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Ostracode fauna of some non-marine Neogene basins in Yugoslavia

Ana SOKAČ[1] and Nadežda KRSTIĆ[2]

[1]*Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Pierottijeva, 6 YU — 41000 Zagreb*
[2]*Geoinstitute, Rovinjska 12, YU — 11050 Beograd 22*

The associations of freshwater ostracode fauna found in the Neogene sediments of various regions in Yugoslavia are described. Ostracodes include the representatives of the genera *Candona, Candonopsis, Cyclocypris, Cypria, Eucypris, Cyprinotus, Pannoninotus, Moenocypris, Amplocypris, Bosnacypris, Herpetocypris, Septocypris, Virgatocypris, Cypridopsis, Potamocypris, Mediocypris, Metacypris, Ilyocypris, Leptocythere, Limnocythere, Paralimnocythere, Dinarocythere,* and *Darwinula.* The stratigraphic position and differences of the ostracode associations in the separate regions are discussed.

Opisane su slatkovodne asocijacije ostrakoda iz neogena različitih područja Jugoslavije. Ostrakodi su zastupani rodovima *Candona, Candonopsis, Cyclocypris, Cypria, Eucypris, Cyprinotus, Pannoninotus, Moenocypris, Amplocypris, Bosnacypris, Herpetocypris, Septocypris, Virgatocypris, Cypridopsis, Potamocypris, Mediocypris, Metacypris, Ilyocypris, Leptocythere, Limnocythere, Paralimnocythere, Dinarocythere* i *Darwinula.* Raspravlja se o stratigrafskom položaju i razlikama u asocijacijama ostrakodske faune različitih područja.

INTRODUCTION

Freshwater Neogene basins are found in all parts of Yugoslavia and in some cases they are quite large. These basins existed in various ages and their duration was variable. They are now the subject of frequent research from stratigraphical and sedimentological points of view. Biostratigraphic analyses so far have been of a limited scope and previous results point to two groups of organisms which are dominant in these sedimentation evironments. These are Mollusca and Ostracoda.

Ostracode fauna has been insufficently investigated. The first paper dealt with the ostracodes of Bunjani and Križ (Papp & Muldini, 1956). This was followed by reports on ostracodes of Bogovina (Krstić & Krstić, 1961), Golubac (Krstić, 1966), Breza (Krstić, 1968), Paraćin (Krstić, 1972), Kraljevo and Kragujevac (Gagić, 1972) and Vladičin Han (Petrović & Gagić, 1973). A number of papers on the ostracode fauna of Metohija have been published by Krstić (1973, 1974a, 1975, 1979). Several other papers list ostracodes from freshwater Neogene of Kragujevac (Krstić, 1974b), from the surroundings of Belgrade (Krstić, 1978), Sinjsko polje (Sokač,

1979), Aleksinac (Krstić, 1980), and part of the Niš (Krstić, 1980), Pljevlja (Krstić, in print), and Ivangrad basins. In addition, some new genera have been established by Krstić (1987), and Sokač (1987, in print).

BIOSTRATIGRAPHIC OCCURRENCE

Carpatho-Balkanides

The Miocene ostracode faunas have been only partly investigated. The Lower Miocene of Bogovina (Krstić & Krstić, 1961), previously considered to be the Upper Oligocene, contains the following forms: *Candona (Candona) bogovinae* Krstić, *Cypridopsis timocensis* Krstić, *Metacypris* cf. *danubialis* Straub, and *Herpetocypris* sp. The species *Herpetocypris snegotini* (Krstić) is described from the freshwater sediments of Snegotin, in the vicinity of Golubac (Krstić, 1966). Also, a new genus *Septocypris* with the type species *S. mlavae* Krstić has been established by Krstić (1987) from the Middle Miocene deposits of the Mehnica in the Mlava basin.

