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Abstract—Data on Callovian and Oxfordian ostracodes of the Ryazan and Kostroma regions and Mordovia are presented for the first time; the ostracode list of the Moscow and Kursk regions is essentially extended. In total, 54 species are recorded, 11 of them are recognized as new, 41 species are comprehensively described, and an atlas of SEM images of ostracode shells and valves is compiled. Lower, Middle, and Upper Callovian and Lower, Middle, and Upper Oxfordian ostracode assemblages are established on the basis of the bed-by-bed study of ostracodes from eight sections. Five stratigraphic units ranked as beds with ostracodes are recognized on the basis of the analysis of their stratigraphic distribution; these are the beds with *Praeschuleridea wartae–Pleurocythere regularis* (Lower Callovian, *calloviense* Zone of the Voronezh Anteclise, Kursk Region); beds with *Paranotacythere (Unicosta) stauropyga–Galliaecytheridea legitima* (Middle Callovian of the Moscow Syneclise and Voronezh Anteclise, Kursk Region); beds with *Infacytheredulcis* (Upper Callovian of the Moscow Syneclise); beds with *Sabacythere attalicata–Vesticytherura costaeirregularis* (Lower Oxfordian of the Moscow Syneclise); beds with *Paranotacythere (Unicosta) solei* (Middle Oxfordian of the Moscow Syneclise). The strata recognized are correlated with various stratigraphic units known in adjacent areas and West European countries. On the basis of ostracodes, cluster analysis of indices of the similarity and dissimilarity was performed for 21 West and East European regions; this led to the recognition of ten paleobiogeographic regions.

INTRODUCTION

Ostracodes are one of those groups of microfauna, whose potential has not been revealed completely. The importance of their thorough investigation for the purpose of biostratigraphy and paleogeography has been repeatedly stressed.

The study of Jurassic ostracodes from the Russian Plate and its nearest marginal region was initiated in the 1930s. One of the most important issues, which researches of the Jurassic faced, was the problem of the boundary between the Middle and Upper Jurassic that was demarcated by various authors either at the bottom or at the top of the Callovian Stage. Currently, this boundary is approved between the Callovian and Oxfordian stages.

Callovian and Oxfordian deposits are widespread over the Russian Plate. They contain abundant fauna of various invertebrates, although only ammonites and foraminifers are used for the stratigraphy and correlation of these sediments. In the meantime, only the numerous and taxonomically rich ostracodes of this period from Ukraine and the Volga-Urals Region have been studied. Such information is fragmentary and extremely scarce from the central regions of Russia. Except for incomplete lists from the Moscow, Kursk, Voronezh, Bryansk, and Orel regions, data on ostracodes from this area are absent or have not been published, whereas only methodical scrutiny of ostracodes throughout the whole territory of the Russian Plain may provide us with a confident basis for amendment of stratigraphic charts and enriched information about conditions of sedimentation and may be used for the reconstruction of the historical development of the paleobasin.

The aim of the present work is a detailed study of ostracodes from the boundary stages of the Middle and Upper Jurassic of central regions of the Russian Plate and comparison with contemporary ostracodes from adjacent areas and Western Europe. Such a study seems to be very important for a composite approach to the investigation of Jurassic rocks of the Russian Plain.

Therefore, several years ago, the author started a meticulous investigation of Callovian and Oxfordian ostracodes from the Ryazan, Moscow, and Kostroma regions (the southern part of the Moscow Anteclise), Mordovia (the Volga-Ural Anteclise), and the Kursk Region (the northern plunge of the Voronezh Anteclise). Primarily, ostracodes were collected from sections which were well studied and sequenced on the basis of other faunal groups.

The tasks of this work included, first, identification of the taxonomic composition of ostracodes and their monographic description according to modern requirements, including the revision of described species and compilation of the atlas of Callovian and Oxfordian ostracodes of the central parts of the Russian Plate, with SEM figures of their valves and shells.

Second, identification of ostracode assemblages, stratification of sections, and the establishment of stratigraphic units (beds with ostracodes) within the territory under investigation, as well as the study of changes in this group at the boundary of the Middle and Upper Jurassic; all the more so as the position of the Callovian Stage within the Jurassic System is ambiguous.

Third, gathering information from available literature on the stratigraphic range of all ostracode species in the Callovian and Oxfordian of both Eastern and Western Europe.

Fourth, comparison of the examined ostracode assemblages with those of adjacent regions and Western European countries and the discovery of the correlation potential of ostracodes with regard to Callovian and Oxfordian deposits of Western and Eastern Europe.

Fifth, paleobiogeographic analysis of the Callovian and Oxfordian of Eastern and Western Europe on the basis of ostracodes.

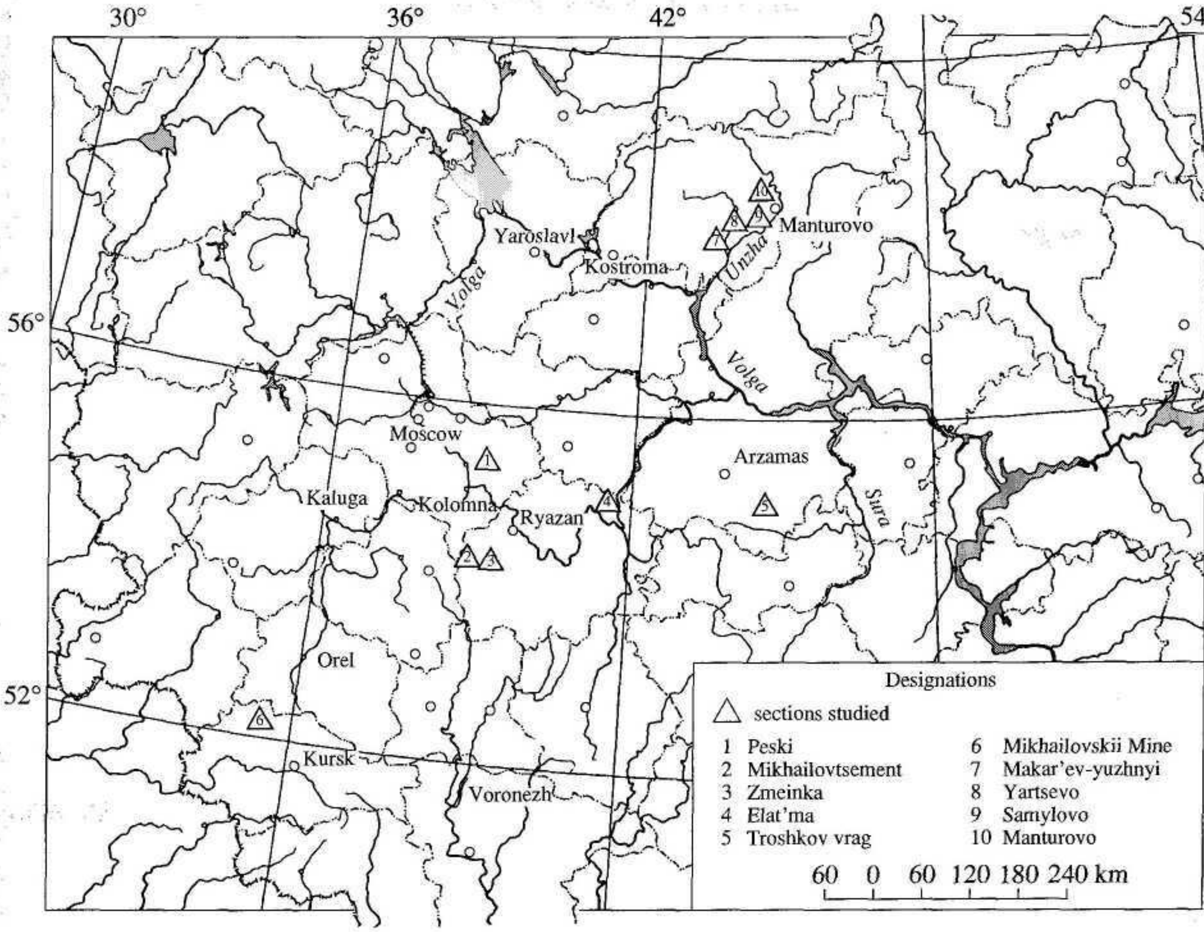


Fig. 1. Map depicting the studied sections.

This work is based on the material collected by the author during three field seasons in the Ryazan Region (1994), the Kostroma Region (1995), and the Kostroma and Ryazan regions and Mordovia (1996). Additionally, specimens collected in the Moscow and Kursk regions by students of the Department of Paleontology, Moscow State University, were used in research. Ten sections were described and tested for the presence of ostracodes, and ostracodes were found in eight of them (Fig. 1).

Ostracodes were extracted from the host rock using decantation and rinsing with water. This was preceded by boiling with sodium carbonate. Then, a sample was dried out and divided into two fractions (greater and less than 0.315 mm). The average weight of a sample was 0.5 kg. Shells and valves were taken with a preparation needle under a binocular microscope MBS-9 at 18x and 32× magnifications. Samples prepared and used for the study of foraminifers were partly examined as well. A total of 145 samples were examined. Ostracodes were found in 90 samples. The total number of shells and valves in the collection exceeds 3500 specimens, 3460 of them were identified as species. Fifty four species belonging to 27 genera were recorded, 11 of them are new.

Photographs were taken by the author using the SEM in the Laboratory of Electronic Microscopy of the Paleontological Institute of the Russian Academy of Sciences (PIN).

The collection is housed at the PIN, no. 4843.

CHAPTER 1. THE HISTORY OF INVESTIGATION OF JURASSIC OSTRACODES OF THE RUSSIAN PLATE AND ADJACENT REGIONS

Jurassic ostracodes of European Russia have been studied since the 1930s in connection with the industrial search for oil and gas. The first micropaleontological laboratory that began planned research of this group of microfauna was the All-Union Research Institute of Oil and Geological Prospecting (VNIGRI), in Leningrad.

Initially, their research covered the southeastern part of the Russian Plate, western Kazakhstan, and Mangyshlak.

An article by E.G. Sharapova should be noted (1937). She made an attempt to subdivide Mesozoic clays and calcareous marls of the Emba oil-bearing field on the basis of ostracodes. In the same paper, she gave diagnoses of 12 species of *Eucythere* and *Cythereis* from the Middle Volgian Substage and, partially, from the Lower Cretaceous.

As a result of the research of ostracodes from the Upper Jurassic and Cretaceous deposits of the Ozinki oil field, which is situated on the boundary between the central and southern parts of the western Obshchii Syrt, Sharapova (1939) described 39 species, 22 of them turned out to be new, and established ostracode assemblages characteristic of the Middle Volgian Substage (*panderi* and *virgatus* zones), Neocomian, Aptian, Albian, Campanian, and Maastrichtian. She also noted that recognition of stages on the basis of ostracodes is rather problematic and is not always possible due to a large number of new species, poor preservation of some specimens, and the incompleteness of assemblages in some parts of a section. It was recognized that the ostracode assemblage from the Upper Jurassic of this region is much more diverse than a contemporary assemblage from the region of Inder Lake.

Sharapova (Sharapova and Mandelstam, 1947) published a short paper on ostracodes in the Jurassic volume of the *Atlas of the Index Forms of Fossil Faunas of the USSR*. In that note, she briefly summarized the lithology of sections with ostracodes, published diagnoses of the genera *Palaeocytheridea* and *Orthonotacythere* and descriptions of seven Nordwick ostracode species, two new species of the genus *Darwinula* from the Bajocian of Mangyshlak, and five new species from the Upper Bajocian and Bathonian of Mangyshlak that had been described by M.I. Mandelstam in his manuscript.

In the same year, a paper by Mandelstam (1947) devoted to ostracodes from the Middle Jurassic of Mangyshlak was published. He recognized and described new genera and species, i.e., *Palaeocytheridea* containing four new species, *Aequacytheridea* containing two new species, and *Timiriasevia* including two new species. He also described a new species of the genus *Protocythere* and two new species of the genus *Darwinula*.

In volume 9 of the *Atlas of the Index Forms of Fossil Faunas of the USSR*, Mandelstam (1949) gave brief characteristics of three ostracode families, whose representatives are most frequent in marine Upper Jurassic deposits, i.e., Cytheridae, Paradoxostomidae, and Cytherellidae. He also listed the main generic features and published diagnoses of four genera and 20 species from the Callovian–Middle Volgian of the Middle Volga Region, Obshchii Syrt, and the marginal region of Inder Lake. He described *Palaeocytheridea*, with four new species included; *Protocythere* containing five new species; *Bythocythere* containing one new species, and *Cytherella*. In addition, Mandelstam described ten previously known species of these genera. For many years, this volume of the *Atlas of the Index Forms of Fossil Faunas of the USSR* was security-restricted and had a "For Official Use Only" stamp. Therefore, Lübimova (1955b) did not cite it, when (for the second time) she published descriptions of species that had been established by Mandelstam.

Starting in 1946, Lübimova began to methodically study the Mesozoic ostracodes of the northwestern Donets Basin and, later, the Middle Volga Region, the Emba Region, and Obshchii Syrt.

At the all-Union meeting on the development of the unified stratigraphic chart of Mesozoic deposits of the Russian Plate, Lübimova (1955a) presented lists of characteristic ostracode assemblages from the Middle Bajocian, Upper Oxfordian, and Kimmeridgian of the northwestern areas of the Donets Basin, the Callovian-Volgian of the Middle Volga Region, the Lower Volgian of the Ural-Volga interfluve and Obshchii Syrt for the first time.

In her monograph on ostracodes from the Middle Volga Region and Obshchii Syrt, Lu'bimova (1955b) established new assemblages and essentially extended previously published assemblages from the Lower Triassic, Bajocian, Bathonian, Callovian, Oxfordian, and Kimmeridgian stages, Lower, Middle, and Upper Volgian substages, and, partially, the Neocomian. Additionally, a change of species composition was detected at boundaries of large stratigraphic units. Lübimova also considered in detail problems of the systematics of Mesozoic ostracodes and presented data on their facial confinement. This paper is of immense importance, since it contains descriptions and figures of 98 ostracode species, 71 of which turned out to be new.

Later, in a large paper on ostracodes from the northwestern plunge of the Donets folding structure, Liibimova (1956) described and gave figures of 37 species; 30 species and one variety were mentioned as new. Ostracode assemblages from the Upper Bajocian, Lower Callovian, Upper Oxfordian, and Kimmeridgian were established and, for the first time, Jurassic ostracode assemblages were compared with the contemporaneous assemblages of Poland, France, Volga Region, and Kazakhstan.

In 1961, Liibimova briefly considered the history of the study of Jurassic ostracodes in the USSR and published data on ostracodes identified from the *bleicheri* Zone of the Volga Region near Ulyanovsk, on their changes at the boundary of the *panderi* and *virgatus* zones in the Obshchii Syrt, and on some characteristic features of changes in ostracode assemblages from the Volga Region and Obshchii Syrt. She first noted that three distinct changes of taxonomic composition of ostracodes occurred at the boundaries between the Triassic and Jurassic, the Kimmeridgian and Lower Volgian, and the Jurassic and Cretaceous. Assemblages differing from each other mainly in species and, in part, in generic composition changed several times during the Bajocian and Oxfordian. It was also demonstrated for the first time that Late Jurassic ostracodes of the Middle Volga Region and Obshchii Syrt are very similar to contemporary ostracode assemblages of the Ural–Emba Region at the species level, being considerably more diverse, whereas they have little in common with the contemporary fauna from the Donets Basin. According to Lübimova, this is caused by the fact that marine sediments of the Donets Basin are interbedded with continental deposits, whereas, in the Volga Region and Obshchii Syrt, sediments are entirely marine.

In the book *StratigrafiyaSSSR* (Stratigraphy of the USSR), Liibimova (1972) summarized the history of the study of ostracodes from the Volga-Ural Region, Ukraine, Central Chernozem Region, Western Siberia, Mangyshlak, Turkmenia, Uzbekistan, Nordwick, and the Lena–Olenek Region. For the first time, she analyzed the distribution of various families in the Jurassic and noted that freshwater ostracodes of the family Darwinulidae were most abundant in the Middle Jurassic. Representatives of the families Cyprididae and Cytherididae occur throughout the Jurassic section with the maximum diversity occurring during the Volgian Time. The family Paradoxostomatidae appeared in the Callovian and did not develop soundly. The family Cytherellidae has persisted since the Middle Jurassic and achieved the acme of diversity in the Volgian Time. The families Bairdiidae and Healdiidae were limited in distribution in the Jurassic.

In 1956, in an extensive review, Mandelstam and Liibimova described ten ostracode genera that occurred in the Jurassic (Mandelstam *et al.*, 1956).

Ostracodes of the Saratov Region were studied by T.N. Khabarova (1955). From the Bajocian of the Don–Medveditsa dislocations, she described seven new species. Later, Khabarova (1961) performed the zonation of Jurassic deposits on the basis of rich and diverse material on foraminifers and ostracodes of the Volga Region near Saratov. Characteristic ostracodes were listed for the Bajocian; Lower, Middle, and Upper Callovian; Oxfordian; and Lower Volgian. When considering the general pattern of foraminifer and ostracode distribution, their extreme richness and diversity were marked in the Late Jurassic, including the Callovian, whereas they were impoverished in the Middle Jurassic. The most confident boundaries were defined between the Bathonian and Callovian, the Lower and Middle Callovian, the Oxfordian and Kimmeridgian, the Kimmeridgian and Lower Volgian, and between the Jurassic and Cretaceous. The distributional pattern of the microfauna in Jurassic deposits of the region under study and its connection with facies were considered as well.

Jurassic ostracodes of the Dnieper-Donets Depression were studied by Kats (1957). Her investigation of ostracodes from drill core samples obtained from Ukraine east of the Dnieper added much to data that had been compiled by Liibimova (1955b). It was noted that the largest number of ostracodes was recorded in the Upper Bajocian and Middle Callovian beds. The Lower Bajocian and Lower Bathonian faunas are represented by few species. Ostracodes of the Upper Bajocian and Middle Callovian were listed, and it was emphasized that all of the species, except for three that had been discovered earlier, were found in this area for the first time. Comparing the taxonomic composition of Upper Bajocian ostracode faunas of the western plunge and marginal northwestern area of the Donets Basin, Kats made conclusions about shallower environments of those areas of the Dnieper-Donets Depression that were adjacent to the Donets Basin.

In the same year, Kats (in Mandelstam *et al.*, 1957) described new genera and species of ostracodes of the families Cyprididae and Cytherididae that came from various beds and regions. She established a new genus, *Naviculina*, from the Bathonian of Ukraine. A new species of this genus was discovered by Liibimova (in Mandelstam *et al.*, 1957). Mandelstam gave a description of a new Jurassic genus, *Rubracea*, from the Callovian of the Transvolga Region near Saratov, and Liibimova described a new species of this genus (in Mandelstam *et al.*, 1957).

Somewhat later in a large paper on cypridids, Mandelstam and Shneider (1963) described three genera, *Pontocypris, Pontocyprella*, and *Paracypris,* from the Jurassic.

Later, Kats and Shaikin (1969) published a paper with identifications of ostracodes from variegated lagoonal–continental sediments of the northwestern area of the Dnieper-Donets Depression. Based on the study of ostracodes and charophytes, they demonstrated, for the first time, on the basis of paleontological evidence the Volgian Age of this sequence, which had been provisionarily referred to the Kimmeridgian, Volgian, or undivided Kimmeridgian–Volgian deposits. Based on the ecological characteristics of ostracodes and charophyte algae, the authors arrived at a conclusion about the lagoonal regime within the Dnieper-Donets Depression at the end of the Kimmeridgian and, mainly, during the first half of the Volgian.

Such a large and important reference book as *Osnovy paleontologii* (Fundamentals of Paleontology) should also be noted. The chapter devoted to ostracodes was published in 1960 in the volume *Chlenistonogie—trilobitoobraznye i rakoobraznye* (Arthropods: Trilobitomorpha and Crustacea). Liibimova compiled diagnoses for genera of the superfamily Cypracea, Mandelstam took part in the preparation of the overall book and composed generic descriptions of the superfamilies Volganellacea, Cypracea, and Cytheracea and, partially, of the suborder Platycopa (Mandelstam and Polenova, 1960; Liibimova *et al.*, 1960b; Kashevarova *et al.*, 1960).

Jurassic ostracodes of the Orel, Bryansk, Voronezh, and Kursk regions were studied by V.N. Preobrazhenskaya. As a result of studying invertebrates, spore, pollen, and microfaunas, including ostracodes, from core samples from the Kursk Region and outcrop samples from the right bank of the Don River within the Voronezh Region, the Jurassic sequence of this territory was subdivided into the Bajocian, Bathonian–Callovian, Middle Callovian, Oxfordian, Kimmeridgian, and Lower Volgian for the first time. For the Callovian, Kimmeridgian, and Lower Volgian, the most characteristic ostracodes were listed (Preobrazhenskaya, 1958).

In a brief paper, Preobrazhenskaya (1961) published a list of several ostracode species from the Lower Volgian of the Kursk Magnetic Anomaly (KMA); only two ostracode species were identified from the Kimmeridgian of that region. In the Bajocian, Bathonian, Callovian, and Oxfordian, the researcher found foraminifers only. It was emphasized that the composition of microfaunal assemblages depends on facies.

Next year, at the Interregional Geological Meeting on the Geology and Mineralogy of the Central Chernozem Region (CCR), Preobrazhenskaya (1962) reported on the significance of ostracodes for the stratigraphy of Jurassic sediments within the KMA. She registered two ostracode species that are characteristic of the Bajocian-Bathonian; three species, characteristic of the Middle Callovian; one species, of the Lower Oxfordian; two species that are typical of the Kimmeridgian; and six species characteristic of the Lower Volgian Substage. It was stressed that ostracodes were not recorded in the Middle Oxfordian.

Four years later, in the monograph *Stratigrafiya otlozhenii yury i nizov nizhnego mela territorii TsChO* (Stratigraphy of the Jurassic and Basal Lower Cretaceous of the Central Chernozem Region), ostracodes of the Bajocian-Bathonian, Middle Callovian, Oxfordian, Kimmeridgian, and Lower Volgian of the Voronezh Anteclise were described (Preobrazhenskaya, 1966). Middle Callovian and Lower Oxfordian ostracode lists borrowed from the preceding paper were reproduced in the text, though in less volume.

The last paper by Preobrazhenskaya (1968) was devoted to the most frequent within the KMA Jurassic ostracodes from the *virgatus* Zone. Six species were registered. Five species were described, three of them belonging to the genera *Palaeocytheridea* and *Schuleridea*, were mentioned as new.

An immense contribution to the study of Triassic and Jurassic ostracodes of the Dnieper-Donets Depression (DDD) was made by M.N. Permyakova. At the Ukrainian-Moldavian colloquium on Jurassic microfauna, she presented the lists of index ostracode species from the Middle and Upper Jurassic of the platform part of Ukraine for the first time and defined the most characteristic species for the Bajocian, Bathonian, Callovian, Oxfordian, and Kimmeridgian of the Dnieper-Donets Depression (Permyakova *et al.*, 1966).

Soon afterward, Permyakova for the first time recognized (1968) for the Dnieper-Donets Depression and the marginal area of the Donets Basin ostracode distribution in the Lower Bajocian and three zones (*niortense, garantiana*, and *doneziana*) of the Upper Bajocian. Later, she published the description of four new species belonging to the genera *Cytherella, Schuleridea, Procytheridea*, and *Orthonotacythere* from the Bajocian of the DDD (Permyakova, 1969). The next year, she published a paper on ostracodes of the genus *Glyptocythere*, which is widespread in Europe. From the Bathonian of the DDD, she described five species, three of which turned out to be new and two others had not been previously known from Ukraine (Permyakova, 1970). In a book on the fossil microfauna of Ukraine, Permyakova (1971) thoroughly considered the history of the study of ostracodes from the Meso-Cenozoic deposits of Ukraine. In 1973, she described new ostracode species of the genus *Southcavea* from the Bajocian-Bathonian of the DDD (Permyakova, 1973).

In 1974, she published three papers. In the first, she described five ostracode species of the genus *Palaeocytheridea* from the Middle Jurassic of the DDD (Permyakova, 1974a). Four species turned out to be new, the fifth species was recorded for the first time in Ukraine; this genus was described as well. In the second paper, she established three new species and one previously known but recorded for the first time in Ukraine of the genus *Procytheridea* from the Middle Jurassic of the DDD (Permyakova, 1974b). These species were demonstrated to be strictly associated with either the Bathonian or Upper Bajocian-Lower Bathonian. In the third paper, three species of the subgenus *Praefuhrbergiella* were described (Permyakova, 1974c). Earlier, one of these species was recorded in the Middle Callovian–Lower Oxfordian of the Donetskii and Chernigovskii districts, the second was known from the Middle Jurassic of Mangyshlak, and the third was newly described from the Upper Bajocian of the DDD.

Her next paper was devoted to ostracodes of the genus *Lophocythere*, which was widespread in the Jurassic of the DDD (Permyakova, 1975a). Before long a profound paper by Permyakova appeared (1975b), in which she briefly considered the history of the study of Jurassic ostracodes from Ukraine and analyzed, in detail, ostracode assemblages from the Lower, Middle, and Upper Jurassic. Taking into account all available information on the ostracodes of that region and the published data, she considered the stratigraphic distribution of the studied species in Ukraine, Middle Volga Region, France, Switzerland, and Germany and concluded that it is difficult to trace particular substages in a large territory on the basis of ostracodes. However, it appeared to be possible to find common species for stages in relatively close regions; such species were listed for the Callovian and Oxfordian of the Ukraine and Middle Volga Region.

The last and most important of her papers was a comprehensive paleontological reference book on Jurassic ostracodes and foraminifers of Ukraine (Pyatkova and Permyakova, 1978). It encompasses 156 ostracode species, with synonyms and figures. Regrettably,

Table 1. State of knowledge of the Jurassic ostracodes of eastern Europe

<table>
<tr><th>Stage</th><th>Substage</th><th>Dnieper–Donets Depression</th><th colspan="2">Northwestern plunge of Donets Basin</th><th>Middle Volga Region</th><th>Obshchii Syrt</th><th>Saratov Region</th><th>Emba Region</th></tr>
<tr><td rowspan="3">Volgian</td><td>Upper</td><td>Permyakova, 1975b, 1978</td><td colspan="2" rowspan="3">Kats and Shaikin, 1969</td><td>Lübimova, 1955a, 1955b</td><td>Sharapova, 1939</td><td></td><td></td></tr>
<tr><td>Middle</td><td>Permyakova, 1975b, 1978</td><td>Lübimova, 1955a, 1955b</td><td>Sharapova, 1939; Mandelstam, 1949; Lübimova, 1955a, 1961</td><td rowspan="2">Khabarova, 1961</td><td>Sharapova, 1937; Lübimova, 1955b</td></tr>
<tr><td>Lower</td><td>Permyakova, 1975b, 1978</td><td>Mandelstam, 1949; Lübimova, 1955a, 1955b</td><td rowspan="3"></td><td rowspan="7"></td></tr>
<tr><td rowspan="2">Kimmeridgian</td><td>Upper</td><td>Permyakova, 1975b, 1978</td><td>Lübimova, 1955a</td><td rowspan="2">Lübimova, 1956</td><td>Mandelstam, 1949; Lübimova, 1955a, 1955b</td><td rowspan="2"></td></tr>
<tr><td>Lower</td><td>Permyakova, 1975b, 1978</td><td>Lübimova, 1955a</td><td>Lübimova, 1955a, 1955b</td></tr>
<tr><td rowspan="3">Oxfordian</td><td>Upper</td><td>Permyakova, 1975b, 1978</td><td colspan="2">Lübimova, 1955a, 1956</td><td>Lübimova, 1955a, 1955b</td><td>Lübimova, 1955b</td><td rowspan="3">Khabarova, 1961</td></tr>
<tr><td>Middle</td><td>Permyakova, 1975b, 1978</td><td colspan="2" rowspan="4"></td><td>Lübimova, 1955a, 1955b</td><td>Lübimova, 1955b</td></tr>
<tr><td>Lower</td><td>Permyakova, 1975b, 1978</td><td>Mandelstam, 1949; Lübimova, 1955a, 1955b</td><td rowspan="12"></td></tr>
<tr><td rowspan="3">Callovian</td><td>Upper</td><td>Permyakova, 1975b, 1978</td><td>Mandelstam, 1949; Lübimova, 1955a, 1955b</td><td>Lübimova, 1955b; Khabarova, 1961</td><td>Lübimova, 1955b</td></tr>
<tr><td>Middle</td><td>Kats, 1957; Permyakova, 1974c, 1975b, 1978</td><td>Mandelstam, 1949; Lübimova, 1955a, 1955b</td><td>Lübimova, 1955b; Khabarova, 1961</td><td rowspan="10"></td></tr>
<tr><td>Lower</td><td>Lübimova, 1956; Permyakova, 1975b, 1978</td><td colspan="2">Lübimova, 1956</td><td>Mandelstam, 1949; Lübimova, 1955a, 1955b</td><td>Khabarova, 1961</td></tr>
<tr><td rowspan="3">Bathonian</td><td>Upper</td><td>Permyakova, 1975b, 1978</td><td colspan="2" rowspan="3"></td><td rowspan="3">Lübimova, 1955b</td><td rowspan="3">Khabarova, 1955</td></tr>
<tr><td>Middle</td><td>Permyakova, 1975b, 1978</td></tr>
<tr><td>Lower</td><td>Kats, 1957; Permyakova, 1973, 1974b, 1974c, 1975b, 1978</td></tr>
<tr><td rowspan="2">Bajocian</td><td>Upper</td><td>Kats, 1957; Permyakova, 1968, 1969, 1970, 1973, 1974a, 1974b, 1974c, 1975b, 1978</td><td colspan="2">Lübimova, 1955a, 1956</td><td rowspan="2">Lübimova, 1955b</td><td rowspan="2">Lübimova, 1955b; Khabarova, 1955, 1961</td></tr>
<tr><td>Lower</td><td>Kats, 1957; Permyakova, 1968, 1975b, 1978</td><td colspan="2" rowspan="4"></td></tr>
<tr><td colspan="2">Aalenian</td><td>Permyakova, 1975b, 1978</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td colspan="2">Toarcian</td><td>Permyakova, 1975b, 1978</td></tr>
<tr><td colspan="2">Pliensbachian</td><td>Permyakova, 1975b, 1978</td></tr>
</table>

Mangyshlak Peninsula	Bryansk, Orel, and Voronezh regions	Kursk Region		Ryazan, Moscow, and Kostroma regions	Mordovia	Timan–Pechora Region	Northeast of the Russian Plate	
						Lev and Kravets, 1982	Kolpenskaya, 1993	Kolpenskaya, 1995
	Preobrazhenskaya, 1962, 1966		Preobrazhenskaya, 1958, 1961, 1962, 1968			Lev and Kravets, 1982		Kolpenskaya, 1995
								Kolpenskaya, 1995
	Preobrazhenskaya, 1961, 1966		Preobrazhenskaya, 1958, 1961, 1962			Lev and Kravets, 1982	Kolpenskaya, 1993	Kolpenskaya, 1995
								Kolpenskaya, 1995
	Unifitsirovannaya…, 1993			Tesakova, 1996–now				
	Unifitsirovannaya…, 1993			Tesakova, 1996–now				
	Preobrazhenskaya, 1961, 1966		Preobrazhenskaya, 1962, 1966	Tesakova, 1996–now			Kolpenskaya, 1995	
	Kolpenskaya *et al.*, 1999	Preobrazhenskaya, 1958		Tesakova, 1996–now; Kolpenskaya *et al.*, 1999		Lev and Kravets, 1982		
	Preobrazhenskaya, 1961, 1966; *Ob'yasnitel'naya…*, 1993; Kolpenskaya *et al.*, 1999		Preobrazhenskaya, 1962, 1966; Tesakova, 1996–now	Tesakova, 1996–now; Kolpenskaya *et al.*, 1999	Tesakova, 1996–now	Lev and Kravets, 1982		
	Kolpenskaya *et al.*, 1999		Tesakova, 1996–now	Tesakova, 1996–now		Lev and Kravets, 1982		
	Preobrazhenskaya, 1961, 1966		Preobrazhenskaya, 1962			Lev and Kravets, 1982		
Sharapova and Mandelstam, 1947						Lev and Kravets, 1982		
Mandelstam, 1947; Sharapova and Mandelstam, 1947								

figures cannot substitute for photographs, which is a flaw in this great work.

The northern provinces of the Russian Plate were studied by O.M. Lev. In 1982, the first review of Jurassic ostracodes from the Timan–Pechora Province was published, in which 12 ostracode assemblages were recognized, one for each of the Lower-Middle Bathonian, Upper Bathonian, Lower, Middle, and Upper Callovian, Upper Kimmeridgian, three assemblages in the Middle Volgian and three in the Upper Volgian. These assemblages were compared with each other and correlated with assemblages of the Arctic regions of Siberia. Neither full lists of assemblages, nor species descriptions, nor images of species were given (Lev and Kravets, 1982).

For the next 11 years, Jurassic ostracodes of the Russian Plate remained unattended, and new works on this subject appeared at the beginning of the 1990s, when Kolpenskaya (1993) described five new ostracode species from the Kimmeridgian and Volgian of the Pechora River Basin. For the regional stratigraphic scheme of Jurassic deposits of the Voronezh Anteclise, Kolpenskaya compiled brief lists consisting of only two to three characteristic ostracode species for the Middle Callovian (*coronatum–jason* zones), Middle Oxfordian (*ilovaiskyi–zenaidae* zones), and Upper Oxfordian (*serratum* Zone) (*Ob"yasnitel'naya zapiska...*, 1993).

In 1995, Kolpenskaya defended her candidate dissertation on Upper Jurassic boreal ostracodes of the Pechora River Basin (Pizhma, Izhma, and Neritsa rivers), Kama–Vyatka interfluve, Volga Region (Unzha River, Gorodishche and Kashpir sections, on the Volga River, village of Orlovka), and Transvolgian Region (Karadzhir ravine). In that study, the bed-by-bed occurrence of ostracodes in the Upper Jurassic of the above sections was studied for the first time. Comparative analysis of ostracode assemblages from different intervals of the Upper Jurassic was undertaken. These assemblages were compared with contemporaneous associations from Western Europe. For the first time, she proposed a biostratigraphic scheme of zonation of Upper Jurassic deposits on the basis of ostracodes from the eastern part of the Russian Plate, which includes 14 units ranked as beds with ostracodes that have been correlated with zones of the ammonite chart of the Russian Plate. Distinctive features in the distribution of some families, genera, and species were revealed, which may be used for the biostratigraphy of the region under study. In the same study, 15 characteristic species, including two new species, were described (Kolpenskaya, 1995).

Continuing this research, she studied core samples from a series of boreholes in the Bryansk Region and published brief notes on ostracode assemblages of the Lower-Middle and Middle-Upper Callovian. In the same paper, she listed some characteristic species of the Middle and Upper Callovian from two boreholes in the Moscow Region (Kolpenskaya *et al*, 1999).

In 1999, Kolpenskaya contributed to a large reference work on Mesozoic ostracodes, *Prakticheskoe rukovodstvo po mikrofaune. Ostrakody mezozoya* (Practical Handbook of Microfauna: Ostracodes of the Mesozoic) (volume 7). In this volume, the authors presented a modern ostracode taxonomy starting at the generic level, a description of many genera, and published SEM photographs of Mesozoic ostracodes. Among the latter, there are images of some holotypes described by Lübimova (1955b) from the Mesozoic of the Volga-Ural Region. Certain debatable questions of Mesozoic ostracode systematics are discussed in this reference book as well. In the geological chapter, the use of ostracodes in the biostratigraphy of the Mesozoic and zonal ostracode-based stratigraphic schemes proposed for some regions are discussed (Andreev *et al.*, 1999; Kolpenskaya, 1999; Neustrueva *et al*, 1999; Nikolaeva, 1999; Nikolaeva and Andreev, 1999a, 1999b, 1999c; Nikolaeva *et al*, 1999a, 1999b).

Ostracodes of the boundary Callovian–Oxfordian deposits of the Moscow Syneclise are currently being studied by the author of the present work. In 1996, for the first time lists of ostracodes were published from the Callovian and Oxfordian of the Ryazan, Moscow, and Yaroslavl regions (Tesakova, 1996). In the same year, Callovian ostracodes from the Moscow and Ryazan regions were depicted for the first time in the atlas *Iskopaemye kelloveiskogo yarusa Tsentral'noi Rossii* (Fossils of the Callovian Stage of Central Russia) and their distribution through substages of the Callovian was observed for the first time (Gerasimov *et al.*, 1996). The main results of that work were presented at the Paleontological Section meeting of the Moscow Society of Nature Explorers (Gerasimov *et al*, 1998).

Analysis of the resultant table (Table 1) that shows the distribution of ostracodes over substages demonstrates that Jurassic ostracodes of the Dnieper-Donets Depression and Volga Region are the best studied, whereas brief data concerning the Moscow Syneclise have only been partially published during recent years.

The review of research of Jurassic ostracodes from the Russian Plate clearly demonstrates numerous gaps in particular stages, which are insufficiently characterized by ostracodes, as well as in some regions, which are still not covered by such research. It turned out that Jurassic ostracodes are badly underinvestigated in the central regions and especially in the Moscow Region, although historically, this was the place where the stratigraphy of the Jurassic started. In the meantime, only methodical stage-by-stage research of this important kind of fossil throughout the entire Russian Plate will result in ostracode-based zonation, which would fundamentally contribute to the stratigraphic scheme of the Jurassic of this region.

CHAPTER 2. STRATIGRAPHY AND THE DESCRIPTION OF SECTIONS

2.1. Stratigraphy of the Callovian and Oxfordian of the Central Region of the Russian Plate

Callovian and Oxfordian deposits are widespread over the Russian Plate and represented by various types of sediments. Due to the presence of ammonites, which are close to those of contemporaneous assemblages from western Europe, these deposits are subdivided into substages and stages (Table 2). In the present paper, the author follows the zonation published in *The Zonal Stratigraphy of the Phanerozoic of the USSR* (Rostovtsev *et al.*, 1991). The local chart of formations (Table 3) has been developed by Olfer'ev (Olfer'ev, 1986; Olfer'ev *et al.*, 1992; *Unifitsirovannaya skhema...*, 1993).

Callovian Stage

Lower Callovian

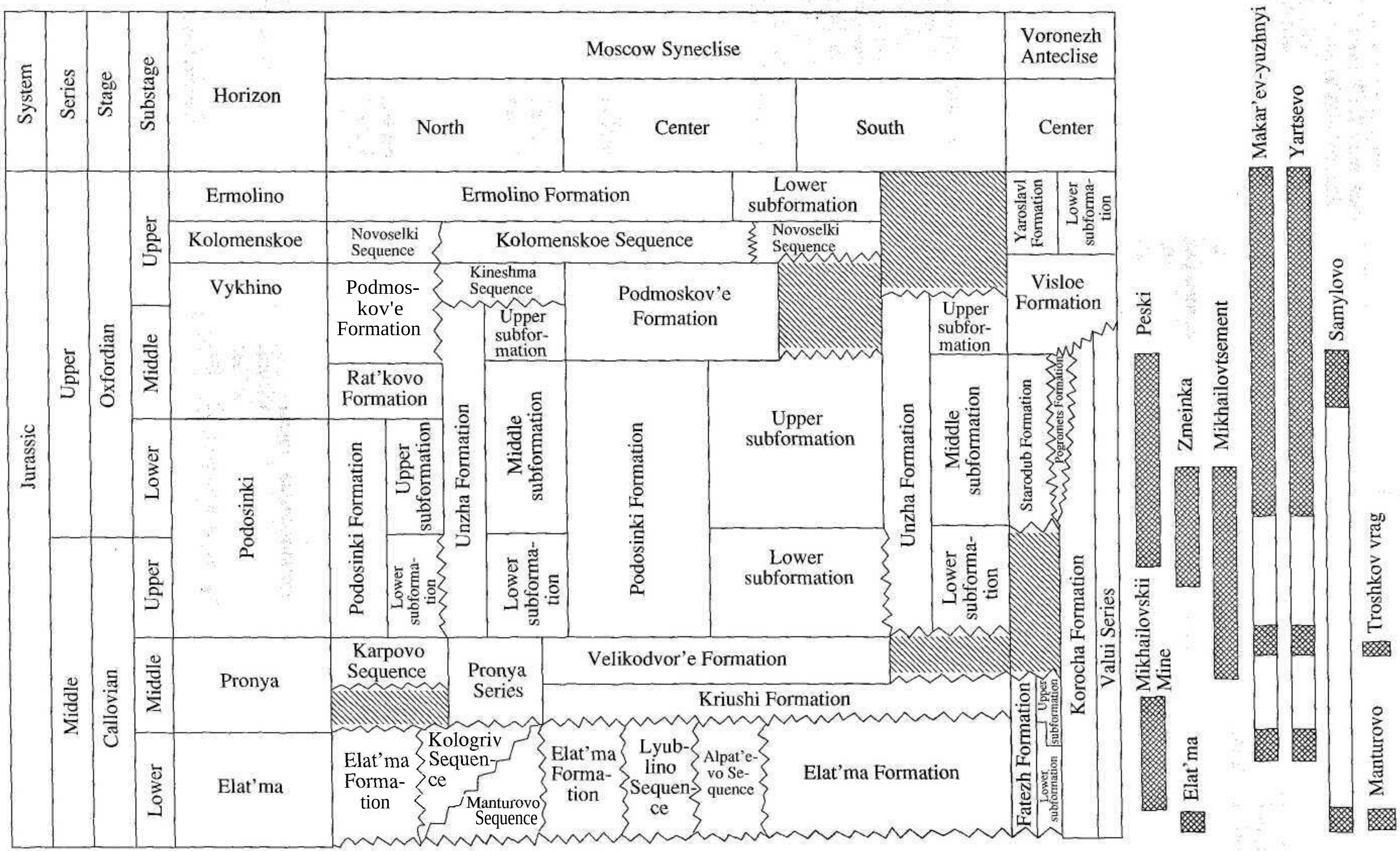
During the Early Callovian, sediments representing different facies were accumulated in the Moscow Syneclise. Hereafter, descriptions of formations from the Moscow Syneclise are given after Olfer'ev (1986, 2001).

Sediments of the **Elat'ma Formation** are observed in the eastern central part of the Moscow Syneclise. They started with dark gray brown-tinted silty clays with large sideritic concretions containing ammonite shells of the *elatmae* Zone (5.4 m thick), which are gradually replaced by argillaceous silt of the same color with a microspeckled texture and containing *Kepplerites* (12.8 m thick). Above this zone is light brown fine-grained sand, which is overlain by a yellowish gray fine-grained sand layer 9.9 m thick. The whole

Table 2. Global and regional stratigraphic schemes of the Callovian and Oxfordian of the Russian Plate (*Unifitsirovannaya...*, 1993)

Global chart					Regional units		
System	Series	Stage	Substage	Zone	ammonite zones and subzones		foraminiferan zones
Jurassic	Upper	Oxfordian	Upper	*Ringsteadia pseudocordata*	*Amoeboceras ravni - Ringsteadia*		*Epistomina uhligi – Lenticulina russiensis*
				Decipia decipiensis	*Amoeboceras serratum*	*Amoeboceras serratum*	
						Amoeboceras koldeweyense	
				Perisphinctes cautisnigrae	*Amoeboceras alternoides*	*Amoeboceras alternoides*	
						Amoeboceras ilovaiskii	*Ophthalmidium strumosum - Lenticulina brestica*
			Middle	*Gregoryceras transversarium*	*Cardioceras tenuiserratum*	*Cardioceras (Miticardioceras)* sp.	
						Cardioceras zenaidae	
				Perisphinctes plicatilis	*Cardioceras densiplicatum*	*Cardioceras densiplicatum*	*Ophthalmidium sagittum - Epistomina volgensis*
						Cardioceras popilaniense	
			Lower	*Cardioceras cordatum*	*Cardioceras cordatum*		
				Quenstedtoceras mariae	*Quenstedtoceras mariae*		
	Middle	Callovian	Upper	*Quenstedtoceras lamberti*	*Quenstedtoceras lamberti*		*Lenticulina tumida - Epistomina elshankaensis*
				Peltoceras athleta	*Peltoceras athleta*		
			Middle	*Erymnoceras coronatum*	*Erymnoceras coronatum*		*Lenticulina cultratiformis— Lenticulina pseudocrassa*
				Kosmoceras jason	*Kosmoceras jason*		
			Lower	*Sigaloceras calloviense*	*Sigaloceras calloviense*	*Sigaloceras calloviense*	*Haplophragmoides infracalloviensis - Guttulina tatariensis*
				Proplanulites koenigi		*Proplanulites koenigi*	
				Macrocephalites herveyi	*Cadoceras elatmae*		
					beds with *Macrocephalites*		

Table 3. Local stratigraphic scheme of the Callovian and Oxfordian of the Moscow Syneclise and the central part of the Voronezh Anteclise (*Unifitsirovannaya...*, 1993, modified after Olfer'ev, 2001}



sequence is characterized by foraminifers of the *Haplophragmoides infracalloviensis–Guttulina tatariensis* Zone and the Lower Callovian spore-pollen assemblage. The stratotype of this formation outcrops on the left bank of the Oka River between the village of Inkino and the town of Elat'ma. To the west, between Shatura and Ryazan, marine sediments of the Elat'ma Formation are replaced by nearshore marine rocks of the **Alpat'evo Beds** the stratotype of which is near the village of Alpat'evo. It is remarkably enriched with sandy rocks. Farther to the west, during the Early Callovian ingression, the Moscow Syneclise was filled with fine-grained sand and silt. The 056 borehole in the Lyublino District of Moscow contained sand containing foraminifers of the *Haplophragmoides infracalloviensis–Guttulina tatariensis* Zone in an interval 33.6-39.0 m deep. The **Lyublino Beds** were established here. In the western part of the northern area of the syneclise, the **Kologriv Beds** are established; they are sand and silt up to 55 m thick containing foraminifers of the *Haplophragmoides infracalloviensis-Guttulina tatariensis* Zone and the ammonites *Keppleritesgowerianus* Sow., *Chamoussettia chamoussetti* d'Orb., *Proplanulites koenigi* Sow., and others. In the eastern part, the deposits of the Lower Callovian are dark gray silt and clay of the **Manturovo Beds** 33 m thick.

Within the Moscow Syneclise, all formations and sequences compose the **Elat'ma Horizon.**

In the central region of the Voronezh Anteclise (Olfer'ev *et al.*, 1992), Lower Callovian deposits are recognized as a 15-m-thick lower part of the **Fatezh Formation,** the stratotype of which is in the Mikhailovskii Mine section. It is gray, unevenly silty clay with interbeds of sideritic concretions and the ammonite fauna of the Lower Callovian *koenigi* Subzone. Eastward, the lower subformation of the Fatezh Formation corresponds to a section of condensed beds of the **Korocha Formation.**

The Lower Callovian was studied by the author in the northern and central regions of the Moscow Syneclise, i.e., in the Elat'ma, Makar'ev-yuzhnyi, Samylovo, Yartsevo, and Manturovo sections, and in the central part of the Voronezh Anteclise, in the Mikhailovskii Mine section (hereinafter, see Fig. 1).

Middle Callovian

Since the Middle Callovian, in connection with expanding transgression, marine conditions developed throughout the Moscow Syneclise, except for isolated islands. The lower layers of the surrounding substage composed of inequigranular, gritty, poorly rounded sands with ferruginous ooliths and ammonites of the *jason* and *coronatum* zones are defined as the **Kriushi Formation.** The stratotype of this formation is in the Yastrebovka Creek valley in the southwestern marginal area of the Dmitrievy Gory settlement on the left bank of the Oka River downstream from the town of Elat'ma. Its thickness reaches 12.8 m. Upsection, sands of this formation gradually but clearly become gray and light gray clays containing a large amount of ooliths at their base, numerous shells of *Posidonornya buchi* (Roem.) and their detritus, and ammonites of *the jason* and *coronatum* zones, which are recognized as the **Velikodvor'e Formation.** Its thickness reaches 15 m, and its stratotype is in the 63.0-68.3 interval in the 434 borehole near Beloe Lake, 2 km north of the village of Velikodvor'e, Spas-Klepiki District, Ryazan Region. The Kriushi and Velikodvor'e formations are united into the **Pronya Horizon** and represent a single rhythm, consisting of a transgressive part (the Kriushi Formation) and sediments accumulated during the maximum of the transgression (the Velikodvor'e Formation). The Pronya Horizon is characterized by foraminifers of the *Lenticulina pseudocrassa–Lenticulina cultratiformis* Zone.

In the central area of the Voronezh Anteclise (Olfer'ev *et al.*, 1992), gray clays of *the jason* Zone characterized by brownish upper layers and Middle Callovian ammonites are recognized as the upper subformation of the **Fatezh Formation** 15.6 m in thickness. In the east, it corresponds to a part of the **Korocha Formation.** The upper layers of the Fatezh Formation belong to the lower half of the Pronya Horizon.

The Middle Callovian deposits were studied by the author at the Yartsevo, Makar'ev-yuzhnyi, Mikhailovtsement, and Troshkov vrag sections within the Moscow Syneclise and the Mikhailovskii Mine section in the Voronezh Anteclise.

Upper Callovian

Upper Callovian rocks cannot be differentiated lithologically from Lower and, in part, from Middle Oxfordian rocks, referred to as a single period of sedimentation. Shallowing of the basin is demarcated in the upper part of the section by the appearance of light oolitic marls, which are replaced by light gray clays with numerous pyritized plant remains. Rare ammonites of the *athleta* and *lamberti* zones and foraminifers of the *Lenticulina tumida–Epistomina elschankaensis* Zone occur. This part of the strata corresponds to the lower subformation of the **Podosinki Formation** named after the Podosinki ravine near the village of Nikitino in the Ryazan Region. In the Transvolga Region near Kostroma, it corresponds to the lower subformation of the **Unzha Formation;** its stratotype is in the section near the town of Makar'ev. The Podosinki Formation and a large part of the Unzha Formation are combined in the **Podosinki Horizon.**

Upper Callovian deposits were studied by the author in the Peski, Zmeinka, and Mikhailovtsement sections of the Moscow Syneclise.

Oxfordian Stage

Lower Oxfordian

A considerable part of the upper subformation of the **Podosinki Formation** and the middle subformation of the **Unzha Formation** belongs to the Lower Oxfordian. Shell detritus gradually appear in the upper subformation of the Podosinki Formation; ammonites become more abundant, reaching their maximum in the upper part where numerous bivalve and gastropod shells, their detritus, and sponge spicules occur. This part of the section corresponds to the *cordatum* Zone on the basis of ammonites and to the *Ophthalmidium sagittum–Epistomina volgensis* Zone on the basis of foraminifers. Despite an abrupt faunal change at the boundary of the Callovian and Oxfordian, the boundary between the stages is not defined lithologically and cannot be traced visually. The middle subformation of the Unzha Formation is distinguished by the change of faunal assemblages, although it does not differ lithologically from the underlying subformation.

Lower Oxfordian deposits were studied by the author in the Yartsevo, Makar'ev-yuzhnyi, Peski, Zmeinka, and Mikhailovtsement sections.

Middle Oxfordian

The interval from the middle of the Middle Oxfordian to the Lower Kimmeridgian inclusive is the next large cycle. It starts with a break in sedimentation often accompanied by erosion. The lower part of this cycle is composed of alternating gray and dark gray, laminate, often platy, in places (on the bottom and on the roof) bituminous shaly clays containing a rich ammonite fauna dominated by *Cardioceras zenaidae* Ilov. (at the bottom of the strata), *C. ilovaiskyi* Sok., and *C. alternoides* Nik. Foraminifers of the *Ophthalmidium strumosum–Lenticulina brestica* Zone occur in these sediments. On the basis of the most representative sections in the Moscow outskirts, the **Podmoskov'e Formation** is recognized; its stratotype is in the 70.0-77.0 m interval in the 17 borehole drilled in the Proletarskii prospekt between the subway stations Kolomenskaya and Kashirskaya. The formation is up to 8.5 m thick.

The lower part of the Podmoskov'e Formation corresponds to the upper subformation of the **Unzha Formation.** Only the lower part of the Podmoskov'e Formation, the upper part of the upper subformation of the **Podosinki Formation,** the upper part of the middle subformation and the upper subformation of the **Unzha Formation** are referred to the Middle Oxfordian.

The Middle Oxfordian was studied by the author in the Samylovo, Yartsevo, Makar'ev-yuzhnyi, and Peski sections.

Upper Oxfordian

The index species of the ammonite *ilovaiskyi* and *alternoides* subzones occur in the upper part of the Podmoskov'e Formation. This part is referred to the Upper Oxfordian. In the Transvolgian Region near Kineshma, it corresponds to the clays of the **Kineshma Beds.** The Kineshma Beds, the upper subformation of the Unzha Formation, and the Podmoskov'e Formation are united into the **Podmoskov'e Horizon.** The Podmoskov'e Formation is overlain without interruption but with a distinct contact and signs of shallowing (an aggregate of bivalve and gastropod shells and their detritus) by the beds of light gray heavily silty clays with a characteristic fucoid structure resulted from the activity of mud-eaters. These clays contain the ammonites *Amoeboceras alternans* Buch and *A. tuberculatoalternans* Nik. and foraminifers of the *Epistomina uhligi-Lenticulina russiensis* Zone. These strata **(Kolomenskoe Beds)** are named after the former village of Kolomenskoe in Moscow, where its stratotype was defined in borehole 17 in the 64.0–70.0 m interval.

Clays resembling the Kolomenskoe Beds but lacking distinct fucoid structure are developed on the right bank of the Unzha River near Makar'ev, above the bituminous shales of the Podmoskov'e Formation and in the south of the Moscow Syneclise; they are named the **Novoselkovo Beds.** The Novoselkovo and Kolomenskoe beds are united into the **Kolomenskoe Horizon.** The Kolomenskoe Horizon is overlain by dark gray to black glauconite clays, occasionally without an interruption but with signs of shallowing and often with distinct signs of erosion. The beds contain numerous pyrite nodules; faunal remains are scarce and represented by isolated bivalves, heavily deformed shells of the ammonite *Amoeboceras (A. bauchini* (Opp.) and *A. novosselkense* Dav.), and *Prorasenia stephanoides* (Opp.). Belemnites and an impoverished foraminifer assemblage of the *Epistomina uhligi–Lenticulina russiensis* Zone are recorded as well. These deposits characterize a new stage of expanding Oxfordian-Kimmeridgian transgression, which led to the submersion of all territories having previously been represented by islands. Upsection, fossils gradually increase in abundance. In the upper part of the glauconite strata, interbeds of black viscous clays containing phosphorites are recorded. Starting at this level, typical Kimmeridgian ammonites and foraminifers appear. The beds of the glauconite clays are recognized as the **Ermolino Formation,** its stratotype is in the 94.5-105.8 interval in the 39 borehole near the village of Ermolino of the Mytishchinskii District; it corresponds to the **Ermolino Horizon.**

This formation is subdivided into two subformations. Only the lower subformation belongs to the Upper Oxfordian. The Podmoskov'e, Kolomenskoe, and Ermolino horizons constitute an integral cycle of transgression and are united into the **Aleksandrov Superhorizon** named after the town of Aleksandrov in the Vladimir Region.

The Upper Oxfordian was studied by the author in the Yartsevo and Makar'ev-yuzhnyi sections only.

2.2. Descriptions of the Sections Studied

Below are descriptions of the sections used in the study of ostracodes.

2.2.1. Mikhailovtsement Section

Four kilometers southwest of the railway station in the town of Mikhailov, Ryazan Region, are operated and abandoned quarries of the Mikhailovtsement plant (Figs. 1, 2). A schematic column of this section was published by Morozova (1994, text-fig. 5) and Smirnova *et al.* (1999). In the present paper, a combined description of this section compiled in 1994 in cooperation with V.V. Mitta is given for the first time. In the working quarry, three outcrops were described; the first is in the northern slope of the quarry, which is the closest to the plant; the second is in the southwestern slope; and the third is exposed in the western slope approximately 100 m west of the second outcrop. The fourth outcrop was described from the northwestern slope of the abandoned quarry. Sequencing is given on the basis of ammonites identified by Mitta and on the basis of foraminifers identified by M.D. Kochanova.

Lower Carboniferous limestone is superimposed upsection by the following strata (the contact is not exposed) (Fig. 3):

Kriushi Formation

Middle Callovian

(1) Brownish dark argillaceous sand containing disperse nodules of yellowish brown ferruginous sandstone. The exposed thickness is 0.1 m.

(2) Dark gray argillaceous sand unevenly ferruginous along the bedding, becoming brownish yellow; patchy gray, becoming upsection yellowish brown, sandy, oolitic clay with interbeds of argillaceous sand; at the top, it becomes yellowish brown and grayish yellow, quartzose, slightly argillaceous sand with cemented interbeds. These interbeds are well traceable along the strike. The thickness is 1 m.

Coronatum Zone

(3) Greenish yellowish brown, massive, dense, and tabular sandstone. It covers underlying sands, overhanging like a peak; in the upper part of the bed, it appears as yellowish brown sandstone, which is unevenly cemented, partially tabular and partially unconsolidated, laminated, and oolitic. There are numerous uneven crimson spots and nodules in the upper part of the bed. The lower part of the bed contains small scarce belemnite rostra only. In the roof, belemnites, gastropods, bivalves, and brachiopods occur. The ammonites *Erymnoceras doliforme* (Roman), *Kosmoceras* ex gr. *jason* (Rein.), *K.* cf. *bigoti* Douville, *Rondiceras* sp., and *Novocadoceras* sp. are identified. The thickness is 1.3 m.

Velikodvor'e Formation

(4) Dark gray, sandy clay, with solid or viscous interbeds; the strata contain disperse marl concretions having a light gray surface and dark gray inner part, bivalve shell detritus, pyrite nodules of irregular shape,

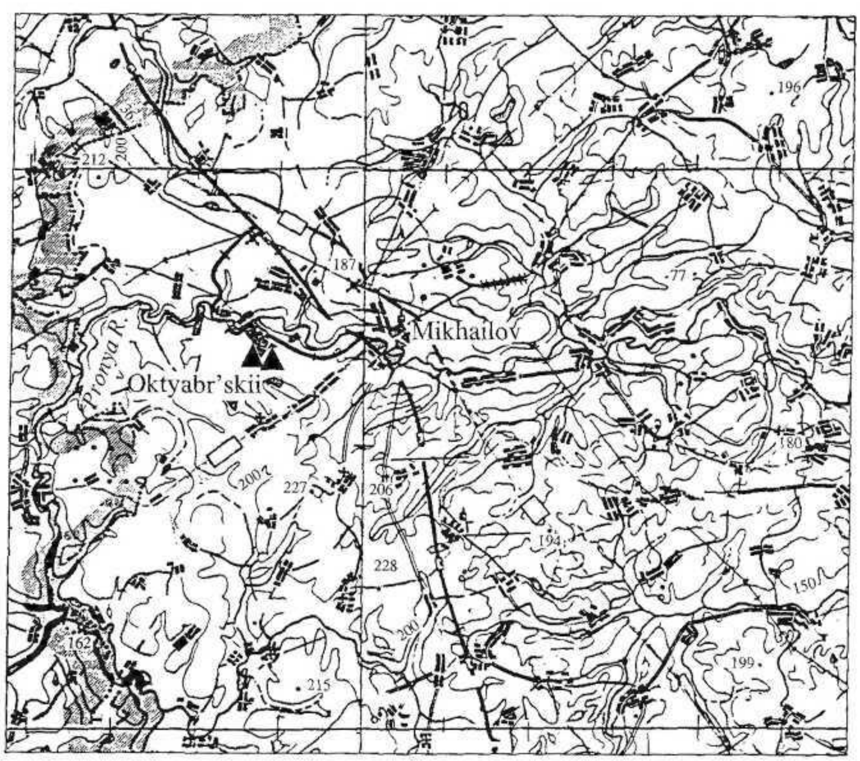


Fig. 2. Map of the Mikhailovtsement and Zmeinka sections.

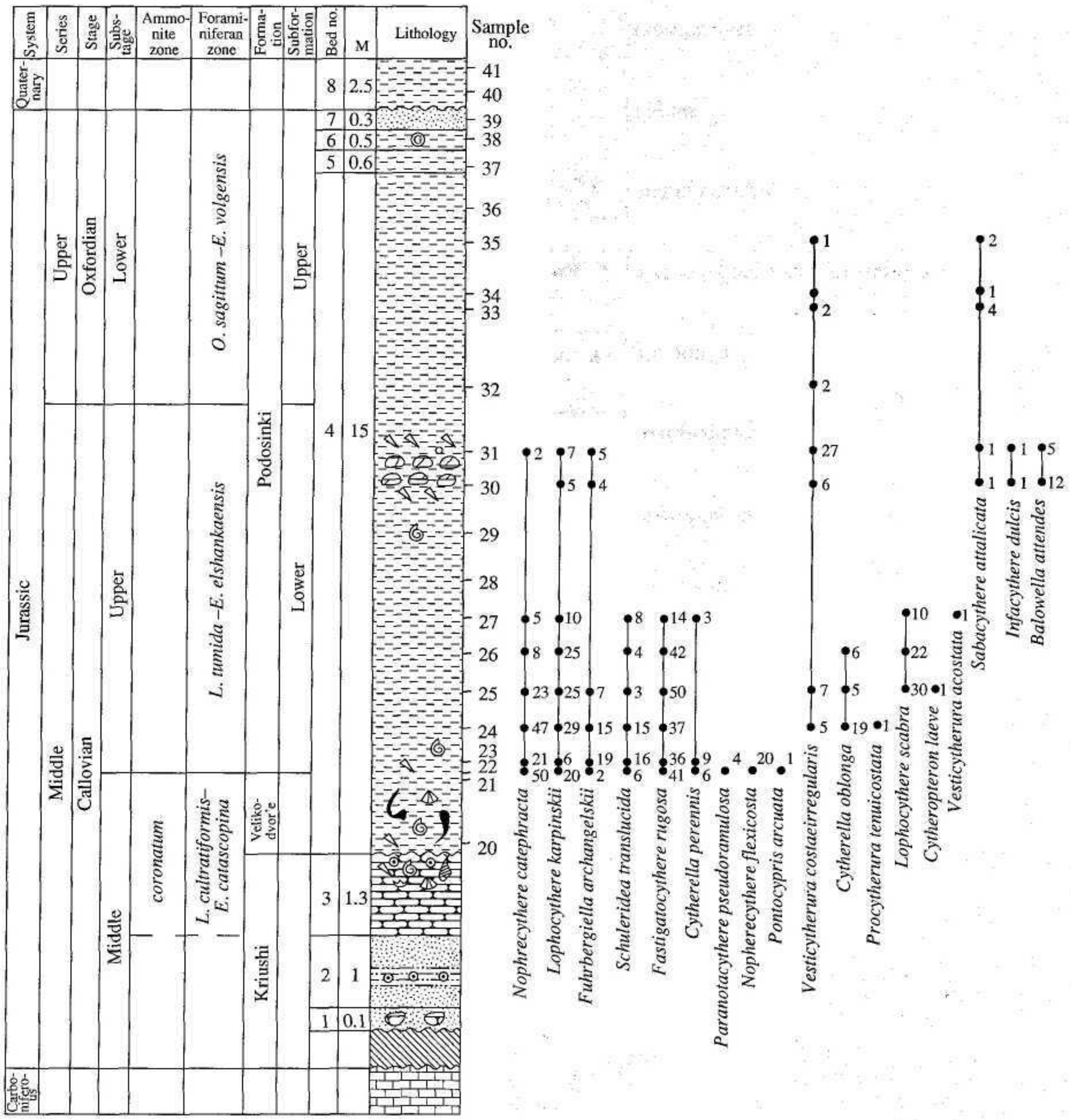


Fig. 3. Distribution of ostracodes through the Mikhailovtsement section.

belemnite rostra, and pyritized ammonite shells. The first layer of solid yellowish gray marl is located 7.2 m above the base of the strata. The second marl layer is 0.5 m above the first. The marl layers range from 10 to 25 cm in thickness. Isolated marl concretions are observed between them and below the first layer. Small and narrow rostra of belemnites of the genus *Hibolithes* are recorded just below the first marl layer. Numerous large belemnite rostra are discovered between the marl layers and in overlying clays. The thickness is 15 m.

