

New important Neogene and Pleistocene mammal assemblages from Poland

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ABSTRACT – Three mammal assemblages of Bełchatów C, Bełchatów B and Bełchatów A are referred to MN 4/5, MN 5/6 and MN 8/9, respectively, on the basis of species composition of rodents and insectivores. Przemyłowice 1-6 localities yielded four faunas of Late Villanyian (MN 17), Early Biharian, Middle Pleistocene and Holocene ages. The fissure filling assemblage from Zalesiaki 1A/13, with *Predicrostonyx compitalis*, probably dates back to the oldest Pleistocene continental glaciation in Europe. Very rich molluscan and vertebrate assemblages from Oblazowa Cave represent a faunal succession in the Carpathians from almost the entire Late Pleistocene.

RIASSUNTO – [Nuove località a mammiferi del Neogene e Pleistocene in Polonia] – Le tre associazioni faunistiche di Bełchatów (Bełchatów C, Bełchatów B e Bełchatów A) sono riferite alle unità MN 4/5, MN 5/6 e MN 8/9 sulla base della composizione specifica (roditori ed insettivori). Le località Przemyłowice 1-6 hanno restituito faune del Villaniano superiore (MN 17), del Bihariano inferiore, del Pleistocene medio e dell'Olocene. L'associazione proveniente dai riempimenti delle cavità carsiche di Zalesiaki 1A/13, fauna con *Predicrostonyx compitalis*, con ogni probabilità può essere riferita alla prima glaciazione continentale Europea del Pleistocene. La ricca documentazione a molluschi e vertebrati di Oblazowa Cave rappresenta una successione faunistica di riferimento per quasi tutto il Pleistocene superiore dei Carpazi.

INTRODUCTION

Last reviews of Neogene and Pleistocene mammal faunas from Poland have presented the state of knowledge for late 1980s (Kowalski, 1989, 1990; Nadachowski, 1990a, b). However, during last decade some more faunal assemblages of considerable significance were discovered and at least partly described. The principal goal of this paper is to analyse the new most important Miocene, Pliocene and Pleistocene faunal assemblages from Poland and to discuss their community structure and biochronological value.

MIocene

BEŁCHATÓW

Bełchatów is an open-cast brown coal mine at Bełchatów, 51° 15'N, 19° 20'E, 15 km S from the town Bełchatów, central Poland. Bone-bearing sediments come from lacustrine carboniferous sediments containing numerous bivalves and gastropods. These calcareous intercalations are situated within the lignite sequences of the main coal-bed, which is constantly exploited, and three seams of small thickness. The total thickness of the profile is ca. 60 m (locally 250 m). The mammal fauna was found at three following levels (bottom to top): Bełchatów C (BE-C) in the upper part of the main bed, unit W, Bełchatów B (BE-B) above xylitic brown coal steam B and Bełchatów A (BE-A) in mid-part of clayey-coal unit I-W consisting of clays and small xylitic-clayey coal layers with lacustrine limestone intercalations (Stworzewicz & Szyrkiewicz, 1989; Stuchlik & Szyrkiewicz, 1998)

(Text-fig. 1). Besides mammals, land and freshwater gastropods as well as bivalves were investigated in detail (Kadolsky & Piechocki, 2000; Stworzewicz, 1995, 1999a, b; Stworzewicz & Sołtys, 1996). Paleobotanical investigations (pollen and leaf flora analyses) have also been carried out (Stuchlik *et al.*, 1990).

In the Neogene sequence of the Bełchatów mine there are several tuffitic intercalation that enable absolute dating. Zircons extracted from two layers yielded fission-track ages of 18 ± 1.7 Ma (TS-3) and 16.5 ± 1.3 Ma (TS-2) (Burchart *et al.*, 1988). These dates suggest that this part of the sediments was deposited between upper Eggenburgian and middle Badenian.

