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# SILURIAN–EARLIEST DEVONIAN OSTRACODE BIOSTRATIGRAPHY OF THE TIMAN–NORTHERN URAL REGION

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**Abstract.** The stratigraphical distribution of the Silurian and earliest Devonian ostracodes in sections of the northern Timan, and Chernov and Chernyshev uplifts in the Timan–northern Ural region is presented. The ostracode successions across the Silurian–Devonian boundary are similar in the Timan–northern Ural region and on Novaya Zemlya. The majority of the previously established Homerian–Lochkovian ostracode biozones have now been recognized in these areas. Ostracode biostratigraphy for the middle Llandovery to middle Wenlock time period in northeastern European Russia is discussed.

**Key words:** ostracodes, biostratigraphy, Silurian, earliest Devonian, Timan–northern Ural region, Russia.

## INTRODUCTION

The first data about Silurian ostracodes (*Cypridina marginata* Keyserling, 1846) as well as about Silurian deposits (Wenlock) in Russia were obtained from the Timan–northern Ural region during the expeditions of A. Keyserling in 1843 and A. Stuckenberg in 1846. (It is noteworthy that R. Murchison also participitated in Keyserling's expedition.) The collection of ostracodes (which included mainly Leperditicopida) of these researchers was described by Schmidt (1873, 1883) and later also by Lebedev (1892).

New data on the Silurian Ostracoda of northeastern Russia became available only in the 1950s and 1960s, as a result of intensive geological studies in the Timan and in the adjacent regions of the Urals (western slope of the Northern and Subpolar Urals) and the Arctic (Vajgach and Dolgij islands, and Novaya Zemlya Archipelago) (Fig. 1).

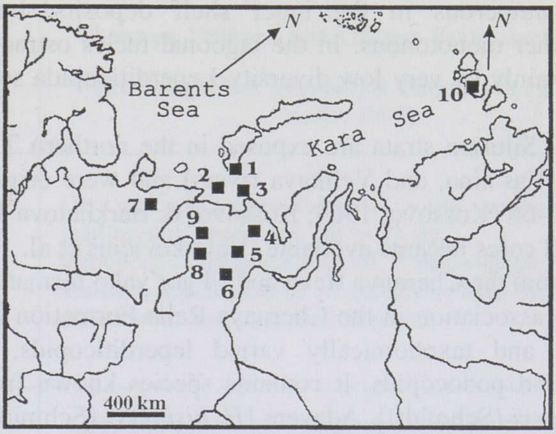


**Fig. 1.** Location of sections where the Silurian–earliest Devonian carbonate deposits are exposed and ostracodes studied. 1, southern Novaya Zemlya; 2, Dolgij Island; 3, Vajgach Island; 4–9, Timan–northern Ural region [4, Chernov Uplift; 5, Subpolar Urals (Kozhym River); 6, Northern Urals (Shchugor River); 7, northern Timan; 8, 9, Chernyshev Uplift: 8, Iz′yayu and Bol′shaya Synya rivers; 9, Dershor Brook]; 10, Severnaya Zemlya.

The results of several studies of the Silurian and earliest Devonian ostracodes from Novaya Zemlya and the Timan–northern Ural region have been published (Abushik 1962, 1970, 1980, 1983; Abushik & Modzalevskaya 1973), and a biostratigraphical scheme based on the distribution of ostracodes has been proposed for the upper Silurian of that region (Abushik 1986, 1997). The detailed distributional data about the Silurian–earliest Devonian ostracodes in the Timan–northern Ural region are presented for the first time herein. The studies reveal that the Homerian–Lochkovian ostracode faunas are identical in both the Timan–northern Ural region and on Novaya Zemlya. On that basis an ostracode zonation for the lower Silurian sequence in these areas is established.

## DISTRIBUTION OF OSTRACODES

**Northeastern European Russia.** In most regions of northeastern European Russia the lower Silurian strata are represented by shallow-water facies. These environments were apparently unfavourable for ostracodes, as they are very rare in such deposits. The Llandovery and lower Wenlock deposits in both the Timan–northern Ural region and Novaya Zemlya are dominated by leperditicopids. In addition, kloedenellocopids and podocopids are rather common in the upper Wenlock.

By contrast, ostracodes are usually abundant in the upper Silurian of the Timan–northern Ural region and Novaya Zemlya. The faunas are most varied in sediments deposited in normal marine, shallow-water open-shelf environments.

