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The ostracode genus *Xylocythere* MADDOCKS & STEINECK, 1987, from the Middle Miocene of the Fore-Carpathian Depression, southern Poland (Central Paratethys), and its biogeographic significance

ABSTRACT: A new species of the ostracode, *Xylocythere carpathica* sp.n., is described from the upper part of the Middle Miocene (*i.e.* the Upper Badenian, corresponding to the Serravallian) of the Fore-Carpathian Depression in southern Poland. This new ostracode species as well as the associated microfossils (other ostracodes, foraminifers and bolboforms), is indicative of the Middle Miocene influence of deep oceanic (including Atlantic) waters into the Central Paratethys.

INTRODUCTION

The deep-water (outer neritic/epibathyal, *i.e.* of the depth about 200 m) ostracodes are recognized in the upper part of the Middle Miocene, *i.e.* the Upper Badenian (corresponding to the Serravallian) of the Fore-Carpathian Depression, in the Jamnica S-119 borehole (depth 251.3 m), situated near Tarnobrzeg, in southern Poland (*see* Text-fig. 1). Among these ostracodes there occurs a species representing *Xylocythere*, the genus which is so far unknown in the pre-Middle Miocene of Europe (including the whole Mediterranean). This species is determined as *Xylocythere carpathica* sp.n. The genus *Xylocythere* is mainly deep- and cold-water ostracode (MADDOCKS & STEINECK 1987, STEINECK & *al.* 1990, COLES & *al.* 1990, CORRÈGE 1993), and seems to be particularly important for the interpretation of the Middle Miocene Paratethyan environment and for the Middle Miocene paleobiogeography.

The newly established species *Xylocythere carpathica* sp.n. occurs in the silty sediment (only an about 5-gram washed sample residuum was available), in the section showing very instable lithology as well as the microfossils content. Except *Xylocythere carpathica* sp.n. (*see* Pl. 1, Figs 1-3), represented by

