CARBONIFEROUS AND PERMIAN OF THE SOUTHERN URALS.*

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(A review based on work by V. E. Ružencev and other authors.)

ABSTRACT.

East of Orenburg in Southern Urals, where most of Karpinsky's Artinskian ammonoids came from, Ružencev has worked out the most complete continuous section of the marine late Paleozoic in the Ural Mountains. Ammonoids are found throughout this section from the Viséan through Namurian, Moscovian, Uralian, and Artinskian. In the same beds fusulinids are present from the Moscovian upward to, and including, the Artinskian. The Uralian is subdivided by Ružencev into a lower part characterized by ammonoids and fusulinids comparable to those of the Cisco and Lower Wolfcamp (now top of Gaptank) of Texas (and the Virgil of Kansas), and into an upper part, which he calls Sakmarian (new name). The Sakmarian is characterized by inflated schwagerinas comparable to those in the Upper Wolfcamp (Wolfcamp in the restricted sense, which corresponds to the lower part of the Big Blue of Kansas) and to the Somohole beds of Timor. The Sakmarian directly underlies the Artinskian and contains primitive medlicottids and other Permian-like ammonoids, the ancestors of the ammonoids of the Artinskian beds above. In the latter beds are found also elongated pseudofusulinas.

INTRODUCTION.

In the last decade, the classical area of the marine facies of the Upper Carboniferous (Uralian) and the Permian along the western slope of the Ural Mountains has again become a subject of enthusiastic research on the part of numerous Russian geologists and paleontologists. Much of this work remains unknown to American geologists because, although most papers by Russian authors are accompanied by summaries in English or some other language, the extensive Russian literature to which reference is made, the brevity of the abstracts, and the contradictory conclusions arrived at by various Russian authors make the task of putting together the new information almost impossible for a busy American geologist unfamiliar with the language and the geography of Russia.

A very good account of the principal Moscovian-Uralian deposits of Russia, based on an up-to-date study of brachiopods and some fusulinids, which are the most important fossils from these rocks, has recently been given to the readers of This Journal by one of the most competent modern Russian spe-

* The conclusions reached in this paper will be discussed in the May number of the Journal by Carl O. Dunbar, Arthur K. Miller, and F. B. Plummer.

cialists on the Moscovian-Uralian problem, Mrs. Semichatova. The present review is devoted chiefly to the work of V. E. Ružencev (pronounced Rujéntsev) and to that of a few other workers in the southern Urals. Their work in this area is reviewed in preference to other important modern papers on the Uralian and Permian of Russia because Ružencev has

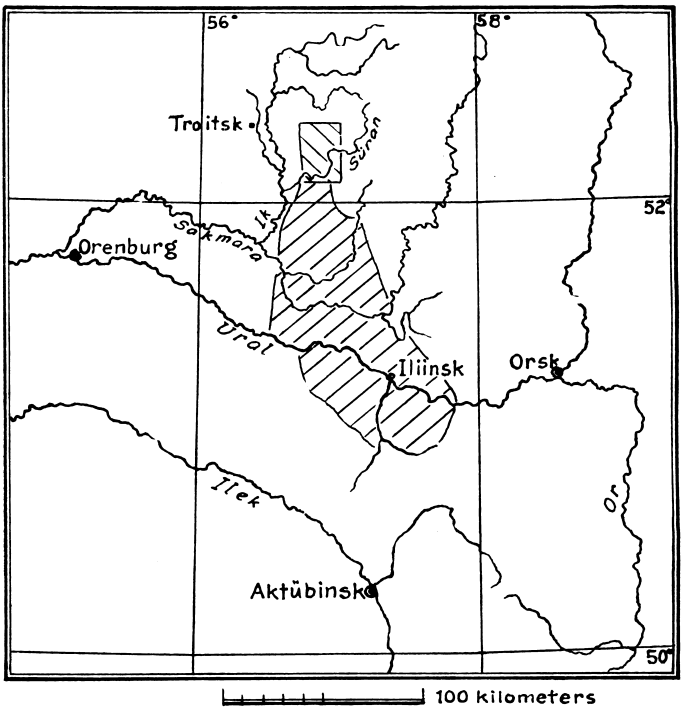

Fig. 1. Location of the area studied by V. E. Ružencev, E. V. Voinova, and their associates, and of the Süran River area studied by V. N. Krestovnikoff and his associates.

shown that here is developed a nearly complete marine succession of the Carboniferous and Permian, characterized throughout by an abundance of ammonoids and fusulinids. Except for meager ammonoid faunas described by Fredericks from the uppermost Uralian at Krosnoufimsk,[1] nowhere else in the Urals or in Europe do ammonoids occur commonly in

[1] Fredericks, G.: Mém. Com. Géol., Petrograd, n. s., vol., 109, 1915; Ann. Russ. Pal. Soc., pp. 73-94, 1918.

beds of Uralian age. In the southern Urals, however, they are found in abundance and in good preservation, and, according to Ružencev, they show distinct affinity to the contemporaneous forms from Texas and Timan. Together with the ammonoids, numerous fusulinids were collected both from the Uralian and from the Artinskian beds of the southern Urals, while the Artinskian of the central and northern Urals has never yielded any fusulinids. These occurrences of guide fossils make the Uralian and Artinskian rocks of the southern Urals most important for correlation with the American Late Paleozoic.