Ostracodes are numerous in the inner shelf deposits, but the fauna is taxonomically rather monotonous. In the lagoonal facies ostracode assemblages are represented mainly by very low diversity Leperditicopida some of which are monospecific.

**Timan Ridge.** Silurian strata are exposed in the northern Timan (the basins of the Chernaya, Vas′kina, and Velikaya rivers) and were originally studied by Kossovoj in 1957–66 (Kossovoj 1963; Kossovoj & Barkhatova 1965). Later, rich material from drill cores became available (Valiukevičius et al. 1983). Ostracodes are known only from the Chernaya Reka and El′gor′yako formations (Fig. 2).

The ostracode association in the Chernaya Reka Formation is represented by rather numerous and taxonomically varied leperditicopids, and by a few beyrichiocopids and podocopids. It contains species known from the Raikküla [*Hisingeria hisingeri* (Schmidt)], Adavere [*H. hisingeri* (Schmidt), *H. abbreviata* (Schmidt)], and Jaani (*Beyrichia bicuspis* Kiesow) stages in Estonia; from the Golomyannyj and Srednij formations (*Hogmochilina orientalis* Abushik) on Severnaya Zemlya; from the Khekanda Formation (*H. orientalis* Abushik) on the Kolyma River, and Agidy Formation (*Gibberella jejuma* Abushik) in East Siberia. *Hisingeria angulata* (Lebedev), *Herrmannina*? *marginata* (Keyserling), and *H.*? *subparallella* (Schmidt) are endemic forms known only from the Timan–Pechora region. The age of the ostracode association from the Chernaya Reka Formation is probably latest Aeronian to Telychian (Llandovery Series). The similarity of this fauna to the Baltic assemblages was noted by previous researchers (Schmidt 1873, 1883; Lebedev 1892; Kossovoj 1963). The new data point to the close connections of these assemblages with those from Severnaya Zemlya (Abushik in press), Siberia, and Kolyma region (Northeast of Russia) (Abushik 1975, 1977; Bazarova 1982). In this respect it is important to note the occurrence of *Beyrichia bicuspis* Kiesow, an early Wenlock taxon, in this association.

The abundance of ostracodes decreases in the El′gor′yako Formation. Besides leperditicopids, which were also observed in the preceding assemblage [*Hisingeria angulata* (Lebedev), *Herrmannina*? *marginata* (Keyserling)], it contains *Microcheilinella variolaris* (Neckaja) and *M. rozhdestvenskaja* Neckaja. These two podocopid species are typical of the upper Telychian–lower Sheinwoodian (latest Llandovery–earliest Wenlock) strata in Podolia (Restevo and Demshin formations) and Lithuania (Švenčionys and Paprieniai formations). *M. variolaris* has also been found in the Jaani Stage (lower Sheinwoodian) in Estonia. The age of this association is considered to be late Telychian–early Sheinwoodian.

**Chernov Uplift.** Silurian ostracodes from this region became known after the study of the Silurian and Devonian deposits by Chernov in 1960–61 (Padimejtyvis, Sizim-Tselebej, and Tar′yu rivers and Bezymyannyj Brook) and by Antoshkina in 1982 (Padimejtyvis River). The lithological and faunal characteristics of these sections are presented in many papers (Chernov 1972; Modzalevskaya 1985; Antoshkina & Beznosova 1987, 1988; Antsygin et al.

| Series | Formation | Chernaya, Velikaya, and Khalmer-Yakha rivers (Kossovoj 1963; Kossovoj & Barkhatova 1965; Kaljo 1987) |
|---|---|---|
| Wenlock | Bol'shoj Nadtej | Grey and yellow-grey dolomitic, oolitic, sandy, and argillaceous limestones (up to 53 m). Conodonts: *Pterospathodus* aff. *P. amorphognathoides* Walliser, *Apsidognathus* aff. *A. tuberculatus* Walliser, *Ozarkodina waugoolaensis* Bischoff |
| Wenlock / Llandovery | El'gor'yako | Grey and yellow-grey, often stromatolitic dolomitic limestones with layers of variegated clay, siltstones, and sandstones, rarely gypsum (20-60 m). Ostracodes: *Hisingeria angulata* (Lebedev), *Herrmannina*? *marginata* (Keyserling), *Microcheilinella variolaris* (Neckaja), *M. rozhdestvenskaja* Neckaja |
| Llandovery | Chernaya Reka | Grey dolomitic, organogenous-clastic, and arenaceous limestones, dolostones, rarely with layers of domerites, siltstones, and gypsum (26-40 m). Ostracodes: *Hisingeria hisingeri* (Schmidt), *H. abbreviata* (Schmidt), *H. angulata* (Lebedev), *Herrmannina*? *marginata* (Keyserling), *H.*? *subparallella* (Schmidt), *Hogmochilina orientalis* Abushik (=*H.* ex gr. *H. maakii* Schmidt), *Gibberella* cf. *G. jejuma* Abushik, *Beyrichia bicuspis* Kiesow, *Microcheilinella* sp. |
| Llandovery | Ust' Chernaya Reka | Domerites, mudstones, sandstones, siltstones with lenses of conglomerates (up to 17 m) |