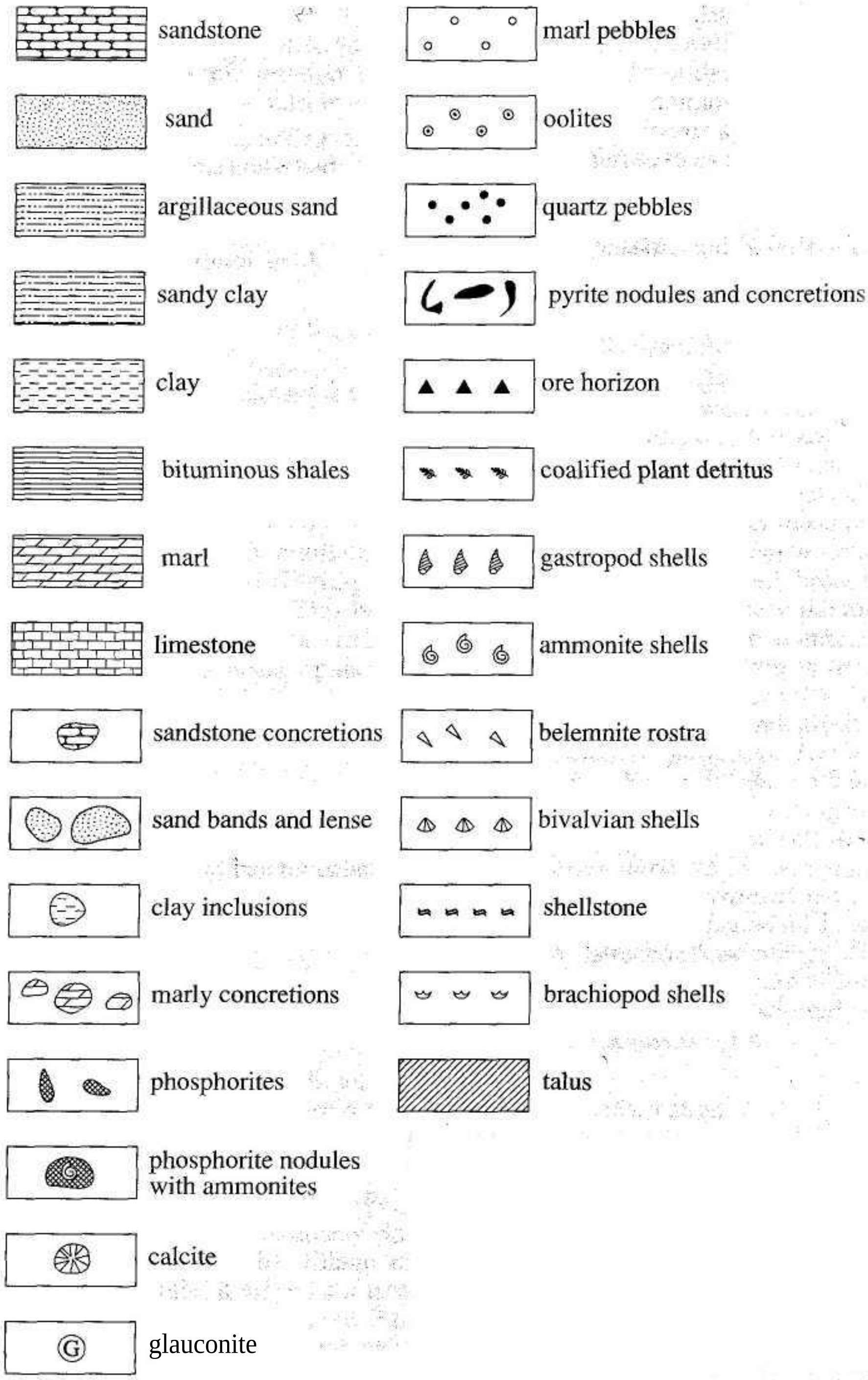
The ammonite *Erymnoceras coronatum* (Bruckm.) is identified at 1.5 m above the base, and the interval from the bottom to this level is referred to the *coronaturn* Zone.

The upper part of the Middle Callovian (samples 20 and 21) is barren of ostracodes. Sample 22 was collected next to the ammonite and yielded the ostracodes *Nophrecythere catephracta, N. flexicosta, Lophocythere karpinskii, Fuhrbergiella archangelskii, Schuleridea translucida, Fastigatocythere rugosa, Cytherella perennis, Paranotacythere* (*Unicosta*) *pseudoramulosa*, and *Pontocypris arcuata.*

Podosinki Formation, Lower Subformation

Upper Callovian, *Epistomina elschankaensis–Lenticulina tumida* Zone

The foraminiferal assemblage from the *Epistomina elschankaensis–Lenticulina tumida* Zone is observed in



Explanation to Figs. 3, 4, 6, 7, 9, 11, 13, 15.

the upper part of Bed 4 (the interval from 1.5 m of the base to 0.05 m below the lower marl interbed); the ammonites *Kosmoceras aculeatum* (Eichwald) and *K. gemmatum* (Phillips) are 7.5 m above the base.

Samples 23–31 yielded numerous ostracodes *Nophrecythere catephracta, Lophocythere scabra, L. karpinskii, Fuhrbergiella archangelskii, Sabacythere attalicata, Infacythere dulcis, Balowella attendens, Schuleridea translucida, Fastigatocythere rugosa, Cyterella oblonga, C. perennis, Vesticyterura costaeirregularis, V. acostata, Procytherura tenuicostata*, and *Cytheropteron laeve*.

Upper Subformation

Lower Oxfordian, the *Ophthalmidium sagittum*-*Epistomina volgensis* Zone

The foraminifers *Epistomina planoconvexa* Biel. et Styk, *E. nemunensis* Grig., and *E. volgensis* Mjatl.

occur just below the lower marl interbed and upwards to the top of the bed; the ammonites *Quenstedtoceras lamberti* (Sow.) and *Kosmoceras* cf. *proniae* (Teisseyre) are recorded just above the upper marl interbed.

The boundary between the Callovian and Oxfordian is defined a little above the upper marl interbed.

Only two rare forms, *Vesticyterura costaeirregularis* and *Sabacythere attalicata*, which came from the Upper Callovian, have been identified in the Lower Oxfordian (samples 32-36).

Beds 5-7 are conditionally referred to as the *Lower Oxfordian.*

(5) Brown and viscous clay. The thickness is 0.6 m. This bed is barren of microfauna (sample 37).

(6) Black and viscous clay with greenish and yellowish gray glauconite admixture. The thickness is 0.5 m. This bed is barren of microfauna (sample 38).

(7) Bright green, glauconitic, heavily argillaceous, ferruginous, and patchy ocherous sand. Ferruginous phosphorite concretions occur on the floor. This bed is overlain by a coarse-grained, argillaceous, reddish brown sand with an admixture of black spots that cements irregularly angled, gray and dark gray sandstone nodules. The thickness is 0.3 m. This bed is barren of microfauna (sample 39).

Quaternary?

(8) Bluish gray, weakly sandy, and patchy ocherous clay. The thickness is 2.5 m. The microfauna (samples 40 and 41) is absent.

The soil was recorded above.

2.2.2. **Zmeinka Section**

This section is described for the first time; the description was compiled in 1994 in coauthorship with Kochanova. The section is sequenced on the basis of ammonites and foraminifers. Ammonites were identified by Mitta, foraminifers were identified by Kochanova.

The working quarry is 4 km west of the railway station of the town of Mikhailov, near the village of Zmeinka (Figs. 1, 2). On the southern slope of a new part of the quarry near the mill and next to the road, 3 m above the roof of the undivided Carboniferous, which is represented by dense, occasionally yellowish, ferruginous limestone, the following strata are exposed upsection (Fig. 4).

Podosinki Formation, Lower Subformation

Undivided Middle-Upper Callovian

(1) Dark gray, dense, somewhat sandy, and patchy brown clays containing bright ferruginous, pyritized nodules, pyrite concretions of an irregular shape, marl pebbles with a light gray surface and dark gray inner part, calcite crystals, aggregates of shell detritus with traces of bright rose nacre in the upper half of the sequence, and plant debris and a dense, fine, light gray spotty pattern in the roof of the bed. The thickness is 7 m.

The layers from the base of the bed to the 0.25 m level, where the ammonites *Kosmoceras proniae* Teisseyre and *Rondiceras* sp. juv. (in the talus) have been found, is referred to as the Middle-Upper Callovian.

The ostracodes *Cytherella oblonga, Fastigatocythere rugosa, Nophrecythere* catephracta, *Lophocythere karpinskii*, and *Schuleridea translucida* were identified from sample 1.

Upper Callovian, *lamberti* Zone

The ammonites *Quenstedtoceras lamberti* (Sow.) and *Q. leachi* (Sow.) were found 0.5 m above the floor, and the foraminifers *Saracenaria engelsensis* Kosyreva, *Planularia flexuosa*(Bruckm.), *Lenticulina tumida* Mjatluk, *L. uhligi* (Wisn.), *Pseudolamarckina rjasanensis* (Uhlig), *Epistomina mosquensis* Uhlig, *E. porcellanea* Bruckm., *L. polonica* (Wisn.), and *Astacolus batra* Riensis were recorded through the entire interval from 0.5 m above the floor to the top of the bed.

Ostracodes are rather numerous in samples 2-12 collected from Bed 1. Sixteen species were identified, *Cytherella oblonga, C. perennis, Nophrecythere catephracta* (dominating quantitatively), *N. zmeinkensis, N. oxfordiana, N. flexicosta, Lophocythere interrupta, L. karpinskii, Fuhrbergiella archangelskii, Fastigatocythere rugosa, Schuleridea translucida, Procytherura tenuicostata, Procytherura* sp., *Vesticytherurapaula, V. costaeirregularis,* and *V. acostata.* It should be noted that *F. rugosa* and *S. translucida* along with *N. catephracta* are the most abundant in the Zmeinka Upper Callovian Ostracode Assemblage. The upper part of the bed (samples 13-15) is barren of ostracodes.

(2) Hard, light, yellowish marl on a weathered surface. The thickness is 0.1 m.

Upper Subformation

Lower Oxfordian, *mariae* Zone

(3) Dark gray, in places brown, weakly sandy clays containing plant debris and numerous small light gray spots. Marl concretions up to 7 cm in diameter are abundant at the top of the bed. The ammonites *Quenstedtoceras leachi* (Sow.) and *Q. mariae* (d'Orb.) were found at the base. The thickness is 1.1 m.

Bed 3 (samples 16 and 17) is barren of ostracodes.

Quaternary?

(4) Black, strongly clayey, and loose sand. This bed overlays with unconformity the clays of the preceding bed. The thickness is 0.5 m.

Ostracodes (samples 18 and 19) are absent.

(5) Brown, dark and light gray, thin-laminated, flaky, cloddy rewashed clays penetrated by modern plant roots. Rounded redeposited belemnite rostra occur. The thickness is 0.5–1.5 m.

The sequence is crowned by Recent soil.

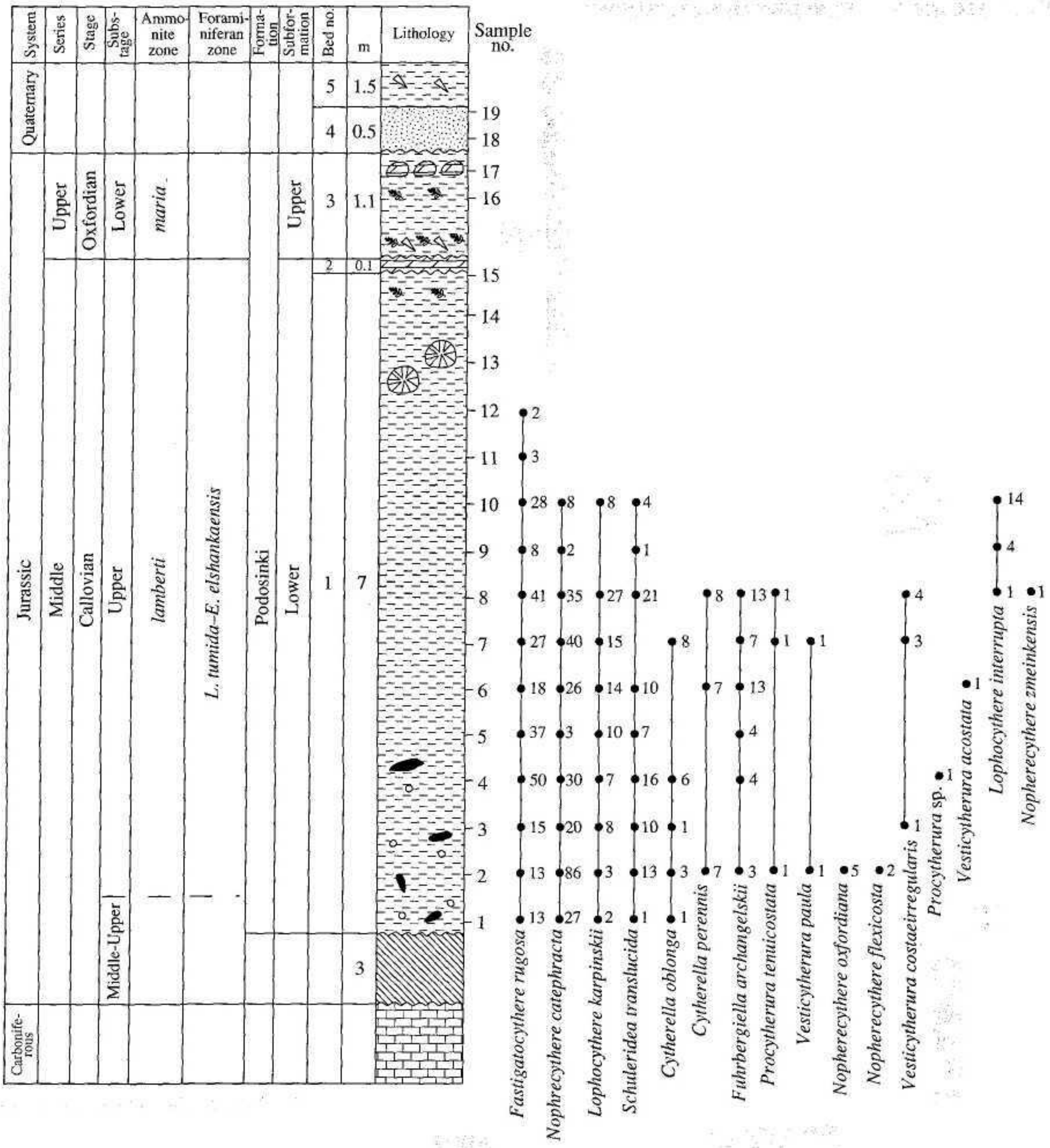


Fig. 4. Distribution of ostracodes through the Zmeinka section.

2.2.3. Elat'ma Section

One of the best Callovian and Oxfordian sections is situated near a quay in the town of Elat'ma on the left bank of the Oka River (Fig. 1). This section was repeatedly described and schematically described by geologists (Nikitin, 1881, 1885; Sazonov, 1957, 1965; Meledina, 1987; Morozov, 1994; Kiselev, 2001). In 1996, I collected two samples of dark gray clays of the Elat'ma Formation that correspond to Bed 10, which had been referred to the Lower Callovian, the *elatmae* Zone (Sazonov, 1965, pp. 3-99). This bed is barren of microfauna.

2.2.4. Makar'ev-yuzhnyi Section

This section was first described by Nikitin (1885) and was repeatedly studied later (Mesezhnikov, 1986; Meledina, 1987; Mesezhnikov *et al.*, 1989; Hantzpergue *et al*, 1998; Mitta, 2000; Kiselev, 2001). In the present paper, a corrected description compiled in 1995 in cooperation with Mitta is given. The stratification of the Callovian part of the section and recognition of the Upper Oxfordian on the basis of ammonites and other macrofaunal groups was performed by Mitta. The Oxfordian is subdivided into the Lower and Middle substages on the basis of ammonites and foraminifers

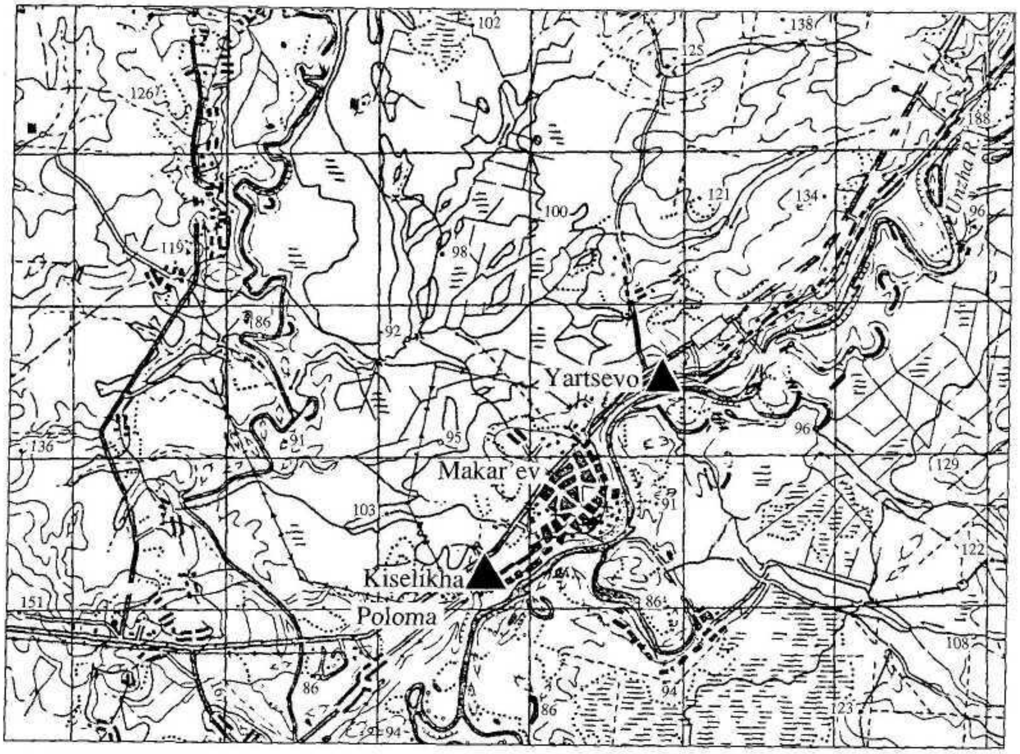


Fig. 5. Map of the Makar'ev-yuzhnyi and Yartsevo sections.

after Mesezhnikov *et al.* (1989) and Hantzpergue *et al.* (1998).

South of the town of Makar'ev of the Kostroma Region, in the slope of the right bank of the Unzha River, 2 km upstream of a monastery (Figs. 1, 5), the following strata outcrop from the water line upsection (Fig. 6).

Kologriv Beds

Lower Callovian, *elatmae* Zone

(1) Quartzose, fine or medium-grained, light brown sand with reddish ferruginous patches, with interbeds of solid nodules of black sandstone, and with inclusions of dark gray clays. Several interbeds of dark gray, weakly silty clays 1 to 4 cm thick occur in the upper part. An interlayer of phosphatic nodules is recorded in the clays.

Identified are the ammonites *Chamoussetia chamousseti stuckenbergii* (Lahusen), *Kepplerites russiensis* Mitta, *K. unzhensis* Mitta, *Pseudocadoceras* sp., and rarer *Kepplerites* ex gr. *goverianus* (Sow.); poorly preserved rostra of *Pachyteuthis* cf. *cuneata* Gust. and the bivalves *Astarte* sp. and *Gresslya* sp. are common. The exposed thickness above the water line is 0.5 m. Ostracodes have not been recorded (samples 1, 2, and 14).

Velikodvor'e Formation

Middle Callovian, *jason* Zone

(2) Argillaceous, light brown sand with bright ferruginous patches, numerous siderite and calcareous phosphorite concretions, and with numerous and various ammonites *Rondiceras milaschevici* (Nik.), *Novocadoceras* sp., *Kosmoceras* ex gr. *jason* (Rein), *Indosphinctes* sp., and *Choffatia* sp., bivalves, gastropods, and the brachiopod *Ivanovella alemanica* (Rollier); the argillaceous component increases upward. This bed overlies a distinctly rough and water-worn surface. Small, often smashed shells and imprints of ammonites of the genera *Rondiceras, Novocadoceras, Elatmites,* and *Kosmoceras* are recorded in the upper, clayey part of the bed. The thickness is 1 m.

The lower part of the bed (samples 3 and 4) is barren of ostracodes. Rare ostracodes *Nophrecythere cataphracta, Schuleridea translucida, Galliaecytheridea spinosa, Vesticytherura costaeirregularis, Paranotacythere* (*Unicosta*) *stauropyga,* and *Oligocythereis kostytschevkaensis* were identified in the roof of the bed (sample 5).

Unzha Formation, Middle Subformation

Lower Oxfordian, *cordatum* Zone, Lower Part of the *O. sagittum–E. volgensis* Zone

(3) Dark gray, weakly silty clays, with frequent thin interbeds and lenses of brown, medium-grained sand in the lower part; small nodules (3-5 cm in diameter) and large concretions (10–20 cm) of marl with a light gray weathered surface and a dark inner part, partially pyritized. The thickness is 3.8 m.

Small Gastropoda and *Cardioceras* sp. were found 1.5 m above the base of the bed.

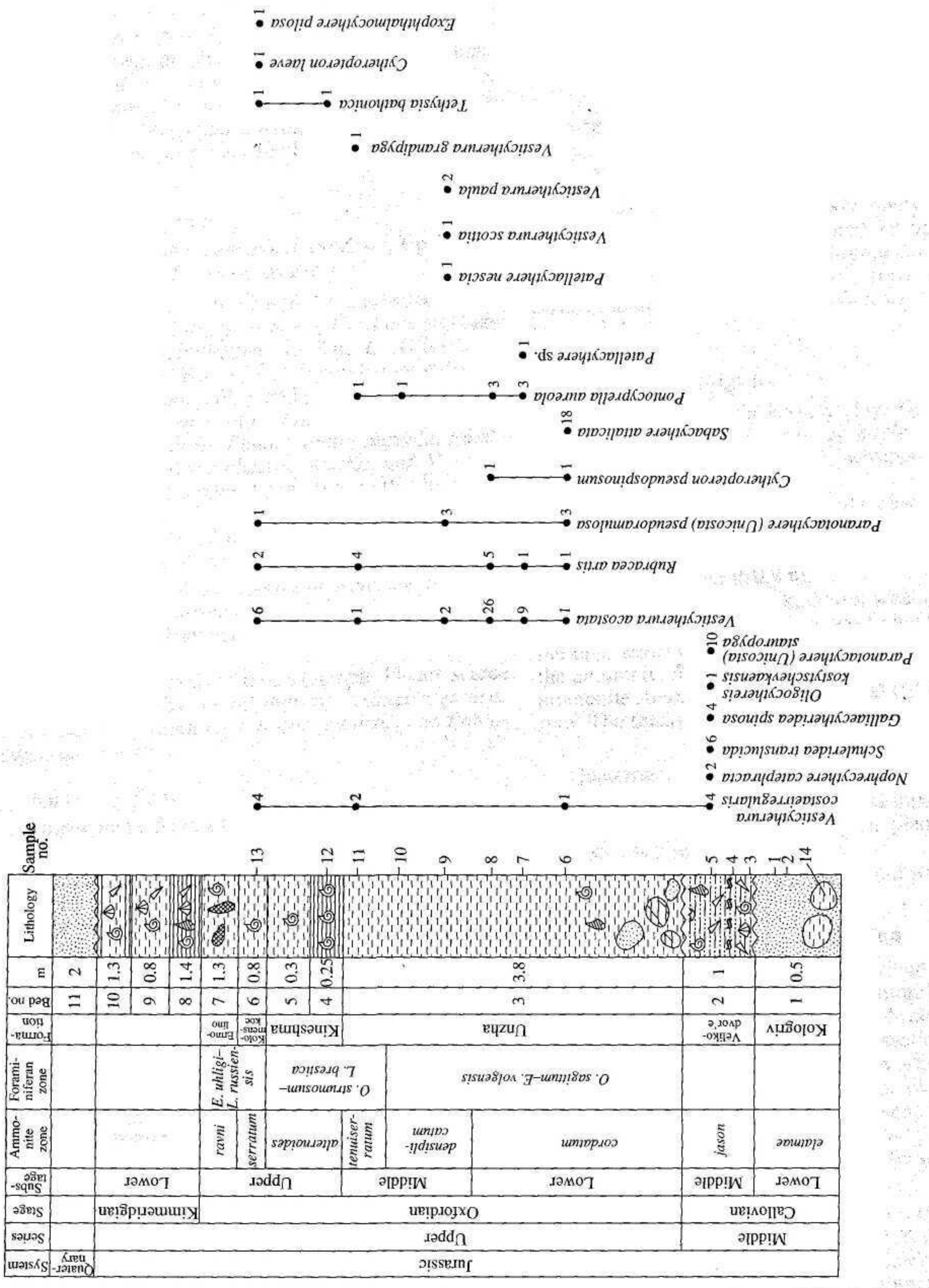


Fig. 6. Distribution of ostracodes through the Makar'ev-yuzhnyi section.

The lower 2 m are referred to the *cordatum* Zone on the basis of the ammonites *Cardioceras* (*Cardioceras*) ex gr. *cordatum* (Sow.), *Cardioceras* sp., and *Perisphinctes* sp.

In addition to *Vesticytherura acostata* and *Sabacythere attalicata* dominating in the assemblage, individual *Vesticytherura costaeirregularis, Rubracea artis, Paranotacythere* (*Unicosta*) *pseudoramulosa, Patellacythere* sp., *Pontocyprella aureola,* and *Cytheropteron pseudospinosum* were identified from this bed (samples 6-8).

Upper Subformation

Middle Oxfordian, *densiplicatum* Zone, Upper Part of the *O. sagittum-E. volgensis* Zone

The subsequent 1.3 m of Bed 3 are referred to this zone on the basis of the presence of *Cardioceras (Subvertebriceras) densiplicatum* Boden, *C.* (*Plasmotoceras) tenuistriatum* Boriss., *C. (P.) popilaniense* Boden, *C. (P.) tenuicostatum* (Nik.), and others.

Vesticytherura acostata, Paranotacythere (Unicostd) pseudoramulosa, Pontocyprella aureola, Patellacythere nescia, Vesticytherura scottia, and *V. paula* were identified in samples 9 and 10 from this interval.

The *tenuiserratum* Zone, Lower Part of the *O. strumosum–L. brestica* Zone

Ammonites of the *tenuiserratum* Zone and foraminifers of the *O. strumosum–L. brestica* Zone are recorded in the subsequent 0.5 m of Bed 3 (Mesezhnikov *et al.*, 1989).

Ostracodes from these layers (sample 11) are scarce and represented by *Vesticytherura costaeirregularis, V. acostata, V. grandipyga, Rubracea artis,* and *Pontocyprella aureola.*

Kineshma Beds

Upper Oxfordian, *alternoides* Zone, Upper Part of the *O. strumosum-L. brestica* Zone

(4) Dark gray bituminous shales containing numerous smashed shells of the ammonites Cardioceratidae; in the lower part, ferruginous. The ammonites *Amoeboceras ilovaiskii* (Sok.) and bivalves *Entolium* sp. and *Dicroloma* sp. occur. The thickness is 0.25 m.

Scarce ostracodes *Tethysia bathonica* are recorded in sample 12.

(5) Dark, almost black clay. The ammonite *Amoeboceras ilovaiskii* (Sok.) is recorded. The thickness is 0.3 m.

Kolomenskoe Beds

The *serratum* Zone, Lower Part of the *E. uhligi–L. russiensis* Zone

(6) Light brown, weakly sandy clay with grayish green and green glauconite interbeds and lenses, with inclusions of yellowish red sand, which is ferruginous 0.6 m above the floor and higher. The ammonites *Cardioceras zenaidae* Ilov., *Amoeboceras* aff. *alternans* (Buch), and *A. ilovaiskii* (Sok.) occur. The thickness is 0.8 m.

The ostracode assemblage (sample 13) is very poor. It includes mostly the same species as those which occur lower, *Vesticytherura costaeirregularis, V. acostata, Paranotacythere (Unicostd) pseudoramulosa, Tethysia bathonica,* and *Rubracea artis.* The listed forms occur singularly. *Cytheropteron laeve* and *Exophthalmocythere pilosa* appear.

Ermolino Formation

The *ravni* Zone, Upper Part of the *E. uhligi–L. russiensis* Zone

(7) Dark gray to black, weakly sandy, dense clay containing disperse phosphorite nodules up to 5 cm in diameter and the ammonites *Ringsteadia* sp., *Amoeboceras* cf. *kitchini* (Salf.), *A.* cf. *ilovaiskii, Cardioceras zenaidae* Ilov., and *Demosphinctes* sp. The thickness is 1.3 m.

Lower Kimmeridgian

(8) Dark gray to black shaly clay. The ammonites *Amoeboceras* sp. and *Pictonia* cf. *baylei* Salf., belemnites, the bivalve *Loripes*, and gastropods occur. The thickness is 1.4 m.

(9) Gray, dense, weakly sandy clay. Poorly preserved bivalves, fragments of belemnite rostra, and spots corresponding to large decayed ammonite shells occur. The thickness is 0.8 m.

(10) Dark gray to black, dense, weakly sandy and shaly clay. The bivalve *Loripes* was found in the roof of the bed; small belemnite rostra, fragmentary molds of the ammonite *Rasenia,* smashed pyritized shells of the ammonite *Amoeboceras* sp. occurred 0.3 m below the roof. The thickness is 1.3 m.

Quaternary?

(11) Fine-grained, light gray sand mixed with clay. This bed is penetrated by modern plant roots. The thickness is 2 m.

The sequence is crowned by Recent soil.

2.2.5. Yartsevo Section

This section was initially described by Sokolov (1929). The description below was compiled in 1995 in cooperation with Mitta. Lower and Middle Callovian ammonites were identified and the section was stratified on the basis of the ammonites by Mitta; Callovian foraminifers were identified by Kochanova. The Oxfordian was stratified by Olfer'ev (personal communication); ammonites were identified by D.B. Gulyaev, D.N. Kiselev, and M.A. Rogov, and foraminifers were identified by A.Ya. Azbel'.

In an outcrop on the right bank of a meander of the Unzha River between the village of Yartsevo and the northern outskirts of the town of Makar'ev (Figs. 1, 5), the following strata are exposed upsection from the water line upward (Fig. 7):

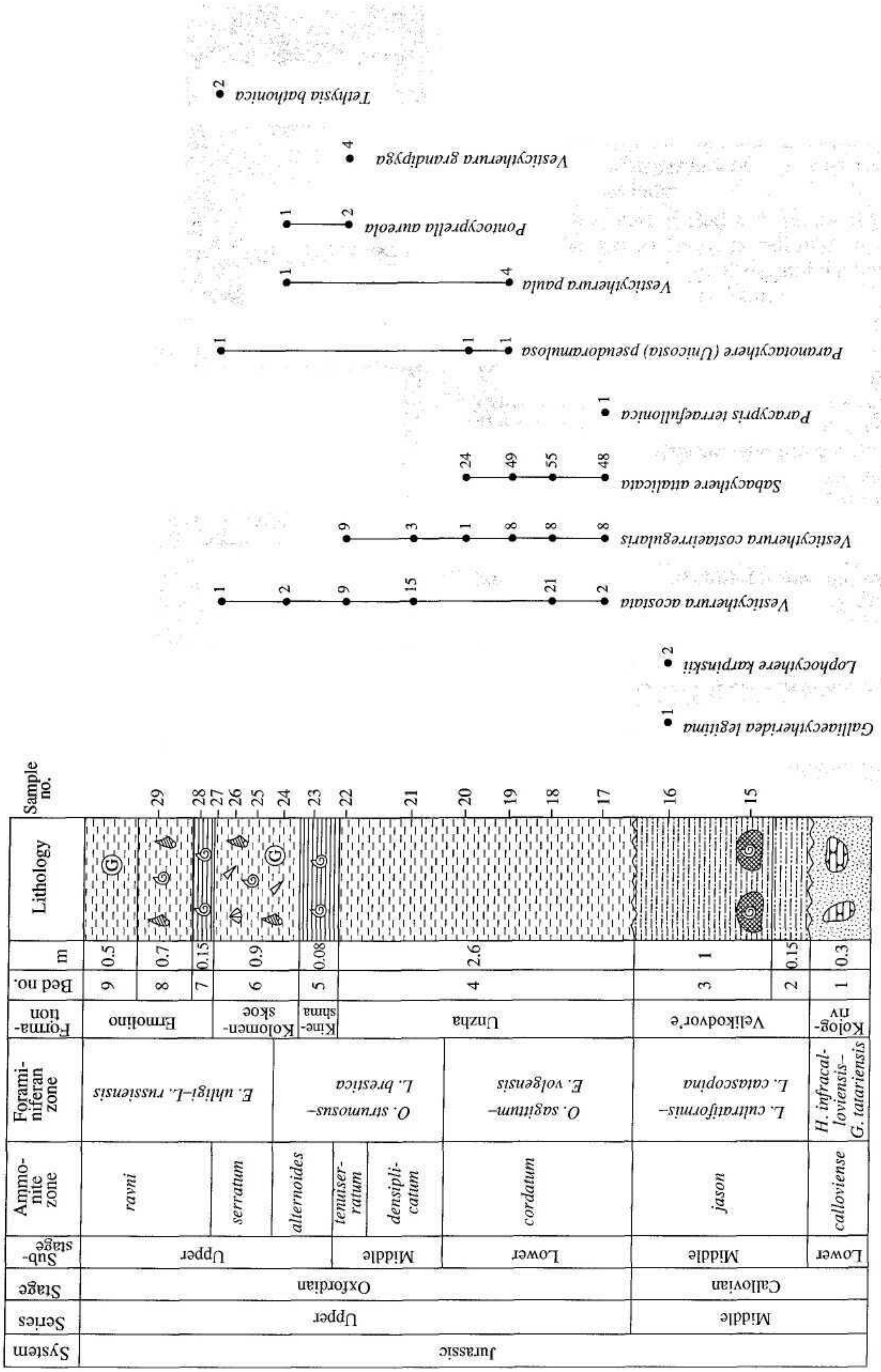


Fig. 7. Dist[redacted]ion of ostracodes through the Yartsevo section.

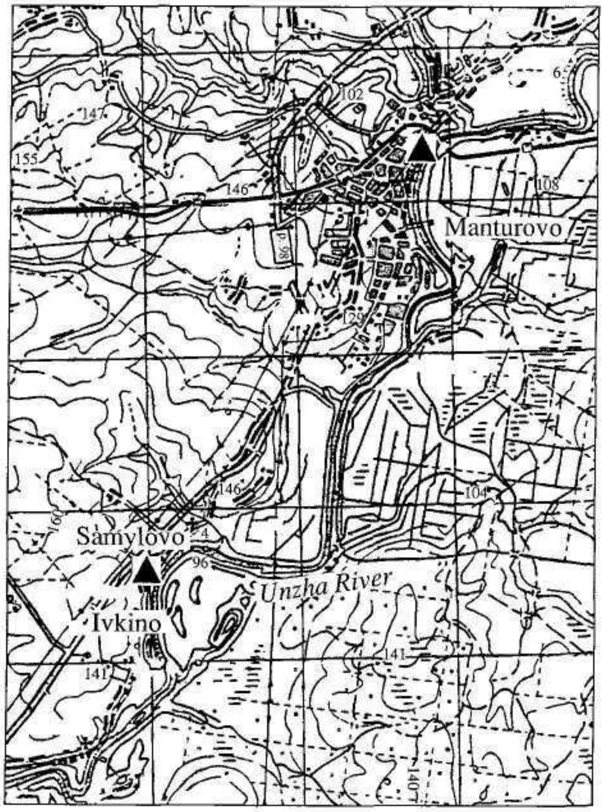


Fig. 8. Map of the Samylovo and Manturovo sections.

Kologriv Beds

Lower Callovian, *calloviense* Zone, *H. infracalloviensis-G. tatariensis* Zone

(1) Quartzose, yellowish gray sand with interlayers and nodules of a coarse-grained, yellowish brown, ferruginous sandstone containing a rich assemblage of Lower Callovian ammonites, including *Kepplerites galilaeii* (Oppel), *K. curtilobus* (Buckman), *Sigaloceras calloviense* (Sowerby), *Rondiceras* spp., and *Novocadoceras* spp. The thickness is 0.3 m.

Velikodvor'e Formation

Middle Callovian, *jason Zone, L. cultratiformis–L. catascopina* Zone

(2) Brownish gray, strongly sandy clay with interbeds of yellowish brown, ferruginous, coarse-grained sand. The thickness is 0–0.15 m.

(3) Dark gray, weakly sandy clay with dark gray and gray phosphorite concretions often containing shells of the ammonites *Rondiceras milachevici* (Nikitin), *Novocadoceras* sp., and *Kosmoceras* cf. *jason* (Reinecke). The thickness is 1 m.

Sample 15 is barren of ostracodes. Individual shells of the ostracodes *Galliaecytheridea legitima* and *Lophocythere karpinskii* were recorded in the upper part of the bed (sample 16).

Unzha Formation

(4) Bluish gray, dense, weakly silty clay. The thickness is 2.6 m.

The ammonite *Cardioceras quadratum* (Buck.) was found approximately 0.8 m above the floor, *Cardioceras tenuicostatum* Nik. was identified 0.8 m upsection, and *Subdiscosphinctes* sp. was recorded 0.5 m higher than the latter.

The lower part of Bed 4, from the floor to approximately the 1.6 m level, is referred to as the Lower Oxfordian, the *cordatum* Zone and the lower part of the *O. sagittum–E. volgensis* Zone.

In the Lower Oxfordian (samples 17-20), infrequent samples of *Vesticytherura costaeirregularis* and *V. acostata* and rather numerous samples of *Sabacythere attalicata* were identified. Additionally, single *Paracypris terraefullonica, V. paula*, and *Paranotacythere* (*Unicosta*)*pseudoramulosa* were found.

The middle part of the bed, up to the 0.5 m level below the top, is referred to as the Middle Oxfordian, the *densiplicatum* Zone and the upper part of the *O. sagittum-E. volgensis* Zone. The upper 0.5 m of the bed belongs to the Middle Oxfordian, the *tenuiserratum* Zone and the lower part of the *O. strumosum–L. brestica* Zone.

The Middle Oxfordian ostracode assemblage (samples 21 and 22) is very poor and represented by small species shells only. Dominating are *Vesticytherura acostata* and *V. costaeirregularis; Vesticytherura grandipyga*, *Pontocyprella aureola*, and *Galliaecytheridea legitima* are singular.

Kineshma Formation

Upper Oxfordian, Lower Part of the *alternoides* Zone, Middle Part of the *O. strumosum–L. brestica* Zone

(5) Dark gray bituminous shales with brownish interbeds and a gray weathered surface; it contains numerous smashed shells of the ammonites *Cardioceras* aff. *ilovaiskii* (Sokolov) and *Perisphinctes* spp. and bivalves. The shells often retain their nacre. The thickness is 0.08 m.

This bed (sample 23) is barren of ostracodes.

Kolomenskoe Beds

Upper Part of the *alternoides* Zone, Upper Part of the *O. strumosum-L. brestica* Zone, Lower Part of the *E. uhligi–L. russiensis* Zone

(6) Dense gray clay; in places, bright green and glauconite in the interval 0.25-0.30 m above the floor. There are abundant small shells of bivalves and gastropods, large smashed shells of the ammonites *Amoeboceras* (*Paramoeboceras*)cf. *damoni* Spath, A. (P.) *koldeweyense* Sykes e.t Callomon, and *A.* (P.) ex gr. *serratum* (Sow.), and belemnite rostra, which are partially smashed and pyritized. The thickness is 0.9 m.

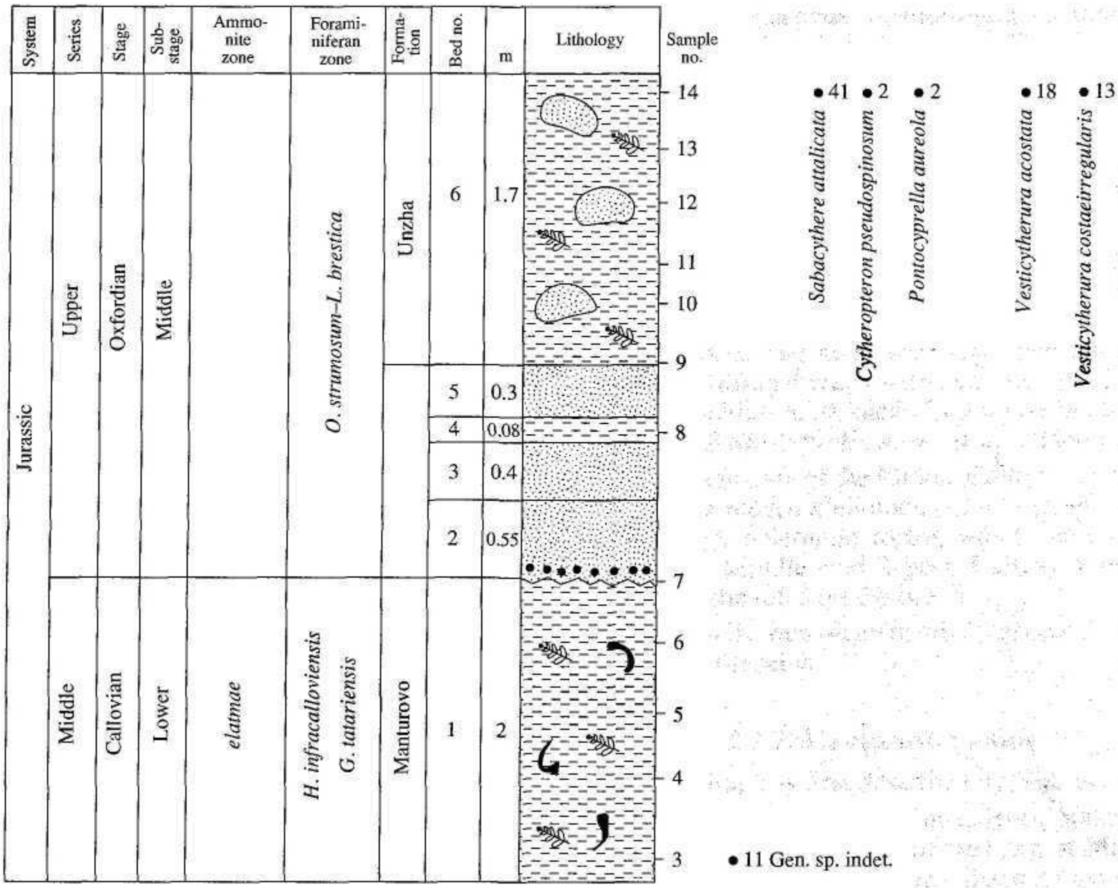


Fig. 9. Distribution of ostracodes through the Samylovo section.

Isolated valves of the ostracodes *Vesticytherura paula, V. acostata, Tethysia bathonica, Paranotacythere (Unicosta) pseudoramulosa*, and *Pontocyprella aureola* were recorded in samples 24–27.

Ermolino Formation

The *ravni* Zone and the Middle and Upper Part of the *E. uhligi–L. russiensis* Zone

(7) Dark gray, shaly clay, transforming upward into bituminous shale and containing abundant detritus and smashed ammonite shells retaining their nacre, *Amoeboceras (A.) tuberculatoalternans* (Nik.), *A.* (A.) *gerassimovi* Mesezhn., and A. (*Paramoeboceras*) *leucum* Spath. The thickness is 0.15 m.

Ostracodes are absent (sample 28).

(8) Dense, dark gray to black clay containing the *Amoeboceras* (A.) cf. *lineatum* (Salf.) ammonite shells retaining their nacre, shell detritus, and gastropods. The thickness is 0.35 m.

Ostracodes are absent (sample 29).

(9) Gray clay with inclusions of greenish gray glauconite grains. The exposed thickness is 0.5 m.

Above is a turf-covered slope.

2.2.6. Samylovo Section

This section was described by Meledina (1987) and Mitta (2000). In the present paper, a description compiled in 1995 in cooperation with Mitta is given. The section is subdivided on the basis of ammonites by Mitta and on the basis of foraminifers by I.V. Nefedova.

On the right bank of the Unzha River between the village of Samylovo and the village of Ivkino (Figs. 1, 8), the following strata are exposed upsection from the water line (Fig. 9):

Manturovo Beds

Lower Callovian, *elatmae* Zone, *Haplophragmoides infracalloviensis–Guttulina tatariensis* Zone

(1) Dark gray, viscous, partly micaceous, partly sandy clay. It contains numerous (up to 25 cm long) pyritic concretions and petrified and pyritized wood represented by small fragments up to trunk parts. The clay becomes nearly black 1.4 m above the floor. The ammonites *Cadoceras tschernyschewi* Sokolov, *Pseudocadoceras* sp., and *Eckhardites pavlowi* (Smorodina) and the foraminifers *Lenticulina tatariensis* (Mjatliuk), *Nodosaria sowerbyi* Schwager, *Dentalina schokinae* Mjatliuk, *D. vasta* Mjatliuk, *Frondicularia crassa*

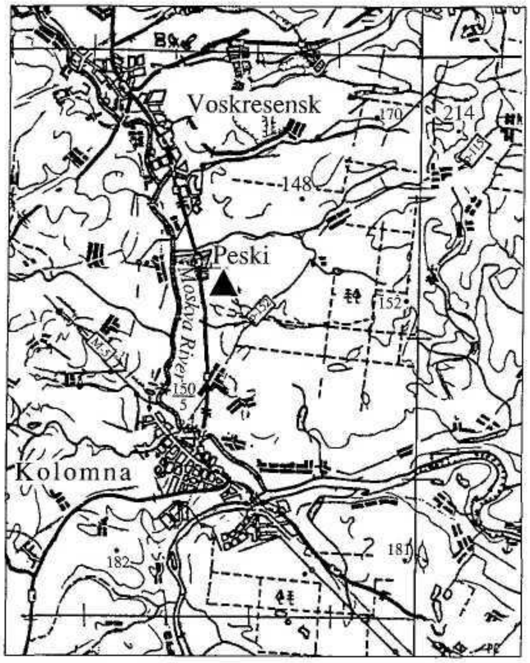


Fig. 10. Map of the Peski section.

Mjatliuk, *Epistomina callovica* Kaptarenko, and others were found. The thickness is 2 m.

At the base of the bed, 11 small and poorly preserved valves of unidentified ostracodes were found in one (sample 3) of five samples (3-7).

Above, with signs of discontinuity occur the following:

(2) Ferruginous, quartzose, medium-grained, in places weakly argillaceous, usually crimson sand, which is partly cemented and forms sandstone. An interbed of pebbles and weakly rounded rock debris, quartz and quartzite debris (2-10 cm in diameter) occur at the base. Isolated pieces of rock debris occur throughout the section as well. This sand was formed as a result of rewashing, which is evident from irregularly wavy, folded, or ball-like sandstone and sand bedding that occasionally includes pieces of the underlying clay. Shells of *Cadoceras elatmae* (Nikitin) filled with redeposited pyrite, which are usually smashed and rarely intact, were recorded. Large, bun-shaped, light gray marl concretions up to 0.35 m in diameter were observed at the base of Bed 3. The thickness is 0.55 m.

(3) Quartzose, yellowish gray sand. The thickness is 0.4m.

(4) Bluish gray, sandy clay. The thickness is 0.08 m.

Ostracodes are absent (sample 8).

(5) Medium-grained, yellowish gray, argillaceous sand. The thickness is 0.3 m.

Unzha Formation

Middle Oxfordian, *O. strumosum–L. brestica* Zone

(6) Unevenly colored, grayish yellowish brown clay with dark gray interbeds and large inclusions of yellowish brown, argillaceous, medium-grained sand, which substitutes for clay along the strike. The clay contains carbonized wood fragments. The foraminifers *Ophthalmidium sagittum* (Bykova), *O. strumosum* (Gümbel), *Epistomina nemunensis* Grigelis, *E. volgensis* Mjatluk, *Lenticulina belorussica* (Mitjanina), and *L. brestica* (Mitjanina) were recorded at the top of the bed. The thickness is 1.7 m.

Among six samples (9-14) collected in this bed, ostracodes and foraminifers were found only in the uppermost sample (sample 14). Six ostracode species were recorded. The most abundant were *Sabacythere attalicata, Vesticytherura acostata*, and *V. costaeirregularis.* In addition, isolated *Cytheropteron pseudospinosum* and *Pontocyprella aureola* were identified.

Mold fragments of the Middle Callovian ammonites *Kosmoceras medea* Callomon, *Elatmites* sp., and others and large belemnite rostra, which most probably came from Middle and Upper Callovian beds, are recorded in the talus on the beach.

Additionally, bun-shaped, gray marl concretions are observed in the talus.

2.2.7. **Manturovo Section**

The section was first described by Nikitin (1885).

On the right bank of the Unzha River 300 m downstream of the railway bridge of the town of Manturovo (Figs. 1, 8), three samples were collected from the dark gray clay of the Manturovo Formation, the Lower Callovian, the *elatmae* Zone. This clay is barren of microfauna. Two samples collected from the clay of the *gowerianus* Zone are also barren of microfauna (stratification after Mitta, 2000).

2.2.8. **Peski Section**

A description of this section has not been published. A schematic map of the locality and the lithological column were given by Morozov (1992). The section was schematically described by Smirnova *et al.* (1999). In the present paper, the description and stratification of this section on the basis of foraminifers and ammonites are given after the Master's Thesis of L.N. Gus'kova and the fourth year student work by A.A. Rozanova (both in 1996), with corrections. Ammonites were identified by Rogov, foraminifers were identified by Gus'kova and Rozanova. This section is especially rich in ostracodes; 35 species of 22 genera have been registered.

The quarry is situated in the Kolomenskii District of the Moscow Region, 2 km southeast of the Peski railway station and 1.5 km northwest of the Konev Bor railway station (Figs. 1, 10). Jurassic clays of the Podosinki Formation with a total thickness of 4.1 m overlie the Middle Carboniferous Moscovian limestone. The following strata are observed upsection in the clays (Fig. 11):

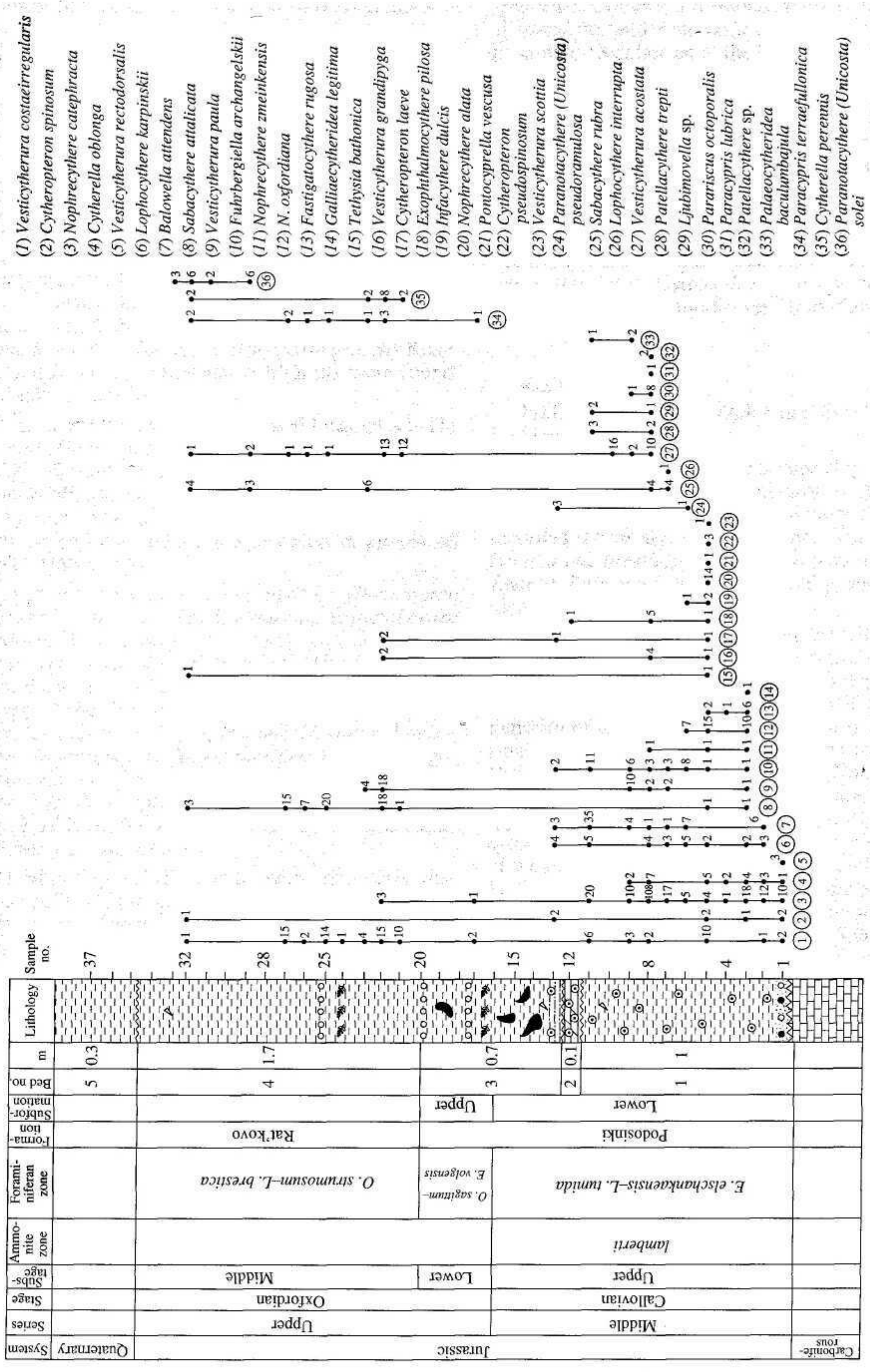


Fig. 11. Distribution of ostracodes through the Peski section.

Lower Subformation of the Podosinki Formation

Upper Callovian, *lamberti* Zone, *Lenticulina tumida–Epistomina elschankaensis* Zone

(1) Dense, gray with a greenish tinge, weakly micaceous, nonlaminated clay. Numerous black and dark brown, variously shaped ooliths are dispersed throughout the bed. The average size of the ooliths is 1-5 mm. Quartz and limestone pebbles up to 3 cm in diameter occur at the base of the clay. The ammonites *Quenstedtoceras lamberti* (Sow.), *Kosmoceras duncani* (Sow.), and *Peltoceras athletoides* Lah. and the foraminifers *Lenticulina tumida* Mjatliuk, *L. polonica* (Wisn.), *Astacolus dalinkevichiusi* Grigelis, *Planularia deeckei* (Wisn.), *Ichthyolaria franconica* (Gümbel), *Citharinella moelleri* (Uhlig), *Saracenaria gracilis* Kosyreva, and *Dentalina bruckmanni* Mjatliuk were found. The thickness is 1 m.

Ostracodes are most abundant in Bed 1 (samples 1–11). The core of the Upper Callovian ostracode assemblage consists of *Nophrecythere catephracta*, *Lophocythere karpinskii*, *Balowella attendens*, *Fuhrbergiella archangelskii*, *Vesticytherura paula*, and *V. costaeirregularis*, which are most abundant and recorded in almost all samples of this bed.

In addition, *Fastigatocythere rugosa*, *Cytheropteron spinosum*, *C. laeve*, *C. pseudospinosum*, *Vesticytherura rectodorsalis*, *V. scottia*, *V. grandipyga*, *V. acostata*, *Tethysia bathonica*, *Paranotacythere (Unicosta) pseudoramulosa*, *Exophthalmocythere pilosa*, *Cytherella oblonga*, *Sabacythere attalicata*, *S. rubra*, *Nophrecythere zmeinkensis*, *N. oxfordiana*, *N. alata*, *Lophocythere interrupta*, *Galliaecytheridea legitima*, *Infacythere dulcis*, *Pontocyprella vescusa*, *Parariscus octoporalis*, *Paracypris lubrica*, *Patellacythere trepti*, *P.* sp., *Ljubimovella* sp., and *Palaeocytheridea baculumbajula* have been found.

(2) Bluish gray, dense marl with irregularly dispersed ooliths and casts of ammonites, primarily perisphinctids. The thickness is 0.1 m.

Ostracodes were not recorded (sample 12).

(3) Dark gray, oolitic clay with pyrite concretions, which is undistinguishable from the clay of Bed 1. Carbonized wood and a horizon with argillaceous phosphatic black nodules were recorded 0.4 m above the bed floor. An imprint of a cardioceroid ammonite was found 0.2–0.25 m above the floor. The foraminifers *Epistomina parastelligera* (Hofker), *Astacolus dalinkevichiusi* Grig., *Ophthalmidium sagittum* (Bykova), *Lenticulina russiensis* (Mjiatliuk), and others occur throughout the bed. The thickness is 0.7 m.

The lower part of the bed from the floor to the 0.25 m level, where the ammonite imprint was found is referred to as the Upper Callovian.

The interval of the section where samples 13–16 were collected (the Upper Callovian) is much impovered in ostracode remains. Individual *Lophocythere karpinskii*, *Fuhrbergiella archangelskii*, *Cytheropteron spinosum*, *C. laeve*, *Paranotacythere* (*Unicosta*) *pseudoramulosa*, and *Balowella attendens* were identified in sample 13 collected at the base of the bed.

Upper Subformation of the Podosinki Formation

Lower Oxfordian, *O. sagittum–E. volgensis* Zone

The upper part of Bed 3 from 0.25 m to the top is referred to the Lower Oxfordian. Individual *Nophrecythere catephracta*, *Paracypris terraefullonica*, and *Vesticytherura costaeirregularis* were found in sample 17. Important is the first occurrence of *P. terraefullonica* at this level. Ostracodes have not been found in other samples from the Lower Oxfordian (samples 16 and 18-20).

Rat'kovo Formation

Middle Oxfordian, *Ophthalmidium strumosum–Lenticulina brestica* Zone

(4) Dark gray, weakly micaceous clays containing a small amount of ooliths. A horizon of black argillaceous phosphatic concretions and carbonized wood is recorded 0.4 m above the bed floor. The foraminifers *Lenticulina brestica* (Mjat.), *L. attenuata* (Kubler et Zwing), *Epistomina mosquensis* Uhlig, and others were identified. The thickness is 1.7 m.

The upper part of the section (samples 20–33) is characterized by an ostracode assemblage differing from the Upper Callovian one. It includes less species (14) and is characterized by the smaller size of the majority of its representatives. Its core is composed of small-sized species *Vesticytherura costaeirregularis*, *V. acostata*, and *Paranotacythere (Unicosta) solei*, which dominate in all the samples, as well as of *Paracypris terraefullonica* and medium-sized species *Sabacythere attalicata* and *S. rubra*, isolated representatives of which were recorded in underlying beds. *Cytherella perennis* appears. The Middle Oxfordian assemblage is supplemented with rare *Cytheropteron spinosum*, *C. laeve*, *Nophrecythere catephracta*, *Sabacythere* sp., *Vesticytherura grandipyga*, *V. paula*, and *Tethysia bathonica*.

(5) The upper part of the clay of Bed 4, which was reworked during the Quaternary, is represented by gray, weakly micaceous, silty clay containing rare ooliths, grains of quartz, amphibole, gneiss, and fragments of Upper Cretaceous glauconite opoka in a fraction larger than 0.05 mm that constitutes up to 25%. The thickness is 0.3 m.

Ostracodes were not found.

Above it was soil.

2.2.9. Troshkov Vrag Section

Previously, this section was described by Sibirtsev (1886). He noted a sharp boundary between the lower sand and the upper clay section. Within the clayey part in particular, a dense oolitic limestone from Bed 3 con-

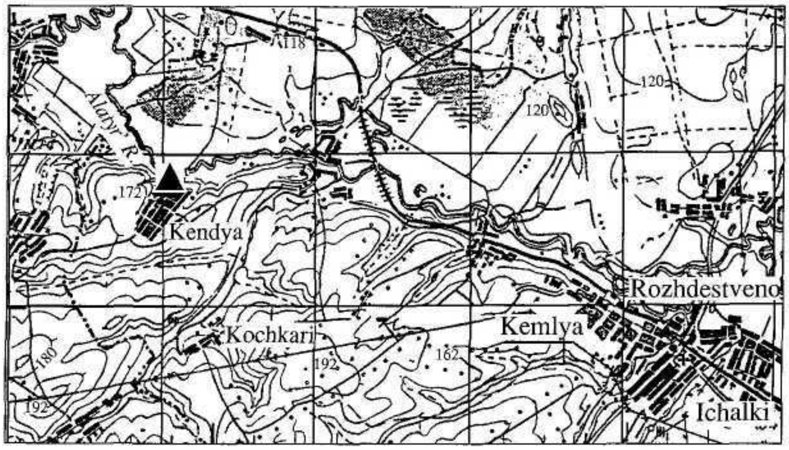


Fig. 12. Map of the Troshkov vrag section.

