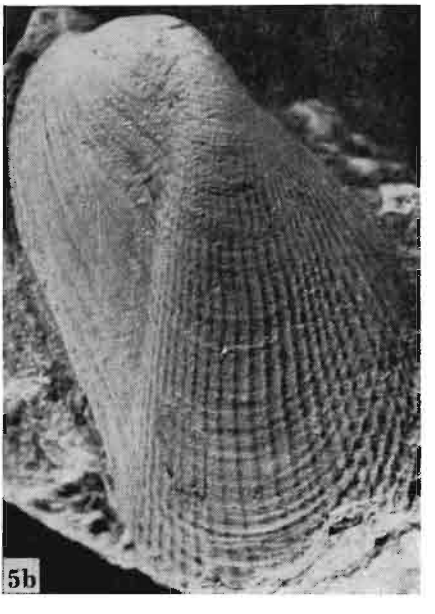
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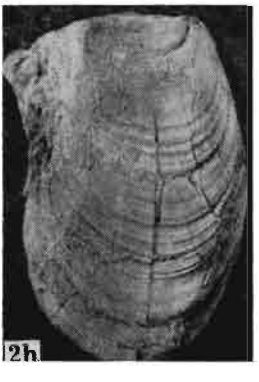
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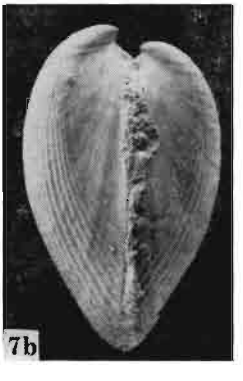
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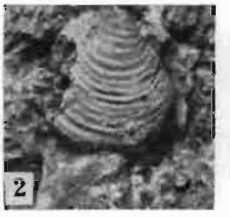
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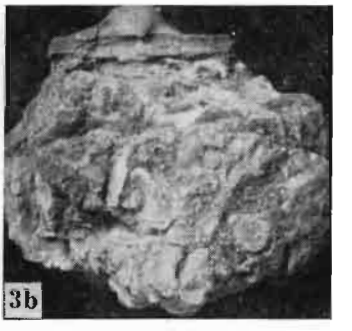
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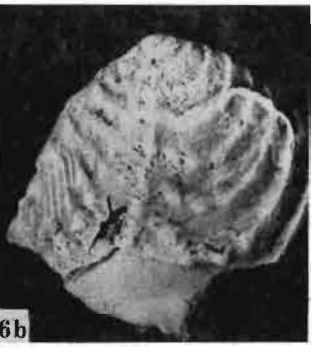
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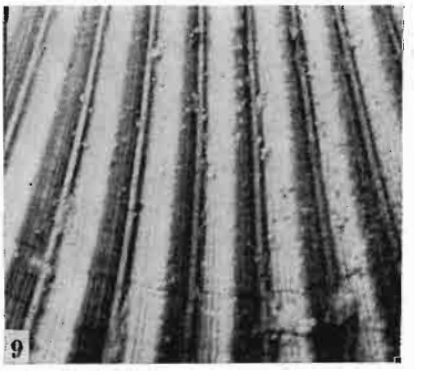
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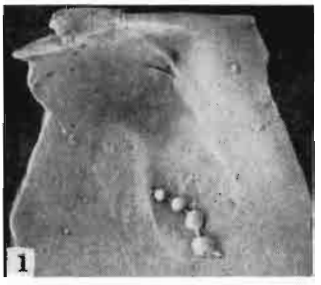