Pomoravlje

This geographically broad region includes several basins which were probably mutually linked in the past: the basins of Niš, Svrljig, Aleksinac, Kruševac, Kragujevac, Kraljevo, Popovac, Levče, and some localities around Belgrade. The following species are common to the various basins: *Ilyocypris pannonicus* Krstić, *Cyprinotus salinus* (Brady), *Cypridopsis subtriangulata* (Gagić), *Dinarocythere costata* (Krstić) and others in the sand facies, and *Candona (Candona)* aff. *pokornyi* Kheil, *C. baljkovicensis* Krstić, *C. nisseana* Krstić and others in the clay acies. There are also other forms, probably restricted to particular regions and localities.

The freshwater Miocene deposits of the Aleksinac basin (Krstić, 1980) are very well explored and stratigraphically subdivided. In the Lower Miocene the species *Cyprinotus moravicus* Krstić and *Pannoninotus paljine* (Krstić) are found. The Middle Miocene is proved by the genus *Mediocypris*. The association of ostracode fauna contains the following forms: *Mediocypris serbica* Krstić, *Candona svetovidi* Krstić, *C.* ex gr. *ratisbonensis* Lutz, *C.* ex gr. *lampadis* Carbonnel, *Cyprinotus kossmanni* (Rzehak), and *Paralimnocythere rostrata* (Straub). In the upper part of the Middle Miocene, another association was also found which includes the following species: *Candona bouei* Krstić, *C. rujevicae* Krstić, *C. (Pseudocandona) moravica* Krstić, *Potamocypris gracilis* (Sieber), *P. pannonica* Krstić, *Cyprinotus salinus* (Brady), *Herpetocypris miocenica* Krstić, *Ilyocypris errabundis* Mandelstam, and *Darwinula stevensoni* (Brady & Robertson).

In the Middle Miocene deposits of Kraljevo and Kragujevac (Gagić, 1972), the species *Cypridopsis subtriangulata* (Gagić) was described. Besides this form, the species *Candona steinheimensis* Sieber and representatives of the genera *Eucypris* and *Ilyocypris* are present. Some

other *Candona*-forms are found in the locality of Baljkovac (Krstić, 1975): *Candona (?Orhidiella) sabantae* Krstić, *C. (?Reticulocandona) boljkovacensis* Krstić, and *C.* aff. *pokornyi* Kheil.

The species *Eucypris simplex* Schneider, as well as some representatives of the genera *Mediocypris, Candona* and *Cyprinotus* were determined from the Middle Miocene deposits of Vladičin Han (Petrović & Gagić, 1973).

The freshwater ostracode fauna of the Upper Miocene of Donja Mutnica (Krstić, 1972) is very rich and well-preserved, including some species and subspecies described from this locality for the first time. The association is characterized by the following forms: *Candona bouei* Krstić, *C. trajani mutnicae* Krstić, *C. paracini* Krstić, *C. (Eucandona)* sp. div., *C. (Pseudocadona) moravica* Krstić, *Cyprinotus salinus* (Brady), *Herpetocypris shevreuxi miocenica* (Krstić), *Potamocypris bouei* Krstić, *Ilyocypris pannonica* Krstić, *Darwinula stevensoni* (Brady & Robertson), *Dinarocythere costata* (Krstić), and *Limnocythere* sp.

The Middle Miocene deposits of the surroundings of Belgrade (Krstić, 1978) contain the following ostracodes: *Candona (Candona)* cf. *luminosa* Bodina, *Mediocypris visnjicae* (Krstić), *Candona (?Reticulocandona) nisseana* Krstić, *Potamocypris slanci* Krstić, *Cyprinotus* ex gr. *grandis* Bodina, and *Ilyocypris* aff. *errabundis* Mandelstam.

From the superposition o these sediments, lying under the *Spiroplectammina carinata* zone of the Middle Badenian (the upper part of the Middle Miocene), we conclude that in the Pomoravlje region freshwater equivalents of the Lower Badenian and pershaps partly also of the Karpatian (the lower part of the Middle Miocene) have developed. Only in the Aleksinac basin ostracode fauna of the older layers was found; it is represented by *Cyprinotus moravicus* Krstić, *Pannoninotus paljine* (Krstić), *Virgatocypris* sp. and others. These beds belong to the Lower Miocene.

