

Upper Miocene Ostracods of the Turiec Basin (Slovakia) - sub-family Cyclocypridinae

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Six species of the sub-family Cyclocypridinae were found in the Upper Miocene of the Turiec Basin, 4 of which are new - *Cypria isosceles*, *C. lenticulata*, *C. polyphema*, *C. bodergatiae*. The differences in arrangement of the zone of the fusion on ventral margin were used to distinguish the species. The genus *Cypria* is represented in whole area of the Turiec Basin but the species are restricted to the ecologically well determined biotopes. Valve shape is compared with ecological stability of the paleo-biotopes.

Keywords : Ostracoda, Miocene, Taxonomy, Paratethys, Slovakia.

Introduction

The recent Cyclocypridinae inhabit the freshwater environment ; their mode of reproduction is bisexual. The morphology of their valves is rather variable and depends on the environmental parameters (Sywula 1974, Tétard 1975, Petkovski 1976, Meisch 2000). They are known in the Lower and Middle Miocene freshwater deposits of Germany (Malz & Moayedpour 1973, Janz 1997, Witt 2000). Many species of Cyclocypridinae, mainly of the genus *Cypria*, are found in the Central Paratethys, since the Pannonian (Tortonian) (Jiricek 1985). In the Miocene deposits of this area, *Cypria* is associated with the brackish species - *Cyprideis*, *Hemicytheria*, *Loxoconcha* - and with the endemic *Candona* species sensu Krstić (1972). The outer margin of the *Cypria* valves ranges between circular, elliptic, triangular in shape and trapezoidal in shape with a concave dorsal margin (Krstić 1975, Pipík 1996).

The Turiec Basin corresponds to a Middle and Upper asymmetric intramountain depression located at the outer margin of the Central Paratethys (Fig. 1). It provides

an important lacustrine ostracods fauna of which six species belong to the Cyclocypridinae (Pipík 2001).

Systematic description

Abbreviations : RV - right valve, LV - left valve, C - carapace, ♀ - female valve, ♂ - male valve, AM - anterior margin, ADM - antero-dorsal margin, DM - dorsal margin, PDM - postero-dorsal margin, PM - posterior margin, PVM - postero-ventral margin, VM - ventral margin, AVM - antero-ventral margin, OM - outer margin, IM - inner margin, H_{max} - maximum height, E_{max} - maximum width, A - adult, n - quantity of measured individuals, l - length of the valve in mm, h - height of the valve in mm, φ - average, h/l - height / length ratio.

The figured individuals are deposited in the Slovak National Museum in Bratislava (Slovakia) under the numbers mentioned in the text.

Class Ostracoda Latreille 1806

Order Podocopida Sars 1866

Suborder Podocopina Sars 1866

Family Candonidae Kaufmann 1900

Subfamily Cyclocypridinae Kaufmann 1900

Genus *Cyclocypris* Brady & Norman 1889

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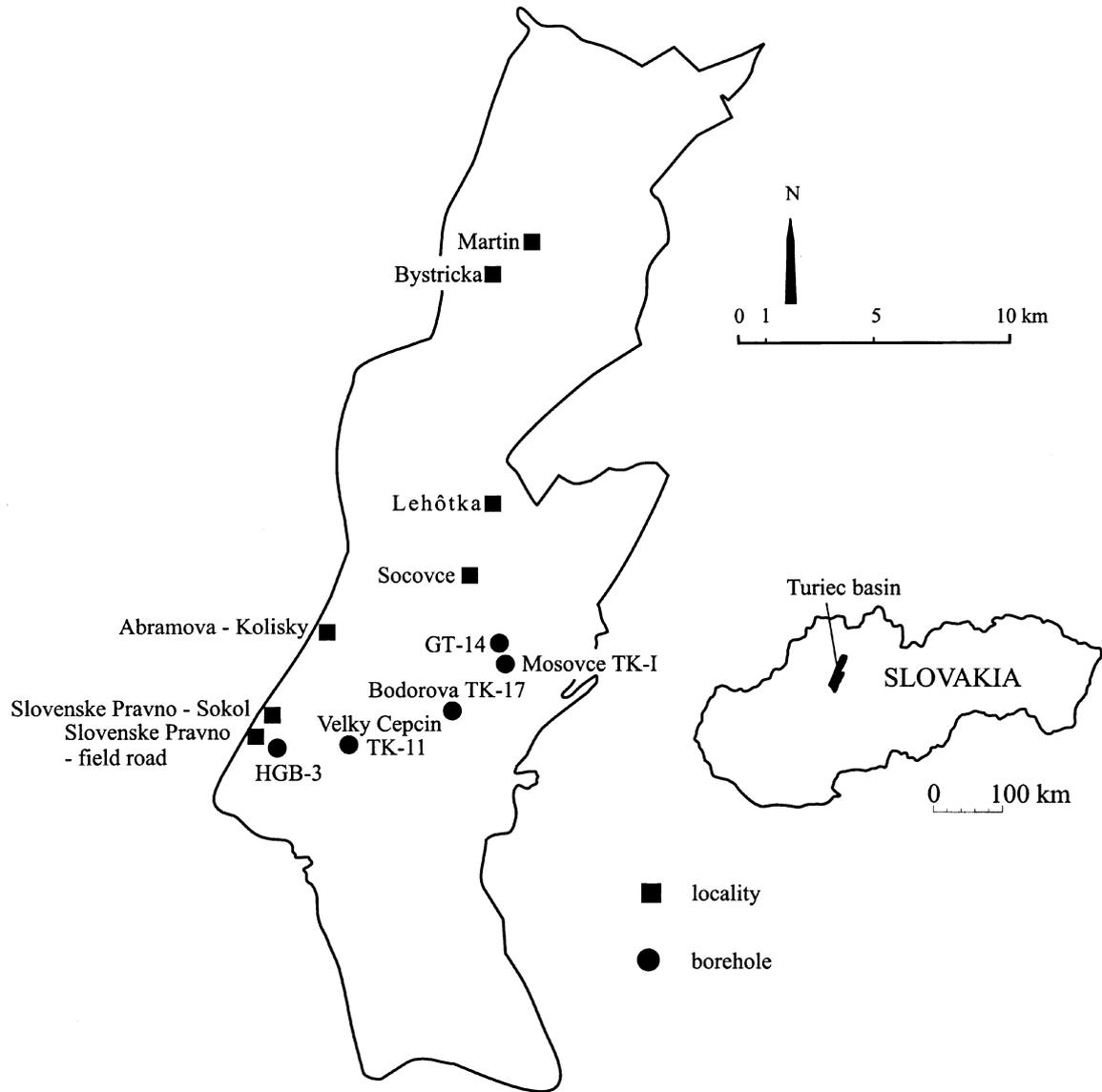


Fig. 1. Distribution of the genus *Cypris* in the Turiec Basin and its geographic location in Slovakia.

Cyclocypris laevis (O.F. Müller 1776)

Plate 1, Fig. 1

Cyclocypris laevis, Absolon, 1973, p. 66, Plate 3, Fig. 6.

Cyclocypris laevis, Diebel & Pietrzeniuk, 1975, p. 1212, Plate VI, Figs. 7-8.

? *Cyclocypris laevis*, Sokac, 1978, p. 32, Plate XVIII, Figs. 8-9.

Cyclocypris laevis, Diebel & Pietrzeniuk, 1978, Plate 26, Figs. 1-2.

Cyclocypris laevis, Diebel & Pietrzeniuk, 1984, p. 303-304, Plate V, Figs. 1-4.

