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Middle Miocene (Badenian) bivalves from the carbonate deposits of the Wójcza-Pińczów Range (southern slopes of the Holy Cross Mountains, Central Poland)

ABSTRACT: The paper deals with Middle Miocene (Badenian) bivalves from the limestones and marls of the Wójcza-Pińczów Range (southern slopes of the Holy Cross Mountains, Central Poland). Totally, 80 bivalve species are recorded, and the taxonomic structure of their assemblage is described. The Neogene European interprovince connections are indicated and the stratigraphic usefulness of pectinids is discussed. The systematic account includes the paleontological descriptions of 23 species, two of them, viz. *Chlamys* (*Aequipecten*) *angelonii* (de STEFANI & PANTANELLI), and *Cyathodonta eggenburgensis* (SCHAFFER), being for the first time reported from the Polish Miocene.

INTRODUCTION

The present paper deals with Middle Miocene (Badenian) bivalves from the carbonate deposits exposed along the southern slopes of the Holy Cross Mts, Central Poland. The material for the present study has been derived from several outcrops situated along the Wójcza-Pińczów Range (Text-figs 1–2).

The Badenian of the Wójcza-Pińczów Range comprises mainly red-algal deposits, known as the Pińczów Limestones (*cf.* STUDENCKI 1988a). They are underlain by marls and non-algal organodetrital limestones, constituting their Middle Miocene substrate, or they directly contact Late Cretaceous marls and sandstones. The total thickness of the Middle Miocene deposits reaches 30 m.

Four facies have been distinguished in the Pińczów Limestones, *viz.* rhodolith pavement facies, branching algae facies, algal-bryozoan facies, and organodetrital facies (STUDENCKI 1988a). The facies considerably differ in fossil species composition; hence, the distribution of bivalve species in the particular facies of the Pińczów Limestones and in the underlying marls is indicated (Table 1).

The Badenian deposits of the Wójcza-Pińczów Range have been formed in a subtropical, shallow-marine environment, within an elongated carbonate platform. They largely originated under moderate to strong water agitation, but the marls accumulated in quiet-water conditions (STUDENCKI 1988a).

The geological age of the Pińczów Limestones and their Miocene substrate had previously been determined (ALEXANDROWICZ & PARACHONIAK 1956, ALEXANDROWICZ 1958) as that what is now regarded as Early to Middle Badenian. This was recently confirmed by foraminiferal (E. ODRZYWOLSKA-BIEŃKOWA, *personal communication*) as well as nannoplankton studies when *Sphenolithus heteromorphus*, the index fossil for NN5 zone, was recognized in a sample from Kików (A. NAGYMAROSY, *personal communication*).

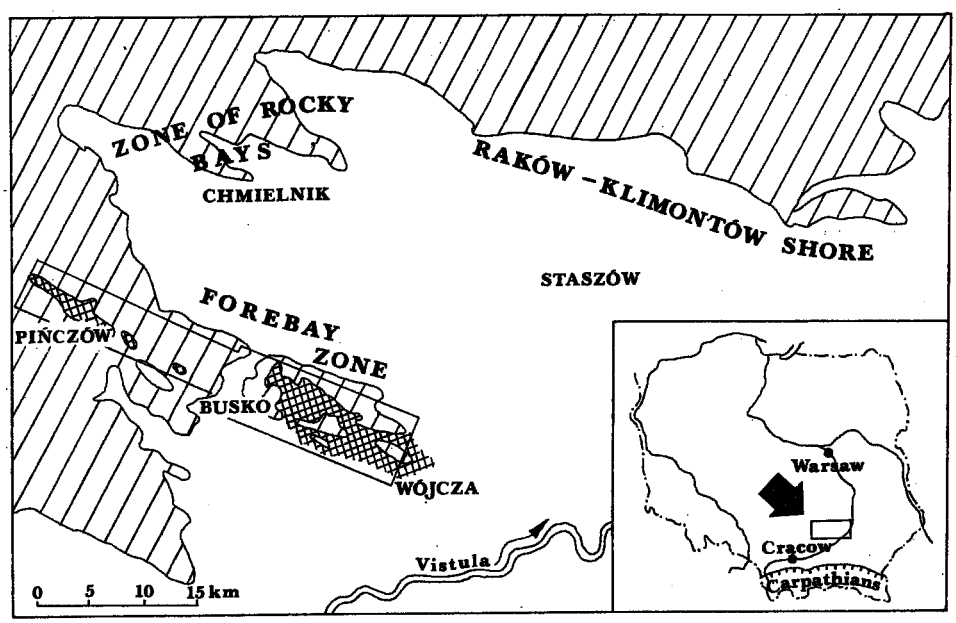


Fig. 1. Location of the Wójcza-Pińczów Range (*rectangled*) and its relation to the Middle Miocene (Badenian) paleogeographic and tectonic units (*adopted from* RADWAŃSKI 1969) Indicated are: present-day exposure areas of the Pińczów Limestones (*checkered*), other Middle Miocene deposits (*blank*), and pre-Miocene substrate (*hachured*)

PREVIOUS WORKS

The bivalves from the Wójcza-Pińczów Range were first presented by PUSCH (1837), who described and partly illustrated 16 species. Their proper identification, however, is frequently impossible, as PUSCH's collections has been lost during the time (KIEPURA 1984).

Three of the species reported by PUSCH (1837), viz. *Arca diluvii* LAMARCK, *Solen vagina* LINNAEUS, and *Panopea rudolphi* EICHWALD, raise no doubts. Further four specific names were recognized by HÖRNES (1859—70) as younger synonyms of other species. These are *Pecten*

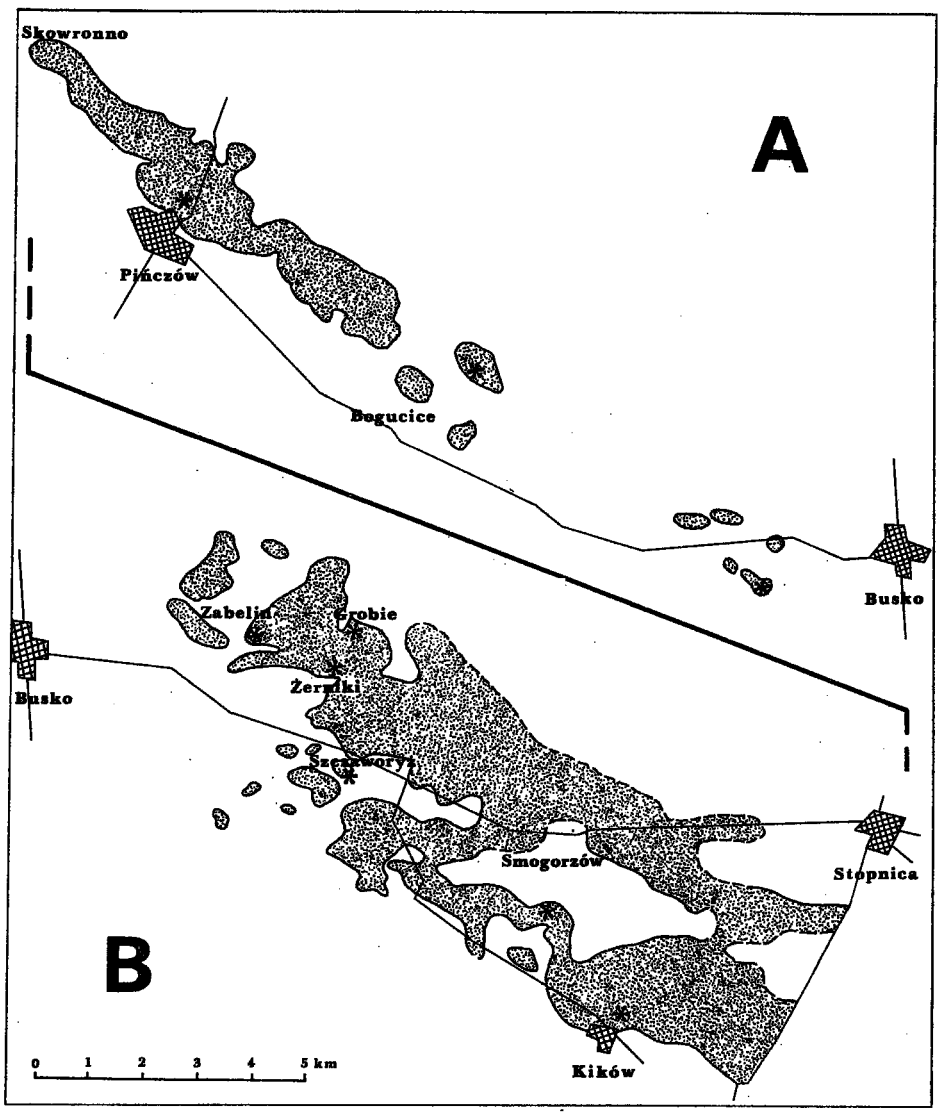


Fig. 2. Locality map of the outcrops mentioned in the text (*asterisked*). Stippled are Badenian deposits over the western (*A*) and the eastern (*B*) parts of the Wójcza-Pińczów Range (*adopted from* STUDENCKI 1988a)

nodosiformis M. de SERRES [= *Pecten latissima* BROCCHI], *P. burdigalensis* LAMARCK var. *polonica* PUSCH [= *P. cristatus* BRONN], *Cytherea lentiformis* SOWERBY [= *Dosinia exoleta* (LINNAEUS)], and *Cyprina islandicoides* BASTEROT [= *Venus gigas* LAMARCK]. The present knowledge of the Badenian bivalves of the Wójcza-Pińczów Range, and of the stratigraphic and paleogeographic distributions of the relative species suggest the correct names for four other taxa reported by PUSCH (1837). This concerns *Pecten beudanti* BASTEROT [?= *Pecten* (*Flabellipecten*) *besseri* ANDRZEJOWSKI], *Ostrea flabellula* LAMARCK [?= *Cubitostrea digitalina* (EICHWALD)], *Venericardia senilis* SOWERBY [?= *Glans* (*Centrocardita*) *rudista* (LAMARCK)], and *Pectunculus insubricus* BROCCHI [?= *Glycymeris* (*Glycymeris*) *deshayesi* MAYER]. The remaining four species names mentioned by PUSCH (1837), *Pectunculus angusticostatus* LAMARCK, *Cytherea plana* BRONGNIART, *Mytilus brardi* BRONGNIART, and *Venericardia laurae* BRONGNIART, give no idea about what species they could really represent. According to FRIEDBERG (1936), the PUSCH collection included also *Chlamys* (*Macrochlamis*) *solarium* (LAMARCK) and *Pecten* (*Oppenheimopecten*) *revolutus* MICHELOTTI (the latter identified by PUSCH as *Pecten obsoletus* SOW. var. *glabra*).

Three particularly large-sized and/or common bivalve species, i.e. *Pecten latissima* de SERRES, *Cardium hians* BROCCHI, and *Panopea menardi* (DESHAYES), were regarded by KONTKIEWICZ (1882) as typical of the Pińczów Limestones.

The most complete list of bivalves, including 30 species and based on the collections of CZARNOCKI and SKRINNIKOV, was given by KOWALEWSKI (1930).

In his monograph of the Polish Miocene bivalves, FRIEDBERG (1934–36) mentioned 18 species from the Pińczów Limestones, 12 of which were located in older collections while the remaining 6 were housed in his own. The latter ones represent exclusively the family Pectinidae: *Pecten revolutus* MICHELOTTI, *P.* (*Grandipecten*) *latissimus* BROCCHI [= *Chlamys* (*Macrochlamis*) *latissima nodosiformis* (de SERRES *in* PUSCH)], *Chlamys multistriata* POLI, *Ch.* (*Manupecten*) *fasciculata* MILLET, *Ch. seniensis* var. *niedzwiedzkii* HILBER [= *Ch.* (*Aequipecten*) *scabrella* LAMARCK], and *Ch. seniensis* var. *lomnickii* HILBER [= *Ch.* (*A.*) *scabrella* LAMARCK]. Only three of these species have been included by FRIEDBERG (1938) into the catalogue of his collection, viz. *P. latissima*, *Ch. seniensis* var. *niedzwiedzkii*, and *Ch. s.* var. *lomnickii*.

Further investigations of the Pińczów Limestones (WRONA 1970, RYSZKIEWICZ 1973, STUDENCKI 1988a, b) considerably enriched the fossil material, bivalves including. The fossil assemblage comprises red algae, foraminifers, corals, polychaetes, bryozoans, brachiopods, bivalves, gastropods, crustaceans, cirripedes, crinoids, echinoids, asteroids, and vertebrates (*cf.* STUDENCKI 1987).

NOTE ON THE MATERIAL

The present study is based on the bivalve collections housed in the Museum of the Earth (Warsaw) and in the Museum of the Geological Survey of Poland (Warsaw). The former collection, including 60 species that represent 50 genera of 31 families, was completed by one of us (W.S.) between 1975 and 1978 (STUDENCKI 1987), and then enriched by specimens collected by R. WRONA (6 species), M. EBERT (1 species), and M. RYSZKIEWICZ (12 species). The collection is housed in the Museum of the Earth under the numbers *MZ VIII Ml 2588–2655*.

Four documentary collections are housed in the Museum of the Geological Survey of Poland. They were completed by J. CZARNOCKI (in 1906), A. SKRINNIKOV (before 1918), A. MAZUREK (in 1926), and K. KOWALEWSKI (in 1929 and 1955), from the area covered by the sheets Pińczów, Działoszyce, and Stopnica. Bivalves dominate in these collections; they are, however, only partly identified to the species level, especially those from the MAZUREK collection. A number of species has now been recognized among the previously undetermined forms: *Nucula* (*Lamellinucula*) cf. *jeffreysi* BELLARDI, *Atrina radwanskii* JAKUBOWSKI (second occurrence of this species), *Dosinia* (*Asa*) cf. *lupinus* (LINNAEUS), *Cultellus* (*C.*) cf. *tenuis*

(PHILIPPI), *Ervilia* cf. *pusilla* PHILIPPI, *Tellina* (*Laciolina*) cf. *pretiosa* EICHWALD, *Gari* (*Gobraeus*) *labordei* (BASTEROT), *Solecurtus scopula* (TURTON), *Azorinus* (*A.*) *chamasolen* (da COSTA), *Glossus* (*Cytheorocardia*), cf. *deshayesi perlongata* (KUTASSY) and *Cyathodonta eggenburgensis* (SCHAFFER). In addition, the species attributions made by KOWALEWSKI have been revised and changed in many cases. Consequently, the appropriate species names are included to the list (Table 1), the older ones being specified in footnotes. The collection of bivalves from the Wójcza-Pińczów Range which is housed in the Museum of the Geological Survey of Poland includes 47 species representing 34 genera of 23 families.

The list of the bivalves found in the Badenian deposits of the Wójcza-Pińczów Range comprises 80 species that represent 60 genera of 33 families (*cf.* Tables 1 and 2).

THE TAXONOMIC STRUCTURE

A comparison of fossil assemblages in terms of their composition on the level of major taxonomic groups is not a standard procedure in paleontological investigations. Such comparisons, however, may be of certain interest in paleoecology, when looking for gross patterns of temporal and spatial distribution of the fauna and for paleobathymetric reconstructions (HICKMAN 1974).

The material available for the present study comprises species representing all Cenozoic subclasses of the Bivalvia according to NEWELL's (1965) arrangement (Table 2). The taxonomic structure of the bivalve assemblage is expressed in percentages of particular subclasses. The subclass Palaeotaxodonta constitutes 5% of the total species number, the Pteriomorpha – 37%, the Heterodonta – 54%, and the Anomalodesmata – 4% (Text-fig. 3). When compared to contemporary and Recent bivalve assemblages, this taxonomic structure shows some characteristic similarities and differences.

Five Middle Miocene bivalve assemblages have been compared to the one from the carbonate deposits of the Wójcza-Pińczów Range. The assemblages from the Upper Badenian of Devinska Nová Ves, Slovakia (ŠVAGROVSKY 1981), and from the Langhian of Vigoleno, Italy (layer named Bancone; *see* VENZO & PELOSIO 1963) occur in carbonate deposits and are characterized by a high proportion of Pteriomorpha (37% and 42%) and a relatively low proportion of Heterodonta (53% and 53%). This may be due to the substrate (carbonate, generally coarse-grained sediment, poor in organic content and susceptible to shifting) being inadequate for burrowing suspension- and deposit feeders and hence, causing epifaunal or actively swimming pteriomorphs to increase in relative abundance.

In turn, the bivalve assemblages from the Middle Miocene (Badenian) sandy facies, *i.e.* from Kinberk, Moravia (TEJKAL 1956), Niskowa, Poland (BAŁUK 1970), and Rybnica and Nawodzice, Poland (STUDENCKA 1986), show the percentages of Pteriomorpha and Heterodonta approximating 30% and 67%, respectively. The proportions of the remaining two subclasses in all the assemblages under comparison are nearly the same.