Metohija

In the association of ostracode fauna of Metohija (Krstić, 1973, 1974a, 1975, 1979) *Candona*-forms are the most numerous. Explored deposits include three levels. In the lower level (»Peć series«) the species *Candona (Candona) luminosa* Bodina, *Mediocypris visnjicae* (Krstić), *Darwinula stevensoni* (Brady & Robertson), and *Moenocypris* sp. have been found. The middle level (»Kosovo series«) contains the following forms: *Candona (Candona) candida pliocenica* Krstić, *C. (Candona)* cf. *formosa* Mikulić, *C. (Candona)* cf. *natronphila* Petkovski, *C. (Candona) marginata krusevocensis* Krstić, *C. (Candona) stupelji* Krstić, *C. (Candona) hvosnoica* Krstić, *C. (Candona) pontometohica* Krstić, *C. (Candona) veljae* Krstić, *C. (Pseudocandona) multipunctata* Krstić, *C. (Fabaeformiscandona)* sp., and *Herpetocypris pontica* Krstić. The ostracode fauna of the upper part (»Metohia series«) includes the species: *Candona (Candona) cabrati* Krstić, *C. (Candona)* aff. *altoides* Petkovski, *C. (Candona)* aff. *trajani* Krstić, *C. (Candona)* aff. *muelleri* Hartwig, *C.*

(Candona) cf. *amplis* Mandelstam et al., *C. gredi* Krstić, *C. (Metacandona) dasherahi* Krstić, *C. (?Eucandona) djakovicae* Krstić, *C. (Pseudocandona) typhlocypriformis* Krstić, *C. (Fabaeformiscandona) krsticae* Petkovski. The last mentioned fauna assemblage belongs to the Pliocene (Pl. I, Fig. 1); however, more recent data suggest that the deposits of the older levels belong to the Middle Miocene (»Kosovo series«) and to the Late Miocene (»Peć series«).

The Pannonian Basin

In the Pannonian basin freshwater ostracodes are found below the marine Middle Miocene deposits of Fruška gora Mountain, in the Jadar basin, the Prnjavor basin, on the slopes of Psunj and Medvednica Mountains, in the boreholes of the Sava depression and some localities near Karlovac. In the first three of these regions there are mainly undetermined specimens of the *Candona*-forms. The ostracode fauna of the other localities is represented by a variety of associations. The ostracode fauna on the slopes of Psunj and Medvednica Mountains is characterized by large forms belonging to the genera *Pannoninotus* and *Amplocypris*, as well as by some representatives of *Candona* and *Leptocythere*. For these beds Šikić (1968) presumed the Middle Miocene age. In the Miocene beds of Bjelanovac, on the western slopes of Psunj, *Pannoninotus slavonicus* Sokač has been established (Sokač, in print) (Pl. I, Fig. 2). In the borehole samples of Bunjani and Križ in the Sava depression (Papp & Muldini, 1956), the species *Candona suevica* Straub and *Cyprinotus* cf. *francofurti* (Linenklaus) Straub have been determined. In the localities of Šljivovac and Dugoselo near Karlovac, rich and well preserved ostracode fauna is found (Pl. II, Fig. 1). It is characterized by the particularly frequent species *Potamocypris fulva* (Brady) and *Cypridopsis biplantata* Straub. In addition to these forms, the following ones have also been found: *Dinarocythere reticulata* (Krstić & Sokač), *Darwinula stevensoni* (Brady & Robertson), *Herpetocypris* sp., and *Candona* sp. On the basis of Molluscan fauna Kochansky-Devidé & Sliškowić (1978), it has been concluded that the deposits of Dugoselo and Šljivovac belong to the Middle Miocene (Karpatian).