Cyclocypris laevis, Fuhrman & Pietrzeniuk, 1990, p. 191, Plate 6, Figs. 9-10.

Cyclocypris laevis, Pietrzeniuk, 1991, Plate 4, Figs. 7-8.

Table 1. Dimensions of *Cyclocypris laevis* (O.F. Müller), Zemnė (Collection of Vladimír Pokorný (Prague)).

		n	l	h	h/l
A	RV	1	0.492	0.337	0.685

Material and dimensions : 1 right valve.

Remarks : *Cyclocypris* cf. *laevis* (O.F. Müller 1776) of Diebel & Pietrzeniuk (1977) from the Pleistocene travertine near Weimar (Germany) is more robust. Its VM is convex, PDM more curved and AM higher. *Cyclocypris taubachensis* Diebel & Pietrzeniuk 1984 from the Late Pleistocene of the Germany is also more robust and more triangular at DM which is straight before and behind point of inflexion with H_{max} located in the first half of the valve (Diebel & Pietrzeniuk 1984). The recent individuals of *Cyclocypris laevis* figured by Sywula (1974) and Meisch (2000) are more rounded at DM. Our individual with low AM, triangular DM, PM regularly rounded and with VM slightly concave in middle of the length corresponds more to the individuals from Germany illustrated by Diebel & Pietrzeniuk (1978, 1984).

Geographic and stratigraphic distribution : recent species from the Holarctic region are found in the Pleistocene and Holocene as well in the Pannonian deposits (Upper Miocene) of Slovakia. In the Collection of V. Pokorný, it was associated with *Euxinocythere lactea* Pipík & Bodergat ; the latest is known from the Upper Miocene of the Turiec Basin (Pipík & Bodergat in press).

Ecology : a species very tolerant of variable ecological conditions, but it prefers permanent and temporary

pools with vegetation ; observed in the springs and lakes from littoral to the deepest zone. It tolerates a low salinity up to 8 ‰ ; thermoeuryplastic.

Regional distribution : Zemnė (from Collection of Vladimír Pokorný (Prague)).

Literature : Van Morkhoven (1962), Devoto (1965), Rybecký (1986), Rühle (1994), Meisch (2000), Pipík (2000).

Genus *Cypria* Zenker, 1854

The significant differences between *Cypria* from the Turiec Basin are observed in the zone of fusion at the ventral margin (Fig. 2). These differences serve to distinguish species with similar valve morphology, such as *Cypria servica* Krstić 1975 and *C. bodergatae* n.sp. and at the same time bring together valves of different outline such as *Cypria polyphema* (Plate 2, Fig. 1-7). The details of the zone of the fusion are described below.

Cypria servica Krstić 1975

Plate 1, Figs. 2-7 ; Plate 2, Fig. 15 ; Text-fig. 2a

Cypria servica, Krstić, 1975, p. 198, Plate I, Figs. 12-13.

The original description being insufficient, we give a description on the basis of the material from the borehole HGB-3 (co-ordinates : 48°51' N and 18° 46' E).

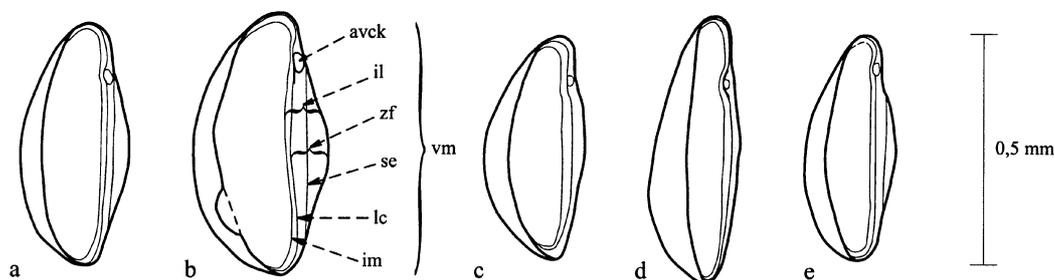


Fig. 2. Zone of the fusion on the ventral margin in dorsal view ; a) *Cypria servica* Krstić, b) *C. isosceles* n.sp., c) *C. lenticulata* n.sp., d) *C. polyphema* n.sp., e) *C. bodergatae* n.sp. ; avck - antero-ventral contact-knob ; il - internal lamella ; zf - zone of fusion ; se - selvage ; lc - line of concrescence ; im - inner margin ; vm - ventral margin.

Table 2. Dimensions of *Cypria servica* Krstič, borehole HGB-3, 54.2 m and 55.5 m.

		n	l	h	h/l
A	LV	4	0.546 – 0.557	0.431 – 0.451	0.786 – 0.821
	RV	4	0.529 – 0.551	0.394 – 0.42	0.744 – 0.772

Originally a diagnosis was not given, only a description of the valves. Accordingly from observations of the Turiec Basin material we can propose the following emended diagnosis.

Emended diagnosis : sub-trapezoidal species ; the LV strongly overlaps the RV on the VM ; LV with broad zone of the fusion on the VM behind the antero-ventral contact knob.

Description :

LV - in lateral view AM low and regularly rounded passing into to the very long and slightly rounded ADM ; DM short and slightly rounded ; PM oblique, abrupt and almost straight passing into the regularly rounded PVM ; VM slightly concave or almost straight ; valve sub-trapezoidal in shape ; in dorsal view VM enlarged just behind the antero-ventral contact-knob ; H_{max} situated at mid-length, E_{max} behind the muscle scars.

RV - in lateral view AM high and regularly rounded, ADM long, almost straight, DM short, straight or rounded and sloping towards anterior, cardinal angles rounded ; PM oblique, abrupt and almost straight passing into the regularly rounded PVM ; VM slightly

concave at the mid-length ; valve high, flattened and sub-trapezoidal in shape ; H_{max} situated at posterior, E_{max} at centre.

Sexual dimorphism : not observed.

Overlap: not observed in dorsal view ; LV strongly overlaps the RV at the ventral side.

Muscle scars : *Cypria* arrangement.

Hinge : adont.