EXPLORATIONS IN THE SOUTHERN URALS.

Geologic explorations in the southern Urals by V. E. Ružencev cover a territory that is about 140 kilometers north-south and 30-50 kilometers east-west. The area comprises that part of Orenburg and Aktübinsk districts east of Orenburg and north of Aktübinsk, and is traversed in an east-west direction by the Ural and Sakmara rivers. Its Late Paleozoic rocks are folded in many parallel anticlines and synclines that run in a general north-northwest—south-southeast direction while the whole system of folds dips toward the south and west. Thus, generally speaking, the oldest rocks predominate in the northeastern and the youngest in the southwestern parts of the area. Topographically, the region is slightly elevated above the general level of the Orenburgskaia step (prairie) and is made of numerous subdued ridges, most of which are hogbacks and which stretch parallel to the general direction of folding. The hills become less prominent and finally die out in the southern part of the area, where the plunging Late Paleozoic folds are overlapped by horizontal Mesozoic (mostly Jurassic) and Tertiary rocks.

The area was explored by Murchison, Verneuil and Keyserling (1845), who differentiated (1) the Carboniferous limestones of Kurmaya hills at Kundurovka village and of Verblüd-Gora (Camel Mountain); (2) the overlying thick sandstones, conglomerates, limestones and gypsum, which were correlated with some doubt with the "grits of Artinsk" of the central Urals; and (3) the younger beds of gypsum, limestones and sandstones, which were referred unquestionably to the Permian. In 1868 Karpinsky began his important study of part of the area and concluded that the local rocks of predominantly sandy character comprise a distinct series which

on the ground of identity of ammonoids he correlated with the Artinsk sandstones. The reviewer considers it important to note here that, although the geologic sections of the southern Urals allowed Karpinsky to differentiate the Artinskian series from the Carboniferous below and the Permian above, the type locality of the Artinskian sandstone remains at Artinsky smelters, where the rocks were originally studied and named "Artinskian grits" by Murchison and his associates. Subsequent studies in the southern Urals by Tihanovich remained for the most part unpublished, but they added little to the previous knowledge of the local stratigraphy.

During the past decade the area has been studied in detail by several groups of geologists and paleontologists, who have discovered that its record of Late Paleozoic rocks is more complete than was formerly supposed, and that it extends from the Lower Carboniferous into the Kungurian or Middle Permian. Voinova and her associates, in their field work from 1927 to 1932, discovered many important horizons of ammonoids and fusulinids, but, as was proved by Ružencev's work of 1932 to 1934, they added to the Artinskian a considerable thickness of underlying beds which range in age from Lower to Upper Carboniferous. Consequently, Ružencev cuts down the greatly exaggerated total thickness of the Artinskian of the southern Urals as given by Voinova and her associates (7000 meters) to 1000-1750 meters (3260-5700 feet). Lower and Middle Carboniferous beds rich in ammonoids were found in the northern part of the area, and farther to the north, on the Süran River, by Krestovnikoff and his associates in 1927. The present description of the stratigraphic sequence of the area is based largely on the data by Ružencev, with some additional information from Krestovnikoff, as cited in the list of references at the end of this review.

LOWER CARBONIFEROUS.

The lowest Carboniferous strata are represented by dark siliceous shales and various kinds of limestones. Although these beds are best developed north of the Ural River, they outcrop also in the south, in the Aktübinsk district, where *Homoceras beyrichianum* Kon., numerous *Glyphioceras* closely related to *G. inostranzewi* Karp., *Gastrioceras* (*Eoasianites*) only slightly different from *G. illinoisense* M. & G., and many other undetermined ammonoids were collected. In another southern locality were secured *Aganides* related to *A. rotatorius*

Kon., numerous Glyphioceratidae, *Proshumardites*, *Pronorites* related to *P. cyclolobus* Phill., *Daraelites* and others. The Lower Carboniferous rocks contain also *Productus* (*Striatifera*) *striatus* Fisch., *Marginifera* aff. *M. viseeniana* Chao, *Squamularia lineata* Mart., *Rhipidomella pecosi* Marc., *Schizophoria resupinata* Mart., *Lonsdaleia floriformis* Mart., *Zaphrentis* cf. *Z. enniskilleni* Edw.-Haime, etc. The thickness of the Lower Carboniferous is 1550 meters (ca. 5100 feet).

