# ATLAS OF THE PANNONIAN AND PONTIAN OSTRACODS FROM THE EASTERN AREA OF THE PANNONIAN BASIN

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**Abstract.** The present paper is neither dogmatic, nor authoritative. In my view, palaeontology is a humanistic discipline which – apart from describing the hard skeleton (the palaeontologic species) and beyond it – attempts to suggest the time when the fossil species existed, their way of life, the morphologic change (called adaptation) they went through and, sometimes, show the evolution of life. Show how life grows. This work seeks to inquire, question, generate as many questions as possible, targeting new research. It is an Atlas and not a Monography, a monographic work. Hence, there is no description of the figured species (except for the new ones), since they had been described, in detail, by their authors. This work is meant for the bold and the open-minded scientist.

**Key words :** Ostracods, endemic ; species ; genre ; Pannonian ; Pontian ; brackish-water ; fresh-water

## INTRODUCTION

Let us remember that every aquatic basin evolution had its unique pattern, its own geological and ecological events and its individual fauna. In the brackish Paratethys realm, no stage is either homogeneous or uniform or similar in all regions, whether it was dubbed the Sarmatian, Pontian or Meotian. The Dacian and the Romanian belong exclusively to the Dacic Basin, while the Pannonian and its fauna belong to the Pannonian area. The existence of a stage, as well as its temporal and spatial dimension, and, in essence, the very existence of biostratigraphy is fauna-related, dependent upon the occurrence, the development and the extinction of the fauna or upon the extinction of part of its fauna. One stage is a faunal community existing in a certain space and at a certain time; in other words, it is a matter of Palaeoecology, just like world history means the history of human societies fragmented into eras, periods and cultures comparable to the geological stages and sub-stages where technological developments (namely, the emergence of new artifacts) take the place of fossils. Let us remember that, until recently, there were Palaeolithic cultures and that in the Neolithic, all the marginal human communities were living, technologically speaking, in the past. The Pannonian and the Pontian from the Pannonic Basin are dominated by two faunal groups: the mollusks and the ostracods. They are - more or less - the subject of biostratigraphy.

In a brackish-water lake, for instance, in the Pannonian Lake, everything had changed, from all points of view. Hence, the ostracod and mollusk fauna closely related to their environment, lead different forms of life in different regions. This makes correlating extremely difficult because we correlate 'environmental states', and not the time intervals of their existence. In other words, they are not always coeval. Once this is accepted, the 'palaeontologic zones' become useless tools (and arguments) for the biostratigrapher. That is why we describe the 'brackish-water archipelago', a fragmentized space and time, neither uniform nor stable, with a heterogenous fauna.

A 'brackish-water' stage (in fact, all the stages in the enormous space of the Paratethys. There are nearly fifty stages, many of which are but a short ecological episode, a passing decrease in salinity, like in the case of the '*Rzezakia*' or '*Spaniodontella* beds') is a distinct faunal unit, bound by an ecological event. The regeneration of the fauna into a new event is often dramatic, as in the cases of the Sarmatian – Meotian – Pontian boundary, the Dacian – Romanian boundary, or the Sarmatian – Pannonian and the Pontian - Paludinian boundaries. Also, there is the case of the 'non-existent boundary': the

case of the Pontian – Dacian, or the Pannonian – Pontian. In these latter cases, the fauna is fluid, there is no hiatus in its succession. This leads to a conventional limit, accepted unanimously (the occurrence of one or more new morphologic structures, like new genes, for example). Such a boundary is needed in the Pannonian to clearly separate the Lower Pontian (from the Pannonian) with a well-defined Middle Pontian (with *Congeria rhomboidea* and several exclusive ostracod species).

This paper describes several fossil deposits with their mollusk, as well as with their ostracod fauna. Those two are (the only) complementary fauna that should have 'moved' similarly, with time. Unfortunately, this was abused (the mollusk zones were 'filled' with ostracod species). Often – not always, certainly - they confirm each other. The young researchers will, hopefully, find the differences.

## THE BIOSTRATIGRAPHY IN THE LIGHT OF THE MOLLUSK

Papp (1951, 1953, 1975) divided the Pannonian *s.l.* into eight mollusk zones (A – H).

**A** – with transitional fauna, from the Sarmatian to the Pannonian (with *Replidacna praecarpatina, R. plancarinata* and some foraminifer species *Nonion granosum, Ammonia beccari*).

**B** – *Melanopsis impressa posterior, M. i. bonellii, Congeria ornithopsis*

**C** – *Melanopsis fossilis fossilis, M. f. constricta, M. vindobonensis, Congeria Hoernesi, C. partschi*

**D** – *Melanopsis fossilis constricta, M. vindobonensis vindobonensis, Congeria partschi partschi, C. ungula caprae, Limnocardium bochi, Arpaticardium conjungens*

**E** – *Melanopsis vindobonensis vindobonensis, Congeria subglobosa subglobosa, Limnocardium brunnense, Dreissenomya primiformis.* Appear variants of *Congeria partschi, C. zsigmondi, Arpadicardium carnuntium, A. schaedeli*.

**F** – The Pontian with fresh water fauna, *Unio wetzleri, Congeria neumayri*, *Dressenomia minima, Melanopsis bouei.* În this time appeared the first species of *Prosostenia*.

**G-H** – *Valvata (Cincinna), Pseudamnicola, Planorbis* etc.

Stevanovici (1951) divided the Pannonian into Pannonian s. str (Lower Pannonian, Lower Congeria beds, the zones A – E, respectively) and the Pontian s. str. (Upper Pannonian, Upper Congeria Beds, Papp zones F – H). The reason of the author was equivalency between „*Abichi* beds" with „*Congeria ungula caprea* beds" (in Tamnaya region) and between „*Congeria rhomboidea* beds" and „*C. triangularis* beds" (in Smederevo region). In 1985, he divided the Pannonian into Slavonian (A-D) and Servian (E) and the Pontian into Lower Pontian (or Novorossian) and the Upper Pontian (or Portaferrian).

Ebersin (1966) found two Pannonnian species, *Melanopsis impressa* and *Congeria praebanatica* in Middle Sarmatian sediments from extra carpathian region (Moldova). Moreover, Jeanrenaud (1963) found a lot of „Pannonian type species" in the Middle Sarmatian from Moldova.

In other word, the roots of Pannonian luxuriant fauna could be found in the brackish water Sarmatian communities.

## THE BIOSTRATIGRAPHY IN THE LIGHT OF THE OSTRACOD

Edith Brestenska (1961) divided the ostracod communities into a Pannonian *s.str* and a Pontian *s. Str* community. What did she say? She established the Pannonian – Lower Pontian (in fact, the Middle Pontian) boundary between „zones C – D" and „zones D – E", suggesting the non-sense of the palaeontological zones.

However, the avalanche of the zones continued. The newborn „mega-zones" appears, the Slavonian (lower and upper), Serbian (lower and upper), Pontian (two substages, Odessian and Portaferrian), each of them filled and even stuffed with ostracod (and mollusk) species and subspecies (Sokač, 1972, 1989 Krstič, 1972a, 1972b, 1973, 1989, Jiřiček, 1975, 1983. Each of these authors found another succesion of fossil species.

This fact suggests uncertainty in assessing the time when these species existed. And this brings us back to the ecological determinism, that is those conditions that allow for the life of a certain species in a specific areal.

## *HEMICYTHERIA* SPECIES DURING THE POST – SARMATIAN TIMES

Inside structure is cvasi similar for all *Hemicytheria* species from Pannonian to Pontian. The differences consist of just the types of lateral ornaments, shape and size of the ventral ridge (Olteanu, 2001).

In the case of *Hemicytheria folliculosa* (Reuss), the ventral ridge is reduced to thin hardly marked trace of it. The pits are arranged in more or less regularly rows. At *Hemicytheria brunnensis*, the surface of the valve is ornamented with polygonale meshes, larger on the central field of the valve. The ventral area bears few sinuous ribblets, which represents just discontinuous thickness of rims. The ventral longitudinale ribblets is homologous to the ventral ridge of „*omphalodes*".

*Hemicytheria marginata* Sokač is shorter, cvasi-truncated valve, closely related to „*folliculosa*" (the group without strong ventral ridge). The lateral surface of the valve is finely punctated, so that sometimes some individuals seem to be completely smooth. *Hemicytheria pannonica* Sokač is absolutely similar with „*marginata*".

*Hemicytheria croatica* Sokač has the same features, like another form of „*folliculosa*". Its deeper pits and the ventral ridge has a different appearance. It is much larger including more than two third of the total length of the valve.*Hemicytheria incerta* Sokač is similar with „*croatica*". It has a prolonged posterior margin, having concave dorsal margin and deep convexity in the ventral margin of the valve.

*Hemicytheria major* Sokač has its lateral surface covered with larger, polygonal meshes cvasi-similar with *H. reticulata* Sokač. It seems to be the same species, „*reticulata*"having anteriorly and posteriorly one well developed flange (not epines or denticles). Their juveniles are pitted surfaces. There is a tendency to punctuation for each meshe as a secondary process of ressorbtion.

Another group is *Hemicytheria dubokensis* Krstič, *H. prisca* Sokač, *H. pejinovicensis* (Zalanyi), *H. biornata* (Zalanyi). They are if not similar, however closely related one to each other. Their shapes are subrectangular with broadly rounded anterior margin, the same dimensions and one elevated ventral ridge. All these are more atenuated in the case of „*dubokensis*"(large and polygonal meshes, divided into 3-4-5 smaller alveolae). Between *Hemicytheria prisca* and *H. pajinovicensis* are not any differences. *Hemicytheria biornata* has another dimension of the ventral ridge than *H. reticulata* and its flange is resumed to the anterior margin of the valve.

The marginal epines (anterior and posterior), number of the marginal pore canals and type of reticulation are shown bellow:

| | Species name | Marginal epines | | Marginal pore canals | Meshes-pits |
|---|---|---|---|---|---|
| | | anterior | posterior | | |
| 1 | *H. folliculosa* (Reuss) | 8 | 4-5 | 75-80 | pits (constant) |
| 2 | *H. brunnesnsis* (Reuss) | 8-9 | 4-5 | 65-70 | meshes and pits |
| 3 | *H. croatica* Sokač | 8-9 | 4-5 | 70-75 | meshes and pits |
| | (=*H. incerta* Sokač) | 8-9 | 4-5 | 70-75 | meshes and pits |
| 4 | *H. biornata* (Zalanyi) | flange | flange | 50-55 | meshes |
| 5 | *H. reticulata* Sokač | flange | flange | 55-60 | meshes |
| 6 | *H. marginata* Sokač | 8-9 | 4-5 | 70-75 | meshes and pits |
| | (=*H. pannonica* Sokač) | 8-9 | 4-5 | 55-60 | meshes and pits |
| 7 | *H. major* Sokač | 8-9 | 4-5 | 70-75 | meshes and pits |
| 8 | *H. dubokensis* Krstič | – | 4-5 | 55-60 | meshes and pits |
| | (=*H. prisca* Sokač) | 8-9 | 4-5 | 60-65 | pits |
| 9 | *H. pejinovicensis* (Zalanyi) | 7-8 | 4-5 | 50-55 | pits |

Nadejda Krstič figured some new *Hemicytheria* species: *Aurila (Hemicytheria)* n.sp. (*setosa*) (Pl. 14, Fig. 1), *Aurila? (H.)* n. sp. (*bosniaca*) (Pl. 14, Fig. 3), *A.? (H.)* n. sp. (*pyrulaeformis*) (Pl. 13, Fig. 6) in the *Propontoniella candeo* and *Amplocypris abcissa* Zone.

Other new specie, *Aurila (H.) insignis* (Pl. 13, Figs 1, 2) is similar with *A. (H.) dubokensis*. (Pl. 13, Fig. 3)

## LOXOCONCHA STORY FROM THE CONGERIAN BEDS

Krstič (1972) figured twenty-one species, five of them are considered as new species. In 1985, she found them a place in her biozones (from 1 to 8, Slavonien, 1-4 and Serbien, 5-6):

*Loxoconcha porosa* (Mehes) (zone 1), *L. rhombovalis* (Pokorný) (zones 1-4), L. aff. *rhombovalis* Pokorný (synonym with *L. ornata* Schneider) (?), *L. petkovici* n. sp.(zones 2-4), *L. mulleri* (Mehaes) (?), *L. granifera* (Reuss) (3-6), *L. hodonica* Pokorný (1-6), *L. kolubarae* n. sp. (5-6), *L. subrugosa* Zalanyi (5-8), *L. fistulosa* n. sp.(7-8), *L. alitera* n. sp. (7-8), *L. kochi* Mehes, (1-8)

Pontian - *Loxoconcha* aff. *mitridata* Livental, *L. schweyeri* Suzin, L. cf. *eichwaldi* Livental, *L. granifera dudichi* Zalanyi *L. comsacui* n. sp., *L.* sp. 29, *L.* sp. 11, *L. djaffarovi* Schneider, and *L.* sp. 38.

Later, I found (Olteanu, 2000) the following species:

In Pannonian - *Loxoconcha schmidi* Cernajsek, *L.* aff. *ornata subornata* Stanceva, *L.* aff. *alveolata* Voroshilova, *L. inexpectata* Olteanu, *L. kochi* Mehes, *L. irregularis* Olteanu, *L. mulleri* (Mehes), *L. punctata* Olteanu and in Pontian - *L. unicornuta* Olteanu, *L. acuticostata* Olteanu, *L pontica tubulosa* Olteanu, *L. kolubarae* Krstič, *L. poenensis* Olteanu, *L. granifera* (Reuss), *L. subrugosa* Zalanyi, *L. rhombovalis* Pokorný, *L. fistulosa* Krstič, *L. schweyeri schweyeri* Suzin, *L. alitera* Krstič.

Totally are about 30 species. Three of them, have been found in Sarmatian (*L. schmidi, L. ornata subornata, L.* aff. *alveolata)* [1].

## CANDONAE STORY AND STRATIGRAPHYCAL PUZZLE

Nadejda Krstič (1973) in an admirable monography on Candonae from Congeria Beds fragmented them into 19 genera and subgenera, 64 described and figured species, 52 of them, new species). At least a part of these new taxa are ambiguoslly defined (*Pseudocandona, Sirmiella, Zalaniella, Propontoniella, Ochridiella, Thaminocypris, Turkmenella*).

The time of Congeria Beds she divided into five substages (?), three for the Pannonian (with 35 species) and two for the Pontian (with 29 species) (p. 96).

For addition of riguour and accuracy, in the same year she divided the Panonian-Pontian time into much more biozones

(**A**) The Lowermost Pannonian (Lower Slavonian or alpha-phase) is divided into two zones. The first, with *Candona post-sarmatica* Krstič (marly-clay facies). The second zone with *Hemicytheria lorenthey* (sandy facies). They could be allied with *Hemicytheria hungarica, Cyprideis tuberculata, Cryptocandona nocens, Amplocypris crassus, Loxoconcha kochi, Hemicytheria ampullata, H. tenuistriata, H. folliculosa* and *Propontoniella pavlovici*.

(**B**) Upper Slavonian (or beta-phase) is divided into two zones (with and without *H. tenuistriata*). The leading species for the Upper Slavonian „as a whole" are *Cyprideis hungarica*, *Loxoconcha granifera, Propontoniella fragilifera* and *Typhlocypris redunca*.

The Upper Pannonian (Servian) is divided into Lower (gama-phase) and Upper Servian. „As the criteria for separating the Servian from the Slavonian I have taken the occuring of *Caspiolla* and *Serbiella* (...) and *Congeria zsigmondi* and *C. czjzeki* in the mollusk fauna" (Krstič, 1973).

(**C**) The Lower Servian has two zones „on the basis of the presence or absence of the Slavonian relics" (Krstič, op.cit.). The first contains leading species such as *Amplocypris abcissa* and *Serbiella unguiculus*. The second one, with *Hemicytheria croatica*. For entire gama-phase there are some characteristic species as *Hemicytheria servica, Cyprideis longa, C. triebeli, Caspiolla praebalcanica praebalcanica, Thaminocypris symmetrica, Lineocypris pupini, Cypria triebeli* „and others". The index mollusk are *Congeria subglobosa* and *Undulotheca pancici*.

(**D**) The beds of Upper Servian are over the gama-phase and below the Pontian. „It is quite easy to distinguish two levels, on basis of ostracods" (Krstič, op.cit.). The lower zone contains *Serbiella sagittosa, S. maxiunguiculata, Zalaniella drzici, Caspiolla alasi alasi*, *Typhlocyprella lineocypriformis*. The common species for the entire interval are *Caspiolla praebalcanica posterior, Thaminocypris trapezoidalis, Cypria dorsoarcuata, Hemicytheria dubokensis* and others. The index mollusk species are *Provaleciennesia pauli* and *Paradacna abichi*.

Nadejda Krstič (op.cit) made few allegations: „a certain number of species could be connected with the Meotian types (...) representatives of the *Candona (Pontoniella), Candona (Hastacandona), Leptocythere* and *Loxooncha*". Then the Pontian apecies „appear, successively, during the final zone of the Pannonian"

In the Lower Pontian „four associations can be distinguished", three on cleyly substratum and one in the gravel-sandy facies. The lower zone, with Pannonian relics is very thin. The upper zone is leading species for the Lower Pontian: *Serbiella ilici, Zalaniella venusta, Cyprideis parallela, Thaminocypris* aff. *labiata* and *Hemicytheria prisca*.

In the Upper Pontian (Portaferrian) are the species: *Caspiolla alasi mislodini, Thaminocypris stevanovici, T. minutissima* (for clayly facies) and *Caspiocypris affinis*, *Hastacandona granulosa, "Hungarocypris" pannonica* (for sandy facies).

Totally are 64 *Candona* species (19 new subgenre and 52 new species), 5 in Lower Pannonian, 10 species in Middle Pannonian, 26 species in Upper Pannonian (gama and delta phase), 15 in Lower Pontian and 29 new species in Upper Pontian.

[1] Note: There are many mono-tuberculated *Loxoconcha* species from Sarmatian to Pontian only:

*Loxoconcha djaffarovi* Schneider (Olteanu, 2000, Fig. 1-4, 2005, Pl. XXXII, Figs 6-7), Middle Pontian - Kimmerian, Euxinian bioprovince;

*Loxoconcha poenensis* Olteanu, (Olteanu, 2000, Pl. IV, Fig. 4), Middle Pontian, Poieni valley, Pannonian bioprovince

*Loxoconcha ornata ornata* Schneider, (Stanceva, 1963, Pl. VI, Fig. 10, 1992, Pl. XXXI, fig. 7, 8, Olteanu, 2000, Pl. III, Fig. 5-6, Olteanu, 2005, Pl. XXXII, Fig. 4), Sarmatian, Dacic basin;

*Loxoconcha ornata subornata* Stanceva, (Stanceva, 1972, Pl. II, Fig. 7, Pl. XXIX, Fig. 8, (from Upper Sarmatian), Olteanu, 2000, Pl. III, Fig. 7, (Early Pannonian, Politioanei valley, Soceni), Pl. IX, Fig. 7) (=*Loxoconcha* sp. in Olteanu, 2005, Pl. XXXII, Fig. 5);

*Loxoconcha hodonica* (Pokorný, 1952, Pl. V, Fig. 1-2, 9, Olteanu, 2000, Pl. V, Fig. 1, 2, Pl. XXII, Fig. 1, 3 and in this paper, Pl. IX, Fig. 10), Pontian, Pannonian bioprovince;

*Loxoconcha alveolata* Voroshilova (Olteanu, 2000, Pl. II, Fig. 3, 4, 5, 8), Early Sarmatian, Beiuş basin and, (Fig. 3, 4) Politioanei Valley (Soceni);

*Loxoconcha* aff. *alveolata* Voroshilova (Olteanu, 2000, Pl. III, Fig. 1, (Early Pannonian, Politioanei valley, Soceni), Fig. 2 (Lower Sarmatian, Dacic basin), Fig. 3, (Middle Sarmatian, Dobrudja), Fig. 8 (Early Pannonian, Carand), in this paper, Pl. III, Fig. 6 (adult) - 7 (juvenile), Early Pannonian, Carand;

*Loxoconcha acuticostata* Olteanu, (Olteanu, 2000, Pl. IV, Fig. 7), Pontian, Pannonian bioprovince;

*Loxoconcha pontica tubulosa* Olteanu (Olteanu, 2000, Pl. V, Fig. 5-6), Pontian, Pannonian bioprovince;

*Lococoncha inexpectata* Olteanu (Olteanu, 2000, Pl. IV, Fig. 3, 4), Pontian, Pannonian bioprovince;

*Loxoconcha unicornuta* Olteanu (Olteanu, 2000, IV, Fig. 5, 6), Pontian, Pannonian bioprovince:

*Loxoconcha* sp. 4 (ex gr *L. pseudohastata* Stanceva) (Olteanu, 2000, Pl. V, Fig. 8), Middle Pontian, Pannonian bioprovince;

*Loxoconcha schmidi* Cernajsek (Olteanu, 2000, Pl. I, Fig. 5, 6, Lower Sarmatian from both bioprovinces, Euxinian and Pannonian and its descendant *Loxoconcha praepannonica* n. sp. (pl. XX, fig. 7)

The same author (1973) described 21 species of *Amplocypris*.

In the Lower Pannonian, she found 11 species: *A.* cfr *intestina* Schneider, *A.* cfr *reticulata* (Hejjas), *A. recta* (Reuss), *A. lipae* Krstič, *A. pavlovici* Krstič, *A. sincera* Zalanyi, *A. sinuosa* Zalanyi, *A. simplex* Zalanyi , *A.* cfr *tenuis* Zalanyi, *A. crassus* Krstič, *A. perphoratus* Krstič. In the Upper Pannonian, other five species: *A. firmus* Krstič, *A. major* Krstič, *A. acuta* Krstič, *A. abcissa* (Reuss), *A. matejici* Krstič and in the Pontian other four species: *A. dorsobrevis karagacensis* Krstič, *A. bacevice* Krstič, *A. odessaensis* Ilnitzkaia, *A. ventrocrassus* Krstič, *A. danubialis* Krstič.

Nadejda Krstič paper (1985, p. 103-113, Pl. I-XIII) seems to be exhaustive (125 species and subspecies mentioned and, in part, figured). The author with devotion respected the Stevanovici biostratigraphy.

The Slavonien (alfa and beta-phase according to Pokorný, 1944) is divided into four biozones:

**1** – *Hemicytheria lorenthey* zone (with *Candona postsarmatica* Krstič, *Amnicythere parallela* (Mehes), *Loxocauda stevanovici* Krstič, *Loxoconcha hodonica* Pokorný, *Hemicytheria ampullata* (Mehes), *Hungarocypris auriculata* (Reuss), *Cyprideis pannonica* (Mehes).

**2** – *Hemicytheria hungarica* zone (with *Hemicytheria ampullata* (Mehes), *Loxoconcha kochi* Mehes, *Amnicythere miscere* Krstič, *Euxinocythere bituberculata* Sheremeta, *Loxoconcha porosa* (Mehes), *Hemicytheria tenuistriata* (Mehes)

**3** – *Hemicytheria tenuistriata* zone (with *Amnicythere servica* Krstič, *Loxoconcha hodonica* Pokorný, *Cytherura moravica* Pokorný, *Amploypris recta* (Reuss), *"Hungarocypris" auriculata* (Reuss), *Amnicythere lacunosa* (Reuss), *Xestoleberis pavlovici* Krstič, *Hemicytheria folliculosa* (Reuss)

**4** – *Propontoniella candeo* zone (with *Amplocypris sinuosa* Zalanyi, *A. tenuis* Zalanyi, *Loxoconcha granifera* (Reuss), *"Hungarocypris" hieroglyphica* (Mehes), *Amplocypris acuta* Krstič, *A. perforata* Krstič, *Cryptocandona dolici* Krstič.

The Serbian is also divided into four biozones (gama and delta phase, according to Pokorný, 1944).

**1** – *Amplocypris abcissa* zone (with *Candona praebalcanica* Krstič, *Caspiolla unguiculus* (Reuss), *Thaminocypeis symmetrica* Krstič, *Loxoconcha rhombovalis* Pokorný, *Amplocypris matejici* Krstič, *Cyprideis heterostigma* (Reuss)

**2** – *Hemicytheria croatica* zone (with *Lineocypris pupini* Krstič, *Hemicytheria marginata* Krstič, *Amplocypris abcissa* (Reuss), *Caspiolla unguiculus* Pokorný

**3** – *Serbiella sagittosa* zone (with *Loxoconcha fistulosa* Krstič, *Cyprideis longitesta* Krstič, *Hemicytheria marginata* Krstič

**4** – *Typhlocyprella lineocypriformis* zone (with *Caspiolla alasi* Krstič, *C. buchii* Krstič, *Thaminocypris trapezoidalis* Krstič, *Maeotocythere buchi* Krstič, *M. praebacuana* (Liventa).

Totally there are 160 species and subspecies.

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Jiřiček (1985, p. 378-408, Pl. I-VIII) is in opposition to Krstič. In his Table (no.11), he presents 110 species and their stratigraphical ranges. Jiřiček is loyal to Papp standard zones.

**A** – *Melanopsis impressa*, (no ostracods)

**B** – *Congeria ornithopsis, Melanopsis posterior* and *Hemicytheria lorenthey, "Hungarocypris" auriculata, Amplocypris subacuta*

**C** – *Congeria hoernesi, Paradacna abichi* and *Cyprideis pannonica, C. tuberculata, C. macrostigma, C. ventricosa, Pseudocandona semicircularis, Pontoniella acuminata* (!)

**D** – *Congeria partschi* and *"Hungarocypris" hieroglyphica, Amplocypris abcissa, A. recta, Lineocypris danubialis, Hemicytheria pejinovicensis*

**E-1** – „Lower Congeria subglobosa and C. ungula caprae beds": *Cyprideis sublittoralis, Lineocypris hodonensis, L. reticulata, Cyprideis hungarica*

**E-2** – *Dreissena auriculata* and *Candona mutans, Cyprideis major, C. seminulum, Candona slovenica*

**E-3** – „Upper Congeria subglobosa and C. spathulata beds": *Hemicytheria brunnensis, H. croatica, Cyprideis obesa, C. spinosa, Caspiolla unguiculus, C. praebalcanica*. This last zone is most abundent of all (46 species).