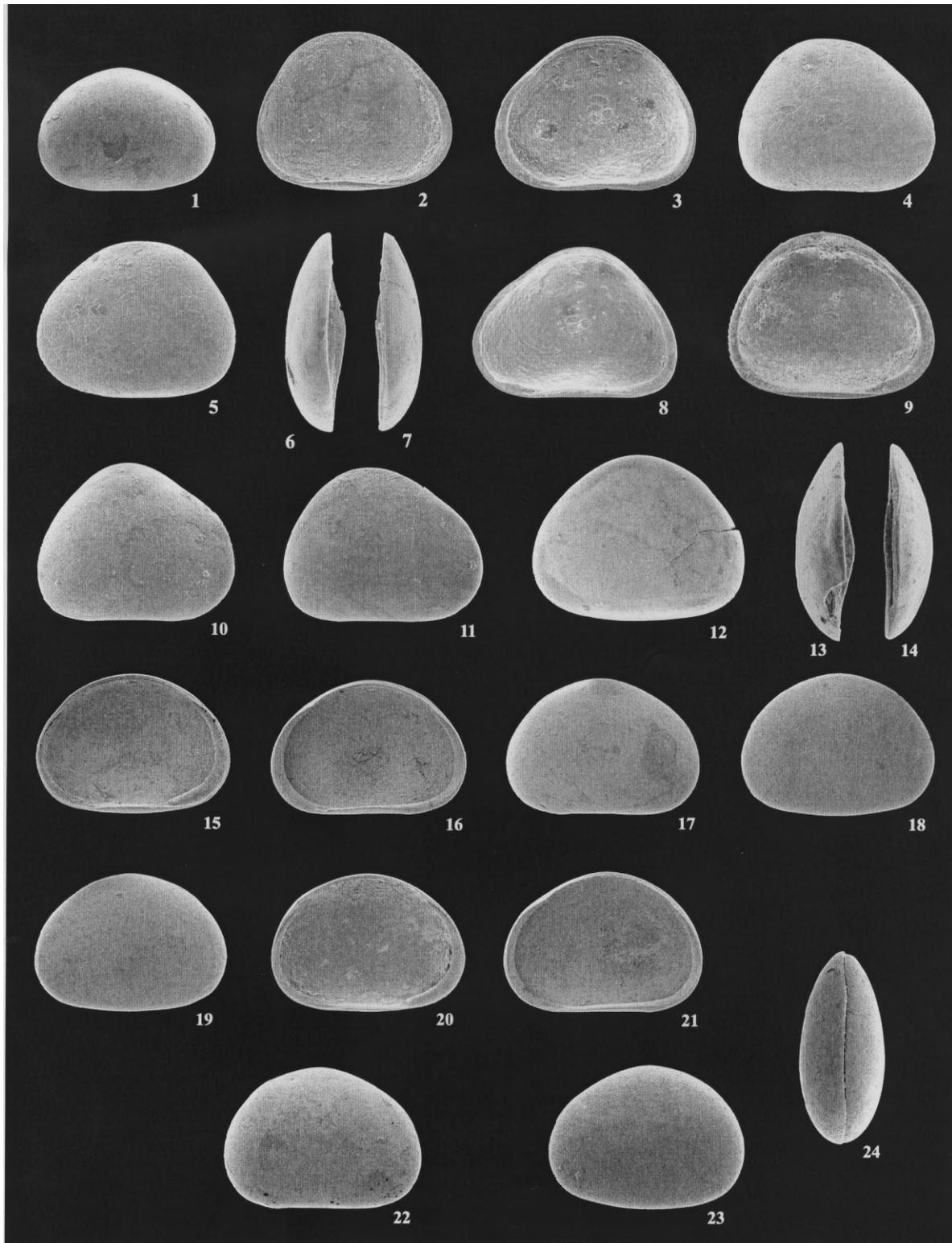
Ornamentation : smooth.

Normal pore canals : simple, regularly distributed over the surface..

Marginal zone (Fig. 2a) : zone of the fusion narrow at both ends, wide at VM of the LV and narrow on the RV ; inner lamella very narrow in anterior and posterior and large at VM ; vestibulum narrow ; line of concrescence and IM parallel to OM at anterior and posterior ; it is straight at VM ; selvage at VM of the LV ; marginal pore canals short, simple and well developed also at VM.

Material and dimensions : about 30 adult valves.

Plate 1. Fig. 1. = *Cyclocypris laevis* (O.F. Müller, 1776). 1 RV, l = 0.492 mm, h = 0.337 mm ; No. RP9-40, Zemné, Pokorný's collection ; external lateral view. Figs 2-7 = *Cypria servica* Krstič, 1975. 2 LV, l = 0.549 mm, h = 0.451 mm ; No. RP15-4, borehole HGB-3, 55.5 m ; internal lateral view. 3 RV, l = 0.529 mm, h = 0.394 mm ; No. RP15-1, borehole HGB-3, 54.2 m ; internal lateral view. 4 RV, l = 0.551 mm, h = 0.42 mm ; No. RP15-2, borehole HGB-3, 55.5 m ; external lateral view. 5 LV, l = 0.557 mm, h = 0.439 mm ; No. RP15-5, borehole HGB-3, 55.5 m ; external lateral view. 6 LV, l = 0.546 mm, h = 0.435 mm, e = 0.157 mm ; No. RP15-6, borehole HGB-3, 54.2 m ; dorsal view. 7 RV, l = 0.543 mm, h = 0.412 mm, e = 0.118 mm ; No. RP15-3, borehole HGB-3, 55.5 m ; dorsal view. Figs 8-14 = *Cypria isosceles* n.sp. 8 RV, holotype, l = 0.549 mm, h = 0.422 mm ; No. RP15-7, borehole HGB-3, 54.6 m ; internal lateral view. 9 LV, paratype, l = 0.569 mm, h = 0.471 mm ; No. RP15-11, borehole HGB-3, 104.8 m ; internal lateral view. 10 RV, paratype, l = 0.589 mm, h = 0.471 mm ; No. RP15-9, borehole GT-14, 177.5-177.6 m ; external lateral view. 11 RV, paratype, l = 0.571 mm, h = 0.434 mm ; No. RP15-8, borehole HGB-3, 104.8 m ; external lateral view. 12 LV, paratype, l = 0.589 mm, h = 0.465 mm ; No. RP15-12, borehole GT-14, 177.5-177.6 m ; external lateral view. 13 LV, paratype, l = 0.569 mm, h = 0.471 mm, e = 0.18 mm ; No. RP15-13, borehole HGB-3, 207.3-207.5 m ; dorsal view. 14 RV, paratype, l = 0.569 mm, h = 0.434 mm, e = 0.137 mm ; No. RP15-10, borehole HGB-3, 207.3-207.5 m ; dorsal view. Figs 15-24 = *Cypria lenticulata* n.sp. 15 LV♀, holotype, l = 0.49 mm, h = 0.347 mm ; No. RP4-43, Slovenské Pravno - field road PC4 ; internal lateral view. 16 RV♀, paratype, l = 0.473 mm, h = 0.316 mm ; No. RP4-46, Slovenské Pravno - field road PC4 ; internal lateral view. 17 RV♀, paratype, l = 0.475 mm, h = 0.333 mm ; No. RP4-45, Slovenské Pravno - field road PC4 ; external lateral view. 18 LV♀, paratype, l = 0.486 mm, h = 0.347 mm ; No. RP4-44, Slovenské Pravno - field road PC4 ; external lateral view. 19 LV♀, paratype, l = 0.484 mm, h = 0.353 mm ; No. RP4-42, Slovenské Pravno - field road PC4 ; external lateral view. 20 LV♂, paratype, l = 0.524 mm, h = 0.373 mm ; No. RP4-48, Slovenské Pravno - field road PC4 ; internal lateral view. 21 RV♂, paratype, l = 0.506 mm, h = 0.359 mm ; No. RP4-49, Slovenské Pravno - field road PC4 ; internal lateral view. 22 RV♂, paratype, l = 0.525 mm, h = 0.369 mm ; No. RP4-56, Slovenské Pravno - field road PC4 ; external lateral view. 23 LV♂, paratype, l = 0.516 mm, h = 0.375 mm ; No. RP4-52, Slovenské Pravno - field road PC4 ; external lateral view. 24 C♀, paratype, l = 0.527 mm, h = 0.373 mm, e = 0.236 mm ; No. RP4-53, Slovenské Pravno - field road PC4 ; dorsal view.



Remarks : The holotype and the paratype described by Krstić (1975) are larger ($l = 0.61$ mm ; $h = 0.51$ mm). Their h/l ratio (0.836, resp. 0.817) is also higher than that of the individuals from the Turiec Basin. The LV is more rounded at VM and less rounded at its DM. The RV is not so concave.

Cypria dorsoconcava Krstić 1975 from the brackish Pannonian deposits of the Serbia is larger with concave DM. H_{max} of the RV is located at the posterior (Krstić 1975). *C. tocorjescui* Hanganu 1962 from the Upper Miocene of the Central Paratethys has the DM longer, it's AM and PM are more abrupt (Sokac 1972). *C. isosceles* n.sp. is triangular with line of concrescence curved at the VM. Its point of inflection is rounded.