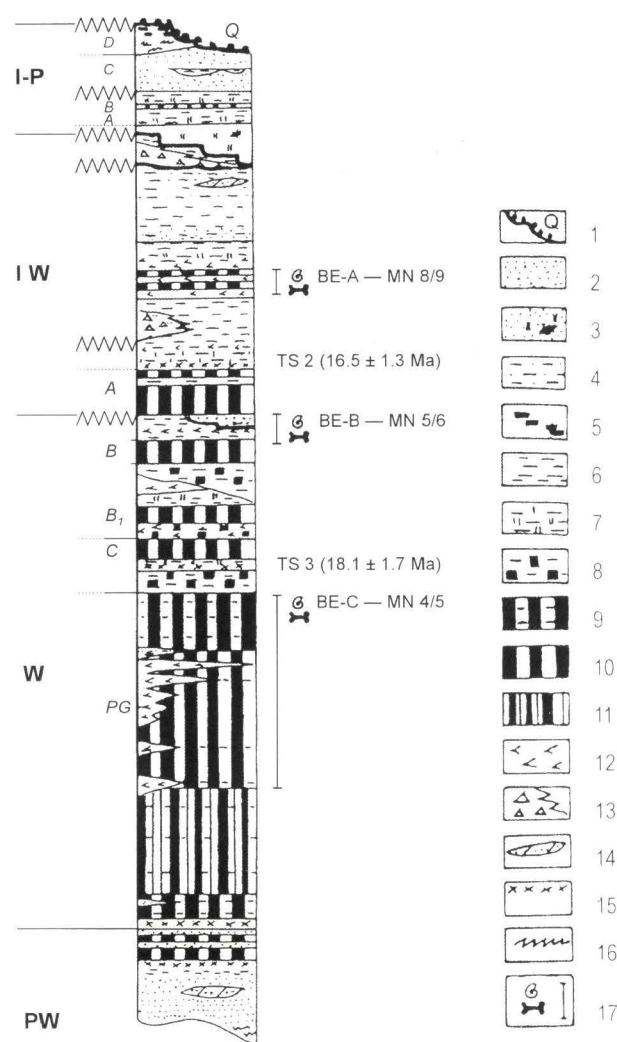
Faunal assemblages

Bełchatów C (BE-C):

cf. *Florinia stehlini*; Heterosoricinae gen. et sp. indet.; *Heterosorex* sp.; *Plesiodimylus* cf. *chantrei*; *Chainodus intercedens*; Megachiroptera (Pteropodidae); Sciuridae; Castoridae; Dipodidae; *Ligerimys antiquus*; *Keramidomys* cf. *thaleri*; *Anomalomys minor*; *Eumyarion bifidus*; *Democricetodon franconicus*; *Democricetodon* sp. 1; cf. *Glis* sp.; *Glirudinus undosus*; *Myoglis antecedens*; cf. *Heteromyoxus* sp.; *Glirulus diremptus*; *Bransatoglis* cf. *infralactorensis*; *Neocometes similis*; Lagomorpha; *Gomphotherium angustidens*; Perissodactyla; Chalicotheriidae; *Hyotherium soemmeringi*; Artiodactyla.

Bełchatów B (BE-B):

Talpidae; *Plesiosorex germanicus*; Soricidae gen. et sp. indet.; cf. *Miosorex* sp.; *Dinosorex* cf. *zapfei*; *Plesiodimylus chantrei*; *Chainodus intercedens*;



Text-fig. 1 - Lithostratigraphic scheme of the Tertiary brown coal deposits of the open-cast mine Bełchatów and correlation of the mammal and malacofauna -bearing horizons: 1) erosion border of the Tertiary and Quaternary (Q) deposits; 2) sands; 3) coaled sands with plant detritus; 4) clayey sands; 5) peat; 6) clays; 7) coaled clays; 8) sapropelic coals; 9) xylite-sapropelic brown coals with clay; 10) xylite brown coals; 11) bituminous-pyropisside brown coals; 12) lacustrine limestones; 13) weathered Mesozoic rocks with silica or ferruginous cement; 14) silicated sands or quartzitic sandstones; 15) kaolinized volcanic tuff (paratonstein); 16) distinct erosion borders and discordance; 17) range of palaeontological profiles with mammals and malacofauna (BE-C, MN 4/5; BE-B, MN 5/6; BE-A, MN 8/9); TS-2, TS-3 - fission-track ages (according to Stworzewicz & Szykiewicz, 1989; Stuchlik & Szykiewicz, 1998 and Szykiewicz, 2000, changed).