Dinaric Karst Region

In the Dinaric karst region Neogene deposits have been investigated in the marginal areas of the larger karst poljes and in the separate small basins, as well as on the island of Rab. The ostracode fauna is known from the vicinity of Bihać, Sinjsko and Livanjsko poljes, and Kupres, Sarajevo—Zenica, Pljevlja and Ivangrad basins.

In the neogene marls of Rab, the most numerous form is *Candona (Metacandona)* sp. In addition to this form, some representatives of the genera *Cypria, Cyprinotus,* and *Amplocypris* have also been found. In Sinjsko polje (Sokač, 1979) the ostracode fauna is represented by the species *Paralimnocythere compressa* (Brady & Norman), *Darwinula stevensoni* (Brady & Robertson), *D. cylindrica* Straub,

Candona oblonga Sars, *C. praecox* Straub, *C. luminosa* Bodina, *Candonopsis kingsleii* (Brady & Robertson), *C. arida* Sieber, *Herpetocypris snegotini* (Krstić), *Cypridopsis biplantata* Straub, and *Potamocypris fulva* (Brady). From the Middle Miocene deposits of Bihać (Krstić, 1987), two new taxa *Dinarocythere reticulata* (Krstić & Sokač) and *Bosnacypris bosniensis* Krstić have been established. Rich and well-preserved ostracode fauna is found in Livanjsko polje (Pl. II, Fig. 2). It is represented by several new taxa, some of them belonging to the genera *Candona* and *Cypria*. According to Kochansky-Devidé & Slišković (1972, 1978, 1980) and Malez & Slišković (1976) the freshwater Neogene sediments of Livanjsko polje belong to the Middle Miocene. A similar ostracode fauna is found also in Kupreško polje. In the Sarajevo—Zenica basin, near Breza, among ostracodes there are *Potamocypris quadrilobata* Krstić, *Leptocythere (Amnicythere)* sp., and different *Candona* species. From the Middle Miocene of Dragačevo the species *Dinarocythere trigonulla* Krstić has been established (Krstić, 1987). In the Middle Miocene deposits of the Rabitlja and Otilović localities in the Pljevlja basin (Krstić, in print), the association of ostracode fauna contains the following species and genera: *Moenocypris montenegrina* Krstić, *Candona (?Propontoniella) besici* Krstić, *C. (Pseudocandona) korjeni* Krstić, *Leptocythere (Amnicythere) cehotinae* Krstić, *Cypria* sp., *Amplocypris* sp. div., *Septocypris* sp., *?Moenocypris* sp., *Metacypris* sp., *Virgatocypris* sp., and *Paralimnocythere* sp. The most numerous is the species *Moenocypris montenegrina* Krstić. The Lower Miocene of the Ivangrad basin is characterized by *Cypridopsis (Obliquopsis)* sp. div., and by numerous representatives of the genus *Moenocypris*.

CONCLUSION

The ostracode fauna from some non-marine Neogene basins in Yugoslavia are presented. Along with the localities described earlier, some new ones are also described and the additional faunal lists in the known basins are supplemented. These non-marine ostracode faunas have been found in the Miocene and Pliocene deposits.

Generally speaking, it can be said that over a wide area of the Pannonian basin and its tributaries (Pomoravlje) in Yugoslavia, the ostracode faunas can be correlated to a considerable degree. They give valuable data pointing to the conclusion that they were deposited at the same time and in similar environments. Small differences, which inevitably exist, are related to the change in conditions within the paleoenvironments. We particularly stress the ostracode fauna of Metohija, which, compared with other units, occurred later and contains common species with the recent ostracode fauna of Macedonia. On the other hand, ostracode associations in the Dinaric karst region are characterized by unusually ornamented species of wide-spread genera, as well as by some new subgenera or even genera. This indicates the specific conditions of the environments as well as the endemic conditions of their evolution.

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Ostrakodska fauna nekih nemarinskih basena u Jugoslaviji

A. Sokač i N. Krstić

U radu je prikazana fauna ostrakoda nekih slatkovodnih basena koji su nastajali u miocenu i pliocenu na različitim područjima Jugoslavije. Regionalno promatrano izdvojeni su: Karpato-Balkanidi, Pomoravlje, Metohija, Panonski basen i područje Dinarskog krša.

