Geological Quarterly, 2004, **48** (2): 193–198

The Miocene brachiopods from the silty facies of the intra-Carpathian Nowy Sącz Basin (Poland)

Maria Aleksandra BITNER and Andrzej KAIM

Bitner M. A. and Kaim A. (2004) — The Miocene brachiopods from the silty facies of the intra-Carpathian Nowy Sącz Basin (Poland). Geol. Quart., **48** (2): 193–198. Warszawa.

The micromorphic brachiopods have been found in the Miocene silty deposits of Kamienica Nawojowska in the intra-Carpathian Nowy Sącz Basin, southern Poland. The assemblage consists of two species *Argyrotheca cuneata* (Risso, 1826) and *A. cordata* (Risso, 1826). The presence of stenohaline brachiopods indicates Middle Miocene (?Badenian) age of the sediment. The preliminary sedimentological and palaeoecological analysis suggests that brachiopods and associated fauna might be transported basinward from a shallower setting.

Maria Aleksandra Bitner and Andrzej Kaim, Institute of Paleobiology, Polish Academy of Sciences, Twarda 51/55, PL-00-818 Warszawa, Poland; e-mail: bitner@twarda.pan.pl, kaim@twarda.pan.pl (received: October 27, 2003; accepted: March 23, 2004).

Key words: southern Poland, Carpathians, Nowy Sącz Basin, Miocene, brachiopods.

INTRODUCTION

Brachiopods are very common in various Middle Miocene shallow-water calcareous rocks (red-algal limestones, marls, clay) that crop out along the northern margin of the Carpathian Foredeep (Barczyk and Popiel-Barczyk, 1977; Popiel-Barczyk, 1977, 1980; Radwańska and Radwański, 1984; Bitner, 1990, 2002; Popiel-Barczyk and Barczyk, 1990). They are also known from similar deposits occurring along the southern margin, close to the edge of the Carpathians (Bitner and Pisera, 2000). In the sandy-silty deposits in the Polish Carpathians at Niskowa, 6 km west of Nowy Sącz (Fig. 1A), the presence of brachiopods was mentioned by Bałuk (1970) who found only one specimen determined by him as *Cistella* sp., the junior synonym of *Argyrotheca*. As neither illustrations nor descriptions were given, it is impossible to evaluate which species of *Argyrotheca* this specimen represented.

The presence of brachiopods in the dark grey sandy-silty deposits from the new fossiliferous locality at Kamienica Nawojowska of Nowy Sącz (Gonera and Styczyński, 2002) is of great interest because of atypical facies in which they occur, as well as the unique palaeogeographical position of these Miocene brachiopod-bearing deposits, far south from the present Carpathian margin (Fig. 1C).

MATERIAL AND METHODS

The four rock samples, about 30 kg each, were taken from the best-exposed part of the section (Fig. 1B). The samples were sieved (mesh size 0.375 mm) with hot water and washing powder. The fossils were manually picked under the binocular microscope.

The brachiopod material consists of 98 specimens (or of 106 valves while treating a complete shell as two valves; see also Table 1); most of them damaged to various degree. There are also many fragments of variable size. The articulated specimens are rare; we found only eight complete shells (~ 8% of the material). Most probably the breakage was caused by compactional fracturing of the specimens, which is commonly observed among calcareous shells from clay and silt deposits. Such fractured specimens crumble on the sieve when washed.

The most fossiliferous sample (KNS-4), taken from the bivalve-gastropod shell bed (Fig. 1E) provided more than half of our brachiopod material (see Table 1).