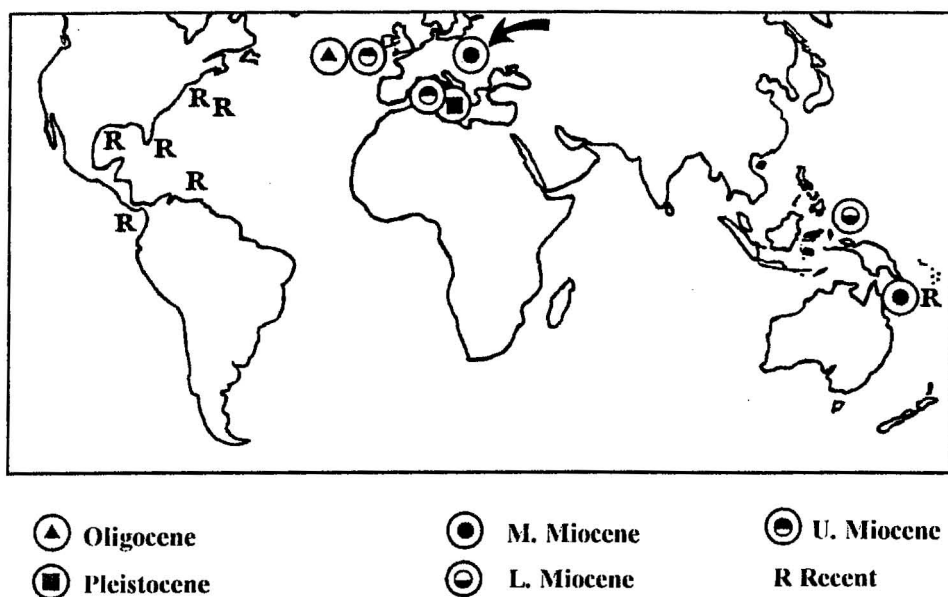


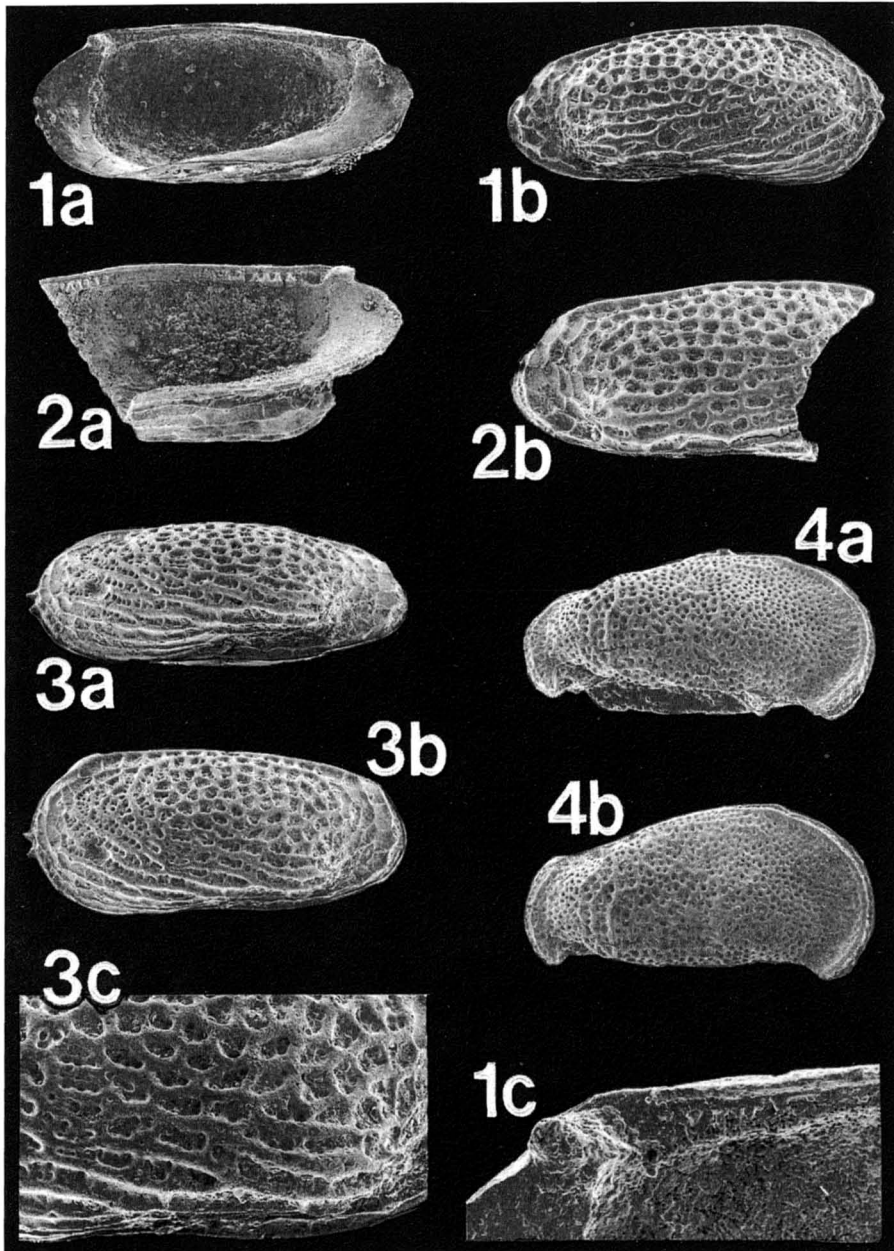
Fig. 1. Distribution of Recent and fossil representatives of the genus *Xylocythere*; given after STEINECK & al. (1990), supplemented by the present author. Arrow indicates location of the Jamnica borehole near Tarnobrzeg, southern Poland, in the Fore-Carpathian Depression

four specimens, there occur such ostracode species as: *Cluthia miocenica* SZCZUCHURA (see Pl. 1, Fig. 4; 1 adult specimen), *Henryhowella asperrima* (REUSS) (see Pl. 2, Figs 2-3; 2 adult damaged valves and 6 badly preserved juvenile valves), *Krithe* sp. (see Pl. 3, Figs 2-6; some remnants of the adult as well as juvenile valves and 4 complete, probably juvenile carapaces), *Argilloecia* sp. (see Pl. 2, Figs 4-6; some remnants of the adult as well as juvenile valves, and 5 complete juvenile valves), *Sagmatocythere* cf. *tenuis* (CIAMPO) (see Pl. 2, Fig. 1; 1 adult valve), *?Semicytherura* sp. (see Pl. 3, Fig. 1; 1 juvenile valve), *Cytheropteron* sp. (one juvenile valve), and few badly preserved, not identified

PLATE 1

Ostracodes from the Jamnica borehole (depth 251.3 m); Upper Badenian

- 1-3 – *Xylocythere carpathica* sp.n.: 1 – adult right valve, ZPAL O. XXXVIII/1, holotype; 1a – internal view, × 115; 1b – external view, × 110, 1c – details of the anterior part of the hinge margin, × 400; 2 – slightly damaged adult right valve, ZPAL O. XXXVIII/2; 2a – internal view, × 130; 2b – external view, × 135; 3 – adult left valve, ZPAL O. XXXVIII/3; 3a – lateroventral external view, × 114; 3b – external view, × 114; 3c – enlarged posterior lateroventral part of valve, to show details of ornamentation, × 400
- 4 – *Cluthia miocenica* SZCZUCHURA: somewhat damaged adult carapace, ZPAL O. XXXVIII/4; 4a – lateroventral view of the right side, × 140; 4b – lateral view of the right side, × 140



specimens (see Pl. 3, Fig. 7). The high ratio of the juvenile forms in the studied ostracode assemblage suggests its rather quiet environment and its *in situ* deposition. The ostracodes are herein associated with numerous bolboforms as well as foraminifers.

The material described is housed at the Institute of Paleobiology of the Polish Academy of Sciences in Warsaw (abbreviated *ZPAL*).

SYSTEMATIC ACCOUNT

Family *Cytheruridae* G.W. MÜLLER, 1894

Subfamily *Eucytherurinae* PURI, 1974

Genus *Xylocythere* MADDOCKS & STEINECK, 1987

Xylocythere carpathica sp.n.

(Pl. 1, Figs 1-3)

HOLOTYPE: The specimen No. ZPAL O. XXXVIII/1, presented in Pl. 1, Fig. 1.

PARATYPES: Specimens Nos. ZPAL O. XXXVIII/2 and ZPAL O. XXXVIII/3, presented in Pl. 1, Fig. 2 and Pl. 1, Fig. 3.

TYPE LOCALITY: SE Poland, Fore-Carpathian Depression, Jamnica S-119 borehole near Tarnobrzeg, depth 251.3 m.

TYPE HORIZON: Upper Badenian (upper part of the Middle Miocene).

DERIVATION OF THE NAME: Lat. *carpathica*, as referred to the region of the Fore-Carpathian Depression.

