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Rare myodocopid ostracods from the Lower Cretaceous (Albian) strata of Vértes Foreland (NW-Hungary)

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(with 6 figures and 1 plate)

Occurrences of myodocopid ostracods in fossil record particularly in Mesozoic sequences are very scarce because of preservation potential of their carapaces, despite that Recent forms occur worldwide in various water depths of marine environments as benthic, nektobenthic or planktonic organisms. Two myodocopid ostracod genera ("*Conchoecia"* and *Polycope*) belonging to two families Halocyprididae and Polycopidae were identified from the studied Lower to Middle Albian successions of the boreholes Agt-2 and Vst-8. These occurrences from Vértes Foreland of Hungary are one of the earliest representatives of halocyprid ostracods. These data completed the palaeobiogeographical distribution of the described genera during the Albian in the Tethys Ocean. The previous paleoenvironmental reconstructions based on planktonic and benthic foraminifera faunas in the studied boreholes confirmed the same ecological requirement of Cretaceous halocyprid forms as that of their living relatives. The depositional environment of Vértessomló Siltstone is shallow bathyal semi-enclosed basin with high organic matter input and dysoxic conditions allowing the preservation of these rare forms.

Introduction

Myodocopid ostracods are very poor in fossil record because of the preservation potential of their weakly calcified carapaces. Recent forms occur worldwide in various water depths of marine pelagic environments as benthic, nektobenthic or planktonic organisms. The modern myodocopid ostracods may have originated from late Palaeozoic forms belonging to the "Superfamily nov. A" via the cypridinacean lineage (Permian to Recent) (BECKER 2003; VANNIER & ABE 1992). Mesozoic record is sporadic compared to the knowledge about Palaeozoic ancestors. Mesozoic myodocopids can be classified into modern superfamilies such as Cyprinidoidea, Thaumatocypridoidea, Polycopoidea and Halocypridoidea. The main aim of the present work is to give a detailed systematic description of myodocopid ostracods from Albian successions of boreholes Agt-2 and Vst-8 in the Vértes Foreland. Documentation, palaeobiogegraphical and palaeoecological interpretations of these forms can provide new data about halocyprid and polycopid lineage of Myodocopida and about the palaeoenvironmental conditions in this region of Tethys during the Early and Middle Albian.

Geological settings

The studied boreholes (Vst-8 and Agt-2) are located in the Vértes Foreland, in the eastern zone of the Transdanubian Central Range, north-western Hungary (Fig 1). The studied strata belong to the Vértessomló Siltstone Formation deposited in the mid-Cretaceous sedimentary cycle, in a shallow bathyal basin environment with low oxygen levels and normal salinity. It interfingers with the Környe Limestone Formation (a platform carbonate, urgon facies) which is a heteropic facies of the Vértessomló Siltstone (GÖRÖG 1993; CSÁSZÁR 2002; SZINGER 2008).

In the borehole Vst-8 the Környe Limestone, an allodapic limestone bed is intercalated in the Vértessomló Siltstone which is transported with a turbidity current from the platform margin into the basin. Beneath the Környe Mészkő bed the strata are rich in glauconitic grains which are derived from nearshore environment (CSÁSZÁR 2002).

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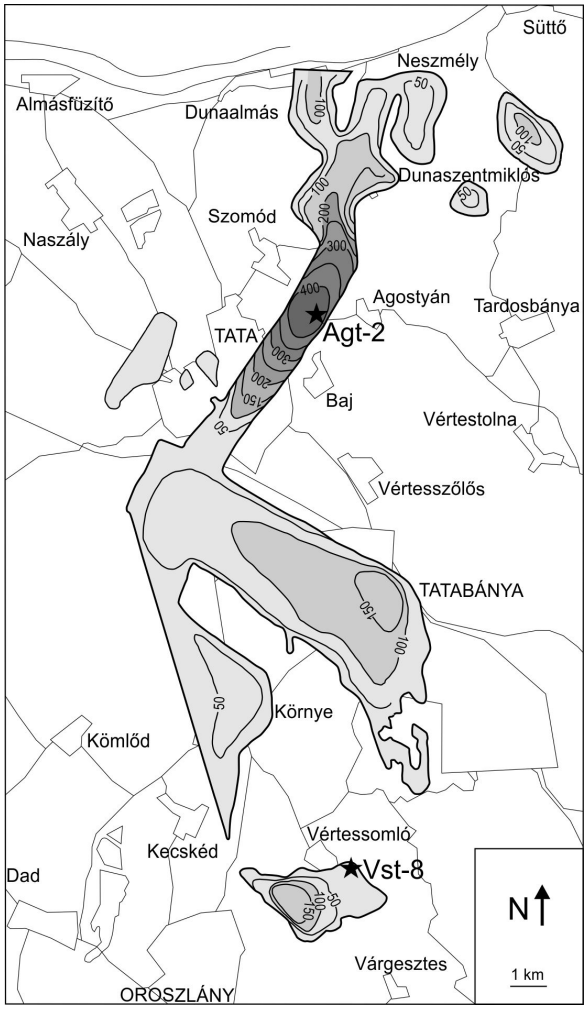