Table 1

List of bivalve species from the Badenian strata of the Wójcza-Pińczów Range

No	Species	Museum of the Earth collections					Geological Survey collections			
			Pińczów Limestones							
		marls	rhodolith pavement facies	branching algae facies	algal-bryozoan facies	organodetrital facies	J. CZARNOCKI (1906)	A. SKRINNIKOV (before 1918)	A. MAZUREK (1926)	K. KOWALEWSKI (1929 and 1955)
	NUCULIDAE									
1	*Nucula* (*Nucula*) *nucleus* (LINNAEUS)	+		+	+	+			+ +	
2	*Nucula* (*Nucula*) *placentina* LAMARCK								+ +	+
3	*Nucula* (*Lamellinucula*) cf. *jeffreysi* BELLARDI								+	
	NUCULANIDAE									
4	*Nuculana* (*Saccella*) cf. *fragilis* (CHEMNITZ)			+	+					
	ARCIDAE									
5	*Barbatia* (*Barbatia*) *barbata* (LINNAEUS)				+					
6	*Barbatia* (*Acar*) *clathrata* (DEFRANCE)				+					
7	*Anadara* (*Anadara*) *diluvii* (LAMARCK)	+					+		+	+
	GLYCYMERIDIDAE									
8	*Glycymeris* (*Glycymeris*) *deshayesi* (MAYER)[a]	+	+	+	+					+

	MYTILIDAE									
9	*Lithophaga* (*Lithophaga*) *lithophaga* (LINNAEUS)				+					
10	*Modiolula* cf. *phaseolina* (PHILIPPI)[b]						+			
	PINNIDAE									
11	*Atrina pectinata* (LINNAEUS)[c]				+					+
12	*Atrina radwanskii* JAKUBOWSKI[d]						+			+
	PECTINIDAE									
13	*Amussium cristatum badense* (FONTANNES)[e]	+			+				+	+
14	*Palliolum* (*Palliolum*) *incomparabile* (RISSO)				+					
15	*Chlamys* (*Chlamys*) *pusio* (LINNAEUS)[f]						+			
16	*Chlamys* (*Aequipecten*) *angelonii* (de STEFANI & PANTANELLI)				+					
17	*Chlamys* (*Aequipecten*) *spinulosa attenuata* KOJUMDGIEVA[g]									+
18	*Chlamys* (*Aequipecten*) *scabrella* (LAMARCK)[h]				+	+	+			+
19	*Chlamys* (*Flexopecten*) *posthuma* HILBER				+					
20	*Chlamys* (*Flexopecten*) *scissa* (FAVRE)				+					
21	*Chlamys* (*Macrochlamis*) *latissima nodosiformis* (de SERRES *in* PUSCH)		+	+	+	+	+			+
22	*Chlamys* (*Macrochlamis*) *solarium* (LAMARCK)					+	+	+		+
23	*Hinnites* cf. *brussoni* de SERRES				+					
24	*Pecten* (*Oppenheimopecten*) *aduncus* EICHWALD									+
25	*Pecten* (*Pecten*) *subarcuatus* TOURNOUËR				+					
26	*Pecten* (*Flabellipecten*) *besseri* ANDRZEJOWSKI				+	+	+			
27	*Pecten* (*Oppenheimopecten*) *revolutus* MICHELOTTI				+		+			
	PLICATULIDAE									
28	*Plicatula* (*Plicatula*) *mytilina* PHILIPPI				+					
	SPONDYLIDAE									
29	*Spondylus* (*Spondylus*) *crassicosta* LAMARCK					+	+			
	ANOMIIDAE									
30	*Pododesmus* (*Monia*) *squamus* (GMELIN)				+	+				
	LIMIDAE									
31	*Lima* sp.				+	+				

Table 1 – continued

No	Species	Museum of the Earth collections					Geological Survey collections			
			Pińczów Limestones							
		marls	rhodolith pavement facies	branching algae facies	algal-bryozoan facies	organodetrital facies	J. CZARNOCKI (1906)	A. SKRINNIKOV (before 1918)	A. MAZUREK (1926)	K. KOWALEWSKI (1929 and 1955)
	GRYPHAEIDAE									
32	*Neopycnodonte navicularis* (BROCCHI)[1]						+			
	OSTREIDAE									
33	*Crassostrea gryphoides* (von SCHLOTHEIM)						+			
34	*Cubitostrea digitalina* (EICHWALD)				+	+	+			
	LUCINIDAE									
35	*Ctena* (*Ctena*) cf. *decussata* (da COSTA)				+					
36	*Loripes dujardini* DESHAYES[1]									+
37	*Megaxinus* (*Megaxinus*) cf. *ellipticus* (BORSON)	+								
38	*Parvilucina* sp.	+			+					
39	*Lucinoma borealis* (LINNAEUS)				+					
	CHAMIDAE									
40	*Chama* (*Psilopus*) *gryphoides* LINNAEUS				+					+

	CARDITIDAE									
41	*Cardita* (*Cardita*) *elongata* (BRONN)				+					
42	*Megacardita laticosta* (EICHWALD)			+						
43	*Glans* (*Centrocardita*) sp.				+					
	CARDIIDAE									
44	*Cardium kunstleri* COSSMANN & PEYROT*	+							+	+
45	*Acanthocardia* (*Acanthocardia*) *paucicostata* (SOWERBY)	+								+
46	*Parvicardium papillosum* (POLI)			+	+					
	MACTRIDAE									
47	*Spisula* (*Spisula*) *subtruncata* (da COSTA)				+					
48	*Lutraria* (*Psammophila*) cf. *magna* (da COSTA)			+						
	MESODESMATIDAE									
49	*Ervilia* cf. *pusilla* PHILIPPI	+							+	
	CULTELLIDAE									
50	*Cultellus* (*Cultellus*) cf. *tenuis* (PHILIPPI)								+	
	TELLINIDAE									
51	*Tellina* (*Laciolina*) cf. *pretiosa* EICHWALD									+
52	*Tellina* (*Oudardia*) *compressa* BROCCHI			+			+		+	
53	*Tellina* (*Peronaea*) *planata* LAMARCK	+		+					+	+
54	*Gastrana fragilis* (LINNAEUS)	+								
	DONACIDAE									
55	*Donax* sp.	+		+						
	PSAMMOBIIDAE									
56	*Gari* (*Azor*) sp.	+								
57	*Gari* (*Gobraeus*) *labordei* (BASTEROT)									+
	SOLECURTIDAE									
58	*Solecurtus scopula* (TURTON)						+			
59	*Azorinus* (*Azorinus*) *chamasolen* (da COSTA)						+		+	+

Table 1 – continued

No	Species	Museum of the Earth collections					Geological Survey collections			
			Pińczów Limestones							
		marls	rhodolith pavement facies	branching algae facies	algal-bryozoan facies	organodetrital facies	J. CZARNOCKI (1906)	A. SKRINNIKOV (before 1918)	A. MAZUREK (1926)	K. KOWALEWSKI (1929 and 1955)
	GLOSSIDAE									
60	*Glossus* (*Glossus*) cf. *humanus* (LINNAEUS)		+		+					
61	*Glossus* (*Cytherocardia*) cf. *deshayesi perlongata* (KUTASSY)	+					+	+	+	+
	VENERIDAE									
62	*Venus* (*Ventricoloidea*) *multilamella* LAMARCK[1]	+		+	+		+			+
63	*Circomphalus subplicatus* (d'ORBIGNY)	+								+
64	*Gouldia* (*Gouldia*) *minima* (MONTAGU)			+	+					
65	*Callista* (*Callista*) cf. *erycinoides* (LAMARCK)	+								+
66	*Callista* (*Callista*) *italica* (DEFRANCE)	+								
67	*Pelecyora* (*Cordiopsis*) *gigas* (LAMARCK)					+				+
68	*Pelecyora* (*Cordiopsis*) *islandicoides* (LAMARCK)	+		+			+		+	+
70	*Dosinia* (*Asa*) cf. *lupinus* (LINNAEUS)								+	+
71	*Paphia* (*Callistotapes*) *vetula* (BASTEROT)	+								

	CORBULIDAE									
72	*Corbula* (*Caryocorbula*) *basteroti* HÖRNES	+		+						
73	*Corbula* (*Varicorbula*) *gibba* (OLIVI)	+		+			+		+	+
	GASTROCHAENIDAE									
74	*Gastrochaena* sp.				+					
	HIATELLIDAE									
75	*Panopea* (*Panopea*) *menardi* (DESHAYES)[m]	+		+		+		+	+	+
	PHOLADIDAE									
76	*Jouannetia* (*Jouannetia*) *semicaudata* des MOULINS				+					
	TEREDINIDAE									
77	*Teredo* sp.	+								
78	*Nototeredo* sp.[n]	+					+	+		+
	PHOLADOMYIDAE									
79	*Pholadomya* (*Pholadomya*) *alpina* MATHERON	+				+				+
	THRACIIDAE									
80	*Thracia* (*Thracia*) *ventricosa* PHILIPPI	+								+
81	*Cyathodonta eggenburgensis* (SCHAFFER)	+								+

a – assigned as "*Pectunculus pilosus* L." by KOWALEWSKI (1930, p. 54)
b – assigned as "*Modiola* sp." by KOWALEWSKI (1930, p. 54)
c – assigned as "*Pinna tetragona* BROCC." by KOWALEWSKI (1930, p. 54); his collection includes specimens numbered *27 II 352*, labelled as "*Pinna pectinata* var. *brocchi* d'ORB."
d – KOWALEWSKI's collection includes specimens numbered *27 II 358* and *28 II 317*, labelled as "*Mytilus* sp."
e – assigned as "*Pleuronectia cristata* BRONN" by KOWALEWSKI (1930, p. 51)
f – assigned as "*Pecten multistriata* POLI" by KOWALEWSKI (1930, p. 54)
g – KOWALEWSKI's collection includes specimens numbered *32 II 62–64*, labelled as "*Chlamys koheni* FUCHS"
h – assigned as "*Pecten romani* FRIEDBERG" by KOWALEWSKI (1930, p. 54); CZARNOCKI's and KOWALEWSKI's collections include specimens numbered *28 II 336* and *27 II 429* (respectively), labelled as "*Chlamys seniensis* LAM. var. *lomnicki* HILBER"
i – assigned as "*Ostrea cochlear* POLI" by KOWALEWSKI (1930, p. 54)
j – assigned as "*Loripes dentatus* BASTEROT" by KOWALEWSKI (1930, p. 51)
k – assigned as "*Cardium hians* BROCC." by KOWALEWSKI (1930, p. 51)
l – assigned as "*Venus multilamella* LAM. v. *marginalis* EICHW." by KOWALEWSKI (1930, p. 51)
m – assigned as "*Glycymeris rudolphii* EICHW." by KOWALEWSKI (1930, pp. 51 and 54)
n – assigned as "*Teredo norvegica* L." by KOWALEWSKI (1930, pp. 51 and 54)

It appears, therefore, that the gross taxonomic structure of bivalve assemblages may depend not only on water depth, as stated by HICKMAN (1974), but also on sediment composition. It would be interesting to compare these results to the taxonomic structure of Recent bivalve assemblages from different substrates, in order to answer the question whether or not the structure remains constant through large time intervals in assemblages inhabiting the same kind of bottom. This would require, however, further investigations because HICKMAN's (1974) data on Recent shallow-water bivalve assemblages (*see also* Text-fig. 3) show only a summary profile.

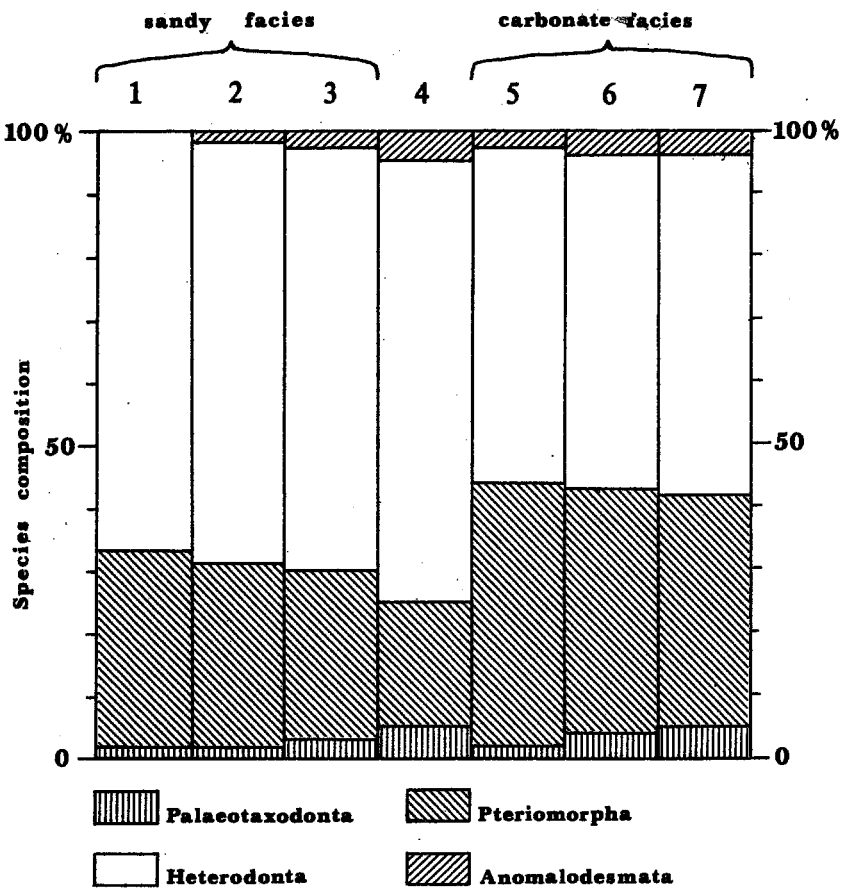


Fig. 3. Percent species composition of major taxonomic bivalve groups collected at the shallow-marine deposits from:
1 – Kinberk, Moravia (TEJKAL 1956; 98 species), Upper Badenian;
2 – Niskowa, Poland (BAŁUK 1970; 48 species), Lower Badenian;
3 – Nawodzice and Rybnica, Poland (STUDENCKA 1986; 101 species), Badenian;
4 – East Pacific (HICKMAN 1974; compiled), Recent;
5 – Vigoleno, Italy (VENZO & PELOSIO 1963; 60 species), Langhian;
6 – Devinska Nová Ves, Slovakia (ŠVAGROVSKY 1981; 51 species), Upper Badenian;
7 – Wójcza-Pińczów Range, Poland (this paper; 80 species), Lower Badenian

BIOGEOGRAPHIC REMARKS

Almost all the bivalve species recorded in the Badenian carbonate deposits of the Wójcza-Pińczów Range have also been reported from Neogene strata of the Mediterranean bioprovince (*cf.* Table 3). A closer look reveals that 30

Table 2

Relative abundances of taxa in the bivalve assemblage from the Badenian strata of the Wójcza-Pińczów Range

Subclasses and families	Number of genera	Number of species
PALAEOTAXODONTA		
1. Nuculidae	1	3
2. Nuculanidae	1	1
PTERIOMORPHA		
3. Arcidae	2	3
4. Glycymerididae	1	1
5. Mytilidae	2	2
6. Pinnidae	2	2
7. Pectinidae	5	15
8. Plicatulidae	1	1
9. Spondylidae	1	1
10. Anomiidae	1	1
11. Limidae	1	1
12. Gryphaeidae	1	1
13. Ostreidae	2	2
HETERODONTA		
14. Lucinidae	5	5
15. Chamidae	1	1
16. Carditidae	3	3
17. Cardiidae	3	4
18. Mactridae	2	2
19. Mesodesmatidae	1	1
20. Cultellidae	1	1
21. Tellinidae	2	4
22. Donacidae	1	1
23. Psammobiidae	1	2
24. Solecurtidae	2	2
25. Glossidae	1	2
26. Veneridae	7	9
27. Corbulidae	1	2
28. Gastrochaenidae	1	1
29. Hiatellidae	1	1
30. Pholadidae	1	1
31. Teredinidae	2	2
ANOMALODESMATA		
32. Pholadomyidae	1	1
33. Thraciidae	2	2

species occur in all the European Neogene bioprovinces of RÖGL & STEININGER (1984), *i.e.* in the Atlantic-Boreal, Mediterranean, and Paratethys bioprovinces. Four species only, viz. *Tellina* (*L.*) *pretiosa* EICHWALD, *Atrina radwanskii* JAKUBOWSKI, *Chlamys* (*F.*) *posthuma* HILBER, and *Megacardita laticosta* (EICHWALD), are confined to the Paratethys bioprovince; *T.* (*L.*) *pretiosa* EICHWALD occurs in both Eastern and Central Paratethys (according to the subdivision proposed by SENEŠ 1959), while the remaining three are endemic to the eastern part of the Central Paratethys.

This low level of endemism and the presence of 51 species in common with the Atlantic-Boreal bioprovince, 15 of which originated in the Atlantic-Boreal bioprovince (*cf.* LAURIAT-RAGE 1981), suggest rather free migration of faunas during the Neogene. Evidently, expansion of bivalve species has not been significantly hindered in spite of the repeated loss of communication between the Paratethys and the world ocean during the Neogene, *i.e.* in the course of 21.4 Ma (NAGYMAROSY 1981, NEVESSKAJA & *al.* 1984, SENEŠ 1985). Relatively long species durations (more than 20 Ma for 56% of the total species number; *cf.* Text-fig. 4) certainly constitute an important factor in controls upon distribution of bivalve species in the Neogene seas.

The rate of interprovince bivalve migration can be estimated by tracing the occurrences of several species. For example, the oldest representatives of *Barbatia* (*B.*) *barbata* (LINNAEUS), *Spondylus* (*S.*) *crassicosta* LAMARCK, *Cardita* (*C.*) *elongata* BRONN, and *Corbula* (*C.*) *basteroti* HÖRNES have been recorded in the Aquitanian of the Atlantic-Boreal bioprovince (COSSMANN & PEYROT 1909–1914), the absolute age of which is determined as 23.7–21.8 Ma (BERGGREN & *al.* 1985). The oldest deposits in the Central Paratethys which contain *Corbula basteroti* HÖRNES are dated by STEININGER & *al.* (1971) as Egerian (25.0–21.8 Ma). The other three species have been reported from the Lower Badenian (16.5–15.0 Ma) of Poland, *i.e.* from the northernmost part of the Central Paratethys (KOWALEWSKI 1930, FRIEDBERG 1934–36), but not from older deposits in that area.

A higher migration rate is observed in *Chama* (*P.*) *gryphoides* LINNAEUS, which had originated in the Burdigalian (21.8–16.8 Ma) of the Atlantic-Boreal bioprovince (COSSMANN & PEYROT 1912), then appeared in the Eggenburgian (21.8 – 19.0 Ma) of the Central Paratethys (STEININGER & *al.* 1971), and finally in the Tarkhanian (16.8–15.5 Ma) of the Eastern Paratethys (NEVESSKAJA & *al.* 1984).

