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Middle Cambrian Trilobites from Borehole Nizhny Imbak 219 (Northwestern Siberian Platform)

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Abstract—Borehole Nizhny Imbak 219 is situated in the northwestern Siberian Platform. Paleontological material comes from the clayey–limestone series at a depth of 2333.3–2314.3 m referred to the *Ovatoryctocara* and *Kounamkites* zones of the Middle Cambrian Amgan Stage and from the overlying limestone series at a depth of 2264.1–2244.0 m referred to the upper part of the *Kounamkites* Zone and an unnamed zone of the Amgan Stage and also to the *Solenopleura patula* and *Dorypyge olenekensis–Corynexochus perforatus* zones of the Middle Cambrian Mayan Stage. The questions of the traditional Lower–Middle Cambrian boundary and the role of Siberian sections in the construction of the International Chronostratigraphic Chart are considered. The trilobites collected are described.

Keywords: trilobites, biofacies, Middle Cambrian, International Chronostratigraphic Chart, Siberian Platform

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INTRODUCTION

Borehole Nizhny Imbak 219 is situated in the Turukhanskii District of the Krasnoyarsk Region in the Nizhny Imbak River Basin of the northwestern Siberian Platform within the Tynep Facies Region of the Bakhta Realm (Melnikov et al., 2013). In the zonation scheme of the Cambrian of the Siberian Platform, this area is localed in the Turukhansk–Irkutsk–Olekma Facies Region, which formed the internal (lagoon) part of a carbonate platform (*Resheniya* ..., 1983; Astashkin et al., 1991). In the Early Cambrian Botomian Age, a united platform was divided into two, the Irkutsk–Olekma Platform occupying a greater southern and eastern parts and the Turukhansk Platform in the northwest. Both platforms were divided by a narrow noncompensated Tynep Depression. This division was retained up to the terminal Amgan Age of the Middle Cambrian (Sukhov, 1997; *Stratigraphiya* ..., 2016). Borehole Nizhny Imbak 219 is located in the transitional zone between the external marginal area of the Turukhansk Carbonate Platform to Tynep Depression, which was a part of an open marine basin surrounding this carbonate platform (Fig. 1).

The borehole covers an interval of the section from the Upper Vendian to Quaternary. Paleontological material new to this region characterize Middle Cambrian deposits. According to Melnikov et al. (2013), at a depth of 2296–2396 m, there is a clayey–limestone series of interbedding marls, clayey limestones, and limestones is opened. At a depth of 2312–2362 m, there are limestones with interbeds of black coalified claystones enriched with organic matter. Limestones are gray, dark gray, from micro- to fine-grain. The rocks are sulfated to varying extent. The clayey–limestone series is overlain with conformity by the limestone series. It is open within an interval of 2196–2296 m and composed of limestones, grayish–greenish beige to gray and dark gray slightly clayey limestones, with sandstone, gravelstone, and brecciated limestone interbeds.

The clayey–limestone series is comparable in rock composition, fossil organisms, and biostratigraphic position to deposits of the Kuonamka Formation of the northern Siberian Platform and the Shumnoi Formation of the northwestern part of the platform, which were formed under conditions of an open marine basin (Sobolev et al., 2010; Melnikov et al., 2013). The new paleontological material is important not only for regional stratigraphy, but also plays a part in the resolution of the question of the position of the traditional boundary between the Lower and Middle Cambrian discussed by international geological community, i.e., the border between the second and third series and the forth and fifth stages of the Cambrian of the International Chronostratigraphic Chart (ICC, Global Scale).

COMPOSITION AND AGE OF THE FAUNA

The trilobites found in the clayey–limestone series belong to assemblages of an open marine basin (Paradoxididae–Oryctocephalidae biofacies) and trilobites from the overlying limestone series are typical for the transitional zone from the external margin of a carbonate platform to a slope of open marine basin (Dorypygidae–Anomocaridae–Proasaphiscidae biofacies) (Fig. 1).

In the upper part of the clayey–limestone series, in the interbeds of black claystones, clayey limestones, and limestones, we found abundant trilobites frequently represented by complete dorsal shields and separate elements of good preservation characteristic of the lower part of the Middle Cambrian Amgan Stage. Trilobite assemblages from 2315.1–2333.3 m of depth belong to the *Ovatoryctocara* Zone of Yudoma–Olenek Facies Region and include *Paradoxides (Acadoparadoxides)* cf. *eopinus* Solovjev, 1969, *Chondranomocare bucculentum* Lazarenko, 1965, *Ch. irbinica* Repina, 1960, *Dolichometopus perfidelis* Egorova in Egorova et Savitsky, 1969, *Corynexochus solitus* Egorova in Bognibova, 1965, *Bathynotus kueichouensis* Lu in Wang, 1964, *Oryctocephalites vicinus* (Tchernysheva, 1962), *O. incertus* Tchernysheva, 1960, *Oryctocephalops frischenfeldi* Lermontova, 1940, *Chondragraulos (Chondragraulos) granulatus* Tchernysheva, 1961, and *Amphoton longus* Tchernysheva, 1961 (fig. 2).

At 2314.5 m and 2314.3 m of depth, the trilobites *Kounamkites ? cornutus* Egorova, 1967, *Peronopsis (Peronopsis) montis* (Matthew, 1899), *Diplorrhina* aff. *recta* (Pokrovskaya et Egorova in Savitsky et al., 1972), etc. belonging to the *Kounamkites* Zone of the Amgan Stage have been recorded. The lower boundary of this zone is drawn at a depth of 2314.5 m based on the appearance in the section of the typical taxon *Kounamkites ? cornutus.* The upper boundary of the zone lacks a reliable paleontological marker and tentatively drawn in the lower part of the overlying limestone series at 2263 m of depth. Close to this level, the composition of structure trilobite assemblages changes; the taxa characteristic of the lower part of the Amgan Stage, in particular, the *Kounamkites* Zone (including *Corynexochus solitus* Egorova, *Chondranomocare irbinica* Repina, *Dolichometopus perfidelis* Egorova) disappear and members of the genera *Solenopleura* Angelin, 1854 and *Pseudanomocarina* Tchernysheva, 1956, which are widespread in the Siberian Platform in the upper part of the Amgan and the lower part the Mayan, appear (Fig. 2).

The clayey–limestone series within 2296–2314 m of depth and also the lower part of the limestone series from 2265 to 2296 m of depth were passed without taking a core. In the limestone series at a depth of 2256.8 m, the index species of the *Solenopleura patula* Zone of the Anabar–Sinsk Facies Region of the Siberian Platform

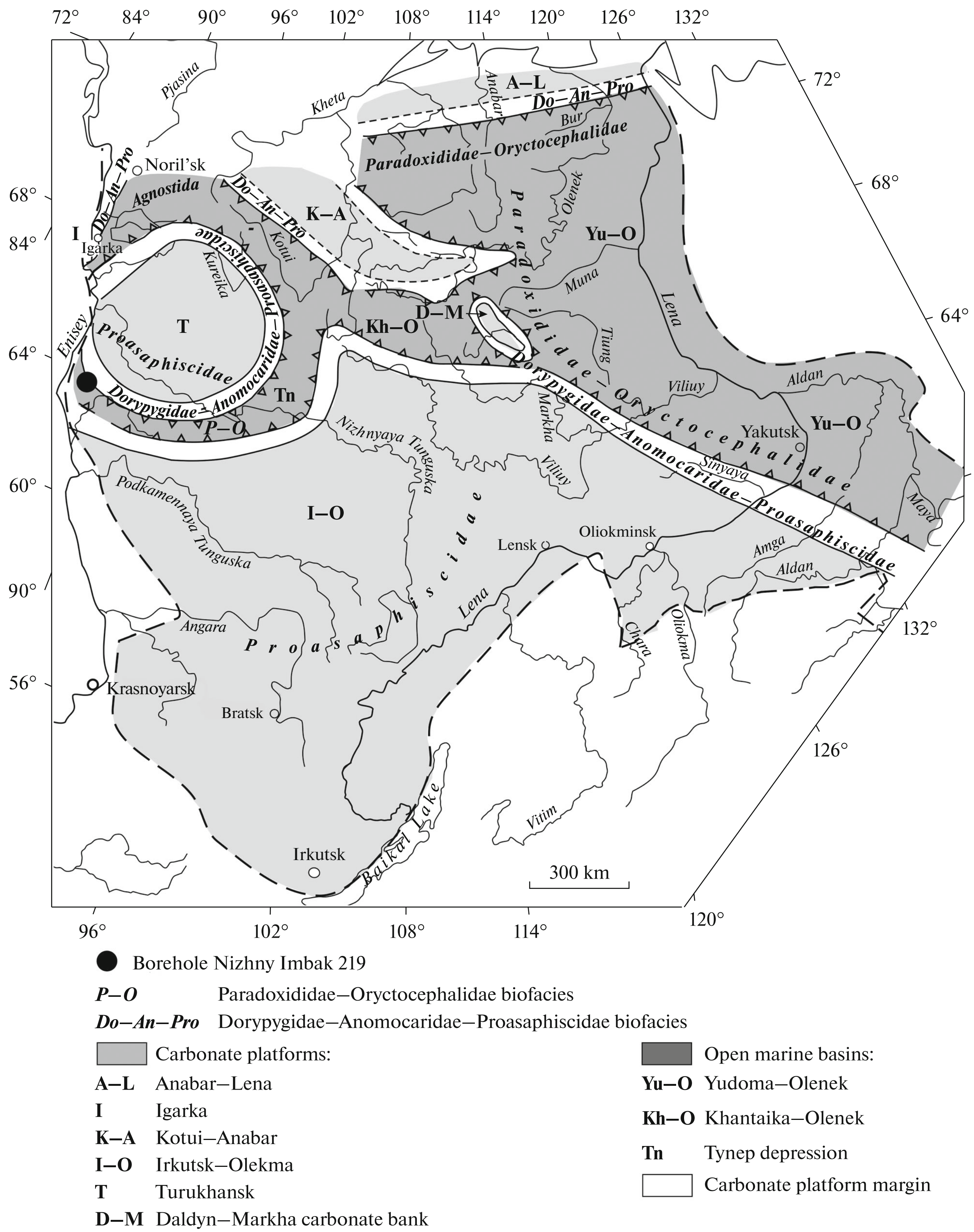


Fig. 1. Cambrian landscape zones and trilobite biofacies of the Siberian Platform; Middle Cambrian, Amgan Stage (after Pegel and Sukhov, 2013, text-fig. 1d, modified).

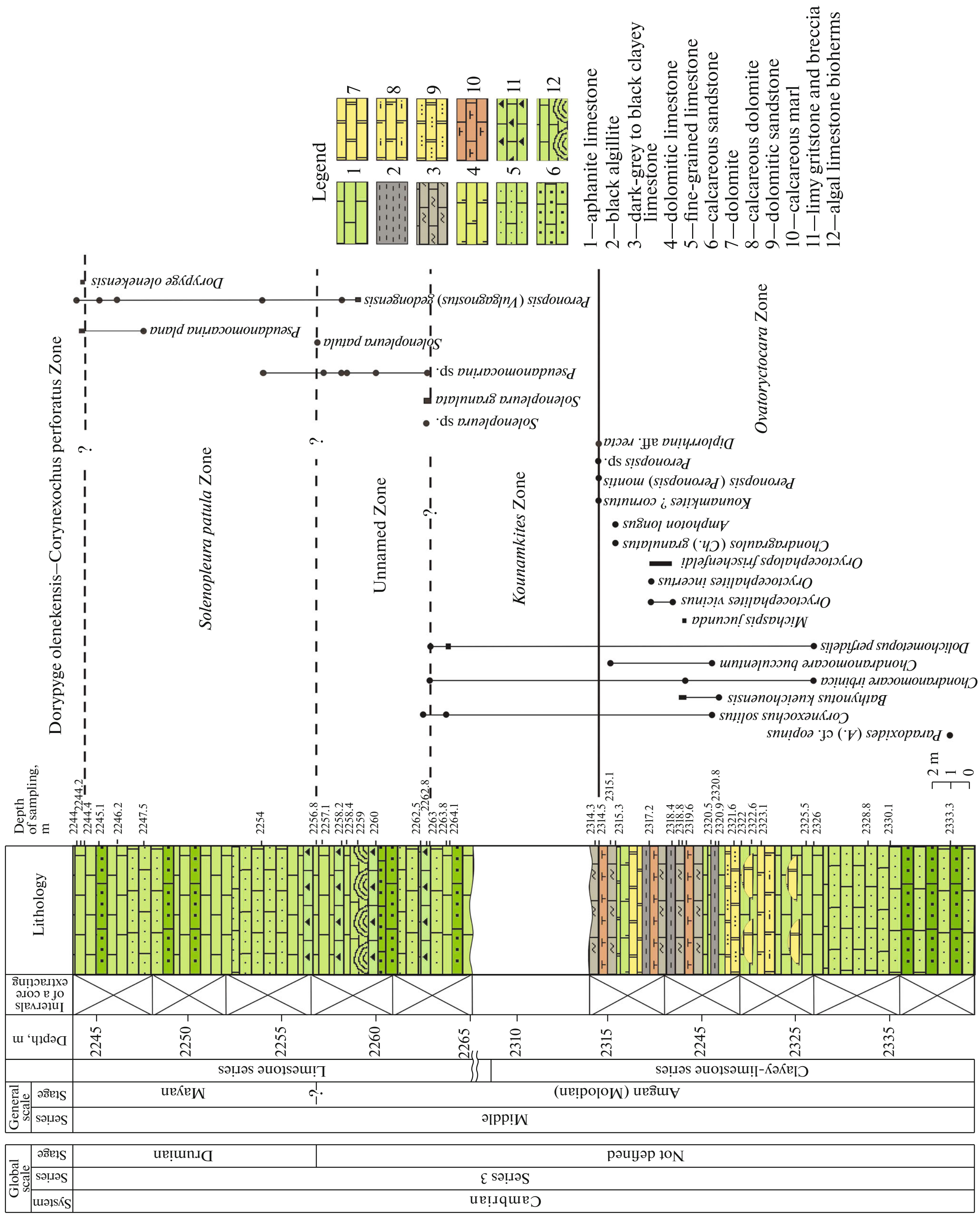


Fig. 2. Distribution of trilobites in the Middle Cambrian deposits of borehole Nizhny Imbak 219. Lithology was studied by D.A. Komlev and E.V. Bushuev.

has been recorded. This zone is contemporaneous with the *Tomagnostus fissus–Acadoparadoxides sacheri* Zone of the basal Mayan Stage of the General Stratigraphical Chart (GSC, General Scale) of Russia (*Postanovleniya* ..., 2016). The deposits underlying these strata at a depth of 2257–2263 m appreciably conditionally, can be tentatively, based only on the position in the section correlated with the upper zone of the Amgan Stage of the Anabar–Sinsk Facies Region of the Siberian Platform, which has not been named officially, and with its age analogue, the *Triplagnostus gibbus* Zone of GSC (*Resheniya* ..., 1983; *Postanovleniya* ..., 2016).

At a depth of 2244.23–2244.42 m, *Dorypyge olenekensis* Lazarenko in Krys'kov et al., 1960, an index species of the zone of the Mayan Stage of the Anabar–Sinsk Facies Region, has been found; this determines the age of enclosing and directly overlying deposits. The boundary of the *Solenopleura patula* and *Dorypyge olenekensis–Corynexochus perforatus* zones (*Resheniya ...,* 1983) is tentatively drawn at the level of the first find in this section of the species *Dorypyge olenekensis.*

PROBLEM OF THE LOWER–MIDDLE CAMBRIAN BOUNDARY

The Cambrian is the only system which does not have a completely developed International Chronostratigraphic Chart (ICC, Global Scale). The officially approved stages are only the lower one (Fortunian) at the base of the Cambrian, two upper stages (Drumian and Guzhangian) of the traditional Middle Cambrian, and two lower stages (Paibian and Jiangshanian) of the upper series of the Cambrian. During years of time, the question of the stratigraphic level corresponding to the boundary of the second and third series (traditionally, the boundary of the Lower and Middle Cambrian), the lower stage of the traditional Middle Cambrian, and its stratotype have been hotly debating.

The Siberian Platform is one of a few regions of the world with such a wide distribution of Cambrian deposits rich in fossils. Naturally, stratigraphical and paleontological materials from this region are of great interest and used for the development of a new ICC. The key role in elaboration of stratigraphical scales belongs to biostratigraphy, involving nonbiological methods of investigation. The index paleontological taxa are chosen as the most widespread genera and species. These are members of communities of open marine basins.

Ecological diversity and the character of paleobiogeographical relationships prevent even the use of the so-called cosmopolite taxa for subdivision and correlation of deposits in many countries. In the majority of countries (including Russia), specific Cambrian stratigraphical scales with use of paleontological taxa most widely distributed in their territories have been developed. The criteria for the establishment of boundaries of particular units of the scale are connected with regional features and, consequently, show wide diversity of both the chosen zonal taxa and positions of boundaries of the stratigraphical units in different countries.

In particular, it was proposed that a criterion for drawing the upper boundary of the Lower Cambrian in North America is the level of extinction of members of the trilobite family Olenellidae; in many countries of Eastern and Western Europe, the first appearance of the family Paradoxididae (in particular, the genus *Paradoxides* Brongniart, 1822); in China, extinction of members of the family Redlichiidae, the genus *Bathynotus* Hall, 1860 and appearance of the trilobite *Oryctocephalus indicus* (Reed, 1910); in Russia, the first appearance of the trilobite family Oryctocephalidae, i.e., the species *Cheiruroides arcticus* Tchernysheva, 1962 and genus *Ovatoryctocara* Tchernysheva, 1962; etc. It is noteworthy that the Olenellidae have not been recorded in China, the Redlichiidae are absent in North America and Europe, the Paradoxididae have not been recorded in China and, in North America, they only occur in the extreme northeast. In the Cambrian of the Siberian Platform, members of all of these families and genera have been recorded, although their stratigraphic ranges not always correspond to that of other countries. In Siberia, the stratigraphic range of members of Olenellidae is shorter than in North America, from the beginning of the Atdabanian Age to the beginning of the Botomian. The ranges of genera of the family Redlichiidae are also limited in this region, with the latest members recorded in the Toyonian Stage. The genus *Ovatoryctocara* appeared in Siberia after the disappearance of Redlichiidae, while in China, they coexisted. The type genus of the family Paradoxididae (*Paradoxides*) appeared in Siberia simultaneously with the first *Ovatoryctocara,* which enables us to compare the levels of the Lower–Middle Cambrian boundary accepted in Siberia and Europe.

Of all variants proposed, the International Working Group on the Lower–Middle Cambrian boundary at the International Subcommission on Cambrian Stratigraphy (ISCS) specially distinguished two stratigraphic levels.

Chinese experts and their followers suggest to draw this boundary at the level of the first appearance datum (FAD) of the trilobite species *Oryctocephalus indicus* (Reed, 1910) (Zhao et al., 2004, 2005, 2007, etc.). Additional criterion for this boundary is the end of the development of members of the family Redlichiidae and the genus *Bathynotus* Hall, 1860 (Peng et al., 2009). The Wuliu section of the Kaili Formation near the village of Balang in Guizhou Province of southern China is proposed to regard as the stratotype boundary (Zhao et al., 2005).

Another variant of the determination of the Lower–Middle Cambrian boundary is based on the level of the FAD of the trilobite *Ovatoryctocara granulata* (Tchernysheva, 1962) (Fletcher, 2003; Geyer, 2005; etc.). Russian experts adhere to this point of view, which corresponds to the position of this boundary in GSC (General Scale) to Russia. The section of the Kuonamka Formation on the Molodo River on the southeast slope of the Olenek Uplift of the Siberian Platform is proposed to regard as the stratotype of this boundary (Shabanov et al., 2008). As a result of the vote with a slight advantage, members of the International Working Group on the boundary between the Lower and Middle Cambrian, recommended the use of the stratigraphic level determined by the FAD of *Oryctocephalus indicus* as the boundary between Series 2 and 3 and Stages 4 and 5, which has not yet been officially recognized.

In the Russian literature, some published specimens of *Oryctocephalus reticulatus* (Lermontova, 1940) show close similarity to *O. indicus;* therefore, some specialists (e.g., Korovnikov, 2001; Zhao et al., 2006; Esteve et al., 2016) hypothesized that the species *Oryctocephalus reticulatus* is a junior synonym of *Oryctocephalus indicus*. However, further investigation of members of this species from China, North America, and Siberia has shown that these are separate taxa (Sundberg et al., 2011). At the same time, some specimens of *reticulatus* figured by Tchernysheva (1962, pl. 2, fig. 2 and 6), Korovnikov and Shabanov (2008, pl. 10, figs. 1, 2, 4) and Shabanov et al. (2008, pl. 11, figs. 1, 2, 4; Shabanov et al., 2008) probably actually belong to *indicus* (Sundberg et al., 2016).

Oryctocephalus reticulatus appeared for the first time in the Siberian Platform at the base of the second zone of the Middle Cambrian Amgan Stage (*Kounamkites* Zone) (Shabanov et al., 2008). The genus *Bathynotus,* the disappearance of which in Chinese sections is considered to be connected with an important stratigraphic level of the series boundary rank, accomplishes its development in Siberia at the *Kounamkites* Zone and its analogues (Lazarenko, 1958; Savitsky et al., 1964). Possibly, the position of the Lower–Middle Cambrian boundary proposed by the Chinese colleagues corresponds to a certain level within the *Kounamkites* Zone. Thus, the considered levels of global correlation (the first appearances of *Oryctocephalus indicus* and *Ovatoryctocara granulata*) are separated in the Russian Chronostratigraphic Chart by an interval of the *Ovatoryctocara* Zone.

Taking a particular paleontological taxon as a tool of global correlation, it is usually believed that this taxon is widespread in paleobasins. However, there are certain additional important criteria. In our opinion, the proposed Lower–Middle Cambrian boundary at the level corresponding to the base of the *Ovatoryctocara* Zone of the Russian Scale marks significant transformations in the development of the organic world. At the end of the Early Cambrian (stratigraphically close to the boundary proposed by us), the major group of reef-building Archaeocyatha became extinct. At this boundary, protolenid trilobites disappeared, while they had been widespread in the Lower Cambrian Botomian and Toyonian stages of Siberia, being characteristic members of Early Cambrian communities in the West European, North American, and North African sections. The level proposed is marked by the appearance and further development of agnostids, a group widespread in open marine basins, the use of which provides a basis for the establishment of already accepted divisions of the upper part of the Cambrian of ICC.

At the same time, the Siberian Platform displays a certain continuity in the development of taxa of the most abundant and diverse Cambrian group of organisms, the trilobites, within the transitional stratigraphical interval from the Lower to Middle Cambrian. The first representatives of the typical Middle Cambrian families Oryctocephalidae (*Cheiruroides* Kobayashi, 1935) and Paradoxididae (*Anabaraspis* Lermontova, 1951) appeared later than the last protolenids and earlier than *Ovatoryctocara granulata* and continued to exist at the beginning of the Middle Cambrian. The type genus of Paradoxididae (*Paradoxides* Brongniart, 1822) appeared simultaneously with *Ovatoryctocara granulata*.

An important feature of the Siberian section on the Molodo River distinguishing it from all other sections considered by the International Working Group of the International Subcommission on Cambrian Stratigraphy is an opportunity of wider correlation due to the development in it of members of the families of different paleogeographical realms (Paradoxididae, Oryctocephalidae, Protolenidae, Agnostidae). This enables correlation at the boundary level of the beds of Cambrian paleocontinents of Siberia, Laurentia, Avalonia, and Gondwana. The main claim to the Molodo River section of members of the International Working Group is the geographical remoteness from the places of civilization and condensation of deposits in the Kuonamka Formation. The newly proposed **Molodian** Stage in this section is about 40 m thick (Shabanov et al., 2008). The lower boundary of the stage coincides with the base of the *Ovatorycrocara* Zone and Amgan Stage of GSC; the upper boundary is located at the base of the *Tomagnostus fissus–Paradoxides sacheri* Zone contemporaneous to the Mayan Stage of the GSC and probably corresponds to the level of the global correlation accepted for the lower boundary of the Drumian Stage of ICC.