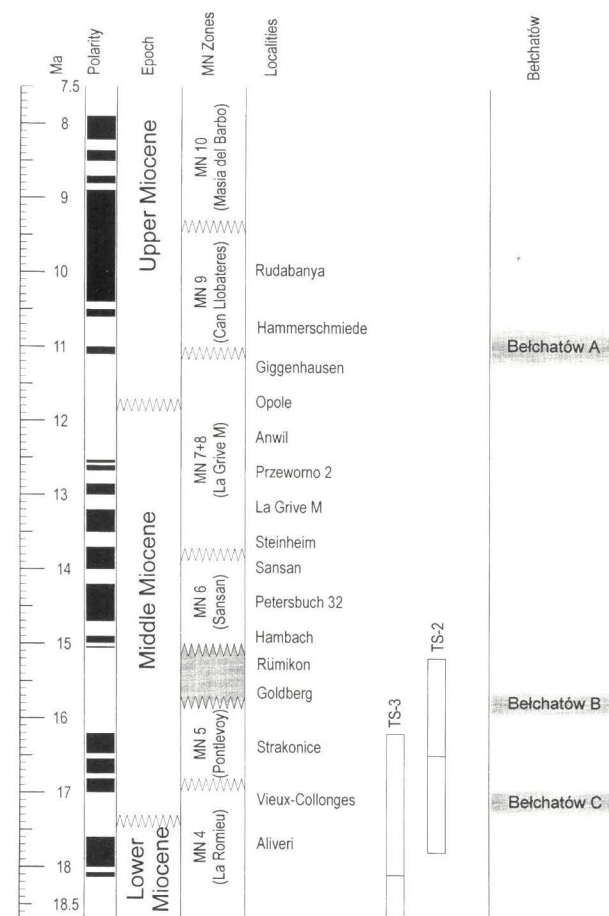
Erinaceidae; Sciuridae; Castoridae; *Keramidomys thaleri*; *Eomyops* aff. *catalaunicus*; *Anomalomys minor*; *Cricetodon* cf. *meini*; *Eumyarion bifidus*; *Eumyarion* cf. *weinfurteri*; *Democricetodon* cf. *brevis* (small);

Democricetodon sp. 2; *Megacricetodon* sp.; *Lartetomys* cf. *zapfei*; *Glis* sp.; *Glirudinus* cf. *minutus*; *Glirudinus* sp.; *Microdryomys koenigswaldi*; *Glirulus werenfelsi*; *Glirulus lissiensis*; *Bransatoglis* sp.; *Neocometes similis*; Lagomorpha; Artiodactyla

Bełchatów A (BE-A):

cf. *Crusafontina* sp.; *Dinosorex* sp.; *Plesiodimylus* sp.; *Plesiodimylus chantrei*; ?*Chainodus* sp.; Sciuridae; Castoridae; *Eomyops oppligeri*; *Eomyops* nov. sp.; *Keramidomys* nov. sp.; *Anomalomys gaudryi*; *Collimys transversus*; *Eumyarion* cf. *latior*; *Democricetodon* cf. *brevis* (large); *Democricetodon* nov. sp.; *Megacricetodon* aff. *minor*; *Microtocricetus molassicus*; *Glis vallesiensis*; *Muscardinus hispanicus*; *Microdryomys* sp.; *Glirulus werenfelsi*; *Glirulus lissiensis*; *Bransatoglis astaracensis*; Lagomorpha; Tetraconodontinae or Suinae; Artiodactyla.