Fig. 1. Geographical locations of the boreholes Vst-8 and Agt-2 and recent extent and thickness distribution of the Vértessomló Siltstone Formation (modified after CSÁSZÁR, 2002)

The Vértessomló Siltstone is underlain by the Tata Limestone which is reappeared above the siltstone caused by reverse fault movement. The lithology of the studied succession is varied because it gradually develops from the Tata Limestone Formation as limestone and marly limestone. The upper part of the Vértessomló Siltstone consists of silty marls (CSÁSZÁR 2002, 1991).

In the borehole Agt-2 the Vértessomló Siltstone is unconformably overlain by Pannonian strata and underlain by Jurassic strata. The succession reaches the maximum thickness (410 m) in this borehole (JÁMBOR et al. 1973).

The upper part of the section – which produced the studied ostracod fauna – consists of silty marls, argillaceous marls and a thin layer of limestone breccia and marly limestone. The lower part bears sandstone and breccia layers, alternating with argillaceous marls and glauconitic sandstone (JÁMBOR et al. 1973; CSÁSZÁR 2002) (Fig. 2.).

The age of the investigated formation according to various biostratigraphical studies is Early to Middle Albian. The planktonic foraminifera and ammonite data indicate Early Albian age, but orbitolinids from the upper part of the section indicate that the deposition continued in the Middle Albian too (FÜLÖP 1975; GÖRÖG 1993; CSÁSZÁR 1998). The borehole Vst-8 penetrated only the Lower Albian strata of Vértessomló Siltstone based on large foraminiferal studies (GÖRÖG 1996). The studied succession in the borehole Agt-2 represent Lower to Middle Albian age according to planktonic foraminiferal studies. Three planktonic foraminiferal zones can be distinguished: *Ticinella bejauensis – Hedbergella gorbachikae* Interval Zone (338 to 421 m, lowermost Albian), *Hedbergella planispira – Hedbergella retroflexa* Interval Zone (162 to 338 m, upper Lower Albian), *Ticinella primula* Interval Zone (20 to 162 m, lower Middle Albian) (BODROGI 1992).

In the borehole Vst-8, SZINGER (2008) divided the studied series into three parts based on the changes of foraminiferal fauna and microfacies. In the lower part of the succession (153 to 135 m) the assemblage indicated a slightly dysoxic, open marine environment. The middle strata (135 to 112 m) which are rich in planktonic foraminifera could be deposited in an offshore, low oxygenated and nutrient poor environment. In the upper part (112 to 100 m) the depositional environment was poor in oxygen and rich in nutrients.

Material and methods

The studied Albian sections produced valuable planktonic ostracod material with 62 specimens of the borehole Vst-8 (interval 104 m to 168 m) and significantly fewer specimens (n=9) from the borehole Agt-2 (interval 235 m to 363 m). All pelagic forms are restricted to the Lower Albian part of the section. About 200 g of the air-dried silty sediments has been soaked in a dilute solution of hydrogen peroxide. From hard limestones the microfauna was extracted by using pure acetic acid. The planktonic ostracods mainly came from the silty marl layers which may be the result of preservation potential. The preservation of studied specimens is good in most cases and there are strongly compressed carapaces in the studied material. Ostracods were separated under stereomicroscope. For the taxonomic work photos were made by scanning electron microscope. The samples are housed in the Department of Palaeontology, Eötvös Loránd University, Budapest.