DIAGNOSIS: A *Xylocythere* with prominent ribs best developed in the anterolateral and anteroventral parts of valve, radiating from the lateroventral ridge; centrolateral part coarsely reticulated, with polygonal meshes.

MATERIAL: Two adult left valves (one damaged) and two adult right valves (one damaged).

DIMENSIONS (in mm):

	holotype ZPAL O. XXXVIII/1 adult right valve	paratype ZPAL O. XXXVIII/3 adult left valve
Length	0.47	0.44
Height	0.23	0.23
Width	0.19	0.20

DESCRIPTION: The valve of the size and the general external as well as internal appearance typical of *Xylocythere*, as described by MADDOCKS & STEINECK (1987). Lateral side of the valve distinctly reticulated, with polygonal meshes best developed in the central part of the valve, and bordered above by a weak rib parallel to the hinge margin. Meshes with cluster pores and the secondary ornamentation. Frontally there occur irregular ribs, tending to be parallel to the anteroventral margin, radiating and branching from the lateroventral ridge; this latter is restricted to the posterior part of the valve where it consists (see Pl. 1, Fig. 3c) of tree short, parallel and almost horizontally arranged ribs of which the middle and upper ones bear distinct, singular pore-conuli. Ventral side flattened, weakly reticulated posteriorly, while covered by ribs anteriorly. Two or three short denticles occur sometimes on the anterior margin at its mid-height. Hinge merodont-entomodont, nearly straight; in the right valve it consists of the terminal teeth and the

median, distinctly crenulated (except the middle part) groove, which is terminated at both ends by sockets. Duplication wide at both ends of valve. Inner margin regular, weakly bent.

VARIATION: Among the collected specimens it is expressed by the details of ornamentation, mostly the shape and arrangement of meshes.

REMARKS: The type of ornamentation in *Xylocythere carpathica* sp.n. is somewhat similar to that in *Xylocythere* sp. 2, described by STEINECK & al. (1990) from the Middle Miocene of the southeastern Pacific. In comparison with this latter species the studied specimens display not arched dorsal margin, lateral reticulation developed mostly in their central part, and the better pronounced frontal ribs.