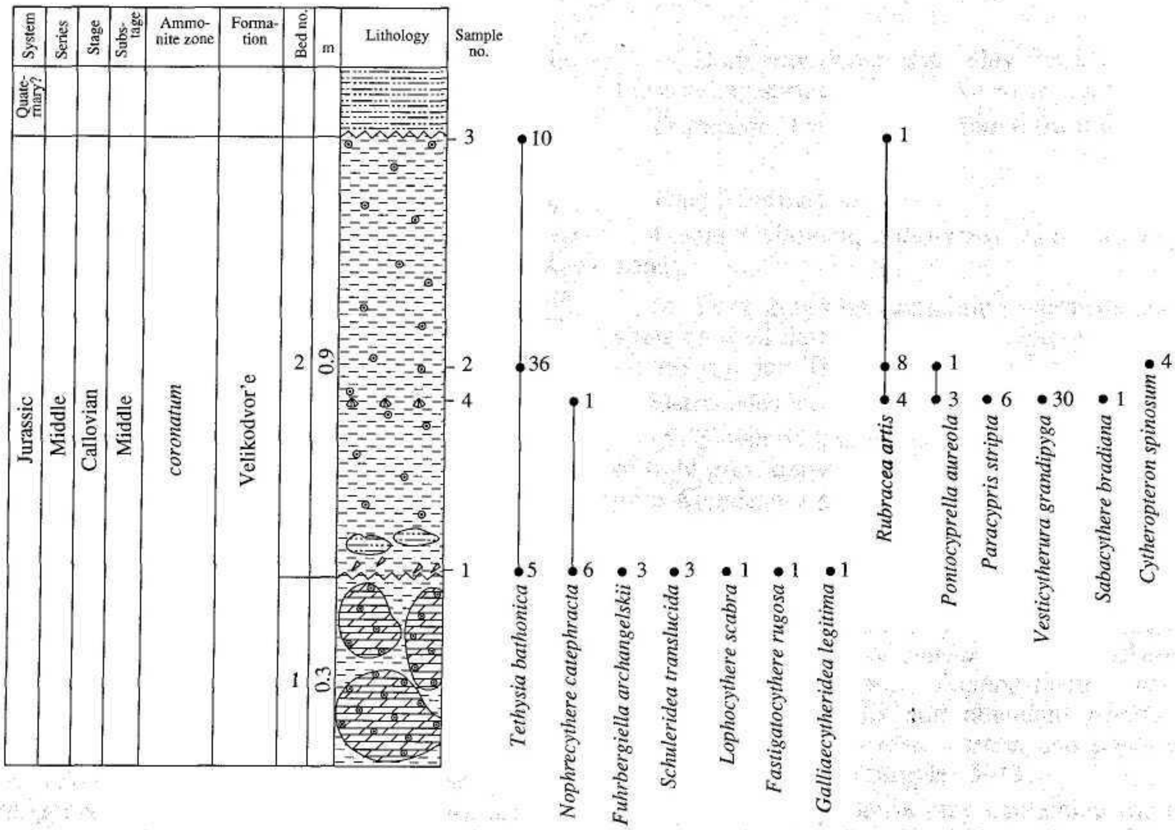


Fig. 13. Distribution of ostracodes through the Troshkov vrag section.

taining fossils of the *coronatum* Zone was recognized. In the present paper, a description compiled in 1996 in cooperation with Mitta is given. Ammonites were identified and the section was stratified by Mitta.

In the middle part of a ravine joining the Alatyr' River just west of the village of Kendya in Mordovia (Figs. 1, 12), on the right slope, the following strata are exposed upsection (Fig. 13):

Velikodvor'e Formation

Middle Callovian, *coronatum* Zone

(1) Gray, solid, partly oolitic marl occurring in blocks in gray clay. The bed seems to be analogous to Bed 3 after Sibirtsev (1886). The thickness is up to 0.3 m.

(2) Gray and bluish gray oolitic clay. Inclusions and lenticular interlayers of strongly sandy, ocherous, rusty

Fig. 14. Map of the Mikhailovskii Mine section.

brown clay are recorded in the lower part. Belemnite rostra and bivalve shells occur. On the basis of the ammonites *Erymnoceras* sp. and *Kosmoceras* sp., this bed is referred to the *coronatum* Zone of the Middle Callovian. The thickness is 0.9 m.

Isolated ostracodes *Nophrecythere catephracta, Fuhrbergiella archangelskii, Tethysia bathonica, Vesticytherura grandipyga, Sabacythere bradiana, Schuleridea translucida, Lophocythere scabra, Fastigatocythere rugosa, Galliaecytheridea legitima, Cytheropteron spinosum, Pontocyprella aureola, Paracypris stripta,* and *Rubracea artis* were identified in samples 1-4.

Above it there is yellowish gray, strongly sandy, probably Quaternary clay superimposed by soil.

2.2.10. Mikhailovskii Mine Section

Previously, a description of this section was published by Olfer'ev (Olfer'ev *et al.*, 1992) and Mitta (Gerasimov *et al.*, 1996). Since the microfauna was sampled by Mitta, the description of the section is given after Gerasimov *et al.*, taking into account stratification and recognition of formations proposed by Olfer'ev *et al.* Ammonites were identified by Mitta, other groups of the microfauna were identified by Gerasimov.

In the Mikhaiilovskii Mine quarry near the town of Zheleznogorsk, the Kursk Region (Figs. 1, 14), the following strata overlie the ore horizon upsection (Fig. 15):

Arkino Formation

Upper? Bathonian

(1) Gray, medium-grained sand with interlayers and lenses of gravel. The thickness is 0.6 m.

Zheleznogorsk Formation

Upper? Bathonian

(2) Sandy, grayish brown clay containing gravel. The thickness is 0.3 m.

(3) Dark gray, dense, shaly clay, weakly sandy along the bedding surface. The thickness is 2.5 m.

Ostracodes have not been found (samples 1-3).

Fatezh Formation

Lower Callovian, *calloviense* Zone, *koenigi* Subzone

(4) Dark gray clay containing interbeds and inclusions of shell detritus and *Cylindroteuthis* and *Pachyteuthis* spp. juv. The thickness is 0.3 m.

Ostracodes have not been found (sample 4).

(5) Bluish dark gray clay with lenticular interlayers of light gray, dense marl in the upper part. The ammonites *Kepplerites gowerianus* (Sow.) and *Proplanulites* sp. and the belemnites *Cylindroteuthis* cf. *okensis* (Nik.) and *Pachyteuthis* sp. were recorded. The thickness is 22.8 m.

Isolated valves of the ostracodes *Nophrecythere catephracta, N. flexicosta, N. zmeinkensis, Procytherura* sp., *Pleurocythere juvenes, Lophocythere interrupta, Parariscus octoporalis* and abundant *Pleurocythere regularis, Praeschuleridea wartae*, and *Lophocythere scabra* were found in samples 5–11.

(6) Bluish gray, dense clay containing the oysters *Gryphaea dilatata* (Sow.) and *G. russiensis* Geras. The thickness is 3 m.

The ostracodes *Lophocythere scabra* and *Parariscus octoporalis* were identified in sample 12.

(7) Bluish gray, dense clay containing abundant *Gryphaea* shells, which often form continuous interbeds. The ammonites *Kosmoceras* ex gr. *enodatum* (Nik.) and *Choffatia* sp.; the belemnite *Cylindroteuthis* cf. *beaumontiana* (d'Orb.); oysters *Gryphaea dilatata* (Sow.), *G. russiense* Geras., and G. *lucerna* Trd.; and other bivalves *Radulopecten laurae* (Et.), *Grammatodon*? sp., *Pleuromya alduini* (Brogn.), *Pholadomya*

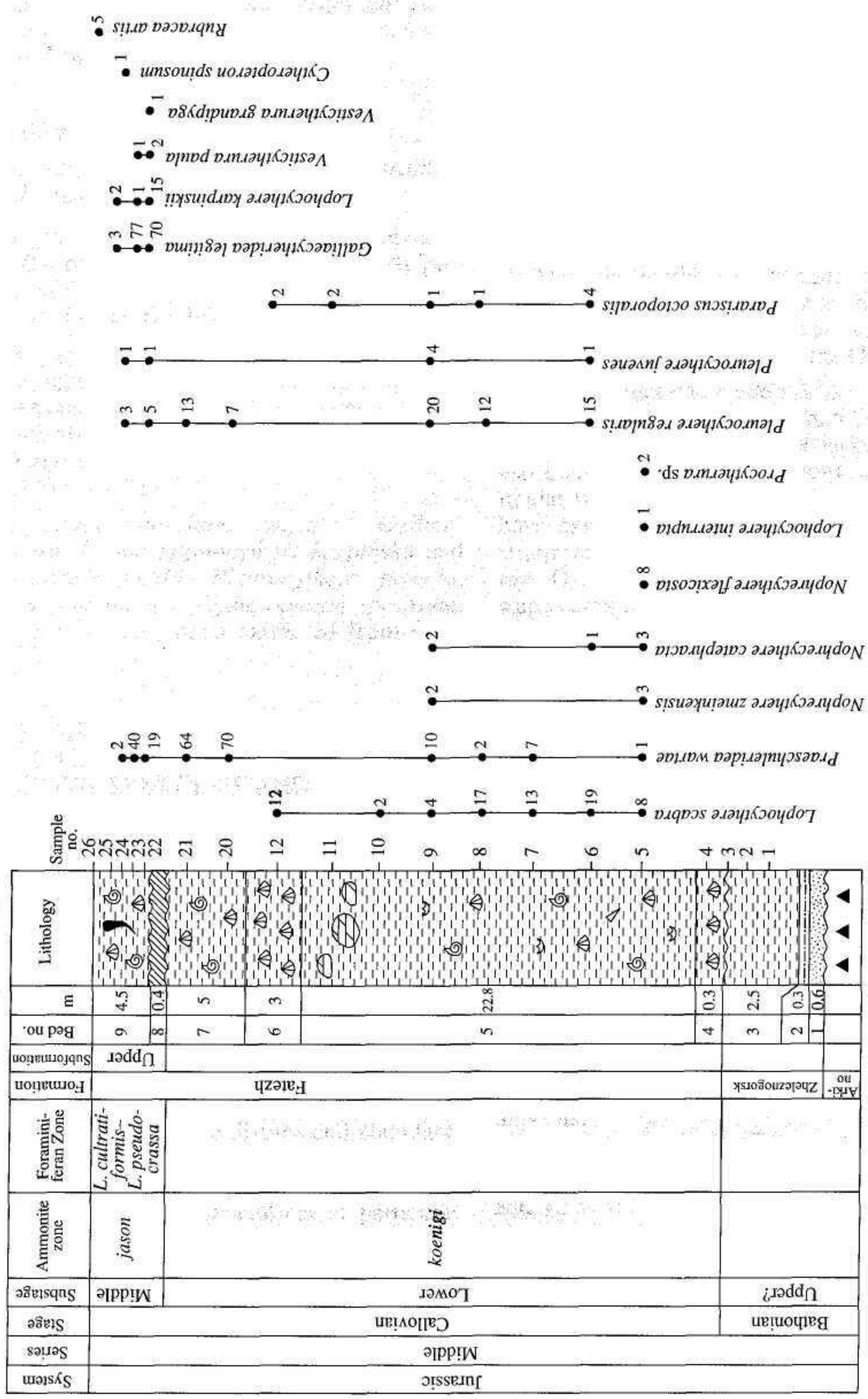


Fig. 15. Distribution of ostracodes through the Mikhailovskii Mine section.

hemicardia Roem., *Modiolus tulipaea* (Lah.), *Trigonia* cf. *elongata* (Sow.), *Trigonia* sp., and *Corbula*? sp. were identified. The thickness is 5 m.

Numerous shells of the ostracodes *Praeschuleridea wartae* and *Pleurocythere regularis* were recorded in samples 13 and 14.

Upper Subformation

Middle Callovian, *jason* Zone, the *L. cultratiformis-L. pseudocrassa* Zone

(8) Light gray, dense marl broken into individual nodules 0.3-0.4 m in diameter. It contains poorly preserved fossils of *Grammatodon*? sp., *Radulopecten* sp., and *Cylindroteuthis* sp. The thickness is 0.4 m.

(9) Bluish gray dense clay, becoming gray and light gray on the weathered surface and containing disperse pyrite concretions, isolated shells and aggregates of shells of the bivalves *Gryphaeadilatata* (Sow.), *G. lucerna* Trd., *Trigonia* cf. *elongata* Sow., and *Pleuromya* sp. The thickness is 4.5 m.

Abundant *Praeschuleridea wartae, Galliaecytheridea legitima,* and *Lophocythere karpinskii* and rare *Vesticytherura paula, Pleurocythere juvenes, P. regularis, V. grandipyga, Cytheropteron spinosum,* and *Rubracea artis* have been extracted from samples 22-26.

CHAPTER 3. DISTRIBUTION OF OSTRACODES IN THE CALLOVIAN AND OXFORDIAN OF THE MOSCOW SYNECLISE AND VORONEZH ANTECLISE (KURSK REGION) AND THEIR STRATIGRAPHIC SIGNIFICANCE

Within the territory studied, ostracodes occur mainly in the Middle and Upper Callovian and Middle Oxfordian. In these deposits, they are present in the majority of sections. Ostracodes are scarce in the Lower Callovian and solitary in the Lower and Upper Oxfordian.

At the same time, ostracode assemblages from the Callovian and Oxfordian substantially differ from each other in their taxonomic composition and abundance. In the Callovian, ostracodes are diverse and abundant. Fifty species of 27 genera have been identified. In the collection, they are represented by 2981 specimens. Certain species reached a high number at particular stratigraphic levels. Thus, 154 valves and complete shells of *Praeschuleridea wartae* were discovered in the Lower Callovian of the Kursk Region; 176 valves and complete shells of *Sabacythere attalicata* were collected in the Upper Callovian of the Kostroma Region; 205 valves and complete shells of *Nophrecythere catephracta* were found in the Upper Callovian of the Moscow Region; and 334 valves and complete shells of *Fastigatocythere rugosa,* 190 valves and complete shells of *Lophocythere karpinskii,* and 374 valves and complete shells of *N. catephracta* were found in the Upper Callovian of the Ryazan Region.

The species diversity of ostracodes decreased abruptly in the Oxfordian. Twenty one species of 11 genera have been recorded there. A total of 477 specimens were collected from the Oxfordian. Except for two species, *Patellacythere nescia* and *Paranotacythere (Unicosta) solei*, all species of the Oxfordian assemblage came from the Callovian. Additionally, the Oxfordian assemblage consists mainly of species having small and medium-sized shells, in contrast to the Callovian assemblage with ostracodes having relatively large shells.

Thus, the number of ostracode species in the Callovian is nearly 2.5 times as great as that in the Oxfordian; the total number of shells that come from the Callovian is six times more than that of the Oxfordian.

Six different ostracode assemblages may be distinguished within the Callovian and Oxfordian. However, the majority of species show a wide stratigraphic range; especially the species that become abundant within particular time intervals. Important is that most of them have essentially different and often wider pattern of stratigraphic distribution beyond the Moscow Syneclise. The species that are characteristic of only one substage occur in a small number of sections and are usually solitary. Therefore, it is very difficult to discover the index species. All these combined with the fact that ostracodes are studied in a small number of sections prevent us from the establishment of zones, but only units ranked as beds with ostracodes. A total of five such units have been recognized.

Callovian

Ostracodes are unevenly distributed in the Callovian. The least rich in ostracodes is the Lower Callovian. Only ten species have been identified in the Lower Callovian; all of them occur in later deposits as well. Twenty six species are known from the Middle Callovian. Six of them passed to the Middle Callovian from the Lower Callovian, and three are recorded in younger beds. Six species are endemic. Only 13 species that appeared in the Middle Callovian passed into later deposits.

The richest in ostracodes is the Upper Callovian. There are 39 species recognized in the Upper Callovian and 12 of them are endemic. Having appeared in the Upper Callovian, seven species passed into the Oxfordian, and eight species came from the Middle Callovian to the Oxfordian. In the Callovian, three stratigraphic units ranked as beds with ostracodes are recognized; they correspond to three substages.

Lower Callovian

Within the territory studied, ostracodes are nearly completely absent from the *elatmae* Zone. In the Samylovo section near the Unzha River, eleven poorly preserved valves identified as Gen. sp. indet. were found in only one of seven samples from clays of the *elatmae* Zone. Ostracodes are not found in the Makar'ev-yuzhnyi section (three samples) and Elat'ma section (two samples). Ostracodes are also absent from the only sample obtained from clays of the *elatmae* Zone in the Kursk Region (Mikhailovskii Mine).

Ostracodes of the younger *calloviense* Zone were studied in the Mikhailovskii Mine section only, where ten samples were collected. A total of 332 well-preserved valves and complete shells were extracted. They belong to ten species, *Lophocythere scabra, L. interrupta, Nophrecythere catephracta, N. flexicosta, N. zmeinkensis, Praeschuleridea wartae, Parariscus octoporalis, Procytherura* sp., *Pleurocythere regularis*, and P. *juvenes*.

Two species, *P. wartae* and *P. regularis,* along with *L. scabra,* which is the third most abundant, are most numerous and constitute the basement of the Callovian assemblage.

According to published data (hereinafter, APPENDIX 1 and Table 4), nearly all ostracode species from the *callovianse* Zone are widespread stratigraphically throughout the Callovian; some species appeared earlier and persisted later. Thus, *L. scabra* is known from the Callovian of Poland and France, Callovian–Lower Oxfordian of Germany, Middle Callovian-Lower Oxfordian of England, Lower and Middle Callovian of Ukraine, and the Middle Callovian of the Voronezh Region; *L. interrupta* occurs in the Middle-Upper Callovian of England and Holland and the Callovian of Germany and Ukraine; *N. catephracta* occurs in the Callovian of Germany, Middle Callovian and Middle Oxfordian of England, Upper Callovian of Poland, Lower Callovian and Upper Oxfordian of Ukraine, and in the Callovian-Middle Oxfordian of the Volga-Ural Region; *N. flexicosta* occurs in the Lower-Middle Callovian of Ukraine and Germany and in the Callovian of Poland; *P. wartae* occurs in the Upper Bajocian–Bathonian of Poland and the Callovian of Ukraine; *P. octoporalis* occurs in the Upper Bajocian–Middle Bathonian of Poland, Middle-Upper Callovian of Holland and the Callovian of Ukraine; P. *regularis* occurs in the Upper Bajocian of Poland, Callovian of Germany, and in the Lower Callovian of Ukraine; and *P. juvenes* occurs in the Lower Callovian of Ukraine.

In the Lower Callovian of the Kursk Region, beds with *Praeschuleridea wartae* and *Pleurocythere regularis* correspond to the *calloviense* Zone (Table 4). The upper boundary may be defined by the appearance of the genera *Paranotacythere (Unicostd), Cytheropteron*, and *Vesticytherura* and the species *Lophocythere karpinskii, Fuhrbergiella archangelskii, Cytherella perennis, Schuleridea translucida, Rubracea artis, Tethysia bathonica, Oligocythereis kostytschevkaensis, Pontocyprella aureola, Pontocypris arcuata, Paracypris stripta, Galliaecytherideaspinosa, G. legitima, Cytherella perennis*, and *Fastigatocythere rugosa* and by the disappearance of *Procytherura* sp., *Parariscus octoporalis*, ***Lophocythere*** *interrupta*, and *Nophrecythere zmeinkensis.*

Middle Callovian

Deposits of the Middle Callovian differ strikingly from those of the Lower Callovian in taxonomic composition and the abundance of ostracodes.

The lower zone of the substage, the *jason* Zone, has been sampled in two sections of the Kostroma Region, Makar'ev-yuzhnyi and Yartsevo. Ostracodes of this zone constitute an insufficiently representative assemblage, consisting of rather scarce species.

In three samples collected in the Makar'ev-yuzhnyi section, only one contains 20 satisfactorily preserved ostracode valves, which belong to six species, *Vesticytherura costaeirregularis, Oligocythereis kostytschevkaensis, Paranotacy there (Unicostd) stauropyga, Nophrecythere catephracta, Schuleridea translucida,* and *Galliaecytheridea spinosa.*

In one of two samples collected in the Yartsevo section, three satisfactorily preserved valves representing two species, *Galliaecytheridea legitima* and *Lophocythere karpinskii,* were found.

However, in the Kursk Region (Mikhailovskii Mine section), 249 well-preserved valves and complete shells belonging to eight species, *Praeschuleridea wartae, Pleurocythere regularis, P. juvenes, Galliaecytheridea legitima, Lophocythere karpinskii, Vesticytherura paula, V. grandipyga,* and *Cytheropteron spinosum*, were found in three of five samples collected in the *jason* Zone.

It is known from published data that *V. paula* is recorded in the Upper Bathonian of Germany, Callovian of the Ukraine, Upper Oxfordian of the Orel Region, Lower Callovian-Middle Volgian of the Volga-Ural Region, and Berriasian–Lower Valanginian of Kolguev Island. *O. kostytschevkaensis* has previously been recorded in the Lower-Middle Oxfordian, Upper Kimmeridgian, and the Lower Volgian Substage of the Volga-Ural Region. Other species are distributed as following. *V. costaeirregularis* is known from the Upper Oxfordian of Scotland, Upper Kimmeridgian of Holland, and Lower Volgian of the Middle Volgian Region; *S. translucida* occurs in the Upper Callovian of Poland, Lower Callovian of Ukraine, and the Middle Callovian of the Volga-Ural Region; *G. spinosa* occurs in the Upper Kimmeridgian–Lower Portlandian of Poland and in the Upper Kimmeridgian of Ukraine; *G. legitima* occurs in the Oxfordian of the Volga Region near Ulyanovsk and the Orel Region; *L karpinskii* occurs in the Middle Callovian of Gemany, Upper Callovian-Lower Oxfordian of Poland, Callovian of Ukraine, and the Lower-Middle Callovian and Lower Oxfordian of the Volga-Ural Region; *C. spinosum* occurs in the Upper Kimmeridgian of Poland, Middle Callovian of Ukraine, and the Middle Callovian-Lower

Oxfodian of the Volga-Ural Region. The only species showing a strictly limited stratigraphic distribution and recorded only in the Middle Callovian is a new one, *P.* (*Unicosta*)*stauropyga*, although it is extremely scarce and found in only one section in the Kostroma Region.

Deposits in the *coronatum* Zone are rich in ostracodes. They are discovered in two sections, Mikhailovtsement, where 150 well-preserved valves and complete shells belonging to nine species were found in one of three samples, and Troshkov vrag, where ostracodes are recorded in each of four samples and include 124 well-preserved valves belonging to 12 species.

This made it possible to distinguish a much more representative ostracode assemblage in the *coronatum* Zone than in the *jason* Zone. A total of 18 species were identified in the former, 12 of them have not been found in the Lower Callovian of the studied territory. *Paranotacythere (Unicostd) pseudoramulosa, Vesticytherura grandipyga, Tethysia bathonica, Galliaecytheridea legitima, Sabacythere bradiana, Lophocythere* karpinskii, *L. scabra, Nophrecythere catephracta, N. flexicosta, Fuhrbergiella archangelskii, Schuleridea translucida, Fastigatocythere rugosa, Cytherella* perennis, *Paracypris stripta, Rubracea artis, Pontocypris arcuata, Pontocyprella aureola,* and *Cytheropteron spinosum* have been found.

The occurrences of the species registered in these strata are as follows: *T. bathonica* is known from the Upper Bathonian of France and Germany; *S. bradiana* is known from the Bathonian of England, Lower Callovian of France, and from the Upper Oxfordian of the Dnieper-Donets Depression; *F. archangelskii* is known from the Lower Callovian–Lower Oxfordian of England, Middle-Upper Callovian of Holland, Lower Callovian of France, Bajocian of Germany, Middle Callovian-Lower Oxfordian of the Dnieper-Donets Depression, Middle Callovian-Lower Oxfordian of the Middle Volga Region, and from the Upper Callovian of Poland and the Timan-Pechora Region; *F. rugosa* is known from the Lower Callovian of Germany and the Callovian of Ukraine; *C. perennis* is known from the Upper Bajocian–Bathonian of Poland and the Upper Bajocian of Ukraine; *P. stripta* is known from the Upper Bathonian of Germany and the Oxfordian and Kimmeridgian of Ukraine; *R. artis* is known from the Middle Callovian of Scotland, Upper Callovian of Poland, Oxfordian of Ukraine, and from the Callovian of the Saratov Region; *P. arcuata* is known from the Lower Oxfordian and Middle Volgian of the Volga-Ural Region; *P. aureola* is known from the Upper Bathonian of Germany, Oxfordian of Ukraine, and from the Middle Callovian–Oxfordian of the Samarskaya Luka.

A total of 26 ostracode species are registered in deposits of the *jason* and *coronatum* zones; the most typical of the Middle Callovian in the central regions of the Russian Plate are *Nophrecythere flexicosta, Galliaecytheridea legitima, Pleurocythere regularis, Rubracea artis, Schuleridea translucida, Fastigatocythere rugosa, Lophocythere karpinskii,* and *Nophrecythere catephracta.*

A characteristic ostracode assemblage allows one to distinguish beds with *Paranotacythere (Unicostd) stauropyga* and *Galliaecytheridea legitima* in the Middle Callovian of the studied territory. These beds are recognized by the presence of *Pontocypris arcuata, Galliaecytheridea spinosa, Sabacythere bradiana, Paracypris stripta, Paranotacythere (Unicostd) stauropyga,* and *Oligocythereis kostytschevkaensis.* The lower boundary may be defined by the appearance of the genera *Paranotacythere (Unicostd), Cytheropteron,* and *Vesticytherura* and the species *Lophocythere karpinskii, Schuleridea translucida, Rubracea artis, Tethysia bathonica, Pontocyprella aureola, Galliaecytheridea legitima, Cytherella perennis,* and *Fastigatocythere rugosa.*

Upper Callovian

Upper Callovian deposits were studied in the Peski, Zmeinka, and Mikhailovtsement sections.

The Upper Callovian is much richer in ostracodes than the Lower and Middle Callovian. Thus, 673 well-preserved valves and complete shells belonging to 15 species were found in seven of nine samples collected in the *Epistomina elschankaensis–Lenticulina tumida* Forminiferan Zone in the Mikhailovtsement section. In the Zmeinka section, 780 well preserved valves and complete shells belonging to 15 species were found in 11 of 14 samples collected from the *lamberti* Zone. In the Peski section, 514 valves and complete shells belonging to 32 species were found in 13 of 15 samples from the *lamberti* Zone.

The Upper Callovian ostracode assemblage is the most representative. In addition to endemic Upper Callovian species, it includes 15 species known from the Middle Callovian. A total of 38 ostracode species have been identified from the *lamberti* Zone, i.e., *Vesticytherura rectodorsalis, V. scottia, V. paula, V. grandipyga, V. acostata, V. costaeirregularis, Paranotacythere (Unicostd) pseudoramulosa, Tethysia bathonica, Procytherura* sp., *P. tenuicostata, Exophthalmocytherepilosa, Cytheropteron laeve, C. spinosum, C. pseudospinosum, Nophrecythere alata, N. catephracta, N. zmeinkensis, N. flexicosta, N. oxfordiana, Cytherella oblonga, C. perennis, Fuhrbergiella archangelskii, Lophocythere karpinskii, L. interrupta, L. scabra, Balowella attendens, Sabacythere attalicata, S. rubra, Galliaecytheridea legitima, Infacythere dulcis, Pontocyprella vescusa, Parariscus octoporalis, Paracypris lubrica, Patellacythere trepti, Patellacythere* sp., *Ljubimovella* sp., *Palaeocytheridea baculumbajula, Fastigatocythere rugosa,* and *Schuleridea translucida* (Table 4).

N. catephracta, F. rugosa, L. karpinskii, F. archangelskii, B. attendens, and *S. translucida* are most abundant in the Upper Callovian.

Oxfodian of the Volga-Ural Region. The only species showing a strictly limited stratigraphic distribution and recorded only in the Middle Callovian is a new one, *P.* (*Unicosta*)*stauropyga*, although it is extremely scarce and found in only one section in the Kostroma Region.

Deposits in the *coronatum* Zone are rich in ostracodes. They are discovered in two sections, Mikhailovtsement, where 150 well-preserved valves and complete shells belonging to nine species were found in one of three samples, and Troshkov vrag, where ostracodes are recorded in each of four samples and include 124 well-preserved valves belonging to 12 species.

This made it possible to distinguish a much more representative ostracode assemblage in the *coronatum* Zone than in the *jason* Zone. A total of 18 species were identified in the former, 12 of them have not been found in the Lower Callovian of the studied territory. *Paranotacythere (Unicostd) pseudoramulosa, Vesticytherura grandipyga, Tethysia bathonica, Galliaecytheridea legitima, Sabacythere bradiana, Lophocythere karpinskii, L. scabra, Nophrecythere catephracta, N. flexicosta, Fuhrbergiella archangelskii, Schuleridea translucida, Fastigatocythere rugosa, Cytherella perennis, Paracypris stripta, Rubracea artis, Pontocypris arcuata, Pontocyprella aureola,* and *Cytheropteron spinosum* have been found.

The occurrences of the species registered in these strata are as follows: *T. bathonica* is known from the Upper Bathonian of France and Germany; *S. bradiana* is known from the Bathonian of England, Lower Callovian of France, and from the Upper Oxfordian of the Dnieper-Donets Depression; *F. archangelskii* is known from the Lower Callovian–Lower Oxfordian of England, Middle-Upper Callovian of Holland, Lower Callovian of France, Bajocian of Germany, Middle Callovian-Lower Oxfordian of the Dnieper-Donets Depression, Middle Callovian-Lower Oxfordian of the Middle Volga Region, and from the Upper Callovian of Poland and the Timan-Pechora Region; *F. rugosa* is known from the Lower Callovian of Germany and the Callovian of Ukraine; *C. perennis* is known from the Upper Bajocian-Bathonian of Poland and the Upper Bajocian of Ukraine; *P. stripta* is known from the Upper Bathonian of Germany and the Oxfordian and Kimmeridgian of Ukraine; *R. artis* is known from the Middle Callovian of Scotland, Upper Callovian of Poland, Oxfordian of Ukraine, and from the Callovian of the Saratov Region; *P. arcuata* is known from the Lower Oxfordian and Middle Volgian of the Volga-Ural Region; *P. aureola* is known from the Upper Bathonian of Germany, Oxfordian of Ukraine, and from the Middle Callovian–Oxfordian of the Samarskaya Luka.

A total of 26 ostracode species are registered in deposits of the *jason* and *coronatum* zones; the most typical of the Middle Callovian in the central regions of the Russian Plate are *Nophrecythere flexicosta, Galliaecytheridea legitima, Pleurocythere regularis, Rubracea artis, Schuleridea translucida, Fastigatocythere rugosa, Lophocythere karpinskii*, and *Nophrecythere catephracta.*

A characteristic ostracode assemblage allows one to distinguish beds with *Paranotacythere* (*Unicosta*)*stauropyga* and *Galliaecytheridea legitima* in the Middle Callovian of the studied territory. These beds are recognized by the presence of *Pontocypris arcuata, Galliaecytheridea spinosa, Sabacythere bradiana, Paracypris stripta, Paranotacythere (Unicostd) stauropyga,* and *Oligocythereis kostytschevkaensis.* The lower boundary may be defined by the appearance of the genera *Paranotacythere (Unicostd), Cytheropteron,* and *Vesticytherura* and the species *Lophocythere karpinskii, Schuleridea translucida, Rubracea artis, Tethysia bathonica, Pontocyprella aureola, Galliaecytheridea legitima, Cytherella perennis,* and *Fastigatocythere rugosa.*

Upper Callovian

Upper Callovian deposits were studied in the Peski, Zmeinka, and Mikhailovtsement sections.

The Upper Callovian is much richer in ostracodes than the Lower and Middle Callovian. Thus, 673 well-preserved valves and complete shells belonging to 15 species were found in seven of nine samples collected in the *Epistomina elschankaensis–Lenticulina tumida* Forminiferan Zone in the Mikhailovtsement section. In the Zmeinka section, 780 well preserved valves and complete shells belonging to 15 species were found in 11 of 14 samples collected from the *lamberti* Zone. In the Peski section, 514 valves and complete shells belonging to 32 species were found in 13 of 15 samples from the *lamberti* Zone.

The Upper Callovian ostracode assemblage is the most representative. In addition to endemic Upper Callovian species, it includes 15 species known from the Middle Callovian. A total of 38 ostracode species have been identified from the *lamberti* Zone, i.e., *Vesticytherura rectodorsalis, V. scottia, V. paula, V. grandipyga, V. acostata, V. costaeirregularis, Paranotacythere (Unicostd) pseudoramulosa, Tethysia bathonica, Procytherura* sp., *P. tenuicostata, Exophthalmocythere pilosa, Cytheropteron laeve, C. spinosum, C. pseudospinosum, Nophrecythere alata, N. catephracta, N. zmeinkensis, N. flexicosta, N. oxfordiana, Cytherella oblonga, C. perennis, Fuhrbergiella archangelskii, Lophocythere karpinskii, L. interrupta, L. scabra, Balowella attendens, Sabacythere attalicata, S. rubra, Galliaecytheridea legitima, Infacythere dulcis, Pontocyprella vescusa, Parariscus octoporalis, Paracypris lubrica, Patellacythere trepti, Patellacythere* sp., *Ljubimovella* sp., *Palaeocytheridea baculumbajula, Fastigatocythere rugosa,* and *Schuleridea translucida* (Table 4).

N. catephracta, F. rugosa, L. karpinskii, F. archangelskii, B. attendens, and *S. translucida* are most abundant in the Upper Callovian.

The occurrence of species from the Upper Callovian of the Moscow Syneclise beyond its boundaries is as follows: *Cytherella oblonga* is known from the Upper Bathonian of Germany, Upper Callovian of Poland, and from the Upper Bajocian of Ukraine; *Pontocyprella vescusa,* from the Oxfordian of Ukraine; *Paracypris lubrica,* from the Volgian of Ukraine and from the Middle Volgian of the Volga-Ural Region; *Patellacythere trepti* is known from the Upper Oxfordian of France, Ukraine, and the Voronezh Region; *Balowella attendens* is known from the Upper Bajocian-Middle Callovian of Ukraine and from the Middle Callovian of the Volga-Ural Region; *Palaeocytheridea baculumbajula* is known from the Oxfordian of Ukraine and from the Upper Kimmeridgian of the Volga-Ural Region; *Sabacythere attalicata* is known from the Upper Callovian of Kazakhstan (Emba), Callovian–Upper Kimmeridgian of the Volga-Ural Region, and from the Oxfordian of Ukraine; *S. rubra* is known from the Upper Callovian of Poland, Callovian–Lower Oxfordian of the Volga-Ural Region, and from the Lower Callovian of Ukraine; *Nophrecythere alata* is known from the Upper Callovian of England and the Middle Callovian of Ukraine; *N. oxfordiana* is known from the Lower and Middle Oxfordian of Germany and Poland and from the Oxfordian of the Dnieper–Donets Depression; *Infacythere dulcis* is an index form of the Upper Callovian of the Dnieper-Donets Depression, the Middle Volga Region, and Germany; *Procytherura tenuicostata* is recorded in the Lower-Middle Oxfordian of England and in the Callovian of Ukraine; *Vesticytherura rectodorsalis* occurs in the Upper Bathonian of Germany and in the Upper Bajocian–Bathonian of Poland; *V. scottla* occurs in the Middle Callovian–Lower Oxfordian of Scotland and in the Kimmeridgian and Ryazanian of Holland.

On the basis of analysis of the above assemblage, the Upper Callovian of the Moscow Syneclise may be recognized as beds with *Infacythere dulcis.*

The following species are unique to this interval: *Infacythere dulcis, Pontocyprella vescusa, Cytherella oblonga, Paracypris lubrica, Balowella attendens, Patellacy there trepti, Palaeocytheridea baculumbajula, Nophrecythere alata, Ljubimovella* sp., *Procytherura tenuicostata,* and *Vesticytherura rectodorsalis.*

Additionally, the lower boundary of these beds may be indicated by the disappearance of such Middle Callovian species as *Paranotacythere* (*Unicosta*) *stauropyga, Pleurocythere regularis, P. juvenes, Praeschuleridea wartae, Rubracea artis, Pontocyprella aureola, Pontocypris arcuata, Galliaecytheridea spinosa, Paracypris stripta,* and *Oligocythereis kostytschevkaensis* and by the appearance of the characteristic Upper Callovian species as well as species which persist into later period, i.e., *Cytheropteron pseudospinosum, C. laeve, Vesticytherura scottia, V. acostata, Sabacythere attalicata, S. rubra, Patellacy there* sp., and *Exophthalmocythere pilosa.* It is important to note that *Procytherura* sp., *Parariscus octoporalis, Lophocythere interrupta*, and *Nophrecythere zmeinkensis*, having disappeared at the boundary between the Lower and Middle Callovian reappear again in the Upper Callovian.

Oxfordian

The ostracode assemblage from the Oxfordian is completely different from that of the Callovian. In the Lower Oxfordian, the number of ostracode species underwent a threefold decrease compared to that in the Upper Callovian. Only 12 species that occurred in the Callovian and persisted later were identified there. New taxa are absent. Apparently, this is connected with a considerable deepening of the basin at the beginning of the Oxfordian, which is evidenced by planctonic foraminifers (Gorbachik and Kuznetsova, 1997). This deepening was accompanied by the development of stagnant conditions (bituminous shales) and, consequently, impaired aeration of the near-bottom water and produced unfavorable conditions for ostracodes. The deepening of the basin at the end of the Callovian and in the Oxfordian is also supported by the change in the palynoflora at the boundary between these stages in the Moscow Syneclise (Smirnova *et al.*, 1999). In the Middle Oxfordian, ostracodes became more diverse; 20 species have been found. Only one form is confined to the Middle Oxfordian, whereas the rest occur in the Callovian and (or) Lower Oxfordian. In the Upper Oxfordian, the number of species decreased again; only nine species have been recorded. All of them are known in older intervals of the Oxfordian and Callovian of the Moscow Syneclise.

In the Oxfordian, small ostracodes of the genera *Vesticytherura, Paranotacythere (Unicostd), Exophthalmocythere*, and *Cytheropteron* began to play a special role. Since large (0.8-1 mm) ostracodes decreased in number, the ratio of small (0.3-0.4 mm) forms increased sharply beginning with the Lower Oxfordian. The exception is *Sabacythere attalicata* having a relatively large shell, which along with small-sized *Vesticytherura costaeirregularis* and *V acostata* dominated the Lower and Middle Oxfordian. These species reached their maximum abundance in the Middle Oxfordian of the Moscow Region, where the species *S. attalicata, V. costaeirregularis,* and *V. acostata* are represented by 64, 52, and 31 valves and complete shells, respectively.

Lower Oxfordian

Lower Oxfordian deposits were studied in the Peski, Zmeinka, Mikhailovtsement, Yartsevo, and Makar'evyuzhnyi sections.

Five samples were collected from clays of the *Ophthalmidium sagittum–Epistomina volgensis* Foraminiferal Zone in the Peski section. Ostracodes are registered in one sample only (sample 17). These are four satisfactorily preserved valves belonging to three spe-

Table 4. Stratigraphic distribution of studied ostracodes

Stages, substages	Bajocian	Bathonian			Callovian			Oxfordian			Kimmeridgian		Volgian	
Ostracode species	Upper	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Upper	Lower	Middle
Praeschuleridea wartae					—	—								
Pleurocythere regularis					—	—								
P. juvenes					—	—								
Procytherura sp.					—		—							
Parariscus octoporalis					—		—							
Nophrecythere zmeinkensis					—		—							
Lophocythere interrupta					—		—							
Nophrecythere flexicosta					—	—	—							
Lophocythere scabra					—	—	—							
Nophrecythere catephracta					—	—	—	—	—					
Pontocypris arcuata						—								
Pontocypris stripta						—								
Galliaecytheridea spinosa						—								
Oligocythereis kostytschevkaensis						—								
Sabacythere bradiana						—								
Paranotacythere (Unicosta) stauropyga						—								
Lophocythere karpinskii						—	—							
Galliaecytheridea legitima						—	—							
Schuleridea translucida						—	—							
Fastigatocythere rugosa						—	—							
Fuhrbergiella archangelskii						—	—							
Cytherella perennis						—	—		—					
Cytheropteron spinosum						—	—		—					
Vesticytherura grandipyga						—	—		—					
Tethysia bathonica						—	—		—	—				
Rubracea artis						—		—	—	—				
Pontocyprella aureola						—		—	—	—				
*Vesticytherura paula**						—	—	—	—	—				
Paranotacythere (Unicosta) pseudoramulosa						—	—	—	—	—				
Vesticytherura costaeirregularis						—	—	—	—	—				
Paracypris lubrica							—							
Patellacythere trepti							—							
Palaeocytheridea baculumbajula							—							
Nophrecythere alata							—							
Ljubimovella sp.							—							
Procytherura tenuicostata							—							
Vesticytherura rectodorsalis							—							
Cytherella oblonga							—							

Table 4. (Contd.)

Stages, substages	Bajocian	Bathonian			Callovian			Oxfordian			Kimmeridgian		Volgian	
Ostracode species	Upper	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Upper	Lower	Middle
Balowella attendens	—	—	—	—	—	—	▬							
Infacythere dulcis							▬							
Pontocyprella vescusa							▬	—	—	—				
Nophrecythere oxfordiana							▬	—	—	—				
Patellacythere sp.							▬	▬						
*Vesticytherura scottia***						—	▬	—	▬		—	—		
Sabacythere rubra					—	—	▬	—	▬					
Sabacythere attalicata					—	—	▬	▬	▬	—	—	—		
Cytheropteron pseudospinosum							▬	▬	▬					
Exophthalmocythere pilosa							▬			▬				
Vesticytherura acostata							▬	▬	▬	▬				
Cytheropteron laeve							▬	▬	▬	▬				
Paracypris terraefullonica							—	▬	▬		—	—	—	—
Patellacythere nescia								—	▬	—			—	
Sabacythera sp.									▬					
Paranotacythere (Unicosta) solei									▬					
Beds with ostracodes					*Praeschuleridea wartae–Pleurocythere regularis*	*Galliaecytheridea legitima–Paranotacythere (Unicosta) stauropyga*	*Infacythere dulcis*	*Sabacythere attalicata–Vesticytherura costaeirregularis*	*Paranotacythere (Unicosta) solei*					

▬ Distribution in studied sections.
— Distribution according to the literature data.
* Species recorded also in the upper Berriasian and lower Valanginian.
** Species recorded also in the Ryazanian Horizon.

cies, *Nophrecythere catephracta*, *Paracypris terraefullonica*, and *Vesticytherura costaeirregularis*. Two samples from the clays of the *mariae* Zone in the Zmeinka section are barren of ostracodes. Eight samples were collected from clays of the *Ophthalmidium sagittum–Epistomina volgensis* Zone in the Mikhailovtsement section. In four lower samples (32-35), only 18 isolated valves belonging to two species, *Vesticytherura costaeirregularis* and *Sabacythere attalicata*, are registered. The rest of the samples are barren of ostracodes. Four samples were collected from the Lower Oxfordian *cordatum* Zone of the Yartsevo section; ostracodes were present in each sample. A total of 230 well-preserved valves and complete shells have been identified; they belong to six species, *Vesticytherura acostata*, *V. costaeirregularis*, *V. paula*, *Sabacythere attalicata*, *Paracypris terraefullonica*, and *Paranotacythere (Unicosta) pseudoramulosa*. Three samples were collected from the Lower Oxfordian (*cordatum* Zone) in the Makar'ev-yuzhnyi section; all of them contain ostracodes. These are 74 well-preserved valves and complete shells of eight species, *Vesticytherura acostata, V. costaeirregularis, Paranotacythere (Unicosta) pseudoramulosa, Sabacythere attalicata, Rubracea artis, Cytheropteron pseudospinosum, Pontocyprella aureola,* and *Patellacythere* sp.

S. attalicata and small-sized *V. costaeirregularis* dominate the Lower Oxfordian assemblage.

In the Lower Oxfordian, beds with *Sabacythere attalicata* and *Vesticytherura costaeirregularis* are distinguished on the basis of domination of these species. The lower boundary of these beds coincides with the Callovian–Lower Oxfordian boundary and may be easily recognized by the disappearance of the vast majority of the Callovian species that are typical of this region (Table 4). Additionally, the first appearance of *Paracypris terraefullonica* known in the Kimmeridgian and Volgian of Ukraine, Upper Callovian of Poland, and in the Upper Bathonian of Germany is recorded at this boundary; *Rubracea artis* and *Pontocyprella aureola* secondarily appear there.

Middle Oxfordian

Middle Oxfordian deposits were sampled for ostracodes in the Peski, Makar'ev-yuzhnyi, Samylovo, and Yartsevo sections.

In Peski, 14 samples were collected from the clays of the *Ophthalmidium strumosum–Lenticulina brestica* Zone; ostracodes occurred in 11 of them. A total of 220 well-preserved valves and complete shells were identified; they belong to 14 species, i.e., *Sabacythere attalicata, S. rubra, Sabacythere* sp., *Vesticytherura costaeirregularis, V. grandipyga, V. paula, V. acostata, Paranotacythere* (*Unicosta*) *solei, Tethysia bathonica, Cytheropteron spinosum, C. laeve, Paracypris terraefullonica, Cytherella perennis,* and *Nophrecythere catephracta.*

Small-sized species dominate; large shells of the genera *Lophocythere, Fuhrbergiella,* and *Schuleridea* are completely absent. 5. *attalicata* and *V. costaeirregularis* are most abundant.

In Makar'ev-yuzhnyi, two samples were collected from the *densiplicatum* Zone and one was from the *tenuiserratum* Zone; ostracodes occur in all of them. These are 19 well-preserved valves belonging to nine species, *Vesticytherura costaeirregularis, V. acostata, V. scottia, V. paula, V. grandipyga, Rubracea artis, Paranotacythere (Unicosta) pseudoramulosa, Pontocyprella aureola,* and *Patellacythere nescia.*

Vesticytherura costaeirregularis, V. acostata, Pontocyprella aureola, Sabacythere attalicata, and *Cytheropteron pseudospinosum* are identified from the clay of the *O. strumosum–L. brestica* Zone in the Samylovo section. *S. attalicata* and *V. acostata* are the most abundant and are represented by 41 and 18 valves, respectively. *V. costaeirregularis* is represented by 13 valves, the rest of the species are singular.

In the Yartsevo section, one sample was taken from each of the *densiplicatum* and *tenuiserratum* zones. In the lower zone, 18 valves of two species, *V. costaeirregularis* and *V. acostata,* were recorded. In the upper zone, 24 valves of four species, *V. costaeirregularis, V. acostata, V. grandipyga,* and *Pontocyprella aureola,* occurred. Preservation is fine in all the cases.

A total of 20 species have been found in the Middle Oxfordian. All but two Middle Oxfordian species passed from the Callovian; however, six of them, *C. perennis, S. rubra, T. bathonica, V. scottia, V. grandipyga,* and *C. spinosum,* were absent from the Lower Oxfordian, and appeared again in the Middle Oxfordian. Eight species passed into the Upper Oxfordian. Three species, *P. (Unicosta) solei, Sabacythere* sp., and *P. nescia* are endemic to the Middle Oxfordian. The species *P. nescia* is also recorded in the Oxfordian of Ukraine and the Lower Volgian of the Volga-Ural Region.

An analysis of ostracode distribution in the Middle Oxfordian of the sections studied provides the basis for the establishment of these deposits as the beds with *Paranotacythere (Unicosta) solei.*

The beds are recognized by the presence of *P. (Unicosta) solei, Sabacythere* sp., and *P. nescia.* Additionally, the lower boundary of these beds is defined by the secondary appearance of *S. rubra, C. perennis, C. spinosum, T. bathonica, V. grandipyga,* and *V. scottia.* The upper boundary is defined by the disappearance of *C. pseudospinosum, C. spinosum, Cyth. perennis, V. grandipyga, V. scottia, S. attalicata, S. rubra,* and *P. terraefullonica.*

Upper Oxfordian

Upper Oxfordian ostracodes were studied in the Yartsevo and Makar'ev-yuzhnyi sections only.

In Makar'ev-yuzhnyi, a sample containing one *Tethysia bathonica* valve was collected in the clay of the *alternoides* Zone. Similarly, one sample was taken from the *serratum* Zone; it contains 16 isolated ostracode valves belonging to seven species, *Vesticytherura costaeirregularis, V. acostata, Rubracea artis, Paranotacythere (Unicosta) pseudoramulosa, Cytheropteron laeve, Tethysia bathonica,* and *Exophthalmocythere pilosa.*

In the Yartsevo section, four satisfactorily preserved valves belonging to three species, *Vesticytherura acostata, V. paula,* and *Pontocyprella aureola,* were found in one of two samples taken from the *alternoides* Zone. Likewise, four valves of *Vesticytherura acostata, Paranotacythere (Unicosta) pseudoramulosa,* and *Tethysia bathonica* were found in one of three samples taken from the *serratum* Zone. Two samples from the *ravni* Zone were barren of ostracodes.

In general, the Upper Oxfordian ostracode assemblage is rather poor, containing nine species passing from the underlying deposits; it includes *Pontocyprella* *aureola, Rubracea artis, Cytheropteron laeve, Exophthalmocytherepilosa, Vesticytherura costaeirregularis, V. paula, V. acostata, Tethysia bathonica*, and *Paranotacythere* (*Unicosta*) *pseudoramulosa*. All but one species come from the Middle Oxfordian; the exception is *E, pilosa*, which is recorded in the Upper Callovian, absent from the Lower and Middle Oxfordian, and appears again in the Upper Oxfordian. All members of the assemblage are represented by isolated specimens.

The author failed to establish beds with ostracodes distinctive of the upper substage.

CHAPTER 4. CORRELATION OF CALLOVIAN AND OXFORDIAN DEPOSITS OF THE MOSCOW SYNECLISE AND THE VORONEZH ANTECLISE (KURSK REGION) BASED ON OSTRACODES

4.1. Comparison of the Studied Assemblages with Contemporaneous Assemblages from an Adjacent Area and Western Europe

The majority of ostracode species discovered in the Callovian and Oxfordian of the central regions of the Russian Plate are characterized by wide stratigraphic ranges. For example, *Sabacythere bradiana* is known from the Bathonian to Oxfordian; *N. catephracta*, from the Lower Callovian to Upper Oxfordian; *Praeschuleridea wartae*, from the Upper Bajocian to Upper Callovian; etc. In addition, the same species may occur in different regions at different stratigraphic levels; in particular, *Tethysia bathonica* is typical of the Upper Bathonian of Western Europe and identified in the Middle and Upper Callovian of the Moscow Syneclise. All these factors combined make ostracodes a difficult group for detailed stratification as well as for correlation, especially distant correlation.

At the same time, such species as *Pleurocythere juvenes, Lophocythere interrupta, L. scabra, Nophrecythere flexicosta*, and *N. catephracta* occur everywhere in the Lower Callovian, including the sections studied, and may be used as good indicators of the Callovian. There are two such species in the Middle Callovian, *Cytheropteron spinosum*, and *Nophrecythere alata. Infacythere dulcis* is confined to the Upper Callovian of both eastern and western Europe.

Taking into account all the above and relying on all the available data on the ostracodes of Europe (published data and our own material), we have correlated to a precision of substage the studied ostracode assemblages of the Moscow Syneclise with those of other regions. It turns out that such a comparison is not possible for the Lower and Middle Oxfordian of the Volga-Ural Region, Dnieper-Donets Depression, and northwestern marginal areas of the Donets Basin. This is associated with a completely different subdivision of the Oxfordian (into two substages) by earlier researchers who treated the lower and middle substages as the Lower Oxfordian. Therefore, the data on ostracodes from two lower substages of the Oxfordian of the Volga-Ural Region and Ukraine are absent. In Appendix 1, the assignment of ostracodes to the Lower (ox1) or Upper (ox2) Oxfordian is given after Lübimova and Permyakova and according to their viewpoints (Liibimova, 1955a, 1955b, 1956; Permyakova, 1975b; Pyatkova and Permyakova, 1978).

Despite the absence of a comparison of the lower and middle substages of the Oxfordian, the essential distinction of the Oxfordian ostracode assemblages of the Volga-Ural Region and Ukraine from that of central Russia should be emphasized. This distinction is manifested in a remarkable increase in species diversity in the Oxfordian compared to the Callovian of Ukraine (Permyakova, 1975b) and the Volga-Ural Region (Liibimova, 1955b), while in the Moscow Syneclise, the diversity abruptly decreases.

The calculation of ostracode species through substages is based on two assumptions. First, when we came across a bibliographic reference that a species was recorded in the Callovian or Oxfordian as a whole, we assumed that it existed in each substage (except for the Lower and Middle Oxfordian of the Volga-Ural Region and Ukraine). Second, if a species was recorded, for example, from the Middle Callovian or Upper Oxfordian of a particular region, we assumed that it existed in each substage from the Middle Callovian to the Upper Oxfordian.

In the Early Callovian, marine ostracodes were not evenly distributed throughout Europe; the species diversity also varied in different regions. Ostracodes have not been registered in the Early Callovian of Holland; only seven species are recorded in Germany; six species occur in both England and Poland. The most representative is the French list, including 18 identified species. In eastern Europe, the richest in Early Callovian ostracodes is the Dnieper-Donets Depression yielding 24 species. Eleven species are recorded in the Lower Callovian of each of northwestern marginal regions of the Donets Basin, the Kursk Region, and the Timan-Pechora Province. Nine species are known in the Middle Volga Region; and four species occur in the Saratov Region. The Obshchii Syrt, Emba, Voronezh, Orel, Ryazan, Moscow, and Kostroma regions and Mordovia are not characterized by Early Callovian ostracodes.

Comparison of the Lower Callovian ostracode assemblage (*calloviense* Zone) from the Kursk Region with contemporaneous assemblages from other regions (Table 5) shows that it is closely similar to those of the Dnieper-Donets Depression (seven common species) and Germany (five common species) and has no common species with the assemblages from the Timan-Pechora Region and England. *N. catephracta* occurs most frequently (in the Dnieper-Donets Depression, northwestern marginal region of the Donets Basin, the Middle Volga Region, and Germany).

Table 5. Lower Callovian ostracode species common to the Kursk Region (the central part of the Voronezh Anteclise) and coeval assemblages of adjacent areas and Western Europe

Kursk Region	1	2	3	4	5	6	7	8
Nophrecythere catephracta			+		+	+	+	
N. flexicosta			+	+	+			
Lophocythere scabra		+	+	+	+			
L. interrupta			+		+			
Pleurocythere juvenes					+	+		
P. regularis			+			+		
Praeschuleridea wartae					+			
Parariscus octoporalis					+			
Nophrecythere zmeinkensis								
Procytherura sp.								

Caption: 1. England, 2. France, 3. Germany, 4. Poland, 5. Dnieper-Donets Depression, 6. northwestern marginal areas of the Donets Basin, 7. Middle Volga Region, 8. Timan-Pechora Region.

Since *Pleurocythere regularis* has not been recorded in the Dnieper-Donets Depression and the species that first appears in the Moscow Syneclise in the Middle Callovian are also known in the literature from other stratigraphic levels, it is impossible to trace beds with *Pr. wartae–Pl. regularis,* which are recognized in the present study in the Lower Callovian, in the Dnieper-Donets Depression and other regions. Consequently, these beds are valid within the Kursk Region only.

Due to transgression in the Middle Callovian, the number of ostracode species increased in all regions, and faunal links between various parts of the basin became stronger. In the Middle Callovian, the Moscow Syneclise was inhabited by the richest ostracode fauna, including 26 known species. In the Dnieper-Donets Depression, 23 species are identified; in the Middle Volga Region, 16 species are recorded; in the Kursk Region, there are 11 species; three species have been registered in each of the northwestern marginal region of the Donets Basin and the Voronezh Region; two species are identified in the Emba Region. Obshchii Syrt and the Orel Region are barren of Middle Callovian ostracodes. In western Europe, the richest assemblage is recorded in England; it consists of 20 species. Eight species are identified in Germany and France; seven occur in Holland; and five occur in Poland.

Middle Callovian ostracode assemblages of the Moscow Syneclise and the Voronezh Anteclise have the highest number of common species with assemblages of the Dnieper-Donets Depression (10 species) and the Middle Volga Region (7 species); the least number of common species is recorded between them and the ostracode assemblages of Holland, France, and Emba; assemblages of the Moscow Syneclise and the Voronezh Anteclise have no common species with assemblages of the Timan-Pechora Region and the northwestern marginal region of the Donets Basin (Table 6).

Nophrecythere catephracta, N. flexicosta, Lophocythere scabra, and *Fuhrbergiella archangelskii* have especially wide ranges in both eastern and western Europe. Such species as *Lophocythere karpinskii* and *Schuleridea translucida* are wide spread in the Middle Callovian of eastern Europe only.

The lower boundary of beds with *P.* (*U.*) *stauropyga-G. legitima* is traced in eastern Europe (beyond the Moscow Syneclise) by the occurrence of *C. spinosum, P. aureola,* and *F. archangelskii,* and the upper boundary may be defined by the occurrence of *Infacythere dulcis.* However, *C. spinosum* and *P. aureola* have not been recorded in Western Europe; *F. archangelskii* has been known since the Lower Callovian. Thus, the beds with *P.* (*U.*) *stauropyga-G. legitima* established in the Middle Callovian of the central regions of the Russian Plate may be traced only within the Middle Volga Region and the Dnieper-Donets Depression.

In the Late Callovian, the diversity of ostracode species reached its maximum in all regions. In the Moscow Syneclise, 39 species were identified; in England, 22 species were recorded; 19 species were found in Poland; 16 occurred in the Middle Volga Region; 14 occurred in the Dnieper-Donets Depression; ten occurred, in France; eight occurred, in the Timan-Pechora Region; seven species each are recorded in both Holland and Germany; one species was found in the Voronezh Region and one in the northwestern marginal region of the Donets Basin. Obshchii Syrt, Emba, and Orel and the Kursk regions lack Upper Callovian ostracodes.

In this stratigaphic interval, the ostracode assemblage of the Moscow Syneclise has maximum common elements with the assemblage of the Dnieper-Donets Depression (eight species) and with assemblages of Poland and the Middle Volga Region (seven species). The least number of shared forms is recorded with

Table 6. Middle Callovian ostracode species common to the Moscow Syneclise (Ryazan and Kostroma regions and Mordovia) and the Voronezh Anteclise (Kursk Region) and coeval assemblages of adjacent areas and Western Europe

Moscow Syneclise and the Voronezh Anteclise	1	2	3	4	5	6	7	8	9	10
Lophocythere scabra	+		+	+	+		+			
Nophrecythere catephracta	+			+			+	+		
Fuhrbergiella archangelskii	+	+					+	+		
Nophrecythere flexicosta				+	+		+			
Schuleridea translucida							+	+	+	
Lophocythere karpinskii							+	+		
Cytheropteron spinosum							+	+		
Vesticytherurapaula							+	+		
Praeschuleridea wartae							+			
Fastigatocythere rugosa							+			
Pontocyprella aureola								+		
Rubracea artis	+							+		
Pleurocythere regularis				+						
Sabacythere bradiana			+							
Pleurocythere juvenes										
Galliaecytheridea legitima										
Cytherella perennis										
Paranotacythere (Unicosta)pseudoramulosa										
P. (U.) stauropyga										
Vesticytherura bathonica										
V. costaeirregularis										
Tethysia bathonica										
Pontocypris arcuata										
Paracypris stripta										
Galliaecytheridea spinosa										
Oligocythereis kostytcshevkaensis										

Caption: 1. England, 2. Holland, 3. France, 4. Germany, 5. Poland, 6. northwestern marginal areas of the Donets Basin, 7. Dnieper-Donets Depression, 8. Middle Volga Region, 9. Emba Region, 10. Timan–Pechora Region.

assemblages of France and the northwestern marginal region of the Donets Basin (one species) (Table 7).

In the Late Callovian, especially wide geographical ranges were characteristic of *F. archangelskii* (England, Holland, Poland, Dnieper-Donets Depression, and Timan-Pechora Region), *N. catephracta* (England, Germany, Poland, Dnieper-Donets Depression, northwestern marginal region of the Donets Basin, and the Middle Volga Region), *L. scabra* (England, France, Germany, and Poland), and *L. interrupta* (England, Holland, Germany, and the Dnieper-Donets Depression).

The beds with /. *dulcis* recognized in the present study in the Upper Callovian may be traced beyond the Moscow Syneclise in both eastern and western Europe by the presence of *I. dulcis*; this species is also recorded in the Upper Callovian of Germany, the Dnieper-Donets Depression, and the Middle Volga Region. Additionally, *Parariscus octoporalis, Lophocythere interrupta*, *Nophrecythere flexicosta*, and *N. alata* disappear everywhere at the boundary between the Callovian and Oxfordian; this allows one to correlate this boundary from England to the Volga-Ural Region on the basis of ostracodes.

The ostracode diversity started to decrease in some regions during the Early Oxfordian.

In England, 23 Lower Oxfordian ostracodes have been found; within the Moscow Syneclise, 12 species are recorded; eight species are identified in Poland; seven occur, in France; five occur in Holland; two species occur in the Voronezh Region; one species has been registered, in each of the Kursk Region and Germany. Lower Oxfordian ostracodes have not been recorded in the Timan-Pechora Region.

Table 7. Upper Callovian ostracode species common to the Moscow Syneclise (Moscow and Ryazan regions) and coeval assemblages of adjacent areas and Western Europe

Moscow Syneclise	1	2	3	4	5	6	7	8	9
Nophrecythere catephracta	+			+	+	+	+	+	
Fuhrbergiella archangelskii	+	+			+		+	+	+
Lophocythere interrupta	+	+		+			+		
L. scabra	+		+	+	+				
L. karpinskii					+		+		
Infacythere dulcis				+			+	+	
Sabacythere attalicata								+	+
S. rubra					+			+	+
Parariscus octoparalis		+					+		
Fastigatocythere rugosa							+		
Procytherura tenuicostata							+		
Nophrecythere flexicosta					+				
N. alata	+								
Vesticytherura scottia	+								
Pontocyprella aureola								+	
Cytheropteron spinosum								+	
Cytherella oblonga					+				
Nophrecythere oxfordiana									
N. zmeinkensis									
Patellacythere sp.									
P. trepti									
Balowella attendens									
C. perennis									
Pontocyprella vescusa									
Paracypris lubrica									
Galliaecytheridea legitima									
Palaeocytheridea baculumbajula									
Ljubimovella sp.									
Cytheropteron pseudospinosum									
C. laeve									
Exophthalmocythere pilosa									
Procytherura sp.									
Paranotacythere (Unicosta) pseudoramulosa									
Tethysia bathonica									
Vesticytherura rectodorsalis									
V. costaeirregularis									
V. grandipyga									
P. paula									
V. acostata									

Caption: 1. England, 2. Holland, 3. France, 4. Germany, 5. Poland, 6. northwestern marginal areas of Donets Basin, 7. Dnieper-Donets Depression, 8. Middle Volga Region, 9. Timan–Pechora Region.

The Lower Oxfordian ostracode assemblage from the Moscow Syneclise is very specific and has a rather faint similarity (one shared species) to those of England and the Voronezh and Kursk regions (Table 8). At that time, *P. aureola* showed the widest range (Voronezh and Kursk regions).

Since the lower boundary of the beds with 5. *attalicata–V. costaeirregularis* that have been established in

Table 8. Lower Oxfordian ostracode species common to the Moscow Syneclise (Kostroma, Moscow, and Ryazan regions) and coeval assemblages of adjacent areas and Western Europe

Moscow Syneclise	1	2	3	4	5	6
Nophrecythere catephracta	+					
Pontocyprella aureola					+	+
Sabacythere attalicata						
Rubracea artis						
Paracypris terraefullonica						
Patellacythere sp.						
Cytheropteron pseudospinosum						
C. laeve						
Vesticytherura acostata						
V. paula						
V. costaeirregularis						
Paranotacythere (Unicosta) pseudoramulosa						

Caption: 1. England, 2. Holland, 3. France, 4. Poland, 5. Voronezh Region, 6. Kursk Region.

