Summary of the scientific achievements

1. First name and surname:

Barbara Studencka

2. Scientific degrees:

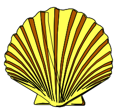
Doctoral degree in Natural Sciences, 1983.
Ph.D. Thesis: Bivalves from the Badenian marine sandy facies of southern slopes of the Holy Cross Mountains
Supervisor: Prof. dr hab. Andrzej Radwański
Faculty of Geology, University of Warsaw

Master of Sciences in Geology, 1973
Faculty of Geology, University of Warsaw

3. Professional Experience:

1973 – present	Polish Academy of Sciences Museum of the Earth in Warsaw 00-488 Warszawa, Al. Na Skarpie 20/26
1973–1983	senior museum assistant, Department of the History of Geological Sciences and Archive
1983–1989	museum adjunct, Department of the History of Geological Sciences and Archive
1989–1990	curator, Department of the History of Geological Sciences and Archive
1990–2006	research adjunct, head of the Department of the Paleozoology
2006–present	senior curator, head of the Department of the Paleozoology

4. Following the article 16 par. 2 of the act of14th March 2003 on scientific degrees and scientific title and on degrees and title in arts (Journal of Laws no. 65, pos. 595 with changes) I indicate eight publications (bolded citations in the text below**) under the collective title**



MIDDLE MIOCENE BIVALVES OF THE PARATETHYS: TAXONOMY, PALAEOBIOGEOGRAPHY AND STRATIGRAPHIC SIGNIFICANCE

as the scientific achievement for the opening of the habilitation procedure:

1. **Studencka B**. (90%), Prysyazhnyuk V.A. and Ljul'eva S.A. (2012) The first data on the bivalve species *Parvamussium fenestratum* (Forbes, 1844) from the Middle Miocene of the Paratethys. *Geological Quarterly*, **56** (3): 513–528. (5-Year IF=0.843)
2. **Studencka B**. (80%) and Jasionowski M. (2011) Bivalves from the Middle Miocene reefs of Poland and Ukraine: A new approach to Badenian/Sarmatian boundary in the Paratethys. *Acta Geologica Polonica*, **61** (1): 79–114. (IF2011=0,565; 5-Year IF=1.134)

3. **Studencka B**. (100%) (1999) Remarks on Miocene bivalve zonation in the Polish part of the Carpathian Foredeep. *Geological Quarterly*, **43** (4): 467–477.

4. **Studencka B**. (60%), Gontsharova I.A. and Popov S.V. (1998) The bivalve faunas as a basis for reconstruction of the Middle Miocene history of the Paratethys. *Acta Geologica Polonica*, **48** (3): 285–342.

5. **Studencka B**. (60%) and Popov S.V. (1996) Genus *Acanthocardia* (Bivalvia) from the Middle Miocene of the Paratethys. *Prace Muzeum Ziemi*, **43**: 17–37.

6. **Studencka B**. (100%) (1994) Middle Miocene bivalve faunas from the carbonate deposits of Poland (Central Paratethys). *Géologie Méditerranéenne*, **21** (1–2): 137–145.

7. **Studencka B**. (80%) and Studencki W. (1988) Middle Miocene (Badenian) bivalves from the carbonate deposits of the Wójcza-Pińczów Range (southern slopes of the Holy Cross Mountains, Central Poland). *Acta Geologica Polonica*, **38** (1-4): 1–45.

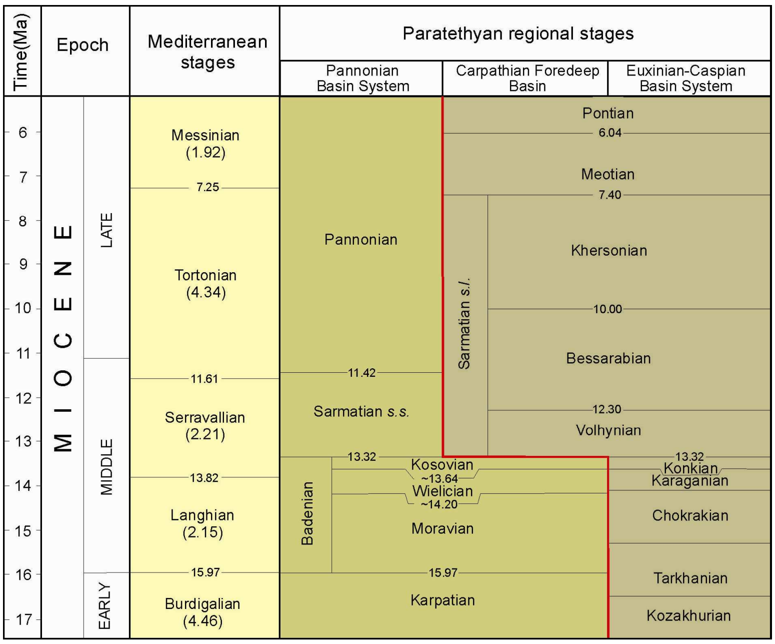
The paper was awarded the Wawrzyniec Teysseire Scientific Prize by the Section VII (Earth and Mining Sciences) of the Polish Academy of Sciences in 1990.

8. **Studencka B**. (100%) (1987) The occurrence of the genus *Kelliella* (Bivalvia, Kelliellidae) in shallow-water, Middle Miocene deposits of Poland. *Acta Palaeontologica Polonica*, **32** (1–2): 73–81.

Scientific aim of the papers mentioned above and the results achieved

Object of studies

My studies were focused on Middle Miocene bivalves from the Paratethys, a vast inland sea constituting of a chain of inland basins ranging from the fore-Alpine region in France to the south-eastern Ustyurt Plateau in Turkmenistan, that was formed in the Early Oligocene (early Rupelian).



The differences in the fossil record of the Mediterranean and Paratethys provinces resulted in the development of three distinct stratigraphic subdivisions: the standard one for the Mediterranean and two others for the Central Paratethys and the Eastern Paratethys.

One crucial condition must be fulfilled before making any paleogeographic reconstruction. This condition is the correlation of the Miocene regional stages in the Central and Eastern Paratethys with the standard stages established in the Mediterranean Province.

The base of the Badenian is isochronous with the base of the Langhian and coincides with the FAD of planktonic foraminifers of the genus *Praeorbulina*.

Due to the absence of the genera *Praerobulina* and *Orbulina* in the Eastern Paratethys the Kozakhurian/Tarkhanian boundary is defined on the basis of the calcareous nannofossils, a stratigraphically significant dinocyst assemblage and the radiometric dating from the two parts of the Paratethys and it falls within the Karpatian. As a consequence the early Tarkhanian (the deposits of which contain abundant bivalve assemblages) roughly corresponds to late Karpatian (age-equivalent of the latest Burdigalian). On the other hand, the Chokrakian of the Eastern Paratethys is contemporaneous to the middle-late Early Badenian of the Central Paratethys.

The knowledge about specific composition of isochronous bivalve assemblages derived from different biogeographic provinces has crucial meaning for making paleogeographic reconstructions. The distribution of particular species within basins constituting the Paratethys allows for indication of passages linking the Central and Eastern Paratethys with the Mediterranean.

The main area of my study is the Carpathian Foredeep Basin, being in the Middle Miocene the northernmost part of the Central Paratethys. Very well preserved bivalves occur in many localities of the Lower and Upper Badenian both on the surface and in the drilling holes. Moreover, the Carpathian Foredeep Basin represents one of few areas within the Central Paratethys where undisturbed sedimentation of monotonous siliciclastic deposits – clays/claystones to silts/siltstones – continued throughout the Late Badenian and Early Sarmatian.
My studies on the Middle Miocene bivalves of the Paratethys significantly contributed to the reconstruction of the Middle Miocene history of the Paratethyan basins, and introduced new ideas concerning the level of endemism of this province. They also allowed to establish that the taxonomic structure of bivalve assemblages (at the Subclass level) depends mainly on the type of sediment they inhabited, and less on the depth of the basin. The study also proved that some scallop species which were regarded as stratigraphically important, may be diagnostic at the stage level but they are useless to indicates the substage, because of their diachronic appearance within the Central Paratethys.

The recognition of the specific composition of Middle Miocene bivalve assemblages within the Paratethys

The abundant fossil material collected during my long-lasting fieldwork as well as the international paleontological expedition in 1988, supplemented with comparative research in many European institutions hosting paleontological collections, allowed for numerous revisions of earlier specific attributions, discussion of taxonomic position of many species, but first of all, led to the construction of complete inventory of bivalve species derived from the Middle Miocene sandy and carbonate facies as well as from reefs in the Central Paratethys.

1. After the investigation of four bivalve collections housed in the Polish Geological Institute–National Research Institute and in the Museum of the Earth, I have completed the composition of the bivalve assemblages from Badenian marls and limestones cropping out along the Wójcza-Pińczów Range. The list consists of 80 species (**Studencka & Studencki**, **1988**). In this paper I made revisions of earlier attributions and described 23 species. Two of them,

Aequipecten angelonii (de Stefani et Pantanelli) and *Cyathodonta eggenburgensis* (Schaffer) have not been reported before from the Miocene of Poland, while *Cardium kunstleri* (Cossmann et Peyrot) had been earlier attributed to *Cardium hians* var. *danubiana* Mayer. Moreover, I identified in this assemblage very rare species *Atrina radwanskii* Jakubowski, reported earlier only from the Lower Badenian Korytnica clays. On the basis of collections housed in the Geological Museum of the Institute of Geological Sciences, PAS in Kraków, and in the Museum of the Earth, I recorded the occurrence of 36 species in the Lower Badenian carbonates from the environs of Rzeszów (**Studencka**, **1994**).