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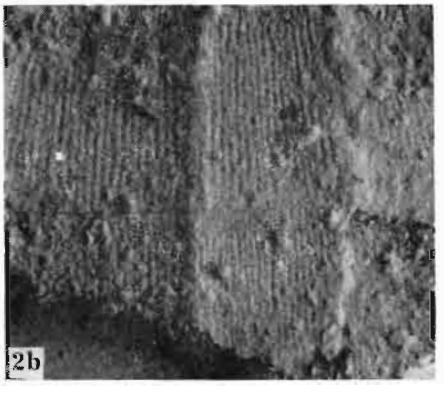
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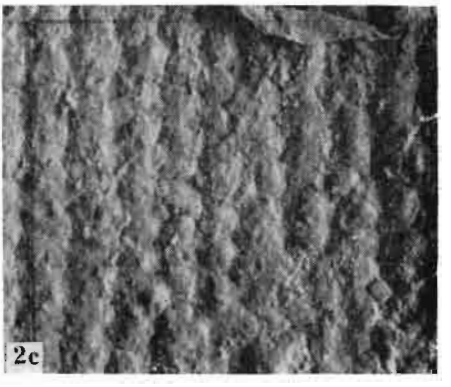
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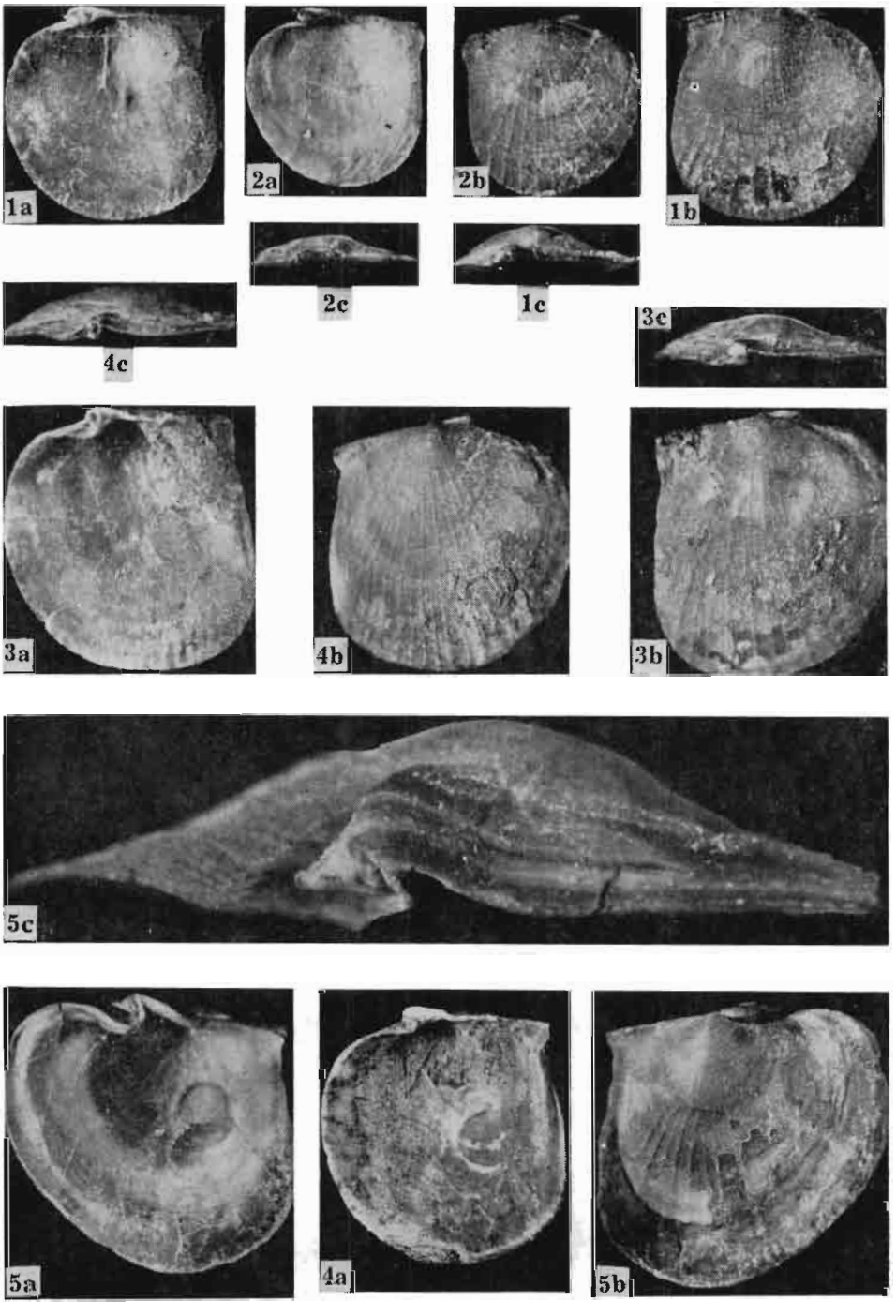
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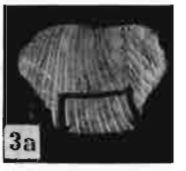
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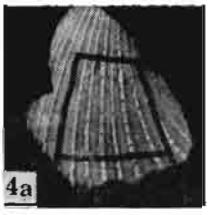
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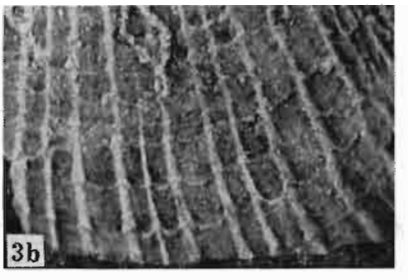
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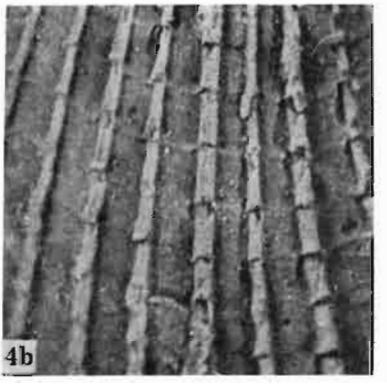