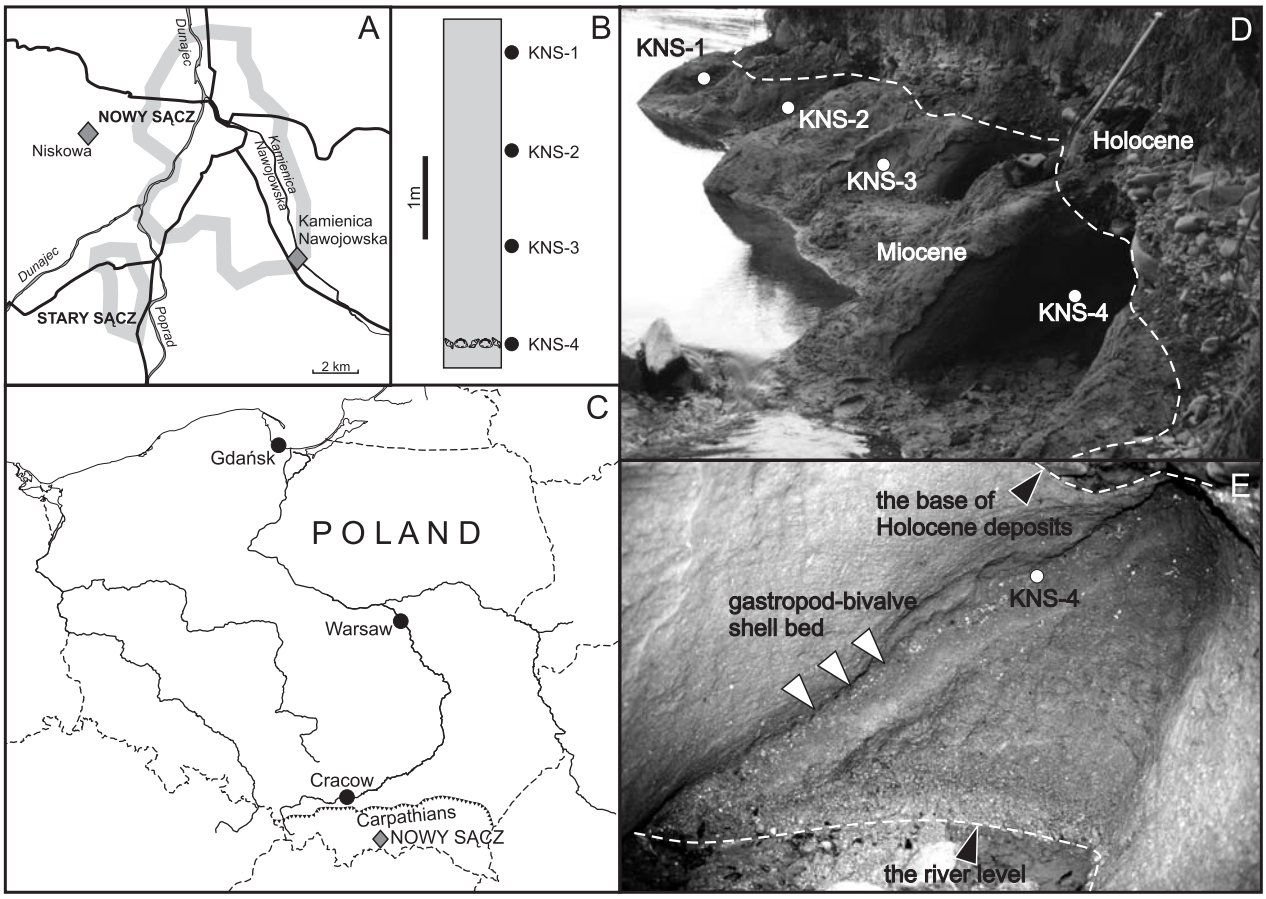

Fig. 1. The sketch maps indicating locality Kamienica Nawojowska of Nowy Sącz and documentation of the brachiopod-bearing section

A — Nowy Sącz region with localities Kamienica Nawojowska and Niskowa indicated; administrative boundaries of towns Nowy Sącz and Stary Sącz marked by wide grey lines; B — sampled part of the Kamienica Nawojowska section; C — sketch map of Poland with the overthrust of Carpathians and Nowy Sącz indicated; D — the photograph of the section as seen in the November 2002; E — close up of the basal part of the section; note the inclined gastropod-bivalve shell bed; the visible deep pit along the shell bed is artificially made by collectors of gastropods

The investigated material is housed at the Institute of Paleobiology, Polish Academy of Sciences, Warsaw, Poland, under the collection number ZPAL Bp.51.

GEOLOGICAL SETTING

The locality Kamienica Nawojowska is situated at the south-east limits of the town Nowy Sącz in the middle part of the Polish Carpathians, southern Poland (Fig. 1A, C).