In the basin of the Süran River, north of the area studied by Ružencev, Krestovnikoff distinguishes several goniatite-bearing horizons which he compares zone by zone with the upper Visean and Namurian subdivisions recognized in western Europe by Schmidt. He gives the following composite section, in descending order:

IV. Sandy limestones with *Reticuloceras* cf. *R. bilingue* Salt. (zone IVγ of Schmidt).

III-c. Limestones with *Proshumardites karpinskii* Rauser and *Reticuloceras reticulatum* Phill. (zone IVβ of Schmidt).

III-b. Limestones with *Homoceras* sp. *Pronorites* cf. *P. ferganensis* Rauser, *Reticuloceras reticulatum* Phill. (zone IVβ of Schmidt).

III-a. Limestones with *Homoceras* sp., *Pronorites* cf. *P. ferganensis* Rauser and *Proshumardites karpinskii* Rauser.

II. Limestones with *Homoceras* cf. *H. barbotanum* Vern., *Eumorphoceras* cf. *E. ornatum* Crick & Foord and *Pronorites* sp. (zone IV of Schmidt).

I. Limestones with *Glyphioceras striatum* Sow. (zone III of Schmidt).

Of these zones, I is referred by Krestovnikoff to the Visean and the rest of the higher zones to the Namurian (= early Upper Carboniferous) of western Europe.

MIDDLE CARBONIFEROUS OR MOSCOVIAN.

The strata which are referred to the Moscovian by Ružencev are ordinarily poorly exposed, a fact which handicaps their study considerably. On the divide between the Sakmara and Ural rivers and farther to the north, the limestones and argillites of the Lower Carboniferous are conformably overlain by sandy clays and greenish-gray sandstones with fossils indicative of Middle Carboniferous age. From the conglomeratic limestones at the base of these beds on the right (north) side of the Sakmara River southeast of Novosamarsky village, Krestovnikoff identified *Gastrioceras martini* Schmidt, *G.* cf.

G. rurae Schmidt, *G.* cf. *G. listeri* Mart. and *Reticuloceras* cf. *R. superbilingue* Bisat.

On the left (south) side of the Sakmara River at Karagaisky village the whole thickness of the Middle Carboniferous is exposed. Part of this section has gigantic breccias in a structureless clay with huge, irregularly scattered blocks of stratified clays, sandstones and limestones. In the structureless clays there is occasionally a diversified fauna made up of species of *Choristites* of Middle Carboniferous aspect, *Marginifera loczii* Chao of the Chinese Middle Carboniferous, the corals *Bothrophyllum* aff. *B. pseudoconicum* Dobr. and *Meniscophyllum* aff. *M. kansuense* Grabau, which are common in the Middle Carboniferous of the Moscow basin, and numerous gastropods. The limestones which are found elsewhere in the section described contain fusulinids of undoubted Middle Carboniferous aspect. The gigantic breccias are interpreted as submarine landslides that originated not far away from the eastern shoreline of the sea. The total thickness of these rocks is estimated to be from 1000 to 1500 meters (3300-5000 feet).

UPPER CARBONIFEROUS OR URALIAN.

Ružencev observed pronounced disconformity (correlated by him with the Asturian phase) at the base of these rocks. In places they overlie the older rocks disconformably, and elsewhere their basal part consists of coarse clastics. He concludes that the ancient Urals east of the area studied suffered sharp uplift at the end of Middle Carboniferous time, and that, in connection with this uplift, this mountainous area had marked glaciation. The effects of this glaciation he thinks are seen in the composition of some of the late Middle Carboniferous strata. These rocks, he states, have considerable amounts of presumably redeposited fusulinids of pre-Uralian age, together with typical Upper Carboniferous forms, all of which he interprets as evidence of intensive erosion and glaciation of the underlying Middle Carboniferous series.

Upper Carboniferous strata are characterized by the disappearance of coarser clastics and the predominance of clays with few interbedded sandstones and still fewer limestones.

On Sholak-Sai River in the district of Aktübinsk the Upper Carboniferous beds are divisible into two groups, as follows:

The upper series, about 600 meters (2000 feet) thick, comprises bluish-gray, infrequently sandy-clayey shales with thin

beds of sandstones and marls. In marly concretions were found *Shumardites* n. sp. cf. *S. simondsi* Smith, *Glaphirites* n. sp., *Gastrioceras* n. sp., *Agathiceras frechi* Böse and *Parapronorites* n. sp. Elsewhere in this series were collected inflated triticites of the *T. beedei* and *T. plummeri* groups, and with these, *Pseudofusulina* of the *P. stabilis* Rauser group and rare specimens of *Schwagerina fusulinoides* Schellw.