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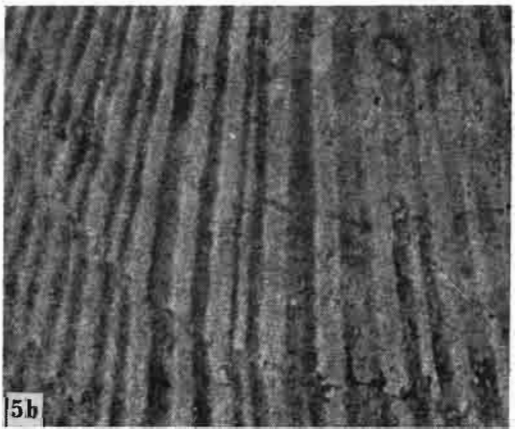
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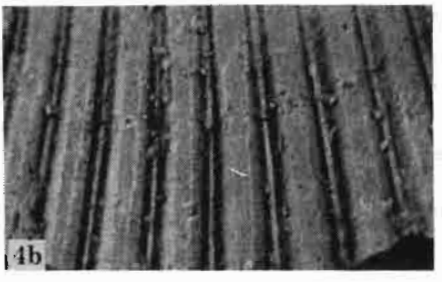
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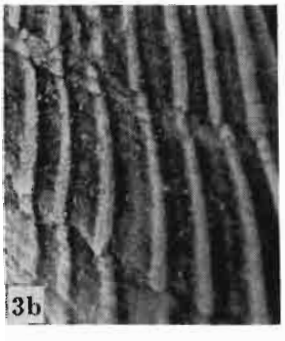
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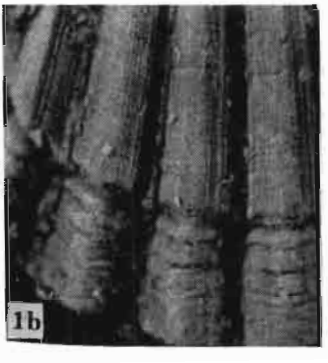
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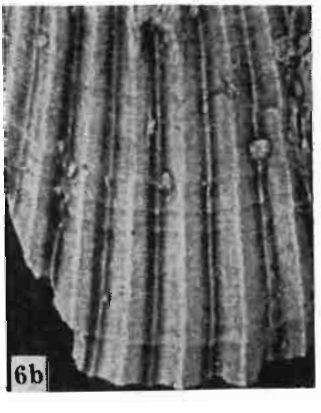
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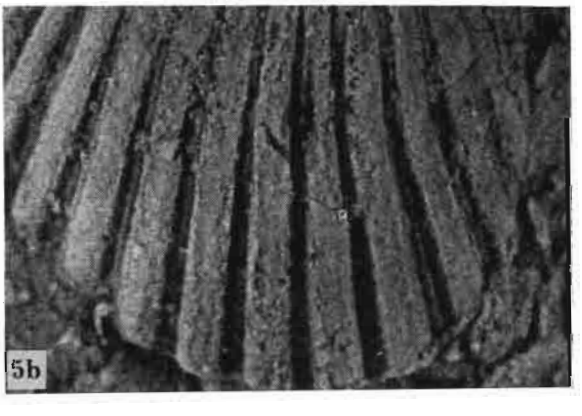
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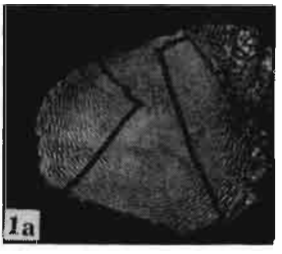