It is a true zones obsession. However, these zones seem to be like an artificial flower, exepting the extreme. No one could separate these zones one from another, according to this table. Astonishingly, Pontian species are present in „E zone", for instance, *Caspiolla sagittosa, Pontoniella acuminata, Pontoleberis attilata*. Besides, an almost fixed Lower Pannonian species, like *Hemicytheria lorenthey* is placed in „E-3 zone" and even up. The Pontian starts with few new apparitions like: *Bacunella dorsoarcuata, Caspiolla lobata, C. balcanica, C. hungarica, C. acronasuta, "Hungarocypris" pannonica*.

Several years after, in 1989, the ostracod stratigraphy of Krstič became more flexible.

During the Upper Pannonian time, the following common species occur: *Camptocypria praebalcanica* Krstič, *Pontoniella sagittosa* (Krstič), *Caspiolla rurica rurica* (Krstič), *Caspiocypris rakosiensis* (Mehes), *Cypria siboviki* Krstič, *Amplocypris abcissa* (Reuss), *A. major* Krstič, *"Hungarocypris" hierogliyphica* (Mehes), *H. pannonica* Sokač, *Hemicytheria reticulata* Sokač, *Amnicythere lacunosa* (Reuss), *Loxoconcha fistulosa* Krstič.

Some of the species crossing the Pannonian-Pontian boundary are the following: *Candona hodonensis* Pokorný, *Reticulocandona reticulata* (Mehes), *Hemicytheria dubokensis* Krstič, *Maeotocythere praebaquana* (Livental), *Pontoleberis pontica* (Stanceva), *Loxoconcha subrugosa* Zalanyi, *Euxinocythere naca* (Mehes), *Loxoconcha djafarovi* Schneider, *Loxoconcha schweyeri* Suzin

New species appear in the Lower Pontian: *Caspiolla ilici* Krstič, *Zalaniella longissima* Krstič, *Cypria tocorjescui* Hanganu, *Hemicytheria prisca* Sokač, *Loxoconcha comsacui* Krstič and, during the Upper Pontian time, new, exclusive species appeared: *Pontoniella truncata* Sokač, *P. hastata* Krstič, *Candona labiata* (Zalanyi), *Candona pontica* Sokač, *Bacunella dorsoarcuata* (Zalanyi).

The fresh-water Paludinian „stage" follows.

Nadejda Krstič's study of fresh-water ostracod communities (1993, 2006), admirably figured 131 species. The following ostracod ecostratigraphic units were established in the Paludinian Beds :

Lower Paludinian –*Cypris subglobosa mandelstami, Neglectocandona freelsi, N. kostici*

Middle Paludinian – *Neglectacandona paludinica* and rare *Zonocypris*

Upper Paludinian - *Ilyocypris slavonica, Scordiscia jiriceki, Ilyocypris malezi tiszanae*

## OTHER AUDACIOUS BIOSTRATIGRAPHIC ASSERTIONS

Kelley R. (1970) made an ostracod stratigraphy synthesis. In the case of *Hemicytheria*, he places the following 11 species in the table: *Hemicytheria lorenthey sarmatica* Jiřiček (Volhinian), *H. omphalodes* (Reuss) (Upper Volhinian - Bessarabian), *H. hungarica* (Zalanyi) (Bessarabian - Lower Pannonian), *H. lorenthey pannonica* Jiřiček (Bessarabian – Lower and Middle Pannonian), *H. ampullata* (Mehes) and *H. pokornýi* (Sheremeta) (Lower and Middle Pannonian), *H. reniformis* (Reuss), *H. lorenthey lorenthey* (Mehes), *H. folliculosa* (Reuss), *H. croatica* Sokač, *H. brunnensis* (Reuss) (Upper Pannonian). No *Hemicytheria* species into Pontian time.

In the ostracod zonation table, the Pannonian is divided into six episodes (A, B, C, D, E-1, E-3), each of them with the two index fossils: A – *Wiliamina subvelatina, Trochamina kibleri,* B – *"Hungarocypris" auriculata, Hemicytheria lorenthey pannonica*, C – *Cyprideis tuberculata, Cyprideis sulcata-pannonica,* D - „*Hungarocypris*" *hieroglyphica, Amplocypris recta*, E-1 – *Cyprideis sublittoralis, Comgeria subglobosa,* E-3 – *Caspiolla unguiculus, Cyprideis obesa. (*A,B,C – Lower Pannonian, D – Middle Pannonian, E 1-3 – Upper Pannonian). In the Pontian, there are the species *Congeria zahalkai, C. brandenburgi,* and a few *Lineocypris* species.

Undoubtedly, the biostratigraphy of the brackish-water facies, generally and especially of the Pannonian Basin, is difficult to accomplish.

## ARE THERE 'FROZEN COMMUNITIES' ?

It is the moment to evade from traditional values of palaeontology focused, primarily, on biostratigraphy and to redirect the studies to the level of the species, community and palaeoenvironment and subsequent evolutionary fate. A basic question about any sequence of phylogeny is how the tempo of modifications have changed through time and what factors have controlled this tempo. Some ostracod species have survived for long geological times without visible changes (for instance, *Aurila punctata* from Upper Eocene to Recent, *Callistocythere flavidofusca* Ruggieri from the Upper Badenian to Recent, *Euxinocythere naca* (Mehes) from Sarmatian to Pontian and *Hemicytheria omphalodes* (Reuss) that appeared, somewhere in the Middle Badenian, traversed the brackish-water Sarmatian „filter" and then, suddenly and rapidly, proliferated as new species within the one short interval of time of the Pannonian, *cf* Olteanu, 2001).

Many other, mollusks and ostracods, rapidly changed.

There are zones (or horizons) with a surprisingly uniform fauna, with exclusive species (Szilaj R. *et al*, 1999). The one of these rare situations is *Congeria ungulacaprae* beds (=*Lymnocardium ponticum* Zone, a transitional stage between the older *L. conjungens* Zone and the younger *L. decorum* Zone) from NW Hungary, the site of rapid delta progradation. Its characteristis are missing towards the southern region of the basin with less sediment input.

Nevertheless, these happy occasions are just an exception. Its age equivalent is Radmanesti (Banat) with substantially richer fauna than NW Hungary (about 120 species, Marinescu, 1990). Yet, the Rădmăneşti assemblage contains many „late" species (final of the lineages); their ancestors are unknown to us.

## PHYLOGENY OR ECOLOGICAL ACCOMODATION?

Phylogeny of the fossil species was always a challenge for palaeontologists. The four lineages of Pontian Lymnocardiids (Szilaj *et al*, op.cit.) show some small and large shells. No other morphological differences, excepting their size. Reduction in size has adaptative significance for population structure. Rapid maturation and small shell size are the primary objects of selection in the unstable environments, and the brackish water biotopes are fundamentally unstable. That imposed a harsh selection, great mortality, rapid colonization, fine-tuned morphological specializations, many juvenile shells and rapid, precocious maturation.

Is it or is it not a real species? The lineage *L. adlaueri* (small), *L. ponticum* (medium) and *L. decorum* (large shape)? The same case is *L. conjungens* (small), *L. penslii* „early form"

(medium) and *L. penslii* (common form), etc. Or, might just progenesis be the possible cause? Many other lineages fall into this biological phenomenon. The *Melanopsis* cases are striking examples.

Müller and Magyar (1992) described a continuous change in shell morphology from the *Lymnocardium decorum ponticum* to *Prosodacnomya vutskitsi* as a gradual, anagenetic transformation (between them are other six transitional ecotypes). However, it is a 'qualitative jump' to another genre, although it means just a change of the overall shape and smoothering of the ribbed surface of the shell. The time of shell modification is about 0.7 Ma. According to the biozone standard, is the time between *Congeria balatonica – Limnocardium decorum* Zone and *Prosodacna vutskitsi* Zone (Pontian age, or *Congeria rhomboidea* mega-Zone). A similar story is *L. disprosopum* and *L. arpadense*, the last originated in the first one by anagensis, „a phenomenon apparently common in Lake pannonian mollusks" (Magyar I., *et al.*, 1999). It obviously is an ecophenotypically controlled tendency visible to many brackish water organisms. Instability of shape, size and external ornamentation (so-called „flexible species") are a quality.

Almost each palaeontologist saw different species on the same specimen (see large row of synonyms. For instance, *L. (E.) scheteri* (Strausz) with six name species by four experts, or *„Paradacna" (?) wurmbi* (Lorenthey). Why? Most of them are „highly variable in many features, such as shell outline, position of the beak, and the number, width, and shape of the ribs" (op.cit.).

The taxonomy of the brackish-water fossils became a real question due to the non-objectivity of species. There is much confusion between evolution and adaptation[2].

Unfortunately, no one can prove that such transformations were coeval in all places from the Pannonian lake immensity. Moreover, it is difficult to discern between biochronological and mollusk or ostracod biofacies units. The different habitats and lithology is not an argument in favour of different geological ages.

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Among the ostracods, the champions of morphological accomodation in local habitats are *Letocythere* (ribs, tubercle), *Candona* (size, shape and juvenile reticulation), *Loxoconcha* (marginal epines and secondary ornamentation), *Hemicytheria* (ridges and meshes, marginal pore canals, see also *Hemicytheria* (with straight marginal pore canals) transfomation into *Tyrrhenocythere*, with its specific, clustering marginal canals after penultimate juvenile stage (Olteanu and Vekua, 1989; Olteanu 2000, 2005). The similar valve transformation during the ontogeny is *Pontoleberis* genre (smooth as juvenile, ornamentated, as adults). *Pontoniella* (*sensu* Krstič, 1972) juvenils have ornamentation, while adults are almost entirely smooth. *Lineocypris* species are „more or less" ornamented (op.cit.). See other examples in this paper.

I would like to quote Dobjansky 'prophetic words' that codified the new concept of the ontogenetical accomodation „the destruction of great masses of organisms „(...) is largely fortuitous by development of increased fertility and acceleration of development and reproduction" (*fide* Gould, 1977). The "residual" species reconstructed a new community, perfectly adequate in the geographic and temporal distribution as new species. This is why all the Lower Pannonian sites have great biomas and little species („*Hungarocypris*" *auriculata, Amplocypris abcissa, A. recta*, *Loxoconcha rhombovalis*, at Şoimi outcrop. All are early species often found locally, in the littoral Sarmatian sediments).

## BRIEF STATISTICAL OBSERVATIONS

The two groups of fossils that populated the Pannonian Basin followed the same direction in their adapting processes.

The Pannonian-Pontian time inerval is delimited by two sharp ecological changes, the boundaries with the Sarmatian and with the Paludinian. Both of them are major discontinuities in fauna „evolution". During this time-interval, between the Sarmatian and the Paludinian, appeared about 110 *Candona* species (including *Bacunella, Pontoniella* and *Typhlocypris*) (Krstič, 1972), 10 *Hemicytheria* species, two *Pontoleberis*, two *Xestoleberis,* 20, *Loxoconcha* species (Krstič, 1972), about 15 *Leptocythere* species and 20 *Amplocypris* species (Krstič, 1973).

2 Note: In Extra-Carpathian areas, there eight known Sarmatian *Limnocardiid* genera (about 90 species) according to the hinge structure, shape, size and surface ornamentation of the shell (Ilina et al., 1976). Under their umbrella, there are numerous forms, curious and even bizzare morphological innovations. During the Pontian-Dacian times, their number increased to about 40 genera and subgenera. Many morphological features, if not all, have a different degree of mobility-fexibility and constancy, so that to arrange a shell within a genre is a delicate matter. As a general rule, a new hinge is a new genre. The hinge structure seems to be more conservative than the costae-play. Not always.

There are eight genre and 16 hinge structures (two for *Plicatiforma*, three for *Obsoletiforma*, two for Inequicostata, three for *Fischericardium*, two for *Sarmaticardium*, two for *Chartocardium*, one for *Planacardium* and one for *Kubanicardium*). During the Pontian-Dacian age, the number of the hinges has increased, as compared to the Sarmatian. Hence, there are almost 52 supraspecific taxa (genera and subgenera) with about 350 species. Generally, the early taxa are closer by the lucinoid type. The ultimate species have simplified hinges, most of them are adonts. There are much more exceptions.

*Cardium* has a lucinoid-type of hinge, consisting of six elements, two teeth antero-lateral, two cardinals and two postero-lateral (and their opposite sockets). The ontogeny of lucinoid structure begins in the first stage with the appearance of the antero-lateral tooth and the lateral-postero-superior tooth, then appears the posterior cardinal (second stage), then the anterior cardinal (third stage) and, finally, the postero-lateral inferior tooth (last stage) before the adult structure. The hinge of Sarmatian Cardiids stopped on the juvenile stages. We see the adult specimens with juvenile hinge structure. In other words, it is a classical neoteny phenomenon (Olteanu, 1999). Unfortunately, in time, they are anarchically distributed between Late Badenian (two hinge types), Volhinian (ten new hinge structures) and Late Bessarabian (one new hinge). No logical order. A confusing story, but not for all. Kojumdjieva (1976) made no more than six Sarmatian substages according to her imaginary phylogeny of the Sarmatian Limnocardiids. The taxonomic order of the brackish-water organisms might need to be changed, perhaps.

There are much more than two hundreds ostracod species, in all.

During the Paludinian time, there were about 140 ostracod species (Krstič, 2006). There were no *Cytherissa* and *Tyrrhenocythere* and there was one species of *Cyprideis (C. torosa*). The story of *Cyprideis* and *Candona* groups is complicated, bushy and prolix. Both of them deserve a lithurgy.

All Pannonian mollusk species, mainly, belong to three dominant genera, *Congeria* (about 25-28 species), *Melanopsis* (22-25 species) and *Limnocardium* (10-12 subgenera).

The Pontian bivalvia and gasteropod species are more numerous. Gillet Suzette and Marinescu Fl. (1971) and Marinescu Fl. (1973) found and described in two sites: Rădmăneşti and Tirol (Banat) (in Portaferrian sediments) more 120 taxa, many of them are older.

The Pannonian-Pontian biodiversity cannot compare with the Sarmatian fauna. Simionescu I. and Barbu I.Z. (1940) found and described 130 bivalvia and about 219 gasteropod species in the Sarmatian from the Moldavian platform, and Jekelius E. (1944) mentioned 140 Sarmatian taxa (84.000 specimens from Politioanei Valley) and 112 Pannonian-Pontian species (16.000 specimens from Turislav Valley). In 1932, he described from post-Pontian-Pleistocene sediments, 73 gasteropod species and another 12 bivalvia species (five *Dreissensia* and seven *Limnocardiids*) from Baraolt area (near Braşov). The ostracods are endemic with bizarre valve morphology (*Candona bimucronata* Klie, *C. combibo* Livental (smooth and tuberculated valves), *Candona* aff. *fagiolata* Stanceva (similar shape), C. aff. *neglecta* Sars, *C.* aff. *candida* (Livental), *Kassinina alutensis* Olteanu, *K. unica* Olteanu, *C. symmetrica* Olteanu, *Pseudocandona albicans* (Brady), *Leptocythere* sp.A, *L.* sp. B, *L.* sp. C, *L.* sp. D, *"Hungarocypris"* aff. *auriculata* (Reuss), *Cyprideis jekeliusii* Olteanu, *C.* aff. *punctilata pliocenica* Rozyeva, *C.* aff. *Ritimica* Livental) (Olteanu, 2003). They are the last representatives of the Pannonian realm, a world of relics. It is the end of the Pannonian cycle. Which, of those hundreds of species, are more useful for bio-stratigraphy ?

## BIOSTRATIGRAPHICAL PUZZLE. BETWEEN MOLLUSKS AND OSTRACODS

In the Pannonian sediments from Romania, there are some classical fossiliferous outcrops, as Şoimi, Soceni, Zorlenţul Mare, Câmpia, Tirol, Rădmăneşti, Poienii de Sus, Rieni, Holod, Hidişelu de Sus, Groşi, Sinteşti, Stracoş, Urvind, Crivina, Vârciorova and a lot of drillings etc. (Jekelius, 1943, quoted 133 outcrops from Transylvania, Banat, Beiuş, etc).

Papp (1951) thought that Soceni point is later than zone B and early than zone E, and Marinescu (1962) stated that the fauna from Şoimi (Fieghiul Valley from Beiuş Basin) seem to be similar to zone B (from Loebersdorf), and Poieniii de Sus is close to zone D. Although the ostracods deny cannon, the palaeontologists refused the negation.

In sociology, there is the so-called 'Thomas theory' that says that: a false situation perceived as a real one, becomes real, owing to its consequences.

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There are two things that appear with clarity from the above: the ostracod biodiversity is enlarged from the Pannonian to Pontian, the ostracod species range is still tied by the mollusks and many species are the morphological variants only, each of them being uniquely adapted to the circumstances of their origin and the local biotope ecological circumstances.

We do not know where is the Lower Pontian (as it is defined in the Dacic basin or Euxinian area).

The surprise was the Câmpia (Langenfeld) site where Halaváts (1883) described some index Pannonian fossils: *Congeria zsigmondi, C. czizeki, Limnocardium boeckhi, L. winkleri, L. brunnense, Melanopsis textilis*. All of them are together with an unexpected and rich Pontian ostracod community: *Amplocypris abcissa, A. matejici, A. subacuta, Pontoniella sagittosa, P. striata, Reticulocandona elongata, Typhlocypris ornata, Cypria tocorjescui, Hemicytheria dubokensis, "Hungarocypris" hieroglyphica, Leptocythere lacunossa, Euxinocythere naca, Maeotocythere prebacuana, Amnicythere servica, A. sinegubi, A. subcaspia, A. cornutocostata, Loxoconcha granifera, L. fistulosa, L. schweyeri, L. subrugosa, Loxoconcha hodonica, Pontoleberis attilata, P. pontica* (Olteanu, 1989b). Almost all of the above are Pontian ostracod species.

The Pontian from Central Paratethys is just the Porrtaferian substage (*Congeria rhomboidea* beds). Are the Early Pontian and the Late Pontian similar or close to extracarpathian Pontian areas or are they not ? Yes, they are, according to Stevanovici (1951), Krstič (all her studies), and many others. And: No, they are not, according to Sacchi and Horvath (2002), Olteanu (1971, 1986, 1989a, 1996, 1997, 2003). Here is the 'Gordian knot'.

Sacchi and Horvath (2002) suggested the introduction of the new stage (or substage) named Transdanubian between the Pannonian *sensu stricto* and the Pontian stage. But it is just Lower Pontian. Is a new stage or substage needed ? It isn't, of course, because there are many Pontian species which justify it.

Over the Portaferrian (with *Congeria rhomboidea*) is not the Dacian stage (and its endemic fauna from Dacic Basin), but the time of the Dacian stage with specific, fresh-water fauna (Krstič, 2006) with another name, Paludinian stage, for instance. The Paludinian stage (part of it) is contemporary with the Dacian stage. It is no Dacian. Any stage is defined by its fauna only and never by lithostratigraphycal, magnetostratigraphical, radiometrical or allostratigraphycal methods. Its time may be coeval. Any stage is really a biostratigraphical question.

This substage (Transdanubian or Early Pontian) "*corresponds to the littoral Congeria balatonica – Limnocardium decorum-serbicum zone and the Congeria ungulacaprae-Prosodacnomya carbonifera-dainelli zone (…) its lower part correlates to the sublittoral Congeria praerhomboidea zone…*" (Magyar *et al.*, 1999, *fide* Sacchi and Horvath, 2002)

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The second doubtful sequence is the Carand outcrop (in Metaliferi Mountain) where over the Bessarabian sandy-clay are seven metre of green clay with ostracod fauna: *Candona (Caspiocypris) postsarmatica* Krstič, *Camtocypria elongata* n. sp., *Candona (Cryptocandona) nocens* Krstič, *Candona carandui* n. sp. (= *Candona* aff. *postsarmatica*, Krstič, 1972, Pl. IV, Fig. 2), *Cyprinotus pannonicus* n. sp., *Cyprinotus* (?) sp., *Cypria* aff. *siboviki* Krstič, *Candona* (?) sp. 6, *Candona* sp. 7, (presumable adult), *Loxocauda stevanovici* Krstič, *Loxoconcha* aff. *alveolata* Voroshilova, *Leptocythere bituberculata* Sheremeta, *Leptocythere (Euxinocythere) carandui* sp. n., *L.* (*Euxinocythere) naca* (Mehes), *Hemicytheria lorenthey sarmatica* Jiřiček, *Loxoconcha schmidi* Cernajsek. Over this community, there is real explosion of *Amplocypris abcissa* (Reuss), *A. recta* (Reuss), *Cypria* aff. s*iboviki* Krstič and *"Hungarocypris" auriculata* (Reuss) few specimens of *Candona (Camptocypria*?) sp. and *Candona* sp. (fragments).

In my view, this community belongs to the Lowermost Pannonian.

## CONCLUSIONS

**1** – The Pannonian fauna is not a result of a Noachian deluge and a species does not appear *ex machina* like Athene from Zeus' head, and neither does a zone. Its ancestors could be found in older sediment deposits, for instance, Badenian, near Mehadia (South-Eastern Banat) where we found rich populations of *"Hungarocypris"* and *Amplcypris*. The first *Hemicytheria* occur in the Badenian time, diversify during the Sarmatian and 'blow up', during the Pannonian.

**2** – Many fossil species from the Pannonian-Pontian deposits seem to be just ecospecies, tied by a specific, local biotope.

**3** – As a result, not even the richest sequence can associate all species from a certain time interval *('...I came to no doubt whether the lower limit of the Subglobosa beds is placed in different parts of the Inner Alpine Basin in the same level (...) ostracod associations whose stratigraphical distribution is exceedingly local and often closely connected with the petrological facies',* said Pokorný, sceptically, in 1952).

**4** – Nevertheless, many other species are good index fossil species: *Loxoconcha kochi, L. porosa, L. mulleri, Hemicytheria lorenthey* (with unstable morphological variants), *H. ampullata, H. reniformis, H. biornata, Amplocypris subacuta, Loxocauda stevanovici, Amnicythere dositeji* (for Lower Pannonian), *Cytherura moravica, Leptocythere lacunosa. Hemicytheria pejinovicensis, Loxoconcha hodonica* (for Upper Pannonian). The Pontian community is different, due to the new genera like *Pontoniella, Pontoleberis, Typhlocypris, Bacunella* or some ponto-caspian species like *Amnicythere subcaspia, Paraloxoconcha pontica* or *Maeotocythere bosqueti* (with local variants).

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In short, the entire succesion of fauna is included between the Middle Sarmatian and the Pleistocene (Baraolt basin, near Braşov). This long time (almost 8-10 Ma) has to be inserted into the geological time and its stages. How? The crucial questions are not the absolute time, duration of the Pannonian in terms of biostratigraphical time. In other words, the Pannonian is contemporaneous or not with Late Bessarabian – Chersonian – Meotian and, consequently, with the existence (or not) of the Chersonian and the Bosphorian in the Pannonian basin. The Paludinian could be an equivalent of the extra-carpathian area (Dacian and the Romanian from the Dacic basin and the Kimmerian, the Kouialnikian, Apscheronian from the Euxinian area).

A stage (in Paratethys area) is defined as a close community of fauna, with other new genera (other architectural structures, as the lineages *Aurila – Hemicytheria - Tyrrhenocythere, Maeotocythere – Euxinocythere - Amnicythere*, *Candona - Reticulocandona, Pontoniella, Bacunella* or *Xestoleberis - Pontoleberis* etc), community which lived within a specific area with specific ecological features and circumstances. Between them, there usually is an ecological break (a marine ecosystem separated by a brackish-water ecosystem or fresh-water one. However, within a brackish ecosystem, there are enormous saline differences which allowed apparition of the new taxa, extinction, migration, species erruption, in short, the change to all directions, particularly, in the case of salinity fluctuation or its constancy (see the Black Sea). So, the boundary means to change, to transform, to modify, to replace, in essence, it is a new start. There is, of course, the conventional boundary, but that is another thing.

The Pannonian–Pontian boundary is much disputed. It is situated, by most palaeontologists, at the base of the *Congeria rhomboidea* beds. Still, most ostracod species are strongly facies-dependent, so that the local species existence did not represent their whole life spans. In fact, we saw some of the zonal or local boundaries that reflect the facies changes more than the real extinction or the origin of the new species. Yet, it is just a banality.

The ostracod communities are well-differentiated into two positions, in the Lower Pannonian and in the Portaferrian (with *Congeria rhomboidea*). Most of the known species cannot be considered as reliable index fossils. The biozones are just a mirage, I think.

## DESCRIPTION OF NEW SPECIES

*Candona (Camptocypria) elongata* **n. sp.**
Pl. II, fig. 2

Holotype – the specimen figured on Pl. II, Fig. 2.

Locus and stratum typicum – Carand village (Metaliferi Mountain), in post-Bessarabian clay and under "explosion" of *Amplocypris abscissa, A. recta, „Hungarocypris" auriculata.*

Description. Valve, very elongated. Anterior margin is broadly curved with longitudinal axis under half of the height. Dorsal margin is asymmetrically arcuated with more regular curvature in its posterior, than in its anterior portion. Greatest height at about 20% of the valve length. Ventral margin is concave with top of the concavity at mid-length. In its posterior part, it is slightly convex. The oral protuberance is prominent. Backwards, the ventral margin is straight. The muscle scars show the typical shape of Candoninae. Inside structure differs insignificantly from other Camtocypris species.

Dimensions: Length – 0.55- 0.60 mm; Height – 0.26 - 0-28 mm;

Age – Early Pannonian.

***Candona (Camptocypria) lata* n. sp.**
Pl. VI, Figs 9, 11

Holotype – the specimen (left valve) figured on Pl. VI, Fig. 9.