STRATIGRAPHIC CONSIDERATIONS

The stratigraphic ranges of 71 species of the discussed assemblage have been determined (Table 3). Out of these, 29 species are extant; 22 of them originated in the Miocene, 6 in the Oligocene, and 1 in the Eocene. Out of all 71 species, 62 species (87%) originated in the Miocene (*cf.* Text-fig. 4). The

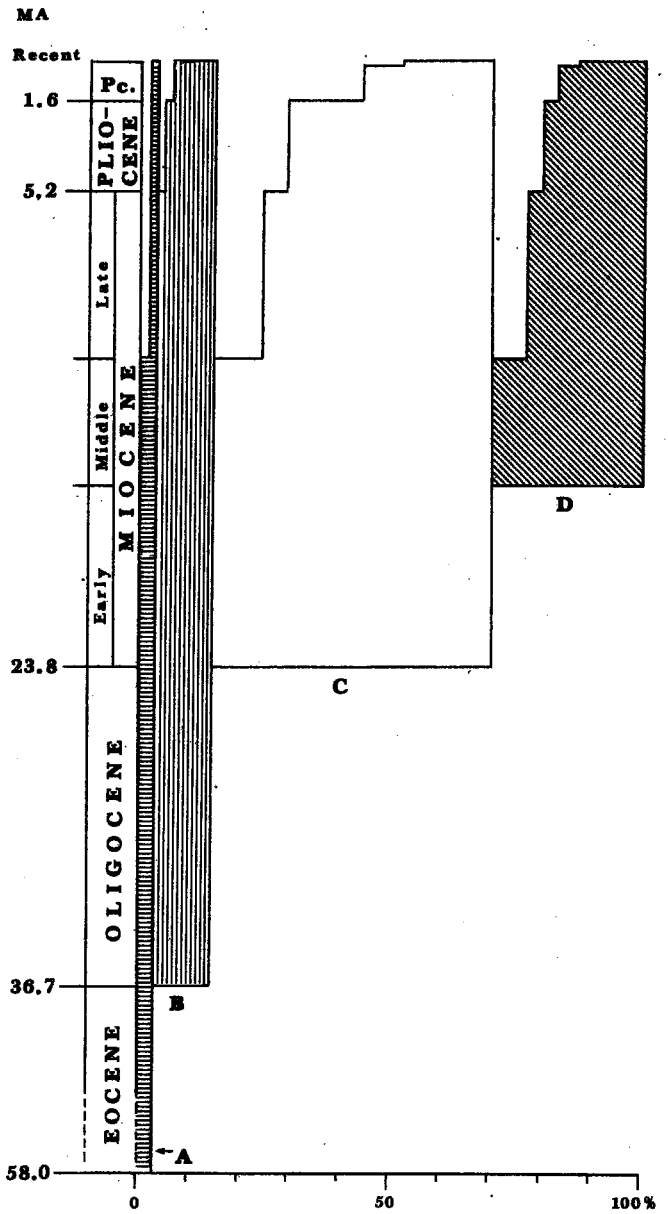


Fig. 4. Stratigraphic ranges of the bivalves from the Badenian deposits of the Wójcza-Pińczów Range

A – species appearing in Eocene time;
B – species appearing in Oligocene time;
C – species appearing in Early Miocene time;
D – species appearing in Middle Miocene time

Table 3

Stratigraphic ranges and paleobiogeography of bivalves from the Badenian strata of the Wójcza-Pińczów Range

No	Species	Stratigraphic ranges								Occurrence in European Neogene bioprovinces			
		Eocene	Oligocene	Miocene: Early	Miocene: Middle	Miocene: Late	Pliocene	Pleistocene	Recent	Atlantic--Boreal	Mediterranean	Central Paratethys	Eastern Paratethys
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	*Nucula* (*Nucula*) *nucleus* (LINNAEUS)		?							+	+	+	+
2	*Nucula* (*Nucula*) *placentina* LAMARCK										+	+	?
3	*Nucula* (*Lamellinucula*) cf. *jeffreysi* BELLARDI									+	+	+	+
4	*Nuculana* (*Saccella*) cf. *fragilis* (CHEMNITZ)									+	+	+	+
5	*Barbatia* (*Barbatia*) *barbata* (LINNAEUS)									+	+	+	+
6	*Barbatia* (*Acar*) *clathrata* (DEFRANCE)									+	+	+	+
7	*Anadara* (*Anadara*) *diluvii* (LAMARCK)									+	+	+	+
8	*Glycymeris* (*Glycymeris*) *deshayesi* (MAYER)									+	+	+	+
9	*Lithophaga* (*Lithophaga*) *lithophaga* (LINNAEUS)									+	+	+	+
10	*Modiola* cf. *phaseolina* (PHILIPPI)									+	+	+	+
11	*Atrina pectinata* (LINNAEUS)									+	+	+	+
12	*Atrina radwanskii* JAKUBOWSKI											+	
13	*Amussium cristatum badense* (FONTANNES)										+	+	+
14	*Palliolum* (*Palliolum*) *incomparabile* (RISSO)										+	+	+
15	*Chlamys* (*Chlamys*) *pusio* (LINNAEUS)									+	+	+	+
16	*Chlamys* (*Aequipecten*) *angelonii* (de STEFANI & PANTANELLI)									+	+	+	

17	*Chlamys (Aequipecten) spinulosa attenuata* KOJUMDGIEVA		•	+	
18	*Chlamys (Aequipecten) scabrella* (LAMARCK)	+	+	+	+
19	*Chlamys (Flexopecten) posthuma* HILBER			+	
20	*Chlamys (Flexopecten) scissa* (FAVRE)	+	+	+	
21	*Chlamys (Macrochlamis) latissima nodosiformis* (de SERRES *in* PUSCH)	+	+	+	
22	*Chlamys (Macrochlamis) solarium* (LAMARCK)	+	+	+	
23	*Hinnites* cf. *brussoni* de SERRES		+	+	
24	*Pecten (Oppenheimopecten) aduncus* EICHWALD	+	+	+	
25	*Pecten (Pecten) subarcuatus* TOURNOUËR	+	+	+	
26	*Pecten (Flabellipecten) besseri* ANDRZEJOWSKI	+	+	+	+
27	*Pecten (Oppenheimopecten) revolutus* MICHELOTTI	+	+	+	
28	*Plicatula (Plicatula) mytilina* PHILIPPI	+	+	+	
29	*Spondylus (Spondylus) crassicosta* LAMARCK	+	+	+	
30	*Pododesmus (Monia) squamus* (GMELIN)	+	?	+	
31	*Neopycnodonte navicularis* (BROCCHI)		+	+	+
32	*Crassostrea gryphoides* (von SCHLOTHEIM)	+	+	+	+
33	*Cubitostrea digitalina* (EICHWALD)	?	?	+	+
34	*Ctena (Ctena)* cf. *decussata* (da COSTA)	+	+	+	
35	*Loripes dujardini* DESHAYES	+	+	+	+
36	*Megaxinus (Megaxinus)* cf. *ellipticus* (BORSON)		+	+	
37	*Lucinoma borealis* (LINNAEUS)	+	+	+	+
38	*Chama (Psilopus) gryphoides* LINNAEUS	+	+	+	+
39	*Cardita (Cardita) elongata* (BRONN)	+	+	+	
40	*Megacardita laticosta* (EICHWALD)			+	
41	*Cardium kunstleri* COSSMANN & PEYROT	+	+	+	
42	*Acanthocardia (Acanthocardia) paucicostata* (SOWERBY)	+	+	+	+
43	*Parvicardium papillosum* (POLI)	+	+	+	+
44	*Spisula (Spisula) subtruncata* (da COSTA)	+	+	+	

Table 3 – continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14
45	*Lutraria* (*Psammophila*) cf. *magna* (da COSTA)									+	+	+	
46	*Ervilia* cf. *pusilla* PHILIPPI									+	+	+	+
47	*Cultellus* (*Cultellus*) cf. *tenuis* (PHILIPPI)									+	+	+	
48	*Tellina* (*Laciolina*) cf. *pretiosa* EICHWALD			?								+	+
49	*Tellina* (*Oudardia*) *compressa* BROCCHI										+	+	
50	*Tellina* (*Peronaea*) *planata* LAMARCK										+	+	+
51	*Gastrana fragilis* (LINNAEUS)									+	+	+	+
52	*Gari* (*Gobraeus*) *labordei* (BASTEROT)										+	+	
53	*Solecurtus scopula* (TURTON)									+	+	+	
54	*Azorinus* (*Azorinus*) *chamasolen* (da COSTA)									+	+	+	
55	*Glossus* (*Glossus*) cf. *humanus* (LINNAEUS)									+	+	+	
56	*Venus* (*Ventricoloidea*) *multilamella* LAMARCK									+	+	+	+
57	*Circomphalus subplicatus* (d'ORBIGNY)										+	+	+
58	*Gouldia* (*Gouldia*) *minima* (MONTAGU)										+	+	+
59	*Callista* (*Callista*) cf. *erycinoides* LAMARCK									+	+	+	+
60	*Callista* (*Callista*) *italica* (DEFRANCE)									+	+	+	+
61	*Pelecyora* (*Cordiopsis*) *gigas* (LAMARCK)										+	+	+
62	*Pelecyora* (*Cordiopsis*) *islandicoides* (LAMARCK)										+	+	+
63	*Dosinia* (*Aso*) cf. *lupinus* (LINNAEUS)						----			+	+	+	+
64	*Paphia* (*Callistotapes*) *vetula* (BASTEROT)										+	+	+
65	*Corbula* (*Caryocorbula*) *basteroti* HÖRNES									+	+	+	
66	*Corbula* (*Varicorbula*) *gibba* (OLIVI)									+	+	+	+
67	*Panopea* (*Panopea*) *menardi* (DESHAYES)									+	+	+	+
68	*Jouannetia* (*Jouannetia*) *semicaudata* DES MOULINS	------	-----								+	+	?
69	*Pholadomya* (*Pholadomya*) *alpina* MATHERON										+	+	+
70	*Thracia* (*Thracia*) *ventricosa* PHILIPPI									+	+	+	+
71	*Cyathodonta eggenburgensis* (SCHAFFER)										+	+	

stratigraphic ranges of 18 species are limited to the Miocene; out of these, 11 species represent the family Pectinidae. Hence, it appears worthwile to discuss the potential stratigraphic importance of these pectinids.

The pectinid assemblage from the Pińczów Limestones inequivocally indicates their Badenian age (Table 4); its composition very closely resembles the one reported by NICORICI (1977) from Girbova de Sus (the Transilvanian Basin, Romania; *see* Table 5). The latter assemblage occurs in the Leitha-type limestones dated by POPESCU (1985) as Late Badenian (Bulimina-Bolivina zone in GRILL's benthic foraminiferal assemblage zonation). The pectinid assemblage from the Pińczów Limestones shows also some similarities to the assemblages known from Leitha-type limestones of Devinska Nová Ves, Slovakia (ŠVAGROVSKY 1981), Hidas and Pécsvárad, Mecsek Mts, Hungary (CSEPREGHY-MEZNERICS 1960, BOHN-HAVAS 1963), and Devecser, Bakony Mts, Hungary (CSEPREGHY-MEZNERICS 1960) (*see* Table 5). The deposits of Devinska Nová Ves belong to the Upper Badenian Bulimina-Bolivina zone, or nannozone NN6 (LEHOTAYOVA 1977). Calcareous nannoplankton studies have shown that the limestones from Hidas and Pécsvárad represent nannozone NN6-7, whereas those from Devecser belong to nannozone NN5 (NAGYMAROSY 1985).

The main differences between the pectinid assemblages from Pińczów, Slovakia, and Hungary concern the occurrences of *Pecten* (*F.*) *leythajanus* (PARTSCH *in* HÖRNES), *Chlamys* (*A.*) *elegans* ANDRZEJOWSKI, and *Ch.* (*F.*) *scissa* (FAVRE). The former two species characterize two substages of the Badenian in Hungary (HÁMOR & *al.* 1987, BOHN-HAVAS & *al.* 1987): *Ch.* (*A.*) *elegans* ANDRZEJOWSKI and *P.* (*O.*) *revolutus* MICHELOTTI are the index species for the pectinid subzone *5a* of littoral Lower Badenian deposits, whilst *P.* (*F.*) *leythajanus* (PARTSCH *in* HÖRNES) and *P.* (*O.*) *aduncus* EICHWALD are typical of the subzone *5b* of littoral deposits of the Middle and Upper Badenian. The species *Ch.*(*F.*) *scissa* (FAVRE), in turn, used to be considered significant in stratigraphic subdivision of the Polish and Ukrainian Badenian deposits (FRIEDBERG 1932; KOWALEWSKI 1958; KRACH 1957, 1958, 1967, 1979; WOŹNY 1962).

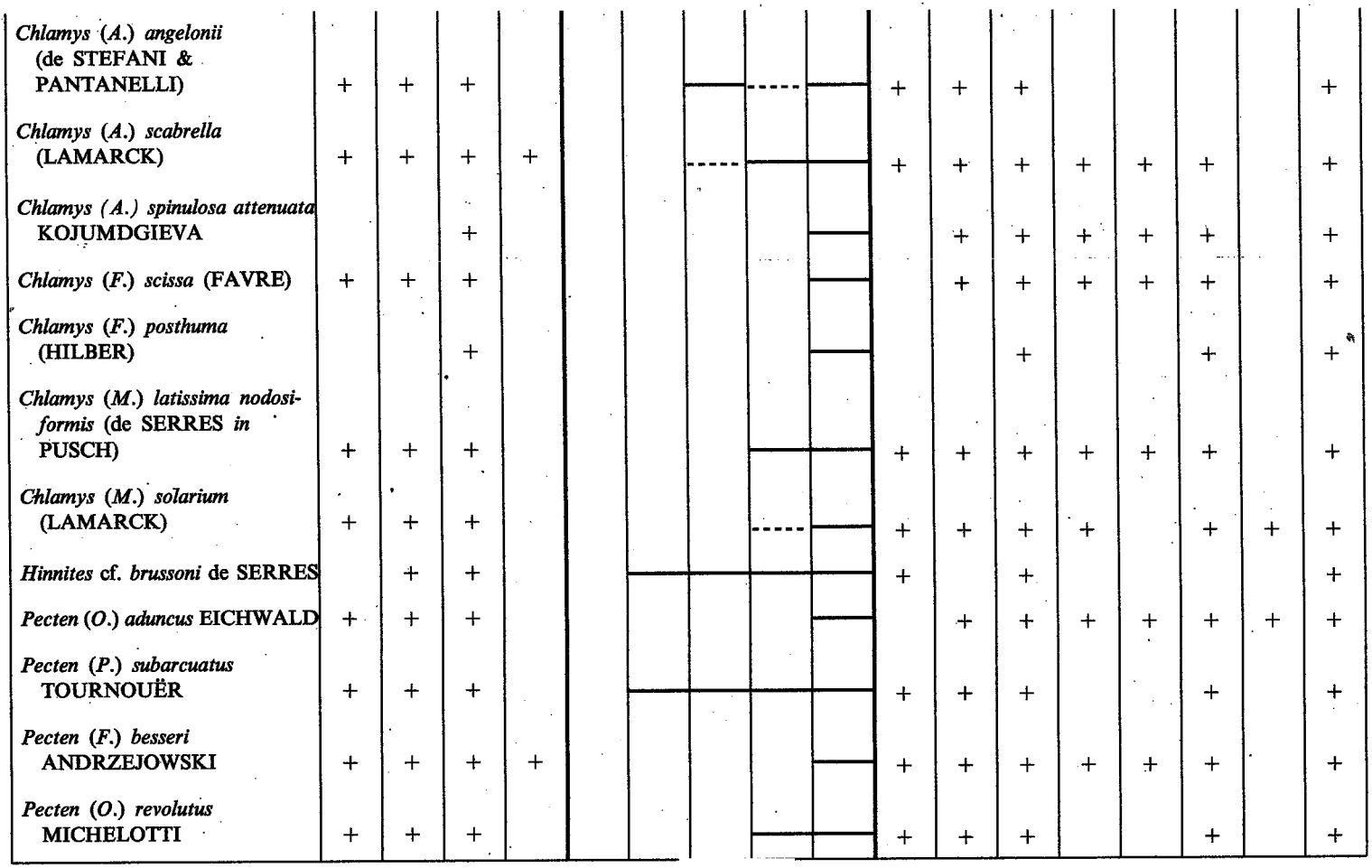
Given the occurrences of *P.* (*F.*) *leythajanus* (PARTSCH *in* HÖRNES), *Ch.* (*A.*) *elegans* ANDRZEJOWSKI, and *Ch.* (*F.*) *scissa* (FAVRE) in the Central Paratethys bioprovince, and given also the recently compiled data on the distribution of Neogene deposits in this area, it is possible to reconstruct the paleobiogeographic and stratigraphic ranges of these species.

(*i*) The specimens of *P.* (*F.*) *leythajanus* (PARTSCH *in* HÖRNES) are common and typical fossils in the Pannonian Basin, viz. in the Middle and Upper Badenian carbonate facies of Austria and Hungary (KAUTSKY 1928, CSEPREGHY-MEZNERICS 1960, BOHN-HAVAS & *al.* 1987), and in the Upper Badenian carbonate facies of Slovakia (ŠVAGROVSKY 1981). In the Transilvanian Basin, Banat, and western Dacian Basin, in turn, *P.* (*F.*) *leythajanus* (PARTSCH *in* HÖRNES) occurs in both the Lower and the Upper Badenian; it is one of the most abundant fossils in the Upper Badenian, along with *P.* (*F.*) *besseri* ANDRZEJOWSKI, *P.* (*O.*) *aduncus* EICHWALD, *Ch.* (*M.*) *nodosiformis* (de SERRES), and *Ch.* (*A.*) *elegans* ANDRZEJOWSKI (*see*

Table 4

Geographic and stratigraphic distribution of pectinids from the Badenian strata of the Wójcza-Pińczów Range

Species	Occurrence in European Neogene bioprovinces				Stratigraphic range within the Central Paratethys					Occurrence in the Badenian of the Central Paratethys							
	Atlantic-Boreal	Mediterranean	Central Paratethys	Eastern Paratethys	Egerian	Eggenburgian	Ottnangian	Karpatian	Badenian	Austria (SIEBER 1956)	Hungary (CSEPREGHY-MEZNERICS 1960, BOHN-HAVAS & *al.* 1987)	Romania (NICORICI 1977)	Bulgaria (KOJUMDGIEVA 1960)	Czechoslovakia (ŠVAGROVSKY 1981)	Ukraine (FRIEDBERG 1936, ZELINSKAJA & *al.* 1968)	Moldavia (JANAKEVICH 1980)	Poland
Amussium cristatum badense (FONTANNES)	+	+	+				—	—	—	+	+	+	+	+	+		+
Palliolum (*P.*) *incomparabile* (RISSO)		+	+	+	—	—	- - -	- - -	—								+
Chlamys (*Ch.*) *pusio* (LINNAEUS)	+	+	+	+		—	—	—	—	+	+	+		+	+	+	+


Chlamys (*A.*) *angelonii* (de STEFANI & PANTANELLI)
Chlamys (*A.*) *scabrella* (LAMARCK)
Chlamys (*A.*) *spinulosa attenuata* KOJUMDGIEVA
Chlamys (*F.*) *scissa* (FAVRE)
Chlamys (*F.*) *posthuma* (HILBER)
Chlamys (*M.*) *latissima nodosiformis* (de SERRES *in* PUSCH)
Chlamys (*M.*) *solarium* (LAMARCK)
Hinnites cf. *brussoni* de SERRES
Pecten (*O.*) *aduncus* EICHWALD
Pecten (*P.*) *subarcuatus* TOURNOUËR
Pecten (*F.*) *besseri* ANDRZEJOWSKI
Pecten (*O.*) *revolutus* MICHELOTTI

NICORICI 1977). The species *P.* (*F.*) *leythajanus* (PARTSCH *in* HÖRNES) has not been found in the fore-Carpathian part of the Central Paratethys, in spite of the presence of well-recognized carbonate facies in Romanian Moldavia, the Ukraine, and Poland (FRIEDBERG 1932; JANAKEVICH 1977, 1980; NICORICI 1977; JAKUBOWSKI & MUSIAŁ 1979a, b; KRACH 1981). This suggests either the Early Badenian age of the Pińczów Limestones, or the geographic distribution of *P.* (*F.*) *leythajanus* (PARTSCH *in* HÖRNES) limited to the inner-Carpathian basins. The only information on this species from an outer-Carpathian basin comes from ROEMER (1870, pp. 396–397). However, the ornamentation of the disc of both the valves, the ornamentation of the auricles of the left valve, the rib number, and the outline of the valves illustrated by ROEMER (1870) suggest that the specimens found in the Leitha-type limestones in Boguchwałów near Głubczyce (Southern Poland) were erroneously attributed to the species *P.* (*F.*) *leythajanus* (PARTSCH *in* HÖRNES). In our opinion, the right valve (ROEMER 1870, Pl. 45, Fig. 3) represents in fact *P.* (*F.*) *besseri* ANDRZEJOWSKI, while the left valve (ROEMER 1870, Pl. 45, Fig. 4) belongs to *Chlamys* (*M.*) *solarium* (LAMARCK).

(*ii*) Presence of the species *Ch.* (*A.*) *elegans* ANDRZEJOWSKI is not indicative of any substage of the Central Paratethys Badenian because its occurrences in this bioprovince appear to be heterochronous. *Ch.* (*A.*) *elegans* ANDRZEJOWSKI is typical of the Lower Badenian carbonate facies of Hungary (HÁMOR & *al.* 1987, BOHN-HAVAS & *al.* 1987); it has also been reported from the Lower Badenian of Romania (NICORICI 1977). On the other hand, the specimens of *Ch.* (*A.*) *elegans* ANDRZEJOWSKI are, along with *Ch.* (*F.*) *scissa* (FAVRE), among the most common pectinid representatives in the Upper Badenian deposits of Romania, Slovakia, and Roztocze Hills in Poland (NICORICI 1977, JAKUBOWSKI & MUSIAŁ 1979 a, b; ŠVAGROVSKY 1981).