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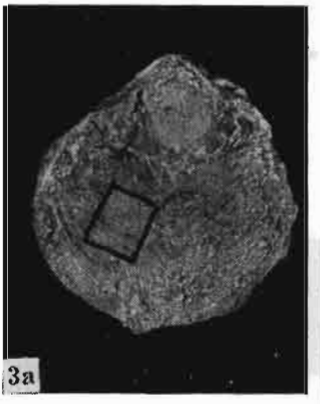
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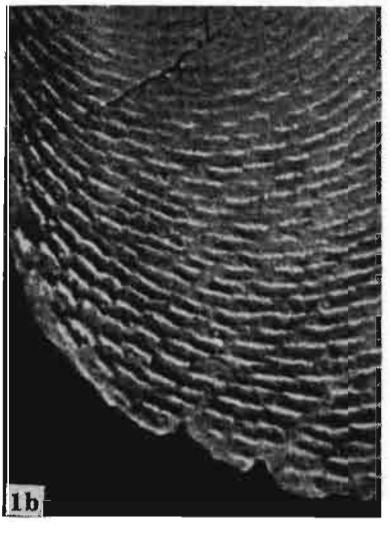
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4b


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3b


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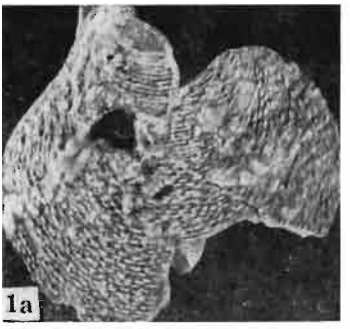
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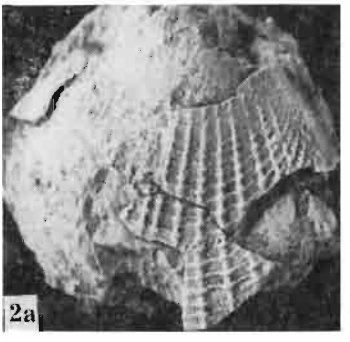
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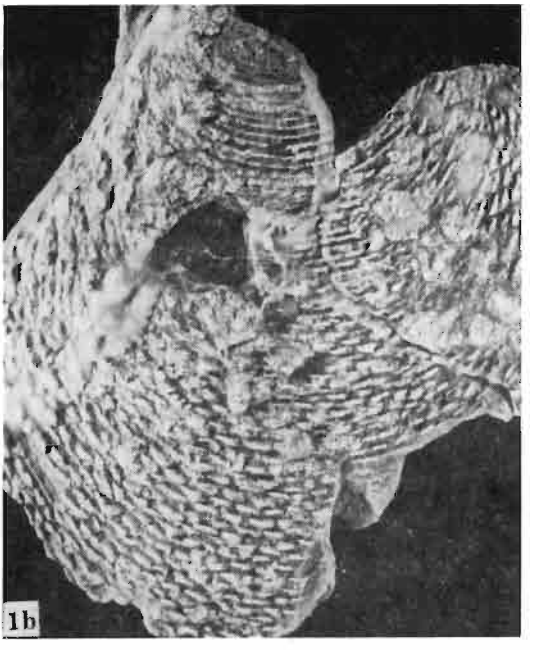
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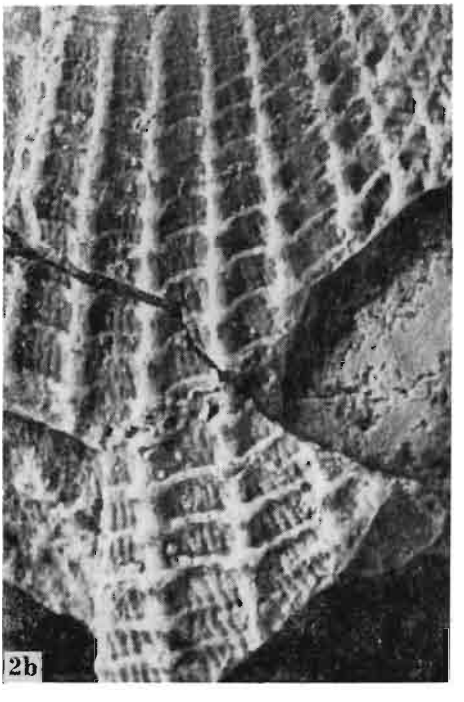