Locus typicus – Chişcău Village. Clay and fine sands with *Congeria banatica, C.* cf *triangularis, C. simplex, C.* aff. *radmanesti, C. auricularis, Melanopsis martiniana, M.* cf *pygmaea* (Jekelius, 1943).

Description. Anterior margin broadly and cvasi-symmetrically rounded. Dorsal margin long, cvasi-rectilinear and inclined to anterior margin. Ventral margin, sinuous, displays a characteristic outline with prominent oral protuberance (see specimen on Fig. 11). Ventral convexity is deep. Posterior margin is extending on the postero-ventral, short and sharp prolongation. Maximum height in the posterior third of the valve, which appears globulous.

Dimensions: Length – 0.95 mm; Height – 0.40 mm;

Observations. This species seem similar with *Candona (Camtocypria) sokaci* Olteanu from Upper Pontian from Dacic basin (Olteanu, 2005, Pl. VIII, Fig. 1) and with *C. (C.) dacica* Olteanu from Getian (Lower Dacian) (Pl. VIII, Fig. 3).

*Candona carandui* **n. sp.**
Pl. II, Fig. 4

Holotype – the specimen figured on Pl. II, Fig. 4.

Locus and stratum typicum – Carand outcrop allied with *C. (C.) elongata* and many other known and new species.

Description. Species of the genus Candona with the globulous shape of the carapace. Left valve larger; the anterior margin is broadly curved, with the apex somewhere below half the height; posterior margin is asymmetric rounded; ventral margin is straight in posterior half of the length and slightly rounded anteriorly. The apex of the ventral convexity is almost in midlength; the outer surface is smooth. The muscle scars are typical for Candoninae.

Dimensions: Length – 0.74 mm; Height - O.40 mm;

Age – Early Pannonian.

Remarks and distribution. The species is restricted in Carand area, an ambiguous ecological biotope with low salinity.

*Cyprinotus pannonicus* **n. sp.**
Pl. II, Fig. 5, 6.

Holotype – the specimen figured on Pl. II, Fig. 5.

Locus typicus – Carand section.

Description. Triangle shape of both valves. Lateral surface is covered with irregular pits on the central portion, more and most visible at juvenile valves (Pl. II, Fig. 6). Muscle scars show the typical number and shape of Cyprinotus genus.

Dimensions: (adult) Length: O.94 mm; height – O.53 mm;

Age – Early Pannonian.

Obs. I found a large population of *Cyprinotus pannonicus*, including many juveniles and adults.

*Leptocythere (Euxinocythere ?) carandui* **n. sp.**
Pl. XIII, Figs 5, 6.

Holotype – the specimen figured on Pl. XIII, Fig. 5.

Locus typicus – Carand section.

Description. The outline of the valve is similar with all Leptocytherinae species. Lateral sculpture of the valves consists of primary and secondary reticulation. The first are represented by polygonal, regular meshes with secondary pits. Three antero-central ribblets are raised to a prolonged tubercle situated backward the ventral convexity (with different shape during ontogeny). The central depression is marked. In front of it, in antero-dorsal position is a large inflation.

Dimensions : Length – 0.64 mm; Height – 0.32 mm;

Age – Early Pannonian.

Observation. *Leptocythere carandui* n sp seems similar with *Leptocythere monotuberculata* Sokač (figured in this paper on Pl. XIII, Fig. 8).

*Hemicytheria para-pannonica* **n.sp.**
Pl. XIV, Fig. 5, 6, Pl. XVIII, Fig. 2

Holotype – the specimen figured on Pl. XIV, Fig. 5.

Locus typicus – Mermeşti village (Crişul Alb valley)

Description. The Hemicytheria topography has a morphological standard for its species. Outside ornamentation consists of regular, polygonal meshes (with impressive similarity of their position on the valve chart), strong ventral ridge (interrupted in the third portion of the valve length). Caudal process is short and strong. Posterior cardinal angle is prominent. On the central surface of the valve (some specimens) slight and irregularly distributed minute pits fill the meshes. Inside structure is normal for Hemicytheria.

Dimensions: Length – 0,95 mm; Height – 0.47 mm;

Age – Early Pannonian.

Observations. This species is a descendant of costulated Hemicytheria as *H. lorenthey* (Mehes). I figured in this paper a lot of similar specimens from the same section. Differences are insignificant, apparently, at least. Between *H. pannonica*

n.sp and *H.* ex gr *pannonica* (Pl. XIV, Fig. 7, 8 and Pl. XVIII, Fig. 1) are superficial morphological differences, too little. The dorsal and anterior flange for *H.* ex gr *pannonica*, or continuity of ventral ridge to the anterior marginal ridge (they are connected). In the case of "*pannonica*", these minute elements are missing. The fact that the conuli pores have a similar position on the valve surface seems to be another element for the closely relation between them.

*Pontoniella acutissima* **n. sp.**
Pl. XIX, Fig. 5

Holotype – the specimen figured on Pl. XIX, Fig. 5.
Locus typicus – Crăiasa valley, Chişcău village (Beiuş basin)
Description. Morphological characters are common for the Pontoniella Genus (longitudinal striae). In this case, the posterior shape is prolonged and sharp.
Dimensions: Length – 0.80 mm; Height – 0.25 mm;
Age – Middle Pontian
Observations. Nadejda Krstič (1972, p. 128) divided Pontoniellae into two subgenera, *Serbiella* (valve surface is ornamented with longitudinal ribs…it appears at the beginning of the Upper Pannonian and it is still alive !) and *Pontoniella* (almost all species are smooth (…) larvas have ornamentations, while adult specimens are almost entirely smooth). For other considerations about Pontoniellae, in Olteanu, 2005, p. 280-281.

At Câmpia (Langenfeld) section (southern region of Banat), I found specimens almost similar with *P. acutissima* n sp. (Olteanu, 1989b, Pl. I, Fig. 8 as *Candona (Pontoniella)* aff. *sagittosa* Krstič). They are different in the posterior angle (65º for *P.* aff. *sagittosa* and 45º for *P. acutissima*) and in shape.

*Loxoconcha praepannonica* **n.sp.**
Pl. XX, Fig. 7

*Loxoconcha schmidi* Cernajsek, Olteanu, 2000, p. 62, Pl. I, Fig. 8;
Holotype – the specimen figured on Pl. XX, Fig. 7
Locus typicus – Carand outcrop (Metaliferi Mountain);
Description. The valve is quasi-trapezoidal in shape, with the dorsal margin straight. Dorsal margin asymmetrically rounded. The ventral concavity is behind of the median axis. Anterior margin largely and symmetrically rounded. The surface valve is ornated with polygonal meshes filled with minute meshes and minute pits of secondary order. Postero-ventral and postero-dorsal are strong and sharp tubercules ornated with meshes.
Dimensions: Length – 0.43 mm; Height – 0.35 mm:
Observations. The bituberculated *Loxoconcha* appear in Badenian (*Loxoconcha hastata* (Reuss) and *Loxoconcha* aff. *hastata* and *Loxoconcha schmidi* Cernajsek in Lower and Middle Sarmatian. *L. Praepannonica* n.sp. differs from the previous species: it is smaller and ornated with secondary pits. It is associated (in Carand section) with many new Pannonian species as *Candona nocens* Krstič, *Loxocauda stevanovici* Krstič, *Loxoconcha* aff. *alveolata* Voroshilova, *Leptocythere bituberculata* Scheremeta, *Cytherura moravica* Pokorný, *Leptocythere* ex gr *kuznetzovae* (Voroshilova), *L. carandui* n. sp., *Hemicytheria lorenthey sarmatica* Jiřiček, etc.

*Leptocythere (Amnicythere) krstici* **n. sp.**
Pl. XII, Fig. 6

Holotype - the specimen figured on Pl. XII, Fig. 6
Locus typicus – Core 1004 – Deva, 171 m.
Description. The lateral surface is ornated with pentagonally shaped meshes and minute pits on the central and posterior field of the valve. A large swelling along the ventral portion of the valve. A smooth and strong ridge runs parallel to the posterior margin. The hinge is of the Amnicythere subgenus.
Dimensions: Length = O.50 mm Height = O.28 mm
Observations. *L. (A.) krstici* n. sp is usually associated with *L. (A.)* aff. *plana* (Schneider), *L.(A.) dositeji* Krstič and their phenotipical variants (Pl. XII, Figs 1, 2, 4, 5).
In 1998 (Olteanu 1998, Pl. VIII, Fig. 8), I thought this was *Leptocythere (Amnicythere) parallela* (Mehes). It is, in fact, a new species.

## ADDENDA

### Where is the stratigraphical truth?

I thought that putting the ostracods and the mollusks side by side would be useful in deciphering the Pannonian-Pontinan biostratigraphy in the main fossiliferous points from the Eastern area of the Pannonian Basin.

**1** – Carand (Metaliferi Mountains)
Lithofacies: sands and clay
Mollusca: unknown
Ostracoda: *Candona postsarmatica, Camptocypris elongata, C. nocens, C. carandui, C. sp A., C. sp. 6, Cyprinotus postsarmaticus, Loxocauda stevanovici, Loxoconcha* aff. *alveolata, L. schmidi, Hemiytheria lorenthey sarmatica, Leptocythere bituberculata, L. carandui, L. naca, L.* aff. *kuznetzovae* etc
Age: Early Pannonian

**2** – Şoimi (Beius basin)
Lithofacies: clay and sands (6 m)
Mollusca - *Melanopsis fossilis, M. vindobonensis, M. pygmea, M. austriaca, M. scripta, M. rarispina, M. brusinai, M. stricturata, M. marcovici, M. sturi, M. martonfii, Congeria ornithopsis* (Paucă, 1935).
Ostracoda – *"Hungarocypris" auriculata, Amplocypris recta, A. abcissa, A.* aff. *illyrica, Loxoconcha rhombovalis, Hemicytheria lorenthey, H. ampullata, Leptocythere naca, L. stanchevae, L. alata, Mediocytherideis* sp., *Loxoconcha* aff. *ornata subornata* (Olteanu, 1986)
Age: Early Pannonian

**3** – Soceni – Turislav valley
Lithofacies: fine sands and clay
Mollusca - *Melanopsis fossilis, M. vindobonensis, Congeria* ex gr *subglobosa, C. partschi, C. zsigmondi. (*Age: Zone C-D, according to Marinescu *et al.*, 1976)
Ostracoda - *Hemicytheria lorenthey, H.* aff. *hungarica, H. folliculosa, "Hungarocypris" auriculata, H. auriculata nodosa, Amplocypris recta, A. abcissa, A.* aff. *villosa, Loxoconcha kochi, L. rhombovalis, L. porosa, L. granulosa, Leptocythere bituber-*

*culata, L. lacunosa, Cytherura moravica, Mediocytherideis* aff. *sarmatica* (Olteanu in Marinescu *et al.*, op. cit.)

Age: Pannonian

**4** – Mermeşti

Lithofacies – clay and sandy clays

Mollusca – *C.* cf *triangularis, C. simplex, C.* aff. *radmanesti, C. auricularis, Dreissenomya* cf *schrockingeri, Cardium* cf *banaticum, Cardium* aff. *penslii, C.* aff. *rothi, Melanopsis martiniana, M.* cf *pygmaea* (from Jekelius, 1943).

Ostracoda – *Amplocypris* aff. *dositeji, Reticulocandona* aff. *posteroerigera, Typhlocypris reducna, Euxinocythere naca, E. ludica, Loxoconcha kochi, L. mulleri, L. punctata, L. minuta, Hemicytheria lorenthey lorenthey, H.* aff. *biornata,*

Age - Pannonian

**5** – Brăneşti

Mollusca - *Congeria subglobosa sopronensis, C. partschi partschi, C. partcshi firmocarinata, C. partschi globosatesta, C. p. elongata, C. pancici pancici, C. czjzeki, C. zsigmondi, C.* aff. *zahalkai,* (Marinescu *et al.*, 1976)

Ostracoda - *"Hungarocypris" auriculata, H. hierogliphyca, Amplocypris abcissa, A. recta, Lineocypris hodonensis, Caspiolla rurica, C. unguiculus, Loxoconcha hodonica, L. granifera, Leptocythere lacunossa,* (Olteanu in Marinescu *et al.*, op. cit.)

Age: Pannonian

**6** – Răchitova

Mollusca - *Congeria partschi partschi* (Marinescu *et al.*, 1976)

Ostracoda - *Leptocythere bituberculata, L. naca, L. lacunossa, L. multituberculata, Loxoconcha* aff. *hodonica, L. rhombovalis,* (Olteanu in Marinescu *et al.*, op. cit.)

Age: Pannonian

**7** – Ciuchici

Mollusca - *Congeria czjzeki, C. czjzeki alatus, C. partschi, C. balatonica balatonica, C. zsigmondi, C. zagrabiensis, Limnocardium criovacensis, L. apertum rothi, L. apertum apertum, L. riegeli, L. pseudobsoletum, L. trifkovici, L. triangulatocostatum, L. winkleri, Pseudocatillus veselinovici, Paradacna abichi, Pontalmyra otiophora, Parvidacna petkovici, Ponalmyra otiophora, Gyraulus* aff. *inornatus, Provalenciennesia* sp., *Melanopsis* aff. *lanzaeana, Radix* sp., *R. kobelti, Velutinellus* aff. *catinus,* (Marinescu *et al.*, 1986)

Ostracoda: *"Hungarocypris" auriculata, H. hierogliphyca, Amplocypris abcissa, A. recta, Lineocypris hodonensis, Caspiolla rurica, Loxoconcha hodonica, L. granifera, L. rhombovalis, Leptocythere lacunossa,* (Olteanu in Marinescu *et al.*, op. cit.)

Age: Late Pannonian

**8** – Nicolinţ

Mollusca - *Limnocardium tegulatum, L. purocostatum, L. pseudosuessi, L. majori, L. apertum rothi, Congeria partschi, C. czjzeki, C. zsigmondi, Planorbis transylvanicus, Velutinopsis velutinus.* (Marinescu *et al.*, 1986)

Ostracoda: *Bacunela dorsoarcuata, Pontoniella acuminata*, *P.* sp 1, *P.* sp 2.

Age: Pontian

**9** – Câmpia (Câmpulung - Langenfeld)

Lithofacies: clay

Mollusca - *Congeria zsigmondi, C. czizeki, Limnocardium boeckhi, L. winkleri, L. brunnense, L. boeckhi, L. pseudosuessi, L. triangulatocostatum, L. hofmanni, L. secans, Melanopsis textilis, Pisidium* sp., *Micromelamia novokovici* (Zone D-E, according to Marinescu *et al.*, 1987).

Ostracoda - *"Hungarocypris" hieroglyphica, Amplocypris abcissa, A. matejici, A. subacuta, Pontoniella sagitossa, P. hastata, P. acuminata striata, Typhlocypris ornata, Cypria* aff. *tocorjescui, Leptocythere lacunoides, L.* aff. *cornutocostata, L. servica, L. pannono-maeotica, L. naca, L. subcaspia, Hemicytheria* aff. *dubokensis, Loxoconcha fistulosa, L. granifera, L. spinulosa, L. subrugosa, L. hodonica, Pontoleberis attillata, P. pontica,* (Olteanu, 1989b)

Age: Early Pontian (Odessian? - Portaferrian)

**10** – Groşi

Lithofacies: sandy clay, clay and fine sands (17 m)

Mollusca: *Limnocardium (Arpadicardium) mayeri, L. apertum, Congeria triangularis*

Ostracoda: *Bacunela dorsoarcuata, Pontoniella acuminata, Leptocythere bosqueti, L. cornutocostata, L. sinegubi, L. lacunossa, Xestoleberis* aff. *fuscomaculata, Loxoconcha pontico-tuberculata, L. granifera, L.* aff. *rhomboidea, Candona (T.) reducna, C. quadrata, C. pupini, C. sinuosa, C. Caspiolla parabalcanica, C. rurica, C. altilla, C. (L.) trapezoidea, Amplocypris robusta, A. firmus, A. abcissa, A. matejici, "Hungarocypris" hierogliphyca, Cyprideis heterostigma obessa, Cypria* aff. *tocorjescui, Hemicytheria* sp.,

Age: Pontian (Odessian ?)

**11** – Sinteşti

Lithofacies: fine, yellow sands (3m)

Mollusca: *Congeria zsigmond, C.* aff. *triangularis*

Ostracoda: *"Hungarocypris" hierogliphyca, Amplocypris matejici, A. angulata, A. subacuta, A. robusta, A. abcissa, A.* aff. *recta, Candona (L.) trapezoidea, C. (L.) quadrata, C. (Caspiolla) macra, Hemicytheria* aff. *pajinovicensis, H.* aff. *josephinae, Loxoconcha unicornuta, Cyprideis heterostigma,*

Age: Pontian

**12** – Crivina

Mollusca - *Melanopsis fossilis rugosa, M. fossilis fossilis, M. impressa, M. decollata, M. affinis, M. bouei, M. guernei, M. austriaca, M. pygmaea, M. stricturata, M. lozanici, M. martiniana, M. textilis, M. vindobonensis, Valvata leptomana, Caspia incerta, C. dybovsky, Sandria kochi, Hydrobia stropida, Orygoceras corniculum, Limnocardium zagrabiense, L. riegeli, L. secans, L. rogenhoferi, L. apertum, L.* aff. *plicataeformis, L. andrusovi spinosum, L. stoosi, L. desertum, Caladacna steindachneri, Congeria zahalkai, C. kuyiovensis, C. ungulacaprae, C.* aff. *spathulata, C. zagrabiensis, C.* aff. *triangularis, C.* aff. *balatonica, C. deoderleini, C.* aff. *rhamphophora, C. croatica, C. drzici, C. mytilopsis,* (Marinescu *et al*, 1986)

Ostracoda - *Candona alta, C.* aff. *fossulata, C. reticulata, C. labiata, C.* aff. *flectimarginata, Pontoniella acuminata, Pontoleberis pontica*, (Olteanu in Marinescu *et al*, op. cit.)

Age: Early Pontian (Odessian)

**13** – Criciova

Mollusca - *Limnocardium duminici, L. penslii, L. schmidti, L. diprosopum, L. banaticum, L. baraci, L. apertum apertum, L. apertum rothi, L. decorum decorum, L. decorum vicinum, Pseudocatillus simplex, Caladacna steindachneri, Phyllocardium complanatum, Parvidacna chartacea radmanesti* (Marinescu, 1986)

Ostracoda – *Pontoniella acuminate, Pontoleberis pontica, Candona alta, C. labiata, Bacunella dorsoarcuata.*

Age - Pontian

**14** – Cireşu (2km near Criciova):

Mollusca - *Limnocardium diprosopum, L. banaticum, Plagiodacna auigenri, Monodacna simplex, Congeria triangularis, Melanopsis cylindrica, M. jekeliusi, Micromelania sp.* (Marinescu, 1986)

Ostracoda – *Bacunella dorsoarcuata, Pontoniella acuminate, Cypria* aff. *tocorjescui*, *Amnicythere multituberculata, Caspiocypris* sp.A, *C.* sp.B

Age: Middle Pontian (Portaferrian)

**15** – Bucovăţ:

Lithofacies – sands (lower sequence) and clay (upper sequence)

Mollusca – *Congeria rhomboidea, C. triangularis, C. dubocaensis, C. zagrabiensis, C. balatonica, C. markovici, C. brandenburgi, C. simulans, C. croatica, C. markovici, Dreissena simplex auricularis, Limnocardium vicinum, L.* aff. *riegeli, L. prionophorum, L. diprosopus, L. decorum, L. secans, L. paulii, L. apertum, L. mayeri multicostata, Phyllocardium complanatum, Valenciennius reussi peltz, Monodacna defensa, Plagiodacna auingeri, Melanopsis tortispina, M. defensa trochiformis, Valenciennius* sp. (Marinescu, 1986)

Ostracoda – (upper sequence) – *Pontoleberis pontica, P. atillata, Pontoniella sagittosa, Amnicythere servica, A. lacunossa, A. subcaspia, A. sinegubi, A. multituberculata, Cypria tocorjescui, Loxoconcha fistulosa, L. unicornuta, L.* aff. *subrugosa, L. granifera, L.* aff. *schweyeri, L.*aff. *kolubarae, Paraloxoconcha hodonica, Caspiocypris* sp. *Amplocypris* sp. (fragments)

Age: Middle Pontian (Portaferrian)

**16** – Zorlenţul Mare

Lithofacies: clay and fine sands

Mollusca: 1 – Lower portion: *Limnocardium apertum rothi, L. riegeli, Congeria zagrabiensis, C. croatica, C. superfoetata, Valenciensis reussi,*

2 - Middle portion*: Limnocardium zagrabiensis, L. rogenhoferi, L. apertum, L. secans, L. majeri multicostata, L.* aff. *syrmiense, L. okrugici, Plagiodacna* aff. *carinata, Congeria zagrabiensis,*

3 - Upper portion: *Congeria croatica, C. balatonica balatonica, C. balatonica cavernosa, Didacna* aff. *chyzeri, C.* aff. *labiata, Pseudocatillus* sp. (Gillet, 1943)

Ostracoda: *Caspiolla lobata, C. alasi alasi, A, altila, Pontoniella paracuminata*, *Hastacandona longitesta, Camptocypria lata, Paraloxoconca hodonica, Amnicythere multituberculata, Euxinocythere cornutocostata, Leptocythere (?) buchii, Hemicytheria dubokensis, H. folliculosa, H. pajinovicensis, H. reticulate. Loxoconcha petkovici, L. alitera, L. spinosa.*

Age: Middle Pontian (Portaferrian)

**17** – Tirol

Lithofacies: clay (2-3 m), yellow, fine sands (6-78 m) (Mieilor valley)

Mollusca: *Limnocardium apertum, L. (Pannonicardium) schmidti, L. (P.) penslii, L.(Budmania) semseyi, L. (B.) cristagalii, L. (B.) ferruginosum, L. (B.) patrulii, L. (Euxinicardium) ochetophorum, L. (Arpadicardium) mayeri, L. (Bosphoricardium) banaticum, Caladacna steindachneri, Congeria rhomboidea, C. triangularis, C. croatica, C. oppenheimi, Dreissenomya schroeckingeri, Valenciennius reussi*. Marinescu (1973), Marinescu *et al*, (1987) (almost 80 species).

Ostracoda: unknown

Age: Middle Pontian (Late Portaferrian)

**18** – Stracoş

Lithofacies: clay, fine sands

Mollusca: *Melanopsis fossilis, M. vindobonensis, M. sturi, M. pygmaea, M. austriaca, M. scripta, M. bouei, M. brusinai, M. stricurata, M. textilis, Pleuroceras kochi, Prososthemia radicevici, Planorbis verticillus, Orygoceras fuchsia, Congeria partschi, C. markovici, C. subglobosa, C. martonfii pseudoauricularis, C. doderleini, C. zsigmondi, C. ramphophora, C. mytiloides, Limnocardium andrusovi, L. trifcovici, L.* cf *desertum, L. hantkeni, Unio atavus* (Jekelius, 1943)

Ostracoda: *Lineocypris trapezoidea, L. sinuosa, L. quadrata, L. symmetrica, L. pupini, Typhlocypris ornate, Paraloxoconcha hodonica, Euxinocythere cornutocostata, Hemicytheria major, H.* aff. *insignis, H.* aff. *marginata, H.* aff. *pannonica, H. reticulata, H. dubokensis, Loxoconcha pontica tuberculata, L. petcovici, L. alitera.*

Age: Middle Pontian (Portaferrian)

**19** – Hidişelu de Sus

Lithofacies – green, fine clay

Mollusca – *Limnocardium secans, Congeria czjzeki, C. rhomboidea* (Papaianopol I., 1984)

Ostracoda – *Bacunella dorsoarcuata, Pontoniella truncata, P. acutissima, Amplocypris* aff. *subacuta, Lineocypris pupini, Typhlocypris ornata, Paraloxoconcha hodonica, Amnicythere multituberculata, Euxinocythere cornutocostata, E.* aff. *bosqueti, Hemicytheria major, H. folliculosa, H.* aff. *marginata, H.* aff. *pannonica, H. reticulata, H. dubokensis, Loxoconcha pontica tuberculata, L. petkovici, L. alitera.*

Age – Middle Pontian (Portaferrian).