(*iii*) The occurrences of *Ch.* (*F.*) *scissa* (FAVRE) in the Central Paratethys are also heterochronous. The oldest findings are from a few Lower Badenian localities of Poland (FRIEDBERG 1932, 1936; KRACH 1957, 1958, 1967, 1979). The species attains its maximum extent and morphologic variability during the Late Badenian, which has resulted in erection of many subspecies (*see* KRACH 1957, 1958, 1967; WOŹNY 1962; but *cf.* STUDENCKA 1986). The specimens of *Ch.* (*F.*) *scissa* (FAVRE) are very common in the Upper Badenian deposits (carbonates including) of Poland, the Ukraine, and Romanian Moldavia (FRIEDBERG 1932, 1936; IONESI 1968; NICORICI 1977; JAKUBOWSKI & MUSIAŁ 1979a, b). In contrast, the species is extremely rare in the Upper Badenian of Hungary, where it has only been recorded near Makkoshotyka, Tokay Mts (CSEPREGHY-MEZNERICS 1960); it has never been reported from Austria (KAUTSKY 1928, SIEBER 1955).

These data show that the species composition of the pectinid assemblage of the Pińczów Limestones evidences their Badenian age, but also, that finer subdivision of the Badenian based on pectinids is impossible. This bivalve group is useful to characterize the particular Neogene stages, as stated by DEPERET & ROMAN (1902–1912), KAUTSKY (1928), FRIEDBERG (1932, 1936), ROGER (1939), de VEIGA FERREIRA (1951, 1954, 1961), KRACH (1957, 1958, 1967, 1979), CSEPREGHY-MEZNERICS (1960), DEMARCQ & BARBILLAT (1971), NICORICI (1977), DEMARCQ (1979a, b), and BOHN-HAVAS & *al.* (1987); but the Badenian substages cannot be characterized in this way, particularly in the Central Paratethys. There is no species of the family Pectinidae to appear isochronously over this area. The process of species expansion has taken an interval of at least stage duration (*i.e.* 16.5–13.6 Ma) and/or the occurrence of species is limited to a part of the bioprovince. The only inference to be made is that the stratigraphic subdivisions based on pectinids hold true only within individual basins of the Central Paratethys bioprovince and cannot be employed for interbasin correlations.

Table 5

Comparison of pectinid assemblages from various Badenian Leitha-type limestones

Species \ Localities	Pińczów (this paper)	Devinska Nová Vés (ŠVAGROVSKY 1981)	Girbova de Sus (NICORICI 1977)	Hidas (CSEPREGHY-MEZNERICS 1960, BOHN-HAVAS 1963)	Devecser (CSEPREGHY-MEZNERICS 1960)	Pécsvárad (BOHN-HAVAS 1963)
Amussium cristatum badense (FONTANNES)	+	+	+	+	+	+
Palliolum (*P.*) *bittneri* (TOULA)		+				
Palliolum (*P.*) *incomparabile* (RISSO)	+					
Chlamys (*Ch.*) *pusio* (LINNAEUS)	+	+	+	+	+	
Chlamys (*A.*) *angelonii* (de STEFANI & PANTANELLI)	+		+			
Chlamys (*A.*) *elegans* (ANDRZEJOWSKI)		+	+	+	+	+
Chlamys (*A.*) *macrotis* (SOWERBY)			+			
Chlamys (*A.*) *malvinae* (du BOIS de MONTPEREUX)		+[b]	+			
Chlamys (*A.*) *scabrella* (LAMARCK)	+		+[c]	+[d]		
Chlamys (*A.*) *spinulosa attenuata* KOJUMDGIEVA	+					
Chlamys (*F.*) *lilli* (PUSCH)		+			+	
Chlamys (*F.*) *posthuma* (HILBER)	+					
Chlamys (*F.*) *scissa* (FAVRE)	+	+[e]	+[f]			
Chlamys (*M.*) *fasciculata* (MILLET)		+				
Chlamys (*M.*) *latissima nodosiformis* (de SERRES *in* PUSCH)	+	+	+[g]	+	+	
Chlamys (*M.*) *solarium* (LAMARCK)	+	+	+	+	+	+
Hinnites cf. *brussoni* de SERRES	+					
Pecten (*O.*) *aduncus* EICHWALD	+	+	+			+
Pecten (*P.*) *praebenedictus* TOURNOUËR					+	
Pecten (*P.*) *subarcuatus* TOURNOUËR	+				+[h]	
Pecten (*F.*) *besseri* ANDRZEJOWSKI	+	+	+	+	+	+
Pecten (*F.*) *leythajanus* (PARTSCH *in* HÖRNES)		+	+	+		+
Pecten (*O.*) *revolutus* MICHELOTTI	+		+	+	+	

Original attributions:

a—to *Ch.* (*A.*) *angelonii spinusovatus*
b—to *Ch.* (*A.*) *flava*
c—to *Ch.* (*A.*) *seniensis seniensis* and *Ch.* (*A.*) *s. lomnickii*
d—to *Ch.* (*A.*) *scabrella lomnickii*
e—to *Ch.* (*F.*) *scissa scissa* and *Ch.* (*F.*) *s. wulkae*
f—to *Ch.* (*F.*) *scissa kneri*
g—together with *Ch.* (*M.*) *l. latissima*
h—to *P. fuchsi styriacus*

SYSTEMATIC ACCOUNT

The terminology and systematic arrangement of bivalves adapted in this paper follow those employed (MOORE 1969) in the *Treatise on Invertebrate Paleontology*, part N, except the family Cardiidae, the systematics of which follows POPOV (1977). Abbreviations used are: L – length of the valve, H – height of the valve.

Class **Bivalvia** LINNAEUS, 1758
Subclass **Pteriomorpha** BEURLEN, 1944
Order **Pterioida** NEWELL, 1965
Suborder **Pteriina** NEWELL, 1965
Superfamily **Pectinacea** RAFINESQUE, 1815
Family **Pectinidae** RAFINESQUE, 1815
Genus *Palliolum* MONTEROSATO, 1844
Subgenus *Palliolum* (*Palliolum*) MONTEROSATO, 1844
Palliolum (*Palliolum*) *incomparabile* (RISSO, 1826)
(Pl. 7, Figs 1–3)

1907. *Chlamys* (*Palliolum*) *incomparabilis* RISSO; S. CERULLI-IRELLI, p. 97, Pl. 6, Fig. 9.
1939. *Chlamys incomparabilis* RISSO; J. ROGER, pp. 204–205, Pl. 20, Fig. 7 and Pl. 21, Fig. 2.
1947. *Chlamys* cf. *incomparabilis* RISSO; W. KRACH, pp. 54–55, Pl. 1, Figs 3–4.
1969. *Palliolum incomparabilis incomparabilis* (RISSO, 1826); F. NORDSIECK, p. 43, Pl. 7, Fig. 30.00.
1971. *Chlamys incomparabilis* RISSO, 1826; F. STEININGER & *al.*, pp. 421–422, Pl. 19, Figs 3–5.
1973. *Chlamys* (*Camptonectes*) *incomparabilis* (RISSO, 1826); T. BÁLDI, pp. 183–184, Pl. 5, Fig. 3 and Pl. 7, Fig. 2.
1977. *Palliolum* (*Palliolum*) *incomparabile* (RISSO, 1826); R. MARASTI & S. RAFFI, p. 18, Pl. 1, Fig. 3.
1979. *Palliolum* (*Palliolum*) *incomparabile* (RISSO, 1826); A. d'ALESSANDRO & *al.*, p. 34, Pl. 3, Fig. 6.

MATERIAL: Busko – 1 right valve, Szczaworyż – 2 right valves.

DIMENSIONS (*in* mm):

	L	H
MZ VIII Ml 2598/1	9.2	9.5
MZ VIII Ml 2598/2	9.3	9.1
MZ VIII Ml 2598/3	6.0	6.5

DESCRIPTION: The valve is small, fragile, orbicular in outline, equilateral and almost flat. Small, acute, weakly prosogyrate beak is placed anteriorly to the midline of the valve, and it slightly projects above the gently concave hinge margin. Anterodorsal margin is concave, while posterodorsal one is rectilinear. Apical angle equals 90°.

Auricles are medium-sized. Anterior auricle bears 4 riblets and a small triangular fasciola. The riblets and the fasciola are intersected with dense, concentric lines forming distinct, square tubercles on the riblets; triangular byssal notch is narrow and deep; ctenolium is distinct. Posterior auricle is slightly concave at its base, ornamented with dense concentric lines forming wide slats close to the suture of the auricle and disc, where two faint radial lines are also present.

External surface of the disc seems to be smooth, with only two narrow ribs close to the suture line of the anterior auricle and disc; however, delicate concentric lines, stronger near the dorsal margin, are discernible under the microscope. They are intersected with equipotential radial lines oriented normally to the disc edge and thus forming a flabellate pattern; fine, but distinct, reticulate pattern results near the suture lines.

Internal surface of the valve could not be observed.

REMARKS: The first record of *Palliolum* (*P.*) *incomparabile* (RISSO) from the Polish Miocene has been by KRACH (1947) who reported *Chlamys* cf. *incomparabilis* RISSO from the Badenian marls of Małoszów. This tentative attribution resulted from the stratigraphic distribution of the species as it was known in the 40's (Pliocene – Recent).

The specimens from the Pińczów Limestones, as well as those from the Małoszów marls, have ornamentation of the external surface indistinguishable from what occurs in the Pliocene and Recent representatives of the species *Palliolum* (*P.*) *incomparabile* (RISSO). In turn, the specimens reported from the Upper Oligocene (BÁLDI 1973) and Lower Miocene (STEININGER & *al.* 1971) have their external surfaces covered with 130–140 fine, densely spaced radial lines running from the beak towards the anterior and posterior margins, and much stronger than the delicate concentric lines.

The Recent representatives of the species *P.* (*P.*) *incomparabile* (RISSO) are confined to the Mediterranean coralligenous facies.

RATIGRAPHIC RANGE: Late Oligocene (BÁLDI 1973) – Recent.

Genus *Chlamys* RÖDING, 1978
Subgenus *Chlamys* (*Aequipecten*) FISCHER, 1886
Chlamys (*Aequipecten*) *angelonii* (de STEFANI & PANTANELLI, 1880)
(Pl. 10, Figs 2–3)

1939. *Chlamys Angelonii* (MENEGHINI) de STEFANI et PANTANELLI; J. ROGER, pp. 138–141, Text-fig. 72, Pl. 18, Figs 7–10 and Pl. 20, Figs 2–3.
1945. *Pecten* (*Aequipecten*) *angelonii* MENEGHINI, sp. 1859; M. GLIBERT, pp. 69–72, Pl. 4, Fig. 2a-j.
1954. *Chlamys angelonii* (MENEGH.) De STEF. et PANT.; I. CSEPREGHY-MEZNERICS, p. 74, Pl. 10, Fig. 3.
1973. *Chlamys angelonii* MENEGHINI, 1859; P. ČTYROKY & *al.*, p. 477, Pl. 12, Fig. 10.
1974. *Chlamys* (*Aequipecten*) *angelonii* (MENEGHINI, 1859 MS) (De STEFANI et PANTANELLI, 1778); A. MALATESTA, pp. 46–47, Pl. 3, Fig. 9.
1977. *Chlamys angelonii angelonii* (MENEGHINI) De STEFANI et PANTANELLI; E. NICORICI, pp. 140–141, Pl. 31, Fig. 1a-f.

MATERIAL: Pińczów – 1 right valve, 1 left valve.
DIMENSIONS (*in* mm):

	L	H
MZ VIII MI 2599/1	18.0	18.2
MZ VIII MI 2599/2	14.7	15.5

DESCRIPTION: The shell is inequivalve, with the right valve being more convex than the left one. The valves are almost equilateral; the gently concave posterodorsal margin is slightly longer than the rectilinear anterodorsal margin. Small, ortogyrate beak of the left valve slightly projects above the straight hinge margin, while the ortogyrate beak of the right valve does not project above gently concave hinge margin. Apical angle equals 95°.

There are 5 riblets and a small, triangular fasciola at the anterior auricle of the right valve. The riblet width increases towards the hinge margin. Densely spaced concentric lines intersect the riblets to from upon them delicate scales. Three ctenoidal teeth are placed in a shallow, triangular byssal notch; ctenolium is distinct. Posterior auricle of the right valve is covered with 7 riblets ornamented with faint scales. Anterior auricle of the left valve, greater and more concave at the base than the posterior one, is ornamented with 7 narrow riblets.

External surface of the disc is ornamented with 16 triangular, slightly flattened ribs, separated with rounded grooves, narrower than the ribs; the disc bears also 2–5 faint riblets near its dorsal margin. Main ribs are sculptured with three rows of scales each, the median row being the strongest. The scales appear at a certain distance from the beak; at the right valve, one row of scales appears 3 mm from the beak while the other two rows appear 8 mm from the beak; at the left valve all three rows of scales appear 12 mm from the beak, at a growth stage. Two rows of scales run in grooves, each row near the rib base; these scales are slightly weaker than those on the ribs. Very regular arrangement and constant intervals between scales, both on the ribs and in the grooves, produce a kind of concentric ornamentation. Growth stages are distinct only at the left valve.

In the investigated material, the right valve hinge is partially damaged; only cardinal crura *c.c.AIII* and *c.c.PIII* are distinct. The crura are straight, slightly oblique to the hinge margin, and almost as long as the latter.

In the left valve, the hinge includes one pair of cardinal crura *c.c.AIV* and *c.c.PIV*, almost as long as the hinge margin, and also one weak, short and very oblique cardinal crus *c.c.AI*.

The right valve bears anterior and posterior auricular crura.

Adductor muscle scar is small, oval in outline and very distinct. Pallial line is indiscernible; ventral margin is crenulated.

REMARKS: The species *Chlamys* (*A.*) *angelonii* (de STEFANI & PANTANELLI) shows some intraspecific variability in shell outline and external ornamentation (*see* GLIBERT 1945). The specimens from the Pińczów Limestones generally fall within this range of variability but differ from those described by GLIBERT (1945) in their smaller rib number (16 instead of 20–25). This may possibly result from their immaturity: adult specimens measure 50–70 mm in length (GLIBERT 1945, MALATESTA 1974) in comparison to the 15–18 mm length of the discussed specimens.

The species *Chlamys* (*A.*) *angelonii* (de STEFANI & PANTANELLI) has not been previously reported from the Polish Miocene.

STRATIGRAPHIC RANGE: Early Miocene (ČTYROKY & *al.* 1973) – Pleistocene (MALATESTA 1974).

Subgenus *Chlamys* (*Flexopecten*) SACCO, 1897
Chlamys (*Flexopecten*) *scissa* (FAVRE, 1869)
(Pl. 3, Figs 3–4)

1957. *Chlamys scissa* (FAVRE) var. *richthofeni* (HILB.); W. KRACH, pp. 330–331, Pl. 45, Figs 1–4.
1962. *Chlamys scissa* (FAVRE) var. *richthofeni* (HILB.); E. WOŹNY, pp. 292–293, Pl. 1, Fig. 1.
1967. *Chlamys scissa richthofeni* (HILB.); W. KRACH, p. 218, Pl. 7, Figs 1–7.
1977. *Chlamys scissa richthofeni* (HILBER); E. NICORICI, p. 147, Pl. 41, Fig. 8a-b.

MATERIAL: Busko – 1 right valve, Zabelin – 1 right valve.

DIMENSIONS (in mm):

	L	H
MZ VIII Ml 2601/1	31.4	33.7
MZ VIII Ml 2601/2	23.9	25.1

REMARKS: The specimens from the Pińczów Limestones are consistent with the descriptions and figures referred to in the synonymy. The investigations by SIMIONESCU (1902), ROGER (1939), GLIBERT (1945), and STUDENCKA (1986) have demonstrated *Chlamys* (*F.*) *scissa* (FAVRE) to be characterized by a strong variation in external ornamentation but also by constant relations between particular shell parameters. As a consequence, the forms named *Pecten* (*Pseudamussium*) *richtohofeni* by HILBER (1882) should be regarded as morphotypes of *Ch.* (*F.*) *scissa* (FAVRE). The present authors are thus opposed to the opinion of KRACH (1967) who raised varietas *richthofeni* to the subspecies level.

STRATIGRAPHIC RANGE: Middle Miocene (FRIEDBERG 1936) – Late Miocene (GLIBERT 1945).

Subgenus *Chlamys* (*Macrochlamis*) SACCO, 1897
Chlamys (*Macrochlamis*) *latissima nodosiformis* (de SERRES *in* PUSCH, 1837)
(Text-pl. 4 and Pl. 5, Fig. 1a-b)

1870. *Pecten latissimus* DEFR.; F. ROEMER, pp. 396–397, Pl. 46, Figs 1–3.
1928. *Pecten* (*Oopecten*) *latissimus* var. *austriaca* nov. var. F. KAUTSKY, pp. 252–253.
1936. *Pecten* (*Grandipecten*) *latissimus* BROCC.; W. FRIEDBERG, pp. 215–217, Pl. 35, Fig. 1 and Pl. 36, Figs 1–2.
part. 1939. *Chlamys latissima* BROCCHI; J. ROGER, pp. 37–43, Pl. 19, Fig. 1 and Pl. 28, Figs 1–1a; [*non* Pl. 18, Figs 1–1a].
1951. *Chlamys latissima* BROCCHI var. *nodosiformis* De SERRES; O. da VEIGA FERREIRA, pp. 164–165, Pl. 6, Fig. 21 and Pl. 7, Figs 26 and 28.
1958. *Chlamys latissima* (BROCCHI); L. ERÜNAL-ERENTÖZ, pp. 148–149, Pl. 23, Fig. 6.
1960. *Chlamys latissima nodosiformis* (de SERRES); I. CSEPREGHY-MEZNERICS, p. 33, Pl. 26, Figs 1–5, Pl. 27, Figs 1–2, Pl. 28, Figs 1–2, Pl. 29, Figs 1–2 and Pl. 32, Figs 1–2.
1960. *Chlamys latissima* (BROCCHI); I. CSEPREGHY-MEZNERICS, p. 33, Pl. 30 and Pl. 31.

1960. *Chlamys (Gigantopecten) latissima* var. *nodosiformis* (de SERRES *in* PUSCH 1837); E. KOJUMDGIEVA, pp. 70–71, Pl. 24, Fig. 1 and Pl. 25, Fig. 1.
1961. *Chlamys latissima* BROCCHI; O. da VEIGA FERREIRA, pp. 441–442, Pl. 7, Fig. 47, Pl. 11, Figs 64 and 69 and Pl. 19, Fig. 140.
1968. *Chlamys latissima* (BROCCHI, 1814); V. A. ZELINSKAJA & *al.*, p. 149, Pl. 39, Fig. 1.
1977. *Chlamys latissima latissima* BROCCHI; E. NICORICI, p. 132.
1977. *Chlamys latissima nodosiformis* (De SERRES); E. NICORICI, pp. 132–133, Pl. 13, Pl. 14, Figs 1a–1b and Pl. 15, Figs 1–4.
1978. *Chlamys (Macrochlamys) latissima nodosiformis* (de SERRES, 1829); F. STEININGER & *al.*, p. 345, Pl, Pl. 10, Figs 2–3.
1981. *Chlamys latissima nodosiformis* (M. SERRES *in* G. PUSCH, 1837); J. ŠVAGROVSKY, pp. 57–58, Pl. 13, Figs 1–3, Pl. 14, Fig. 1 and Pl. 15, Fig. 1.