In the clayey–limestone series open by borehole Nizhny Imbak 219, *Bathynotus kueichouensis* Lu in Wang, occurring in the Chinese sections below the level of *Oryctocephalus indicus* (Reed) FAD, is recorded for the first time in Siberia (Goryaeva et al., 2012). This level is connected in China with the boundary drawn between the traditional Lower and Middle Cambrian. The find of this species in borehole

Nizhny Imbak 219 4.3 m below the *Kounamkites* Zone confirms the point of view of possible correlation of the Lower–Middle Cambrian boundary traditionally accepted in China with a certain level in the *Kounamkites* Zone of the Middle Cambrian Amgan Stage of the Russian Scale. *Paradoxides,* which marks the Middle Cambrian in Europe, eastern North American, and Siberia, recorded stratigraphically lower in the borehole under consideration is evidence that the range of *B. kueichouensis* is compared with the deposits assigned in these regions to the Middle Cambrian.

CONCLUSIONS

From the point of view of Russian researchers, the level of global correlation determined by FAD of *Ovatoryctocara granulata* and corresponding to the traditional lower boundary of the Middle Cambrian of the Russian Scale has high correlation potentialities and can be used as the boundary between the second and third series of the Cambrian of ICC. Close to this boundary, essential changes in the development of the organic world occurred, i.e., extinction of Archaeocyatha and protolenid trilobites, appearance of the first oryctocephalids, paradoxidids, and agnostids, as observed in the Siberian Platform and, to some extent, in the Cambrian beds of different regions of the world.

Another level determined by FAD of *Oryctocephalus indicus* and also regarded by many experts as a potential boundary of Series 2 and 3 (Stages 4 and 5) of the Cambrian System is stratigraphically closest to the upper boundary of the *Ovatoryctocara* Zone (=base of the *Kounamkites* Zone) of the Amgan Stage on the Russian Scale. This conclusion is supported by the finds of Oryctocephalidae in the section of the Kuonamka Formation on the Molodo River in the Siberian Platform (Shabanov et al., 2008; Sundberg, 2011). An additional confirmation of this statement is *Bathynotus kueichouensis* recorded in the beds below the *Kounamkites* Zone of the Amgan Stage in borehole Nizhny Imbak 219 in the northwestern Siberian Platform. This species occurs under the *Oryctocephalus indicus* Zone in the sections of China (Peng et al., 2009).

SYSTEMATIC PALEONTOLOGY

Below the trilobites coming from borehole Nizhny Imbak 219 are described.

In the description, we use the terminology and alphabetic indices following *Treatise* ... (1997). The measurements of elements of the dorsal shield performed along the longitudinal axis, are designated by the abbreviation *sag.* in parentheses (from sagittal section, perpendicular to the transverse section); *exsag.* designates the measurements parallel to the sagittal section, but taken outside it; and *tr.* (from the Latin transversum) designates the measurements perpendicular to the sagittal section. (M) designates in Agnostina transverse elements of the glabella (numbered from the posterior to anterior end of the glabella) or axes of the pygidium (numbered from the anterior to posterior margin of the shield); (F) in Agnostina, designates the lateral furrows of the glabella (numbered from the posterior to anterior end of the glabella) or furrows of the pygidium separating the segments and lobes (numbered from the anterior to posterior margin of the shield); (L) in polymeric trilobites, the glabellar lobe or transverse element (numbered from the posterior to anterior end); (S) in polymeric trilobites, glabellar furrows: occipital furrow (S0) or lateral furrows of the glabella, numbered from the posterior to anterior end.

The photographs were taken by P.V. Fomin in the Department of Stratigraphy and Paleontology of the Siberian Research Institute of Geology, Geophysics, and Mineral Resources, Novosibirsk (SNIIGGiMS).

The trilobites under study are stored in the Central Siberian Geological Museum, Novosibirsk (TsSGM); collection no. 2078.

Borehole Nizhny Imbak 219 is situated in the Nizhny Imbak River Basin of the Krasnoyarsk Region, in the northwestern Siberian Platform, 88°30'26" E and 63°35′49″ N.

Order Agnostida

Family Peronopsidae Westergård, 1936

Genus *Peronopsis* Hawle et Corda, 1847

R e m a r k s. Naimark (2012) revised the genus *Peronopsis,* established 16 morphological species groups (genera and subgenera) in its composition, and essentially improved the taxonomy of the family Peronopsidae. Species of the genus *Peronopsis* are grouped in four subgenera. In the present study, we follow the concept of this author.

Subgenus *Peronopsis* Hawle et Corda, 1847

Peronopsis (Peronopsis) montis (Matthew, 1899)

Plate 1, figs. 1 and 2

Agnostus montis: Matthew, 1899, p. 43, pl. 1, fig. 6.

Peronopsis montis: Kobayashi, 1939, p. 115.

Peronopsis montis: Rasetti, 1951, p. 134, pl. 25, figs. 11–14.

Peronopsis aff. *integra:* Egorova et al., 1976, p. 66, pl. 44, figs. 22 and 23

Peronopsis crassa: Savitsky et al., 1972, p. 64, pl. 7, figs. 11 and 12; Egorova et al., 1976, p. 67, pl. 48, fig. 8, pl. 50, figs. 13 and 17; Korovnikov and Shabanov, 2008, p. 78, pl. 6, figs. 5, 7, and 8, pl. 8, fig. 7.

Peronopsis fallax: Savitsky et al., 1972, p. 62, pl. 6, fig. 6; Egorova et al., 1976, p. 64, pl. 28, figs. 2 and 3; Ogienko and Garina, 2001, p. 97, pl. 2, figs. 9 and 11.

T y p e s p e c i m e n s. The holotype is stored in the Royal Ontario Museum; the plesiotype is in the United States National Museum, no. 116215-6 [Rasetti, 1951]. Canadian Rocky Mountains; Middle Cambrian, *Bathyuriscus–Elrathina* Zone.

D e s c r i p t i o n. The cephalon is 1.5 mm long, convex, rounded subsquare in outline, with somewhat straightened anterior margin opposite the glabella. The cephalon is 0.9 as long as the basal width. The glabella is 0.6 as long as the cephalon; at the base, it (without posterolateral lobes) is as wide as the anterior lobe. The anterior lobe of the glabella is slightly convex, rounded subsquare. It is about half as long as the posterior lobe. The posterior lobe narrows slightly anteriorly, with an inflated posterior end, from which the glabellar surface lowers gently anteriorly. On the posterior lobe, lateral furrows F1 and F2 are weakly developed at the dorsal furrows. F3 is deep and straight. In the posterior part of M2, there is an axial node. In M1, the posterior margin is widely rounded. The basal lobes are small, convex. The dorsal furrows are wide, deep, weakly converging, slightly wavy on each side, shallow at the anterior lobe. The pleural field of the acrolobe is wide, convex, abruptly lowering on each side, and, anterior to the glabella, more gently sloping to the marginal furrow. At the base of the cephalon, the pleural field is as wide as the glabella without basal lobes, that is, 1.4 as wide as the field opposite the glabella (sag.). The marginal furrow is narrow and shallow at the posterolateral corners of the cephalon, becoming deeper and wider anteriorly. The border is ridgelike, moderately wide in the anterior part (sag.) and strongly narrowed at the posterolateral corners of the cephalon. Opposite the glabella, the border width is 0.1 of the cephalon length. The posterior furrow is deep; the posterior border has a posterolateral spine. The cephalon surface is fine-grained.

The pygidium (1.75 mm long) is subsquare, slightly transversely expanded, convex, with a gently rounded posterior margin. The pygidium is about 0.9 as long as its maximum width. The axis is wide, very weakly posteriorly expanded, strongly convex, with a rounded pointed posterior end. The maximum width of the axis is about half that of the pygidium and approximately four times wider than the pleura at the anterior margin of the shield. The anterior lobe and anterior part of the posterior lobe are incompletely preserved. At the dorsal furrow, there are two pairs of very weak furrows. The pleurae are moderately convex, relatively narrow in anterior part, narrowing posteriorly, and fused posterior to the axis. The marginal furrow is deep and moderately wide, expands at the posterolateral corners of the pygidium. The border is convex, considerably expands from the anterior to posterior margin of the shield. The greatest width of the border at the posterolateral corners of the pygidium is 0.7 as wide as the pleura at the anterior margin of the shield. The border edge lacks distinct spines. The surface is fine-grained.

C o m p a r i s o n a n d r e m a r k s. The specimens described show the same structural characters as the forms referred in Russian studies to *Peronopsis crassa* (see synonymy). An exception is provided by the holotype of this species, which was briefly described and poorly figured by Lermontova (1940). As a result of revision of the genus *Peronopsis* and examination of the holotype of *P. crassa*, Naimark (2012) concluded that this holotype should be transferred to the genus *Ammagnostus*. Other specimens of *P. crassa* described from the lower part of the Middle Cambrian of the Siberian Platform should be assigned to *Peronopsis montis*. The last species was originally described from the Stephen Formation of British Columbia, Canada (Matthew, 1899; Rasetti, 1951), the *Ptychagnostus praecurrens* Zone, which is correlated with the *Paradoxides pinus* Zone of the Middle Cambrian of Sweden and from the base of the *Ptychagnostus gibbus* Zone (Robison, 1976, 1982). *Peronopsis montis* combines the following characteristics, which are also observed in specimens from our collection: the presence on the pygidium of a very short undivided postaxial space in the case that the axis terminates short of reaching the border; the axis is very wide, inflated, with weak F1; the pleurae are narrow, the border has thickened corners; the cephalon has a narrow border; the anterior glabellar lobe is large, oval; the lateral furrows of the glabella are poorly pronounced; and the basal lobes are small.

O c c u r r e n c e. Middle Cambrian, *Ptychagnostus praecurrens* and *Ptychagnostus gibbus* zones, North America; *Ovatoryctocara, Kounamkites, Pseudanomocarina* zones, Siberian Platform.

L o c a l i t y and material. Clayey–limestone series, 2314.5 m of depth. Amgan Stage, basal *Kounamkites* Zone. One cephalon and three pygidia.

Subgenus *Vulgagnostus* Naimark, 2012

***Peronopsis (Vulgagnostus) gedongensis* Huang and Yuan, 1994**

Plate 1, figs. 5–15

Agnostus fallax: Tullberg, 1880, pl. 2, fig. 22.

Peronopsis fallax: Westergård, 1936, pl. 1, figs. 9, 12–15; Egorova et al., 1976, p. 64, pl. 34, fig. 6.

Peronopsis gedongensis: Huang and Yuan, 1994, pl. 1, figs. 12 and 16.

Peronopsis taijiangensis: Yuan et al., 2002, pl. 1, fig. 8.

H o l o t y p e. GTB-17-4-165, Balang, southeastern Guizhou (China), middle part of the Kaili Formation (Huang and Yuan, 1994, pl. 1, fig. 12).

D e s c r i p t i o n. The cephala are 1.3–3.0 mm long, oval subsquare in outline, convex. At the base, the cephalon width is 0.9–1.0 of its length. The glabella slightly narrows toward the rounded anterior end. Anterior to the basal lobes, the glabella is 1.1 as wide as anterior lobe. The glabella occupies 0.6 of the cephalon length. The anterior lobe is slightly convex, extended somewhat transversely (length-to-width ratio is 0.66). The posterior lobe is most convex at the posterior end, has an axial node. The anterior lobe is half as long as the posterior lobe. F1 and F2 are very poorly developed near the dorsal furrows. F3 is distinct, straight or slightly posteriorly curved. The basal lobes are triangular, relatively small, slightly convex. The dorsal furrows are moderately deep and wide,

Plate 1

slightly converging, becoming shallower anterior to the glabella. The pleural field of the acrolobe regularly lowers on all sides of the glabella. At the posterior margin of the cephalon, the pleural field is 1.0–1.4 as wide as anterior to the glabella (sag.). The marginal furrow is narrow, shallow on the lateral sides, expanding somewhat anteriorly. The border is slightly convex, narrow on the lateral sides, and expanded anteriorly, reaching 0.1 of the cephalon length. The cephalon surface is fine-tuberculate.

The pygidia are 1.3–3.0 mm long, convex, subsquare in outline, with the posteriorly diverging sides and gently rounded and straightened in the middle posterior margin. The pygidium length is equal to its width at the anterior margin. The axis is large, strongly convex, subcylindrical, with a pointed posterior end, slightly narrows at the M2 level, and reaches or closely approaches the marginal furrow. F1 and F2 are hardly discernible at the dorsal furrows. M2 has a flat axial node. The axis is 0.77 as long as and 0.5 as wide as the pygidium. The dorsal furrows are narrow and sharp. The pleurae are narrow, convex, but to a lesser extent than the axis, sharply narrowed at the posterior end of the axis, sometimes completely disappear. At the anterior margin, they are 0.15 as wide as the pygidium and 0.3 as wide as the axis. The marginal furrow strongly expands from the anterior to posterior margin, particularly at the posterolateral corners at the level of the posterior end of the axis. The border is flat, expands from the anterior to posterior margin of the shield, has relatively small spines at the posterolateral corners of the pygidium. At the posterior margin, the width of border (sag.) is 0.15 of the pygidium length. The surface is fine-tuberculate.

C o m p a r i s o n a n d r e m a r k s. The cephala and pygidia described belong to members of *Peronopsis,* which are usually referred in Russian studies to one of the most widespread species of this genus, *Peronopsis fallax* (Linnarsson, 1869). Based on the literature on *P. fallax,* Naimark (2012) concluded that the specimens described from the lower part of the Middle Cambrian of Scandinavia and Siberia, in contrast to specimens of this species from younger beds, have a narrow marginal furrow of the cephalon, a smaller postaxial space, and more straightened site of the border of the pygidium between marginal spines, as typical for the species *Peronopsis gedongensis* Huang et Yuan, 1994. Naimark proposed that specimens of *P. fallax* described from the beds correlated in age with the Mayan Stage of Siberia probably belong to different species of the genera *Baltagnostus* Lochman in Lochman and Duncan, 1944, *Acadagnostus* Kobayashi, 1939, and *Pseudoperonopsis* Harrington, 1938. All of them usually have a wide marginal furrow of the cephalon. Following Robison (1995), Naimark concluded that the species *Peronopsis fallax* is a junior synonym of the type species of *Acadagnostus, A. acadicus* (Hartt in Dawson, 1868).

The main characteristics of the forms described above are the narrow marginal furrow of the cephalon; wide and long, subcylindrical axis of the pygidium reaching or closely approaching a wide marginal furrow; the pleurae separated by a rounded pointed end of the axis or forming a threadlike postaxial space; the flat border of the pygidium, with very small spines; and the posterior pygidial margin straightened in the middle. Based on these characters, the forms described should be referred to the species *Peronopsis (Vulgagnostus) gedongensis.* A minor difference is possible presence of a very narrow postaxial space on the pygidium in some specimens from our collection.

O c c u r r e n c e. Middle Cambrian. Scandinavia, *Paradoxides oelandicus* Zone; China, *Oryctocephalus indicus* Zone; Siberia, Amgan Stage and basal Mayan Stage.

L o c a l i t y. Limestone series, 2258.9–2259.2 m of depth (two pygidia), 2258.2 m (five cephala, one pygidium); Amgan Stage, unnamed zone; 2254 m of depth (one cephalon, two pygidia), 2246.2 m of depth (one pygidium), 2245.15 m of depth (one pygidium); Mayan Stage, *Solenopleura patula* Zone. Limestone series, 2244 m of depth (two cephala); Mayan Stage, *Dorypyge olenekensis–Corynexochus perforatus* Zone.

E x p l a n a t i o n o f P l a t e 1

Figs. 1 and 2. *Peronopsis (Peronopsis) montis* (Matthew, 1899): (1) specimen TsSGM, no. 35/2078, cephalon, ×26; (2) specimen TsSGM, no. 43/2078, pygidium, ×23; clayey–limestone series, depth of 2314.5 m, Amgan Stage, basal *Kounamkites* Zone.

Fig. 3. *Diplorrhina* aff. *recta* (Pokrovskaya et Egorova in Savitsky et al., 1972), TsSGM, specimen no. 42/2078, pygidium, ×19; the same locality.

Fig. 4. *Peronopsis* sp., specimen TsSGM, no. 41/2078, ×35, pygidium; the same locality.

Figs. 5–15. *Peronopsis (Vulgagnostus) gedongensis* Huang and Yuan, 1994: (5–7, 10, 13) cephala, limestone series: (5) specimen TsSGM, no. 45/2078, ×21.5, depth of 2258.2 m, Amgan Stage, unnamed zone; (6) specimen TsSGM, no. 49/2078, ×15.5, the same locality; (7) specimen TsSGM, no. 1/2078, ×26.5, the same locality; (10) specimen TsSGM, no. 67/2078, ×21, depth of 2254 m, Mayan Stage, *Solenopleura patula* Zone; (13) specimen TsSGM, no. 37/2078, ×15, depth of 2244.05 m, Mayan Stage, *Dorypyge olenekensis–Corynexochus perforatus* Zone; (8, 9, 11, 12, 14, 15) pygidia, limestone series: (8) specimen TsSGM, no. 14/2078, ×13, depth of 2259 m, Amgan Stage, unnamed zone; (9) specimen TsSGM, no. 38/2078, ×12.5, depth of 2258.2 m, Amgan Stage, unnamed zone; (11) specimen TsSGM, no. 20/2078, ×19, depth of 2254 m, Mayan Stage, *Solenopleura patula* Zone; (12) specimen TsSGM, no. 18/2078, ×15, the same locality; (14) specimen 36/2078, ×10, depth of 2245.15 m, Mayan Stage, *Solenopleura patula* Zone; (15) specimen 3/2078, ×7, depth of 2246.2 m, Mayan Stage, *Solenopleura patula* Zone.

***Peronopsis* sp.**

Plate 1, fig. 4

C o m p a r i s o n a n d r e m a r k s. Since the specimen from our collection is immature, so that some species characters are impossible to recognize, it is described in open nomenclature. Nevertheless, it resembles somewhat *Peronopsis (Svenax) scutalis* (Salter in Hicks, 1872). They are similar in the presence of the postaxial furrow, the narrow uniformly wide marginal furrow, and the border without spines.

L o c a l i t y a n d m a t e r i a l. Clayey–limestone series, depth of 2314.5 m. Middle Cambrian, Amgan Stage, base of the *Kouinamkites* Zone. One juvenile pygidium.

Genus *Diplorrhina* Hawle et Corda, 1847

***Diplorrhina* aff. *recta* (Pokrovskaya et Egorova in Savitsky et al., 1972)**

Plate 1, fig. 3

D e s c r i p t i o n. The pygidium is 2 mm long, semicircular in outline, convex. The pygidium length is about 0.9 of the width at the anterior margin. The axis is large, strongly convex, slightly expands toward posterior third and, then, sharply narrows to the rounded pointed posterior end. The greatest convexity of the axis is in the anterior half; the posterior lobe is inclined gently posteriorly. F1 are short, weak, inclined slightly anteriorly. F2 are distinct, transverse, not connected at the middle. F1 and F2 are pitlike at the internal ends. Lobe M2 has an axial node, the posterior end of which does not extend beyond the anterior lobe. The posterior lobe has very weak depressions delineating a lanceolate field and a weak transverse depression located close to the middle of its length. The posterior lobe is slightly shorter than the anterior lobe, 0.86 as long as the latter. At the anterior margin, the axis is 0.4 as wide as the pygidium and 1.8 as wide as the pleura. The pleurae are less convex, gently inclined in all directions from the axis, sharply narrowing toward the posterior pygidial margin, and fused posterior to the axis. The marginal furrow is narrow, deep, uniform in width throughout its extent. The border is ridgelike, narrowed at the anterolateral corners of the pygidium and retains constant width over most of its length. The edge of the border lacks spines. The border width is 0.1 of the pygidium length. The surface is fine-tuberculate at high magnification.

C o m p a r i s o n a n d r e m a r k s. A large subcylindrical axis with a rounded pointed posterior end and pitlike depressions in the internal ends of lateral furrows and on the posterior lobe is a distinctive character of the forms described in Russian studies as *Peronopsis recta* Pokrovskaya et Egorova in Savitsky et al., 1972 from the *Kounamkites* Zone of the Middle Cambrian Amgan Stage of the Siberian Platform. Naimark (2012) assigned this species to the genus *Diplorrhina* Hawle et Corda, 1847. The pygidium described here differs from the type specimens of *D. recta* in the short posterior lobe of the axis and the relatively narrow and convex border without projections on the sides.

L o c a l i t y a n d m a t e r i a l. One pygidium from the clayey–limestone series, 2314.5 m of depth; Middle Cambrian, Amgan Stage, basal *Kounamkites* Zone.

Order Redlichiida

Family Bathynotidae Hupé, 1953

Genus *Bathynotus* Hall, 1860

***Bathynotus kueichouensis* Lu in Wang, 1964**

Plate 2, figs. 1–7; Plate 3, figs. 1–7; Pl. 4, figs. 1–8

Bathynotus kueichouensis: Webster, 2009, pp. 391–392 (synonymy).

H o l o t y p e. Large specimen figured by Lu (in Wang, 1964, p. 27, pl. 2, fig. 3; designated by Webster, 2009) and stored in the Nankin Institute of Geology and Paleontology of the Chinese Academy of Sciences. Upper part of the Lower Cambrian.

D e s c r i p t i o n. The dorsal shield is spindle-shaped in outline, with very wide and convex axial part and narrow flattened pleural part, with a large cephalon and small pygidium. The cranidium is 0.3 as long as the dorsal shield; the pygidium is 0.3 of the cranidium length. The cranidium is convex, with a narrow (tr.), almost straight, very slightly rounded anterior margin. The width of the anterior margin is equal to the distance between the anterior branches of facial sutures and 0.3–0.43 of the width of the posterior margin of the cranidium (=distance between the ends of the posterior branches of facial sutures). The cranidium length ranges from ~0.6 to ~0.9 of its width at the base. The glabella occupies most of the cranidium. It is convex, distinctly and uniformly tapering toward the anterior end, which is gently rounded and reaches the anterior border. The glabella is divided by three pairs of lateral furrows. S1 is most distinct and deepest, inclined posteriorly and almost fused in the middle. S2 is in the shape of wide pitlike depressions positioned perpendicular to the longitudinal axis of the glabella or inclined slightly posteriorly in cranidia with a 2.5-mm-long (or longer) glabella (Pl. 2, figs. 1, 2;

E x p l a n a t i o n o f P l a t e 2

Figs. 1–7. *Bathynotus kueichouensis* Lu in Wang, 1964: (1–5) dorsal shields: (1) specimen TsSGM, no. 63/2078, ×9.7, depth of 2318.85–2319.6 m; (2) specimen TsSGM, no. 66/2078, ×9, depth of 2320.9 m; (3) specimen TsSGM, no. 31/2078, ×10, the same locality; (4) specimen TsSGM, no. 61/2078, ×9, the same locality; (5) specimen TsSGM, no. 59/2078, ×10, the same locality; (6, 7) pygidia: (6) dorsal shield fragment, specimen TsSGM, no. 57/2078, ×16.6, depth of 2320.9 m; (7) fragment of a dorsal shield, specimen TsSGM, no. 2/2078, ×15, the same locality; clayey–limestone series, Amgan Stage, *Ovatoryctocara* Zone.