Geographic and stratigraphic distribution : fossil species are known from the Pannonian (Upper Miocene) of the Yugoslavia (Central Paratethys) (Krstić 1975).

Regional distribution : borehole GT-14, borehole HGB-3.

Cypria isosceles n.sp.

Plate 1, Figs. 8-14 ; Plate 2, Fig. 16 ; Text-fig. 2b

Derivatio nominis : gr. ἰσοσκεῖλος - isosceles, after the triangular shape of the valves.

Holotype : RV, No. RP15-7 ; Plate 1, Fig. 8 ; Plate 2, Fig. 16.

Paratypes: Plate 1, Fig. 9-14 (No. RP15-8, No. RP15-9, No. RP15-10, No. RP15-11, No. RP15-12, No. RP15-13).

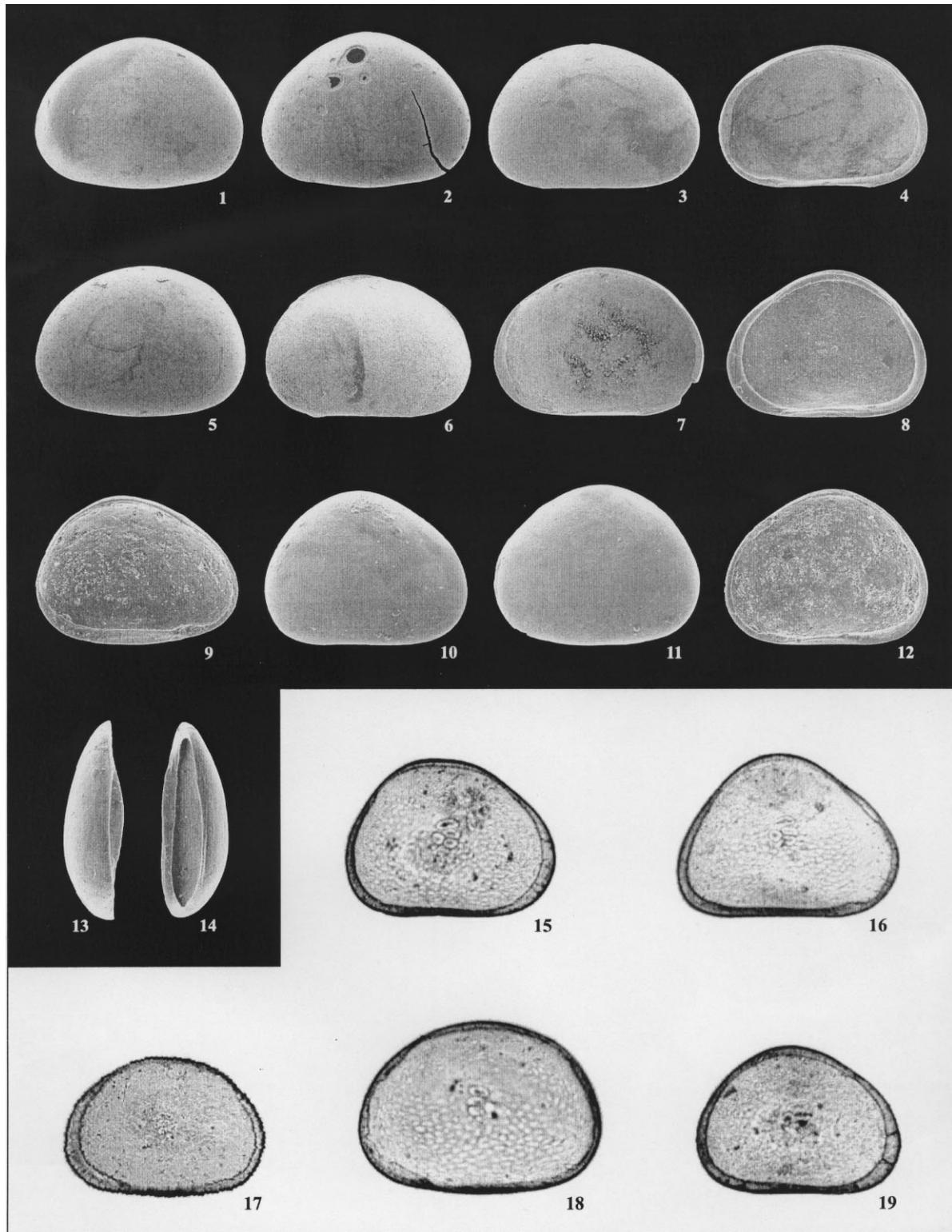
Locus typicus: borehole HGB-3, sample 104.8 m, Turiec Basin (Slovakia) ; co-ordinates - $48^{\circ}51'$ N and $18^{\circ}46'$ E.

Stratum typicum : Upper Miocene.

Table 3. Dimensions of *Cypria isosceles* n.sp., borehole HGB-3, 104.8 m.

	n	l	h	h/l	
A	RV, holotype	0.549	0.422	0.769	
	LV	1	0.569	0.471	0.828
atypical individuals	RV	3	0.531 – 0.571	0.373 – 0.434	0.701 – 0.786
	LV	3	0.524 – 0.535	0.404 – 0.414	0.769 – 0.781
A-1	RV	2	0.531 – 0.551	0.373 – 0.396	0.701 – 0.719
	LV	3	0.47 – 0.49	0.355 – 0.373	0.728 – 0.779
A-2	RV	2	0.469 – 0.471	0.349 – 0.353	0.745 – 0.75
	LV	1	0.412	0.3	0.729
A-3	RV	2	0.396 – 0.435	0.302 – 0.316	0.725 – 0.762
	RV	1	0.353	0.261	0.739

Plate 2. Figs 1-7 = *Cypria polyphema* n.sp. 1 LV, holotype, $l = 0.551$ mm, $h = 0.396$ mm ; No. RP3-30, Slovenské Pravno - field road PC4 ; external lateral view. 2 LV, paratype, $l = 0.582$ mm, $h = 0.431$ mm ; No. RP3-31, Martin MT-33 ; external lateral view. 3 RV, paratype, $l = 0.549$ mm, $h = 0.375$ mm ; No. RP3-36, Slovenské Pravno - field road PC4 ; external lateral view. 4 RV, paratype, $l = 0.55$ mm, $h = 0.376$ mm ; No. RP3-37, Slovenské Pravno - field road PC4 ; internal lateral view. 5 LV, paratype, $l = 0.612$ mm, $h = 0.451$ mm ; No. RP3-35, Martin MT-33 ; external lateral view. 6 RV, paratype, $l = 0.567$ mm, $h = 0.414$ mm ; No. RP3-32, Slovenské Pravno - field road PC4 ; external lateral view. 7 RV, paratype, $l = 0.578$ mm, $h = 0.41$ mm ; No. RP3-33, Slovenské Pravno - field road PC4 ; internal lateral view. Figs 8-14 = *Cypria bodergatiae* Pipík n.sp. 8,14 RV♀, holotype, $l = 0.512$ mm, $h = 0.38$ mm, $e = 0.12$ mm ; No. RP14-22, borehole HGB-3, 104.8 m ; 8 - internal lateral view, 14 - dorsal view. 9, 13 LV♀, paratype, $l = 0.492$ mm, $h = 0.392$ mm, $e = 0.122$ mm ; No. RP14-25, borehole HGB-3, 104.8 m ; 9 - internal lateral view, 13 - dorsal view. 10 RV♀, paratype, $l = 0.5$ mm, $h = 0.375$ mm ; No. RP14-23, borehole HGB-3, 104.8 m ; external lateral view. 11 LV♀, paratype, $l = 0.496$ mm, $h = 0.388$ mm ; No. RP14-26, borehole HGB-3, 104.8 m ; external lateral view. 12 RV♂, paratype, $l = 0.514$ mm, $h = 0.394$ mm ; No. RP14-24, borehole HGB-3, 104.8 m ; internal lateral view. Fig. 15 *Cypria servica* Krstić, 1975 ; RV, $l = 0.529$ mm, $h = 0.394$ mm ; No. RP15-1, borehole HGB-3, 54.2 m ; external lateral view. Fig. 16. *Cypria isosceles* n.sp. ; RV, holotype, $l = 0.549$ mm, $h = 0.422$ mm ; No. RP15-7, borehole HGB-3, 54.6 m ; external lateral view. Fig. 17. *Cypria lenticulata* n.sp. ; LV♀, holotype, $l = 0.49$ mm, $h = 0.347$ mm ; No. RP4-43, Slovenské Pravno - field road PC4 ; external lateral view. Fig. 18. *Cypria polyphema* n.sp. ; LV, holotype, $l = 0.551$ mm, $h = 0.396$ mm ; No. RP3-30, Slovenské Pravno - field road PC4 ; external lateral view. Fig. 19. *Cypria bodergatiae* Pipík n.sp. ; RV♀, holotype, $l = 0.512$ mm, $h = 0.38$ mm ; No. RP14-22, borehole HGB-3, 104.8 m ; external lateral view.