MATERIAL: Bogucice – 2 incomplete left valves, Kików – 1 shell, Pińczów – 1 shell, 2 right valves, 3 left valves; Szczaworyż – 1 shell, Żerniki – 1 shell.
DIMENSIONS (*in* mm):

	L	H
MZ VIII Ml 2603/2	140.0	130.0
MZ VIII Ml 2603/1	98.0	90.0

REMARKS: The specimens from Skotniki near Busko had been originally attributed by PUSCH (1837) to the species *Pecten nodosiformis* de SERRES. Subsequently, however, the specimens indistinguishable from these described by PUSCH (1837) were usually referred to either *Chlamys latissima* (BROCCHI), or *Chlamys latissima nodosiformis* (de SERRES *in* PUSCH). In the former case, the name *P. nodosiformis* was regarded as a younger synonym of *Ch. latissima* (cf. HÖRNES 1867, pp. 395–397; FRIEDBERG 1936, pp. 215–217; MALATESTA 1974, pp. 51–53); in the latter, *P. nodosiformis* was thought to represent the subspecies of *Ch. latissima* (CSEPREGHY-MEZNERICS 1960, p. 33; GLIBERT & VAN de POEL 1965, p. 17; NICORICI 1977, pp. 132–133). The latter opinion follows the statement of ROGER (1939) who, based on abundant material from all European Neogene bioprovinces, ascertained validity of four morphological varieties of the species *latissima*: *latissima* BROCCHI, *apollo* DOLLFUS & DAUTZENBERG, *nodosiformis* de SERRES, and *restitutensis* FONTANNES. According to ROGER (1939), the variety *latissima* occurs exclusively in the Lower Pliocene of the Mediterranean and, in part, Atlantic-Boreal bioprovinces, while the remaining three varieties occur in the Miocene: *restitutensis* in the Burdigalian of the Rhône valley, Langhian of northern Italy and Aquitaine; *apollo* in the Upper Miocene of Anjou (France, Atlantic-Boreal bioprovince); *nodosiformis* in the Burdigalian of southern France and northern Italy, Langhian of Italy, Sardinia and Syria, and Badenian of the Vienna Basin and Poland.

Later studies by da VEIGA FERREIRA (1951, 1961) and DEMARCQ (1979a) have evidenced the occurrence of the form *nodosiformis* also in the Burdigalian and Langhian of Portugal, and its invariable co-occurrence with the form *restitutensis* in both Portugal and southern France. On the other hand, CSEPREGHY-MEZNERICS (1960), NICORICI (1977), and Dr. G. JAKUBOWSKI (*personal communication*) observed predominance of the form *nodosiformis* in the Badenian populations, the form *latissima* being rare or lacking at all.

As a consequence, the form *nodosiformis* is here considered as being not only a part of the large species *Ch. latissima* BROCCHI, which conforms to ROGER's (1939) statement, but also as representing the temporal subspecies of the latter. All populations of this species from the Pliocene should then be assigned to *Ch. latissima latissima* BROCCHI, while those from the older strata (*i.e.* Burdigalian, Langhian, Badenian) to *Ch. l. nodosiformis* (de SERRES *in* PUSCH). This conclusion is supported by the following arguments: (*i*) Both the forms are confined to the same facies, *i.e.* red-algal, more or less organodetrital limestones; (*ii*) the features typical of *Ch. l. nodosiformis* (de SERRES *in* PUSCH), *i.e.* nodules on the left valve, prominent main ribs and presence of lateral ribs, are visible also in the immature stages of *Ch. l. latissima* BROCCHI; (*iii*) the Miocene populations are dominated by individuals showing features typical of *Ch. l. nodosiformis* (de SERRES *in* PUSCH).

STRATIGRAPHIC RANGE: Early Miocene (ROGER 1939) – Late Miocene (ROGER 1939).

Chlamys (*Macrochlamis*) *solarium* (LAMARCK, 1819) (Pl. 4, Figs 1–2)

part. 1870. *Pecten Leythayanus* PARTSCH; F. ROEMER, p. 397, Pl. 45, Fig. 4 [*non* Pl. 45, Fig. 3].
1936. *Pecten (Amusstopecten) solarium* LAM.; W. FRIEDBERG, pp. 214–215, Pl. 33, Fig. 2 and Pl. 35, Fig. 2.
1939. *Chlamys solarium* LAMARCK; J. ROGER, pp. 13–14.
1951. *Chlamys solarium* LAMARCK; O. da VEIGA FERREIRA, pp. 161–162, Pl. 10, Figs 44 and 47.
1958. *Chlamys solarium* (LAMARCK); L. ERÜNAL-ERENTÖZ, pp. 146–147, Pl. 23, Fig. 4, Pl. 24, Fig. 1 and Pl. 25, Fig. 1.
1960. *Flabellipecten solarium* (LAMARCK); I. CSEPREGHY-MEZNERICS, pp. 15–16, Pl. 7, Figs 3–7 and Pl. 8, Figs 1–3.
1960. *Chlamys (Oopecten) solarium* (LAMARCK); E. KOJUMDGIEVA, pp. 67–68, Pl. 23, Fig. 1.
1961. *Chlamys solarium* LAMARCK; O. da VEIGA FERREIRA, pp. 439–440, Pl. 2, Figs 7 and 15.
1963. *Flabellipecten solarium* (LAMARCK); G. TAVANI & M. TONGIORGI, pp. 12–13, Pl. 5, Fig. 1, Pl. 7, Fig. 1, Pl. 8, Fig. 1 and Pl. 9, Fig. 1.
1968. *Chlamys solarium* (LAMARCK, 1819); V. A. ZELINSKAJA & *al.*, p. 153, Pl. 40, Fig. 8.
1977. *Chlamys solarium* (LAMARCK); E. NICORICI, p. 131, Pl. 11, Figs 1a-c and Pl. 12, Figs 1–3.
1978. *Pecten (Flabellipecten) solarium* LAMARCK, 1819; F. STEININGER & *al.*, p. 346, Pl. 10, Figs 3–7 and Pl. 11, Fig. 1.
1981. *Flabellipecten solarium* (LAMARCK, 1819); J. ŠVAGROVSKY, pp. 50–51, Pl. 7, Fig. 1, Pl. 8, Figs 1–2 and Pl. 9, Figs 1–3.

MATERIAL: Pińczów – 4 left valves.

DIMENSIONS (*in* mm):

	L	H
Coll. M. RYSZKIEWICZ	130.0	115.8
MZ VIII Ml 2604/1	48.7	48.5

REMARKS: The considered specimens are consistent with the descriptions and illustrations referred to in the synonymy.

The generic attribution of the species *solarium* changed through time as indicated in the synonymy. Its taxonomic position accepted in this paper follows the opinion of ROGER (1939) who attributed the species *solarium* to the group of *Oopecten* SACCO, 1897, within the genus *Chlamys* RÖDING, 1798. Subsequently, however, the name *Oopecten* SACCO has been shown to be a synonym of *Macrochlamis* SACCO, 1897 (*cf.* HERTLEIN 1969, p. *N*358).

STRATIGRAPHIC RANGE: Early Miocene (ROGER 1939) – Middle Miocene (ŠVAGROVSKY 1981).

Genus *Pecten* O. F. MÜLLER, 1776
Subgenus *Pecten* (*Pecten*) O. F. MÜLLER, 1776
Pecten (*Pecten*) *subarcuatus* TOURNOUËR, 1874 (Pl. 2, Fig. 4)

1939. *Pecten subarcuatus* TOURNOUËR; J. ROGER, pp. 237–238.
1939. *Pecten fuchsi* FONTANNES; J. ROGER, p. 238.
1964. *Pecten fuchsi styriacus* HILB.; G. HÁMOR, Pl. 25, Figs 6 and 11.
1969. *Pecten (Pecten) fuchsi styriacus* (HILBER, 1879); P. ČTYROKY, pp. 23–24.
1961. *Pecten subarcuatus* TOURNOUËR; O. da VEIGA FERREIRA, pp. 420–421, Pl. 13, Figs 85–86.
1961. *Pecten fuchsi* FONTANNES; O. da VEIGA FERREIRA, p. 421, Pl. 2, Fig. 11.
1977. *Pecten fuchsi styriacus* HILBER; E. NICORICI, pp. 127–128, Pl. 44, Figs 3–5.
1986. *Pecten (Flabellipecten) subarcuatus* TOURNOUËR, 1874; B. STUDENCKA, pp. 42–43, Pl. 3, Fig. 4a-b [*cum syn.*].

MATERIAL: Kików – 1 left valve.
DIMENSIONS (*in* mm):

	L	H
MZ VIII Ml 2606	37.6	35.7

REMARKS: The only specimen of *Pecten* (*P.*) *subarcuatus* TOURNOUËR from the Pińczów Limestones is entirely consistent with the descriptions and illustrations referred to in the synonymy. For the more complete description and remarks see STUDENCKA (1986).

STRATIGRAPHIC RANGE: Early Miocene (ROGER 1939) – Late Miocene (IVOLAS & PEYROT 1900).

Subgenus *Pecten* (*Flabellipecten*) SACCO, 1897
Pecten (*Flabellipecten*) *besseri* ANDRZEJOWSKI, 1830
(Pl. 6, Figs 1–2)

part. 1870. *Pecten Leythayanus* PARTSCH; F. ROEMER, p. 397, Pl. 45, Fig. 3 [*non* Pl. 45, Fig. 4].
1882. *Pecten* (*Vola*) *Besseri* ANDRZ.; V. HILBER, pp. 30–31, Pl. 4, Figs 3–4.
1907. *Pecten* (*Vola*) *Besseri* ANDRZ.; W. FRIEDBERG, pp. 36–39, Pl. 3, Figs 3a–b, 4a–b and 5.
1910. *Flabellipecten Besseri* ANDRZEJOWSKI; C. DEPERET & F. ROMAN, pp. 119–122, Pl. 13, Figs 2–2a and 3–3a.
1934. *Pecten* (*Flabellipecten*) *Besseri* ANDRZ.; W. FRIEDBERG, pp. 212–214, Pl. 34, Figs 1–5.
1958. *Flabellipecten besseri* ANDRZEJOWSKI; L. ERÜNAL-ERENTÖZ, p. 157, Pl. 26, Fig. 12.
1960. *Flabellipecten besseri* (ANDRZEJOWSKY); I. CSEPREGHY-MEZNERICS, p. 14, Pl. 5, Fig. 7 and Pl. 6, Figs 1–2.
1960. *Pecten* (*Flabellipecten*) *besseri* ANDRZEJOWSKY 1830; E. KOJUMDGIEVA, p. 66, Pl. 22, Figs 3–5.
1961. *Flabellipecten besseri* ANDRZEJOWSKI; O. da VEIGA FERREIRA, pp. 433–434, Pl. 4, Fig. 24, Pl. 8, Fig. 50, Pl. 20, Fig. 152 and Pl. 21, Fig. 156.
1968. *Pecten besseri* ANDRZEJOWSKI, 1830; V. A. ZELINSKAJA & *al.*, pp. 156–157, Pl. 41, Fig. 4.
1969. *Pecten* (*Flabellipecten*) *besseri* ANDRZEJOWSKI; M. A. ATANACKOVIĆ, p. 179, Pl. 3, Figs 6–6d.
1970. *Pecten* (*Flabellipecten*) *besseri* ANDRZEJOWSKI; W. BAŁUK, Pl. 3, Fig. 5.
1977. *Flabellipecten besseri* (ANDRZJOWSKY); E. NICORICI, pp. 128–129, Pl. 4, Figs 1–2, Pl. 5, Figs 1–4 and Pl. 6, Fig. 1a–b.
1978. *Pecten* (*Flabellipecten*) *besseri* ANDRZEJOWSKY, 1830; F. STEININGER & *al.*, p. 345, Pl. 10, Figs 4–5 and Pl. 11, Figs 2–3.
1981. *Flabellipecten besseri* (ANDRZEJOWSKI, 1830); J. ŠVAGROVSKY, pp. 52–53, Pl. 10, Figs 2–3 and Pl. 11, Figs 1–4.

MATERIAL: Busko – 4 incomplete right valves, Pińczów – 2 right valves.

DIMENSIONS (*in* mm):

	L	H
MZ VIII Mł 2607/1	83.5	73.0
MZ VIII Mł 2607/2	72.6	64.0

DESCRIPTION: The valve is large, convex, flabelliform, with slightly concave dorsal margin. Small, acute beak is placed anteriorily to the midline of the valve. Apical angle equals 120°.

Auricles are large but partially broken, the posterior one being slightly greater than the anterior, both of them ornamented with concentric lamellae near the margin.

External surface of the disc is ornamented with 19 ribs showing flabellate arrangement, two marginal ribs being weaker than the others. Rib width increases ventrally, while the width of grooves remains nearly constant from the beak to the ventral margin. Upper surface of the ribs is flattened and smooth, while the grooves are covered with densely spaced, straight concentric lamellae, which climb up the rib slopes and bend towards the beak. The marginal ribs, both anterior and posterior, also bear lamellae but exclusively near the ventral margin. Concentric ornamentation appears some 30 mm from the beak, both the ribs and the grooves being smooth at the earlier ontogenetic stage.

Hinge margin is flanged to the inside of the valve and delicately scaled. Deep groove ornamented with fine vertical lines runs obliquely to the hinge margin at the posterior auricle. Short, oblique cardinal crus *c.c.PIII* is situated beneath the groove, separated from the very short, oblique cardinal crus *c.c.PI* by another groove, shallower but also vertically lined. Auricular crura are very strong, the anterior one being slightly shorter than the posterior.

Adductor muscle scar is large and distinct, with its upper margin situated halfway between the beak and the pallial line. Pallial line shows no sinus and is very distant from the ventral margin. Internal ribs extend far inside the valve.

REMARKS: In his description of the specimens from Żukowce, the type locality of *Pecten* (*F.*) *besseri* ANDRZEJOWSKI, FRIEDBERG (1907) characterized their external ornamentation as consisting of 20–21 ribs in the right valve and of 18–20 ribs in the left valve. Ribs are angular, with their slopes gentle, never divided into secondary riblets. Whole valve is covered with densely spaced, distinct concentric lamellae, particularly well visible in the grooves.

After comparative investigations of both W. FRIEDBERG's collection (housed in the

Institute of Geological Sciences, Cracow), and I. CSEPREGHY-MEZNERICS' collection (housed in the National Museum, Budapest), the intraspecific variability in shell ornamentation of *P.* (*F.*) *besseri* ANDRZEJOWSKI may be characterized as follows:

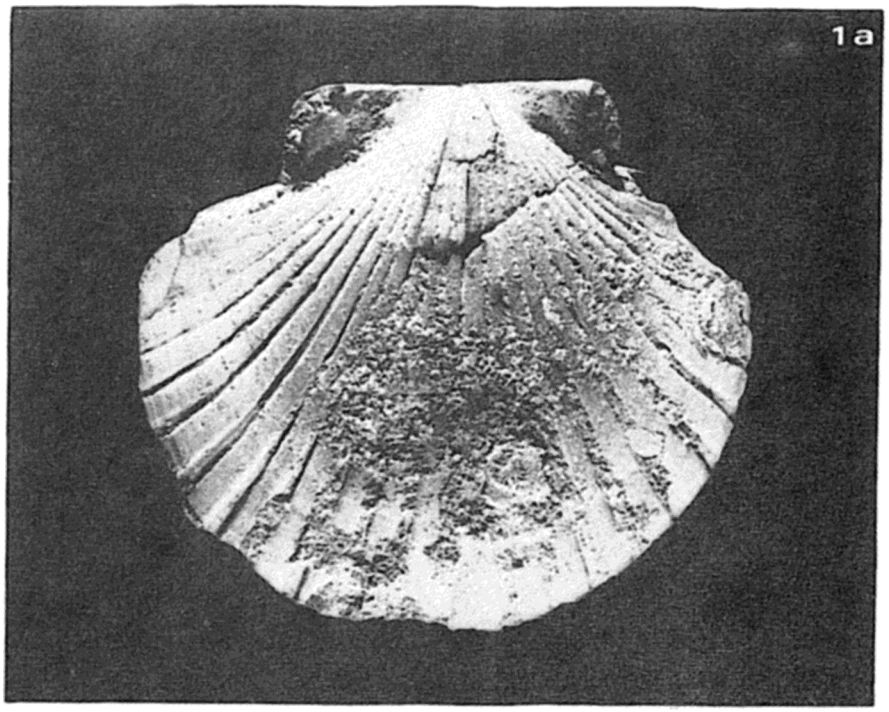
The ribs on the right valve are either rounded, with upper surface slightly flattened, or they are angular, rounded in the upper part. They are only slightly broader than the flattened grooves, but sometimes their width is 1.5 – 2 times the width of the grooves. The rib number ranges from 19 to 23, but 1–3 anterior and 2–4 posterior ribs are narrower and lower than the others. In juveniles (up to 25 mm in height), the concentric ornamentation is distinct, the concentric lines being relatively sparsely spaced and stronger in the grooves near the beak but rather densely spaced and equal in strength in the grooves and on the ribs further away from the beak. In adults (up to 80 mm in height), some variability in concentric ornamentation is observed. In most cases, distinct lines or fillets are present in the grooves and on the rib slopes, the upper rib surfaces being smooth. Sometimes, however, concentric lines are visible on the whole surface of the disc: straight in the grooves but weak and arcuate on the ribs. In some specimens, concentric ornamentation arises far from the beak, after a prominent growth line, and then densely spaced lamellae occur both in the grooves and on the ribs, instead of the faint lines in the grooves.

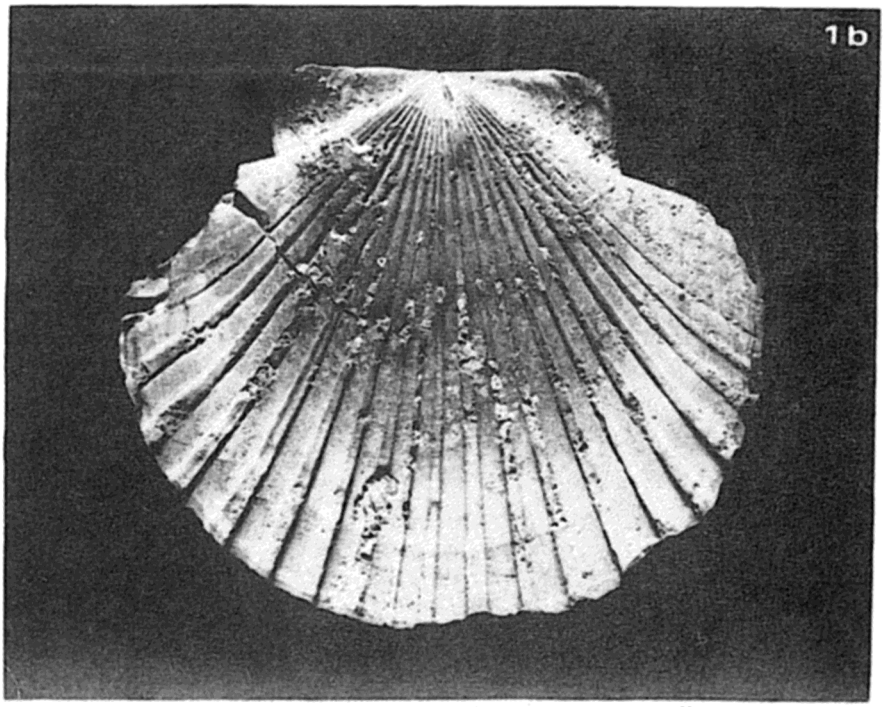
The disc of the left valve is ornamented with 19–21 rounded ribs which flatten distally. The ribs are generally slightly narrower, but rarely as much as twice narrower, than the flat grooves. Some specimens show alternating wide bands, cream-colored and grey. Their presence is connected with concentric ornamentation that covers either the whole disc, or only the distal parts of cream-colored bands. In the latter case, concentric lines are sparsely spaced at first, then tightened, to disappear at the border of the next grey band.