Plate 2

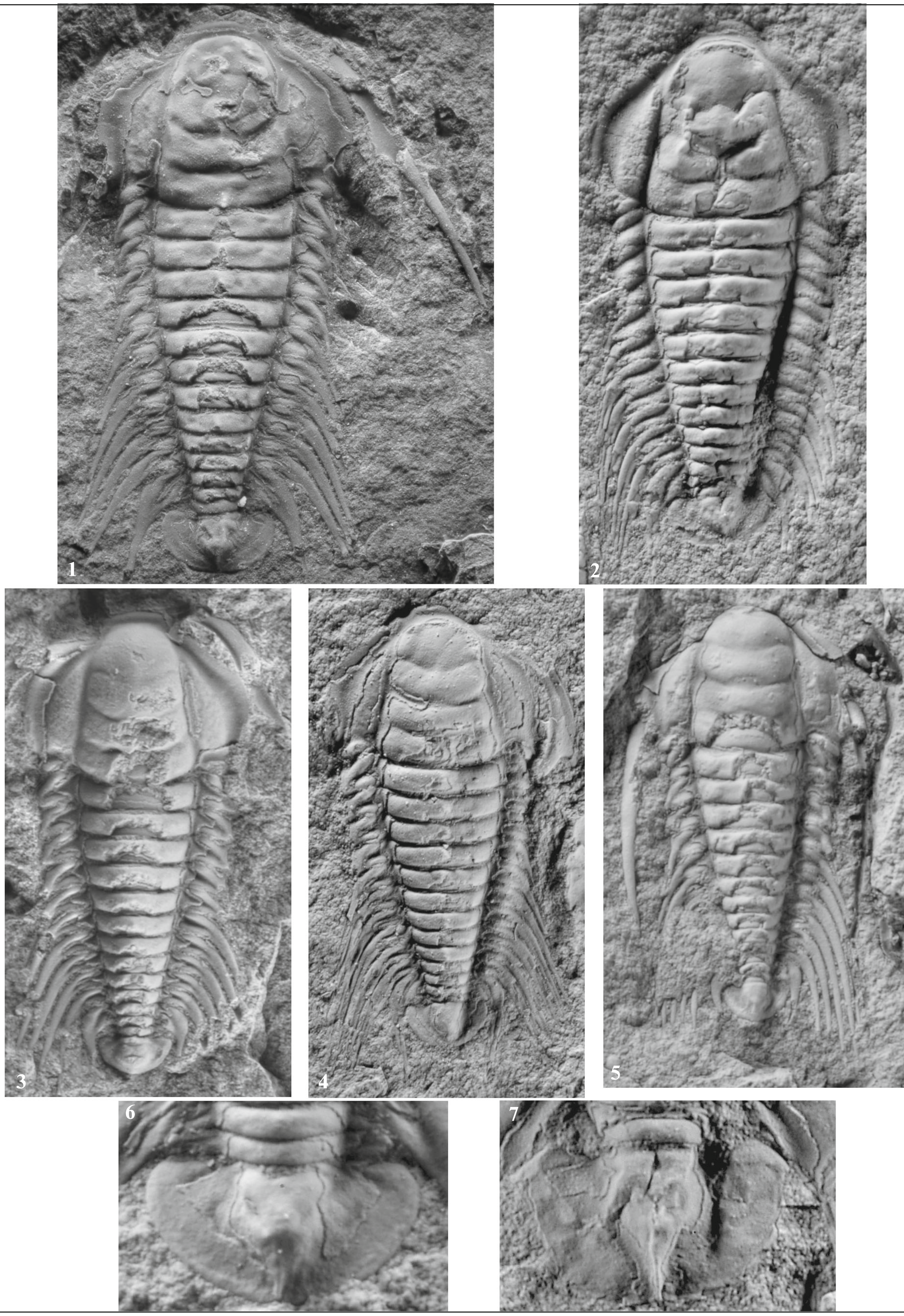
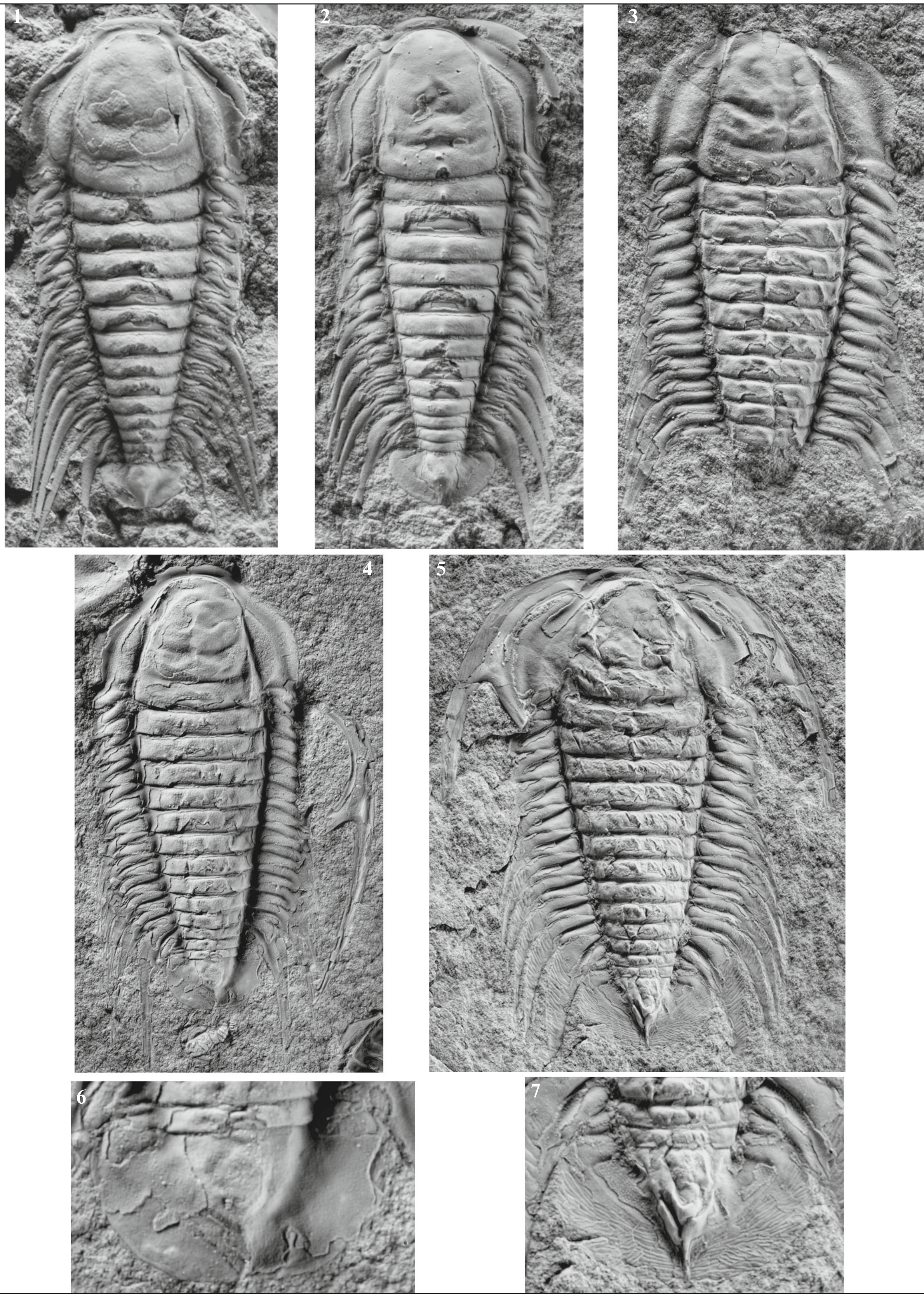


Plate 3



Pls. 3 and 4). In the cranidia with 1.8–2.3-mm-long glabella (Pl. 2, figs. 3–5), these furrows follow the outline of S1, but shallower. S3 are positioned closer to the anterior end of the glabella, short, indistinct, inclined slightly anteriorly. S0 is wide (sag.), deep, almost straight in the middle, directed slightly anteriorly on the sides, following the outline of S1. The occipital ring is approximately as convex as the glabella. At its posterior margin, there is a small medial node. The glabella (including the occipital ring) is 0.91 as long as the cranidium; that without the occipital ring is 0.7–0.85. The width of the occipital ring (tr.) is 1–1.2 of the glabellar length in specimens with a 4–11-mm-long glabella (Pl. 3, figs. 3–5; Pl. 4, figs. 1–5). In specimens with a 1.7–3.7-mm-long glabella (Pl. 2, figs. 1–5; Pl. 3, figs. 1, 2), the width of the occipital ring (tr.) is 0.95–1.16 of the glabellar length. At the base, the glabellar width is 0.83–1.0 of the glabellar length in specimens with a 4-mm-long glabella (Pl. 2, figs. 1–5; Pl. 3, figs. 1, 2). In specimens with a 4–11-mm-long glabella (Pl. 3, figs. 3–5; Pl. 4, figs. 1–5), this value is 0.97–1.1. At the S2 level, the width-to-length ratio of the glabella is 0.6–0.87. The dorsal furrows are deep and relatively wide at the base of the glabella. They become narrower and shallower towards the anterior end. On the sides of the glabella, furrows are almost straight or slightly concave. The palpebral areas are subtriangular, positioned lower than the glabella, expanded at the posterior margin of the cranidium, narrowed gradually anteriorly up to complete disappearance near the S3 level at the dorsal furrows. The width of the palpebral area opposite the posterior end of the palpebral lobe is 0.2–0.3 of the glabellar length or 0.2–0.29 of the glabellar width at the S0 level, or 0.27–0.43, at the S2 level. The postocular areas are most convex in the posterior part, which terminates close to the level of the midlength (sag.) of the occipital ring. The posterolateral projections are represented by very wide posterior marginal furrows expanding and deviating backward from the dorsal furrows. The palpebral furrows are wide, especially at the midlength, gently and sometimes nonuniformly arched. They are deepest at the posterior ends of palpebral lobes, becoming shallower toward the anterior end of the glabella. The palpebral lobes are narrow, gently archedly, sometimes with a weak angular curvature at the S1 level near the dorsal furrows. Their proximal part is directed posteriorly and laterally at an angle of 40°–60° relative to the longitudinal axis of the cranidium. Opposite the lateral margin of L2, they curve posteriorly. The distal part of palpebral lobes is positioned at an angle of 5°–10° to the longitudinal axis of the cranidium. The posterior ends of palpebral lobes closely approach the posterior marginal furrows; the anterior ends are close to the anterior marginal furrow. The palpebral lobes are 0.87–1.2 as long as the glabella. The frontal part of the cranidium is represented by a narrow (sag.), short (tr.), and slightly convex or flattened anterior border, which is separated from the glabella by a narrow anterior marginal furrow. The ratio of the distances between the anterior and posterior branches of facial sutures is 0.4. The posterior marginal furrow is very wide, becoming deeper at the occipital ring and wider and shallower externally and posteriorly. The posterior border is convex, geniculate at the level of the palpebral furrow, and then, deviates sharply posteriorly. Branches of the facial sutures are very short, subparallel anteriorly, slightly longer and diverging posteriorly.

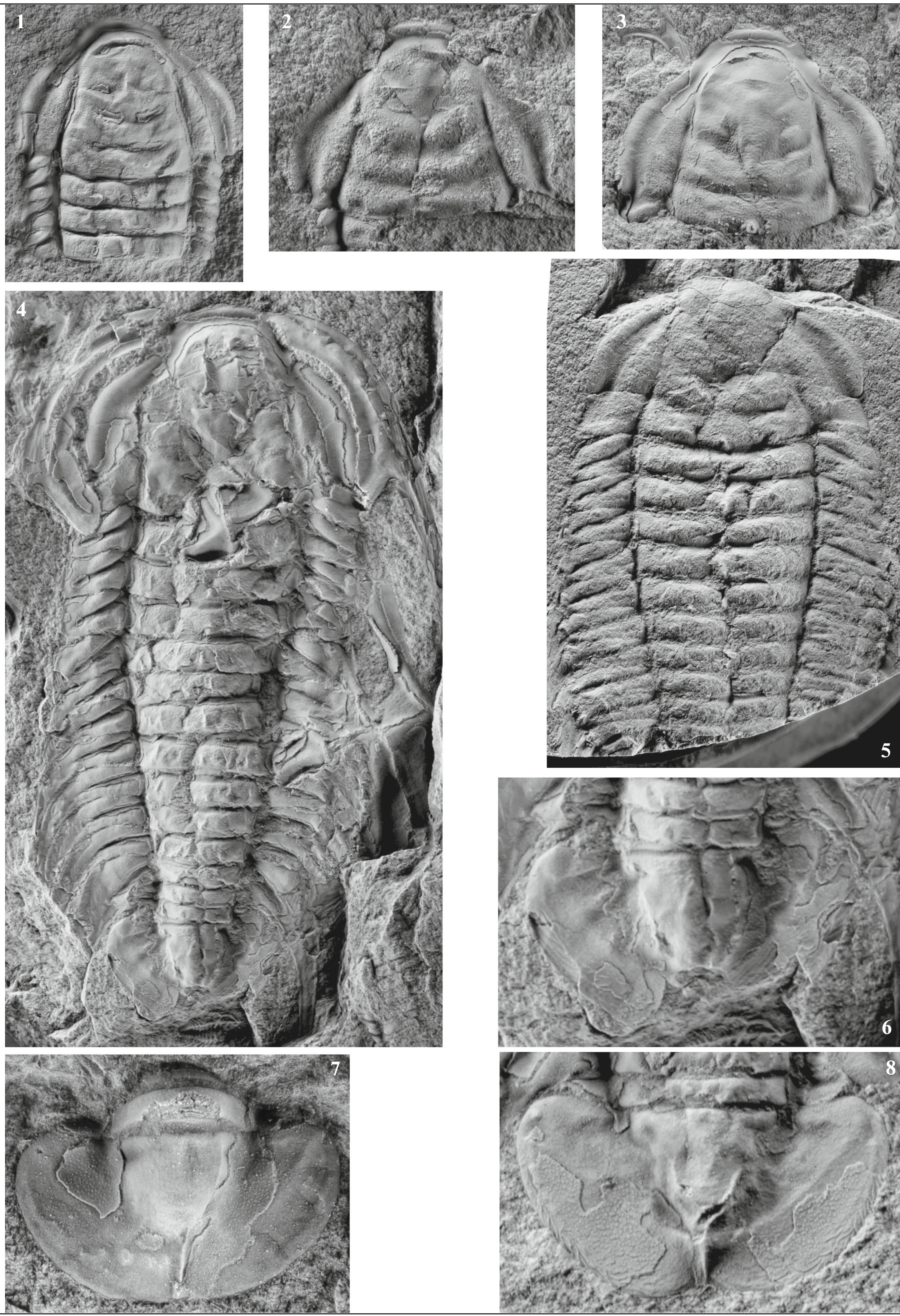
The librigena has a narrow convex librigena field and flattened lateral border of the same width. The lateral border terminates into a librigenal spine, which is directed laterally and terminates at the level of the posterior margin of the third thoracic segment (Pl. 3, fig. 5). The posterior margin of the librigena extends sharply anteriorly and laterally from the posterolateral projection of the cranidium at an angle of about 40° relative to the longitudinal axis of the cephalon. The base of the librigenal spine is positioned opposite the lateral margin of L1.

The thorax consists of 13 segments with medial nodes. The axis width (tr.) and segment length (sag.) decrease from the anterior to posterior margin (by 2.3 and 2.5 times, respectively). The axis is convex; the pleurae are narrow (tr.), flattened, almost constant in width, which is about 0.3 of the axis width. As specimens increase in size, the axial rings of the thorax decrease in relative width. The first ring of the axis is 0.6 as wide as the entire segment (tr.) in specimens with a 5.6–11-mm-long glabella (Pl. 3, figs. 4, 5; Pl. 4, figs. 3–5). In specimens with a 1.7–4.5-mm-long glabella (Pl. 2, figs, 1–5; Pl. 3, figs. 1–3; Pl. 4, fig. 1), the first axial ring is 0.59–0.7 as wide as the first segment. The tenth axial ring is 0.36–0.46 as wide as the entire segment in specimens with a 5.6–11-mm-long glabella (Pl. 3, figs. 4, 5; Pl. 4, fig. 4). In specimens with a 1.7–4.5-mm-long glabella (Pl. 2, figs. 1–5; Pl. 3, figs. 1–3), this ratio ranges from 0.43 to 0.54. In three anterior segments, the ends are short. Beginning from the fourth segment, the pleurae extend sharply laterally and posteriorly, terminating into flat spines, which

Explanation of Plate 3

Figs. 1–7. *Bathynotus kueichouensis* Lu in Wang, 1964: (1) specimen TsSGM, no. 30/2078, dorsal shield, ×8, depth of 2320.9 m; (2) specimen TsSGM, no. 58/2078, dorsal shield, ×6, depth of 2320.9 m; (3) specimen TsSGM, no. 53/2078, ×5.5, cranidium with thoracic segments, depth of 2318.85–2319.6 m; (4) specimen 50/2078, dorsal shield, ×3, depth of 2318.85–2319.6 m; (5) specimen 51/2078, dorsal shield, ×2.8, depth of 2318.85–2319.6 m; (6) pygidium (fragment of the dorsal shield shown in fig. 4), ×10.5; (7) pygidium (fragment of the dorsal shield shown in fig. 5), ×6; clayey–limestone series, Amgan Stage, *Ovatoryctocara* Zone.

Plate 4



gradually increase in length posteriorly. Spines of the eleventh segment are directed posteriorly parallel to the longitudinal axis of the shield. The twelfth and thirteenth segments are very short, lack spines.

The pygidium is transversely extended, the length-to-width ratio is 0.5–0.75; it is 0.3 as long as the cranidium and has a short, wide, convex, rounded conical axis and flat pleural field. On the sides of the anterior end of the axis, an anterior ring is at the initial stage of differentiation. The anterior pygidial margin is straight; the posterior margin is regularly rounded. In the majority of specimens, the median excavation in the posterior margin is hardly discernible or not preserved, although in some specimens, it is distinct (Pl. 2, fig. 7; Pl. 4, fig. 8). A wide, flat, and slightly concave border is observed; it is separated from the pleurae by a very weak bend of the surface. A postaxial ridge extends from the posterior end of the axis to pygidial margin. The pleurae are narrow, flat, narrowing from the anterior pygidial margin posteriorly and taper out at the posterior end of the axis. In specimens with 11-mm-long glabella, the pleurae of the pygidium are weakly divided into three segments (Pl. 4, figs. 4, 6). Anteriorly, the axis is 3.6 times as wide as the pleura. The border width is 0.4 of the pygidium length. The axis is as long as wide at the anterior end and 0.45–0.58 as wide as the pygidium at the anterior margin. The border sometimes has doublure lines passing onto long spines of segments 3–11 of the thorax.

The dorsal shield surface is fine-granulated, except for furrows. On the exfoliated parts of shield, the surface is smooth.

Comparison and remarks. Webster (2009) revised the genus *Bathynotus* and, based on the morphometric measurements of many specimens, concluded that only four of previously established species of this genus are valid: *B. holopygus* (Hall, 1859), *B. granulatus* Lermontova, 1940, *B. kueichouensis* Lu in Wang, 1964, and *B. namanensis* Lermontova, 1940. Each species is characterized by a unique set of feature, while an individual character is usually cannot be used for diagnosis. The authors of the present paper adhere to this point of view.

According to Webster (2009), *Bathynotus kueichouensis* has a considerably wider glabella (especially at the S1 and S2 levels) than *Bathynotus granulatus,* short libragenal spines in specimens of all dimensional classes (as in *B. granulatus*), and retains an excavation in the pygidium with growth (in contrast to *B. granulatus* and *B. holopygus*). It has a granulated surface (as *B. holopygus* and *B. granulatus*). *Bathynotus kueichouensis* differs from *B. holopygus* in the shorter libragenal spines and preservation of a weak excavation in posterior pygidial margin (in *B. holopygus,* it disappears in the course of ontogeny). *Bathynotus kueichouensis* differs from *B. granulatus* in the wider axis and from *B. namanensis* in the presence of granulation. An isolated cranidium of *B. holopygus* is indistinguishable from that of *B. kueichouensis.*

Peng et al. (2009, pp. 101–102) listed the following diagnostic characters of *B. kueichouensis:* wide conical glabella, the length of which is shorter than the width at the base; narrow fixigenae subtriangular on outline; curved and rounded eye ridge; short genal spines reaching only the fourth thoracic segment; wide pygidial margin; and wide (tr.) terminal axial ring subtriangular in outline. In the same paper (Peng et al., 2009, p. 102), *B. elongatus* (=*B. granulatus* after Webster, 2009) is characterized "by thin and elongated exoskeletons, long glabellae, short genal spines, which are longer in meraspid specimens approaching almost one-half of the length of the entire exoskeleton, narrow fixigena, eye ridges laterally sloping close to the axial furrow of the glabella, a terminal axial ring that is distinct, convex and longer, flat lateral lobes of the pygidium, and a pygidial margin that is not developed."

We initially adhered to the point of view of Peng et al. (2009) concerning the independence of *B. elongatus* and assigned to this species some specimens of *Bathynotus* with relative elongated glabella (glabellar width at S0 level <0.9 glabellar length) from the trilobite assemblage collected in borehole Nizhny Imbak 219 (Goryaeva et al., 2012). A more thorough examination of this collection has shown that this structure of the glabella is observed in specimens with a 1.7–4-mm-long glabella. At the same time, their thoraxes lack a well-pronounced expansion of the pleural part from the fourth to ninth segments (and, hence, a relative narrowing of the thoracic axis is absent), as observed in *B. granulatus* (=*B. elongatus*). Specimens with more than 5-mm-long glabella display all main characters of the species *Bathynotus kueichouensis.* An exception is provided by not always distinctly visible excavation in the posterior pygidial margin.

Individual variation of *B. kueichouensis* is manifested in the character of curvature of palpebral lobes, ranging from regularly and gently curved to a greater curvature at the S2 level. In accordance with this curvature, the palpebral furrow increases in width and the inclination of the proximal part of palpebral lobes in

Explanation of Plate 4

Figs. 1–8. *Bathynotus kueichouensis* Lu in Wang, 1964: (1) specimen 64/2078, cranidium articulated with thoracic segments, ×5, depth of 2320.9 m; (2) specimen TsSGM, no. 65/2078, cranidium, ×7, depth of 2318.85–2319.6 m; (3) specimen 60/2078, cranidium, ×3.5, the same locality; (4) specimen TsSGM, no. 52/2078, dorsal shield, ×3, the same locality; (5) specimen TsSGM, no. 54/2078, cranidium articulated with thoracic segments, ×2, the same locality; (6–8) pygidia: (6) fragment of the dorsal shield shown in fig. 4, ×6; (7) specimen TsSGM, no. 46/2078, ×11, depth of 2318.85–2319.6 m; (8) specimen TsSGM, no. 56/2078, ×10, the same locality; clayey–limestone series, Amgan Stage, *Ovatoryctocara* Zone.

relation to the longitudinal axis of the cranidium also increases. The depth and distinctness of the excavation in the posterior pygidial margin changes. Furrows S1 of the glabella are connected in the middle or located at a small distance from each other.

O c c u r r e n c e. Uppermost Lower Cambrian and lower part of the Middle Cambrian; China, Australia, and Siberia.

L o c a l i t y a n d m a t e r i a l. Clayey–limestone series, 2318.86–2319.6 m of depth (23 dorsal shields varying in completeness, ten cranidia, two pygidia), 2320.9 m of depth (15 dorsal shields varying in completeness). Middle Cambrian; Amgan Stage, *Ovatoryctocara* Zone.

Family Paradoxididae Hawle et Corda, 1847

Genus *Paradoxides* Brongniart, 1822

Subgenus *Paradoxides (Acadoparadoxides)* Šnajdr, 1957

***Paradoxides (Acadoparadoxides)* cf. *eopinus* Solovjev, 1969**

Plate 5, fig. 1

D e s c r i p t i o n. The cranidium is about 15 mm long, flattened, about 0.8 as long as the width at the level of the midlength of palpebral lobes; at the level of the anterior margin, the cranidial width is equal to the width at the level of the midlength of palpebral lobes. The glabella is flattened, with a convex frontal lobe, which comes in contact with the anterior border over a short segment without narrowing it. The glabella is divided by three pairs of furrows not connected in the middle. The glabella is about 0.8 as long as the cranidium. The glabellar width at the base is 0.6 of its width at the S3 level. S0 is straight; the occipital ring is extended posteriorly in the middle. Dorsal furrows are shallow, slightly concave. The preglabellar furrow is hardly discernible, marked by a bend of the surface. The palpebral areas are flat, horizontal. At the level of the midlength of palpebral lobes, they are 0.4 as wide as the glabella at this level and at the level of the posterior end of the glabella. Palpebral lobes are curved, slightly convex; their posterior ends reach the S0 level. The palpebral lobes are about 0.4 of the glabellar length and half width of the palpebral areas at the level of the midlength of the palpebral lobes. Palpebral furrows are poorly developed, very shallow. Eye ridges are oblique, approximately half as long as the palpebral lobes. The preglabellar field is absent. Preocular fields are flattened, triangular in outline. The anterior border furrow is distinct shallow, narrow, and gently arched. The anterior border is flattened, slightly narrowed (sag.) in the middle, gently arched. Its width (sag.) is 0.14 of the glabellar length. Anterior branches of the facial sutures are moderately long, diverging. Posterior branches are short, diverging. The cranidium surface is granular.

C o m p a r i s o n a n d r e m a r k s. The cranidium described displays a number of characteristics of *Paradoxides (Acadoparadoxides) eopinus* from the lower part of the Amgan Stage of the Siberian Platform: the anterior border is almost constant in width, with a slight narrowing in the middle part on the side of the external contour rather than the glabellar side; the glabellar furrows are discontinuous in the middle part, although S1 of this species can be connected at the middle; the eye ridges are well developed, half as long as the palpebral lobes; the anterior end of the glabella is round in outline.