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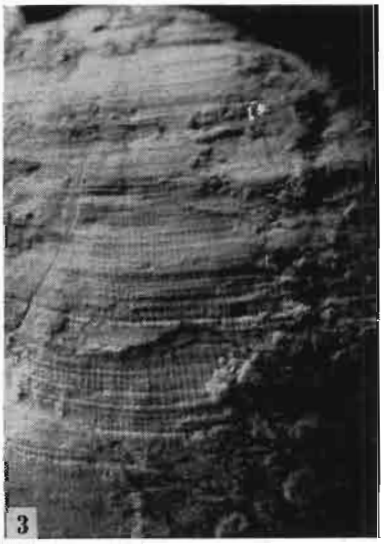
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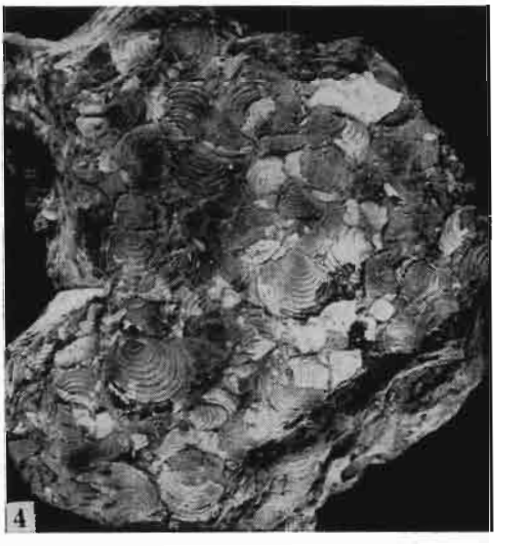
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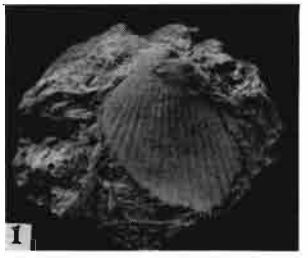
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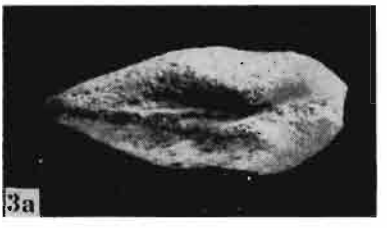
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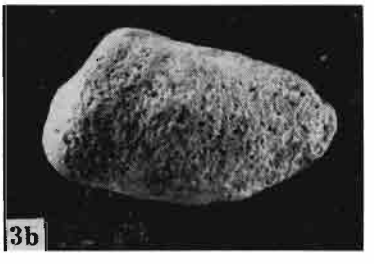
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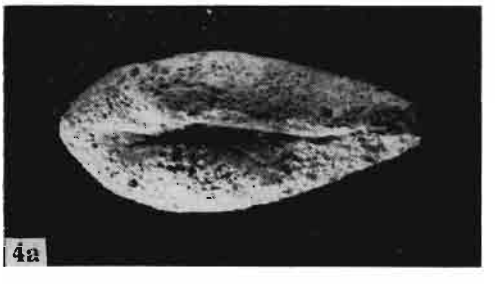
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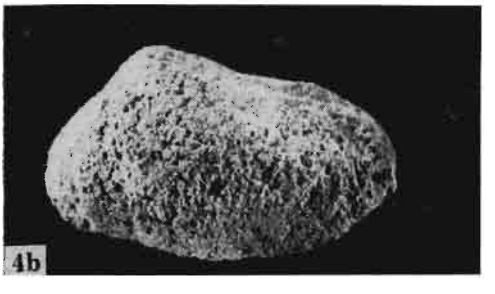