**Fig. 2.** Stratigraphical scheme and ostracode assemblages of the Lower Silurian of the Timan.

1993). The Silurian and Lower Devonian strata in this region are subdivided into Bezymyannyj, Padimejtyvis, Sizim, Tselebej, Ust′Syv′yu, and Ovinparma formations. Ostracodes have been obtained from all these units (Fig. 3), but they are most abundant in the Padimejtyvis and Sizim formations. Ostracode faunas from all these formations include certain index species and/or stratigraphically

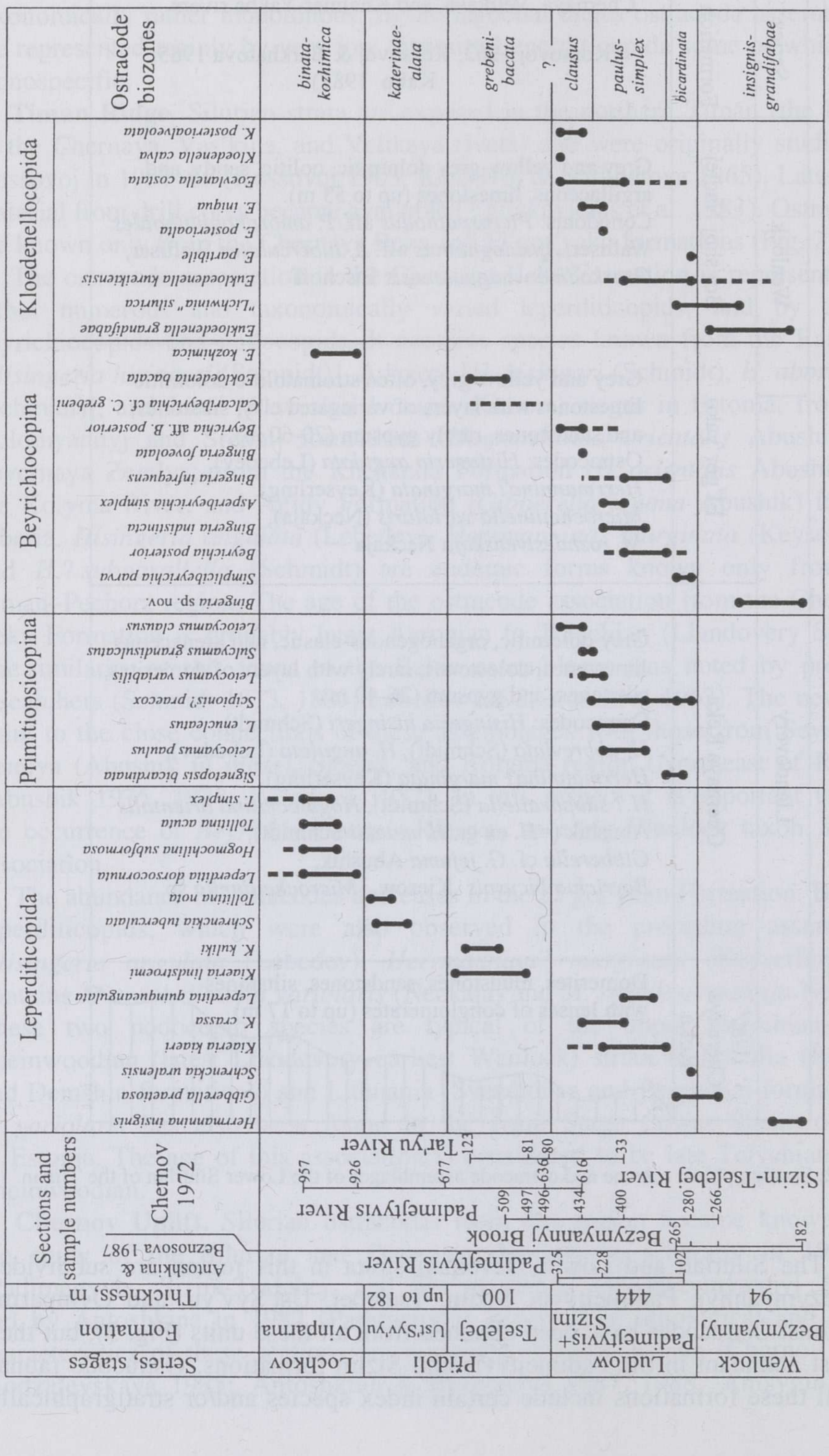


Fig. 3. Distribution of ostracodes in the Silurian–earliest Devonian of the Chernov Uplift.