The cranidium from borehole Nizhny Imbak 219 differs from the type specimens of *P. (A.) eopinus* in the presence of three (versus two) pairs of lateral furrows of the glabella. The absence in our collection of other elements of the dorsal shield, especially pygidium with its well-pronounced distinctive structure, and incomplete preservation of the cranidium prevent reliable identification of this specimen as *P. (A.) eopinus.*

L o c a l i t y a n d m a t e r i a l. One distorted cranidium from the clayey–limestone series, 2333.3 m of depth; Middle Cambrian, Amgan Stage, *Ovatoryctocara* Zone.

Order Corynexochida

Family Dorypygidae Kobayashi, 1935

Genus *Dorypyge* Dames, 1883

***Dorypyge olenekensis* Lazarenko in Krys'kov et al., 1960**

Plate 5, figs. 2–5

Dorypyge olenekensis: Lazarenko (Krys'kov et al.), 1960, p. 218, pl. 50, figs. 2–4.

H o l o t y p e. TsNIGR Museum (Chernyshev Central Research Geological Museum, St Peters-

E x p l a n a t i o n o f P l a t e 5

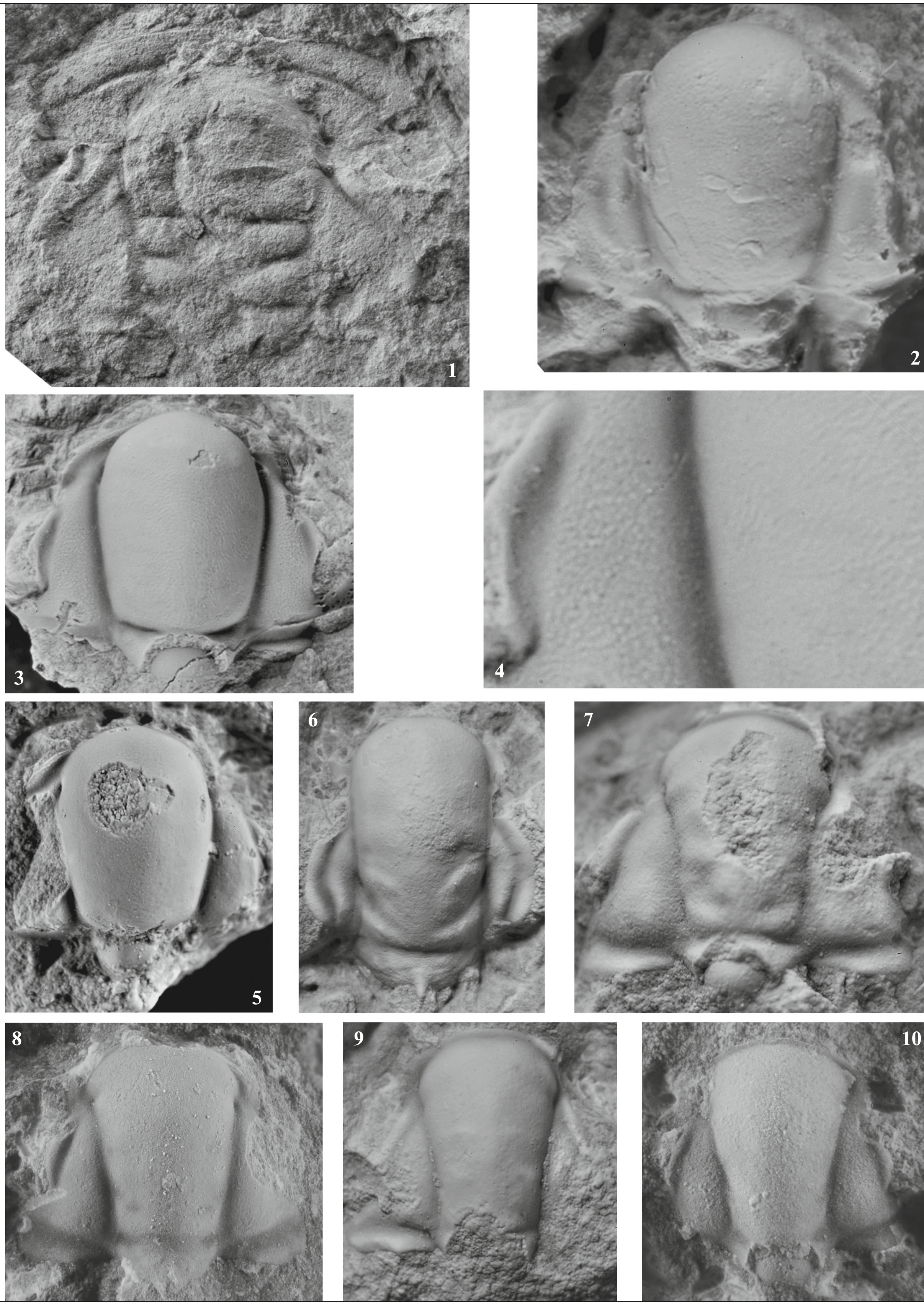
Fig. 1. *Paradoxides (Acadoparadoxides)* cf. *eopinus* I. Solovjev, 1969, specimen TsSGM, no. 39/2078, incomplete distorted cranidium, ×4; clayey–limestone series, depth of 2333.3 m, Amgan Stage, *Ovatoryctocara* Zone.

Figs. 2–5. *Dorypyge olenekensis* Lazarenko in Krys'kov et al., 1960, cranidia: (2) specimen TsSGM, no. 25/2078, ×14; (3) specimen TsSGM, no. 9/2078, ×7; (4) detail of the cranidium shown in fig. 3, ×21; (5) specimen TsSGM, no. 24/2078, ×11; limestone series, depth of 2244.23–2244.42 m; Mayan Stage, *Dorypyge olenekensis–Corynexochus perforatus* Zone.

Fig. 6. *Amphoton longus* Tchernysheva, 1961, specimen TsSGM, no. 32/2078, cranidium, ×8; clayey–limestone series, depth of 2315.3 m, Amgan Stage, *Ovatoryctocara* Zone.

Figs. 7–10. *Dolichometopus perfidelis* Egorova in Egorova et Savitsky, 1969, cranidia: (7) specimen TsSGM, no. 70/2078, ×15.5; (8) specimen TsSGM, no. 71/2078, ×13; (10) specimen TsSGM, no. 72/2078, ×17; limestone series, depth of 2263.8–2264.1 m; Amgan Stage, *Kounamkites* Zone; (9) specimen TsSGM, no. 73/2078, incomplete cranidium, ×12; clayey–limestone series, depth of 2326 m, Amgan Stage, *Ovatoryctocara* Zone.

Plate 5



burg), no. 1/9089, cranidium (Krys'kov et al., 1960, p. 218, pl. 50, fig. 2); Siberian Platform, Khorbusuonka River; Middle Cambrian, basal Mayan Stage.

Description. The cranidium is 3.7–6.5 mm long, with a curved angular anterior margin. The glabella is strongly convex, expands towards the rounded anterior end. At the base, the glabella is 0.6 as wide as at the anterior end. Three pairs of lateral furrows are hardly discernible under oblique illumination. All of them are at identical distance from each other and directed posteriorly. The dorsal furrows diverge; they are wide and deep along the posterior part of the glabella and narrow, shallow, distinct at its anterior part. At the anterolateral corners of the glabella, they contain pitlike depressions (fossules). The preglabellar furrow is shallow and narrow and outlines only lateral sites of the anterior end of the glabella. The central part of the glabellar end reaches the anterior margin of the cranidium. S0 is narrow, straight, deep on the sides of the glabella and shallower in the middle. The occipital ring is convex, expanded in the middle part (sag.), reaching less than 0.2 of the glabellar length. The palpebral areas are slightly convex, horizontal. At the level of the midlength of the palpebral lobes, they are 0.3 as wide as the glabella. The posterolateral projections are relatively short, wide, convex. The palpebral lobes are narrow, convex, gently curved, oblique, posterior to the midlength of the glabella. They are approximately 0.4 as long as the glabella. Palpebral furrows are moderately wide and deep, slightly curved. Eye ridges are weakly developed, marked by a bend of the surface, oblique. The eye ridge is 0.4 as long as the palpebral lobe. The preglabellar field is absent. The preocular fields are very short and narrow, abruptly inclined to the anterolateral corners of the cranidium. The anterior border furrow is shallow, indistinct, only observed on the sides of the cranidium; approaching the glabella, it disappears. The anterior border is only represented by lateral sites, convex, narrowed toward the glabella. The posterior border furrow is deep, wide, expanded toward the distal part. The posterior border is convex, narrow, geniculate at the level of palpebral lobes. Anterior branches of the facial sutures are very short, subparallel in front of the palpebral lobes, converge on the border, cutting the corners. Posterior branches are longer, diverging.

The glabellar surface shows distinct concentric ridges; remaining cranidial surface (except for furrows) is fine-tuberculate (Pl. 5, fig. 4). The anterior border displays longitudinal (tr.) terrace ridges.

Remarks. *Dorypyge olenekensis* is only tentatively referred to the genus *Dorypyge*. It is distinguished from members of this genus by the absence of an anterior border and marginal furrow anterior to the glabella; in addition, it lacks a distinct narrowing of the glabella anterior to the fossules.

The cranidia described here differ from the type specimens of *Dorypyge olenekensis* only in the presence of very weak lateral furrows of the glabella.

Occurrence. Middle Cambrian, lower part of the Mayan Stage; Siberian Platform.

Locality and material. Three cranidia from the limestone series, 2244.23–2244.42 m of depth. *Dorypyge olenekensis–Corynexochus perforatus* Zone.

Family Oryctocephalidae Beecher, 1897

Genus *Oryctocephalites* Resser, 1939

Oryctocephalites vicinus (Tchernysheva, 1962)

Plate 7, figs. 1–8

Oryctocephalus vicinus: Tchernysheva, 1962, p. 19, pl. II, fig. 9, 10; Korovnikov and Shabanov, 2008, p. 91, pl. 8, fig. 1.

Holotype. TsNIGR Museum, no. 10/8194, cranidium (Tchernysheva, 1962, pl. II, fig. 10); Siberian Platform, Nekekit River; basal Middle Cambrian.

Description. The cranidium is from 3 to 4 mm long, flattened, trapezoid, with a gently arched anterior margin and almost straight posterior margin. The cranidial length is about 0.7 of the cranidial width across the center of the palpebral lobes. The glabella expands slightly anteriorly, is slightly convex, slightly raised above the fixigenae, elongated; the glabellar length is about 1.6 of the glabellar posterior width. It is sometimes slightly pear-shaped because of expanded

Explanation of Plate 6

Figs. 1, 2, 4–6. *Corynexochus solitus* Egorova in Bognibova, 1965: (1) specimen TsSGM, no. 28/2078, cranidium, ×14.5; (2) specimen TsSGM, no. 74/2078, cranidium, ×17.5; clayey–limestone series, depth of 2320.5 m, Amgan Stage, *Ovatoryctocara* Zone; (4) specimen TsSGM, no. 75/2078, cranidium, ×18; (5) specimen TsSGM, no. 76/2078, cranidium, ×30; limestone series, depth of 2262.6 m, Amgan Stage, unnamed zone; (6) specimen TsSGM, no. 77/2078, pygidium, ×15, limestone series, depth of 2263.8 m, Amgan Stage, *Kounamkites* Zone.

Fig. 3. *Chondragraulos (Chondragraulos) granulatus* Tchernysheva, 1961, specimen TsSGM, no. 78/2078, incomplete cranidium, ×8; clayey–limestone series, depth of 2315.3 m, Amgan Stage, *Ovatoryctocara* Zone.

Figs. 7–11. *Chondranomocare irbinica* Repina, 1960: (7) specimen TsSGM, no. 79/2078, pygidium, ×5.5, limestone series, depth of 2263 m, Amgan Stage, unnamed zone; (8) specimen TsSGM, no. 80/2078, cranidium, ×14, the same locality; (9–11) cranidia: (9) specimen TsSGM, no. 81/2078, ×14, depth of 2326 m; (10) specimen TsSGM, no. 82/2078, ×19, depth of 2319.5 m; (11) specimen TsSGM, no. 83/2078, ×4, depth of 2319.5 m; clayey–limestone series, Amgan Stage, *Ovatoryctocara* Zone.

Figs. 12 and 13. *Chondranomocare bucculentum* Lazarenko, 1965, cranidia: (12) specimen TsSGM, no. 84/2078, ×11, depth of 2320.5 m; (13) specimen TsSGM, no. 85/2078, ×5.5, depth of 2315.1 m; clayey–limestone series, Amgan Stage, *Ovatoryctocara* Zone.

Plate 6

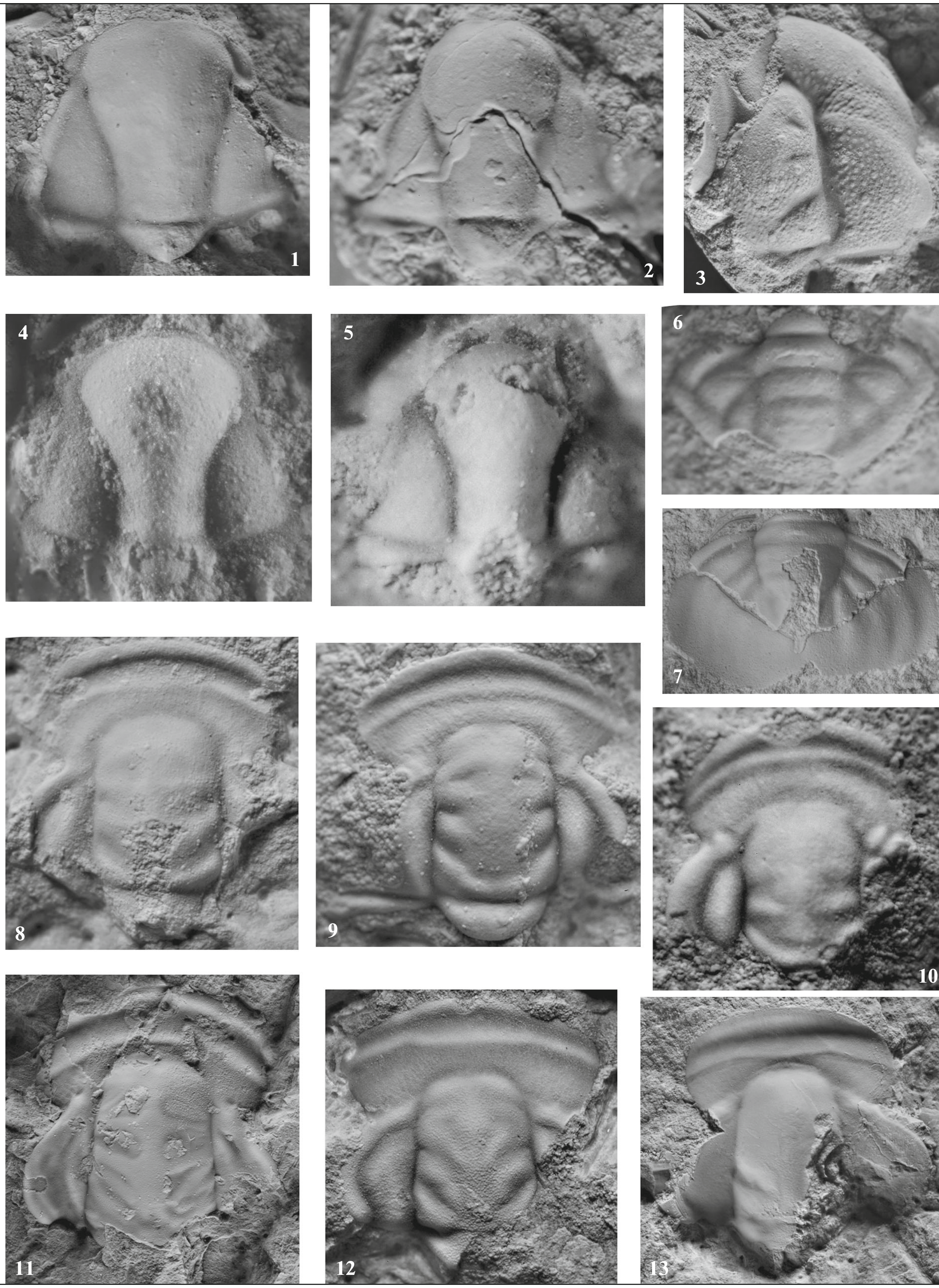
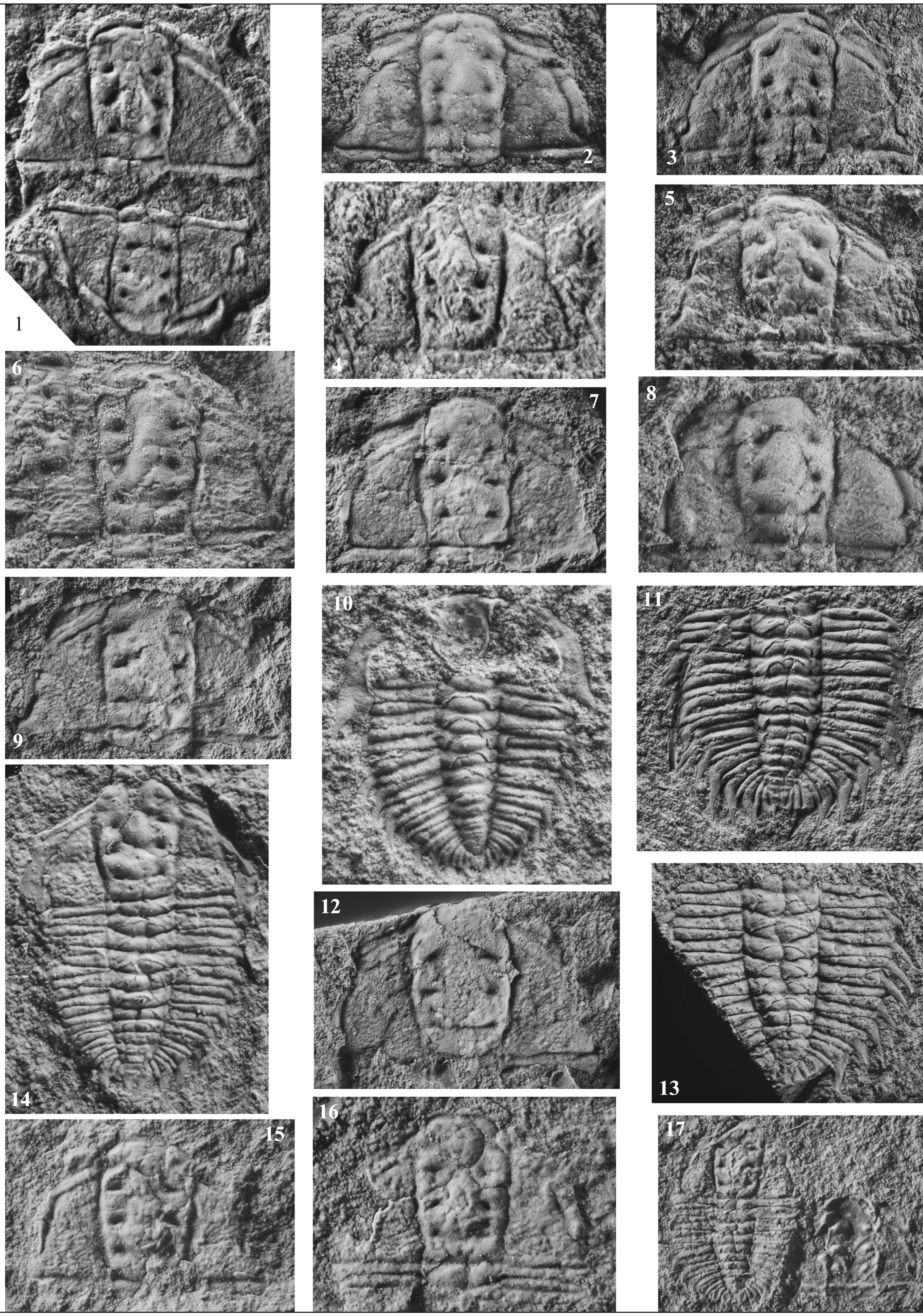


Plate 7



L3. The anterior end of the glabella is blunted, reaches the anterior border, slightly compressing it. The longitudinal profile of the glabella is gently arched, with the highest point close to the middle of the arch. The transverse profile of the glabella is almost straight, with a weak carination in the axial part. Dorsal furrows are distinct, narrow, moderately deep, diverging slightly anteriorly at the posterior part of the glabella, frequently slightly arched in the anterior part, and, slightly rounding the anterolateral corners of the glabella, pass into the equally deep and sharp preglabellar furrow. The glabella has four pairs of distinct, deep lateral furrows. S1 is in the shape of two deep round pits located at a distance from dorsal furrows and connected by a wide and shallow transverse furrow curving posteriorly. S2 and S3 are also in the shape of deep subtriangular or round pits, although not connected by transverse grooves, nor reaching the dorsal furrows. A weak longitudinal groove connecting two posterior pairs of lateral furrows is sometimes observed (Pl. 7, fig. 2). S4 looks like narrow, short, shallow, and anteriorly oblique grooves beginning from dorsal furrows at the point of junction between the eye ridges and glabella. The occipital furrow is narrow, distinct, slightly shallower than dorsal furrows; it is deepest at the sides of the occipital ring, but does not reach dorsal furrows; it is curved slightly posteriorly. The occipital ring is short, shorter than the posterior lobe of the glabella, constant in length throughout its extent, sometimes has a very small medial node. The occipital ring (sag.) is about 0.13 as long as the glabella. The posterior margin of the occipital ring is curved slightly posteriorly. The highest point of the occipital ring is considerably lower than that of the glabella. The fixigenae are wide, subtriangular, flattened, sometimes slightly convex, with a wider and slightly posteriorly inclined posterior part. Their width across the center of palpebral lobes is about 0.8–0.9 of the glabellar width at the same level. The highest point of fixigenae is considerably lower than the highest point of the glabella. The posterior border furrows are equal in depth and width to dorsal furrows, slightly narrower at the glabella and somewhat expanded toward the margins of the cranidium, sometimes slightly curved close to the middle of the posterior border, approaches the glabella at the S0 level. The posterior border is narrow at the occipital ring, convex, slightly expands beginning from near the midlength to the margins; almost straight or slightly curved, long, 1.3 as wide as the glabella at the base. The palpebral furrows are distinct, narrow, less deep than dorsal furrows. The palpebral lobes are long, narrow, convex, distinctly outlined, slightly arched, gently pass into equally narrow, convex, posteriorly oblique, and straight eye ridges. The palpebral lobes are about half as long as the glabella. Their anterior ends are closer to the glabella than the posterior ends and positioned almost opposite S3. The posterior ends of palpebral lobes terminate at a short distance from the border furrows. Eye ridges adjoin dorsal furrows at an angle of 80°–85°. The preglabellar field is absent. The preocular fields are in the shape of transversely extended, narrow, slightly concave depressions between eye ridges and anterior border. The anterior border furrow is distinct, at the sides, equal in depth to dorsal furrows, in the central part, fused with the preglabellar furrow. The anterior border is very narrow, ridgelike, more convex on the sides, arched gently anteriorly. In some specimens, the most abrupt curvature is observed opposite the glabella. The highest point of the anterior border is considerably lower than that of glabella. The anterior border width (sag.) is less than 0.1 of the glabellar length.

The anterior branches of facial sutures are short, straight, slightly diverging in front of the palpebral lobes and converging on the anterior border. Posterior branches of facial sutures are slightly shorter than the anterior branches, obliquely diverging.

V a r i a b i l i t y. In the specimens described, varying characters include the extent of anterior expansion and pear-shaped appearance of the glabella, the blunting extent of the anterior glabellar margin, the extent of curvature of the anterior and posterior borders, the length of palpebral lobes, the shape of the preocular fields, and the inclination of eye ridges relative to the longitudinal cranidim axis, ranging from 70° to 80°.