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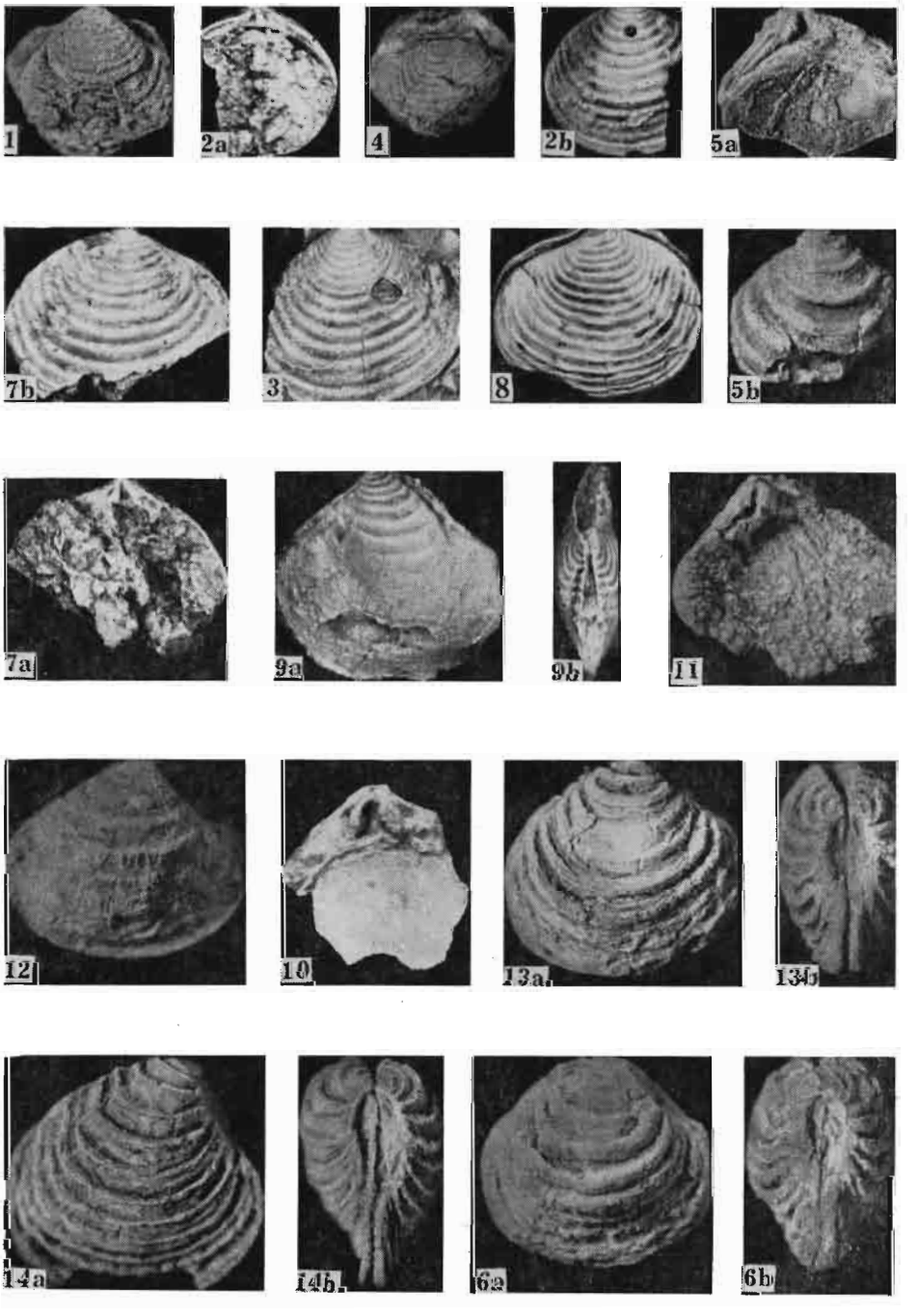
4b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1a


1b


1c


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2a


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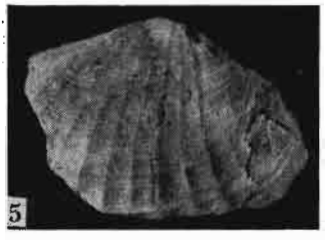
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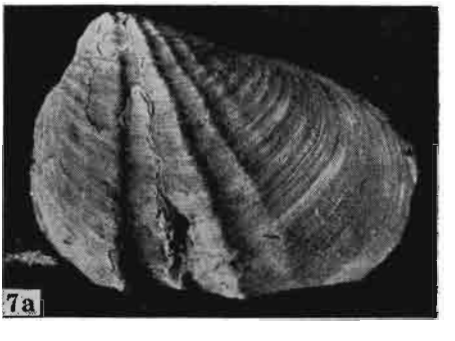
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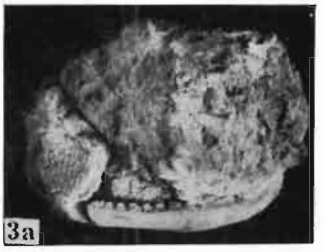
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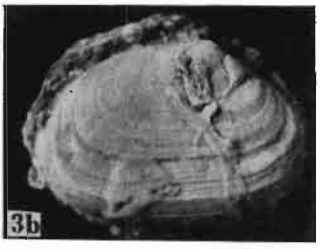
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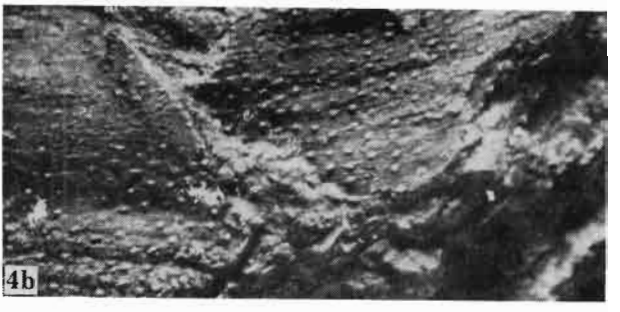