Table 9. Middle Oxfordian ostracode species common to the Moscow Syneclise (Kostroma and Moscow regions) and coeval assemblages of adjacent areas and Western Europe

Moscow Syneclise	1	2	3	4	5	6
Pontocyprella aureola					+	
Nophrecythere catephracta	+					
Patellacythere nescia						
Rubracea artis						
Sabacythere attalicata						
S. rubra						
S. sp.						
Paranotacythere (Unicosta) pseudoramulosa						
P. (U.) solei						
Cytherella perennis						
Pamcypris terraefullonica						
Cytheropteron pseudospinosum						
C. laeve						
C. spinosum						
Tethysia bathonica						
Vesticytherura costaeirregularis						
V. scottia						
V. grandipyga						
V. paula						
V. acostata						

Caption: 1. England, 2. Holland, 3. France, 4. Poland, 5. Voronezh Region, 6. Orel Region.

the present study in the Lower Oxfordian of the Moscow Syneclise coincides with the boundary between the Callovian and Oxfordian stages, it may be traced in both eastern and western Europe by the disappearance of *Infacythere dulcis, Parariscus octoporalis, Lophocythere interrupta, Nophrecythere alata*, and *N. flexicosta*. However, the upper boundary cannot be recognized beyond the Moscow Syneclise. Thus, the beds with *S. attalicata–V. costaeirregularis* may be used within the Moscow Syneclise only.

Table 10. Upper Oxfordian ostracode species common to the Moscow Syneclise (Kostroma Region) and coeval assemblages of adjacent areas and Western Europe

Moscow Syneclise	1	2	3	4	5	6	7	8	9	10
Pontocyprella aureola					+		+		+	
Vesticytherurapaula									+	+
V. costaeirregularis	+									
Rubracea artis					+					
Cytheropteron laeve										
Tethysia bathonica										
Vesticytherura acostata										
Paranotacythere (Unicosta) pseudoramulosa										
Exophthalmocythere pilosa										

Caption: 1. England, 2. Holland, 3. France, 4. Poland, 5. Dnieper-Donets Depression, 6. northwestern plunge of the Donets basin, 7. Voronezh Region, 8. Orel Region, 9. Middle Volga Region, 10. Obshchii Syrt

In the Middle Oxfordian, ostracodes of the Moscow Syneclise became more diverse taxonomically; at this time, the greatest number of species, i.e., 20 species is recorded. Seven species are known in Poland; six occur in England and Holland; three occur in the Orel Region; and two occur, in the Voronezh Region and France. Middle Oxfordian ostracodes have not been recorded in Germany and the Kursk and Timan-Pechora regions.

The Middle Oxfordian ostracode assemblage of the Moscow Syneclise has little in common with contemporaneous assemblages of England and the Voronezh Region, i.e., only one shared species. There are no common forms with ostracodes of Holland, France, Poland, and the Orel Region. *Pontocyprella aureola* (Voronezh Region) and *Nophrecythere catephracta* (England) show especially wide ranges.

In the Upper Oxfordian, the diversity of ostracodes from the Moscow Syneclise substantially decreased, although in other regions, it remained at the same level as in the Middle Oxfordian.

The maximum number of species (29) is recorded in the Dnieper-Donets Depression; 17 species are known in the northwestern marginal region of the Donets Basin and the Middle Volga Region; 12 occur in France; ten occur in Holland; eight occur, in Poland; nine occur in the Moscow Syneclise; five occur in both the Voronezh Region and Obshchii Syrt; two occur in England; and one species is known from the Orel Region. Upper Oxfordian ostracodes have not been recorded in Germany, Emba, and the Timan-Pechora Region.

From a comparison of the Upper Oxfordian ostracode assemblage of the Moscow Syneclise with those of adjacent areas and west European countries, it is clear that the former one is somewhat closer to assemblages of the Dnieper-Donets Depression and the Middle Volga Region, having two common species. It has one species in common with ostracode assemblages of England, the Voronezh Region, and Obshchii Syrt. With other regions, it has no shared elements. The most widespread species is *Pontocyprella aureola* (the Dnieper-Donets Depression and the Voronezh and Middle Volga regions).

4.2. Subdivision and Correlation of the Callovian–Oxfordian of Western and Eastern Europe on the Basis of Ostracodes

An ostracode zonation of the Callovian of western Europe was proposed by Bodergat (1997). On the basis of ostracodes, the Lower Callovian is divided into two zones (Table 11). The lower *bicostata–escovillensis* Zone corresponds to the *herveyi* Ammonite Zone. The lower boundary of this zone is defined by the occurrence of the index species *Nodophtalmocythere bicostata* Dépêche and *Micropneumatocythere escovillensis* Depeche. The upper *cruciata–franconica* Zone corresponds to the *koenigi* and *callovlense* ammonite zones. Its lower boundary is defined by the disappearance of the index species of the lower zone and by the occurrence of the *Lophocythere cruciata franconica* Lutzei index species.

One ostracode zone, the *scabra-interrupta interrupta* Zone, corresponding to the *jason–lamberti* zones has been recognized in the Middle and Upper Callovian. The lower boundary is defined by the occurrence of the index species *Lophocythere scabra* Triebel and *L. interrupta interrupta* Triebel. The upper half of the *coronatum* Zone and the *athleta* and *lamberti* zones are united into the *calloveica* Subzone by the time of the appearance of the species *Monoceratina calloveica* (Mand.).

Zonal species that are used in Western Europe for the Lower Callovian have not been recorded in Eastern Europe; *Lophocythere scabra* and *L, interrupta interrupta,* the zonal species in the Middle and Upper Callovian, have also been found in eastern Europe in the Lower Callovian, and *L. scabra* is also recorded in the Lower Oxfordian. Therefore, these zones cannot be recognized in eastern Europe in their original volume.

Nonetheless, the use of correlation of Callovian deposits of western and eastern Europe based on ammonites allows for the correlation between west European ostracode zones and beds with ostracodes in the central regions of the Russian Plate, as was per-

Table 11. Ostracode zones, beds, and assemblages of Western and Eastern Europe

System	Series	Stage	Substage	Ammonite zones of the Boreal Province of Western Europe	Ostracode zones of Western Europe (Bodergat, 1997)	Ostracode zones of France after Dépêche (1985), with corrections (Bodergat, 1997)	Ammonite zones of the East European Platform (*Unifitsirovannaya…*, 1993)	Ostracode beds of the Moscow Syneclise	Ostracode beds of the Voronezh Anteclise	Ostracode beds of the Transvolgian Region near Kostroma (Kolpenskaya, 1995, 1999)	Ostracode assemblages of Ukraine (Permyakova, 1975b)	Ostracode assemblages of the Middle Volga Region (Lübimova, 1955b)	Ostracode assemblages of the Timan–Pechora Region (Lev and Kravets, 1982)
Jurassic	Upper	Oxfordian	Upper	*Ringsteadia pseudocordata*		*pulchra pulchra–postrotunda*	*Amoeboceras ravni*				*Nophrecythere multicostata–Patellacythere trepti*	*Galliaecytheridea legitima–Galliaecytheridea monstrata*	
							Amoeboceras serratum						
				Perisphinctes cautisnigrae		*minuta*	*Amoeboceras alternoides*						
			Middle	*Gregoryceras transversarium*			*Cardioceras tenuiserratum*	*Paranotacythere (Unicosta) solei*		*Sabacythere nikiforovae*			
				Perisphinctes plicatilis		*multipunctata*	*Cardioceras densiplicatum*				*Pontocyprella aureola–Patellacythere aliena*	*Pontocypris arcuata–Paracypris stripta*	
			Lower	*Cardioceras cordatum*			*Cardioceras cordatum*	*Sabacythere attalicata–Vesticytherura costaeirregularis*					
				Quenstedtoceras mariae		*oertlii*	*Quenstedtoceras mariae*						
	Middle	Callovian	Upper	*Quenstedtoceras lamberti*	*calloveica*		*Quenstedtoceras lamberti*	*Infacythere dulcis*			*Infacythere dulcis*	*Infacythere dulcis–Palaeocytheridea descripta*	*Sabacythere rubra, S. attalicata, Fuhrbergiella archangelskii*
				Peltoceras athleta			*Peltoceras athleta*						
			Middle	*Erymnoceras coronatum*	*scabra–interrupta interrupta*		*Erymnoceras coronatum*	*Paranotacythere (Unicosta) stauropyga–Galliaecytheridea legitima*			*Paracypris bellula–Fuhrbergiella archangelskii*	*Paracypris bellula–Patellacythere faceta*	*Camptocythere* aff. *scrobiculata, Orthonotacythere* aff. *schweyeri*
				Kosmoceras jason			*Kosmoceras jason*						
			Lower	*Sigaloceras calloviense*	*cruciata–franconica*		*Sigaloceras calloviense*		*Praeschuleridea wartae–Pleurocythere regularis*		*Pleurocythere juvenes–Fuhrbergiella nikitini*	*Palaeocytheridea cinicinnusa–Pyrocytheridea pergraphica*	*Camptocythere muricata, C. laciniosa*
				Proplanulites koenigi									
				Macrocephalites herveyi			*Cadoceras elatmae*						
					bicostata–escovillensis		beds with *Macrocephalites*						

formed in the present study. The *cruciata-franconica* Zone of the upper beds of the Lower Callovian of western Europe correlates to the beds with *P. wartae–P. regularis* established in the Voronezh Anteclise. The *scabra–interrupta interrupta* Zone correlates to the beds with *P. (U.) stauropyga-G. legitima* and beds with *I. dulcis* of the Moscow Syneclise and the Voronezh Anteclise (Table 11).

In the Oxfordian, Bodergat (1997) recognized ostracode zones in France only. The *mariae* Zone of the Lower Oxfordian corresponds to the *oertlii* Ostracode Zone with its lower boundary defined by the appearance of the index species *Terquemula oertlii* (Bizon). The *cordatum* and *plicatilis* zones of the Lower-Middle Oxfordian correspond to the *multipunctata* Ostracode Zone with its lower boundary recognized by the first occurrence of the index species *Progonocythere multipunctata* Whatley. The *transversarium* and *cautisnigrae* zones of the Middle and Upper Oxfordian correspond to the *minuta* Ostracode Zone recognized by the time of occurrence of the index species *Schuleridea minuta* Donze. Its upper limit is additionally stressed by the appearance of four species characteristic of the next ostracode zone of *pulchra pulchra-postrotunda.* The latter comprises the rest of the section that corresponds to the *pseudocordata* Ammonite Zone. The *pulchra pulchra-postrotunda* Zone is recognized by the first occurrence of the species *Macrodentina (P.) pulchra pulchra* (Schmidt) and *Galliaecytheridea postrotunda* Oertli and by the time of occurrence of the species *Macrodentina (M.) tenuistriata* Malz and *Verneuiniella sequana* Oertli.

Since the index species of ostracode zones of the Oxfordian of France have not been found in eastern Europe, these zones cannot be traced within the studied territory. However, similarly to the Callovian strata, the ostracode beds of the Moscow Syneclise may be correlated with the French zones. Thus, the beds with *S. attalicata-V. costaeirregularis* of the Lower Oxfordian correspond to the *oertlii* Zone and the lower part of the *multipunctata* Zone. The beds with P. *(U.) solei* of the Middle Oxfordian correspond to the upper part of the *multipunctata* Zone and the lower part of the *minuta* Zone.

Ostracode zones had never been recognized in the Callovian and Oxfordian of Russia. For the first time, beds with ostracodes within the interval in question were defined by Kolpenskaya (1995, 1999) in undivided Lower-Middle Oxfordian deposits of the Volga Region near Kostroma. In the Makar'ev-yuzhnyi section, she recognized beds with *Sabacythere nikiforovae.* The ostracode assemblage from these beds includes a small number of forms and consists of three species, *Exophthalmocythere fuhrbergensis* Steghaus, *Vesticytherura paula,* and *Pontocyprella aureola,* in addition to the index species. We did not find the index species in the Kostroma Region. Two other species, *P. aureola* and *V. paula,* present in assemblages from the beds with *S. attalicata-V. costaeirregularis* of the Lower Oxfordian and *P. (U.) solei* of the Middle Oxfordian. Stratigraphically, the beds with *S. nikiforovae* correspond to the beds with *S. attalicata-V. costaeirregularis* and with *P. (U.) solei,* which were proposed in the present study for the Lower and Middle Oxfordian of the Moscow Syneclise.

Beds with ostracodes were not recognized by Lübimova (1955b) on the basis of ostracodes from the Volga Region; however, ostracode assemblages of the Lower, Middle, and Upper Callovian and Lower and Upper Oxfordian were described in detail and correlated with the ammonite zones. On the basis of characteristics provided by Lübimova, we demonstrated them in Table 11 and correlated them with the beds proposed in the present study. We proposed formal names of ostracode assemblages from the Volga Region.

Beds with *P. wartae-P. regularis* of the Voronezh Anteclise correspond to the assemblage with *Palaeocytheridea cinicinnusa* and *Pyrocytheridea pergraphica* recognized in the Lower Callovian of the Middle Volga Region. However, only one species, *Nophrecythere catephracta*, are shared by these assemblages.

Beds with *P. (U.) stauropyga-G. legitima* from the Middle Callovian of the central regions of the Russian Plate correspond to the assemblage with *Paracypris bellula* and *Patellacythere faceta* of the Middle Volga Region, sharing with the latter the species *Nophrecythere catephracta, Lophocythere karpinskii, Schuleridea translucida, Pontocyprella aureola, Rubracea artis, Fuhrbergiella archangelskii, Cytheropteron spinosum,* and *Vesticytherura paula.*

Beds with *I. dulcis* of the Moscow Syneclise correspond to the assemblage with *Infacythere dulcis* and *Palaeocytheridea descripta*; common species are *Nophrecythere catephracta, Fuhrbergiella archangelskii, Infacythere dulcis, Sabacythere attalicata, S. rubra, Pontocyprella aureola,* and *Cytheropteron spinosum.*

Beds with *S. attalicata-V. costaeirregularis* and *P. (U.) solei* of the Moscow Syneclise correspond to the assemblage with *Pontocypris arcuata–Paracypris acuta*; common species are *Pontocyprella aureola* Lüb., *Cytheropteron spinosum* Lüb., *Vesticytherura paula* Lüb., *Sabacythere attalicata* (Mand.), *S. rubra* (Mand.), and *Nophrecythere catephracta* (Mand.).

Ostracode assemblages of the Lower, Middle, and Upper Callovian and Lower and Upper Oxfordian are also known in Ukraine, i.e., the Dnieper-Donets Depression and the northwestern marginal region of the Donets Basin (Permyakova, 1975b, 1978). Using their description, we gave them formal names and depicted them in the summary table (Table 11).

The assemblage with *Pleurocythere juvenes* and *Fuhrbergiella nikitini* from the Lower Callovian of Ukraine corresponds to the beds with *P. wartae-P. regularis* established in the Voronezh Anteclise. Common species are *Praeschuleridea wartae, Parariscus octoporalis, Pleurocythere juvenes, P. regularis, Lophocythere scabra, L. interrupta, Nophrecythere catephracta,* and *N. flexicosta.*

The Ukrainian Middle Callovian Ostracode Assemblage with *Paracypris bellula* and *Fuhrbergiella ar-*

changelskii corresponds to the beds with *P.* (*U.*) *stauropyga-G. legitima* of the central regions of the Russian Plate. Common species are *Fuhrbergiella archangelskii, Fastigatocythere rugosa, Nophrecythere flexicosta, N. catephracta, Lophocythere scabra, L. karpinskii, Praeschuleridea wartae, Schuleridea translucida, Cytheropteron spinosum*, and *Vesticytherura paula.*

The assemblage with *Infacythere dulcis* in the Upper Callovian of Ukraine corresponds to the beds with *I. dulcis* of the Moscow Syneclise. Common species are *Infacythere dulcis, Parariscus octoporalis, Fastigatocythere rugosa, Procytherura tenuicostata, Lophocythere interrupta, L. karpinskii, Fuhrbergiella archangelskii*, and *Nophrecythere catephracta.*

The ostracode assemblage with *Paracypris acris* Oertli and *Patellacythere aliena* (Lüb.) from the Lower-Middle Oxfordian of Ukraine corresponds to the beds with *S. attalicata–V. costaeirregularis*, and *P. (U.) solei* of the Moscow Syneclise. Common species are *Patellacythere nescia, Nophrecythere catephracta, Pontocyprella aureola, Sabacythere attalicata,* and *Rubracea artis.*

In the Timan-Pechora Region, Lev established ostracode assemblages in the Lower, Middle, and Upper Callovian and defined the index species (Lev and Kravets, 1982). The age of embedding rocks was identified by foraminifers. On the basis of descriptions from that work, we show these assemblages as well.

Ostracodes of the beds with *P. wartae–P. regularis* from the Voronezh Anteclise correspond to the assemblage with *Camptocythere muricata* and *C. laciniosa.* Ten species are indicated for this assemblage, although there are no species in common with ostracodes from the Voronezh Anteclise.

The assemblage of the beds with *P.* (*U.*) *stauropyga~G. legitima* of the central regions of the Russian Plate corresponds to the assemblage with *Camptocythere* aff. *scrobiculata* and *Orthonotacythere* aff. *schweyeri*, differing from the latter by the occurrence of these two species only. There are no species which are in common with Central Russia.

The assemblage from the beds with *I. dulcis* corresponds to the assemblage with *Sabacythere rubra, S. attalicata*, and *Fuhrbergiella archangelskii,* which includes 14 species. Only index species are shared.

CHAPTER 5. OSTRACODE PALEOBIOGEOGRAPHY OF THE CALLOVIAN AND OXFORDIAN OF EUROPE

5.1. Paleobiogeography of the Callovian and Oxfordian Seas of Western and Eastern Europe

Paleobiogeography studies the patterns and causes of the spatial distribution of various organisms and their assemblages during certain time intervals (Ochev *et al.*, 1995). There are two main approaches to this study. The biochorological approach includes the study of the geographic ranges of individual taxa, compilation and comparison of the schematic maps of their areals, generalization of the areals (coareals) of individual taxa that form certain assemblages, and delineation of the areas of these assemblages. The ecological approach means recognition of regions differing in environment conditions and the faunal assemblages characteristic of these regions on the basis of the climatic, biofacial, and landscape methods.

The main typological unit of paleobiogeography is a biochore. The nomenclature of biochores is not unequivocal. However, the majority of paleozoologists accept the hierarchy that includes realms, regions, subregions, and provinces. The term *region* is used freely. The endemic taxa of a realm are usually orders and, more rarely, classes or subclasses; those of regions are families and subfamilies; endemic taxa of subregions are subfamilies and genera; and those of provinces are species and subspecies (Makridin and Meyen, 1988).

The largest biochore of the climatic zonation is a zone. The analysis of many groups of Mesozoic invertebrates (Saks *et al.*, 1971) has shown that in the Middle Jurassic seas of the northern hemisphere the Boreal paleobiogeographical zone appeared in addition to the Tethyan zone.

On the basis of the Middle Jurassic ammonite assemblages studied in Boreal basins, the Boreal zone has been divided into three independent paleozoogeographical regions: Arctic, Boreal-Atlantic, and Boreal-Pacific.

In the second half of the early Callovian, northwestern and eastern Europe formed the Boreal-Atlantic paleobiogeographical region, which was delineated on the basis of characteristic ammonite genera. This region is subdivided into the western European (England, northwestern France, Poland, and Baltic Region) and eastern European (central regions) provinces. During the first half of the early Callovian, the central regions of the Russian Plate belonged to the North Siberian Province of the Arctic Region (Saks *et al.*, 1971; Meledina, 1994).

Using areal-genetic and typological paleobiogeographical criteria, the entire diversity of Jurassic foraminifer assemblages was brought to three main groupings, which characterize the largest biochores, regions or zones. In the Boreal-Atlantic Region, the nodosariid–epistominid type, characterized by the absence of larger foraminifers with a complex inner structure, is clearly defined (Basov, 1974, 1991). Kuznetsova (1979) also subdivided the Boreal Zone into the Arctic and Boreal-Atlantic regions, within which she placed the North Siberian, Greenlandian–Khatangian, Chukot-Canadian, eastern European, and western European provinces.

The paleobiogeography of the Jurassic of the Russian Plate was thoroughly discussed in a book by Sazonova and Sazonov (1967), and the dynamics of the biota in the Callovian sea of the Russian Plate were comprehensively treated in recent papers by Yanin (1998, 1999).

Benthic ostracodes are closely connected with a benthic environment; hence, their advantageous use for paleobiogeographic reconstructions. Of recent papers published in Russian, those devoted to the Jurassic foraminifers and ostracodes of Syria (Kuznetsova and Dobrova, 1995, 1997) provide a good example.

Regrettably, no special paleobiogeographic research on ostracodes of the Russian Plate has been undertaken. In the present work, we make an attempt to analyze the geographic distribution of ostracodes in the central regions of the Russian Plate and to apply statistics to obtain an ostracode zonation of the Callovian–Oxfordian basin in Europe.

5.2. Characteristic Features of the Geographic Distribution of Ostracodes in the Callovian and Oxfordian of Central Russia

A comparison made between lists of ostracodes from different sections shows some interesting features in the distribution of certain species and their assemblages. These features were apparently caused by some paleogeographical features. The most striking feature is a complete absence from the central regions of the Russian Plate of representatives of thermophilic families Bairdiidae, known in Poland and Ukraine, and Polycopidae, known in England and the Dnieper-Donets Depression. Therefore, one may make a conclusion about a relatively low water temperature and isolation of the Central Russia Basin in the Callovian and Oxfordian. Second, the thermophilic family Cytherellidae was also evidently depressed. Rare finds of two species of the genus *Cytherella* in the upper Callovian of the Moscow and Ryazan regions, their complete absence from the lower Oxfordian, and the reappearance of one of these species in the middle Oxfordian argue in favor of a cooler environment in the Oxfordian in contrast to the Callovian. This conclusion is supported by data on isotopic analysis of the oxygen from belemnite rostra, which show a considerable decrease (by 4-5°C) in water temperature by the beginning of the Oxfordian (Smirnova *et al.*, 1999).

A number of species widely distributed within the studied territory may be recognized (see Appendix 2): *Galliaecytheridea legitima* from the middle-upper Callovian of the Kostroma and Moscow regions and Mordovia and from the Kursk Region in which it is particularly abundant, *Schuleridea translucida* from the middle-upper Callovian of the Kostroma and Ryazan regions and Mordovia, *Fastigatocythere rugosa* from the middle-upper Callovian of the Moscow and Ryazan regions and Mordovia, *Lophocythere scabra* from the Callovian of the Ryazan and Kursk regions and Mordovia, *L. karpinskii* from the middle-upper Callovian of the Kostroma, Moscow, Ryazan, and Kursk regions, *Sabacythere attalicata* from the upper Callovian–middle Oxfordian of the Kostroma, Moscow, and Ryazan regions, *Vesticytherura paula* from the middle Callovian-upper Oxfordian of the Kostroma, Ryazan, Moscow, and Kursk regions, *V. costaeirregularis* from the middle Callovian–upper Oxfordian of the Kostroma, Ryazan, and Moscow regions, *V. grandipyga* from the middle Callovian–middle Oxfordian of the Kostroma, Moscow, and Kursk regions and Mordovia, *V. acostata* from the upper Callovian-upper Oxfordian of the Kostroma, Moscow, and Ryazan regions, *Tethysia bathonica* from the middle Callovian-upper Oxfordian of the Kostroma and Moscow regions and Mordovia, and *Paranotacythere (Unicosta) pseudoramulosa* from the middle Callovian-upper Oxfordian of the Kostroma, Ryazan, and Moscow regions.

The only ubiquitous species is *Nophrecythere cataphracta* from the lower Callovian-middle Oxfordian.

Such species as *Paranotacythere (Unicosta) stauropyga*, *Oligocythereis kostytschevkaensis*, and *Galliaecytheridea spinosa* from the middle Callovian and *Patellacythere nescia* from the middle Oxfordian are restricted within the studied territory to the Kostroma Region. *Nophrecythere alata*, *Palaeocytheridea baculumbajula*, *Vesticytherura rectodorsalis*, *Pontocyprella vescusa*, *Paracypris lubrica*, *Ljubimovella* sp., and *Patellacythere trepti* from the upper Callovian, *Sabacythere rubra* from the upper Callovian-middle Oxfordian, and *Paranotacythere (Unicosta) solei* from the middle Oxfordian are restricted to the Moscow Region. *Pontocypris arcuata* from the middle Callovian and *Procytherura tenuicostata* from the upper Callovian are restricted to the Ryazan Region. *Pleurocythere regularis*, *P. juvenes*, and *Praeschuleridea wartae* are known only from the lower-middle Callovian of the Kursk Region.

In the Kostroma Region the Callovian and Oxfordian deposits are the poorest in ostracodes, and, in contrast to other regions, the species diversity, which was very low in the Callovian, showed an increase in the Oxfordian. These data support the conclusion that the Callovian of the Kostroma Region was characterized by shallow, near-shore conditions, which gradually gave way to a deeper-water environment in the Oxfordian; the latter is supported by the appearance of planktonic foraminifers (Gorbachik and Kuznetsova, 1997). Anyway, the Oxfordian basin appears to be shallower than those of the Moscow and Ryazan regions, in which the abundance of ostracode shells and valves abruptly decreased in the Oxfordian.

The comparison demonstrates the closest similarity between ostracode assemblages of the Moscow and Ryazan regions. Apparently, very similar conditions existed in these regions and there were no barriers between them. Decreased thickness and the condensation of ostracode shells in Peski explain, in my opinion, the fact that the ostracode assemblage of the Peski section (Moscow Region) turned out to be more representative than those of the Zmeinka and Mikhailovtsement sections (Ryazan Region).

5.3. Ostracode Paleobiogeography of the Callovian and Oxfordian Sea Basins of Europe

All available data on the Callovian and Oxfordian ostracodes of both eastern and western Europe have been summarized to make a more complete paleobiogeographic analysis. All localities are grouped into 21 regions. The total list includes more than 200 species (see Appendix 1). Currently, there are various statistical methods for treating large data arrays. In the Russian literature, the comparative analysis of animal groupings is usually made using coefficients of faunistic similarity. Jaccard and S0rensen's paired coefficients are the most popular indices. They may be presented both in proportions and in percents. A number of approaches to further analysis and comparison of these paired indices has been developed. The Jaccard formula is more useful, since it yields indices that directly reflect similarity, whereas Sørensen's formula gives relative values (Chernov, 1975). That is why we have chosen the Jaccard formula for analyzing lists of ostracode species.

Above, the Callovian and Oxfordian ostracode assemblages of the central regions of the Russian Plate were compared with the assemblages of adjacent areas and western European countries in order to show differences and similarities that existed between them at different times. Then, we made an attempt to apply statistical methods to the lists of ostracode species of eastern and western Europe at the substage level. However, this approach failed because of the striking nonuniformity in data on different regions. Therefore, to eliminate an error of statistical treatment, we decided to use the lists of ostracode species combined at the stage level.

In order to assess the similarity of each pair of 21 regions, the Jaccard coefficient was calculated from the formula: $Z = C/N_1 + N_2 - C$, where Z is the Jaccard coefficient of similarity, C is the number of species shared between two regions, and N_1 and N_2 are the numbers of species in the first and second regions, respectively. On the basis of calculated coefficients, a matrix of differences was compiled to be processed by the STATISTICA program package using cluster analysis. This treatment yielded two dendrograms. The first dendrogram, which includes all regions divided into three clusters, i.e., the Emba Region (Kazakhstan), the Timan–Pechora Region, and the third cluster that includes all the other regions of eastern and western Europe, is of no use for the analysis of relationships between the regions belonging to the third cluster. The second dendrogram was calculated without the Emba and the Timan-Pechora regions since their ostracode composition is markedly different from all the other regions (Fig. 16).

This dendrogram allows recognition of ten ostracode regions within the basin of the Boreal Province that existed in Europe in the Callovian and Oxfordian (Fig. 17).

The first region was situated within the territory of Germany, Poland, Ukraine (northwestern marginal areas of the Donets Basin, the Dnieper-Donets Depression), and Russia (the Kursk and Voronezh regions). It coincides with the latitudinal strait that connected the seas of western and eastern Europe. This strait provided the easiest exchange of ostracode faunas. The degree of divergence *(dd)* between ostracodes of all these areas is 1.12. The closest ostracode assemblages are those of the Voronezh Region and Germany (Z = 0.467, *dd* = 0.82); the ostracode assemblage of the Kursk Region is somewhat more distant (Z = 0.214, *dd* = 1.06). The most typical genera are *Nophrecythere, Galliaecytheridea, Lophocythere*, and *Pleurocythere* (Table 12).

The second region includes the Orel Region and Mordovia (Z = 0.267, *dd* = 1.06), which are the closest to the first region *(dd* with the first region is 1.14). The most abundant ostracodes are representatives of the genera *Schuleridea, Vesticytherura, Cytheropteron*, and *Lophocythere*.

The third region encompasses the territory of the Moscow, Ryazan, and Kostroma regions. The degree of divergence with both the first and second regions is 1.16. The commonest are representatives of the genera *Lophocythere, Vesticytherura*, and *Sabacythere*.

The fourth region includes the Middle Volga Region *(dd* = 1.12). The similarity between this and the above regions is much smaller *(dd* = 1.24). The number of endemic species greatly increases in the sections of the Volga Region near Ulyanovsk, Saratov, Tatarstan, and the Samara Bend (Samarskaya Luka). The typical genera are *Palaeocytheridea, Fuhrbergiella*, and *Vesticytherura*.

The fifth region lies within the Obshchii Syrt. Its ostracode assemblage is so distinctive that the degree of divergence between this and the above assemblages is very high *(dd* = 1.27). The most abundant genera are *Terquemula, Nophrecythere*, and *Balowella*.

The sixth region lies as far West as England, where the number of endemics is the same as on the Obshchii Syrt *(dd* = 1.27). This is the only region where *Pseudoperissocytheridea, Argilloecia, Pedicythere*, and *Glabellacythere* dominate.

The seventh and the eighth regions were situated in the west of the paleobasin, within the territory of France and Holland; they differ greatly from the above regions *(dd* = 1.32). These regions are characterized by the presence of *Vernoniella* and *Macrodentina*. Additionally, species of the genera *Nodophtalmocythere, Polydentina*, and *Micropneumatocythere* have been found in France, and species of the genus *Eripleura* have been found in Holland.

Ostracode assemblages in western Kazakhstan (the Emba Region) and the Timan-Pechora Region are completely different. In both cases, the degree of divergence between them and the above regions is about 70. We recognize the ninth region for western Kazakhstan and the tenth region for the Timan-Pechora Region. Species of the genera *Camptocythere, Pyrocytheridea*, and *Orthonotacythere* are most characteristic of the Timan-Pechora Region, and species of the genus *Terquemula* are characteristic of western Kazakhstan. The connection of these parts of the basin to the main water area appears to be greatly hindered.

Table 12. Distribution of ostracode genera in the Callovian and Oxfordian of Europe

Region	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Family Polycopidae Sars, 1865																					
Polycope	+				+	+															
Family Cytherellidae Sars, 1866																					
Cytherella			+	+	+	+	+				+	+									
Cytherelloidea			+			+	+														
Family Bairdiidae Sars, 1887																					
Bairdia						+	+														
Cardobairdia					+																
Family Paracyprididae Sars, 1923																					
Paracypris	+		+		+	+	+					+	+	+			+				
Family Pontocyprididae Sars, 1923																					
Pontocypris											+						+				
Pontocyprella					+	+	+	+		+		+	+	+			+				
Argilloecia	+																				
Protoargilloecia																	+				
Family Macrocyprididae G. Müller, 1912																					
Macrocypris	+																				
Family Bythocytheridae Sars, 1926																					
Bythocythere																	+	+			+
Bythoceratina			+																		
Patellacythere	+		+	+	+	+		+									+				
Family Cytherideidae Sars, 1925																					
Galliaecytheridea	+	+	+		+	+	+	+		+		+	+	+	+		+				
Vernoniella		+	+																		
Ljubimovella												+									
Family Loxoconchidae Sars, 1925																					
Mandelstamia		+				+	+								+	+					
Family Cytheruridae G. Müller, 1894																					
Metacytheropteron	+					+															
Cytheropteron	+					+				+	+	+	+	+		+	+				
Eocytheropteron			+	+																	
Parariscus	+	+	+			+				+		+				+	+				
Procytherura	+					+				+	+										
Orthonotacythere			+																		+
Vesticytherura	+					+			+	+	+	+	+	+	+	+	+	+	+		
Paranotacythere (*Unicosta*)											+	+	+								
Pseudohutsonia	+	+	+		+																
Balowella						+					+	+				+	+				
Eripleura		+																			

Table 12. (Contd.)

Region	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Family Schulerideidae Mandelstam, 1959																					
Praeschuleridea	+		+			+				+											
Schuleridea			+	+	+	+	+	+			+		+	+			+	+		+	
Eudachacythere			+																		
Family Pleurocytheridae Mandelstam, 1960																					
Pleurocythere	+	+		+		+	+			+											
Sabacythere			+		+	+	+			+	+	+	+			+	+		+	+	+
Palaeocytheridea	+			+	+	+	+			+		+			+	+	+		+		
Progonocythere	+			+	+																
Family Neurocytheridae Gründel, 1975																					
Fuhrbergiella	+	+	+		+	+					+	+		+	+	+	+	+			+
Lophocythere	+	+	+	+	+	+		+		+	+	+	+	+			+		+	+	
Platylophocythere			+					+													
Terquemula			+		+		+														
Nophrecythere	+	+	+	+	+	+	+			+	+	+	+	+		+	+	+	+		
Infacythere				+		+					+	+						+			
Family Progonocytheridae Sylvester-Bradley, 1948																					
Fastlgatocythere				+		+					+	+		+							
Macrodentina		+	+																		
Glabellacythere	+				+																
Pseudoperissocytheridea	+																				
Polydentina			+																		
Micropneumatocy there			+																		
Procytheridea			+		+	+	+														
"*Procytheridea*"			+		+																
Camptocythere																					+
Family Eucytheridae Puri, 1954																					
Pyrocytheridea																	+				+
Family Trachyleberididae Sylvester-Bradley, 1948																					
Tethysia												+	+	+							
Oligocythereis													+			+	+		+		
Exophthalmocythere												+	+			+					
Nodophthalmocythere			+																		
Family Paracytherideidae Puri, 1957																					
Pedicythere	+																				
Family Judahellidae Sohn, 1968																					
Trachycythere						+															
Genus not included in system due to lack of information																					
Rubracea	+				+	+				+			+	+				+			

Regions: 1. England and Scotland, 2. Holland, 3. France, 4. Germany, 5. Poland, 6. Dnieper-Donets Depression, 7. northwestern marginal areas of the Donets Basin, 8. Voronezh Region, 9. Orel Region, 10. Kursk Region, 11. Ryazan Region, 12. Moscow Region, 13. Kostroma Region, 14. Mordovia, 15. Tatarstan, 16. Volga Region near Ulyanovsk, 17. Samarskaya Luka, 18. Saratov Region, 19. Obshchii Syrt, 20. Emba Region, 21. Timan–Pechora Region.

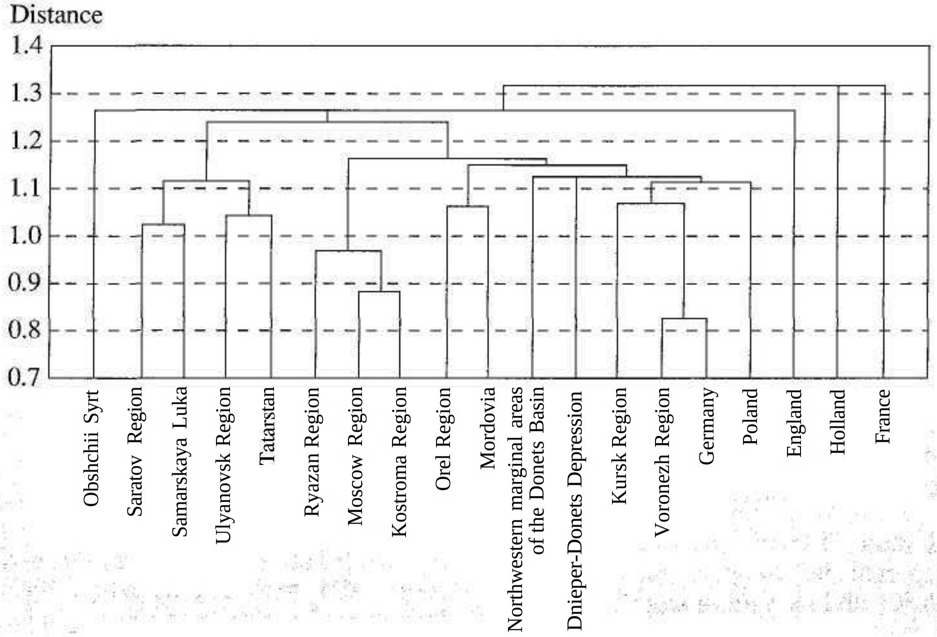


Fig. 16. Tree diagram for 19 variables; single linkage; euclidean distances.

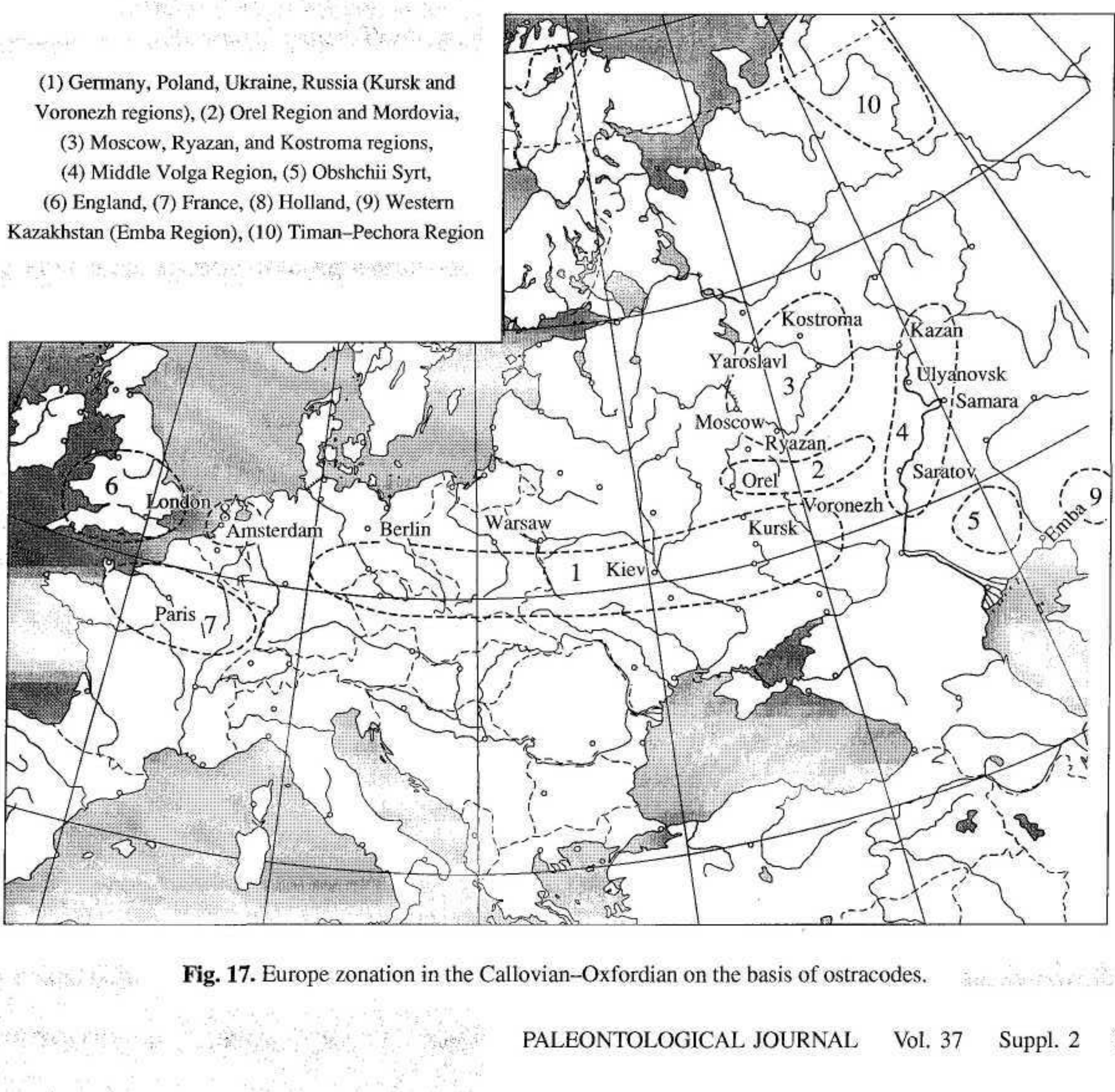


Fig. 17. Europe zonation in the Callovian–Oxfordian on the basis of ostracodes.

CHAPTER 6. DESCRIPTIONS OF THE CALLOVIAN AND OXFORDIAN OSTRACODES OF THE MOSCOW SYNECLISE

CLASS OSTRACODA LATREILLE, 1802

Order Platycopida Sars, 1865

Superfamily Cytherellacea Sars, 1865

Family Cytherellidae Sars, 1865

Subfamily Cytherellinae Sars, 1865

Genus *Cytherella* Jones, 1849

Cytherella: Mandelstam, 1949, p. 263; Lubimova, 1955b, p. 104; Suzin, 1956, p. 159; Mandelstam and Polenova, 1960, p. 334; Reyment, 1961, p. 382; Sheremeta, 1969, p. 40; Nikolaeva, 1989a, p. 86; Kaever *et al.*, 1994, p. 71; and Nikolaeva and Andreev, 1999a, p. 21.

Type species. *Cytherina ovata* Roemer, 1841; Cenomanian of northwestern Germany.

Diagnosis. Shell medium-sized, ovoid, elliptic, or rounded quadrate, thinner at anterior and thicker at posterior end. Right valve larger than left valve, embracing latter along entire margin or along dorsal and ventral margins. Anterior and posterior ends arcuately rounded. Posterior end often lower than anterior end. Dorsal and ventral edges straight, convex, or concave. Dorsal edge more sharply sloping toward posterior end than ventral edge. Valves smooth, pitted, or cellular, sometimes with terminal spines. Pore-canal zone narrow, with numerous short, straight, thin pore canals. Hinge simple; consisting of circular ridge in left valve and matching distinct groove in right valve.

Composition. More than 600 species.

Comparison. From the genus *Cytherelloidea* Alexander, 1929, similar in general shape and the structure of the hinge, it differs in having smooth valves.

Occurrence. Triassic–Recent; worldwide.

Cytherella oblonga Permyakova, 1969

Plate 1, figs. 1–6

Cytherella oblonga: Permyakova, 1969, p. 34, pl. 1, fig. 1; Pyatkova and Permyakova, 1978, p. 122, pl. 44, fig. 4; and Gerasimov *et al.*, 1996, pl. 3, fig. 1.

Cytherella recta: Brand, 1990, p. 145, pl. 1, fig. 8; Olempska and Błaszyk, 2001, p. 555, figs. 1A-1F.

Holotype. IGN AN UkrSSR, no. 16-1, left valve; Kharkov Region, the town of Lozovaya; Bajocian, *garantiana* Zone.

Description. The shell is rounded rectangular, elongated, and weakly convex. The right valve is slightly larger than the left valve, embracing the latter along the dorsal and ventral edges only, the overlapping is not visible at the ends. The anterior end is high, flattened along its margin. The posterior end is lower than the anterior end, evenly rounded, sloping in the dorsal area. The dorsal edge is weakly convex in the posterior half, forming a distinct bend in the middle of the convexity, and fusing with the anterior and posterior edges smoothly. The ventral edge is parallel to the dorsal edge, weakly concave in the middle part, and fuses with the anterior and posterior edges smoothly. The maximum length of the shell is at the mid-height, the maximum height is in the middle of the valve, and the maximum width is at the posterior end. In the dorsal half of the shell, a shallow subvertical groove is developed in the middle part of the lateral face of the valve. The valve surface is smooth or, more rarely, has fine pores.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-75	0.71	0.36	0.30
4843-74	0.67	0.34	0.26
4843-169	0.50	0.26	0.23
4843-30	0.43	0.22	0.22

Variability. The height of the posterior end slightly varies with the slope of the posterior edge in the dorsal part.

Comparison. From C. *nota* Lubimova, 1955 from the middle Volgian Substage (*panderi* Zone) of the Middle Volga Region and the Obshchii Syrt (Lubimova, 1955b, p. 106, pl. 13, fig. 1), it differs in the broader posterior end of the shell, in the flattening developed along the anterior margin, and in the presence of a groove in the dorsal half of the valve. From forms described as *C. limpida* Błaszyk, 1967 from the upper Bajocian (*niortense* and *garantiana* zones) of the Dnieper-Donets Depression (Pyatkova and Permiakova, 1978, p. 122, pl. 44, fig. 5), it differs in the much higher posterior end of the shell and in the posterior edge less sloping in the dorsal part. From true *C. limpida* from the upper Bajocian-Bathonian of Poland (Błaszyk, 1967, p. 13, pl. 1, figs. 2-13, pl. 2, fig. 12; Bielecka *et al.*, 1988, p. 168, pl. 65, fig. 2), it differs in the much lower posterior end of the shell. From the species identified as *C. fullonica* Jones et Sherborn, 1888 from the Callovian and Oxfordian of England (Whatley, 1970, p. 313, pl. 1, figs. 12-14, 16, 18), it differs in the lower posterior end of the shell.

Occurrence. The upper Callovian of Poland, the upper Bathonian of Germany, the upper Bajocian of the Dnieper-Donets Depression and the marginal areas of the Donets Basin, and the upper Callovian of the Ryazan and Moscow regions.

Material. Twelve well-preserved valves from the upper Callovian (*lamberti* Zone) of the Zmeinka section, 30 well-preserved valves from the upper Callovian (*Epistomina elschankaensis–Lenticulina tumida* Zone) of the Mikhailovtsement section, and 24 well-preserved valves from the upper Callovian (*lamberti* Zone) of the Peski section.

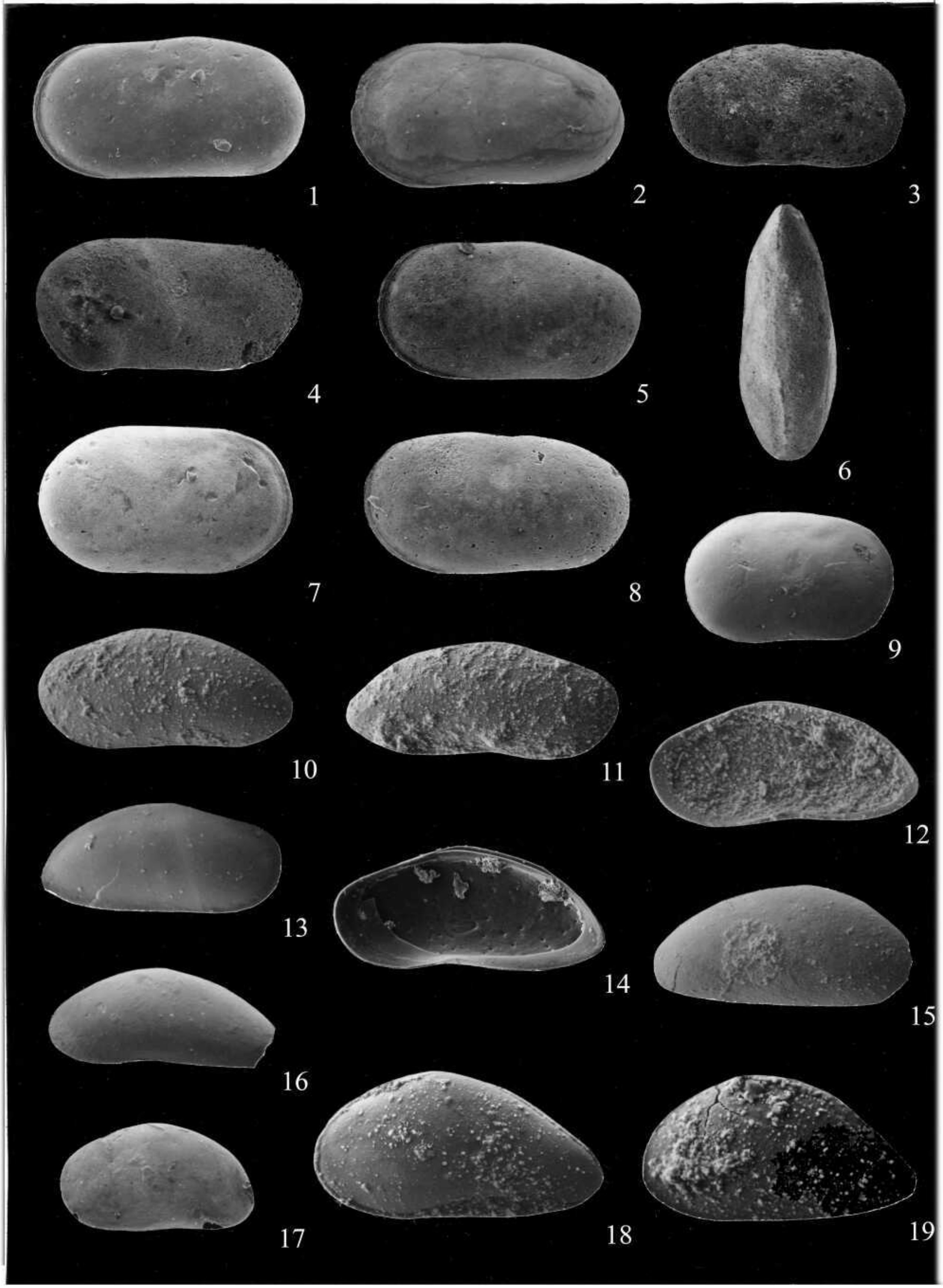
Cytherella perennis Błaszyk, 1967

Plate 1, figs. 7-9

Cytherella perennis: Błaszyk, 1967, p. 16, pl. 2, figs. 1-11, pl. 3, figs. 6 and 7; Bielecka *et al.*, 1988, p. 169, pl. 65, fig. 3; Pyatkova and Permyakova, 1978, p. 122, pl. 45, fig. 1; and Gerasimov *et al.*, 1996, pl. 3, figs. 2 and 3.

Holotype. ZPAL O.IV/25, complete shell; Poland, Jaworznik; upper Bathonian, *morrisi* Zone.

Plate 1



Description. The shell is rounded rectangular, elongated, evenly high, and weakly convex. The right valve is slightly larger than the left valve, embracing the latter along its entire margin except for the anterior end. The anterior and posterior ends are equally high. The anterior end is flattened along its margin. The dorsal margin is straight, fusing smoothly with the anterior and posterior margins in the right valve and fusing at an obtuse angle with the anterior margin in the left valve. The ventral margin is parallel to the dorsal margin. The maximum length is at the mid-height of the valve, the maximum width is in its posterior third. A shallow subvertical groove is developed at the midlength in its dorsal half. The valve surface is smooth.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-264	0.63	0.38	0.24
4843-60	0.53	0.27	0.22
4843-92	0.66	0.37	0.27

Variability. The height of the posterior end is slightly variable.

Comparison. From forms described as *C. collapsa* Grekoff, 1963 from the middle Callovian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 122, pl. 44, rig. 3), it differs in the shallower and less distinct transverse groove on the valves; from *C. tortuosa* Lubimova, 1955 from the lower Volgian Substage (*nikitini* Zone) of the Ulyanovsk Region (Lubimova, 1955b, p. 110, pl. 13, fig. 2), in the straight dorsal margin.

Occurrence. The upper Bajocian and the Bathonian of Poland, the upper Bajocian of the Dnieper-Donets Depression, the middle Oxfordian of the Moscow Region, and the middle and upper Callovian of the Ryazan Region.

Material. Twenty-two variously preserved valves from the upper Callovian (*lamberti* Zone) of the Zmeinka section, 12 satisfactorily preserved valves from the upper Callovian (*Epistomina elschankaensis–Lenticulina tumida* Zone) and 6 well-preserved valves from the middle Callovian (*coronatum* Zone) of the Mikhailovtsement section, and 14 variously preserved valves from the middle Oxfordian (*Ophthalmidium strumosum–Lenticulina brestica* Zone) of the Peski section.

Order Podocopida Sars, 1865

Suborder Cypridocopina Jones in Chapman, 1901

Superfamily Cypridacea Baird, 1845

Family Pontocyprididae G. Müller, 1894

Subfamily Pontocypridinae G. Müller, 1894

Genus *Pontocyprella* Mandelstam, 1955

Pontocyprella: Lubimova, 1955b, p. 19; Mandelstam *et al.*, 1956, p. 106; Lübimova *et al*, 1960, p. 349; Swain, 1961, p. 246; Mandelstam and Shneider, 1963, p. 61; and Neustrueva *et al.*, 1999, p. 31.

Type species. *Bairdia harrissiana* Jones, 1949; Turonian of England.

Diagnosis. Shell medium-sized, rounded rectangular. Left valve narrowly embracing right valve along its entire margin. Anterior end of shell high, gently rounded. Posterior end of shell low, beveled in the dorsal part, occasionally cuspidate ventrally. Dorsal edge weakly convex. Ventral edge concave. Outer surface of valve smooth. Pore-canal zone wide, with densely spaced straight pore canals. Inner duplicature slightly visible at anterior end. Hinge adont, simple,

Explanation of Plate I

Figs. 1-6. *Cytherella oblonga* Permyakova: (1) no. 4843-75, left valve of female, lateral view, x70; (4) no. 4843-74, right valve of female, lateral view, x70; sample 94-2, Ryazan Region, Zmeinka, upper Callovian, *lamberti* Zone; (2) no. 4843-169, left valve of male, lateral view, ×100; (3) no. 4843-30, right valve of male, lateral view, ×100; sample Pyum-22, middle Oxfordian, *O. strumosum–L. brestica* Zone; (5) no. 4843-159, left valve of male, lateral view, x80; (6) no. 4843-350, complete male shell, dorsal view, x70; sample Pyum-8, upper Callovian, *lamberti* Zone, Moscow Region, Peski.

Figs. 7-9. *Cytherella perennis* Błaszyk: (7) no. 4843-92, right valve of male, lateral view, Ryazan Region, Zmeinka, sample 94-4, upper Callovian, *lamberti* Zone, x70; (8) no. 4843-60, right valve of female, lateral view, Moscow Region, Peski, sample Pyum-3, upper Callovian, *lamberti* Zone, x90; (9) no. 4843-264, right valve of male, lateral view, Ryazan Region, Mikhailovtsement, sample 94-22, middle Callovian, *coronatum* Zone.

Figs. 10–14. *Pontocyprella aureola* Lubimova: (10) no. 4843-291, left valve, lateral view, ×115; (11) no. 4843-293, right valve, lateral view, x85; (12) no. 4843-281, right valve, inner view, ×130; Mordovia, Troshkov vrag, sample 96-4, middle Callovian, *coronatum* Zone; (13) no. 4843-228, right valve, lateral view, Yartsevo, sample 95-22, middle Oxfordian, *O. strumosum–L. brestica* Zone, xlOO; (14) no. 4843-252, right valve, inner view, Kostroma Region, Makar'ev-yuzhnyi, sample 95-8, lower Oxfordian, *O. sagittum–E. volgensis* Zone, x75.

Fig. 15. *Pontocyprella vescusa* Lubimova, no. 4843-283, right valve, lateral view; Mordovia, Troshkov vrag, sample 96-4, middle Callovian, *coronatum* Zone, xlOO.

Fig. 16. *Pontocypris arcuata* Lubimova, no. 4843-270, left valve, lateral view; Ryazan Region, Mikhailovtsement, sample 94-22, middle Callovian, *coronatum* Zone, ×100.

Fig. 17. *Paracypris lubrica* Lubimova, no. 4843-166, left valve, lateral view; Moscow Region, Peski, sample Pyum-8, upper Callovian, *lamberti* Zone, ×133.

Figs. 18 and 19. *Paracypris stripta* Lubimova: (18) no. 4843-290, complete shell, lateral view, ×130; (19) no. 4843-289, complete shell, lateral view; Mordovia, Troshkov vrag, sample 96-4, middle Callovian, *coronatum* Zone, ×160.

dextral, consisting of blind groove (in left valve) and blade-shaped ridge (in right valve).

Composition. Around 30 species.

Comparison. From the genus *Pontocypris* Sars, 1865, similar in hinge structure and in the absence of the sculpture, it differs in the rounded rectangular rather than rounded triangular contour of its shell, in the higher posterior end, and in the wide pore-canal zone.

Occurrence. Callovian-Cretaceous, worldwide.

***Pontocyprella aureola* Liibimova, 1955**

Plate 1, figs. 10–14

Pontocyprella aureola: Liibimova, 1955b, p. 20, pl. 1, fig. 2; Mandelstam and Shneider, 1963, p. 63, pl. 3, fig. 5; and Pyatkova and Permyakova, 1978, p. 127, pl. 47, fig. 7.

Pontocyprella cf. *subaureola*: Brand, 1990, p. 149, pl. 1, fig. 14.

Holotype. VNIGRI, no. 117-2, complete shell; Samarskaya Luka, the village of Kostychi; lower Oxfordian.

Description. The shell is elongated, irregularly oval, moderately convex. The overlapping of the right valve is most expressed at the dorsal, ventral, and posterior margins. The anterior end is weakly beveled on the dorsal side. The posterior end is triangularly acuminate. The dorsal edge is slightly inclined toward the posterior end of the shell, fusing with the anterior and posterior edges almost smoothly. The ventral edge is concave in its middle portion, fusing with the anterior and posterior edges smoothly. The maximum length is found in the lower half of the shell, the maximum height and width are in the middle of the valve.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-291	0.34	0.18	0.06
4843-293	0.59	0.23	0.09
4843-281	0.38	0.16	0.06
4843-228	0.45	0.22	0.08

Variability. The length-to-height ratio of the valve and the slope of the anterior end of the shell vary only slightly.

Comparison. From forms identified as *P. izjumica* Liibimova, 1956 from the Oxfordian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 127, pl. 47, fig. 4), it differs in the lower and more acuminate posterior end. The comparison with *P. vescusa* Liibimova, 1956 is given below in the section describing the latter species.

Remarks. Forms identified as *Paracypris* cf. *bajociana* Bate, 1963 (Błaszyk, 1967, p. 21, pl. 4, figs. 1-3) and *P. bajociana* Bate, 1963 (Bielecka *et al.*, 1988, p. 179, pl. 73, fig. 6) were described from the upper Bajocian and Bathonian of Poland. In appearance, they closely resemble *Pontocyprella aureola.* However, the Polish forms are difficult to synonymize because of the poor quality of their photographs and the absence of data on the inner surface of their valves.

Occurrence. The upper Bathonian of Germany; the Oxfordian of the Dnieper-Donets Depression, northwestern marginal areas of the Donets Basin, and the Kostroma and Voronezh regions; the middle Callovian–Oxfordian of Samarskaya Luka; the lower Oxfordian of the Kursk Region; and the middle Callovian of Mordovia.

Material. Six well-preserved valves from the lower Oxfordian and two well-preserved valves from the middle Oxfordian of the Makar'ev-yuzhnyi section, two well-preserved valves from the middle Oxfordian (*Ophthalmidium strumosum-Lenticulina brestica* Zone) of the Samylovo section, two well-preserved valves from the middle Oxfordian *(Ophthalmidium strumosum–Lenticulina brestica* Zone) and one well-preserved valve from the upper Oxfordian *(Ophthalmidium strumosum-Lenticulina brestica* Zone) of the Yartsevo section, and four well-preserved valves from the middle Callovian (*coronatum* Zone) of the Troshkov vrag section.

***Pontocyprella vescusa* Liibimova, 1956**

Plate 1, fig. 15

Pontocyprella vescusa: Liibimova, 1956, p. 535, pl. 1, fig. 1; Mandelstam *et al.*, 1956, p. 535, pl. 1, fig. 1; Mandelstam and Shneider, 1963, p. 63, pl. 3, fig. 4; and Pyatkova and Permyakova, 1978, p. 127, pl. 47, fig. 6.

Holotype. VNIGRI, no. 138-32, right valve; northwestern Donets Basin, Izyum District, the Bol'shaya Kamenka River; Oxfordian.

Description. The shell is angular oval, evenly convex, gradually flattening toward its ends. The left valve overlaps the right valve. Overlapping is most distinctly expressed on the ventral side. The posterior end of the shell is inclined toward the ventral side. The dorsal edge forms a poorly defined angular bend in its middle part. The ventral edge is concave in its middle part. The maximum length is at the mid-height of the shell, the maximum height and width are in the middle of the valve.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-283	0.47	0.21	0.09

Variability. The height of the shell and the roundness of the anterior and posterior ends vary only slightly.

Comparison. From *P. aureola,* it differs in the less acute posterior end of the valve and in the dorsal edge which leans less toward the posterior end.

Occurrence. The Oxfordian of Ukraine, the upper Callovian of the Moscow Region.

Material. One well-preserved valve from the upper Callovian *(lamberti* Zone) of the Peski section.

Genus *Pontocypris* Sars, 1865

Pontocypris: Lübimova, 1955b, p. 18; Lübimova *et al.*, 1960, p. 347; Swain and van den Bold, 1961, p. 247; Mandelstam and Shneider, 1963, p. 53; and Kovalenko *et al.*, 1989, p. 93.

Type species. *Cythere* (*Bairdia*) *mytiloides* Norman, 1862; Recent species from the Atlantic Ocean, Norway offshore.

Diagnosis. Shell small and medium-sized, elongated, rounded triangular, with thin muri. Right valve slightly larger than left valve, with occasional inverse overlapping. Anterior end higher than posterior end, gently rounded. Posterior end low, strongly elongated, and beveled dorsally. Dorsal margin convex, arched, sometimes angular. Ventral margin concave. Outer surface of valve smooth. Surface pores small, numerous. Pore-canal zone narrow, with straight densely spaced pore canals. Inner duplicature wider at anterior end of shell in contrast to posterior end. Hinge adont, represented by steplike depression in left valve and bladelike bar in right valve. Sexual dimorphism not expressed in shell structure.

Composition. Around 120 species.

Comparison. The comparison with the most close genus *Pontocyprella* Mandelstam, 1955 was given above when describing the latter genus.

Occurrence. Middle Jurassic-Recent; worldwide.

Pontocypris arcuata Liibimova, 1955

Plate 1, fig. 16

Pontocypris arcuata: Liibimova, 1955b, p. 19, pl. 1, fig. 1.