Diagnosis : A species with triangular valve in shape ; in dorsal view VM enlarged strongly on the LV and weakly on the RV ; zone of the fusion very enlarged at VM of the LV ; course of the line of concrescence at ventral opposite to course of the VM (Fig. 2b).

Description :

LV - in lateral view AM low and regularly rounded, DM triangular, PM oblique, abrupt and slightly rounded, PVM rounded, VM largely rounded ; valve triangular in shape ; in dorsal view VM strongly enlarged ; H_{max} situated at the centre, E_{max} behind the muscle scars.

RV - in lateral view AM high and regularly rounded, DM triangular and curved at the point of inflexion, PM straight, PVM rounded, VM largely concave ; valve flattened, triangular in shape ; in dorsal view VM slightly enlarged ; H_{max} situated behind mid-length, E_{max} behind muscle scars.

Atypical individuals : outline identical with normal individuals ; their zone of the fusion is very narrow at VM.

Sexual dimorphism : not observed.

Overlap : in ventral view LV strongly overlaps the RV.

Muscle scars : *Cypria arrangement*.

Hinge : adont.

Ornamentation : surface smooth or covered by weak punctuation.

Normal pore canals : simple, regularly distributed over the surface.

Marginal zone (Fig. 2b) : zone of the fusion narrow at anterior and posterior, very wide at VM of the LV ; it is narrow on the RV ; inner lamella narrow anteriorly and somewhat narrower posteriorly, vestibulum narrow ; line of concrescence and inner margin parallel at anterior and posterior ; course of the line of concrescence at ventral opposite to course of the VM ; selvage at VM of the LV ; marginal pore canals short, simple and well developed also at VM.

Material and dimensions : about 30 adult valves and a few tens of juveniles.

Remarks : It is necessary to emphasise the very broad zone of fusion on the LV of *C. isosceles* n.sp. which distinguishes it from the other species of the Turiec Basin. *Cypria servica* Krstić from the Turiec Basin has a subtrapezoidal shape with straight DM. Its line of concrescence is always straight at the VM. *C. bodergatiae* n.sp. is smaller, subcircular to subtriangular. The triangular forms of *Cypria* are well-known from the Upper Miocene of SE Pannonian Basin but their morphological characteristics well differentiate them from *C. isosceles* n.sp. *C. triebeli* Krstić 1975 has straight DM, *C. siboviki* Krstić 1975 has rounded DM and anterior and posterior of the same height (Krstić 1975). With an equilateral triangle shape, outline of *Advenocypris alpherovi* Schneider 1956 from the Sarmatian deposits of the former USSR presents an extremely symmetrical form (Mandelstam & Schneider 1963). H_{max} of *C. karamani* Petkovski 1976 and *C. sketi* Petkovski 1976, both the recent species from the former Yugoslavia, is situated at the mid-length ; their IM is almost parallel with the outline at the VM. In dorsal view, *C. sketi* is wider posteriorly (Petkovski 1976).

Regional distribution : Abramová - Kolísky, Slovenské Pravno - Sokol, Socovce, borehole GT-14, borehole HGB-3, borehole Mosovce TK-I, borehole Bodorová TK-17.

Cypria lenticulata n.sp.

Plate 1, Figs. 15-24 ; Plate 2, Fig. 17 ; Text-fig. 2c

Derivatio nominis: lat. lenticularis - having the shape of the lens, after the lentil-like outline of the valves.

Holotype: LV♀, No. RP4-43 ; Plate 1, Fig. 15 ; Plate 2, Fig. 17.

Paratypes: Plate 1, Fig. 16-24 (No. RP4-42, No. RP4-44, No. RP4-45, No. RP4-46,

Table 4. Dimensions of *Cypria lenticulata* n.sp., Slovenské Pravno - field road PC 4.

	n	l	φ	h	φ	h/l	φ
A	LV♀, holotype	0.49	-	0.347	-	0.708	-
	LV♂	0.506 - 0.535	0.518	0.359 - 0.388	0.372	0.696 - 0.739	0.718
	RV♂	0.48 - 0.529	0.508	0.337 - 0.375	0.354	0.676 - 0.726	0.697
	LV♀	0.473 - 0.512	0.49	0.333 - 0.361	0.35	0.677 - 0.732	0.713
	RV♀	0.467 - 0.512	0.487	0.317 - 0.353	0.336	0.665 - 0.709	0.69

No. RP4-48, No. RP4-49, No. RP4-52, No. RP4-53, No. RP4-56).

Locus typicus: Slovenské Pravno - field road, sample PC 4, Turiec Basin (Slovakia) ; co-ordinates - 48° 53' N and 18° 46' E.

Stratum typicum: Upper Miocene.

Diagnosis: small subcircular species ; in dorsal view contour inflated and symmetrical on the LV and asymmetrical on the RV ; course of the overlap sinusoidal at DM, PVM of the RV carrying a small expansion.

Description :

LV♀ - in lateral view AM regularly rounded, DM rounded, PM rounded, VM slightly convex ; in dorsal view contour inflated and symmetric ; valve subcircular in shape ; H_{max} situated at mid-length, E_{max} behind muscle scars.

RV♀ - in lateral view AM high and rounded, DM rounded or slightly triangular, PM rounded, VM concave ; in dorsal view contour slightly inflated and symmetrical ; valve subcircular in shape ; PVM carrying a small expansion ; $H♀$ at centre, $E♀$ behind muscle scars.

LV♂ - in lateral view AM rounded, lower than PM ; ADM almost straight, DM rounded, PM high and rounded, VM slightly convex ; in dorsal view contour slightly inflated and asymmetrical ; valve subcircular in shape ; H_{max} situated at mid-length, E_{max} at posterior.

RV♂ - in lateral view AM rounded and lower than PM, DM slightly triangular with rounded point of inflection, PDM angled, PM rounded, VM slightly concave ; in dorsal view contour slightly inflated and symmetrical ; valve subcircular in shape ; PVM carrying a small expansion ; H_{max} situated at centre, E_{max} at posterior.