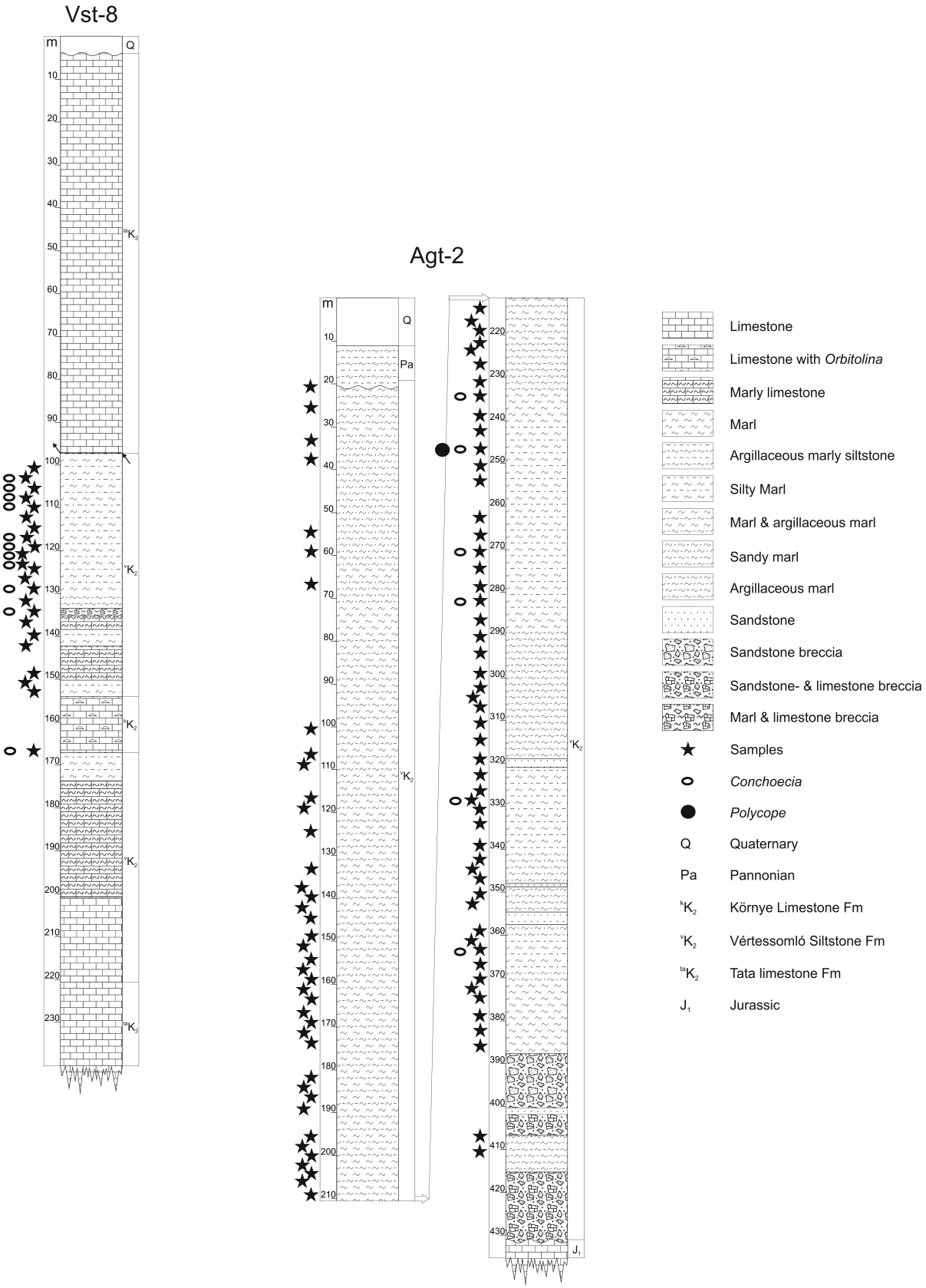

Fig. 2. Litostratigraphical sections of the boreholes Vst-8 and Agt-2

Previous studies about Cretaceous halocyprid and polycopid ostracods

First fossil halocyprid ostracod was described by POKORNÝ (1964), from the Coniacian strata from the former Czechoslovakia as *Conchoecia cretacea*. Previously the *Conchoecia* genus was known only from recent material. Later other scientists also found specimens assumed belonging to this genus in Cretaceous sequences (e.g., COLIN & ANDREU 1990), however they have an uncertain taxonomic place due to the hiatus in the fossil record and slight differences in morphological characters of the carapaces such as the lack of rostrum and rostral incisure (genus aff. "*Conchoecia*"). Moreover, the taxonomy of Recent ostracods mainly based on the number and features of their limbs and other unfossilized characteristics of the soft body which possess difficulties in classification of fossil taxa.

The described Cretaceous specimens occurred mainly in Albian to Cenomanian fine-grained sediments in Atlantic as well as in Tethyan realm. For example, they were extracted from argillaceous marls and marls from the Joux Valley in Switzerland and from Israel (CHAROLLAIS et al. 1977; ROSENFELD & RAAB 1984), from calcareous shales and mudstones in England (KAYE 1965), from organic-rich calcareous shales, mudstones, siltstones of Potiguar and Sergipe basins in Brazil (VIVIERS et al. 2000). Further occurrences of genera *Conchoecia* and aff. "*Conchoecia*" in Cretaceous sequences summarized in Fig. 3.