Holotype. VNIGRI, no. 226-1, complete shell; Samara Region, the basin of the Irgiz River, the village of Ukrainka; lower Volgian, *panderi* Zone.

Description. The shell is small and weakly convex. The left valve narrowly embraces the right valve along its entire margin. The anterior end of the shell is high and beveled on the dorsal side. The posterior end of the shell is lower than the anterior end, rounded, and strongly beveled on the dorsal side. The dorsal margin is smoothly fused with the anterior and posterior margins. The ventral margin is concave. The maximum length is below the mid-height of the valve, the maximum height and width are in the middle of the valve.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-270	0.44	0.16	0.09

Comparison. Being similar in shell outline to *P. obstipis* Mandelstam from the Turonian of Turkmenia (Liibimova, 1955b, p. 19), it differs from the latter in the less convex dorsal margin and in the more concave ventral margin of the shell.

Occurrence. The lower Oxfordian of Samarskaya Luka, the middle Volgian Substage of the Obshchii Syrt, the middle Callovian of the Ryazan Region.

Material. One well-preserved left valve from the middle Callovian (*coronatum* Zone) of the Mikhailovtsement section.

Family Paracyprididae Sars, 1923

Subfamily Paracypridinae Sars, 1923

Genus *Paracypris* Sars, 1865

Paracypris: Liibimova, 1955b, p. 21; Liibimova *et al.*, 1960, p. 349; Swain, 1961, p. 245; Mandelstam and Shneider, 1963, p. 66; and Neustrueva *et al.*, 1999, p. 32.

Type species. *P. polita* Sars, 1865; Recent species from the Atlantic Ocean, Norway offshore.

Diagnosis. Shell large to medium-sized, podshaped, weakly or moderately convex. Left valve larger than right valve. Anterior end of shell gently rounded. Posterior end of shell lower than anterior end, rounded triangular, sometimes acuminate. Dorsal margin weakly convex or straight. Ventral margin weakly concave in anterior half. Outer surface of valves smooth. Hinge adont. Terminal vestibules large. Marginal pore canals branched.

Composition. Around 150 species.

Comparison. Being similar in shell outline and hinge structure to the genus *Pontocypris* Sars, 1928, it differs from the latter in the narrower and more extended posterior end of the shell and in the higher valves.

Occurrence. Jurassic-Recent; worldwide.

Paracypris lubrica Lübimova, 1955

Plate 1, fig. 17

Paracypris lubrica: Liibimova, 1955b, p. 24, pl. 1, fig. 5; Pyatkova and Permyakova, 1978, p. 125, pl. 46, fig. 6.

Holotype. VNIGRI, no. 226-2, complete shell; the Samara Region, the Tananyka River basin, the village of Sergeevka; lower Volgian Substage, *virgatus* Zone.

Description. The shell is medium-sized, elongated. The left valve is slightly larger than the right valve and embraces the latter along its entire margin. The anterior end of the shell is low, strongly beveled on the dorsal side. The posterior end of the shell is rounded triangular, strongly beveled on the dorsal side. The dorsal margin is short, weakly convex, slightly leaning toward the posterior end, fusing with the anterior and posterior ends at an obtuse angle. The ventral margin is nearly horizontal, weakly concave in the anterior third of the shell, fusing smoothly with the anterior and posterior ends. The maximum length is below the mid-height, the maximum height is in the middle of the valve, the maximum width is in the anterior half of the shell.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-166	0.26	0.15	0.05

V a r i a b i l i t y. The height of the shell and the convexity of the dorsal margin vary only slightly.

C o m p a r i s o n. From forms identified as *P. acuta* (Cornuel, 1844) from the lower Oxfordian of Samarskaya Luka and the Penza Region and the middle Volgian Substage of Samarskaya Luka and the Obshchii Syrt (Lübimova, 1955b, p. 23, pl. 1, fig. 3), it differs in the smaller length and greater height of the shell, also in the sharper bends at the points of fusion of the dorsal margin with the anterior and posterior margins of the valve; from *P. bellula* Liibimova, 1955 from the middle Callovian of Ukraine (Pyatkova and Permyakova, 1978) and Samarskaya Luka (Liibimova, 1955b, p. 22, pl. 1, fig. 4), in the smaller height of the shell, higher posterior end, and in the less sharp bends at the points of fusion of the dorsal margin with the anterior and posterior ends.

O c c u r r e n c e. The Volgian of the Dnieper-Donets Depression, the middle Volgian Substage of the Obshchii Syrt, the upper Callovian of the Moscow Region.

M a t e r i a l. One well-preserved valve from the upper Callovian (*lamberti* Zone) of the Peski section.

Paracypris stripta Liibimova, 1956

Plate 1, figs. 18 and 19

Paracypris stripta: Liibimova, 1956, p. 537, pl. 1, fig. 3; Pyatkova and Permyakova, 1978, p. 126, pl. 46, fig. 9.

Pontocypris stripta: Mandelstam and Shneider, 1963, p. 57, pl. 1, fig. 13.

Macrocyprisaequabilis: Brand, 1990, p. 150, pl. 1, fig. 16.

H o l o t y p e. VNIGRI, no. 111-60, left valve; Ukraine, Izyum District, the Bol'shaya Kamenka River; Kimmeridgian.

D e s c r i p t i o n. The shell is medium-sized, irregularly oval, evenly convex, laterally compressed, gently flattening toward the ends. The left valve extends over the right valve along its entire free margin except for the anterior end. The anterior end of the shell is high, gently rounded on the ventral side and more sharply rounded on the dorsal side. The posterior end of the shell is lower than the anterior end, elongated and pointed ventrally. The dorsal margin is angularly bent in the anterior third, fusing smoothly with the anterior and posterior margins. The ventral margin is slightly concave in its middle part. The maximum length is below the mid-height of the valve, the maximum height is in the end of the anterior third, and the maximum width is in the middle of the shell.

M e a s u r e m e n t s (mm):

Specimen no.	Length	Height	Width
4843-290	0.40	0.20	0.07
4843-289	0.30	0.17	0.06

V a r i a b i l i t y. The convexity of the dorsal margin and the height of the valves slightly vary.

C o m p a r i s o n. From forms identified as *P. acuta* (Cornuel, 1844) from the lower Oxfordian of Samarskaya Luka and the Penza Region and the middle Volgian Substage of Samarskaya Luka and the Obshchii Syrt (Liibimova, 1955b, p. 23, pl. 1, fig. 3), it differs in the higher shell and in the valves having their ends more gently rounded.

O c c u r r e n c e. The upper Bathonian of Germany, the Oxfordian of the Dnieper-Donets Depression, the Kimmeridgian of the northwestern plunge of the Donets Basin, the middle Callovian of Mordovia.

M a t e r i a l. Six well-preserved valves and complete shells from the middle Callovian (*coronatum* Zone) of the Troshkov vrag section.

Suborder Cytherocopina Gründel, 1967

S u p e r f a m i l y Bythocytheracea Sars, 1926

Family Bythocytheridae Sars, **1926**

Subfamily Bythoceratinae Sars, 1926

Genus *Patellacythere* Griindel et Kozur, 1971

Monoceratina: Kaever *et al.*, 1994, p. 51.

Patellacythere: Nikolaeva, 1999, p. 44.

T y p e s p e c i e s. *Monoceratina williamsi* Stephenson, 1946; middle Eocene of the United States.

D i a g n o s i s. Shell medium-sized, elongated, rounded triangular, with equal valves, flattened near its ends, and convex in its middle part. Anterior end higher than posterior end, arched. Posterior end rounded triangular, strongly beveled ventrally. Dorsal margin straight, forming caudal process at the point of fusion with the posterior margin. Ventral margin concave. Spine may be present on posteroventral swelling. Vertical groove developed in anterior or middle part of shell. Surface smooth, pitted, cellular, with fine ridges. Hinge adont. Adductor scars consist of five elongated tubercles, arranged in a vertical row that arches toward the anterior end, where two antennal muscle scars are distinctly visible.

C o m p o s i t i o n. Around 20 species.

C o m p a r i s o n. From the genus *Bythoceratina* Hornibrook, 1952, similar in valve outline and in sculpture, it differs in the adont hinge.

O c c u r r e n c e. Middle Triassic–Neogene; worldwide.

Patellacythere trepti (Donze, 1962)

Plate 2, fig. 7

Monoceratina trepti: Pyatkova and Permyakova, 1978, p. 129, pl. 48, fig. 7; Gerasimov *et al.*, 1996, pl. 3, fig. 15.

H o l o t y p e. No data on the holotype have been found in the available literature.

D e s c r i p t i o n. The shell is rhomboid, with the posterior end being drawn toward the top, strongly irregularly convex. The anterior end is high. The posterior end is low, abruptly beveled ventrally. The dorsal margin is fused with the anterior margin through a distinct bend, and forms an acute angle with the posterior margin. The ventral margin is parallel to the dorsal margin, weakly concave in the anterior third, and weakly convex in the posterior third, fusing smoothly with the anterior and posterior margins. The maximum length of the shell coincides with the dorsal margin, the maximum height is in the posterior third, the maximum width is near the middle of the valve, but closer to the posterior end. A deep median depression running from the dorsal margin up to the middle of the valve is distinctly visible in the middle of the swelling. A large and long spine rises perpendicular to the surface on the ventral side closer to the posterior end. The surface of the valve, except for the anterior and posterior ends, depression, and spine, is dotted with shallow pits. Several thin ridgelets run along the dorsal margin and on the ventral side of the base of the spine. Numerous large pores are scattered over the whole surface of the valve except for the spine.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-157	0.50	0.27	0.22

Variability. The density of pits varies.

Comparison. From forms described as *P. denticulata* (Donze, 1962) from the upper Oxfordian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 128, pl. 48, fig. 3), it differs in the shorter depression and in the absence of additional tubercles from its sides; from shells identified as *P. polita* (Donze, 1962) from the upper Oxfordian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 128, pl. 48, fig. 6), it differs in the less convex ventral margin, narrower and deeper depression, and flatter anterior and posterior ends; from *P. aliena* (Lubimova, 1955) from the middle Volgian Substage (*panderi* Zone) of the Obshchii Syrt (Lubimova, 1955b, p. 34, pl. 2, fig. 3) and from the Oxfordian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 127, pl. 48, fig. 2), it differs in the presence of a large spine and in the pitted not cellular sculpture; from *P. calloveica* (Mandelstam, 1949) from the middle Callovian of Syzran and its environs (Mandelstam, 1949, p. 262, pl. 85, fig. 9), the lower Callovian of the Timan-Pechora Region (Lev and Kravets, 1982), and the Callovian–Oxfordian of the Volga-Urals Region (Lubimova, 1955b, p. 30, pl. 1, fig. 10) and from *P. scrobiculata* (Triebel et Bartenstein, 1938) from the upper Callovian of Poland (Olempska et Błaszyk, 2001, p. 573, figs. 13A–13D) and the Toarcian–Dogger of Germany (Brand, 1990, p. 154, pl. 2, fig. 10; Kaever *et al.*, 1994, p. 51, pl. 6, fig. 79), it differs in the pitted uncellular sculpture and in the smooth, unomamented, and flattened ends of the shell.

Occurrence. The upper Oxfordian of France, the Dnieper-Donets Depression, and the Voronezh Region, the upper Callovian of the Moscow Region.

Material. Five variously preserved valves from the upper Callovian (*lamberti* Zone) of the Peski section, Moscow Region.

***Patellacythere* sp.**

Plate 2, figs. 8 and 9

Description. The shell is rounded rectangular, strongly convex in the center and flattened at the anterior and posterior ends. The anterior end is high. The posterior end is low and acuminate. The dorsal margin is connected to the anterior margin at an obtuse angle and to the posterior margin through a small scarp. The ventral margin is parallel to the dorsal margin, weakly concave in its anterior third, and smoothly fused with the anterior and posterior margins. The maximum length of the shell coincides with the dorsal margin, the maximum height is in the anterior third, and the maximum width is in the posterior third. The central swelling of the shell is divided in its dorsal half by a short and deep median depression running from the middle of the dorsal margin. The surface of the swelling is covered with large polygonal fossae with thick muri. Muri occasionally fuse to form archlike ridgelets on the ventral side. The flattened anterior and posterior ends and the median depression are smooth.

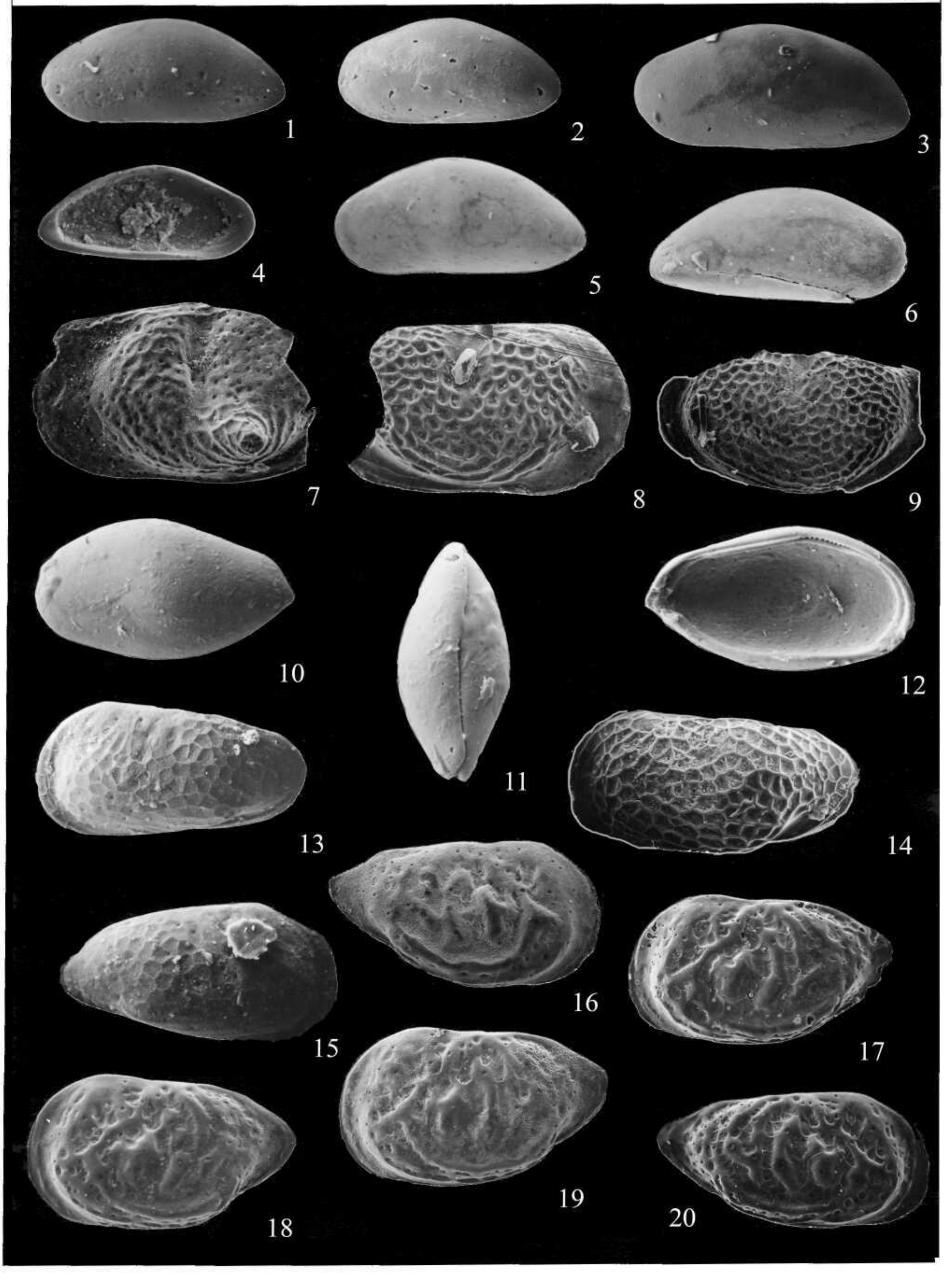
Measurements (mm):

Specimen no.	Length	Height	Width
4843-37	0.50	0.23	0.20
4843-158	0.59	0.31	0.28

Variability. The thickness of muri is slightly variable.

Comparison. In the sculpture and shape of its valve, this form is the closest to *P. aliena* (Lubimova, 1955) from the Oxfordian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 127, pl. 48, fig. 2) and the middle Volgian Substage *(panderi* and *virgatus* zones) of the Obshchii Syrt (Lubimova, 1955b, p. 34, pl. 2, fig. 3; Nikolaeva and Andreev, 1999, pl. 16, fig. 4), from which it differs in having no ornamentation on the surface of the anterior and posterior ends of the valve and on the median depression. The number and preservation of the available specimens is inadequate to designate this form as a new species. From *P. nescia* (Lubimova, 1955) from the middle Volgian Substage *(panderi* and *virgatus* zones) of the Volga-Urals Region (Lubimova, 1955b, p. 33, pl. 2, fig. 2), it differs in having a larger size, greater flattening of the anterior and posterior ends of the valve, and a much deeper and longer depression; from *P. faceta* (Lubimova, 1955) from the middle-upper Callovian and the middle Volgian Substage *(panderi* Zone) of Samarskaya Luka (Lubimova, 1955b, p. 32, pl. 2, fig. 1), it differs in the flatter posterior end of the valve and in the larger size. The comparison with *P. trepti* (Donze, 1962), which is similar in sculpture, has been made above when describing the latter species.

Plate 2



Remarks. Forms identified as *P. vulsa* (Jones et Scherborn, 1888) in the lower Callovian of France (Dépêche, 1985, pl. 31, fig. 15), as *Monoceratina* cf. *vulsa* in the middle Callovian of Germany (Lutze, 1960, p. 433, pl. 37, fig. 4), as *P. paravulsa paravulsa* Brand, 1990 in the upper Bathonian of Germany (Brand, 1990, p. 155, pl. 2, figs. 12-15), as *P. paravulsa* in the upper Callovian of Poland (Olempska et Błaszyk, 2001, p. 576, figs. 13E-13G), which are identical to *P. aliena* (Lübimova, 1955). Specimens identified as *P. vulsa* (Jones et Scherborn, 1888) from the Oxfordian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1987, p. 129, pl. 48, fig. 8), from the lower Callovian–middle Oxfordian of England and Scotland (Whatley, 1970, p. 319, pl. 3, figs. 18-25), from the Bajocian of Poland (Błaszyk, 1967, p. 68, pl. 10, fig. 4), and from the lower Callovian–lower Oxfordian of Poland (Bielecka *et al.*, 1988, p. 178, pl. 73, fig. 5) differ from *P. aliena* in having no cellular ornamentation on the outer surface of their valves.

Occurrence. The upper Callovian *(lamberti* Zone) of the Moscow Region, the lower Oxfordian of the Kostroma Region.

Material. One poorly preserved valve from the lower Oxfordian (*Ophthalmidium sagittum-Epistomina volgensis* Zone) of the Makar'ev-yuzhnyi section, two satisfactorily preserved valves from the upper Callovian *(lamberti* Zone) of the Peski section.

Superfamily Cytheracea Baird, 1850

Family Cytheruridae G. Müller, 1894

Subfamily incertae sedis

Genus *Procytherura* Whatley, 1970

Procytherura: Whatley, 1970, p. 51.

Type species. *Procytherura tenuicostata* Whatley, 1970, Oxfordian of England and Scotland.

Diagnosis. Shell small, thin-walled, with slightly unequal valves. Right valve slightly larger than left valve. Occasionally embracing inverse. Shell with shallow median depression. Outer surface of valves nearly smooth to wrinkled or ribbed. Radial canals long and thin. Hinge lophodont. Eye spot weakly expressed. Narrow vestibule present at anterior and posterior ends of shell.

Composition. A few species.

Comparison. From the very similar genus *Cytherura* Sars, 1865, it differs in the lophodont rather than hemimerodont hinge, and in the presence of the vestibule; it differs from the genus *Vesticytherura* Gründel, 1964, in having no large eye spots and no cellular ornamentation on the outer surface of the valves.

Occurrence. Callovian and Oxfordian, England, Scotland, and Russia; Valanginian, Poland.

***Procytherura* sp.**

Plate 2, figs. 13-15

Description. The shell is elongated, rounded rectangular, moderately convex. The left valve is slightly larger than the right valve, overlapping the latter along the antero- and posterodorsal margins. The anterior end of the shell is high, evenly rounded, flattened along its edge; in the right valve, it is slightly beveled on the dorsal side. The posterior end of the shell is low, rounded triangular, flattened; in the right valve, it is more beveled on the dorsal side than in the left valve. The dorsal margin is straight, fusing with the anterior and posterior margins at obtuse angles; in the left valve, it is connected to the posterior margin through a scarp. The ventral margin is parallel to the dorsal margin, weakly concave in its anterior third. The maximum length is at the mid-height of the shell, the maximum height is in the anterior third, and the maximum width is in the posteroventral part of the valve. A shallow gently sloping median depression is visible in the median part of the dorsal half of the shell. The outer surface of the valves is large-meshed cellular. The fossae are

Explanation of Plate 2

Figs. 1-6. *Paracypris terraefullonica* (Jones et Scherborn): (1) no. 4843-213, left valve, lateral view, sample Pyum-23, ×130; (2) no. 4843-215, left valve, lateral view, sample Pyum-27, x70; (4) no. 4843-211, left valve, inner view, sample Pyum-22, ×110; (5) no. 4843-110, left valve, lateral view, sample Pyum-32, x60; (6) no. 4843-118, right valve, lateral view, sample Pyum-27, ×120; Moscow Region, Peski, middle Oxfordian, *O. strumosum–L. brestica* Zone; (3) no. 4843-251, left valve, lateral view, Kostroma Region, Makar'ev-yuzhnyi, sample 95-7, lower Oxfordian, *O. sagittum–E. volgensis* Zone, x75.

Fig. 7. *Patellacythere trepti* (Donze), no. 4843-157, left valve, lateral view; Moscow Region, Peski, sample Pyum-8, upper Callovian, *lamberti* Zone, ×120.

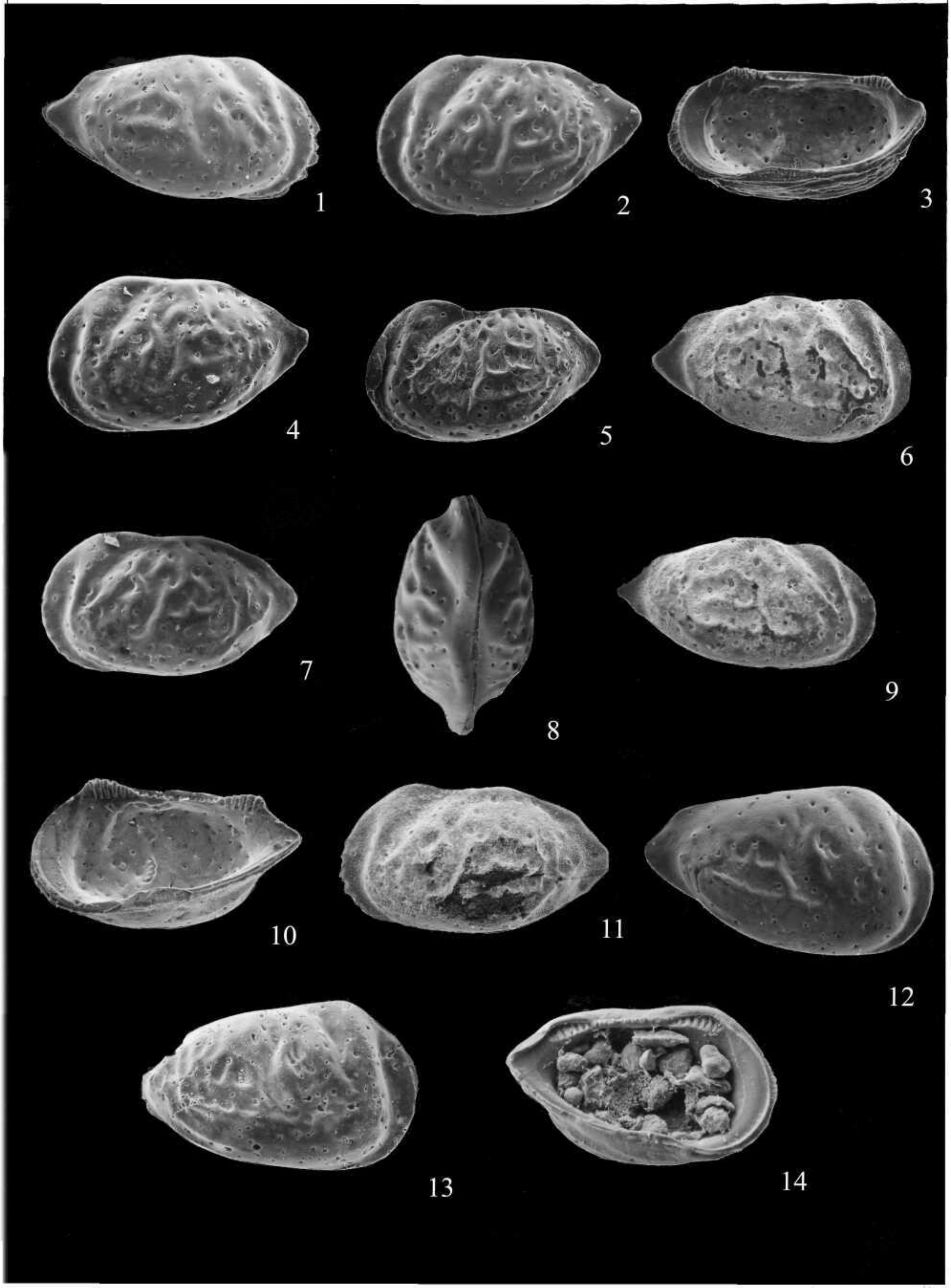
Figs. 8 and 9. *Patellacythere* sp.: (8) no. 4843-37, right valve, lateral view, sample Pyum-5, ×120; (9) no. 4843-158, left valve, lateral view, sample Pyum-8, x90; Moscow Region, Peski, upper Callovian, *lamberti* Zone.

Figs. 10-12. *Rubracea artis* Liibimova: (10) no. 4843-231, left valve, lateral view, ×1 10; (11) no. 4843-230, complete shell, dorsal view, ×100; (12) no. 4843-232, left valve, inner view, ×120; Kursk Region, Mikhailovskii Mine, sample 95-26, middle Callovian, *jason* Zone.

Figs. 13–15. *Procytherura* sp.: (13) no. 4843-325, left valve, lateral view, ×167; (15) no. 4843-324, right valve, lateral view, ×167; Kursk Region, Mikhailovskii Mine, sample 95-9, lower Callovian, *koenigi* Zone; (14) no. 4843-91, left valve, lateral view, Ryazan Region, Zmeinka, sample 94-4, upper Callovian, *lamberti* Zone, ×140.

Figs. 16–20. *Balowella attendens* (Lübimova): (16) no. 4843-45, right valve, lateral view, sample Pyum-5, ×130; (17) no. 4843-22, left valve, lateral view, X1OO; (18) no. 4843-23, left valve, lateral view, X11O; (19) no. 4843-24, left valve, lateral view, X11O; (20) no. 4843-21, right valve, lateral view, x1OO; sample Pyum-6, Moscow Region, Peski, upper Callovian, *lamberti* Zone.

Plate 3



irregularly penta- and hexagonal, having low and narrow muri and numerous fine pores basally.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-325	0.29	0.14	0.08
4843-324	0.30	0.15	0.09
4843-91	0.37	0.18	0.09

Variability. The thickness of cell walls varies only slightly.

Comparison. From *P. rara* (Lübimova, 1955) from the Neocomian of Samarskaya Luka (Liibimova, 1955b, p. 59, pl. 5, figs. 7a-7c), this form differs in the absence of elongated tubercles in the middle of the valve, in the fossae being more polygonal, and in the absence of ridges from the ends and the ventral side of the shell.

Remarks. This is most probably a new species since nothing comparable has been described from the Jurassic. Superficially, it does not differ from the Valanginian form identified from Poland as *Eucytherura nuda* Kaye, 1964 (Kubiatowicz, 1983, p. 48, pl. 20, figs. 1, 2) and known from the Hauterivian and Barremian of England. The number of available specimens is inadequate to designate a new species.

Occurrence. The upper Callovian of the Ryazan Region, the lower Callovian of the Kursk region.

Material. One well-preserved valve from the upper Callovian (*lamberti* Zone) of the Zmeinka section, two well-preserved valves from the lower Callovian (*koenigi* Zone) of the Mikhailovskii Mine section.

Subfamily Parataxodontinae Mandelstam, 1960

Genus *Balowella* Wienholz, 1967

Balowella: Nikolaeva and Andreev, 1999b, p. 56.

?*Pseudohutsonia*: Nikolaeva and Andreev, 1999b, p. 56.

Type species. *Protocythere attendens* Liibimova, 1955; Callovian of Samarskaya Luka.

Diagnosis. Shell medium-sized, with distinct ventral swelling and ill defined ventral ridge, which bears roller-shaped transverse ridges: three behind and one (with bulge) in front muscle tubercle. Eye tubercle absent. Hinge merodont.

Comparison. From the genus *Parataxodonta* Mandelstam, 1956, which is similar in the shape and structure of the hinge, it differs in the thicker shell, the presence of ornamentation on the surface, and in the absence of the eye tubercle and median depression; from the genus *Paranotacythere* Bassiouni, 1974, having a similar ribbed sculpture and, sometimes, similar hinge structure, it differs in the absence of the eye tubercle, caudal process, and median depression.

Composition. Several species.

Occurrence. Callovian–Oxfordian; Europe.

Balowella attendens (Lubimova, 1955)

Plate 2, figs. 16-20

Protocythere attendens: Lubimova, 1955b, p. 74, pl. 9, fig. 2.

Balowella attendens: Pyatkova and Permyakova, 1978, p. 134, pl. 52, fig. 8; Gerasimov *et al.*, 1996, pl. 4, figs. 3 and 4; and Nikolaeva and Andreev, 1999b, pl. 27, fig. 1.

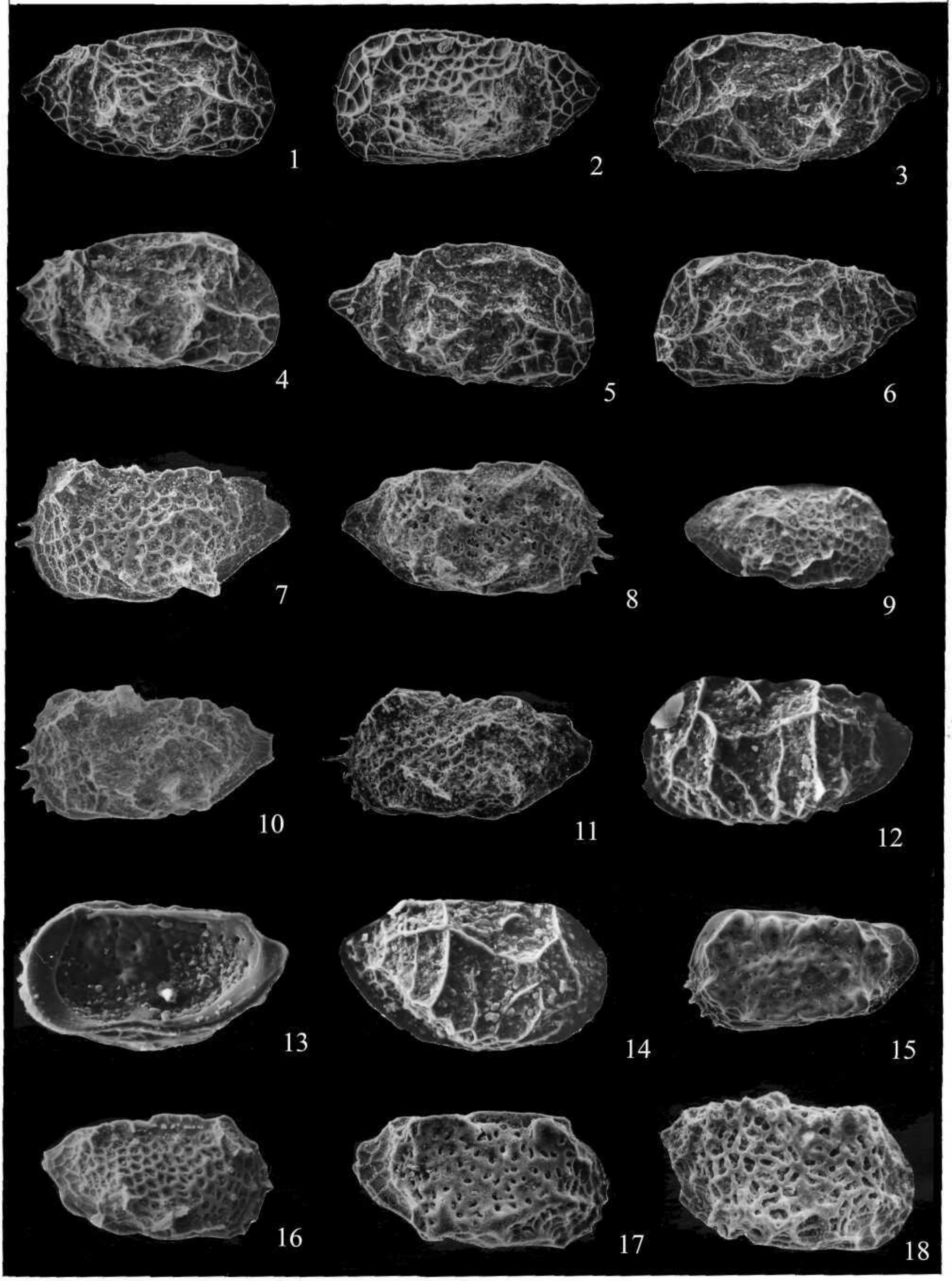
Holotype. VNIGRI, no. 117-13, left valve; Samarskaya Luka, the Rep'evka village; middle Callovian.

Description. The shell is nearly oval, strongly convex ventrally, having narrow flattening along the anterior and posterior ends. The left valve is larger than the right valve and embraces the latter along the anterodorsal and posterodorsal margins. In the left valve, the dorsal margin is weakly concave, fusing with the anterior and posterior margins in an archlike manner; in the right valve, it is slightly convex in the median part, fusing with the anterior and posterior margins at obtuse angles. The ventral margin is short, parallel to the dorsal margin, concave in the middle, and fusing smoothly with the anterior and posterior margins. The anterior end of the shell is high, evenly rounded; the posterior end is low, triangular, strongly beveled on the ventral side. The maximum length of the shell is in the dorsal half of the valve, the maximum height is in the anterior third, the maximum width is in the posterior third of the shell. A large irregularly rounded muscle tubercle is located near the anterior end. The most distinct is the ventral ridge that gently turns toward the dorsal margin at the anterior end. Another ridge, less distinct but longer, runs below it being parallel to the ventral margin and reaching the middle of the anterior end of the valve. A short oblique ridge is located at the anterior end of the shell; it runs from the midlength of the dorsal margin to the midlength of the anterior margin, where it fuses with ventral ridges. Two or three vertical, short ridges, which are bent toward the posterior margin, are located behind the muscle tubercle. Between ridges the surface of the shell is either smooth or indistinctly cellular, ornamented with low, leveled ridges.

Explanation of Plate 3

Figs. 1-14. *Fastigatocythere rugosa* Wienholz: (1) no. 4843-94, right valve, lateral view, x70; (7) no. 4843-95, left valve, lateral view, x70; sample 94-4; (2) no. 4843-107, left valve, lateral view, sample 94-8, x70; (3) no. 4843-73, right valve, inner view, x70; (4) no. 4843-71, left valve, lateral view, x70; (5) no. 4843-72, left valve, lateral view, x70; sample 94-2; (6) no. 4843-86, right valve, lateral view, sample 94-3, x70; (9) no. 4843-96, right valve, lateral view, x60; (11) no. 4843-97, left valve, lateral view, x60; sample 94-5; (10) no. 4843-81, right valve, inner view, sample 94-1, x70; Zmeinka, upper Callovian, *lamberti* Zone; (8) no. 4843-266, complete shell, dorsal view, x70; (14) no. 4843-268, left valve, inner view, x70; sample 94-22; Mikhailovtsement, middle Callovian, *coronatum* Zone; Ryazan Region; (12) no. 4843-57, right valve, lateral view, ×1 10; (13) no. 4843-58, right valve, lateral view, ×130; Moscow Region, Peski, sample Pyum-3, upper Callovian, *lamberti* Zone.

Plate 4



Measurements (mm):

Specimen no.	Length	Height	Width
4843-45	0.37	0.21	0.14
4843-24	0.45	0.25	0.15
4843-22	0.49	0.24	0.16
4843-21	0.49	0.24	0.16

Variability. The height and sharpness of the muscle tubercle and ridges are variable. The ridges may be broken up into rows of elongated tubercles. The development of fossae varies as well.

Comparison. From *B. pteriformis* (Biaszyk, 1967) from the Bathonian of Poland and the upper Bajocian of the Dnieper-Donets Depression (Biaszyk, 1967, p. 52, pl. 18, figs. 4, 5; Bielecka *et al.*, 1988, p. 175, pl. 71, fig. 4; Pyatkova and Permyakova, 1978, p. 134, pl. 53, fig. 1), it differs in the arrangement of ridges at the posterior end and in the wider anterior end; from *B. nucleopersica* (Błaszyk, 1967) from the lower-middle Bathonian of Poland (Biaszyk, 1967, p. 50, pl. 18, figs. 1-3; Bielecka *et al.*, 1988, p. 175, pl. 71, fig. 3), in the posterior end being not beveled on the dorsal side, in the cellular not pitted microsculpture, and in the wider ridges at the anterior end.

Remarks. Whatley (1970, p. 349, pl. 15, figs. 5-10, 12–14, 16, 18) described a new species, *Pseudohutsonia hebridica*, from the upper Callovian–lower Oxfordian deposits of Scotland; later, it was identified from the upper Callovian of Poland (Olempska and Biaszyk, 2001, p. 563, fig. 6), its figure strongly resembles the species being described. Taking into account that synonymizing the genus *Pseudohutsonia* with the genus *Balowella* is not unequivocal now, we keep ourselves from the inclusion of *P. hebridica* (Whatley, 1970) into synonymy of the species *B. attendens*.

Occurrence. The upper Bajocian–middle Callovian of the Dnieper-Donets Depression, the middle Callovian of Samarskaya Luka and the Ulyanovsk Region, the lower Oxfordian of the Ryazan Region, the upper Callovian of the Moscow Region.

Material. Seventeen well-preserved valves from the lower Oxfordian (*O. sagittum–E. volgensis* Zone) of the Mikhailovtsement section, 57 well-preserved valves and complete shells from the upper Callovian (*lamberti* Zone) of the Peski section.

Genus *Paranotacythere* Bassiouni, 1974

Paranotacythere: Kaever *et al.*, 1994, p. 55; Nikolaeva and Andreev, 1999b. p. 56.

Type species. *Orthonotacythere diglypta* Triebel, 1941, Hauterivian of Germany.

Diagnosis. Small to medium-sized, with a straight dorsal margin, sometimes weakly convex in its anterior portion, and with a caudal extension. The ventrolateral ridge demarcates median depression from below. Sculpture consisting of ridges and fossae. Eye tubercle always present. Paleomerodont or merodont hinge.

Composition. Two subgenera, *Paranotacythere* and *Unicosta*.

Occurrence. Late Jurassic-Lower Cretaceous, Eurasia.

Subgenus *Unicosta* Bassiouni, 1974

Unicosta: Nikolaeva and Andreev, 1999b, p. 56.

Type species. *P. (U.) nealei* Bassiouni, 1974, Kimmeridgian of England.

Diagnosis. Sculpture devoid of tubercles and lower ventral ridges. Eye tubercle small. Hinge mainly hemimerodont, with smooth median section.

Composition. Not less than ten species.

Comparison. From the subgenus *Paranotacythere* Bassiouni, 1974, it differs in the absence of tubercles and ventral ridges from the sculpture, and in the small eye tubercle.

Occurrence. Upper Jurassic, Europe.

Paranotacythere (Unicosta) ***solei*** **Tesakova, sp. nov.**

Plate 4, figs. 1–6

Etymology. From Latin *solei* (sunny).

Explanation of Plate 4

Figs. 1-6. *Paranotacythere (Unicosta) solei* sp. nov.: (1) no. 4843-142, right valve, lateral view, sample Pyum-23, ×150; (2) no. 4843-115, left valve, lateral view, sample Pyum-32, ×133; (3) holotype no. 4843-152, left valve, lateral view, sample Pyum-21, ×133; (4) no. 4843-208, right valve, lateral view, ×167; (5) no. 4843-151, right valve, lateral view, ×140; (6) no. 4843-150, left valve, lateral view, ×140; sample Pyum-22; Moscow Region, Peski, middle Oxfordian, *0. strumosum–L. brestica* Zone.

Figs. 7-11. *Paranotacythere (Unicosta) pseudoramulosa* sp. nov.: (7) holotype no. 4843-10, left valve, lateral view, ×130; (11) no. 4843-177, left valve, lateral view, ×130; sample Pyum-6, upper Callovian, *lamberti* Zone; (8) no. 4843-140, right valve, lateral view, sample Pyum-24, ×150; (10) no. 4843-125, left valve, lateral view, sample Pyum-27, ×130; Moscow Region, Peski, middle Oxfordian, *O. strumosum–L. brestica* Zone; (9) no. 4843-224, right valve, lateral view, Kostroma Region, Yartsevo, sample 95-20, lower Oxfordian, *cordatum* Zone, ×140.

Figs. 12–14. *Paranotacythere (Unicosta) stauropyga* sp. nov.: (12) holotype no. 4843-243, left valve, lateral view, ×167; (13) no. 4843-242, right valve, inner view, ×167; (14) no. 4843-244, right valve, lateral view, ×167; Kostroma Region, Makar'ev-yuzhnyi, sample 95-5, middle Callovian, *jason* Zone.

Fig. 15. *Vesticytherurascottia* (Whatley), no. 4843-186, left valve, lateral view; Moscow Region, Peski, sample Pyum-5, upper Callovian, *lamberti* Zone, ×1 10.

Figs. 16–18. *Vesticytherura rectodorsalis* (Biaszyk): (16) no. 4843-276, right valve, lateral view, sample Pyum-11, ×130; (17) no. 4843-190, right valve, lateral view, sample Pyum-1, ×167; (18) no. 4843-191, right valve, lateral view, sample Pyum-1, ×167; Moscow Region, Peski, upper Callovian, *lamberti* Zone.

Holotype. PIN, no. 4843-152, left valve; Moscow Region, Peski; middle Oxfordian, *Ophthalmidium strumosum-Lenticulina brestica* Zone.

Description. The shell is small, elongated oval, weakly convex, with equal valves. The anterior end of the shell is high, gently arched, weakly beveled on the dorsal side. The posterior end of the shell is lower than the anterior end, triangular, and bears a caudal extension. The anterior and posterior ends of the shell are flattened. The dorsal margin is weakly convex in its anterior half, fusing with the anterior margin smoothly and with the posterior margin through a scarp. The ventral margin runs gently toward the posterior end of the shell and is weakly concave in the middle. The maximum length is at the mid-height of the shell, the maximum height is in the anterior third, the maximum width is in the posterior half of the valve. A gently sloping median depression bordered ventrally by a ventrolateral ridge is located in the middle of the valve. Thin, curled ridges are visible on the outer surface of the valve. The longest ridge runs obliquely from the posterodorsal corner toward the anterior end of the shell. In the anterior half of the valve, this ridge has a small tubercle, from which another ridge runs in the posteroventral direction to fuse with the ventrolateral ridge. These ridges form a characteristic pattern resembling radiating rays. A thin ridge, which is concave in its posterior third, runs along the dorsal margin. The whole surface of the valves between ridges is covered with large polygonal fossae with thin muri. These fossae are larger on the anterior and posterior ends.

Measurements (mm):

Specimen no.	Length	Height	Width
Holotype 4843-152	0.38	0.19	0.09
4843-142	0.32	0.15	0.08
4843-115	0.36	0.17	0.07
4843-208	0.29	0.15	0.06
4843-151	0.35	0.18	0.08
4843-150	0.34	0.17	0.08

Variability. The development of cellular sculpture on the valves and the convexity of the dorsal ridge are slightly variable.

Comparison. From *P. (U.) stauropyga* sp. nov., it differs in the distinctive pattern of ridges at the anterior end of the shell, in the absence of the vertical ridge at the posterior end of the shell, and in the larger fossae.

Occurrence. The middle Oxfordian *(Ophthalmidium strumosum-Lenticulina brestica* Zone) of the Moscow Region.

Material. Seventeen well-preserved valves and several complete shells from the Peski section.

***Paranotacythere* (*Unicosta*) *pseudoramulosa* Tesakova, sp. nov.**

Plate 4, figs. 7–11

Etymology. From Greek *pseudos* (false) and *P. (U.) ramulosa* (Sharapova, 1939).

Holotype. PIN, no. 4843-10, left valve; Moscow Region, Peski; upper Callovian, *lamberti* Zone.

Description. The shell is small, elongated oval, weakly convex, with equal valves. The anterior end of the shell is high, arched, with five large, downcurved spines in its median and ventral parts. The posterior end of the shell is lower than the anterior end, with attenuated quadrangular caudal extension, fusing with the ventral margin smoothly and with the dorsal margin through a distinct scarp. The anterior and posterior ends of the shell are flattened. The dorsal margin is straight. The ventral margin is parallel to the dorsal margin, weakly concave in the middle. The maximum length is at the mid-height of the shell, the maximum height is in the posterior third, and the maximum width is in the posterior half of the valve. A sloping median depression is developed in the middle of the valve. This depression is bordered ventrally by a short ventrolateral ridge that may occasionally have a large tubercle in its rear portion. A short oblique ridgelet reaching the mid-height of the shell runs from the middle of the ventrolateral ridge toward the anterodorsal corner. The posterior portion of the ventrolateral ridge arches toward the dorsal margin. Two short, low ridges, which are arched toward the dorsal margin, are present above the ventrolateral ridge, it the mid-height of the valve and near the dorsal margin. Another thin ridge runs along the anterior half of the dorsal margin. A short oblique ridge starting at the eye tubercle is present at the anterior end of the shell. All of the ridges are formed by fused muri of large polygonal fossae that cover the outer surface of the shell.

Measurements (mm):

Specimen no.	Length	Height	Width
Holotype 4843-10	0.37	0.18	0.15
4843-177	0.34	0.17	0.14
4843-140	0.31	0.16	0.15
4843-125	0.35	0.18	0.16

Variability. The degree of the development of the cellular pattern on the valves, the height of the ridges, especially that of the dorsal ridge, and the height of the posteroventral tubercle are slightly variable.

Comparison. Being most similar in valve outline and sculpture to *P. (U.) ramulosa* (Sharapova, 1939) from the Neocomian of Samarskaya Luka (Sharapova, 1939, p. 29, pl. 3, fig. 34; Lübimova, 1955b, p. 93, pl. 10, fig. 5), it differs from the latter in the absence of tubercles in the posterodorsal corner, in the presence of a short convex ridge in the middle portion of the posterior half of the shell, and in the presence of a short oblique ridge in the anteroventral portion of the valve; from *P. (U.) solei* sp. nov., to which is very similar in valve outline, it differs in the arrangement of ridges that concentrate mainly at the posterior end of the shell, in their small size, and in the absence of a central tubercle at the anterior end of the shell.

Occurrence. The upper Callovian of the Moscow Region, the middle Callovian of the Ryazan Region, the upper Callovian–upper Oxfordian of the Kostroma Region.

Material. Four well-preserved valves from the middle Callovian (*coronatum* Zone) of the Mikhailovtsement section, two well-preserved valves from lower Oxfordian and one satisfactorily preserved valve from the upper Oxfordian of the Yartsevo section, three well-preserved valves from the lower Oxfordian, three well-preserved valves from the middle Oxfordian, and one well-preserved valve from the upper Oxfordian of the Makar'ev-yuzhnyi section, four well-preserved valves from the upper Callovian (*lamberti* Zone) of the Peski section.

***Paranotacythere* (*Unicosta*) *stauropyga* Tesakova, sp. nov.**

Plate 4, figs. 12-14

Etymology. From Greek *stauros* (cross) and *pyga* (nates).

Holotype. PIN, no. 4843-243, left valve; the Kostroma Region, Makar'ev-yuzhnyi; middle Callovian, *jason* Zone.

Description. The shell is small, elongated rectangular, weakly convex, with slightly unequal valves. The left valve is slightly larger than the right valve, overlapping the latter along the anterodorsal and posterodorsal margins. The anterior end of the shell is high, gently arched, weakly beveled dorsally. The posterior end of the shell is lower than the anterior end and triangular. The anterior and posterior ends of the shell are flattened. The dorsal margin is straight, fusing with the anterior end of the shell smoothly and with the posterior end through a scarp. The ventral margin is parallel to the dorsal margin and concave in its middle. The maximum length is at the mid-height of the shell, the maximum height is in the middle, and the maximum width is in the posterior half of the valve. A broad median depression bordered ventrally by the ventrolateral ridge is visible in the middle of the valve. Numerous transverse ridges and one longitudinal ridge lie on the outer surface of the valves. In the posterior half of the shell, there are two long and thin ridges, intersecting one another at a right angle. One of these ridges (transverse) extends up to the anterior end of the shell, where it terminates at the forklike ridge that starts near the eye tubercle and reaches the ventrolateral ridge with its branches. From the ventrolateral ridge, three thin vertical ridges run to the transverse ridge and one thin ridge, which is inclined toward the anterior end, terminates at the posterior process of the forklike ridge. The whole space between the ridges is covered with small, thin-walled fossae.

Measurements (mm):

Specimen no.	Length	Height	Width
Holotype 4843-243	0.30	0.16	0.05
4843-242	0.30	0.16	0.04
4843-244	0.30	0.16	0.04

Variability. The length and angles of inclination of ridges on the valves are slightly variable.

Comparison. The comparison of this species with *P.* (*U.*) *solei* has been given above when describing the latter species.

Occurrence. The middle Callovian (*jason* Zone) of the Kostroma Region.

Material. Ten well-preserved valves from the Makar'ev-yuzhnyi section.

Subfamily Cytherurinae G. Müller, 1894

Genus *Vesticytherura* Gründel, 1964

Vesticytherura: Nikolaeva and Andreev, 1999b, p. 56.

Type species. *Eucytherura neocomiana* Kaye, 1964, Lower Cretaceous, Hauterivian of England.

Diagnosis. Shell very small, rounded rectangular, with weak median depression, sometimes with muscle tubercle. Dorsal ridge often transformed into row of separated tubercles. Eye tubercle distinct. Ventral ridge borders weak ventrolateral widening. Hinge lophodont, with shortened marginal elements; hinge bar developed in left valve, weakly incised.

Composition. More than ten species.

Comparison. From the genus *Renicytherura* Griindel, 1981, similar in hinge structure and the shape of the shell, it differs in the dorsal ridge being transformed into a row of separated tubercles.

Occurrence. Callovian-Paleogene; Eurasia.

***Vesticytherura scottia* (Whatley, 1970)**

Plate 4, fig. 15

Eucytherura (Vesticytherura) scottia: Whatley, 1970, p. 328, pl. 7, figs. 7-13; Witte and Lissenberg, 1994, p. 32, pl. 9, figs. 21 and 22.

Holotype. HU.18.J.36, left valve; Scotland, Staffin Bay; lower Oxfordian, *cordatum* Zone.

Description. The shell is weakly convex. The right valve is slightly larger than the left valve. Overlapping is best expressed on the ventral side of the posterior end of the shell. The anterior end of the shell is high, evenly rounded, flattened along its margin. The posterior end of the shell is low, rounded triangular, flat, stronger beveled ventrally in the left rather than in the right valve. The dorsal margin is straight, fusing with the anterior margin at an obtuse angle; the posterodorsal margin is convex. The ventral margin is straight, leaning toward the posterior end, weakly concave in the middle. The maximum length of the shell is in its upper half, the maximum height is at the anterior end, and the maximum width is in the posteroventral half of the shell. A thin zigzag ridge runs along the anterior margin; it runs along the ventral side up to the posterior end to disintegrate into several massive tubercles. A short, low, tuberculate ridge is also visible in the posterior half of the dorsal margin. There is a large round tubercle between this ridge and the eye tubercle. The ends of the shell are sculptured with large, thin-walled fossae. All the rest of the surface of the valve is covered with shallow, small, rounded pits, which are often fused in pairs, and with indistinct rare tubercles. Four small acute spines directed downward are located in the ventral part of the anterior end.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-186	0.38	0.20	0.04

Comparison. Being most similar in sculpture to *V. acostata* sp. nov., it differs from the latter in the pitted unreticulate sculpture, in stronger expressed tubercles along the dorsal margin, and in the presence of a low ventral ridge; from *V. rectodorsalis*, in the dorsal ridge being transformed into tubercles, in the absence of oblique ridges, and in the pitted pattern of the sculpture.

Occurrence. The Kimmeridgian and the Ryazan Horizon of Holland, the middle Callovian–lower Oxfordian of England and Scotland, the upper Callovian of the Moscow Region, the middle Oxfordian of the Kostroma Region.

Material. One well-preserved valve from the middle Oxfordian deposits (*Ophthalmidium strumosum–Lenticulina brestica* Zone) of the Makar'ev-yuzhnyi section, one well-preserved valve from the upper Callovian (*lambertl* Zone) of the Peski section.

Vesticytherurarectodorsalis (Błaszyk, 1967)

Plate 4, figs. 16-18

Eucytherura rectodorsalis: Błaszyk, 1967, p. 55, pl. 19, figs. 1-3; Bielecka *et al.*, 1988, p. 177, pl. 72, fig. 5; and Brand, 1990, p. 170, pl. 6, fig. 11.

Holotype. ZPAL, O.IV/147; Poland, Iwanowice Wielke; upper Bathonian, *heterocostatus* Zone.

Description. The shell is rounded quadrangular and weakly convex. The left valve is slightly larger than the right valve. Overlapping is most distinct on the dorsal side of the posterior and anterior ends. The anterior end is high, evenly rounded. The posterior end is lower than the anterior end, rounded triangular, and flat. In the right valve, the anterior and posterior ends are more strongly beveled than in the left valve. The dorsal margin is straight, fusing with the anterior and posterior margins through a scarp, which is more distinct in the right valve. The ventral margin is parallel to the dorsal margin, weakly concave in its anterior third, fusing smoothly with the anterior and posterior margins. The maximum length is at the mid-height of the valve, the maximum height is in the anterior third, and the maximum width is in the posteroventral part of the shell. A straight, low ridge reaching the valve midlength runs along the anterior half of the dorsal margin above the eye tubercle. Another low ridge with a massive base is present in the posterodorsal corner. A large, elongated tubercle rises in the posterodorsal part of the shell; a thin, smooth ridge directed toward the middle of the anterior end starts at this tubercle. A thin, ill-defined ridge fusing at the anterior end with the lower oblique ridge into a single ridge runs obliquely from the posterodorsal ridge. The outer surface of the valve, except for ridges and tubercles, is covered with numerous small fossae with thick muri that become thinner and larger at the anterior and posterior ends. Five short spines are visible in the dorsal half of the anterior end.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-276	0.32	0.17	0,06
4843-190	0.27	0.15	0.05
4843-191	0.29	6.16	0.05

Variability. The development and length of ridges are variable. The reticulation of valves varies widely from fine-celled and thin-walled to pitted.

Comparison. From forms identified as *V.* sp. cf. *Eucytherura (Vesticytherura) soror* (Pokorny, 1973) from the upper Kimmeridgian of Holland (Witte and Lissenberg, 1994, p. 32, pl. 5, figs. 28, 29), it differs in the fused oblique and ventral ridges, from *Eucytherura (Vesticytherura)* sp. A from the upper Kimmeridgian–Ryazanian deposits of Holland (Witte and Lissenberg, 1994, p. 32, pl. 9, figs. 23, 24), in the oblique ridge reaching the anterior end of the shell and fusing with the ventral ridge there. The comparison with *V. scottia* is given above when describing the latter species.

Occurrence. The upper Bajocian and Bathonian of Poland, the upper Bathonian (*discus* Zone) of Germany, the upper Callovian of the Moscow Region.

Material. Three well-preserved valves from the upper Callovian (*lambertl* Zone) of the Peski section.

Vesticytherura costaeirregularis (Whatley, 1970)

Plate 5, figs. 1-8

Eucytherura (Vesticytherura) costaeirregularis: Whatley, 1970, p. 325, pl. 6, figs. 9-19, 21; Lord *et al.*, pl. 9, figs. 1–4.

Eucytherura sp. cf. *E. (Vesticytherura) costaeirregularis*: Witte and Lissenberg, 1994, p. 32, pl. 8, fig. 19.

Paranotacy there aff. *paula*Gerasimov *et al.*, 1996, pl. 3, fig. 8.

Holotype. Hu. 18.J.40, left valve; Scotland, York, Melton; sample AC-Mel-5, upper Oxfordian, *cautlsnlgrae* Zone.

Description. The shell is rounded quadrangular, weakly convex. The left valve is slightly larger than the right valve, embracing the latter along the posterodorsal and anteroventral margins. The anterior end of the shell is high and evenly rounded. The posterior end of the shell is lower than the anterior end, rounded quadrangular, stronger beveled dorsally in the right valve than in the left valve. The anterior and posterior ends of the shell are flattened. The dorsal margin is straight, fusing with the anterior and posterior margins at an obtuse angle. The ventral margin is nearly parallel to the dorsal margin, weakly concave in the anterior third, fusing smoothly with the anterior and posterior ends. The maximum length is at mid-height, the maximum height is in the anterior third, and the maximum width is in the posteroventral part of the shell. A large, rounded eye tubercle is distinctly expressed at the anterodorsal margin. Two thin and short ridges running toward the anterior and ventral margins start from the eye tubercle. One of these ridges, i.e., that running toward the ventral margin, fuses with a low, horizontal median ridge that turns ventrally at the anterior end. A short, twisting horizontal ridge runs in the posterior third of the shell under the median ridge. Another short, oblique ridge runs from the posterodorsal margin toward the posterior end of the shell. Two large triangle tubercles with their apices directed backward the rear are clearly visible in the ventral side. Another (small) tubercle lies on the dorsal margin, immediately beyond the eye tubercle. The whole outer surface of the valves is covered with large irregular fossae with thick muri. At the anterior and posterior ends of the shell, muri are thinner and fossae become polygonal. Rare large pores are mostly confined to elevated elements in the sculpture. The solum of the fossae is dotted with abundant granules. Five short, ventrally directed spines are located in the ventral half of the anterior end.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-207	0.26	0.14	0.13
4843-122	0.28	0.15	0.13
4843-123	0.29	0.15	0.12
4843-135	0.30	0.15	0.13
4843-138	0.31	0.17	0.14
4843-149	0.30	0.16	0.14

Variability. The degree of the cellular sculpture, the length and height of the ridges, and their fusion pattern vary greatly.

Comparison. Being most similar in sculpture to the species *V. paula* (Lübimova, 1955), it differs from the latter in the presence of an additional short horizontal ridge developed under the median ridge, in the presence of a tubercle beyond the eye tubercle, and in the considerably less-developed reticulation; from *V. acostata* sp. nov., in the presence of ridges and in the presence of a tubercle beyond the eye tubercle and in the less considerably developed reticulation of the valve surface; from forms identified as *Vesticytherura* sp. cf. *E. (Vesticytherura) soror* (Pokorny, 1973) from the upper Kimmeridgian of Holland (Witte and Lissenberg, 1994, p. 32, pl. 5, figs. 28, 29), in the presence of median ridges and in the reticulate sculpture; from *V. grandipyga* sp. nov., in the development of horizontal ridges and the oblique posterior ridge, in the presence of a tubercle beyond the eye tubercle, and in the straight dorsal margin.

Occurrence. The upper Oxfordian (*cautisnigrae* Zone) of Scotland, the upper Kimmeridgian of Holland, the lower Volgian Substage of the Volga Region, the middle Callovian–upper Oxfordian of the Kostroma Region, the upper Callovian-middle Oxfordian of the Moscow Region, the upper Callovian and lower Oxfordian of the Ryazan Region.

Material. Thirteen well-preserved valves from the middle Oxfordian of the Samylovo section, 25 well-preserved valves and complete shells from the lower Oxfordian (*Ophthalmidium sagittum–Epistomina volgensis* Zone), 12 well-preserved valves from the middle Oxfordian (*Ophthalmidium strumosum–Lenticulina brestica* Zone) of the Yartsevo section, four well-preserved valves from the middle Callovian, one well-preserved valve from the lower Oxfordian (*Ophthalmidium sagittum-Epistomina volgensis* Zone), two valves from the middle Oxfordian (*Ophthalmidium strumosum-Lenticulina brestica* Zone) and four well-preserved valves from the upper (*serratum* Zone) Oxfordian of the Makar'ev-yuzhnyi section, 24 well-preserved valves and complete shells from the upper Callovian (*lamberti* Zone), two well-preserved valves from the lower Oxfordian and 62 well-preserved valves and complete shells from the middle Oxfordian of the Peski section, eight well-preserved valves from the upper Callovian of the Zmeinka section, 45 well-preserved valves and complete shells from the upper Callovian, and 11 well-preserved valves from the lower Oxfordian of the Mikhailovtsement section.

Vesticytherura grandipyga Tesakova, sp. nov.