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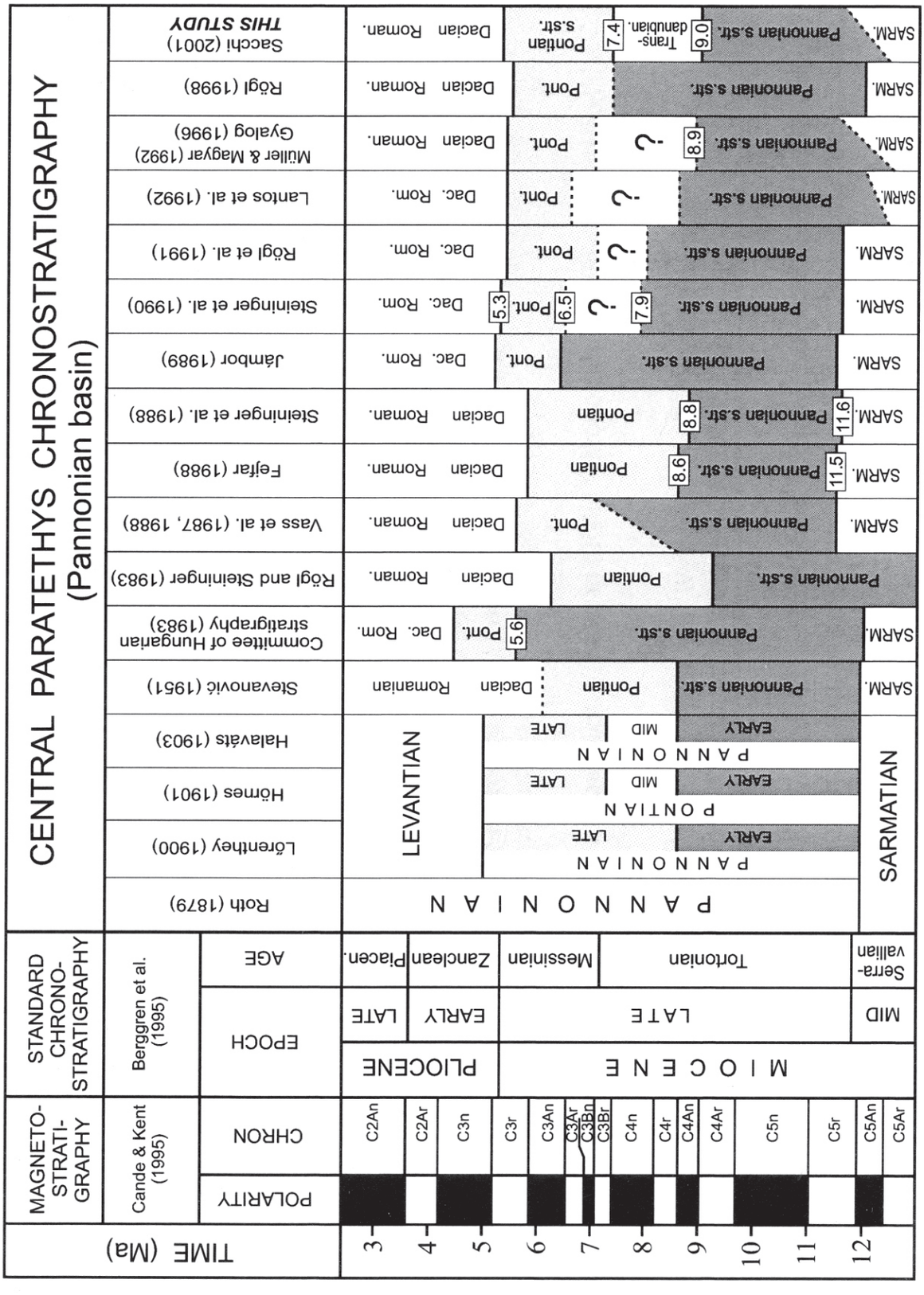
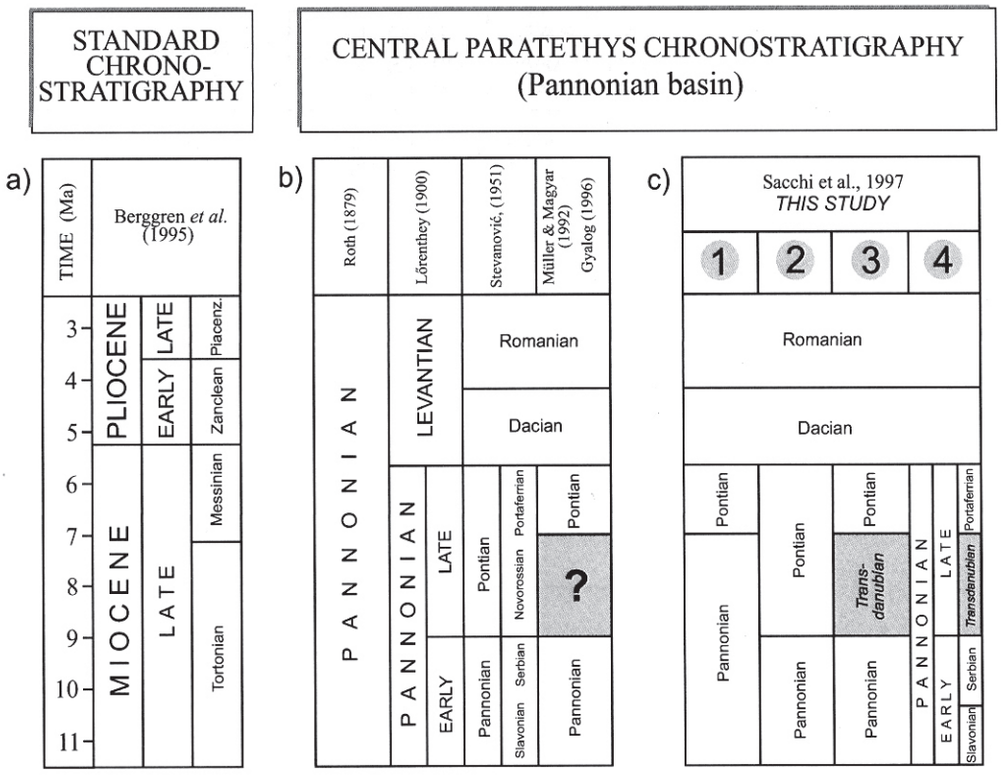
My thoughts go to the memory of Dr. Florin Marinescu for the time we spent together on field trips.


CENTRAL PARATETHYS CHRONOSTRATIGRAPHY
(Pannonian basin)
TIME (Ma)
MAGNETO-STRATI-GRAPHY
Cande & Kent (1995)
POLARITY
CHRON
STANDARD CHRONO-STRATIGRAPHY
Berggren et al. (1995)
EPOCH
AGE
C2An C2Ar C3n C3r C3An C3Ar C3Bn C3Br C4n C4r C4An C4Ar C5n C5r C5An C5Ar
PLIOCENE
MIOCENE
LATE
EARLY
LATE
MID
Piacen.
Zanclean
Messinian
Tortonian
Serra-vallian
SARMATIAN
LEVANTIAN
PANNONIAN
PONTIAN
EARLY
MID
LATE
Roth (1879)
Lörenthey (1900)
Hörnes (1901)
Halaváts (1903)
Stevanović (1951)
Committee of Hungarian stratigraphy (1983)
Rögl and Steininger (1983)
Vass et al. (1987, 1988)
Fejfar (1988)
Steininger et al. (1988)
Jámbor (1989)
Steininger et al. (1990)
Rögl et al. (1991)
Lantos et al. (1992)
Müller & Magyar (1992)
Gyalog (1996)
Rögl (1998)
Sacchi (2001)
THIS STUDY
Dacian Roman.
Pontian
Pont.
Dac. Rom.
Daco-Romanian
SARM.
Pannonian s.str.
Trans-danubian.
5.6
6.5
5.3
7.9
6.8
11.5
8.6
11.6
8.8
7.4
9.0




1. Shift the boundary between Pannonian s. str. and Pontian s. Stevanović (1951) up to the base of the Pontian as it is defined in its type section of the Eastern Paratethys.
2. Maintain the Pontian s. Stevanović (1951) only for the Central Paratethys and use the term Pontian with two different meanings.
3. Introduce a new stage (Transdanubian) in order to fill the "chronostratigraphic gap" between the Pannonian s. str. and Pontian s. str. .
4. Delete the stage name "Pontian" from the Western-Central Paratethys stage system and reintroduce the use of the term "Pannonian" s. Lőrenthey (1900).

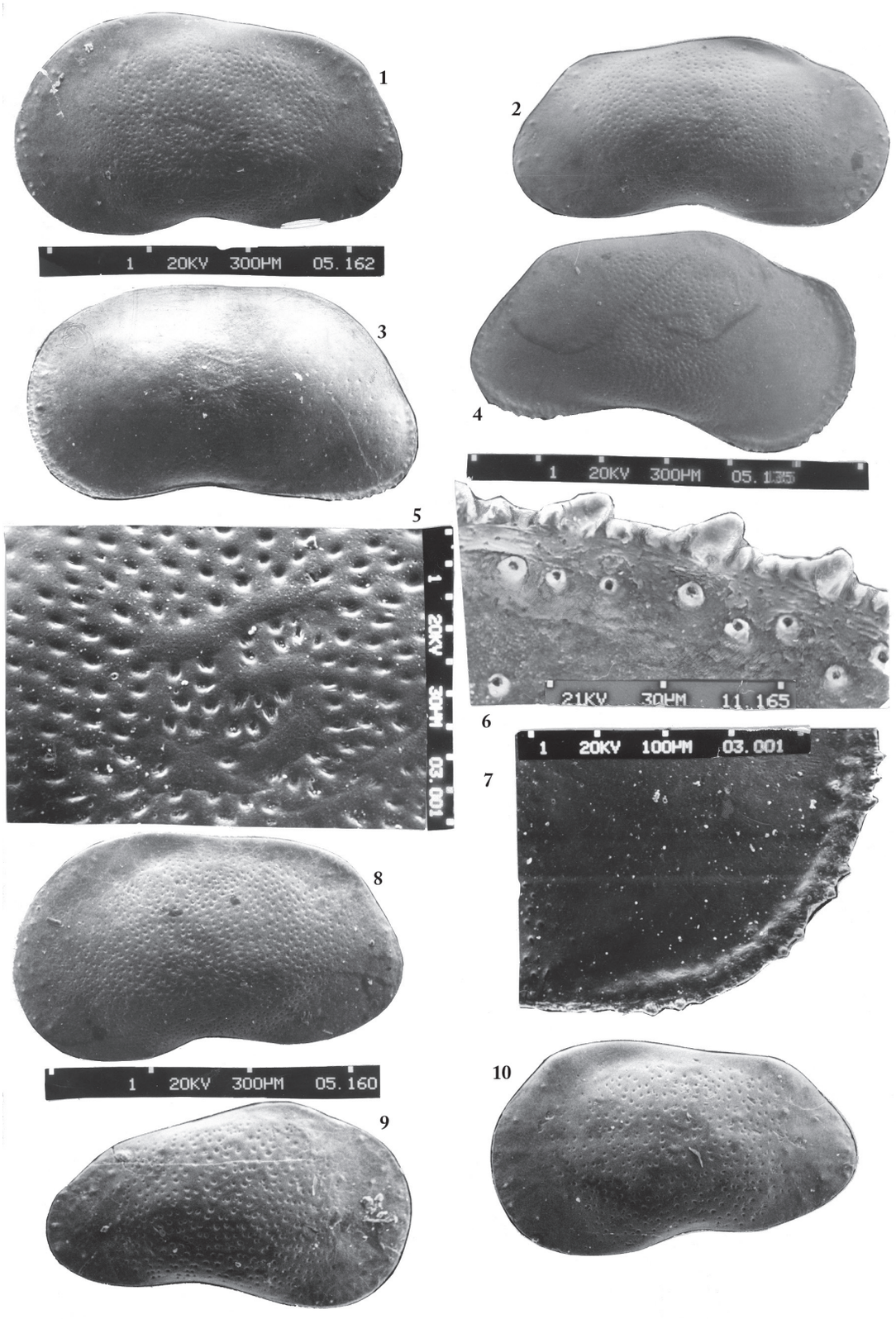



**Plate I. Fig. 1** – "*Hungarocypris" hieroglyphica* (Mehes), left valve, adult, Middle Pontian, Holod (Beiuş basin, northern region of the Apuseni Mountains); **Fig. 2** – "*Hungarocypris" auriculata* (Reuss), right valve, adult, Middle Pontian, Holod; **Fig. 3** – "*Hungarocypris" hieroglyphica* (Mehes), left valve, adult, Pannonian, Şoimi (Beiuş basin); **Fig. 4** – "*Hungarocypris" auriculata* (Reuss), right valve, adult, Pontian, Chişcău (Crăiasa valley); **Fig. 5** – "*Hungarocypris" auriculata* (Reuss), central portion of the left valve; **Fig. 6** – "*Hungarocypris" auriculata* (Reuss), anterior margin; **Fig. 7** – "*Hungarocypris" auriculata* (Reuss), posterior portion of the right valve; **Fig. 8** – "*Hungarocypris" hieroglyphica* (Mehes), left valve, adult, Pannonian, Şoimi; **Fig. 9 - 10** - "*Hungarocypris*" aff. *auriculata* (Reuss), right and left juvenile valves, Pannonian, Şoimi

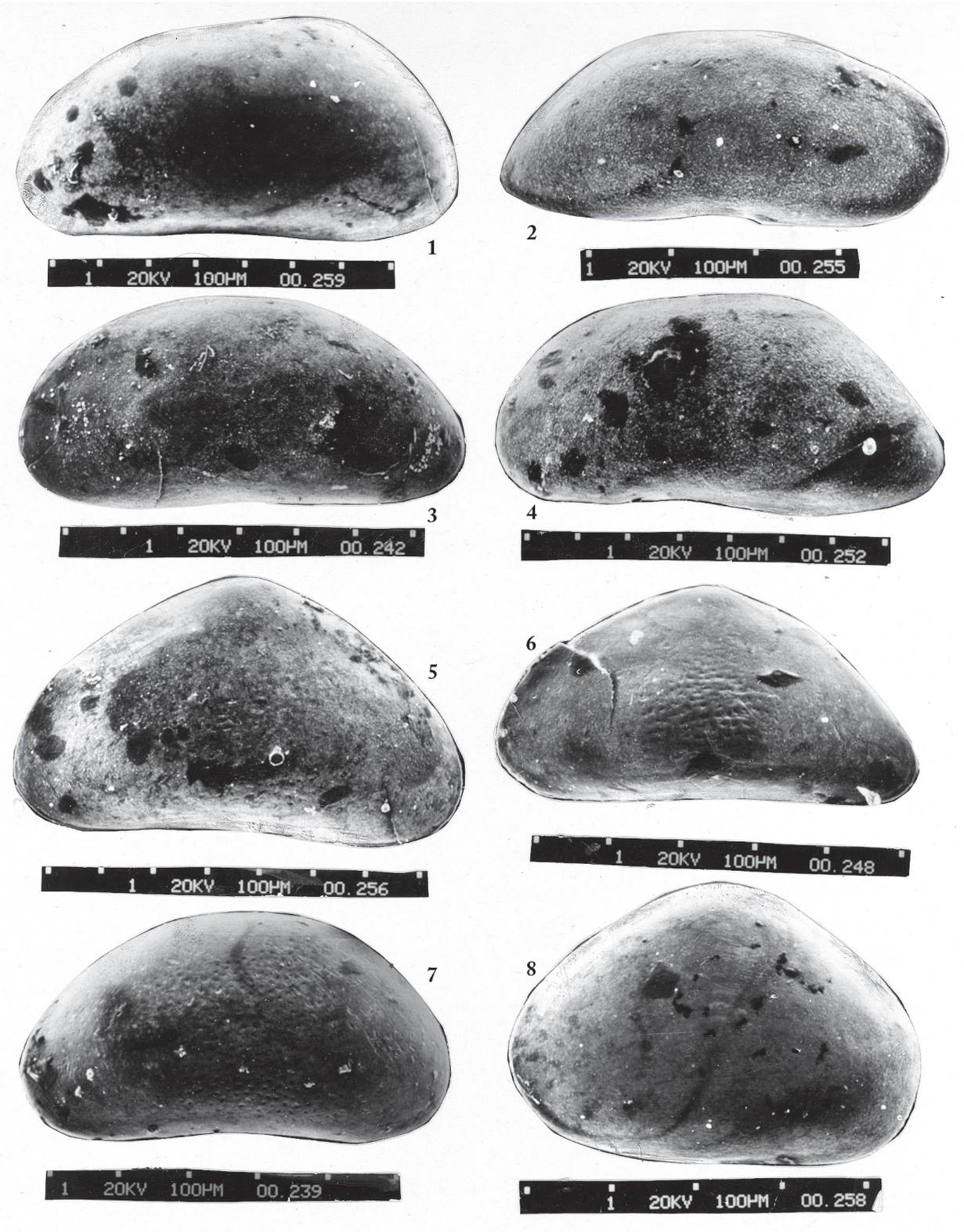



**Plate II. Fig. 1** – *Candona (Caspiocypris) postsarmatica* Krstič, left valve, adult, Early Pannonian, Carand (Metaliferi mountains); **Fig. 2** – *Candona* (*Camtocypria) elongata* n. sp., right valve, adult, Early Pannonian, Carand; **Fig. 3** – *Candona (Cryptocandona) nocens* Krstič, left valve, juvenile (?), Early Pannonian, Carand; **Fig. 4** – *Candona carandui* n. sp. left valve, adult, Early Pannonian, Carand; **Fig. 5** – *Cyprinotus pannonicus* n. sp., left valve, adult, Early Pannonian, Carand; **Fig. 6** – *Cyprinotus pannonicus* n. sp., left valve, juvenile, Early Pannonian Carand; **Fig. 7** – *Cyprinotus* (?) sp. 1, right valve, adult, Early Pannonian, Carand; **Fig. 8** – *Cyprinotus* (?) sp. 2, left valve, adult, Early Pannonian, Carand

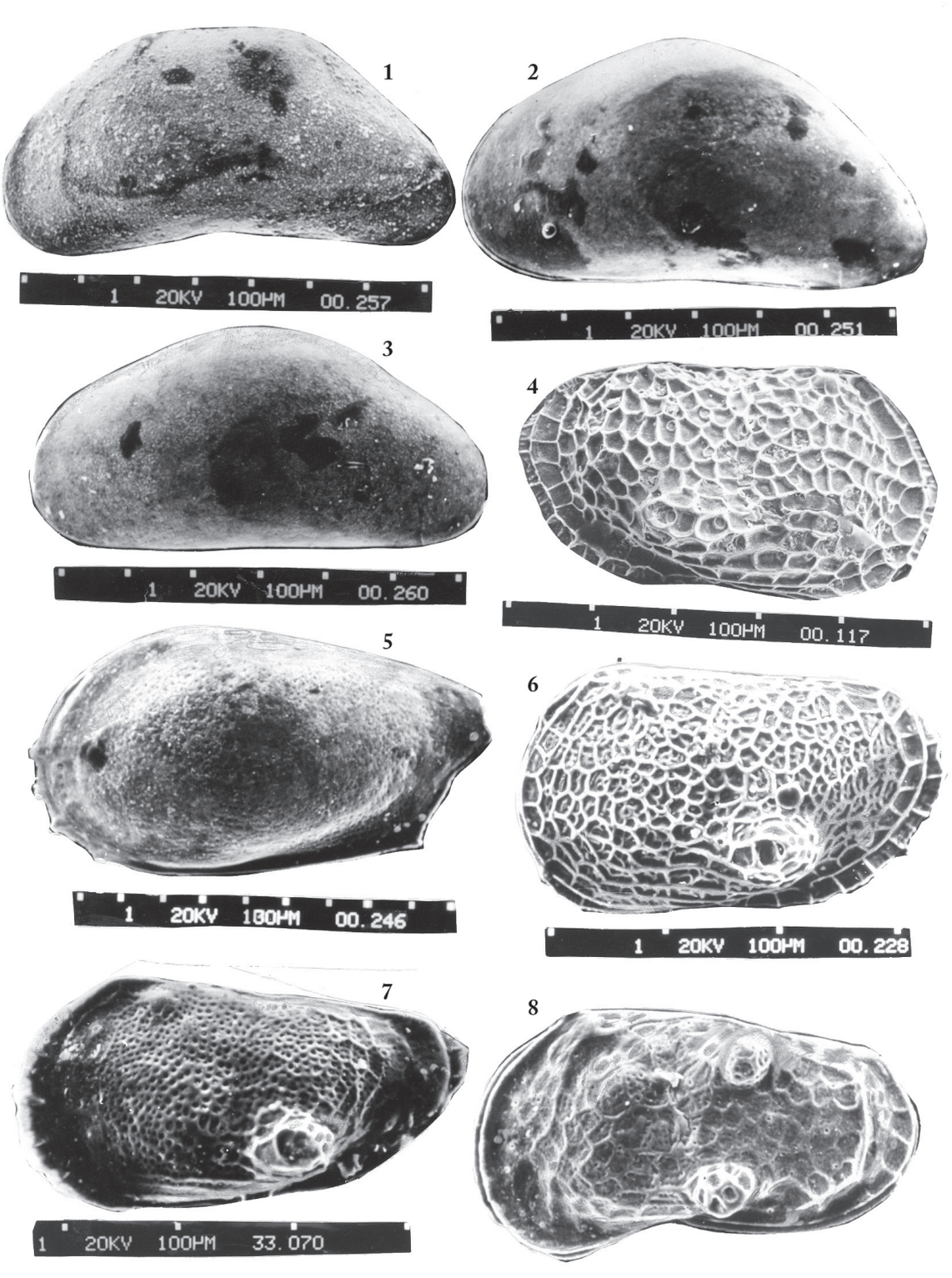



**Plate III. Fig. 1** – *Candona* sp. A, left valve, adult, Early Pannonian, Carand; **Fig. 2** – *Candona* (?) sp. 6, left valve, adult, Early Pannonian, Carand; **Fig. 3** – *Candona* aff. *nocens* Krstič, presumable left valve, adult, Early Pannonian, Carand; **Fig. 4** – *Loxoconcha praepannonica* n. sp., right valve, adult, Pannonian, Soceni, Turislav valley; **Fig. 5** – *Loxocauda stevanovici* Krstič, left valve, adult, Early Pannonian, Carand; **Fig. 6** – *Loxoconcha* aff. *alveolata* Voroshilova, left valve, adult, Early Pannonian, Carand; **Fig. 7** – *Loxoconcha* aff. *alveolata* Voroshilova, left valve, juvenile, Early Pannonian, Carand; **Fig. 8** – *Leptocythere bituberculata* Sheremeta, left valve, adult, Early Pannonian, Carand

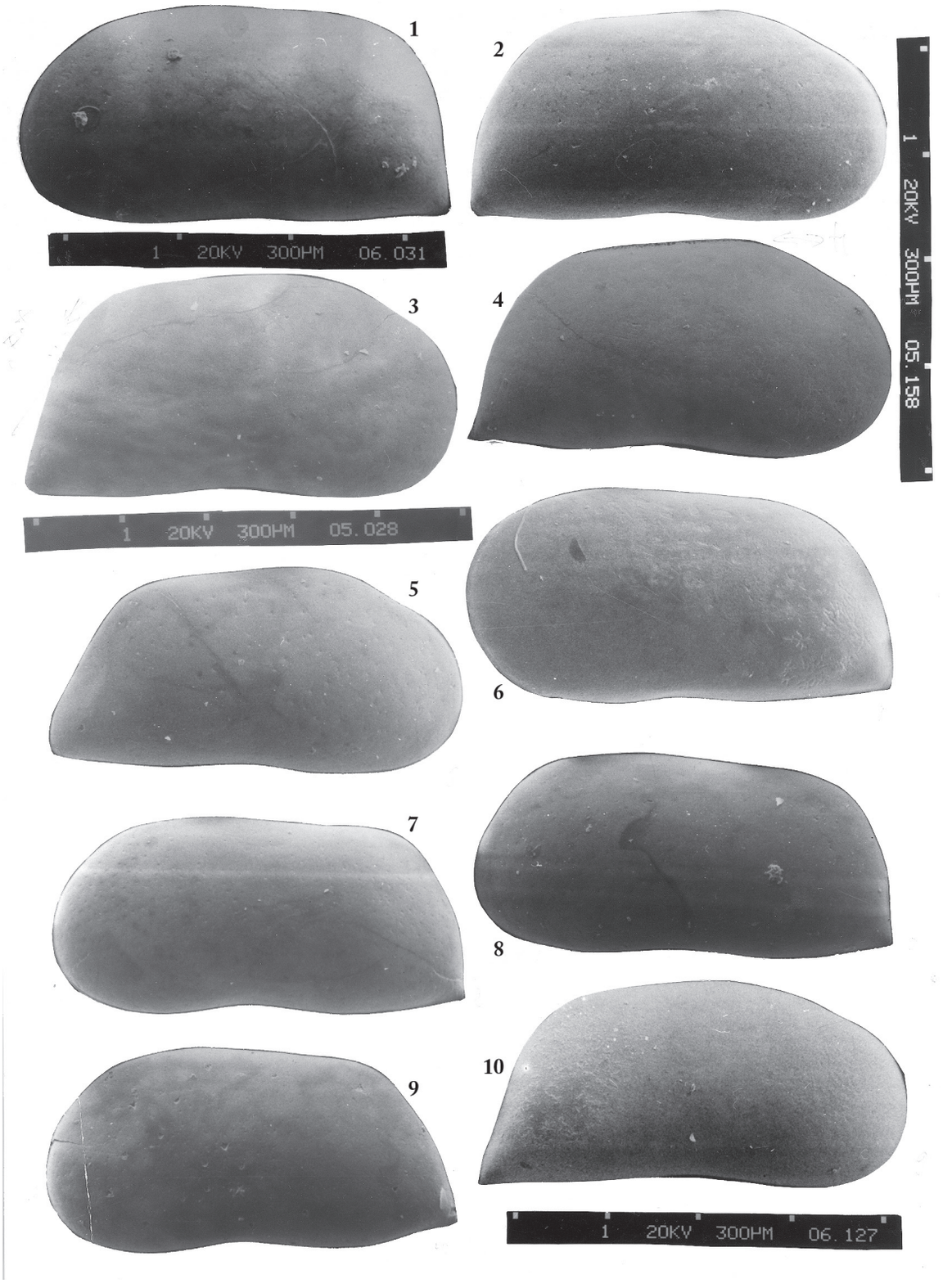



**Plate IV. Fig. 1** – *Amplopcypris* sp. 7, adult, left valve, Ponţian, Sinteşti; **Fig. 2** – *Amplocypris* aff. *major* Krstič, adult, right vave, Pannonian, Soceni 1, Turislav valley; **Fig. 3** – *Amplocypris major* Krstič, adult, right valve, Pannonian, Soceni, Turislav valley ; **Fig. 4** – *Amplocypris* sp. 7, adult, right valve, Pontian, Groşi; **Fig. 5** – *Amplocypris* aff. *bacevice* Krstič, adult, right valve, Pontian, Holod; **Fig. 6** – *Amplocypris* sp. 9, adult (?), right valve, Pontian, Holod; **Fig. 7** – *Amplocypris* sp. 10, adult, left valve, Pontian, Holod; **Fig. 8** – *Amplocypris* sp. 10, adult, left valve, Pannonian, Soceni, Turislav valley; **Fig. 9** – *Amplocypris* sp. 7, adult, left valve, Pontian, Sinteşti; **Fig.10** – *Amplocypris* aff. *acuta* Krstič, adult, right valve, Pontian, Holod