Although the first representatives of undoubtedly polycopid ostracods have already been described from Carboniferous strata (e.g., NEALE 1983; KORNICKER & SOHN 2000), the fossil record is very poor in Mesozoic as well as in Cenozoic era (NEALE 1983). This phenomenon is also characteristic of Cretaceous faunas. The representatives of the genus *Polycope* have been described only from Berriasian to Albian fine grained sediments such as calcareous clays from southeastern Czech Republic (POKORNÝ 1973), gray shales from Algoa Basin in South Africa (BRENNER & OERTLI 1976), marls from Bauges and Chartreuse Mountains in France and North Tunisia (DONZE 1964, 1971; DONZE et al. 1975) and gray marls from Israel (ROSENFELD & RAAB 1984). Moreover Cenomanian to Maastrichtian soft, unstratified, pale grayish-white chalk sediments also produced specimens of *Polycope* genus: from Rügen Island in North Germany (HERRIG 1963, 1964, 1994; HERRIG et al. 1997), from Wrotham in England (KAYE 1965) and from southeastern England (WEAVER 1982) (Fig. 4.). Detailed stratigraphic distributions are shown in Fig. 5.

The genus *Polycopsis* is less common than *Polycope* and published only from Maastrichtian chalk sediments (Rügen Island in North Germany (HERRIG 1963, 1966) and Mont Aimé in France (MARGERIE 1967)).

The detailed discussion about Cretaceous halocyprid ostracods (genera *Conchoecia* and aff. "*Conchoecia*") is published by COLIN & ANDREU (1990) and about polycopid ostracods by NEALE (1983).

Systematic descriptions

Classification of the ostracods follows that of HARTMANN & PURI (1974) and MARTIN & DAVIS (2001). The specimens are deposited in the Department of Palaeontology of Eötvös University. Abbreviations: L=length and H=height.

Subclass Ostracoda LATREILLE, 1806
Order Myodocopida SARS, 1866
Suborder Halocypriformes SKOGSBERG, 1920
Superfamily Halocypridoidea DANA, 1853
Family Halocyprididae DANA, 1852
Genus *Conchoecia* Dana, 1849
„*Conchoecia*" sp.
Pl. 1, figs 1-3, 5-7.

1965. ?*Conchoecia* sp. B; KAYE p. 230-231, pl. 1, figs 1-2; pl. 2, figs 2,7.
1977. *Conchoecia*? sp.; OERTLI (in CHAROLLAIS et al.), pl. 1, fig. 8.
1979. '*Conchoecia*' GA D 31; GROSDIDIER (in COLIN & ANDREU 1990), pl. 1, fig. 5.
1984. Genus aff. „*Conchoecia*" sp. 215; ROSENFELD & RAAB, p. 113, pl. 7, figs 8-9.
1984. Genus aff. „*Conchoecia*" sp. 150; ROSENFELD & RAAB, p. 113, pl. 7, fig. 10.
1992. *Conchoecia* sp.; ANDREU, pl. 1, fig.1.
1995. *Conchoecia*(?) sp.; DAMOTTE, p. 577, pl. 3, figs 11-12.
2000. *Conchoecia*? sp.; VIVIERS et al., pl. 24, figs 9-17.

Material. Borehole Vst-8: 104 m: 1 carapace, 106 m: 1 carapaces, 108 m: 2 carapaces, 110 m: 7 carapaces, 117 m: 3 carapaces, 119 m: 38 carapaces, 121 m: 5 carapaces, 123 m: 1 carapace, 129 m: 2 carapaces, 135 m: 1 carapace, 168 m: 1 carapace. Borehole Agt-2: 235 m: 1 carapace, 247 m: 1 carapace, 271 m: 1 carapace, 279 m: 3 carapaces, 283 m: 1 carapace, 329 m: 1 carapace, 363 m: 1 carapace.