2. The bivalve assemblage in the Upper Badenian of Roztocze consists of 79 species. In spite of that all fossiliferous deposits originated in similar, shallow-marine conditions, the composition of bivalve assemblages in particular localities shows considerable differences. In Węglin 46 species were recorded, in Węglinek – 68 and in Łychów Szlachecki – 54 species (**Studencka**, **1994**). Five of them, *Brachidontes biali* (Cossmann et Peyrot), *Gregariella fuchsi* (Sinzov), *Dacrydium vitreum* (Holböll), *Aequipecten macrotis* (Sowerby) and *Callista guaderortensis* Schaffer, were recognised in the Badenian of Poland for the first time. The specimens of *Brachidontes biali* were previously erroneously attributed to *Septifer oblitus* Michelotti. The fieldwork undertaken between 2001 and 2011 in the western Ukraine allowed to recognise the Upper Badenian assemblages from the coralline algal-vermetid reefs of Medobory (**Studencka & Jasionowski**, **2011**). The data on the occurrence of particular species in the three (mentioned above) exposures in Roztocze and in the area of Ukrainian and Moldovian parts of Medobory are presented in the "Appendix" to the paper of **Studencka & Jasionowski** (**2011**). The detailed information about the bivalve assemblages from the coralline algal-vermetid and serpulid-microbialite reefs of Medobory are presented on pp. 13–16 below.

3. I have undertaken the revisions of the bivalve collections housed at: the Institute of Paleobiology of the Georgian Academy of Sciences in Tbilisi; the Natural History Museum of the National Ukrainian Academy of Sciences in Lviv; the Paleontological Museum of the National Ukrainian Academy of Sciences in Kiev; the Hungarian Geological Institute, the Hungarian Natural History Museum in Budapest and the Geological Faculty of the University of Budapest; the Geological Faculty of the University in Sofia; the F.N. Chernyshev Scientific and Research Museum in Saint Petersburg, Zoological Institute, Russian Academy of Sciences and the Paleontological Museum of the Saint Petersburg State University; the Royal Belgian Natural History Museum in Brussels; the Natural History Museum in Vienna; the Geological Museum of the Theological Seminar in Barcelona, the Faculty of Geology of the University of Barcelona; the Grigore Antipa National Museum of Natural History in Bucharest, the Natural History Museum in Iasi ; the Slovak National Museum in Bratislava, the Faculty of Natural Sciences, Comenius University in Bratislava; the Paleontological Institute of the Russian Academy of Sciences in Moscow; and of collections of the Museum of the Earth Society. These revisions formed the basis to complete the specific composition of bivalve assemblages from 8 exposures of Lower Badenian sandy facies, 7 exposures of Chokrakian, 12 exposures of Upper Badenian, and 8 exposures of Konkian (**Studencka et al**., **1998**). As many as 343 bivalve species were recognised in 8 exposures of the Lower Badenian sandy facies in the Central Paratethys. The

diversity of the Late Badenian assemblages is only slightly smaller: 316 species. The assemblages from the Eastern Paratethys show much smaller diversity: 71 species in the Chokrakian and 97 species in the Konkian.

Good example of my work comes from the classical Romanian exposures of the Lower Badenian in Coştei and Lăpugy, in the Banat region. The bivalves, along with gastropods, are the most abundant and diversified group of fossils but have never been the subject of paleontological study. The specific composition of bivalve assemblages from Coştei (151 species) and Lăpugy (145 species) presented in **Studencka et al.** (**1998**) was a result of revisions of collections housed in the Natural History Museum in Budapest, the Grigore Antipa Natural History Museum in Bucharest, the Natural History Museum in Iasi, the Palaeontology and Stratigraphy Museum of the University in Cluj-Napoca, and PAS Museum of the Earth, and were supplemented with data from Nicorici (1977) and Chira (1995).

4. The bivalve assemblages from the Lower Sarmatian show very low specific diversity compared to the Badenian ones. One of the most diversified in the whole Paratethys is the assemblage from the sandy barrier deposits from Chmielnik (Studencka & Studencki 1980; Czapowski & Studencka, 1990). The descriptions of its 14 species: *Mytilaster volhynicus* (Eichwald), *Musculus gatuevi* (Kolesnikov), *M. naviculoides* (Kolesnikov), *M. sarmaticus* (Gatuev), *M. voroninae* Studencka, *Loripes dujardini* (Deshayes), *Inaequicostata inopinata* (Grischkevitsch), *I. ringeiseni* (Jekelius), *Obsoletiforma volhynica* (Grischkevitsch), *O. procarpatina spinosa* (Jekelius), *Plicatiforma praeplicata* (Hilber), *P. pseudoplicata* (Friedberg), *Mactra* (*Sarmatimactra*) *eichwaldii* Laskarew, and *Abra* (*Syndosmya*) *reflexa* (Eichwald), are presented by me in: Jakubowski et al. (1999).

The taxonomic structure of bivalve assemblages

A comparison of fossil assemblages in terms of their composition at the level of major taxonomic units is not a standard procedure in paleontological investigations. Such comparison, however, may be meaningful in palaeogeographic reconstructions and for tracing gross patterns of temporal distribution of fossil faunas.

The material from the Lower Badenian carbonate deposits of the Wójcza-Pińczów Range comprises species representing all Cenozoic subclasses of the Bivalvia, i.e. Palaeotaxodonta, Pteriomorphia, Heterodonta and Anomalodesmata. The subclass Palaeotaxodonta constitutes 5% of the total species number, the Pteriomorphia – 43%, the Heterodonta – 48%, and the Anomalodesmata – 4% (**Studencka & Studencki**, **1988**). The taxonomic structure of these bivalve assemblages closely corresponds to other Middle Miocene bivalve assemblages from the carbonate deposits (Upper Badenian in Devinska Nová Ves, Slovak Republic; Langhian in Vigoleno, Italy) but shows some characteristic differences from the assemblages that occur in the sandy facies, i.e. from the Lower Badenian in Kinberk, Moravia (Pteriomorphia – 33%), from the Upper Badenian in Niskowa, Poland (Pteriomorphia – 31%) and from the Upper Badenian in Nawodzice and Rybnica (Pteriomorphia – 30%).

Analyses of the bivalve fossil assemblages demonstrated that the taxonomic structure (expressed as percentages of particular subclass of the Bivalvia) may depend not only on water depth, as stated by Hickman (1974), but also on the nature of the substrate. Unfortunately, those inferences were based on the fossil assemblage considerably impoverished by leaching of aragonitic shells (not only the fossils from Pińczów but also from the Vienna Basin and Northern Italy). As a result the majority of bivalves were preserved as casts and moulds. Only species of the Pteriomorphia subclass, having calcitic shells, were very well preserved. One question, then, was of crucial meaning: is this high proportion of Pteriomorphia (37–47% compared to 22.5% in present-day Pacific bivalve assemblages described by Hickman, 1974) really dependent on sediment composition or, rather, it reflects diagenetic changes, favourizing calcitic shells. To answer this question it was necessary to analyse also other rich bivalve assemblages preserved in carbonate deposits more completely, with their aragonitic shells still retained in the rock.

This requirement was fulfilled in the case of bivalves from the Lower Badenian carbonates in the Rzeszów region, and the Upper Badenian carbonates that occur in the Roztocze Hills (SE Poland). My study was also based on the bivalve collections housed in the PAS Museum of the Earth, and in the Geological Museum of the Institute of Geological Sciences PAS in Krakow. The analysis showed clearly that the percentages of Pteriomorphia are similar in all bivalve assemblages derived from both Lower and Upper Badenian carbonates of the Carpathian Foredeep Basin in Poland (**Studencka**, **1994**). Of course, the specific composition is distinct in each case, which results from different depth and hydrodynamic conditions. In both Early Badenian bivalve assemblages from Pińczów and Niechobrz the most important families of Pteriomorphia are Pectinidae and Ostreidae, whereas in the Late Badenian bivalve assemblages from the Roztocze Hills – the Arcidae, Mytilidae and Limidae families dominate. The other difference is observed in the composition of the family Pectinidae: in the Pińczów Limestones the specific composition is diversified, the most common species being *Gigantopecten nodosiformis* (de Serres) and *Aequipecten scabrellus* (Lamarck). On the other hand, the pectinid assemblages from the Roztocze Hills are strongly dominated by *Crassadoma multistriata* (Poli), with occasionally found specimens of *Aequipecten elegans* (Andrzejowski) and extremely rare valves of other species.

Thus, these analyses confirm our assertion (**Studencka & Studencki**, **1988**) that the nature of the substrate had a profound effect on the taxonomic structure of bivalve assemblages. The assemblages from limestones are characterized by high proportion of Pteriomorphia, mostly epifaunal, representing forms cementing to the substrate as well as those being byssally attached. Carbonate sediment, generally coarse-grained, poor in organic content is the limiting factor for infaunal burrowing suspension-feeders which dominate the subclass Heterodonta and prefer sandy bottom. Thus, the dominating feeding strategies and life habit preferences are probably responsible for the differences in the bivalve assemblages inhabiting shallow-marine sandy facies and those from carbonate deposits.

Pectinid biozonation of the Paratethys strata

Bivalves are among the best recognised fossil invertebrates occurring in the Miocene strata of the Paratethys. Many students of the Paratethyan faunas consider bivalves to be of high importance for the age determination of deposits laid down in shallow-water environments of the Paratethys, in which planktonic organisms such as foraminifers and calcareous nannoplankton flora are poorly represented. Crucial role has been attributed to scallops, representatives of which build calcitic shells and their preservation state in various deposits is excellent (Krach 1979; Bohn-Havas et al., 1987). On the basis of selected pectinid species, five biostratigraphic zones and some subzones were proposed in the Miocene shallow water deposits of the Pannonian Basin, Hungary (Bohn-Havas et al., 1987). The Badenian regional stage can be characterized by the Flabellipecten besseri assemblage zone. In addition, selected species allow the subdivision of the Badenian strata in Hungary into two subzones: the lower Chlamys elegans–Pecten revolutus zone and the upper Flabellipecten leythajanus–Pecten aduncus zone.