C o m p a r i s o n a n d r e m a r k s. Sundberg (2014) performed a detailed phylogenetic analysis of Oryctocephalidae using 35 characters and, based on this, improved the diagnoses of the subfamilies Oryctocephalinae (which includes only one genus, *Oryctocephalus*) and Lancastriinae. According to them, *Oryctocephalus vicinus* Tchernysheva, 1962 should be

Explanation of Plate 7

Figs. 1–8. *Oryctocephalites vicinus* Tchernysheva, 1962, cranidia: (1) specimen TsSGM, no. 86/2078, 87/2078, ×7; (2) specimen TsSGM, no. 88/2078, ×12; (3) specimen TsSGM, no. 89/2078, ×7; (4) specimen TsSGM, no. 90/2078, ×13; (5) specimen TsSGM, no. 91/2078, ×7; (6) specimen TsSGM, no. 92/2078, ×12.5; (7) specimen TsSGM, no. 93/2078, ×9; (8) specimen TsSGM, no. 94/2078, ×13; clayey–limestone series, depth of 2318.4 m, Amgan Stage, *Ovatoryctocara* Zone.

Figs. 9–13. *Oryctocephalops frischenfeldi* Lermontova, 1940: (9) specimen TsSGM, no. 95/2078, cranidium, ×9.5; (10) specimen TsSGM, no. 96/2078, incomplete dorsal shield, ×18; (11) specimen TsSGM, no. 97/2078, incomplete dorsal shield, ×8.5; (12) specimen TsSGM, no. 98/2078, cranidium, ×11; (13) specimen TsSGM, no. 99/2078, incomplete dorsal shield, ×11; clayey–limestone series, depth of 2317.25–2318.4 m; Amgan Stage, *Ovatoryctocara* Zone.

Figs. 14–17. *Oryctocephalites incertus* Tchernysheva, 1960: (14) specimen TsSGM, no. 100/2078, dorsal shield, ×12; (15) specimen TsSGM, no. 101/2078, cranidium, ×15; (16) specimen TsSGM, no. 102/2078, cranidium, ×14; (17) specimen TsSGM, no. 103/2078, dorsal shield, ×9; clayey–limestone series, depth of 2317.25 m, Amgan Stage, *Ovatoryctocara* Zone.

assigned to the subfamily Lancastriinae based on the anteriorly expanding glabella and absence of a longitudinal furrow connecting lateral pitlike furrows of the glabella and reaching the posterior margin of the occipital ring. However, judging from the data reported by Sundberg (2014), the generic affiliation of *vicinus* remains uncertain: in pl. 1, figs. 1, 2, 3, and 5, it is referred to as *Oryctocephalites vicinus,* while in the section *Systematic Paleontology,* it is assigned to the genus *Protoryctocephalus* Zhou in Lu et al., 1974. The diagnoses of the genera *Oryctocephalites* and *Protoryctocephalus* provided in this work show that they are very close in cranidium structure. Significant differences concern the structure of the thoraxes and pygidia of these genera. However, in our collection, complete dorsal shields are absent. Nevertheless, in our opinion, it is possible to assign *vicinus* to the genus *Oryctocephalites* based on the following characters: the glabella expands toward the anterior end; dorsal furrows are only slightly diverging, almost straight; lateral furrows are in the shape of round pits, of which S1 is transglabellar; the frontal lobe of the glabella lacks a median furrow; eye ridges are distinct; the posterior border furrow is connected with S0. The specimens from borehole Nizhny Imbak are distinguished from the type specimens of *O. vicinus* (Tchernysheva, 1962, p. 19) by the presence of a transglabellar S1 and, sometimes, weak longitudinal grooves connecting two posterior pairs of lateral furrows (Pl. 7, fig 2).

O c c u r r e n c e. Middle Cambrian, Amgan Stage, *Ovatoryctocara, Kounamkites,* and *Triplagnostus gibbus* zones; Siberian Platform, basins of the Olenek, Malaya Kuonamka, Molodo, Nekekit, and Nizhny Imbak rivers.

L o c a l i t y a n d m a t e r i a l. More than ten cranidia of good and satisfactory preservation from the clayey–limestone series, 2317.25–2318.4 m of depth; *Ovatoryctocara* Zone.

Oryctocephalites incertus **Tchernysheva, 1960**

Plate 7, figs. 14–17

Oryctocephalites incertus: Tchernysheva in Krys'kov et al., 1960, p. 219, pl. 51, fig. 7; Tchernysheva, 1962, p. 26, pl. 3, figs. 7–10; Savitsky et al., 1972, p. 76, pl. 16, fig. 2; Egorova et al., 1976, p. 95, pl. 51, fig. 5.

H o l o t y p e. TsNIGR Museum, no. 1/9180, pygidium (Tchernysheva in Krys'kov et al., 1960, p. 219, pl. 51, fig. 7); Siberian Platform, Anabar River; Middle Cambrian, basal Amgan Stage, Kuonamka Formation.

D e s c r i p t i o n. The dorsal shields are 4–5 mm long, oval or ovoid, with slightly convex axial and pleural parts. The cephalon is semielliptical, transversely expanded, occupies more than one-third of the dorsal shield length and is considerably larger than the pygidium; the cephalic length is about 0.6 of the posterior cranidial width.

The structure and proportions of the elements of the cranidium are similar to that of *O. vicinus* (see above). The main differences concern the shape and division of the glabella. The glabella is elongated, expanded anteriorly, sometimes expanded in the middle part. The glabellar length is about 1.9 of the posterior glabellar width. Lateral furrows of the glabella are distinct, deep, comprise four pairs. S1 is in the shape of deep, transversely elongated pits located at a distance from dorsal furrows and connected by a transverse groove curved posteriorly. S2 and S3 are also shaped as distinct transversely extended pits, but not connected by transverse grooves.

The thorax consists of six or seven segments, is slightly convex; from the fourth segment, it narrows slightly anteriorly and regularly and more considerably narrows toward the pygidium. The maximum width of the thorax is approximately 1.2 of the length of the thorax and pygidium. The axis is slightly convex, with slightly curved furrows separating the axial rings, significantly narrowing in the posterior part; the axial part is as wide as the pleura. Dorsal furrows are narrow and shallow. The segments gradually decrease in length (sag.) from the anterior to posterior margin of the thorax. The pleurae are wide, convex, separated by distinct, narrow, and deep interpleural furrows. Pleural furrows are oblique, significantly wider and deeper than interpleural furrows. Beginning from the fourth segment, the pleurae are extended into relatively small, posteriorly curved spines.

The pygidium is small, semicircular, slightly transversely extended, consists of four segments, with a short, slightly convex conical axis and the divided pleurae. Dorsal furrows are shallow and narrow; the pleural furrows are slightly wider and deeper, arranged like a fan; the posterior pair of furrows extends almost parallel to the longitudinal axis of the pygidium. Furrows terminate at the base of short thickened marginal spines.

C o m p a r i s o n a n d r e m a r k s. The specimens described display characteristics of *O. incertus:* the cranidium is small and trapezoid, with relatively sharply curved anterior margin; the glabella is elongated and expanded in the middle, with four pairs of lateral furrows in the shape of distinct transversely extended pits, the posterior pair of which is connected by a transverse groove; the thorax has six segments; and the pygidium is small. The dorsal shields in the collection probably belong to holaspis.

The cranidia of *O. incertus* are most similar in morphology to the co-occurring species *Oryctocephalites vicinus* (Tchernysheva, 1962) and differ from it in the glabella which can be barrel-shaped expanded in the middle, the transversely elongated rather than rounded pitlike furrows of the glabella, S0 reaching dorsal furrows, the occipital ring slightly elongated (sag.) in the middle (in *O. vicinus*, it is constant in length), and in the narrower fixigenae.

O c c u r r e n c e. Middle Cambrian, Amgan Stage, *Ovatoryctocara* Zone; northern and northwestern Siberian Platform, basins of the Olenek, Malaya Kuonamka, Nekekit, Boroluolakh, and Nizhny Imbak rivers.

L o c a l i t y a n d m a t e r i a l. Two incomplete dorsal shields and two cranidia of good and satisfactory preservation from the clayey–limestone series, 2317.25 m of depth.

Genus *Oryctocephalops* Lermontova, 1940

Oryctocephalops frischenfeldi Lermontova, 1940

Plate 7, figs. 9–13

Oryctocephalops frischenfeldi: Lermontova, 1940, p. 137, pl. XLII, figs. 1, 1a–1c; Tchernysheva, 1962, p. 44, pl. III, figs. 11–14; Suvorova, 1964, p. 247, pl. XXVIII, figs. 1–11, pl. XXIX, figs. 1–7; Bognibova et al., 1971, p. 140, pl. 13, fig. 7; Savitsky et al., 1972, p. 77, pl. 15, fig. 9; Egorova et al., 1976, p. 96, pl. 44, fig. 14; pl. 45, figs. 17–19; pl. 46, figs. 13 and 14; pl. 47, fig. 18; Korovnikov and Shabanov, 2008, p. 93, pl. 1, fig. 5; pl. 2, figs. 2 and 3; pl. 4, fig. 10; pl. 5, figs. 4 and 13; pl. 11, figs. 10 and 11.

L e c t o t y p e. TsNIGR Museum, no. 9182, dorsal shield (Lermontova, 1940, p. 137, pl. XLII, fig. 1; designated by Tchernysheva, 1962, p. 44); Siberian Platform, Anabar River Basin; basal Middle Cambrian.

D e s c r i p t i o n. The dorsal shields are 7–8 mm long, ovoid, with moderately convex axial and pleural parts. The cephalon is in the shape of semiellipse, strongly transversely extended, its length is about 0.4 of the posterior width. The cranidia are from 3 to 4 mm long, wide, flattened, trapezoid, with a gently arched anterior margin and almost straight posterior margin. The cranidial length is about 0.7 of its width across the center of palpebral lobes. The glabella is long, subcylindrical or expanding slightly anteriorly, slightly convex. The glabellar length is about 1.8 of its posterior width. The anterior end of the glabella gently rounded, reaches the anterior border, slightly compressing it. The longitudinal profile of the glabella is slightly arched. The transverse profile of the glabella shows a weak carination. Dorsal furrows are distinct, narrow, deep, diverging slightly anteriorly at L1 and L2, then, slightly converging at L4, pass into an equally narrow preglabellar furrow. The glabella has four pairs of distinct, deep, transversely extended up to slitlike lateral furrows. S1 are located at a distance from dorsal furrows and connected by a posteriorly curved transverse furrow. S2 and S3 are directed slightly anteriorly, also terminate short of the dorsal furrows, but are not connected by transverse grooves. S4 are in the shape of short, shallow, anteriorly oblique grooves opposite the junction between eye ridges and glabella. S0 is narrow, distinct, curved slightly posteriorly, constant in depth throughout its extent. The occipital ring is short (sag.), slightly shorter than L1, uniform in length. The occipital ring is approximately 0.1–0.15 as long as the glabella. The posterior margin of the occipital ring is curved slightly posteriorly. Fixigenae are moderately wide, subtriangular, flattened, slightly convex in the middle part. Posterolateral projections are relatively small. Across the palpebral lobe center, the fixigenae are approximately 0.75 as wide as the glabella at the same level. The posterior border furrow is as deep and as wide as S0, slightly expands toward the margins of the cranidium, sometimes is slightly curved. The posterior border is narrow, convex, slightly expands toward the margins; slightly curved at the external ends. The palpebral furrows are distinct, narrow, relatively shallow. Palpebral lobes are long, narrow, convex, slightly curved, gently pass into equally narrow, convex, straight eye ridges. The palpebral lobes are approximately 0.6 as long as the glabella. The anterior ends of palpebral lobes are located closer to the glabella than the posterior ends and opposite the middle of L3. The posterior ends of palpebral lobes terminate short of reaching the border furrow. Eye ridges adjoin the glabella at an angle of 80°. The preglabellar field is absent. The preocular fields are in the shape of narrow slightly concave depressions extended along eye ridges. The anterior border furrow is narrow, distinct. The anterior border is very narrow, lacelike opposite the glabella, and significantly expands toward the lateral parts of the cranidium, slightly arched. Anterior branches of facial sutures are short, slightly diverging in front of the palpebral lobes, and converging on the anterior border. Posterior branches of facial sutures are shorter than the anterior branches, obliquely diverging.

The thorax consists of 12 segments, is wide, slightly convex; from the fourth segment, it narrows slightly anteriorly and considerably narrows toward the pygidium. The maximum width of the thorax is about 1.1 of its length. The axis is convex, with almost straight furrows separating the axial rings, distinctly outlined by deep and narrow dorsal furrows, significantly narrows in the posterior part; the axial width of the first segment is about 0.7 of the pleural width. The segments gradually decrease in length (sag.) from the anterior to posterior end of the thorax by 1.5 times. Pleurae are wide, slightly convex, separated by distinct, narrow, and deep interpleural furrows. Pleural furrows are slightly wider and deeper, slightly oblique, disappear at the base of pleural spines. Beginning from segments 3–4, the pleurae extend into narrow, posteriorly curved spines, the length of which is 0.8 of the width of a respective segment. Four posterior spines curve posteriorly and inside.

The pygidium is very small, rounded, slightly transversely extended, consists of two segments, with a small short axis divided by a transverse groove, and flattened pleurae. The maximum width of the pygidium is about 0.4 of the axis width of the first thoracic segment. The pleural fields are separated by distinct and narrow pleural and interpleural furrows. Pleurae of the first segment are curved posteriorly and terminate in narrow spines curving inside to the pygidial axis. Pleurae of the last segment are turned posteriorly, slightly furrowed, and have short spines.

Comparison and remarks. The specimens described differ from the lectotype and most of the other members of *O. frischenfeldi* Lerm. from the Kuonamka Formation of the northeastern Siberian Platform in the subcylindrical glabella with the shorter lateral furrows and also in the less expanded anterior border opposite eye ridges. The dorsal shields of *O. frischenfeldi* from our collection are somewhat similar to *O. guizhouensis* Zhao et Yuan and *O. ellipsoidalis* Zhao et Yuan (Yuan et al., 2002, p. 235, pl. 15, figs. 4–7, pl. 16, figs. 1–7) from the lower part of the Kaili Formation of Guizhou Province of southern China. The specimens described here are distinguished by the relatively longer cranidium, the shorter lateral furrows of the glabella, which are not connected to dorsal furrows, the narrower fixigenae, less curved palpebral lobes, the shorter occipital ring, and the presence of twelve thoracic segments.

Occurrence. Middle Cambrian, Amgan Stage, *Ovatoryctocara* Zone; northern and northwestern Siberian Platform, basins of the Olenek, Malaya Kuonamka, Nekekit, Boroluolakh, Udzha, Buom-Pastakh, Molodo, and Nizhny Imbak rivers; Altai–Sayany Folded Belt, Altai Mountains, Kuznetsky Alatau (Batenevsky Ridge).

Locality and material. Three incomplete dorsal shields and two cranidia of good and satisfactory preservation from the clayey–limestone series, 2317.25–2318.4 m of depth.

Family Dolichometopidae Walcott, 1916

Genus *Amphoton* Lorenz, 1906

Amphoton longus Tchernysheva, 1961

Plate 5, fig. 6

Amphoton longus: Tchernysheva, 1961, p. 85, pl. 7, figs. 9–12; Egorova and Savitsky, 1969, p. 157, pl. 41, figs. 1–7; Bognibova et al., 1971, p. 122, pl. 10, figs. 1 and 2; Egorova et al., 1976, p. 77, pl. 28, fig. 22, pl. 30, fig. 22, pl. 32, fig. 19, pl. 33, fig. 9; Shabanov et al., 1987, p. 56, pl. 3, fig. 4; Ogienko and Garina, 2001, p. 117, pl. 16, figs. 5–10.

Holotype. TsNIGR Museum, no. 9181, cranidium (Tchernysheva, 1961, p. 85, pl. 7, figs. 9a, 9b); Siberian Platform, Amga River Basin; Middle Cambrian, Amgan Stage.

Description. The cranidium is 6.1 mm long, convex, longitudinally extended, with a rounded anterior margin. The cranidial length is approximately 1.3 of the cranidial width across the center of palpebral lobes. The glabella occupies 80% of the cranidial length, subcylindrical, slightly anteriorly expanded, convex, and strongly elevated above fixigenae. The glabellar length is about 2.0 of the posterior glabellar width. The anterior margin of the glabella is evenly rounded. The longitudinal profile of the glabella is arched, with the highest point displaced slightly anteriorly from the glabellar center; the anterior site of the arch is more abrupt than posterior one. The transverse profile of the glabella is abruptly arched. Dorsal furrows are shallow, narrow (at most 0.1 mm wide), slightly wider in the posterior part of the extent, and diverging slightly anteriorly, straight. Three pairs of lateral furrows are variously developed. S1 is widest, deep, and long (terminates at a small distance from the longitudinal axis), directed obliquely posteriorly from dorsal furrows and, further, arched toward the central part of the glabella. S2 begins at a distance from dorsal furrows. It is shallower and slightly shorter than S1, oblique posteriorly as S1, but lacks a curvature. S3 is located opposite the anterior ends of palpebral lobes in the shape of very small, hardly discernible, short depressions separated from dorsal furrows. S0 is wide (at most 0.25 mm), deepest in the central part, but slightly shallower in the lateral sites, slightly posteriorly arched. The occipital ring is short (approximately 0.2 as long as the glabella), somewhat elongated in the axial part, elevated posteriorly, with the posteriorly arched posterior margin. A short medial occipital spine overhangs the posterior margin of the ring. The highest point of the occipital ring is considerably lower than that of glabella. The palpebral areas are narrow, in the shape of a circular segment, flat in the anterior part and, in the posterior part, shaped as narrow longitudinal ridges parallel to palpebral lobes and slightly inclined relative to the glabella and posterior border furrow. The highest point of the palpebral area is in its anterior part, lower than the highest point of the glabella. The fixigenal width across the center of palpebral lobes is approximately 0.3 of the glabellar width at the same level. Posterolateral projections are very small, inclined posteriorly and to the cranidial sides. The posterior border is not preserved. The palpebral furrows are wide, shallow, shaped as a bend of the shield surface. Palpebral lobes are narrow, almost half as long as the glabella, flattened, arched, inclined to palpebral areas and backward. The palpebral lobes are approximately half as long as the glabella. They are slightly displaced toward the posterior cranidial margin, so that their centers are located posterior to the glabellar center. The anterior ends of palpebral lobes adjoin the glabella opposite the anterior pair of lateral furrows. The posterior ends of palpebral lobes are positioned at a small distance from the glabella, located opposite the middle of its posterior lobe. The preocular fields are in the shape of a small subtriangular areas on the sides the glabella. The preglabellar field is absent. The anterior border is very narrow, threadlike.

The cranidial surface is covered with uniform finepunctate sculpture.

Remarks. The specimen described differs from the type specimens of *Amphoton longus* from the section of the Amgan Stage on the Amga River (Tchernysheva, 1961) in the more convex and less anteriorly expanded glabella with deeper and longer lateral furrows, more convex posterior lobes of the glabella, slightly longer spine overhanging the posterior margin of the occipital ring, and in the flattened palpebral lobes.

O c c u r r e n c e. Middle Cambrian, lower half of the Amgan Stage; Siberian Platform, basins of the Amga, Buom-Pastakh, and Lena rivers, Turukhanskii District, Igarskii District, Daldyno–Alakitskii District, Altai–Sayany Folded Belt, Altai Mountains, Kuznetsky Alatau (Batenevsky Ridge).

L o c a l i t y a n d m a t e r i a l. One well-preserved cranidium from the clayey–limestone series, 2315.3 m of depth; *Ovatoryctocara* Zone.

Genus *Dolichometopus* Angelin, 1854

Dolichometopus perfidelis Egorova, 1969

Plate 5, figs. 7–10

Dolichometopus perfidelis: Egorova and Savitsky, 1969, p. 160, pl. 41, figs. 11–16; Repina et al., 1974, p. 152, pl. 42, figs. 12 and 13, pl. 43, figs. 1–3; Egorova et al., 1976, p. 78, pl. 17, fig. 12, pl. 31, fig. 20, pl. 33, fig. 6, pl. 44, fig. 24, pl. 47, fig. 16, pl. 49, fig. 22, pl. 51, figs. 18 and 19, pl. 52, figs. 12 and 13, pl. 53, fig. 6; Shabanov et al., 1987, p. 56, pl. 3, figs. 1 and 2; Ogienko and Garina, 2001, p. 117, pl. 16, figs. 1–4.

H o l o t y p e. TsNIGR Museum, no. 335/8363, cranidium (Egorova and Savitsky, 1969, p. 160, pl. 41, fig. 11); Siberian Platform, western Anabar Region, Buom-Pastakh River; Middle Cambrian, Amgan Stage.

D e s c r i p t i o n. The cranidium is 2.5–3.5 mm long, convex, trapezoid, with gently rounded anterior margin and almost straight posterior margin. The cranidial length is about 1.1 of the cranidial width across the center of palpebral lobes; the posterior cranidial width is about 1.6 of the anterior cranidial width. The glabella is large, occupies about 75% of the cranidial length, regularly and considerably anteriorly expanded, moderately convex, elevated above fixigenae, with slightly rounded anterior margin. The anterior glabellar width is about 1.6 of the posterior glabellar width; the glabellar length is about 2.1 of the posterior glabellar width. The longitudinal profile of the glabella is slightly arched; the highest point of the arch is displaced slightly anteriorly; the anterior site of the arch is slightly abrupter than the posterior site. The transverse profile of the glabella is arched angular, with a sharp bend of the arch in the center. Dorsal furrows are distinct, moderately wide, relatively shallow, diverging anteriorly, almost straight with a weak curvature toward the longitudinal axis of the cranidium. Three pairs of lateral furrows are in the shape of indistinct transverse depressions. S1 is most distinct and deep, begins from dorsal furrows and oblique slightly posteriorly. S3 is shaped as short lateral depressions near dorsal furrows in place of junction between eye ridges and glabella. S0 is wider than dorsal furrows, shallower and curved weakly anteriorly in the central part. The occipital ring is short, subtriangular, moderately convex, with posteriorly extended and elevated posterior margin, which has a short spine or small node. The occipital ring is approximately 0.25 as long as the glabella. The highest point of the occipital ring is considerably lower than that of glabella. Palpebral areas are narrow, subtriangular, slightly convex; anterior parts are inclined anteriorly and toward palpebral lobes; the postocular areas are abruptly inclined relative to the cranidial sides and posteriorly. The fixigenal width across the center of palpebral lobes is about 0.3 of the glabellar width at the same level. The highest point of the fixigena is located opposite the midlength of the palpebral lobe near the glabella, lower than the highest point of the glabella. Posterolateral projections are relatively large, transversely extended. The posterior border is flattened or slightly convex, narrow near the occipital ring and considerably expanded to the cranidial margins (more than twice); it is strongly inclined from the occipital ring to sides and extended slightly posteriorly at external corners. The posterior border furrow near the occipital ring is deeper and narrower than the occipital furrow, becoming shallow and wide toward the external margins; arched slightly anteriorly. Palpebral furrows are deep, narrower than dorsal furrows, slightly curved. Palpebral lobes are narrow, relatively short, slightly convex, curved, inclined from fixigenae and posteriorly. The palpebral lobe is about 0.3 as long as the glabella. The anterior ends of palpebral lobes are located closer to the glabella than the posterior ends; the centers of palpebral lobes are positioned almost opposite the cranidium center. Eye ridges are short, indistinct, fused with palpebral lobes. The anterior border is very narrow, lace-like, expands somewhat opposite small, flattened, rhomboid preocular fields, which are inclined anteriorly and to the cranidial sides. The preocular fields (tr.) are slightly shorter than the maximum width of fixigenae. The anterior border furrow is deep, narrow, distinct. Anterior branches of facial sutures are short, straight, slightly diverging. Posterior branches of facial sutures are much longer than anterior branches, diverging diagonally. The cranidial surface is smooth.

C o m p a r i s o n a n d r e m a r k s. The specimens described here differ from the holotype and paratypes from the Buom-Pastakh River Basin (Egorova and Savitsky, 1969) in the shorter palpebral lobes, more distinct S3, and in the slightly wider posterior border. They differ from the type species *Dolichometopus suecicus* Angelin, 1854 in the more strongly anteriorly expanded glabella, with indistinct lateral furrows, in the narrower subtriangular palpebral areas, the narrow (sag.) anterior border, shorter and less curved palpebral lobes, the longer (sag.) occipital ring with a short spine.

O c c u r r e n c e. Middle Cambrian, Amgan Stage; Siberian Platform, basins of the Buom-Pastakh, Daldyn (western Anabar Region), Nekekit, and Boroluolakh (eastern Anabar Region) rivers, middle and lower reaches of the Lena River, Turukhanskii District, Igarskii District.