The Miocene sandy silt and clay crop out for about 50 metres along the left bank of the Kamienica Nawojowska River. Those strata belong genetically to the Miocene Nowy Sącz Basin (Oszczypko *et al*., 1992). The silts are discordantly covered by the Holocene fluvial gravel (Fig. 1D). The section of the Miocene silt can be observed over a long stretch of the riverbank as small isolated spots of rock just at the water surface. As neither the stratification nor the characteristic horizons are visible at most of them, the succession of particular parts of the section is hard to establish. Potentially the strata can be

Table 1

Number of complete shells, ventral and dorsal valves of particular species in particular samples, and the relation of total number of valves of each sample to the whole brachiopod material

Samples	*Argyrotheca cuneata*			*Argyrotheca cordata*			Total number of valves	
	complete shells	ventral valves	dorsal valves	complete shells	ventral valves	dorsal valves	number	%
KNS-1	–	–	–	1	8	7	17	16.0
KNS-2	–	–	1	–	1	3	5	4.7
KNS-3	–	1	2	1	6	5	16	15.1
KNS-4	–	2	5	6	20	29	68	64.2

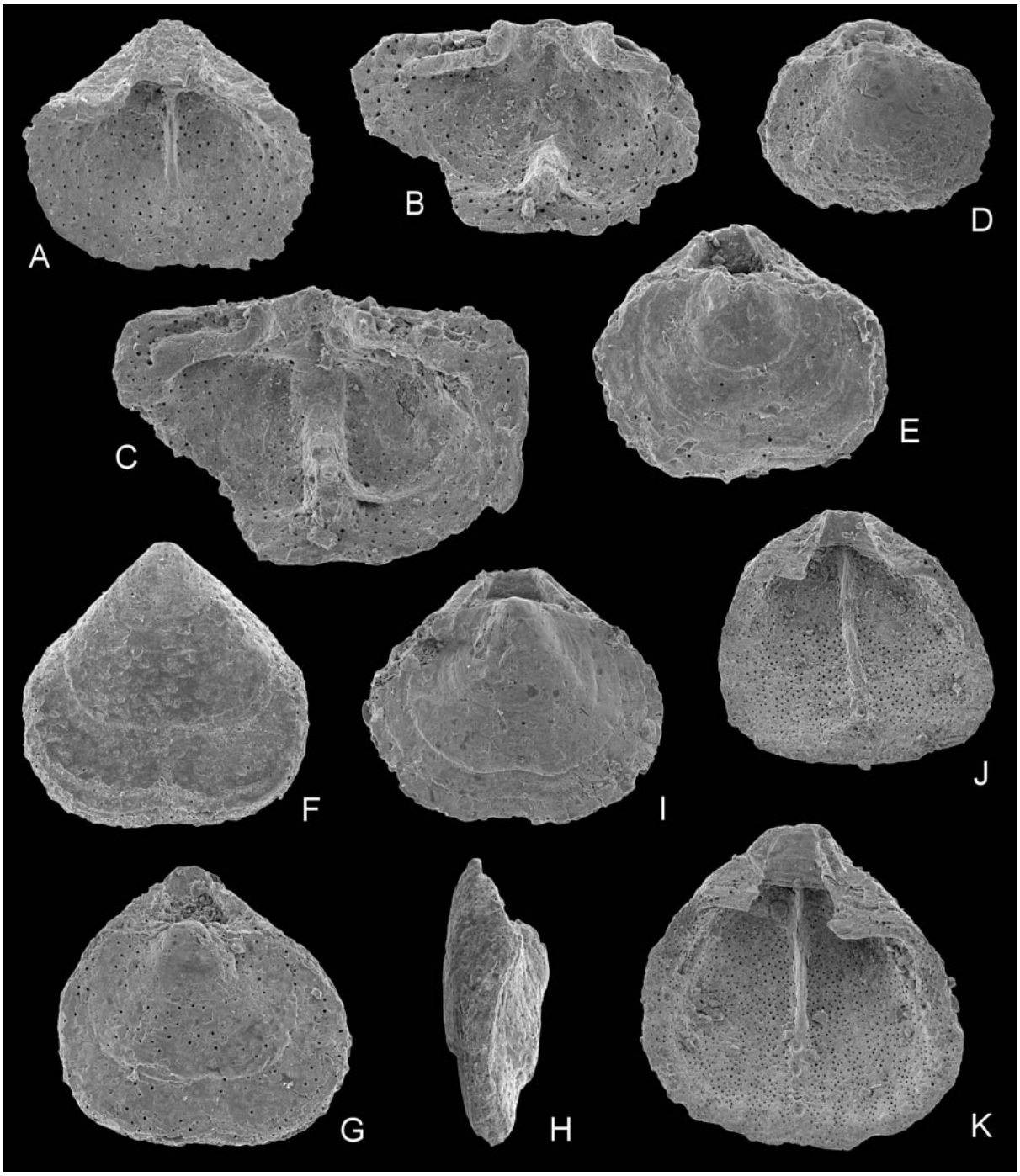

Fig. 2. **A**–**C** — *Argyrotheca cuneata* (Risso, 1826), Kamienica Nawojowska of Nowy Sącz: **A** — inner view of ventral valve, KNS-3, ZPAL Bp.51/1, x 37; **B** — inner view of dorsal valve, KNS-2, ZPAL Bp.51/2, x 37; **C** — inner view of dorsal valve, KNS-4, ZPAL Bp.51/3, x 32; **D**–**K** — *Argyrotheca cordata* (Risso, 1826), Kamienica Nawojowska of Nowy Sącz: **D** — dorsal view of complete immature specimen, KNS-3, ZPAL Bp.51/15, x 37; **E** — dorsal view of complete specimen, KNS-4, ZPAL Bp.51/14, x 37; **F**–**H** — ventral, dorsal and lateral views of complete specimen, KNS-1, ZPAL Bp.51/12, x 27.5; **I** — dorsal view of complete specimen, KNS-4, ZPAL Bp.51/13, x 32; **J**, **K** — inner views of two ventral valves, KNS-1, ZPAL Bp.51/16-17, x 18.5

folded and/or tectonically repeated that is why we sampled the material only from the best-exposed part of the section, where the stratification of the sediment is visible (Fig. 1E). This part of the section consists of about four metres of the sandy silt and clay dipping about 35° to the south. A thin, matrix-supported shell bed (Fig. 1E) underlies the sandy silt. The shell bed consists mainly of bivalves and gastropods. Many of large