Marine strata filling up the Polish part of the Carpathian Foredeep Basin represent only the Middle Miocene, and only one pectinid zone corresponding to the Badenian stage, i.e. the Flabellipecten besseri assemblage zone, can be recognised. The hitherto study revealed 30 scallop species in both the Lower and Upper Badenian sandy and carbonate deposits from Poland. The occurrence of eleven species is restricted to the Lower Badenian (Krach 1979; **Studencka & Studencki**, **1988**; **Studencka**, **1994**). I intended to reveal whether the pectinid subzones proposed for the Hungarian Badenian are valid in the Carpathian Foredeep Basin. My studies were focused on pectinds from five Lower Badenian outcrops (Wieliczka, Małoszów, Pińczów, Korytnica and Niechobrz) and ten Upper Badenian outcrops (Gliwice Stare, Niskowa, Bogucice, Nawodzice, Rybnica, Węglin, Węglinek, Łychów, Monastyrz and Huta Różaniecka).

The characteristic species for the Lower Badenian carbonate deposits of Hungary is *Aequipecten elegans* (Andrzejowski) which occurs only sporadically in the Lower Badenian of Romania and is unknown in the Lower Badenian of Poland and Slovakia. On the other hand, *Aequipecten elegans* along with representatives of the genus *Pseudamussium* Mörch, is the most common species in the Upper Badenian of Romania, Slovakia and Poland.

The species typical for the Upper Badenian carbonate deposits of Hungary is *Flabellipecten leythayanus* (Partsch), also very frequent in the Upper Badenian of Austria and Slovakia (Švagrovský, 1981). Along with *Flabellipecten besseri* (Andrzejowski), *Oppenhaimopecten aduncus* (Eichawald) and *Gigantopecten nodosiformis* (de Serres), it is one of the most common species in both Lower and Upper Badenian of the Transylvanian, Banat and the western part of Dacian basins in Romania. The species *Flabellipecten leythayanus* has never been reported from the Badenian of Poland, Ukraine and Moldova.

Thus, the stratigraphic distribution of scallops in the Central Paratethys unequivocally indicates that this bivalve family is useful to characterise the particular Miocene stages, but subzonation based on pectinids holds true only within individual basins due to heterochronous appearance of index species within individual Paratethyan basins.

The Hungarian studies revealed that pectinid assemblages can be useful for age determination not only of shallow-water strata but also of basin deposits (Bohn-Havas et al., 1987). Four pectinid zones have been established. The species *Lentipecten corneus denudatus* (Reuss) is regarded to be characteristic for the oldest basin deposits of Hungary (middle Egerian–lower Eggenburgian). In the early Eggenburgian the Pannonian Basin was inhabited by *Parvamussium duodecimlamellatum* (Bronn). Its occurrence together with *Lentipecten corneus denudatus* (Reuss) is regarded to be characteristic for the basin deposits of the Lower Eggenburgain–Karpatian. The first occurrence of *„Amussium" cristatum badense* (Fontannes) is dated to early Karpatian; in the Karpatian and Badenian it was founded together with *Lentipecten corneus denudatus* and *Parvamussium duodecimlamellatum.* In the Late Badenian the Pannonian Basin was inhabited by *Palliolum zoellikoferi* (Bittner).

In Poland the occurrence of *Lentipecten corneus denudatus* and *„Amussium" cristatum badense* is limited to the Lower Badenian deposits underlying the gypsum strata (Gąsiewicz et al., 2011). None of these four species has been detected in the Upper Badenian of the Polish part of the Carpathian Foredeep Basin (Kowalewski, 1966; Krach 1979; **Studencka**, **1994**, **1999**; **Studencka et al**., **1998**).

Studies of pectinid assemblages from the Paratethyan Province show that molluscan biozonation proposed for the Miocene of Hungary by Bohn-Havas & al. (1987) is not valid for the Polish and Ukrainian parts of Carpathian Foredeep Basin. The hitherto study revealed that the representatives of the genus *Pseudamussium* Mörch, 1853 together with *Palliolum bittneri* (Toula,1899) [=*Chlamys elini* Zhizhchenko, 1953] are typical of the uppermost Badenian (Zhizhchenko, 1953; Švagrovsky, 1981; Bohn-Havas et al., 1987; **Studencka et al**., **1998**; **Studencka**, **1999**). The appearance of the letter species in the Paratethyan Province is recognized as a distinct marker for reliable correlation of the uppermost Badenian and Konkian (Krach, 1979; Bohn-Havas et al., 1987; **Studencka**, **1999**).

None of the Paratethyan scallop species (and none of other stenohaline groups) survived the water chemistry crisis that occurred in this area around the Badenian/Sarmatian boundary (Krach 1979; Bohn-Havas et al., 1987; **Studencka**, **1999**; **Studencka & Jasionowski**, **2011**).

Paleogeographic reconstructions of the Middle Miocene Paratethys based on bivalve faunas

In the 80s of the last century there were two distinct visions on the Paratethyan paleogeography in the Middle Miocene (Rögl & Steininger, 1983, 1984; Nevesskaja et al., 1986, 1987).

1. According to Rögl & Steininger (1984), in the Early Badenian (in their opinion an age equivalent of the Tarkhanian) both parts of the Paratethys were linked together and connected independently with the word ocean: the Central Paratethys with the Mediterranean through a passage in the present-day Slovenia whereas the Eastern Paratethys – with the Indo-Pacific part of the Tethys. On the other hand, in the Late Badenian (after closure of the western connection with the Mediterranean via Slovenia) the Central Paratethys was linked

with the Indo-Pacific part of the Tethys through the Eastern Paratethys and the Mesopotamia region as shown on the maps in 1983 and 1984.

2. Another view has been presented by a team led by L.A. Nevesskaja. In the opinion of Nevesskaja et al. (1986, 1987), in the Early Badenian (age-equivalent of the Chokrakian) the Eastern Paratethys became disconnected with the Central Paratethys, whereas the two part of the Paratethys were independently connected with the world ocean: the Central Paratethys through the Mediterranean while the Eastern Paratethys via Iran and Turkey with the Indo-Pacific regions of the Tethys. In the Konkian, the south-eastern passage has been re-opened, to link the Eastern Paratethys with the Indo-Pacific regions of the Tethys. According to Nevesskaja et al. (1986, 1987) both parts of the Paratethys were connected only shortly.

In my opinion, bivalves are a valuable tool for palaeobiogeographic purposes because they occupy a wide range of ecological niches and have a sensitive reaction to all environmental parameters. I had the opportunity to examine rather extensive Miocene bivalve collections deposited in more than twenty European scientific institutions (all these institutions are listed in the paper by **Studencka et al**., **1998**). The bivalve material under study has been verified (where erroneously determined earlier), the specific names were updated or recognized as synonymous with earlier attributions.

The parallel study by I.A. Goncharova was concentrated on the Tarkhanian and Chokrakian bivalves of the Eastern Paratethys and the study by S.V. Popov concerned the Konkian fauna of the Eastern Paratethys. The original goal of this common study undertaken by I.A. Goncharova and S.V. Popov, both from the Paleontological Institute of the Russian Academy of Sciences, Moscow, and myself, was to check if it is possible to reconstruct, on the basis of the bivalve fauna, the connections between the Eastern and Central Paratethys, as well as to look for migration routes of bivalve faunas. The results of our study are following:

1. **Finally 429 bivalve species that represent 178 genera of 63 families occurring in the Lower and Upper Badenian sandy deposits of the Central Paratethys and contemporaneous Chokrakian and Konkian strata of the Eastern Paratethys**. Data on the distribution of particular species in the 36 bivalve-bearing outcrops from different basins of both parts of the Paratethys as well as in the Lower and Middle Miocene strata of the Mediterranean and Atlantic provinces are listed in the Table 1 of the paper by **Studencka et al**. (**1998**).

2. The bivalve assemblages which inhabited the shallow water sandy bottoms of the Central Paratethys were more diversified than the contemporaneous faunas living in the Eastern Paratethys. In the Badenian sandy deposits 386 species in total were recognized, 13 of which have been previously been not reported from the Paratethyan Province and three others were described as new species i.e. *Lucina* (*Lucina*) *kadievi* Popov, *Acanthocardia allae* Studencka et Popov and *Acanthocardia antonihoffmani* Studencka et Popov.

3. Very similar species composition of the Early Badenian shallow-water assemblages living in distant parts of the Central Paratethys reflects active faunal interchange between fore-Carpathians and intramountainous basins and wide connection of this area with the world

ocean. This is evidenced by low level of endemism in the Central Paratethys as well as by high percentage of species common with the Mediterranean and Atlantic provinces. From among **386** species known in the Central Paratethys, 207 are recorded in the Atlantic Province. On the basis of species composition of assemblages and geographic distribution of selected species within particular basins of the Central Paratethys we postulated two passages linking the Central Paratethys with Mediterranean (**Studencka et al**., **1998**). The western passage through Slovenia bears good geological evidence while the East-Mediterranean connection is, in our opinion, supported by the composition of the Early Badenian Bulgarian assemblages (Nikolov et al., 1996) and by geographic pattern of several oriental and indo-pacific immigrants which occur in the Early Badenian biota but are not recorded in the contemporaneous Langhian biota in the western part of the Mediterranean.