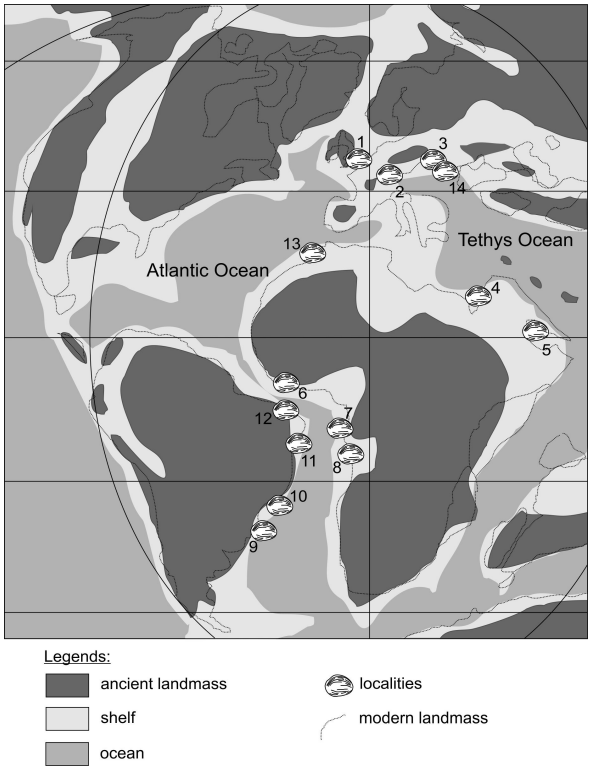

Fig. 3. Palaeogeographic map of Early Cretaceous *Conchoecia* (modified after Atlantic Geoscience Society & Geological Survey of Canada)**1**: ?*Conchoecia* sp. A & B Wrotham, England (KAYE 1965); **2**: *Conchoecia*? sp. Switzerland, Joux Valley in the Vaudois Jura (CHAROLLAIS et al. 1977); **3**: *Conchoecia cretacea* POKORNÝ 1964, Czech Republic (COLIN & ANDREU 1990); **4**: Genus aff. „*Conchoecia*" sp. 215 & 150 Israel (ROSENFELD & RAAB 1984); **5**: '*Conchoecia*' IR O 27 Persian Gulf, Iran (COLIN & ANDREU 1990); **6**: Ivory Coast (COLIN & ANDREU 1990) unpublished; **7**: '*Conchoecia*' GA D 31 & GA E 1 Gabon (COLIN & ANDREU 1990); **8**: Congo (COLIN & ANDREU 1990) unpublished; **9, 10**: Santos and Campos basins (COLIN & ANDREU 1990); **11, 12**: *Conchoecia*? sp. Potiguar and Sergipe basins, NE Brazil (COLIN & ANDREU 1990, VIVIERS et al. 2000); **13**: *Conchoecia* sp. Agadir-Nador, Morocco (ANDREU 1992).

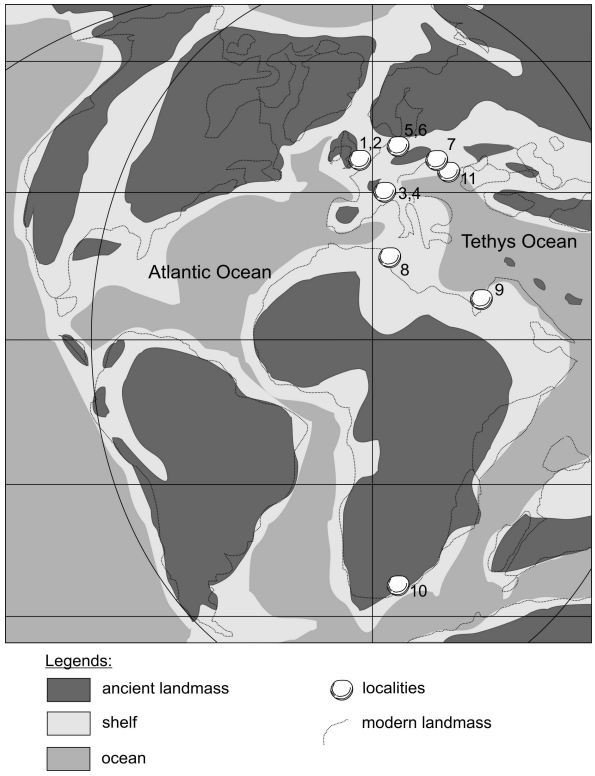

Fig. 4. Palaeogeographic map of Cretaceous *Polycope* (modified after Atlantic Geoscience Society & Geological Survey of Canada)- **1**: *Polycope nuda* KAYE, 1965 *P. oweni* KAYE, 1965 Wrotham, England (KAYE 1965); **2**: *P. bluebellensis* WEAVER, 1982, *P. delicate* WEAVER, 1982, *P. nuda* KAYE, 1965, *P. oweni* Kaye, 1965 SE England (WEAVER, 1982); **3**: *Polycope* sp. Bauges and Chartreuse Mountains, France (DONZE 1964); **4**: *Polycope* sp. SE France (DONZE,1971); **5**: *P. avicularia* HERRIG et al., 1997 *P. bonnemai* HERRIG, 1963, *P. luxuriosa* HERRIG, 1964 Rügen Island, N Germany (HERRIG 1963, 1964, HERRIG et al. 1997); **6**: *P. bonnemai* HERRIG 1963, *P. dorsispinata* HERRIG 1994, *P. krauseae* HERRIG 1994, *P. luxuriosa* HERRIG 1964, *P. nuda* KAYE 1965, *P. proboscidea* HERRIG, 1994, near Malchow, NE Germany (HERRIG 1994); **7**: *Polycope* sp. South-eastern part of Czech Republic (POKORNÝ 1973); **8**: *Polycope* sp. N Tunisia (DONZE et al 1975); **9**: *Polycope* spp., Israel (ROSENFELD & RAAB 1984); **10**: *Polycope* sp. Algoa Basin, S Africa (BRENNER & OERTLI 1976); **11**: *Polycope* sp. Hungary.