Biochronology - Of the three mammal assemblages in Bełchatów, the older BE-C and BE-B are not



Text-fig. 2 - Correlation of Bełchatów mammal assemblages with MN zones. TS-3 and TS-2 - fission track ages, the horizontal line indicates the mean (TS-3: 18.1 Ma; TS-2: 16.5 Ma) and rectangles illustrate the standard deviations from the mean.

remote in age, while BE-A is considerably younger (Garapich, 2000; Garapich & Kälin, 1999; Made van der & Kowalski, 1996; Kowalski, 1993a, b; 1994; 1997a, b; Kowalski & Kubiak, 1993; Rzebik-Kowalska, 1993, 1994, 1996; Rzebik-Kowalska & Kowalski, 2001). On the basis of the species composition of glirids and the presence of some other rodent species (*Anomalomys*, *Neocometes* and *Microtocrictetus*) the BE-C, BE-B and BE-A assemblages were correlated by Kowalski (1997b) to MN 4, MN 5/6 and MN 9, respectively. Studies of eomyids and cricetids undertaken by Garapich (2000) changed the proposed age of BE-C to MN 4/5, due to the first appearance of *Keramidomys* (Mein, 1999). On the other hand, the BE-A assemblage seems to be older (MN 8/9), with an age similar to the fauna of Anvil (Engesser, 1972) (Text-fig. 2).

The mammal material collected hitherto in Bełchatów provided an exceptional opportunity to study faunal succession during almost ten million years in Central Europe. Moreover, very rich land and freshwater gastropods and bivalves as well as pollens and leaf flora described from the same sections increase the importance of the site.

PLIOCENE AND EARLY PLEISTOCENE

PRZYMIŁOWICE

Przymiłowice is a complex of karst fissures in a quarry near Olsztyn, 50° 45' N / 19° 18' E, central part of the Cracow - Wieluń Upland, central Poland. In the quarry nine lithological units were distin-

guished which filled fossil-bearing karst forms (Text-fig. 3). Some of them yielded snail and vertebrate remains of different age. The mammal faunas were discovered in 6 localities - Przymiłowice 1-6 (PE1, PE2, PE3, PE4, PE5, PE6) (Nadachowski *et al.*, 1991). On the basis of the occurrence of several index species of *Mimomys* and lack of *Allophaiomys*, fauna A is ascribed to Late Villanyian age (MN 17), while fauna B (with *Allophaiomys*) - to Early Pleistocene (Q1). Due to the lack of sufficiently good index fossils in fauna C, the assemblage is believed to be of Middle Pleistocene (?) age; fauna D is of subfossil character.

The molluscan and vertebrate fauna (mainly mammals) were found in four assemblages (Nadachowski *et al.*, 1991; Stworzewicz, 1994). The so-called fauna A is deposited in unit 4 of the PE3. The assemblage contains among others: land snails (Stworzewicz, 1994), *Beremendia fissidens*, *Rhinolophus macrorhinus*, *Plecotus abeli*, *Hypolagus beremendensis*, *Mimomys ostramosensis*, *M. tornensis*, *M. pitomyoides*, *M. pusillus*, *Clethrionomys kretzoi*, *Ungaromys* sp. The fauna B was found in unit 5 of PE1, PE2 and PE3 localities. The fossil assemblage is characterised by the presence of *Allophaiomys pliocenicus* accompanied by *Beremendia fissidens*, *Allocricetus* sp., *Clethrionomys kretzoi*, *Mimomys pusillus*, *Lemmus* sp., *Pliomys episcopalis* and in PE2 by *Microtus* ex gr. *oeconomus*. Unit 6 supplied another fossil assemblage (fauna C), containing mainly various species of bats with predominance of *Myotis emarginatus* and *M. bechsteini* (PE4, PE5 and PE6). Fauna D from unit 9 (PE2) contained e.g. *Microtus arvalis*, *Arvicola terrestris*, *Cricetus cricetus* and *Vulpes vulpes*.