4. On the other hand, the comparison of the species composition of the Early Badenian and Chokrakian bivalve assemblages reveals that the Eastern Paratethys was cut off from communication with the Central Paratethys. Following arguments support the disconnection of both basins: (i) taxonomic composition of scallops, the group recognized as important for stratigraphic subdivision of the European Neogene. From among 30 scallop species reported from the sandy deposits of the Central Paratethys <u>none</u> is recorded in the Eastern Paratethys, where merely 3 endemic species occur and (ii) geographic distribution of the Chokrakian bivalve assemblages in the Eastern Paratethys. From among 71 bivalve species found in the Chokrakian deposits, the majority are remnants of the Eastern Paratethys Tarkhanian fauna. Biogeographic affinities and distributional pattern of eleven bivalve species which invaded the Eastern Paratethys in the Chokrakian indicate that the Eastern Paratethys was linked with the East-Mediterranean (via eastern Turkey and Iran) and Indo-Pacific, but seaway towards the Central Paratethys became closed.

5. The Late Badenian assemblages are less diversified than the Early Badenian ones (316 species compared to 343 species) but they consist largely of Early Badenian survivors. Apart from the Early Badenian remnants this fauna contains as many as 26 open-marine migrants which populated the Central Paratethys during the Late Badenian. The newcomers are clearly related to the Mediterranean, Atlantic, and even North Sea provinces. This fact, along with the distinct Atlantic-Mediterranean affinity (at the generic level) of the newly evolved species prove that the connection of the Central Paratethys with the Mediterranean was still in existence despite the closure of the western passage. The problem is, however, to point the location of the potential corridor linking the Central Paratethys with the East-Mediterranean. Geological data definitely show the closure of the western connection with the Mediterranean which remained open during the Early Badenian. On the other hand, the occurrence of 273 species in both Early and Late Badenian bivalve assemblages reveals that the Middle Badenian salinity crisis had a minor effect on the their taxonomic composition.

6. The closure of the connection with the world ocean in the latest Chokrakian resulted in the creation of semi-marine conditions in the Eastern Paratethys following by the reduction of diversity of molluscan faunas. Only representatives of the genus *Barnea* Risso survived the Karaganian salinity crisis. In the beginning of the Konkian normal marine waters invaded

again the Eastern Paratethys and marine bivalve fauna once again re-established. The Konkian fauna consists, in its great majority, of species that had survived in areas adjacent to the Eastern Paratethys, and re-invaded it during the Konkian transgression. The taxonomic composition of the Konkian assemblages and its geographic pattern suggest that the Eastern Paratethys has been connected with the East-Mediterranean (through a south-eastern passage which re-opened in the early Konkian) and with the Central Paratethys. Among 97 species constituting the Konkian fauna, 90 species occur also in the Late Badenian Central Paratethys. In addition, all scallops known in the Eastern Paratethys also populated the Central Paratethys in Late Badenian. In conclusion, the bivalve fauna have evidenced that in the Late Badenian – Konkian (age equivalent of the early Serravallian) both parts of the Paratethys were linked together and connected independently in the south with the East Mediterranean province.

7. With the closure of the seaways towards the Mediterranean (dated radiometrically to 13.3 Ma in both Central and Eastern Paratethys) and the broad connection between its two parts, whole Paratethys changed into a mixo-mesohaline (semi-marine) basin, causing strong endemism of the shallow-water faunas. Out of 204 species that have been recorded in the Upper Badenian sandy facies and carbonates of Poland, only 20 species survived in the Early Sarmatian (Czapowski & Studencka, 1990; **Studencka**, **1999**; **Studencka & Jasionowski**, **2011**). Early Sarmatian faunas from the Paratethys and those from the Mediterranean Province show no resemblance. The earliest taxa ancestral to Sarmatian species originated in the Central Paratethys (**Studencka at al**., **1998**; **Studencka & Jasionowski**, **2011**) and not in the Eastern Paratethys as supposed by Kókay (1985).

Paleogeographic reconstructions presented in the paper of Studencka et al (1998) were incorporated by Dercourt J., Gaetani M. et al. (Eds.) into the Atlas of the Peri-Tethys, Palaeogeographic maps CCGM/CGMW, Paris 2000.

Representatives of the genus *Acanthocardia* Gray: example illustrating the history of the Paratethys connections

An extensive bivalve material collected by myself and S. Popov as well as the material housed in the PAS Museum of the Earth and, the Paleontological Institute RAS in Moscow, the Geological Museum of the Institute of the Geological Sciences PAS in Krakow (the Friedberg collection), the Royal Belgian Natural History Museum in Brussels (the Dautzenberg collection), the Natural History Museum in Vienna (the M. Hörnes and Sieber collections) and in the Faculty of Geology, the University of Barcelona (the Domenech collection), was the basis for taxonomic revisions of previous attributions, for corrections of erroneous attributions of many bivalve species and for creation of two new species: *Acanthocardia antonihoffmani* Studencka et Popov and *A. allae* Studencka et Popov. The bivalve material comprised about one hundred complete shells and some 1600 separate valves (for detailed information of all analyzed specimens see **Studencka & Popov**, **1996**).

In the Middle Miocene (Badenian) strata of the Central Paratethys six species of *Acanthocardia* Gray have been recorded: *A. antonihoffmani* Studencka et Popov, 1996, *A. brocchii* (Mayer,1866) [=*Cardium praeechinatum* Hilber, 1882; =*Cardium pseudoturonicum* Mikhailovsky, 1903], *A. paucicostata* (Sowerby, 1836) [=*Cardium clavatum* Hilber, 1879; =*Cardium aculeatum* var. *perrugosa* Fontannes, 1879; = *Cardium turonicum* var. *grundense* Ivolas et Peyrot, 1900; =*Cardium andrussovi* var. *tulskajensis* Pavlinova-Iljina, 1957], *A. turonica* (Hörnes,1861) [=*Cardium barrandei* Ivolas et Peyrot, 1900; =*Cardium schafferi* Kautsky, 1925], *A. allae* Studencka et Popov, 1996 and *A. ritzingense* (Sieber, 1956). Two latter species are endemic for the Paratethys and their occurrences are limited to the Late Badenian strata. Whereas, *A. brocchii, A. antonihoffmani*, *A. paucicostata* and *A. turonica*, recorded in the Lower Badenian and/or Upper Badenian within Paratethys are also known to occur in the Pliocene of Mediterranean province.

In the Eastern Paratethys the genus *Acanthocardia* is represented by four species, three of them are the Paratethyan endemics: *A. centumpania* (Andrussov, 1911)[=*Cardium impar* Zhizhchenko, 1936] are limited to the Tarkhanian and the Chokrakian whereas *A. andrusovi* (Sokolov, 1899)[=*Cadium platovi* Bogatschew, 1905] and *A. turkmenica* (Zhizhchenko, 1936) have been recorded together with *A. paucicostata* in the Konkian deposits.

Out of nine species discussed in the paper by **Studencka & Popov (1996)** only *A. paucicostata* (Sowerby) – ranging since the Early Miocene until the Recent – has been reported from the Middle Miocene strata of both Central (Lower to Upper Badenian) and Eastern Paratethys (Konkian, equivalent to Upper Badenian).

The history of the genus Acanthocardia Gray reflects in very typical way the reaction of bivalve faunas to the changes in the environment during the Paratethyan Miocene. The first occurrence of the genus *Acanthocardia* Gray in the Paratethys Basin is dated to the Early Miocene: Eggenburgian in the Central Paratethys and Sakaraulian in the Eastern Paratethys. However, form dominating in that time are very much different from those known in the Middle Miocene. The representatives of *A. grandis* (Hölzl) and *A.*? *kubeckii* (Hauer) from the Eggenburgian as well as *A. kupradzei* (Charatischvili) and *A. otarii* (Charatischvili) dominating in the Sakaraulian strata have shells large (up to 140 mm in length), tetragonal to oval in outline, covered with 26-34 rounded or triangular ribs ornamented with nodes or tubercles. This kind of rib sculpture is typical of the subgenus *Acanthocardia (Rudicardium)* Coen. Three other species: *A. michelotianum* (Mayer), *A. miocenica* (Schaffer) and *A. rugicostata* (Schaffer), are closely allied to the Middle Miocene *A. paucicostata* and reported also from the Lower Miocene of the Central Paratethys.

The temporary closure of connections of the Paratethys with the world ocean (in the late Ottnangian–Kocachurian) and decrease of its salinity resulted in extinction of majority of marine stenohaline species, including representatives of *Acanthocardia.* The later connection of the Paratethys with the world ocean in the late Burdigalian and the increase in its salinity enabled recolonization of the basin by marine bivalve species. Different source areas of immigrants resulted in distinct species composition in the two parts of the Paratethys. During the Karpatian the species *A. paucicostata* entered the Central Paratethys, coming from the West-Mediterranean, whereas the species *A. centumpania*, reported from the Tarkhanian of the Eastern Paratethys, arrived most probably from the Indo-Pacific Province.

Together with the next, Early Badenian transgression in the Central Paratethys, the species *A. turonica* immigrated from the Atlantic province via the Mediterranean. During the Late Badenian transgression four species i.e. *A. antonihoffmani*, *A. brocchii*, *A. allae* and *A. ritzingense* populated the Central Paratethys. The two latter are the Paratethyan endemics: *A. allae* is known only in the fore-Carpathian part of the Central Paratethys while *A. ritzingense* is recorded only in the Upper Badenian strata of the inner-Carpathian basins. The connection of both parts of the Paratethys during the Late Badenian/Konkian enabled *A. paucicostata* the colonization of the Eastern Paratethys. It is very likely that this species was the ancestor for the endemic Paratethyan species *A. andrusovi.* In turn, the roots of *A. turkmenica* which appeared in the middle Karaganian of the northern Kazakhstan of the Eastern Paratethys, are most probably located outside the Mediterranean area.

The next interruption of the connection of the Paratethys with the world ocean in latest Badenian-latest Konkian (Middle Miocene) caused the extinction of the marine stenohaline taxa including the genus *Acanthocardia*. The representatives of *A. antonihoffmani*, *A. brocchii* and *A. turonica* persisted in the Mediterranean until the Late Pliocene. Out of nine *Acanthocardia* species known in the Middle Miocene of the Paratethys only *A. paucicostata* lives until the Recent and occurs along the European coasts of the Atlantic as well as in the Mediterranean.