The lower series, about 500 meters (1650 feet) thick, is predominantly limestone. There is an abundance of fusulinids, including *Triticites simplex* Schellw., *T. montiparus* Ehr. & Möll., *T. incisus* Schellw., *T. ventricosus* Schellw. and many new species, *Quasifusulina longissima* Möll., *Fusulinella usvae* Dutk. and others. Freqently present are such ancient foraminifers as *Archaediscus karreri* Brady, *Staffella struvei* Möll., *S. sphaeroidea* Ehr., *S. angulata* Colani, *Fusulina cylindrica* Fisch., and *Fusulinella colanii* Lee & Chen, which are of Lower and Middle Carboniferous ages. In conglomeratic limestones have been encountered *Uralites orenburgensis* Voinova (nom. nud.) *Glaphirites* n. sp., and *Gastrioceras* (*Eoasianites*) aff. *G. hanieli* Smith. In this series occur locally gigantic breccias made of older rocks and ascribed to glacial activity. These breccias, together with conglomerates, sands and clays, make up the lower series at the east, while in the west predominates the fusulinid-bearing conglomeratic limestones (limestones that contain pebbles of other rocks). The anticlinal conglomeratic limestones south of Novouralsky village yield *Triticites montiparus* Ehr. & Möll., *T. umbonoplicatus* var. Rauser & Beliaeff, *T.* aff. *T. arcticus* Schellw., *T. parvulus* Schellw., *Quasifusulina longissima* Möll., *Fusulinella usvae* Dutk., *F. pulchra* Rauser & Beliaeff, and numerous redeposited forms such as *Fusulina cylindrica* Fisch., *F. samarica* Rauser & Beliaeff, *Wedekindellina uralica* Dutk., numerous *Staffella* and others. Here in black limestones were found also *Glaphirites* and *Gastrioceras*. On the north side of Ural River at Iliinsk village on Maiak Mountain limy concretions out of a clay formation contained *Neodimorphoceras*, *Prouddenites*, *Uddenites*, *Glaphirites*, *Vidrioceras*, *Prothalassoceras*, *Agathiceras* and other genera. These forms are believed to be from the uppermost beds of the lower series. The ammonoids from this and other localities of the Upper Carboniferous rocks include the following principal forms: *Pronorites* sp.; several species of *Parapronorites*, which are different from the species of this genus in the Artinsky beds: *Prouddenites* n. sp., very different

from *P. primus* Mill.; *Uddenites* n. sp. cf. *U. schucherti* Böse; *Daraelites* sp. cf. *D. texanus* Böse; *Uralites orenburgensis* Voinova, related to *Prothalassoceras*; *Prothalassoceras* n. sp. cf. *P. welleri* Böse; *Vidrioceras* cf. *V. uddeni* Böse; *Marathonites* sp.; *Agathiceras* sp.; several forms of *Glaphirites* (group of *Gastrioceras modestum* Böse); *Shumardites* n. sp. cf. *S. simondsi* Smith; *Neodimorphoceras* n. sp. cf. *N. lenticulare* Girty; *Gastrioceras* (s.s.) of the *G. listeri* group.

SAKMARIAN (CONSIDERED TO BE BASAL PERMIAN).

The Sakmarian series corresponds to the Schwagerina zone of other writers and to the "Lower zone" of the Artinskian of Karpinsky, who held that the Sakmara River ammonoids are older than those from near Artinsk smelters, but nevertheless included them in the Artinskian. An analysis of the newly collected ammonoids, partly from the Karpinsky locality at Sakmara River, supported by stratigraphic observations, leads Ružencev to separate the Sakmarian from the Artinskian, a conclusion which is in accord with the early observations by Karpinsky (1874).

The Sakmarian contains numerous ammonoids, fusulinids (among them *Schwagerina*) and a few brachiopods.

Aktübinsk district.—Along the Aidaralash River, the argillaceous rocks with Upper Carboniferous ammonoids are overlain by interbedded sandstones and clays of the Sakmarian with abundant *Schwagerina* in the calcareous coarse-grained sandstones; and these are followed in turn by the coarse Artinskian conglomerates. Along the Sholak-Sai River the triticites-bearing Upper Carboniferous rocks are succeeded by predominantly argillaceous rocks which have at the base *Schwagerina* sp., pseudofusulinids and triticites. In a sandstone that belongs in the lower part of the Sakmarian the following ammonoids were collected: *Parapronorites* sp., *Artinskia* n. sp., *Agathiceras frechi* Böse and *Gastrioceras* (*Eoasianites*) *subhanieli* Ruž.