important taxa which allow the recognition of the associations of the Novaya Zemlya and Timan–northern Ural ostracode zonal scheme.

The Homerian (upper Wenlock) *Herrmannina insignis–Eukloedenella grandifabae* Biozone is recognized due to the presence of both index species, namely *H. insignis* Abushik and *E. grandifabae* Abushik, in these strata. This biozone corresponds to the middle and upper members of the Bezymyannyj Formation.

The Ludlow Series ostracode biozones (*Signetopsis bicardinata–Simplicibeyrichia parva*, *Leiocyamus paulus–Asperibeyrichia simplex–Beyrichia posterior*, and *Leiocyamus clausus*) are identified by the occurrence of the index species and some important associated taxa. *Schrenckia uralensis* (Schmidt), *Kiaeria crassa* Abushik, and *Leiocyamus paulus* Zenkova are very important in recognition of the *S. bicardinata–S. parva* and *L. paulus–A. simplex–B. posterior* biozones, whereas *Sulcyamus grandisulcatus* Abushik, *Kloedenella calva* Abushik, and *Kloedenella posterioalveolata* Abushik allow recognition of the *L. clausus* Biozone. The latest Ludlow, *Dolgitia triangula–Eokloedenia subbacata* Biozone has not been recognized in the sequence of the Chernov Uplift, probably, due to a stratigraphical gap. The occurrence of *Eokloedenia bacata* Abushik, *Kiaeria kuliki* Glebovskaja, and *K. lindstroemi* (Schmidt) in the Tselebej Formation correlates these strata with the early Přidoli Series *Calcaribeyrichia grebeni–Eokloedenia bacata* ostracode Biozone.

The Ust′Syv′yu Formation (upper Přidoli) yields only a few leperditicopids. However, its correlation with the late Přidoli *Kiaeria katerinae–K. alata* ostracode Biozone is based on the occurrence here of two important zonal species, *Schrenckia tuberculata* Abushik and *Tollitina nota* Abushik, and on a change in the ostracode association identical to that at the Silurian–Devonian boundary in the Subpolar Urals.

The oldest Devonian (Lochkovian) ostracode zone, the *Cornikloedenina binata–Eokloedenia kozhimica* Biozone, has been identified in the strata of the Ovinparma Formation, by the occurrence there of the typical Lochkovian leperditicopids *Leperditia dorsocornuta* Abushik, *Tollitina simplex* (Abushik), *T. acuta* (Abushik), and *Hogmochilina subformosa* Abushik.

Generally, the late Wenlock–early Lochkovian ostracode succession on the Chernov Uplift is analogous to that in Novaya Zemlya.

**Chernyshev Uplift.** In the northern part of the Chernyshev Uplift, in the basin of the Adz′va River (Dershor Brook), there is a section of Silurian–Devonian boundary deposits, namely the Ust′Syv′yu, Ovinparma, and Sotchemkyrta formations, all of which are rather well characterized faunally (corals, brachiopods, and ostracodes). Ostracodes from this section were studied by Saldin (Tsyganko et al. 1989).

Based on the presence of the ostracode index species *Kiaeria katerinae* Abushik, the late Přidoli *K. katerinae–K. alata* Biozone, corresponding to the Ust′Syv′yu Formation, is recognized here. The character of the changes in the ostracode associations across the Silurian–Devonian boundary in the Chernyshev

Uplift sequence is analogous to that in the Subpolar Urals. Ostracodes are rare in the lower part of the Ovinparma Formation, where only *Tollitina minima* (Abushik) and *T. simplex* (Abushik) were found. An abundant ostracode association (24 species) was found about 50 m above the base of the Ovinparma Formation, in Member 3 (22.5 m thick). Together with several transitional Lochkovian taxa, some long-ranging Early Devonian species and two species related to the index species of the *C. binata–E. kozhimica* and *Welleriella ventriumbonata* ostracode biozones were found in this association. *Cornikloedenina* aff. *binata* Abushik occurs in the uppermost strata of the lower half of Member 3; *Welleriella* n. sp. occurs in the lowermost strata of the upper half of the same member. The occurrence of these species at closely located levels demonstrates a continuous succession of these two basal Early Devonian ostracode biozones corresponding to the Ovinparma Formation and the overlying Sotchemkyrta Formation. The upper boundary of the *W. ventriumbonata* Biozone is not exposed in this section.