Age		Unit	PE 1	PE 2	PE 3	PE 4	PE 5	PE 6
Pleistocene	Late	9		D				
		8						
		7						
	Middle	6						
		b a						
Pliocene	Early Biharian	5	B	B	B			
	Late Villanyian	4			A			
		3						
		2						

Text-fig. 3 - Correlation of the deposit filling in the fossil-bearing karst forms in the Przymiłowice quarry. Units: 2) dark-brown loamy clay (nodular in structure) with scraps of brown loam and iron-manganese concretions; 3) brown- and dark-grey clay; 4) red-brown silty clay; 5) sharp-edged limestone rubble with light-brown clay; 6) sharp-edged limestone rubble (unit 6a) with yellowish sands (unit 6b); 7) yellow, orange, red and brown sands of different lithology; 8) gray sands with limestone debris; 9) limestone rubble with humus and sand. The presence of faunal assemblages is indicated by corresponding letters in circles. PE1-PE6 - Przymiłowice 1-6 localities.

The complex of sites in Przemyślówice is tied to defined lithological units and represent important faunal succession around Pliocene/Pleistocene boundary in Poland.

ZALESIAKI 1A/13

Zalesiaki 1A is a complex of karst fissures in Zalesiaki near Działoszyń, 51° 06'N / 18° 56' E, Cracow-Wieluń Upland, Central Poland. Zalesiaki 1A locality yielded several faunal samples of Late Biharian age (Nadachowski, 1990a). Zalesiaki 1A/13 assemblage was found in a sandy clay sediment in the lower part of the quarry. Except mammal fauna, which is of late Biharian age, no other datings are available. However, the presence of *Predicrostonyx* together with morphologically advanced *Allophaiomys* and primitive *Microtus* indicates the possible age of assemblage above the Early/Late Biharian boundary, most probably corresponding to the final part of the Matuyama Chron, preceding the Jaramillo event.

Fauna – *Spermophilus polonicus*, *Pliopetaurista meini*, *Cricetus runtonensis*, *Prospalax* sp., *Predicrostonyx compitalis*, *Lemmus* sp., *Clethrionomys* sp., *Pliomys episcopalus*, *Allophaiomys pliocaenicus praehintoni*, *Allophaiomys pliocaenicus nutiensis*, *Microtus ex*

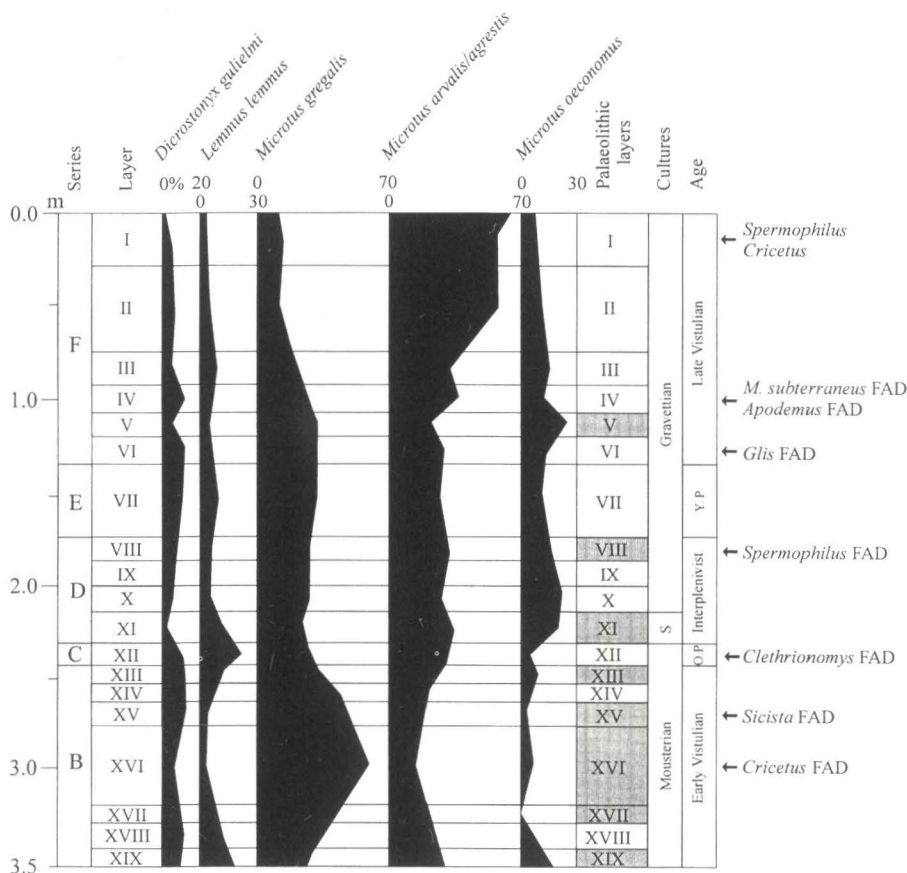
gr. *hyperboreus*, *Microtus* sp., *Mimomys pusillus*, *Mimomys savinii* and *Apodemus* cf. *flavicollis* (Nadachowski, 1992).