Bivalves of the Medobory reefs: evidence of environment changes in the Paratethys around Badenian/Sarmatian boundary

The Medobory reefs are distributed widely (ca 300 km) in the north-eastern and eastern borders of the Carpathian Foredeep Basin in western Ukraine (between Pidkamin and Kamianec Podilskyi) and northern Moldova. The time span they have developed i.e. Late Badenian – Early Sarmatian was very peculiar period in the history of the Paratethys.

In the Late Badenian the Paratethys was normal marine sea that had wide connection with the Mediterranean, but the location of the passage linking the Central Paratethys with the Mediterranean is still disputable (Kókay, 1985; **Studencka et al**., **1998**; Kováč et al., 2007). During the Late Badenian there was a wide connection between the intra-Carpathians and fore-Carpathians basins, whereas only a temporary connection between the Central Paratethys and Eastern Paratethys was limited to narrow straits in the Predobrogean area (**Studencka et al**., **1998**; **Studencka & Jasionowski**, **2011**).

The Badenian/Sarmatian boundary witnessed fundamental reorganization of the Paratethys paleogeography. The connection between the Mediterranean and the Central Paratethys was interrupted in latest Badenian. At the same time the connection between intra-Carpathian and fore-Carpathian basins became strongly restricted, whilst the fore-Carpathian basins became a marginal part of the Eastern Paratethys (**Studencka**, **1999**; **Studencka & Jasionowski**, **2011**).

The Middle Miocene Medobory reefs, unique constructions in the Paratethys, consist predominantly of Upper Badenian coralline-algae boundstones in their axial part and bioclastic grainstones and rudstones on the reef slopes. These reefs originated in normal marine environments, during the last marine transgression in the history of the Central Paratethys (~13.6 Ma to 12.7 Ma; see Kováč et al., 2007). At that time (age-equivalent of the early Serravallian), a vast territory of the Volhynian-Podolian region in Ukraine, along the SW margin of the East European Platform, was covered by shallow sea where conditions favoured the growth of coralline algal-vermetid reefs. Field observations have shown that the main frame-builders of the Upper Badenian reefs are crustose coralline algae and shells of sessile vermetid gastropod *Petaloconchus intortus* (Lamarck), and they are usually 100 meters high and several dozens meters long.

In the latest Badenian the connection between the Mediterranean and the Central Paratethys was interrupted which caused a drastic change of environmental conditions which ceased the growth of coralline algal-vermetid reefs. The Medobory region entered the phase of emersion. The younger generation of reefs - the Early Sarmatian serpulid-microbialite reefs – originated in extremely stressed environments related to mesohaline salinity and elevated alkalinity. The Early Sarmatian reefs usually overgrew eroded and karstified surfaces of the Badenian reefs. They cover the western slopes of the Badenian reefs and seldom overlie their tops. Reaching only a few metres in thickness they are characterised by the biggest lithofacial diversity (Jasionowski, 2006; Jasionowski et al., 2003, 2006; Górka et al., 2012). The serpulid-microbialite reefs show distinct internal structure: they are composed of dome-shaped massifs built of thick carpets of incrusting organisms: mainly bryozoans and coralline algae (Jasionowski, 2006). The Early Sarmatian reefs occur also at the south-west slopes of the Badenian reefs forming isolated mounds reaching several tens meters in height.

The Badenian coralline algae-vermetid reefs were inhabited by molluscan community (gastropods and bivalves), echinoids and decapods (crabs and shrimps)and quite ubiquitous hermatypic corals (Jasionowski et al., 2006; Górka et al., 2012). However, within reef-dwellers, bivalves formed the most diversified and dominant group. On the basis of published material, review of the collections of the PAS Museum of the Earth in Warsaw and of the Geological Museum of the Institute of the Geological Sciences PAS in Krakow, and fossil material derived recently during our fieldwork in the Ukrainian part of the Medobory, 58 bivalve species representing 43 genera belonging to 36 families have been recognized (**Studencka & Jasionowski**, **2011**). In the Moldavian part of the Medobory 46 species representing 34 genera were recognized by Janakievich (1977, 1980, 1993) and Voloshina (1973). Unfortunately, the originally aragonitic shells were dissolved. Only bivalve genera such as *Ostrea, Lima* and several scallops (*Manupecten*, *Crassadoma*, *Aequipecten* and *Gigantopecten*), having calcitic shells, are well preserved. In spite of scallops being only subordinate element in the Medobory reefs we found the shells of *Manupecten fasciculata* (Millet) and *Gigantopecten nodosiformis* (de Serres). These warm-temperature bivalve taxa have not been found earlier in the contemporaneous Roztocze reefs but they were reported from the Lower Badenian carbonate deposits in Poland (Pisera, 1985; **Studencka & Studencki**, **1988**; **Studencka**, **1994**, **1999**).

Field observations have shown that three bivalve associations occur in Medobory reefs: (i) *Chama* (*Psilopus*) *gryphoides–Lima* (*Lima*) *lima*, (ii) *Neopycnodonte navicularis* and (iii) *Lithophaga–Gastrochaena–Jouannetia*. The most diverse and most common in the Badenian reefs is the *Chama* (*Psilopus*) *gryphoides-Lima* (*Lima*) *lima* association. Except of *Chama gryphoides,* the shells of which cement to the substrate, byssally attached species such as *Acar clathrata* (Defrance)*,* *Barbatia* (*Barbatia*) *barbata* (Linnaeus) and *Lima* (*Lima*) *lima* (Linnaeus) were conspicuous elements of this associations. Like in the Roztocze reefs specimens of *Venus* (*Ventricoloidea*) *libella* (Rayneval, Van de Hecke et Ponzi) occur very frequently.

The next recognized association – monospecific accumulations of *Neopycnodonte navicularis* (Brocchi) – forms dense overgrowths constituting oyster buildups. The buildups are usually several meters thick and are generally made of articulated, massive shells. Fossil bioconstructions composed mainly of *Neopycnodonte navicularis* are rare in fossil record. They were reported from the Upper Badenian deposits of Roztocze (Zdziechowice) (Pisera, 1985; Studencka et al., 2005, 2006) and from the eastern part of the Vienna Basin (Devinska Nová Ves near Bratislava) as well as from the Upper Miocene (Tortonian) strata in the Sorbas Basin in southern Spain (Videt & Néraudeau, 2002).

In the uppermost part of the reefs, bivalve association is dominated by *Lithophaga*, *Gastrochaena* and *Jouannetia* – genera typical of high-energy, rocky environments. The population density of the rock-boring bivalve genus *Lithophaga* was very high. The scavenger gastropod *Diodora* was an important element of this association. Interesting is the fact that in the contemporaneous Roztocze reefs the rock-boring bivalves are very rare (Pisera, 1985).

At the Badenian/Sarmatian boundary the connection of the Paratethys with the Mediterranean was ceased, which resulted in decreased water salinity which, in turn, caused not only severe extinction of marine stenohaline taxa but was also followed by relatively quick evolution and dispersal of few opportunistic euryhaline species which were only subordinate element among latest Badenian faunas. In new, low-competition conditions these species became extremely numerous and sometimes much larger in size than their earlier relatives.

The Medobory reefs contain an excellent bivalve record and show how the bivalve faunas reflected the temporary closure of seaways between the Paratethys and the Mediterranean around the Badenian/Sarmatian boundary (~13.3 Ma). Out of 116 species inhabiting the Upper Badenian coralline algal-vermetid Medobory and Roztocze reefs, only 3 species: *Mytilaster volhynicus* (Eichwald), *Crassostrea gryphoides* (Schlotheim) and *Obsoletiforma vindobonensis* (Laskarew) are known to have survived the Badenian/Sarmatian boundary. The Sarmatian serpulid-microbialite reefs hosted only gastropods (representatives of the genus *Mohrensternia* and *Cerithium*) and twelve bivalve species belonging to four families: Mytilidae, Ostreidae, Cardiidae and Mesodesmatidae. Family Mytilidae is represented by three species – *Mytilaster volhynicus*, *Musculus sarmaticus* (Gatuev) and *Musculus voroninae* Studencka. Shells of *Musculus sarmaticus* along with cockle shells are very frequent. On the other hand, representatives of the family Mesodesmatidae – *Ervilia podolica* (Eichwald) and *Ervilia trigonula* Solokov are very rare. The family Ostreidae is represented by the sole species *Crassostrea gryphoides*, representative of the genus that tolerate near shore environments characterized by water with reduced and fluctuating salinity, conditions that are inhospitable to other biota.

The serpulid-microbialite reef bivalve assemblages are characterised by relatively high frequency of the representatives of the subfamily Lymnocardiinae, belonging to the sole genus – *Obsoletiforma* Paramonova. This Paratethyan endemic genus is inferred to spring from the genus *Cerastoderma* Poli. Similarly to modern representatives of *Cerastoderma edule* (Linnaeus), it colonized near shore muddy bottoms. The co-occurrence of serpulids and microbialites in rock-forming amounts as it has happened in the Early Sarmatian in the Paratethys is unique in the fossil record. The only other example of similar assemblage was reported from the Triassic of Spain and Italy (Braga & Lopez-Lopez, 1989; Cirilli et al., 1999), where serpulid-microbialite buildups have formed on the shelf, in mesohaline and disoxic conditions. Today, massive accumulations of serpulid tubes are typical of environments of high ecological stress that are inhospitable to other biota.