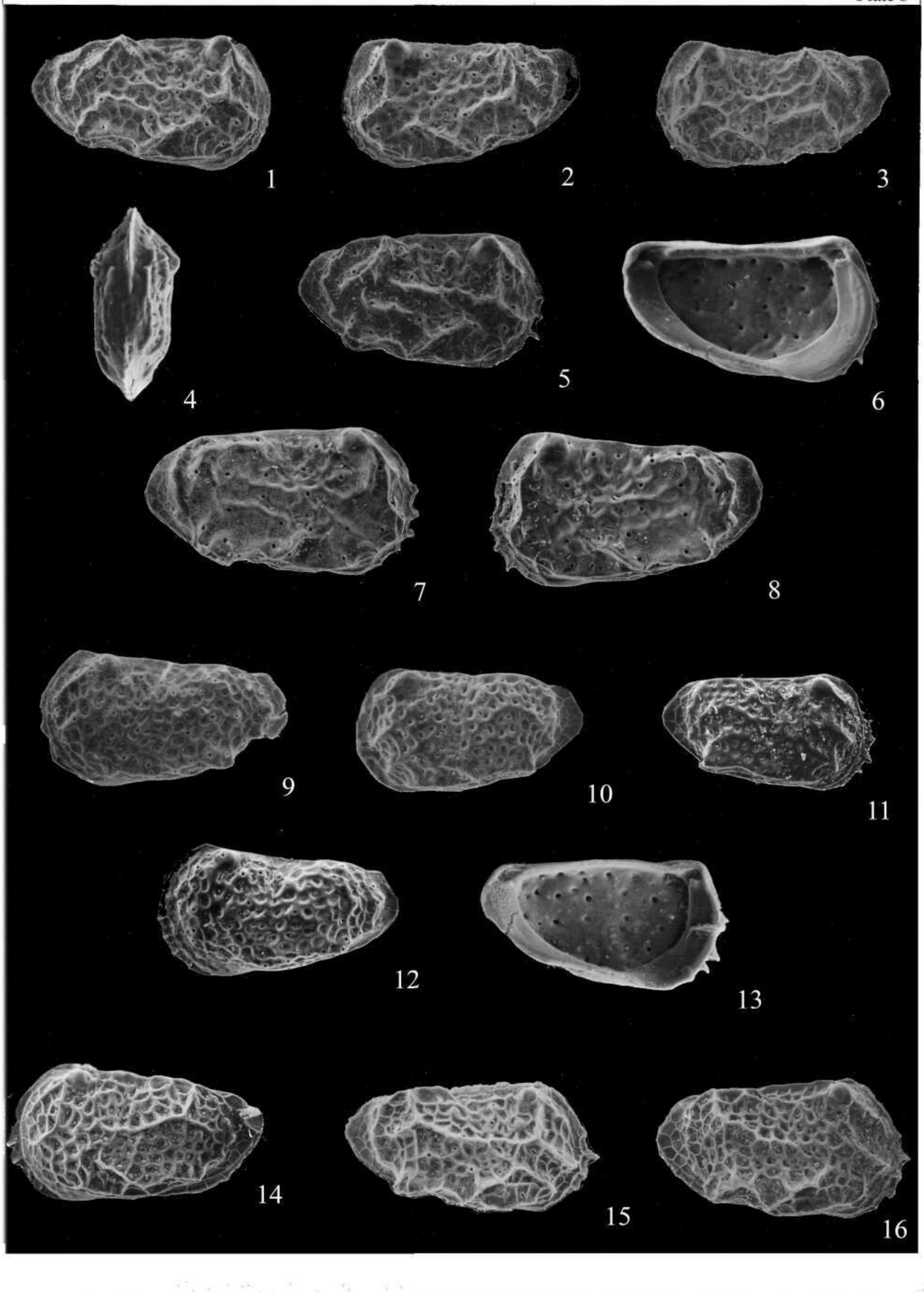
Plate 5, figs. 9-13

Etymology. From Latin *grandis* (big) and Greek *pyga* (nates).

Holotype. PIN, no. 4843-130, left valve; Moscow Region, Peski; middle Oxfordian, *Ophthalmidium strumosum-Lenticulina brestica* Zone.

Description. The shell is rounded quadrangular, weakly convex; the convexity is greater in the posterior half. The left valve embraces the right valve along the posterodorsal margin. The anterior end of the shell is high and evenly rounded. The posterior end of the shell is lower than the anterior end, rounded quadrangular in the left valve and triangular in the right valve. The anterior and posterior ends are flattened. The dorsal margin is weakly concave in the middle, fusing with the anterior margin at an obtuse angle and with the posterior margin at an obtuse angle in the right valve and through an excavation in the left valve. The ventral margin is nearly parallel to the dorsal margin, weakly concave in the anterior third, fusing smoothly with the anterior and posterior margins. The maximum length is at the mid-height, the maximum height is in the anterior third, and the maximum width is in the rear part of the

Plate 5



valve. A shallow median depression nearly reaching the ventral margin is present in the middle of the valve. A large eye tubercle is distinctly expressed on the anterodorsal edge. A high ridge with a massive base lies in the posterior half of the ventral side. Three short ridges directing obliquely toward the ventral margin are present at the anterior end of the shell. Three short ridges arched toward the dorsal margin are traced in the posterior, convex half of the shell. The entire surface of the valve is covered with rounded pits, the solum of which is covered with fine, round granules. Polygonal thin-walled fossae are developed on flattened areas of the anterior and posterior ends. Five short, acute, ventrally oriented spines are developed at the anterior end of the shell.

Measurements (mm):

Specimen no.	Length	Height	Width
Holotype 4843-130	0.34	0.17	0.08
4843-175	0.27	0.13	0.09
4843-180	0.27	0.14	0.09
4843-14	0.29	0.16	0.08

Variability. The size of pits varies from large to small; additionally, the height of the hind ridges is slightly variable.

Comparison. From *V. acostata* sp. nov., it differs in the concave dorsal margin, in the more convex posterior part of the valve, and in the absence of tubercles both beyond the eye tubercle and in the posterior third of the dorsal margin; from *V. paula* (Lübimova, 1955), in the absence of the horizontal ridge and hind oblique ridge, and in the presence of pits instead of thin-walled fossae, also in the concave dorsal margin and more convex posterior half of the valve. The comparison with *V. costaeirregularis* (Whatley, 1970) is provided above when describing the latter species.

Occurrence. The middle Oxfordian of the Kostroma Region, the upper Callovian and middle Oxfordian of the Moscow Region, the middle Callovian of the Kursk Region, the middle Callovian of Mordovia.

Material. Four well-preserved valves from the middle Oxfordian (*Ophthalmidium strumosum-Lenticulina brestlca* Zone) of the Yartsevo section, one well-preserved valve from the middle Oxfordian (*Ophthalmidium strumosum-Lenticulina brestica* Zone) of the Makar'ev-yuzhnyi section, five well-preserved valves from the upper Callovian (*lamberti* Zone) and two well-preserved valves from the middle Oxfordian of the Peski section, one well-preserved valve from the middle Callovian (*jason* Zone) of the Mikhailovskii Mine section, 30 well-preserved valves and complete shells from the middle Callovian (*coronatum* Zone) of the Troshkov vrag section.

***Vesticytherura** paula* **(Lübimova,** 1955)

Plate 5, figs. 14–16; Plate 6, figs. 1-12

Orthonotacythere paula: Lubimova, 1955b, p. 90, pl. 10, fig. 7.

Paranotacytherepaula: Pyatkova and Permyakova, 1978, p. 136, pl. 53, fig. 7.

Paranotacythere aff. *paula* Gerasimov *et al.*, 1996, pl. 3, figs. 9 and 10.

Renicytherura paula: Nikolaeva and Andreev, 1999b, pl. 26, figs. 2-5; Kupriyanova, 2000, pl. 1, figs. 5 and 6.

Renicytherura (R.)parairregularis: Brand, 1990, p. 172, pl. 6, figs. 1-6.

Holotype. VNIGRI, no. 148-1; Emba Region, Lake Inder, Karadzhir Gorge; middle Volgian Substage, *panderi* Zone.

Description. The shell is rounded quadrangular, weakly convex. The left valve overlaps the right valve along the dorsal parts of the anterior and posterior margins of the shell. The anterior end of the shell is high, evenly rounded; in the right valve, it is slightly beveled dorsally. The posterior end of the shell is lower than the anterior end, rounded quadrangular in the left valve and rounded triangular in the right valve. Both ends of the shell are flattened. The dorsal margin is straight, fusing with the anterior and posterior margins of the shell at an obtuse angle in the right valve. In the left valve, the anterodorsal margin is convex and the posterodorsal margin is concave. The ventral margin is not parallel to the dorsal margin, it is weakly concave in the anterior third. The maximum length is at the mid-height of the valve, the maximum height is in the anterior third, and the maximum width is in the posterior half of the shell. The median depression is weakly

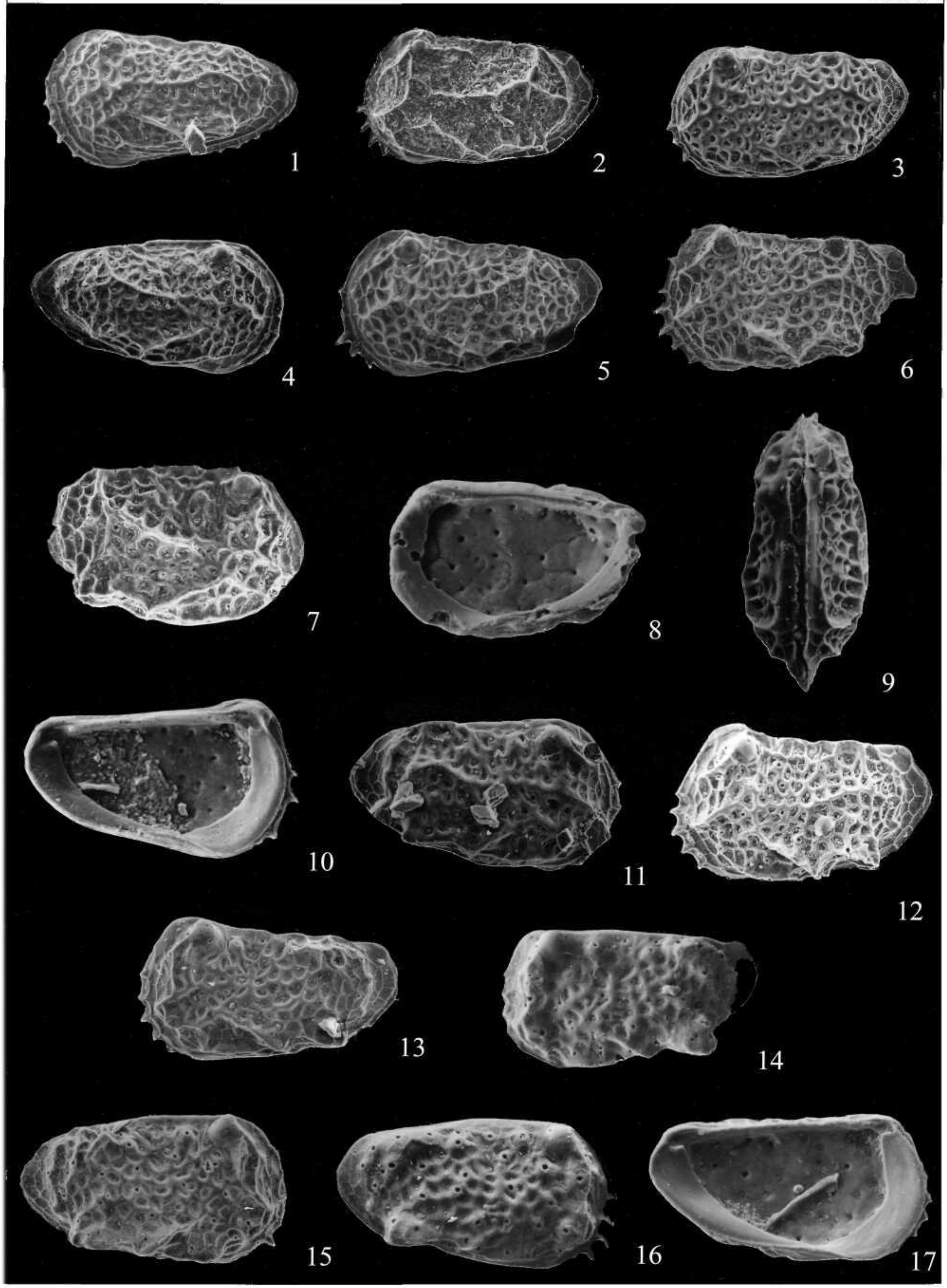
Explanation of Plate 5

Figs. 1-8. *Vesticytherura costaeirregularis* (Whatley): (1) no. 4843-122, left valve, lateral view, ×150; (2) no. 4843-123, left valve, lateral view, ×150; sample Pyum-27; (3) no. 4843-135, left valve, lateral view, ×150; (5) no. 4843-138, right valve, lateral view, ×150; sample Pyum-25; (7) no. 4843-149, right valve, lateral view, ×167; (8) no. 4843-148, left valve, lateral view, ×167; sample Pyum-22; middle Oxfordian, *O. strumosum–L. brestica* Zone; (4) no. 4843-207, left valve, lateral view, sample Pyum-9, upper Callovian, *lamberti* Zone, ×133; Moscow Region, Peski; (6) no. 4843-219, left valve, inner view, Kostroma Region, Yartsevo, sample 95-17, lower Oxfordian, *cordatum* Zone, ×167.

Figs. 9-13. *Vesticytherura grandipyga* sp. nov.: (9) no. 4843-180, left valve, lateral view, ×167; (11) no. 4843-14, right valve, lateral view, ×130; sample Pyum-6; (12) no. 4843-175, left valve, lateral view, sample Pyum-7, ×167; upper Callovian, *lamberti* Zone; (10) holotype no. 4843-130, left valve, lateral view, sample Pyum-26, middle Oxfordian, *O. strumosum-L. brestica* Zone, ×130; Moscow Region, Peski; (13) no. 4843-227, left valve, inner view, Kostroma Region, Yartsevo, sample 95-21, middle Oxfordian, *densiplicatum* Zone, ×167.

Figs. 14-16. *Vesticytherura paula* (Lubimova): (14) no. 4843-46, left valve, lateral view, sample Pyum-5, upper Callovian, *lamberti* Zone, ×167; (15) no. 4843-112, right valve, lateral view, sample Pyum-32, ×140; (16) no. 4843-126, right valve, lateral view, sample Pyum-27, ×167; middle Oxfordian, *O. strumosum-L. brestica* Zone, Moscow Region, Peski.

Plate 6



developed on the outer surface of the anterior half of the valves; this depression shallows toward the middle of the valve. A large eye tubercle is distinctly expressed on the anterodorsal margin. The longest ridge transects obliquely the entire valve from the posterior to the anterior end of the shell. This ridge dichotomizes in its anterior and posterior ends; its upper processes reach the dorsal margin, its lower processes are obliquely directed downward toward the anterior and posterior ends. Three short, oblique ridges are developed at the anterior end. Two large, acuminate tubercles with their bases fused appear in the posterior half of the ventral side. The entire outer surface of the shell, except for the eye tubercle and ridges, is covered with large polygonal fossae with high acuminate muri; these fossae form reticulation. The solum is finely porous. In the flattened areas of the anterior and posterior ends, muri are very thin. Five or six short, downward directed spines are present at the anterior end.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-46	0.30	0.15	0.13
4843-35	0.27	0.15	0.14
4843-186	0.29	0.16	0.13
4843-178	0.27	0.15	0.13
4843-202	0.30	0.16	0.14
4843-171	0.28	0.15	0.14

Variability. Ridges are less developed in specimens with wider and lower muri; vertical processes of the median ridge may be lacking in such specimens.

Comparison. Differences from *V. costaeirregularis* (Whatley, 1970) and *V. grandipyga* sp. nov. have been given above when describing these species. From *V. acostata* sp. nov., it differs in the presence of a median ridge, in the absence of tubercles beyond the eye tubercle, and in the reticulate not cellulate sculpture on the valve surface.

Remarks. Nikolaeva and Andreev (1999b), Kupriyanova (2000), and Brand (1990) referred this species to the genus *Renicytherura* on the basis of the dorsal ridge that is not disintegrated into separate tubercles. Due to the fact that the genus *Vesticytherura* includes species with a poorly defined dorsal ridge, and taking into account the great similarity of the sculpture in this species and in *V. costaeirregularis* (Whatley, 1970) and *V. acostata* sp. nov., we place this species into the genus *Vesticytherura.*

Forms identified as *Orthonotacythere* aff. *paula* from the Valanginian of Salekhard (West Siberian Lowland) (Lübimova *et al.*, 1960) may belong to this species. Lübimova mentions "a somewhat different arrangement of ridges on the surface" as a character separating the West Siberian form from *V. paula;* however, in the description of both species, the information on the sculpture and ridges, in particular, is identical. Lacking a photograph of *O.* aff. *paula* and the similarity of its depiction with that of *V. costaeirregularis* prevent us from synonymizing *O. aff. paula* with *V. paula.*

Occurrence. The upper Bathonian of Germany, the Callovian of the Dnieper-Donets Depression, the middle Volgian Substage (*panderi* Zone) of Kazakhstan, the middle Callovian–upper Kimmeridgian of Samarskaya Luka, the lower Oxfordian–middle Volgian Substage of the Obshchii Syrt; the upper Oxfordian of Tatarstan and the Orel Region, the upper Berriasian–lower Valanginian of Kolguev Island (Barents Sea), the upper Callovian–Oxfordian of the Kostroma Region, the upper Callovian and the middle Oxfordian of the Moscow Region, the upper Callovian of the Ryazan Region, and the middle Callovian of the Kursk Region.

Material. Four well-preserved valves from the lower Oxfordian and one well-preserved valve from the upper Oxfordian of the Yartsevo section, two well-preserved valves from the middle Oxfordian (*Ophthalmidium strumosum-Lenticulina brestica* Zone) of the Makar'ev-yuzhnyi section, 15 well-preserved valves and complete shells from the upper Callovian (*lamberti* Zone) and 15 well-preserved valves and complete shells from the middle Oxfordian of the Peski section, two well-preserved valves from the upper Callovian (*lamberti* Zone) of the Zmeinka section, three well-preserved valves from the middle Callovian (*jason* Zone) of the Mikhailovskii Mine section.

Explanation of Plate 6

Figs. 1-12. *Vesticytherura paula* (Lübimova): (1) no. 4843-35, left valve, lateral view, ×167; (5) no. 4843-189, left valve, lateral view, X167; (11) no. 4843-186, right valve, lateral view, ×150; sample Pyum-5; (2) no. 4843-12, left valve, lateral view, ×167; (4) no. 4843-178, right valve, lateral view, ×167; sample Pyum-6; (3) no. 4843-171, left valve, lateral view, sample Pyum-7, ×150; (9) no. 4843-202, complete shell, dorsal view, sample Pyum-8, ×150; upper Callovian, *lamberti* Zone; (6) no. 4843-136, left valve, lateral view, sample Pyum-25, ×167; (7) no. 4843-4-b, right valve, lateral view, ×167; (12) no. 4843-4-a, left valve, lateral view, ×140; sample Pyum-27; (10) no. 4843-212, left valve, inner view, sample Pyum-22, ×167; middle Oxfordian, *O. strumosum–L. brestica* Zone; Moscow Region, Peski; (8) no. 4843-223, right valve, inner view, Kostroma Region, Yartsevo, sample 95-19, lower Oxfordian, *cordatum* Zone.

Figs. 13-17. *Vesticytherura acostata* sp. nov.: (13) no. 4843-114, left valve, lateral view, ×167; (15) no. 4843-113, right valve, lateral view, ×140; Moscow Region, Peski, sample Pyum-32, middle Oxfordian, *O. strumosum–L. brestica* Zone; (14) holotype no. 4843-226, left valve, lateral view, sample 95-21, middle Oxfordian, *densiplicatum* Zone, ×167; (17) no. 4843-220, left valve, inner view, lower Oxfordian, *cordatum* Zone, sample 95-17, ×167; Kostroma Region, Yartsevo; (16) no. 4843-294, right valve, lateral view, Mordovia, Troshkov vrag, sample 96-3, middle Callovian, *coronatum* Zone, ×167.

Vesticytheruraacostata **Tesakova, sp. nov.**

Plate 6, figs. 13-17

E t y m o l o g y. From the Greek *a* (without) and Latin *costa* (rib).

H o l o t y p e. PIN, no. 4843-226, left valve; Kostroma region, the Yartsevo village; upper Callovian, *Lenticulina tumida–Epistomina elshankaensis* Zone.

D e s c r i p t i o n. The shell is rounded quadrangular and weakly convex. The left valve slightly overlaps the right valve along the antero- and posterodorsal margins. The anterior end of the shell is high, evenly rounded; in the right valve, it is slightly beveled dorsally. The posterior end is lower than the anterior end; it is rounded quadrangular in the left valve and rounded triangular in the right valve. The anterior and posterior ends of the shell are flattened. The dorsal margin is straight, fusing with the anterior and posterior margins smoothly in the right valve and at an obtuse angle in the left valve. The ventral margin is not parallel to the dorsal one and weakly concave in the anterior third. The maximum length is at the mid-height, the maximum height is in the anterior third, and the maximum width is in the posteroventral portion of the shell. On the dorsal side, there are a large eye tubercle, a small tubercle developed just beyond the eye tubercle, and another small tubercle in the posterior third of the dorsal margin. Two large pointed tubercles having their bases fused and apices directed towards the rear arise in the posterior half of the ventral side. Up to three thin, oblique small ridges may be outlined at the anterior end of the shell. The entire surface of the valve, except for the eye tubercle, is covered with large, rounded, thick-walled fossae. The solum is finely granulated. The muri are thinner on the flattened areas of the anterior and posterior ends of the shell. Five short downcurved spines are developed on the ventral side of the anterior end of the shell.

M e a s u r e m e n t s (mm):

Specimen no.	Length	Height	Width
Holotype 4843-226	0.27	0.15	0.07
4843-220	0.30	0.16	0.06
4843-114	0.28	0.15	0.06
4843-113	0.34	0.18	0.08

V a r i a b i l i t y. The variability is expressed in the degree of cellular sculpture development.

C o m p a r i s o n. Differences from *V. costaeirregularis* (Whatley, 1970) and *V. grandipyga* sp. nov. are provided above under the description of the latter species.

O c c u r r e n c e. The Oxfordian of the Kostroma Region, the upper Callovian and the middle Oxfordian of the Moscow Region, and the upper Callovian of the Ryazan Region.

M a t e r i a l. Eighteen well-preserved valves and complete shells from the middle Oxfordian of the Samylovo section, 23 well-preserved valves and complete shells from the lower Oxfordian (*Ophthalmidium sagittum–Epistomina volgensis* Zone), 24 well-preserved valves and complete shells from the middle Oxfordian *(Ophthalmidium strumosum-Lenticulina brestica* Zone) and three satisfactorily preserved valves from the upper Oxfordian of the Yartsevo section, 36 well-preserved valves and complete shells from the lower Oxfordian *(Ophthalmidium sagittum-Epistomina volgensis* Zone), three well-preserved valves from the middle Oxfordian *(Ophthalmidium strumosum-Lenticulina brestica* Zone) and six well-preserved valves from the upper Oxfordian of the Makar'ev-yuzhnyi section, 28 well-preserved valves and complete shells from the upper Callovian (*lamberti* Zone) and 31 well-preserved valves and a complete shell from the middle Oxfordian of the Peski section, one well-preserved valve from the upper Callovian *(lamberti* Zone) of the Zmeinka section, and one well-preserved valve from the upper Callovian of the Mikhailovtsement section.

Subfamily Cytheropterinae Hanai, 1957

Genus *Cytheropteron* Sars, 1865

Cytheropteron: Lübimova, 1955b, p. 94; Kashevarova *et al.*, 1960, p. 404; Reyment *et al.*, 1961, p. 292; Nikolaeva and Pavlovskaya, 1989, p. 133; Kaever *et al*, 1994, p. 54; and Nikolaeva and Andreev, 1999b, p. 57.

T y p e s p e c i e s. *Cythere latissima* Norman, 1865; a Recent species from the Atlantic Ocean.

D i a g n o s i s. Shell small to medium-sized, oval or subrhomboid, strongly to moderately convex, with equal or slightly unequal valves. Anterior end high, arched. Posterior end lower than anterior end, rounded triangular. Dorsal margin archlike, forming caudal process at point of fusion with posterior margin. Winglike widening often ending with spine developed on ventral side. Surface smooth, pitted reticulate, reticulate or wrinkled. Eye tubercle absent. Hinge merodont in Mesozoic forms and entomodont in Cenozoic forms; in right valve, represented by two elongated teeth incised into five parts in marginal regions and by a crenellate groove in the median region; in the left valve, the arrangement of elements is reverse.

C o m p o s i t i o n. Around 50 species.

C o m p a r i s o n. From the genus *Procytheropteron* Lübimova, 1955, similar in shell contour, it differs in the merodont hinge (in contrast to the antimerodont hinge in the latter genus) and in the development of wing-shaped widening on the ventral side (in contrast to the ventrolateral prominence in the latter genus).

O c c u r r e n c e. Lower Jurassic-Recent; worldwide.

Cytheropteron spinosum **Lübimova, 1955**

Plate 7, figs. 1-7

Cytheropteron (?) spinosum: Lübimova, 1955b, p. 95, pl. 10, fig. 9.

Cytheropteron sp.: Kubiatowicz, 1983, p. 24, pl. 7, figs. 9 and 12.

Cytheropteron spinosum: Pyatkova and Permyakova, 1978, p. 158, pl. 72, figs. 1-3.

Cytheropteron tenuis: Gerasimov *et al*, 1996, pl. 5, fig. 13.

H o l o t y p e. VNIGRI, no. 117-9, right valve; Samarskaya Luka, the village of Rep'evka; middle Callovian.

Description. The shell is very small, irregular oval, moderately convex, with slightly unequal valves. The left valve slightly overlaps the right valve along the antero- and posterodorsal margins. The anterior end of the shell is high, rounded, weakly beveled dorsally, and flattened along its margin. The posterior end of the shell is much lower than the anterior end, stretched out toward the dorsal margin and flattened, strongly beveled ventrally, fusing with the dorsal margin through a scarp and with the ventral margin smoothly. The ventral margin is parallel to the dorsal margin and weakly concave in the anterior third. The maximum length is just below the dorsal margin. The maximum height is in the anterior third, and the maximum width is in the posteroventral part of the shell. An acute spine is present in the posteroventral part of the valve. The entire surface of the valve is covered with large, rounded fossae with wide muri that are thinner at the anterior and posterior ends of the shell and fuse into small ridges on the prominence below the spine. The solum is dotted with numerous fine pores that are more distinct at the anterior and posterior ends of the shell. A flat, translucent bordering is developed along the anterior margin and lower part of the posterior margin.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-344	0.29	0.14	0.09
4843-168	0.34	0.19	0.10
4843-185	0.24	0.12	0.07
4843-286	0.29	0.15	0.09
4843-284	0.33	0.15	0.09

Variability. The length of the spine and the degree of the development of reticulation are slightly variable.

Comparison. From *C. pseudospinosum* sp. nov., it differs in the rounded shape of the fossae and in the much thinner and lower spine.

Occurrence. The upper Kimmeridgian of Poland, the middle Callovian of the Dnieper-Donets Depression, the middle Callovian–lower Oxfordian of Samarskaya Luka and the Ulyanovsk region, the upper Callovian and the middle Oxfordian of the Moscow Region, and the middle Callovian of the Kursk Region and Mordovia.

Material. Seven well-preserved valves from the upper Callovian (*lamberti* Zone) and one well-preserved valve from the middle Oxfordian (*Ophthalmidium strumosum–Lenticulina brestica* Zone) of the Peski section, one well-preserved valve from the middle Callovian (*jason* Zone) of the Mikhailovskii Mine section, four well-preserved valves from the middle Callovian (*coronatum* Zone) of the Troshkov vrag section.

Cytheropteron pseudospinosum **Tesakova, sp. nov.**

Plate 7, figs. 8-12

Etymology. From the Greek *pseudos* (false) and *C. spinosum* Lübimova, 1955.

Cytheropteron spinosum: Gerasimov *et al.*, 1996, pl. 5, figs. 14 and 15.

Holotype. PIN, no. 4843-38, left valve; Mordovia, Troshkov vrag; middle Callovian, *coronatum* Zone.

Description. The shell is small, elongated, moderately convex. The left valve slightly overlaps the right valve along the antero- and posterodorsal margins. The anterior end of the shell is high and evenly rounded, weakly beveled dorsally. The posterior end is much lower than the anterior end, strongly beveled ventrally, fusing with the dorsal margin through a scarp and with the ventral margin smoothly. The anterior and posterior ends of the shell are flattened. The dorsal margin is straight. The ventral margin is parallel to the dorsal margin and weakly concave in the anterior third. The maximum length is just below the dorsal margin. The maximum height is in the anterior half, and the maximum width is in the posteroventral part of the valve. A very massive, long spine with flat flanks is developed in the posteroventral part of the valve. The entire valve surface, except for the spine, is covered with large polygonal fossae with wide muri. On the ventral side, the muri fuse together to form several short, thin, convex ridgelets that are parallel to the ventral margin. At the anterior and posterior ends of the shell, the fossae are especially large, polygonal, and thin-walled. The solum is finely porous.

Measurements (mm):

Specimen no.	Length	Height	Width
Holotype 4843-38	0.28	0.15	0.09
4843-275	0.27	0.15	0.09
4843-274	0.32	0.16	0.10
4843-183	0.30	0.14	0.08

Variability. The width of the muri and the height of the spine are slightly variable.

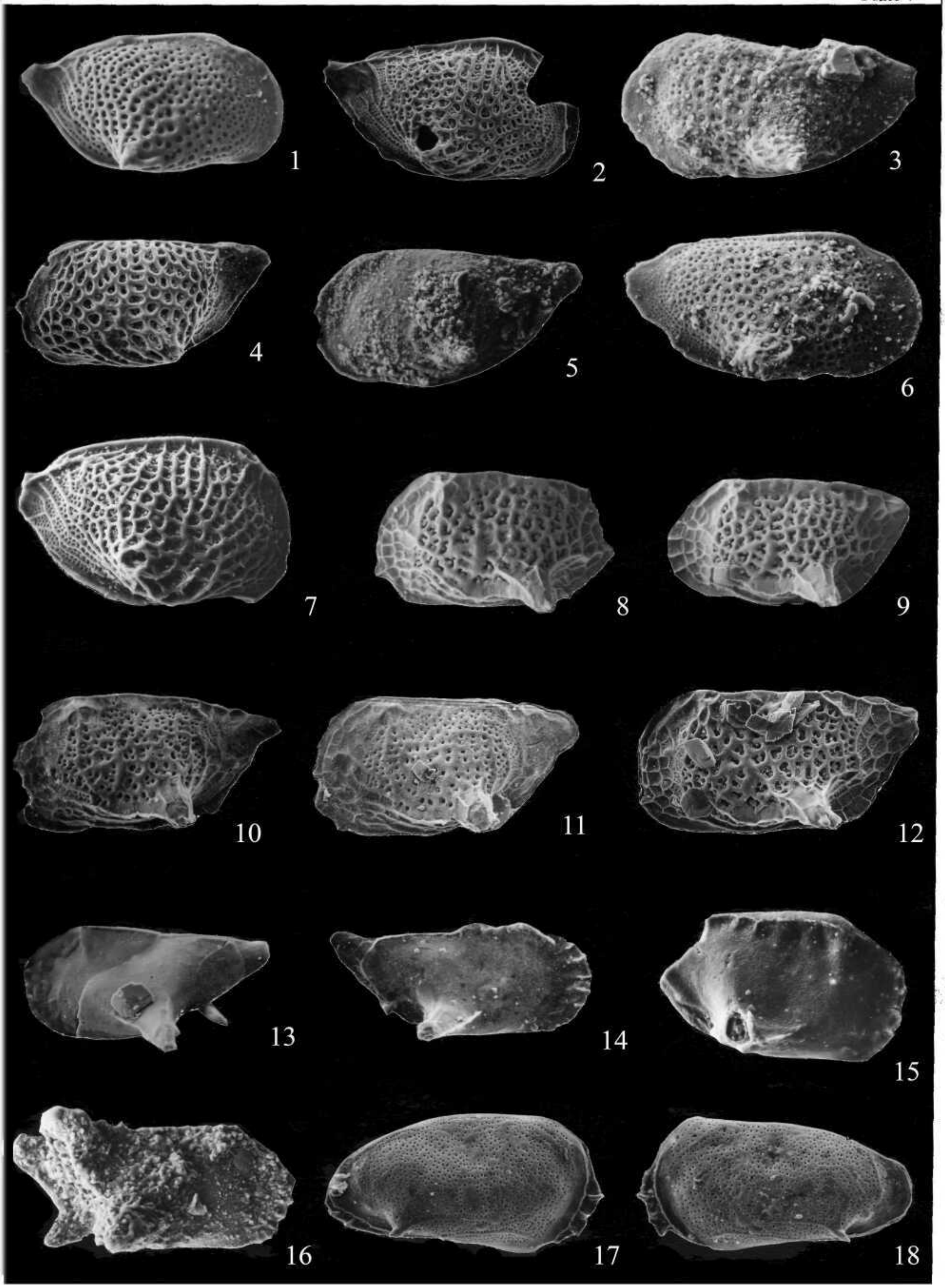
Comparison. Differences from *C. spinosum* Lübimova, 1955 are given under the description of the latter species.

Remarks. The specimen depicted by myself in the paper by Gerasimov *et al.* (1996, pl. 5, figs. 14, 15) was erroneously identified as *C. spinosum.*

Occurrence. The lower and middle Oxfordian of the Kostroma Region, the upper Callovian of the Moscow Region.

Material. Two well-preserved valves from the middle Oxfordian (*Ophthalmidium strumosum–Lenticulina brestica* Zone) of the Samylovo section, two well-preserved valves from the lower Oxfordia (*Ophthalmidium sagittum-Epistomina volgensis* Zone) of the Makar'ev-yuzhnyi section, and three well-preserved valves from the upper Callovian (*lamberti* Zone) of the Peski section.

Plate 7



Cytheropteron laeve **Tesakova, sp. nov.**

Plate 7, figs. 13–16

Etymology. From Latin *laevis* (smooth).

Metacytheropteron sp. A: Whatley, 1970, p. 330, pl. 8, figs. 1-4.

Holotype. PIN, no. 4843-146, right valve; Moscow Region, Peski; middle Oxfordian, *Ophthalmidium strumosum–Lenticulina brestica* Zone.

Description. The shell is small and moderately convex. The left valve slightly overlaps the right valve along the antero- and posterodorsal margins. The anterior end of the shell is high and evenly rounded, weakly beveled in the dorsal half. The posterior end is low, strongly beveled ventrally and stretched upward, fusing with the dorsal margin through a scarp and with the ventral margin smoothly. The anterior end of the shell is flattened. The dorsal margin is straight. The ventral margin is parallel to the dorsal one, weakly concave in the anterior third. The maximum length is just below the dorsal margin. The maximum height occurs in the anterior third, and the maximum width is in the center of the valve. The ventral wing-shaped extension terminates in a long and thick spine. The second spine, smaller and thinner, is developed closer to the posterior margin. A thin longitudinal ridgelet occasionally runs along the dorsal margin in its anterior half. The entire outer surface of the valves is smooth.

Measurements (mm):

Specimen no.	Length	Height	Width
Holotype 4843-146	0.31	0.13	0.09
4843-193	0.26	0.12	0.07
4843-256	0.28	0.15	0.09
4843-282	0.38	0.16	0.10

Variability. The length of the lesser spine and the degree of the development of the anterodorsal longitudinal ridgelet are slightly variable.

Comparison. From *C. spinosum* and *C. pseudospinosum* described above, it differs in the presence of the second spine in the posteroventral part of the valve and in the smooth outer surface of the valves.

Occurrence. The middle Callovian of Scotland, the upper Oxfordian of the Kostroma Region, the upper Callovian and the middle Oxfordian of the Moscow Region, and the upper Callovian of the Ryazan Region.

Material. One satisfactorily preserved valve from the upper Oxfordian of the Makar'ev-yuzhnyi section, two well-preserved valves from the upper Callovian (*lamberti* Zone) and two well-preserved valves from the middle Oxfordian (*Ophthalmidium strumosum-Lenticulina brestica* Zone) of the Peski section, and one satisfactorily preserved valve from the upper Callovian the Mikhailovtsement section.

Superfamily Cytherideidacea Sars, 1925

Family Cytherideidae Sars, 1925

Subfamily Galliaecytherideinae Andreev et Mandelstam, 1964

Genus *Galliaecytheridea* Oertli, 1957

Galliaecytheridea: Oertli, 1957, p. 654; Howe *et al.*, 1961a, p. 276; Kaever *et al.*, 1994, p. 52; and Nikolaeva *et al.*, 1999a, p. 83.

Type species. *G. dessimilis* Oertli, 1957; Kimmeridgian of France.

Diagnosis. Shell medium-sized, suboval, with flattening in the anterior marginal zone or with a marginal rolllike ridge. Valves unequal; left valve embracing right valve along entire margin or leaves free only anterior margin. Anterior end of shell high, gently rounded. Posterior end lower than anterior end, triangular rounded. Dorsal margin straight. Ventral margin concave in anterior half. Outer surface of shell smooth or pitted. Hinge hemimerodont; in left valve, represented by incised marginal sockets and crenellate bar; in right valve, arrangement of elements reverse. Pore-canal zones narrow; 10 to 15 pore canals present in anterior one.

Composition. Around 40 species.

Explanation of Plate 7

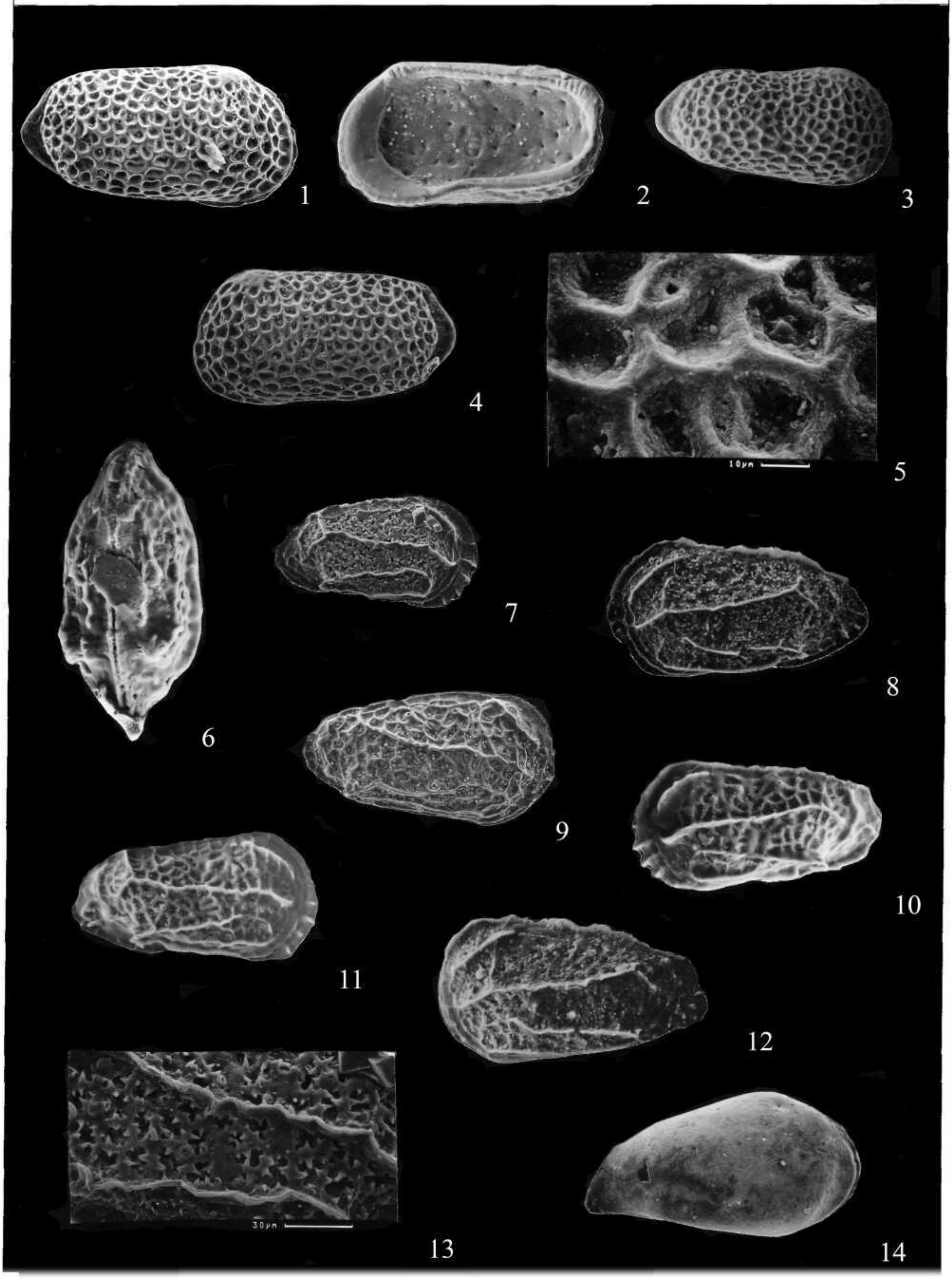
Figs. 1-7. *Cytheropteron spinosum* Lübimova: (1) no. 4843-344, right valve, lateral view, Kursk Region, Mikhailovskii Mine, sample 95-23, middle Callovian, *jason* Zone, ×167; (2) no. 4843-168, right valve, lateral view, sample Pyum-32, middle Oxfordian, *O. strumosum–L. brestica* Zone, ×133; (4) no. 4843-185, left valve, lateral view, sample Pyum-5, upper Callovian, *lamberti* Zone, ×200; Moscow Region, Peski; (3) no. 4843-284, left valve, lateral view, ×167; (5) no. 4843-286, left valve, lateral view, ×167; (6) no. 4843-288, right valve, lateral view, ×167; Mordovia, Troshkov vrag, sample 96-4, middle Callovian, *coronatum* Zone; (7) no. 4843-258, right valve, lateral view, Kostroma Region, Samylovo, sample Sam-14, middle Oxfordian, *O. strumosum-L. brestica* Zone, ×167.

Figs. 8-12. *Cytheropteron pseudospinosum* sp. nov.: (8) no. 4843-275, left valve, lateral view, ×167; (9) no. 4843-274, left valve, lateral view, ×140; sample Pyum-11; (10) no. 4843-183, left valve, lateral view, ×167; (11) no. 4843-39, left valve, lateral view, ×167; sample Pyum-5; Moscow Region, Peski, upper Callovian, *lamberti* Zone; (12) holotype no. 4843-38, left valve, lateral view, Mordovia, Troshkov vrag, sample 96-4, middle Callovian, *coronatum* Zone, ×167.

Figs. 13-16. *Cytheropteron laeve* sp. nov.: (13) no. 4843-193, left valve, lateral view, sample Pyum-5, upper Callovian, *lamberti* Zone, ×170; (14) holotype no. 4843-146, right valve, lateral view, sample Pyum-22, middle Oxfordian, *O. strumosum-L. brestica* Zone, ×150; Moscow Region, Peski; (15) no. 4843-256, right valve, lateral view, Kostroma Region, Makar'ev-yuzhnyi, sample 95-13, upper Oxfordian, *serratum* Zone, ×170; (16) no. 4843-282, right valve, lateral view, Mordovia, Troshkov vrag, sample 96-4, middle Callovian, *coronatum* Zone, ×133.

Figs. 17 **and 18.** *Palaeocytheridea baculumbajula* (Mandelstam): (17) no. 4843-155, right valve, lateral view, X170; (18) no. 4843-154, left valve, lateral view, ×170; Moscow Region, Peski, sample Pyum-9, upper Callovian, *lamberti* Zone.

Plate 8



Comparison. Being similar in hinge structure and shell outline to the genus *Palaeocytheridella* Mandelstam, 1958, it differs from the latter in the absence of spines in the posteroventral part of the valve.

Occurrence. Upper Jurassic; Eurasia.

Galliaecytheridea legitima (Lübimova, 1955)

Plate 9, figs. 1-8

Palaeocytheridea legitima: Liibimova, 1955b, p. 43, pl. 4, fig. 5; Gerasimov *et al.*, 1996, pl. 3, fig. 6.

Holotype. VNIGRI, no. 226-33, left valve; Ulyanovsk Region, the village of Gorodishche; upper Oxfordian.

Description. The shell is elongated, irregular oval. The valves are unequal; the left valve embraces the right valve along the entire margin. The anterior end of the shell is slightly beveled dorsally. The anterior and posterior ends of the shell are flattened along their margins, having a wide pore-canal zone. The dorsal margin is nearly straight, weakly convex in its medial part, lowering toward the posterior end, fusing with the latter through a small scarp and with the anterior end smoothly. The ventral margin is not parallel to the dorsal margin, weakly concave medially, fusing smoothly with both the anterior and posterior margins. The maximum length of the shell is at its mid-height, the maximum height is in the anterior third of the valve, and the maximum width is in the middle of the ventral side. Irregularly scattered small, rounded pits are developed on the outer surface of the valve, except for the flattened areas of the anterior and posterior ends; their size decreases from the center to the margins. A shallow, convex rearward median depression is sometimes present in the middle part of the outer surface of the valve; this depression is developed above the adductor.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-336	0.53	0.32	0.27
4843-335	0.53	0.30	0.26
4843-338	0.57	0.34	0.29
4843-337	0.53	0.30	0.26
4843-342	0.49	0.30	0.28

Variability. The degree of the dorsal margin leaning and the pitted sculpture of the valves are slightly variable.

Comparison. Being similar in shell shape and sculpture to the species *G. mandelstami* (Liibimova, 1955) from the Oxfordian, Kimmeridgian, and the lower and middle Volgian substages of the Volga Region and the middle Volgian Substage of the Obshchii Syrt (Lübimova, 1955b, p. 42, pl. 4, fig. 4), it differs from the latter in the more convex ventral part of the shell, in the presence of the scarp in the upper part of the dorsal end, and in the well-developed pore-canal zone.

Remarks. In the shell outline and sculpture, representatives of the genus *Galliaecytheridea* much resemble ostracodes of the genus *Amphicythere* Triebel, 1954, which is referred to the subfamily *incertae sedis* of the family *incertae sedis* of the superfamily Progonocytheracea Sylvester-Bradley, 1948, but differ from them in the hemimerodont hinge (in contrast to the amphidont hinge in the latter) and in the absence of an eye spot. A new species of ostracodes identified as *Amphicythere kilenyii* Bielecka, Błaszyk, et Styk, 1976 (Bielecka *et al*, 1988, p. 373, pl. 170, fig. 3) has been discovered in the lower Kimmeridgian of Poland. A very similar specimen is known and identified as *Amphicythere* sp. cf. *kilenyii* in the lower Oxfordian of Holland (Witte and Lissenberg, 1994, p. 33, pl. 3, fig. 12). On the basis of the shell shape and the absence of the eye spot, the Polish and the Dutch forms may be allocated to the genus *Galliaecytheridea* and to the above species; however, we refrain from their identification because of the absence of a description and drawings of their hinge.

There are several different species referred to the genus *Amphicythere* in the Jurassic of Poland; unfortunately, the description and drawings of their hinges are lacking. Since their shell outlines and their valve sculpture resemble those of G. *legitima*, below we compare them. From *A. delicatipunctata* Bielecka, Błaszyk, et Styk, 1976 from the lower Kimmeridgian of Poland (Bielecka *et al*, 1988, p. 372, pl. 170, fig. 2), *G. legitima* differs in the wider flattening of the anterior and posterior ends and in more dispersely scattered pits; from forms identified as *A. confundens* Oertli, 1957 from the

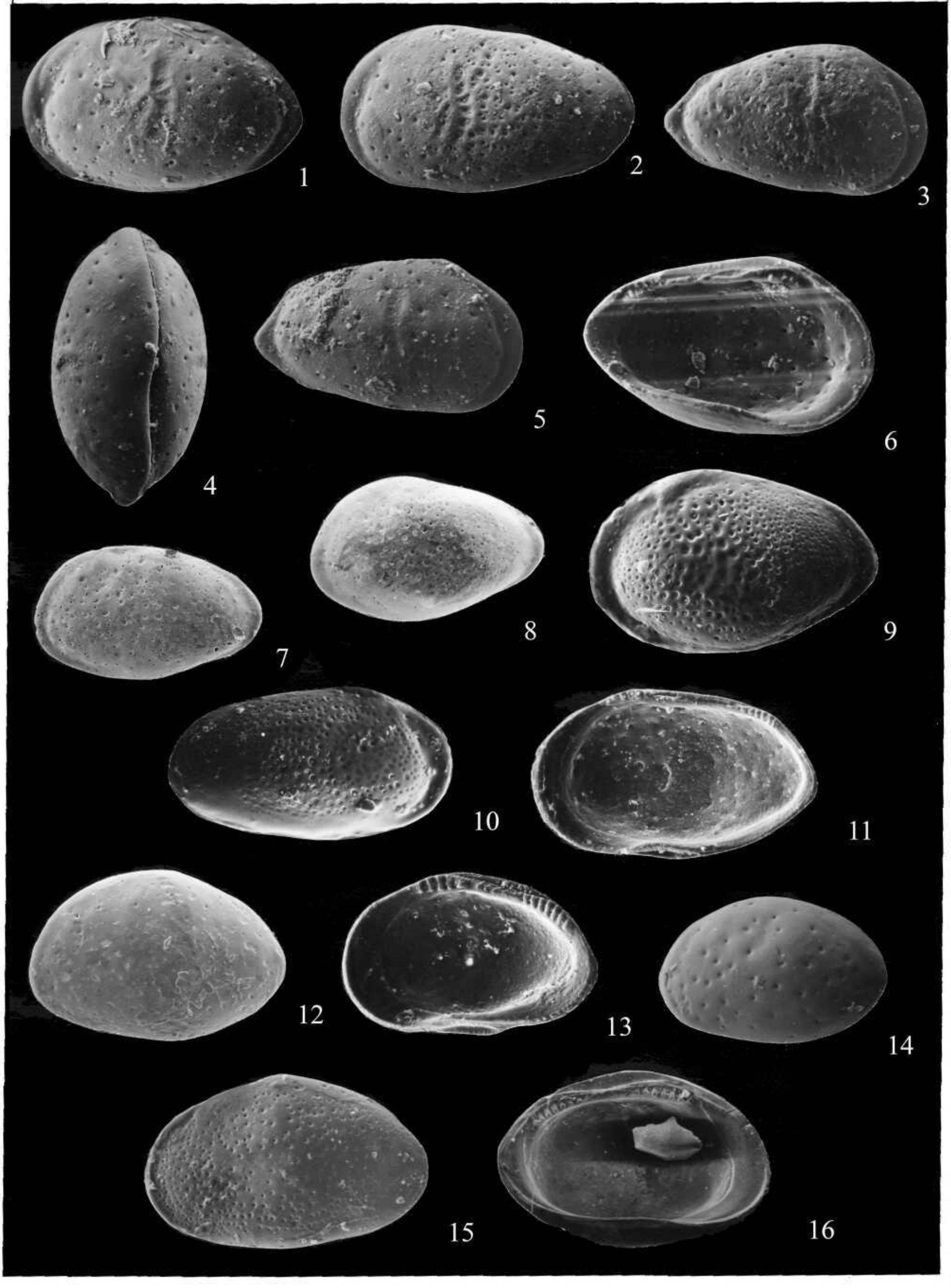
Explanation of Plate 8

Figs. 1-5. *Parariscus octoporalis* Błaszyk: (1) no. 4843-163, right valve, lateral view, ×130; (2) no. 4843-206, right valve, inner view, X135; (3) no. 4843-201, right valve, lateral view, ×130; (5) no. 4843-163, reticulate pores, X800; sample Pyum-8; (4) no. 4843-154, left valve, lateral view, sample Pyum-9, ×120; Moscow Region, Peski, upper Callovian, *lamberti* Zone.

Figs. 6-13. *Tethysia bathonica* Scheppard: (6) no. 4843-255, complete shell, dorsal view, sample 95-12, ×167; (12) no. 4843-257, left valve, lateral view, sample 95-13, ×167; Makar'ev-yuzhnyi, upper Oxfordian, *E. uhligi–L. russiensis* Zone; (10) no. 4843-237, left valve, lateral view, Yartsevo, sample 95-29, upper Oxfordian, *E. uhligi-L. russiensis* Zone, ×167; Kostroma Region; (7) no. 4843-34, right valve, lateral view, sample Pyum-5, ×130; (13) no. 4843-34, calcareous spines inside fossae, x400; (9) no. 4843-12, right valve, lateral view, sample Pyum-6, ×130; upper Callovian, *lamberti* Zone; (8) no. 4843-143, left valve, lateral view, sample Pyum-23, ×167; (11) no. 4843-218, right valve, lateral view, sample Pyum-32, ×167; middle Oxfordian, *O. strumosum–L. brestica* Zone; Moscow Region, Peski.

Fig. 14. *Ljubimovella* sp., no. 4843-161, right valve, lateral view, Moscow Region, Peski, sample Pyum-8, upper Callovian, *lamberti* Zone, ×150.

Plate 9



lower Kimmeridgian of Poland (Bielecka *et al.*, 1988, p. 372, pl. 170, fig. 1), in much larger pits and in the greater flattening of the posterior end.

Occurrence. The Oxfordian of Tatarstan, the Samara and Voronezh regions, the upper Callovian of the Moscow Region, the middle Callovian of Mordovia and the Kostroma and Kursk regions.

Material. One well-preserved valve from the upper Callovian (*lamberti* Zone) of the Peski section, one satisfactorily preserved valve from the middle Callovian (*jason* Zone) of the Yartsevo section, one satisfactorily preserved valve from the middle Callovian (*coronatum* Zone) of the Troshkov vrag section, 150 well-preserved valves and complete shells from the middle Callovian (*jason* Zone) of the Mikhailovskii Mine section.

Galliaecytheridea spinosa Kilenyi, 1969

Plate 9, figs. 9–11

Galliaecytheridea spinosa: Kilenyi, 1969, p. 128, pl. 26, figs. 10–20; Pyatkova and Permyakova, 1978, p. 132, pl. 50, figs. 6–8; and Witte and Lissenberg, 1994, p. 15, pl. 5, figs. 22-24.

Holotype. HU 2.J.1.11, left valve of female; England, Dorset; upper Kimmeridgian, *rotunda* Zone.

Description. The shell is elongated, oval. The left valve embraces the right valve along its entire margin. The anterior end of the shell is slightly beveled dorsally. The anterior and posterior ends are flattened along their margins. The dorsal margin is straight, leaning toward the posterior end, with which fuses through a poorly defined scarp; fuses with the anterior end smoothly. The ventral margin is not parallel to the dorsal margin, weakly concave medially, fusing smoothly with the anterior and posterior margins. The maximum length of the shell is at its mid-height, the maximum height is in the anterior third of the valve, and the maximum width is in the middle of the ventral side. Numerous, large, rounded pits are irregularly dispersed on the outer surface of the valve, except for the flattened areas at the anterior and posterior ends; their size decreases from the center toward the margins.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-238	0.64	0.38	0.30
4843-239	0.65	0.41	0.28
4843-240	0.74	0.39	0.28

Variability. The length-to-height ratio of the valve and the degree of development of the pitted sculpture are slightly variable.

Comparison. From *G. legitima* described above, this species differs in the more regularly oval contour of the valves and in more abundant and larger pits.

Occurrence. The upper Kimmeridgian–lower Portlandian of Holland, the upper Kimmeridgian of the Dnieper-Donets Depression, and the middle Callovian of the Kostroma Region.

Material. Four well-preserved valves from the middle Callovian (*jason* Zone) of the Makar'ev-yuzhnyi section.

Family Schulerideidae Mandelstam, 1959

Genus _Schulerideа_ Swartz et Swain, 1946

Aequacytheridea: Mandelstam, 1947, p. 247; Lübimova, 1955b, p. 96.

Schuleridea: Kashevarova *et al.*, 1960, p. 370; Howe *et al*, 1961a, p. 284; Sheremeta, 1969, p. 83; Nikolaeva, 1989b, p. 185; Kaever *et al.*, 1994, p. 53; Nikolaeva *et al.*, 1999a, p. 86.

Type species. *S. acuminata* Swartz et Swain, 1946; Kimmeridgian of the United States.

Diagnosis. Shell medium-sized, suboval, ovoid or triangular, evenly convex. Left valve larger than right valve. Anterior end higher than posterior end and is evenly rounded. Posterior end evenly rounded, strongly beveled dorsally, having scarp in right valve. Dorsal margin leaning toward posterior end. Ventral margin concave medially. Outer surface of valves smooth or pitted. Eye spot present. Hinge paleo- and holomerodont, having bar in right valve. In left valve, hinge represented by smooth median groove and marginal sockets that incised into five sections. In right valve, arrangement of elements reverse. Inner margin and fusion line usually coinciding. Pore-canal zone broad at

Explanation of Plate 9

Figs. 1–8. *Galliaecytheridea legitima* (Lubimova): (1) no. 4843-338, left valve, lateral view, x90; (2) no. 4843-339, left valve, lateral view, ×100; (3) no. 4843-335, right valve, lateral view, x90; (5) no. 4843-337, right valve, lateral view, x90; (6) no. 4843-336, left valve, inner view, X100; sample 95-20; (4) no. 4843-342, complete shell, dorsal view, sample 95-21, X100; Kursk Region, Mikhailovskii Mine, middle Callovian, *jason* Zone; (7) no. 4843-64, left valve, lateral view, x85; (8) no. 4843-63, left valve, lateral view, x100; Moscow Region, Peski, sample Pyum-3, upper Callovian, *lamberti* Zone.

Figs. 9-11. *Galliaecytheridea spinosa* Kilenyi: (9) no. 4843-239, left valve, lateral view, x80; (10) no. 4843-240, right valve, lateral view, x70; (11) no. 4843-238, right valve, inner view, x80; Kostroma Region, Makar'ev-yuzhnyi, middle Callovian, *jason* Zone.

Figs. 12–16. *Schuleridea translucida* (Lubimova): (12) no. 4843-69, left valve of female, lateral view, x85; (16) no. 4843-68, left valve of female, lateral view, x100; Zmeinka, sample 94-2, upper Callovian, *lamberti* Zone; (14) no. 4843-271, left valve of female, lateral view, Mikhailovtsement, sample 94-22, middle Callovian, *coronatum* Zone, x80; Ryazan Region; (13) no. 4843-245, right valve, inner view, x100; (15) no. 4843-247, left valve of male, lateral view, x100; Kostroma Region, Makar'ev-yuzhnyi, sample 95-5, middle Callovian, *jason* Zone.

anterior end, where number of pore canals varies from 10-30 in Jurassic species to 60 in Cretaceous species.

Composition. Around 60 species.

Comparison. From the genus *Praeschuleridea* Bate, 1963, similar in shell outline and hinge structure, it differs in the shorter and higher shell.

Occurrence. Middle Jurassic (Bathonian)-Cretaceous; worldwide.

***Schuleridea translucida* (Lübimova, 1955)**

Plate 9, figs. 12-16

Aequacytheridea translucida: Liibimova, 1955b, p. 97, pl. 11, fig. 1; 1956, p. 564, pl. 3, figs. 7 and 8.

Schuleridea translucida: Pyatkova and Permyakova, 1978, p. 138, pl. 53, figs. 10 and 11; Gerasimov *et al.*, 1996, pl. 3, fig. 5.

Schuleridea lukoviensis: Olempska et Błaszyk, 2001, p. 558, fig. 3.

Holotype. VNIGRI, no. 117-24, left valve; Samarskaya Luka, the village of Rep'evka; middle Callovian.

Description. The shell is oval. The left valve embraces the right valve along its entire margin; however, this overlapping is more strongly expressed along the dorsal and ventral margins. The anterior end is high. The posterior end is slightly lower than the anterior end. The dorsal margin is convex, fusing with the anterior margin gently and with the posterior margin through a small scarp. The ventral margin is nearly straight, weakly concave in the anterior third. The maximum length is at the mid-height of the shell, the maximum height is at the midlength, and the maximum width is in the middle of the ventral margin. The outer surface of the shell is dotted with small rare pores.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-247	0.51	0.32	0.20
4843-271	0.52	0.34	0.21
4843-68	0.61	0.39	0.23
4843-245	0.47	0.29	0.18
4843-69	0.55	0.35	0.21

Variability. The length-to-height ratio of the valve is slightly variable.

Comparison. From forms described as *S. triebeli* (Steghaus, 1951) from the lower Oxfordian and lower Kimmeridgian of Holland (Witte and Lissenberg, 1994, p. 8, pl. 4, figs. 18-20), it differs in the absence of both flattening at the anterior end and a small oblique depression near the anterodorsal margin of the valve; from *S. triebeli polipora* Błaszyk, 1967 from the upper Bajocian–middle Bathonian of Poland (Błaszyk, 1967, p. 39, pl. 11, figs. 1-5, pl. 12, figs. 3-7; Bielecka *et al.*, 1988, p. 176, pl. 72, fig. 1), in the absence of a pitted sculpture.

Remarks. This species was described for the second time as a new one by Lübimova (1956), who designated a new holotype (VNIGRI, no. 138-17, right valve) coming from the lower Callovian of the Kanev District.

Occurrence. The upper Callovian of Poland, the lower Callovian of the Dnieper-Donets Depression, and the western plunge of the Donets Basin, the middle Callovian of the Volga Region, the Emba Region, Mordovia, the Kostroma, Voronezh, and the Ryazan regions, and the upper Callovian of the Ryazan Region.

Material. Three well-preserved valves from the middle Callovian (*coronatum* Zone) of the Troshkov vrag section, 83 well-preserved valves and complete shells from the upper Callovian (*lamberti* Zone) of the Zmeinka section, six well-preserved valves from the middle Callovian (*coronatum* Zone) and 46 well-preserved valves and complete shells from the upper Callovian (*Epistomina elschankaensis–Lenticulina tumida* Zone) of the Mikhailovtsement section, and six well-preserved valves from the middle Callovian (*jason* Zone) of the Makar'ev-yuzhnyi section.

Superfamily Progonocytheracea Sylvester-Bradley, 1948

Family Neurocytheridae Gründel, 1975

Genus *Lophocythere* Sylvester-Bradley, 1948

Lophocythere: Howe *et al.*, 1961b, p. 327; Kaever *et al.*, 1994, p. 62; and Nikolaeva *et al.*, 1999b, p. 65.

non *Progonocythere* Sylvester-Bradley, 1948 (*Lophocythere* Sylvester-Bradley, 1948): Kashevarova *et al.*, 1960, p. 399.

Type species. *Cytheridea ostreata* Jones et Sherborn, 1888; Bathonian of England.

Diagnosis. Shell medium to large-sized, elongated, irregular quadrangular, moderately convex, flattened at ends, with unequal valves. Dorsal margin straight or weakly concave, parallel to ventral margin. Outer surface of shell reticulate or tubercular, bearing one or several keel-like longitudinal ridges. Eye spot present. Hinge entomodont. In right valve, it is represented by two elongated marginal teeth incised into six parts and by a crenellated median groove. Sexual dimorphism expressed in female shells is higher and shorter than those of males.

Composition. Around ten species.

Comparison. It differs from the sculpture genus *Nophrecythere* Griindel, 1975 in the comblike profile of its ridges although they have similar shell contours.

Occurrence. Bathonian-Oxfordian, Volgian; Eurasia.

***Lophocythere karpinskii* (Mandelstam, 1949)**

Plate 10, figs. 5-16

Protocythere karpinskii: Mandelstam, 1949, p. 261, pl. 85, fig. 5; Liibimova, 1955b, p. 71, pl. 8, fig. 5.

Lophocythere scabra bucki: Lutze, 1960, p. 430, pl. 37, figs. 2 and 3.

Lophocythere karpinskyi: Pyatkova and Permyakova, 1978, p. 145, pl. 60, fig. 6; Bielecka *et al.*, 1988, p. 171, pl. 67, fig. 4; Gerasimov *et al*, 1996, pl. 5, figs. 9-12; Nikolaeva *et al*, 1999b, pl. 32, fig. 64; and Olempska et Błaszyk, 2001, p. 570, fig. 10.

Holotype. VNIGRI, no. 117-6, left valve; the Volga River, the town of Syzran and its environs; middle Callovian.