Osim do sada poznatih i opisanih fauna ostrakoda, koje su u ovom radu djelomično revidirane i dopunjene novim podacima, prikazane su i asocijacije ostrakodskih fauna koje ranije nisu bile poznate. Time se dobio pregled dosadašnjeg poznavanja razvoja nemarinskih basena u Jugoslaviji te je bilo moguće izvršiti njihovu usporedbu.

U području Karpato-Balkanida fauna ostrakoda miocenske starosti samo je djelomično istražena iz okoline Golupca, Mlavskog i Sokobanjskog basena. Utvrđene su naslage donjeg i srednjeg miocena.

Geografski široko područje Pomoravlja obuhvaća basene, odnosno lokalitete Niš, Svrljig, Aleksinac, Kruševac, Kraljevo, Kragujevac, Popovac, Levče i okolinu Beograda. U odnosu na superpoziciju istraživanih sedimenata, koji leže ispod *Spiroplectammina carinata*-zone srednjeg badena, zaključuje se da su u Pomoravlju razvijeni ekvivalenti donjeg badena i moguće dijelom karpata. Jedino u Aleksinačkom basenu nađena je ostrakodska fauna donjeg miocena.

Fauna ostrakoda Metohije sadrži pretežno vrste koje su po prvi put opisane s ovog područja, uz neke poznate oblike i vrste iz recentne faune Makedonije. U pogledu stratigrafske pripadnosti izdvojena su tri nivoa, od kojih jedan pripada srednjem miocenu, drugi mlađem miocenu, a treći pliocenu.

Relativno dosta podataka o ostrakodskoj fauni Panonskog basena upućuje na moguću korelaciju unutar ovog prostora, premda su razlike u asocijacijama prisutne, što se može tumačiti različitim paleoekološkim uvjetima za vrijeme taloženja miocenskih naslaga. Naslage miocena nađene su u Fruškoj gori, Jadranskom basenu, Prnjavorskom basenu, obroncima Psunja i Medvednice, u bušotinama Savske potoline i na nekim lokalitetima u blizini Karlovca.

U području Dinarskog krša slatkovodne miocenske naslage nalaze se u okolini Bihaća, u Sinjskom, Livanjskom i Kupreškom polju, u Sarajevo-Zeničkom, Pljevaljskom i Ivangradskom basenu te na otoku Rabu. Do sada je ostrakodska fauna samo djelomično istražena, ali već i dosadašnje poznavanje ove faune pokazuje razlike od faune ostrakoda naprijed navedenih područja. Ističu se krupne, skulpturirane forme, od kojih mnoge još nisu opisane, a asocijacije u cjelini upućuju na izoliranost pojedinih basena i prostora gdje su se taložile miocenske saltkovodne naslage i razvoj endemične faune.

PLATE — TABLA I

Fig. 1. Pliocene ostracode association of Đakovica, Metohija (Pliocenska asocijacija ostrakoda Đakovice, Metohija)

Fig. 2. Middle Miocene ostracode association of Bjelanovac, Psunj Mountain (Srednjemiocnska asocijacija ostrakoda Bjelanovca, Psunj)