Along the Yaman-Kargala River the ridges built by the Sakmarian, here 900 meters thick, consist of *Schwagerina*-bearing sandstones and fine conglomerates, which contrast markedly with the subdued topography of the valley that is carved in the argillaceous Upper Carboniferous strata. The following fusulinids have been identified in the Sakmarian

of the Dombar River: *Schwagerina fusiformis* Krot., *S.* aff. *S. kansasensis* Beede & Kniker, *Pseudofusulina verneuili* Möll., *P.* aff. *P. tschernyschewi* Schellw., *P. alpina* Schellw. and *Triticites* sp.

Northwestern area.—Along the southern tributaries of the Ural River the argillaceous Upper Carboniferous is overlain by interbedded greenish-gray compact clays, hard sandstones and conglomerates with fine to medium-sized pebbles. In the thin beds of hard bluish calcareous sandstone were identified *Schwagerina fusulinoides* Schellw., *Pseudofusulina prisca* Möll., *P. uralica* Krot., *Quasifusulina longissima* Möll. and rare *Triticites.*

The higher Sakmarian is composed of thick coarse-grained sandstones and coarse conglomerates with occasional huge fragments of Carboniferous limestone. The fusulinids of this division include *Schwagerina princeps* Ehr., *S.* aff. *S. muongthensis* Depr., *Pseudofusulina tschernyschewi* Schellw., *Staffella* aff. *S. sphaerica* Abich and *Triticites* sp.

The total thickness of the Sakmarian in this area is 1200 meters (ca. 4000 feet).

In the west, in the type region of the Sakmarian, Karpinsky described from the Sakmara River exposures the following forms: *Pronorites praepermicus* Karp., *P. postcarbonarius* var. *tetragonus* Karp., *Propinacoceras sakmarae* Karp., *Paragastrioceras jossae* Karp., *Agathiceras uralicum* Karp., *Popanoceras lahuseni* Karp. and *Thalassoceras gemmellaroi* Karp. Both Ružencev and Noinsky, who studied this area, conclude that this fauna came from *Schwagerina*-bearing beds. Ružencev collected from the same limestone that yielded Karpinsky's material the following additional ammonoids: *Gastrioceras* (*Eoasianites*) *beluense* Han., *Metalegoceras* sp. and *Paragastrioceras* aff. *P. suessi* Karp. From elsewhere but at about the same stratigraphic horizon he also collected *Agathiceras* sp., *Pronorites postcarbonarius* var. *tetragonus* Karp., *Medlicottia* cf. *M. orbignyana* Vern., *Popanoceras* sp. and *Neoshumardites* (new genus).

The most complete section for the northwestern region occurs on the divide between the Sakmara and Kasmarka rivers, and is as follows from the top downward:

6. Bryozoa-crinoid-fusulinid limestones with rare *Schwagerina* above and gray brecciated limestones below; predominantly argillaceous beds in the middle . . 140 meters (460 feet)

5. Sandy-argillaceous group with interbedded gray limestones .....310 meters (1020 feet)
4. Gray flaggy brecciated limestones, with the ammonoids listed above .....85 meters(280 feet)
3. Predominantly argillaceous beds with numerous gray cherty and argillaceous limestones and also some crinoidal limestones and greenish-gray fine-grained sandstones.....
155 meters (510 feet)
2. Gray flaggy brecciated bituminous limestones with thin gray calcareous shales and two prominent "mosaic" limestones made up of dark fragments cemented by light-colored cement. *Agathiceras uralicum* Karp. present. .....
135 meters (445 feet)
1. Predominantly argillaceous group with some limestones. At the base, a very persistent crinoidal limestone, 2.4 meters (8 feet) thick, with numerous fusulinids and *Schwagerina*
185 meters (610 feet)

The limestones increase in thickness toward the north and on the Assel River groups 2 and 4 make a single calcareous series at least 450 meters (1500 feet) thick.

Ružencev gives the following paleontologic characteristics for the Sakmarian. It differs from the Upper Carboniferous in the appearance of the following ammonoids genera: *Neoshumardites* n. gen., *Metalegoceras*, *Paragastrioceras*, *Popanoceras*, *Thalassoceras*, *Medlicottia*, *Artinskia* and *Propinacoceras*. It differs from the Artinskian in the presence of *Gastrioceras* (*Eoasianites*) *beluense* Han. and *G.* (*E.*) *subhanieli* Ruž., which are identical with or related to Somohole forms of Timor that are older than Artinskian. Restricted to the Sakmarian is *Pronorites postcarbonarius* var. *tetragonus* Karp., while the very conservative *Agathiceras* is very common in the Sakmarian and rare in the lower Artinskian. *Neoshumardites* of the Sakmarian is different from the species of the same genus in the Artinskian. *Artinskia* n. sp. of the Sakmarian differs from *Artinskia artiensis* of the Artinskian. *Medlicottia*, *Paragastrioceras* and *Metalegoceras* become common only in the Artinskian, where appear also the common *Adrianites* and *Riphaeites* (section of *Metalegoceras*). To the Sakmarian belong schwagerinas and *Pseudofusulina prisca* Möll., *P. krotowi*, Schellw., *P. uralica* Krot., *P. alpina* Schellw., *P. tschernyschewi* Schellw., while in the Artinskian

the fusulinid complex becomes poor in number of species, and *Pseudofusulina lutugini* Schellw. predominates.