Description. The shell is medium-sized. The left valve is larger than the right valve and overlaps the latter. This overlapping is most expressed along the dorsal margin and in the posterodorsal part. The dorsal margin is straight. The ventral margin is nearly parallel to the dorsal margin, weakly leaning toward the posterior end, concave in the anterior third. The anterior end of the shell is high and evenly rounded. The posterior end of the shell is low, triangular and beveled ventrally. The anterior and posterior ends of the shell are flattened. A thin translucent bordering bearing short spines is developed along the anterior and posterior ends. A second row of up to eight spines is developed above the bordering on the anterior margin. One to four short spines are arranged along the posterior end. The maximum length of the shell is at the mid-height. The maximum height is in the anterior third, and the maximum width is in the ventral part of the posterior half of the shell. The entire outer surface of the valves is covered with tubercles of various length and diameter. The largest tubercles are concentrated in the central part of the valve. One tubercle is placed at the dorsal margin midlength. A row consisting of five massive tubercles stretches in a wide arch nearly parallel to the ventral margin. Numerous smaller tubercles form subvertical rows. The bases of some tubercles along the anterior margin fuse together to form a sort of arched ridge that is better developed in the dorsal part of the shell. A high flattened ridge runs along the ventral margin. In some specimens, it breaks into separate entities, which suggests its formation by fusion of tubercle bases. In the left valve only, large tubercles are present in the anterodorsal and posterodorsal corners as well. In some specimens, short, high and flat ridges are developed instead of these tubercles. At the anterior and posterior ends of the shell, the spines are small and arranged in subvertical rows.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-61	0.64	0.34	0.32
4843-93	0.69	0.43	0.35
4843-106	0.67	0.31	0.33
4843-105	0.71	0.39	0.33
4843-341	0.63	0.38	0.34

Variability. The variability is most expressed in the degree of development of the valval sculpture. In specimens with small tubercles, these tubercles tend to be arranged in vertical rows, whereas they tend to fuse and form high comblike ridges in valves with massive tubercles.

Comparison. From *L. carinata* Błaszyk, 1967 from the Bathonian of Poland (Błaszyk, 1967, p. 31, pl. 7, figs. 8-10; Bielecka *et al.*, 1988, p. 170, pl. 66, fig. 6) and the upper Bathonian of Germany (Brand, 1990, p. 218, pl. 15, fig. 4), it differs in its right valve not having a short flat ridge in the posterior part of the dorsal margin; from *L. scabra*, in having massive unfused spines arranged in a wide arch parallel to the ventral margin instead of a high flat ridge, as well as in the larger tubercles not fusing in subvertical short ridges.

Remarks. Specimens having a fine sculpture and resembling *L. scabra* appear where the diversity and abundance of ostracodes in a section are in decline, i.e., near the upper part of the *lamberti* Zone.

Occurrence. The middle Callovian of Germany, the upper Callovian–lower part of the lower Oxfordian of Poland, the Callovian of the Dnieper-Donets Depression, the lower Callovian-lower Oxfordian of the Volga-Urals Region, the upper Callovian of the Moscow Region, the middle-upper Callovian of the Ryazan Region, the middle Callovian of the Kostroma Region and the environs of the town of Syzran, and the middle Callovian of the Kursk Region.

Material. Twenty-eight well-preserved valves from the upper Callovian (*lamberti* Zone) of the Peski section, 94 well-preserved valves and complete shells from the upper Callovian (*lamberti* Zone) of the Zmeinka section, 20 well and satisfactorily preserved valves from the middle Callovian (*coronatum* Zone), 101 well-preserved valves and complete shells from the upper Callovian (*Epistomina elschankaensis–Lenticulina tumida* Zone) of the Mikhailovtsement section, two well-preserved valves from the middle Callovian (*jason* Zone) of the Yartsevo section, 18 well-preserved valves from the middle Callovian (*jason* Zone) of the Mikhailovskii Mine section.

Lophocythere scabra Triebel, 1951

Plate 11, figs. 1-7

Lophocythere scabra: Triebel, 1951, p. 95, pl. 46, figs. 26-30, pl. 47, figs. 31-34; Pyatkova and Permyakova, 1978, p. 145, pl. 61, figs. 1 and 2; Dépêche, 1985, pl. 32, figs. 2 and 3; Bielecka *et al*, 1988, p. 172, pl. 67, fig. 6.

Lophocythere scabra scabra: Lutze, 1960, p. 429, pl. 37, fig. 1.

Lophocythere scabra bucki: Malz, 1962, pl. 24, fig. 6c; Kaever *et al.*, 1994, p. 62, pl. 9, fig. 4.

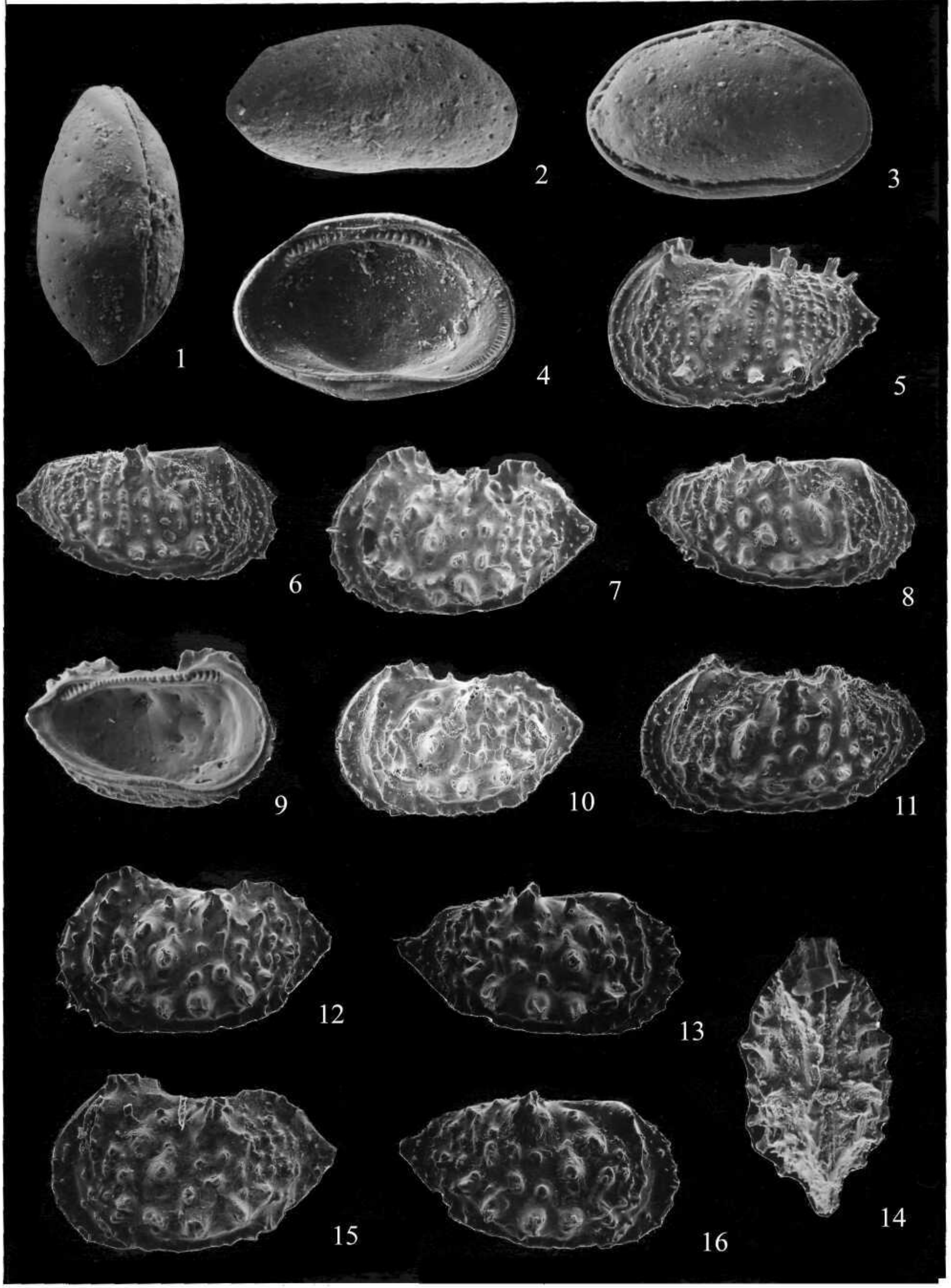
Lophocythere (Lophocythere) scabra bucki: Whatley, 1970, p. 334, pl. 8, figs. 15-24, pl. 9, figs. 1 and 5.

non *Lophocythere scabra:* Gerasimov *et al.*, 1996, pl. 5, fig. 16.

Holotype. Xe 1767, complete shell; Germany, 166 Fuhrberg borehole, depth 125-131 m; Dogger E, *ornatum* beds.

Description. The shell is medium-sized. The left valve is larger than the right valve. Overlapping is most expressed along the antero- and posterodorsal margins. The anterior and posterior margins of the shell are high and flattened. The anterior end is evenly arch-like rounded. The posterior end is triangular acuminate, equally beveled dorsally and ventrally in the left valve and stronger beveled dorsally in the right valve. The dorsal margin is straight, fusing with both the anterior and posterior margins at obtuse angles. The ventral margin is nearly parallel to the dorsal margin, concave in the anterior third, fusing smoothly with both the

Plate 10



anterior and posterior margins. The maximum length of the shell is at the mid-height. The maximum height is in the anterior third of the valve, and the maximum width is in the ventral part of the valve. Interrupted subvertical ridges resulted from the fusion of low rounded tubercles appear on the outer surface of the shell. A narrow, high, semicircular ridge is developed at the anterior end of the shell; two similar ridges stretching parallel to the ventral margin meet it ventrally, one above the other. Several small tubercles are developed along the anterior margin.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-261	0.54	0.30	0.28
4843-259	0.56	0.31	0.28
4843-260	0.63	0.34	0.27
4843-303	0.71	0.34	0.30
4843-299	0.63	0.38	0.27

Variability. The massiveness of the sculpture and the ratio of the shell length to its height are variable.

Comparison. Differences from *L. karpinskii* are provided under the description of the latter species. From *L. interrupta*, it differs in the less sharp sculpture, in the presence of two, not three ventral ridges, and in the subvertical ridges being interrupted.

Remarks. A form erroneously identified as *L. scabra* Triebel, 1951 is figured in the paper by Gerasimov *et al.* (1996, pl. 5, fig. 16).

Species *L. karpinskii*, *L. scabra*, and *L. interrupta*, seem to represent a single row. The differences between them are insignificant and expressed in the degree of the development of their sculpture, which grows coarser from *L. karpinskii* through *L. scabra* to *L. interrupta*.

Occurrence. The Callovian–lower Oxfordian of Germany, the middle Callovian-lower Oxfordian of Scotland, the Callovian of France, the lower Callovian-lower part of the upper Callovian of Poland, the lower-middle Callovian of the Dnieper-Donets Depression, the upper Callovian of the Ryazan Region, the lower Callovian of the Kursk Region, and the middle Callovian of the Voronezh Region and Mordovia.

Material. Seventy-five well-preserved valves and complete shells from the lower Callovian (*koenigi* Zone) of the Mikhailovskii Mine section, one well-preserved valve from the middle Callovian (*coronatum* Zone) of the Troshkov vrag section, 62 well-preserved valves from the upper Callovian (*Epistomina elschankaensis–Lenticulina tumida* Zone) of the Mikhailovtsement section.

Lophocythere interrupta Triebel, 1951

Plate 11, figs. 8 and 9

Lophocythere interrupta: Triebel, 1951, p. 96, pl. 47, figs. 35–41.

Fastigatocythere interrupta: Pyatkova and Permyakova, 1978. p. 142, pl. 58, figs. 4a–4c.

Lophocythere interrupta interrupta: Lutze, 1960, p. 431, pl. 36, fig. 6; Malz, 1962, pl. 24, fig. 6a; Kaever *et al,* 1994, p. 64, pl. 9, fig. 8, pl. 1, fig. 15.

Lophocythere (Lophocythere) interrupta interrupta: Whatley, 1970, p. 335, pl. 9, figs. 2–4, 6–10; Witte et Lissenberg, 1994, p. 23, pl. 1, figs, 1 and 2.

Lophocythere scabra: Gerasimov *et al,* 1996, pl. 5, fig. 16.

Holotype. Xe 1778, complete shell; Germany, 148 Fuhrberg borehole, depth 380–384 m; Dogger, *ornatum* beds.

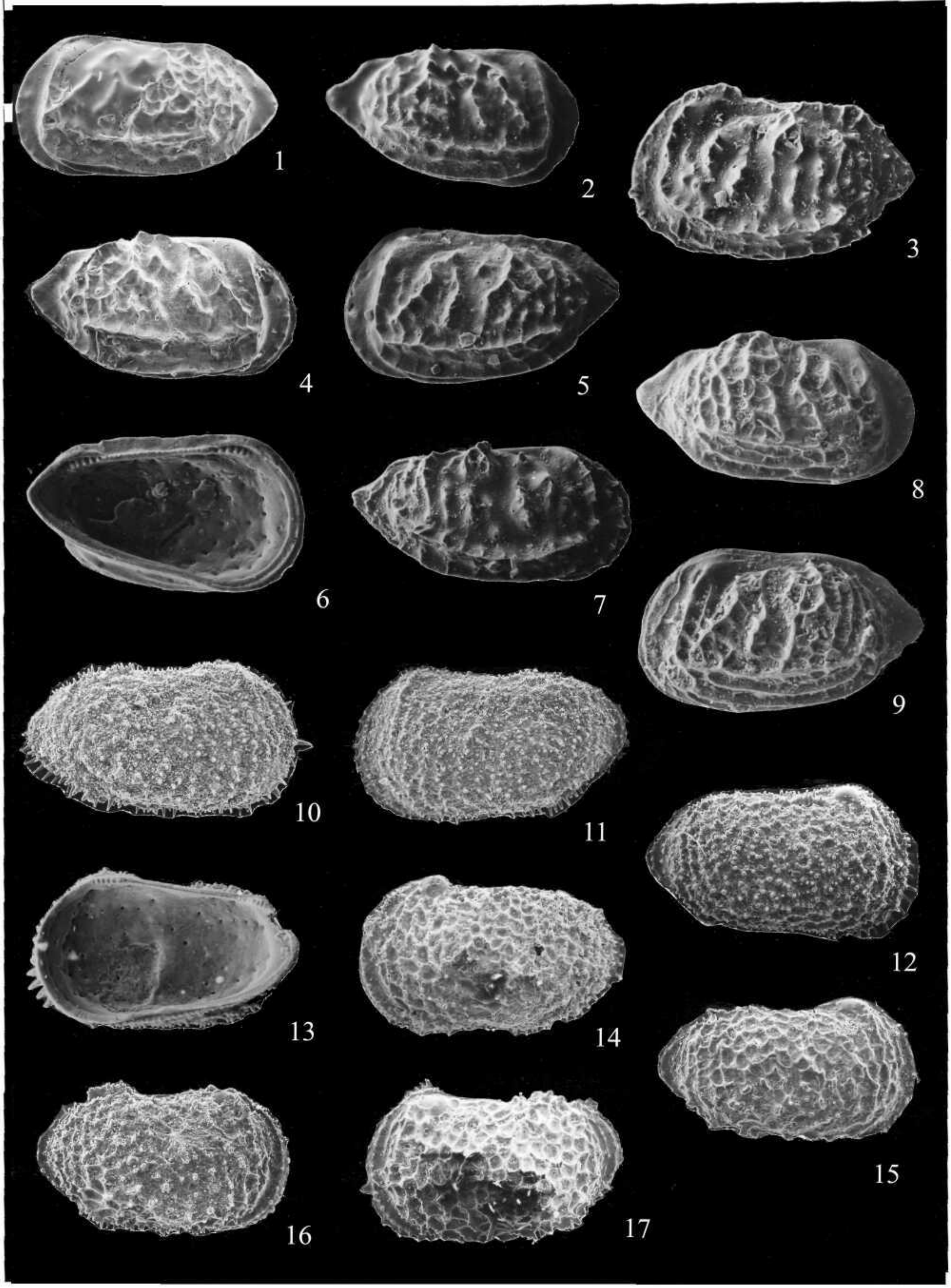
Description. The shell is large to medium-sized, rounded quadrangular, elongated, evenly convex. The left valve is slightly larger than the right valve, overlapping the latter along the antero- and posterodorsal margins. The anterior end of the shell is high and evenly rounded. The posterior end of the shell is narrow, acute triangular, beveled dorsally in the right valve. The anterior and posterior ends of the shell are flattened. The dorsal margin is straight in the right valve and slightly concave in the left valve. The ventral margin is nearly parallel to the dorsal margin, concave in the anterior third. The maximum length is at the mid-height, the maximum height is in the anterior third, and the maximum width is in the ventral part of the posterior half of the shell. Three high, thin, horizontal ridges are visible in the ventral part of the valve. The medial ridge, which is longest, stretches from the posterior end of the shell parallel to the ventral margin, sharply bends toward the dorsal margin at the anterior end and terminates near the eye tubercle. The lower ridge is shorter and lower, running along the ventral margin. The upper ridge starts near the posterior end of the shell, running

Explanation of Plate 10

Figs. 1–4. *Praeschuleridea wartae* Błaszyk: (1) no. 4843-343, complete shell, dorsal view, sample 95-21, ×100; (4) no. 4843-340, left valve of female, inner view, sample 95-20, x90; middle Callovian, *jason* Zone; (2) no. 4843-313, right valve of male, lateral view, ×105; (3) no. 4843-314, complete shell of female, lateral view, X1OO; sample 95-7, lower Callovian, *koenigi* Zone; Kursk Region, Mikhailovskii Mine.

Figs. 5-16. *Lophocythere karpinskii* (Mandelstam): (5) no. 4843-62, left valve, lateral view, ×70; 6–no. 4843-61, right valve, lateral view, x70; sample Pyum-3; (10) no. 4843-9, left valve, lateral view, sample Pyum-6, x70; Moscow Region, Peski, upper Callovian, *lamberti* Zone; (7) no. 4843-93, left valve, lateral view, sample 94-4, x70; (8) no. 4843-106. right valve, lateral view, x70; (11) no. 4843-105, left valve, lateral view, x70; sample 94-8; (12) no. 4843-87, left valve, lateral view, x70; (13) no. 4843-88, right valve, lateral view, x70; sample 94-3; (15) no. 4843-80, left valve, lateral view, ×90; (16) no. 4843-79, right valve, lateral view, ×80; sample 94-1; Zmeinka, upper Callovian, *lamberti* Zone; (9) no. 4843-267, left valve, inner view, Mikhailovtsement, sample 94-22, middle Callovian, *coronatum* Zone, x70; Ryazan Region; (14) no. 4843-341, complete shell, dorsal view, Kursk Region, Mikhailovskii Mine, sample 95-20, middle Callovian, *jason* Zone, x80.

Plate 11



parallel to two other ridges, and may reach the vertical portion of the medial ridge at the anterior end. One short and low ridgelet is visible in the posterior part of the valve between the medial and upper ridges. The rest of the surface of the valve, except for the flattened areas of the anterior and posterior ends, is covered with short, thin, curved, dichotomizing subvertical ridges meeting together in a point at the midlength of the dorsal margin; fine, short vertical ridgelets or elongated tubercles are developed in the interspaces between them. A fine reticulation formed by the fusion of small ridge ends is traced in the posterior third of the valve. The outer surface of the valve between ridges and inside fossae is smooth and may occasionally have small, rounded tubercles. Bases of six small spines are on the anterior margin. A narrow, translucent bordering occasionally runs along the anterior margin of the shell.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-300	0.63	0.33	0.30
4843-332	0.56	0.31	0.28

Variability. The degree of sculpture development on the valval surface and the ratio of the shell length to its height are slightly variable.

Comparison. From forms described as *L. juglandica* (Jones, 1884) from the Bathonian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 142, pl. 59, fig. 1) and *Fastigatocythere juglandica* (Jones, 1884) from the upper Bathonian of Germany (Brand, 1990, p. 207, pl. 14, fig. 4), it differs in the ventral and dorsal margins being nearly parallel, in the higher anterior end, in the much higher horizontal ridges, and in the more angular and thinner vertical ridges. It is compared with *L. scabra* under the description of the latter species.

Occurrence. The middle and upper Callovian of England, Scotland, and Holland, the Callovian of Germany and the Dnieper-Donets Depression, the lower Callovian of the Kursk Region, the upper Callovian of the Ryazan and Moscow regions.

Material. One well-preserved valve from the lower Callovian (*koenigi* Zone) of the Mikhailovskii Mine section, 19 well-preserved valves from the upper Callovian (*lamberti* Zone) of the Zmeinka section, and one well-preserved valve from the upper Callovian (*lamberti* Zone) of the Peski section.

Genus *Fuhrbergiella* Brand et Malz, 1962

Fuhrbergiella: Brand and Malz, 1962, p. 2; Kaever *et al.*, 1994, p. 60.

Type species. *F. gigantea* Brand et Malz, 1962; upper Bajocian (*parkinsonia* Zone) of Germany.

Diagnosis. Shell medium to large-sized, rounded quadrangular, moderately convex. Anterior margin of shell high, gently rounded. Posterior margin lower than anterior margin, rounded triangular. Dorsal margin straight or slightly concave. Ventral margin convex. Outer surface of shell reticulate, cellulate, or spiny cellulate, sometimes with weakly developed ridges. Eye tubercle present. Inner margin and fusion line coinciding. Pore-canal zone narrow; at anterior end it has nine straight, simple pore canals, at posterior end it has three to four pore canals. Hinge entomodont; in left valve, it is represented by marginal teeth subdivided into six parts and a median bar.

Composition. Several species.

Comparison. From the genera *Lophocythere* Sylvester-Bradley, 1948 and *Nophrecythere* Gründel, 1975, identical in their hinge structure and similar in their valve outline, this genus differs in its cellulate, often spiny sculpture and in the absence of large ridges from the valval surface.

Occurrence. Middle-upper Jurassic; Europe.

Fuhrbergiella archangelskii (Mandelstam, 1949)

Plate 11, figs. 10–17

Palaeocytheridea archangelskii: Mandelstam, 1949, p. 259, pl. 84, fig. 8; Lübimova, 1955b, p. 39, pl. 4, fig. 1.

Fuhrbergiella (Praefuhrbergiella) horrida horrida: Brand and Malz, 1962, p. 19, pl. 4, figs. 33-37, pl. 5, fig. 46; Whatley, 1970, p. 343, pl. 12, figs. 13–15, pl. 13, figs. 1-5; and Witte and Lissenberg, 1994, p. 24, pl. 1, fig. 5.

Fuhrbergiella (Praefuhrbergiella) archangelskyi: Pyatkova and Permyakova, 1978, p. 143, pl. 59, fig. 2.

Fuhrbergiella horrida: Dépêche, 1985, pl. 32, fig. 14.

Fuhrbergiella horrida horrida: Kaever *et al.*, 1994, p. 60, pl. 8, fig. 7.

Fuhrbergiella archangelskyi: Gerasimov *et al.*, 1996, pl. 4, figs. 5-8; Olempska and Błaszyk, 2001, p. 573, fig. 12.

Acantocythere (Protoacantocythere) archangelskyi: Nikolaeva *et al.*, 1999b, pl. 34, fig. 4...

Explanation of Plate 11

Figs. 1-7. *Lophocythere scabra* Triebel: (1) no. 4843-102, left valve, lateral view, x90; (4) no. 4843-101, right valve, lateral view, x80; Zmeinka, sample 94-9; (2) no. 4843-259, right valve, lateral view, x80; (5) no. 4843-260, left valve, lateral view, x80; (6) no. 4843-261, left valve, inner view, x900; Mikhailovtsement, sample 94-27; Ryazan Region, upper Callovian, *lamberti* Zone; (3) no. 4843-299, left valve, lateral view, sample 95-5, x80; (7) no. 4843-303, right valve, lateral view, sample 95-6, x70; Kursk Region, Mikhailovskii Mine, lower Callovian, *koenigi* Zone.

Figs. 8 and 9. *Lophocythere interrupta* Triebel: (8) no. 4843-300, right valve, lateral view, sample 95-5, x80; (9) no. 4843-332, left valve, lateral view, sample 95-16, x90; Kursk Region, Mikhailovskii Mine, lower Callovian, *koenigi* Zone.

Figs. 10–17. *Fuhrbergiella archangelskii* (Mandelstam): (10) no. 4843-16, right valve, lateral view, x90; (11) no. 4843-15, left valve, lateral view, ×100; (13) no. 4843-198, right valve, inner view, ×100; (16) no. 4843-17, right valve, lateral view, ×100; Moscow Region, Peski, sample Pyum-6, upper Callovian, *lamberti* Zone; (12) no. 4843-108, right valve, lateral view, sample 94-8, x100; (14) no. 4843-99, left valve, lateral view, ×110; (15) no. 4843-98, right valve, lateral view, x100; sample 94-6; (17) no. 4843-100, left valve, lateral view, sample 94-5, x80; Ryazan Region, Zmeinka, upper Callovian, *lamberti* Zone.

Holotype. VNIGRI, no. 117-1, left valve; the Volga River, environs of the town of Syzran; middle Callovian.

Description. The shell is medium-sized, having equal valves. The anterior and posterior margins of the shell are flattened along the very margin. The dorsal margin is straight, but may appear to be medially concave due to the tubercular and spiny sculpture near the posterodorsal corner. The ventral margin is nearly parallel to the dorsal margin. The maximum length is at the mid-height of the valve. The maximum height is in the anterior third, and the maximum width is in the posteroventral third of the shell. A vague muscle tubercle is developed in the middle of the valve. An oval eye tubercle is present by the anterodorsal margin. The entire outer surface of the valves, except for the eye tubercle, is evenly covered with angled fossae and densely dotted with short acute spines. Spines along the posterodorsal and posteroventral margins may be longer and more massive. Numerous fine spines are also developed along the anterior and posterior ends.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-16	0.52	0.30	0.28
4843-15	0.69	0.27	0.26
4843-198	0.50	0.26	0.25
4843-17	0.45	0.26	0.23
4843-99	0.42	0.26	0.23

Variability. The sculpture varies from that having low fossae and fine spines to that having high fossae and spines in cell corners.

Comparison. From *F. kizilkaspakensis* (Mandelstam, 1947) from the Bajocian of the Mangyshlak Peninsula (Mandelstam, 1947, p. 246, pl. 1, figs. 1-3) and the lower Bathonian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 143, pl. 59, figs. 3, 4), it differs in the more distinct reticulate pattern of its sculpture with spines on the muri and in the absence of a tendency of the muri to fuse and form ridges; from *F. postsauzei* Permyakova, 1974 from the upper Bajocian (*niortense* and *garantiana* zones) of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 144, pl. 59, figs. 5-7), in the absence of short oblique ridges from the anterior end and in the absence of ridges stretching along the anterior and ventral margins, and posterior part of the dorsal margin; from *F. verrucosa* (Błaszyk, 1967) from the upper Bajocian–Bathonian of Poland (Błaszyk, 1967, p. 29, pl. 7, figs. 5-7; Bielecka *et al.*, 1988, p. 172, pl. 67, fig. 7), in the absence of large tubercles on the ventral side of the shell; from *F. (P.) lurida* Błaszyk, 1967 from the Bathonian of Poland, in the valves being equal (the left valve is larger than the right valve in the latter species).

Remarks. This species was described as a new one for the second time by Mandelstam in Lübimova's paper (1955b). Since the papers by Mandelstam (1949) and Lübimova (1955b) were not widely known abroad, forms belonging to this species were subsequently described in Europe by Brand and Malz (1962) under the name *F. (Praefuhrbergiella) horrida horrida*.

Occurrence. The Bajocian of Germany, the middle and upper Callovian of Holland, the lower Callovian-lower Oxfordian of England, the upper Callovian-lower Oxfordian of Scotland, the lower Callovian of France, the middle Callovian-lower Oxfordian of the Dnieper-Donets Depression and Volga-Urals Region, the upper Callovian of Poland and the Timan–Pechora Region, the upper Callovian of the Moscow Region, the middle and the upper Callovian of the Ryazan Region, the middle Callovian of Mordovia.

Material. Thirty-five well-preserved valves and complete shells from the upper Callovian (*lamberti* Zone) of the Peski section, two well-preserved valves from the middle Callovian and 50 well-preserved valves and complete shells from the upper Callovian of the Mikhailovtsement section, 44 well-preserved valves and complete shells from the upper Callovian (*lamberti* Zone) of the Zmeinka section, and three well-preserved valves from the middle Callovian (*coronatum* Zone) of the Troshkov vrag section.

Genus *Nophrecythere* Gründel, 1975

Nophrecythere: Nikolaeva *et al.*, 1999b, p. 65.

Type species. *Lophocythere cruciata* Triebel, 1951; Middle Jurassic, the lower Callovian of Germany.

Diagnosis. Shell small to large, rounded rectangular, moderately convex, with rounded or acuminate posterior end. Anterior and posterior ends equally high or anterior end a little higher. Overlapping developed mainly along dorsal margin or around hinge ears. Dorsal margin straight or weakly concave, parallel to ventral margin. Anterior roll-like marginal ridge, ventral ridge, and three longitudinal ridges, which may be connected in a Z-shaped manner or by crossridges, present. Interspaces between ridges reticulated. Eye tubercle expressed. Hinge entomodont.

Composition. More than ten species.

Comparison. From the closest in the pattern of the sculpture and in the hinge structure genus *Lophocythere* Sylvester-Bradley, 1948, it differs in the roll-like shape of its ridges in contrast to the comblike ridges in the latter genus.

Remark. The genus *Crucicythere* Malz, 1975 is a synonym of the genus *Nophrecythere* Griindel, 1975.

Occurrence. Bathonian–Kimmeridgian; Eurasia.

Nophrecythere catephracta **(Mandelstam, 1949)**

Plate 12, figs. 1-15; Plate 13, figs. 1-3

Protocythere catephmcta: Mandelstam, 1949, p. 261, pl. 85, fig. 7; Lubimova, 1955b, p. 70, pl. 8, figs. 4a and 4b.

Lophocythere cruciata cruciata: Triebel, 1951, p. 99, pl. 49, figs. 53-56.

Lophocythere (Neurocythere)cruciata cruciata: Whatley, 1970, p. 340, pl. 11, figs. 18-22.

Crucicytherecruciata: Pyatkova and Permyakova, 1978, p. 146, pl. 61, figs. 4a–4c.

Non *Nophrecythere cruciata:* Depeche, 1985, pl. 32, fig. 20.

Crucicythere catephracta: Gerasimov *et al.*, 1996, pl. 5, figs. 1–4.

Nophrecythere catephracta: Nikolaeva *et al.*, 1999b, p. 65, pl. 32, fig. 7.

Nophrecythere triebeli: Olempska et Błaszyk, 2001, p. 566, fig. 8.

Holotype. VNIGRI, no. 117-8, right valve; the Volga River, environs of the town of Syzran; upper Callovian.

Description. The shell is medium-sized, rounded rectangular, moderately convex. The left valve is larger than the right one and embraces the latter around the hinge ear or along the entire posterior margin. The anterior end of the shell is high, arched, smoothly rounded, having a broad, sometimes wavy border that may not always be preserved in fossils. The posterior end of the shell is lower than the anterior one, triangular, flattened, acuminate and turned upwards in the right valve, and rounded in the left valve. A thin border may be present along the posterior margin of the shell. The dorsal margin is straight. The ventral margin is nearly parallel to the dorsal one, weakly turning dorsally in the posterior half of the valve, and weakly concave in the anterior third. The maximum length is at the mid-height of the valve. The maximum height is near the hinge ear, and the maximum width is in the posterior half of the shell. An oval eye tubercle is distinctly expressed on the anterodorsal margin. Thin and long ridges are developed on the outer surface of the valves; the longest ridge is the median one that runs from the posterior to the anterior margin of the valve and turns in the anterior third toward the ventral side. In the left valve, the dorsal margin is high, flattened, and elevated above the valve, fusing with the median ridge at the posterior end. In the right valve, a low convex ridge terminating before the eye tubercle and sometimes having a faint constriction at its midlength runs along the dorsal margin. On the ventral side, two thin ridges run parallel to the ventral margin; both of them are fusing with the median ridge at the anterior end. Two to three thin striated ridgelets develop below them, along the same margin. A thin transverse ridge runs along the anterior margin of the shell, starting at the eye tubercle. Sometimes at the intersection with the median ridge, it fuses with the upper ventral ridge and forms a single ridge with the latter. The entire surface of the valves between the ridges except for the posterior end is covered with large quadrangular or pentagonal fossae, whose muri form a reticulate sculpture due to their fusion. Several fossae above the muscle area may be arranged into a vertical, rosette-shaped row that arches towards the rear.

Measurements (mm):

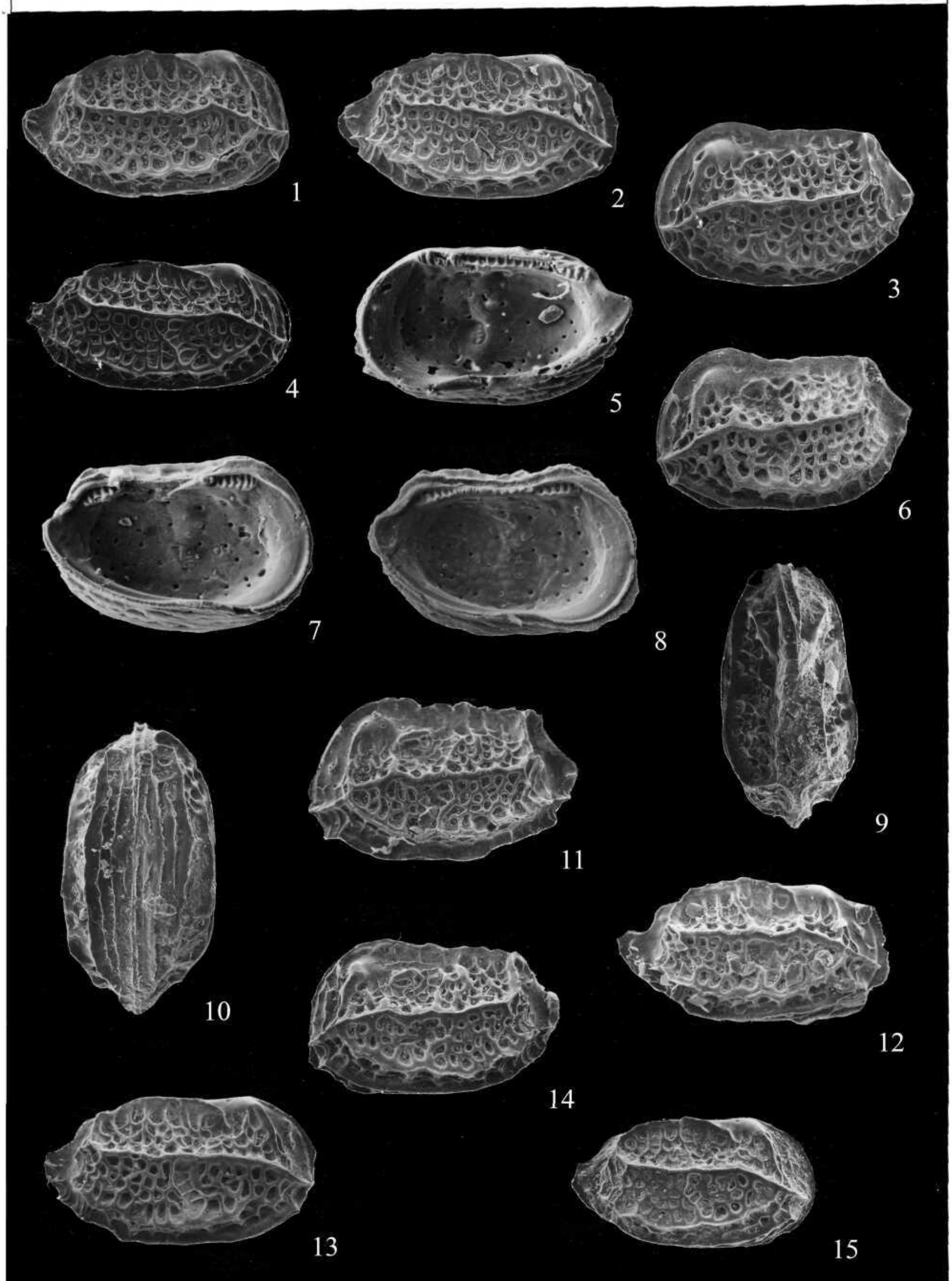
Specimen no.	Length	Height	Width
4843-197	0.56	0.34	0.30
4843-199	0.52	0.34	0.30
4843-269	0.53	0.33	0.30
4843-273	0.65	0.42	0.37
4843-59	0.58	0.35	0.30
4843-76	0.61	0.33	0.28

Variability. The width of the ridges and muri and the shape of the upper ridge in the right valve are slightly variable.

Comparison. From forms identified as *N. multicostata* (Oertli, 1957) from the upper Oxfordian of France (Oertli, 1957, p. 667, pl. 4, figs. 146-153; Depeche, 1985, pl. 32, fig. 21), the Oxfordian of Poland (Bielecka *et al.*, 1988, p. 366, pl. 165, fig. 1), and the upper Oxfordian–lower Kimmeridgian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 147, pl. 63, figs. la-Id), it differs in the absence of the dorsal ridge from the left valve, absence of intercalary small ridges between the dorsal, median, and ventral ridges, and the reverse inequality of its valves; from *N. flexicosta* (Triebel, 1951), in the absence of the dorsal ridge from the left valve, in the median ridge being long, not short, and in a less elongated posterior end; from *N. franconica* (Triebel, 1951) from the lower Callovian of Germany (Triebel, 1951, p. 100, pl. 49, figs. 57-59; Lutze, 1960, p. 421, pl. 34, figs. 2, 4), the lower Callovian–lower Oxfordian of Poland (Bielecka *et al.*, 1988, p. 171, pl. 67, fig. 2), and the Callovian of Ukraine (Pyatkova and Permyakova, 1978, p. 146, pl. 62, fig. 2), in the rectangular, not oval, silhouette of the shell when viewed from the dorsal side; from *N. intermedia* (Lutze, 1960) from the upper Callovian of Poland (Olempska and Błaszyk, 2001, p. 568, fig. 9) and the middle Callovian of Germany (Lutze, 1960, p. 423, pl. 34, figs. 5, 6) and the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 146, pl. 62, figs. 3, 4), in the absence of fine vertical ridgelets from the posterior portion of the shell; from *N. oxfordiana* (Lutze, 1960), in more massive ridges and muri (the fossae appear to be smaller); from *N. plena* (Triebel, 1951) from the Middle Jurassic of Germany (Triebel, 1951, p. 100, pl. 49, figs. 60-63; Lutze, 1960, p. 420, pl. 34, figs. 1, 3), in a sharply rectangular shell outline when viewed from the dorsal side (in contrast to the rounded rectangular shell of *N. catephracta).*

Remarks. This species was initially described by Mandelstam in 1949. It was redescribed by Mandelstam in (Lubimova, 1955). Triebel (1951) described ostracodes belonging to this species under the name of *Lophocythere cruciata cruciata* from the Middle Jurassic of Germany. It explains the fact that the name proposed by Triebel is being used in the European literature.

Plate 12



A form identified as *N. cruciata* (Dépêche, 1985, pl. 32, fig. 20), but belonging to *N. intermedia* (Lutze, 1960), according to our opinion, is figured in the Atlas of ostracodes of France.

Occurrence. The Callovian of Germany, the middle Callovian–the middle Oxfordian of England and Scotland, the upper Callovian of Poland, the Callovian of the Dnieper-Donets Depression, the Callovian-Oxfordian of the northwestern marginal areas of the Donets Basin, the Callovian–lower Oxfordian of Samarskaya Luka and the Middle Volga Region, the lower Oxfordian of the Obshchii Syrt, the lower Callovian of the Kursk region, the middle Callovian of the Kostroma and Ryazan regions and Mordovia, the upper Callovian of the Moscow and Ryazan regions, the lower and middle Oxfordian of the Moscow Region.

Material. Two hundreds and five well-preserved valves and complete shells from the upper Callovian (*lamberti* Zone), one satisfactorily preserved valve from the lower Oxfordian (*Ophthalmidium sagittum–Epistomina volgensis* Zone), and three satisfactorily preserved valves from the middle Oxfordian (*Ophthalmidium strumosum–Lenticulina brestica* Zone) of the Peski section, two well-preserved valves from the middle Callovian (*jason* Zone) of the Makar'ev-yuzhnyi section, 50 well-preserved valves and complete shells from the middle Callovian (*coronatum* Zone) and 106 well-preserved valves and complete shells from the upper Callovian (*Epistomina elschankaensis–Lenticulina tumida* Zone) of the Mikhailovtsement section, 277 well-preserved valves and complete shells from the upper Callovian (*lamberti* Zone) of the Zmeinka section, five well-preserved valves from the lower Callovian (*koenigi* Zone) of the Mikhailovskii Mine section, seven satisfactorily preserved valves from the middle Callovian (*coronatum* Zone) of the Troshkov vrag section.

Nophrecythere oxfordiana (Lutze, 1960)

Plate 13, figs. 4–12

Lophocythere cruciata oxfordiana: Lutze, 1960, p. 425, pl. 35, fig. 5; Bielecka *et al.*, 1988, p. 366, pl. 164, fig. 6.

Crucicythere oxfordiana: Pyatkova and Permyakova, 1987, p. 147, pl. 61, fig. 5.

Holotype. Pr. 303, complete shell; Hannover (Hannover-Ricklingen), Tenniesberg; lower Oxfordian, *cordatum* Zone.

Description. The shell is medium-sized, rounded rectangular, moderately convex. The left valve is little larger than the right one and embraces the latter near the hinge ear and along the entire posterior margin. The anterior end of the shell is high, arched, and evenly rounded. The posterior end of the shell is lower than the anterior one, triangular and flattened, stronger beveled dorsally in the right valve and bent upward. The dorsal margin is straight. The ventral margin is parallel to the dorsal one, weakly turning towards the dorsal side in the posterior half of the valve and is weakly concave in the anterior third. The maximum length is at the mid-height of the valve. The maximum height is near the hinge ear, and the maximum width is in the posterior half of the shell. The oval eye tubercle is expressed on the anterodorsal margin. Thin and long ridges are developed on the outer surface of the valves. The median and the longest one stretches obliquely from the posterior to the anterior margin of the valve. A low convex ridge runs along the dorsal margin in the right valve. In the left valve, the dorsal margin is high, flattened and elevated above the valve surface; the dorsal ridge is lacking. Two thin ridges parallel to the ventral margin are developed on the ventral side; both are connected to the median ridge at the anterior end. Below, along the very ventral margin two to three thin striated ridgelets are visible. A thin transverse ridge runs along the anterior margin of the shell; it starts near the eye tubercle and often fuses with the upper of the ventral ridges. The entire surface of the valves between the ridges except for the posterior end is covered with large quadrangular or pentagonal fossae, whose thin muri form a reticulate sculpture.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-48	0.46	0.27	0.23

Variability. The width of the ridges and muri are slightly variable; occasionally, the valve surface may appear to be smooth.

Comparison. This species is most similar to *N. catephracta,* differing in the characters provided under the description of the latter species.

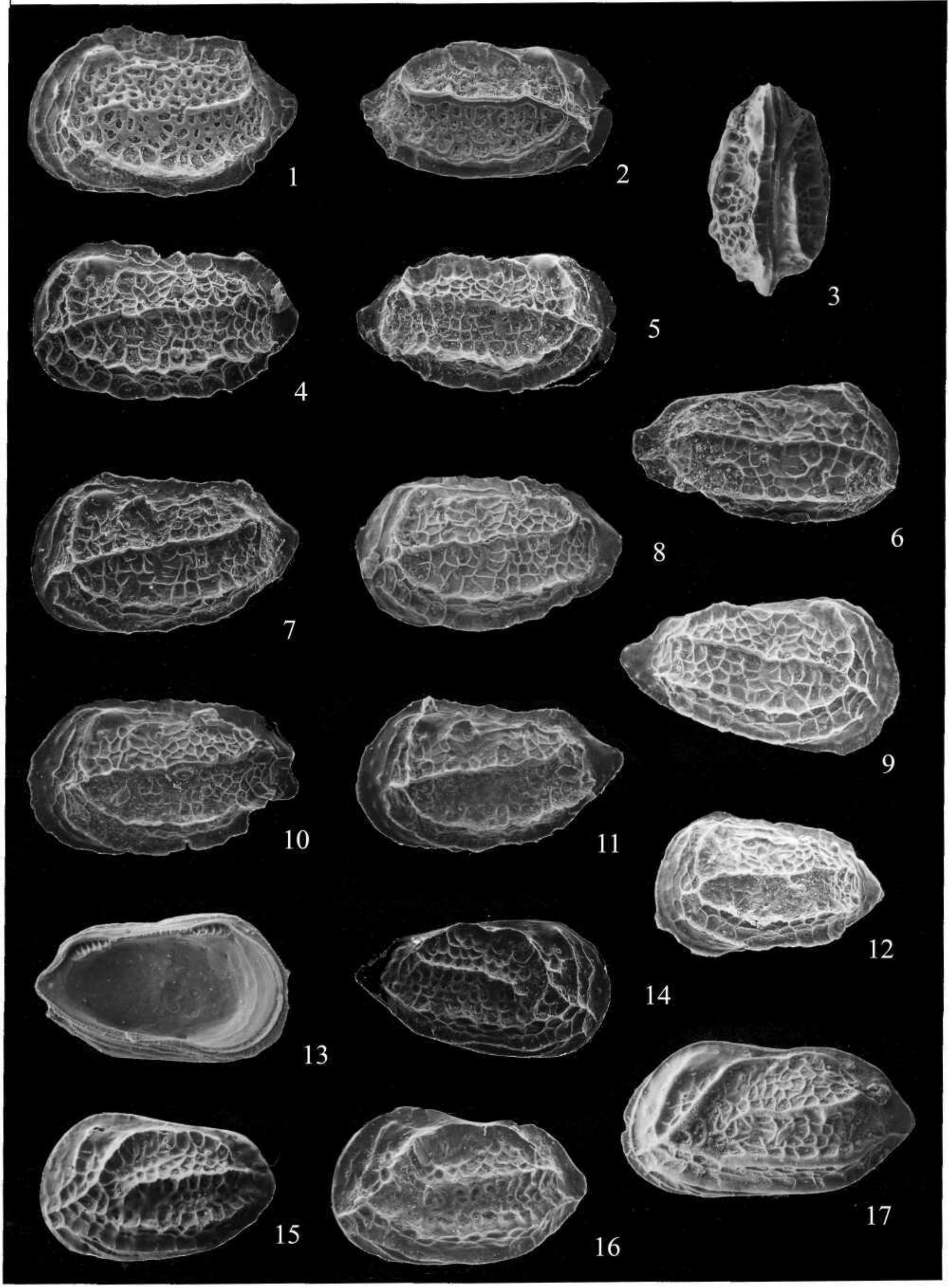
Occurrence. The Oxfordian of the Dnieper-Donets Depression, the lower-middle Oxfordian of Germany and Poland, the upper Callovian of the Moscow and Ryazan region.

Material. Thirty-two well-preserved valves from the upper Callovian (*lamberti* Zone) of the Peski section, five well-preserved valves from the upper Callovian (*lamberti* Zone) of the Zmeinka section.

Explanation of Plate 12

Figs. 1-15. *Nophrecythere catephracta* (Mandelstam): (1) no. 4843-53, right valve, lateral view, ×100; (2) no. 4843-52, right valve, lateral view, ×90; (11) no. 4843-49, left valve, lateral view, x1OO; (14) no. 4843-47, left valve, lateral view, x80; sample Pyum-3; (5) no. 4843-197, right valve, inner view, x90; (7) no. 4843-199, left valve, inner view, x90; sample Pyum-7; (12) no. 4843-25, right valve, lateral view, ×100; sample Pyum-5; Moscow Region, Peski, upper Callovian, *lamberti* Zone; (3) no. 4843-85, left valve, lateral view, x80; (4) no. 4843-84, right valve, lateral view, x70; (6) no. 4843-82, left valve, lateral view, ×80; sample 94-1; (9) no. 4843-65, complete shell, dorsal view, x70; (10) no. 4843-59, complete shell, ventral side, x90; (15) no. 4843-76, right valve, lateral view, x70; sample 94-2; (13) no. 4843-83, right valve, lateral view, sample 94-1, x90; Zmeinka, upper Callovian, *lamberti* Zone; (8) no. 4843-269, left valve, inner view, Ryazan Region, Mikhailovtsement, sample 94-22, middle Callovian, *coronatum* Zone, ×90.

Plate 13



***Nophrecythere flexicosta* (Triebel, 1951)**

Plate 13, figs. 13–17

Lophocythere flexicosta: Triebel, 1951, p. 97, pl. 48, figs. 46–48.

Lophocythere flexicosta flexicosta: Lutze, 1960, p. 428, pl. 35, fig. 8; Malz, 1962, pl. 24, fig. 6d; and Kaever *et al.*, 1994, p. 63, pl. 9, fig. 7.

Crucicythere flexicosta: Pyatkova and Permyakova, 1978, p. 146, pl. 62, figs. la-Id; Gerasimov *et al.*, 1996, pl. 5, figs. 5 and 6.

Lophocythere flexicostata: Bielecka *et al.*, 1988, p. 171, pl. 67, fig. 3.

H o l o t y p e. Xe 1806, complete shell; Germany, 148 Fuhrberg borehole, 380–384 m depth; Middle Jurassic, *ornatum* beds.

D e s c r i p t i o n. The shell is medium-sized, rounded rectangular, moderately convex. The left valve overlaps the right one along the entire margin, especially along the antero- and posterodorsal margins. The anterior end of the shell is high, arched, weakly flattened, having a translucent bordering along its margin. The posterior end of the shell is lower than the anterior one, triangle, flattened, and more sharply beveled in the right valve. The dorsal margin is straight. The ventral margin slightly leans towards the posterior end and is weakly concave medially. The maximum length is at the mid-height. The maximum height is in the anterior third of the valve, and the maximum width is in the posterior half of the shell. Several thin and high ridges are developed on the outer surface of the valves. The median ridge is short, oblique, and runs from the posterior end towards its middle. The dorsal ridge which is long and convex toward the dorsal margin starts at the posterior end, where it fuses with the median ridge, turns ventrally at the anterior end, and reaches the anterior margin below the midlength of the latter. Two long ventral ridges running parallel to the ventral margin fuse with the dorsal ridge at the anterior end of the shell. Two more long and striated ridgelets are developed on the ventral margin below them. Two thin, short, and parallel-to-the-anterior margin ridgelets fuse with the dorsal ridge and are visible in the dorsal half of the anterior end. The entire surface of the valves between the ridges except for the anterior and posterior ends is covered with large quadrangular and pentagonal thin-walled fossae.

M e a s u r e m e n t s (mm):

Specimen no.	Length	Height	Width
4843-265	0.56	0.34	0.30
4843-262	0.63	0.37	0.32
4843-301	0.74	0.41	0.35
4843-78	0.50	0.28	0.25
4843-75	0.50	0.27	0.27

V a r i a b i l i t y. The width and length of the ridges and the development of the reticulation are slightly variable.

C o m p a r i s o n. Differences from *N. catephracta* (Mandelstam, 1949) are given under the description of the latter species. From *N. multicostata* (Oertli, 1954) from the upper Oxfordian of France (Oertli, 1957, p. 667, pl. 4, figs. 146–153; Dépêche, 1985, pl. 32, fig. 21), the Oxfordian of Poland (Bielecka *et al.*, 1988, p. 366, pl. 165, fig. 1), and the upper Oxfordian–lower Kimmeridgian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 147, pl. 63, figs. la-Id), it differs in a shorter median ridge, in the absence of the intercalary ridgelets between the dorsal, median, and ventral ridges, in a higher shell, and in the inverse pattern in size of the valves; from *N. flexicosta lutzei* (Whatley, 1970) from the middle and upper Callovian of Scotland (Whatley, 1970, p. 341, pl. 12, figs. 1-12) and the Callovian of France (Depeche, 1985, pl. 32, fig. 19), it differs in its ridges being narrower.

O c c u r r e n c e. The lower and middle Callovian of Germany, the upper part of the lower-upper Callovian of Poland, the lower and middle Callovian of the Dnieper-Donets Depression, the middle and upper Callovian of the Ryazan Region, the lower Callovian of the Kursk Region.

M a t e r i a l. Two well-preserved valves from the upper Callovian *(lamberti* Zone) of the Zmeinka section, 20 well-preserved valves from the middle Callovian *(coronatum* Zone) of the Mikhailovtsement section, eight well-preserved valves from the lower Callovian *(koenigi* Zone) of the Mikhailovskii Mine section.

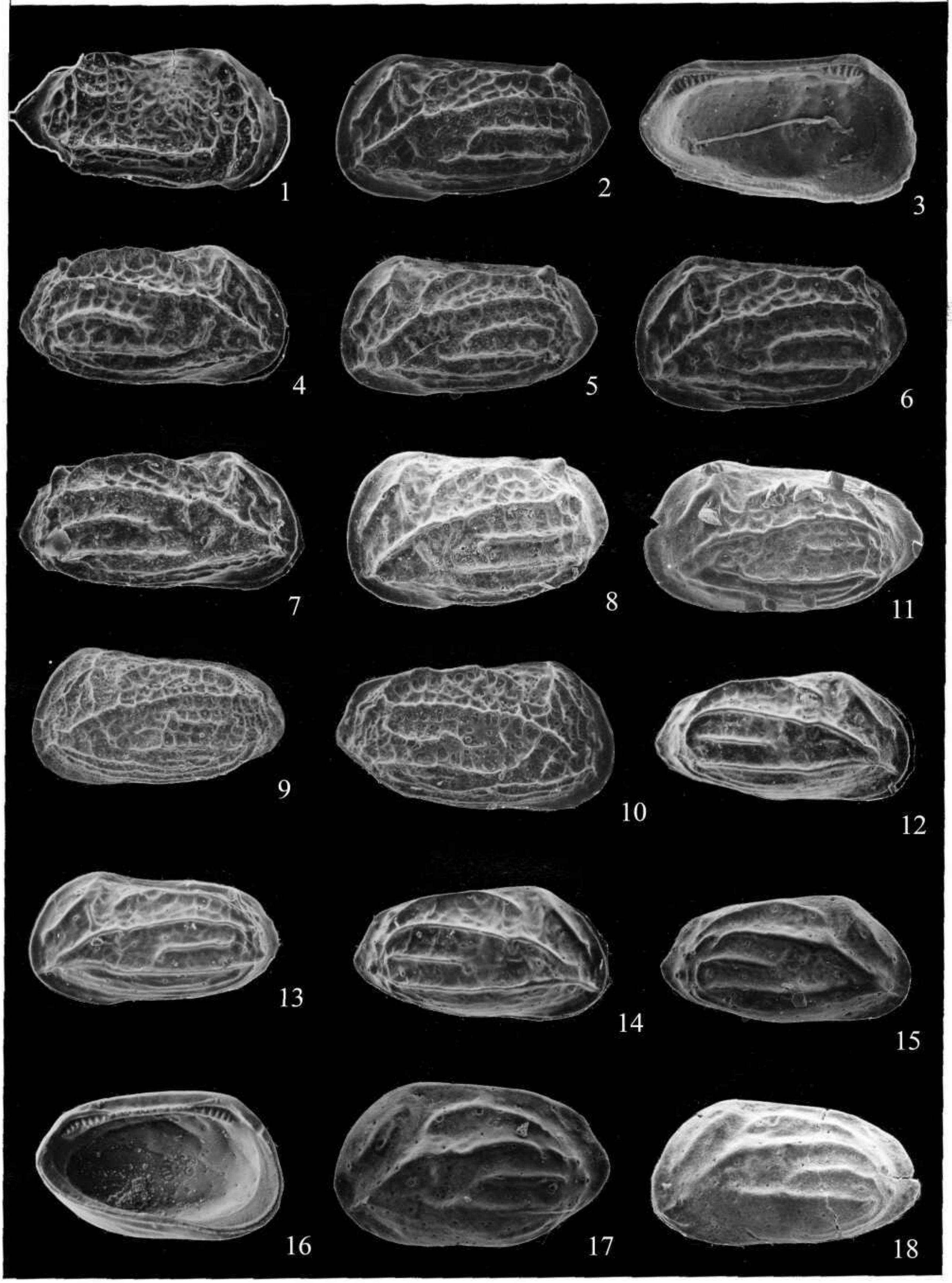
Explanation of Plate 13

Figs. 1-3. *Nophrecythere catephracta* (Mandelstam): (1) no. 4843-18, left valve, lateral view, ×100; (2) no. 4843-20, right valve, lateral view, x90; Moscow Region, Peski, sample Pyum-6, upper Callovian, *lamberti* Zone; (3) no. 4843-273, complete shell, dorsal view, Ryazan Region, Mikhailovtsement, sample 94-21, middle Callovian, *coronatum* Zone, x60.

Figs. 4–12. *Nophrecythere oxfordiana* (Lutze): (4) no. 4843-48, left valve, lateral view, X100; (6) no. 4843-54, right valve, lateral view, x90; (9) no. 4843-56, right valve, lateral view, ×130; sample Pyum-3; (5) no. 4843-19, right valve, lateral view, sample Pyum-6, x100; (8) no. 4843-31, left valve, lateral view, x100; (10) no. 4843-28, left valve, lateral view, x100; (11) no. 4843-26, left valve, lateral view, X100; sample Pyum-5; upper Callovian, *lamberti* Zone; (12) no. 4843-3, left valve, lateral view, sample Pyum-32, middle Oxfordian, *O. strumosum–L. brestica* Zone, ×100; Moscow Region, Peski; (7) no. 4843-77, left valve, lateral view, Ryazan Region, Zmeinka, sample 94-2, upper Callovian, *lamberti* Zone, ×100.

Figs. 13–17. *Nophrecythere flexicosta* (Triebel): (13) no. 4843-265, left valve, inner view, x80; (15) no. 4843-262, left valve, lateral view, x70; Mikhailovtsement, sample 94-22, middle Callovian, *coronatum* Zone; (14) no. 4843-78, right valve, lateral view, x90; (16) no. 4843-75, left valve, lateral view, x80; Zmeinka, sample 94-2, upper Callovian, *lamberti* Zone; Ryazan Region; (17) no. 4843-301, left valve, lateral view, Kursk Region, Mikhailovskii Mine, sample 95-5, lower Callovian, *koenigi* Zone, ×100.

Plate 14



Genus *Infacythere* Gründel, 1975

Infacythere: Nikolaeva *et al.*, 1999b, p. 65.

Type species. *Lophocythere dorni* Lutze, 1960; upper Callovian (*lamberti* Zone) of Germany.

Diagnosis. Margins slightly converge toward the acuminate posterior end. Isolated anterior marginal and longitudinal ventral ridges developed. Dorsal ridge better expressed in posterior portion and may connect to short median ridge. Surface between ridges reticulate. Eye tubercle present. Hinge entomodont.

Composition. Monotypic.

Comparison. From the genus *Lophocythere* Sylvester-Bradley, 1948, which is similar in hinge structure and in the reticulation of the valve surface between ridges, this genus differs in the presence of only one long longitudinal ridge that is isolated from the anterior marginal ridge.

Occurrence. Upper Callovian; Germany, Russia, and Ukraine.

Infacythere dulcis (Lübimova, 1955)

Plate 14, fig. 1

Protocythere dulcis: Lübimova, 1955b, p. 75, pl. 8, fig. 8.

Lophocythere dorni: Lutze, 1960, p. 426, pl. 36, figs. 4 and 5; Kaever *et al.*, 1994, p. 63, pl. 9, fig. 6.

Infacythere dulcis: Pyatkova and Permyakova, 1978, p. 148, pl. 63, fig. 7; Gerasimov *et al.*, 1996, pl. 4, fig. 12; and Nikolaeva *et al.*, 1999b, p. 65, pl. 33, fig. 2.

Holotype. VNIGRI, no. 117-16, right valve; the Saratov Region, Karabulak; upper Callovian.

Description. The shell is medium-sized, elongated, rounded rectangular, weakly convex. The left valve is larger than the right one and overlaps the latter along the antero- and posterodorsal margins. The anterior end is high, broadly rounded, flattened along its margin. The posterior end is low, triangular acuminate, flat. The dorsal margin is straight. The ventral margin is parallel to the dorsal one, weakly concave in the anterior third. The maximum length is at the valve mid-height. The maximum height is in the anterior third, and the maximum width is in the posteroventral part of the shell. Two narrow and high ridges running parallel to the ventral margin are developed in the ventral part of the valve; the upper ridge stretches for two-thirds of the shell length from the posterior end, the lower ridge runs from the posterior end up to the anterior one, where it turns towards the dorsal side and reaches the dorsal margin. A short and oblique ridge develops in the posterior portion of the dorsal margin. The entire surface of the valves except for the flattened areas of the anterior and posterior ends and ridges is covered with large, rounded quadrangular fossae. A narrow, indentated bordering is developed along the anterior margin.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-176	0.45	0.23	0.18

Occurrence. The upper Callovian of Germany, the Dnieper-Donets Depression, Saratov, Ryazan, and Moscow regions.

Material. Two well-preserved valves from the upper Callovian of the Mikhailovtsement section and three well-preserved valves from the upper Callovian (*lamberti* Zone) of the Peski section.

Family Pleurocytheridae Mandelstam, 1960

Genus *Sabacythere* Wienholz, 1967

Sabacythere: Nikolaeva *et al*, 1999b, p. 66.

Type species. *Pleurocythere (Sabacythere) arcuata* Wienholz, 1967; lower-middle Callovian of Germany.

Diagnosis. Shell small to medium-sized, trapezoidal, elongated, moderately or weakly convex. Left valve larger than right one. Margins slightly converging towards posterior end; anterior end slightly beveled. One oblique anterodorsal and four basal longitudinal ridges that may fuse at posterior end of shell present. Eye tubercle present. Hinge antimerodont. Terminal hinge elements curved, incised into six to seven parts being slightly subdivided from above.

Composition. Few species.

Comparison. From similar in the hinge structure and ridged sculpture genera *Pleurocythere* Triebel,

Explanation of Plate 14

Fig. 1. *Infacythere dulcis* (Liibimova), no. 4843-176, right valve, lateral view; Moscow Region, Peski, sample Pyum-6, upper Callovian, *lamberti Zone*, ×110.

Figs. 2–8. *Sabacythere attalicata* (Mandelstam): (2) no. 4843-120, left valve, lateral view, x90; (6) no. 4843-119, left valve, lateral view, x90; sample Pyum-27; (4) no. 4843-134, right valve, lateral view, ×100; (5) no. 4843-133, left valve, lateral view, x90; (7) no. 4843-131, right valve, lateral view, x90; sample Pyum-25; (8) no. 4843-5, left valve, lateral view, sample Pyum-32, x90; Moscow Region, Peski, middle Oxfordian, *O. strumosum-L. brestica* Zone; (3) no. 4843-349, left valve, inner view, Kostroma Region, Yartsevo, sample 95-17, lower Oxfordian, *cordatum* Zone.