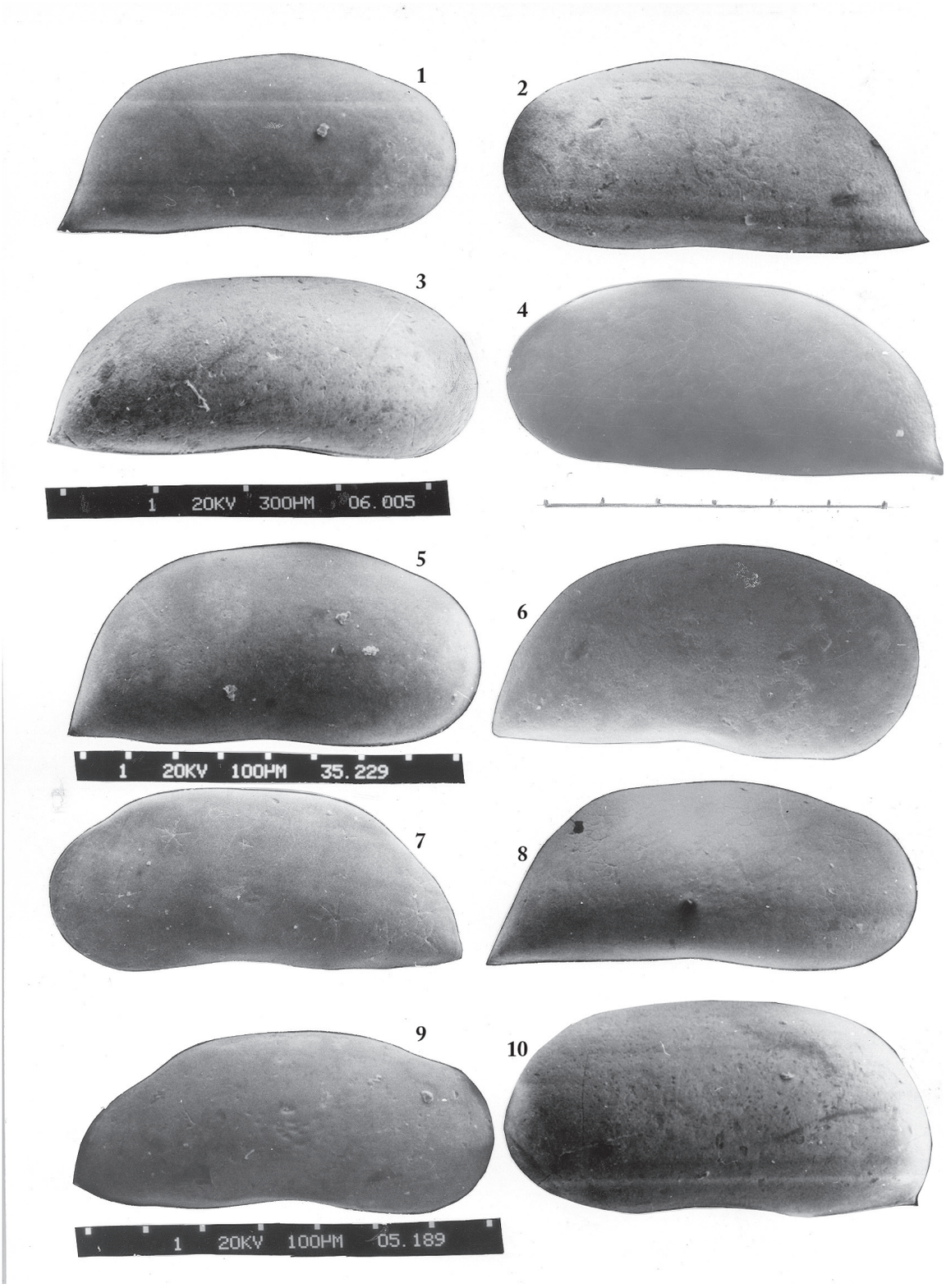



**Plate V. Fig. 1** – *Amplocypris subacuta* Zalanyi, adult, right valve, Pontian, Sinteşti; **Fig. 2** – *Amplocypris subacuta* Zalanyi, adult, left valve, Pontian, Sinteşti; **Fig. 3** – *Amplocypris* aff. *subacuta* Zalanyi, adult, right valve Middle Pontian, Hidişelu de Sus; **Fig. 4** – *Candona (Caspiolla) rurica* Krstič, adult, left valve, Middle Pontian, Râpa; **Fig. 5** – *Amplocypris* aff. *abcissa* (Reuss), adult, right valve, Pontian, Sinteşti; **Fig. 6** – *Candona (Caspiolla) lobata* (Zalanyi), right valve, adult, Middle Pontian, Hidişelu de Sus; **Fig. 7** – *Candona (Caspiolla)* aff. *alasi alasi* Krstič, left valve, adult, Middle Pontian, Râpa; **Fig. 8** – *Candona (Caspiolla) macra* Krstič, right valve, adult, Sinteşti; **Fig. 9** – *Candona (Caspiolla)* aff. *alasi alasi* Krstič, right valve, adult, Pontian, Chişcău; **Fig. 10** – *Candona (Caspiolla) altila* Olteanu, adult, left valve, Pontian, Groşi


**Plate VI. Fig. 1** – *Candona (Caspiolla) praebalcanica posterior* Krstič, adult, left valve, Middle Pontian, Hidişelu de Sus (with *Congeria rhomboidea*); **Fig. 2** – *Candona (Caspiolla)* aff. *parabalcanica* Krstič, adult, left valve, Pontian, Groşi; **Fig. 3** – *Pontoniella paracuminata* Krstič, adult, left valve, Middle Pontian (with *Congeria rhomboidea*), Hidişelu de Sus; **Fig. 4** – *Candona (Hastacandona) longitesta* Krstič, adult, right valve, Hidişelu de Sus; **Fig. 5** – *Pontoniella* sp., adult, right valve, Middle Pontian, Hidişelu de Sus; **Fig. 6** – *Pontoniella* aff. *paracuminata* Krstič, adult, left valve, Middle Pontian, Hidişelu de Sus (with *Congeria rhomboidea*); **Fig. 7** – *Candona (Caspiolla)* aff. *magna* Krstič, adult, right valve, Pontian, Chişcău; **Fig. 8** –*Candona (Caspiolla) alasi midlodjini* Krstič, adult, right valve, Pontian, Chişcău; **Fig. 9** – *Candona (Camptocypria) lata* n. sp., adult, left valve, Pontian, Crăiasa valley, Chişcău; **Fig. 10** – *Candona (Camptocypria) hungarica* Zalanyi, adult, right valve, Pontian, Holod; **Fig. 11** – *Candona (Camtocypria) lata* n. sp., adult, left valve, Pontian, Craiasa valley, Chişcău.

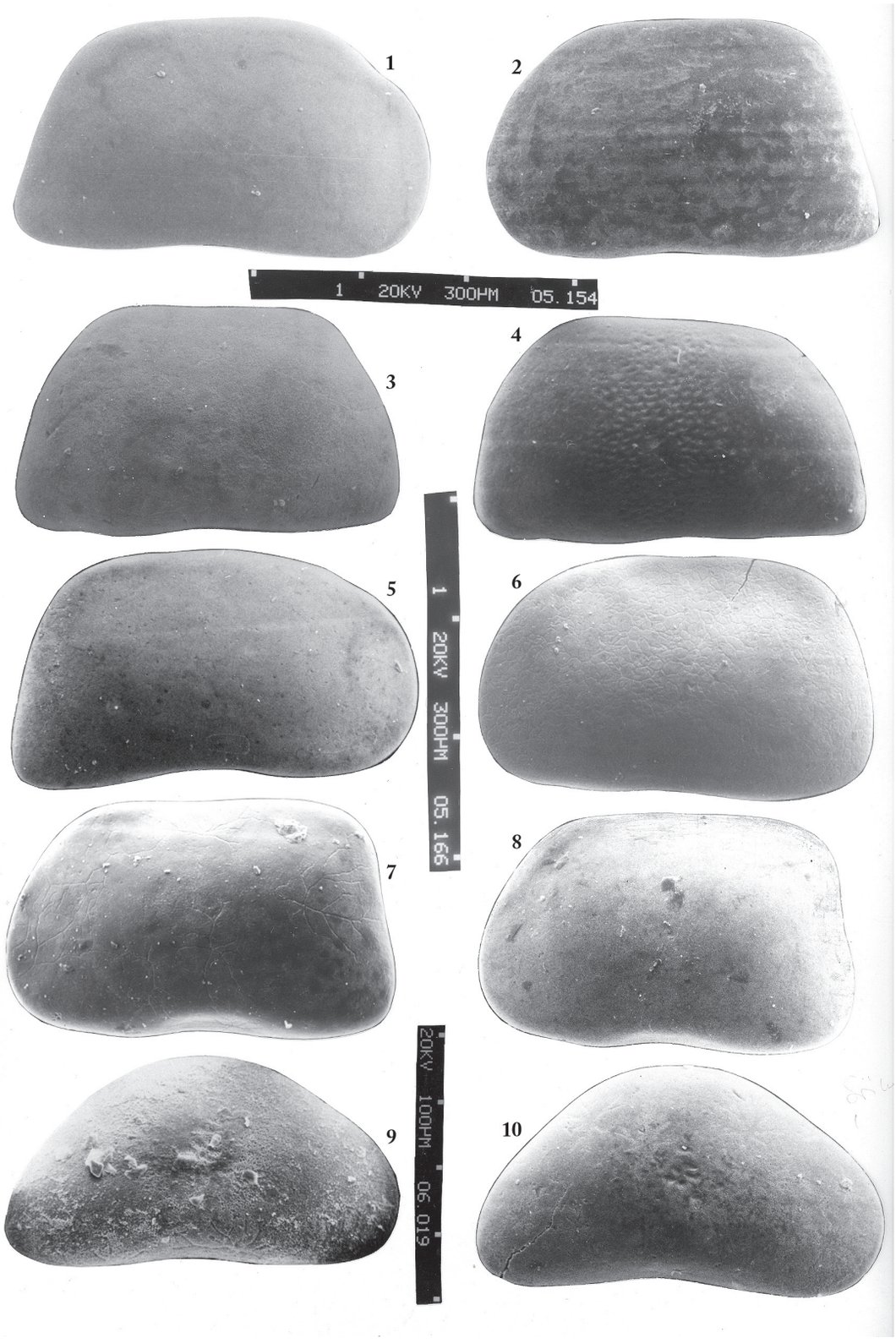



**Plate VII. Fig. 1** – *Candona (Lineocypris) trapezoidea* Zalanyi, right valve, adult, Middle Pontian, Râpa**. Fig. 2** - *Candona (Lineocypris) trapezoidea* Zalanyi, adult, left valve, Pannonian, Şoimi; **Fig. 3** – *Candona (Lineocypris) sinuosa* Olteanu, adult, right valve, Pontian, Holod; **Fig. 4** – *Candona (Lineocypris) sinuosa* Olteanu, juvenile, left valve, Pontian, Holod; **Fig. 5** – *Candona (Caspiocypris)* aff. *impobrus* Krstič, adult, right valve, Pontian, Sinteşti 3; **Fig. 6** – *Candona (Caspiocypris)* n. sp. (?), adult, left valve, Pontian, Chişcău; **Fig. 7** – *Candona (Lineocypris) quadrata* Olteanu, adult, left valve, Pontian, Sinteşti; **Fig. 8** – *Candona (Lineocypris) quadrata* Olteanu, adult, left valve, Pontian, Sinteşti; **Fig. 9** – *Candona (Typhlocypris) reducna* (Zalanyi), adult, left valve, Pontian, Groşi; **Fig. 10** – *Candona (Typhlocypris)* aff. *reducna* (Zalanyi), adult, right valve, Pannonian, Şoimi

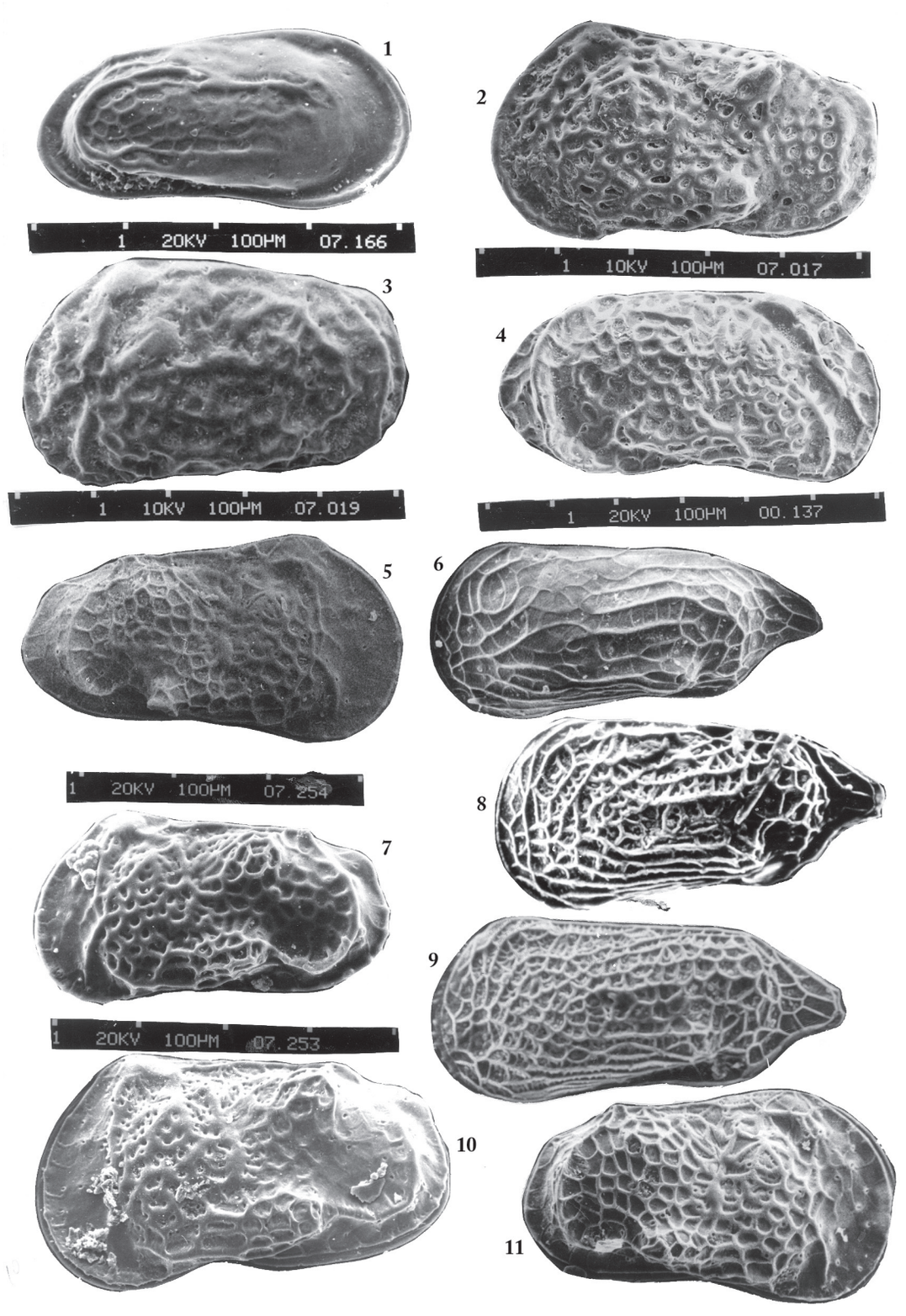



**Plate VIII. Fig. 1** – *Candona (Reticulocandona) posteroerigera* Krstič, adult, left valve, Pannonian, F-1001 Deva, 171m**. Fig. 2** – *Candona (Lineocypris) symmetrica* Krstič, adult, right valve, Pontian, Câmpia; **Fig. 3** – *Candona (Reticulocandona)* sp., adult, left valve, Pontian, Săbolci; **Fig. 4** - *Candona (Reticulocandona) reticulata* (Mehes), adult, right valve, Middle Pontian, Rieni; **Fig. 5** – *Candona (Lineocypris)* aff. *symmetrica* Krstič, adult (?), right valve, Pontian, Holod; **Fig. 6** – *Typhlocypris elongata* Olteanu, adult, right valve, F-102, Lugoj, 231 m, (Banat), Middle-Upper Pontian; **Fig. 7** – *Caspiocypris (Lineocypris) pupini* Krstič, adult, left valve, Pontian, Chişcău**. Fig. 8** – *Typhlocypris ornata* Olteanu, adult, left valve, Early Pontian, Chişcău**. Fig. 9** – *Candona (Lineocypris)* aff. *pupini* Krstič adult (?), left valve, Pontian, Holod; **Fig. 10** – *Candona (Lineocypris) pupini* Krstič, adult, left valve, Middle Pontian, Râpa (Omului valley).

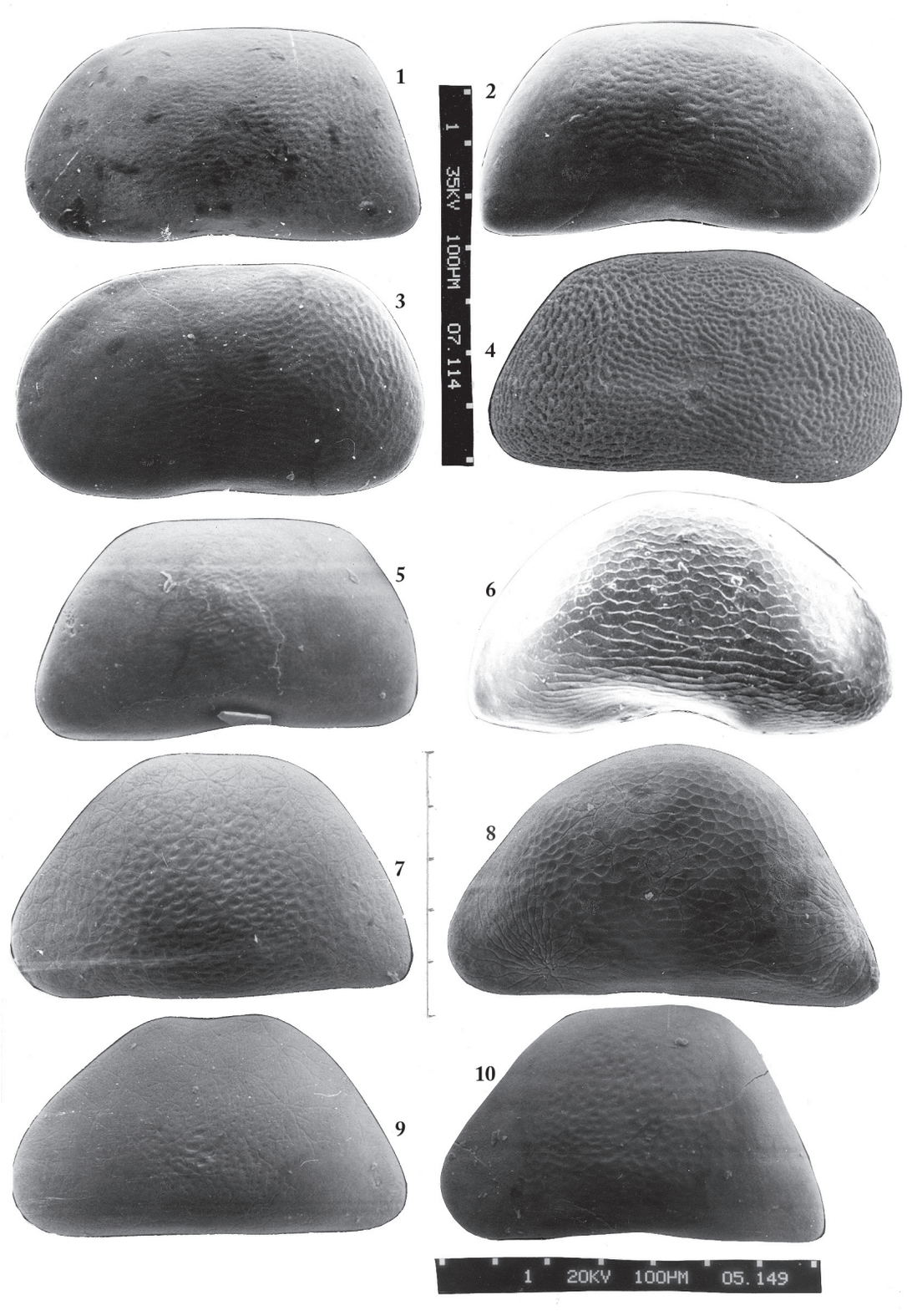



**Plate IX. Fig. 1** – *Bacunella krstici* Olteanu, adult, right valve, Pontian, Urvind (Borod basin); **Fig. 2** – *Bakunella dorsoarcuata* (Zalanyi), adult, right valve, Pontian, Câmpia**. Fig. 3** – *Pontoleberis pontica* (Stanceva), adult, left valve, Pontian, Câmpia; **Fig. 4** – *Pontoleberis altilla* (Stanceva), adult, left valve, Pontian, Câmpia; **Fig. 5** – *Leptocythere (Amnicythere) multituberculata* (Livental), adult, right valve, F-12 Lugoj, Middle-Upper (?) Pontian; **Fig. 6** – *Candona* sp. ex gr. *Candona caudalis* Krstič, juvenile, right valve, Pontian, Chişcău; **Fig. 7** – *Loxoconcha ornata subornata* Stanceva, adult, left valve, Pannonian, Soceni, Turislav valley; **Fig. 8** – *Leptocythere aculeata* Olteanu, adult, left valve, Pontian, Câmpia; **Fig. 9**. *Mediocytherideis chersonica* Krstič, adult, left valve, Early Pannonian, F-Mermeşti, 332m; **Fig. 10** – *Loxoconcha hodonica* Pokorný, adult, left valve, Pannonian, Soceni, Turislav valley; **Fig. 11** – *Paraloxoconcha pontica* n. name (= *Paraloxoconcha hodonica* (Pokorný), in Olteanu, 1995, p. 308, Plate XXXI, Fig.1-7, Plate XXXII, Fig. 6-9) adult, left valve, Middle Pontian, Rieni

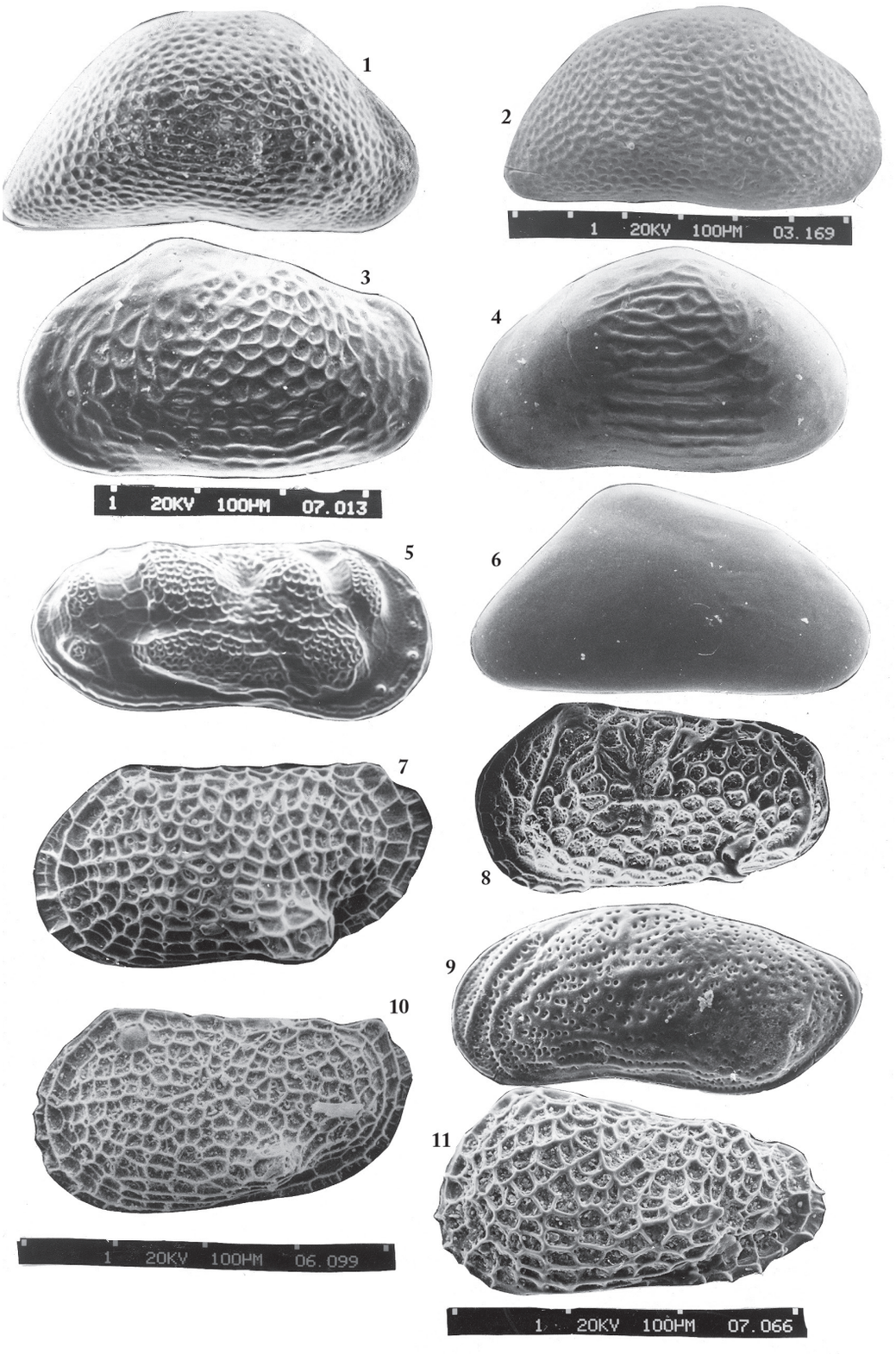



**Plate X. Fig. 1** – *Leptocythere (Amnicythere) subcaspia* (Livental), adult, right valve, Middle Pontian, Râpa; **Fig. 2** – *Leptocythere (Euxinocythere)* sp. A, adult, left valve, Pannonian, F-1001 Mermeşti, 240m; **Fig. 3** – *Leptocythere (Maeotocythere) bosqueti* (Livental), adult, left valve, Soceni, Turislav valley, Pannonian; **Fig. 4** – *Leptocythere (Euxinocythere) ludica* Olteanu, adult (?), right valve, Pannonian, F-1001, Mermeşti, 130m; **Fig. 5** – *Leptocythere (Maeotocythere?) radae* Krstič, adult, right valve, Pannonian, F-1001, Mermeşti, 130m; **Fig. 6** – *Cytherura* sp. A, adult, left valve, Soceni, adult, left valve, Pannonian, F-1001, Mermeşti, 130m; **Fig. 7** – *Leptocythere (Euxinocythere) pannono-maeotica* Olteanu, juvenile, left valve, presumable Early Pannonian, Şoimi**. Fig. 8** – *Cytherura moravica* Pokorný, adult, left valve, Early Pannonian, Carand; **Fig. 9** – *Cytherura moravica* Pokorný, adult, left valve, Pannonian, Soceni, Turislav valley**. Fig. 10** - *Leptocythere (Euxinocythere) pannono-maeotica* Olteanu, adult, left valve, Pontian, Câmpia; **Fig. 11** - *Leptocythere (Euxinocythere) pannono-maeotica* Olteanu, juvenile, right valve, Pontian, Câmpia