GEOGRAPHIC DISTRIBUTION AND ENVIRONMENTAL SIGNIFICANCE OF THE STUDIED OSTRACODES AND ASSOCIATED MICROFOSSILS

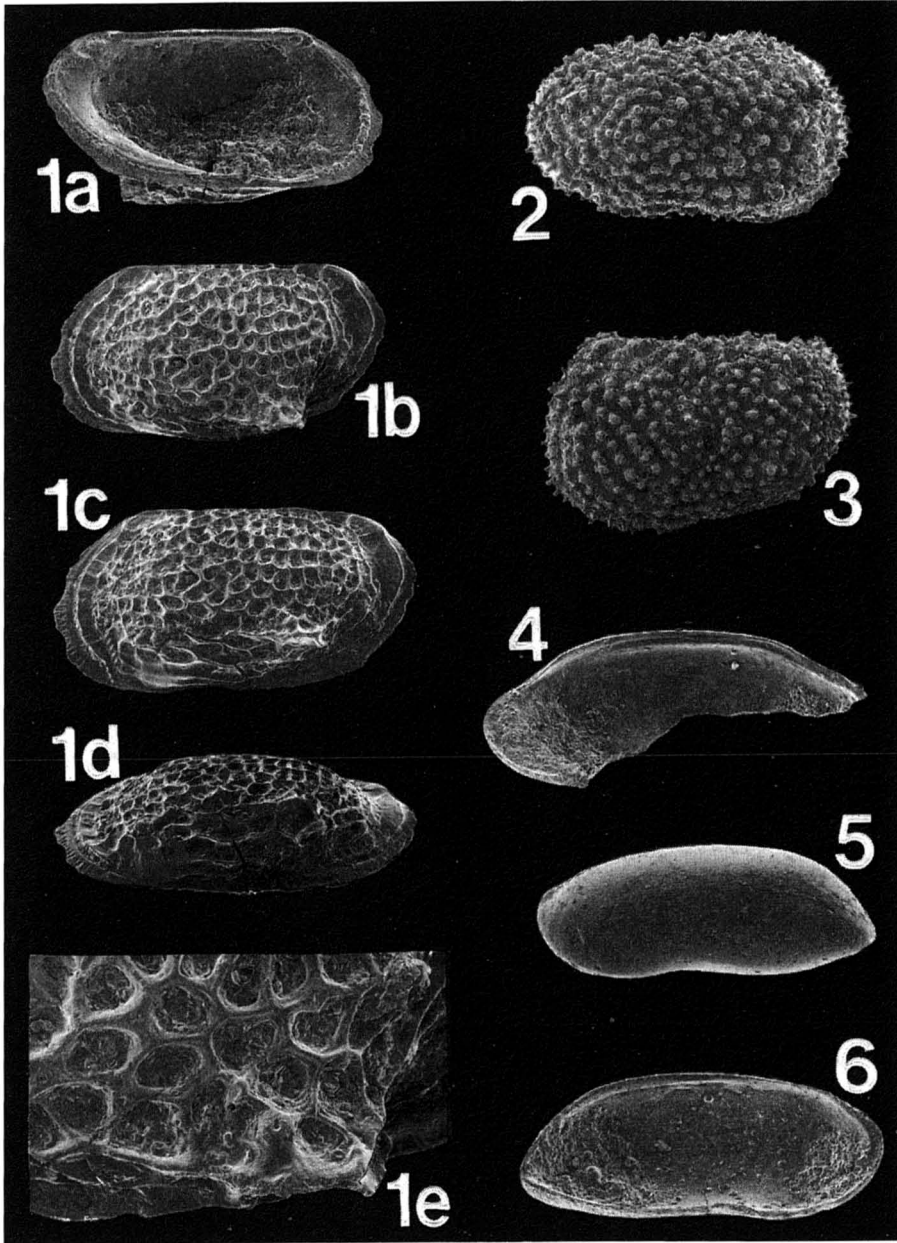
THE GENUS *XYLOCYTHERE*

The genus *Xylocythere* belongs to the xylophile ("wood-liking"), deep-water ostracodes, which are generally represented by rare (sometimes single) individuals and which are known up to now from a few regions of both hemispheres, from the Oligocene up to Recent. Besides the Middle Miocene of the Fore-Carpathian Depression in Poland, the fossil representatives of that genus occur in the Upper Oligocene and the Upper Miocene of the northeastern Atlantic, Lower Miocene of the Central equatorial Pacific, Middle Miocene of the southwestern Pacific (STEINECK & al. 1990), and the Upper Miocene as well as the Lower Pleistocene of the Mediterranean region in Italy (COLALONGO & PASINI 1980, CIAMPO 1985, STEINECK & al. 1990; see Text-fig. 1 herein). Interesting is, that the fossil *Xylocythere* representatives are known mostly of the deep-sea drillings, from sediments below the present water depths from 1430 to 4536 m. In the Upper Miocene as well as the Pleistocene of Italy

PLATE 2

Ostracodes from the Jamnica borehole (depth 251.3 m); Upper Badenian

- 1 – *Sagmatocythere* cf. *moncharmonti* (CIAMPO): adult left valve, ZPAL O. XXXVIII/5; 1a – internal view, × 115; 1b – external view, × 115; 1c – somewhat oblique external view, × 123; 1d – lateroventral external view, × 120; 1e – enlarged posterior lateroventral part of valve, to show details of ornamentation, × 500
- 2-3 – *Henryhowella asperrima* (REUSS): 2 – juvenile right valve, ZPAL O. XXXVIII/6, external view, × 75; 3 – juvenile left valve, ZPAL O. XXXVIII/7, external view, × 56
- 4-6 – *Argilloecia* sp.: 4 – damaged adult right valve, ZPAL O. XXXVIII/8, internal view, × 80; 8 – juvenile left valve, ZPAL O. XXXVIII/9, × 98; 10 – juvenile left valve, ZPAL O. XXXVIII/10, internal view, × 123



they cooccur with a deeper-water ostracodes; CRONIN (1983) suggested the upper bathyal origin of the Pleistocene ostracode assemblage from Calabria, containing *Xylocythere producta*, and described by COLALONGO & PASINI (1980). The Recent occurrence of *Xylocythere* is recorded from the SW Pacific (CORRÈGE 1993), from the depth below 2000 m, as well as the areas along the northwestern coasts of the South America and the southeastern coasts of the North America, from the depth below 1500 m.

CORRÈGE (1993), working on Recent ostracodes of the western part of the South Pacific (western Coral Sea), distinguished four ostracode assemblages of different bathymetric ranges, and stated that this ostracode bathymetric zonation depends on the water masses properties, mostly temperature, food supply and dissolved oxygen content; moreover, he found *Xylocythere* in the deepest water masses in the studied area, *i.e.* cold and situated below the oxygen minimum zone and below the bathyal thermocline.

OTHER OSTRACODES

Within the studied ostracode assemblage, besides *Xylocythere*, the most important, especially as the environmental and biogeographic markers, are: *Henryhowella asperrima* (REUSS), *Cluthia miocenica* SZCZECURA, the representatives of the genera *Krithe*, *Cytheropteron*, and *Argilloecia*. The genera *Semicytherura* and *Sagmatocythere* have a wide environmental (bathymetric and thermic) tolerance, *Sagmatocythere tenuis* (CIAMPO), however, in the Upper Miocene of Italy (*see* CIAMPO 1980, BENSON 1990) coexists with a deeper-water ostracodes. The present author's analysis (SZCZECURA 1994) of the spatiotemporal distribution of *Henryhowella asperrima* (REUSS) as well as that of *Cluthia miocenica* SZCZECURA and, to some extent, *Krithe*, allowed to refer these ostracodes to the psychrospheric fauna and to suggest the Middle Miocene influence of the Atlantic deep and cold waters into the Central Paratethys. The genera *Argilloecia* and *Cytheropteron* prefer also deeper and cold waters (PEYPOUQUET 1980, STEINECK 1983, HARTEN & DROST 1988, COLES & *al.* 1990, BARRA & *al.* 1955); it seems worth noting that *Cluthia*, *Henryhowella*, *Argilloecia*, *Cytheropteron*, *Krithe*, and *Semicytherura* representatives are associated with *Xylocythere* in the deepest water masses, below the Antarctic Intermediate Water, in the southwestern Pacific (CORRÈGE 1993). Thus, all these ostracodes may serve as the additional indicators of the oceanic cold and presumably at least slightly low-oxygen waters.

BOLBOFORMS (CHRYSOPHYTA?)