Field observations have shown that three bivalve associations may be identified: (i) *Crassostrea gryphoides*, (ii) *Obsoletiforma volhynica-Mytilaster volhynicus*, (iii) *Osoletiforma sarmatica* and (iv) *Obsoletiforma lithopodolica-Musculus sarmaticus*. The species *Crassostrea gryphoides*, similar to other oyster representatives producing calcitic shells of high preservation potential, are the most conspicuous fossils in different sediments of many European Neogene basins. During the Early Miocene (late Burdigalian and contemporaneous Ottnangian) oyster bioconstructions developed extensively on the margins of the Atlantic (Tagus Basin, Portugal), in the Mediterranean (Rhône Basin, France), and in the Central Paratethys (Borsad Basin, Hungary) as well. Their shells and shell clusters are common in Neogene strata, forming often huge accumulations in near shore lagoons, vast deltas or estuaries (Bohn-Havas, 1985; Georgiades-Dikeoulia et al., 2000). The *Crassostrea gryphoides* bioconstructions have been for the first time documented by us in the Sarmatian serpulid-microbialite reefs.

We also reported for the first time peculiar associations of *Obsoletiforma* with serpulids. Although volumetrically subordinate in the Sarmatian reefs, the serpulids played a key role in the reef frame construction. The occurrence of cockle species *Obsoletiforma volhynica* (Grischkevitsch) is largely restricted to the serpulid-microbialite frame consisting of superimposed bunches of semi-parallel serpulid tubes covered with microbialitic crusts. It could show similar behaviour to *Musculus sarmaticus* (Gatuev) observed together with it wherever the environmental conditions were sufficient to allow the growth of densely clotted serpulid colonies providing shelter for byssally attached bivalves.

Occurrence of the genera *Parvamussium* Sacco and *Kelliella* M. Sars in the shallow water of the Upper Badenian of the Paratethys

The specimens of the extremely rare scallop species *Parvamussium fenestratum* (Forbes) were recognized by me in samples derived from the Surzha borehole (near Kamianec Podilskyi, Ukraine), donated by V.A. Prysyazhnyuk (the Institute of the Geological Sciences, National Academy of Sciences of Ukraine in Kiev). This first finding of *Parvamussium fenestratum* (Forbes) in the Central

Paratethys triggered the taxonomic study on the representatives of the genus *Parvamussium* Sacco. The examination of other *Parvamussium* species stored in the PAS Museum of the Earth in Warsaw and in the Hungarian Natural History Museum in Budapest revealed more Paratethyan records of *Parvamussium fenestratum* in the Badenian of the Tokaj Mountains in Hungary (Csepreghny-Meznerics, 1966), and in the Badenian of the Roztocze Hills, Poland (Jakubowski, 1977). Its specimens were previously erroneously attributed to *Parvamussium felsineum* (Foresti).

Previous fossil records of this extraordinarily rare species are restricted to Lower Miocene (the uppermost Burdigalian) of Italy and to Lower Pliocene (Zancelan) of Spain. The present-day findings of the *P. fenestratum* that lives in the Mediterranean Sea are also very rare. On the other hand, modern *P. fenestratum* is widespread throughout the north-eastern Atlantic (from Iceland into the Cape Verde Islands) inhabiting the lower part of sublittoral zone and in bathyal zone.

In the paper by **Studencka et al**. **(2012)** I inserted data on the distribution of five *Parvamussium* species i.e. *Parvamussium bronni* (Mayer), *P. duodecimlamellatum* (Bronn), *P. felsineum* (Foresti), *P. fenestratum* (Forbes) and *P. miopliocenicum* (Ruggieri) in Neogene Mediterranean and Paratethyan provinces. In addition, relying on the published data, I presented how the representatives of the genus *Parvamussium* Sacco changed their environmental requirements in the time span since the Early Cretaceous until Recent. The earliest occurrence of *Parvamussium* begins with the Early Cretaceous within the circum-Pacific area (Japan and Borneo regions). Some species from the Northern Hemisphere occur in the Late Cretaceous deeper water mudstones. So far no species of *Parvamussium* is recorded in the Upper Cretaceous of Southern Hemisphere but since Paleogene, *Parvamussium* was reported from New Zealand, southern Australia and southern South America. Contrary to Cretaceous records from Northern Hemisphere, the oldest paleontological data from the Southern Hemisphere suggest that during the Early Paleogene *Parvamussium* inhabited shallow environments. It has changed its ecological requirements during Late Oligocene to Middle Miocene. Since the Miocene it inhabited the upper part of the bathyal zone (ca. 200–800 m). Modern *Parvamussium* is a diversified, cosmopolitan genus including more than fifty species, majority of them being adapted to the bathyal zone of the Pacific Ocean.

Four of five species of *Parvamussium* which occur in the Oligocene-Miocene succession in the Paratethys were confined to clays deposited in the upper part of the bathyal zone. The only species that is extant, is *P. fenestratum*, very common in the north-eastern Atlantic (at the depths 99 m to 1193 m). During the late Middle Miocene (Late Badenian) *P. fenestratum* inhabited shallow sublittoral environments, being reported from Poland, Ukraine and Hungary.

Similar change of ecological requirements was also recognized in the case of the other bivalve species, *Kelliella barbara* Studencka, inhabiting the Middle Miocene Paratethys (**Studencka**, **1987**). Its occurrence in the Upper Badenian shallow-water deposits of Poland suggests that the genus *Kelliella* M. Sars has distinctly changed its ecological requirements over the last 15 Ma.

The present-day genus *Kelliella* M. Sars is represented by eleven species. The occurrence of eight species, i.e. *K. adamsi* (Smith), *K. atlantica* (Smith), *K. galatheae* Knudsen, *K. indica* Knudsen, *K. nitida* Verrill, *K. pacifica* (Smith), *K. tasmanensis* Knudsen and *Kelliella* sp., is limited to the abyssal zone (2000–6000 m). Two abyssal species, *K. adamsi* and *K. pacifica,* along with two others species *K. bruuni* (Filatova) and *K. sundanensis* Knudsen, are reported from the hadal zone, below 5000 m. The only species reported from shallower depths is *K. miliaris* (Philippi). It is known to occur in the deeper parts of the sublittoral zone (ca.100–400 m) and within the bathyal zone (ca. 400-2000 m), being relatively well widespread in the Mediterranean Sea and along the European Atlantic coasts. Apart from *K. barbara*, this is the only living species of the genus *Kelliella* known in the fossil record, from the Pleistocene of Sicily and Rhodos.

Early Sarmatian bivalves

The bivalve assemblages from the Lower Oligocene to Pliocene sequences and their changing composition in time give strong evidence of several biota crises that occurred in the history of the Paratethys. The crises resulted from dramatic changes of environmental factors caused by temporary closures of seaways between the Paratethys and the world ocean. One of the most important was the one defining the Badenian/Sarmatian boundary in the Central Paratethys and the Konkian/Sarmatian boundary in the Eastern Paratethys.

The Paratethyan bivalve fauna above the Badenian/Sarmatian boundary is characterized by decreased number of families, impoverished generic composition and the absence of marine stenohaline taxa (Nevesskaja et al., 1986; **Studencka & Jasionowski**, **2011**). The Early Sarmatian bivalve fauna is dominated by endemic taxa belonging to 17 euryhaline families, of which the Cardiidae Lamarck reached its highest development (Nevesskaja et al., 1986, 2005; Paramonova 1994; **Studencka & Jasionowski**, **2011**). As a matter of fact, the great difference in species composition between faunas of the Paratethys and those from the middle Serravallian Mediterranean Sea is observed. The composition of new Sarmatian bivalve assemblages and the ecological requirements of particular species prove the mixo-mesohaline character of the Sarmatian Sea (30–18‰) and indicate eastward decrease in salinity (**Studencka & Jasionowski**, **2011**). The degree of endemism of these assemblages is high: nearly two-thirds of all the bivalve species have not been recorded outside the Paratethyan Province. This is probably a reflection of the partially enclosed nature of the Paratethys basins, where for a long period during the Middle Miocene fully marine conditions were confined to a small Central Paratethys, while over most of the Eastern Paratethys marginal marine conditions with fluctuating or generally lower salinities prevailed (**Studencka & Jasionowski**, **2011**).

Bivalve record from the Carpathian Foredeep Basin is a good example to show how the bivalve fauna reflected the temporary closure of seaways between the Paratethys and the Mediterranean area around 13.3 Ma. Totally 204 bivalve species that represent 61 families, populated on the carbonate and sandy bottom of the Late Badenian Sea (Kowalewski, 1966; **Studencka**, **1994**; **Studencka et al**., **1998**; **Studencka & Jasionowski**, **2011**). Out of them, only 20 species occur in the Early Sarmatian assemblages (Czapowski & Studencka, 1990; **Studencka**, **1999**; Gąsiewicz et al., 2011). Until now, 28 bivalve species that represent 14 families were documented in the Lower Sarmatian strata of the Polish part of the Carpathian Foredeep Basin (Studencka & Studencki, 1980; Czapowski & Studencka, 1990; **Studencka & Jasionowski**, **2011**). Majority of them represent the Paratethyan endemics that originated in the Late Badenian (6 species) or the Early Sarmatian (13 species).

The separation of the Paratethys and Mediterranean around the Badenian/Sarmatian boundary resulted not only in dramatically reduced diversity of the bivalve fauna but also a great uniformity in species composition between the two parts of the Paratethys. **The generally accepted division of the Sarmatian stage (sensu Barbot de Marny, 1866) into three substages was done in 1899 by N.I. Andrussov on the basis of bivalve assemblages and categorised as Volhynian, Bessarabian and Chersonian substages by I. Simionescu in 1903.** More recently, Kojumdgieva et al. (1988) proposed to subdivide Sarmatian detrital deposits (sands, sandstones and detritic limestones) into six bivalve concurrent-range-zones (distinguishing two zones in each Sarmatian substage i.e. Volhynian, Bessarabian and Chersonian) on the basis of distinct bivalve assemblages. On the other hand, Sarmatian basin facies are subdivided into four bivalve zones (two zones are recognized for Bessarabian) (Kojumdgieva et al., 1988).