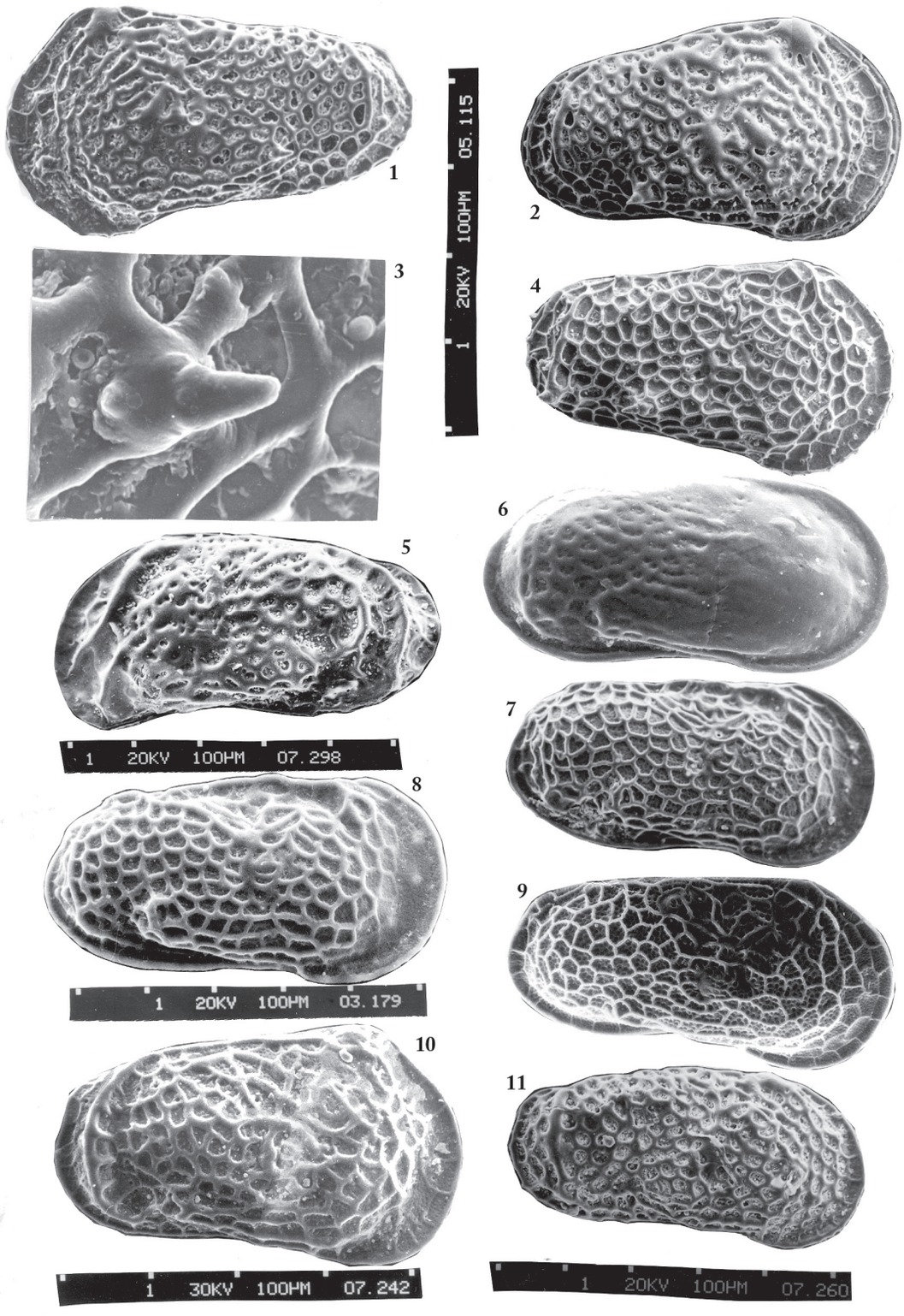



**Plate XI. Fig. 1** – *Leptocythere (Euxinocythere) servica* Krstič, adult, left valve, Pontian, Câmpia; **Fig. 2** - *Leptocythere (Euxinocythere) servica* Krstič, adult, right valve, Pontian, Câmpia; **Fig. 3** - *Leptocythere (Euxinocythere) servica* Krstič, postero-ventral epine; **Fig. 4** - *Leptocythere (Euxinocythere) biaccicularia* Olteanu, adult, right valve, Pontian, Câmpia; **Fig. 5** - *Leptocythere (Euxinocythere) alasi* Krstič, adult, left valve, Pontian, Câmpia; **Fig. 6** - *Leptocythere (Euxinocythere)* aff. *cornutocostata* (Schweyer), juvenile, right valve, Pontian, Crivina; **Fig. 7** – *Leptocythere (Euxinocythere) sinegubi* Krstič, adult, right valve, Pontian, Groşi; **Fig. 8** – *Leptocythere* (*Euxinocythere) sinegubi* Krstič, presumable juvenile, right valve, Pontian, Câmpia; **Fig. 9** – *Leptocythere (Euxinocythere)* aff. *olivina* (Livental), adult, right valve, Pontian, Câmpia; **Fig. 10** - *Leptocythere (Euxinocythere)* sp. D, adult (?), right valve, Pontian, Câmpia; **Fig. 11** - *Leptocythere (Euxinocythere)* sp. E, adult, right valve, Pannonian, Şoimi

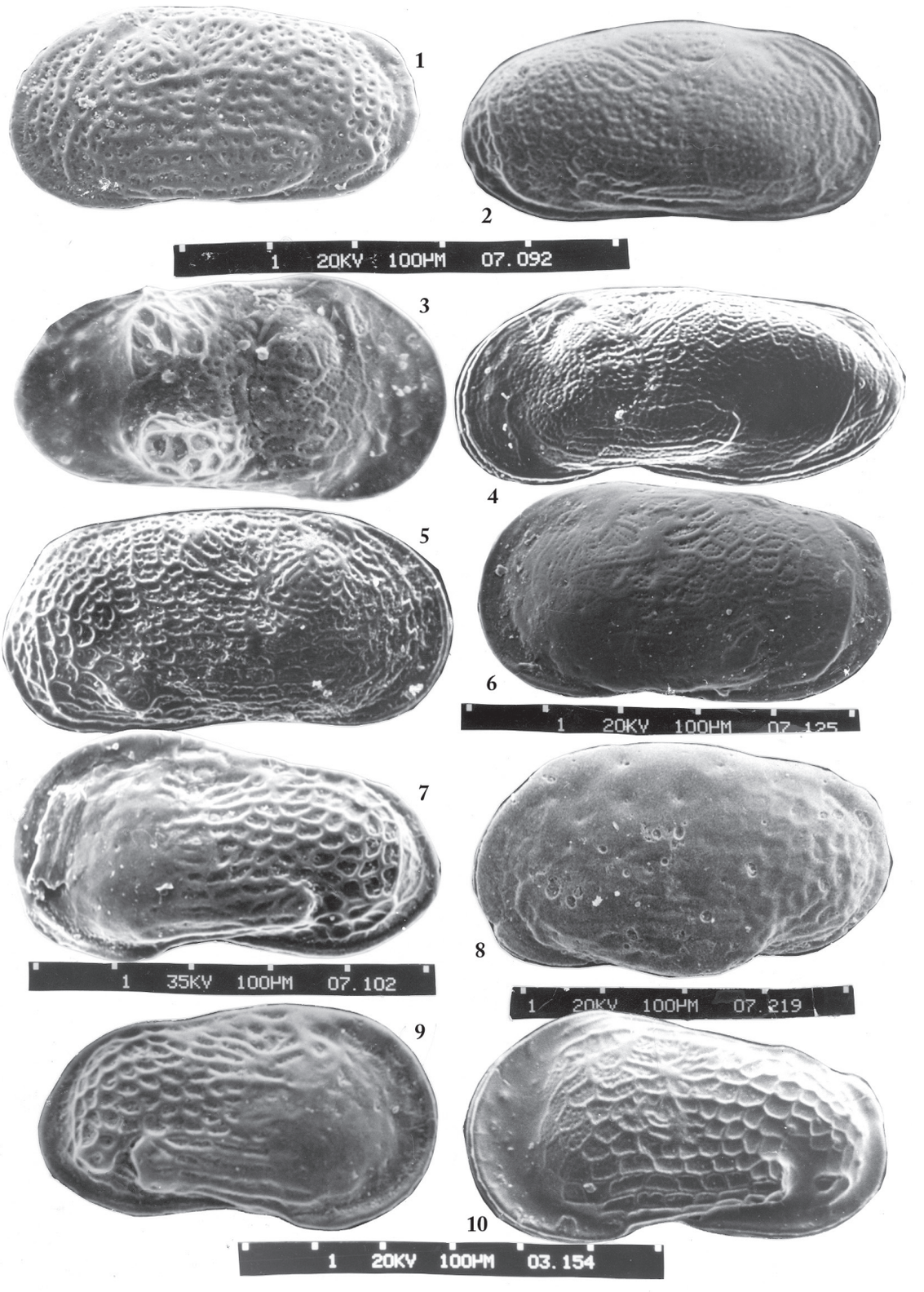



**Plate XII. Fig. 1** – *Leptocythere (Amnicythere)* sp. A, adult, left valve, Pannonian, Şoimi; **Fig. 2** - *Leptocythere (Amnicythere)* sp. B, juvenile, right valve, Pannonian, Şoimi; **Fig. 3** - *Leptocythere (Euxinocythere) kuznetzovae* (Voroshilova) (similar to *Euxinocythere emilie* (Stanceva) and *E. pseudolitiginosa* (Stanceva) from Kersonian), presumable juvenile, right valve, Late Sarmatian (oligohaline water facies), Carand**. Fig. 4** - *Leptocythere (Amnicythere)* sp. B, juvenile, left valve, Pannonian, Şoimi**. Fig. 5** - *Leptocythere (Amnicythere) dositeji* Krstič, adult, right valve, Pannonian, Soceni (1-2); **Fig. 6** - *Leptocythere (Amnicythere) krstici* n. sp. adult, left valve, F-1001, Deva, 171 m; **Fig. 7** – *Leptocythere (Euxinocythere) cornutocostata* (Schweyer), adult, left valve, Pontian, Săbolci; **Fig. 8** – *Leptocythere alata* Olteanu, adult, left valve, Pannonian, Şoimi; **Fig. 9** – *Leptocythere (Euxinocythere) cornutocostata* (Schweyer), adult, right valve, Pontian, Groşi; **Fig. 10** – *Lepocythere (Euxinocythere) cornutocostata* (Schweyer), adult, left valve, Lugoj F-12, 342m, (Banat) Upper (?) Pontian

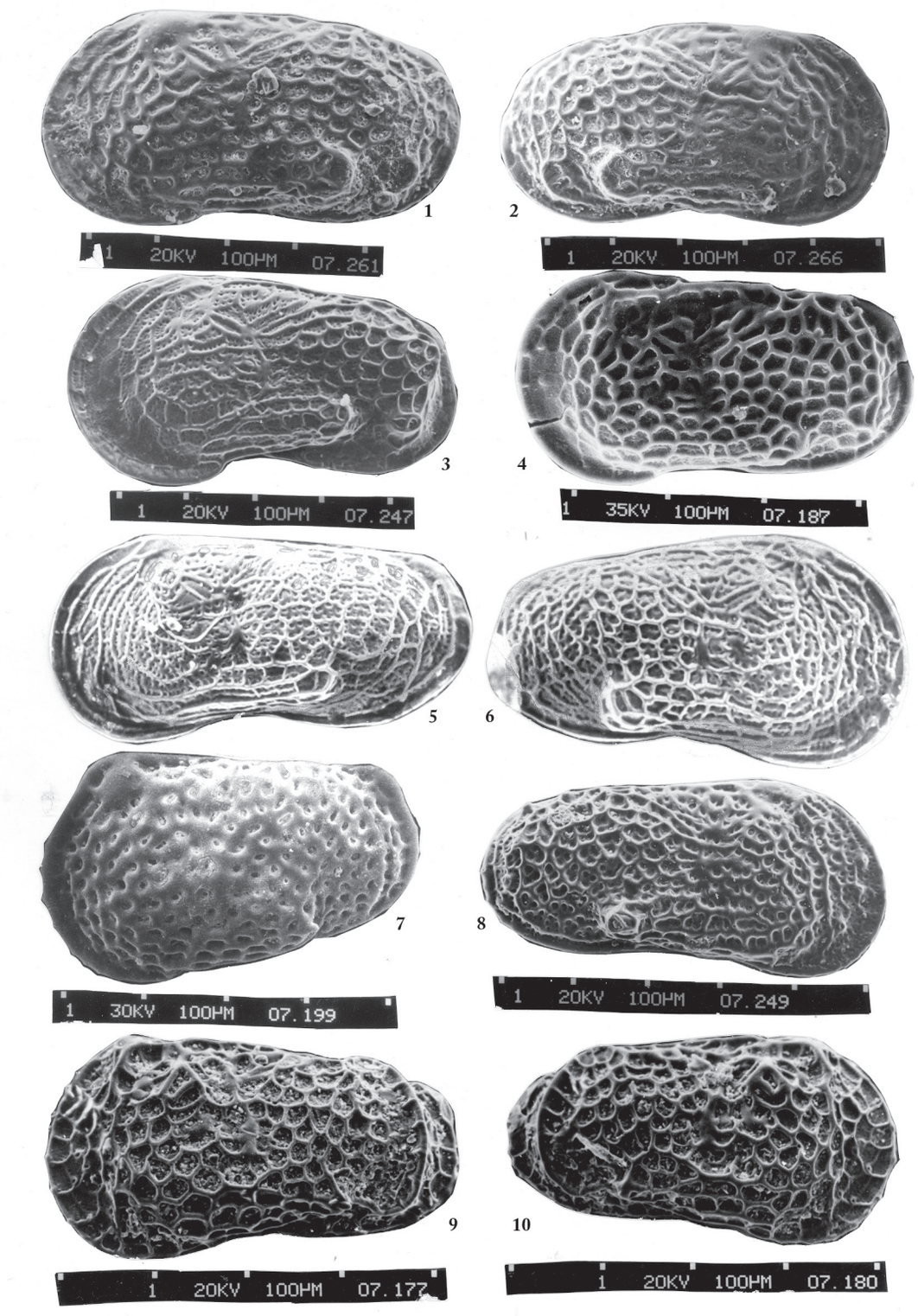



**Plate XIII. Fig. 1** – *Leptocythere (Amnicythere) stanchevae* Krstič, adult, left valve, Şoimi; **Fig. 2** - *Leptocythere (Amnicythere)* aff. *stanchevae* Krstič, adult, right valve, Şoimi; **Fig. 3** – *Leptocythere (Amnicythere) stanchevae* Krstič, juvenile, Soceni, Turislav valley; **Fig. 4** – *Leptocythere (Amnicythere)* aff. *stanchevae* Krstič, juvenile, Soceni, Turislav valley; **Fig. 5** – *Leptocythere (Euxinocythere) carandui* n. sp., adult, left valve, Early Pannonian, Carand; **Fig. 6** – *Leptocythere (Euxinocythere) carandui* n. sp.h, adult, right valve, Early Pannonian, Carand; **Fig. 7** – *Leptocythere (Amnicythere) lacunoidea* Krstič, adult, left valve, Pontian, Groşi; **Fig. 8**– *Leptocythere (Amnicythere) monotuberculata* Sokač, adult, right valve, Soceni, Turislav valley; **Fig. 9** - *Leptocythere (?) buchii* Krstič, adult, left valve, Middle Pontian, Râpa (with *Congeria rhomboidea*); **Fig. 10** - *Leptocythere (?) buchii* Krstič, juvenile, right valve, Pontian, Râpa (with *Congeria rhomboidea*)

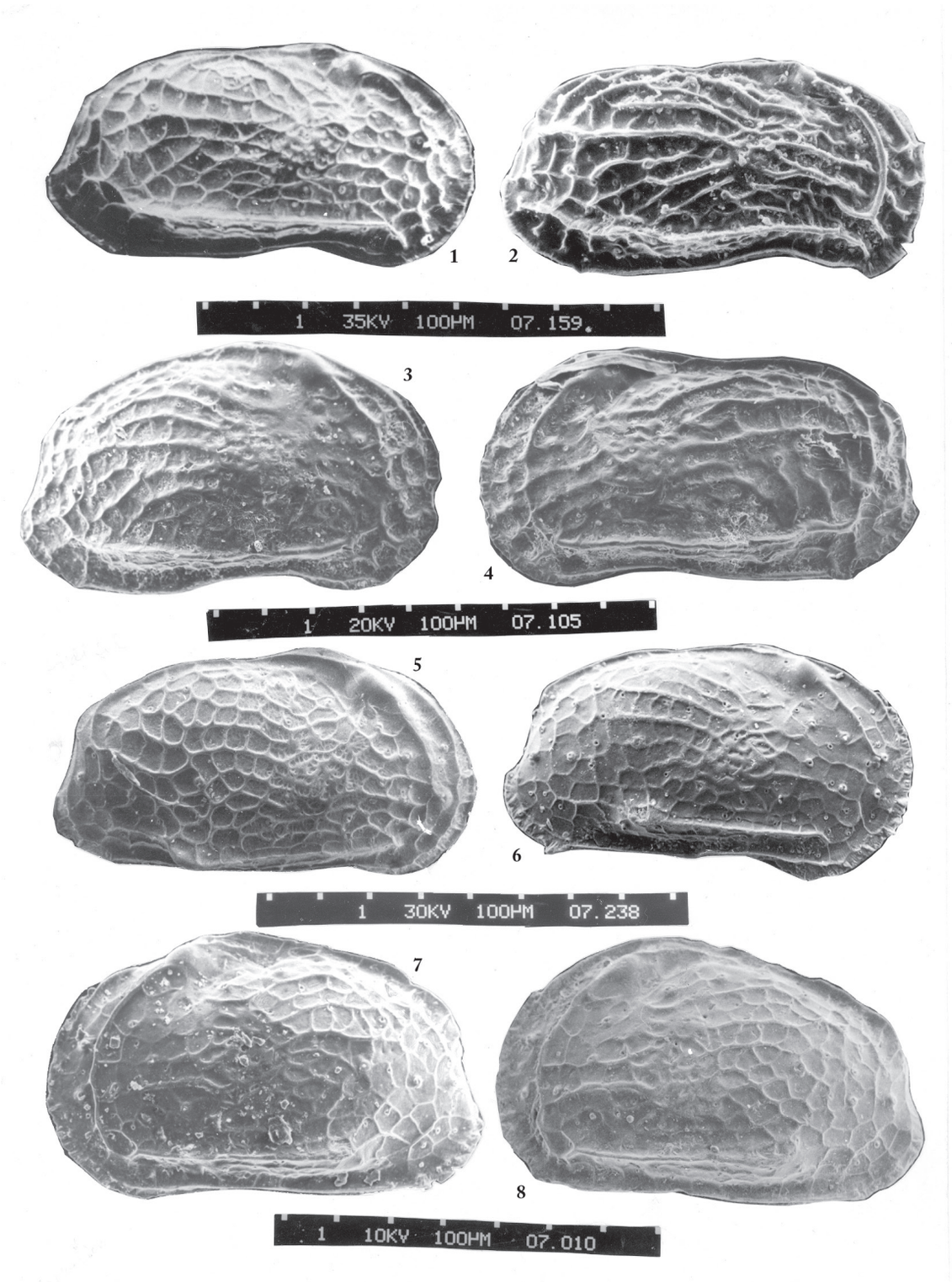



**Plate XIV. Fig. 1** – *Hemicytheria lorenthey sarmatica* Jiřiček, adult, right valve, Early Pannonian, Carand; **Fig. 2** – *Hemicytheria lorenthey* (Mehes), adult, right valve, Soceni, Turislav valley, Pannonian; **Fig. 3** – *Hemicytheria omphalodes sarmatica* Jiřiček, adult, right valve, Pannonian, F-1001, Mermeşti, 3o3 m**. Fig. 4** - *Hemicytheria lorenthey* (Mehes), adult, left valve, Pannonian, F-1001, Mermeşti, 3o3 m**. Fig. 5** – *Hemicytheria pannonica* n sp, adult, right valve, Pannonian, F-1001 Mermeşti, 202m, Pannonian; **Fig. 6** – *Hemicytheria pannonica* n sp, adult, right valve, F-1001 Mermeşti, 202m, Pannonian; **Fig. 7** – *Hemicytheria* ex gr *H. pannonica* n sp, adult, left valve, F-1001 Mermeşti, 205m, Pannonian; **Fig. 8** – *Hemicytheria* ex gr *H. pannonica* n sp, adult, left valve, F-1001 Mermeşti, 205m Pannonian

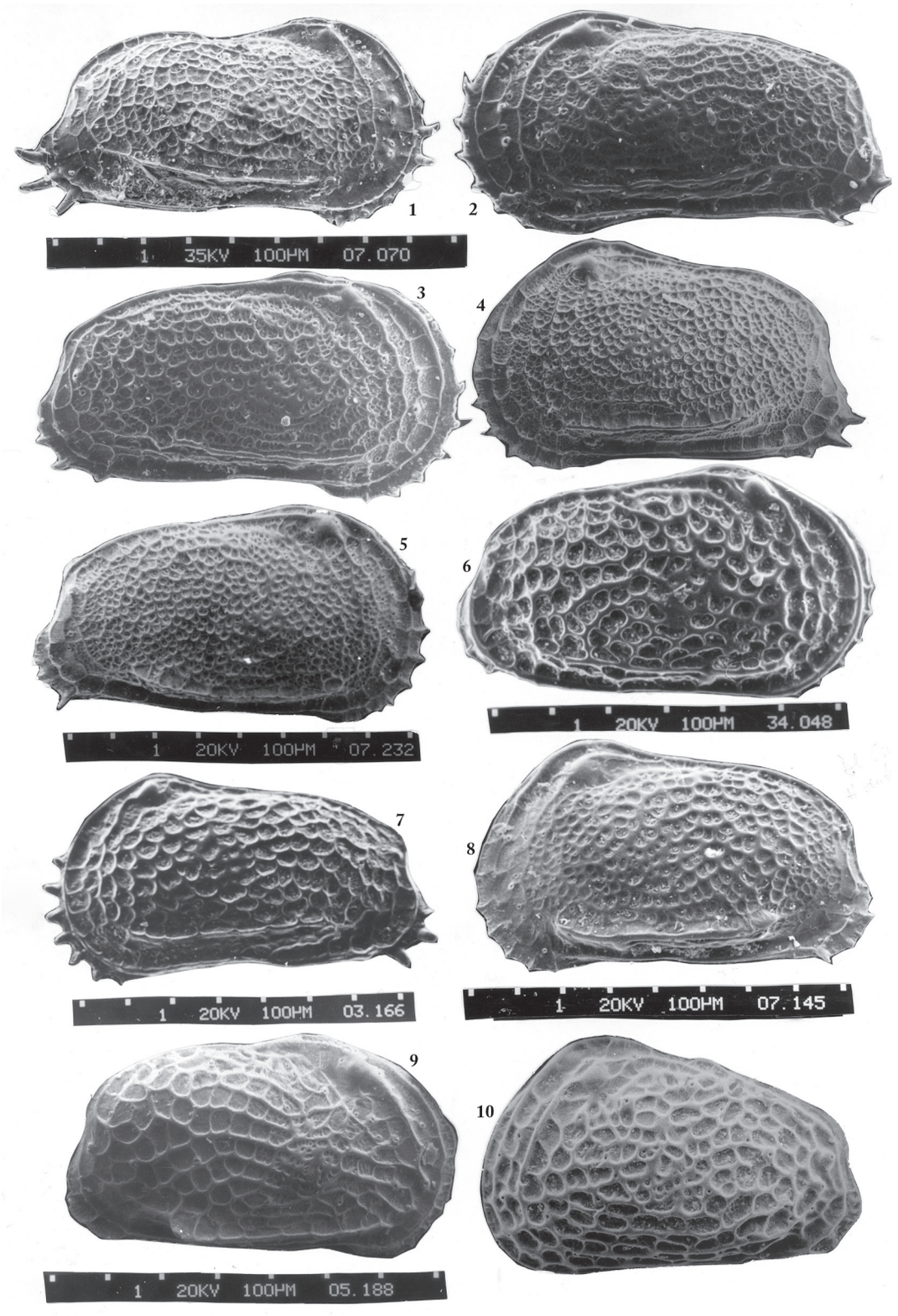



**Plate XV. Fig. 1** – *Hemicytheria major* Sokač, adult, right valve, Pontian, Săbolci; **Fig. 2** – *Hemicytheria major* Sokač, adult, left valve, Pontian, Câmpia; **Fig. 3** - *Hemicytheria* aff. *major* Sokač, juvenile, right valve, Pontian, Câmpia; **Fig. 4** - *Hemicytheria* aff. *insignis* Krstič, adult (?), left valve, Pontian,**. Fig. 5** - *Hemicytheria* aff. *marginata* Krstič, juvenile, right valve, Pontian, Holod**. Fig. 6** – *Hemicytheria* aff. *setosa* Krstič, adult, right valve, Middle Pontian, Săbolci. This ecotype appear in Lower Meotian also**.. Fig. 7** – *Hemicytheria pajinovicensis* (Zalanyi), adult, left valve, Middle Pontian, Râpa (with *Congeria rhomboidea*); **Fig. 8** – *Hemicytheria* aff. *prisca* Sokač, adult, left valve, F-1001 Mermeşti, Pannonian; **Fig. 9** – *Hemicytheria pannonica* n. sp., adult, right valve, Pontian, Hidişelu de Sus (with *Congeria rhomboidea*); **Fig. 10** – *Hemicytheria* sp aff. *H. biornata* (Zalanyi), juvenile, left valve, Pontian, Holod

