NOTES ON THE CORRELATION OF RUSSIAN AND MIDCONTINENT CARBONIFEROUS AND PERMIAN AMMONITE ZONES.

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The publications on the ammonites in the Midcontinent of America by Smith,[1] Girty,[2] Böse,[3], Miller,[4] Miller and Cline,[5] and Plummer and Scott,[6] and in Russia by Karpinsky,[7] Ružencev,[8] Krestovnikoff,[9] and Voinova,[10] furnish important new data for the correlation of the Carboniferous and Permian strata in America and Russia. Some of the recent Russian work was reviewed in the April number of the Journal by M. K. Elias, who through his knowledge of the Russian language and literature, has done an excellent deed in making critical information more available to American readers. There remains only an opportunity to make use of the data, particularly of the information presented on the ammonites, to correlate the American and Russian strata in a little more detail than has been attempted in Dr. Elias' review.

Sixteen separate ammonite zones have been discovered recently in the Carboniferous and Permian strata of the Midcontinent of America by the paleontologists mentioned above. Many of the ammonites in these zones occur in England, Germany, and Russia. Not only are closely related index ammonites found in all the countries mentioned, but also whole assemblages of ammonites in American Carboniferous zones are represented in Europe by identical or very closely related forms.

The oldest assemblage of ammonites in Texas occurs in thin black shale and limestone strata at the base of the Barnett formation in San Saba County. The list of species is as follows:

Neoglyphioceras newsomi (Smith)
Neoglyphioceras entogonum (Gabb)
Neoglyphioceras caneyanum (Girty)
Goniatites cumminsi (Hyatt)
Goniatites choctawensis Shumard
Adelphoceras meslerianum Girty

The same assemblage occurs in the lower Caney shale of southeastern Oklahoma, in the Moorefield shale in western Arkan-

sas, and in the upper Mississippian shale near Crab Orchard, Kentucky. Closely related if not identical forms, according to Bisat,[11a] occur in the lower Bowland shale zone in England and, according to Schmidt,[12] in his Zone III in Germany.

The next younger ammonite assemblage occurs at the top of the Barnett shale, youngest Mississippian formation in Texas. It includes the following species:

Eumorphoceras bisulcatum Girty
Nuculoceras incisum (Hyatt)
Cravenoceras richardsonianum (Girty)
Goniatites cumminsi (Hyatt)

The same assemblage has been found in the middle Caney shale in Oklahoma, in the upper Moorefield shale in Arkansas, and according to Bisat[11] a similar assemblage occurs in Zone E in the Bowland shale at the base of the Lancastrian in north England. A very similar assemblage has been found by Schmidt[12] in the Westphalian in Germany in his E-H zone, and by Krestovnikoff[9] in beds that outcrop in the basin of Süran River in the northern Ural region of Russia, designated Zone II by him.

A third very important ammonite zone occurs near the top of the Smithwick shale in central Texas, where the following species have been identified:

Gastrioceras listeri (Martin)
Gastrioceras occidentale (Miller and Faber)
Nuculoceras smithwickense Plummer and Scott
Glaphyrites raymondi Plummer and Scott
Pronorites arkansasensis Smith

The same assemblage occurs in shales north of Marble Canyon, Diablo Plateau, Hudspeth County, west Texas, in the basal Atoka formation near Clarita, eastern Oklahoma, in strata thought to be in the Johns Valley shale in Johns Valley, southeastern Oklahoma, and in the Kendrick shale of the upper Pottsville formation on Cow Creek, Harold quadrangle, eastern Kentucky. Part at least of the same assemblage of ammonites has been found by Bisat[11] in Zone G in the Rough Rock shale of the lower Coal Measures of England, and by Schmidt in his Zone V in the Magerkohle group of beds in Westphalia, Germany. In Russia Krestovnikoff[9] reports a similar assemblage in beds that he refers to the base of the Moscovian from a locality on the north side of the Sakmara River southeast of Novosamarsky Village. Some of the same

group of fossils have been reported by Grabau[13] from China. The assemblage is, therefore, world-wide in its distribution and marks an important zone at the top of the Bendian and Pottsville in this country, the top of the lower Coal Measures in England, and the base of the Moscovian in Russia.

Ammonite zones in the Strawn and Des Moines series in the Midcontinent appear not to have been discovered in Russia. In Texas and Oklahoma these formations of Middle Pennsylvanian age are characterized by *Paralegoceras*, by *Paraschistoceras strawnense* Plummer and Scott, an early ancestor of the tuberculate *Paraschistoceras hildrethi* (Morton) and by very globose thick forms of the unsculptured gastrioceratid now referred to Ruženčev's recently erected genus *Glaphyrites*.