ARTINSKIAN.

Aktübinsk district.—In the east are developed chiefly coarse conglomerates interbedded with sands and clays. Only in the upper part do the clays begin to predominate, and here also appear yellow-gray splintery limestones. The ammonoids are represented by *Parapronorites urmensis* Tschernow, *Artinskia artiensis* Grün., *Medlicottia orbignyana* Vern., *Thalassoceras* n. sp., *Stacheoceras krasnopolskyi* Karp., *Popanoceras* n. sp., *Adrianites* n. sp., *Paragastrioceras* n. sp., *Metalegoceras sogurense* Ruž., *M. ajdaralense* Ruž. The thickness is not more than 1200-1250 meters (ca. 4000 feet).

In the west the Artinskian is represented by a sandy-argillaceous series within which occur in some places conglomerates and in others thick beds of dolomites and dolomitic limestones with thin interbedded clays. The following descending section has been taken on the Jaksy-Kargala River:

3. Splintery sandstones and clays with interbedded marls 300 meters (ca. 1000 feet)

2. Gray compact bituminous dolomites with a great abundance of ammonoids: *Parapronorites permicus* Tschernow, *P. urmensis* Tschernow, *Artinskia artiensis* Grün., *Medlicottia orbignyana* Vern., *Propinacoceras* sp., *Daraelites elegans* Tschernow, *Thalassoceras* sp., *Popanoceras sobolewskyi* Vern., *P. hanieli* Smith, *P.* n. sp., *Marathonites invariabilis* Ruž., *M. timorensis* Han., *Stacheoceras krasnopolskyi* Karp., *S.* n. sp., *Agathiceras uralicum* Karp., *Adrianites fredericksi* Emel., *A.* n. sp., *Paragastrioceras jossae* Vern., *P. ellipsoidale* Fred., *P. karpinskyi* Fred., *P. fedorowi* Karp., *P.* n. sp., *Metalegoceras sogurense* Ruž., *M. ajdaralense* Ruž., *M. jacksoni* Eth. n. var., *M. evolutum* Han., *Riphaeites* (*Metalegoceras*) *aktubensis* Ruž., *R. kargalensis* Ruž., *R. pseudomeneghini* var. *uralensis* Ruž., *Eothinites* (*Metalegoceras*) *aktastensis* Ruž. and *Neoshumardites* n. gen. n. sp.....200 meters (ca. 600 feet)

1. Conglomerates and sandstones ..450 meters (ca. 1500 feet)

Northwestern area.—South and southeast of Iliinsk village the Artinskian is composed chiefly of sands and clays with some conglomerates; the conglomerates are comparatively persistent only near the top of the series. Numerous *Pseudofusulina* aff. *P. lutugini* Schellw. have been found in the coarse

sandstones of the middle part of the section, which is up to 1580 meters thick. At the base is conglomeratic limestone with *Schwagerina princeps* Ehr., which is taken to mark the top of the Sakmarian.

To the southwest of Iliinsk the conglomerates gradually disappear from the Artinskian section and here begin to appear dolomitic limestone such as are so typical for western sections. In the hard blue sandstones interbedded with bluish-gray clays of the lower part of the Artinskian occur *Pseudofusulina* aff. *P. lutugini* Schellw. and the ammonoids *Parapronorites permicus* Tschernow, *Artinskia artiensis* Grün., *Popanoceras* sp., *Paragastrioceras* aff. *P. suessi* Karp. and *Riphaeites* (*Metalegoceras*) sp. In the argillaceous beds above there are large septarian concretions and a 5-meter (16.5 feet) bed of dolomite; above these strata follows a group of coarse conglomerates which terminates the Artinskian section.