molluscs are preserved as disarticulated but not fragmented shells. This may be suggestive of low-energy transport, e.g. sediment flow down a submarine slope. The large shells disappear upwards and in the upper part of the section shells are dominated by small specimens that are hardly visible macroscopically. The amount of quartz grains also decreases towards the top of the section.

The outcrop was briefly described by Gonera and Styczyński (2002) who also provided the preliminary report of the encountered fauna. Based on foraminifers they postulate the age of the silts as Miocene (no detailed data available at that paper). The preliminary palaeoecological analysis of Gonera and Styczyński (2002) suggested a shallow-water nature of the faunal association. The taphonomy and the character of sediment may indicate that the shelly assemblage represent an exotic input of the shallow-water fauna transported basinward. Such a phenomenon is known in the peri- and intra-Carpathian Tertiary basins. Similar type of the redeposited fauna was described from the Eocene of Koniusza (Polish Eastern Carpathians) by Krach (1985).

The preliminary investigations of the co-occurring gastropods, conducted by the second author, have shown that the mollusc fauna is very similar to that described by Bałuk (1970) from Niskowa (6 kilometres west of Nowy Sącz, Fig. 1A), the type locality of the Niskowa Formation (Oszczypko *et al*., 1992). This formation was dated by Oszczypko *et al*. (1992) as the Early Sarmatian.

SYSTEMATIC PALAEONTOLOGY

Phylum **Brachiopoda** Duméril, 1806
Subphylum **Rhynchonelliformea** Williams, Carlson, Brunton, Holmer and Popov, 1996
Class **Rhynchonellata** Williams, Carlson, Brunton, Holmer and Popov, 1996
Order **Terebratulida** Waagen, 1883
Suborder **Terebratellidina** Muir-Wood, 1955
Superfamily **Megathyridoidea** Dall, 1870
Family **Megathyrididae** Dall, 1870
Genus *Argyrotheca* Dall, 1900
Type species: *Terebratula cuneata* Risso, 1826

Argyrotheca cuneata (Risso, 1826) (Fig. 2A–C)

2000 *Argyrotheca cuneata* (Risso); Bitner and Pisera, p. 9, pl. 1, figs. 1–7 (*cum syn*.).

M a t e r i a l . — One dorsal valve from the sample KNS-2; one ventral valve and two dorsal valves from the sample KNS-3; and two ventral valves, 5 dorsal valves and two fragments from the sample KNS-4. Some specimens are damaged.