The most spectacular find is *Predicrostonyx compitalis*. The presence of collared lemming in the assemblage most probably indicates the oldest continental glaciation in Europe (the Narew glaciation in Polish nomenclature).

LATE PLEISTOCENE

OBŁAZOWA CAVE

The Obłazowa cave is situated in the south-western part of the Obłazowa Klippe (670 m a.s.l.) in the western termination of the Pieniny Klippen Belt, 49° 25' N, 20° 09' E, the Carpathians, southern Poland. The cave infilling is a series of 4.5 m deep sediment with 21 lithologically differentiated layers (marked from the bottom to the top: XXI - I), pooled into 6 series (A-E). The lower part is a series of fluvial gravel with granite cobbles up to 30 cm in diameter (layer XXI) and above-lying cave sediments of autochthonous limestone rubble and loam (Madeyska, 1991). Archaeological materials are represented by 9 Palaeolithic cultural layers (Mousterian, Szeletian and Gravettian age) (Text-fig. 4). The cultural level of



Text-fig. 4 - Succession of predominant rodent species in the profile of Obłazowa Cave. S = Szeletian culture; O.P. = Older Plenivistulian; Y.P. = Younger Plenivistulian; FAD = first appearance datum.

layer VIII, linked to the Pavlovian of the East-Gravettian culture zone (Valde-Nowak, 1991) yielded the most spectacular find from this side – a boomerang made of a mammoth tusk (Valde-Nowak *et al.*, 1987). The sequence covers almost whole Vistulian (= Weichselian) (Text-fig. 4). Several radiocarbon dating were made from bone, antler and ivory using ASM method (Oxford University) and the radiometric decay counting method.

Fauna – Faunal assemblages from the locality Obłazowa Cave are one of the richest in Poland in the number of remains as well as the number of taxa (Madeyska, 1991; Valde-Nowak, 1991; Valde-Nowak *et al.*, 1987, 1995). In the whole profile following animal groups were identified (in brackets number of species identified): snails (66), fishes (6), amphibians (12), reptiles (6), birds (107), and mammals (68) including: insectivores (11), bats (17), carnivores (12), proboscideans (1), perissodactyls (2), artiodactyls (6), rodents (15) and lagomorphs (4). The proportions of remains of particular ecological groups of mammals and birds were different in subsequent layers and series of sediment, which suggests the changes of habitats according to climatic changes during the time of sedimentation. However, the composition of the mammal fauna, exemplified here by succession of rodents (Text-fig. 4), indicates steppe-tundra or forest-steppe biome for all the time; this means that cold or cool conditions and mosaic habitats prevailed. Details are discussed in the monographic study of the site [Valde-Nowak, P., Nadachowski, A. & Madeyska, T. (eds.), in press].

The Obłazowa Cave yielded very diversified vertebrate fauna of unique importance for the reconstruction of the Late Pleistocene faunal history in the Carpathians.