The Early Sarmatian bivalve assemblages from the clayey facies are dominated by *Abra* (*Syndosmya*) *reflexa* (Eichwald) and representatives of small (shell long ca 5–10 mm), spiny cockle species *Inaequicostata inopinata* (Grischkevitsch). The first occurrence of these two species along with *Inaequicostata nigra* (Zhizhchenko) [its younger synonymous are: *Cardium gleichenbergense* Papp and *Cardium transcarpaticum* Grischkevitsch] dates the base of the Abra reflexa zone (Kojumdgieva et al., 1988), corresponding to the Badenian/Sarmatian boundary.

The fossil material derived from the cores of three research boreholes – Busko (Młyny) PIG-1, Kazimierza Wielka (Donosy) PIG-1 and Jamnica–119, from the Carpathian Foredeep Basin enable to estimate the age of the upper part of the Machów Formation. Sedimentation of the Machów Formation took place throughout the Late Badenian and Early Sarmatian. Mass accumulations of shells and internal molds of opportunistic species *Abra* (*Syndosmya*) *reflexa* characteristic for the Lower Sarmatian (Volhynian) of the Paratethys together with the foraminifera assemblage of the Anomalinoides dividens interval-zone have allowed to define the upper part of the Machów Formation as the Early Sarmatian (Volhynian) (Czapowski et al., 2012). These clayey deposits of the basin facies of the Machów Formation are isochronous with sandy barrier bivalve-bearing deposits from the vicinity of Chmielnik (Studencka & Studencki, 1980; Studencka, 1990; Czapowski & Studencka, 1990) as well as with marly clays of the Pannonian Basin (Bohn-Havas, 1983).

The biostratigraphically youngest bivalve assemblage containing *Plicatiforma plicatofittoni* (Sinzov), *Obsoletiforma volhynica* (Grischkevitsch) and *Mactra* (*Sarmatimactra*) *andrussovi* Kolesnikow was recorded in the Jamnica-119 borehole. It allows to date this part of the Machów Formation to the Volhynian/Bessarabian boundary **(Studencka**, **1999**).

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The plan of future research

At present I am focused on the revision of the Early Sarmatian representatives of the genus *Obsoletiforma*. My paper "Revision of Late Miocene bivalves from Cacela (Algarve, southern Portugal) housed at the Geological Museum of INETI in Lisbon" is also under preparation.

The paper about bivalves from the Oligocene menilite beds from Jabłonica Polska near Krosno, prepared commonly with S.W. Popow, M. Bieńkowska-Wasiluk and R. Wasiluk is in its final stage, to be published in the Geological Quarterly.

In near future I will start the work on the two bivalve collections newly registered in the PAS Museum of the Earth, derived from two Badenian localities in Nowy Sącz and Borský Mikuláš. Nowadays, the both fossiliferous site are inaccessible for study.

5. Other scientific achievements

Below I present a brief description of my activity in fields other than the scientific achievements presented above. The citations below along with my personal contribution to each of the presented papers are listed in Annex 3A (Załącznik 3A).

Bivalves from the Eastern Outer Carpathians

The occurrences of the Paleogene molluscan faunas in the Polish and Ukrainian Outer Carpathians are rare and limited to the deposits which originated through submarine debris flows. Therefore, the findings of shallow-water molluscan faunas are limited to the olistostrome and olistolith bodies within the Silesian and Skole (Skyba) nappes and the Boryslav-Pokuttya Unit.

The oldest assemblage, showing also the greatest diversity, was discovered by B. Kropaczek in 1907 in the Kosina stream in Babica near Rzeszów. A total of 150 gastropod species were recognized by Kropaczek in the material derived from clays of then unknown age within the Skole Nappe. This finding was crucial for understanding the geological history of the Carpathians and offered the opportunity to determine the age of the Carpathian flysch which based on facial analysis. After detailed taxonomic and paleontological study of 80 gastropod species, the age of these clays, called by Kropaczek (1910) as the Babica Clays, was considered as early Paleocene.

In 1958 the PAS Museum of the Earth purchased a manuscript without the title and authors' name derived from the scientific heritage of E. Panow. The manuscript, comprising almost 450 unnumbered pages written in German, contained material for a monograph of the Tertiary gastropods. After a thorough study, I have established that the manuscript is the crude version of the PhD Thesis by B. Kropaczek „Montienfauna aus dem Flysch der Nord Karpaten von Babica bei Rzeszów. I Teil Gastropoda". On the basis of this Thesis he was awarded in 1910 the PhD title at the Vienna University. Moreover, I established that Kropaczek borrowed from the Vienna University Archive the only copy of his PhD Thesis in order to complete the gastropod illustrations and prepare the text for publishing. Unfortunately, this extensive paleontological monograph of gastropods from Babica, highly praised by V. Uhlig, has never been published. The manuscript almost ready for publication (only 42 gastropod illustrations were not yet prepared) was lost during the World War II. On the basis of the manuscript stored in the PAS Museum of the Earth I presented the review of the PhD Thesis by Kropaczek (**Studencka, 1986b**). The object of this paper

(**Studencka**, **1986b**) was not only to present the story of the Kropaczek PhD Thesis, which was the first study of the Palaeocene gastropod fauna in the Outer Carpathians in Poland, but also to give the information on his life, and to show some fragments of this manuscript in Polish version, including the list of all 193 gastropod species collected from the Babica Clays by B. Kropaczek, W. Rogala and W. Krach. The fragmentary Kropaczek collection is housed in the Geological Museum of the Institute of Geological Since, PAS in Krakow.

In 1989 I participated in the International paleontological expedition to the Ukrainian Outer Carpathians led by S. V. Popov (Paleontological Institute RAS in Moscow), with the prime aim to complete collection of molluscs from the menilite series. The Paleogene bivalves from the upper Eocene and Oligocene menilite series of the Ukrainian Carpathians (Skyba Nappe and Boryslav-Pokuttya Unit) were collected by A. Maximov and served as a basis for his PhD Thesis. The unpublished manuscript [383 pages + 17 plates] including the paleontological description of 63 bivalve species is stored in the Russian State Library in Moscow. Only descriptions of new eight species erected by Maximov were published in 1961. Unfortunately, poor quality of illustrations and lack of the access to the original material (apparently lost) preclude any verification of Maximov's determination.

Within the material collected in 1989, 30 bivalve and 20 gastropod species have been identified. Preliminary study indicated great similarity of the Carpathians molluscan fauna to this from the Boreal province. The results of our joint study were presented by me at the Conference "Carpathian Geology 2000" in Smolenice (**Studencka et al**., **1999**). Our joint fieldwork in the Ukrainian Carpathians continued during the season of 2000. The work has resulted in molluscan collections gathered from two stratigraphic levels: the basal part of the menilite series in the Boryslav-Pokuttya Unit (exposed in the Pistinka river at Kosmach and in the Rybnica river at Kosov) and the uppermost part of the menilite series in the Skyba Nappe (exposed in the Chechva River at Spas and in the Luzhanka river at Stankivtsy). In 2004, together with S.V. Popov, I examined molluscan material gathered by I. Hamrat from the Lower Oligocene (Kiscellian) clay in the vicinity of Budapest and housed in the Hungarian Natural History Museum in Budapest. The examination of the material from the historical collection added valuable information concerning its taxonomic content: we verified earlier specific attributions referring to the unpublished material. Moreover, it appeared that isochronous bivalve assemblages from Budapest and Ukrainian Carpathians have very few species in common.

The unique and richest collection from the Ukrainian Carpathians was gathered from the Subchert Member, lying directly below the Lower Chert Level, at Kosmach. It comprises 37 bivalve species and 11 gastropod species. In the contemporaneous deposits at Kosov we recognised 15 bivalve species and five gastropod species (**Popov et al**., **2009**). The youngest bivalve assemblages were collected from the Middle Menilite Subformation of the Skyba Nappe. Based on the planktonic foraminifera, its age is determined as latest Oligocene (late Chattian). Thirty bivalve species and representatives of three gastropod families have been identified within the material taken from the river section the Chechva at Spas and five bivalve species have been recognised in the river section Luzhanka at Stankivtsy (**Popov et al**., **2009**). The molluscan material gathered in 1988 and 2000 in four Ukrainian outcrops is stored at the PAS Museum of the Earth in Warsaw.

The most recent field work undertaken in the Silesian Nappe has resulted in the bivalve material gathered at Jabłonica Polska near Krosno from the Dynów Marls, the origin of which is connected with submarine debris flows (**Studencka et al**., **2009**). Our study of bivalves from Jabłonica Polska indicates that they represent a peculiar assemblage typical for the Solenovian and the middle Kiscellian, regional Paratethyan stages (age-equivalent of the early Rupelian). The Solenovian assemblages are characterized by the occurrence of endemic bivalve genera, able to adapt to changes in salinity. The bivalve fauna from Jablonica Polska, represented by 16 species, is the richest assemblage not only in the Carpathians but in the whole Paratethys Province.

The newly collected material, first of this kind in Poland and third in the Outer Carpathians (Čtyroký, 1991; Rusu, 1999), is of great importance for correlation of the Carpathians flysch with the Kiscellian deposits of Hungary and in Transylvania, Romania. It also shows that around the NP22/NP 23 nannozones boundary, peculiar bivalve fauna populated both the Carpathians (Čtyroký, 1991; Rusu, 1999; and our study) and the Pannonian Basin (Báldi, 1986; Rusu, 1988); it was also typical for the Solenovian of Ukraine, Russia, Georgia and Kazakhstan. This fauna represents the first real Paratethyan endemic macrofaunal zone around 32 Ma and indicates conditions of an inland sea with pliohaline (salinity less than 25‰) water oxygenated at the surface and euxinic environmental conditions at the bottom.