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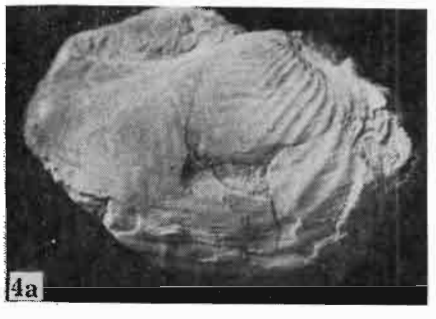
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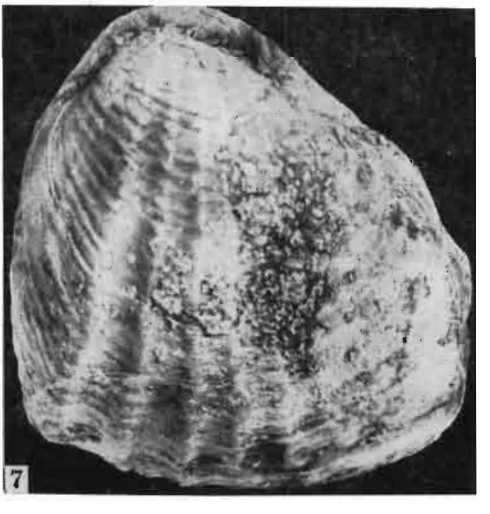
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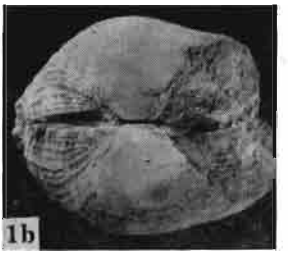
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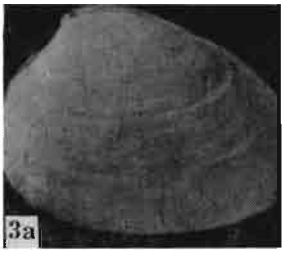
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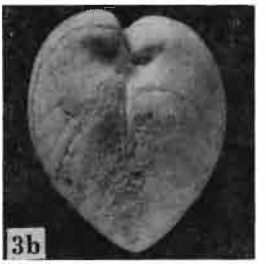
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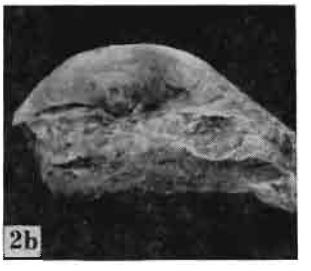
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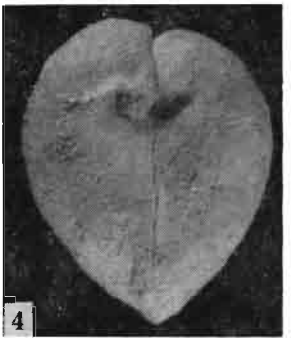