R e m a r k s . — *Argyrotheca cuneata* is very rare in the investigated material. This species is, however, common in the Neogene of the Central Paratethys (Bitner, 1990, 1993; Popiel-Barczyk and Barczyk, 1990; Bitner and Pisera, 2000) and of the Mediterranean region (Davidson, 1870; Sacco, 1902) as well as in the Recent Mediterranean Sea (Logan, 1979; Logan and Noble, 1983; Brunton, 1988; Logan *et al*., 2002) and the Atlantic Ocean (Brunton and Curry, 1979; Logan, 1983, 1988, 1993). *A*. cf. *cuneata* was also found in the South Atlantic (Kowalewski *et al*., 2002).

The specimens under study, although smaller, correspond very well to those hitherto described. The shell is small (our largest specimen is a dorsal valve 1.4 mm long and 1.9 mm wide), transverse with the greatest width at hinge line, and ventri-biconvex with large, triangular foramen. The surface is covered with up to 6 single ribs, low and rounded in profile. In the dorsal valve, the sockets are widely spaced with prominent inner socket ridges (see Fig. 2B, C). The medium septum is short but high.

A. cuneata differs from *A. cordata* in its transverse outline and external ribbing, as well as the lack of tubercles on the internal side.

O c c u r r e n c e . — This species is known from the Miocene of Poland, Italy and Bulgaria. Its recent representatives are living in the Mediterranean Sea, the Lusitanian and Mauritanian regions of the Atlantic Ocean, as well as South Atlantic (see Bitner, 1990; Bitner and Pisera, 2000; Kowalewski *et al*., 2002).

Argyrotheca cordata (Risso, 1826) (Figs. 2D–K and 3A–E; Table 2)

2000 *Argyrotheca cordata* (Risso); Bitner and Pisera, p. 9–10, pl. 2, figs. 1–9 (*cum syn*.).

M a t e r i a l . — One complete specimen, 8 ventral valves and 7 dorsal valves from the sample KNS-1; one ventral valve and three dorsal valves from the sample KNS-2; one complete specimen, 6 ventral valves and 5 dorsal valves from the sample KNS-3; 6 complete specimens, 20 ventral valves and 29 dorsal valves from the sample KNS-4; and many fragments of various size (see also Table 1). Many specimens are damaged.

T a b l e 2

Measurements of *Argyrotheca cordata* (Risso, 1826)

Specimen number	Length [mm]	Width [mm]	Thickness [mm]
ZPAL Bp.51/12	1.6	1.5	0.6
ZPAL Bp.51/14	1.1	1.2	0.5
ZPAL Bp.51/16	2.2	2.2	–

R e m a r k s . — This species dominates in the investigated material. The studied specimens are entirely consistent with those from the Miocene (Dreger, 1889; Friedberg, 1921; Zilch, 1934; Barczyk and Popiel-Barczyk, 1977; Bitner, 1990, 1993; Popiel-Barczyk and Barczyk, 1990; Bitner and Pisera, 2000), as well as with extant ones from the Mediterranean Sea (Logan, 1979; Logan and Noble, 1983; Brunton, 1988) and Atlantic Ocean (Logan, 1983, 1988, 1993). This small, thin-shelled species is subtriangular in outline, smooth to covered with almost imperceptible ribs. The anterior commissure is slightly sulcate with a shallow sulcus present in both valves. Internally the dorsal valve has high inner socket ridges and a distinct cardinal process (Fig. 3). The median septum is high and triangular, beginning at about one-third of the length and sloping towards the margin with three serrations (Fig. 3C). The internal margin of both valves is covered with tubercles, always better visible on the brachial valve. The internal features, such as tubercles on