In the southern part of the Chernyshev Uplift, the Silurian–Early Devonian strata are most completely exposed in the valleys of the Iz′yayu and Bol′shaya Synya rivers. These sections were studied by V. Chekhovich and A. Abushik during the field work in 1962. The biostratigraphy, based on the distribution of corals, was published earlier (Chekhovich 1965); the data about ostracodes are shown for the first time herein (Figs. 4, 5).

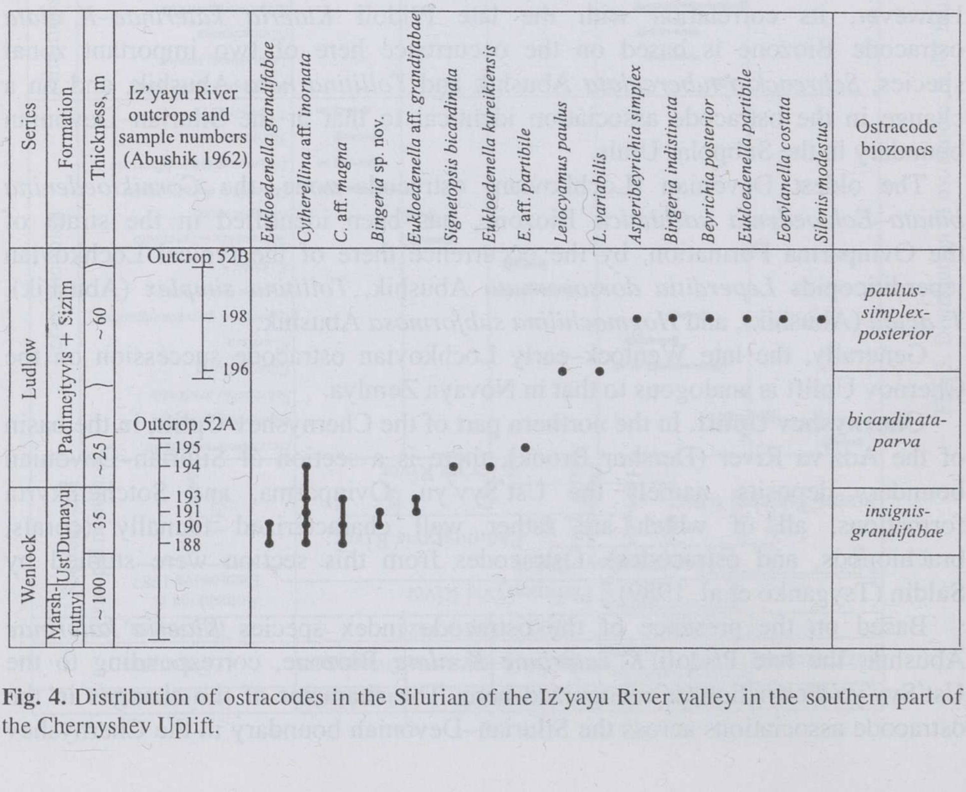


**Fig. 4.** Distribution of ostracodes in the Silurian of the Iz′yayu River valley in the southern part of the Chernyshev Uplift.