Sexual dimorphism : the morphological differences between the sexes are weak ; in the lateral view the males are higher and angled at PDM while the females are broader

Overlap : irregular, sinusoidal at DM, LV overlaps the RV at both ends.

Muscle scars : *Cypria* arrangement.

Hinge : adont.

Ornamentation : smooth.

Normal pore canals : simple, regularly distributed over the surface.

Marginal zone (Fig. 2c) : zone of the fusion narrow at anterior and posterior, twice as large at VM ; inner lamella narrow ; vestibulum narrow ; line of conrescence and IM parallel to OM except of VM ; they are

firstly slightly curved and then straight ; marginal pore canals short, fine, straight, more dense at AVM.

Material and dimensions : about 300 adult valves.

Remarks : The outline of *Cypria lenticulata* n.sp. in external lateral view is rather similar to *Cyclocypris*. The presence of only one antero-ventral contact-knob differentiates it from the *Cyclocypris* species which have two ventral contact knobs (Morkhoven 1962). The outline of *Cypria lenticulata* n.sp. seems morphologically very similar to the recent Middle European species especially to *Cypria ophthalmica* (Jurine 1820) whose morphology is quite variable. *C. ophthalmica* is larger (0.54-0.70 mm) ; its DM is largely and regularly rounded ; the VM is slightly concave (Meisch 2000). *Cypria reptans* 1928 Bronshtein has a broader inner lamella with more concave VM. *Cypria exsculpta* (Fischer 1855) has longitudinal striation on the valves. *Cypria subsalsa* Redeke 1936 is more elliptical ; its DM is largely rounded. *Cypria sywulae* Meisch 2000 is broader with more symmetrical and almost circular outline. The line of overlap in dorsal view of all the mentioned species is straight or slightly curved before mid-length (Sywula 1974, Meisch 2000). On the other hand, it is sinusoidal in *C. lenticulata* n.sp.

Regional distribution : Slovenské Pravno - field road. It is known also from the Martin locality although not from its actual profile.

Cypria polyphema n.sp.

Plate 2, Figs. 1-7, 18 ; Text-fig. 2d

Derivatio nominis: lat. Polyphemos - Polyphemos, son of Neptune in Greek mythology, cyclop ; according to eye shape of the outline.

Holotype: LV, No. RP3-30 ; Plate 2, Fig. 1, 18.

Paratypes: Plate 2, Fig. 2-7 (No. RP3-31, No. RP3-32, No. RP3-33, No. RP3-35, No. RP3-36, No. RP3-37).

Locus typicus: Martin, sample MT-33, Turiec Basin (Slovakia) ; co-ordinates - 49° 04' N and 18°53' E.

Stratum typicum: Upper Miocene.

Diagnose : subcircular and slightly inflated in shape ; OM of the LV exceeds outline at ventral side ; PVM of the RV carrying a small expansion ; zone of the fusion narrow at VM ; line of conrescence follows the changes of the VM.

Description :

LV adult - in lateral view AM and DM regularly rounded, PM rounded, VM straight or convex ; valve slightly inflated and subcircular in shape ; ventral area exceeds OM ; in dorsal view VM slightly inflated and

Table 5. Dimensions of *Cypria polyphema* n.sp., Slovenské Pravno - field road PC 4 ;
* - LV from Slovenské Pravno - field road PC 1, PC 4 and Martin MT-33.94.

		n	l	φ	h	φ	h/l	φ
A	LV, holotype		0.551	-	0.396	-	0.719	-
	LV*	5	0.551-0.612	0.582	0.396-0.451	0.428	0.719-0.742	0.735
	RV	4	0.569 – 0.583	-	0.395 – 0.414	-	0.695 – 0.728	-
atypical	LV	15	0.531 – 0.569	0.549	0.375 – 0.398	0.39	0.693 – 0.727	0.71
individuals	RV	11	0.527 – 0.555	0.544	0.353 – 0.386	0.37	0.652 – 0.708	0.681
A-1	LV	25	0.453 – 0.524	0.48	0.316 – 0.369	0.333	0.675 – 0.713	0.695
	RV	31	0.451 – 0.494	0.474	0.298 – 0.343	0.315	0.646 – 0.7	0.664
A-2	LV	4	0.404 – 0.422	-	0.278 – 0.29	-	0.676 – 0.689	-
	RV	3	0.393 – 0.394	-	0.257 – 0.267	-	0.653 – 0.677	-

symmetrical ; H_{max} situated slightly before mid-length of the valve, E_{max} in central area.

RV adult - in lateral view rounded AM pass to straight ADM, DM rounded, PDM rounded to slightly rounded, PM rounded, VM straight ; valve slightly inflated and subcircular in shape ; PVM carrying a small expansion ; H_{max} situated at middle of the length, E_{max} in posterior area.

LV atypical - in lateral view AM rounded, DM rounded before a point of inflection, oblique and almost straight behind it, PDM slightly curved, PM rounded, VM convex, slightly inflated subcircular in shape ; in dorsal view outline enlarged and symmetrical ; H_{max} situated before mid-length, E_{max} at centre.

RV atypical - in lateral view AM rounded, DM slightly triangular, PM rounded, VM concave ; slightly inflated subcircular in shape ; in dorsal view outline symmetrical and very slightly inflated ; PVM carrying a small expansion ; H_{max} situated at centre or before mid-length, E_{max} at centre of the valve.

Sexual dimorphism : difficult to distinguish.

Overlap : LV overlaps RV.

Muscle scars : *Cypria* arrangement.

Hinge : adont.

Ornamentation : smooth.

Normal pore canals : simple, regularly distributed over the surface.

Marginal zone (Fig. 2d) : zone of the fusion narrow over all its length, inner lamella narrow, wider at VM ; vestibulum narrow ; line of conrescence parallel to

OM over all its length ; it follows the line of OM ventrally ; IM parallel to OM at anterior and posterior ; it is slightly curved at area of antero-ventral contact-knob then straight until the posterior end of the VM ; marginal pore canals simple, thin, short, fairly dense over all the length of AVM, very rare at ADM.

Material and dimensions : 17 adult valves, about 40 valves of atypical individuals and 90 juveniles valves.

Remarks : The line of overlap at DM of *Cypria subsalsa* is straight behind the mid-length. In internal view, the LV is concave at VM and its h/l ratio is lower than that of *C. polyphema* n.sp. *C. lenticulata* n.sp. is smaller ; its zone of fusion is broad at VM.

Cypria ophthalmica has straight or concave VM and more circular and wider postero-dorsal part. The inner lamella of *Cypria reptans* is broad (Sywula 1974, Meisch 2000).

The LV of *Cypria obesa* Sharpe 1897 from the Pleistocene of Illinois (USA) with H_{max} anteriorly is close to the atypical individuals of *C. polyphema* n.sp., but the adults of *C. obesa* are larger, more elongated and with slightly triangular DM (Staplin 1963).

Cypria polyphema n.sp. is larger and more circular than *C. abbreviata* (Reuss 1850) from the Pannonian of the Central Paratethys which has strongly calcified valves ; its zone of fusion is narrow at VM (Jiříček 1985, Pipík 1996).

Regional distribution : Lehôtka, Slovenské Pravno - field road, Martin, Bystricka, borehole Vel'ký Čepčín TK-11.

Cypria bodergatae Pipík n.sp.