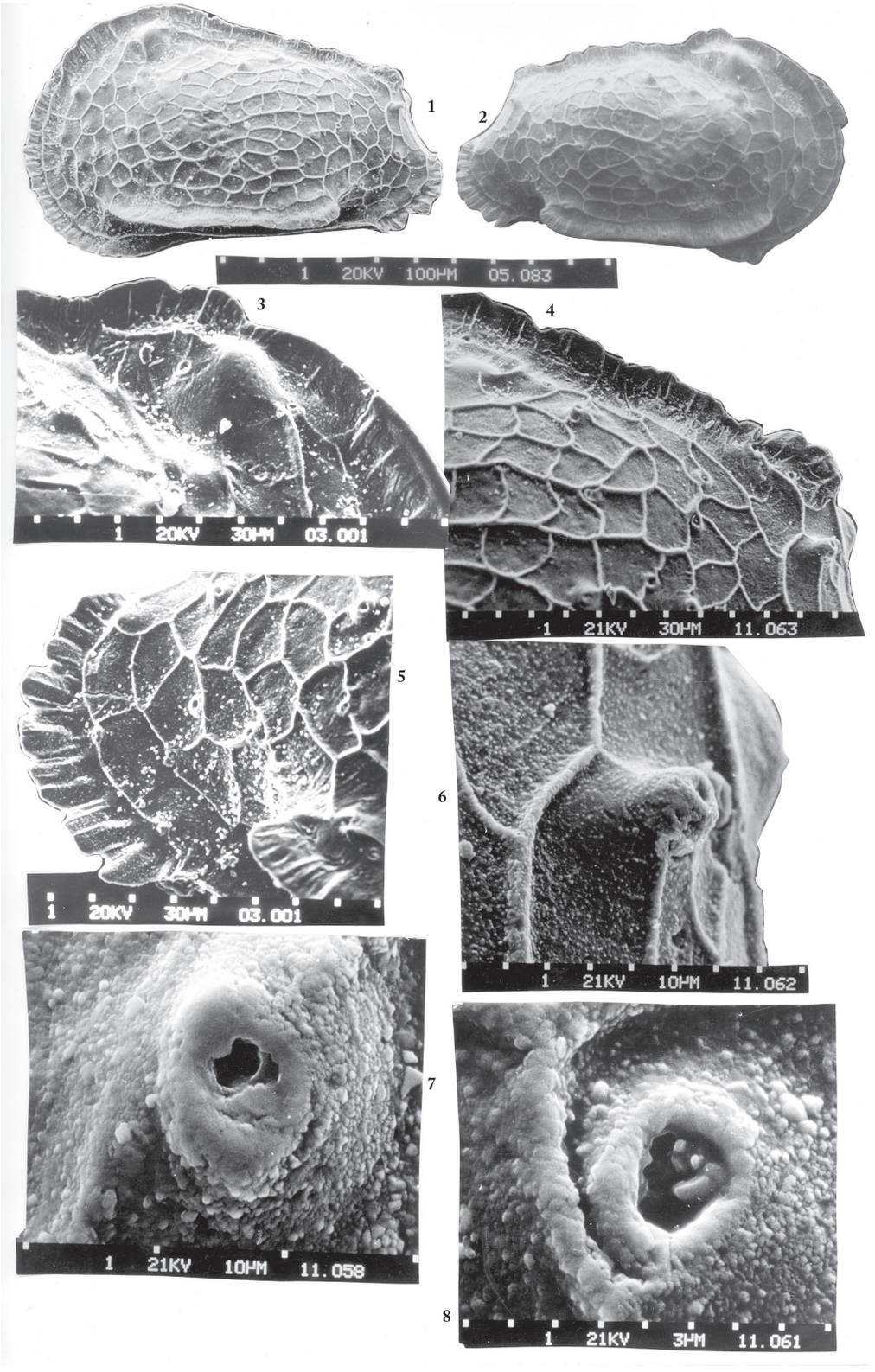



**Plate XVI. Fig. 1** – *Hemicytheria reticulata* Sokač, adult, left valve, Middle Pontian, Holod; **Fig. 2** - *Hemicytheria reticulata* Sokač, adult, right valve, Middle Pontian, Holod; **Fig. 3** - *Hemicytheria reticulata* Sokač, adult, right valve, ocular tubercle,; **Fig. 4** - *Hemicytheria reticulata* Sokač, adult, left valve, postero marginal flange; **Fig. 5** - *Hemicytheria reticulata* Sokač, adult, right valve, posterior flange; **Fig. 6** – **7** - *Hemicytheria reticulata* Sokač, adult, left valve, conulus pore; **Fig. 8** - *Hemicytheria reticulata* Sokač, sieve-pore


**Plate XVII. Fig. 1** – *Hemicytheria hungarica (*Mehes) (*sensu* Krstič), adult, right valve, Pannonian, Soceni, Turislav valley; **Fig. 2** - *Hemicytheria* aff. *hungarica* (Mehes), adult, left valve, Middle Pontian, Hidişelu de Sus (with *Congeria rhomboidea*); **Fig. 3** – *Hemicytheria reniformis* (Reuss), adult, left valve, Pontian, Holod; **Fig. 4** – *Hemicytheria folliculosa* Pokorný, adult, left valve, Pontian, Chişcău (Crăiasa valley); **Fig. 5** – *Hemicytheria hungarica* (Mehes), adult, right valve, Pannonian, Soimi; **Fig. 6** – *Hemicytheria hungarica (Mehes)*, adult, right valve, Pannonian, Soimi; **Fig. 7** – *Hemicytheria bipunctata* (Zalanyi), adult, right valve, F-1004, Deva-231m, Pannonian; **Fig. 8** – *Hemicytheria bipunctata* (Zalanyi), adult, left valve, F-1004, Deva-231m, Pannonian; **Fig. 9** – *Hemicytheria ampullata* (Zalanyi), adult, left valve, Pannonian, Şoimi; **Fig. 10** - *Hemicytheria ampullata* (Zalanyi), adult, right valve, Middle Pontian, Hidişelu de Sus (with *Congeria rhomboidea*, Beiuş basin)

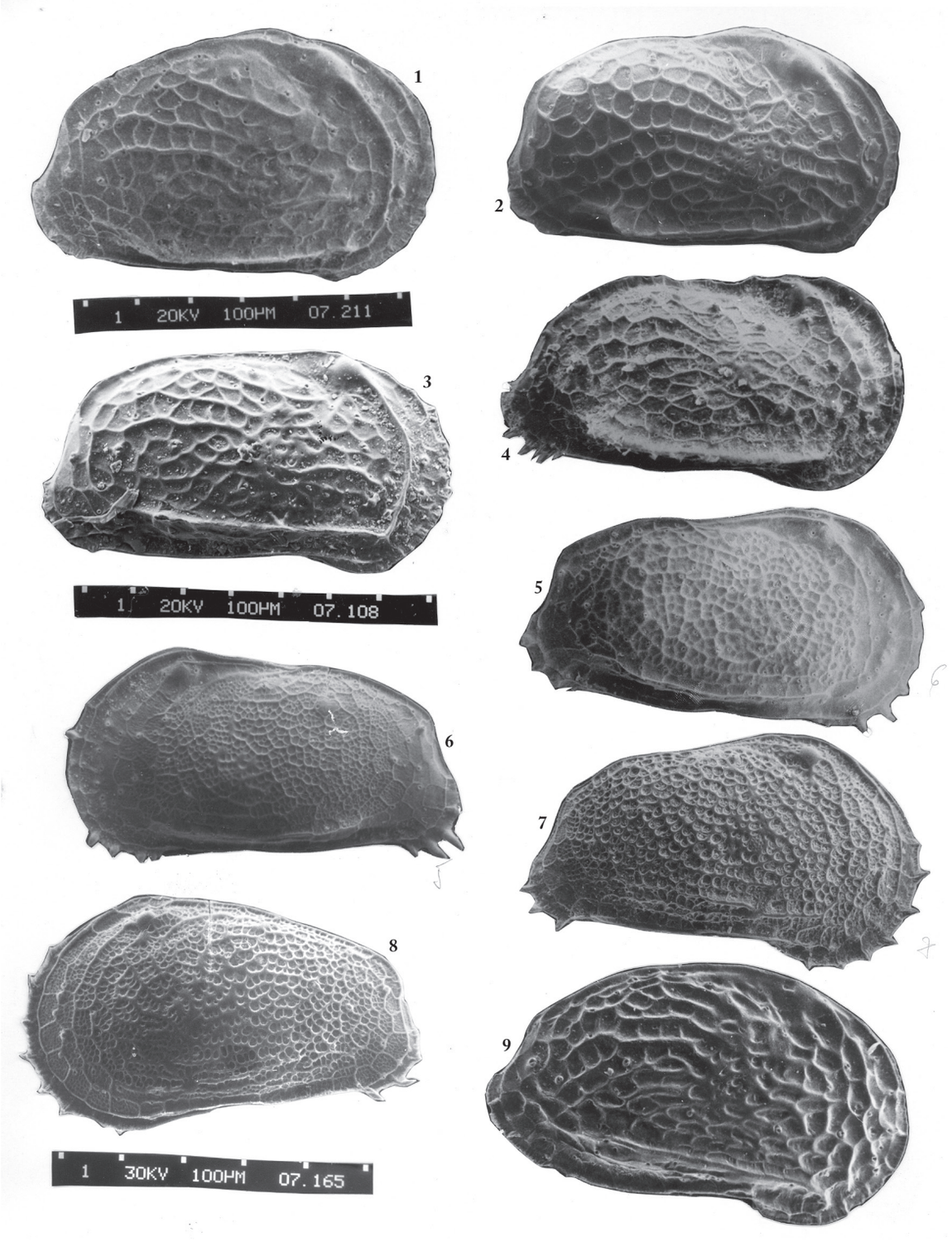



**Plate XVIII. Fig. 1** – *Hemicytheria sp*, A, adult, right valve, Pannonian, Mermeşti F.1001, 2015 m; **Fig. 2** – *Hemicytheria pannonica* n. sp., adult, right valve, Middle Pontian, Hidişelu de Sus; **Fig. 3** – *Hemicytheria* sp. 11, adult, right valve, Pannonian, Deva, 1001, 189m; **Fig. 4** – *Hemicytheria* sp. 12, adult, right valve, Pontian, Şimleu (Malului valley)**. Fig. 5** – *Hemicytheria* sp. Sokač, Pontian, Holod**. Fig. 6** – *Hemicytheria* aff. *dubokensis* Krstič, juvenile, left valve, Pontian, Drăgeşti; **Fig. 7** – *Hemicytheria* aff. *dubokensis* Krstič, juvenile, right valve, Pontian, Câmpia; **Fig. 8** – *Hemicytheria* aff. *dubokensis* Krstič, juvenile, left valve, Pontian, Câmpia; **Fig. 9** – *Hemicytheria omphalodes omphalodes* (Reuss), adult, right valve

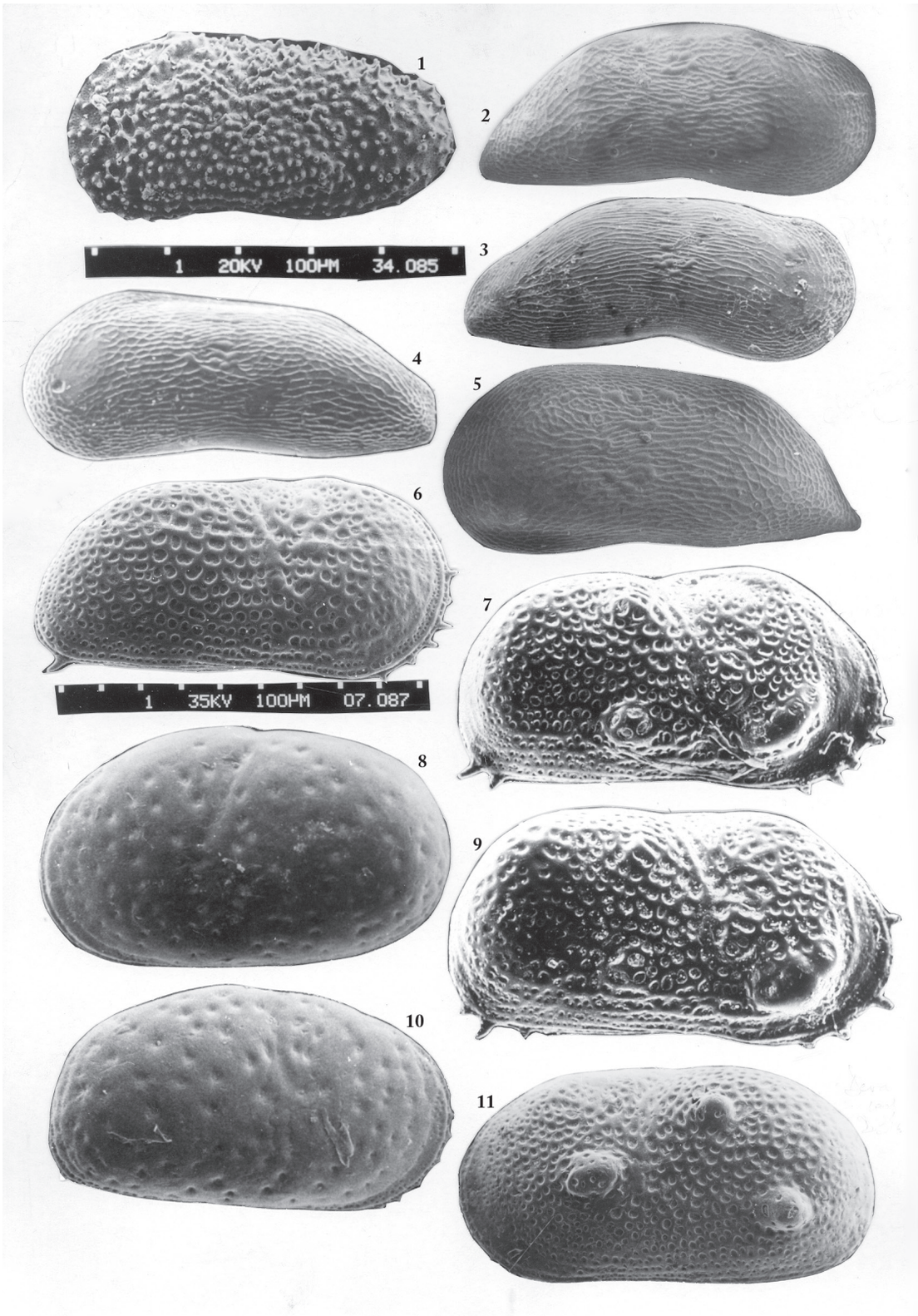



**Plate XIX. Fig. 1** – *Leptocythere (Euxinocythere) naca* (Mehes), adult, left valve, Pannonian, Şoimi**. Fig. 2** – *Pontoniella acuminata* (Zalanyi), adult, right valve, Pontian, Holod; **Fig. 3** – *Pontoniella kolubarae* Krstič, adult, right valve, Middle Pontian, Râpa (with *Congeria rhomboidea*); **Fig. 4** – *Pontoniella* aff. *truncata* Sokač, adult, left valve, Pontian, Crivina; **Fig. 5** – *Pontoniella acutissima* n. sp. adult, left valve, Pontian, Chişcău; **Fig. 6** – *Cyprideis* aff. *fusus* right valve, adult, Krstič, Pontian, Câmpia; **Fig. 7** – *Cyprideis* aff. *kolmanni* Krstič, adult, right valve, Urvind (Borod), Pontian; **Fig. 8** – *Cyprideis* aff. *heterostigma* (Reuss), adult, left valve, Pannonian, F-1004 Deva, 302m**. Fig. 9** – *Cyprideis* aff. *kolmanii* Krstič, adult, right valve, Urvind (Borod), Pontian; **Fig. 10** - *Cyprideis* aff. *heterostigma* (Reuss), adult, right valve, Pannonian, F-1004 Deva, 302m; **Fig. 11** – *Cyprideis tuberculata* (Mehes), adult, left valve, Pannonian, F-1001 Deva, 231m

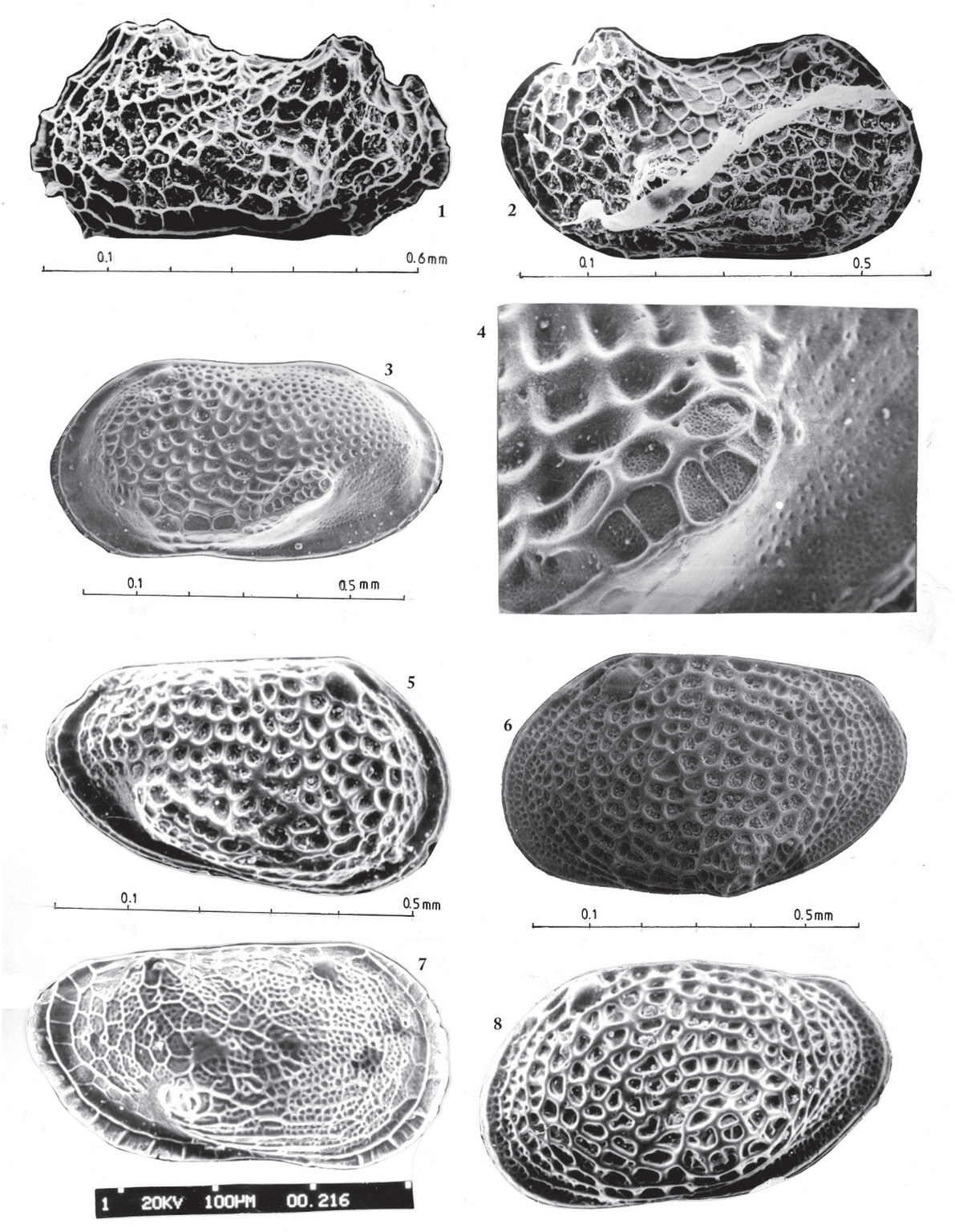



**Plate XX. Fig. 1** – *Loxoconcha inexpectata* Olteanu, adult, left valve, Volhinian, Soceni, Politioanei valley; **Fig. 2** - *Loxoconcha inexpectata* Olteanu, adult, right valve, Pannonian, Soceni, Turislav valley; **Fig. 3** – *Loxoconcha unicornuta* Olteanu, adult, left valve, Pontian, Sinteşti (Banat); **Fig. 4** – *Loxoconcha unicornuta* Olteanu, detail of posteroventral tubercle; **Fig. 5** – *Loxoconcha acuticostata* Olteanu, adult, right valve, Pontian, Câmpia; **Fig. 6** – *Loxoconcha* sp. 4, adult, left valve, Middle Pontian, Rieni (with *Congeria rhomboidea*); **Fig. 7** – *Loxoconcha praepannonica* n. sp, adult (?), right valve, Early Pannonian, Carand; **Fig. 8** – *Loxoconcha pontica tuberculata* Olteanu, adult, left valve, Middle - Upper (?) Pontian, F-Lugoj, 232 m

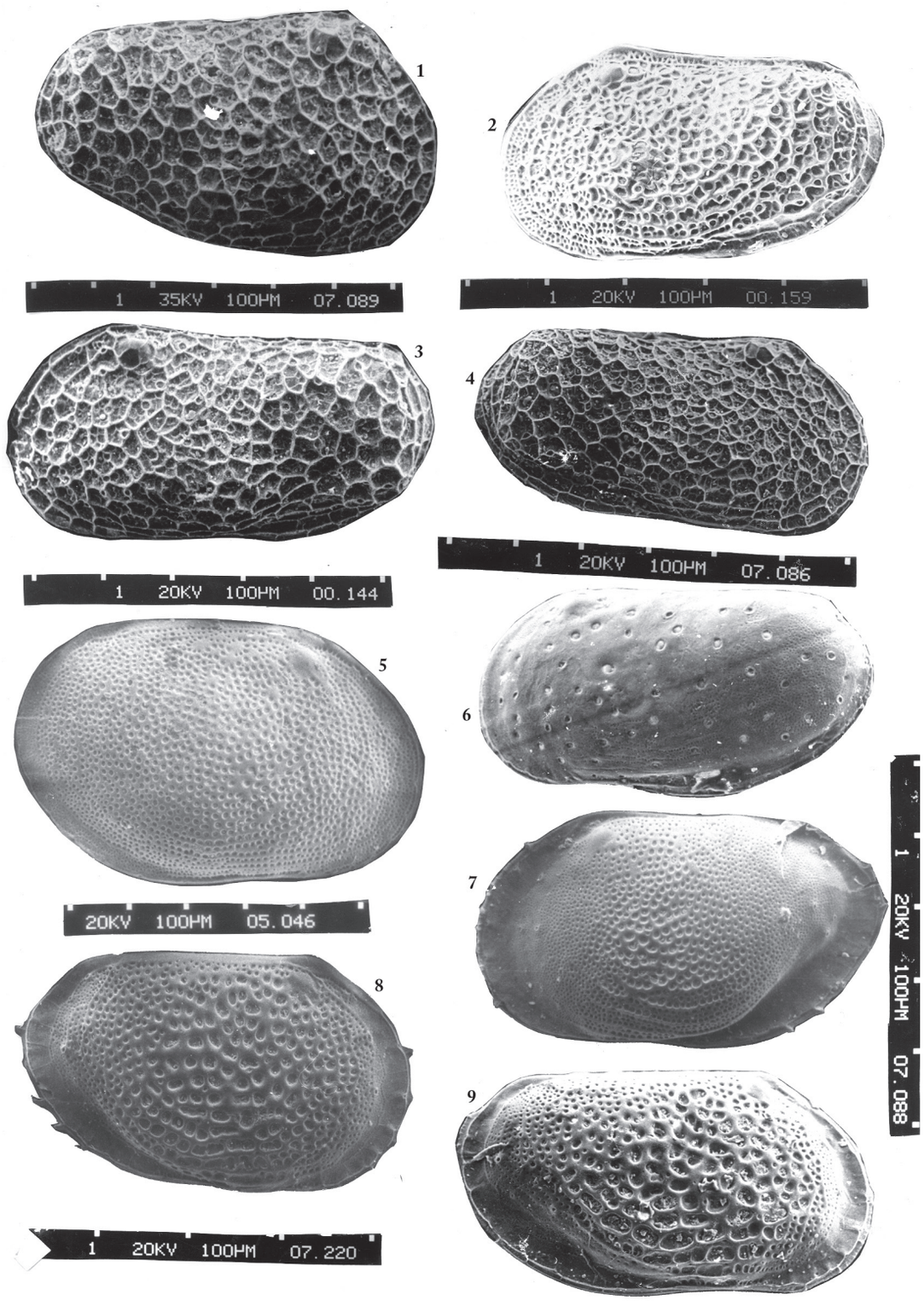



**Plate XXI. Fig. 1** – *Loxoconcha kochi* Mehes, adult, right valve, Pannonian, F-Deva nr. 1004, 221m; **Fig. 2** – *Loxoconcha kochi* Mehes, adult, left valve, Pannonian, F-Deva nr. 1004, 235m; **Fig. 3** - *Loxoconcha kochi* Mehes, adult, left valve, Pannonian, Soceni, Turislav valley 1; **Fig. 4** – *Loxoconcha kochi* Mehes, adult, right valve, Pannonian, F- Deva 1004, 235m; **Fig. 5** – *Loxoconcha rhombovalis* Pokorný, adult, right valve, Pannonian, Şoimi; **Fig. 6** – *Loxoconcha mulleri* (Mehes), adult, left valve, Pannonian, F-1004 Deva, 244m; **Fig. 7** - *Loxoconcha petkovici* Krstič, juvenile, left valve, juvenile, left valve, Pontian, Holod; **Fig. 8** – *Loxoconcha petkovici* Krstič, adult, right valve, Pontian, Holod; **Fig. 9** – *Loxoconcha fistulosa* Krstič, adult, right valve, Pannonian, F-1004 Deva, 322m