REFERENCES

- BURCHART, J., KASZA, L. & LORENC, S., 1988, Fission-track zircon dating of tuffitic intercalations (Tonstein) in the brown-coal mine "Bełchatów": Bull. Pol. Acad. Sci., Earth Sciences, 36 (3-4): 281-286.
- ENGESSER, B., 1972, Die obermiozäne Säugetierfauna von Anvil (Baselland): Tätigkeitsberichte Naturforsch. Ges. Basel, 28: 37-363.
- GARAPICH, A., 2000, Systematics and evolution of Cricetidae and Eomyidae from the Miocene of Bełchatów and their biostratigraphic significance: Unpubl. Thesis, Inst. Syst. Evol. Animals, PAS, Kraków, 188 pp., 34 Tabl. [in Polish].
- & KÄLIN, D., 1999, New findings on the rare and peculiar genus *Lartetomys* (Cricetidae, Rodentia, Mammalia): Eclogae geol. Helv., 92: 495-502.
- KADOLSKY, D. & PIECHOCKI, A., 2000, Freshwater Rissooidea from the Miocene of Bełchatów, Poland (Gastropoda Prosobranchia: Hydrobiidae, Pomatiopsidae): Arch. Molluskenkunde, 128 (1/2): 217-236.
- KOWALSKI, K., 1989 (ed.), History and evolution of land fauna of Poland: Folia Quatern., 59-60: 151-176 [in Polish].
- , 1990, Stratigraphy of Neogene mammals of Poland. In Lindsay, E. H., Fahlbusch, V. & Mein, P., (eds.), European Neogene Mammal Chronology. Plenum Press, New York: 193-209.
- , 1993a, *Microtocrictetus molassicus* Fahlbusch & Mayr, 1975 (Rodentia: Mammalia) from the Miocene of Bełchatów (Poland): Acta zool. cracov., 36 (2): 251-258.
- , 1993b, *Neocometes* Schaub & Zapfe, 1953 (Rodentia: Mammalia) from the Miocene of Bełchatów (Poland): Acta zool. cracov., 36 (2): 259-265.
- , 1994, Evolution of *Anomalomys* Gaillard, 1900 (Rodentia: Mammalia) in the Miocene of Poland: Acta zool. cracov., 37 (1): 163-176.
- , 1997a, Gliridae (Rodentia: Mammalia) from the Miocene of Bełchatów in Poland: Acta zool. cracov., 40 (2): 173-198.
- , 1997b, Rodents of the Miocene locality Bełchatów in Poland. In Aguilar, J.-P., Legendre, S. & Michaux, J., (eds.), Actes du Congrès Biochrom'97. Mém. Trav. E.P.H.E., Inst. Montpellier, 21: 697-703.
- & KUBIAK, H., 1993, *Gomphotherium angustidens* (Cuvier 1806) (Proboscidea: Mammalia) from the Miocene of Bełchatów and the Proboscidean Datum in Poland: Acta zool. cracov., 36 (2): 275-280.
- MADE, VAN DER J. & KOWALSKI, K., 1996, Suidae (Artiodactyla, Mammalia) from the Miocene of Bełchatów in Poland: Acta zool. cracov., 39 (1): 305-310.
- MADEYSKA, T., 1991, Sediments of Palaeolithic site – Obłazowa Cave (Polish Carpathians): Bull. Pol. Acad. Sci. Earth Sci., 39 (2): 173-185.
- MEIN, P., 1999, European Miocene mammal biochronology. In Rössner, G. & Heissig, K., (eds.), The Miocene land mammals of Europe, Verlag Dr. Friedrich Pfeil, München: 25-38.
- NADACHOWSKI, A., 1990a, Lower Pleistocene rodents of Poland: faunal succession and biostratigraphy: Quartärpaläont., 8: 215-223.
- , 1990b, Review of fossil Rodentia from Poland: Senckenbergiana biol., 70 (4/6): 229-250.
- , 1992, Early Pleistocene *Predicrostonyx* (Rodentia, Mammalia) from Poland: Acta zool. cracov., 35 (2): 203-216.
- , WOLSAN, M. & GODAWA, J., 1991, New localities of Late Cenozoic faunas from Przemyślówice in the Cracow-Wieluń Upland, Poland: Acta zool. cracov., 34 (2): 425-435.
- RZEBIK-KOWALSKI, B., 1993, Insectivora (Mammalia) from the Miocene of Bełchatów in Poland. I. Metacodontidae: *Plesiosorex* Pomel, 1854: Acta zool. cracov., 36 (2): 267-274.
- , 1994, Insectivora (Mammalia) from the Miocene of Bełchatów in Poland. II. Soricidae Fischer von Waldheim 1817: Acta zool. cracov., 36 (2): 267-274.
- , 1996, Insectivora (Mammalia) from the Miocene of Bełchatów in Poland. III. Dimylidae Schlosser 1887: Acta zool. cracov., 39 (1): 447-468.
- & KOWALSKI, K., 2001, The northernmost fossil locality of fruit bats (Megachiroptera, Mammalia) in the Miocene of Bełchatów (Poland): Acta zool. cracov., 44 (1): 59-63.
- STUCHLIK, L. & SZYNKIEWICZ, A., 1998, General geological situation and palynological investigations of the brown coal deposits. Tertiary-Quaternary (Pleistocene) floras of Bełchatów (Middle Poland) and several localities in southwestern Poland. The 5th European Paleobotanical and Palynological Conference, Cracow. Guide to excursion 2: 6-11.
- , ŁAŃCUCKA-ŚRODONIOWA, M. & ZASTAWIAK, E., 1990, Results of the till now palaeobotanical investigations of the Tertiary brown coal bed "Bełchatów" (Central Poland): Acta palaeobot., 30 (1-2): 259-305 [in Polish].