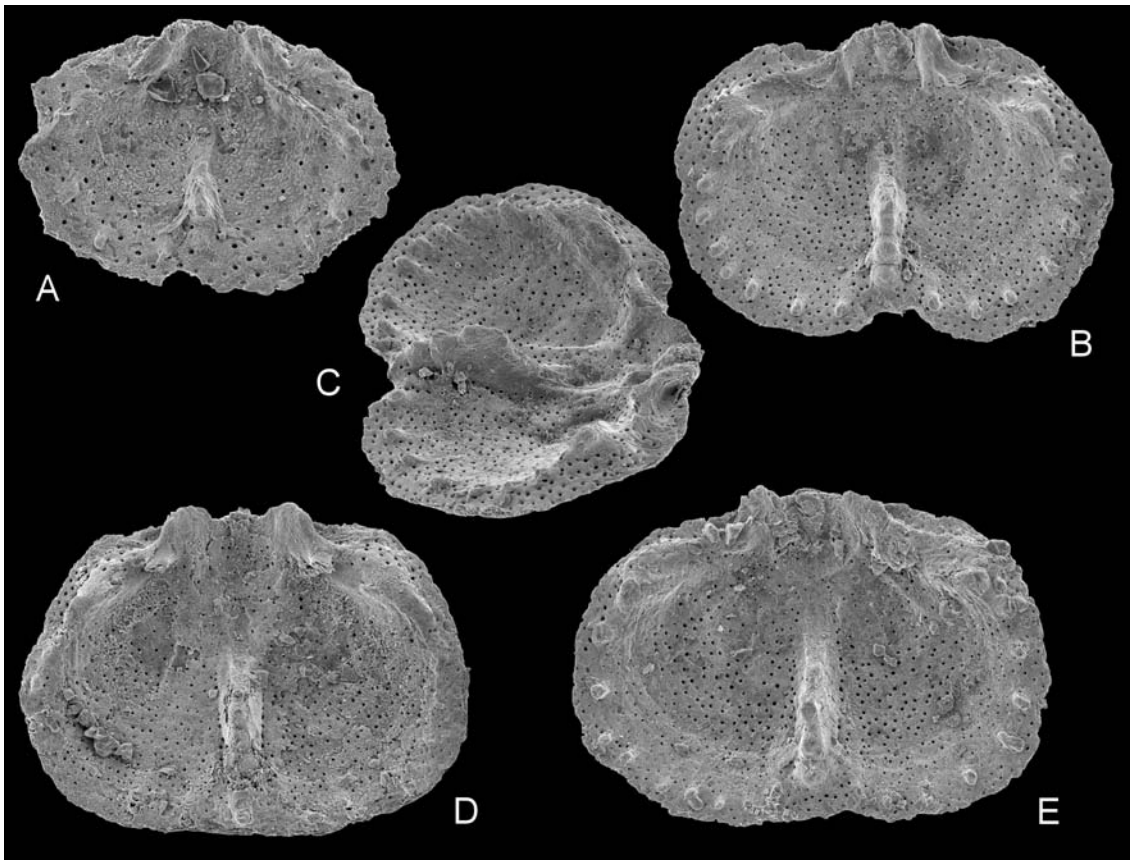

Fig. 3. **A**–**E** — *Argyrotheca cordata* (Risso, 1826), Kamienica Nawojowska of Nowy Sącz, KNS-1: **A** — inner view of dorsal valve of immature specimen, ZPAL Bp.51/18, x 40; **B**, **C** — inner and lateral views of dorsal valve, well visible tubercles on the margin and serrations on the septum, ZPAL Bp.51/19, x 25; **D**, **E** — inner views of dorsal valves, ZPAL Bp.51/20-21, x 25

the margin of both valves, make this species easily distinguishable from *A. cuneata*. It also differs externally from *A. cuneata* by its triangular outline and smooth shell surface.

O c c u r r e n c e . — In the fossil record *A. cordata* is known from the Miocene throughout Europe and from the Pliocene of Italy and Spain. Today it is living in the Mediterranean Sea and the Mauritanian region of the Atlantic Ocean (see Bitner, 1990; Bitner and Pisera, 2000).

DISCUSSION

The brachiopod assemblage from this newly recognised locality at Kamienica Nawojowska of Nowy Sącz, Polish Carpathians is of low diversity and contains only two micromorphic congeneric species, *Argyrotheca cuneata* (Risso, 1826) and *A. cordata* (Risso, 1826). The latter species dominates in the studied material and constitutes nearly 89% of the material. The brachiopods are found in all the samples. However, *A. cuneata* was absent in the sample KNS-1.