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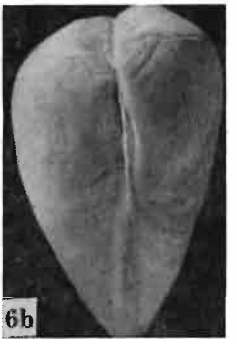
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6a


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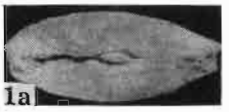
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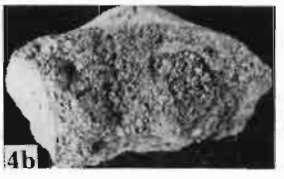
1b


3a


4a


5a


2a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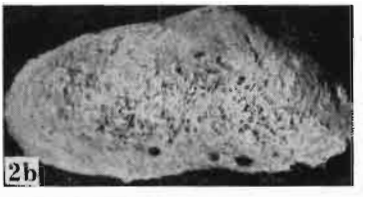
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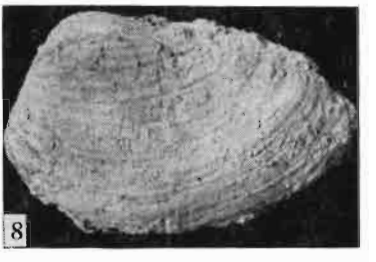
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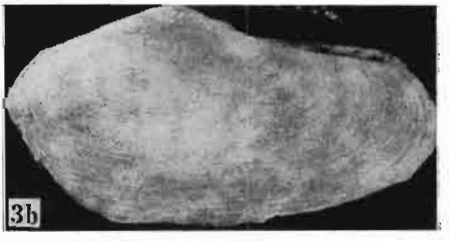
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