Figs. 9 and 10. *Sabacythere* sp.: (9) no. 4843-132, left valve, lateral view, sample Pyum-25, x90; (10) no. 4843-121, right valve, lateral view, sample Pyum-27, x100; Moscow Region, Peski, middle Oxfordian, *O. strumosum–L. brestica* Zone.

Figs. 11-18. *Sabacythere rubra* (Mandelstam): (11) no. 4843-29, left valve, lateral view, x100; sample Pyum-5; (15) no. 4843-172, right valve, lateral view, x80; sample Pyum-7; (16) no. 4843-204, left valve, inner view, x90; (17) no. 4843-160, left valve, lateral view, x90; sample Pyum-8; upper Callovian, *lamberti* Zone; (12) no. 4843-117, right valve, lateral view, x90; (13) no. 4843-116, left valve, lateral view, x80; sample Pyum-29; (14) no. 4843-111, right valve, lateral view, x80; (18) no. 4843-2, left valve, lateral view, x80; sample Pyum-32; middle Oxfordian, *O. strumosum-L. brestica* Zone; Moscow Region, Peski.

1951 and *Palaeocytheridea* Mandelstam, 1947, it differs from the former genus in the presence of four, not three basal longitudinal ridges and from the latter one in the absence of an oblique posterodorsal ridge.

Occurrence. Callovian–Kimmeridgian; Europe, West Siberia.

Sabacythere attalicata **(Mandelstam, 1949)**

Plate 14, figs. 2-8

Protocythere attalicata: Mandelstam, 1949, p. 261, pl. 85, fig. 8.

Protocythere attalica: Lübimova, 1955b, p. 73, pl. 8, figs. 3a and 3b.

Progonocythere attalica: Lübimova, 1956, p. 549, pl. 2, figs. 6a and 6b.

Terquemula attalica: Pyatkova and Permyakova, 1978, p. 147, pl. 63, figs. 2a and 2b.

Terquemula attalicata: Gerasimov *et al.*, 1996, p. 30.

Acrocythere attalica: Nikolaeva *et al.*, 1999b, pl. 33, fig. 5.

Holotype. VNIGRI, no. 117-9, right valve; the Volga River, environs of the town of Syzran; lower Oxfordian, *cordatum* Zone.

Description. The shell is medium-sized, rounded rectangular, moderately convex, having anterior and posterior margins of the valves flattened, and weakly unequal valves. The left valve is larger than the right one and overlaps the latter near the hinge ear and the posterodorsal margin. The anterior end of the shell is wide, rounded and slightly beveled dorsally in the right valve, where it connects with the dorsal margin through a scarp. In the left valve, the anterior margin transits in the dorsal margin smoothly; it transits smoothly in the ventral margin in both valves. The posterior end is low and rounded triangular being sharper beveled dorsally in the right valve. The dorsal margin is straight. The ventral margin is nearly parallel to the dorsal one, slightly leaning posteriorly and weakly concave in the anterior third. The maximum height occurs in the anterior third of the shell. The maximum length is at the mid-height, and the maximum width is in the posterior part of the shell. Numerous thin ridges are developed on the outer surface of the valves; the longest ridge is an oblique one stretching from the anteroventral towards the posterodorsal margin, where it turns to the ventral side. A short, comblike ridge arched toward the dorsal side sometimes fusing with the oblique ridge is developed along the posterior part of the dorsal margin. Two thin parallel ridges are developed at the ventral margin; the upper one of these ridges fuses with the oblique ridge at the anterior end. In the posterior part of the valve, there are two more intercalary ridges between the upper and the oblique ridges; the lower one of them may be rather long. A forklike ridge starts at the eye tubercle; its anterior process is parallel to the anterior end and reaches the mid-height of the shell. The posterior process is two times as long as the anterior one, running sharply backward being interrupted by the oblique ridge into two parts, and may reach the lower of the intercalary ridges. The space between all ridges is filled with large polygonal fossae. Small tubercles may be present at the posterior end of the shell. One large tubercle is developed in the posterodorsal angle.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-349	0.55	0.29	0.26
4843-120	0.54	0.30	0.28
4843-119	0.53	0.30	0.28
4843-134	0.47	0.24	0.22

Variability. The length of the ridges is rather variable, and they may turn out to be disconnected if shortened. The development of fossae between the ridges is slightly variable as well.

Comparison. From the most similar *S. rubra* (Mandelstam, 1949), this species differs in the presence of a large ventral ridge, distinctly expressed fossae between the ridges, and in the tubercle being developed in the posterodorsal angle; from *S. elegans* (Depeche, 1984) from the upper Bathonian of France (Dépêche, 1985, pl. 30, fig. 8), in a more rounded posterior end, in the presence of two, not one, intercalary ridge between the median and upper ventral ridges, in the presence of the tubercle in the posterodorsal angle, and in the fork-like shape of the ridge starting at the eye tubercle. Differences from *S. zmeinkensis* are provided under the description of the latter species.

Remarks. This species was redescribed as a new one by Mandelstam in Lübimova's paper (1955b).

Occurrence. The Oxfordian of the northwestern environs of the Donets Basin, the upper Callovian of Kazakhstan and Timan-Pechora Region, the lower Callovian–upper Kimmeridgian of Samarskaya Luka, the middle Callovian–lower Oxfordian of the Ulyanovsk Region, the lower Oxfordian of the Obshchii Syrt, the Penza Region, and environs of the town of Syzran, the upper Callovian and lower Oxfordian of the Ryazan Region, the lower and middle Oxfordian of the Kostroma Region, the upper Callovian–middle Oxfordian of the Moscow Region.

Material. Two well-preserved valves from the upper Callovian and seven well-preserved valves from the lower Oxfordian of the Mikhailovtsement section, 18 well-preserved valves and complete shells from the lower Oxfordian of the Makar'ev-yuzhnyi section, 41 well-preserved valves and complete shells from the middle Oxfordian of the Samylovo section, 176 well-preserved valves and complete shells from the lower Oxfordian of the Yartsevo section, two well-preserved valves from the upper Callovian and 64 well-preserved valves and complete shells from the middle Oxfordian of the Peski section.

Sabacythere rubra **(Mandelstam, 1949)**

Plate 14, figs. 11-18

Protocythere rubra: Mandelstam, 1949, p. 261, pl. 85, fig. 6; Lubimova, 1955b, p. 72, pl. 8, figs. 6a and 6b.

Palaeocytheridea sudorocostata: Lubimova, 1956, p. 553, pl. 2, fig. 11.

Pleurocythere (Sabacythere) sudorocostata: Pyatkova and Permyakova, 1978, p. 150, pl. 66, figs, la, 1b, 2a, and 2b.

Pleurocythere rubra: Gerasimov *et al.*, 1996, pl. 3, figs. 12 and 13.

Sabacythere rubra: Nikolaeva *et al.*, 1999b, p. 66, pl. 34, fig. 1.

Sabacythere sudorocostata: Nikolaeva *et al.*, 1999b, p. 66, pl. 33, figs. 6 and 7.

Pleurocythere (Sabacythere) arcuata: Olempska and Błaszyk, 2001, p. 562, fig. 5.

H o l o t y p e. VNIGRI, no. 117-7, right valve; the Volga River, environs of the town of Syzran; middle Callovian.

D e s c r i p t i o n. The shell is medium-sized, rounded rectangular, moderately convex, with unequal valves. The left valve is larger than the right one. The overlapping is most expressed at the anterior and posterior ends of the shell, which are flattened. The anterior end is broad, arched, weakly beveled dorsally; however, the inclination is stronger in the right valve. A narrow bordering bearing spines is developed along the anterior margin of the shell. A similar but even narrower bordering is developed along the lower portion of the posterior margin. The posterior end of the shell is rounded triangular, lower than the anterior one. In the right valve, the posterior end is beveled dorsally stronger than in the left valve, which results in its more acute shape. The dorsal margin is straight. The ventral margin is not parallel to the dorsal one, approaches the latter at the posterior end of the shell, and is weakly concave in the anterior third. The maximum height is in the anterior third of the shell. The maximum length is at the mid-height, and the maximum width is in the posterior third of the valve. Several thin and low ridges are developed on the outer surface of the valve. The median ridge is longest and stretches from the posterior end to the anterior end of the shell, turning ventrally at the anterior end. Above the median ridge is situated a short and convex dorsal ridge that often connects to the median ridge with its posterior end or both ends. Two unequal ridges parallel to the dorsal margin run closer to the ventral margin. The upper one of them is short and situated between the posterior end and the valve midlength; it may be straight or slightly arched towards the dorsal margin. The lower ridge is long, often straight, stretching from the posterior end to the anterior end of the valve, and may connect to the median ridge. Several thin striated ridgelets are developed along the ventral margin; at the posterior end, they turn upwards and at the anterior end, they meet the median ridge. A short, oblique ridge runs along the anterior margin in its upper half; it starts near the hinge ear, where it may have a backward directed, ill defined process that makes the ridge fork-shaped. Several small tubercles are present at the posterior end. The outer surface of the valve is smooth or has short connectors between the ridges, with rare large pores.

M e a s u r e m e n t s (mm):

Specimen no.	Length	Height	Width
4843-173	0.47	0.25	0.22
4843-172	0.56	0.29	0.22
4843-204	0.50	0.30	0.25

V a r i a b i l i t y. The length and height of the ridges and the development of connectors between them are insignificantly variable.

C o m p a r i s o n. Differences from the closest in terms of sculpture *S. attalicata* (Mandelstam, 1949) are provided under the description of the latter species.

R e m a r k s. This species was described again as a new one by Mandelstam in Lubimova (1955b).

In 1956, Lubimova described a new species, *Palaeocytheridea sudorocostata,* from the Callovian of eastern Ukraine, the settlement of Traktemirovo. Subsequently, Permyakova allocated that species to the subgenus *Sabacythere* on the basis of the absence of a short posterodorsal ridge. Examination of SEM images of *S. rubra* (Nikolaeva *et al*, 1999b, p. 66, pl. 34, fig. 1) and *S. sudorocostata* (Nikolaeva *et al.*, 1999b, p. 66, pl. 33, figs. 6, 7) revealed that these are the same species.

O c c u r r e n c e. The upper Callovian of Poland, the lower Callovian of Ukraine, the Callovian–lower Oxfordian of Samarskaya Luka, the lower Oxfordian of Obshchii Syrt, the upper Callovian of the Timan–Pechora Region, the upper Callovian and middle Oxfordian of the Moscow Region.

M a t e r i a l. Eight well-preserved valves from the upper Callovian (*Lenticulina tumida-Epistomina elschankaensis* Zone) and 13 well-preserved valves from the middle Oxfordian (*Ophthalmidium strumosum–Lenticulina brestica* Zone) of the Peski section.

Sabacythere zmeinkensis **Tesakova, sp. nov.**

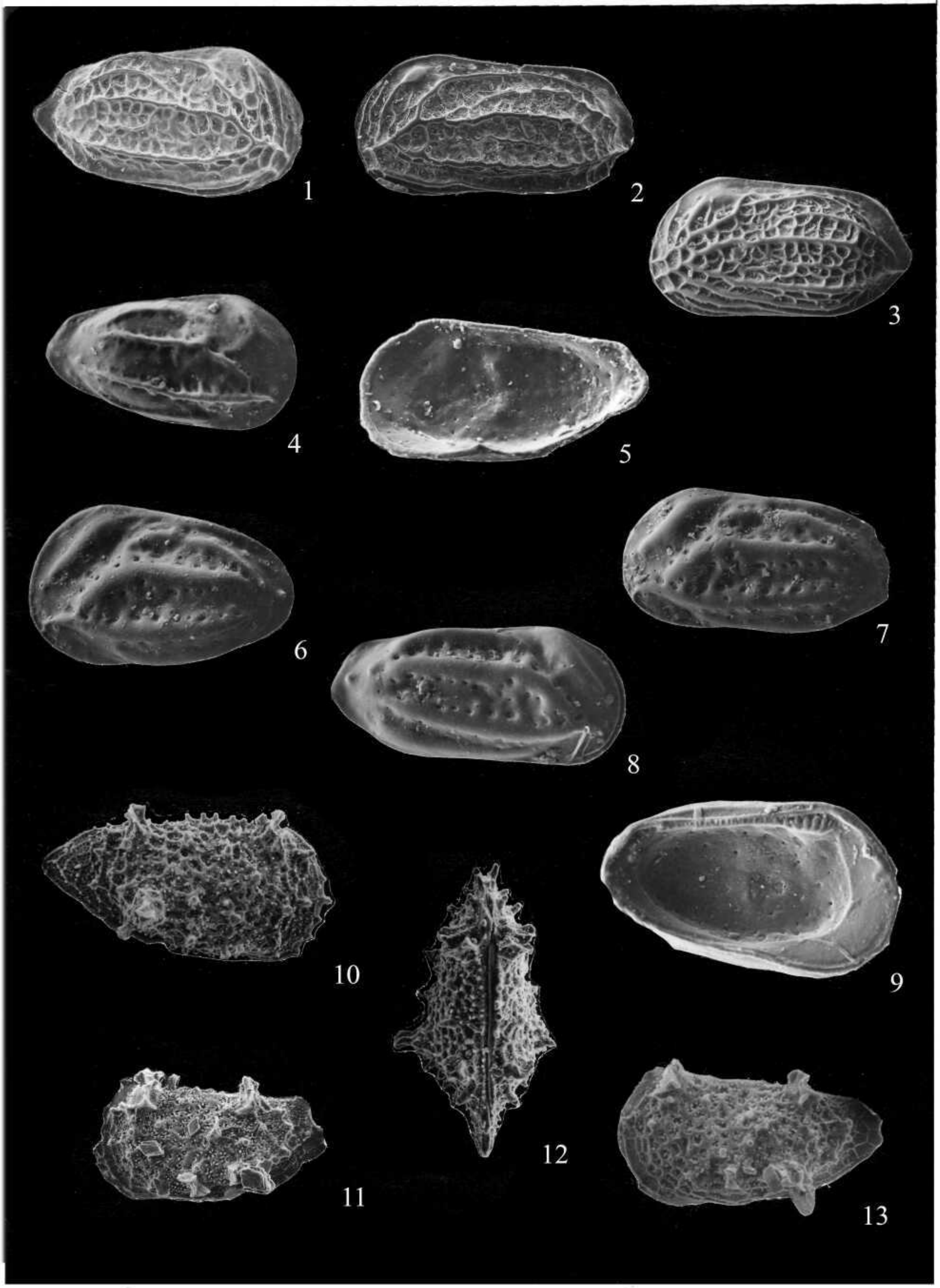
Plate 15, figs, 1 and 2

E t y m o l o g y. From the Zmeinka quarry.

H o l o t y p e. PIN, no. 4843-104, left valve; Ryazan Region, the Zmeinka quarry; upper Callovian, *lamberti* Zone.

D e s c r i p t i o n. The shell is medium-sized, oval rectangular, moderately convex, having flattened anterior and posterior ends, with unequal valves. The right valve is larger than the left one. The overlapping is better expressed along the posterodorsal margin near the hinge ear. The anterior end is high and broadly rounded. The posterior end is lower than the anterior one, rounded triangular. A flat and narrow bordering is developed along the anterior and posterior ends. The dorsal margin is straight. The ventral margin is nearly

Plate 15



parallel to the dorsal one, initially leaning towards the posterior end or weakly concave medially. The maximum length is at the mid-height. The maximum height is in the anterior third, and the maximum width is in the posterior half of the shell. An oval eye tubercle is developed on the anterodorsal margin. Numerous thin ridges of different length are developed on the outer surface of the valves. All long ridges, i.e., two ventral, a median, and a dorsal one, start at the posterior end of the shell. At the anterior margin, the median and dorsal ridges fuse into a single oblique ridge reaching the anterior margin. The upper one of the ventral ridges rests against this oblique ridge; the lower ventral ridge reaches the anterior margin of the valve. In the posterior half of the valve, two thin intercalary ridges are developed below and above the median ridge respectively; the upper one is longer. Two other short ridgelets resting below against the oblique ridge and parallel to the anterior margin are developed in the upper half of the anterior end of the valve. The entire surface of the valves except for flattened areas of the anterior and posterior ends of the shell and the eye tubercle is covered with quadrangular and pentagonal fossae having thin muri.

Measurements (mm):

Specimen no.	Length	Height	Width
Holotype 4843-104	0.71	0.36	0.32
4843-55	0.50	0.26	0.24

Variability. The reticulation is slightly variable.

Comparison. From the most similar in the pattern of sculpture *S. bradiana* (Jones, 1884) from the lower Callovian of France (Dépêche, 1985, pl. 30, fig. 9), Bathonian of England (Oertli, 1957, pl. 4, fig. 154), upper Oxfordian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 148, pl. 63, figs. 4, 5, 6), and middle Callovian of Mordovia (PL 15, fig. 3), it differs in the dorsal and median ridges being fused into a single oblique ridge at the anterior end and in the presence of an intercalary ridgelet between the median and upper ventral ridges; from *S. attalicata*, in the absence of a tubercle from the posterodorsal margin and the absence of a fork-shaped ridge from the anterior margin, in the presence of an intercalary ridgelet between the dorsal and median ridges, and in one, not two as in *S. attalicata* intercalary ridgelets between the median and ventral ridges.

Occurrence. The upper Callovian of the Ryazan and Moscow regions, the lower Callovian of the Kursk Region.

Material. One well-preserved valve from the upper Callovian (*lamberti* Zone) of the Zmeinka section, three well-preserved valves from the upper Callovian (*lamberti* Zone) of the Peski section, five well-preserved valves from the lower Callovian (*koenigi* Zone) of the Mikhailovskii Mine section.

Genus *Pleurocythere* Triebel, 1951

Pleurocythere: Kashevarova *et al.*, 1960, p. 402; Howe *et al.*, 1961b, p. 330; and Nikolaeva *et al.*, 1999b, p. 66.

Type species. P. *richteri* Triebel, 1951; upper Bajocian (*parkinsonia*Zone) of Germany.

Diagnosis. Shell small to middle-sized, elongated oval, weakly or moderately convex, consisting of unequal valves. Left valve little larger than right one. Margins converging toward posterior end, anterior end little beveled. Lateral surface with three main longitudinal ridges. Additionally, short marginal, anterodorsal ridge present. Median ridge bifurcating, fusing with anterodorsal ridge in upper half and nearly resting below against ventral ridge that always reaches anterior end. Surface between ridges may be reticulated. Eye tubercle developed. In left valve, hinge represented by incised marginal sockets with wedge-like toothlets above them and by a granulated median bar with minute wedge-shaped pits.

Composition. More than 20 species.

Comparison. From the genus *Acrocythere* Neale, 1960, which is similar in sculpture and hinge structure, it differs in the median ridge being forked and in marginal hinge elements being subdivided into six to seven parts, in contrast to four to five parts in the latter genus.

Occurrence. Mainly Bajocian and Bathonian; Europe.

Explanation of Plate 15

Figs. 1 and 2. *Sabacythere zmeinkensis* sp. nov.: (1) no. 4843-55, right valve, lateral view, Moscow Region, Peski, sample Pyum-3, upper Callovian, *lamberti* Zone, ×100; (2) holotype no. 4843-104, left valve, lateral view, Ryazan Region, Zmeinka, sample 94-2, upper Callovian, *lamberti* Zone, x70.

Fig. 3. *Sabacythere bradiana* (Jones), no. 4843-293, left valve, lateral view; Mordovia, Troshkov vrag, sample 96-4, middle Callovian, *coronatum* Zone, x70.

Figs. 4 and 5. *Pleurocythere juvenes* Lübimova: (4) no. 4843-312, right valve, lateral view, sample 95-6, xlOO; (5) no. 4843-319, right valve, inner view, sample 95-9, ×100; Kursk Region, Mikhailovskii Mine, lower Callovian, *koenigi* Zone.

Figs. 6-9. *Pleurocythere regularis* Triebel: (6) no. 4843-304, left valve, lateral view, XlOO; (7) no. 4843-305, left valve, lateral view, x90; (8) no. 4843-306, right valve, lateral view, x90; (9) no. 4843-307, left valve, inner view, ×110; Kursk Region, Mikhailovskii Mine, sample 95-6, lower Callovian, *koenigi* Zone.

Figs. 10–13. *Exophthalmocythere pilosa* sp. nov.: (10) holotype no. 4843-164, right valve, lateral view, ×167; (12) no. 4843-165, complete shell, dorsal view, ×167; sample Pyum-8; (11) no. 4843-32, left valve, lateral view, ×130; (13) no. 4843-187, left valve, lateral view, ×167; sample Pyum-5; Moscow Region, Peski, upper Callovian, *lamberti* Zone.

Pleurocythere juvenes **Lubimova, 1956**

Plate 15, figs. 4 and 5

Pleurocythere juvenes: Lubimova, 1956, p. 54, pl. 2, fig. 3; Pyatkova and Permyakova, 1978, p. 150, pl. 65, fig. 3.

Holotype. VNIGRI, no. 138-15, left valve; the Kanev District, the Traktemirovo River; lower Callovian.

Description. The shell is small, elongated, irregularly oval and weakly convex. The left valve is little larger than the right one and overlaps the latter along the anterodorsal and posterodorsal margins. The anterior end of the shell is high, gently arched, and beveled dorsally. The dorsal margin is straight, fusing with the anterior margin at nearly a right angle and with the posterior margin at an obtuse angle. The ventral margin is concave in its anterior third. The maximum length is at the mid-height of the shell. The maximum height is in the anterior third, and the maximum width is in the posterior half of the shell. One low longitudinal ridge which is forked in the anterior part runs along the mid-height of the valve. One of its branches terminates in the dorsal part of the anterior end of the shell; another, in the ventral part. One longitudinal weakly expressed ridge runs along each of the dorsal and ventral margins. The outer surface of the valve between ridges is smooth.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-312	0.45	0.24	0.15
4843-319	0.51	0.25	0.16

Comparison. From *P. richteri* Triebel, 1951 from the Middle Jurassic of Germany (Triebel, 1951, p. 89, pl. 44, figs. 1-7), this species differs in its smaller size, weakly developed dorsal and ventral longitudinal ridges, and in the absence of a tubercle from the anterior third of the shell.

Occurrence. The lower Callovian of the Dnieper-Donets Depression and northwestern plunge of the Donets Basin, the lower and middle Callovian of the Kursk Region.

Material. Five satisfactorily preserved valves from the lower Callovian (*koenigi* Zone) and two well-preserved valves from the middle Callovian (*jason* Zone) of the Mikhailovskii Mine section.

Pleurocythere regularis **Triebel, 1951**

Plate 15, figs. 6–9

Pleurocythere regularis: Triebel, 1951, p. 92, pl. 45, figs. 13-16; and Bielecka *et al.*, 1988, p. 173, pl. 68, fig. 5.

PL (Pleurocythere) caudata: Pyatkova and Permyakova, 1978, p. 149, pl. 63, fig. 8.

Holotype. Xe 1750, complete shell; Germany, Blumberg, upper reaches of the Wutach River; Middle Jurassic, *blagdeni* beds.

Description. The shell is medium-sized, elongated oval, moderately convex. The left valve is larger than the right one; the overlapping is better developed along the anterodorsal and posterodorsal margins. The anterior end of the shell is high, rounded, and beveled dorsally in the right valve stronger than in the left valve. The posterior end of the shell is lower than the anterior end, flattened. In the right valve, the posterior end is rounded quadrangular, leaning towards the ventral side; in the left valve, it is more gently rounded triangular. The dorsal margin is weakly concave medially, leaning toward the posterior end of the shell, connecting to the posterior margin through a scarp in the right valve and more gradually in the left valve. The ventral margin is nearly straight, not parallel to the dorsal margin, concave in the anterior third. The maximum length is at the mid-height of the shell. The maximum height is in the anterior third, and the maximum width is in the posterior third of the valve. Four distinct roll-like longitudinal ridges are developed on the outer surface of the valve. The median ridge and the upper ventral ridge fuse at the anterior end of the shell into a single short, oblique ridge. The convex and short dorsal ridge turns to the ventral side at the posterior end and fuses there with the median ridge. A short oblique ridge reaching the midlength of the anterior margin is developed in the dorsal part of the anterior margin. The lower ventral ridge is slightly shorter than the upper ridge and fuses with the latter in the anterior third of the valve. The entire surface of the valves except for the flattened area of the posterior end and ridges is covered with rounded fossae.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-305	0.55	0.28	0.19
4843-304	0.47	0.29	0.20
4843-306	0.59	0.28	0.18
4843-307	0.50	0.27	0.17

Variability. The development of the sculpture and the shape of the posterior end are slightly variable.

Comparison. From *P. richteri* Triebel, 1951 from the Middle Jurassic of Germany (Triebel, 1951, p. 89, pl. 44, figs. 1-7), the upper Bajocian of Poland (Bielecka *et al.*, 1988, p. 173, pl. 68, fig. 6), and the upper Bajocian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 150, pl. 65, figs. 5, 6), this species differs in the absence of a median excavation in the center of the valve and the reticulation; *P. impar* Triebel, 1951 from the Middle Jurassic of Germany (Triebel, 1951, p. 91, pl. 45, figs. 8-12), the upper Bajocian–middle Bathonian of Poland (Błaszyk, 1967, p. 24, pl. 5, figs. 4-7; Bielecka *et al*, 1988, p. 173, pl. 68, fig. 4), and the lower Bathonian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 149, pl. 65, fig. 1), it differs in its valves being unequal, the more rounded shape of the anterior end, and in the pitted, not reticulate sculpture of the surface between the ridges; from *P. connexa* Triebel, 1951 from the Middle Jurassic of Germany (Triebel, 1951, p. 93, pl. 46, figs. 19-22), the upper Bajocian–Bathonian of Poland (Błaszyk, 1967, p. 23, pl. 5, figs. 1-3; Bielecka *et al.*, 1988, p. 173, pl. 68, fig. 3), and the upper Bajocian of the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 149, pl. 64, fig. 4), in the median ridge being uninterrupted and in pitted, unreticulate sculpture of the surface between the ridges; from *P. longicosta* Triebel, 1951 from the Middle Jurassic of Germany (Triebel, 1951, p. 93, pl. 46, figs. 23-25), it differs in the flattened posterior end.

Occurrence. The Callovian of Germany, the upper Bajocian of Poland, the lower Callovian of the Dnieper-Donets Depression and northwestern settling of the Donets Basin, the lower and middle Callovian of the Kursk Region.

Material. Sixty-seven well-preserved valves and complete shells from the lower Callovian (*koenigi* Zone) and eight well-preserved valves from the middle Callovian (*jason* Zone) of the Mikhailovskii Mine section.

Superfamily Trachyleberidacea Sylvester-Bradley, 1948

Family Trachyleberididae Sylvester-Bradley, 1948

Subfamily (?) Exophthalmocytherinae Gründel, 1966

Genus *Exophthalmocythere* Triebel, 1938

Exophthalmocythere: Lubimova, 1955b, p. 85; Kashevarova *et al.*, 1960, p. 386; Bold van den *et al.*, 1961, p. 350; Kaever *et al.*, 1994, p. 59.

Type species. *Exophthalmocythere mamillata* Triebel, 1938; Hauterivian of Germany.

Diagnosis. Shell small, irregularly oval, moderately convex, flattening towards the ends; valves equal. Anterior end of shell high, gently rounded. Posterior end of shell low, rounded triangular. Dorsal margin straight. Ventral margin concave medially. Eye tube terminating with hemispherical eye spot elevates above the dorsal margin. Outer surface of valve smooth or pitted-tubercular, sometimes bearing spines. In left valve, anterior section of hinge consists of socket with three notches and a tooth, which is also divided into three parts beyond this socket; the median section consists of a thin bar; the posterior section is represented by socket bearing five notches.

Composition. Rare species.

Comparison. From the genus *Rasthalmocythere* Griindel, 1976, it differs in the presence of the eye tube and in the identical shape of the posterior end in both valves.

Occurrence. Middle Jurassic-Lower Cretaceous; Europe.

Exophthalmocythere pilosa **Tesakova, sp. nov.**

Plate 15, figs. 10–13

Etymology. From Latin *pilosus* (hairy).

Holotype. PIN, no. 4843-164, right valve; Moscow Region, Peski; upper Callovian, *lamberti* Zone.

Description. The shell is small, elongated, resembling an apple seed, weakly concave. The left valve is slightly larger than the right one, overlapping the latter along the antero- and posterodorsal margins. The right valve overlaps the left one along the dorsal margin. The anterior end of the shell is high, evenly rounded and flattened along its margin. The posterior end of the shell is low, triangular, beveled similarly on the dorsal and ventral sides, flattened. The dorsal margin is straight, transiting into the anterior and posterior margins at obtuse angles. The ventral margin is not parallel to the dorsal one, weakly leaning toward the posterior end, weakly concave in the anterior third, connecting to the posterior margin smoothly and to the anterior margin at an obtuse angle. The maximum length is at the mid-height, the maximum height is in the anterior third, and the maximum width is in the posteroventral part of the valve. Three large, apically split spines are developed on the posteroventral, posterodorsal, and anterodorsal margins. The rest of the outer surface of the valves is densely covered with rounded quadrangular fossae with thick muri that are densely dotted with small to medium-sized spines. At the anterior and posterior ends of the shell, smaller fossae are distinctly visible on the solum of large fossae. In the right valves only, several medium-sized spines are elevated above the dorsal margin. Six small and straight spines are developed along the anterior margin of both valves.

Measurements (mm):

Specimen no.	Length	Height	Width
Holotype 4843-164	0.31	0.15	0.18
4843-165	0.31	0.16	0.18
4843-187	0.28	0.40	0.16
4843-32	0.31	0.18	0.20

Comparison. From forms identified as *E. insignis* Donze, 1965 from the lower Valanginian of Poland (Kubiatowicz, 1986, p. 39, pl. 14, fig. 1), this species differs in more spiny muri, large spines possessing flattened edges, and uncircular transverse section processes. Additionally, antero- and posterodorsal spines are much more developed in *E. pilosa* than in *E. insignis* and a row of elevated spines is present along the dorsal margin in the right valve. From *E. affabra* Lubimova, 1955 from the middle Volgian Substage of the Obshchii Syrt (Lubimova, 1955b, p. 87, pl. 10, fig. 3), which is similar in the reticulate spiny sculpture, it differs in the presence of two exceptionally large spines on the posteroventral and posterodorsal margins and in a smaller shell; from *E. tricornis* Lubimova, 1955 from the upper Oxfordian–lower Volgian Substage of the Ulyanovsk Region (Lübimova, 1955b, p. 87, pl. 10, fig. 2), it differs in the absence of a larger spine on the anteroventral margin and in a sculpture consisting of fine spines in contrast to the reticulation in latter species; from *E. fuhrbergensis* Steghaus, 1951 from the lower Kimmeridgian of France (Oertli, 1957, p. 662, pl. 3, figs. 98-100; Dépêche, 1985, pl. 33, fig. 12) and the Dnieper-Donets Depression (Pyatkova and Permyakova, 1978, p. 157, pl. 71, fig. 5), the upper Oxfordian-lower Volgian Substage of the Volga Region (Lübimova, 1955b, p. 87, pl. 10, fig. 2), in the absence of a large tubercle from the anteroventral margin, in the posterior end being more acute, and in the sculpture of the valves consisting of fine spines in contrast to the pitted sculpture in the latter species.

Occurrence. The upper Callovian of the Moscow Region, the upper Oxfordian of the Kostroma Region.

Material. Seven well-preserved valves and complete shells from the upper Callovian (*lamberti* Zone) of the Peski section, one well-preserved valve from the upper Oxfordian of the Makar'ev-yuzhnyi section.

Genus incertae sedis

Genus *Rubracea* Mandelstam, 1957

Rubracea: Mandelstam *et al.*, 1957, p. 177; Kashevarova *et al.*, 1960, p. 376; van den Bold *et al.*, 1961, p. 354.

Type species. *R. artis* Lübimova, 1957; Callovian of the Transvolga Region near Saratov.

Diagnosis. Shell small, elongated, with diverging posterior ends of valves. Anterior end high, gently rounded. Posterior end triangular, much lower than anterior end. Valves smooth. Eye spot not expressed. In left valve, hinge consisting of elongated subdivided sockets in terminal sections; median section represented by bar. In right valve, the hinge has a reverse set of elements; marginal teeth fusing with elevated inner edge of valve. Outer margin narrow.

Composition. Monotypic.

Occurrence. Callovian and Oxfordian; Scotland, Poland, Ukraine, and Russia.

Remarks. This genus was described by Mandelstam (1957) on the basis of a single species, which had been described by Liibimova in the same year, and placed in the family Cytheridae Baird, 1850, the superfamily Cytheracea Ulrich et Bassler, 1923, although the muscle scars were not examined. In the Fundamentals of Paleontology (Kashevarova *et al.*, 1960), this genus is allocated to the tribe Palaeocytherideides Mand. within a new subfamily Palaeocytherideinae Mand. of the family Cytheridae Baird, 1850, superfamily Cytheracea Baird, 1850. In the American Treatise (Bold van den *et al.*, 1961), this genus was pushed off familial classification for the first time, being retained within the superfamily Cytheracea Baird, 1850. Permyakova (Pyatkova and Permyakova, 1978) took the genus *Rubracea* back to the family Cytheridae Baird, 1850 of the suborder Podocopa Sars, 1866. In the most recent compendium, the Practical Manual of Mesozoic Ostracodes (1999), this genus has been completely removed from classification due to the scarcity of data. We follow the latter opinion, since we also failed to examine the muscle scars.

***Rubracea artis* Ltibimova, 1957**

Plate 2, figs. 10–12

Rubracea artis: Mandelstam *et al.*, 1957, p. 178, pl. 3, figs. 1 and 2; Kashevarova *et al.*, 1960, p. 374, fig. 1048; Pyatkova and Permyakova, 1978, p. 133, pl. 52, figs. 4 and 5.

Krausella sp. A: Whatley, 1970, p. 316, pl. 2, figs. 1, 2, 5, and 6.

Cardobairdia sp.: Olempska et Błaszyk, 2001, p. 556, fig. 1H.

Holotype. VNIGRI, no. 207, complete shell; Transvolga Region near Saratov; Callovian.

Description. The shell is oval, moderately convex, having unequal valves. The left valve embraces the right valve along its dorsal, ventral, and anterior margins. The right valve is longer than the left one, projecting over it posteriorly. At the posterior end, the zone of fusion of both valves is distinct and visible as a triangle area when the valves are closed. The anterior end of the shell is high, evenly rounded, uniformly weakly beveled on the dorsal and ventral sides. The posterior end of the shell is lower than the anterior one, triangular, evenly beveled on the dorsal and ventral sides. In the left valve, the dorsal margin is convex, fusing smoothly with the anterior margin; the posterodorsal margin is convex. In the right valve, the dorsal margin is straight, fusing with the anterior and posterior margins at obtuse angles. The ventral margin is convex, being stronger convex in the left valve, fusing smoothly with the anterior and posterior margins. The maximum length is at the mid-height of the valve, the maximum height and width are in the middle of the valve.

Measurements (mm):

Specimen no.	Length	Height	Width
4843-231	0.44	0.23	0.18
4843-230	0.49	0.23	0.20
4843-232	0.42	0.22	0.18

Variability. The height and width of the shell are slightly variable.

Remarks. There is a form in the middle Callovian of Scotland that was described, figured, and identified by Whatley (1970) as *Krausella* sp. A. Since the genus *Krausella* was established by Ulrich in 1894 for middle Ordovician–lower Devonian forms possessing an asymmetrical shell lacking a zone of fusion, Whatley's placement of the Callovian species into the Paleozoic genus is erroneous. The form figured as *Krausella* sp. A does not differ from *R. artis* in any details.

Occurrence. The middle Callovian *(coronatum* Zone) of Scotland, the upper Callovian of Poland, the Oxfordian of the Dnieper-Donets Depression, the Callovian of the Transvolgian Region near Saratov, the middle Callovian of Mordovia and the Kursk Region, the Oxfordian of the Kostroma Region.

Material. Thirteen well-preserved valves from the middle Callovian *(coronatum* Zone) of the Troshkov vrag section, five well-preserved valves from the middle Callovian *(calloviense* Zone) of the Mikhailovskii Mine section, seven well-preserved valves from the lower Oxfordian, four well-preserved valves from the middle Oxfordian, and two well-preserved valves from the upper Oxfordian of the Makar'ev-yuzhnyi section.

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Appendix 1. Distribution of the Callovian and Oxfordian Ostracodes in Europe

Region: (1) England and Scotland (Whatley, 1964, 1970; Kilenyi, 1969), (2) Holland (Herngreen, Wong, 1989, Witte et Lissenberg, 1994), (3) France (Oertly, 1957, 1963; Depeche 1969, 1984, 1985; Depeche, Guyader, 1970; Bodergat, 1997), (4) Germany (Triebel, 1951; Lutze, 1960; Malz, 1962; Brand, 1990; Kaever, Oekentorp, Siegfried, 1994), (5) Poland (Błaszyk, 1967; Kubiatowicz, 1983; Bielecka *et al.*, 1988; Olempska and Błaszyk, 2001), (6) Dnieper-Donets Depression (Lubimova, 1955a, 1956; Kats, 1957; Permyakova, 1974c, 1975b, 1978), (7) northwestern marginal regions of the Donets Basin (Lubimova, 1955a, 1956; Permyakova, 1978), (8) Voronezh Region (Preobrazhenskaya, 1958, 1966; *Unifitsirovannaya*...,1993), (9) Orel Region (Preobrazhenskaya, 1966), (10) Kursk Region (Preobrazhenskaya, 1958, 1962, 1966; Tesakova), (11) Ryazan Region (Tesakova), (12) Moscow Region (Tesakova), (13) Kostroma Region (Tesakova), (14) Mordovia (Tesakova), (15) Tatarstan (Lubimova, 1955b), (16) Volga Region near Ulyanovsk (Lübimova, 1955b; Lord *et al*, 1987), (17) Samarskaya Luka (Lubimova, 1955b), (18) Saratov Region (Lubimova, 1955b; Khabarova, 1961), (19) Obshchii Syrt (Lubimova, 1955b), (20) Emba Region (Lubimova, 1955b), (21) Timan-Pechora Region (Lev and Kravets, 1982).

Regions	1	2	3	4	5	6	7	8	9
Family Polycopidae Sars, 1865									
Polycope cf. *maculata* Müller, 1894					bs 2	ox			
P. sp. *11* Glashoff, 1964						ox			
P. *pelta* Fischer, 1961	ox 1								
P. sububiquita Whatley, 1970	cl 3-ox 1								
P. sp. Olempska et Błaszyk, 2001					cl 3				
Family Cytherellidae Sars, 1866									
Cytherella collapsa Grekoff, 1963						cl 2			
C. limpida Błaszyk, 1967					bs 2-bt 3	bs 2			
C. oblonga Permyakova, 1969				bt 3	cl 3	bs 2	bs 2		
C. perennis Błaszyk, 1967					bs 2-bt	bs 2			
C. suprajurassica Oertli, 1957			ox 3-km 1		ox 3-km				
C. fullonica Jones et Sherborn, 1888	cl, ox								
Cytherelloidea magna Depeche, 1984			1						
C. chonvillensis Depeche, 1969			1						
C. biplicata (Lubimova, 1956)						ox	ox		
Family Bairdiidae Sars, 1887									
Bairdia obliqua Lubimova, 1956						ox	ox		
B. opulenta Lubimova, 1956						x 3	ox 3		
B. positiva Lübimova, 1956						ox 3	ox 3		
Cardobairdia argoviensis (Oertli, 1959)					ox2-3				
Family Paracyprididae Sars, 1923									
Paracypris acris Oertli, 1959						ox			
P. sp. A Schmidt, 1955			ox 3-km 1						
P. sp. A Whatley, 1970	cl 2-3								
P. bellula Lubimova, 1955						cl 2	cl 2		
P. lubrica Lubimova, 1955						vol			
P. acuta (Cornuell, 1844)									
P. makridini Lubimova, 1956						ox			
P. procerus Błaszyk, 1967					bs 2-bt 3	ox			
P. stripta Lubimova, 1956				bt 3		ox	km		

10	11	12	13	14	15	16	17	18	19	20	21
	cl 3	cl 3									
	cl 2–3	ox 2									
							cl 2				
		cl 3							vol 2		
							ox 1, vol 2		vol 2		
				cl 2							

Appendix 1. (Contd.)

Regions	1	2	3	4	5	6	7	8	9
P. terraefullonica (Jones et Sherborn, 1888)				bt 3	cl 3	km, vol			
Family Pontocyprididae G. Müller, 1894									
Pontocypris arcuata Lübimova, 1955									
Pontocyprella aureola Liibimova, 1955				bt 3		ox	ox	ox	
P. izjumica Liibimova, 1956						ox			
P. vescusa Lübimova, 1956						ox	ox 3		
P. suprajurassica Oertli, 1959					ox 1-3				
Argilloecia (?) sp. *A* Oertli, 1959	ox 1								
Protoargilloecia impurata Liibimova, 1955									
Family Macrocyprididae G. Miiller, 1912									
Macrocypris aequabilis Oertli, 1959	ox 1								
Family Bythocytheridae Sars, 1926									
Patellacythere calloveica (Mandelstam, 1955)									
Bythocythere scherbomi (Jones et Hinde, 1890)									
B. faceta Liibimova, 1955									
Bythoceratina (Praebythoceratina) sp.			1						
Patellacythere aliena (Liibimova, 1955)			1	cl 2, bt 2	el 3	ox			
P. sp.									
P. amygdaliformis (Błaszyk, 1967)					bs 2-bt 3	ox			
P. denticulata (Donze, 1962)						ox 3			
P. gerdae (Liibimova, 1955)						ox			
P. nescia (Liibimova, 1955)						ox			
P. polita (Donze, 1962)						ox 3			
P. trepti (Donze, 1962)			ox 3			ox 3		x 3	
P. vulsa (Jones et Sherborn, 1888)	l 1-ox 2			J 3	cl 1-ox 1, bs	ox			
P. scrobiculata (Triebel et Bartenstein, 1938)				J 1-2	cl 3				
P. stimulea (Schwager, 1866)	ox 1								
Family Cytherideidae Sars, 1925									
Galliaecytheridea? alveolata (Terquem, 1886)						1	1		
G. mandelstami Liibimova, 1955									
G. ? arcessita Liibimova, 1956						1	1		
G. *? cultis* Liibimova, 1956							ox		
G. *globosa* Liibimova, 1956							ox	cl 3	
G. ? cibaria (Liibimova, 1956)							ox 3		
G. contracta (Liibimova, 1956)							ox 3		
G. *grigorievi* (Liibimova, 1956)							ox 3		
G. *kamenkaensis* (Liibimova, 1956)							ox		
G. *wolburgi* (Steghaus, 1951)			ox 3-km 1			ox 3-km			
G. *dorsetensis* Christensen et Kilenyi, 1970		ox 3-km 1							
G. *ingentis* Witte et Lissenberg, 1994		ox 1-2-3							

10	11	12	13	14	15	16	17	18	19	20	21
		ox 1-2	ox 1-2								
	cl 2						ox 1		vol 2		
ox 1			ox 1-3	cl 2			cl 2-ox 3				
		cl 3									
							bt, cl3				
							ox, cl 1-3	cl 2			cl 1
								cl 3			
							cl 2-3				
									vol 2		
		cl 3	ox 1								
							cl 2-3		ox		
			x 2			vol 1			vol 2		
		cl 3									
						vol 1-2	ox, km		vol 2		

Appendix 1. (Contd.)

Regions	1	2	3	4	5	6	7	8	9
G. *oxfordiana* Witte et Lissenberg, 1994		ox 1-2							
G. *punctata* Kilenyi, 1969		ox 3-km 1							
G. *robusta* Witte et Lissenberg, 1994		ox 3-km 1							
G. sp. *A* Witte et Lissenberg, 1994		ox 3-km 1							
G. *dissimilis* Oertli, 1957			ox 3-km 1		ox 2-3			ox3	
G. *argoviensis* (Oertli, 1959)					ox 2-3				
G. *raripunctata* Bielecka, Błaszyk, Styk, 1976					ox 3-km 1				
G. *inaequalipunctata* Bielecka, Błaszyk, Styk, 1976					ox 3-km 1				
G. *legitima* (Lübimova, 1955)								ox	
G. ? *grossepunctata* Witte et Lissenberg, 1994		ox 1-2							
G. ? *ventrostriata* Witte et Lissenberg, 1994		ox 1-3							
G. *postrotunda* Oertli, 1957			ox 3-km 1						
G. *staffinensis* Whatley, 1970	ox 1								
G. *spinosa* Kilenyi, 1969		km 2-vol 1				km 2			
Vernoniella sequana Oertli, 1957		ox 2-3	ox 3-km 1						
Ljubimovella sp.									
Family Loxoconchidae Sars, 1925									
Mandelstamia ventrocornuta (Sharapova, 1939)						ox			
M. kowalevskyi (Lubimova, 1956)						ox	ox		
M. facilis Liibimova, 1955									
M. verrucifera Lubimova, 1955									
M. (Xeromandelstamia?) immanis Witte et Lissenberg, 1994		ox 1-2							
Family Cytheruridae G. Mtiller, 1894									
Metacytheropteron sp. *A* Whatley, 1970	cl 2					cl			
M. sutherlandensis A Whatley, 1970	cl 2								
Cytheropteron spinosum Lübimova, 1955					km2	cl 2			
C. laeve sp. nov.	cl 2								
C. tenuis Błaszyk, 1967					bs 2-bt 1-2	bs 2			
C. pseudospinosum sp. nov.									
C. aquitanum Donze, 1960	cl 2-ox 2								
Eocytheropteron decoratum (Schmidt, 1954)			cl 3-km 2	km					
E.? sp. aff. *purum* (Schmidt, 1954)			ox 3						
Parariscus octoporalis Błaszyk, 1967		cl 2-3			bs 2-bt 1-2	cl			
P. volgaensis (Mandelstam in Lubimova, 1955)						km 2			
P. terraefullonica (Jones et Sherborn, 1988)	cl 1-3								
P. bathonicus Oertli, 1984			1						

10	11	12	13	14	15	16	17	18	19	20	21
cl 2		cl 3	cl 2	cl 2	ox		ox				
			cl 2								
		cl 3									
					ox	ox					
						ox					
					ox	ox					
cl 2		cl 3, ox 2		cl 2		cl 2-ox 1	cl 2-ox 1				
	cl 3	cl 3, ox 2	ox 3								
		cl 3	ox 1-2								
1 1		cl 3									
					lkm 1-vol 1	ox-vol 1	ox-vol 1				

Appendix 1. (Contd.)

Regions	1	2	3	4	5	6	7	8	9
Procytherura tenuicostata Whatley, 1970	ox 1-2					cl			
P. sp. nov.									
Orthonotacythere borealis Gerke et Lev, 1985									
O. interrupta Triebel, 1941			ox 3-km 2						
O. aff. *schweyeri* Scharapova, 1937									
Vesticytherura paula (Lübimova, 1955)				bt 3		cl			ox 3
V. rectodorsalis (Błaszyk, 1967)				bt 3	bs 2-bt				
V. scottia (Whatley, 1970)	cl 2-ox 1	km, bs 2-3							
V. grandipyga sp. nov.									
V. acostata sp. nov.									
V. horrida (Whatley, 1970)	cl 3-ox 1								
V. costaeirregularis (Whatley, 1970)	ox 3	km 2							
Paranotacythere (Unicosta) solei sp. nov.									
P. (U.) pseudoramulosa sp. nov.									
P. (U.) stauropyga sp. nov.									
Pseudohutsonia tuberosa Wienholz, 1967		cl 2-3	l 1						
P. hebridica Whatley, 1970	cl 3-ox 1				cl 3				
P. sp. *A* Whatley, 1970	ox 1								
Balowella attendens (Liibimova, 1955)						bs 2-cl 2			
Eripleura eleanorae Wilkinson, 1987		ox 3-km 1							
Family Schulerideidae Mandelstam, 1959									
Praeschuleridea lepida Błaszyk, 1967					bs 2-bt 2	cl			
P. wartae Błaszyk, 1967					bs 2-bt	cl			
P. confossa Sheppard, 1980			bt 3-cl 3						
P. caudata Donze et Enay, 1962			bt 3-ox 1						
P. batei Whatley, 1970	cl 1-3								
Schuleridea elavata (Liibimova, 1956)							ox, km		
S. translucida (Liibimova, 1955)					cl 3	l 1	l	cl 2	
S. triebeli Steghaus, 1951			ox 3-lm 1	bt-vol 1-2					
Eudachacythere puncticava Dépêche et Guyader, 1970			l						
Family Pleurocytheridae Mandelstam, 1960									
Pleurocythere regularis Triebel, 1951				cl	bs 2		l 1		
P. (Pl.) explicata Lübimova, 1956						l 1	cl 1		
P. (Pl. juvenes Liibimova, 1956						l 1	l 1		
P. ? romeini Witte et Lissenberg, 1994		ox 3							
P. borealis borealis et carinata Whatley, 1970	cl 2-ox 1								
P. caledonia Whatley, 1970	cl 3-ox 1								
'abacythere attalicata (Mandelstam, 1947)							ox		
'. rubra (Mandelstam, 1947)					cl 3	l 1	cl 1		
'. bradiana (Jones, 1884)	bt		cl 1			ox 3			
. zmeinkensis sp. nov.									

10	11	12	13	14	15	16	17	18	19	20	21
	cl 3										
1	cl 3										
											bt-cl
											cl 2
cl 2	cl 3	cl 3-ox 2	cl 3-ox 3		ox 3	ox 1-vol 2	cl 2-km 2	ox	ox 1-vol 2		
		cl 3									
		cl 3	ox 2								
cl 2		cl 3, ox 2	ox 2	cl 2							
	cl 3	cl 3, ox 2	ox 1-3								
	cl 3-ox 1	cl 3, ox 2	cl 2-ox 3			vol 1					
		ox 2									
	cl 2	cl 3	ox 1-3								
			cl 2								
	ox 1	cl 3				cl 2	cl 2				
cl 1-2											
	2-3		cl 2	cl 2			cl 2	cl 2		cl 2	
cl 1-2											
cl 1-2											
	ccl 3, ox 1	cl 3-ox 2	ox 1-2			cl 2-ox 1	cl 1-km 2		ox 1	cl 3	cl 3
		cl 3, ox 2					cl-ox 1		ox 1		cl 3
			cl 2								
cl 1	c13	cl 3									

Appendix 1. (Contd.)

Regions	1	2	3	4	5	6	7	8	9
5. sp. nov.									
Palaeocytheridea parabakirovi Malz, 1962	cl 1-2					cl 2			
P. baculumbajula (Mandelstam in Liibimova, 1955)						ox			
P. kremencensis Liibimova, 1956							ox		
P. cinicinnusa Mandelstam, 1947									
P. prolongata (Sharapova, 1939)									
P. pavlovi Liibimova, 1955									
P. sokolovi Liibimova, 1955									
P. volema Liibimova, 1955									
P. descripta Lübimova, 1955									
P. monstrata Liibimova, 1955									
Progonocythere callovica Wienholz, 1967				cl	cl 3				
P. multipunctata Whatley, 1964	ox 1								
P. parastilla Whatley, 1964	ox 3								
Family Neurocytheridae Gründel, 1975									
Fuhrbergiella (F.) milanovskyi (Liibimova, 1955)						l 1			
F. (F.) nikitini (Liibimova, 1955)						l 1			
F. (Praefuhrbergiella) archangelskii (Mandelstam, 1947)	cl 1-ox 1	cl 2-3	cl 1	bs	cl 3	cl 2-ox 1			
Lophocythere ex gr. *richteri* (Triebel, 1951)					bs 2-bt			cl 2	
L. scabra Triebel, 1951	cl 2-ox 1		cl	cl-ox 1	cl 1-3	cl 1-2		cl 2	
L. karpinskii (Mandelstam, 1947)				cl 2	cl 3-ox 1	cl			
L. (L.) interrupta Triebel, 1951	cl 2-3	cl 2-3		cl		cl			
L. (L.) interrupta subsp. A (Lutze, 1960)		cl 2-3							
L. (Neurocythere) bipartita Wienholz, 1967		cl 2-3							
L. caesa Triebel, 1951				cl 2	cl 3				
Platylophocythere hessi Oertli, 1959			cl 3-ox 1					ox 2	
Terquemula memorabilis (Liibimova, 1956)							ox		
T. oertlii (Bizon, 1958)			ox 1						
T. lutzei (Whatley, 1970)					cl 3				
Nophrecythere catephracta (Mandelstam, 1947)	cl 2, ox 2			cl	cl 3	cl	cl 1, ox 3		
N. alata (Whatley, 1970)	cl 3					cl 2	cl 2		
N. flexicosta (Triebel, 1951)				cl 1-2	cl 1-3	cl 1-2			
N. flexicosta lutzei (Whatley, 1970)	cl 2-3		cl 1-3						
N. franconica (Triebel, 1951)				l 1	cl 1-ox 1	cl	cl		
N. intermedia (Lutze, 1960)	cl 2-ox 1		cl 1-3	cl	cl 3	cl 2			
N. multicostata (Oertli, 1957)			ox 3		ox 1-3	ox 3-km 1			
N. triebeli (Lutze, 1960)				cl 3					
N. oxfordiana (Lutze, 1960)				ox 1-2	ox 1-2	ox			
Infacythere dulcis (Liibimova, 1955)				cl 3		cl 3			
Family Progonocytheridae Sylvester-Bradley, 1948									
Fastigatocythere rugosa Wienholz, 1967				l 1		cl			
Macrodentina (M.) cicatricosa Malz, 1958		ox 3-km 1							

10	11	12	13	14	15	16	17	18	19	20	21
		ox 2									
		cl 3					km 2				
									ox		
cl							l 1	l 1			
					cl 2		cl 2				
					l 1		1	l 1			
						cl 2	cl 2-3, ox				
							ox				
							cl 3				
					ox	ox					
					l 1		l 1	l 1			
							l 1				
	cl 2-3	cl 3		cl 2		cl 2	cl 2-3, ox 1				cl 3
cl 2										cl 2	
l 1	cl 3			cl 2							
cl 2	cl 2-3	cl 3	cl 2				cl 1-2		ox 1		
l 1	cl 3	cl 3									
cl 1	cl 2-3	cl 3-ox 2	cl 2	cl 2		cl 2, ox 1	cl, ox 1	cl 3	ox 1		
		cl 3									
l 1	cl 2-3										
	cl 3	cl 3									
	cl 3	cl 3						cl 3			
	cl 2-3	cl 3		cl 2							

Appendix 1. (Contd.)

Regions	1	2	3	4	5	6	7	8	9
M. punctata Oertli, 1957			ox 3-km 1						
M. tenuistriata Malz, 1958			ox 3						
Glabellacythere reticulata Whatley, 1970	cl2-ox1				cl 3				
G. dolabra (Jones et Sherborn, 1888)	cl 1-ox 1								
Pseudoperissocytheridea parahieroglyphica Whatley, 1970	ox 1-2								
Polydentina pulchra (Schmidt, 1955)			ox 3-km 1						
Micropneumatocythere escovillensis Depeshe, 1984			cl 1-3						
Procytheridea aff. *pseudocrassa* Wienholz, 1967						cl 2			
P. reticulata (Lübimova, 1956)						cl 1	cl 1		
P. gublerae (Bizon, 1959)			cl 3		ox 1-2				
"Procytheridea" gublerae Bizon, 1958			cl 3-ox 3		cl 3				
"Pr." pseudocrassa Wienholz, 1967			cl 1-2						
"Pr." martini Bizon, 1958			cl 1-3						
Camptocythere dextra Gerke et Lev, 1985									
C. scrobiculata Gerke et Lev, 1985									
C. ex gr. *scrobiculata* Gerke et Lev, 1985									
C. aff. *scrobiculata* Gerke et Lev, 1985									
C. ex gr. *spinulosa* (Sharapova, 1937)									
C. laciniosa Gerke et Lev, 1985									
C. laeva Gerke et Lev, 1985									
C. muricata Gerke et Lev, 1985									
Family Eucytheridae Puri, 1954									
Pyrocytheridea munda Gerke et Lev, 1985									
P. pergraphica Liibimova, 1955									
P. pura Gerke et Lev, 1985									
Family Trachyleberididae Sylvester-Bradley, 1948									
Tethysia bathonica Sheppard, 1981			bt 3	bt 3					
Oligocythereis kostytschevkaensis (Lubimova, 1955)									
Exophthalmocythere tricornis Lubimova, 1955									
E. fuhrbergensis Steghaus, 1951			km 1			kml			
E. pilosa sp. nov									
Nodophthalmocythere leucorum Depeche, 1969			l 1						
N. bicostata Depeche, 1984			l 1						
Family Paracytherideidae Puri, 1957									
Pedicythere anterodentina Whatley, 1970	cl 3-ox 1								
Family Judahellidae Sohn, 1968									
Trachycythere sp. Bate, 1969						cl			
Species not included into the system for the lack of data									
Rubracea artis Lubimova, 1955	cl 2				cl 3	ox			

10	11	12	13	14	15	16	17	18	19	20	21
											bt-cl
											bt-cl
											bt-cl
											cl 2
											bt-cl
											1
											1
											1 1
											bt-cl
							l 1				
											bt-cl
		cl 3, ox 2	ox 3	cl 2							
			cl 2		km 2	ox 3-vol 1	ox 1, km 2		ox 3		
						ox 3-vol 1					
						ox 3-vol 1					
		cl 3	ox 3								
cl 2			ox 1-3	cl 2				cl			

Appendix 2. Distribution of Ostracodes through the Studied Sections

Age	cl 1	cl 2				
Region	Kursk	Kostroma		Ryazan	Kursk	Mordovia
Section	Mikhailov-skii Mine	Yartsevo	Makar'ev-yuzhnyi	Mikhailov-tsement	Mikhailov-skii Mine	Troshkov vrag
Bed no.	4–7	2, 3	2	3, lower-most 4	8, 9	2
Cytherella oblonga Pennyakova, 1969						
C. perennis Błaszyk, 1967				6		
Pontocyprella aureola Lübimova, 1955						4
P. vescusa Lübimova, 1956						
Pontocypris arcuata Liibimova, 1955				1		
Paracypris lubrica Liibimova, 1955						
P. terraefullonica (Jones et Sherborn, 1888)						
P. stripta Liibimova, 1956						6
Patellacythere sp.						
P. nescia (Liibimova, 1955)						
P. trepti (Donze, 1962)						
Galliaecytheridea splnosa Kilenyi, 1969			4			
G. legitima (Liibimova, 1955)		1			150	1
Rubracea artis Liibimova, 1957					5	13
Balowella attendens (Liibimova, 1955)						
Palaeocytheridea baculumbajula (Mandelstam, 1949)						
Parariscus octoporalis Błaszyk, 1967	10					
Schuleridea translucida (Liibimova, 1955)			6	6		3
Praeschuleridea wartae Błaszyk, 1967	154				61	
Pleurocytheridea regularis Triebel, 1951	67				8	
P. juvenes Liibimova, 1956	5				2	
Fastigatocythere rugosa Wienholz, 1967				41		1
Fuhrbergiella archangelskii (Mandelstam, 1949)				2		3
Lophocythere scabra Triebel, 1951	75					1
L. karpinskii (Mandelstam, 1949)		2		20	18	
L. interrupta Triebel, 1951	1					
Sabacythere attalicata (Mandelstam, 1949)						
S. rubra (Mandelstam, 1949)						
S, bradiana (Jones, 1884)						1
S. zmeinkensis sp. nov.	5					
S. sp.						
Nophrecythere catephracta (Mandelstam, 1949)	5		2	50		7
N. oxfordiana (Lutze, 1960)						
N. flexicosta (Triebel, 1951)	8			20		
N. alata (Whatley, 1970)						
Infacythere dulcis (Liibimova, 1955)						
Ljubimovella sp.						
Cytheropteron spinosum Liibimova, 1955					1	4
C. pseudospinosum sp. nov.						

cl 3			ox 1				ox 2				ox 3	
Moscow	Ryazan		Kostroma		Moscow	Ryazan	Kostroma			Moscow	Kostroma	
Peski	Zmeinka	Mikhailovtsement	Yartsevo	Makar'ev-yuzhnyi	Peski	Mikhailovtsement	Samylovo	Yartsevo	Makar'ev-yuzhnyi	Peski	Yartsevo	Makar'ev-yuzhnyi
1, 2, lowermost 3	1–3	middle 4	lowermost 4	lowermost 3	uppermost 3, lowermost 4	uppermost 4, 5–7	3–7	uppermost 4	uppermost 3	uppermost 4	5–9	4–7
24	12	30										
	22	12								14		
				6			2	2	2		1	
1												
1												
			1		1				2	10		
2				1								
									1			
5												
1												
				7					4			2
57		17										
3												
9												
	83	46										
9	255	179										
35	44	50										
		62										
28	94	101										
2		2	176	18		7	41			64		
8										13		
3	1											
										2		
205	277	106				1				3		
32	5											
	2											
14												
3		2										
3												
7										1		
3				2			2					

Appendix 2. (Contd.)

Age	cl 1	cl 2				
Region	Kursk	Kostroma		Ryazan	Kursk	Mordovia
Section	Mikhailov-skii Mine	Yartsevo	Makar'ev-yuzhnyi	Mikhailov-tsement	Mikhailov-skii Mine	Troshkov vrag
Bed no.	4 7	(N, 3	2	3, lowermost 4	8, 9	(N
C. laeve sp. nov.						
Exophthalmocythere pilosa sp. nov.						
Procytherura tenuicostata Whatley, 1970						
P. sp.	2					
Vesticytherura rectodorsalis (Błaszyk, 1967)						
V scottia (Whatley, 1970)						
V. costaeirregularis (Whatley, 1970)			4			
V. paula (Liibimova, 1955)					3	
V. grandipyga sp. nov.					1	30
V. acostata sp. nov.						
Paranotacythere (Unicosta) pseudoramulosa sp. nov.				4		
P. *(U.) solei* sp. nov.						
P. (*U.*) *stauropyga* sp. nov.			10			
Oligocythereis kostytschevkaensis (Liibimova, 1955)			1			
Tethysia bathonica Sheppard, 1981						51

cl 3			ox 1				ox 2				ox 3	
Moscow	Ryazan		Kostroma		Moscow	Ryazan	Kostroma			Moscow	Kostroma	
Peski	Zmeinka	Mikhailovtsement	Yartsevo	Makar'ev-yuzhnyi	Peski	Mikhailovtsement	Samylovo	Yartsevo	Makar'ev-yuzhnyi	Peski	Yartsevo	Makar'ev-yuzhnyi
1, 2, lowermost 3	1-3	middle 4	lowermost 4	lowermost 3	uppermost 3, lowermost 4	uppermost 4, 5–7	3-7	uppermost 4	uppermost 3	uppermost 4	5-9	4-7
2		1								2		1
7												1
	3	1										
	1											
3												
1									1			
24	8	45	25	1	2	11	13	12	2	62		4
15	2		4						2	15	1	
5								4	1	2		
28	1	1	23	36			18	24	3	31	3	6
4			2	3					3		1	1
										17		
1										1	2	2