The Artinskian is composed predominantly of clays. Until the detailed study of the fossils is completed, its base is arbitrarily drawn at the top of the well-differentiated group of bryozoan-crinoidal-fusulinid limestones, which occasionally contain *Schwagerina* and which are referred to the Sakmarian. The Artinskian sequence of the west can be subdivided on lithologic grounds into three groups which are clearly recognizable by their topographical expressions. They are as follows, from the top downward:

3. Conglomeratic limestone group. Clays with numerous sandstones, few conglomerates and numerous light-colored limestones, dolomites and conglomeratic and sandy limestone often with plant fragments. In the extreme north, conglomerates disappear and the most typical rocks of the group are yellowish-gray sandy limestones with plant fragments and calcareous fine-grained sandstones. In lenses of dolomitic limestones were collected *Parapronorites urmensis* Tschernow, *P. permicus* Tschernow, *Artinskia artiensis* Grün., *Medlicottia orbignyana* Vern., *Paragastrioceras jossae* Vern., *P.* aff. *P. suessi* Karp., *Stacheoceras krasnopolskyi* Karp., *Popanoceras hanieli* Smith and *Metalegoceras* aff. *M. sogurense* Ruž.
Up to 540 meters (ca. 1800 feet)

2. Sandy group. Mainly clays, with numerous sandstones and few limestones, partly conglomeratic.....
Up to 290 meters (ca. 860 feet)

1. Calcareous group. Brecciated and splintery gray limestones and dolomites interbedded with clays and sandstones
Ca. 370 meters (ca. 1220 feet)

KUNGURIAN.

The Kungurian begins ordinarily with gypsum, below which infrequently are Artinskian dolomites containing ammonoids. In the southern part of the Aktübinsk district the Kungurian can be subdivided into two groups, as follows:

Upper group. Various clays, sandstones and marls above, and splintery marls below .....150-250 meters (500-830 feet)

Lower group. Gypsum and occasionally salt .....
75-150 meters (250-500 feet)

This lower group changes laterally to very thick light-colored recrystallized bituminous limestones .....
500-700 meters (1650-2310 feet) thick

In the northern part of the Aktübinsk district gypsum is found throughout the Kungurian.

CORRELATION WITH OTHER REGIONS.

When comparing his horizons with the North American marine Late Paleozoic, Ružencev considers his Upper Carboniferous or Uralian (formerly named by him also "Kargalinsky") ammonoid fauna of southern Urals to be synchronous with the faunas of the Cisco and the older Wolfcamp, and his Sakmarian Schwagerina zone with the *Schwagerina*-bearing upper Wolfcamp. He further concludes that the nearest ammonoid relationship is with the Somohole beds of Timor, while the ammonoids of the Bitauni beds resemble very much the Artinskian fauna of the southern Ural, both having abundant representatives of the genus *Metalegoceras*. On the basis of the marked resemblance noted by Rauser between the Russian Upper Carboniferous fusulinids and those of the *Triticites*-bearing Auernig beds of the Alps, he correlates the Uralian and Carnic zones, and thinks that the Rattendorf beds of the Alps, with Schwagerinas, correspond closely to the Sakmarian. The Chuanshan and Taiyuan of China may be analogous to the Sakmarian, a correlation which he sees as another proof of Schuchert's opinion that these Chinese series belong to the Permian system. This of course is a logical conclusion when the Schwagerina zone, now called Sakmarian in the southern Urals, is added to the Permian. Ružencev agrees in this with Beede and other American authors, but at the same time he demonstrates that the Sakmarian of the southern Urals is older than the typical Artinskian.

REMARKS BY THE REVIEWER.

The reviewer wishes to make the following further correlations. Broadly speaking, the Schwagerina zone may belong to the upper Uralian or to the Lower Permian, or to both, depending partly upon how the Permian is delimited. In different regions, the Schwagerina zone may be and probably is a limited zone stratigraphically, and in the southern Ural region it belongs, according to Ružencev, directly below the Artinskian which bears fusulinids of the *Pseudofusulina lutugini* group, and above the Uralian which carries the typical *Triticites* fauna that includes species of the *T. beedei-T. plummeri* group. The lower part of this succession is indeed very much like that of Kansas and Texas where the schwagerines also appear above the zone with abundant *Triticites* of the *T. plummeri* and *T. beedei* type. However, subcylindrical pseudofusulinids comparable to *P. lutugini* appear in Kansas below and in the zone of *Schwagerina.* Indeed, these subcylindrical species of *Pseudofusulina* have no direct genetic relation to *Schwagerina.* Both these phyla seem to be contemporaneous groups of fusulinids but in different regions they apparently hold somewhat different stratigraphic levels, and the horizons of their appearance are useful for local correlations. On the other hand, even within the region of the Ural Mountains, the horizons with Schwagerinas may not be necessarily exactly contemporaneous. In North America, for instance, occurrences of *Schwagerina kansasensis* in the Neva limestone and of schwagerines (undescribed) in the Florence limestone of Kansas and Oklahoma may not be (and probably are not) exactly contemporaneous with occurrences of *Schwagerina* identified as *S. kansasensis* and other schwagerines at various horizons in Texas. The same is probably true in regard to the horizons with *Pseudofusulina* of the *lutugini* group in the Ural Mountains and elsewhere. The reviewer believes that still more detailed studies of fusulinids than those now generally practiced, with an attempt to establish average values of measurements based on several specimens for each occurrence of species in a stratigraphic succession, and an attempt to find exact phylogenetic relations, not of genera, but of species and their stratigraphic mutations, will lead to much greater exactness in interregional and intercontinental correlation than is now possible.