The only recognized species of bolboforms, abundantly present in the studied sample, is *Bolboforma badenensis* SZCZECURA (*see* Pl. 3, Figs 12-13). It is an index form for the Upper Badenian of the Central Paratethys, although it

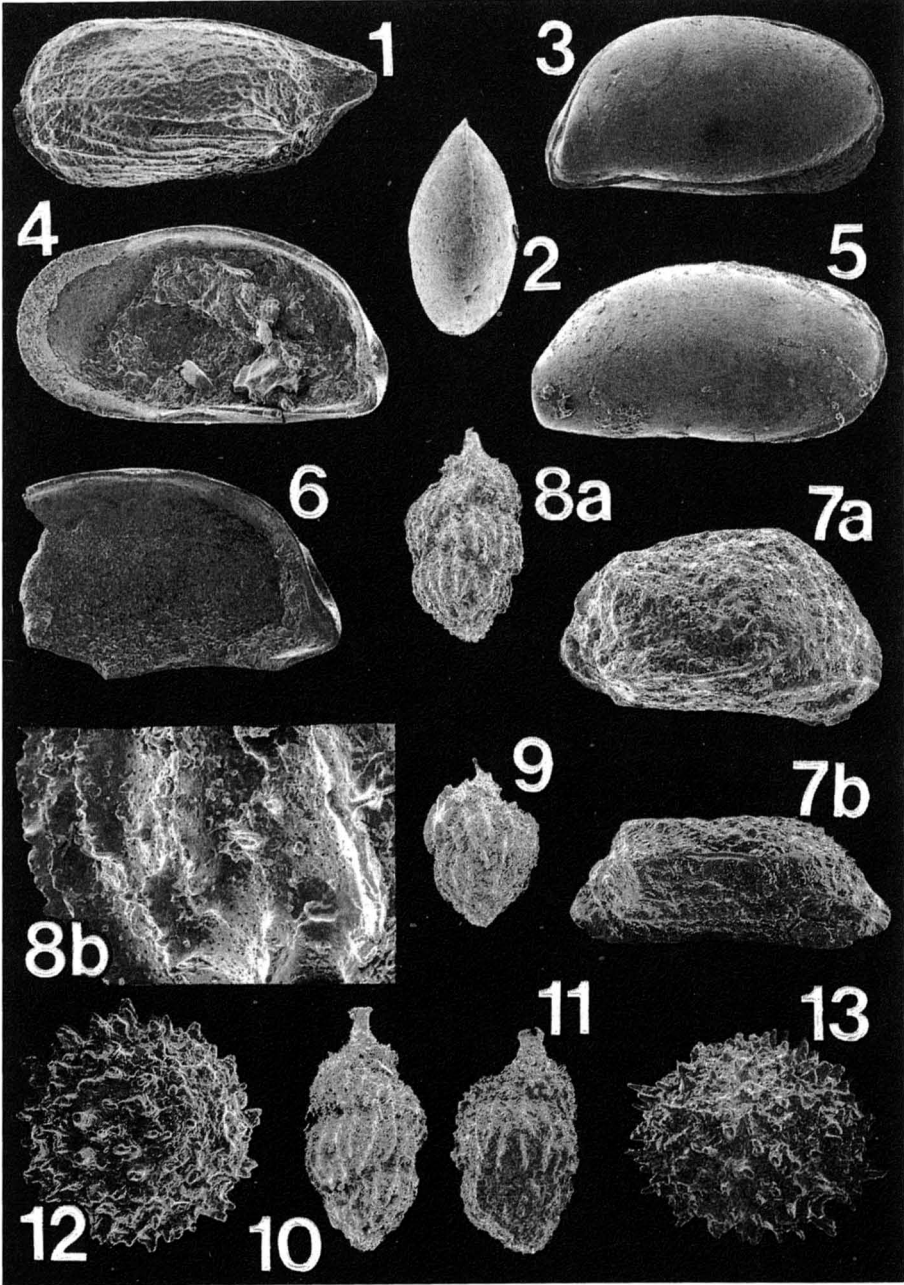
is also known from the upper part of the NN 6 Zone and NN 6/7 Zone, *i.e.* including the upper part of the Middle Badenian and the Upper Badenian, in the Vienna Basin (SZCZUCHURA 1982, SPIEGLER & RÖGL 1992). POAG & KAROWE (1987) described *Bolboforma badenensis* SZCZUCHURA from the Lower and Middle Miocene of the western margin of the North Atlantic Ocean. In the global range chart of *Bolboforma*, however, this species ranges (*see* SPIEGLER & VON DANIELS 1991) from the Middle Miocene to the lower part of the Upper Miocene, *i.e.* from the upper part of NN 4 Zone up to the top of NN 10 Zone. According to these authors *Bolboforma badenensis* SZCZUCHURA occurs in the Middle Miocene of the Central Paratethys and the Mediterranean, on both sides of the North Atlantic, on the western side of the South Atlantic, and in the southern Indian Ocean. Interesting to note are the various ranges of the discussed species in the mentioned areas, and especially the earlier appearance of *Bolboforma badenensis* in the oceans (including the Atlantic Ocean) than in the Mediterranean and in the Central Paratethys.