Allied with *P.* (*F.*) *besseri* ANDRZEJOWSKI is the species *P.* (*E.*) *leythajanus* (PARTSCH *in* HÖRNES, 1870). These two species can be distinguished by their different shell outlines and external ornamentations (Text-pl. 1, Fig. 1a–b). The shell of *P.* (*F.*) *leythajanus* (PARTSCH *in* HÖRNES) is more flattened, the difference between valve convexities being lesser than in *P.* (*F.*) *besseri* ANDRZEJOWSKI. The greatest convexity of the right valve in *P.* (*F.*) *besseri* ANDRZEJOWSKI is in 1/3 of its height, the left valve being generally weakly convex but flat to concave near the beak. In contrast, the right valve of *P.* (*F.*) *leythajanus* (PARTSCH *in* HÖRNES) attains its greatest convexity by its mid-height; the left valve is weakly but regularly convex; the dorsal margin is longer and more strongly arcuate than in *P.* (*F.*) *besseri* ANDRZEJOWSKI, which makes the shell more flabellate in outline. Auricles are large and equidimensional in both the compared species, but they terminate in the middle of the dorsal margin in *P.* (*F.*) *leythajanus* (PARTSCH *in* HÖRNES) whereas they reach 2/3 – 3/4 of the dorsal margin length in *P.* (*F.*) *besseri* ANDRZEJOWSKI. The disc of the right valve is ornamented with 19–23 ribs in *P.* (*F.*) *besseri* ANDRZEJOWSKI; the disc of its left valve has 19–21 ribs that are narrower than grooves. In *P.* (*F.*) *leythajanus* (PARTSCH *in* HÖRNES), in turn, the disc of the right valve is ornamented with 21–23 rectangular, relatively low ribs that are twice to three times wider than the flat grooves; the left valve is covered with 19–24 ribs which are wider than the grooves; concentric ornamentation is rather inconspicuous, distinct only in the grooves near the ventral margin.

Also allied with *P.* (*F.*) *besseri* ANDRZEJOWSKI is the species *P.* (*F.*) *fraterculus* (SOWERBY *in* SMITH, 1847). Its right valve shows a similar outline but lesser convexity (with its maximum in the valve mid-height) than in the former species (Text-pls 2–3). The main differences between the two species under comparison are expressed in the rib number and shape. The disc of the right valve of *P.* (*F.*) *fraterculus* (SOWERBY *in* SMITH) is ornamented with 15–17 wide, flat, rectangular and relatively low ribs that are twice narrower than the grooves; the disc of the left valve is covered with 13 rounded, but ventrally flattening ribs, twice wider than the flat grooves. As in *P.* (*F.*) *besseri* ANDRZEJOWSKI, the concentric ornamentation is more conspicuous on the left valve, where it consists of faint lines, compressing ventrally. On the right valve, the concentric lines either cover the whole disc, or arise near the marked growth lines, but they are never as distinct as in *P.* (*F.*) *besseri* ANDRZEJOWSKI.

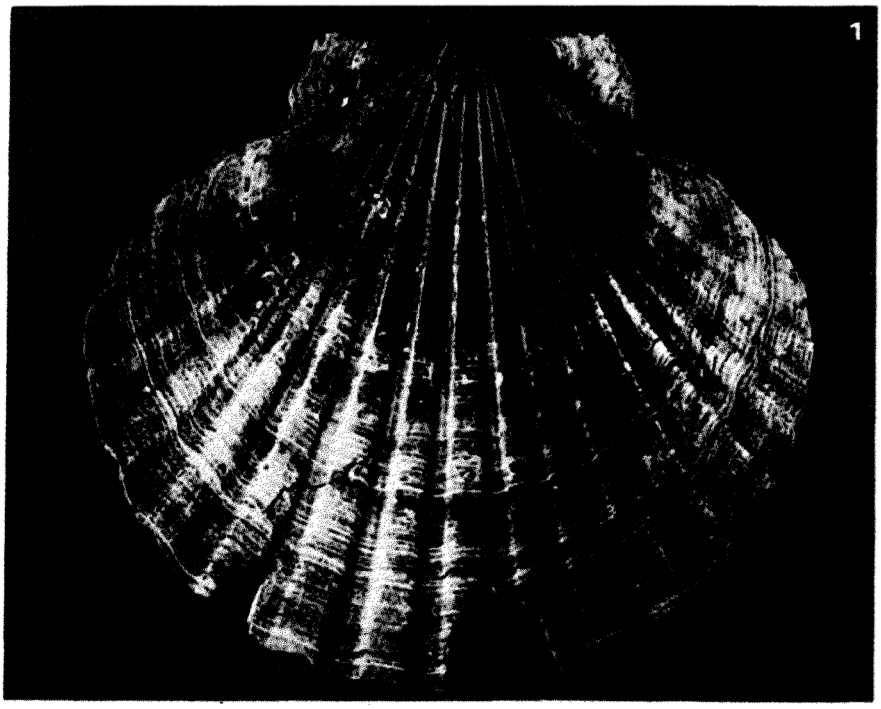
STRATIGRAPHIC RANGE: Middle Miocene (NICORICI 1977).

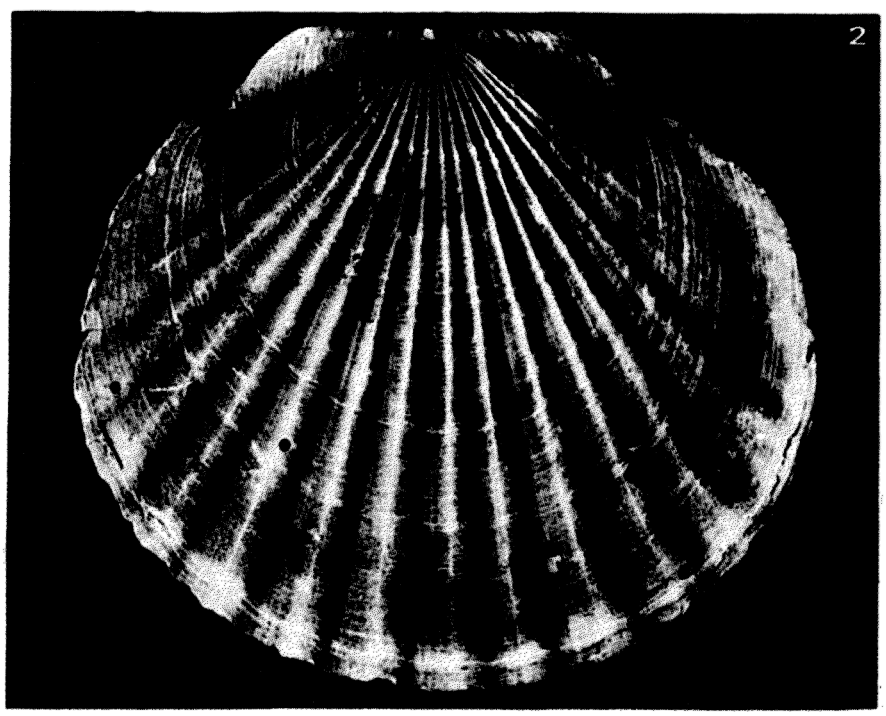




Pecten (*Flabellipecten*) *leythajanus* (PARTSCH *in* HÖRNES, 1870)

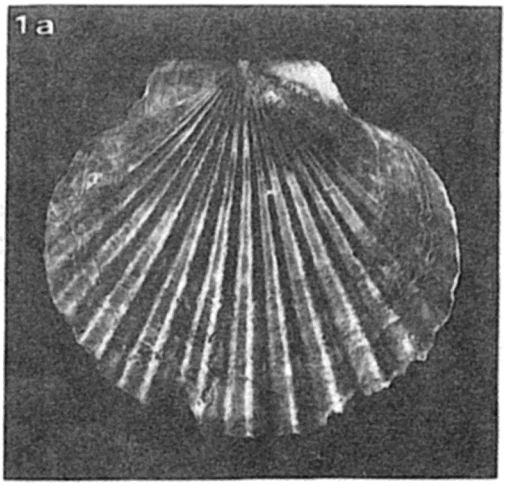
1a-1b – Shell (coll. J. KÓKAY); *1a* view from the right valve, *1b* view from the left valve, nat. size; Budapest, Upper Badenian

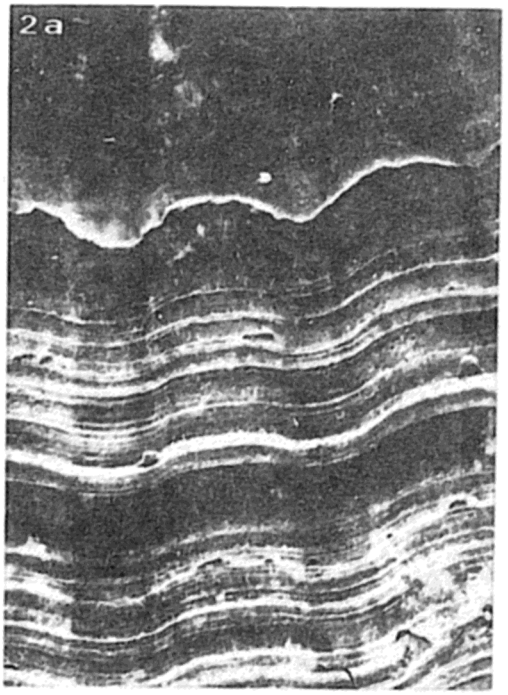


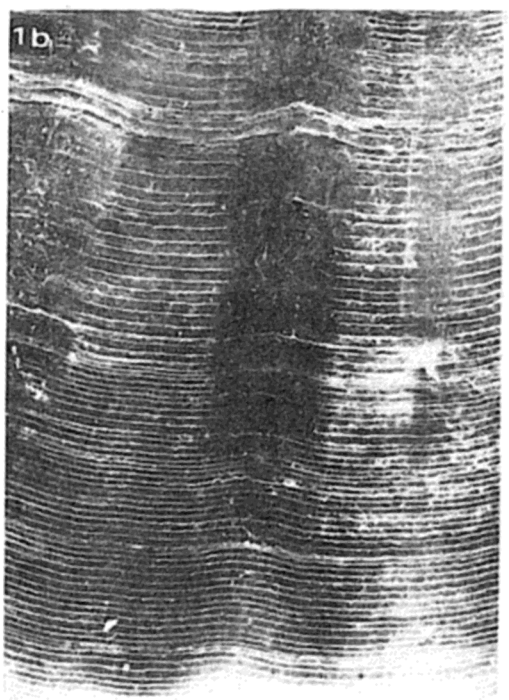


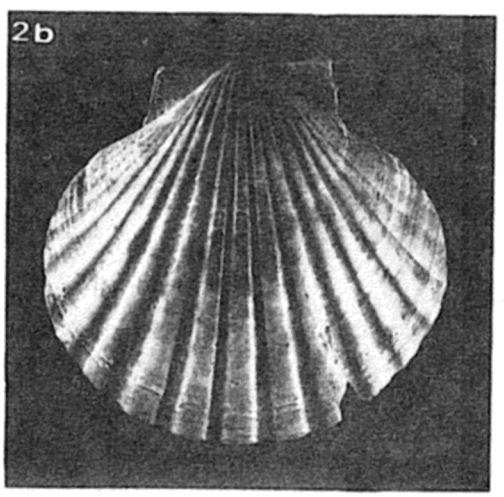
Pecten (*Flabellipecten*) *fraterculus* (SOWERBY *in* SMITH, 1847)

1 – Right valve, exterior (IRScNB IST-IG 9694/19E), nat. size; Salles (France), Langhian
2 – Left valve, exterior (IRScNB IST-IG 9694/19A), nat. size; Salles (France), Langhian





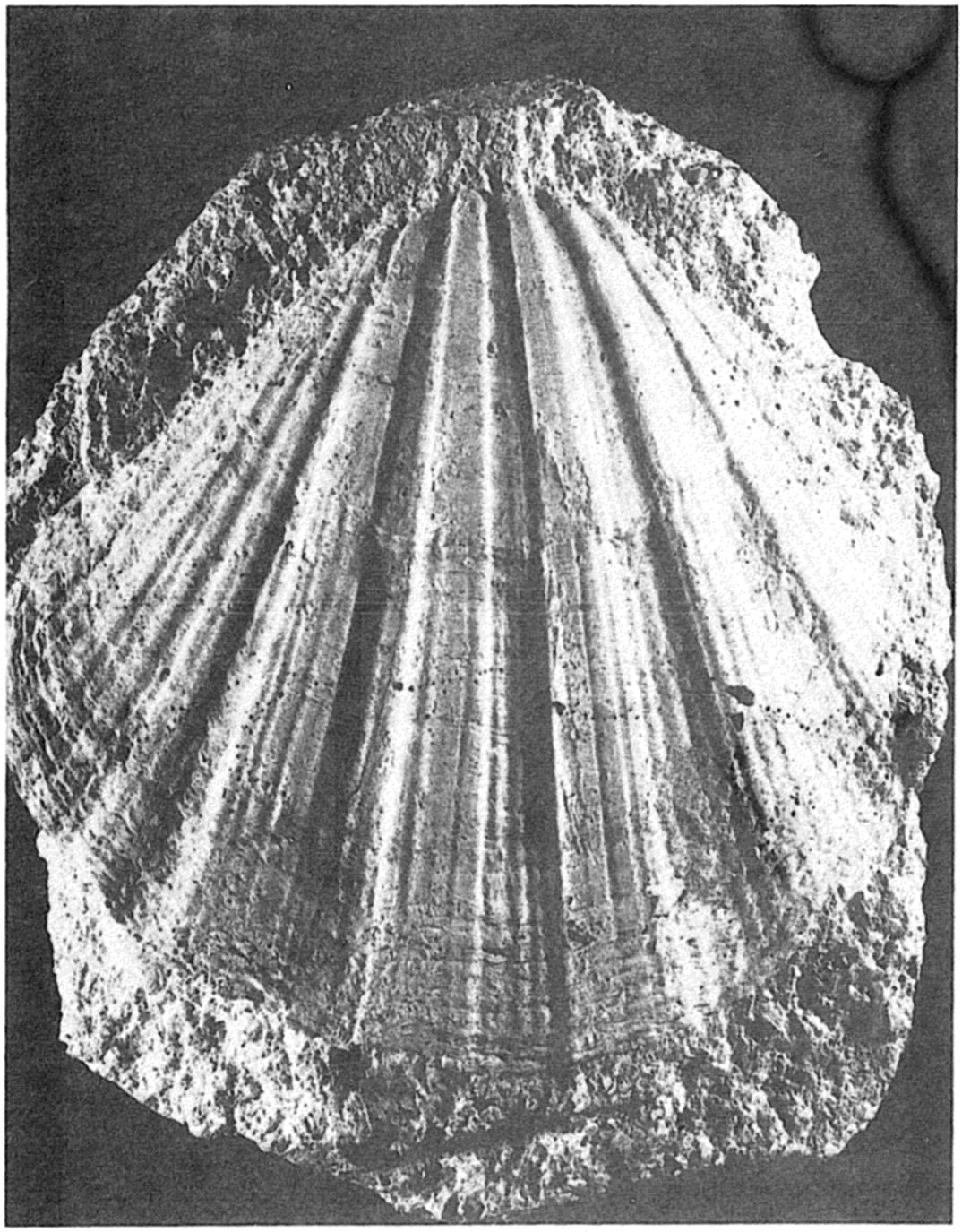




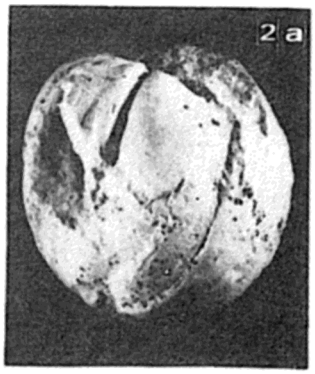
Pecten (*Flabellipecten*) *fraterculus* (SOWERBY *in* SMITH, 1847)

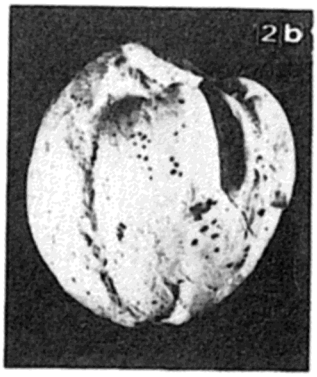
1a-1b – Left valve (Institute royal des Sciences naturelles de Belgique; specimen No. IRScNB IST-IG 9694/19G); *1a* exterior, nat. size; *1b* detail of the external surface, × 6; Salles (France), Langhian

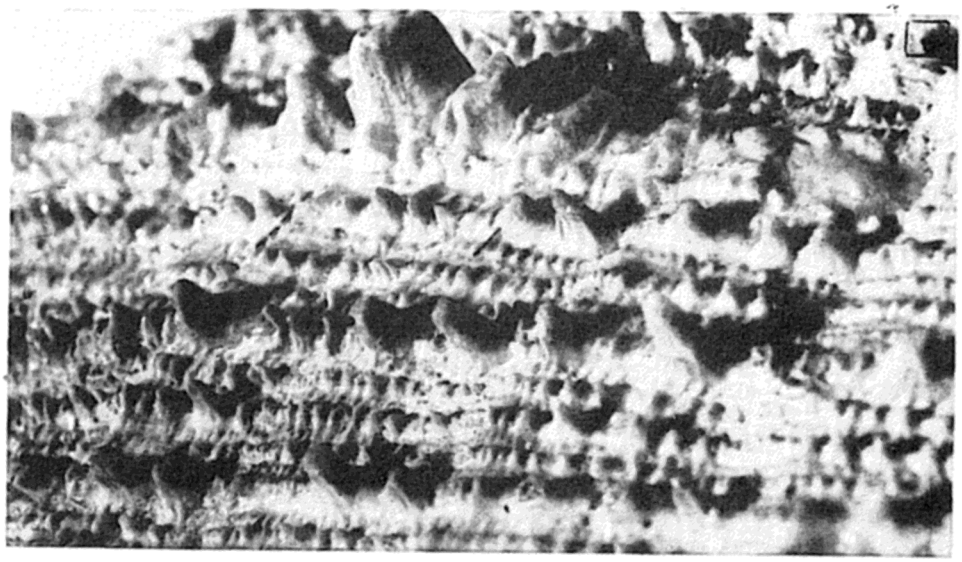
2a-2b – Right valve (IRScNB IST-IG 9694/19F); *2a* detail of the external surface, × 6; *2b* exterior, nat. size; Salles (France), Langhian