PALEONTOLOGIC ADDENDA.

Because many new genera of ammonoids and fusulinids have recently been introduced and are used partly in place of old familiar names, it is important that the readers should have a clear idea as to what the generic names used in this review indicate. The following brief diagnoses are inserted for this purpose.

AMMONOIDS.

Artinskia Karpinsky 1926. Introduced for the most primitive medlicottids that have low ventral lobes with serrations arranged in finger-like fashion. Genotype, *Goniatites artiensis* Grünewaldt = *G. falx* Eichwald.

Eoasianites Ružencev 1933. Section of Gastrioceras, differing from typical representatives of the genus in the absence of umbilical nodes and in the nearly smooth surface of shell, with faint transverse striae. Conch cadicone with cone-shaped wide umbilicus. In the paper reviewed, Ružencev proposes the new name *Prometalegoceras* "instead of *Eoasianites*," with the same genotype, which is against the International Rules of Nomenclature. Genotype, *Eoasianites subhanieli* Ružencev.

Eothinites Ružencev 1933. Section of *Metalegoceras*, with subquadrate cross-section of volutions of evolute conch. Genotype, *E. kargalensis* Ružencev.

Glaphirites Ružencev, 1936. *Gastrioceras* like shells, with only faint lines of growth. The lateral saddles are dumbbell-shaped, in contrast with wedge-shaped saddles of *Eoasianites*. Conch is cadycone but more evolute than in *Eoasianites*. Genotype: *Gastrioceras modestum* Bose.

Neoshumardites Ružencev, 1936. Inflated shell with medium umbilicus and spiral (longitudinal) striae like in *Proshumardites*. Differs from the latter in tridentate shape of all three lobes of the inner suture.

Paragastrioceras Tschernow 1907. *Gastrioceras*-like shells that differ from typical species of the genus in having lines of growth and constrictions with forward ventral bow in place of hyponomic sinus, an evolute conch, and spiral striae on sides and venter of shell. Genotype, *Gastrioceras jossae* Verneuil, selected by subsequent designation by Ružencev.

Prometalegoceras. See *Eoasianites.*

Proshumardites Rauser 1928. Conch as in *Goniatites,* with ellipsoid to sub-sphaerical shape, small to moderate umbilicus and spiral striae. Differs from *Goniatites* in shape of external suture, which has a single wide tripartite lateral lobe. Differs from *Neoshumardites* by wedge-shaped instead of tripartite lobes of the inner suture. Genotype, *Proshumardites karpinskii* Rauser.

Riphaeites Ružencev 1933. Section of *Metalegoceras,* with subelliptical cross-section of volutions of evolute conch. Genotype, *R. pseudomeneghinii* Haniel var. *uralensis* Ružencev.

Uralites. Nomen nodum belongs to the Thalassoceratidae, and has sutures as in *Thalassaceras* but differs in other respects that are not mentioned here in order not to create an unintentional introduction of the genus, which is to be described in a forthcoming paper by Voinova.

FUSULINIDS.

Quasifusulina Chen 1934. Like *Pseudofusulina,* with subcylindrical shell and fluting throughout the test, but with axial filling and indistinct alveolar structure in thin keriotheca. Genotype, *Fusulina longissima* Möller.

Pseudofusulina Dunbar and Skinner 1931. Now considered by Dunbar and Skinner to be a synonym of *Schwagerina,* while for the latter genus in its common understanding two new generic names, *Pseudoschwagerina* and *Paraschwagerina,* are introduced (Dunbar and Skinner 1936, Jour. Pal., vol. 10, pp. 83-91). Genotype for *Pseudofusulina, P. huecoensis* Dunbar and Skinner.

Schwagerina Möller 1877. Until revised by Dunbar and Skinner, 1936, this generic name was commonly understood to apply to fusulinids with shell structure like that in *Triticites* but with a sudden expansion of volutions around a tightly coiled juvenarium. Inasmuch as Rauser, who identified fusulinids for Ružencev, recently explained that this is also her understanding of the genus (Bull. Acad. Sci., Sér. Géol., 1936, pp. 61-86, published prior to the revision by Dunbar and Skinner), it is clear that *Schwagerina* as recorded by Ružencev also indicates fusulinids with this shell structure.

In the critical discussion at the end of the review, the terms *Pseudofusulina* and *Schwagerina* are used in the same respective sense as by the Russian authors of the papers considered.

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