POAG & KAROWE (1987) suggested that *Bolboforma* preferred a bathyal habitat and that the number of its species and specimens decreased in sublittoral and abyssal environments. Similar opinions concerning the paleoenvironmental conditions of bolboforms, *i.e.* preference for the open-ocean (bathyal) and temperate waters were expressed also by MURRAY (1986), KENNETT & KENNETT (1990), and DIESTER-HAASS (1995). In the present author's opinion, the above mentioned environmental parameters (mostly the depth and temperature) seem to be the most important for the spatiotemporal distribution of bolboforms, especially their particular morphotypes ("taxa") and seem to be responsible for their various ranges in the Paleogene and Neogene deposits all over the world.

PLATE 3

Ostracodes, bolboforms and foraminifers from the Jamnica borehole (depth 251.3 m); Upper Badenian

- 1 – ?*Semicytherura* sp.: juvenile right valve, ZPAL O. XXXVIII/11, external view, × 118
 2-6 – *Krithe* sp.: 2 – ?juvenile carapace, ZPAL O. XXXVIII/12, dorsal view, × 94; 3 – ?juvenile carapace, ZPAL O. XXXVIII/13, lateral view of the right side, × 115; 4 – juvenile right valve, ZPAL O. XXXVIII/14, internal view, × 112; 5 – juvenile right valve, ZPAL O. XXXVIII/15, external view, × 90; 6 – slightly damaged ?adult right valve, ZPAL O. XXXVIII/16, internal view, × 85
 7 – Specifically indeterminable juvenile right valve, ZPAL O. XXXVIII/17; 7a – external view, × 165; 7b – external lateroventral view, × 165
 8-11 – *Uvigerina peregrina* CUSHMAN group: 8a, 9-11 – side view, ZPAL F. XLI/1-4 (× 60, × 60, × 65, × 63, × 60 respectively); 8b – details of ornamentation, ZPAL F. XLI/3, × 420
 12-13 – *Bolboforma badenensis* SZCZUCHURA, side views, ZPAL V. XXIII/1, 2 (× 210, × 200 respectively)



FORAMINIFERS

The benthic foraminifers are represented by the calcareous as well as the arenaceous forms. These latter consist of the numerous, simple ("primitive") and mostly fragmented tests belonging to astrorhizids; there are, however, also hormosinids, textularids and lituolids. Such an abundance of the arenaceous foraminifers, especially of their simple forms, is characteristic of the oxygen-deficient environments (BOLTOVSKOY & WRIGHT 1976, MOORKENS 1991).

Within the counted calcareous benthic forms (about 300 specimens), the following species were distinguished (arranged according to their percentage abundance): *Cassidulina laevigata* D'ORBIGNY (syn. *C. laevigata carinata* SILVESTRI), *Uvigerina romaniaca* PAPP & SCHMID (= *U. peregrina* CUSHMAN group in the present paper; see Pl. 3, Figs 8-11), ?*Spirosigmoilina* sp., *Sphaeroidina bulloides* D'ORBIGNY, *Bulimina aculeata* D'ORBIGNY, *Gyroidina* cf. *umbonata* D'ORBIGNY, *Gyroidina* cf. *soldanii* D'ORBIGNY, *Cibicides* sp., *Hanzawaia boueana* D'ORBIGNY, *Trifarina angulosa* (WILLIAMSON), *Heterolepa dutemplei* (D'ORBIGNY), *Pullenia* sp. div. (including *P. bulloides* D'ORBIGNY), *Melonis pompilioides* FICHTEL & MOLL, *Uvigerina* sp., and *Cibicides ungerianus* D'ORBIGNY. The extensive literature concerning the significance of benthic, fossil and Recent, foraminifers for the interpretation of their environment allows to suppose that this assemblage is evidently lacking the typical shallow-water dwelling forms and it represents, at least, outer neritic/epibathyal environmental conditions. Most of these foraminiferal species are known of the Middle Miocene of the Pacific, Indian and Atlantic oceans, where they preferred the deeper-water (bathyal) conditions (see e.g. BOLTOVSKOY 1984, VAN MORKHOVEN & al. 1986). Various authors (e.g. WOODRUFF 1985, MURRAY 1991, BOLTOVSKOY & al. 1992) found a relation between the water masses and benthic foraminiferal assemblages, and stated that the distribution of these foraminifers depends on migration of water masses. There are, however, various opinions concerning the water masses distinguished in the past oceans and their foraminiferal (including planktic as well as benthic) contents.

Among the recognized foraminifers, the *Uvigerina peregrina* CUSHMAN group (being a prominent component of the assemblage) seems to be, however, particularly interesting as the environmental marker. The *Uvigerina peregrina* group (i.e. the group of the hispidocostate uvigerinids) includes i.a. *Uvigerina romaniaca* (see e.g. VAN DER ZWAAN & al. 1986) described by PAPP & SCHMID (1978) from the Upper Badenian of the Central Paratethys. On the other hand, *Uvigerina romaniaca* PAPP & SCHMID is in the present author's opinion very close to *U. venusta* FRANZENAU, as well as to *U. pygmaea* D'ORBIGNY; VAN DER ZWAAN & al. (1986) referred these two latter species to the *Uvigerina peregrina* CUSHMAN group. Both these species are recorded (among others) from the middle part of the Middle Miocene of the Central Paratethys, i.e. the substage of the Badenian, characterized by the evaporite deposits (see CÍCHA & al. 1986). The discussed group of foraminifers, but *Uvigerina peregrina* CUSHMAN group

particularly, is known as displaying a greatly variable form of the test ornamentation, dependant on the environment (mostly depth), living in the bottom sediment and preferring open marine and offshore, *i.e.* deep, rather highly saline as well as relatively low oxygen, rich in organic carbon and cold waters conditions (SCHNITKER 1979, 1993, VAN DER ZWAAN & *al.* 1986, VAN LEEUWEN, 1986, QUINTERNO & GARDNER 1987, GALLUZZO & *al.* 1990, THOMAS & *al.* 1990, VERHALLEN 1991, KATZ & MILLER 1993). Recent *Uvigerina peregrina* CUSHMAN is a cosmopolitan species living along the continental coasts, mostly in the upper bathyal waters. According to WESTON (1985), LUTZE (1986), VAN DER ZWAAN & *al.* (1986), and MURRAY (1991) it is particularly numerous in waters rich in food supplies.