The genus *Argyrotheca* is an important, often dominant element in Middle Miocene brachiopod assemblages of the Paratethys. The composition of the assemblage from Kamienica Nawojowska is identical with that from Łychów, Roztocze Hills (Bitner, 1990), where two *Argyrotheca* species are present with a strong dominance of *A. cordata*. The fossil assemblage from Łychów is interpreted as a shallow water kelp assemblage (Hoffman *et al*., 1978). In the oyster bioherm at Zdziechowice (Bitner, 1990) the brachiopod assemblage is also composed of those two species, however, a dominating species is *A. cuneata*. The brachiopod assemblages at Ohrid, Bulgaria (Bitner, 1993) and from the outcrop N1 at Niechobrz (Bitner and Pisera, 2000) have a very similar composition to that from Kamienica Nawojowska. Among *Argyrotheca* species, *A. cordata* dominates, and the only difference is in the additional presence of two other species, however, in negligible amounts (at Ohrid 7.8% and at Niechobrz 1.5%). The species composition of the brachiopod assemblage occurring at Radwanówka, Roztocze Hills (Bitner, 1990) is also similar. Similarly as at Łychów, the fossil assemblage at Radwanówka is interpreted as a shallow water one, structured by the presence of submarine flora (Pisera, 1985).

All this suggests that also fauna at Kamienica Nawojowska is of shallow water nature, the fact additionally supported by preliminary palaeoecological studies of Gonera and Styczyński (2002). Recent brachiopods have a very wide depth range, and thus are difficult to use in the bathymetrical interpretations (see discussion in Bitner, 1990, and Bitner and Pisera, 2000). The age of the brachiopod-bearing deposits has not been precisely determined yet. However, the presence of stenohaline brachiopods, which have never been reported from the Upper Miocene

(Sarmatian), points to the Middle Miocene (?Badenian) age. Sedimentological data and palaeoecological analysis may suggest that the brachiopods and associated molluscs could have been brought down into the deeper part of the basin from a shallower setting.

CONCLUSIONS

1. Two micromorphic brachiopods, *Argyrotheca cuneata* (Risso) and *A. cordata* (Risso) have been recognised in the Miocene silty deposits of Kamienica Nawojowska, near Nowy Sącz, Polish Carpathians.

2. The brachiopod assemblages of identical or very similar species composition are reported from Łychów, Radwanówka and Zdziechowice in the Roztocze Hills, from Niechobrz, southern Poland and from Ohrid, Bulgaria. All fossil assemblages from those localities were interpreted as shallow water.

3. The presence of stenohaline brachiopods suggests the Middle Miocene (?Badenian) age.

4. Preliminary sedimentological and taphonomical analysis suggests that the shelly assemblage from Kamienica Nawojowska might be transported basinward from a shallower setting.

Acknowledgements. We wish to express our thanks to Dr. M. Kowalewski (Virginia Tech, Blacksburg, Virginia) who reviewed the paper, supplied valuable comments and improved the language. The samples were washed and brachiopods were picked by Mrs. A. Bakuła (Institute of Paleobiology, Warsaw). The SEM micrographs were taken in the SEM laboratory of the Institute of Paleobiology (Warsaw) using *Philips XL-20* scanning microscope.

REFERENCES

BAŁUK W. (1970) — The Lower Tortonian at Niskowa near Nowy Sącz, Polish Carpathians (in Polish with English summary). Acta Geol. Pol., **20** (1): 101–157.

BARCZYK W. and POPIEL-BARCZYK E. (1977) — Brachiopods from the Korytnica Basin (Middle Miocene; Holy Cross Mountains, Poland). Acta Geol. Pol., **27** (2): 157–167.

BITNER M. A. (1990) — Middle Miocene (Badenian) brachiopods from the Roztocze Hills, south-eastern Poland. Acta Geol. Pol., **40** (3–4): 129–157.

BITNER M. A. (1993) — Middle Miocene (Badenian) brachiopods from coral reefs of north-western Bulgaria. Acta Geol. Pol., **43** (1–2): 147–155.

BITNER M. A. (2002) — Size-frequency distributions of Miocene micromorphic brachiopods: interpretation tool for population dynamics. P.S.Z.N. Marine Ecol., **23** (1): 19–30.

BITNER M. A. and PISERA A. (2000) — Brachiopod fauna from the Middle Miocene deposits of Niechobrz, south-eastern Poland. Tertiary Res., **20** (1–4): 7–15.

BRUNTON C. H. C. (1988) — Some brachiopods from the eastern Mediterranean Sea. Israel J. Zool., **35**: 151–169.

BRUNTON C. H. C. and CURRY G. B. (1979) — British brachiopods. Synopses of the British Fauna (New Series), **17**: 1–64.

DREGER J. (1889) — Die tertiären Brachiopoden des Wiener Beckens. Beiträge zur Paläont. Oesterreich-Ungarns, **7** (2): 179–192.