L o c a l i t y a n d m a t e r i a l. Clayey–limestone series, 2326 m of depth (one cranidium), *Ovatoryctocara* Zone; limestone series, 2263 m of depth (two satisfactory preserved cranidia), base of unnamed zone; 2264 m of depth (one cranidium), *Kounamkites* Zone.

Family Corynexochidae Angelin, 1854

Genus *Corynexochus* Angelin, 1854

Corynexochus solitus Egorova (in Bognibova, 1965)

Plate 6, figs. 1, 2, 4–6

Corynexochus solitus: Egorova in Bognibova, 1965, p. 69, pl. 1, figs. 7 and 8; Egorova and Savitsky, 1969, p. 167, pl. 42, figs. 1–10; Bognibova et al., 1971, p. 127, pl. 10, fig. 22; Ogienko and Garina, 2001, p. 126, pl. 18, figs. 1–5.

H o l o t y p e. SNIIGGiMS, no. 251/15, pygidium (Bognibova, 1965, p. 69, pl. 1, fig. 8); Siberian Platform, Buom-Pastakh River Basin; Middle Cambrian, basal Amgan Stage.

D e s c r i p t i o n. The cranidium is 2.5–2.8 mm long, convex, trapezoid, with gently rounded anterior margin and slightly posteriorly arched posterior margin. The posterior margin of the cranidium is approximately 1.4 as wide as the anterior margin; the cranidium is approximately 1.1 times longer than wide across the center of palpebral lobes. The glabella is large, occupies slightly more than 80% of the cranidial length, clavate, expands nonuniformly and considerably anteriorly, with the maximum expansion of two anterior lobes. The glabella is approximately 2.6 times longer than wide across the center of palpebral lobes; the anterior part of the glabella is about 1.8 times as wide as the posterior part. The glabella is strongly convex in the anterior part, raised above fixigenae, with a rounded anterior margin. The longitudinal profile of the glabella is abruptly arched; the highest point of the arch is displaced strongly anteriorly; the anterior segment of the arch is significantly abrupter than the posterior segment. The transverse profile of the glabella is abruptly arched, with a sharp bend of the arch in the center. Dorsal furrows are distinct, relatively narrow and shallow, slightly concave and diverging anterior to the occipital furrow to the point of junction with palpebral lobes and, then, converging archedly anteriorly; opposite S2 and S3, they have small, longitudinally extended depressions. Three pairs of lateral furrows are very short, effaced, shaped as transversely extended, shallow depressions. S3 is most distinct and deepest of them, short, begins from dorsal furrows at the point of junction of eye ridges, and is oblique slightly anteriorly. S1 and S2 are very weak. S0 is distinct, wider and slightly deeper than dorsal furrows, straight. The occipital ring is short, subtriangular, slightly convex, with an abruptly arched and raised posterior margin. The occipital ring is approximately 0.25 as long as the glabella. The ring has a small node displaced to the posterior margin. The highest point of the occipital ring is considerably lower than that of the glabella. The palpebral areas are narrow, subtriangular in outline, with an acute anterior angle, convex. Across the center of palpebral lobes, the fixigena is approximately half as wide as the glabella at the same level. The palpebral areas are inclined anteriorly and to palpebral lobes; the postocular areas descend to the posterior border furrow. The highest point of the fixigena is opposite the center of the glabella, lower than the highest point of the glabella. The postocular parts of fixigenae are large, slightly wider than the glabella at the posterior end; inclined strongly to the cranidial sides and posteriorly. The posterior border is slightly convex, narrow at the occipital ring, becoming more than twice wider to the cranidial margins (exsag.); inclined from the occipital ring to the cranidial sides, and arched slightly anteriorly. At the occipital ring, the posterior border furrow is shallower and wider than the occipital furrow, becoming wider toward the external margin; arched slightly anteriorly. Palpebral furrows are hardly discernible, shallow, slightly curved. The palpebral lobes fused with eye ridges are narrow, moderately long, convex, slightly curved, inclined externally and posteriorly. Their posterior ends are positioned at the level of S2. The palpebral lobe is approximately 0.4 as long as the glabella. Eye ridges are very short, inclined; their anterior ends adjoin dorsal furrows opposite S3. The preocular fields are small, flattened, inclined externally. In two specimens, the anterior border is very narrow in the shape of a narrow band (Pl. 6, figs. 1, 4); in other specimens, it has not been recognized. Anterior branches of facial sutures are very short, almost parallel. Posterior branches are much longer than anterior branches, diverging diagonally. The cranidial surface is smooth.

The pygidium is 1.7 mm long, transversely expanded, semicircular, with a slightly arched anterior margin. The length-to-width ratio of the pygidium is about 0.65. The axis is long, wide, convex, slightly narrowed toward rounded posterior end, which reaches the border. The axis is approximately 0.8 as long as the pygidium; the axial posterior width is about 0.3 of the pygidial width. The axis is divided by two distinct deep straight furrows and a weak third furrow. Dorsal furrows are distinct, relatively shallow, curved wavy. The pleural fields are relatively narrow, becoming narrower posterior to the anterior pygidial margin, slightly convex, distinctly divided into three segments. The pleural region is approximately 0.25 as wide as the pygidium. The border is distinct, narrow, slightly expands toward the posterior pygidial margin, is separated from pleural fields by a wide and shallow furrow. The external margin of the border is even.

C o m p a r i s o n a n d r e m a r k s. *C. solitus* is most similar to *C. macrophthalmus* Lermontova in Tchernysheva, 1953 from the Middle Cambrian of Eastern Siberia and differs from it in the narrower fixigenae, the narrow posterior border, and in the less curved palpebral lobes. In addition, the pygidium of *C. solitus* is distinguished from that of *C. macrophthal-*

mus by the distinct border and the segmented pleural fields.

The specimens described here differ from the type specimens of *C. solitus* from the basins of the Buom-Pastakh and Khara–Tas–Ulakhan–Yuryakh rivers (Egorova and Savitsky, 1969) in the shape of the anterior cranidial margin, the distinct dorsal furrows, the less pronounced lateral furrows, and in the very narrow (sag.) anterior border.

O c c u r r e n c e. Middle Cambrian, Amgan Stage; Siberian Platform, basins of the Buom-Pastakh, Khara–Tas–Ulakhan–Yuryakh, and Daldyn rivers (western Anabar Region), Turukhanskii District, Altai–Sayany Folded Belt, Kuznetsky Alatau (Batenevsky Ridge).

L o c a l i t y a n d m a t e r i a l. Clayey–limestone series, 2320.5 m of depth (two cranidia), *Ovatoryctocara* Zone; limestone series, 2262.6 m of depth (two cranidia), unnamed zone; 2263.8 m of depth (one pygidium), *Kounamkites* Zone.

Family Utiidae Kobayashi, 1935

Genus *Chondragraulos* Lermontova, 1940

Subgenus *Chondragraulos* Lermontova, 1940

Chondragraulos (Chondragraulos) granulatus Tchernysheva, 1961

Plate 6, fig. 3

Chondragraulos granulatus: Tchernysheva, 1961, p. 167, pl. 20, figs. 1–6; Shabanov et al., 1987, p. 65, pl. 7, fig. 6; Ogienko and Garina, 2001, p. 142, pl. 22, figs. 8–10.

H o l o t y p e. TsNIGR Museum, no. 9181, cranidium (Tchernysheva, 1961, p. 167, pl. 20, figs. 1a–1c); Siberian Platform, Amga River; Middle Cambrian, Amgan Stage.

D e s c r i p t i o n. The cranidium is about 6 mm long, convex, subsquare, slightly transversely expanded, with an arched anterior margin. The cranidial length is about 0.8 of the cranidial width across the center of palpebral lobes. The glabella is trapezoid, narrowed strongly anteriorly, moderately convex, slightly raised above the fixigena, approximately as long as wide; the glabellar length is approximately 1.05 of the glabellar posterior width. The anterior end of the glabella is slightly rounded and somewhat blunted. The longitudinal profile of the glabella is moderately arched, with the highest point in the middle of the arch, regularly lowered to the anterior and posterior ends of the glabella. The transverse profile of the glabella is arched, abruptly descending on the lateral parts at dorsal furrows. Dorsal furrows are deep, wide (at most 0.25 mm), straight, converging strongly anteriorly, slightly curved opposite the posterior lateral lobes of the glabella. The preglabellar furrow is somewhat narrower and shallower than dorsal furrows, arched slightly anteriorly. The glabella is divided by four pairs of lateral furrows. S1 is widest, deepest, and longest (up to one-third of the glabellar width at the base), begins from dorsal furrows and directed obliquely posteriorly, with a weak curvature; at the ends, it bifurcates to form a short anterior and long posterior branches, which terminates short of reaching S0. S2 is shallower, narrower, and considerably shorter than S1, less inclined posteriorly and begins close to dorsal furrows. S3 is located opposite eye ridges, at a small distance from dorsal furrows; similar in width and depth to S2, but shorter than it and directed obliquely anteriorly. S4 is very shallow, hardly discernible, almost parallel to S3. S0 is very narrow and deepest at the sides of the occipital ring, from which it is directed obliquely posteriorly. In the central part, S0 is considerably shallower and expands somewhat anteriorly with a weak curvature. The occipital ring is short on the sides, longer in the middle, with the posterior margin arched posteriorly. The occipital ring is approximately 0.2 as long as the glabella. The highest point of the occipital ring is considerably lower than that of the glabella. The palpebral areas are wide, subtriangular, with a round external margin, convex, inclined slightly posteriorly, abruptly descend to dorsal and posterior border furrows. Across the center of palpebral lobes, the fixigena is approximately 0.6 as wide as the glabella at the same level. The highest point of the fixigena is near the eye ridge, lower than the highest point of the glabella, but higher than that of the preocular field. The posterior border furrow begins posterior to the point of junction between the occipital and dorsal furrows, significantly narrower than dorsal furrows. At the occipital ring, it is shallow and indistinct, expands somewhat toward the cranidial margin, and becomes as deep as dorsal furrows. The furrow is almost straight, directed slightly anteriorly at an angle of approximately 5°–7° to the transverse axis of the cranidium. The posterior border is only partly preserved, convex, narrow at the occipital ring, slightly expands toward the external margin. The palpebral furrow is indistinct, very shallow, shaped as a weak bend of the shield surface. The palpebral lobe is narrow, rather short, flattened, slightly arched, inclined externally and displaced slightly posteriorly; its center is opposite the outer end of S1 of the glabella. The palpebral lobe is approximately 0.35 as long as the glabella. The anterior and posterior ends of palpebral lobes are at equal distances from the longitudinal axis of the cranidium. The eye ridge is distinctly outlined only on the side of the frontal field; it is narrow, weakly convex, slightly arched, and slightly posteriorly oblique (inclination is 80°–85°). It adjoins the dorsal furrow, slightly compressing the glabella at the level of S4. The preglabellar field and anterior border form a united moderately convex surface, which downslopes smoothly anteriorly. Its highest point located at the preglabellar furrow is below the highest point of the glabella. The preocular field is long (exsag.), slightly convex, gently downsloping toward anterolateral corners of the cranidium. The anterior border furrow in the shape of a bend of the surface is observed at anterolateral corners of the cranidium. In general, the anterior part of the cranidium is long, almost half of the glabellar length; the preglabellar field length + anterior border width (sag.) ≈0.45 of the glabellar length. Anterior branch of the facial suture is arched, at a short distance slightly diverging from the palpebral lobe, and, further within the border, curves gently inwards. Posterior branches of facial sutures are not preserved.

The cranidial surface is regularly covered with well-pronounced tubercles, which do not come in contact with each other. The tubercles vary in size, reaching 0.15 mm. In the center of large tubercles, there are small pits (pores). The palpebral lobe and strongly developed furrow lacks sculpture.

C o m p a r i s o n   a n d   r e m a r k s. The species described is most similar to the type species *Chondragraulos minussensis* Lerm. (Lermontova, 1940, p. 143) and differs from it in the distinct division of the glabella by four pairs of lateral furrows, the coarse tuberculate sculpture, with pores in the center of tubercles, and in the more distinct eye ridges. The specimen from borehole Nizhny Imbak differs from the holotype of *Ch. (Ch.) granulatus* in the weaker tapering glabella, the arched anterior margin of the cranidium and glabella, and in the shorter preocular field.

O c c u r r e n c e. Middle Cambrian, Amgan Stage (lower part); Siberian Platform, basins of the Amga, Daldyn, and Nizhny Imbak rivers.

L o c a l i t y   a n d   m a t e r i a l. One incomplete cranidium from the clayey–limestone series, 2315.3 m of depth, *Ovatoryctocara* Zone.

Family Anomocaridae Poulsen, 1927

Genus *Chondranomocare* Poletaeva, 1956

***Chondranomocare bucculentum* Lazarenko, 1965**

Plate 6, figs. 12 and 13

Chondranomocare bucculentum: Lazarenko, 1965, p. 17, pl. 1, figs. 11–18; Egorova and Savitsky, 1969, p. 199, pl. 40, figs. 14–16; Savitsky et al., 1972, p. 80, pl. 17, figs. 5–7; Egorova et al., 1976, p. 110, pl. 30, figs. 8 and 9, pl. 49, figs. 12 and 21, pl. 51, fig. 8; Ogienko and Garina, 2001, p. 152, pl. 25, figs. 8 and 9.

H o l o t y p e. TsNIGR Museum, no. 8/8763, cranidium (Lazarenko, 1965, p. 17, pl. 1, fig. 11); Siberian Platform, lower reaches of the Olenek River; Middle Cambrian, Amgan Stage.

D e s c r i p t i o n. The cranidium is 5–8 mm long, slightly convex, with a gently rounded anterior margin. The cranidial width opposite the midlength of palpebral lobes is slightly greater than the cranidial length; the cranidial length is about 0.95 of cranidial width across the center of palpebral lobes. The glabella occupies about 65% of the cranidial extent, elongated, narrowed regularly anteriorly, with a rounded and slightly blunted anterior end, moderately convex, raising above fixigenae. The glabellar length is about 1.3 of the glabellar posterior width; the glabellar anterior width is about 0.75 of the glabellar posterior width. The longitudinal profile of the glabella is slightly arched, with a more abrupt and short anterior segment of the arch and very flat posterior segment. The highest point of the arch is displaced slightly anteriorly. The transverse profile of the glabella is slightly carinate. Lateral furrows are represented by three pairs. S1 is longest and widest of them, deep at dorsal furrows in the shape of extended depressions, directed obliquely posteriorly and terminates short of reaching the glabellar axis. S2 is of the same length, but considerably shallower and narrower than S1; sometimes, it is effaced. S3 is shortest and shallowest, begins opposite the eye ridges and is inclined slightly anteriorly. Dorsal furrows are distinct, relatively shallow, narrow, almost straight or slightly wavy at the points of junction with S1 and S2, gently pass into wider and shallower preglabellar furrow. At the lateral parts of the occipital ring, S0 is as deep as S1. Opposite the central part of the occipital ring, S0 becomes considerably shallower, very slightly posteriorly arched or straight. The occipital ring is short on the sides and slightly elongated in the middle (sag.), flattened, approximately 0.2 as long as the glabella. The highest point of the occipital ring is lower than that of the glabella. The palpebral areas are moderately wide, only slightly wider half glabellar width opposite the midlength of palpebral lobes, with a rounded external margin, flattened, inclined posteriorly and slightly to the glabella. Across the center of palpebral lobes, the fixigena is approximately 0.55 as wide as the glabella at the same level. The highest point of the the palpebral area is at its anterior margin, lower than the highest point of the glabella. The posterior part of the fixigena is considerably lowered to the posterior border furrow. Palpebral furrows are indistinct, visible under oblique illumination. Palpebral lobes are long, narrow, flat, strongly arched, and inclined posteriorly. The palpebral lobe is about 0.7 as long as the glabella. The anterior ends of palpebral lobes are closer to the glabella than the posterior ends, which terminate at a short distance from the level of the occipital furrow. The centers of palpebral lobes are located almost opposite the cranidial center. Eye ridges are short, oblique, distinct, slightly convex. The preglabellar field is moderately long (sag.), flattened, approximately 0.2 as long as the cranidium. The tropidium is in the shape of a distinct, narrow ridge extending almost parallel to the anterior border furrow, located in the middle of the preglabellar field or closer to the glabella. Opposite the anterior end of the glabella, the tropidium is smoothly posteriorly arched and, in the preocular fields, it is arched anteriorly. The preocular fields are almost flat, long (exsag.), slightly inclined toward anterolateral corners of the cranidium. The anterior border furrow is indistinct, in the shape of a smooth bend of the surface. The anterior border is flattened, raised above the preglabellar field, inclined posteriorly. The border is relatively narrow, slightly expanding opposite the glabella, where its width is significantly less than the preglabellar field length (sag.).

Anterior branches of facial sutures are long, arched, diverging before crossing the tropidium and, then, converging smoothly archedly. The cranidial surface is rough; one specimen retains very fine granulation.

R e m a r k s. A comparison of specimens from our collection with members of the species from other localities (Egorova and Savitsky, 1969; Savitsky et al., 1972; Ogienko and Garina, 2001) has shown that *C. bucculentum* is characterized by a wide range of individual variation. Relatively weak variations concern the clearness and number of furrows of the glabella, the shape of its anterior end ranges from rounded to slightly blunted, the preglabellar and preocular fields length, position of the tropidium, width (sag.) of the anterior border and fixigenae, and relative length of the glabella vary.

O c c u r r e n c e. Middle Cambrian, Amgan Stage; Siberian Platform, basins of the Buom-Pastakh, Daldyn (Western Anabar Region), Nekekit, and Khorbusuonka rivers (eastern Anabar Region), basin of the middle and lower reaches of the Lena River, Turukhanskii District (Nizhny Imbak River).

L o c a l i t y a n d m a t e r i a l. Clayey–limestone series, 2315.1 m of depth (one cranidium), 2320.5 m of depth (one cranidium), *Ovatoryctocara* Zone.

Chondranomocare irbinica **Repina, 1960**

Plate 6, figs. 7–11

Chondranomocare irbinica: Repina, 1960, p. 209, pl. 16, figs. 8 and 9; Egorova and Savitsky, 1969, p. 197, pl. 39, figs. 1–9; Savitsky et al., 1972, p. 79, pl. 17, figs. 1–4; Egorova et al., 1976, p. 111, pl. 34, fig. 12, pl. 47, figs. 10, 12, and 13, pl. 51, fig. 9; Shabanov et al., 1987, p. 69, pl. 8, fig. 8, pl. 9, fig. 7; Ogienko and Garina, 2001, p. 151, pl. 25, figs. 1–3.

H o l o t y p e. GIN (Geological Institute, Russian Academy of Sciences, Moscow), no. 3549/67, cranidium (Repina, 1960, p. 209, pl. 16, fig. 9); Altai–Sayany Folded Belt, eastern Sayan, Malaya Irba River, Kizir Formation; Middle Cambrian, Amgan Stage.

D e s c r i p t i o n. The cranidium ranges from small to medium-sized, 2.5–11 mm long, moderately convex, slightly longer than wide opposite the middle of palpebral lobes (the ratio of the cranidial width to its width across the center of palpebral lobes is about 1.1), with an arched anterior margin and almost straight posterior margin. The glabella is large, convex, carinate, occupies about 60% of the cranidium length, elongated, rectangular or narrowed slightly anteriorly, with a blunted anterior end. The glabellar length is about 1.48 of the glabellar posterior width; the glabellar anterior width is about 0.89 of the glabellar posterior width. The longitudinal profile of the glabella is slightly arched, with the highest point displaced slightly anteriorly. The anterior segment of the arch is very flat, gently descending to the anterior margin of the glabella. The glabella is divided by three or four pairs of lateral furrows. S1 is deepest, widest, and longest, begins at dorsal furrows, extends obliquely posteriorly, and, then, becomes smoothly arched, continuous in the axial part of the glabella. S2 is shorter and shallower than S1, begins from dorsal furrows, is oblique slightly posteriorly or directed almost transversely. S3 is very weak, shallow, shaped as small depressions, begins opposite eye ridges, at a distance from dorsal furrows, and is directed slightly anteriorly. S4 is narrow, short, and shallow, shaped as anteriorly directed notches opposite the inner ends of eye ridges. Dorsal furrows are distinct, narrow, moderately deep along the posterior part of glabella and shallower in its anterior part, straight with a weak arched curvature opposite L3. The preglabellar furrow is very shallow and indistinct. S0 is slightly deeper and wider than dorsal furrows, constant in width throughout its extent, arched slightly posteriorly. The occipital ring is short on the sides, strongly extended in the middle part, convex, with an arched posterior margin. The occipital ring is approximately 0.2 as long as the glabella. The central part of the ring is raised. The highest point of the occipital ring is lower than that of the glabella. The palpebral areas are 40% of the glabellar width opposite the midlength of palpebral lobes, with an arched external margin, slightly convex; have a weak inclination posteriorly and to the glabella. The highest point of the palpebral area is at its anterior margin, lower than the highest point of the glabella. The posterior part of the fixigenal field smoothly descends to a deep and wide posterior border furrow. The posterior border is slightly convex, narrow at the occipital ring, expanded more than twofold towards the cranidial sides (exsag.), and curves slightly posteriorly. Palpebral furrows are indistinct, in the shape of a bend of the shield surface. Palpebral lobes are long, narrow, flattened, gently curved, inclined to the glabella and posteriorly, smoothly pass into distinct, oblique, short, convex eye ridges. The palpebral lobe is approximately 0.65 as long as the glabella. Palpebral lobes have narrow longitudinal depressions extending parallel to their external margin (Pl. 6, fig. 11). The anterior ends of palpebral lobes are slightly closer to the glabella than the posterior ends, which are located almost opposite S0 and terminate short of reaching the posterior border; the centers of palpebral lobes are displaced slightly posteriorly from the cranidial center. The preglabellar field is moderately long (sag.), flat, inclined anteriorly. It is approximately 0.2 as long as the cranidium. The tropidium is in the shape of a distinct bend of the surface or ridge extending parallel to the anterior marginal furrow and located close to the middle of the preglabellar and preocular fields, or displaced slightly anteriorly. The preocular fields are long (exsag.), weakly convex, slightly inclined toward anterolateral corners of the cranidium. The anterior marginal furrow is indistinct, shaped as a bend of the surface. The anterior border is slightly narrow, convex, almost constant in width throughout its extent, raised above the preglabellar field, and inclined posteriorly.

Anterior branches of facial sutures are long, arched, diverging before crossing the tropidium and, then, converging abruptly archedly, slightly cutting the anterior border. Posterior branches of facial sutures are short, sharply diverging. The cranidial surface is fine-tuberculate. Large specimens have additional sculpture in the shape of thin longitudinal–radial curved veins on the fixigenal field.

The pygidium is medium-sized, suboval in outline, strongly transversely extended, convex, approximately 1.7 wider than long. Its anterior margin is more arched than the posterior margin. The posterior pygidial margin has a small gentle excavation in the middle. The pygidium is widest at the posterior margin. The axis is long, convex, raises above the pleurae, conical, indistinctly divided by relatively shallow furrows into three rings, except the articular halfring and terminal piece. The axis is approximately 0.75 as long as the pygidium. The anterior ring has a small transversely extended node. The pleural fields are slightly convex, narrowing from the anterior to posterior margin, divided into three distinct segments and terminal area; posterior to the axis, they become fused. The pleural field surface gently descends to the posterior margin. The border is relatively narrow and convex in the anterior part of the pygidium and strongly flattened and expanded in the posterior part. The pygidial surface is fine-tuberculate.

C o m p a r i s o n a n d r e m a r k s. *Chondranomocare irbinica* differs from the type species *Ch. bidjensis* Poletaeva, 1956 in the slightly carinate glabella divided by three pairs of furrows, the position of the tropidium in the middle of the preglabellar field or displaced slightly anteriorly, the wider palpebral areas, the presence of sculpture in the shape of thin radial veins on the fixigenal field, and in the slightly longer palpebral lobes.

The specimens described here differ from the holotype of *Ch. irbinica* from the Kizir Formation of the eastern Sayan (Repina, 1960) in the slightly longer and slightly anteriorly narrowed glabella with a faintly blunted anterior end, the better developed lateral furrows, the presence of thin radial veins on the preocular and preglabellar fields. The intraspecific variation observed in comparisons with specimens of this species from Kharatas and Udachnyi formations of the Anabar Region (Egorova and Savitsky, 1969; Ogienko and Garina, 2001) involves small differences in the length of the preocular and preglabellar fields, relative length of the glabella, width of palpebral areas, distinctness of the occipital node, length of S1, which are occasionally connected in the middle.