Dimensions: L: 0.43-1.30 mm
H: 0.22-1.05 mm
L/H: 1.1-1.9

Description. Form #1 (figs 6-7.): Carapace rounded. Anterior margin straight to convex; dorsal margin strongly arched; posterior margin slightly pointed; ventral margin convex. Valves ornamented by narrow longitudinal ribs, slightly arched by following the shape of the outline. Internal features not observed. Eye spot absent.

Form #2 (fig. 2.): Carapace suboval, elongated. Anterior margin concave; dorsal margin convex; posterior margin pointed, below 2/3 height; ventral margin convex. Valves ornamented by narrow longitudinal ribs, slightly arched by following the shape of the outline, but more pronounced than Form #1. Internal features not observed. Eye spot absent.

Form #3 (figs 1, 3, 5.): Carapace subcircular. Anterior, dorsal and ventral margins convex; posterior margin slightly pointed. Ornamentation of the valve surface is longitudinal ribs similarly to the Form #2. Most of these specimens are flat and deformed. Internal features not observed. Eye spot absent.

Remarks. The classification in genus level is

questionable because of the lack of the rostrum and rostral incisure. The specimens can be split into three different groups based on their shapes and their sizes. Form #1 is mainly distributed in the group 0.5-0.7 mm, but two specimens are smaller than 0.5 mm. Forms #2 and #3 are larger than 0.7 mm.

Occurences and stratigraphic ranges. Czech Republic: Coniacian (POKORNÝ 1964) Wrotham, Kent, England: Upper Albian (KAYE 1965), Switzerland, Joux Valley in the Vaudois Jura: Middle Albian (CHAROLLAIS et al. 1977), Israel, Coastal Plain: Albian, Albian to Lower Cenomanian (ROSENFELD & RAAB 1984), Agadir-Nador, Morocco: Upper Albian (ANDREU 1992), Iran: Albian (GROSDIDIER 1973); Gabon: Lower Albian (GROSDIDIER 1979); Mid-Pacific Mountains: Albian (DAMOTTE 1995), Florianopolis and Santos basins, Brazil: Lower to Middle Albian (KOUTSOUKOS & DIAS-BRITO 1987); Potiguar and Sergipe basins, northeastern Brazil: Albian (VIVIERS et al. 2000).

Suborder Cladocopa SARS, 1866
Superfamily Polycopoidea SARS, 1865
Family Polycopidae SARS, 1866
Genus *Polycope* Sars, 1866

Polycope sp.
Pl. 1, Fig. 4.

Material. Borehole Agt-2: 247 m: 1 specimen.
Dimensions: L: 0.40 mm
H: 0.37 mm
L/H: 1.1

Description. . Carapace subcircular. Dorsal margin straight to convex; anterior, posterior and ventral margins rounded. Along the margin strongly depressed. Valve weakly reticulated with small tubercles, ornamentation confined to the margins. Internal features not observed. Eye spot absent.

Remarks. The described specimen is similar in its ornamentation to the *Polycope* sp. described by ROSENFELD & RAAB (1984, Pl. 1, fig. 1.) but their shape is very different.