Plate 2, Fig. 8-14, 19 ; Text-fig. 2e

Derivation nominis : after Dr. Anne-Marie Bodergat, french ostracodologist.

Holotype: RV, No. RP14-22 ; Plate2, Fig. 8, 14, 19.

Paratypes: Plate2, Fig. 9-13 (No. RP14-23, No. RP14-24, No. RP14-25, No. RP14-26).

Locus typicus: borehole HGB-3, sample 104.8 m, Turiec Basin (Slovakia) ; co-ordinates - 48° 51' N and 18° 46' E.

Stratum typicum: Upper Miocene.

Diagnose: subtriangular to subelliptical small-sized species ; in dorsal view VM of the LV large, broad and symmetrical.

Description :

LV♀ - in lateral view AM low and rounded, DM at first straight then strongly curved, VM slightly concave ; subtriangular to subelliptical in shape ; in dorsal view VM symmetrically rounded ; H_{max} situated at the mid-length, E_{max} right behind the muscle scars.RV♀ - in lateral view AM regularly rounded and high, ADM oblique and straight or slightly concave, DM slightly triangular and curved at its point of inflexion, DM at first slightly curved and then strongly curved, VM slightly concave at the level of the muscle scars ; subtriangular to subcircular in shape ; in dorsal view VM very slightly enlarged or almost straight ; H_{max} is situated behind the mid-length, E_{max} in posterior area.

LV♂ - not known.

RV♂ - in lateral view AM regularly rounded, ADM straight, DM at first slightly rounded, abrupt and then strongly curved, VM slightly concave ; circular in shape ; in dorsal view VM very slightly enlarged or almost straight ; H_{max} situated at mid-length, E_{max} in posterior area.

Sexual dimorphism : the male is more enlarged at the PDM and more abrupt at its PM, the females are more triangular.

Overlap: not observed.

Muscle scars : *Cypria* arrangement.

Hinge: adont.

Ornamentation: smooth.

Normal pore canals: simple, regularly distributed over the surface.

Marginal zone (Fig. 2e) : zone of the fusion narrow, wide at VM of the LV ; inner lamella very narrow posteriorly, larger anteriorly ; vestibulum narrow ; line of concrescence and IM parallel to OM at anterior and posterior ; it is parallel to selvage at VM of the LV ; marginal pore canals short, straight, thin and denser at AVM than ADM ; a few marginal pore canals are also developed at VM.

Material and dimensions : 76 adult valves.

Remarks : *Cypria isosceles* n.sp. is triangular. Its juveniles are more flattened on the dorsal area and their H_{max} is situated at the anterior. DM of *C. servica* is straight ; VM is asymmetrical. Valves of *C. polyphema* are slimmer and subcircular ; its zone of the fusion is always thin at VM. *Cypria exsculpta* is plumper. DM of *Cypria ophthalmica* is bow-shaped as in *C. helokrenica* Kantorek & Absolon 1975, recent species, in which the inner lamella is larger (Sywula 1974, Kantorek & Absolon 1975, Meisch 2000). The left valve of *C. dorsalta* Malz & Moayedpour 1973 from the Miocene of the Germany has DM longer, more rounded and symmetrical. H_{max} of the right valve is situated more posteriorly ; its PM is more abrupt (Malz & Moayedpour 1973). H_{max} of *C. karamani* and *C. sketi* is situated at mid-length ; their IM is almost parallel with OM. *C. sketi* is larger posteriorly in dorsal view ; its right valve is more triangular (Petkovski 1976).

Regional distribution : borehole HGB-3, Slovenské Pravno-Sokol.

Remarks on the morphology and the ecological distribution of the *Cypria* speciesIn *Cypria* known in Recent environments, the valves of both sexes are either identical (*C. subsalsa*, *C. sywulae*, *C. karamani*), or the females ones are a littleTable 6. Dimensions of *Cypria bodergatae* n.sp., borehole HGB-3, 104.8 m.

	n	l	φ	h	φ	h/l	φ
A	RV♀, holotype	0.512	-	0.38	-	0.742	-
	RV♂	0.514	-	0.394	-	0.767	-
	LV♀	0.491 – 0.512	0.5	0.382 – 0.394	0.39	0.768 – 0.797	0.779
	RV♀	0.492 – 0.512	-	0.373 – 0.385	-	0.743 – 0.78	-

larger with the dorsal margin convex and the anterior margin regularly-rounded and more or less large (*C. ophthalmica*, *C. exsculpta*) (Sywula 1974, Petkovski 1976, Bronshtein 1988, Meisch 2000).

The sexual organs impressions are not always seen in the *Cypria* of the Turiec Basin. The bi-modal distribution of the length and height of the *C. lenticulata* n.sp. valves gives evidence of intra-specific variability (Fig. 3). The differences between the valves are particularly conspicuous on the postero-dorsal and posterior area where the sexual organs are located. We suppose the morphometric differences observed have their origin in sexual dimorphism. The males would be higher and angled on the postero-dorsal margin and the females more or less broadened.

The sexual dimorphism is also manifest in *C. bodergatae* n.sp. but for the three other species described in this paper the differences between both sexes are not evident.

Heterochronous development (peramorphosis with acceleration) (McNamara 1986, Godfrey & Sutherland

1995) is noticed in some juveniles of *C. isosceles* n.sp. and *C. polyphema* n.sp. Indeed, their outline is similar to the adult specimens but their size is slightly smaller; the other morphological characters - very narrow zone of fusion and lower calcification - are the juvenile ones. This anomaly is frequent in Slovenské Pravno - field road locality which has provided 32 ostracod species (*Candona*, *Euxinocythere*, *Herpetocypris*, *Darwinula*, *Candonopsis*). In *Cypria polyphema* n.sp., the maximum height of abnormal individuals is on the left valve in front of mid - length. This character is only observed in the juvenile specimens. So, we could assume they belong to other species but it is only an hypothesis. It would be interesting to know the parameters which induce the variations of shape in ontogeny of species.

In the Turiec Basin, the minimum and maximum length range lies in the lower limit of the genus (Fig. 4). Among the *Cypria* species, *C. bodergatae* n.sp. and *C. lenticulata* n.sp. are the shortest species known in Europe from the Miocene to the Recent. Their maximum length does not reach more than 0,55 mm. The *C.*