Microphotographs enlarged (Mikrofotografije povećane): cca 16 ×

Photos by (Foto): N. Rendulić

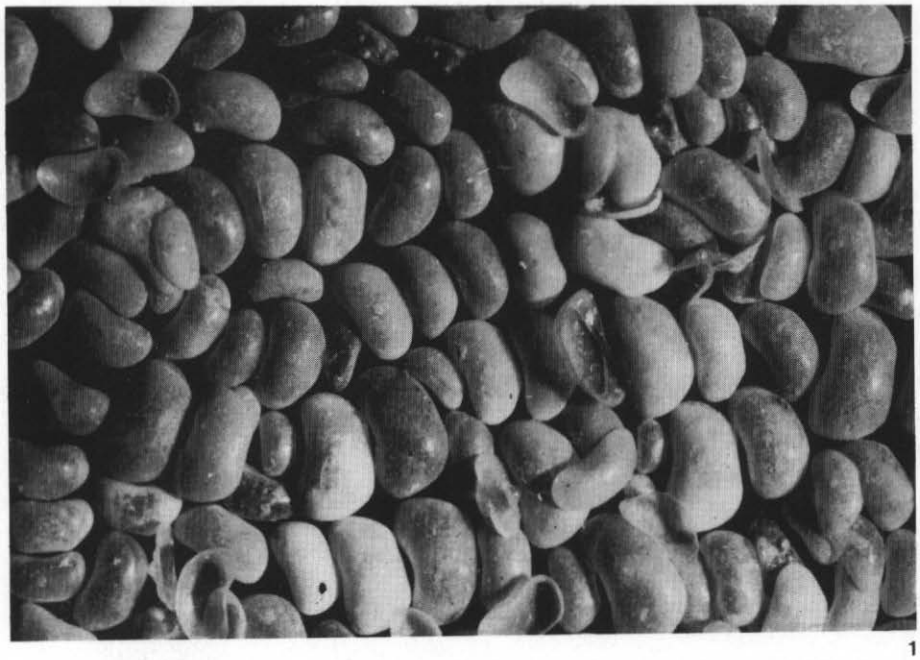

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PLATE — TABLA II

Fig. 1. Middle Miocene ostracode association of Dugoselo near Karlovac (Srednjemiocenska asocijacija ostrakoda Dugosela kod Karlovca)

Fig. 2. Middle Miocene ostracode association of Livno (Srednjemiocenska asocijacija ostrakoda Livna)

Photomicrographs enlarged (Mikrofotografije povećane): cca 16 ×

Photos by (Foto): N. Rendulić

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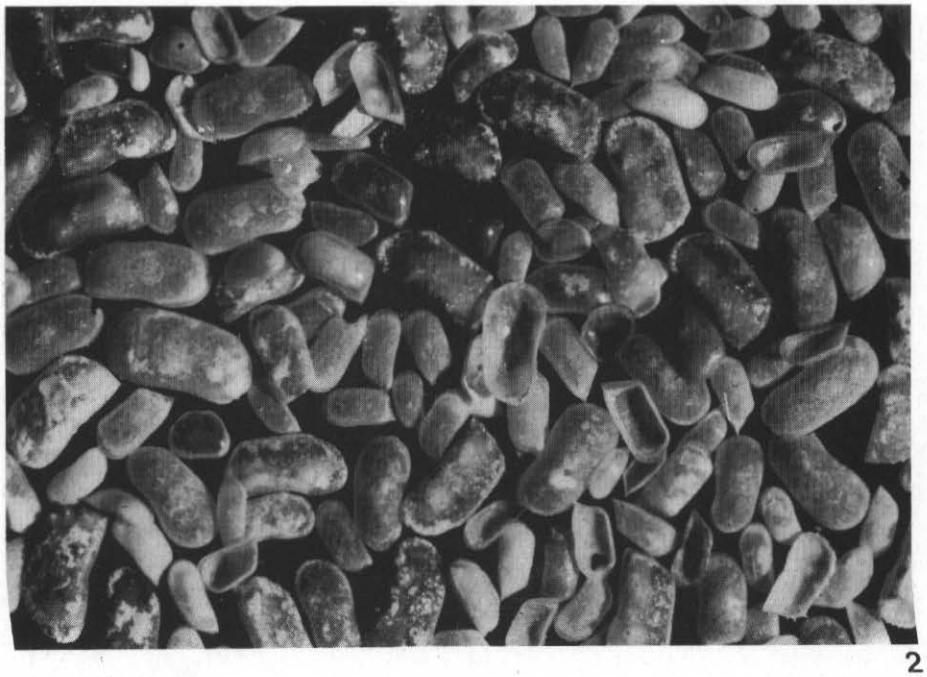

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