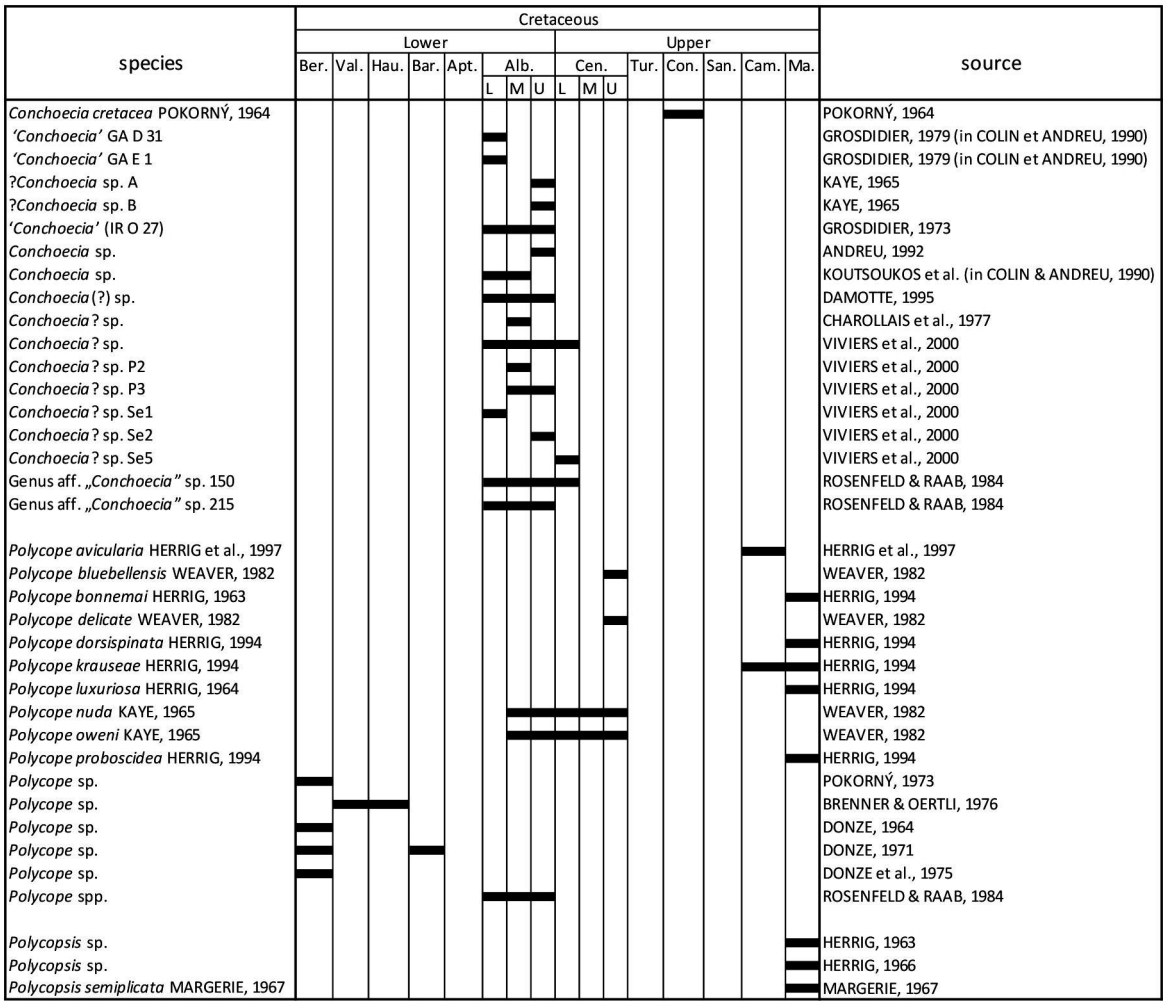

Fig. 5. Stratigraphical distribution of Cretaceous halocyprid and polycopid ostracods Ber.: Berriasian, Val.: Valanginian, Hau.: Hauterivian, Apt.: Aptian, Alb.: Albian, Cen.: Cenomanian, Tur.: Turonian, Con.: Coniacian, San.: Santonian, Cam.: Campanian, Ma.: Maastrichtian

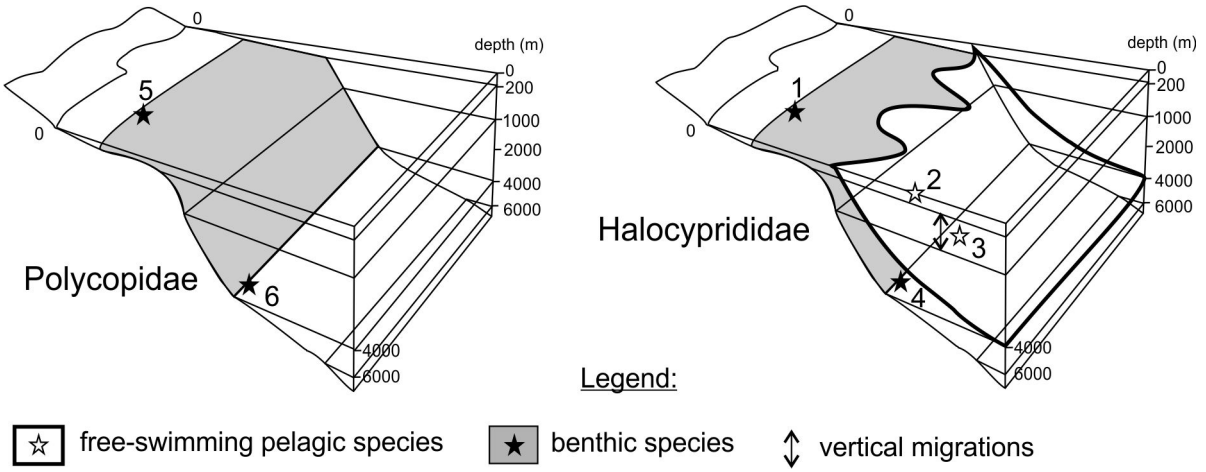

Fig. 6. Depth range of recent podocopid and halocyprid ostracods (modified after VANNIER & ABE, 1992). **1**: non spinous *Bathyconchoecia* (130 to 3165 m); **2**: neustonic halocyprids (= the surface 10 cm of the water column); **3**: planktonic halocyprids; **4**: *Bathyconchoecia septemspinosa* (271 to 3600 m); **5**: *Polycope japonica* (0 to 0.3 m); **6**: *Polycope ovalis* (335 to 3105 m).