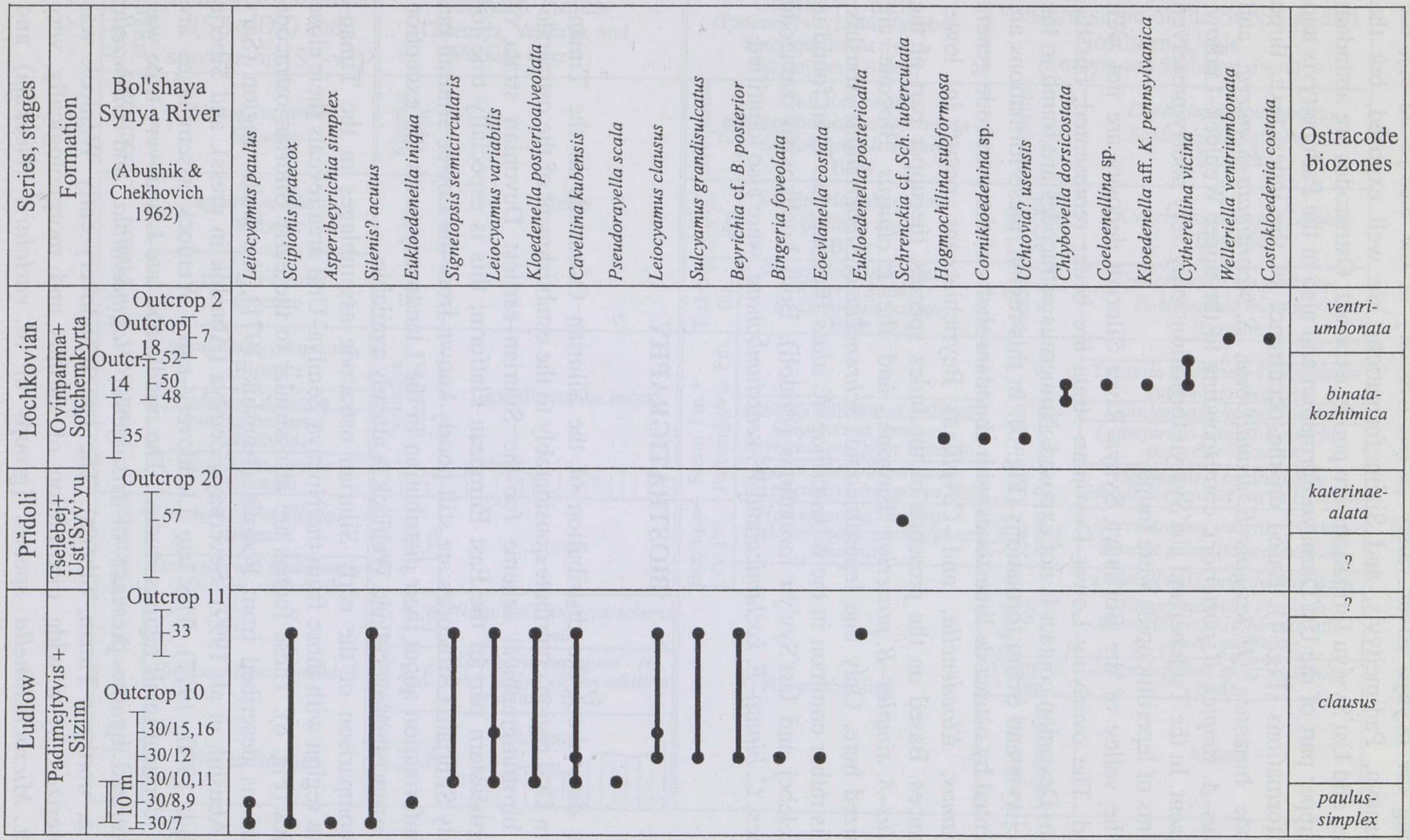


**Fig. 5.** Distribution of ostracodes in the Silurian–earliest Devonian of the Bol′shaya Synya River valley in the southern part of the Chernyshev Uplift.

Along the Iz′yayu River valley (a left tributary of the Kos′yu River), the Ust′Durnayu, Padimejtyvis, and Sizim formations are well exposed, but the Tselebej and Ust′Syv′yu formations are poorly exposed. Ostracodes are abundant in the upper part of the Ust′Durnayu Formation and also in the Padimejtyvis and Sizim formations (Fig. 4). Based on the occurrence of the index taxa, three ostracode biozones (*H. insignis–E. grandifabae*, *S. bicardinata–S. parva*, and *L. paulus–A. simplex–B. posterior*), corresponding to the upper Wenlock–Ludlow, are present. In the Tselebej and Ust′Syv′yu formations only very poorly preserved fragments of leperditicopids were found.

In the valley of the Bol′shaya Synya River Silurian deposits are not well exposed. The overlying Lower Devonian strata are better represented, but the Silurian–Devonian contact is not exposed. Numerous ostracodes are found in the Padimejtyvis and Sizim formations (Fig. 5). In this region, these formations are represented by ostracode limestones with abundant shells of the ostracode genera *Leiocyamus*, *Kloedenella*, and *Cavellina*. Beyrichiaceans occur in lower abundances. Based on the presence of the index species, the upper part of the *L. paulus–A. simplex–B. posterior* Biozone, and the *L. clausus* Biozone are recognized here. Only one leperditicopid, *Schrenckia* cf. *tuberculata* Abushik, which is rather common in the *K. katerinae–K. alata* Biozone, has been found in the Tselebej and Ust′Syv′yu formations (Přidoli). Both Lochkovian ostracode biozones, *C. binata–E. kozhimica* and *W. ventriumbonata*, were also identified.