Similar environmental preference may be ascribed to *Cassidulina laevigata* D'ORBIGNY (*see* MACKENSEN & HALD 1988, WESTON 1985, SCHILLING 1984); important is the marked abundance of this species in the Holocene sediments underlying sapropel and representing nearly anoxic conditions (SCHILLING 1984).

According to VAN DER ZWAAN & *al.* (1986), in the Miocene of Europe the *Uvigerina peregrina* CUSHMAN group appeared first in the Lower Miocene of the Mediterranean basins, while in the Central Paratethys and the northwestern Germany (North Sea) only in the Middle Miocene. BORSETTI & *al.* (1986), however, paid attention to the Serravallian entry of *Uvigerina peregrina* CUSHMAN into the Mediterranean basins, explained as coinciding with a considerable cooling connected with the Antarctic glaciation and the closure of the old, eastern end of the Tethys. On the other hand, VON DANIELS (1986) indicated that in the NW Germany in the upper part of the Middle Miocene there was probable an influx of colder water masses from the North Atlantic, together with the invasion of the *Uvigerina pygmaea/venusta* group which replaced the warm-water species.

The numerous and generally well preserved planktic foraminifers, represented exclusively by the *Globigerina*-like forms, e.g. *Globigerina cf. bulloides* D'ORBIGNY, *G. praebulloides* BLOW, *G. concinna* REUSS, *G. cf. tarchanensis* SUBBOTINA & CHUTZIEVA, *G. diplostoma* REUSS, *G. cf. bollii* CITA & PREMOLI SILVA, characteristic of the *Globigerina* ecozone within the upper part of the Middle Badenian (SZCZUCHURA 1982, SZCZUCHURA & PISERA 1986), prove the open marine and rather cold-water environmental conditions of the studied biofacies. The lower part of the Middle Badenian sediments of the Central Paratethys (including its northernmost part) contains rich (well diversified and numerous) warm-water planktic foraminifers as well as large benthic foraminifers (*cf.* SZCZUCHURA 1982, 1994; SZCZUCHURA & PISERA 1986).

It should be added, that the undertaken, although very preliminary, observations of the microfauna (mostly foraminifers) succession in the discussed Jamnica section, allow to estimate that this microfauna represents a very instable and rather dramatically changing environment. The studied sample

belongs to the part of the section some meters above sediments corresponding to the evaporites and developed here as rather shallow-water ones, and, at the same time, some meters below the Badenian/Sarmatian boundary, marked by a drastic and rapid shallowing of the sea. Just below the studied sample there occur deposits with a microfauna markedly dominated by the buliminids (mostly *Bulimina elongata* D'ORBIGNY) and bolivinids. Such low-diversified foraminiferal assemblage suggests its stressed environment. Moreover, its systematic composition is treated by some authors (e.g. BROLSMA 1978, VAN DER ZWAAN 1983, MURRAY 1991) as indicators of the raised salinity and oxygen-deficiency. Thus, the studied sample from Jamnica seems to correspond to the rather short lasting Middle Miocene deeper basin (or its part), which rapidly deepened then shallowed, and was characterized by the stressed environmental conditions.

DISCUSSION AND CONCLUSIONS

The studied microfossils from the Jamnica borehole seem to indicate that the appearance of *Xylocythere carpathica* sp.n. and at least some of the associated microfossils, is a result of the later Middle Miocene influx of the deeper, rather highly saline and cold waters to that area. The domination of *Cassidulina laevigata* D'ORBIGNY and the *Uvigerina peregrina* CUSHMAN group, as well as the simple arenaceous forms within foraminifers, suggest a sediment rich in the organic matter and an oxygen-deficient environment. This latter suggestion may be proved by the pyrite richness in the studied residuum and the particularly abundant buliminids and bolivinids in the directly underlying sediment. It seems worth mentioning, that there was a marked abundance of buliminids and bolivinids in the Upper Badenian of the whole Central Paratethys; PAPP & al. (1978) introduced the *Bulimina-Bolivina* Zone for this time interval. Thus, the younger Badenian low-oxygen environment was probably typical of the entire region of the Central Paratethys, and this event is seemingly in accordance with KATZ'S & MILLER'S (1993) opinion that the increase of uvigerinids (plus organic carbon) in the late Middle to the Late Miocene resulted from an expansion of the oxygen minimum zone controlled by global oceanic changes.

A somewhat later, and rather short-lasting, appearance of the *Uvigerina peregrina* CUSHMAN group and the associated microfossils in the studied area than in other areas of the Central Paratethys (Fore-Carpathian Depression including) may be a result of different development of the Central Paratethys basins, mostly their topography.

The analysis of the spatiotemporal distribution of the studied microfossil assemblages from the Jamnica borehole, allows to conclude that they appeared first in the oceans (including the the Atlantic) and *via* the Iberian "corridor", and then through the peri-Alpine depressions they migrated into the Fore-Carpathian Depression.