The preliminary results of this study were presented by me at the 10th Anniversary Conference of Czech, Polish and Slovak Paleontologists, Banská Bystrica (**Studencka et al**., **2009**), the 21st Conference of Polish Palaeontologists, Żarki-Letnisko (**Studencka et al**., **2010**) and on the Second Polish Geological Congress, Warsaw (**Studencka et al**., **2012**). I am the sole author of all abstracts of these lectures. In February 2014 the common paper "Oligocene bivalve fauna of the Solenovian type from the Polish Outer Carpathians" [in Russian] prepared jointly with S.V. Popov has been submitted to Paleontologicheskij zhurnal.

Late Miocene bivalves of Algarve (southern Portugal)

Several times (1998, 2002, 2003 and 2012) I had the opportunity to undertake the field works in the Algarve Region and to study paleontological material housed in the Geological Museum in Lisbon. In 1998, my studies were realised within the Programme of Scientific and Cultural co-operation between governments of Poland and Portugal thanks to the financial support from the Portugal Ministry of Science and Technology; in 2002 financial support for the work in Portugal was provided through the EC Marie Curie Fellowship grant MCFI-2001-00100 "Middle Miocene bivalves of Algarve, Portugal: new approach to stratigraphy and paleogeography of the region"; study in 2003 formed part of the project No 3 P04D 061 22 "Diversity of European Tertiary oyster bioconstructions and their paleoenvironmental conditions" financially supported by the Polish Committee for Scientific Research while in 2012 my studies were realised thanks to PalSIRP-*Sepkoski Grants* from American Paleontological Society.

The complete sequence of the Miocene deposits in Algarve is made up of two superimposed formations. The lower one distinguished as the Lagos-Portimão Formation consists mainly of the

Lower and Middle Miocene carbonates which in the western part of Algarve form the picturesque cliffs almost 40 m high. The base of the formation is exposed in few localities where it unconformably overlies Jurassic or Cretaceous carbonates.

Landscape of the eastern Algarve is quite different: long barrier islands cut off vast lagoon from the Atlantic. The Upper Miocene slightly cemented siliciclastic deposits distinguished as the Cacela Formation occur now as isolated patches due to the post-Miocene erosion and its widely scattered occurrence indicates formerly extensive distribution. Only in few localities it forms cliff ca 10 m high. Nowadays its base crops out only during the low tide or on banks of small streams.

The most diversified Miocene molluscan fauna of Portugal has been reported from the Cacela Formation. Prior to my study, bivalves had been only described by Dollfus et al. (1903) from the Cacela River (a reference section for the Cacela Formation) and by Chavan (1940) from Monte Alto near Cacela Velha. Only the lower part of the Cacela River sequence that yields the molluscan fauna of highest species diversity and unique, excellent shell preservation has been dated as latest Tortonian on the base of calcareous nannoplankton and planktonic foraminifera. Nowadays, the fossiliferous site, in which molluscan material was recovered by F.A. Pereira da Costa in 1860s, is no more exposed. More than twenty outstanding illustrations prepared under his supervision, representing Portuguese Tertiary bivalves were published by Dollfus et al. (1903), who had updated all the illustrated material. This monograph includes 47 species from the vicinity of the Cacela Velha, 44 of which were illustrated. In 1940 A. Chavan documented 27 bivalve species at Monte Alto and revised some determinations given by Ph. Dollfus. This material was considerably enriched in 1905–1908. Unfortunately, no comprehensive, systematic review of this material has been undertaken. Only four scallop species were discussed by O. da Veiga Ferreira (1951) and a new venerid species *Paphia* (*Paphia*) *zbyszewskii* was established by S. Freneix (1957).

My current re-examination and revision of the fossil material under consideration revealed that bivalve fauna is more diversified than it was expected from the two monographic works by Dollfus et al. (1903) and Chavan (1940). Ninety two bivalve species have been identified within the material taken between 1860 and 1908 both from the type section of the Cacela Formation and several other sites. In addition, I took the photographs of selected specimens from the original F.A. Pereira da Costa material. They will be included into the paper under preparation "Revision of Late Miocene bivalves from Cacela (Algarve, southern Portugal) housed at the Geological Museum of INETI in Lisbon”. The list of 37 bivalve species with their current identification gathered at Conceição de Tavira, the most far-away outcrop from the present-day seashore was published in paper by **Studencka & Zieliński** (**2013**).

The field work undertaken by me in 2002 in the eastern Algarve resulted in the abundant and diversified bivalve material derived from three outcrops: Barroquinha, Cabanas and Lacem. A brief account on the presence of the molluscan fauna in the Barroquinha and Cabanas sections was given by M. Cachão in 1995 in his unpublished PhD Thesis. The newly collected material is deposited in the Polish Academy of Sciences Museum of the Earth in Warsaw, Poland and also in the Centre for Marine and Environmental Studies (CIMA), University of Algarve, Faro, Portugal.

Taxonomic study which followed the fieldwork has shown that the most diversified bivalve assemblage is derived from Cabanas: sixty one species have been identified that represent 48 genera of 22 families. The family Veneridae is characterized by particularly high taxonomic diversity. Four species: *Pseudopythina macandrewi* (P. Fischer), *Coripia corbis* (Philippi), *Glossus* (*Glossus*) *humanus* (Linnaeus) and *Cyathodonta dollfusi* (Cossmann et Peyrot) have previously not been reported from the Miocene of southern Portugal. Unfortunately, diagenetic processes of aragonite dissolution had strongly influenced the quality of shell preservation. Majority of them are preserved as moulds or composite moulds with partial shell preservation. The knowledge about the age of these sections i.e. Barroquinha, Cabanas and Lacem, is of fundamental importance for understanding paleontological and geological history of the Algarve region which, in turn, was closely related to the Late Miocene evolution of the Guadalquivir Basin. The scarcity of nannoplankton and planktonic foraminifera involve stratigraphic uncertainties. That is why the application of strontium isotope stratigraphy was carried out based on well-preserved calcitic scallop shells from the Barroquinha and Cabanas sections as well as on the aragonitic shells of other bivalves from the Cacela River and Lacem sections.

The analyses of strontium isotopic ratio ($^{87}Sr/^{86}Sr$) performed by mass spectrometer VG Sector 54 (equipped with 7 faraday collectors) at the Institute of Geological Sciences, Polish Academy of Sciences in Warsaw revealed that the geological age of bivalve fauna from the Cacela River site should be attributed to the latest Tortonian which is in agreement with biostratigraphic data. The Barroquinha data indicate the age range corresponding to the Tortonian/Messinian boundary. Finally, based on the ratio of two isotopes of strontium in scallop shells from Cabanas, the Messinian age has been defined. In this way, the occurrence of Messinian strata in Portugal was proved for the first time. With these new data the Cacela Formation offers the opportunity to better understand relations between the Atlantic Messinian shallow water molluscan fauna and that of the Mediterranean (**Studencka & Zieliński**, **2013**).

The preliminary results of this study were presented by me at the International Symposium "Shallow Tethys" in Budapest (**Studencka et al**., **2003**), the 4th International Congress "Environment and Identity in the Mediterranean", Corte (**Studencka et al**., **2004**), the 12th Congress RCMNS, "Patterns and processes in the Neogene of the Mediterranean Region", Vienna, (**Studencka**, **2005**) and on the First Polish Geological Congress, Krakow (**Studencka**, **2008**). I am the sole author of all abstracts of mentioned above lectures and I am the sole author of poster abstract presented during the 32nd International Geological Congress, Florence (**Studencka et al**., **2004**) and an abstract published in the materials of the France Third Congress of the Regional Committee on Atlantic Neogene Stratigraphy, Tetouan, Morocco (**Studencka et al**., **2003**).

Chitons from the sandy deposits of the Paratethys

The chitons form only a small part of the abundant and diverse Middle Miocene shallow-water molluscan fauna. Until now, the richest chiton fauna of the Paratethys has been reported from the Lower Badenian Korytnica clays (Bałuk 1971, 1984).

Chiton (Polyplacophoran) skeletal remains were collected by me and W. Studencki from the Upper Badenian sands along the southern slopes of the Holy Cross Mountains. Taxonomic studies of material derived at four outcrops: Gieraszowice, Nawodzice and Rybnica (two outcrops) revealed presence of eight species belonging to six genera (**Studencka & Studencki**, **1988**). The predominant faunal element is *Chiton corallinus* (Risso).

Based on the monograph publications describing particular localities and the chiton collections housed in the PAS Museum of the Earth we compiled the list of chiton species from both the Lower and Upper Badenian strata of the Central Paratethys. The total Early Badenian fauna comprises 30 species belonging to 10 genera, whereas the Late Badenian – 20 species representing nine chiton genera. In addition, we provided the list of eight species from Varovtsi (western Ukraine), that were collected by us during the international paleontological expedition in 1988.

Chitons from the western Ukraine briefly mentioned by Studencka & Studencki (1988) were later described in detail by **Studencka & Dulai** (**2010**). Eight species were identified. The predominant faunal element appeared *Acanthochitona faluniensis* (Rochebrune). We proved that the form described by Sacco under the name *Middendorffia subcajetana* (d'Orbigny) represented in fact huge specimens of *Lepidopleurus cajetanus* (Poli). Moreover, we have shown evidence that the synonimization of fossils species *Acanthochitona faluniensis* (Rochebrune) with the modern species *Acanthochitona fascicularis* (Linnaeus) is unjustified.

The next joint study of ours is based on the material housed in the PAS Museum of the Earth and the Hungarian Museum of Natural History in Budapest. Our contribution on chitons from Romania (Bahna, Buituri, Coştei, Delineşti and Lapugy) and Bulgaria (Tarnienie) is under preparation; the paper entitled "*Badenian* (*Middle Miocene*) *chitons* (*Mollusca: Polyplacophora*) *from Romania and Bulgaria* (*Central Paratethys*)" will be submitted for publication in *Geologica Carpathica*.

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