## BIOSTRATIGRAPHY

The data about the distribution of the Silurian Ostracoda in the Timan–northern Ural region contribute considerably to the establishment of the ostracode-based biostratigraphical scheme for the Silurian–earliest Devonian strata of the northeastern part of the East European Platform; this is especially true for the early Silurian. Ostracodes are still poorly known from the Lower Silurian but some information about their distribution in the Llandovery (with the exception of the lower Llandovery) and Wenlock is already available.

A comparison of the early Silurian ostracode assemblages in the Timan–Pechora region with those from the Novaya Zemlya–Ural area reveals their close affinities (Fig. 6). These faunas are also similar to the early Silurian ostracode associations described from Podolia (Abushik 1971), the Baltic region (Sarv 1970; Abushik et al. 1999), Severnaya Zemlya (Abushik in press), and Siberia (Abushik 1960, 1977). The late Llandovery–early Wenlock assemblages are almost identical in all regions studied. The middle and late Llandovery time was characterized by the presence of *Hisingeria*, *Hogmochilina*, and *Gibberella* (Estonia, northern Timan, Siberia). The late Llandovery–early Wenlock was characterized by a wide distribution of various and morphologically very distinct *Microcheilinella* species [groups of *M. variolaris* (Neckaja) and

| Series, stages | Ostracode biozones ($S_1w_2$-$D_1l$) and succession ($S_1l$-$w_1$) | Northern Timan (Chernaya, Velikaya, and Vas'kina rivers): Fm. | Northern Timan: ostracodes | Chernov Uplift (Padimejtyvis, Sizim-Tselebej-Shor, and Tar'yu rivers, Bezymyannyj Brook): Fm. | Chernov Uplift: ostracodes | Western slope of the Subpolar and Northern Urals (Kozhym and Shchugor rivers): Fm. | Western slope of the Subpolar and Northern Urals: ostracodes |
|---|---|---|---|---|---|---|---|
| Lochkov. | *binata-kozhimica* Biozone | Kharius Fm. | Absent | Ovinparma Fm. | *Tollitina acuta-Hogmochilina subformosa-Eokloedenia kozhimica* Beds | Ovinparma Fm. | *Cornikloedenina binata-Eokloedenia kozhimica* Biozone |
| Přidoli | *katerinae-alata* Biozone | Eptarma Fm. | Absent | Ust'-Syv'yu Fm. | *Schrenckia tuberculata-Tollitina nota* Beds | Ust'-Syv'yu Fm. | *Kiaeria katerinae-K. alata* Biozone |
| Přidoli | *grebeni-bacata* Biozone | Eptarma Fm. | Absent | Tselebej Fm. | *Schrenckia lindstroemi-Kiaeria kuliki-Eokloedenia bacata* Beds | Tselebej Fm. | *Calcaribeyrichia grebeni-Eokloedenia bacata* Biozone |
| Ludlow | *triangulata-subbacata* Biozone | Velikaya Reka Fm. | Leperditicopida indet. | Sizim Fm.+ Padimejtyvis Fm. | ? | Sizim Fm.+ Padimejtyvis Fm. | ? *Dolgitia triangula-Eokloedenia subbacata* Biozone |
| Ludlow | *clausus* Biozone | Velikaya Reka Fm. | Leperditicopida indet. | Sizim Fm.+ Padimejtyvis Fm. | *Leiocyamus clausus* Biozone | Sizim Fm.+ Padimejtyvis Fm. | *Leiocyamus clausus* Biozone |
| Ludlow | *paulus-posterior* Biozone | Velikaya Reka Fm. | Leperditicopida indet. | Sizim Fm.+ Padimejtyvis Fm. | *Leiocyamus paulus-Beyrichia posterior* Biozone | Sizim Fm.+ Padimejtyvis Fm. | *Leiocyamus paulus-Beyrichia posterior* Biozone |
| Ludlow | *bicardinata-parva* Biozone | Velikaya Reka Fm. | | Sizim Fm.+ Padimejtyvis Fm. | *Signetopsis bicardinata-Simplicibeyrichia parva* Bz | Sizim Fm.+ Padimejtyvis Fm. | *Signetopsis bicardinata-Simplicibeyrichia parva* Biozone |
| Wenlock | *insignis-grandifabae* Biozone | Bol'shoj Nadtej Fm. | Absent | Bezymyannyj Fm. | *Herrmannina insignis-Eukloedenella grandifabae* Biozone | Ust'-Durnayu Fm. | *Herrmannina insignis-Eukloedenella grandifabae* Biozone |
| Wenlock | *Daleiella* aff. *mukshensis* *Microch. variolaris* | Bol'shoj Nadtej Fm. | Absent | Bezymyannyj Fm. | Not established | Marshrutnyj Fm. | *Daleiella* aff. *mukshensis* Beds |
| Llandovery | *Daleiella* aff. *mukshensis* *Microch. variolaris* | El'go-r'yako Fm. | *Microcheilinella variolaris* Beds | | Not established | Marshrutnyj Fm. | *Microcheilinella convexa-M. variolaris-Gibberella* aff. *praetiosa* Beds |
| Llandovery | *Hogmochilina orientalis* | Chernaya Reka Fm. | *Hisingeria hisingeri - H. abbreviata - Hogmochilina orientalis* Beds | | Not established | Filipp"el' Fm. | *Hogmochilina* ex gr. *elongata* Beds |
| Llandovery | Not established | Ust'Chernaya Reka Fm. | Absent | | Not established | Yarenej Fm.+ Lolashor Fm. | Absent |