O c c u r r e n c e. Middle Cambrian, Amgan Stage; Siberian Platform, basins of the Buom-Pastakh, Daldyn (western and southern Anabar Region), Nekekit (east Anabar Region), and Nizhny Imbak (Turukhanskii District) rivers, middle reaches of the Lena River. Altai–Sayany Folded Belt, eastern Sayan, Malaya Irba River.

L o c a l i t y a n d m a t e r i a l. Clayey–limestone series, 2319.5 m of depth (two cranidia), 2326 m of depth (one cranidium), *Ovatoryctocara* Zone; limestone series, 2263 m of depth (one cranidium and one pygidium), unnamed zone.

Order Ptychopariida

Family Ptychopariidae Matthew, 1887

Genus *Kounamkites* Lermontova (in Tchernysheva, 1956)

***Kounamkites ?* cornutus Egorova, 1967**

Plate 8, figs. 1–4, 6, and 7

Kounamkites ? cornutus: Egorova, 1967, p. 76, pl. 9, fig. 13; Egorova and Savitsky, 1969, p. 58, fig. 16, p. 234, pl. 36, fig. 5.

H o l o t y p e. SNIIGGiMS, no. 251/10, incomplete cranidium (Egorova, 1967, pl. 9, fig. 13); Siberian Platform, Buom-Pastakh River; Middle Cambrian, Amgan Stage, *Kounamkites* Zone.

D e s c r i p t i o n. The cranidium is subsquare, convex, with two hornlike spines in anterolateral positions. The glabella is elevated above the cranidial surface, slightly carinate, narrowed toward the truncated anterior end, compressed somewhat on the sides. The glabellar width at the anterior end is 0.7 of the width at

E x p l a n a t i o n o f P l a t e 8

Figs. 1–4, 6, and 7. *Kounamkites ?* cornutus Egorova, 1967: (1, 2, 4) specimen TsSGM, no. 44/2078, cranidium with lost anterior border, ×6: (1) dorsal view, (2) lateral view, (4) anterior view; (3) specimen TsSGM, no. 29/2078, incomplete cranidium, ×5; (6) specimen TsSGM, no. 26/2078, pygidium, ×6; (7) specimen TsSGM, no. 29a/2078, external mold of the cranidium shown in fig. 3, with preserved hornlike spines on the anterior border, ×8.5; clayey–limestone series, depth of 2314.5 m, Amgan Stage, *Kounamkites* Zone.

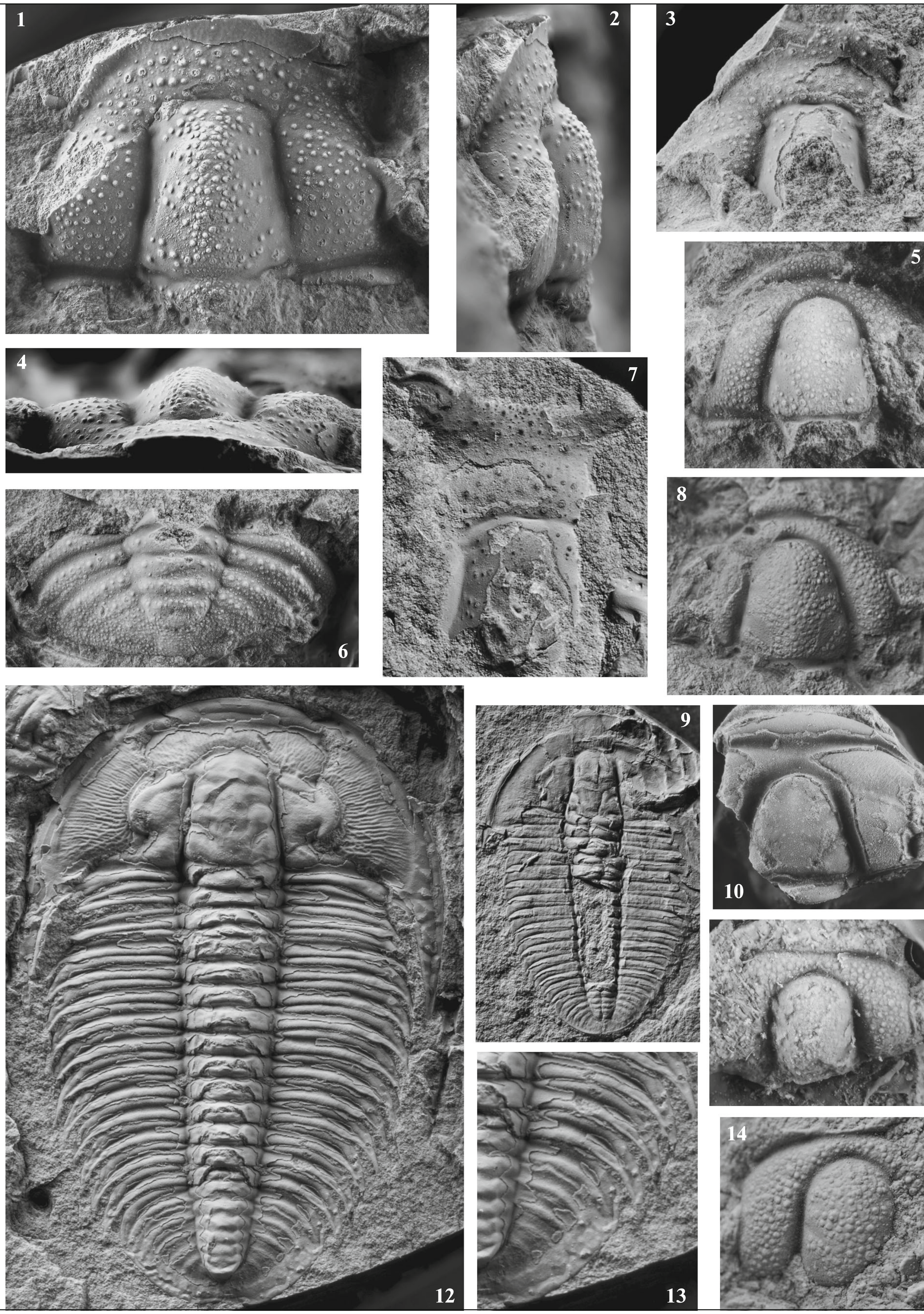
Figs. 5 and 8. *Solenopleura granulata* M. Romanenko in Romanenko et al., 1967: (5) specimen TsSGM, no. 69/2078, cranidium, ×8; (8) specimen TsSGM, no. 34/2078, cranidium, ×7; limestone series, depth of 2263 m, Amgan Stage, unnamed zone.

Figs. 9, 12, and 13. *Michaspis jucunda* Pegel et Shabanov, sp. nov.: (9) specimen TsSGM, no. 62/2078, distorted dorsal shield, ×3; (12) holotype TsSGM, no. 55/2078, dorsal shield, ×3.8; (13) pygidium and thoracic segments with large tubercles in the marginal part (detail of the specimen shown in fig. 12), ×4; clayey–limestone series, depth of 2318.85–2319.6 m; Amgan Stage, *Ovatoryctocara* Zone.

Fig. 10. *Solenopleura patula* Egorova in Egorova et al., 1976, specimen TsSGM, no. 22/2078, cranidium, ×2; limestone series, depth of 2256.8 m, Mayan Stage, *Solenopleura patula* Zone.

Figs. 11 and 14. *Solenopleura* sp., cranidia: (11) specimen TsSGM, no. 48/2078, ×15; (14) specimen TsSGM, no. 33/2078, ×11; limestone series, depth of 2262.8 m, Amgan Stage, unnamed zone.

Plate 8



the base. Three or four pairs of lateral furrows are marked by breaks in sculpture. S1 is most distinct, wide, long, inclined sharply posteriorly, closely approaching the occipital furrow. S2 is perpendicular to the longitudinal axis of the glabella. S3 and S4 are short, directed anteriorly. Dorsal furrows are narrow, deep, and slightly concave on the sides of the glabella. The preglabellar furrow is slightly shallower, straight. S0 is distinct, deeper on the sides, shallower in the middle, and curved slightly anteriorly. The occipital ring is subtriangular, about 0.3 as long (sag.) as the glabella. The palpebral areas are moderately convex; their surface is slightly inclined to the glabella and palpebral lobes. At the level of the midlength of palpebral lobes, palpebral areas are approximately 0.8 as wide as the glabellar. Posterolateral projections are moderately long and wide. Palpebral lobes are flat, crescent, raised above fixigenae, medial relative to the midlength of the glabella. They are 0.4 as long as the glabella. The palpebral furrow is shallow, defined by a bend of the surface. Eye ridges are poorly pronounced, long, straight, oblique. The preglabellar field is convex, regularly inclined to the glabella and anterior margin, 0.3 as long (sag.) as the glabella. The preocular fields are sharply inclined from eye ridges to anterolateral corners of the cranidium. The anterior marginal furrow is wide, shallow, shaped as a bend of the surface, gradually passing in a wide, slightly concave anterior border with two hornlike spines, only bases of which are preserved. These spines are distinctly visible in the external mold (Pl. 8, fig. 7) of one incomplete cranidium (Pl. 8, fig. 3). The border is wide (sag.), slightly concave along the outer margin; its central part is visible on the mold of this cranidium (Pl. 8, fig. 3). In other specimens, the border is not completely preserved. On the sides, the border is sharply narrowed. The posterior marginal furrow is deep, straight, narrower at dorsal furrows and expanded proximally. The posterior border is narrow, convex, transverse up to the level of palpebral lobes; it becomes flat, expands and curves backward near cranidial posterolateral margin.

Anterior branches of facial sutures are subparallel. Posterior branches are almost as long as anterior ones, moderately diverging. The cranidial surface is densely covered with very small tubercles, against a background of which, there are larger and more sparse tubercles not coming onto furrows. The preocular and preglabellar fields show radial venation extending onto the anterior marginal furrow.

The pygidium of this species is described here for the first time. It is lenticular in outline, transversely extended, convex. The greatest width of the pygidium is at the level of the posterior end of the axis. The axis is convex, raised above the pleural region, subconical, with a rounded posterior end, distinctly divided into four rings and terminal piece. The pleural fields are convex, narrowed from the anterior to posterior shield margins, fused posterior to the axis. Their surface abruptly descends to the border. There are three pairs of distinct pleurae with furrows, the fourth indistinct pair, and terminal area. The marginal furrow is narrow, shallow, accentuated by a bend of the surface. The border is slightly convex, narrow, especially opposite the posterior end of the axis. The pygidial surface, including furrows, is covered with very small tubercles; convex sites have larger and more sparse tubercles.

M e a s u r e m e n t s, mm. Specimen TsSGM, no. 26/2078, pygidium (Pl. 8, fig. 6): length without articulating half-ring, 3; maximum width, 6.5; axial length, 2; axial anterior width, 1.8; maximum width of border, 0.5; maximum width of pleural field, 1.5.

C o m p a r i s o n a n d r e m a r k s. The main differences of *Kounamkites ? cornutus* from the majority of species of *Kounamkites* are hornlike spines on the anterior border and the absence of a tropidium (transverse projection in the posterior part of the preglabellar and preocular fields). The cranidia from our collection differ from the holotype in the character of sculpture composed of numerous small and densely spaced large tubercles covering the cranidial surface. In *Kounamkites? cornutus* from the western Anabar Region, the cranidial surface is covered with small, densely spaced tubercles. A series of larger tubercles and weak radial venation are only observed on the preocular and preglabellar fields.

O c c u r r e n c e. Middle Cambrian, Amgan Stage, *Kounamkites* Zone; Siberian Platform.

L o c a l i t y a n d m a t e r i a l. Three cranidia and one pygidium from the clayey–limestone series, 2314.5 m of depth.

Family Solenopleuridae Angelin, 1854

Genus *Solenopleura* Angelin, 1854

Solenopleura patula Egorova in Egorova et al., 1976

Plate 8, fig. 10

Solenopleura patula: Egorova et al., 1976, p. 135; pl. 35, fig. 14; pl. 58, fig. 13; pl. 59, figs. 24 and 25; Shabanov et al., 1987, p. 79, pl. 9, fig. 15; Ogienko and Garina, 2001, p. 207, pl. 31, figs. 13 and 14.

H o l o t y p e. TsNIGR Museum, no. 983/11262, cranidium (Egorova et al., 1976, p. 135; pl. 58, fig. 13); Siberian Platform, Amga River; Middle Cambrian, Amgan Stage.

D e s c r i p t i o n. The cranidium is 14 mm long, transversely expanded, with a gently arched anterior margin. The glabella is subconical, with a rounded anterior end, slightly convex, with a weak axial carina. The glabellar width at the base is equal to its length. The glabellar sides are divided by three pairs of furrows; the posterior furrow consists of two branches. The posterior branch is deep, wide, inclined sharply posteriorly, reaching S0 and outlining the L1 lobe. The anterior branch is short, shallow, transverse. Dorsal furrows are very wide and deep. The preglabellar furrow is very wide and shallow. S0 is wide, deep, straight. The occipital ring is short (sag.), convex, with a straight posterior margin. The palpebrasl areas are slightly convex, raise from dorsal furrows to palpebral lobes somewhat above the glabella. At the level of the midlength of palpebral lobes, the palpebrasl area is 0.6 as wide as the glabella. The palpebral lobe is short, straight, medial relative to the midlength of the glabella; it is 0.2 as long as the glabella. Eye ridges are narrower and longer than palpebral lobes, oblique, 2.5 as long as palpebral lobes. The anterior marginal furrow is deep, with an almost straight anterior margin; in the middle of the length, its posterior margin curves posteriorly, fusing with the preglabellar furrow opposite the middle of the anterior end of the glabella. The anterior border is convex, sharply narrowing from the axial part of the cranidium to lateral sites. Its width (sag.) is 0.4 of the length of the preglabellar part of the cranidium. Anterior branches of facial sutures are subparallel anterior to eye ridges up to crossing with the border and, then, abruptly converge to the longitudinal axis of the cranidium. The cranidial surface, including furrows, is covered with very small tubercles with sparse larger tubercles.

Comparison and remarks. The cranidium described here displays all characteristics of *Solenopleura patula* observed in the structure of the glabella and anterior part of the cranidium. *Solenopleura patula* is very similar to *Solenopleura canaliculata* (Angelin, 1951) from the *Solenopleura brachymetopa* Zone of Sweden. The main differences are manifested in the structure of the frontal part of the cranidium and width of fixigenae. The anterior border of *S. canaliculata* is capelike, expanding towards the glabella; in *S. patula,* this border is almost straight in the middle. At the level of the midlength of palpebral lobes, palpebral areas of *S. patula* are narrower than the glabella at the same level; in *S. canaliculata,* they are identical in width.

Occurrence. Middle Cambrian, basal Mayan Stage, *Solenopleura patula* Zone; Siberian Platform.

Locality and material. One incomplete cranidium from the limestone series, 2256.8 m of depth.

Solenopleura granulata M. Romanenko in Romanenko et al., 1967

Plate 8, figs. 5 and 8

Solenopleura granulata: Romanenko et al., 1967, p. 164, pl. 2, figs. 24 and 25.

Holotype. West Siberian Geological Board, Novokuznetsk (ZSGU), no. 2058/148, cranidium (Romanenko et al., 1967, p. 164, pl. 2, figs. 24, 25); Altai–Sayany Folded Belt, Altai Mountains, vicinity of the Kiska Creek; lower part of the Middle Cambrian.

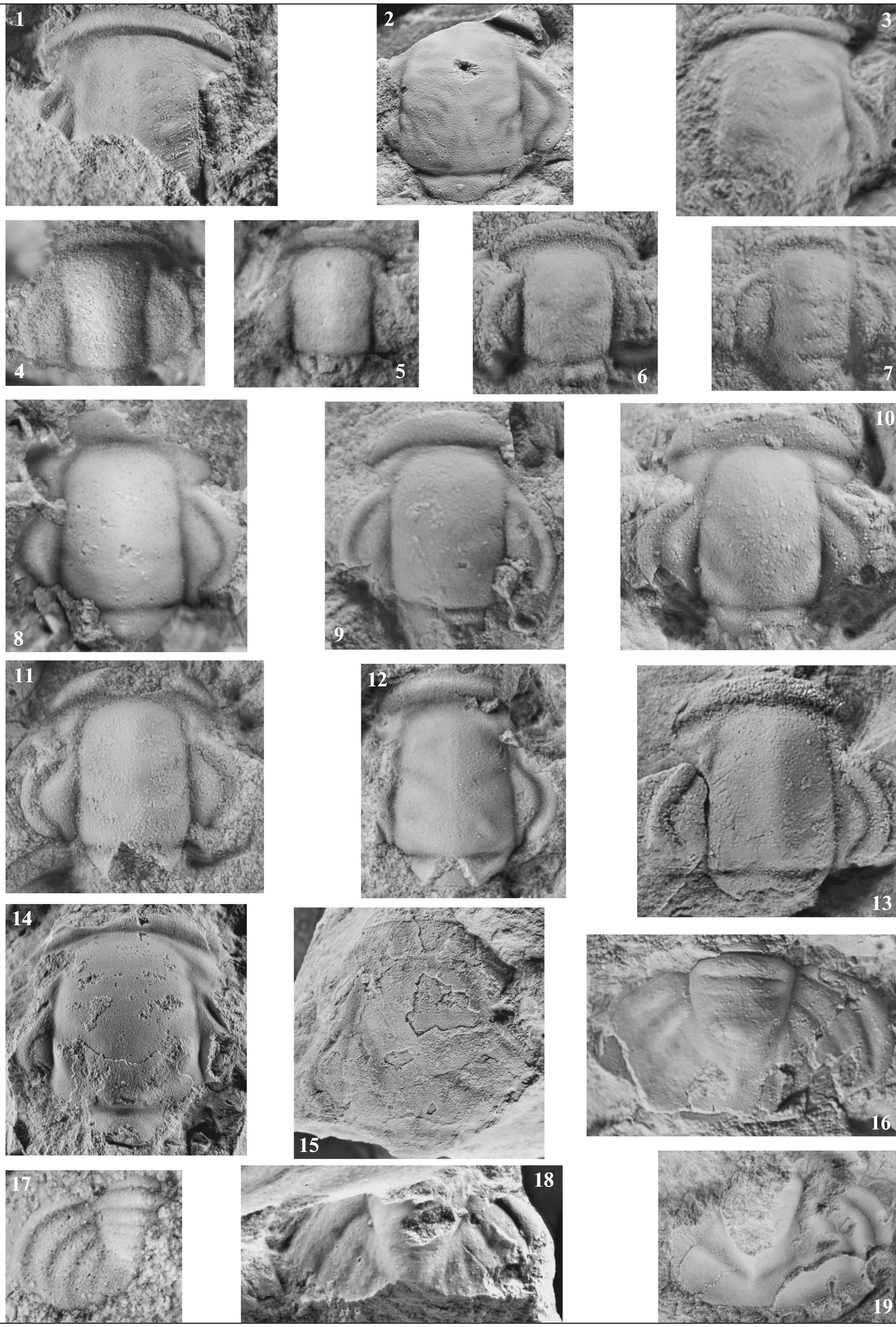
Description. The cranidium is about 5 mm long, convex, transversely expanded, with a rounded anterior margin. The glabella is strongly convex, with regularly curved profile (sag.), subconical, with a rounded anterior end. At the base, the glabella width is 1.6 times greater than its width at the anterior end and 0.8 of the glabellar length. Three pairs of wide and shallow lateral furrows are marked by a break in surface sculpture. S1 is longest and inclined sharply posteriorly; S2 is oblique slightly posteriorly; S3 is perpendicular to the longitudinal axis or inclined slightly posteriorly. S2 and S3 are positioned relatively close to each other. Dorsal furrows are deep, wide at the posterior end of the glabella, narrowed anteriorly. The preglabellar furrow is narrow and deep. S0 is wide and deep. The occipital ring is convex, posteriorly extended (sag.) in the middle. The palpebral areas are convex, but to a lesser extent than the glabella, 0.6 as wide as the glabella at the level of the midlength of palpebral lobes. Posterolateral projections are wide and short. The palpebral furrows are narrow and deep. Palpebral lobes are short (less than 0.4 of the glabellar length), convex, medial or anterior relative to the midlength of the glabella, inclined in parallel to dorsal furrows. Eye ridges are indiscernible. The preglabellar and preocular fields are convex, slightly inclined from the glabella to anterior border and, abruptly, to anterolateral corners of the cranidium. The preglabellar field (sag.) is 0.2 as long as the glabella and 1.4 of the anterior border width (sag.). The anterior marginal furrow is deep, gently arched, expanded in the middle. The anterior border is strongly convex, narrowed in the lateral segments. The posterior marginal furrow is very wide and deep. The posterior border is convex, with a bend at the level of the palpebral lobe. Anterior branches of facial sutures are slightly converging; within the border, they converge more strongly, cutting the lateral segments of the border. Posterior branches are diverging. The cranidial surface is covered with tubercles varying in size and lacking furrows.

Comparison and remarks. The cranidia from our collection are tentatively referred to the species *Solenopleura granulata* from the lower part of the Middle Cambrian of the Altai Mountains because of insufficiently complete initial description. They are similar in the anteriorly narrowed glabella with a regular curvature of the surface and division by three pairs of very weak lateral furrows; the width of palpebral areas at the level of the midlength of palpebral lobes; the position of palpebral lobes; absence of well-pronounced eye ridges; short preglabellar field, the length of which is slightly greater than the width (sag.) of the anterior border; and the tuberculate sculpture.

S. granulata is close to *S. zwerevi* Lermontova, 1940 from the Mayan Stage of the Siberian Platform and differs from it in the somewhat elongated glabella, arched anterior marginal furrow, the preglabellar field longer than the sagittal width of the anterior border, and in the absence of distinct eye ridges.

The cranidia described here is distinguished from *Solenopleura urjakhensis* Tchernysheva, 1953 from the Mayan Stage of the Siberian Platform by the slightly

Plate 9



elongated glabella, unbranched furrow S1, the absence of a pit in the preglabellar furrow or a small bulge in the preglabellar field near the anterior end of the glabella, which are characteristic of *S. urjakhensis*. In addition, in the last species, palpebral areas are sharply raised from the glabella to palpebral lobes, which are shifted anteriorly to a greater extent.

O c c u r r e n c e. Middle Cambrian, Amgan Stage; Altai–Sayany Folded Belt, Siberian Platform.

L o c a l i t y a n d m a t e r i a l. Limestone series, 2263 m of depth (three incomplete cranidia), 2262.8 m of depth (cranidium fragment); unnamed zone.

***Solenopleura* sp.**

Plate 8, figs. 11 and 14

C o m p a r i s o n a n d r e m a r k s. These 2–3-mm-long cranidia come from the same beds as the specimens of *Solenopleura granulata* described above. They differ from *S. granulata* in the subcylindrical shape of the glabella, the relatively wider palpebral areas (0.8 as wide as the glabella at the level of the midlength of palpebral lobes), the somewhat more posterior position of palpebral lobes, the narrow dorsal furrows, and in the presence of poorly pronounced eye ridges.

L o c a l i t y a n d m a t e r i a l. Two incomplete cranidia from the limestone series, 2262.8 m of depth; Middle Cambrian, Amgan Stage, unnamed zone.

Family Proasaphiscidae W. Zhang, 1963

Genus *Pseudanomocarina* Tchernysheva, 1956

Sudanomocarina: Jell in Jell and Robison, 1978, pp. 14–15.

R e m a r k s. We adhere to the concept of the genus *Pseudanomocarina* Tchernysheva accepted by Russian paleontologists.

***Pseudanomocarina plana* Tchernysheva, 1956**

Plate 9, figs. 7, 10, 12–16

Pseudanomocarina plana: Tchernysheva, 1956, p. 167, pl. 31, figs. 6–8; Tchernysheva, 1961, p. 188, pl. 22, figs. 1–10; Bognibova et al., 1971, p. 153, pl. 16, figs. 9 and 15; Egorova et al., 1976, p. 109, pl. 30, fig. 26, pl. 33, fig. 8, pl. 34, fig. 14, pl. 35, fig. 17, pl. 38, fig. 13, pl. 58, fig. 21, pl. 59, figs. 14, 15, and 18; Egorova et al., 1982, p. 92, pl. 53, figs. 4 and 6; Shabanov et al., 1987, p. 67, pl. 7, figs. 15–18, pl. 8, fig. 9; Lisogor, 2004, p. 45, pl. 14, fig. 6; Dalmatov and Vetluzhskikh, 2003, p. 68, pl. 60, figs. 7 and 11.