The herein presented conclusions concerning the Middle Miocene paleogeography are in contrast with those expressed by some authors, mostly those considering the Neogene ostracodes distribution. According to BENSON (1976b), MCKENZIE (1986), and YASSINI (1986) in the later Middle Miocene the Central Paratethys contained rather shallow-water basins connected mostly with those of the Eastern Paratethys. BENSON (1976a, 1976b, 1978) was of the opinion that in the Middle Miocene there was an influence of the Atlantic waters to the Mediterranean, however, it was restricted mostly to its central part as well as southern areas of the Western Paratethys. Moreover, some authors (e.g. BENSON 1976b, RÖGL & STEININGER 1984, STEININGER & RÖGL 1985, RÖGL & BRANDSTÄTTER 1993) indicated that in the Middle Miocene there was a connection between the Central Paratethys and the Indo-Pacific. In the present author's opinion it was rather poor and allowed a migration mostly of the shallow-water forms (e.g. large foraminifers, common in the early Middle Miocene of the Central Paratethys and Indo-Pacific, as mentioned by RÖGL & BRANDSTÄTTER, 1993), while the deeper-water faunas, recorded in the Central Paratethys, are of the Atlantic origin. The fact that the *Uvigerina peregrina* CUSHMAN group appeared simultaneously in the Mediterranean, northwestern Europe and the Central Paratethys rather excludes the other route of its invasion into the Fore-Carpathian Depression and proves a panregional character of this bioevent.

The explanation of that bioevent may be found in some interpretations, based on faunal as well as isotopic data (e.g. ZACHARIASSE & SPAAK 1983, BERGGREN 1984, MURRAY & *al.* 1986, WOODRUFF & SAVIN 1989, BENSON 1990, WHATLEY 1992). All these authors noted a distinct Middle Miocene changes in foraminiferal and/or ostracode fauna, resulting from the oceanic changes, especially from the closure of the eastern end of the Tethys, and from the climatic change (cooling) and/or a change of the oceanic water column structure as well as in the water mass circulation; then, the deep and cold Antarctic bottom waters entered the Atlantic Ocean and even allowed to transfer the Indian Ocean faunas.

The above conclusions seem to be useful for understanding the origin of *Xylocythere carpathica* sp.n. and the associated ostracodes in the later Badenian of the Fore-Carpathian Depression. Moreover, they allow to understand an atypical (*i.e.* not deep bathyal being typical of the so far known representatives of that genus) habitat in the Fore-Carpathian Depression. CRONIN (1983) and DINGLE & LORD (1990), working on the distribution of Recent ostracodes in the Atlantic, confirmed the direct relation between the vertical distribution of the ostracodes and the water temperature (that is, the position of thermocline) as well as the dissolved oxygen content. According to DINGLE & LORD (1990), the deep-water ostracodes may live in shallow waters if these are enough cold, relatively low-saline and less oxygenated. At least some basins (or their parts) of the Middle Miocene Central Paratethys are believed to be

characterized by the similar environmental conditions. Worth seems to be mentioned, that according to BENSON (1990, p. 50) the Middle Miocene was a time interval when, e.g. in the Atlantic, "the warm neritic faunas of the west migrated poleward, while the deeper faunas mounted the eastern continental slopes". The Middle Miocene *Xylocythere carpathica* sp.n. and the associated ostracodes found in the Jamnica borehole seem to prove this suggestion.

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J. SZCZECURA

MAŁŻORACZKI Z RODZAJU *Xylocythere* MADDOCKS & STEINECK, 1987, Z MIOCENU ZAPADLIKA PRZEDKARPACKIEGO I ICH ZNACZENIE PALEOGEOGRAFICZNE

(Streszczenie)

W środkowomiocenijskich (górnobadeńskich) osadach Zapadlika Przedkarpacciego, napotkanych w wierceniach Jamnica S-119 koło Tarnobrzega (patrz fig. 1), znaleziono małżoraczki — w tym zwłaszcza z rodzaju *Xylocythere*, reprezentowanego przez gatunek *X. carpathica* sp.n. — preferujące głębsze wody pochodzenia oceanicznego (patrz pl. 1-3).

Współwystępujące z tymi małżoraczkami otwornice i bolboformy określają wiek osadów oraz potwierdzają ich głęboko- i zimnowodne, a przypuszczalnie także zubożone w tlen warunki środowiskowe.

Analiza rozprzestrzenienia badanego zespołu mikroskamieniałości sugeruje, że przedostały się one do Zapadlika Przedkarpacciego (Paratetydy Centralnej) w górnej, bądź już w środkowej części miocenu środkowego z Atlantyku, poprzez tzw. korytarz iberyjski, a następnie poprzez zapadlisko przedalpejskie.

Pojawienie się badanej mikrofauny i flory (bolboform) w młodszym badaniu Paratetydy Centralnej wiąże się prawdopodobnie z młodszym i odmiennym niż w czasie transgresji wczesnobadeńskiej napływem chłodnych i być może zubożonych w tlen mas wodnych pochodzenia oceanicznego. Wydarzenie to, stwierdzone także w innych częściach świata, mogło być konsekwencją zmian cyrkulacji w oceanach, zwłaszcza w wyniku ówczesnego zamknięcia Oceanu Tetydy na wschodzie i/albo środkowomiocenijskiego ochłodzenia klimatu.