An important unconformity near the top of the Strawn in Texas and of the Des Moines in Kansas is marked by prominent widespread beds of sandstone and conglomerate—the Turkey Creek conglomerate in Texas and the Bourbon sandstone in Kansas, which may correspond approximately to the disconformity noted by Ruženčev[8a] at the base of the Uralian. At any rate, both the ammonites and the fusulinids of the Canyon and basal Cisco appear to be more closely related to forms in the Uralian than to those in the Moscovian. This unconformity in Texas and, according to R. C. Moore,* also in Kansas, is marked by the extinction of the brachiopod genus *Mesolobus*, by the first appearance of the fusulinid genus *Triticites*, and by the beginning of the very important ammonite genera *Shumardites*, *Schistoceras*, *Prouddenites*, and *Marathonites*.

The first ammonite zone above the unconformity marked by the Turkey Creek conglomerate in Texas is in the basal beds of the Canyon group and contains the following species:

Prouddenites primus A. K. Miller
Paraschistoceras reticulatum (A. K. Miller)
Shumardites fornicatus Plummer and Scott
Glaphyrites kansasensis (Miller and Gurley)
Preshumardites illinoisensis (Miller and Gurley)
Goniolaboceras gracellenae A. K. Miller and Cline
Schistoceras smithi Böse
Marathonites parkeri (Heilprin)

A quite similar assemblage occurs in the Nellie Bly formation west of Sand Springs, Oklahoma, in the Drum limestone of

* R. C. Moore, personal communication.

the Kansas City group in Kansas, in upper Pennsylvanian strata in Montgomery County, Illinois, and in the Brush Creek limestone of the Conemaugh group near Pittsburgh, Pennsylvania.

About 800 feet (246 m.) above this basal Canyon ammonite zone and in the basal strata of the Cisco group is another very prolific and persistent assemblage of ammonites characterized by the following species:

Uddenites schucherti Böse
Marathonites sulcatus Böse
Marathonites ganti (Smith)
Agathiceras frechi (Böse)
Schistoceras diversecostatum Böse
Paraschistoceras hildrethi (Morton)
Neodimorphoceras texanum (Smith)
Vidrioceras irregulare Böse
Prothalassoceras kingorum A. K. Miller
Shumardites simondsi Smith
Glaphyrites kansasensis (Miller and Gurley)
[= Gastrioceras modestum (Böse)]
Wiedeyoceras pingue A. K. Miller and Cline
Goniolobоceras welleri Smith
Daraelites texanus Böse

The identical assemblage occurs at Wolf Camp in west Texas in beds placed by Udden[14] and Böse[3] in the basal Wolfcamp and referred to the Permian but now known to be Pennsylvanian in age and placed in the top of the Gaptank formation. The rich ammonite zone has been traced across north-central Texas, where it is associated everywhere with the fusulinid *Triticites cullomensis* Dunbar and Condra.

Several characteristic representatives of the assemblage occur at the base of the Wabaunsee group near Howard, Kansas, east of Emporia, Kansas, in the Sparland formation of the McLeansboro group of Rolls Ford, Illinois, and in the Conemaugh formation near Cambridge, Ohio.

Many forms very similar to both the last two assemblages are listed by Ružencev[8a] from the upper Uralian of Russia. The fauna from the limestone exposed on the north side of Ural River at Illinsk Village on Maiak Mountain shows especially a close relationship with the American assemblages, as indicated by Ružencev's[8a] following list of species which he collected at Illinsk Village and at other localities in the Upper Carboniferous.

Prouddenites sp.
Uddenites cf. U. schucherti Böse
Daraelities cf. D. texanus Böse
Vidrioceras cf. V. uddeni Böse
Marathonites sp.
Agathiceras sp.
Glaphyrites group of Gastrioceras modestum (Böse)
Shumardites cf. S. simondsi Smith
Neodimorphoceras cf. N. lenticulare (Girty)

It appears safe from these similar lists to correlate the Canyon and basal Cisco beds up to the top of the Graham formation of Texas and the Missouri series and lower half of the Virgil series of Kansas with the Uralian.

An unconformity marked by a conglomerate, a wide-spread sandstone, and a decided change in fauna occurs in the section above the Thrifty formation in central Texas.