H o l o t y p e. TsNIGR Museum, no. 9181, cranidium (Tchernysheva, 1961, p. 188, pl. 22, figs. 1a, 1b); Siberian Platform, Amga River; Middle Cambrian, Amgan Stage, *Pseudanomocarina* Zone.

D e s c r i p t i o n. The cranidium is 1.4–13 mm long, flattened, subsquare in outline, with a gently curved anterior margin. The glabella is large, slightly narrowed toward the blunted anterior end, flat, divided by three pairs of very weak and short lateral furrows. Dorsal and preglabellar furrows and S0 are narrow and shallow. The occipital ring has a medial node at the posterior margin. The palpebral areas are slightly convex, slightly raised toward palpebral lobes. At the level of the midlength of palpebral lobes, they are less than 0.3 as wide as the glabella. Palpebral lobes are narrow, arched, slightly convex, about 0.6 of the glabellar length. Eye ridges are very short, oblique, identical in width to palpebral lobes, about 0.2 of their lengths. The preglabellar field is absent. The preocular fields are very slightly convex. The anterior marginal furrow is narrow, shallow, gently curved, formed by the bend of the surface. The anterior border is slightly convex. In the middle, its width (sag.) is about 0.2 of the glabellar length, remaining constant over most of its length (tr.). Anterior branches of facial sutures are moderately long, diverging from eye ridges; within the border, they converge, cutting from it small lateral segments. Posterior branches are short, diverging. The cranidial surface is fine tuberculate at high magnification.

The pygidium is 3.8 mm long, transversely expanded, with an abruptly curved anterior margin

E x p l a n a t i o n o f P l a t e 9

Figs. 1–6, 8, 9, 11, 17–19. *Pseudanomocarina* sp.: (1–3) incomplete cranidium: (1) specimen TsSGM, no. 15/2078, ×8, depth of 2260 m; (2) specimen TsSGM, no. 13/2078, ×4.5, depth of 2258.4 m; (3) specimen TsSGM, no. 8/2078, ×4, depth of 2262.8 m; Amgan Stage, unnamed zone; (4–6, 8, 9, 11, 17–19) immature cranidia: (4) specimen TsSGM, no. 40/2078, ×18.5, depth of 2258.2 m, Amgan Stage, unnamed zone; (5) specimen TsSGM, no. 68/2078, ×15, depth of 2254 m, Mayan Stage, *Solenopleura patula* Zone; (6) specimen TsSGM, no. 16/2078, ×13, depth of 2260 m, Amgan Stage, unnamed zone; (8) specimen TsSGM, no. 27/2078, ×17, depth of 2262.8 m, Amgan Stage, unnamed zone; (9) specimen TsSGM, no. 7/2078, ×15.7, depth of 2262.8 m, Amgan Stage, unnamed zone; (11) specimen TsSGM, no. 19/2078, ×11, depth of 2254 m; Mayan Stage, *Solenopleura patula* Zone. Pygidia: (17) specimen TsSGM, no. 47/2078, ×24, depth of 2262.8 m, Amgan Stage, unnamed zone; (18) specimen 17/2078, ×7, depth of 2257.1 m, Amgan Stage, unnamed zone; (19) specimen TsSGM, no. 21/2078, ×5, depth of 2254 m, Mayan Stage, *Solenopleura patula* Zone; limestone series.

Figs. 7, 10, 12–16. *Pseudanomocarina plana* Tchernysheva, 1956: (7) specimen TsSGM, no. 4/2078, juvenile cranidium, ×18.5, depth of 2247.5 m, *Solenopleura patula* Zone; (10) specimen TsSGM, no. 12/2078, cranidium, ×12, depth of 2244.42 m, *Dorypyge olenekensis–Corynexochus perforatus* Zone; (12) specimen TsSGM, no. 6/2078, cranidium, ×8, depth of 2247.5 m, *Solenopleura patula* Zone; (13) specimen TsSGM, no. 5/2078, cranidium, ×9, depth of 2247.5 m, *Solenopleura patula* Zone; (14) specimen TsSGM, no. 23/2078, cranidium, ×4, depth of 2244.42 m, *Dorypyge olenekensis–Corynexochus perforatus* Zone; (15) specimen TsSGM, no. 10/2078, cranidium, ×3, the same locality; (16) specimen TsSGM, no. 11/2078, pygidium, ×8, the same locality; limestone series, Mayan Stage.

and slightly curved posterior margin with an indentation opposite the posterior end of the axis. The maximum width of the pygidium is positioned closer to the posterior margin. The axis is subconical, divided into four rings and terminal piece. The anterior ring is most convex and distinctly differentiated; other rings are almost completely fused. The posterior end of the axis terminates short of reaching the border and is connected to it by a longitudinal postaxial ridge. Dorsal furrows are narrow and distinct anteriorly, becoming hardly discernible along the posterior part of the axis. The pleural fields are slightly convex, inclined from the axis to posterolateral corners of the pygidium, divided by pleural furrows into three ribs and terminal area. The border is slightly concave, marked by a bend of the surface. The width of the border at posterolateral corners of the pygidium is 0.2 of the pygidial length. The border passes into a narrow band opposite the posterior end of the axis. Pleural furrows pass onto the border. The pygidial surface is fine tuberculate at high magnification.

C o m p a r i s o n a n d r e m a r k s. A juvenile 1.4-mm-long cranidium (Pl. 9, fig. 7) found along with adult specimens is tentatively referred to this species. It differs from mature forms in the cylindrical outline of the glabella with hardly recognized division, the wide palpebral areas, the regularly arched palpebral lobes. Other characters, including surface sculpture, correspond to adult cranidia.

The specimens described here display a number of characters typical for *Pseudanomocarina plana;* therefore, they are referred to this species; the cranidium is slightly convex, flattened; the glabella is slightly convex, narrowed slightly anteriorly; lateral furrows are only visible at a particular illumination; palpebral areas are very narrow and slightly convex; palpebral lobes are flattened; palpebral furrows are shallow, accentuated by a bend of the surface; the anterior border is slightly slightly convex, horizontal, constant in width (sag., exsag.); the anterior marginal furrow is very shallow, formed by a bend of the surface. The pygidia of *P. plana* from our and type collections are identical in structure.

In the original description of the species, the following characters, which are not observed in specimens from our collection are regarded as distinctive: the elongated outline of the cranidium, rounded anterior end of the glabella, and presence of a preglabellar field. However, some figures of *Pseudanomocarina plana* provided by Tchernysheva (1961) show certain deviant characters typical for cranidia from our collection: subsquare cranidium, in which the width at the level of the midlength of palpebral lobes is equal to its length (Tchernysheva, 1961, pl. 22, fig. 4); glabella with a blunted anterior end (Tchernysheva, 1961, pl. 22, figs. 4, 5, 8); very short (sag.) preglabellar field formed by fusion of preglabellar and anterior marginal furrows (Tchernysheva, 1961, pl. 22, fig. 3). Practical absence of the preglabellar field is observed in many cranidia of *P. plana* figured by Egorova et al. (1976), including those from the Amgan Formation. All this enables the assignment of the cranidium from our collection to the species *Pseudanomocarina plana*.

Specimens from the Amgan Formation on the Amga River have a smooth surface. Some shields of this species from borehole Nizhny Imbak 219 have a fine tuberculate (granular) surface, which is only visible at high magnification.

O c c u r r e n c e. Middle Cambrian, Amgan Stage and basal Mayan Stage; Siberian Platform, Altai–Sayany Folded Belt.

L o c a l i t y a n d m a t e r i a l. Limestone series, 2244.23–2244.42 m of depth (three cranidia and one pygidium); Mayan Stage, basal *Dorypyge olenekensis–Corynexochus perforatus* Zone. Limestone series, 2247.5 m of depth (three cranidia); Mayan Stage, upper part of the *Solenopleura patula* Zone.

***Pseudanomocarina* sp.**

Plate 9, figs. 1–6, 8, 9, 11, 17, 18, and 19

D e s c r i p t i o n. The cranidia range from 1.6 to 9 mm of length, moderately convex, subsquare. The glabella is convex, carinate, slightly narrowed toward blunted rounded anterior end. The sides of the glabella are divided by three pairs of furrows, which are deepened pitlike and uncertainly bifurcated in the internal ends. Dorsal furrows are distinct; the preglabellar furrow is poorly pronounced; the gently inclined anterior end of the glabella is fused with the preocular fields. The occipital ring has a medial node. The palpebral areas are slightly convex, slightly raised toward palpebral lobes. The palpebral lobes are slightly convex, curved, about 0.6 as long as the glabella. Palpebral furrows are wide, moderately deep, distinct, sharply curved. Eye ridges are extremely short, 0.1 as long as palpebral lobes. The preglabellar field is absent. The anterior marginal furrow is narrow, distinct, arched. The anterior border is narrow, constant in width (sag., exsag.), convex, arched. The border width (sag.) is 0.13–0.2 of the glabellar length. Anterior branches of facial sutures are short, diverging, on the border, converging, cutting off small corners. The cranidial surface is fine tuberculate at high magnification.

The collection contains two pygidia about 4 and 5 mm of length, with a strongly damaged surface (Pl. 9, figs. 18, 19) and one incomplete pygidium 1 mm of length (Pl. 9, fig. 17). The pygidia are transversely extended, with an abruptly curved anterior margin and gently curved, almost straight posterior margin, possibly with an indentation opposite the posterior end of the axis. In the smaller specimen, a convex subconical axis is preserved and divided into three distinct rings and a terminal piece. The pleural fields are flat, divided by pleural furrows into four ribs and a terminal area. The axis terminates short of the posterior margin of the shield. The border is narrow (sag., exsag.), concave, restricted by a bend of the surface.

V a r i a b i l i t y. In specimens having 1.6–1.8-mm-long cranidium (Pl. 9, figs. 4, 5), the glabella is slightly expanded at the anterior end; in 2.3–2.6-mm-long cranidia (Pl. 9, figs. 6, 8, 9), the glabella is cylindrical. Palpebral lobes are regularly arched in 1.6–2.6-mm-long cranidia (Pl. 9, figs. 4–6, 8, 9) and, in 3.5-mm-long and larger cranidia, (Pl. 9, figs. 1–3, 11), they are sharply curved. The division of the glabella is rather distinct in cranidia more than 5 mm of length. At the level of the midlength of palpebral lobes, palpebral areas are 0.2 as wide as the glabella of adults and 0.3–0.4 as wide as the glabella in immature specimens. The anterior border is slightly convex in small cranidia less than 3.5 mm of length and convex in adults.

C o m p a r i s o n a n d r e m a r k s. Mature specimens of *Pseudanomocarina* sp. distinctly differ from cranidia of *Pseudanomocarina plana* occurring stratigraphically higher in the limestone series of borehole Nizhny Imbak 219.

In *Pseudanomocarina* sp., the cranidium, glabella, and anterior border are convex; the anterior end of the glabella is rounded, not delineated by a preglabellar furrow, and is fused with preocular fields; furrows of the glabella are distinct, deepened pitlike and indistinctly bifurcated in the internal ends; the eye ridge is 0.1 as long as the palpebral lobe; the anterior marginal furrow is distinct; and the anterior border is narrow and convex.

In *Pseudanomocarina plana,* the cranidium, glabella, and anterior border are flattened; the anterior end of the glabella has a straightened anterior margin delineated by a weak preglabellar furrow; furrows of the glabella are short, visible only at a particular illumination; the eye ridge is 0.2 as long as the palpebral lobe; the anterior marginal furrow is very shallow, marked by a bend of the surface; the anterior border is slightly convex.

The cranidia described are most similar to members of *Pseudanomocarina aojiformis* Tchernysheva, 1956 from the upper part of the Amgan Stage and basal Mayan Stage (*Kounamkites* and *Tomagnostus fissus* zones) of the Middle Cambrian of the Siberian Platform. They are similar in the subsquare outline of the cranidium, almost rectangular shape of the glabella with a weak carination, the character of division of the glabella, and the absence of a preglabellar field. The main difference of *Pseudanomocarina* sp. from this species and from the majority of other known species of this genus is the strongly convex anterior border of the cranidium. An exception is *Pseudanomocarina serotina* Ogienko (Ogienko, 1991, pp. 28–29, pl. 2, figs. 5–7) from the Mayan Stage of the southern Anabar Region. However, in *P. serotina,* the glabella is relatively narrower, flat, and slightly compressed at the eye ridges, the preglabellar field is present, and the anterior border is regularly narrowed from the center to sides. The specimens from our collection apparently belong to a new species of *Pseudanomocarina;* however, the establishment of this new species requires additional material.

L o c a l i t y a n d m a t e r i a l. Limestone series, 2254 m of depth (two immature cranidia, one incomplete pygidium); Middle Cambrian, basal Mayan Stage, *Solenopleura patula* Zone. Limestone series, 2257.1 m of depth (one incomplete pygidium), 2258.2 m of depth (two immature cranidia), 2258.4 m of depth (one incomplete cranidium), 2260 m of depth (one incomplete cranidium and one immature cranidium), 2262.8 m of depth (one incomplete cranidium, two immature cranidia and one pygidium); Middle Cambrian, Amgan Stage, unnamed zone.

Genus *Michaspis* Egorova et Savitsky, 1968

Michaspis jucunda Pegel et Shabanov, sp. nov.

Plate 8, figs. 9, 12, and 13

E t y m o l o g y. From the Latin *jucundus* (pleasant, attractive).

H o l o t y p e. TsSGM, no. 55/2078, dorsal shield (Pl. 8, figs. 12, 13; designated here); northwestern Siberian Platform, Nizhny Imbak River Basin, borehole Nizhny Imbak 219, clayey–limestone series, 2318.8–2319.6 m of depth; Middle Cambrian, Amgan Stage, *Ovatoryctocara* Zone.

D i a g n o s i s. Cranidium with gently rounded anterior margin, straightened opposite anterior end of glabella. Length of preglabellar field equal to 0.9 of width (sag.) of anterior border. Palpebral lobes short, crescent, as wide as eye ridges. Palpebral areas half as wide as glabella at level of midlength of palpebral lobes. Genal spines reaching level of posterior margin of fifth thoracic segment. Thorax consisting of 13 segments. Axis of pygidium consisting of six rings and terminal piece. Pleural fields divided into five pleurae and terminal area. Surface sculpture of cephalon fine tuberculate, with radial venation on preglabellar and preocular fields and librigenal fields. Large scattered tubercles visible on border and spines of librigenae, at ends of thoracic segments, and on border of pygidium.

D e s c r i p t i o n. The dorsal shield is elliptical in outline. The cephalon is semioval; the cranidium is subsquare. The glabella is convex, slightly narrowed toward the blunted rounded anterior end. The glabella is 0.6 as long as the cranidium. The glabellar width at the base is 0.8 of the glabellar length; at the level of furrow S1, it is 0.7 of the glabellar length; and at the level of the anterior end, 0.6 of the glabellar length. The glabella is divided by three pairs of distinct and hardly discernible fourth pair of lateral furrows. Furrow S1 has a bifurcation. The posterior branch is inclined abruptly posteriorly, closely approaching the occipital furrow. The anterior branch is short, shallower, directed perpendicular to the longitudinal axis of the cranidium. Furrows S2 and S3 are transverse, deepened in the internal ends, not connected in the middle of the glabella. Furrow S4 is very short, shallow, directed anteriorly. Dorsal furrows are narrow, deep, straight. The preglabellar furrow is shallower. S0 is narrow, relatively shallow, straight. The occipital ring is convex, with a straight posterior margin and medial node. The occipital ring is constant in width (sag.) throughout its extent and 0.2 of the glabellar length. The palpebral areas are convex, raised from the glabella toward palpebral lobes. The greatest width of the palpebral area is 0.5 of the glabellar width at the level of the midlength of palpebral lobes and 0.4 of the glabellar width at the base. Postocular areas are convex and wide (exsag.). Posterolateral projections are flat and narrow at the distal ends. Palpebral lobes are relatively narrow, convex, abruptly curved, slightly raised above the palpebral areas, short, 0.4 as long as the glabella. Their ends are located within the same vertical (exsag.) plane. Palpebral furrows are deepened at the ends of palpebral lobes, becoming shallower in the middle, where palpebral lobes are almost fused with palpebral areas. Eye ridges are distinct, equal in width to palpebral lobes, slightly inclined, 0.8 as long as palpebral lobes. The preglabellar field is moderately convex. Preocular fields and more convex, slightly inclined to the anterolateral corners of the cranidium. The length of the preglabellar field is 0.2 of the glabellar length and 0.9 of the width (sag.) of the anterior border. The anterior marginal furrow is accentuated by a bend of the surface. It is shallow, curved, narrow on the sides and somewhat expanded and straight in the middle part. The anterior border is wide, moderately convex, raised, with straightened anterior and posterior margins in the site opposite the glabella and with a sharp narrowing in lateral sites. The central part of the border opposite the anterior end of the glabella has an elongated depression, which probably resulted from distortion of the surface. Posterolateral furrows of the cranidium are deep, straight, wide, especially in the lateral sites. The posterior borders are narrow (exsag.), convex near the occipital ring, and flattened in the lateral sites, which expand posteriorly. Anterior branches of facial sutures are long, arched, diverging at an angle of 28°. Within the border, they converge to the level of anterolateral corners of the glabella, cutting lateral sites of the anterior border. Posterior branches are long, abruptly diverge. The diverging part of anterior branches of facial sutures is 0.6 as long as posterior branches.

The librigena has a wide, slightly convex field and a wide lateral border. The lateral border is moderately convex along the internal margin and slightly concave at the external margin. The width of the librigena is 0.4 of its length; the width of the lateral border is 0.3 of the maximum librigenal width. The librigenal spine reaches the level of the posterior furrow of the fifth thoracic segment; the spine is 0.66 as long as the librigena.

The thorax consists of 13 segments with wide (tr.) pleurae terminating into short spines. The axial ring (tr.) is as wide as the pleura of the segment without a terminal spine. The axial rings have medial nodes. The rings and pleurae decrease in width toward the posterior margin of the thorax. The first axial ring is 1.3 times as wide as the thirteenth ring and respective pleurae are 1.6 times as wide.

The pygidium is oval in outline, with rounded anterior and posterior margins. The pygidium is 0.2 as long as the dorsal shield and 0.6 as long as the cranidium. The axis is convex subconical, with a rounded blunt posterior end, consists of six rings and a terminal piece. The axial rings have medial nodes. The maximum width of the axis at the anterior end is 0.6 of its length. The pleural fields are slightly convex, narrowed posteriorly to complete disappearance at the posterior end of the axis, distinctly divided by pleural and interpleural furrows into five pleurae and terminal area. Furrows pass onto the border of the pygidium. The border is marked by a bend of the surface. The border is flat and slightly concave, one-third as wide as the pleural field at the anterior margin of the shield and narrow toward the posterior margin. Opposite the posterior end of the axis, the posterior pygidial margin has a weak curvature toward the axis.

The preserved sites of the external surface of the cranidium show fine-tuberculate sculpture. The preglabellar, preocular and, librigenal fields have a distinct branching radial venation. The lateral borders and spines of librigenae, ends of thoracic segments, and border of the pygidium have large scattered tubercles (Pl. 8, figs. 12, 13).

M e a s u r e m e n t s, mm. Holotype TsSGM, no. 55/2078 (Pl. 8, fig. 12), dorsal shield: length, 27; cranidial length, 8.9; cranidial anterior width, ~9; cranidial width across center of palpebral lobes, 9.5; cranidial posterior width, ~15; anterior border width (sag.), 1.2; preglabellar field length, 1.1; glabellar length, 5.5; occipital ring length (sag.), 1.0; occipital ring width (tr.), 4.5; glabellar posterior width, 4.5; glabellar width across S1, 4; glabellar width across S2, 3.8; glabellar anterior width, 3.34; L1 length, 1.5; L2 length, 1.0; L3 length, 1.0; fixigenal width across center of palpebral lobes, 2.0; fixigenal width across posterior ends of palpebral lobes, 1.5; fixigenal width across anterior ends of palpebral lobes, 1.7; palpebral lobe length, 2.2; palpebral lobe width, 0.5; eye ridge length, 1.9; anterior branch of suture length, ~2.5; posterior branch of suture length, 4.0; librigenal length, 9.0; maximum width of librigena, 3.5; lateral librigenal border width, 1.1; librigenal spine length, 6.0; basal width of librigenal spine, 2.0; maximum width of librigenal field, 3.0; thoracic length, 12.4; axial width of the first thoracic segment, 4.5; axial length of the first thoracic segment, 0.8; width of the first thoracic segment, 14.5; axial width of the thirteenth thoracic segment, 3.5; width of the thirteenth thoracic segment, 9; pleural width of the first thoracic segment, 4.5; pleural width of the thirteenth thoracic segment, 3.5; pygidial length, 5.7; axial length, 4.5; anterior width of axis, 3.0; pygidial border width, 1.0

Comparison and remarks. The dorsal shields described here are referred to the genus *Michaspis* Egorova et Savitsky, 1968 (Egorova and Savitsky, 1968) based on the combination of the following characters typical for the genus: the cranidium is subsquare with a very gently curved anterior margin straightened opposite the glabella; the glabella is large, slightly narrowed toward the rounded blunt anterior end, divided by three or four pairs of distinct furrows, of which S1 bifurcates; dorsal furrows are sharp; palpebral areas are relatively narrow, raising from the glabella to palpebral lobes; palpebral lobes are relatively small, curved; eye ridges are distinct, oblique; there is a well-developed preglabellar field; the anterior border is wide opposite the glabella, moderately convex, elevated; branches of facial sutures diverge; the thorax consists of 13 segments; the pygidium shows distinct division into five pleurae, the axis consisting of six rings and a terminal piece, and well-pronounced border; sculpture of the cranidium is fine tuberculate, the preglabellar, preocular and librigenal fields display a distinct branching radial venation.

The new species is most similar to the type species *Michaspis librata* Egorova et Savitsky, 1968 (Egorova and Savitsky, 1968) from the lower beds of the Mayan Stage of the Suluda Formation of the western Anabar Region and differs from it in the anterior margin of the cranidium straightened for a shorter distance, only opposite the anterior end of the glabella; palpebral areas are slightly wider, 0.5 of the glabellar width at the level of the midlength of palpebral lobes; in *M. librata*, this ratio is less than half. The genal spines are longer, reaching the level of the fifth thoracic segment, while in *M. librata,* it reaches the third segment. In *M. librata,* the preglabellar field is frequently absent or considerably shorter (sag.). In the new species, the anterior border is narrowed in lateral sites; in *M. librata,* it is constant in width (sag., exsag.). Diverging parts of branches of facial sutures of the type species are equal in length, while in the new species, posterior branches are longer than anterior branches. Converging parts of anterior branches of facial sutures of *M. librata* are short, cut off small corners of the anterior border. In the new species, these parts of branches are longer, gently converge on the border, remaining only the border segment opposite the glabella. The number of thoracic segments also differs; the new species has 13 and the type species has 12. The new species displays radial venation on the preglabellar and preocular fields and rare tubercles along the margin of the dorsal shield, which are not observed in *M. librata*.

Michaspis lunata Ogienko (Ogienko and Garina, 2001) from the basal beds of the Mayan Stage of the Udachnyi Formation of the southern Anabar Region differs from the new species in the long gently curved palpebral lobes, the semicircular and narrower palpebral areas composing one-third of the glabellar width at the level of the midlength of palpebral lobes, the straight anterior margin of the cranidium, the anterior border of the cranidium constant in width (sag., exsag.), the branches of facial sutures equal in length, the proportionally narrower eye ridges, flat preglabellar and preocular fields, very short preglabellar field, and in the sculpture composed of sparse tubercles.

Michaspis prisca Ogienko (Ogienko and Garina, 2001) from the *Schistocephalus* Zone of the Amgan Stage of the Udachnyi Formation of the southern Anabar Region differs from the new species in the flattened cranidium, the posteriorly expanding occipital ring, narrow eye ridges, semicircular outline of palpebral areas, the oval shape of the glabella, and in the flat and elevated preglabellar field.

Locality. See Holotype.

Material. One well-preserved dorsal shield and one distorted dorsal shield.

Explanation of Plates

All specimens come from Borehole Nizhny Imbak 219; Krasnoyarsk Region, Nizhny Imbak River Basin, northwestern Siberian Platform; Middle Cambrian.

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