DAVIDSON T. (1870) — On Italian Tertiary brachiopoda. Geol. Mag., **7** (8–10): 359–370, 399–408, 460–466.

FRIEDBERG W. (1921) — Les brachiopodes miocènes de la Podolie Occidentale. Prace Nauk. Uniw. Pozn., Sekcja Mat.-Przyr., **2**: 1–20.

GONERA M. and STYCZYŃSKI M. (2002) — New locality with Miocene marine sediments in the Nowy Sącz Basin — a preliminary information (in Polish). Prz. Geol., **50** (8): 669–670.

HOFFMAN A., PISERA A. and STUDENCKI W. (1978) — Reconstruction of a Miocene kelp-associated macrobenthic ecosystem. Acta Geol. Polon., **28** (3): 377–388.

KOWALEWSKI M., SIMÕES M. G., CARROLL M. and RODLAND D. L. (2002) — Abundant brachiopods on a tropical, upwelling-influenced shelf (Southeast Brazilian Bight, South Atlantic). Palaios, **17** (3): 277–286.

KRACH W. (1985) — The Eocene mollusc fauna from Koniusza near Przemyśl (Polish Eastern Carpathians) (in Polish with English summary). Ann. Soc. Geol. Pol., **55** (1–2): 139–190.

LOGAN A. (1979) — The recent Brachiopoda of the Mediterranean Sea. Bull. Inst. Océanogr. Monaco, **72** (1434).

LOGAN A. (1983) — Brachiopoda collected by CANCAP I-III expeditions to the south-east North Atlantic. 1976–1978. Zool. Meded. Leiden, **57** (18): 165–189.

LOGAN A. (1988) — Brachiopoda collected by CANCAP IV and VI expeditions to the south-east North Atlantic. 1980–1982. Zool. Meded. Leiden, **62** (5): 59–74.

LOGAN A. (1993) — Recent brachiopods from the Canarian-Cape Verdean region: diversity, biogeographic affinities, bathymetric range and life habits. Courier Forsch.-Inst. Senckenberg, **159**: 229–233.

LOGAN A., BIANCHI C. N., MORRI C., ZIBROWIUS H. and BITAR G. (2002) — New records of recent brachiopods from the Eastern Mediterranean Sea. Ann. Mus. Civ. Stor. Nat. "G. Doria", **94**: 407–418.

LOGAN A. and NOBLE J. P. A. (1983) — Recent brachiopods from Malta. Central Medit. Natur., **1** (2): 33–42.

OSZCZYPKO N., OLSZEWSKA B., ŚLĘZAK J. and STRZĘPKA J. (1992) — Miocene marine and brackish deposits of the Nowy Sącz Basin (Polish Western Carpathians) — new lithostratigraphic and biostratigraphic standards. Bull. Pol. Acad. Sc., Earth Sc., **40** (1): 83–96.

PISERA A. (1985) — Paleoecology and lithogenesis of the Middle Miocene (Badenian) algal-vermetid reefs from the Roztocze Hills, south-eastern Poland. Acta Geol. Pol., **35** (1–2): 89–155.

POPIEL-BARCZYK E. (1977) — A new locality of Miocene brachiopod fauna in Roztocze region (in Polish with English summary). Prz. Geol., **25** (5): 246–248.

POPIEL-BARCZYK E. (1980) — Brachiopod genus *Cryptopora* Jeffreys from the Miocene deposists of the Lublin Upland. Acta Geol. Pol., **30** (1): 110–120.

POPIEL-BARCZYK E. and BARCZYK W. (1990) — Middle Miocene (Badenian) brachiopods from the southern slopes of the Holy Cross Mountains, Central Poland. Acta Geol. Pol., **40** (3–4): 159–181.

RADWAŃSKA U. and RADWAŃSKI A. (1984) — A new species of inarticulate brachiopods, *Discinisca polonica* sp. n., from the Korytnica Basin (Middle Miocene; Holy Cross Mountains, Central Poland). Acta Geol. Pol., **34** (3–4): 253–269.

SACCO F. (1902) — I Brachiopodi dei terreni terziarii del Piemente e della Liguria. Clausen. Torino.

ZILCH A. (1934) — Zur Fauna des Mittel-Miociäns von Kostej (Banat); Typus Bistimmung und Tafeln zu O. Boettger's Bearbeitungen. Senckenbergiana, **16**: 193–302.