- STWORZEWICZ, E., 1994, New locality of Late Pliocene snail fauna from Przymiłowice 3 in the Cracow-Wieluń Upland, Poland: *Acta zool. cracov.*, 37 (2): 81-86.
- , 1995, Miocene land snails from Bełchatów (Central Poland), I: Cyclophoridae, Pomatiasidae (Gastropoda Prosobranchia): *Paläont. Z.*, 69 (1/2): 19-30.
- , 1999a, Miocene land snails from Bełchatów (Central Poland), III: Carychiinae (Gastropoda; Pulmonata: Ellobiidae): *Paläont. Z.*, 73 (3/4): 261-276.
- , 1999b, Miocene land snails from Bełchatów (Central Poland), IV: Pupilloidea (Gastropoda; Pulmonata). Systematic, biostratigraphic and palaeoecological studies: *Folia Malacol.*, 7 (3): 133-170.
- & SOŁTYS, Z., 1996, Miocene land snails from Bełchatów (Central Poland), II: Aciculidae (Gastropoda Prosobranchia): *Paläont. Z.*, 70 (1/2): 67-77.
- & SZYNKIEWICZ, A., 1989, Miocene land snails in the eastern part of coal mine Bełchatów: *Kwart. geol.*, 32: 655-662 [in Polish].
- SZYNKIEWICZ, A., 2000, Age of the brown coal deposits from the Bełchatów lignite mine (Central Poland): *Prz. Geol.*, 48: 1038-1044 [in Polish].
- VALDE-NOWAK, P., 1991, Studies in Pleistocene settlement in the Polish Carpathians: *Antiquity*, 65: 593-606.
- , MADEYSKA, T. & NADACHOWSKI, A., 1995, Obłazowa cave. Settlement, sediments and fossil fauna: *Pieniny – Przyroda i Człowiek*, 4 (5): 5-23 [in Polish].
- , NADACHOWSKI, A. & WOLSAN, M., 1987, Upper Palaeolithic boomerang made of a mammoth tusk in southern Poland: *Nature*, 329: 436-438.

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