Chlamys (*Macrochlamis*) *latissima nodosiformis* (de SERRES *in* PUSCH)
Right valve, exterior (MZ VIII Mł 2603/2), nat. size; Pińczów





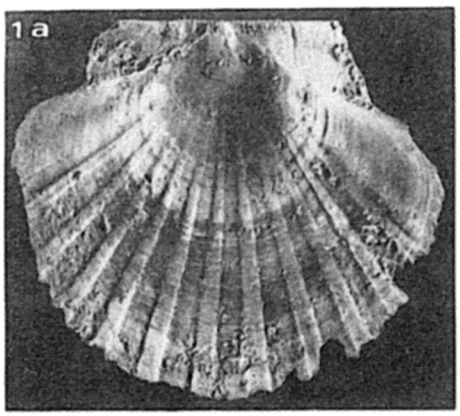


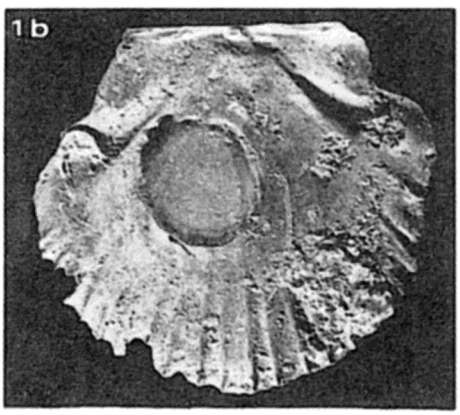
Spondylus (*Spondylus*) *crassicosta* LAMARCK

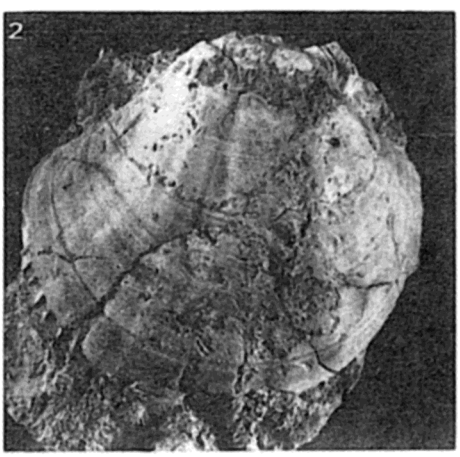
1a-1b – Left valve (IG 28II339); *1a* exterior, nat. size; *1b* detail of the external surface, × 5; Pińczów

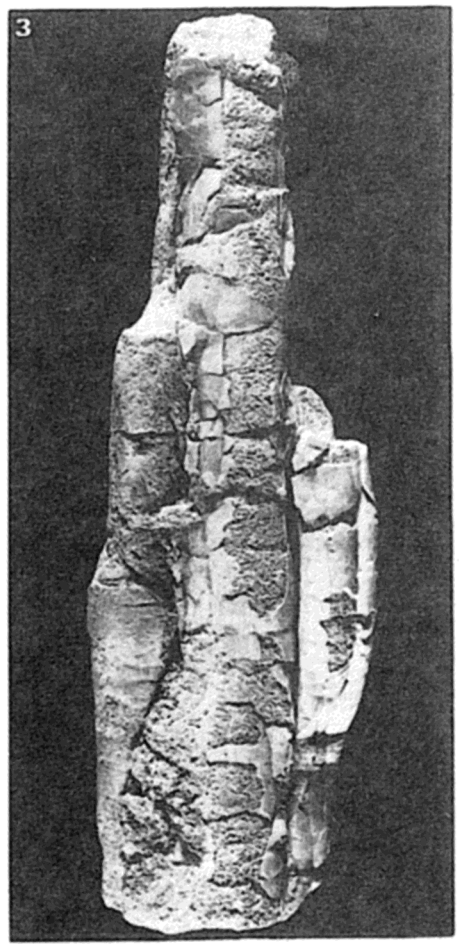
Jouannetia (*Jouannetia*) *semicaudata* DES MOULINS

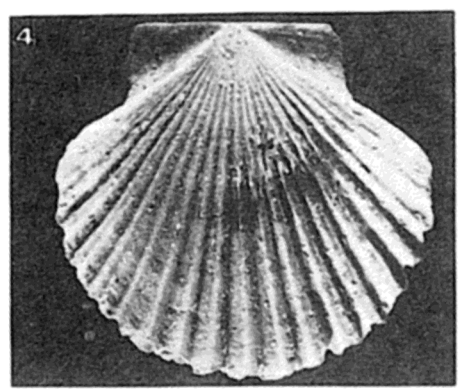
2a-2b – Internal mold (MZ VIII MI 2650/1); *2a* view from the right valve, *2b* view from the left valve, × 3; Grobie











Pecten (*Oppenheimopecten*) *revolutus* MICHELOTTI

1a-1b – Left valve (MZ VIII Mł 2608/2); *1a* exterior, *1b* interior, × 1.5; Pińczów

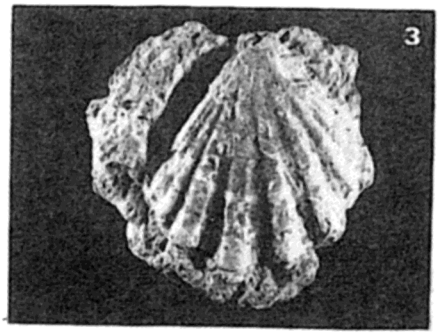
2 – Shell, view from the right valve (MZ VIII Mł 2608/1); × 1.5; Kików

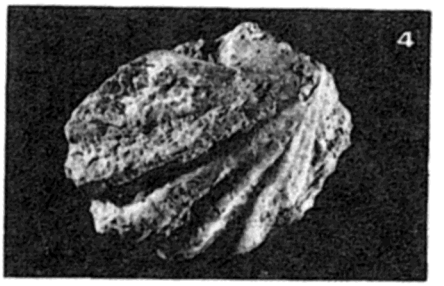
Teredo sp.

3 – System of tube molds (MZ VIII Mł 2655/1), nat. size; Pińczów

Pecten (*Pecten*) *subarcuatus* TOURNOUËR

4 – Left valve, exterior (MZ VIII Mł 2606/1); × 1.5; Kików



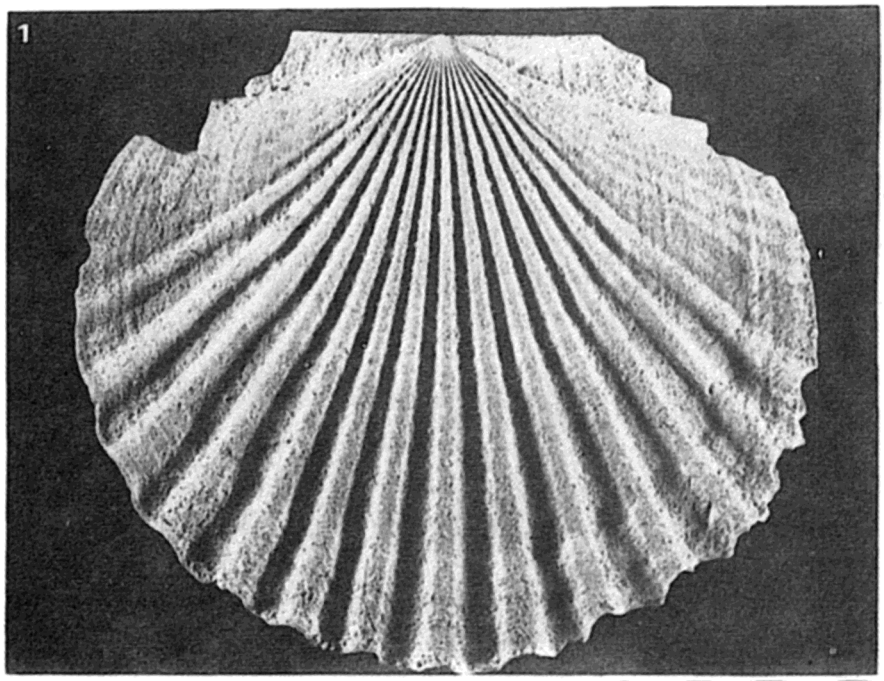


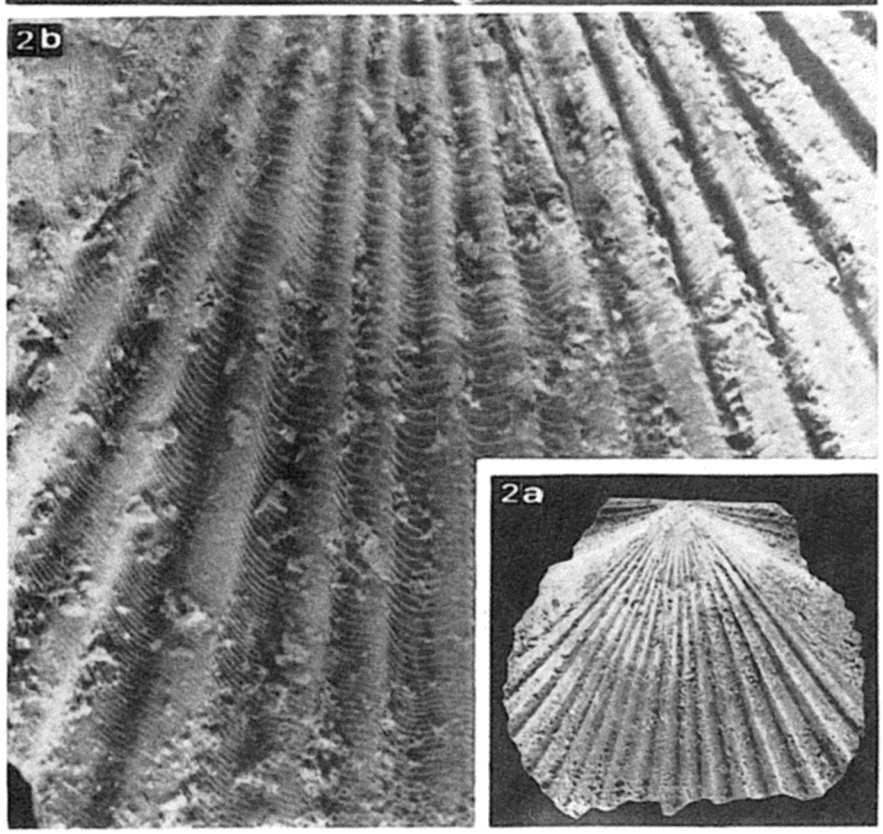
Nototeredo sp.

1 – System of tube molds (MZ VIII Mł 2651/1), nat. size; Pińczów
2 – System of tube molds (MZ VIII Mł 2651/2), nat. size; Pińczów

Chlamys (*Flexopecten*) *scissa* (FAVRE)

3 – Right valve, exterior (MZ VIII Mł 2601/1), nat. size; Zabelin
4 – Right valve, exterior (MZ VIII Mł 2601/2), × 1.5; Busko

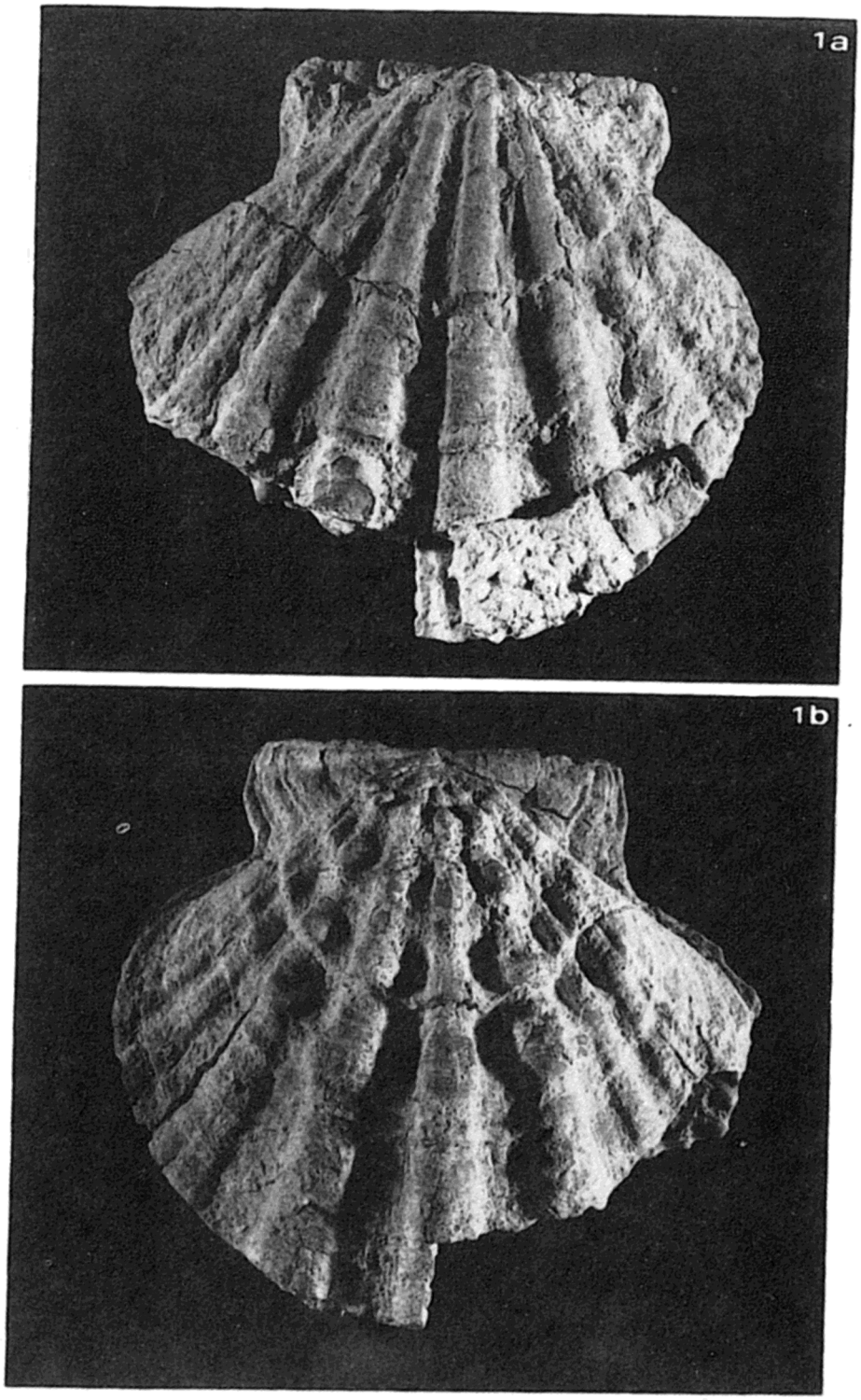




Chlamys (*Macrochlamis*) *solarium* (LAMARCK)

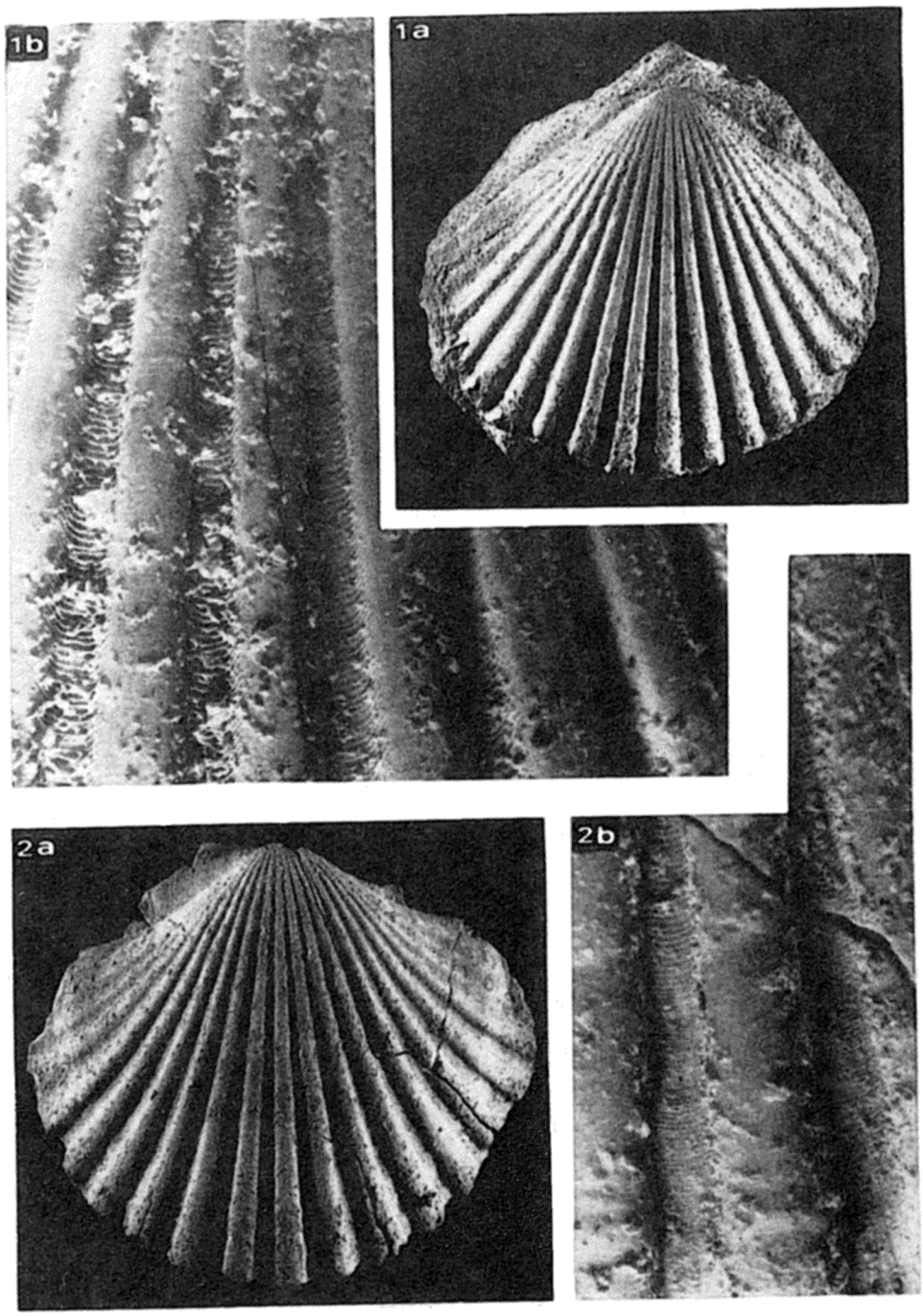
1 – Left valve, exterior (coll. M. RYSZKIEWICZ), × 0.75; Pińczów

2a-2b – Left valve (MZ VIII Mł 2604/1); *2a* exterior, nat. size; *2b* detail of the external surface, × 4; Pińczów