Discussion

Myodocopid ostracods have a very rare occurrence compared to the other podocopid and platycopid ostracods in Cretaceous sequences due to their poor preservation potential. In most cases they occur in fine-grained sediments such as organic-rich clays, siltstones and marls of Lower Cretaceous sequences and Upper Cretaceous chalk sediments. The halocyprid forms mostly derived from Albian to Cenomanian organic-rich sediments (Fig. 5). They have fragile, weakly calcified carapaces which mainly consist of organic matter, so their preservation requires low oxygenated bottom water conditions. These conditions often result in pyrite-filled moulds of the carapace. The partly organic carapace is capable of plastic deformation which results strongly depressed and compressed carapaces. These phenomena can be very well recognized on the studied specimens from Vértessomló Siltstone Formation, also.

However the carapace of *Polycope* genus is more calcified than halocyprid ostracods, their occurrence in Cretaceous sediments is very similar as that of the genera *Conchoecia* and aff. „*Conchoecia*".

Palaeogeographical distribution of the above mentioned halocyprid ostracod seems to be worldwide during the Albian to Cenomanian, but they mainly occur in the Tethyan and Atlantic regions which can be explained by the human factor (Fig. 3). A single record was published from Albian sequences of Mid-Pacific Mountains (DAMOTTE 1995). The cause of the widespread occurrence of the genera *Conchoecia* and aff. „*Conchoecia*" during the Albian to Cenomanian is their lifestyle. Probably in the Late Cretaceous the situation is similar, but the fossil record is more incomplete. During the Cretaceous spatial distribution of *Polycope* genus is more restricted compared to the *Conchoecia* and aff. „*Conchoecia*" and moreover the specimens from different localities belong to different species in most cases. More than 10 species were described (Fig. 4). In contrast of this fact the *Conchoecia* genus subdivided only maximum two species. These phenomena can be explained by the different mode of life between the two taxa. The lifestyle of Recent *Polycope* is benthic and capable of swimming only short distances limiting wide distribution. Moreover benthic or nektobenthic myodocopid forms biogeographic regions can be recognized based on recent studies (KORNICKER 1975). The palaeoecological value of the genus is low in palaeoenvironmental reconstruction because its habitat range is very wide. Recently they live in water depth from 0 to 3000 m.

The *Conchoecia* is a free-swimming pelagic ostracod whom vertical migration depends on nutrient supply. Recent forms live in 0 m (neuston) to 3900 m (surface water to abyssopelagic region), with a maximum abundance of 200 to 400 m and with a maximum diversity of 1000 to 1500 m in the water column (VANNIER & ABE 1992). Planktonic mode of life of Cretaceous *Conchoecia* is confirmed by the wide distribution (Atlantic, Pacific and Tethyan realm) (Fig. 6). Presumably the Cretaceous representatives of the genus lived in an environment with similar conditions.

SZINGER (2008) and BODROGI (1992) estimated shallow bathyal water depth (180 to 350 m) with normal marine and dysoxic conditions as depositional environment of the Vértessomló Siltstone based on

the palaeoecological interpretation of the benthic and planktonic foraminifera faunas from the studied borehole Vst-8 and Agt-2. This interpretation well fits to the maximum abundance of the Recent planktonic halocyprids.

Conclusions

Two myodocopid ostracod genera were identified from the Lower Albian Vértessomló Siltstone Formation (of boreholes Vst-8 and Agt-2), namely „*Conchoecia*" and *Polycope*. The *Polycope* genus is presented by only one well-preserved carapace and halocyprid forms by numerous strongly deformed carapaces. ítheir ratios compared to the podocopids and platycopids are low in the studied samples. The specimens from the genus „*Conchoecia*" can be divided into three forms based on size and shapes but their taxonomic value is questionable. During the Albian to Cenomanian the worldwide distribution of halocyprid form can be explained by their free-swimming pelagic lifestyle based on recent analogies. Recent forms live with a maximum abundance in 200 to 400 m in water column. The described Albian specimens from Vértessomló Siltstone may live at similar water depth. This interpretation is supported by the previous benthic and planktonic foraminiferal results suggesting 180 to 350 m water depth as the depositional environment of the studied strata.

Acknowledgements

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Plate 1

Figs 1-3., 5-7. *Conchoecia* sp.

Fig. 1. borehole Vst-8, 119 m

Fig. 2. borehole Agt-2, 329 m

Fig. 3. borehole Vst-8, 110 m

Fig. 5. borehole Vst-8, 106 m

Fig. 6. borehole Vst-8, 108 m

Fig. 7. borehole Vst-8, 110 m

Fig. 4. *Polycope* sp. borehole Agt-2, 247 m

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Plate 1