In the 1,000 feet (308 m.) of strata above the unconformity no ammonites have been found, although other fossils, especially mollusks and fusulinids, are common, and *Pseudofusulina* occurs in the upper part. These ammonite-barren layers, which comprise the upper two-thirds of the Cisco and the basal part of the Wichita groups, are not represented in the Marathon district of west Texas, where a conglomerate and marked unconformity intervene between the *Uddenites* zone and true Permian beds. These upper Cisco beds may be equivalent to the Admire and lower part of the Council Grove group of the Big Blue series of Kansas and may possibly be equivalent to the Sakmarian beds of Russia, which contain ammonites referred by Ruženčev[8a] to the Permian, namely, *Propinacoceras sakmarae* (Karpinsky), *Paragastrioceras jossae* (Karpinsky), *Agathiceras uralicum* (Karpinsky), *Popanoceras* sp., *Eoasianites beluense* (Haniel), *Metalegoceras* sp., and others.

Above the ammonite-barren beds of the Upper Cisco in a zone 50 feet above the Coleman Junction limestone of the Wichita group a rich ammonite assemblage has been found in Texas. These ammonites are much younger than the *Uddenites* assemblage and comprise the following characteristically Permian forms:

Artinskia adkinsi Plummer and Scott
Perrinites bösei Plummer and Scott
Metalegoceras colemanense Plummer and Scott
Paragastrioceras admiralense Plummer and Scott
Marathonites sellardsi Plummer and Scott

The same or a very similar fauna occurs above the unconformity near the base of the Wolfcamp formation (restricted) in west Texas, and two of the species, or very similar ones, occur in the Florena shale of the Council Grove group, Big Blue series, in Kansas. Three of the species are very closely related to ammonites described by Karpinsky[7] from the Artinskian of Russia from a locality between the Petschara and Ural rivers in the vicinity of Artinsk. The assemblage appears to be a little younger than the fauna described by Ružencev[8] in the Aktioubinsk region in the southern Urals listed above, which he has placed in his new Sakmarian series. The deposits along the western slopes of Ural Mountains in the central part of the Ufa plateau and adjacent territory are divided by Tolstikhina[15] as follows:

Artinskian	Porous dolomite *Artinskia artiensis* limestone
Uralian	Irgina beds. Fossiliferous clastic limestone. Chernaia Rachka beds. Richly fossiliferous limestones and marls. 160 meters thick. Jurezan beds. Massive reef limestones, grading into richly fossiliferous clastic limestones 150 meters thick.

The Artinskian here, according to Tolstikhina, is separated from the Uralian by an unconformity since the basal *A. artiensis* limestone rests upon different thicknesses of upper Uralian deposits. This then represents the relationships that exist in Glass Mountains in Texas where *Artinskia bösei* limestone and conglomerate rest on different thicknesses of the Upper Carboniferous shales. According to Licharew,[16] no marked hiatus exists between the Uralian and Artinskian in areas adjacent to the Ufa plateau. The only change between the Uralian and Artinskian is a marked reduction in brachiopods in the Artinskian. The Uralian limestone, according to Licharew,[16] contains *Enteletes* related to *E. hemiplicatus* Hall, *Chonetes latesinatus* Schellwien (related to *C. meekanus*) and *Derbya regularis* (related to *D. cymbula*) and *Schwagerina*. All these related forms are characteristic of the upper Cisco of Texas and occur above the Thrifty formation. Therefore, it appears that the relationship between the Artinskian and Uralian in these areas adjacent to the Ufa plateau, as described by Licharew, is comparable to the relationship of

the Wichita and upper Cisco groups in central Texas. Licharew[16] contends that these upper Uralian beds should be placed in the Carboniferous, not in the Permian. Ruženčev[8a] prefers to make these upper beds into a new division, the Sakmarian, and to place them in the Permian. The exact age of the upper Cisco beds has not been settled. Sellards[17] has recently placed the upper third of these undetermined beds which lie above the Moran limestone in the Permian but treats the Permian-Carboniferous boundary as an unsettled problem. On the other hand, the correlation of the Artinskian zone at the top of these questionable beds is reasonably certain. *Artinskia* is a short-range genus; its characters are definite and easily recognizable. It occurs in the Sakmarian in Russia, the base of the Wolfcamp formation in west Texas, the base of the Admiral formation of the Wichita group in central Texas, and occurs in the lower half of the Big Blue series in Kansas.

It is always dangerous to try to identify fossils definitely or to compare them without recourse to the type specimens. The sutures of Carboniferous ammonites, however, constitute a sufficiently definite character to make comparisons somewhat more certain. The generic identifications, at least, ought to be definite.

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