**Fig. 6.** Correlational biostratigraphical scheme of the Timan–northern Ural region and Novaya Zemlya. Bz, biozone.

*M. rozhdestvenskaja* Neckaja] in Podolia, southern Baltic, Chernov Uplift, and the Subpolar and Northern Urals.

Typical of the middle and late Wenlock was the development of abundant and various *Eukloedenella*, "real" *Herrmannina* (with shevron-shaped muscle scar), and *Daleiella* (group of *D. corbuloides* Jones & Holl). Additional investigations of ostracode assemblages from the El′gor′yako, Marshrutnyj, and Ust′Durnayu formations of the Timan–Pechora region (materials from boreholes), and from coeval strata of southern Novaya Zemlya will probably make it possible to establish an ostracode zonation for also the early Silurian.

In conclusion, the distribution of ostracodes in the upper Silurian and lower Devonian in the Timan and the Chernov and Chernyshev uplifts is similar to that in the Novaya Zemlya–Ural region and agrees well with the data proposed earlier (Abushik 1986, 1997; Shamsutdinova 1995, 1999).

## CONCLUSIONS

1. The Silurian–earliest Devonian ostracode successions in the Timan–northern Ural region and Novaya Zemlya are almost identical. In both areas the same ostracode biozones, based on the distribution of the same index species and important associated taxa, have been established for the Wenlock–Lochkovian strata.

2. The establishment of an ostracode biozonal scheme for the Llandovery, and for the early and middle Wenlock, requires additional studies.

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## SILURI JA VARADEVONI OSTRAKOODIDE STRATIGRAAFIA TIMAANI–UURALI PÕHJAOSA REGIOONIS

Anna ABUŠIK

On esitatud andmed Timaani–Uurali põhjaosa regioonis Põhja-Timaani, Tšernovi kerkeala ja Tšernõševi mäeaheliku läbilõigetes uuritud siluri ja alam-devoni ostrakoodide leviku kohta. Ülem-Wenlocki–Lochkovi ostrakoodide bio-stratigraafiline järjestus on selles regioonis analoogne nende järjestusele Novaja Zemljal. Mõlemas piirkonnas on ära tuntavad ühed ja samad ostrakooditsoonid. On püütud välja töötada ostrakoodidel põhinev Kesk-Llandovery–Kesk-Wenlocki tsonaalsus Venemaa Euroopa-osa kirdepiirkonna jaoks.

# СИЛУРИЙСКО-РАННЕДЕВОНСКАЯ БИОСТРАТИГРАФИЯ ТИМАНО-СЕВЕРОУРАЛЬСКОГО РЕГИОНА ПО ОСТРАКОДАМ

Анна АБУШИК

Представлено распространение силурийско-раннедевонских остракод Тимано-Североуральского региона, изученных в разрезах Северного Тимана, поднятия Чернова и гряды Чернышева. Установлено, что остракодовая биостратиграфическая последовательность этого региона в интервале поздний венлок–лохков аналогична Новоземельской. В этих регионах распознается большинство одноименных остракодовых зон. Сделана попытка установить на северо-востоке европейской части России остракодовую биостратиграфическую последовательность для интервала средний лландовери–средний венлок.