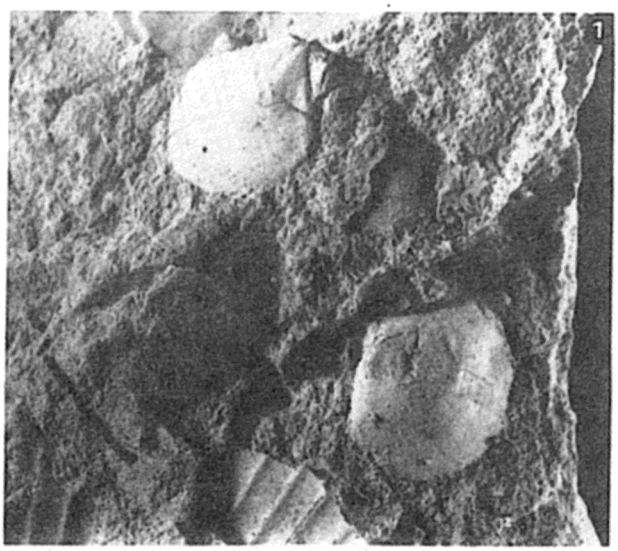
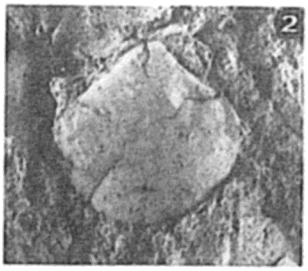
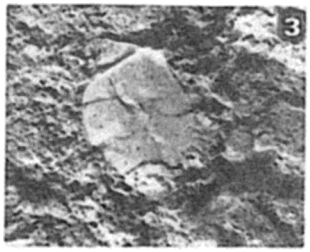
Chlamys (*Macrochlamis*) *latissima nodosiformis* (de SERRES *in* PUSCH)

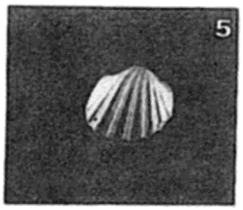
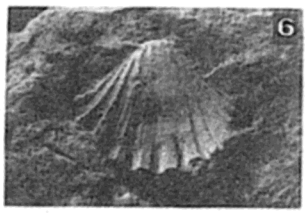
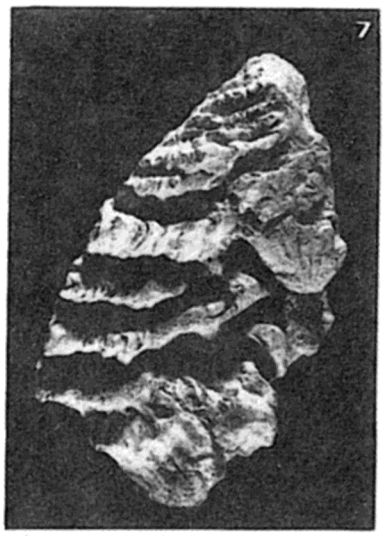
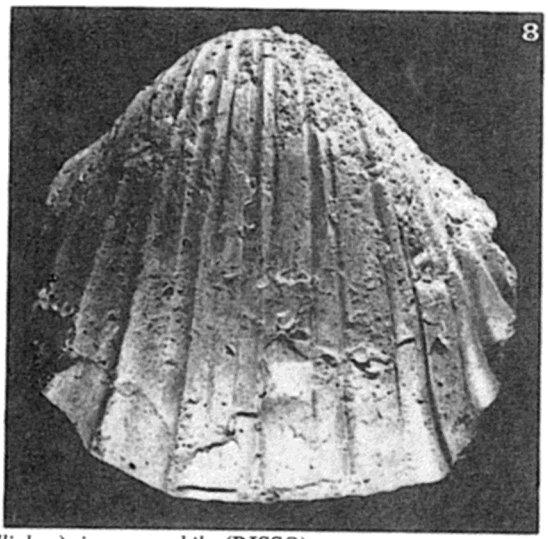
1a-1b – Shell (MZ VIII Ml 2603/1); *1a* view from the right valve, *1b* view from the left valve, nat. size; Kików



Pecten (*Flabellipecten*) *besseri* ANDRZEJOWSKI

1a-1b – Right valve (MZ VIII MI 2607/2); *1a* exterior, nat. size; *1b* detail of the external surface, × 5; Pińczów
2a-2b – Right valve (MZ VIII MI 2607/1); *2a* exterior, nat. size; *2b* detail of the external surface, × 5; Pińczów

Palliolum (*Palliolum*) *incomparabile* (RISSO)

1 – Two right valves, exterior (upper specimen MZ VIII Mł 2598/1, lower specimen MZ VIII Mł 2598/2), × 3; Szczaworyż
2 – Right valve, exterior (MZ VIII Mł 2598/1), × 3; Szczaworyż
3 – Right valve, exterior (MZ VIII Mł 2598/3), × 3; Busko

Cyathodonta eggenburgensis (SCHAFFER)

4 – Right valve, external mold (MZ VIII Mł 2654/1), × 1.5; Szczaworyż

Acanthocardia (*Acanthocardia*) *paucicostata* (SOWERBY)

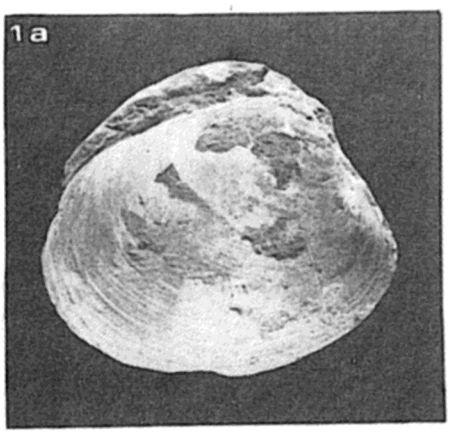
5 – External shell mold, view from the right valve (MZ VIII Mł 2623/2), × 1.5; Pińczów
6 – External mold of the left valve (MZ VIII Mł 2623/1), × 1.5; Pińczów

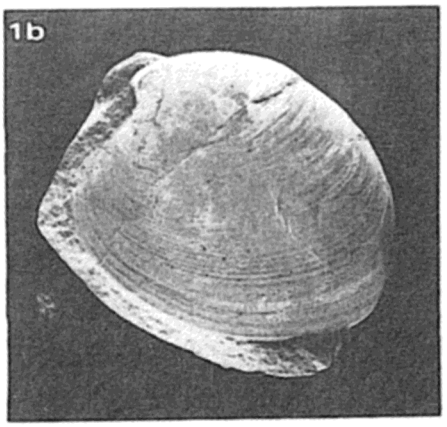
Cubitostrea digitalina (EICHWALD)

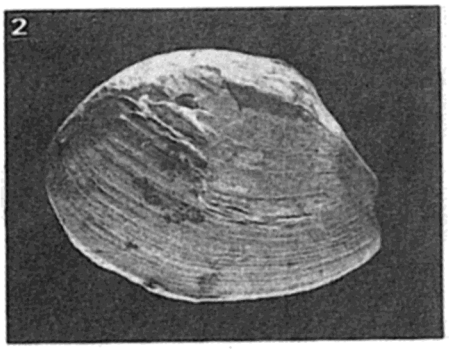
7 – Fragment of the left valve (MZ VIII Mł 2613/1), × 1.5; Szczaworyż

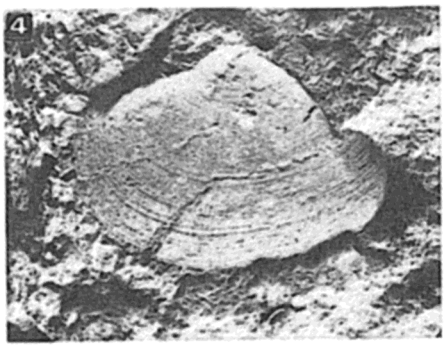
Cardium kunstleri COSSMANN & PEYROT

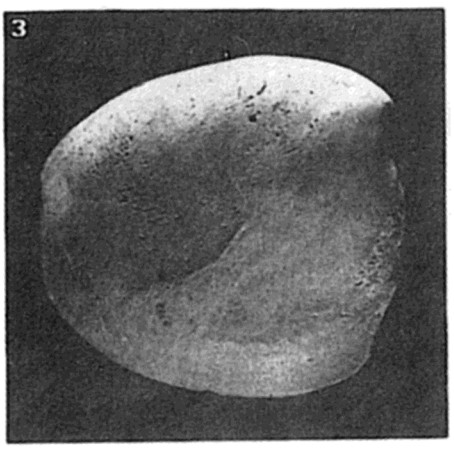
8 – Internal shell mold, view from the left valve (MZ VIII Mł 2622/1), nat. size; Pińczów

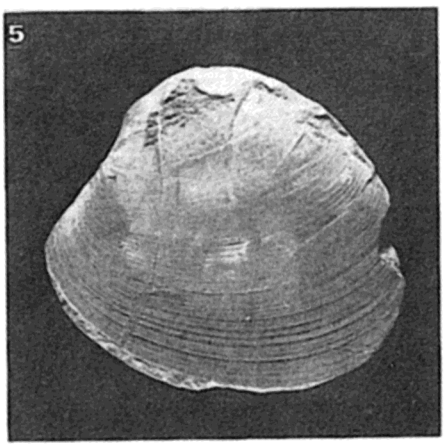










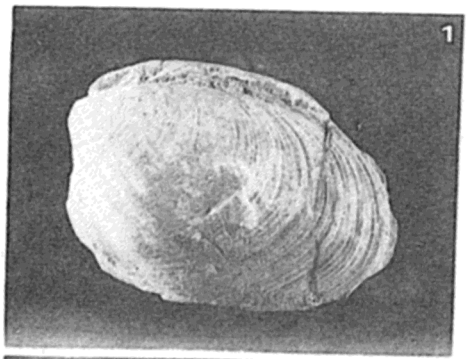


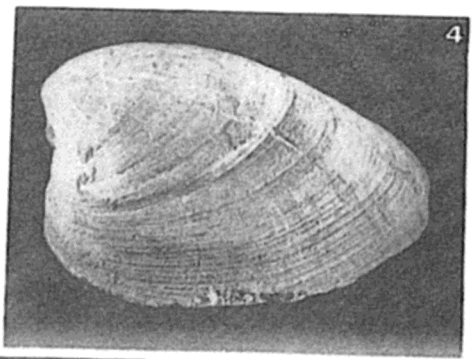
Pelecyora (*Cordiopsis*) *islandicoides* LAMARCK

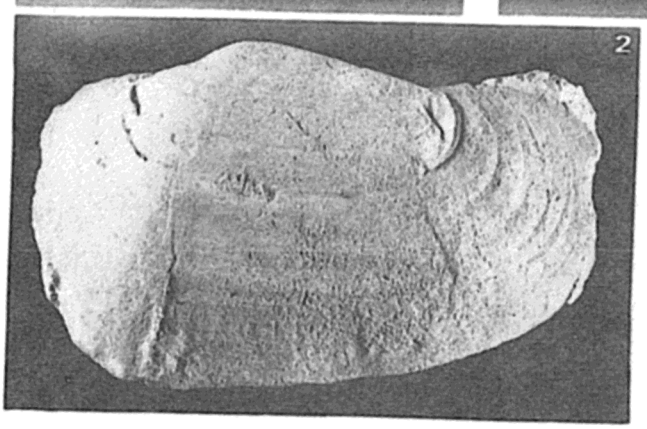
1a-1b – External shell mold (MZ VIII Ml 2643/2); *1a* view from the right valve, *1b* view from the left valve, nat. size; Pińczów
2 – External shell mold, view from the right valve (MZ VIII Ml 2643/4), nat. size; Pińczów
3 – Internal shell mold, view from the right valve (MZ VIII Ml 2643/1), nat. size; Pińczów
5 – External shell mold, view from the left valve (MZ VIII Ml 2643/3), nat. size; Pińczów

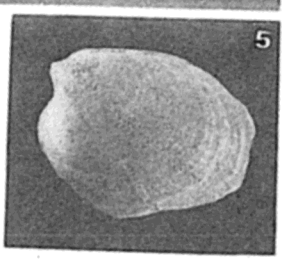
Tellina (*Peronaea*) *planata* LINNAEUS

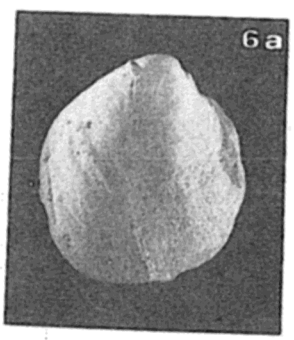
4 – External mold of the left valve (MZ VIII Ml 2631/1), × 1.5; Szczaworyż

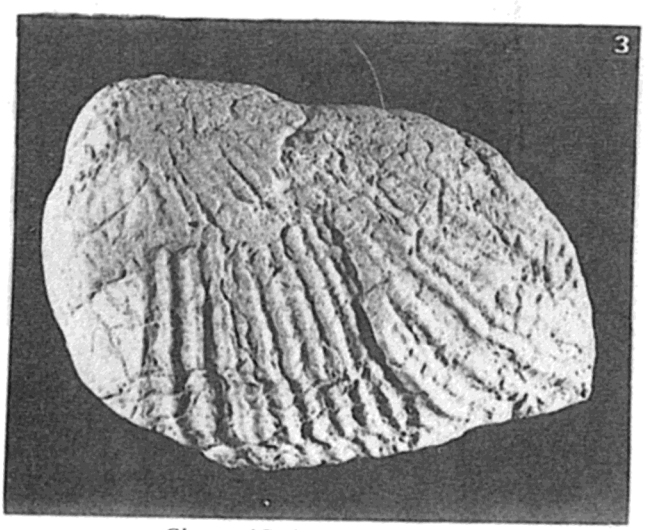


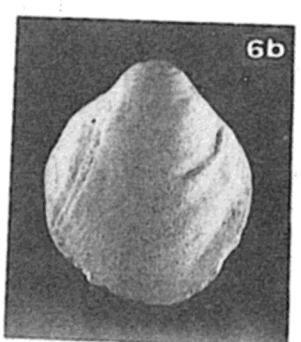












Glossus (*Cytherocardia*) cf. *deshayesi perlongata* (KUTASSY)

1 – External shell mold, view from the left valve (MZ VIII Mł 2644/2), nat. size; Pińczów
4 – External shell mold, view from the left valve (MZ VIII Mł 2644/1), nat. size; Pińczów
5 – External shell mold, view from the left valve (MZ VIII Mł 2644/3), × 1.5; Pińczów

Panopea (*Panopea*) *menardi* (DESHAYES)

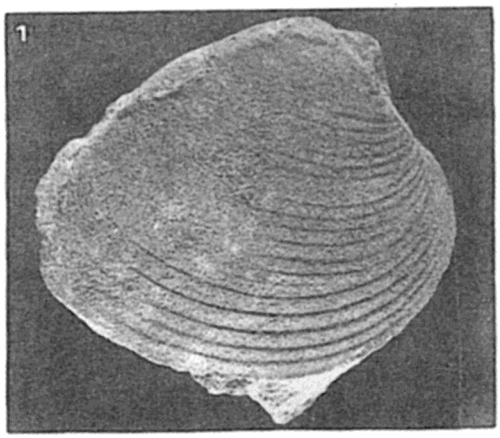
2 – External shell mold, view from the left valve (MZ VIII Mł 2649/1), × 0.75; Kików

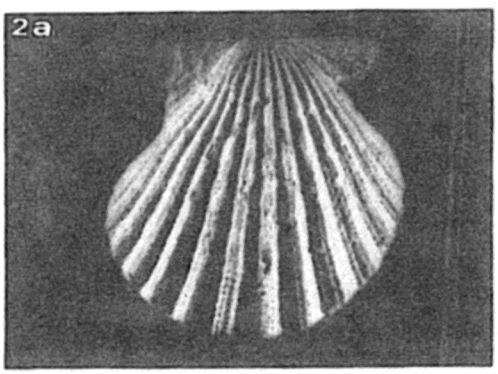
Pholadomya (*Pholadomya*) *alpina* MATHERON

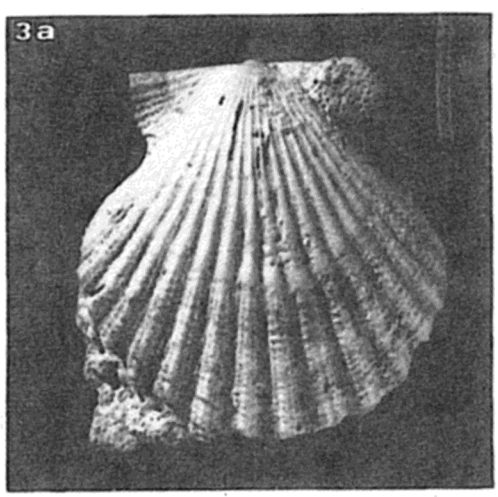
3 – External shell mold, view from the left valve (MZ VIII Mł 2652/1), nat. size; Pińczów

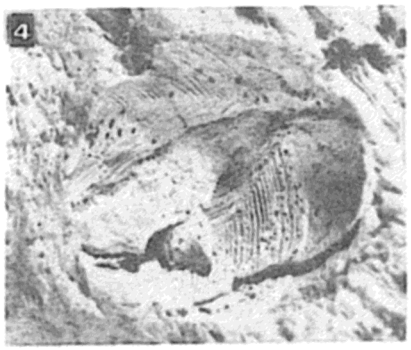
Megaxinus (*Megaxinus*) cf. *ellipticus* (BORSON)

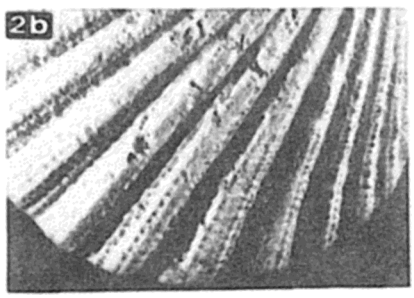
6a-6b – External shell mold (MZ VIII Mł 2615/1); *6a* view from the right valve, *6b* view from the left valve, × 1.5; Pińczów

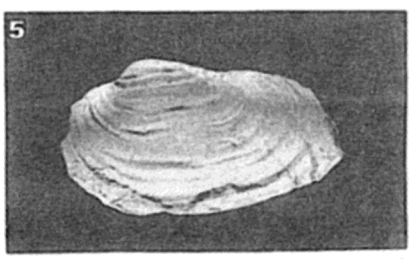


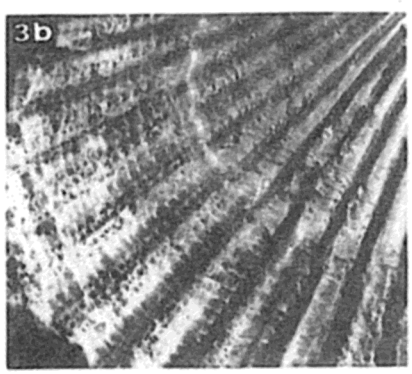












Callista (*Callista*) *italica* (DEFRANCE)

1 – External mold of the right valve (MZ VIII Mł 2642/1), nat. size; Pińczów

Chlamys (*Aequipecten*) *angelonii* (de STEFANI & PANTANELLI)

2a-2b – Right valve (MZ VIII Mł 2599/2); *2a* exterior, × 3; *2b* detail of the exterior surface, × 6; Pińczów
3a-3b – Left valve (MZ VIII Mł 2599/1); *3a* exterior, × 3; *3b* detail of the external surface, × 6; Pińczów

Jouannetia (*Jouannetia*) *semicaudata* DES MOULINS

4 – Shell impression (MZ VIII Mł 2650/1), × 3; Grobie

Panopea (*Panopea*) *menardi* (DESHAYES)

5 – External shell mold, view from the left valve (MZ VIII Mł 2649/2), nat. size; Pińczów