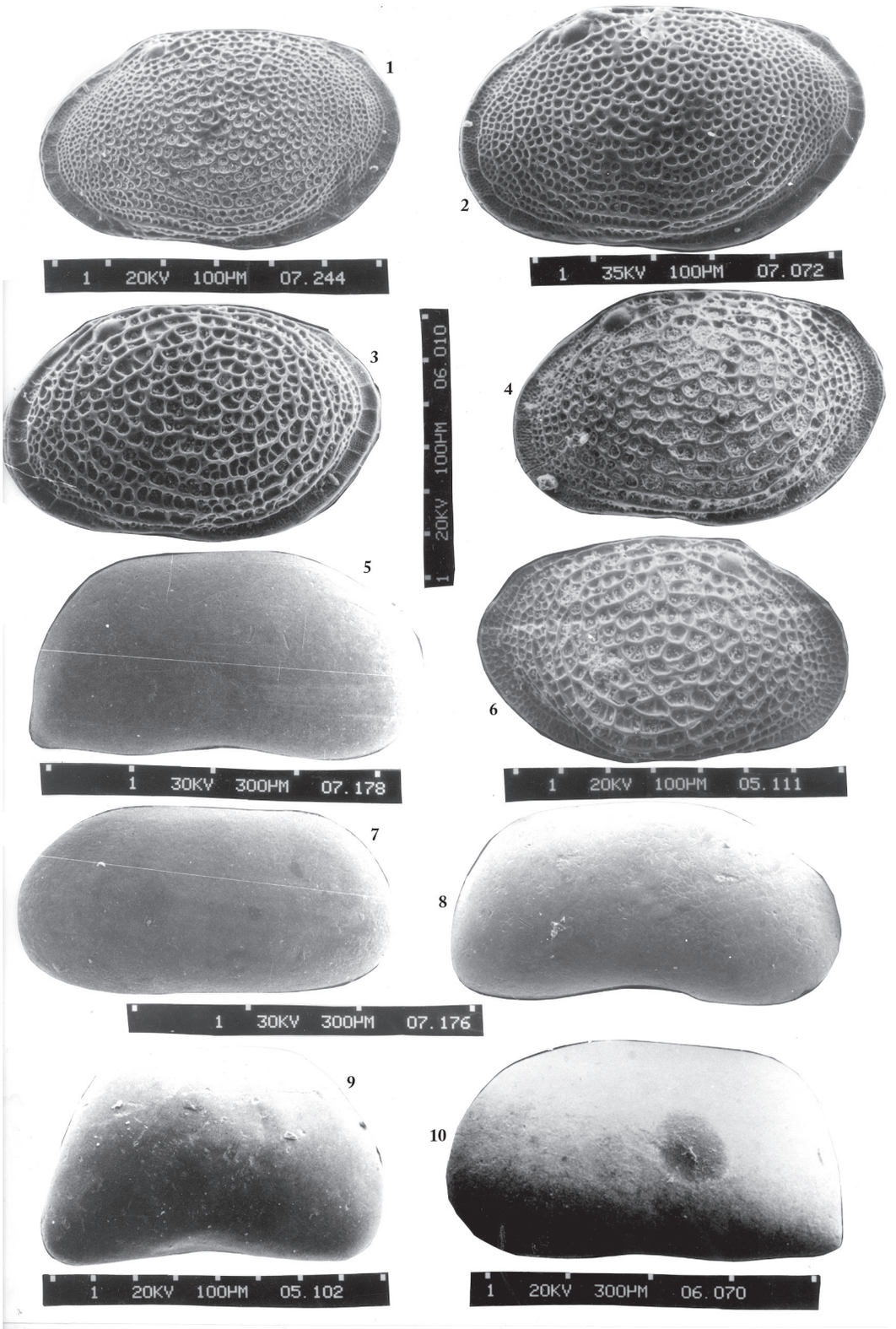



**Plate XXII. Fig. 1** – *Loxoconcha* sp. D, adult, left valve, Pannonian, Soceni, Turislav valley; **Fig. 2** - *Loxoconcha* aff. *subrugosa* Zalanyi, juvenile, left valve, Pontian, Săbolci (Borod basin); **Fig. 3** – *Loxoconcha subrugosa* Zalanyi, adult, right valve, Pontian, Holod; **Fig. 4** – *Loxoconcha alitera,* Krstič, adult, left valve, Pontian, Şimleu (Malului valley); **Fig. 5** – *Amplocypris abcissa* (Reuss), adult, right valve, Pannonian, Şoimi**. Fig. 6** – *Loxoconcha* aff. *alitera* Krstič, adult, right valve, Pontian, Holod; **Fig. 7** – *Amplocypris recta* (Reuss), adult, left valve, Pannonian, Şoimi; **Fig. 8** – *Amplocypris* sp E, adult, right valve, Pontian, Groşi; **Fig. 9** – *Candona* sp. aff. *C. robusta* Krstič, adult, right valve, Pontian, Groşi; **Fig. 10** – *Amplocypris* aff. *firmus* Krstič, adult, left valve, Pontian, Groşi

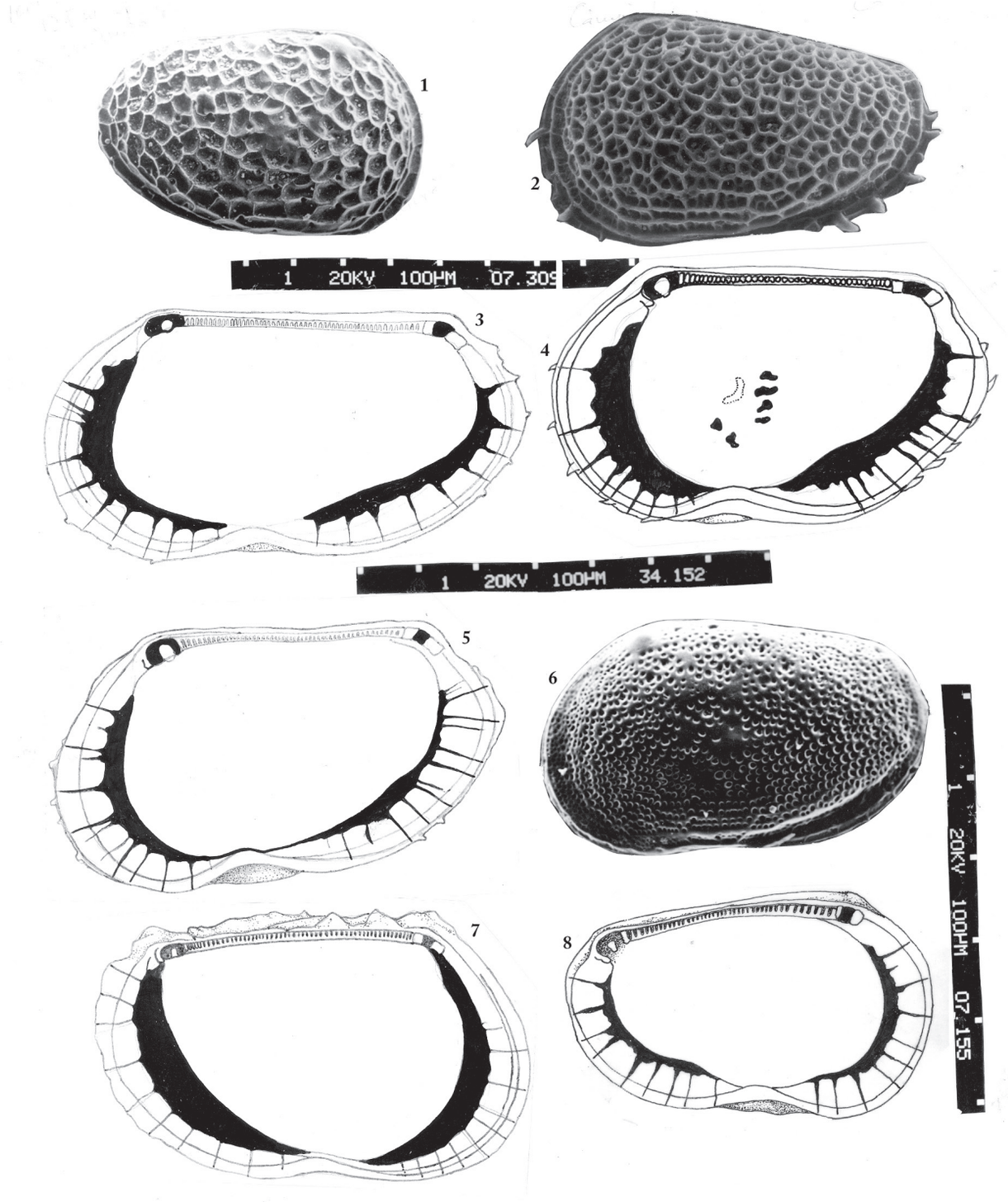



**Plate XXIII. Fig. 1** – *Loxoconcha minuta* Olteanu, adult, right valve, Pannonian, F-1001 Deva, 125m; **Fig. 2** – *Loxoconcha spinosa* Sokač, juvenile, left valve, Middle Pontian, Hidişelu de Sus (with *Congeria rhomboidea*); **Fig. 3** – *Loxoconcha fistulosa* Krstič, adult, right valve, inside structure, Middle Pontian, Hidişelu de Sus (with *Congeria rhomboidea*); **Fig. 4** – *Loxoconcha granifera* (Reuss), adult, right valve, inside structure, Pontian, Câmpia; **Fig. 5** – *Loxoconcha unicornuta* Olteanu, adult, right valve, inside structure, Pontian, Sinteşti; **Fig. 6** – *Loxoconcha punctata* Olteanu, adult, left valve, Pannonian, F-1004 Deva, 127m; **Fig. 7** – *Loxoconcha pontica tuberculata* Olteanu, adult, left valve, inside structure, Pontian, Groşi; **Fig. 8** – *Loxoconcha punctata* Olteanu, adult, left valve, inside structure, Pannonian, F-1004 Deva, 127m

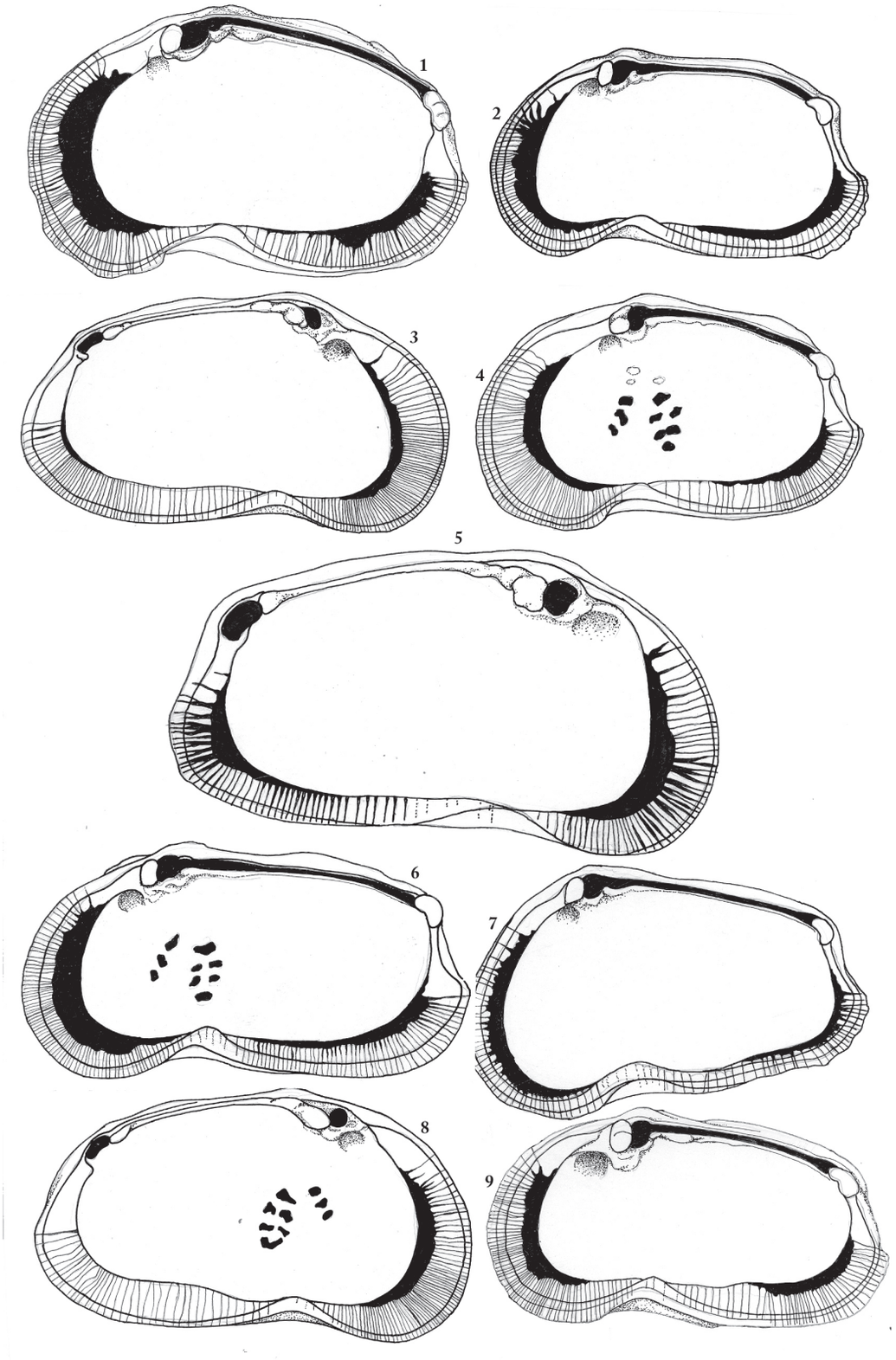



**Plate XXIV. Fig. 1** – *Aurila notata* (Reuss), adult, right valve, inside structure, Lower Sarmatian (Volhinian), Soceni, Politioanei valley; **Fig. 2** – *Hemicytheria omphalodes omphalodes* (Reuss), adult, right valve, inside structure, Middle Sarmatian (Bessarabian), Alb river, Hateg (South Transilvania); **Fig. 3** – *Hemicytheria folliculosa* (Reuss), adult, left valve, inside structure,**. Fig. 4** – *Hemicytheria lorenthay sarmatica* Jiříček, juvenile (?), right valve, inside structure, Sarmatian, Hateg (Southern Transylvania)**. Fig. 5** – *Hemicythera lorenthey lorenthey* (Mehes), adult, left valve, inside structure, Pannonian; **Fig. 6** – *Hemicytheria* aff. *pannonica* n. sp, adult, right valve, inside structure, Pannonian; **Fig. 7** – *Hemicytheria* aff. *biornata* (Zalanyi), juvenile, right valve, inside structure, Pannonian; **Fig. 8** – *Hemicytheria hungarica* (Mehes), adult, left valve, inside structure, Pannonian; **Fig. 9** – *Hemicytheria ampullata* (Zalanyi), adult, right valve, inside structure, Pannonian

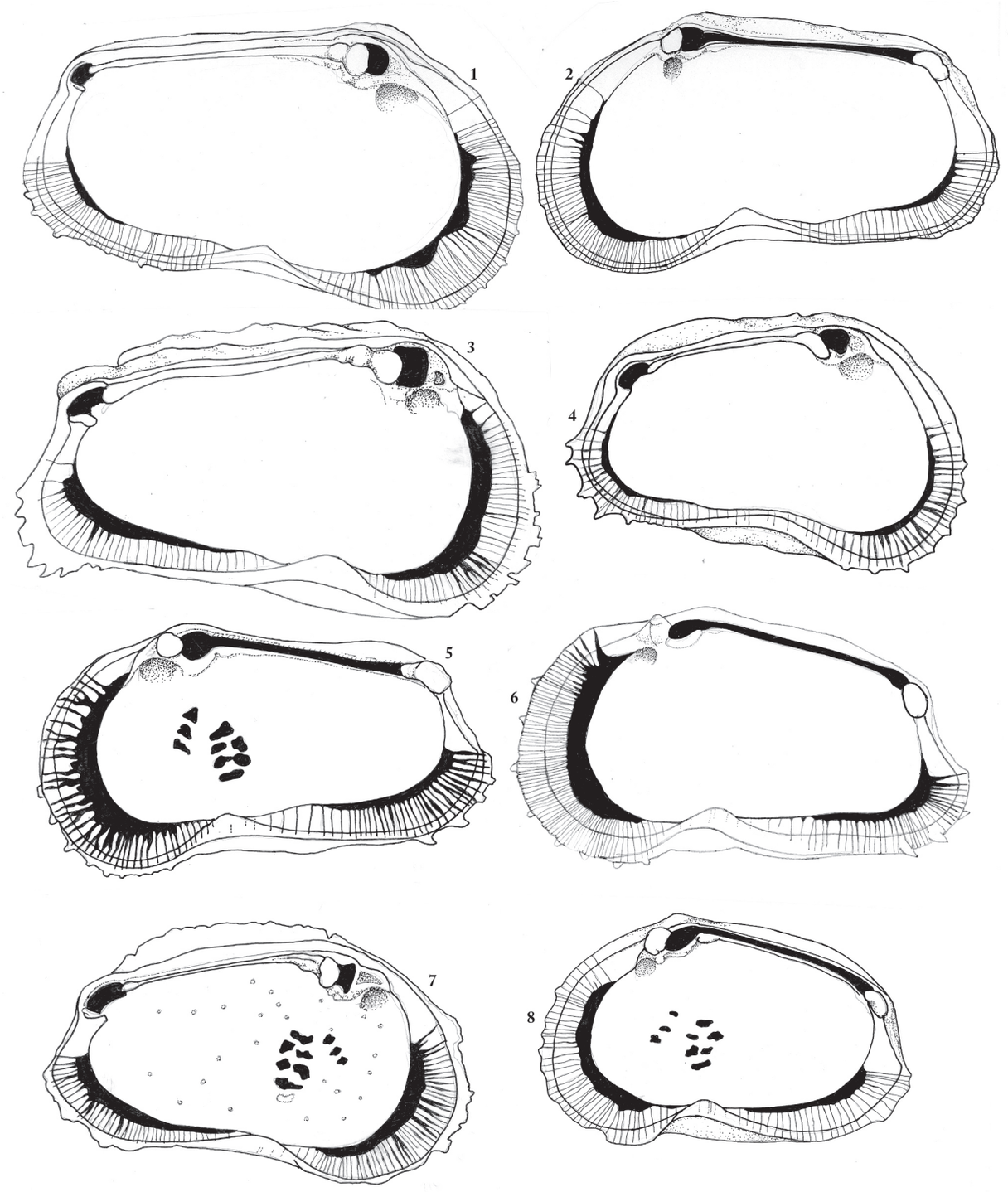



**Plate XXV. Fig. 1** – *Hemicytheria omphalodes sarmatica* Jiříček, adult, left valve, inside structure; **Fig. 2** – *Hemicytheria omphalodes sarmatica* Jiříček, juvenile (?), right valve, inside structure; **Fig. 3** – *Hemicytheria reticulata* Sokač, adult, left valve, inside structure; **Fig. 4** – *Hemicytheria* aff. *pajinovicensis* (Zalanyi), adult, left valve, inside structure; **Fig. 5** – *Hemicytheria major* Sokač, adult, right valve, inside structure; **Fig. 6** – *Hemicytheria dubokensis* Krstič, adult, right valve, inside structure; **Fig. 7** – *Hemicytheria* aff. *pannonica* n. sp., adult, left valve, inside structure. The specimen with marginal flange.; **Fig. 8** – *Hemicytheria omphalodes omphalodes* (Reuss), juvenile, right valve, inside structure

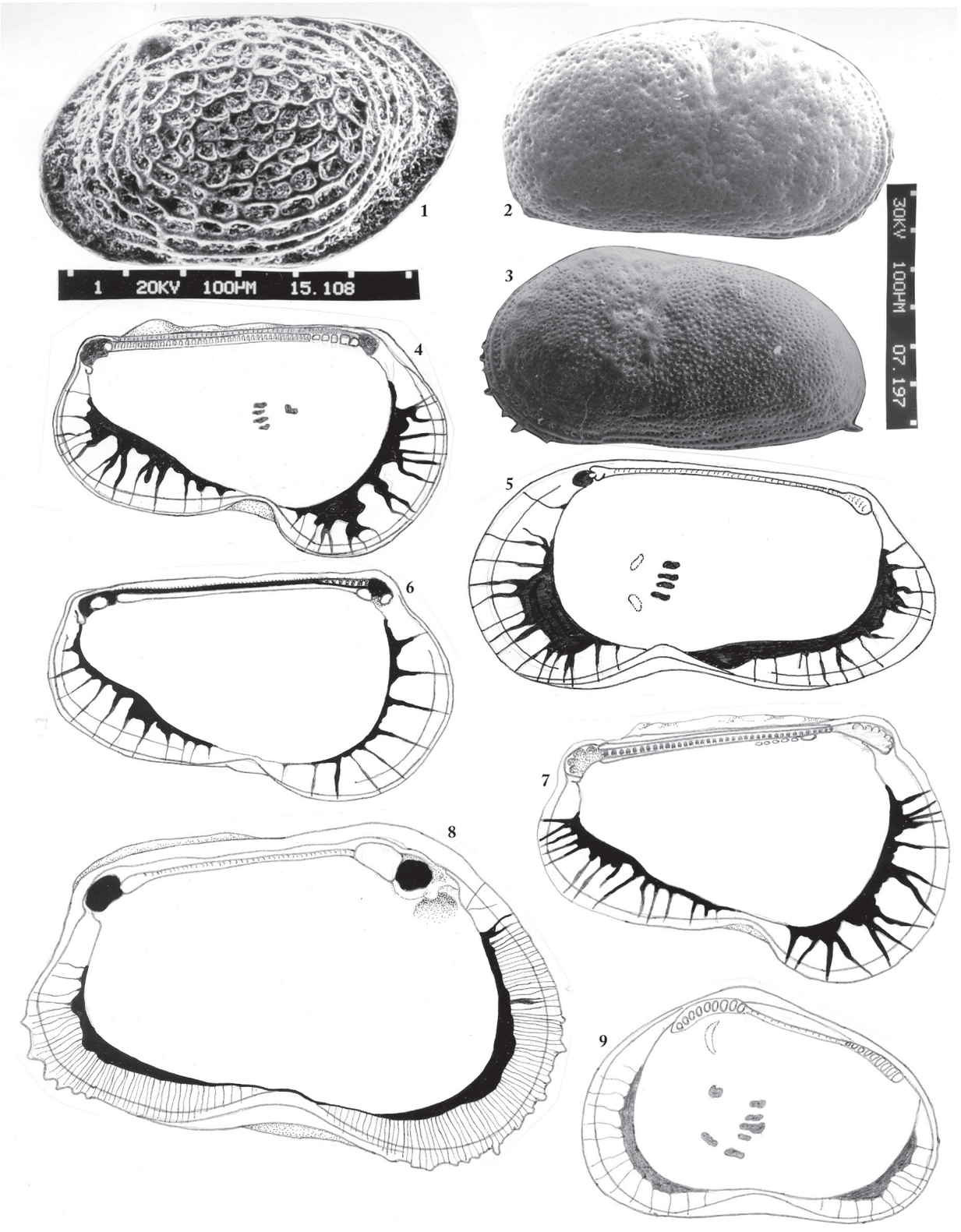



**Plate XXVI. Fig. 1** – *Loxoconcha schweyeri schweyeri* (Suzin), adult, left valve, Pontian, Urvind (Borod basin, North of Apuseni Mountains); **Fig. 2** – *Cyprideis heterostigma* (Reuss), adult, right valve, Pontian, Sinteşti; **Fig. 3** – *Cyprideis* sp., adult, left valve, Middle Pontian, Râpa, (with *Congeria rhomboidea*); **Fig. 4** – *Leptocythere servica* Krstič, adult, left valve, inside structure, Ponțian, Rieni (with *Congeria rhomboidea*); **Fig. 5** – *Leptocythere (Amnicythere) cornutocostata* (Schweyer), adult, right valve, inside structure, Pontian, Câmpia; **Fig. 7** – *Leptocythere bosqueti* (Livental), adult, left valve, inside structure, Pontian, Groşi; **Fig. 6** – *Leptocythere lacunossa* (Reuss), adult, left valve, inside structure, Pontian, Groşi; **Fig. 8** – *Hemicytheria* aff. *tenuistriata* (Mehes), adult, left valve, inside structure; **Fig. 9** - *Xestoleberis* aff. *fuscomaculata* G.W.Muller (*sensu* Mehes, 1908, p. 540-541, Fig. 1-4), adult, right valve, inside structure, Pontian, Groşi (Banat)

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