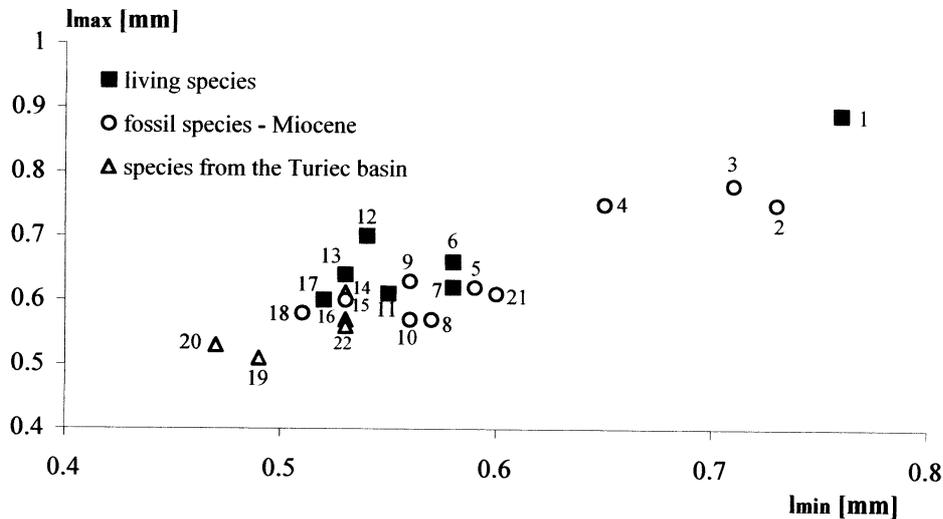


Fig. 4. Size of the *Cypria* species since Miocene as a minimum length (l_{min}) vs. maximum length (l_{max}). The species from the Turiec Basin are situated at the lower limit of the genus. 1. *Cypria exsculpta* (Fischer); 2. *C. triebeli* Krstić; 3. *C. dorsoconcava* Krstić; 4. *C. reniformis* (Hejjas); 5. *C. pannonica* Krstić; 6. *C. reptans* Bronshtein; 7. *C. karamani* Petkovski; 8. *C. siboviki* Krstić; 9. *C. teslae* Krstić; 10. *C. tocorjescui* Hanganu; 11. *C. sywulae* Meisch; 12. *C. ophthalmica* (Jurine); 13. *C. subsalsa* Redeke; 14. *C. polyphema* n.sp.; 15. *C. abbreviata* (Reuss); 16. *C. isosceles* n.sp.; 17. *C. skeiti* Petkovski; 18. *C. dorsalta* Malz & Moayedpour; 19. *C. bodergatae* n.sp.; 20. *C. lenticulata* n.sp.; 21. *C. servica* Krstić (from Belgrade area); 22. *C. servica* from the Turiec Basin (size of the species after Janz 1997, Jiríček 1985, Krstić 1975, Meisch 2000, Petkovski 1976, Reuss 1850).

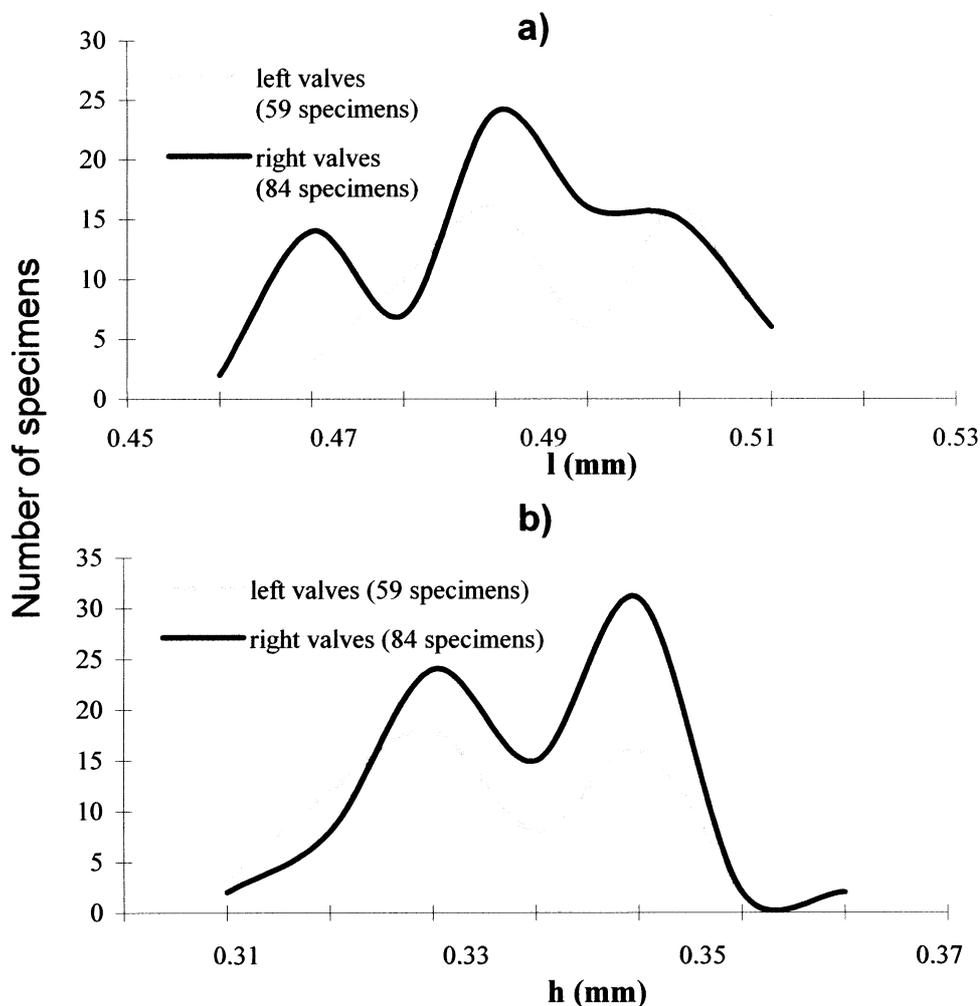


Fig. 3. Length (Fig. 3a) and height (Fig. 3b) distribution of the specimens of *Cyprina lenticula*. A bimodal distribution of the valves results from the presence of sexual dimorphism. The males would be longer and higher than the females (see also Table 4).

servica Krstić individuals from Yugoslavia (Krstić 1975) are also larger than the Turiec ones. According to Martens (1994), the small size of species characterizes the endemic ones of the Ancient lakes.

The shape of the three new species of *Cyprina* we have described in this paper is triangular, sub-triangular and sub-triangular to sub-elliptical. It is slightly different to the sub-circular one of *C. polyphema* n.sp. and *C. lenticulata* n.sp.

Cyprina have been recorded in every area of the Turiec Basin (Fig.1). The three former species have been found in the *Candona aculeata-armata-stagnosa-nubila-simplaria* assemblage located in the central and southern area of the Turiec Basin. This assemblage includes trapezoidal, rectangular with sharp-pointed postero-ventral margin species and triangular *Candona* s.l. species. These shapes indicate small environmental fluctuations with a low temperature below

40 m in a profundal of the recent lakes (Dussart 1966, Carbonel et al. 1988). The triangular shapes of *Cypria* are also found in the Pannonian Basin (Central Paratethys) (Krstić 1975).

The sub-circular species (*C. polyphema* n.sp. and *C. lenticulata* n.sp.) have been found in the *Cypria lenticulata* and *Herpetocypris denticulata* assemblage and in *Candona clivosa* and *C. robusta-jiriceki* ones which occur in the northern part of the Turiec Basin and on its edge. The geological records which have provided these three assemblages are rich in recent species which occur in unstable environments (*Herpetocypris* Brady & Norman 1889, *Darwinula stevensoni* (Brady & Robertson 1870), *Vestalenula pagliolii* (Pinto & Kotzian 1961), *Heterocypris salina* (Brady 1868), *Pseudocandona compressa* (Koch 1838), *Fabaeformiscandona balatonica* (Daday 1894)) and in vegetal remains which attest a shallow freshwater environment (*Potamogeton*, *Nelumbium*, *Typha latissima*, Characeae) (Sitár 1966, Pipík 2001). This environment corresponds to a littoral to sub-littoral area subdued great ecological variations (Pipík 2001).

We assume the environment could have influenced on the external outline of the *Cypria* valves. The triangular and sub-triangular outline could correspond to the stable environment. In the *Cypria* of the Turiec Basin, the differences at the level of the zone of the fusion have a specific value. On the other hand the external outline of the valve would not have any relationship with the intra-specific variation (except the sexual dimorphism). The variations noticed at the level of the outer margin of the *Cypria* valves would be connected with ecological fluctuations in the Turiec Basin and consequently express an adaptation to the life-environment. Similar observations have already been made on recent Candoninae species in Europe (Danielopol 1978).

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